Draft
2012 Clear Creek Technical Team Report for the
Coordinated Long-Term Operation BiOps Integrated Annual Review
Prepared by Matt Brown, with contributions from Clear Creek Technical Team members
Sarah Giovannetti, Jim Earley, Patricia Bratcher
October 1, 2012

Brief background on Clear Creek and the Technical Team: Since 1995, Central Valley Project Improvement Act (CVPIA) and later CALFED have undertaken extensive habitat and flow restoration in Clear Creek (See Figure 1). The restoration has increased stocks of fall Chinook four fold and re-established populations of spring Chinook and steelhead. The Clear Creek Technical Team (CCTT) has been working since 1996 to facilitate implementation of CVPIA anadromous salmonid restoration actions. Team attendance and /or participation has varied over the years depending on what topics are being covered in the meetings. The majority of the topics have involved fisheries-related physical habitat restoration funded by CVPIA and CALFED. More recently topics have included NMFS Coordinated Long-Term Operations (CLTO) BO Reasonable and Prudent Alternative (RPA) actions. In the last 2 years the CCTT has been more diligent in taking notes to document the meetings and to be clear how decisions are made.

The Clear Creek Restoration Program of CVPIA has implemented a variety of actions to improve salmon and steelhead populations and the ecosystem on which they depend including increasing minimum flows, temperature control through flow management, dam removal, large scale stream and floodplain restoration, gravel augmentation, and erosion control. The effect of these actions has been to 1) increase the escapement of fall Chinook four fold, primarily due to increased minimum flows (Figure 2), 2) re-establish populations of threatened spring Chinook and steelhead primarily through dam removal, increased flows and temperature management, 3) rehabilitation of stream and floodplain habitats, 4) re-initiation of sediment transport and stream channel movement processes, in some reaches, which help create and maintain fish habitat, and 5) greatly increase the amount of spawning habitat. The actions have are also believed to have increased the resilience of the fall Chinook population, allowing it to perform better than the rest of the Central Valley watersheds during the 2007 to 2010 coastal Chinook fishery collapse. During that period, while Central Valley escapement decreased to 24% of baseline, Clear Creek consistently maintained an average 74% of baseline escapement (Figure 3).

Current Active Members:

- Russ Weatherbee, Whiskeytown National Park Service
- Naseem Alston/Bruce Oppenheim, National Marine Fisheries Service
- Matt Brown/Mark Gard/Sarah Giovannetti/Jim Earley, U.S. Fish and Wildlife Service
- Alicia Young, Natural Resources Conservation Service
- Tom Kisanuki, U.S.Bureau of Reclamation
- Gary Diridoni, U.S. Bureau of Land Management
- Patricia Bratcher/Eda Eggeman/Matt Johnson, California Department of Fish and Game
- Aric Lester, California Department of Water Resources
- Guy Chetelat, Regional Water Quality Control Board
- Ryan Teubert, Western Shasta Resource Conservation District

Summary of Clear Creek RPA Actions:	**Progress in FY 2012?**
• Spring Attraction Flows	Yes
• Channel Maintenance Flows	Yes
• Spawning Gravel Addition	Yes
• Replace Temperature Curtain	Yes
• Thermal Stress Reduction	Yes / Not for water temperature modeling
• Adaptively Manage to Habitat Suitability / IFIM Study Results	Yes
• Other required monitoring and operations	Yes

Summary of Clear Creek Team Meeting CLTO Related Discussions- The following list is of topics that were covered in CCTT meetings in WY 2012. The list does not include non- CLTO topics. Items with asterisks* involve NMFS CLTP BO RPA required monitoring.

December 15, 2011- Update on Environmental Water Program (EWP) channel maintenance flow project
Update on Cloverview Long Term Gravel and Mercury Abatement Project
Update on long-term programmatic permits
Update on Phase 3B proposed project actions
Developing new flow prescription based on IFIM studies, temperature criteria and adaptive management, including discussion of fall flows and red dewatering and full power peaking
Revisit proposal for water temperature modeling for downstream temperature targets
Proposal to adaptively manage flows to encourage steelhead to become anadromous.
2011 gravel evaluation
2011 Spring Chinook snorkel survey and weir operation*

March 15, 2012- Geomorphic Monitoring Update*
Cloverview Long Term Gravel and Mercury Abatement Project update
Temperature control using the lower and upper outlets of Whiskeytown Dam
Full-power peaking be avoided in the Trinity and Carr powerhouses
Oak Bottom Curtain be repaired and maintained
Evaluate the performance of the Spring Creek Curtain
Update on the EWP Channel Maintenance Flows Monitoring Workshop

April 17, 2012- Cloverview Long Term Gravel and Mercury Abatement Project

May 1, 2012- Cloverview Long Term Gravel and Mercury Abatement Project

May 21, 2012- Cloverview Long Term Gravel and Mercury Abatement Project

June 21, 2012- Phase 3B Restoration projects update
Cloverview Long Term Gravel and Mercury Abatement Project
Steelhead and Late-Fall Survey Results 2012*
Results of 2012 spring attraction pulse flows*
Environmental Water Program Updates on Channel Capacity Study

Monitoring and Adaptive Management Plan
Geomorphic monitoring of Pulse Flow's*
Gravel projects and sediment transport*
Modify "Spring Attraction Flows" to increase flexibility and adaptive management.
Limiting Full Power-Peaking to Times Water Temperatures are Not Negatively Affected
Developing Clear Creek Flow Recommendations: Ramping Down Fall Flows
Developing Clear Creek Flow Recommendations: Getting the Plan Together!

July 17, 2012- Dale Fire field Trip
Dale Fire discussion
Cloverview Long Term Gravel and Mercury Abatement Project
Long Term Flow prescriptions RPA I.1.6.
Smokey Pittman EWP Flows presentation*
Recent Temperatures from Whiskeytown presentation

September 20, 2012- Phase 3B Restoration projects update.
Gravel Project updates for 2012 and 2013
Cloverview Long Term Gravel and Mercury Abatement Project
Fish Monitoring Updates*
EWP Channel Maintenance Flow Update
Temperature outcomes of 2012 reservoir operations
Discussion on 2012 Clear Creek Technical Team Report to the CLTO BO Science Panel

Summary of Whiskeytown Operations

When water year 2012 began, releases from Whiskeytown into Clear Creek were 225 cfs. The RPA section I.1.4 discussion on the temperature control proposal to avoid fall red dewatering will explain the reasons for the following Whiskeytown release changes:

11/3/11 decreased to 215 cfs
11/9/11 decreased to 205 cfs
11/17/11 increased to 215 cfs
12/9/12 decreased to 200 cfs.

Releases of 200 cfs continued until the May and June pulse flows (Figures 4 and 5). After the pulse flows, 200 cfs releases were gradually reduced in 15 cfs increments over 2 weeks to 125 cfs on July 3rd (Figure 4 and 5). Due to rising water temperatures (Figure 6) releases were increased to 175 cfs in three release changes ending July 11th. Rising water temperatures were due to an inadvertent switch to the upper outlet gates on July 3rd. After switching back to the 'middle' gate on July 11th, temperatures at Whiskeytown outlet decreased by three degrees F. Starting on July 16th, flows were decreased to 86 cfs. After switching to the lower outlet gates on July 23rd Whiskeytown outlet water temperatures decreased about another three degrees.

Starting on September 14 (Figure to be provided in final report), releases were increased from 86 cfs to 200 cfs over 16 days to reduce water temperatures to less than 56 degrees at Igo (see RPA Action I.1.5.) and then to increase spawning habitat for spring and fall Chinook spawning.

Powerplant operations in 2012 were different from previous years and will be discussed in the I.1.5 temperature control discussion on avoiding full power peaking.

The outlet gates for releases to Clear Creek were operated differently to improve water temperatures. This will be discussed in the RPA Action I.1.5 temperature control discussion and the proposal on using upper and lower outlet gates (Appendix B). On March 27, the outlet gates were adjusted to release the greatest proportion of upper level water possible. In July, the gates were adjusted to release a combination of upper and lower water ("middle" configuration, Figure 6). On July 3, gates were changed to release mostly upper level water. On July gates were returned to the "middle" configuration and on July 23rd gates were changed to release water only from the lower level.

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: The CCTT proposed to change the 2012 flow targets to one 400 cfs and one 800 cfs pulse flow instead of two 600 cfs pulse flows. Results from the 2011 spring pulse flows verified that 800 cfs can be released from Whiskeytown Dam while allowing the Clear Creek Community Service District to receive water from Whiskeytown. Earlier information had suggested that only 600 cfs was possible.

The higher 800 cfs flows may be more useful in: 1) removing the large amount of fine sediments which have increased in Clear Creek due to catastrophic wildfire that occurred in 2008, and 2) moving stockpiled spawning gravel downstream to create spawning habitat (Figures 10 and 11) as called for in RPA Action I.1.3. "Spawning Gravel Augmentation". These geomorphic flow benefits would help meet the objectives of RPA action I.1.2 "Channel Maintenance Flows" to improve degraded spawning habitat for Spring-run and steelhead.

The higher or lower pulse flows may also be more effective than 600 cfs in meeting the primary objective of the pulse flows, which is to encourage spring-run Chinook to move to upstream Clear Creek habitats for holding and spawning. Fish passage and stream flow data from other spring Chinook tributaries in the Central Valley (Mill, Deer and Battle Creeks) suggest that smaller flow increases are also associated with increases in spring Chinook passage and that larger flow increases do not always result in higher fish passage. Increased passage appears to be related to increases in turbidity. The second pulse flow would very likely have a higher turbidity if preceded by a lower flow rather than a similar flow. The second flow would move accumulated debris and spawning gravel further up on the stream bank that was not accessible to the lower flows. Most of the spawning gravel placed in recent years is in the reach downstream of Whiskeytown Dam which rarely experiences elevated flows besides the pulse flows.

Therefore, in this context, having two different flows could better meet the objective of action I.1.1.

By reducing the magnitude of the first pulse flow and increasing the magnitude of the second pulse flow, we hoped to: A) remove more fine sediment and create more spawning habitat, B) result in the same amount of water being used by two 600 cfs pulse flows, C) evaluate sediment transport and fish passage at two different flows, and D) have lower flows for the initial operation of a new fish counting weir which will be used to evaluate the pulse flows.

Two pulse flows were provided between May 21 and June 11, 2012 (Figures 4 and 5) of 400 and 800 cfs respectively. Flows during the two pulses peaked at the Igo gage at at about 500 and 1,000 cfs respectively. The large differences in the targeted and achieved flows were not due to tributary flow or accretions. This difference is consistent with previous results suggesting that the rating curve for the Whiskeytown outlet underestimates discharge during high releases. In this case the releases were up to 25% higher than indicated by the rating curve.

The pulse flows were successful in moving gravel downstream from 2 supplementation sites in the reach just downstream of Whiskeytown Dam, where flows are rarely high enough to move gravel. The Dog Gulch gravel site is intended to move every year to provide gravel to the downstream reach. The Above Peltier Road Bridge site is intended to not move and provide immediate habitat benefit. (Figure 11, Above Dog Gulch). Preliminary data suggests that large amounts of sand were transported during the second pulse, however during the first pulse sediment transport was not measured. Therefore at least the second pulse flow was successful in the secondary objectives of moving gravel and fine sediment.

As in 2010 and 2011, spring Chinook monitoring results in 2012 were inconclusive due to low adult counts. An a priori assumption was made that at least 50 Chinook would be needed to draw firm conclusions. Snorkel surveys counted 9 spring-run Chinook before the pulse flows, 13 after the first pulse flow and 39 after the second pulse flow. The August count which is used as the population index was 68 Chinook. In 2010 the counts were 1, 10, 11 and 21 respectively. In 2011 the counts were 1, 2, 9, and 8 respectively. Performance measures included the percent change in counts of Chinook between snorkel surveys, the distribution of spring Chinook during the August Index and the distribution of redds at the end of the season.

Recommendations: The CCTT proposed to amend this action to allow increased flexibility to aid in adaptive management (see Appendix A for attached proposal and amended action). The proposal would allow the Clear Creek Technical Team to recommend to NMFS and Reclamation, changes in the timing, magnitude and duration of the spring attraction flows to better meet objectives of the Clear Creek RPA actions, additional ecosystem goals, operational constraints, and adaptive management. The team also recommends attraction flows in 2013 similar in magnitude to 2012, earlier in the season.

Action I.1.2. Channel Maintenance Flows

Objective: Minimize project effects by enhancing and maintain previously degraded spawning habitat for spring-run 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: This RPA Action has not been implemented yet. In 2008, CDFG awarded a contract to the FWS, in the amount of $813,745, to plan and implement a one-time re-operation of the type required in this RPA Action. Funding issues associated with the State of California's inability to pay, delayed the project for 3 years. The contract was finally signed in April 2011 and a 3-year time extension was approved. The project timeline targeting implementation of the flows in 2013 may need to be amended to 2014 due to delays.

A three-day Orientation & Review Workshop for the project was held October 25 to 27, 2011 in Sacramento. Seven briefing papers were produced from the workshop. A 3-day Monitoring and Adaptive Management Workshop was held in February 2012 to develop a core geomorphic and biological effectiveness monitoring plan. A summary report produced from the workshop was used to develop the draft monitoring plan.

Graham Matthews and Associates, Inc. and Northern Hydrology and Engineering, Inc. estimated Clear Creek channel capacity at 15,850 cfs without backwater effects from the Sacramento River. Backwater effects from the Sacramento begin to effect flows in Clear Creek when flows at Bend Bridge are 103,000 cfs. Re-operation to achieve channel maintenance flows would only occur if Sacramento River flows were much lower than this magnitude. Backwater effects decrease Clear Creek channel capacity by 4% when Sacramento River is at FEMA 100 year base flood elevation of 113,000. FEMA 100-year base flood elevations are incorrect in the vicinity of the Crown Estates subdivision. The maximum channel capacity flows would exceed the existing (incorrect) base flood elevations by more than one foot.

Geomorphic monitoring indicates that the 2008 Moon Fire and subsequent salvage logging resulted in a large increase in fine sediment in salmonid spawning areas in Clear Creek (Figure 7). During the same period, juvenile productivity of spring Chinook, steelhead and fall Chinook has been reduced. CVPIA's attempts to inventory and control erosion, and to physically remove sediment from the creek have not occurred. Channel maintenance flows may be the most cost effective and feasible method for removing fine sediment from spawning areas of Chinook and steelhead.

On July 5, 2012, the Dale fire burned about 1,000 acres in the Clear Creek watershed including the entire footprint of the Lower Clear Creek Long-term Gravel Supply Project. Some of the lower terrace fine sediments appear especially vulnerable to entering Clear Creek with negative effects on salmonid eggs and embryos. The fine sediment can suffocate the early life stages or entrap them in the red when it is time to emerge. While fire and temporary increases in fine sediment were part of the environment in which salmonids evolved, Clear Creek has reduced capacity to recover from these disturbances because intermediate and high flows have been reduced in frequency due to Whiskeytown Dam.

Recommendations: Reclamation and other agencies should continue discussions through the EWP Pilot Program regarding implementation of this RPA Action beyond the EWP project. The agencies should discuss the incorrect FEMA 100-year base flood elevations with the City of Redding.

Action I.1.3. Spawning Gravel Augmentation

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

Action: "Reclamation, in coordination with the Clear CCTT, 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: Ongoing spawning gravel actions that continued in Clear Creek were: design and permitting of the long-term gravel supply project, obtaining long-term permits for gravel additions, adding gravel at 4 sites, and performing geomorphic monitoring and fish monitoring. Due to reduced levels of CVPIA funding, no gravel additions are planned for 2013.

Clear Creek Mercury Abatement and Fisheries Restoration Project (also known as Lower Clear Creek Longterm Gravel Supply Project): CVPIA continued work on projects to provide a long-term supply of spawning gravel and provide long-term permits for placing it instream. CVPIA funded planning, design and permitting for this project to provide an inexpensive, long-term gravel supply for Clear Creek restoration. The project, which is located on Bureau of Land Management and California Department of Fish and Game lands, could provide gravel for 20 to 40 years with a fixed acquisition cost. By February 2012, the Ecosystem Restoration Program decided to fund the entire project ($4.5 million) using a combination of Proposition 13 Mine Remediation and Proposition 84 funds. A fire occurred in late June, 2012, which burned the entire project area and led to changes in design. As of September, 2012, the contract to implement the project is in the process of obtaining final signatures. Revisions to the contract and project design have been implemented with active assistance from the Clear Creek Technical Team. Implementation of this four-year project is expected to begin in 2013.

Since 1996 150,000 tons of gravel has been added to Clear Creek. In 2012, 10,000 tons of spawning gravel was placed at 4 sites in the 4 different geomorphic reaches of Clear Creek. The table below lists locations and amounts of gravel added:

2012 Gravel Injections	
Location	**Amount (tons)**
Guardian Rock	2,000
Placer Road Bridge	4,500
Clear Creek Road Crossing	1,500
Tule Backwater	2,000

Monitoring: Evaluation of the effectiveness of the gravel additions has been ongoing since 1996 and consists of many complementary physical and biological elements on a range of scales. [insert section here]

Action I.1.4. Spring Creek Temperature Control Curtain

Objective: Reduce adverse impacts of project operations on water temperature for listed salmonids in the Sacramento River.

Action: "Reclamation shall replace the Spring Creek Temperature Control Curtain in Whiskeytown Lake by 2011". [This action was not implemented by the CCTT]

Results: Replacement of the broken temperature control curtain was intended to reduce the temperature of water diverted to the Sacramento River via the Spring Creek tunnel. The Spring Creek Temperature Control Curtain (SCTCC) was designed to pull cold water from lower levels of Whiskeytown Reservoir. Reclamation replaced the curtain by June 15, 2011. Although the objective of the project was to improve water temperatures in the Sacramento River, water temperatures have not been analyzed to evaluate the effect of the curtain replacement project in Clear Creek.

At the 2011 CLTO BO workshop, CCTT recommended evaluating the effectiveness of the SCTCC. This section gives reasons to evaluate not just the SCTCC, but also the OBTCC and the LTCC. The Science Panel wrote after the 2011 review:

> "At the workshop in Sacramento, the IRP [Independent Review Panel] wondered why an evaluation of the new temperature curtain was not conducted in conjunction with its installation. The information provided was that the new temperature curtain simply replaced a similar previous curtain and the effectiveness of the technology was not in question. So, the IRP wonders why the SRTTG would now see a need to test the new curtain. (Page 27)"

After the 2011 Science Panel review, the CCTT reviewed results of the original evaluations of the three TCC's (Vermeyen 1995, 1997a, 1997b, 2001) and some important recommendations were discovered. The studies recommended:

> "1994 data showed that [full] peaking power operations resulted in a 3° temperature gain in water routed through Lewiston Reservoir. Smaller temperature gains were measured at the Carr (Judge Francis Carr) Powerplant tailrace curtain. Consequently, peaking power operations should be avoided for Trinity and Carr Powerplants during periods when release temperature restrictions are in effect. (Vermeyen 1997, page 1)" [This will be referred to as "Avoid full power peaking"]

> "Monitoring of the curtain performance resulted in an understanding of the hydraulic characteristics but also revealed that these curtains are very dynamic structures, and their

> performance depends on many factors, such as flow rate, powerplant operations, inflow temperatures, reservoir stratification, etc (Vermeyen Page 2)."

Some conditions have changed since the studies in 1992 to 1994 including reductions in diversions from the Trinity River due to the Trinity River Record of Decision, and the Oak Bottom TCC is no longer intact, nor fully operational. Reduced diversions from the Trinity River increase Whiskeytown water temperatures. Poor condition of the OBTCC increases Whiskeytown temperatures. However, the temperature benefits of avoiding full power peaking at Trinity PH and Carr PH occur separately from the temperature benefits of the Oak Bottom curtain (Tracy Vermeyen, SRTTG meeting, June 26, 2012).

1) We suggest that Reclamation may learn valuable operational information that could improve the ability to control water temperatures while meeting other project goals. The evaluation of the original temperature control curtains revealed important operational information which led among other things, to the Vermeyen (1997) guidance to avoid full power peaking. The evaluation was critical to understanding how best to use the curtains. A new evaluation may lead to further improvements in the operation and maintenance of the curtains.

2) After the 2011 Science Panel meeting there was an increased awareness that the Oak Bottom TCC is damaged and cannot be fully deployed (Figure 12). The OBTCC is more effective than the SCTCC at reducing water temperatures (Tracy Vermeyen, Reclamation, Personal Communication, March 2012). The upstream curtain was intended to prevent mixing of cold and warm water, and the downstream curtain was intended to insure that the lower water was withdrawn at Spring Creek. If the water is mixed upstream, then the downstream curtain will be withdrawing warmer water than intended. Therefore the action to replace just the SCTTT may not be meeting the intent of the RPA. The agencies should analyze if the downstream curtain is not functioning as anticipated in the BO. The agencies should discuss the concept that since the OBTCC is damaged and not allowing the SCTCC to operate as intended in the RPA, that indirectly the OBTCC becomes a requirement of the SCTCC RPA action.

3) Evaluations of appropriate scale should be routine on a construction project of this magnitude and considered part of the action itself. Therefore it is not an additional element of the RPA, but one that should have been an integral part of the project, as it was with the original curtains.

4) It is possible that the earlier evaluation did not effectively test the effect of full power peaking at the SCTCC and powerhouse, because it came at the end of the study when water temperatures had become so warm that water was no longer brought over from the Trinity River for the rest of the season.

5) Reclamations operation and maintenance of the curtain and the long-term usefulness of the curtain could benefit from the curtain evaluation. The SCTCC failed and was replaced with a similar structure. The original evaluation discovered broken parts and equipment failures that had to be fixed. The evaluations identified and recommended routine maintenance that should be carried out to keep the curtain functional. Some of the elements that failed were replaced with new ones that should be evaluated to see if they are working.

6) The integrity of the Lewiston TCC is unknown. An inspection may reveal cost-effective ways to improve water temperatures.

7) There is widespread agreement within the CCTT and the SRTTG that the Oak Bottom TCC should be replaced and pre-project baseline information would help evaluate the effectiveness of the replacement.

Recommendations: Replace the OBTCC and update evaluations of the four TCC's. Provide a strategy of actions and tools that will be used to reduce Clear Creek temperature exceedances in the next year.

Action I.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run 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: Reclamation has not identified a schedule for making improvements to modeling water temperatures in Clear Creek. Reclamation has not fully assessed improvements to modeling water temperatures in Clear Creek.

Table 2. Proportion of days that water temperatures at Clear Creek Igo gage met targets.

	From	To	Target	Average 2001 to 2008	2009	2010	2011	2012
Holding	01-Jun	14-Sep	60° F	99%	100%	100%	100%	100%
Spawning	15-Sep	31-Oct	56° F	93%	**28%**	**26%**	**62%**	**31%?**

The CCTT discussed and recommended many actions intended to improve water temperatures in Clear Creek (and the Trinity and Sacramento rivers). Some of the proposals are in very draft form. The following proposals are discussed in this report:

a) Evaluate temperature control curtains (see discussion in RPA section I.1.4).
b) Improve and implement water temperature modeling.
c) Use the upper Whiskeytown outlet when temperatures are not warm; Use the lower outlet when temperatures are warm. (Appendix B).
d) Avoid full power peaking at Trinity and Carr powerhouses (Appendixes C and D).
e) Replace Oak Bottom TCC (Appendices C and D, see discussion in section I.1.4).

f) Move the Igo temperature compliance point downstream (Appendix E).
g) Fall Flow Prescription to Avoid Redd Dewatering and allow higher flows and better temperature control (Appendix F).

Specific questions to the IRP pertaining to water temperature management in Clear Creek are provided in the charge to the IRP.

c) Use the upper Whiskeytown outlet when temperatures are not warm. Use the lower outlet when temperatures are warm (Appendix B). On March 27, the Whiskeytown outlet gates were adjusted to release the greatest proportion of upper level water possible. On July 3rd the gates were somewhat inadvertently changed to release mostly upper level water (Figure 6) and temperatures increased greatly. On July 11 gates were returned to the "middle" configuration and on July 17 gates were changed to release water only from the lower level. After both changes, water temperatures decreased on the order of 3 degrees. While water temperatures suggest that significant improvements in water temperature resulted, at the date of this report it is unclear how long live the improvements lasted. Temperatures were below the 60 degree criteria during these actions.

Recommendation: Continue to use the upper and lower outlets for selective withdrawal of reservoir cold water pool to improve temperature control. Evaluate how increased release of Whiskeytown water may or may not deplete the cold water pool.

d) Avoid full power peaking at Trinity and Carr powerhouses and
e) Replace Oak Bottom TCC (Appendices C and D). Reclamation reports based on evaluations of the three TCCs (Vermeyen 1995, 197a, 197b, and 2000) recommended that "1994 data showed that peaking power operations resulted in a 3° temperature gain in water routed through Lewiston Reservoir. Smaller temperature gains were measured at the Carr (Judge Francis Carr) Powerplant tailrace curtain. Consequently, [full] peaking power operations should be avoided for Trinity and Carr Powerplants during periods when release temperature restrictions are in effect (Vermeyan 1997)". For the purpose of the reports three types of power generation are defined (Figure 13) as: no power peaking in which flows remain relatively constant, partial power peaking in which power generation is higher during a portion of the day but water continues to flow, and full power peaking in which during part of the day flows drop to zero or near zero. Some conditions have changed since the studies in 1992 to 1994 including reductions in diversions from the Trinity River due to the Trinity River Record of Decision, and the Oak Bottom TCC is no longer intact, nor fully operational. Reduced diversions from the Trinity River increase Whiskeytown water temperatures. Poor conditions of the OBTCC increase Whiskeytown temperatures. However, the temperature benefits of avoiding full power peaking at Trinity PH and Carr PH occur separately from the temperature benefits of the Oak Bottom curtain (Tracy Vermeyen, SRTTG meeting, June 26, 2012).

After the 1995 and 1997 Reclamation recommendations, power peaking was avoided during hot periods in the summer (Figure 14). Beginning in 2005, however, full power peaking was generally not avoided during the summer perhaps due to a change in power generation scheduling that occurred that year. Since then, full power peaking may have contributed to exceeding temperature compliance targets in 5 of the last 8 years. Therefore the CCTT proposed to avoid full power peaking. The proposal was presented to the SRTTG (Appendix C) which did not come to unanimous agreement on what to do, so the issue was forwarded to the WOMT (Appendix D) which forwarded the issue to NMFS and Reclamation management. The proposal requested:

1) Do not operate the Trinity, Carr, and Spring Creek powerhouses in full power-peaking mode from July 15 to September 30, 2012.

2) Evaluate the performance of the Trinity Division Temperature Control Curtains (TCC) and the impact of power peaking operations on water temperatures in the Trinity River, Clear Creek and the Sacramento River. Before July 15th 2012, operate the powerhouses to experiment with baseline, and full and partial power peaking operations to estimate their relative effects on water temperatures in the reservoirs and rivers.

3) Replace the Oak Bottom Temperature Control Curtain in Whiskeytown Reservoir.

Reclamation management would not agree to limit full power peaking. Experimental flows to estimate the lowest flow required to maintain temperatures did not occur. However, planned maintenance of some of the Trinity Division power generators restricted the ability to full power peak. At Carr powerhouse, full power peaking was avoided until August 26 (Figure 15). The Trinity Powerhouse avoided full power peaking (Figure 17) by releasing at least 500 cfs most of the summer and for a shorter period always releasing at least 1,000 cfs. It is unclear why full power peaking was avoided at Trinity Powerhouse.

Resulting water temperatures from the Whiskeytown Outlet were the coldest since records began in 2000. These markedly lower water temperatures may be due to using the upper and lower outlets for selective withdrawal and due to avoiding full power peaking at Trinity and Carr powerhouses. Other reasons considered less likely for the colder water temperatures through early September included:

1) Increased water volume released through Carr Powerhouse (Figure 18) since water volumes were similar in 2011 when temperatures were poor.

2) Increased water volumes released from Trinity reservoir (Figure 19) since volumes were similar in 2011 up through early September when increased releases were made to the Trinity River to cool down the Klamath River.

3) Colder Trinity reservoir water temperatures (Figure 20) since water temperatures were similar in 2011 and 2012.

4) Cooler Redding air temperatures (Figure 21) since temperatures were not cooler than 2011.

The CCTT predicts that Whiskeytown Outlet water temperatures will warm more rapidly because of the full power peaking that began at Carr powerhouse on August 26 and continued at least until the date of this document.

Recommendations: Limit full power-peaking to periods when water temperatures for listed salmonids are not negatively affected. Experiment with partial peaking in June and early July to determine the lowest flow required to avoid temperature impacts. Using this flow would theoretically reduce impacts to power generation. Obtain funding to replace the Oak Bottom TCC.

f) Move the Igo temperature compliance point downstream (Appendix E). The Clear Creek Technical Team discussed changing the temperature compliance point from the Igo gage at rivermile 10.9, to the location of the spring Chinook segregation weir at rivermile 7.4, to improve protection of spring Chinook adults and incubating eggs and over-summering O. mykiss juveniles.

Recent fish distribution and water temperature information indicate that: A) 50% of adult spring Chinook adults hold downstream of the Igo temperature gage, B) 40% of spring Chinook spawn downstream of the gage and C) 80% of O. mykiss spawn downstream of the gage and therefore most juveniles rear downstream of the gage, and D) these downstream fish are not protected by the water temperature criteria in the RPA. In addition, this change would improve conditions for fall Chinook spawning and incubation in lower Clear Creek. Informal temperature targets of 56 degrees at the bottom of the fall Chinook spawning reach, have not been met in recent years.

Temperature targets during spring Chinook holding and steelhead rearing have been easily met in all years, suggesting that it is feasible to move the temperature target downstream. However, it is possible that using more water during this early summer period would decrease the amount of cold water later in the summer during spring Chinook spawning. There is uncertainty about this aspect of Whiskeytown water temperatures because the cold water supply comes from water being delivered from the Trinity River during the summer and potentially from much smaller reserves in the deeper portions of Whiskeytown Reservoir. We should consider the effect of higher early summer releases on water temperatures later in the summer. The ability of the 60 degree early summer criteria to protect rearing steelhead juveniles in the lower creek should be evaluated.

Although the spawning temperature criteria has not been met in many years, in years where it is feasible, protective temperatures could be provided to spring Chinook further downstream than the Igo gage. These temperature improvements would also benefit fall Chinook spawning in the lower creek.

Recommendation: The CCTT should continue to consider this proposal.

g) Fall Flow Prescription to Avoid Redd Dewatering and allow higher flows and better temperature control. After temperature control operations end October 31, flows have sometimes been reduced to 200 cfs if flows are not already at 200 cfs. The 200 cfs flow is maintained to provide for fall Chinook spawning. Reductions in flow can dewater redds of spring and fall Chinook. Rather than incur redd dewatering, flows capable of meeting temperature control criteria have not been attempted. This proposal (Appendix G) outlines different approaches to ramping flows to avoid temperature control impacts or redd dewatering. The preferred approach would be to maintain higher releases from October 31 to May 31 at the same levels provided during temperature control for spring Chinook spawning. Steelhead spawning in Clear Creek would also benefit from higher flows in this time period. This approach is probably not feasible in all years due to limitations in project storage, B2 water availability, and environmental conditions. Therefore other options are included in the proposal for the agencies to use in balancing impacts.

Recommendations: The CCTT will prepare an outline of options presenting the rationale for the options and the costs, benefits and consequences of each option. The outline could be used by Reclamation in conjunction with others such as the B2 program of CVPIA to decide which option to implement in a particular year taking into account the current conditions. The outline would be included in the long term flow prescription of CVPIA and in the RPA action I.1.6 flow prescription. The options would include at least:

1) Ramp down releases as temperatures decrease- spring and fall Chinook redds may be dewatered
2) Ramp down releases as accretions increase- this would further reduce variability of the hydrograph. (Conditions in fall 2011 were dry and there were no accretion flows. Before Whiskeytown Dam, base flows at Igo would increase after October 1 in more than 90% of years. After Whiskeytown Dam base flows at Igo don't increase as much).
3) Ramp down releases from November 1 to November 30- this would dewater fall Chinook redds.
4) Maintain higher releases from October 31 to May 31 at same levels provided during spring Chinook spawning. Recent draft IFIM results indicate that these higher flows provide more spawning habitat for Chinook and steelhead.
5) Prescribe higher releases every year for Chinook and steelhead spawning through May31.

Action I.1.6. Adaptively Manage to Habitat Suitability/IFIM Study Results
The CCTT proposed that the RPA I.1.6 prescription include proposed flows to:

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) studies are completed, whichever occurs later.

R**esults:** The FWS began a new IFIM study on Clear Creek in 2004. Field work for the project is complete. The results of the study will be contained in 4 reports, 3 of which have been finalized. A report to synthesize these results of the IFIM studies was drafted in 2012. The CCTT intends to produce a report meeting the needs of both the RPA Action I.1.6 and the CVPIA Clear Creek Restoration Program which has a mandate to provide a long-term flow prescription. The prescription will cover 5 types of flow needs to:

1) meet habitat needs based on IFIM and habitat suitability study results;
2) provide temperature control;
3) move and maintain spawning gravels and create and maintain riparian vegetation;
4) avoid fish and redd stranding / dewatering; and

5) encourage anadromy of Oncorhynchus mykiss (steelhead / rainbow trout) through an adaptive management approach.

Recommendations: Working with NMFS and the Clear creek Technical Team, assess if Clear Creek flows shall be further adapted to reduce adverse impacts on spring-run Chinook and steelhead and encourage the restoration of these runs/species.

Other CLTO BO Required Monitoring:

Clear Creek Video Weir Background: Clear Creek currently sustains populations of spring, fall, and late-fall Chinook salmon, and Onchyrunchus mykiss (resident and anadromous) which require year round monitoring due to their life histories. The Red Bluff Fish and Wildlife Office (RBFWO) and California Department of Fish and Game Red Bluff Fisheries Office (RBFO) currently monitor these populations using snorkel, walking, and kayak surveys to obtain redd, live, and carcass counts, and rotary screw traps for outmigrating juvenile salmonids. While our current techniques are cost effective and provide good estimates for adult salmonid escapement, there are some limitations and uncertainly in estimates that could be improved or validated with the use of an alternative method. Fish counting devices including Didson, Vaki, and video have been recommended in the Central Valley Steelhead and Chinook Salmon Monitoring Plans for the purpose of recording passage of adult salmonids migrating into creeks (Bergman et al 2012, Eilers et al 2010). The video station monitoring technique has shown to be an effective method for assessing fall Chinook passage estimates on Battle Creek and Cow Creek, and has also been used on Cottonwood, Mill and Bear Creeks (Killam and Merrick 2012).

The RBFWO has been conducting steelhead and late-fall Chinook salmon kayak surveys since 2003 to obtain redd counts and collect biological data from carcasses. Steelhead and late fall spawn in Clear Creek from December through April. Although redd counts provide a good estimate of the spawning populations, there may be inaccuracies in estimates due to the environmental conditions during surveys, and life history characteristics of steelhead. Surveys may be missed due to storm conditions, which in turn may lead to missed redds (underestimates) and fewer carcasses recovered (hatchery origin, sex ratios).

Spring Chinook salmon migrate into Clear Creek from March through August and spawning begins in early September. To monitor their populations, we conduct snorkel surveys from August through November. We place a temporary picket weir in Clear Creek to separate spring and fall Chinook salmon during spawning to prevent hybridization between runs. We conduct an August snorkel survey to obtain a population index and count redds and collect biological data from carcasses throughout the spawning season. Redd counts are a good estimate of the spawning population, except in years where there are early rain storms that cause us to miss surveys, or cause weir breaches that allow fall Chinook to pass the weir. There are also observer errors associated with live adult counts (missed fish).

The RBFO has conducted mark-recapture walking carcass surveys to estimate fall Chinook salmon escapement for almost 50 years. Surveys are conducted from October through December, and fall Chinook begin migrating into Clear Creek in early September. To improve estimates and cost effectiveness, they have used the video counting stations in other watersheds

(Killam and Merrick 2012) and want to use the same technique on Clear Creek (Matt Johnson, personal communication).

To improve and validate our current monitoring methods, we determined that the use of a video station weir in conjunction with an underwater sonar device would be a good technique to use on Clear Creek to obtain adult salmonid passage estimates, given the need for year round monitoring due to the life history characteristics of the species and the range of environmental conditions. An underwater and overhead video camera can be used at the video station when the water is clear and the flows are low. However, detection by video cameras can be limited in turbid water, and requires the weir to be fully functional during high flows by blocking fish and funneling them through the opening. The Aris® is an underwater sonar device that can record images when water is turbid due to high flow and storm events, and visibility is zero. It does not require a function weir and can also be used when the weir is breached or laid flat during high flows.

By using both video and sonar, we hope to get more information about migration timing of all runs, and validate or improve our current monitoring methods, which may influence management decisions. Fall and spring Chinook salmon spawn timing overlaps in Clear Creek and more precise determination migration timing at the video station may help determine weir installation dates. Comparing live counts of adult Chinook salmon to passage at the video station will help tighten our current survey estimates for the fall Chinook population estimate, spring Chinook August index, and redd counts for late-fall and spring run. For steelhead, differentiating between anadromous and resident forms is extremely difficult because spawning adults are rarely observed, there are few carcasses, and spawning may occur at the same time. Video and sonar images of O. mykiss migrating into Clear Creek may help determine levels of anadromy (based on size and timing). By comparing video and sonar passage estimates to redd counts, we may be able to assess the potential influence of resident trout populations.

Video Weir Installation and Operation: We selected a video station site based on several criteria: (1) wide to accommodate high flows, (2) uniform bottom, (3)located downstream of the restoration projects and close to the mouth so all salmonids entering to spawn would be counted, (4) landowner permission, and (5) ideally have access to power and some security from vandalism. We chose our site near the mouth of the Sacramento River that had access to power and security at the City of Redding Clear Creek Waste Water Treatment Plant (Figure 23). The City of Redding provided access and power to the site and have been extremely supportive and cooperative. Video station design was developed by staff at the RBFO and is described in Killam and Merrick (2012). The video station uses a horizontal weir design to allow debris passage. A portion of the video station weir also incorporated an Alaskan style picket weir on one side due to the uneven stream bottom. This style of weir is described in (Giovannetti and Brown 2009). On June 1, 2012, staff from the RBFWO and RBFO installed the video station. We attempted to have the video station installed prior to both pulse flows and the onset of spring Chinook salmon adult migration, but installation and planning logistics took a significant amount of time. At the time of installation, only the overhead camera was installed. On June 3, a single underwater camera was installed and “jump fencing” to accommodate high flows due to the scheduled second pulse flow. The weir was maintained and repaired during the pulse flow, and video footage was captured with the overhead camera and single underwater camera. However, turbid conditions and having only a single underwater camera limited viewing conditions, which may have underestimated passage. There were also some issues with undercutting, weir overtopping, and debris, which may have allowed fish passage by the weir outside the video monitoring area for short periods before it was repaired. Viewing conditions were poor until June 6 when turbidity cleared up. The final two underwater cameras were installed by June 11 after the final pulse flows. The video station has had been in operation since. The RBFWO is responsible for monitoring and maintaining the station from mid Dec to mid-August for spring Chinook, steelhead, and late fall Chinook monitoring and RBFO for the remainder of the period for fall Chinook salmon monitoring. We will be incorporating sonar imaging as soon as units become available and working through techniques and data processing throughout the next year.

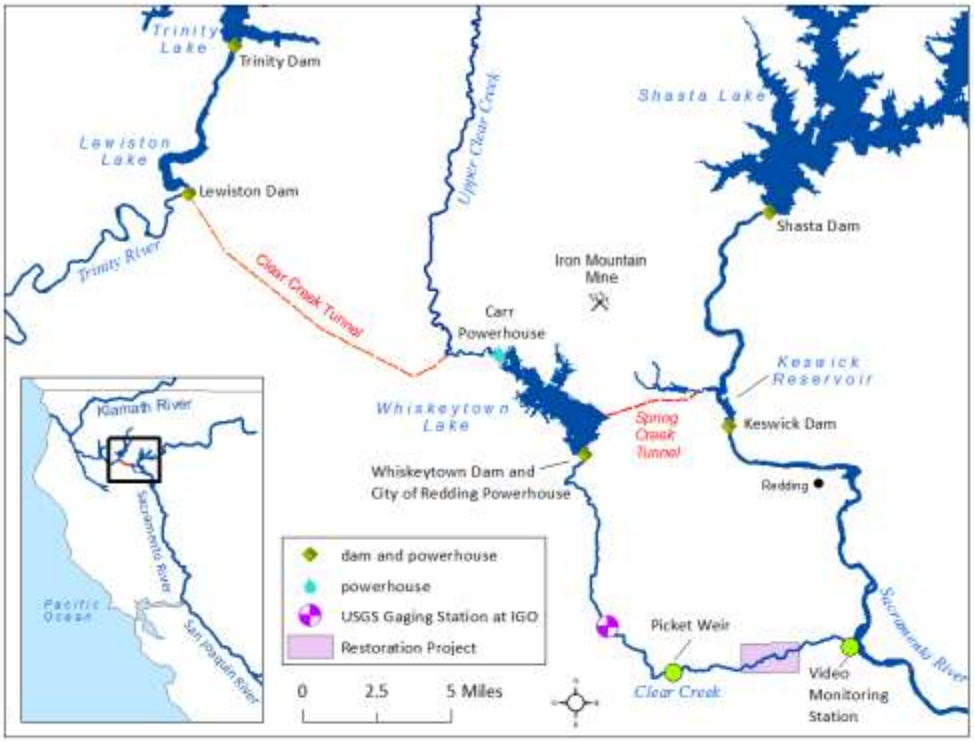

Figure 1.—Location of Lower Clear Creek in Northern California, showing Trinity, Whiskeytown, and Shasta Reservoirs and related CVP facilities.

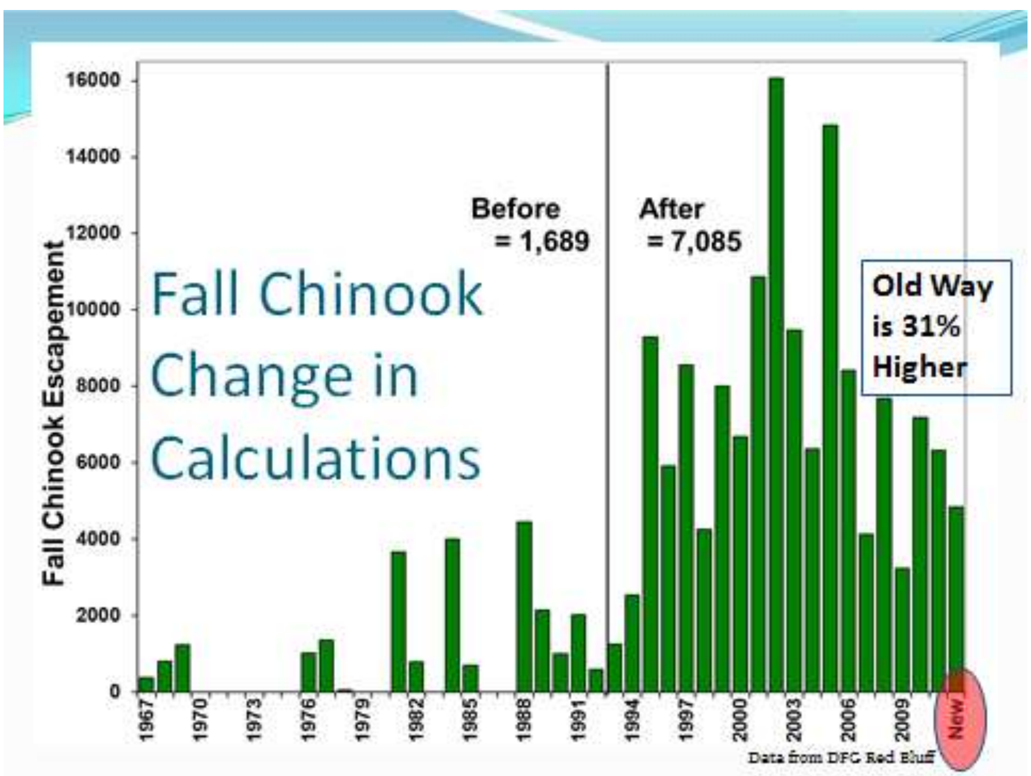

Figure 2. Fall Chinook escapement into Clear Creek increased four to five fold since restoration began. A Jolly-Seber method was used for the first time in 2011 for estimating escapement. The old Schaeffer method was also used and produced an estimate 31% higher than the Jolly-Seber.

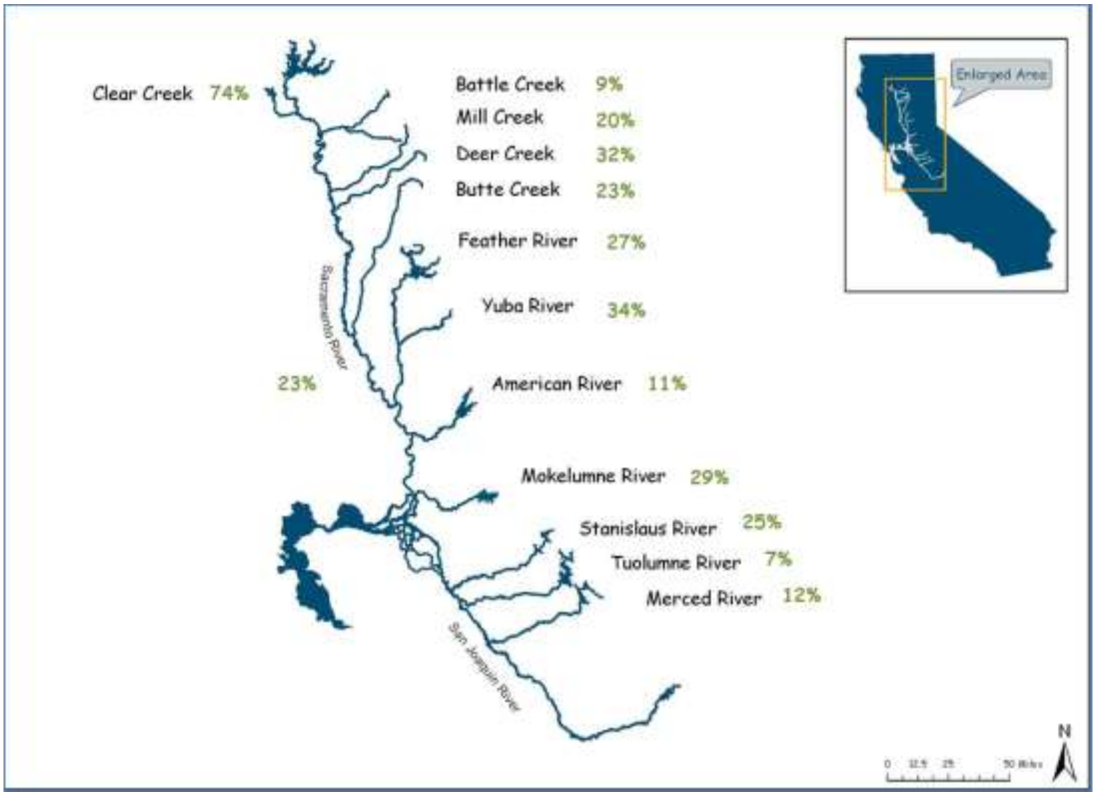

Figure 2.—From 2007-2010, the Central Valley fall Chinook salmon escapement estimate was 21% less than the fifteen year average from 1992 to 2006.

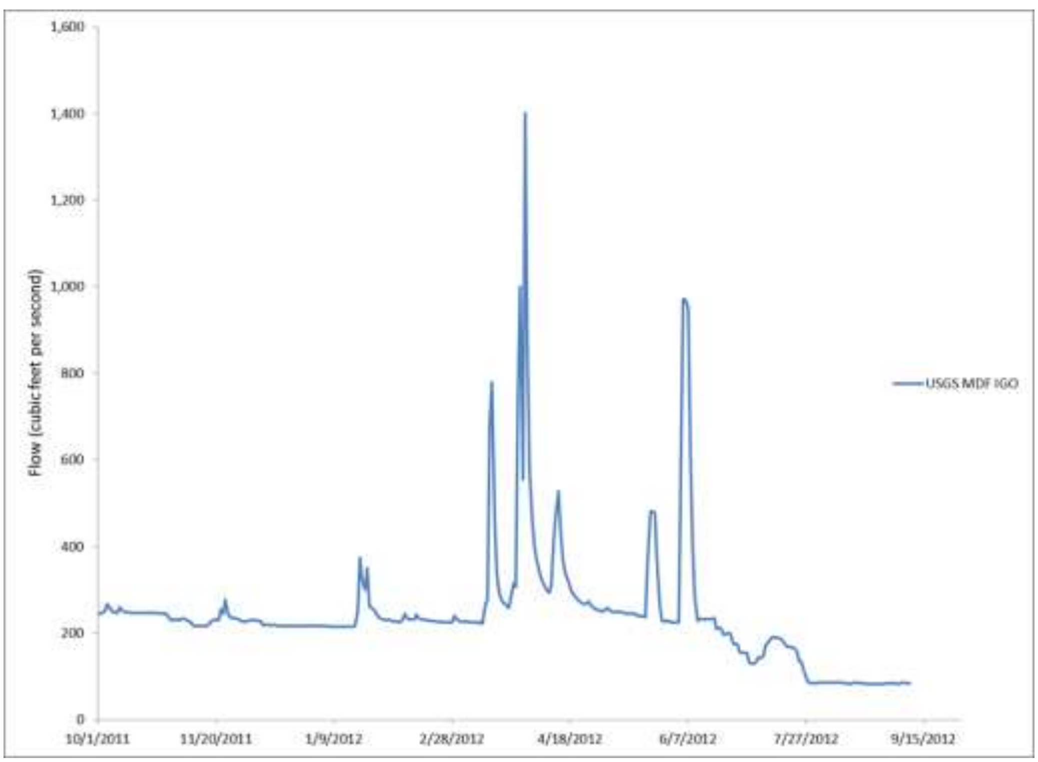

Figure 4. Clear Creek at Igo WY 2012 annual hydrograph.

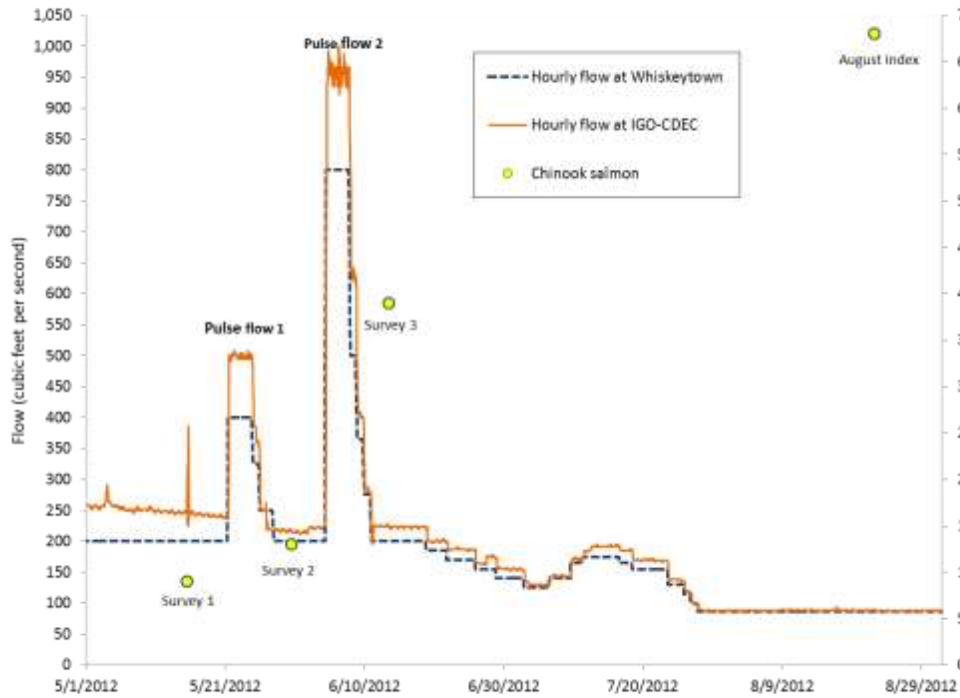

Figure 5. Discharge at Igo and nominal release from Whiskeytown Reservoir 2012.

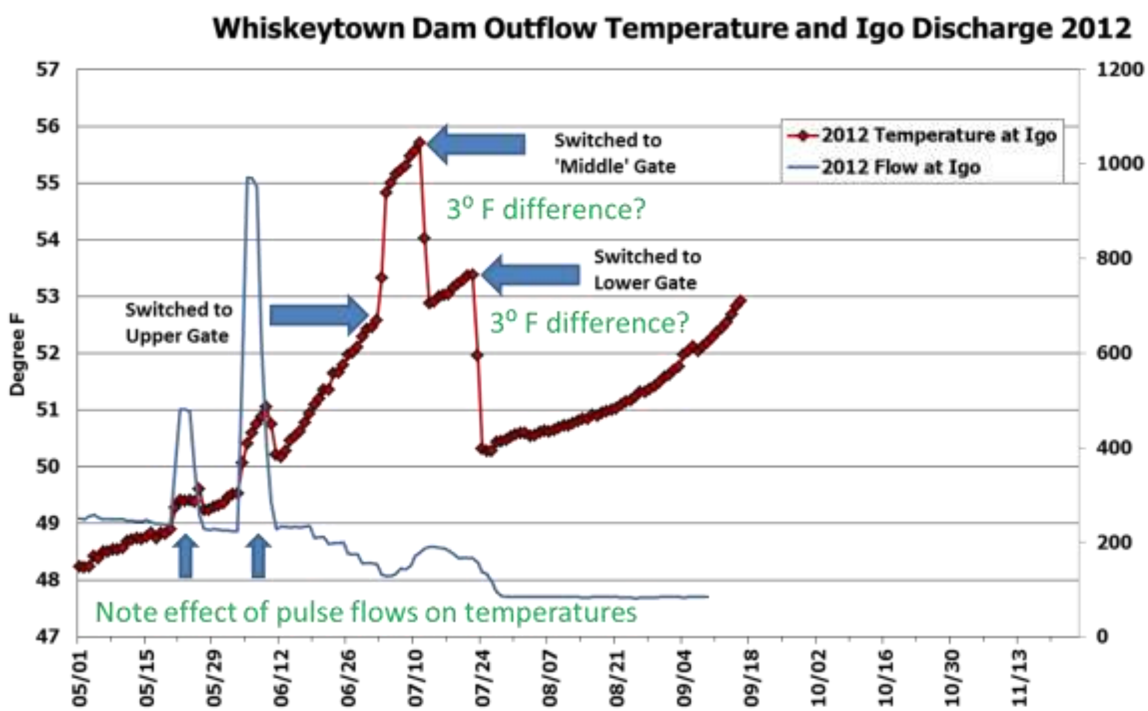

Figure 6. Whiskeytown Outflow water temperature 2012 and discharge at Igo gage.

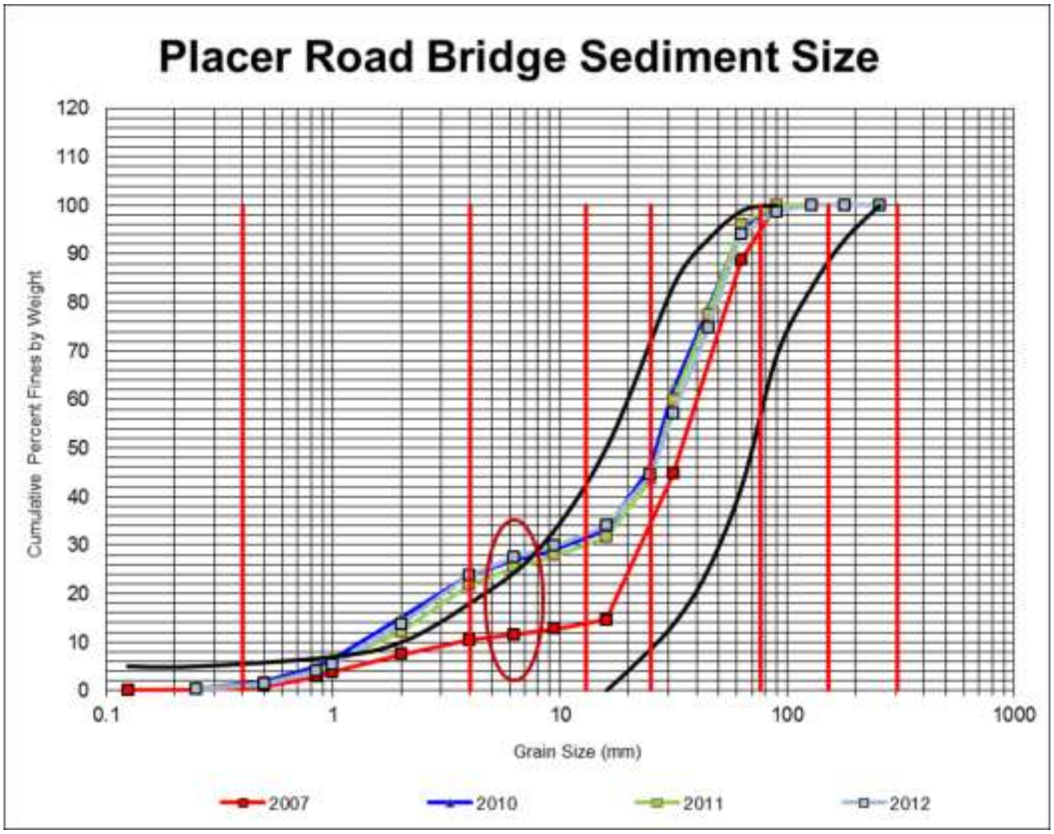

Figure 7. The percent of fine sediment in spawning gravels doubled after the Moon Fire and has not decreased.

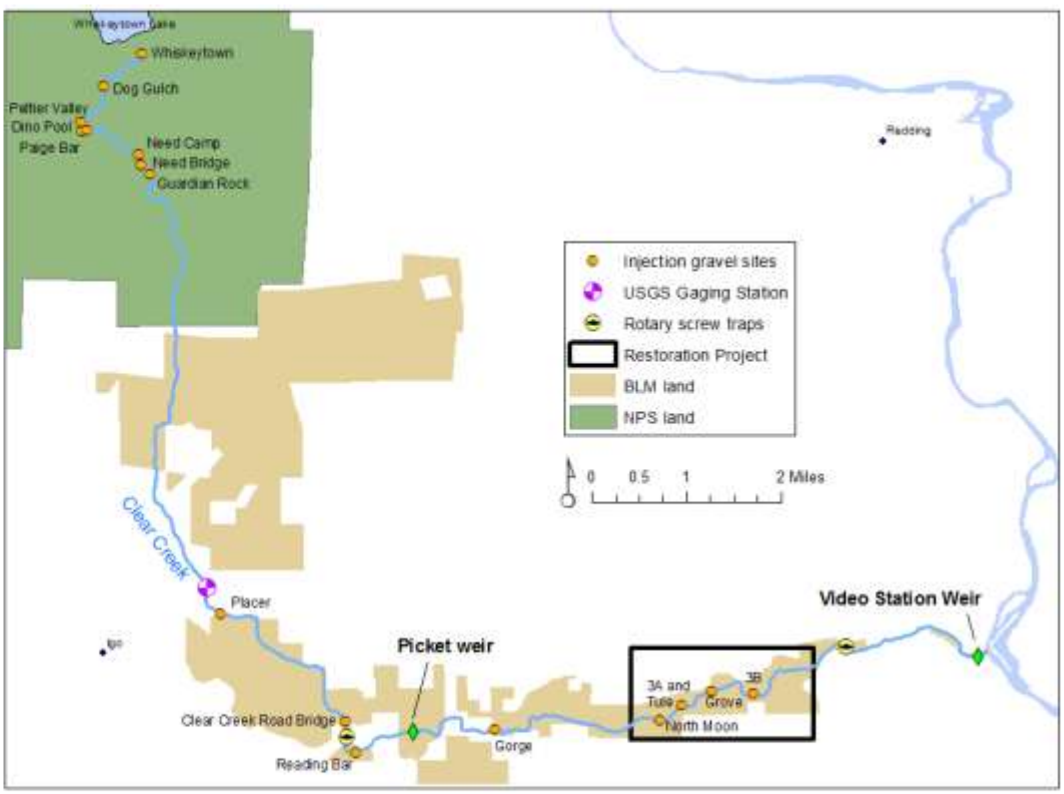

Figure 8.Map of Lower Clear Creek with gravel addition sites, Igo gage and segregation and counting weirs.

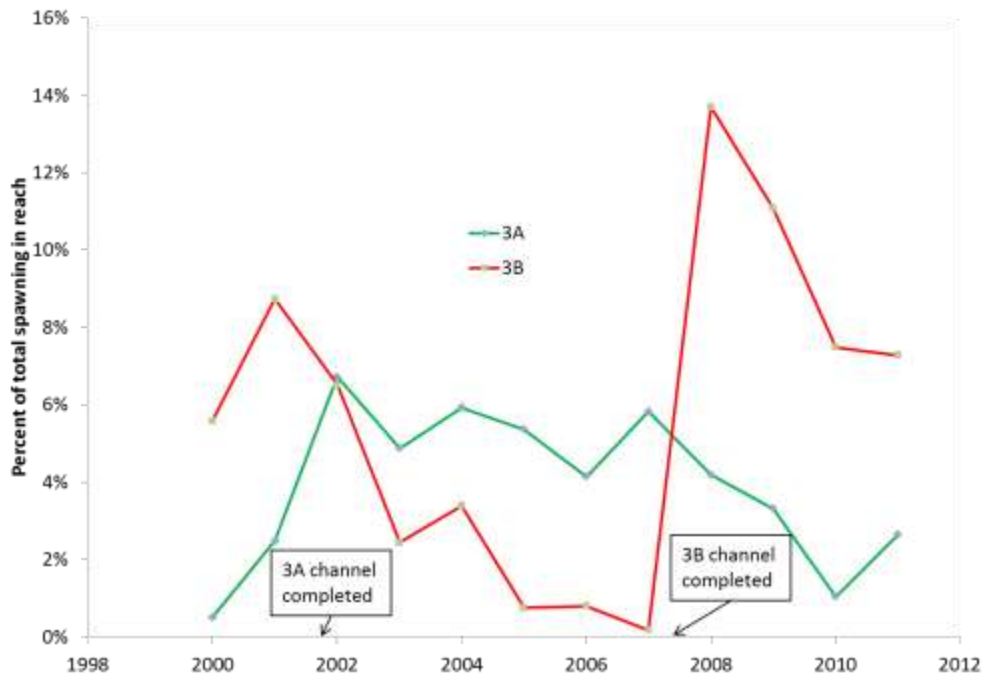

Figure 9. Increase in spawning habitat used by fall Chinook before and after completion of restoration projects. Spawning is given as percent of total spawning in the creek.

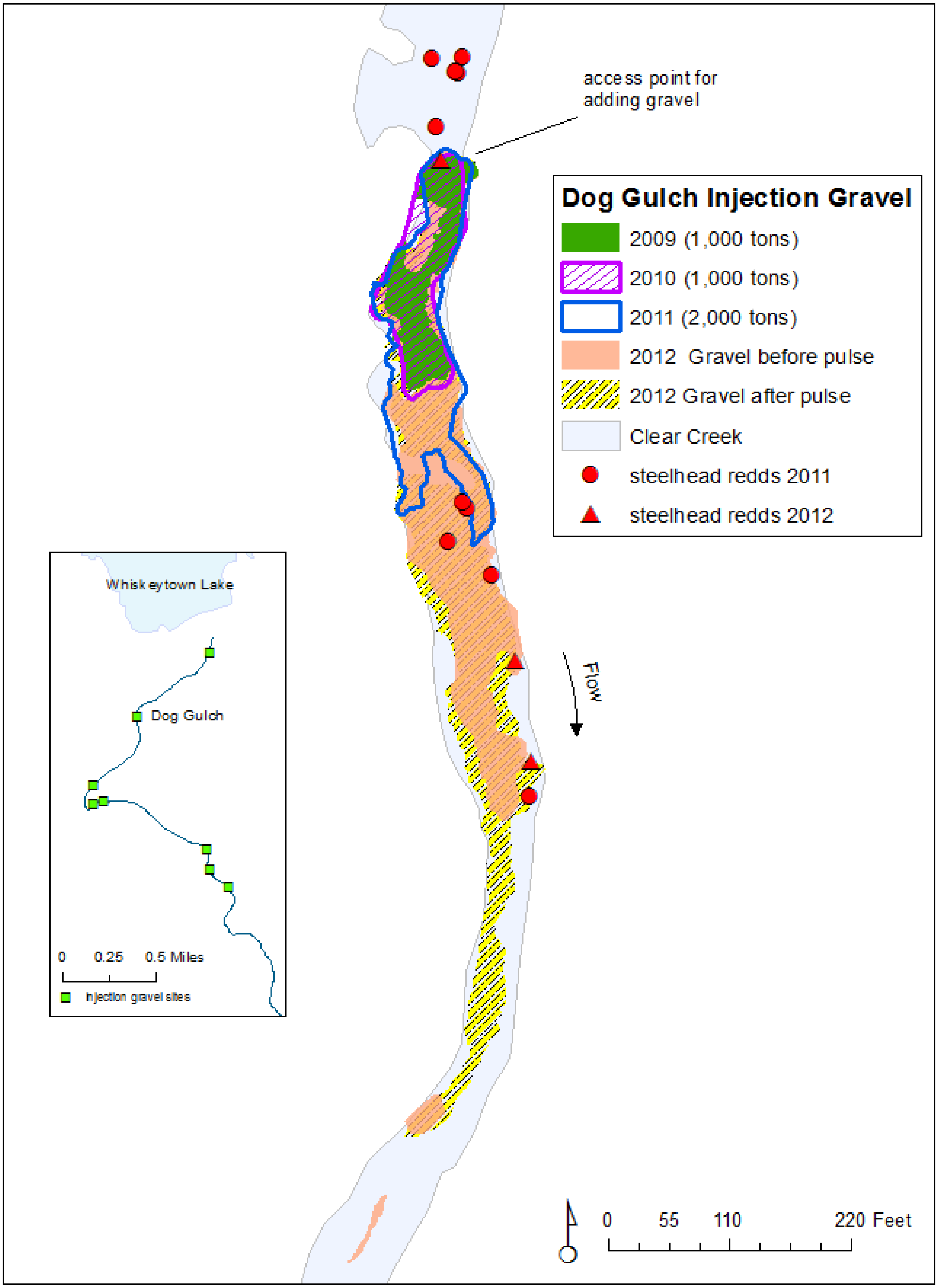

Figure 10. The Dog Gulch gravel site showing locations of the three gravel additions and locations of steelhead redds. Locations of original additions compared to locations after pulse flows suggest relatively large movement of gravel downstream compared to Peltier Valley in Dog Gulch in subsequent Figure 11 .

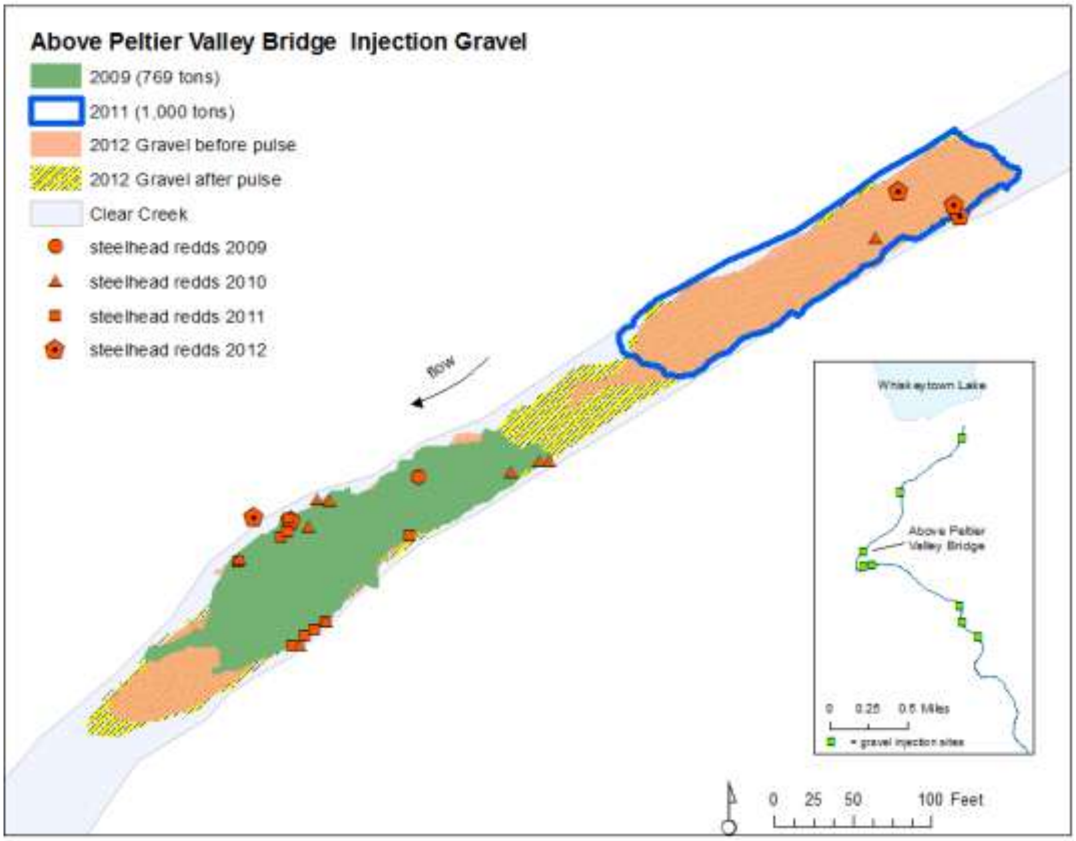

Figure 11. The Above Peltier Valley Road Bridge gravel site showing locations of the two gravel additions and locations of steelhead redds. Locations of original additions compared to locations after pulse flows suggest relatively limited movement downstream compared to Dog Gulch in previous figure 10.

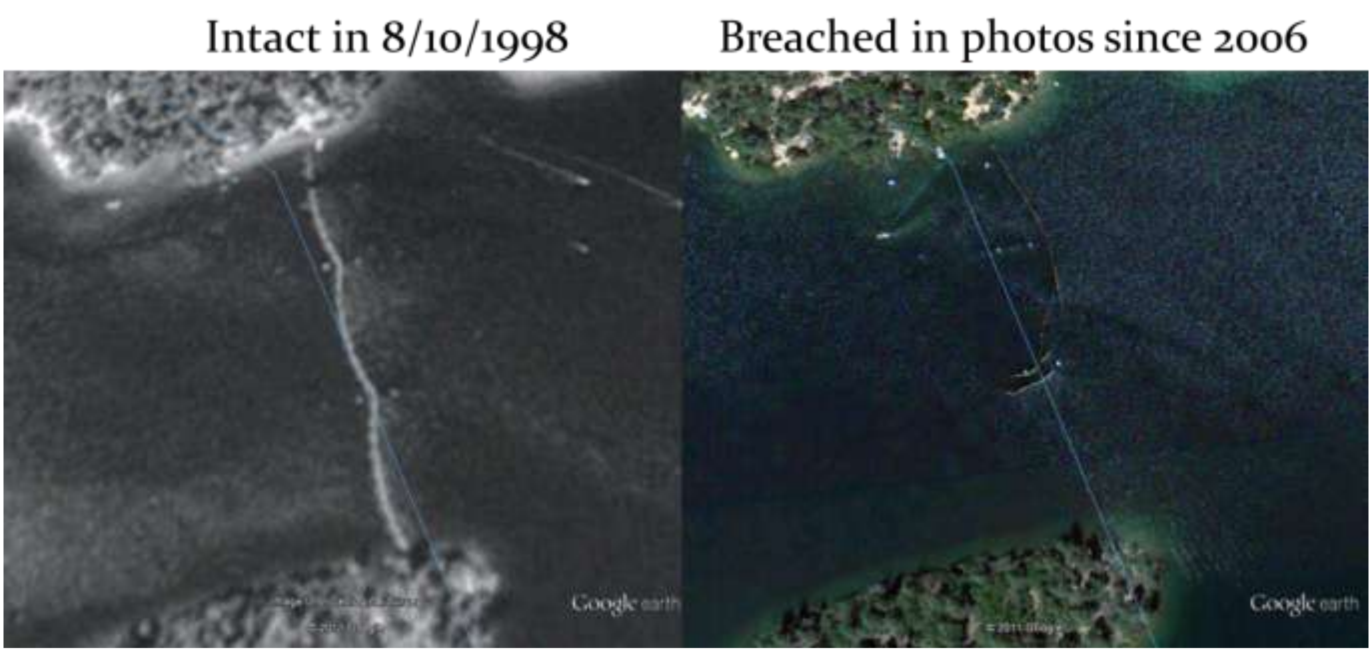

Figure 12 . Aerial photos from Google Earth showing the Oak Bottom Temperature Control Curtain intact on the left and breached on the right.

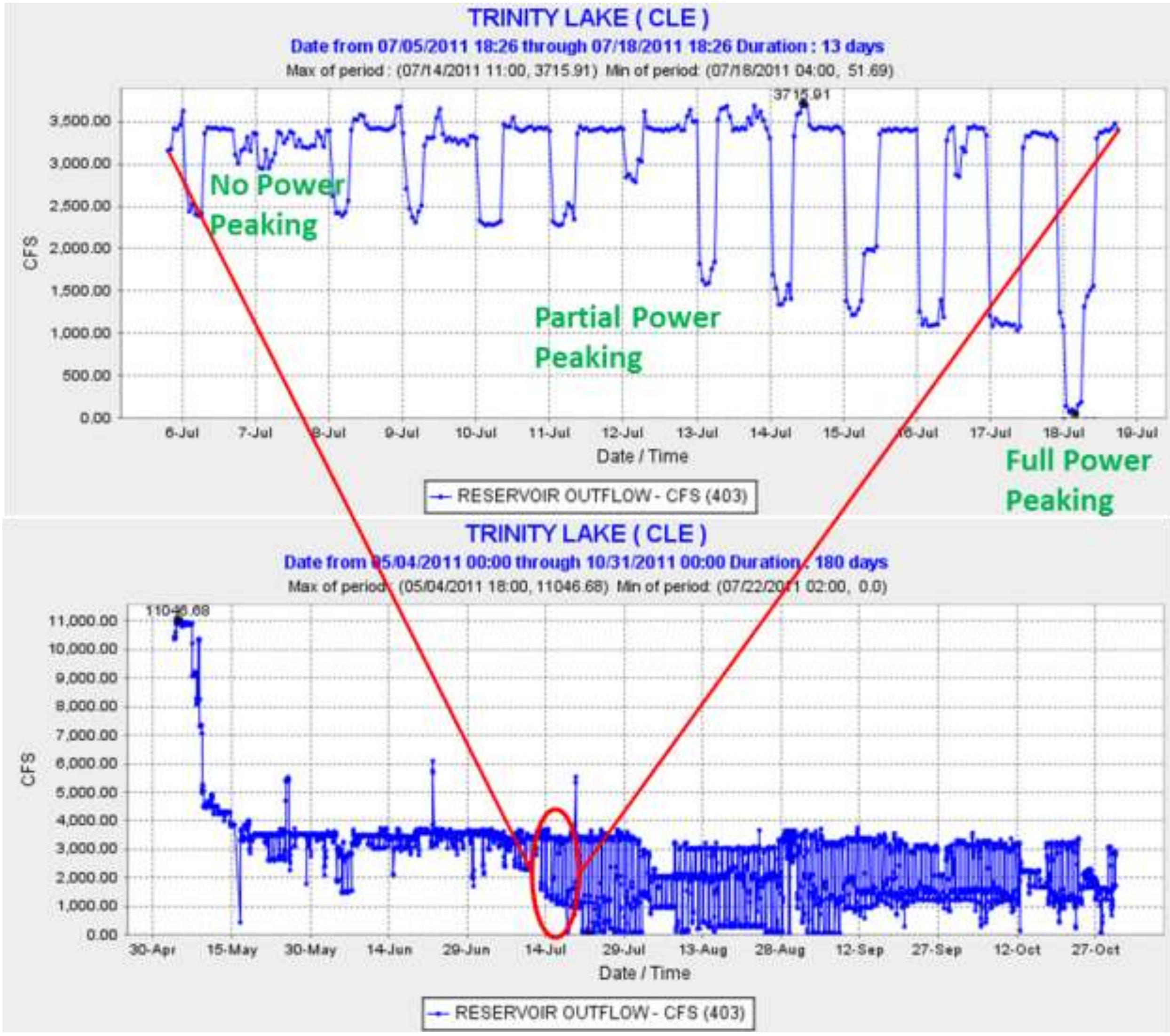

Figure 13. Definitions of types of power generation: no power peaking, partial power peaking and full power peaking. Chart includes hourly discharge from Trinity Reservoir during summer 2011. The upper figure includes 2 weeks which are circled in the lower figure.

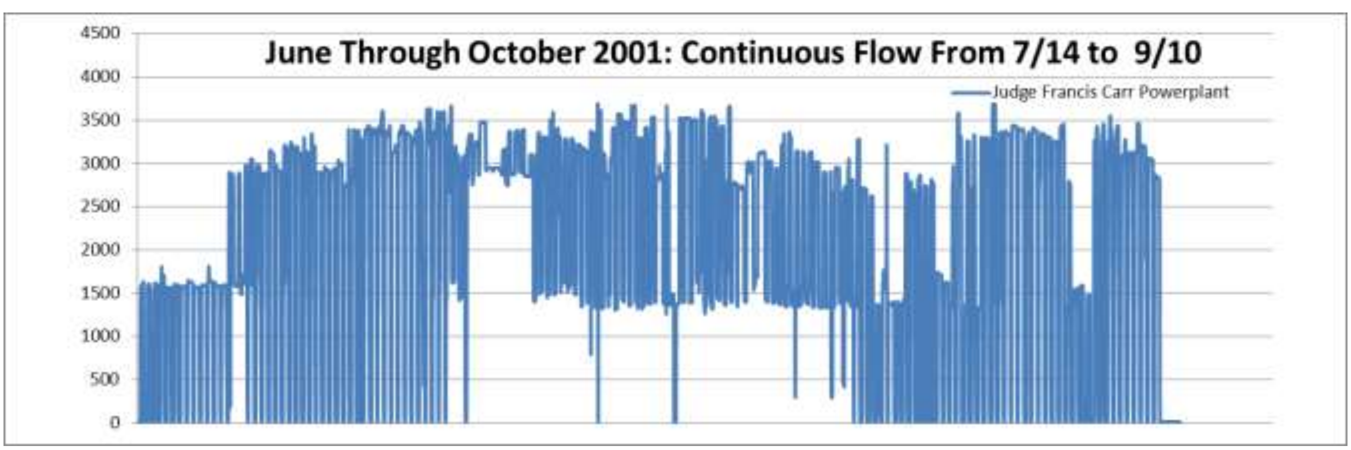

Figure 14. Hourly discharge from Carr Powerhouse summer 2001showing the period from 7/14 to 9/10 with little full power peaking.

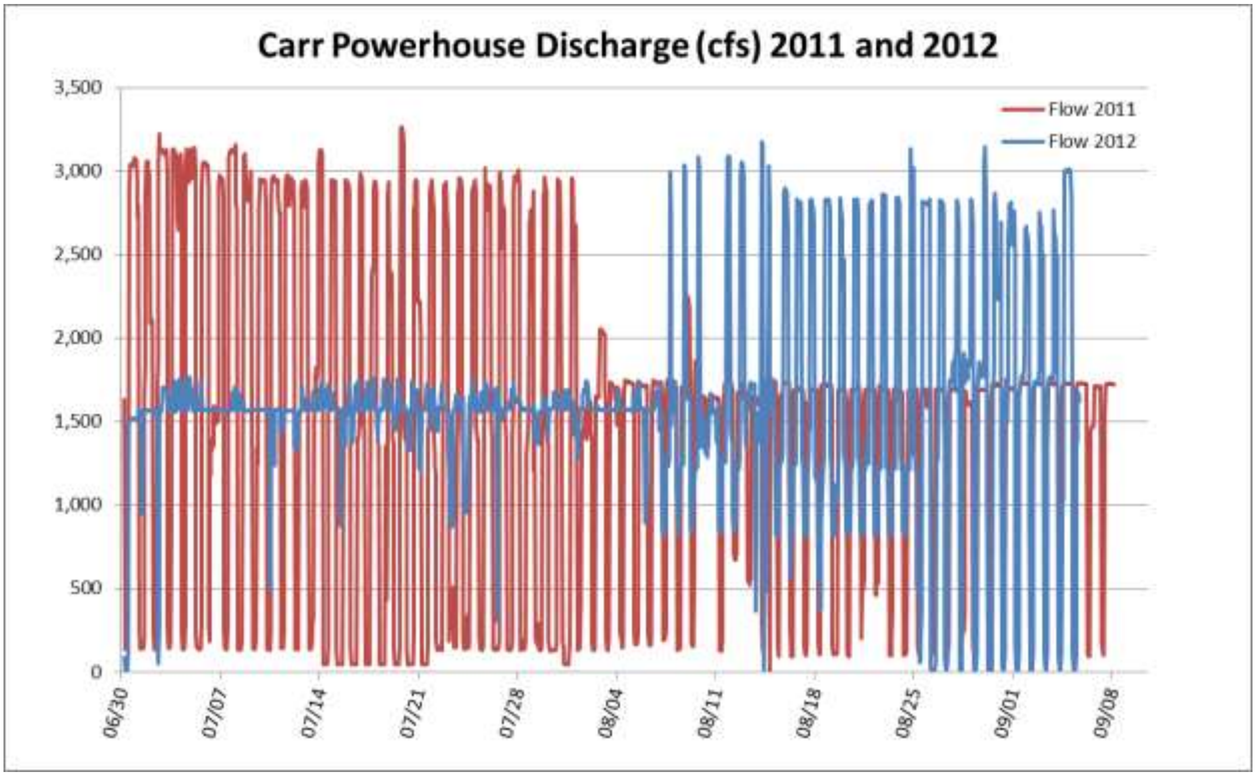

Figure 15. Comparison of hourly discharge from Carr Powerhouse during the summer 2011 and 2012. During 2011 full power peaking occurred most of the time. During 2012 continuous full power peaking began on August 26.

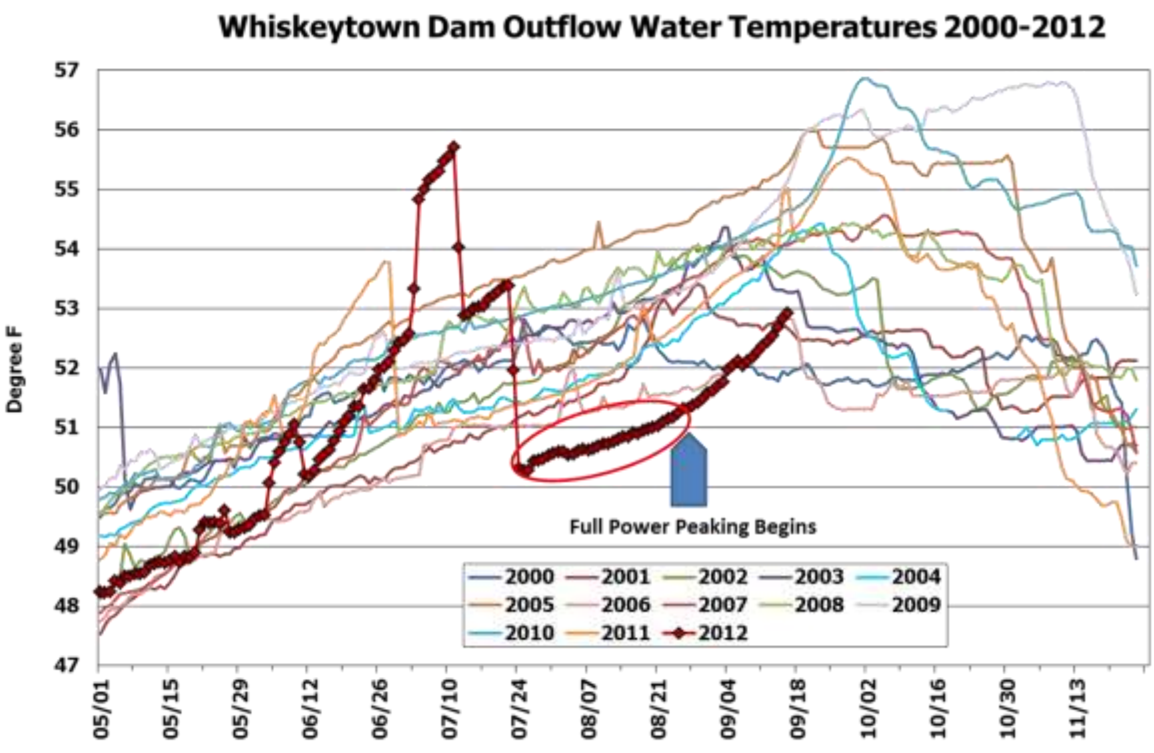

Figure 16. Whiskeytown Dam outflow temperatures 2000 to 2012. Circled area indicates very low temperatures potentially due to use of upper outlets and avoiding full power peaking. Arrow indicates when full power peaking began for the season in 2012.

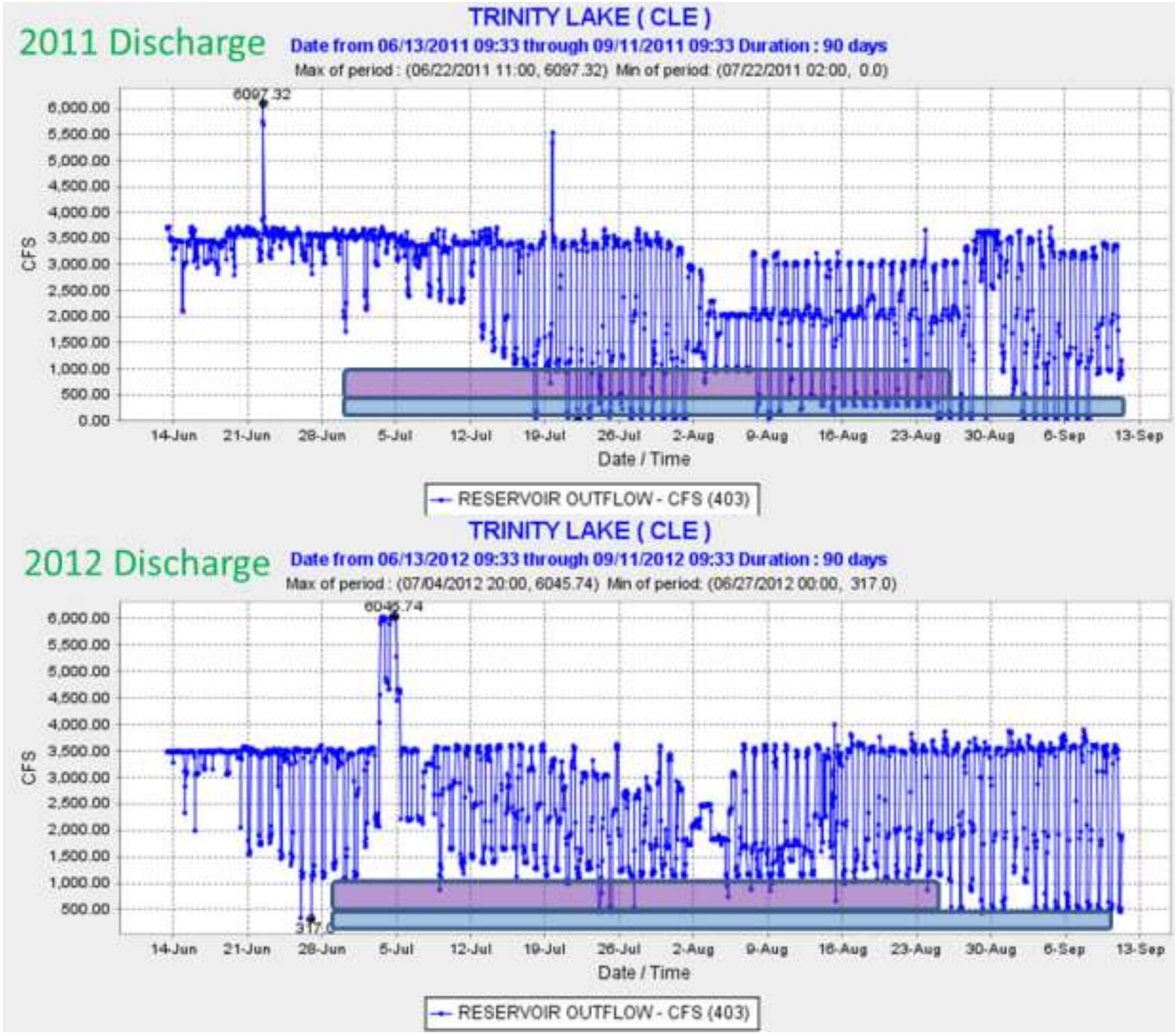

Figure 17. Comparison of hourly discharge from Trinity Powerhouse in summer 2011 and 2012. Unlike 2011, full power peaking was avoided in much of 2012. Flows did not go below 500 cfs in 2012 but did in 2011, for the extended period indicated by the blue boxes. Flows did not go below 1,000 cfs in 2012 but did in 2011, for the period indicated by the purple boxes.

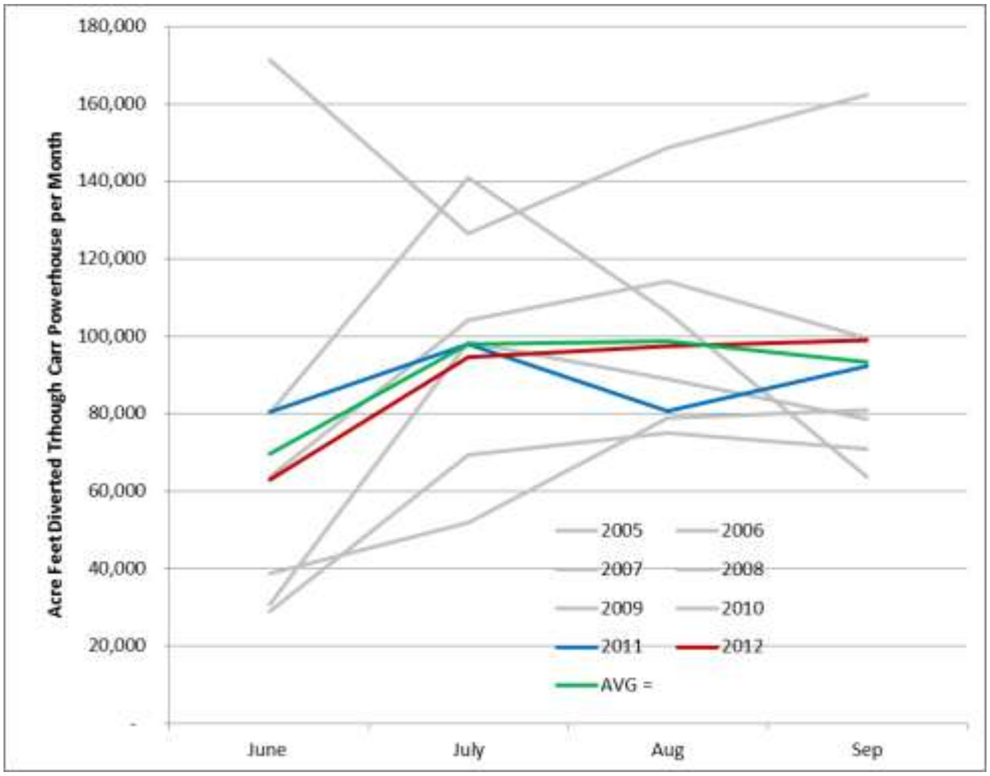

Figure 18. Acre feet of water brought over through Carr Powerhouse were not different between summer 2011 and 2012.

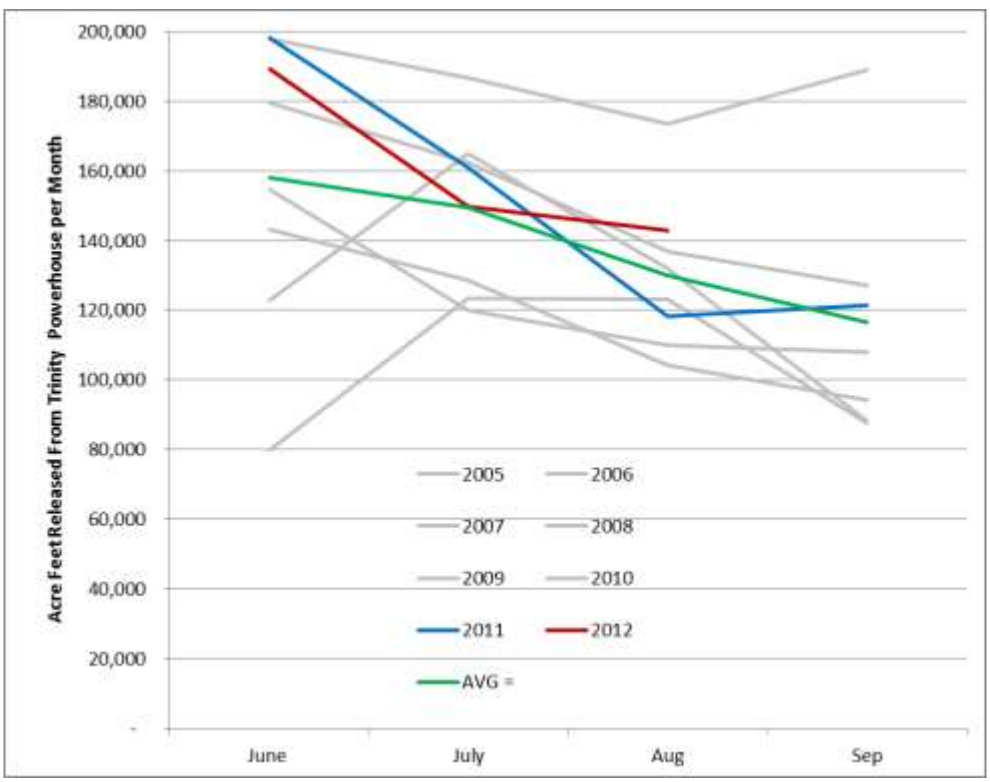

Figure 19. Acre feet of water released from the Trinity River were not different between summer 2011 and 2012.

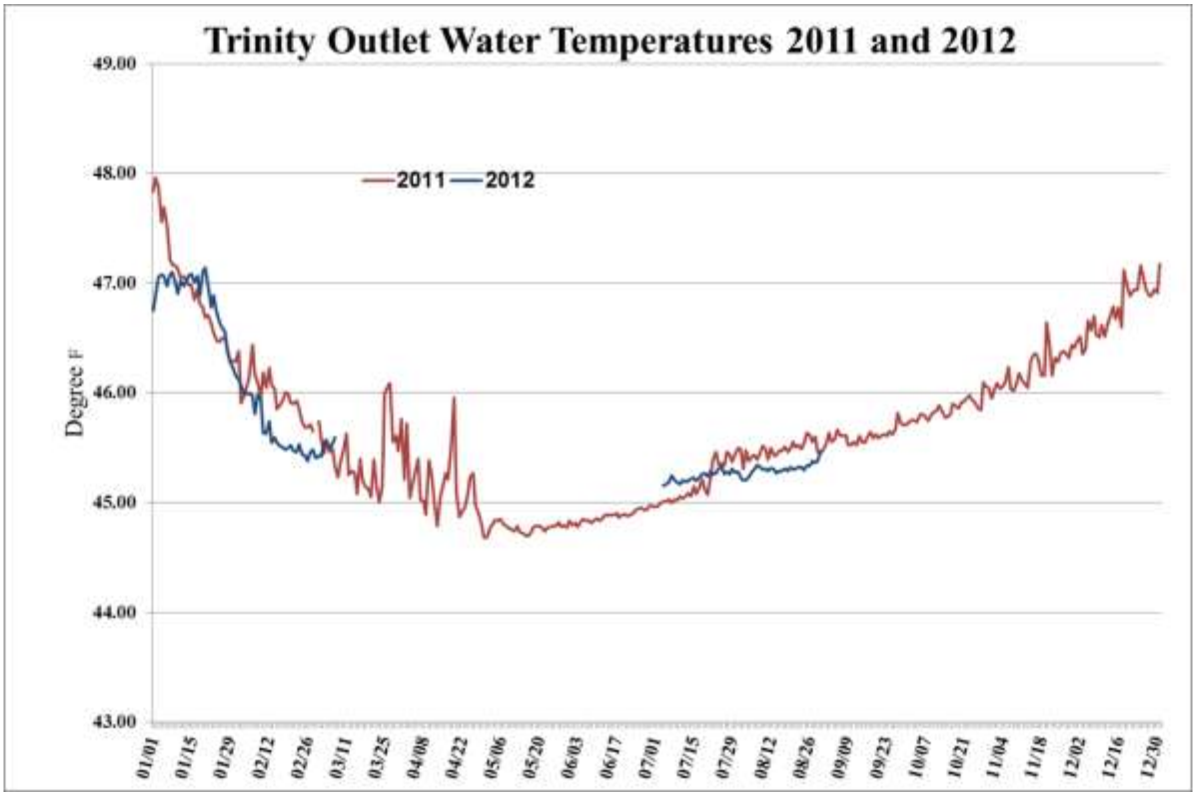

Figure 20. Trinity Dam Release water temperatures were not cooler in 2012. More data may be available by the workshop.

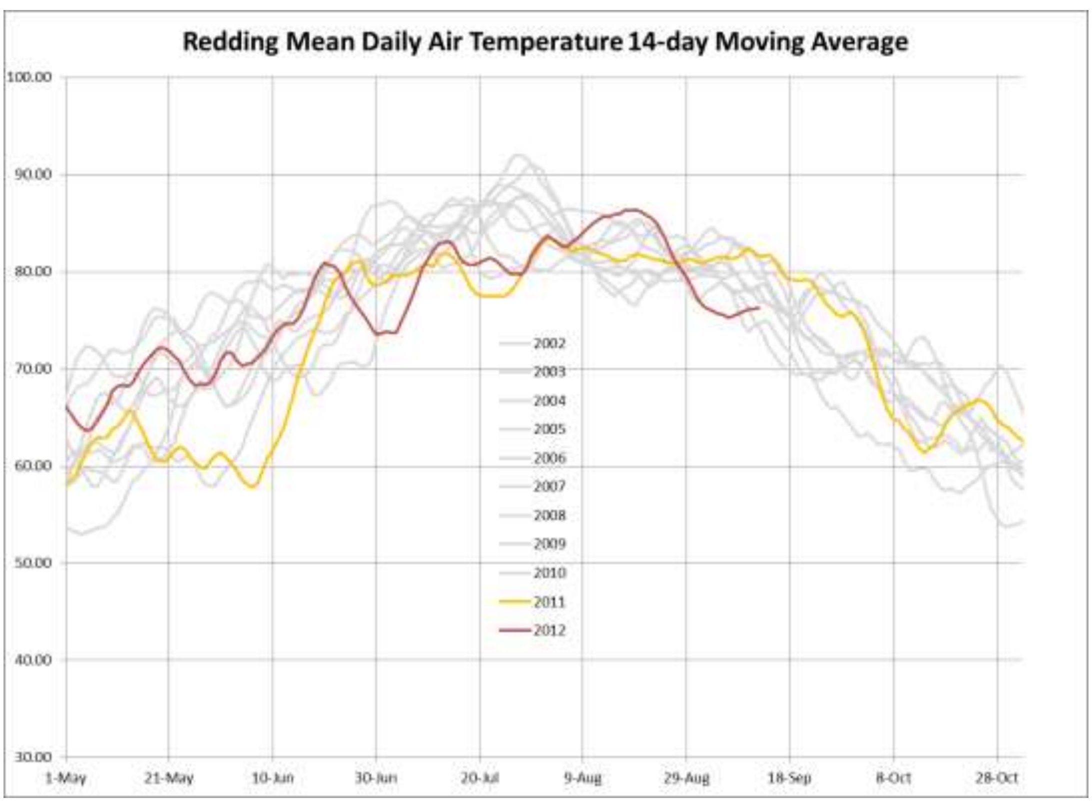

Figure 21. Redding air temperatures were not cooler in 2012 than 2011.

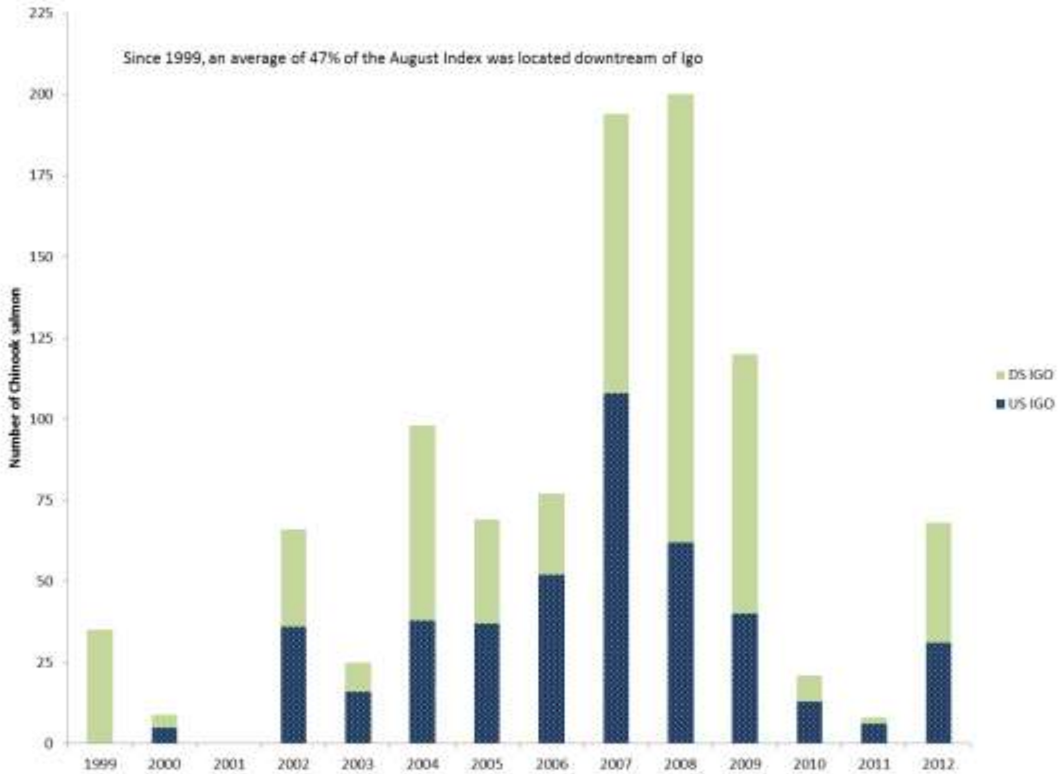

Figure 22. Since 2003 50 percent of spring Chinook holding has taken place downstream of the Igo temperature compliance point.

Figure 23. Aerial photograph of the new Clear Creek fish counting weir at the Wastewater Treatment Plant at the confluence with the Sacramento River.

Acronyms and Abbreviations

BO Biological Opinion
CDFG California Department of Fish & Game
CCTT Clear Creek Technical team
CLTO Coordinated Long-term Operationcfs Cubic feet per second
CVP Central Valley Project
CVPIA Central Valley Project Improvement Act
FWS U.S. Fish & Wildlife Service
IFIM Instream Flow Incremental MethodologyNMFS National Marine Fisheries Service
OBTC Oak Bottom Temperature curtain

Reclamation U.S. Bureau of Reclamation
rm river mile
RPA Reasonable and prudent alternative
SCTCC Spring Creek TCC
TCC Temperature control curtain

Reference

Vermeyen, T.B. (1995). "Use of Temperature Control Curtains to Modify Reservoir Release Temperatures." Proceedings, ASCE's First International Conference on Water Resources Engineering, San Antonio, Texas, August 14-18, 1995.

Vermeyen, T.B. (1997a). "Modifying Reservoir Release Temperatures Using Temperature Control Curtains." Proceedings of Theme D: Energy and Water: Sustainable Development, 27th IAHR Congress, San Francisco, CA, August 10-15, 1997.

Vermeyen, T.B. (1997b). "Use of Temperature Control Curtains to Control Reservoir Release Water Temperatures." Report R-97-09, U.S. Department of Interior, Bureau of Reclamation, Technical Service Center, Denver, CO, December 1997.

Vermeyen, T.B. (2000). "Application of Flexible Curtains to Control Mixing and Enable Selective Withdrawal in Reservoirs." Presented at the 5th International Symposium on Stratified Flows, IAHR, July 10-13, 2000, Vancouver, Canada.

<u>Appendix A</u>

Proposal from the Clear Creek Technical Team to Amend NMFS OCAP BO RPA Clear Creek Action I.1.1 Spring Attraction Flows July 18, 2012

The Clear Creek Technical Team proposes to amend the language of the National Marine Fisheries Service Operation Criteria and Plan Biological Opinion Reasonable and Prudent Alternative (RPA) Clear Creek Action I.1.1 "Spring Attraction Flows", to allow increased flexibility to aid in adaptive management. The proposal would allow the Clear Creek Technical Team to recommend to NMFS and Reclamation, changes in the timing, magnitude and duration of the spring attraction flows to better meet objectives of the Clear Creek RPA actions, additional ecosystem goals, operational constraints, and adaptive management.

Background: The objective of the flow action is to encourage spring-run Chinook to move to upstream Clear Creek habitats for holding and spawning. In these habitats spring Chinook can access a) colder water temperatures, b) large and remote holding pools, and c) newly-provided and clean spawning gravel; and d) can avoid hybridization and competition with fall-run Chinook.

Proposal: We propose the following language be added to the RPA:

The timing, magnitude, and duration of the flows are intended to provide certain hydrologic features at certain times of year to benefit spring Chinook, as explained in the Rationale. Based upon the advice of Clear Creek Technical Team and the concurrence by NMFS, the flows may be implemented with modifications to the timing, magnitude, and/or duration, as long as NMFS concurs that the rationale for the shift in timing, magnitude, and/or duration is deemed by NMFS to be consistent with the intent of the action. The timing, magnitude and duration of the pulse flows can be altered to better meet objectives of the Clear Creek RPA actions, additional ecosystem goals, operational constraints, and the needs of adaptive management.

For example, Reclamation may execute one 400 cfs and one 800 cfs pulse flow instead of two 600 cfs pulse flows to better meet the Spring Attraction Flow objectives by increasing the turbidity of the second pulse. The higher 800 cfs flow may better meet objectives of RPA Action I.1.3. "Spawning Gravel Augmentation" and RPA action I.1.2 "Channel Maintenance Flows" to improve and maintain degraded spawning habitat for Spring-run and steelhead.

<u>Rationale for 2012 amendment:</u> The amendment to Action I.1.1 is intended to provide the CCTT with more flexibility to adjust the timing, magnitude, and duration of the pulse flows based on considerations such as:

a) optimizing intended benefits to spring Chinook attraction (e.g., based on observed fish distribution, run timing and the intent of the pulse flow as described in the "Rationale," above),

b) optimizing intended benefits to spring Chinook and steelhead habitat improvement and maintenance (e.g. based on observed movement of spawning gravels, creation and

maintenance of spawning and rearing habitat and the intent of RPA Actions "Channel Maintenance Flows" and "Spawning Gravel Augmentation"),
c) Minimizing impacts to other ecosystem components such as ground nesting vertebrates, and
d) Improving operational flexibility and adaptive management.

Any change in the timing, magnitude, and/or duration of the pulse flows must provide protection to spring Chinook and critical habitat that is equal to or greater than the protection provided by the original pulse flows.

Amendment to Clear Creek RPA I.1.1 Spring Attraction Flows

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).

Rationale: In order to prevent spring-run from hybridizing with fall-run in the Sacramento River, it is important to attract early spring-run adults as far upstream in Clear Creek as possible, where cooler water temperatures can be maintained over the summer holding period through releases from Whiskeytown Dam. This action will also prevent spring-run adults from spawning in the lower reaches of Clear Creek, where water temperatures are inadequate to support eggs and pre-emergent fry during September and October.

The timing, magnitude, and duration of the flows are intended to provide certain hydrologic features at certain times of year to benefit spring Chinook, as explained in the Rationale. Based upon the advice of Clear Creek Technical Team and the concurrence by NMFS, the flows may be implemented with modifications to the timing, magnitude, and/or duration, as long as NMFS concurs that the rationale for the shift in timing, magnitude, and/or duration is deemed by NMFS to be consistent with the intent of the action. The timing, magnitude and duration of the pulse flows can be altered to better meet objectives of the Clear Creek RPA actions, additional ecosystem goals, operational constraints, and the needs of adaptive management.

For example, Reclamation may execute one 400 cfs and one 800 cfs pulse flow instead of two 600 cfs pulse flows to better meet the Spring Attraction Flow objectives by increasing the turbidity of the second pulse. The higher 800 cfs flow may better meet objectives of RPA Action I.1.3. "Spawning Gravel Augmentation" and RPA action I.1.2 "Channel Maintenance Flows" to improve and maintain degraded spawning habitat for Spring-run and steelhead.

Rationale for 2012 amendment: The amendment to Action I.1.1 is intended to provide the CCTT with more flexibility to adjust the timing, magnitude, and duration of the pulse flows based on considerations such as:

a) optimizing intended benefits to spring Chinook attraction (e.g., based on observed fish distribution, run timing and the intent of the pulse flow as described in the "Rationale," above),
b) optimizing intended benefits to spring Chinook and steelhead habitat improvement and maintenance (e.g. based on observed movement of spawning gravels, creation and maintenance of spawning and rearing habitat and the intent of RPA Actions "Channel Maintenance Flows" and "Spawning Gravel Augmentation"),
c) Minimizing impacts to other ecosystem components such as ground nesting vertebrates, and
d) Improving operational flexibility and adaptive management.

Any change in the timing, magnitude, and/or duration of the pulse flows must provide protection to spring Chinook and critical habitat that is equal to or greater than the protection provided by the pulse flows.

Appendix B

Proposal for Operation of Whiskeytown Dam Upper and Lower Releases

March 26, 2012

Whiskeytown Reservoir can release from two different levels about 80 feet apart. We request Reclamation use the upper outlet in colder months and the lower outlet in warmer months to improve both summer and winter water temperatures in Clear Creek. End of summer water temperatures have exceeded criteria set for threatened spring Chinook in the last three years. Water temperatures have also been excessive for fall Chinook during October in recent years. Using the upper outlet in colder months: 1) provides warmer water closer to the optimal temperature for developing eggs and fry, and 2) conserves colder water to be used later in the summer. Use of the lower outlet in the summer will draw from lower and colder levels of the reservoir. Due to how the reservoir is plumbed, this description is somewhat misleading. The upper valve can be used by itself for flows below 150 cfs. To achieve releases above 150 cfs while using the upper intake valve, the lower intake valve would also have to be open producing a mixture of water perhaps 50:50 from the two intakes.

The outlets were operated this way in 2009 and the resulting water temperatures measured at the base of Whiskeytown dam suggested a small improvement in water temperatures (Figure 1). Mean daily water temperature increased 0.7 F when switching to the upper outlet in March and decreased 0.38 F when switched to the lower outlet in May. While 0.5 F may not seem like much benefit, Chinook salmon eggs in laboratory studies experience a change from 0% to 100% mortality within 5 F. This suggests that an increase 0.5 F could result in a measureable increase in mortality.

We request that the upper outlet be used until it is difficult to meet the water temperature target of 60 F at Igo during the summer. We expect that the switch to the lower outlet would occur much later than in 2009 when the threshold temperature target was only 56 degrees.

Occasionally (maybe less than once a year), the Clear Creek Community Water District requests that Reclamation switch outlets when small aquatic organisms become too abundant and begin to clog their filtration system. This is the only complication we foresee. This prudent measure should have no negative impact to water supply or power generation.

Appendix C

Request for Limiting Full Power-Peaking to Periods When Water Temperatures for Listed Salmonids are Not Negatively Affected.

April 6th, 2012

This proposal requests that Reclamation only operate the Trinity, Carr, and Spring Creek powerhouses in full power-peaking mode when water temperatures for listed salmonids in the Trinity River, Clear Creek and the Sacramento River will not be negatively affected. In general water temperatures could be negatively affected from June 1 to October 31. The proposal also includes requests to evaluate and improve temperature control curtains (TCC) associated with the three watersheds.

Reclamation is required to manage regulation of water temperatures in these rivers to benefit salmonids which require cold water temperatures in the summer. Unfortunately in Clear Creek during the last three years, water temperature targets for threatened spring Chinook spawning in Clear Creek were not met 61% of the time. In the previous 8 years these water temperature targets were not met only 7% of the time. Dry weather conditions, reduced trans-basin diversions due to the Trinity River Record of Decision, and inadequate planning of the dredging of the Spring Creek arm of Keswick Reservoir have contributed to the recent poor water temperatures. Full power-peaking operations of the three powerhouses also contributed to warmer water temperatures. The power plants have three modes of power generation: 1) no power peaking is when both generators are in constant use, 2) partial peaking is when one generator is in constant use and the other is only used during daily peak generation periods, and 3) full power-peaking is when both generators are turned off for a portion of the day (Figure 1).

Reclamations Trinity River Division includes three TCCs which reduce the temperature of water delivered to the Trinity River, Clear Creek and the Sacramento River. Evaluations of these curtains by Reclamation (Vermeyen 1995) established that "Curtains have reduced temperature gains of Trinity River water diversions by 4 to 5 F during late summer and early fall (Vermeyen 1997a)," and that "For seven consecutive years, flexible curtains have been successfully used to control reservoir mixing and permit selective withdrawal (Vermeyen, 2000)."

These studies established that "Hydro-power operations have a strong influence on curtain performance. Peaking power operations increased temperature gains in Lewiston Reservoir by 3.5 F (Vermeyen 1997a)," and concluded that "Consequently, peaking power operations should be avoided for Trinity and Carr Powerplants during periods when release temperature restrictions are in effect (Vermeyen 1997b)." Full power-peaking operations were avoided for many years, apparently for these reasons. More recently however, full power-peaking is being used at times when water temperature criteria are being exceeded (Figure 1).

These Reclamation studies also established that the Oak Bottom TCC (a.k.a. Carr powerhouse TCC) produces a greater temperature benefit than the Spring Creek TCC. Unfortunately the Oak Bottom TCC has degraded and has sometimes not been deployed (Larry Ball, personal communication). Inspection of aerial photos taken during summer months (Figure 2) reveals that since 2006 the Oak Bottom curtain has been breached with a large section no longer in place.

This breach degrades performance of the curtain by allowing warm Whiskeytown water to mix with the colder Trinity River water (Tracy Vermeyen, personal communication). Therefore, we request that Reclamation repair, maintain and operate the Oak Bottom TCC to reduce water temperatures in the Sacramento River and Clear Creek.

Knowledge from the evaluation of these curtains has proven important in managing water temperatures for listed salmonids. Therefore we request evaluation of the performance of the repaired Oak Bottom TCC and the new Spring Creek TCC (replaced in 2011), including an evaluation of the impact of full power-peaking of the Spring Creek Powerhouse on Sacramento River water temperatures. We suggest that the evaluations include at least 1) deployment of temperature recorders upstream and downstream of the Oak Bottom and Spring Creek TCCs, 2) operation of the three power plants in no peaking, partial peaking and full peaking modes in succession during the summer to compare temperature gains during the three modes, and 3) review of past flow and water temperature data to determine when full power-peaking occurred and what the potential affects may have been, to guide future operations. We also request that knowledge from these studies be incorporated into reservoir operations to improve water temperatures in the Trinity River, Clear Creek and Sacramento River systems.

These actions are warranted under NMFS OCAP BO RPA sections on Clear Creek: I.1.5 "Thermal Stress Reduction" and I.1.4 "Spring Creek Temperature Control Curtain" and on the Sacramento River: I.2 .1 to I.2.4. "Shasta Operations"

Action I.1.5. Thermal Stress Reduction states:

> Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.
>
> Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of:
>
> 1) 60oF at the Igo gage from June 1 through September 15; and
>
> 2) 56oF 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.

Action I.2. Shasta Operations states:

> Objectives: The following objectives must be achieved to address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:
>
> 1) Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the

population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.

> 2) Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents…

Flow releases for both listed and unlisted salmonids using cold water from the three reservoirs are authorized under the Trinity River Record of Decision and the Central Valley Project Improvement Act (CVPIA). The CVPIA granted fish and wildlife mitigation a higher project purpose then power generation. While value may be lost due to the timing and pricing of power generation, the same amount of electricity would be generated. Reclamation does not have contractual or other commitments requiring the use of full power-peaking (Barry Mortimeyer, personal communication).

References:

Vermeyen, T.B. (1995). "Use of Temperature Control Curtains to Modify Reservoir Release Temperatures." Proceedings, ASCE's First International Conference on Water Resources Engineering, San Antonio, Texas, August 14-18, 1995.

Vermeyen, T.B. (1997a). "Modifying Reservoir Release Temperatures Using Temperature Control Curtains." Proceedings of Theme D: Energy and Water: Sustainable Development, 27th IAHR Congress, San Francisco, CA, August 10-15, 1997.

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Vermeyen, T.B. (2000). "Application of Flexible Curtains to Control Mixing and Enable Selective Withdrawal in Reservoirs." Presented at the 5th International Symposium on Stratified Flows, IAHR, July 10-13, 2000, Vancouver, Canada.

Appendix D.

Request for to WOMT for Limiting Full Power-Peaking to Periods When Water Temperatures for Listed Salmonids are Not Negatively Affected.

May 22th, 2012

Writing of this proposal was assigned to Matt Brown after discussion during the Sacramento River Temperature Task Group (SRTTG) meeting on April 19, 2012. The proposal is similar to one presented at the Clear Creek Technical Team Meeting on March 15th, 2012. Subsequent to the SRRTG meeting, Reclamation staff changed opinions on the proposal. Significant differences in opinion were:

1) **BOR:** Conditions have changed since the Reclamation studies in the 1990's. Conclusions should not be based on old studies. Further studies are required before conclusions can be made. **Others:** The changed conditions would not change the conclusions of the studies. The changed conditions make water temperatures worse and the proposal more urgent. The conclusions were already reached by Reclamation in published reports.

2) **BOR:** The group decided without dissent to continue studying the problem. **Others:** The group decided without dissent to implement the proposal. The group was explicitly asked if there was dissent and no one dissented. Many members voiced agreement with the proposal. It was stated that if there was not agreement to implement the proposal, then the disagreement and the proposal should be communicated to NMFS and the WOMT, per the RPA implementation guidelines. Either way the proposal would be discussed by the WOMT.

If SRTTG members agree to this proposal, the proposal should be forwarded to NMFS and Reclamation. "NMFS shall determine whether the proposed action is consistent with the implementation procedures in the RPA... Both the proposal and NMFS' recommendation shall be presented to the WOMT for discussion and concurrence" (NMFS OCAP BO page 582 section 4).

If the SRTTG members do not agree to the proposal, the proposal and meeting notes should be forwarded to NMFS for consideration. "NMFS will make a recommendation for action within the procedural guidelines of the RPA. NMFS will present its recommendations to the WOMT for discussion and concurrence" (IBID).

Summary of Requests:

1) Do not operate the Trinity, Carr, and Spring Creek powerhouses in full power-peaking mode from July 15 to September 30, 2012.

2) Evaluate the performance of the Trinity Division Temperature Control Curtains (TCC) and the impact of power peaking operations on water temperatures in the Trinity River, Clear Creek and the Sacramento River. Before July 15th 2012, operate the powerhouses to experiment with baseline, and full and partial power peaking operations to estimate their relative effects on water temperatures in the reservoirs and rivers.

3) Replace the Oak Bottom Temperature Control Curtain in Whiskeytown Reservoir.

Original Request:

This proposal requests that Reclamation only operate the Trinity, Carr, and Spring Creek powerhouses in full power-peaking mode when water temperatures for listed salmonids in the Trinity River, Clear Creek and the Sacramento River will not be negatively affected. In general water temperatures could be negatively affected from June 1 to October 31. The proposal also includes requests to evaluate and improve temperature control curtains (TCC) associated with the three watersheds.

Reclamation is required to manage regulation of water temperatures in these rivers to benefit salmonids which require cold water temperatures in the summer. Unfortunately in Clear Creek during the last three years, water temperature targets for threatened spring Chinook spawning in Clear Creek were not met 61% of the time. In the previous 8 years these water temperature targets were not met only 7% of the time. Dry weather conditions, reduced trans-basin diversions due to the Trinity River Record of Decision, and inadequate planning of the dredging of the Spring Creek arm of Keswick Reservoir have contributed to the recent poor water temperatures. Full power-peaking operations of the three powerhouses also contributed to warmer water temperatures. The power plants have three modes of power generation: 1) no power peaking is when both generators are in constant use, 2) partial peaking is when one generator is in constant use and the other is only used during daily peak generation periods, and 3) full power-peaking is when both generators are turned off for a portion of the day (Figure 1).

Reclamations Trinity River Division includes three TCCs which reduce the temperature of water delivered to the Trinity River, Clear Creek and the Sacramento River. Evaluations of these curtains by Reclamation (Vermeyen 1995) established that “Curtains have reduced temperature gains of Trinity River water diversions by 4 to 5 F during late summer and early fall (Vermeyen 1997a),” and that “For seven consecutive years, flexible curtains have been successfully used to control reservoir mixing and permit selective withdrawal (Vermeyen, 2000).”

These studies established that “Hydro-power operations have a strong influence on curtain performance. Peaking power operations increased temperature gains in Lewiston Reservoir by 3.5 F (Vermeyen 1997a),” and concluded that “Consequently, peaking power operations should be avoided for Trinity and Carr Powerplants during periods when release temperature restrictions are in effect (Vermeyen 1997b).” Full power-peaking operations were avoided for many years, apparently for these reasons (Figure 2). More recently however, full power-peaking is being used at times when water temperature criteria are being exceeded (Figures 1 and 2).

These Reclamation studies also established that the Oak Bottom TCC (a.k.a. Carr powerhouse TCC) produces a greater temperature benefit than the Spring Creek TCC. Unfortunately the Oak Bottom TCC has degraded and has sometimes not been deployed (Larry Ball, personal communication). Inspection of aerial photos taken during summer months (Figure 3) reveals that since 2006 the Oak Bottom curtain has been breached with a large section no longer in place. This breach degrades performance of the curtain by allowing warm Whiskeytown water to mix with the colder Trinity River water (Tracy Vermeyen, personal communication). Therefore, we request that Reclamation repair, maintain and operate the Oak Bottom TCC to reduce water temperatures in the Sacramento River and Clear Creek.

Knowledge from the evaluation of these curtains has proven important in managing water temperatures for listed salmonids. Therefore we request evaluation of the performance of the repaired Oak Bottom TCC and the new Spring Creek TCC (replaced in 2011), including an evaluation of the impact of full power-peaking of the Spring Creek Powerhouse on Sacramento River water temperatures. We suggest that the evaluations include at least 1) deployment of temperature recorders upstream and downstream of the Oak Bottom and Spring Creek TCCs, 2) operation of the three power plants in no peaking, partial peaking and full peaking modes in succession during the summer to compare temperature gains during the three modes, and 3) review of past flow and water temperature data to determine when full power-peaking occurred and what the potential affects may have been, to guide future operations. We also request that knowledge from these studies be incorporated into reservoir operations to improve water temperatures in the Trinity River, Clear Creek and Sacramento River systems.

An April 7, 2011 letter to Don Glaser highlighted the need for Reclamation to explore options to avoid non-compliance with RPA Action I.1.5 (Thermal Stress Reduction) in Clear Creek: "NMFS strongly encourages Reclamation to fully explore actions that could be taken earlier in the year to avoid potential exceedences in the future, and to proactively manage and coordinate operations within the Shasta Division to ensure timely temperature compliance on Clear Creek".

Authorities:

These actions are warranted under NMFS OCAP BO RPA sections on Clear Creek: I.1.5 "Thermal Stress Reduction" and I.1.4 "Spring Creek Temperature Control Curtain" and on the Sacramento River: I.2 .1 to I.2.4. "Shasta Operations"

Action I.1.5. Thermal Stress Reduction states:

> Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.
>
> Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of:
>
> 1) 60oF at the Igo gage from June 1 through September 15; and
>
> 2) 56oF 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.

Action I.2. Shasta Operations states:

> Objectives: The following objectives must be achieved to address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:
>
> 1) Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD

operations, projected climate change hydrology, and increased water demands in the Sacramento River system.

2) Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents…

Flow releases for both listed and unlisted salmonids using cold water from the three reservoirs are authorized under the Trinity River Record of Decision and the Central Valley Project Improvement Act (CVPIA). The CVPIA granted fish and wildlife mitigation a higher project purpose then power generation. While value may be lost due to the timing and pricing of power generation, the same amount of electricity would be generated. Reclamation does not have contractual or other commitments requiring the use of full power-peaking (Barry Mortimeyer, personal communication).

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Vermeyen, T.B. (1997b). "Use of Temperature Control Curtains to Control Reservoir Release Water Temperatures." Report R-97-09, U.S. Department of Interior, Bureau of Reclamation, Technical Service Center, Denver, CO, December 1997.

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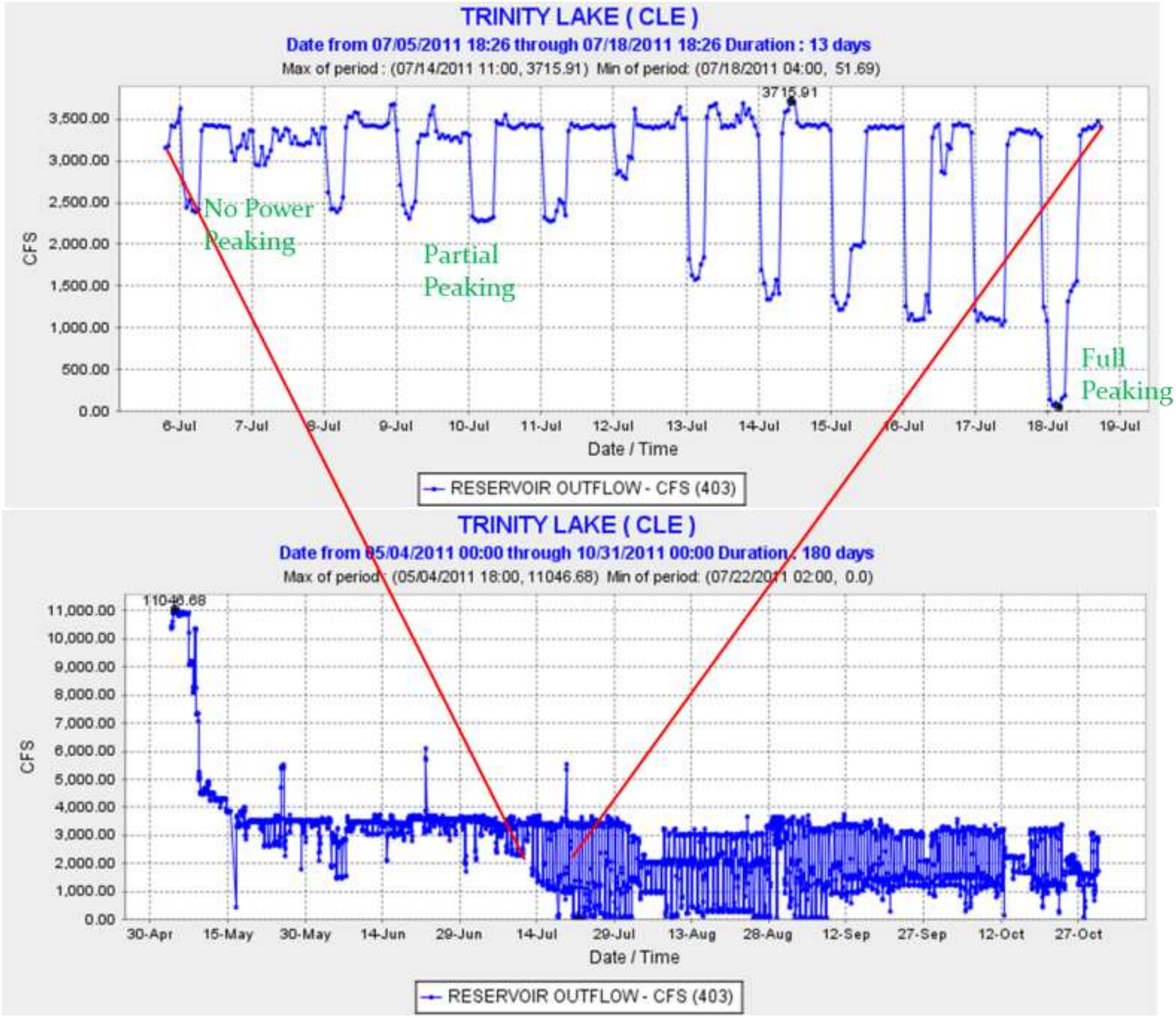

Figure 1. Examples of no peaking, partial peaking and full peaking power generation at Trinity Lake powerplant in 2011.

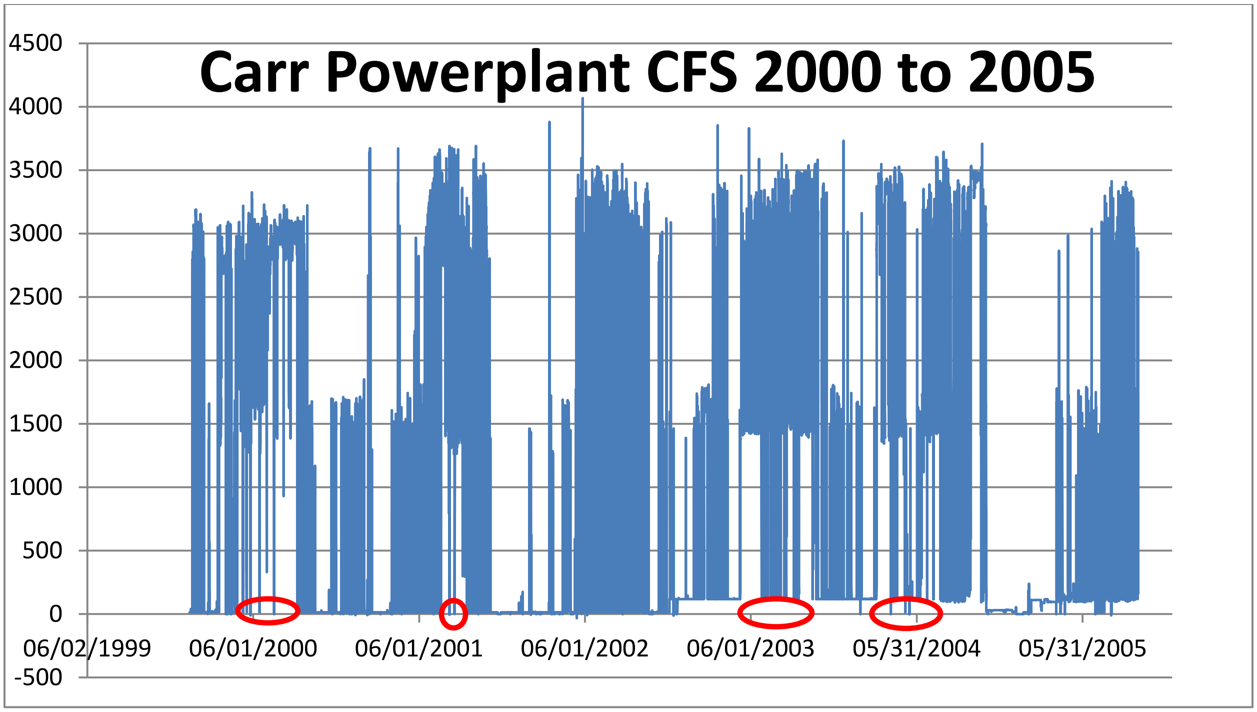

Figure 2A. Red circles suggest periods when full-power-peaking was avoided during summer.

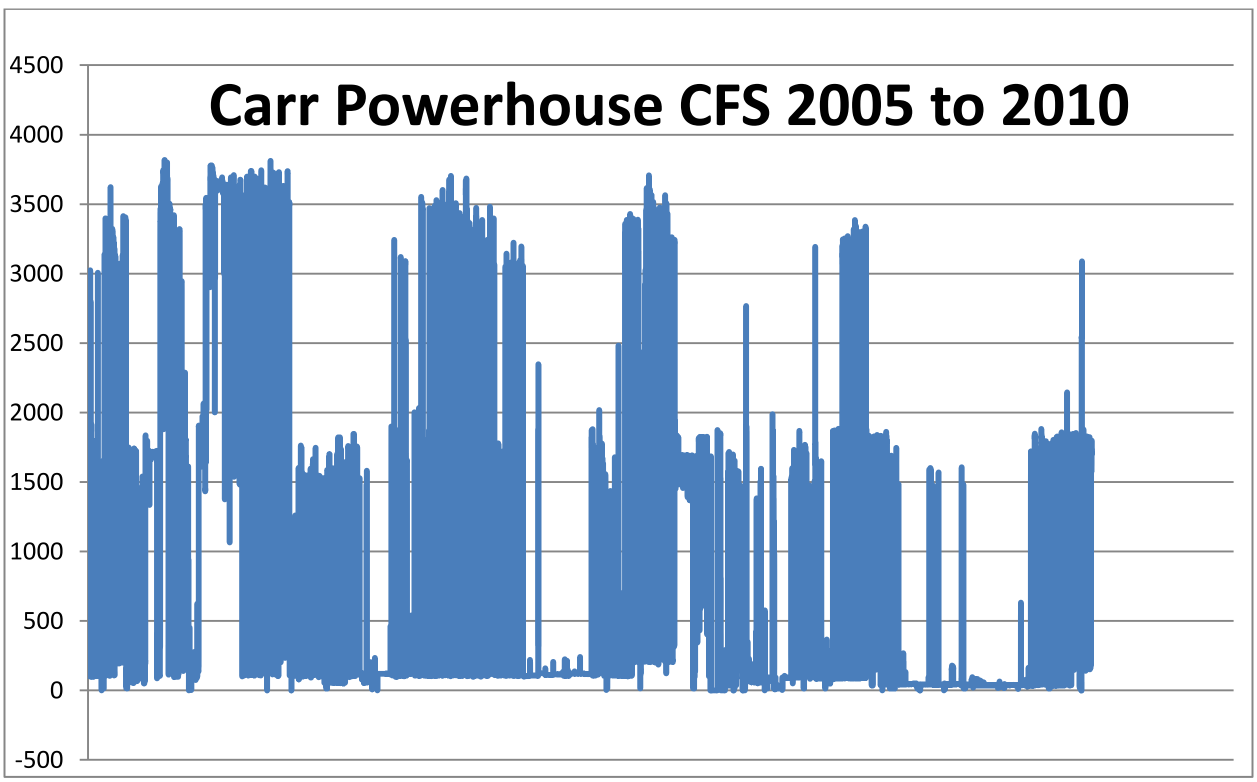

Figure 2B) Full power peaking was apparently not avoided more recently.

Oak Bottom Temperature Control Curtain Is Breached

Intact in 8/10/1998 Breached in photos since 2006

Figure 3. Summer aerial photos from Google maps since 2006 show the Oak Bottom Temperature Control Curtain is breached. Aerial from 1998 shows the intact configuration.

Appendix E

Draft Proposal to Move the Temperature Compliance Point on Clear Creek
Proposal from the Clear Creek Technical Team
June 19, 2012

The Clear Creek Technical Team proposes to **change the temperature compliance point from the Igo gage at rivermile 10.9, to the location of the spring Chinook segregation weir at rivermile 7.4,** to improve protection of spring Chinook adults and incubating eggs and over-summering O. mykiss juveniles.

Recent fish distribution and water temperature information indicate that: A) 50% of adult spring Chinook adults hold downstream of the Igo temperature gage, B) 33% of spring Chinook spawn downstream of the gage and C) 80% of O. mykiss spawn downstream of the gage and therefore most juveniles rear downstream of the gage, and D) these downstream fish are not protected by the water temperature criteria in the RPA. In addition, this change would improve conditions for fall Chinook spawning and incubation in lower Clear Creek. Informal temperature targets of 56 degrees at the bottom of the fall Chinook spawning reach, have not been met in recent years.

Recently temperature compliance targets for spring Chinook spawning and incubation from September 15 to October 31 have not been met in the last three years. Therefore it is worth considering if using a more difficult control point further downstream is warranted. However, several actions may be taken in the future that could improve Clear Creek water temperatures:

> 1) Improvement of the Oak Bottom Temperature Control Curtain would reduce water temperatures;
>
> 2) Reclamation may avoid full-power peaking during times when water temperatures are deleterious for listed salmonids; this has been shown to improve water temperatures.
>
> 3) Water releases in September and October may be increased due to the reduced threat of stranding after October 31; increased releases would improve water temperatures.
>
> 4) Use of the upper Whiskeytown outlet until water temperatures get hot may conserve colder water that could be accessed by switching to the lower outlet; A small decrease in water temperature has been observed in the past.
>
> 5) Development of water temperature models integrating operations of the Trinity and Shasta Divisions may improve operations for temperature control;
>
> 6) Evaluation of the Trinity division temperature control curtains may suggest further temperature improvements;

In addition, although it may not be possible to meet the temperature target in some years, in the other years there would be more benefit or production of spring Chinook. You have to hope the good years outweigh the bad. You make the good years better for the fish that are downstream of Igo and weather it in the bad years. Otherwise you are subjecting fish to deleterious water temperatures unnecessarily in the good years. Maximize the amount of habitat with suitable water temperatures in every year, not just the bad ones.

This change would affect the National Marine Fisheries Service (NMFS) Operation Criteria and Plan (OCAP) Biological Opinion (BO) Reasonable and Prudent Alternative (RPA) Clear Creek Action I.1.5 “Thermal Stress Reduction”, which prescribes water temperature targets at Igo.

The change could be implemented under RPA Clear Creek Action I.1.6 “Adaptively Manage to Habitat Suitability/IFIM Study Results” which prescribes flows to provide suitable water temperatures. The plan required under I.1.6 is due “September 30, 2012, or until 6 months after current Clear Creek salmonids habitat suitability (e.g., IFIM) studies are completed, whichever occurs later”. It would be advantageous and adaptive to work on this potential change now before I.1.6 is due so that it could be implemented and inform the final I.1.6 flow recommendation.

Reservoir release changes could be managed using either a new telemetered temperature gage near the weir or using a temperature model to estimate temperatures at the weir based on the Igo gage.

Appendix F

Fall Flow Prescription to Avoid Redd Dewatering
Revised June 1, 2012

Objectives: Prescribe flows to: 1) meet temperature control objectives for spring Chinook spawning September 15 to October 31, 2) provide steelhead spawning flows based on weighted usable area from December through June, 3) avoid dewatering of fall Chinook and steelhead redds, and 4) provide inter-annual variability in minimum instream flows based on hydrologic conditions.

Prescription: Maintain minimum Whiskeytown Dam releases from October 31 to May 31, at levels released during the spring Chinook spawning period of September 15 to October 31st. This results in increased releases in years with hotter water temperatures during spring Chinook spawning.

Background: Whiskeytown Dam releases provided to meet the 56 F temperature objective at Igo from September 15 to October 31 (Blue oval in Figure 1), can be higher than the 200 cfs currently provided October 1 to May 31st for fall Chinook and steelhead spawning habitat (Green oval in Figure 1). Decreasing flow releases after the temperature control period ends on October 31st can dewater redds. For instance, stream surveys in fall 2011 observed that many fall Chinook redds were or would have been dewatered. Reservoir releases were partially maintained to minimize dewatering. Maintaining higher releases to fully protect these fall Chinook redds would have required additional flows until March when the last fry emerged from redds. Reducing flows in March could dewater steelhead redds which are created from early December through March. Maintaining higher releases to protect steelhead redds would have required additional flows through May when the last fry emerged. To avoid impacting Chinook and steelhead, releases would have to be maintained at spring Chinook spawning levels through May 31st. Therefore, without additional water, this difference in spring Chinook temperature control releases and spawning habitat releases results in negative impacts to fall and late fall Chinook and steelhead.

This situation can negatively impact spring Chinook temperature compliance and potentially negatively affect spring Chinook spawning success. In the past 3 years, the 56 F temperature criteria in Clear Creek has not been met. Higher flows could have been provided to try to meet the criteria, but would have either increased impacts on Chinook and steelhead or incurred higher water costs. This impact on spring Chinook could be reduced or eliminated by increasing releases in hotter years.

Potential Approaches:

1) Ramp down releases as temperatures decrease- spring and fall Chinook redds may be dewatered
2) Ramp down releases as accretions increase- this would further reduce variability of the hydrograph. (Conditions in fall 2011 were dry and there were no accretion flows. Before Whiskeytown Dam, base flows at Igo would increase after October 1 in more than 90% of years. After Whiskeytown Dam base flows at Igo don't increase as much).
3) Ramp down releases from November 1 to November 30- this would dewater fall Chinook redds.
4) Maintain higher releases from October 31 to May 31 at same levels provided during spring Chinook spawning. Recent draft IFIM results indicate that these higher flows provide more spawning habitat for Chinook and steelhead.
5) Prescribe higher releases every year for Chinook and steelhead spawning through May31.

Considerations:

Spawning releases for Chinook and steelhead may be increased based on recent IFIM studies. The above approaches would still be relevant. For instance if fall Chinook spawning flows are increased to 225 cfs, there will still be years with higher spring Chinook temperature control flows.

Spring Chinook redds could be dewatered in future years due to decreases in reservoir release. Spring Chinook spawn in areas with fewer accretions, than fall Chinook.

Maintaining higher releases in hotter years provides more variability in flows between years.

How significant is the dewatering from reductions in reservoir release?

Are the B2 water costs of maintaining higher releases acceptable? What are the foregone benefits in other B2 watersheds?

Are there temperature impacts of maintaining higher releases?

Are there operational impacts of maintaining higher releases?

Discussion:

Approaches 4 and 5 have the highest biological benefits and be easiest to implement. Approach 4 would have a lower water cost than 5 and would increase inter-annual variability. I would like to get more references on flow variability related to costs and benefits to salmon or the ecosystem upon which they depend.

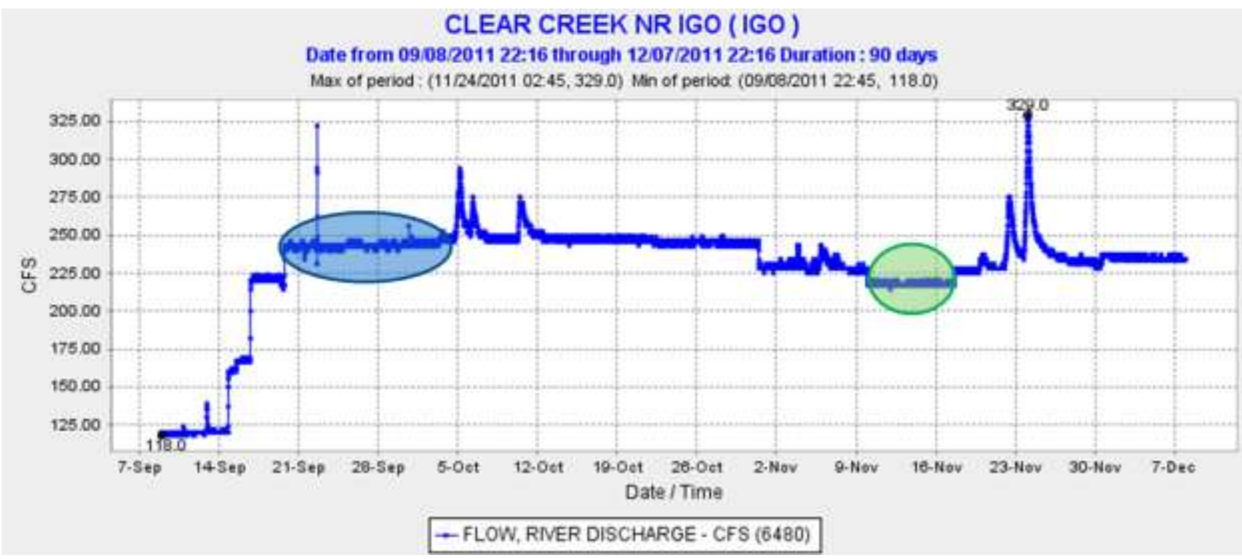

Figure 1. Clear Creek hydrograph at Igo Gage in later 2011. Blue oval indicates period of spring Chinook spawning. Green oval indicates period of 200 cfs spawning release.