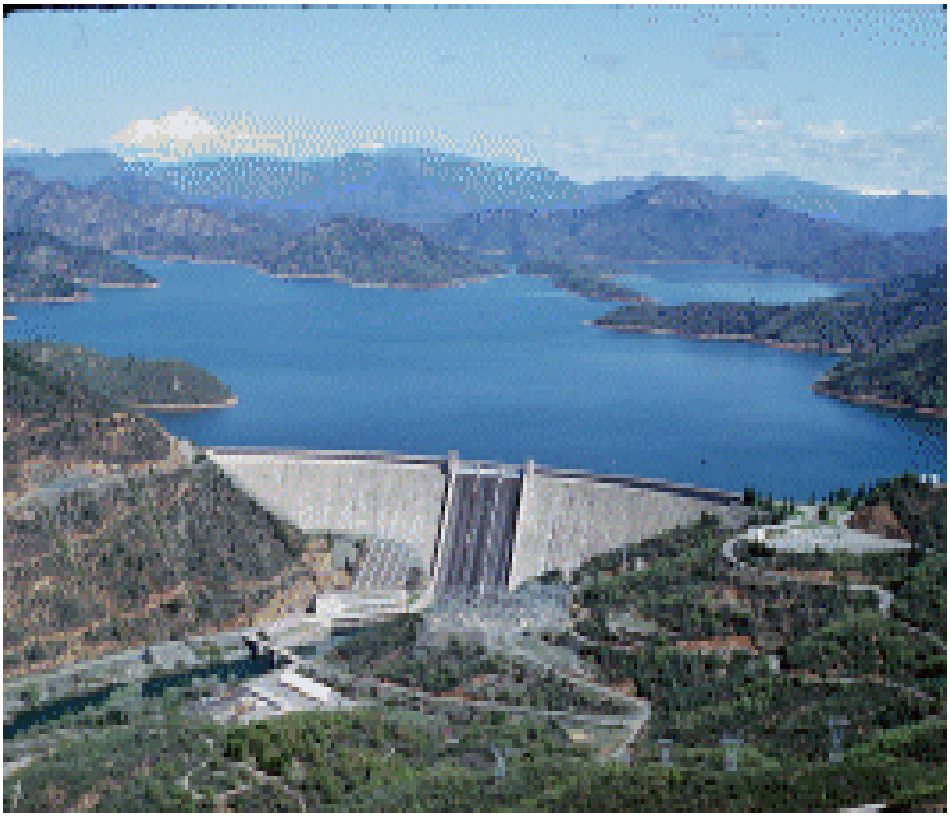
Sacramento River Temperature Task Group



Annual Report

October 1, 2010, through September 30, 2011

Acronyms:

BiOp	Biological Opinion
BND	Bend Bridge compliance point
BSF	Balls Ferry compliance point
CDFG	California Department of Fish & Game
CDEC	California Data Exchange Center
CVPIA	Central Valley Project Improvement Act
cfs	cubic feet per second
CVP	Central Valley Project
DWR	California Department of Water Resources
EOS	End-of-September
ESA	Endangered Species Act
FWS	U.S. Fish & Wildlife Service
JLF	Jellys Ferry compliance point
maf	million acre feet
NMFS	National Marine Fisheries Service
NASA	National Aeronautics and Space Administration
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
SRTTG	Sacramento River Temperature Task Group
SWRCB	State Water Resources Control Board
taf	thousand acre feet
TCD	temperature control device (Shasta Dam)
TCP	temperature compliance point
WAPA	Western Area Power Administration
WR	Water Rights Order

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Chapter 1. Background

This document describes the water year (WY) 2011 actions taken in the upper Sacramento River by the Sacramento River Temperature Task Group (SRTTG) to meet the requirements of NOAA's National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) biological opinions (BiOps) concerning the Central Valley Project (CVP) and State Water Project (SWP) long-term operations. Full accounting for WY 2011 has not yet been completed; therefore, this report only describes the actions taken in a qualitative format.

The objectives of the May 15 through October 31 Sacramento River instream temperature criteria are to manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run Chinook salmon, spring-run Chinook salmon, California Central Valley steelhead, and the Southern Distinct Population Segment of North American green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for the following year's cohort. In addition, to the extent feasible, another objective is to manage for suitable temperatures for naturally spawning fall-run/late-fall-run Chinook salmon.

Depending on carryover storage, water year type, and fish distribution, the SRTTG advises the U.S. Bureau of Reclamation (Reclamation) on the best course of action to take based on fish surveys, real-time data, and temperature modeling. In many years, it is not possible to attain 56° Fahrenheit (F) at Bend Bridge, and the SRTTG will advise that the temperature compliance point (TCP) be established further upstream. This was the case in both 2009 and 2010.

A. Membership

The SRTTG consists of representatives from Reclamation, FWS, NMFS, California Department of Fish and Game (CDFG), State Water Resources Control Board (SWRCB), Western Area Power Administration (WAPA), and the Hoopa Tribe. Other agencies have participated in the past and may be added to the SRTTG, provided existing agencies approve of the addition in membership. SRTTG member agencies and the lead contacts are:

US Bureau of Reclamation (Reclamation)
Peggy Manza
Russ Yaworsky
Rod Wittler
Stacey Smith

National Marine Fisheries Service (NMFS)

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U.S. Fish & Wildlife Service (FWS)
Nick Hindman
Craig Anderson
Jim Smith
Matt Brown

California Dept. of Fish & Game (CDFG)
Alice Low
Mike Berry

State Water Resource Control Board (SWRCB)
Kari Kyler

Western Area Power Administration (WAPA)
Tom Patton

Hoopa Valley Tribe
Robert Franklin

Chapter 2. Summary of Actions and Results

The purpose of the SRTTG is to provide advice to Reclamation on managing water temperatures downsteam of CVP reservoirs in the Sacramento River, Trinity River and Clear Creek. The SRTTG deals with the short-term operational aspects of reservoir management such as coordinating real-time operations. The Clear Creek Technical Team plans and implements long-term restoration actions and reports on such things as pulse flows, gravel augmentation, and channel forming flow required in the NMFS BiOp. It also coordinates monitoring for these actions. The SRTTG reports on the temperature requirements as specified in the State Water Resource Control Board (SWRCB) Water Rights Order (WR) 90-5 and also the required actions described in NMFS' 2009 reasonable and prudent alternative (RPA) with 2011 amendments. Both groups coordinate their actions with the B2 Interagency Team which manages the use of CVPIA (b)2 water in CVP reservoirs.

The SRTTG used historical data, the latest modeled water temperatures, operator experience, and the latest biological data available to adaptively manage water releases from Shasta, Trinity and Whiskeytown Reservoirs. A salmon decision process (Appendix C) was used as initial guidance in prioritizing actions. On the Sacramento River, due to initial reports of low winter-run Chinook spawners in the aerial redd surveys (Figure 11) and carcass surveys, the SRTTG tried to

protect as much of the spawning habitat downstream as possible by managing to a water temperature of 56°F to provide as much opportunity for spawning and to limit any adverse temperature effects. Given that this WY was considered one the best for maximizing the cold water pool in Shasta Reservoir (*i.e.*, high storage and inflows), the SRTTG set the TCP as far downstream as physical capacity exists, using the temperature control device (TCD) on Shasta Dam to the maximum extent.

There were eight SRTTG meetings/calls on; 5/17/11, 5/25/11, 6/9/11, 6/22/11, 7/20/11, 7/29/11, 8/18/11, and 9/22/11. The first 2 meetings discussed operational forecasts and water temperature modeling results for the year in the Sacramento River, Trinity River, and Clear Creek. A draft temperature control plan to the SWRCB was reviewed. The next meetings dealt with operational issues, forecasting, and the need to adjust the TCP on the Sacramento River based on near real-time monitoring information and variations from average meteorological conditions (note: historical averages are used for tributary flows where gauges are not maintained). There was one emergency call dealing with the use of the Keswick spillway instead of the powerhouse, and the last meetings dealt with Clear Creek temperature compliance.

A. Clear Creek

RPA 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 June 2011.
Result: This action was completed in June 2011, with unknown temperature improvements from June through September when Trinity River diversions are typically at their highest.

RPA 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^{o}F at the Igo gage from June 1 through September 15; and

2) 56^{o}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.

Result: Daily mean water temperatures were met up until September 15, and then exceeded the last two weeks in September.

B. Sacramento River

RPA Action 1.2.1. Shasta Operation Performance Measures

Action: The following long-term performance measures shall be attained. Reclamation shall track performance and report to NMFS at least every 5 years. If there is significant deviation from these performance measures over a 10-year period, measured as a running average, which is not explained by hydrological cycle factors (*e.g.,* extended drought), then Reclamation shall reinitiate consultation with NMFS.

Performance measures for EOS carryover storage at Shasta Reservoir:
87 percent of years: Minimum EOS storage of 2.2 MAF
82 percent of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
40 percent of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly's Ferry compliance point in following year)

Measured as a 10-year running average, performance measures for temperature compliance points during summer season shall be:
Meet Clear Creek Compliance point 95 percent of time
Meet Balls Ferry Compliance point 85 percent of time
Meet Jelly's Ferry Compliance point 40 percent of time
Meet Bend Bridge Compliance point 15 percent of time

Result: The end-of-April storage was 4.0 MAF allowing at least a Balls Ferry TCP early in the year. In April the EOS storage was forecasted to be 2.79 MAF, however, the actual storage increased to 4.42 MAF by May 15 allowing a Jelly's Ferry TCP for the rest of the year.

RPA Action 1.2.2. Fall Actions, Keswick Releases (November – February)

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as detailed below.

RPA Action 1.2.2 A. EOS Storage at 2.4 MAF or Above

Action: A workgroup shall consider and the following criteria by November 1 each year in developing a Keswick release schedule:

1) Need for flood control space: A maximum 3.25 MAF end-of-November storage is necessary to maintain space in Shasta Reservoir for flood control.

2) Need for stable Sacramento River level/stage to increase habitat for optimal spring-run and fall-run redds/egg incubation and minimization of redd dewatering and juvenile stranding.

3) Need/recommendation to implement USFWS' Delta smelt Fall X2 action as determined by the Habitat Study Group formed in accordance with the 2008 Delta smelt Opinion.

Result: Since EOS storage in Shasta was above 2.4 MAF the above criteria applied.

RPA Action 1.2.3. February Forecast Keswick Releases (March – May 15)
Action: NMFS reviews forecast and allocations for consistency with temperature management. Reclamation must maintain a TCP not in excess of 56°F between Balls Ferry and Bend Bridge between April 15 and May 15.

RPA Action I.2.3.B Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Only Balls Ferry Compliance or 2.2 MAF EOS, but Not Both, Is Achievable

1) On or before February 15, Reclamation shall reduce Keswick releases to 3,250 cfs, unless NMFS concurs on an alternative release schedule. This reduction shall be maintained until a flow schedule is developed per procedures below.
2) In coordination with NMFS, by March 1, Reclamation shall develop an initial monthly Keswick release schedule, based on varying hydrology of 50 percent, 70 percent, and 90 percent (similar in format to the fall and winter action implementation procedures – see table above). These schedules shall be used as guidance for monthly updates and consultations.
3) Based on this guidance, Reclamation shall consult with NMFS monthly on Keswick releases. Reclamation shall submit a projected forecast, including monthly average release schedules and temperature compliance point to NMFS every month, within 7 business days of receiving the DWR runoff projections for that month. Within 3 business days of receiving this information from Reclamation, NMFS will review the draft schedule for consistency with the criteria below and provide written recommendations to Reclamation.
4) The initial monthly Keswick release schedule, and subsequent monthly updates, shall be developed based on the following criteria and including the following actions:
   a) Maintain minimum monthly average flows necessary to meet nondiscretionary delivery obligations and legal requirements.
   b) Provide for flow-related biological needs of spring life stages of all species covered by this Opinion in the Sacramento River and Delta, to the greatest extent possible.
   c) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:
      - CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick Dam release (or other planned release based on biological needs of species); and
      - if it is necessary to curtail combined exports to values more restrictive than 2000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom Dam; and
      - in general, Reclamation shall increase releases from Keswick Dam as a last resort.
      - Based on improvements in updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

Results: Reclamation maintained a minimum Balls Ferry TCP during this time period. Reclamations' forecast for EOS storage was 2.169 MAF, which triggered the above implementation procedures. Initially, the B2 Interagency Team met and recommended holding Keswick releases at 4,000 cfs. NMFS, with support from the FWS and CDFG, recommended an alternative release schedule for Reclamation to maintain Keswick Dam releases at 4,000 cfs to minimize dewatering of fall and late fall-run Chinook salmon redds, in addition to stranding of rearing winter-run, spring-run, and steelhead. Reclamation eventually discontinued cutting back releases to conserve storage and held releases at 3,900 cfs. This issue is discussed further in Chapter 3.E, "Maintaining flows to reduce impacts to salmonids," below.

RPA Action 1.2.4. Keswick Release Schedule (May 15 –October)
Action: Reclamation shall develop and implement an annual Temperature Management Plan by May 15 to manage the cold water supply within Shasta Reservoir and make cold water releases from Shasta Reservoir and Spring Creek to provide suitable temperatures for listed species, and, when feasible, fall-run.

Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

1) Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.

2) Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

3) As part of the adaptive management process, and in coordination with NMFS, by March 2010, Reclamation shall fund an independent modeler to review these procedures and the recommendations of the Calfed Science Panel report on temperature management and recommend specific refinements to these procedures to achieve optimal temperature management.

Results: The SRTTG recommended a TCP at Balls Ferry until June 1, and then Jellys Ferry until October 31. Reclamation maintained 56°F at the TCP from May 15 – present. Reclamation has not yet funded a modeler to refine this procedure (action #3).

Chapter 3. Issues

A. Use of Keswick spillway

On July 29, the SRTTG had an emergency call to discuss the WAPA proposal to bypass the power penstocks at Keswick Dam for the following 6 weeks and divert all releases through the

spillway to the Sacramento River. A strategy was needed to bypass power generation since the power lines did not have enough transmission capacity. The SRTTG considered several alternatives, since a spillway release was likely to attract adult winter-run Chinook salmon away from the ladder and fish trap. In addition, releasing water through the spillway could result in supersaturated oxygen conditions, which could negatively impact developing eggs and newly emerging fry downstream. Alternatives considered were use of the Carr and Trinity Powerplants, and ramping rates at Keswick Dam if the spillway was used. The use of the Carr Power House was determined to have the least adverse effects to all life stages and all fish present below the dams. No water was released through the Keswick spillway.

B. NOAA/NASA Temperature Model

During last year's annual review on November 8-9, 2010, the NMFS-Southwest Fisheries Science Center presented a NOAA/NASA Temperature Model that predicts real-time water temperatures in the Sacramento River. Use of the NOAA/NASA Temperature Model was supported by the independent review panel in its December 9, 2010, report, specifically, "Improved temperature predictions were demonstrated by the NOAA/NASA study which should replace the concept of temperature compliance points with continuous spatial temporal predictions of temperature in the river and tributaries of the Central Valley. Linking the predictions from models with temperature and precipitation across seasonal and yearly scales should vastly improve the efficacy of within year and across year decisions on allocations of cool water resources in the system." The temperature model was presented at a meeting on June 22, 2011. Attendees from previous presentations of the model had comments from both the operators of Shasta Dam and the SRTTG (ultimate users of the model). In 2011, the model was not completed until the end of temperature control season, therefore it was not used this year. The recommendation of the SRTTG was to put the model through a 1-year pilot period starting in 2012. Initial thoughts at the presentation in June was that the new model would be helpful in real-time temperature management decisions because it incorporated the latest weather data and showed temperature effects on a finer scale. The model is up and running in real time at the following website: http://161.55.160.14/stream/stream.html

C. Fall X2 actions and flood control releases (cold water storage issue)

The FWS' BiOp on delta smelt has an RPA action that calls for maintaining a certain X2 (salinity requirement) in the Sacramento/San Joaquin River Delta during the fall of any year classified as a "wet year." Since 2011 was the first year that the RPA condition was met following the issuance of the FWS' BiOp on December 15, 2008, Reclamation intends to meet the requirement through increased releases and reduced exports. The Fall X2 action was modeled early in May. The Fall X2 action was included in the forecast used for the initial water temperature runs (both at the 50 and 90 percent probability of exceedance). Due to most of the

CVP and SWP reservoirs being in flood control operations during the fall as a result of high storage conditions throughout the summer, this action is not likely to have an impact on storage. However, if hydrologic conditions are dry in water year 2012, there could be an impact on Shasta Reservoir storage and its cold water pool volume.

D. Operational difficulties from tributary side flows

This spring, considerable warming of the Sacramento River occurred from the high runoff associated with tributaries just downstream of Keswick Dam (*i.e.*, Clear, Battle, Cow, and Cottonwood creeks) due to a late snow melt. The effect of this tributary runoff on mainstem Sacramento River water temperatures is difficult to model because there are no water temperature gauges on these streams. In this case, the SRTTG relies on historical average tributary flows for modeling purposes and real-time operator experience in managing the TCD on Shasta Dam to effectively overcome this effect. The ability to change the TCP and to conserve colder water early in the year gives the ability to gradually distribute cold water releases over the course of the summer and into to fall. Operators are also able to adjust diversions from the Trinity River into Keswick Reservoir, which has a greater cooling effect early in the year versus later in the fall.

E. Maintaining flows to reduce impacts to salmonids

Starting in November, after the temperature control season ends, Shasta releases are typically ramped down to conserve storage for the following year, consistent with the intent of the NMFS BiOp. However, a conflict arises in trying to protect spawning fall/late fall-run Chinook salmon (see RPA action 1.2.2.A). Eggs that are deposited in November can be dewatered as flows decrease in December and January. A study was initiated in 2011 by DFG that documented Chinook salmon redd dewatering in December and January 2010. Late fall-run Chinook salmon can spawn as late as February in the Sacramento River. In February 2011, Reclamation issued a draft February forecast that indicated an EOS Shasta storage volume of 2.169 MAF, which triggered implementation of Action I.2.3.B. In the interest of complying with the action, Reclamation informed the fish agencies of its intent to reduce releases out of Keswick Dam to 3,250 cfs as soon as possible. In an effort to reduce the loss of fall-run and late fall-run Chinook salmon redds, in addition to rearing winter-run, spring-run, and CV steelhead, NMFS and FWS recommended using CVPIA (b)2 water to stabilize releases through February. At that time, Reclamation was reluctant to maintain the higher releases because it might reduce the ability to conserve cold water through the summer and, therefore, issued a change order to reduce releases. Ultimately, it boiled down to the ability to accurately forecast the next 6 months, and the risk of reducing negative effects of operations in real time, compared to the modeled and forecasted potential challenges to the cold water pool and effects on winter-run in subsequent months. NMFS, with support from the FWS and CDFG, was willing to take the risk so early in the

season, and therefore, proposed an alternative release schedule, that is, for Reclamation to hold the Keswick Dam releases at 3,900 cfs. Reclamation ultimately accepted the alternative schedule and maintained releases of 3,900 cfs out of Keswick Dam. In the end, the alternative release schedule ended up being a win-win situation. Negative effects to salmonids in the upper Sacramento River were minimized, and as a result of increased precipitation throughout the spring, not only did Shasta Reservoir approach maximum capacity, but at one point, Reclamation had to increase flood management releases to 50,000 cfs. Real-time operations decisions in consideration of future beneficial or adverse effects would benefit from the use of accurate long-term hydrologic forecasts for the upper Sacramento River basin.

Chapter 4. Summary of Operations

Initial carryover storage in Shasta Reservoir was 3.31 MAF at the beginning of water year 2011, and the year was classified as a "wet year" following 3 years of drought. In April, due to high inflows into Shasta Reservoir, Reclamation made flood control releases to the Sacramento River (Figure 1). A late spring and heavy runoff from the tributaries downstream of Keswick Dam contributed to higher than normal river levels going into the temperature control season. Due to the high initial storage, Reclamation's temperature model forecasted a compliance point 34 miles downstream of Keswick Dam at Jellys Ferry was attainable all summer (Figure 4). Setting the TCP at Bend Bridge (42 miles downstream) was shown to exceed the 56ºF criterion by 2ºF through much of June and July in the model runs (Figure 3 and 4). However, since the tributaries downstream of Keswick Dam were contributing large amounts of warm water due to the late spring snow melt, the SRTTG set the TCP in May at Balls Ferry (26 miles downstream) in order to conserve cold water. In May, winter-run Chinook salmon typically have not started spawning and, therefore, setting the TCP at Balls Ferry was not likely to negatively affect spawners. After June 1, the SRTTG advised Reclamation to change the TCP to Jellys Ferry for the rest of the season (NMFS BiOp requires temperature control from May 15 through October 31).

Clear Creek modeled water temperatures showed that 60ºF (NMFS criterion) was attainable until September 15 when the criterion in the NMFS BiOp changes to 56ºF (Figure 6). After September 15, modeling showed about a 2-week period when water temperatures were likely to be exceeded by 1-2ºF (Figure 6). By this time of year diversions from the Trinity River through Carr Power House decrease, causing a longer retention time in Whiskeytown Reservoir (Figure 7). Water temperatures at the Whiskeytown outlet were compared to the amount of water diverted from the Trinity River for the last 6 years. Temperature criteria were achieved in 2006 through 2008, but they were not achieved in 2009 through 2011, perhaps due to reduced diversions from the Trinity River in the last 3 years. As part of the NMFS BiOp (RPA Action I.1.4), the temperature control curtain in Whiskeytown Reservoir was replaced in June 2011. In an effort to control Clear Creek water temperatures in real-time, the SRTTG recommended

several flow increases from Whiskeytown Dam and changing the release point to the lowest river outlet. Despite these efforts, the 56ºF criterion was exceeded for 2 weeks in September until ambient air temperatures cooled down the water downstream of Whiskeytown Dam in the creek (Figure 8).

Modeled water temperatures in the Trinity River showed that compliance with the SWRCB WR 90-5 temperature requirements was possible all year due to high reservoir storage and sufficient cold water pool in Trinity Reservoir (Figure 9). Actual observed water temperatures in water year 2011 were under the criteria all year (Figure 10).

Chapter 5. Assessment and Monitoring Activities (see also Appendix B)

Location	**Time Period**
56 F Sacramento River @ Balls Ferry	April to May 31
56 F Sacramento River @ Jellys Ferry	June 1st to October 31
60 F Trinity River @ Douglas City	June 1st to September 15
60 F Clear Creek @ Igo	June 1st to September 15
56 F Clear Creek @ Igo	September 15 to October 31

The SRTTG was able to effectively implement EOS storage actions and adaptively manage water temperatures in the upper Sacramento River while meeting the SWRCB water temperature criteria with only minor exceedances of less than 1ºF for less than three days. These exceedances were not likely to cause harm to the various life stages of salmonids and sturgeon present (*i.e.*, egg, pre-emergent fry, fry, juveniles, smolts and adults). No winter-run Chinook salmon were observed spawning below the 56 ºF TCP at Jellys Ferry in 2011 (Figure 11). Clear Creek water temperatures at Igo continue to exceed the water temperature criteria (Action I.1.5) between September 15 and October 15. A temperature model for Whiskeytown Reservoir and the effects of water operations should be developed, pursuant to RPA Action I.1.5 in the NMFS BiOp. Such a model would improve the ability of the SRTTG to assess water temperatures in Clear Creek. However, no schedule for model development has been identified. Given the high storage levels in Trinity Reservoir this year, water temperatures in Clear Creek should not have been a problem.

Coordination of real-time operations with input from the SRTTG was effective, as seen in the Keswick spillway emergency. An effective alternative was chosen with minimal or no adverse impacts to downstream fisheries. The SRTTG used the best available tools (*e.g.*, up-to-date modeling, latest surveys, and decision process) to implement the RPA actions. In the future, the SRTTG will test the use of the new NASA model on the Sacramento River to see if it would further improve real-time temperature management.

Chapter 6. Requests for feedback from the Independent Review Panel

1) The RPA actions dealing with temperature criteria in Clear Creek could be improved by developing a model for Whiskeytown Reservoir that includes alternative operations like seasonal shifts in Trinity River diversions to maintain cold water moving through the reservoir to the Sacramento River.

2) An evaluation of the effectiveness of the new Spring Creek temperature curtain (*i.e.*, before and after repairs were made) should be conducted to improve the model above.

3) Real-time operational decisions concerning the EOS carryover storage in Shasta Reservoir (*e.g.*, reducing fall flows to conserve storage) would benefit from the use of long-term (6-8 month) hydrologic projections.

4) The Decision Criteria document for the Sacramento River Water Temperature Management should be updated to be consistent with the NMFS 2009 BiOp.

Figures 1-11:

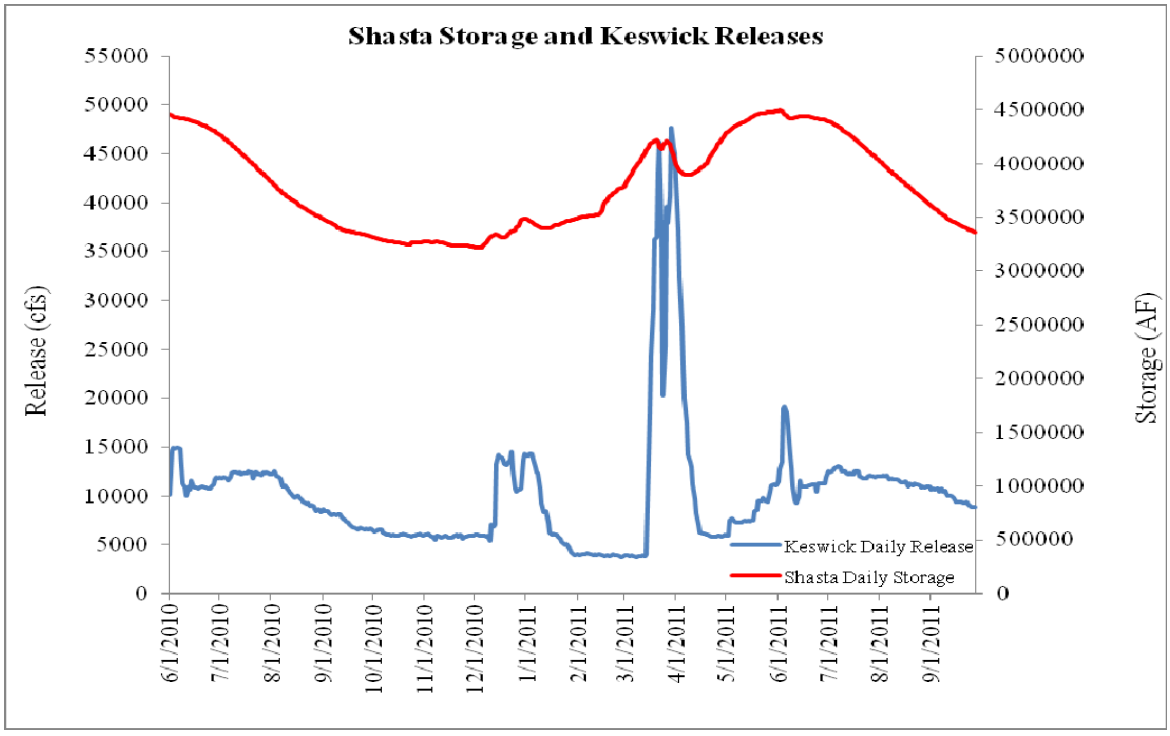

Figure 1. Shasta Reservoir storage and Keswick Dam releases from 6/2010 through 9/29/11.

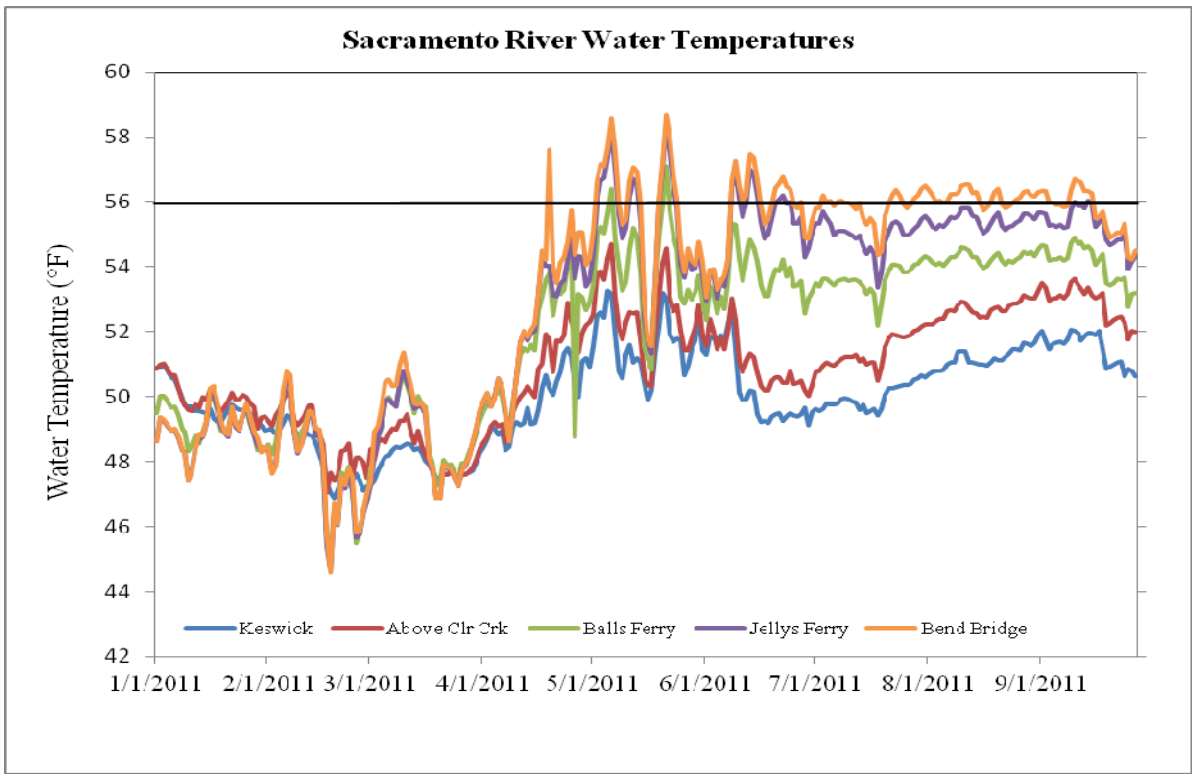

Figure 2. Sacramento River observed mean daily water temperatures January 1 through September 27, 2011 for all compliance locations (black line indicates 56F criteria).

May 25, 2011
Upper Sacramento River – May 2011 Preliminary Temperature Analysis

Summary of Temperature Compliance Results by Month

Initial Compliance Location	MAY	JUN	JUL	AUG	SEP	OCT
May 50%-Exceedance Outlook						
Jellys Ferry (JLF)	**BSF**	**JLF**	**JLF**	**JLF**	**JLF**	**JLF**
Bend Bridge (BND)	**BSF**	**BND**	**BND/JLF**	**JLF**	**JLF**	**JLF**

Model Performance and Fall Temperature Index:

1. Based on past analyses, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56˚F is a good indicator of fall water temperature in the river reach to Balls Ferry.
3. For river temperatures not to exceed 56 ˚F downstream to Balls Ferry, the end-of-September lake volume less than 56˚F should be greater than about 600 TAF, see chart below:

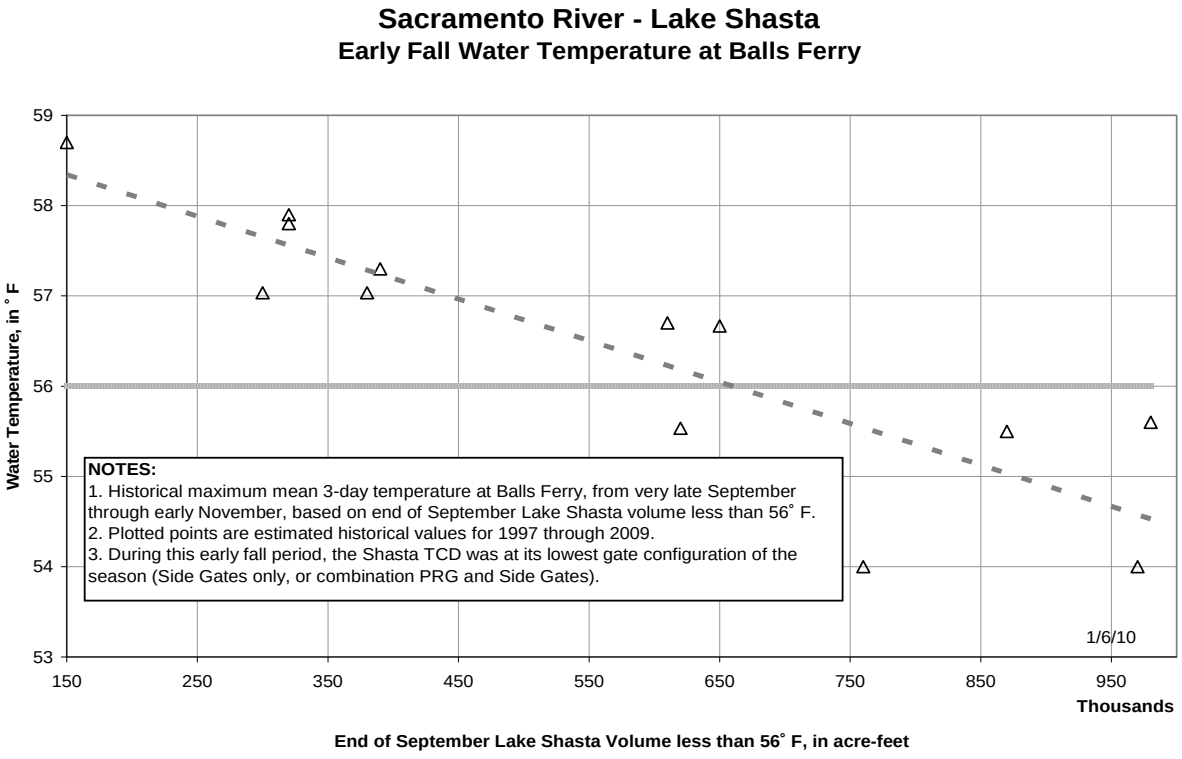

Figure 3. USBR Temperature Model results

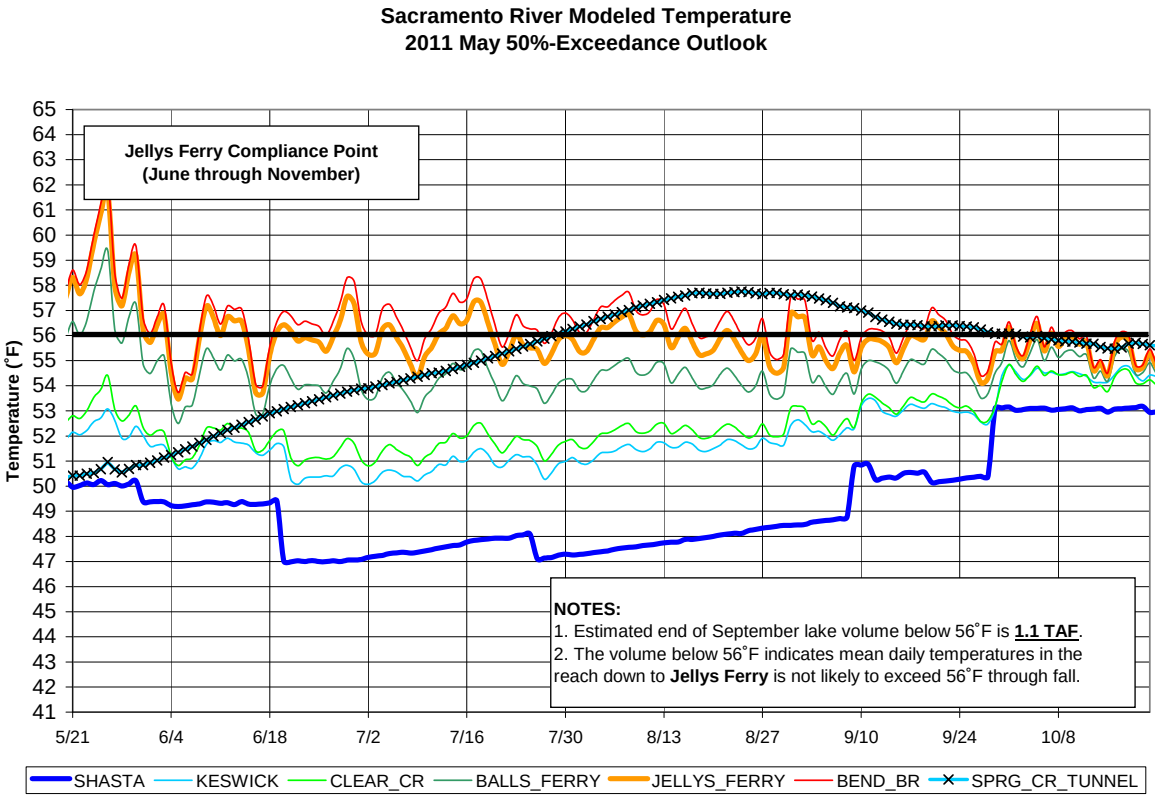

Figure 4. Jellys Ferry is a likely compliance location through fall. The end-of-September lake volume below 56˚F (1.1 MAF) indicates that a Jellys Ferry compliance is possible through fall (mean daily water temperatures at Jellys Ferry tends to be approximately 0.5-1.0˚F warmer than at Balls Ferry after September).

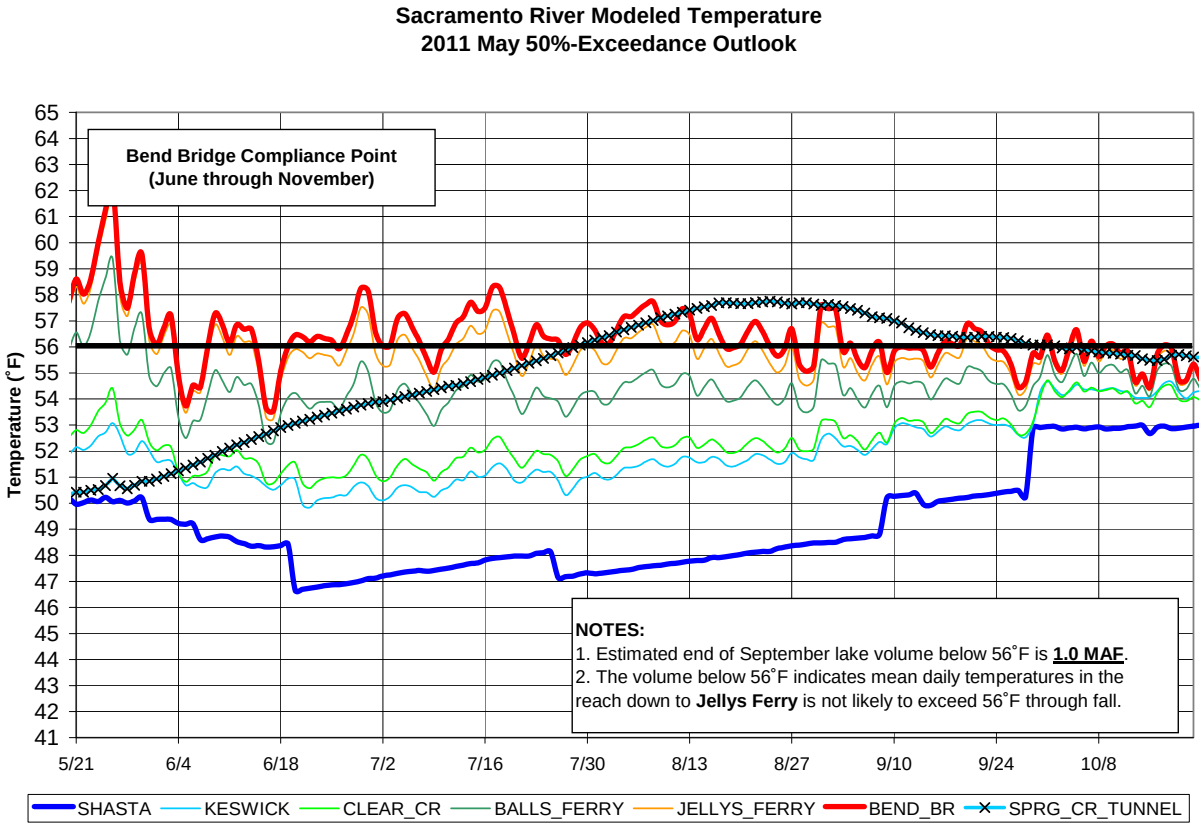

Figure 5. A Bend Bridge compliance location is likely to be met through mid-July. However, based on operation in the May 50%-exceedance outlook, it may be difficult to maintain Bend Bridge compliance during the peak of the temperature management season, mid-July through August.

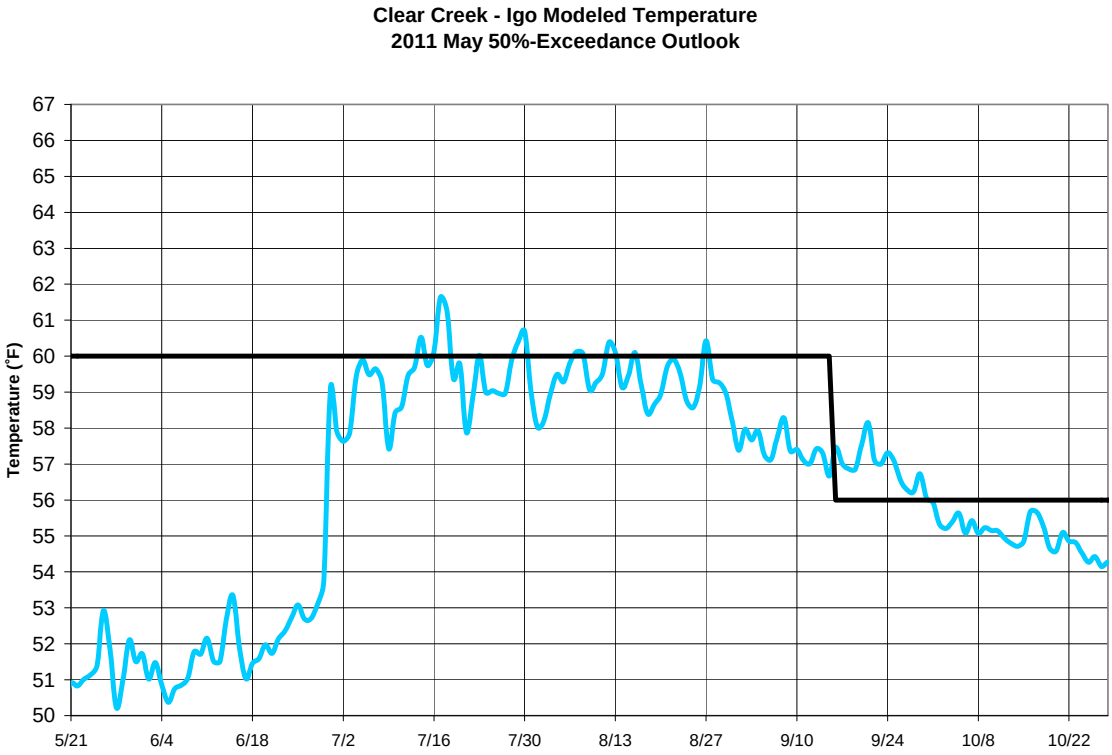

Figure 6. Model results for Clear Creek at Igo. NMFS RPA criterion changes from 60F to 56F on September 15 to protect early spring-run Chinook spawning.

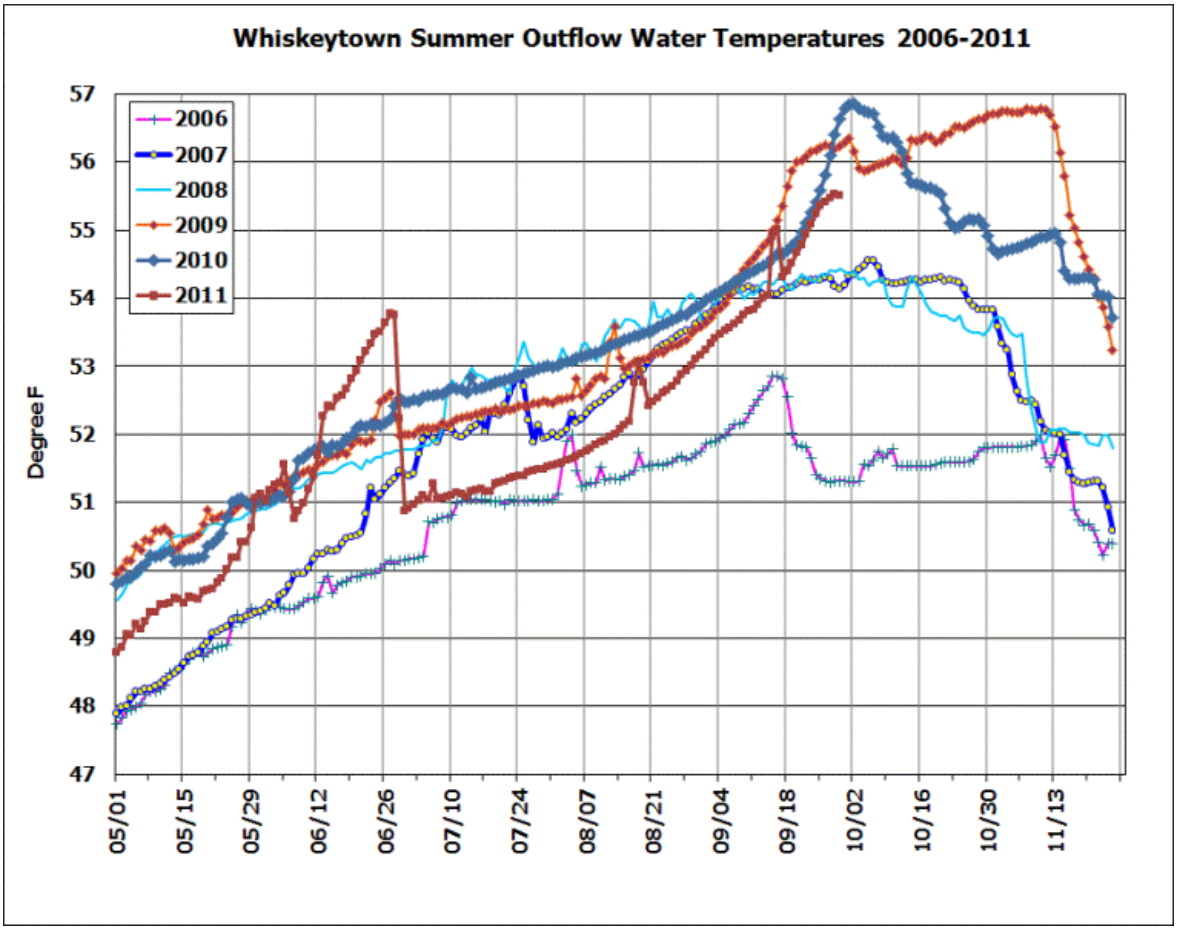

Figure 7. Comparison of Whiskeytown Dam outflow temperatures from 2006 through 2011.

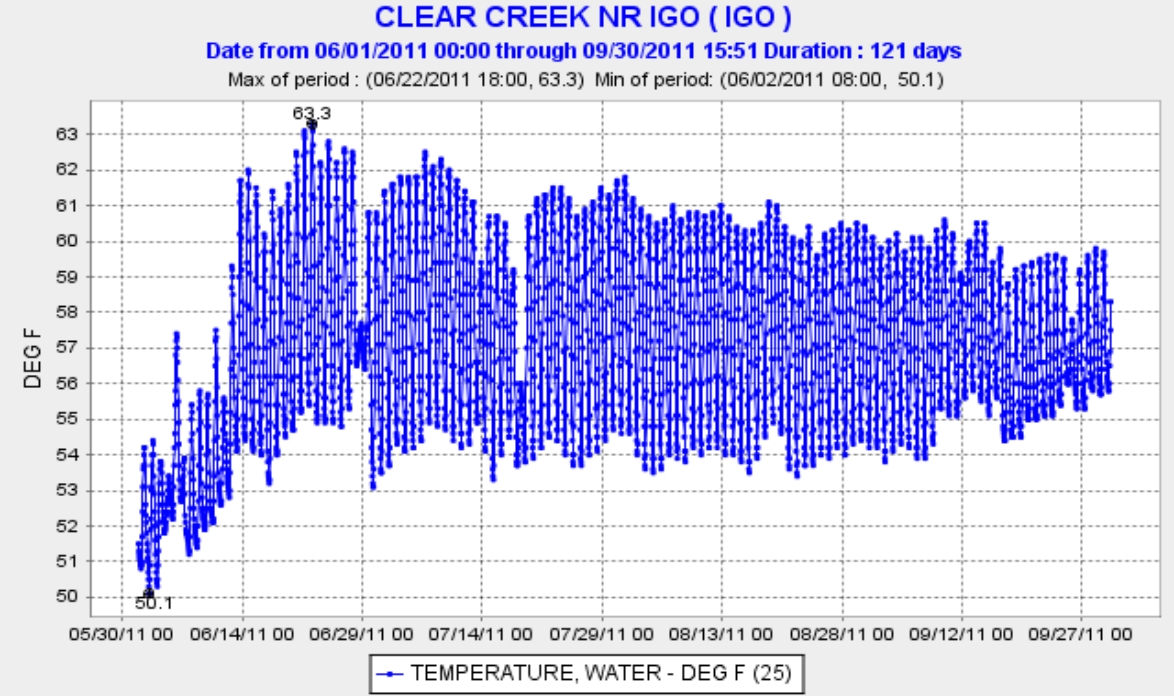

Figure 8. Clear Creek observed water temperatures at Igo gauge, May 30-Sept 27, 2011.

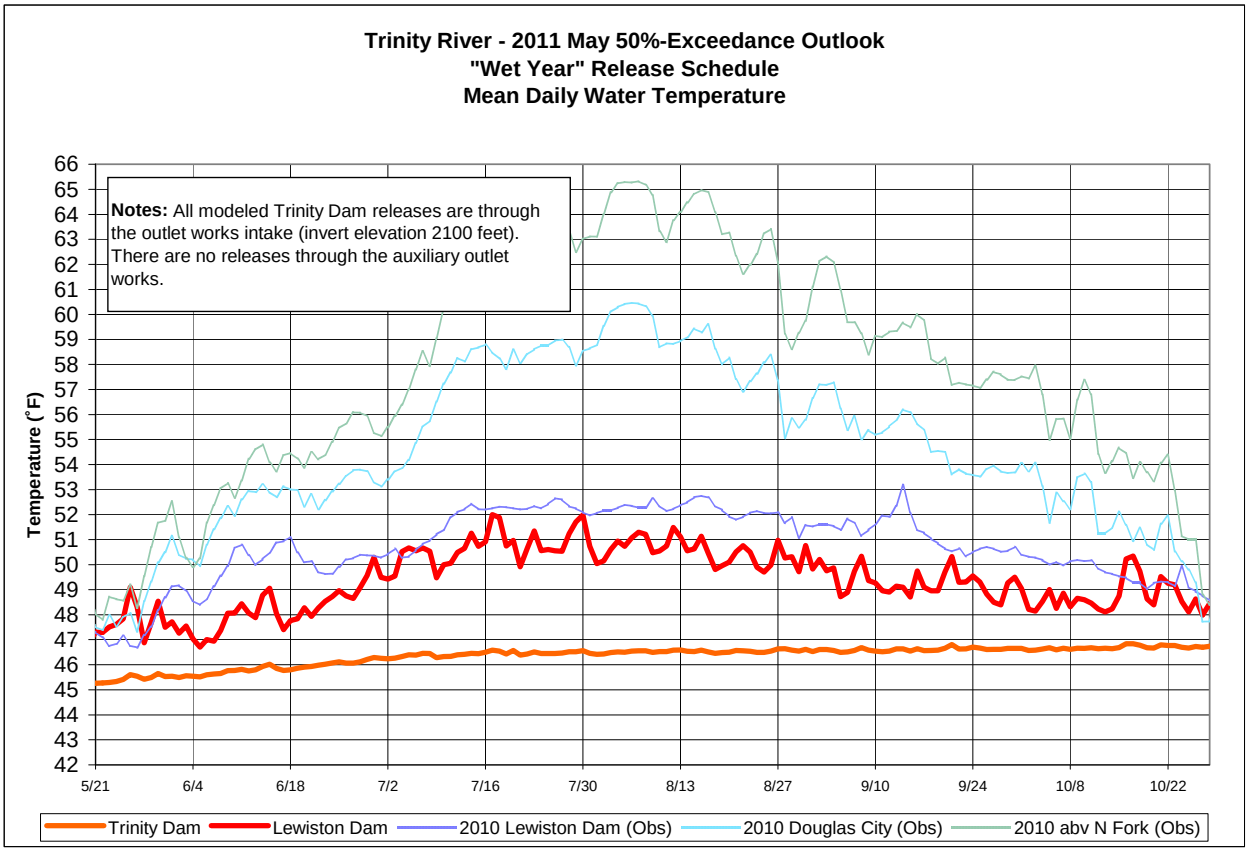

Figure 9. Forecasted temperatures for the Trinity River at Lewiston Dam. The dashed lines are the 2010 mean daily temperatures at selected locations.

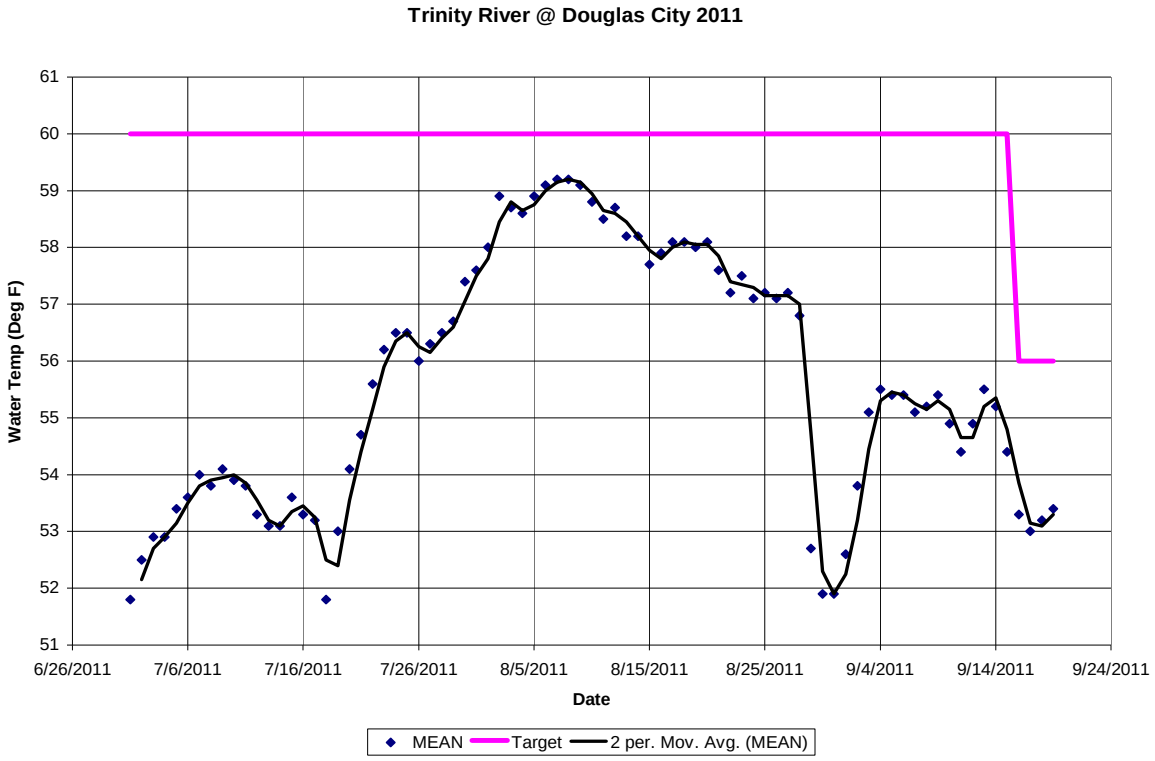

Figure 10. Trinity River observed mean daily water temperature at Douglas City, June-Sept 2011.

Year 2011 Aerial Redd Counts (New redds only)

NUMBER OF NEW REDDS VIEWED BY AERIAL OBSERVATIONS

DATE	4/19/2011	6/16/2011	6/23/2011	6/30/2011	7/6/2011	7/14/2011	7/21/2011	7/28/2011	8/4/2011	2011	
Aircraft	plane	helo	helo	helo	helo	helo	helo	helo	helo		
Visibility	poor-good	fair	fair	fair	fair	poor	fair-poor	fair-poor	fair-poor		
FLOW from Keswick	6,041	10,533	11,154	11,914	13,000	12,308	11,921	11,964	12,015	TOTALS	
Race	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	WINTER	% Dist.
Keswick to A.C.I.D. Dam.	0	0	0	1	0	0	0	0	0	1	5.6%
A.C.I.D. Dam to Highway 44 Bridge	0	0	2	2	4	5	0	0	0	13	72.2%
Highway 44 Br. to Airport Rd. Br.	0	0	0	0	0	4	0	0	0	4	22.2%
Airport Rd. Br. to Balls Ferry Br.	0	0	0	0	0	0	0	0	0	0	0.0%
Balls Ferry Br. to Battle Creek.	0	0	0	0	0	0	0	0	0	0	0.0%
Battle Creek to Jellys Ferry Br.	0	0	0	0	0	0	0	0	0	0	0.0%
Jellys Ferry Br. to Bend Bridge	0	0	0	0	0	0	0	0	0	0	0.0%
Bend Bridge to Red Bluff Diversion Dam	0	0	0	0	0	0	0	0	0	0	0.0%
Red Bluff Diversion Dam to Tehama Br.	0	0	0	0	0	0	0	0	0	0	0.0%
Tehama Br. To Woodson Bridge	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	0.0%
Woodson Bridge to Hamilton City Br.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	0.0%
Hamilton City Bridge to Ord Ferry Br.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	0.0%
Ord Ferry Br. To Princeton Ferry.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	0.0%
TOTALS	0	0	2	3	4	9	0	0	0	18	100.0%

Figure 11. Winter-run Chinook salmon redd surveys by week in 2011.

Appendix A

UNITED STATES

BUREAU OF RECLAMATION

MID-PACIFIC REGION

ANNUAL REPORT ON

PROPOSED OPERATION OF

SHASTA/TRINITY DIVISIONS

AND

SACRAMENTO RIVER TEMPERATURES

FOR

SALMON RESOURCES

PROJECTED FOR THE PERIOD

APRIL THROUGH NOVEMBER 2011

September 2011

TABLE OF CONTENTS

INTRODUCTION

This report is submitted to the State Water Resources Control Board (Board) in compliance with Water Rights Orders WR-90-5, WR-91-01, and WR-92-02.

Shasta Reservoir storage on April 1, 2011, was 3,987,985 acre-feet (ac-ft), and Trinity Reservoir storage was 2,116,636 ac-ft. Based on the April 1st National Weather Service and California Department of Water Resources (DWR) monthly 90 percent runoff forecasts, the water year inflow for Shasta Reservoir is forecast to be 6.2 million acre-feet (maf), approximately 109 percent of average. The 90 percent runoff to Trinity Reservoir was forecasted to be 1.626 maf for water year 2011, or approximately 130 percent of average.

In order to discuss and evaluate proposed 2011 Sacramento River temperature control operations, two Sacramento River Temperature Task Group (SRTTG) meetings were held, on May 17, and May 25, 2011. The SRTTG representatives consists of representatives of the State Water Resources Control Board (SWRCB), the California Department of Fish and Game (DFG), the U. S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), Western Area Power Administration (WAPA), DWR, the Hoopa Valley Tribe, and the U. S. Bureau of Reclamation (Reclamation). Some of the SRTTG agency representatives participated in the preparation and review of this report.

FINDINGS

Water Rights Order 90-5, as amended, requires meeting 56.0 degrees Fahrenheit (ºF) at Red Bluff Diversion Dam during times that higher temperatures would be detrimental to the fishery resources. After consultations with NMFS and review of temperature model results from February, March, April and May, and supported by operational experience, temperatures of 56.0ºF or less cannot be met at Red Bluff Diversion Dam regardless of the water supply allocation to Central Valley Project contractors nor volume of water in Shasta Reservoir.

Water year 2011 is classified as a wet year for the Sacramento River basin. This is a wet year following a dry year. Initial temperature model runs completed in April 2011 showed that Reclamation should be able to meet the Jellys Ferry temperature compliance point (TCP) required in the NMFS 2009 biological opinion. The initial TCP was set at Balls Ferry until May 31 in order to conserve cold water in Shasta Reservoir. Subsequent model runs in May, based on the updated forecasts and profiles, continued to support a TCP of Jellys Ferry. Therefore, on June 1st, the TCP was changed to Jellys Ferry for the remainder of the year based on an increase in storage and modeling results.

The basic objective of WR Order 90-5 is to control temperatures in the upper Sacramento River to 56.0ºF during times when higher temperatures would be harmful to fish. The ability to control daily temperatures to the desired range depends on numerous factors which unfold as the year progresses. Temperature operations may be affected by deviation from average meteorological conditions, actual inflow volumes and air temperatures, wind driven mixing, rainfall, cloud cover, spring reservoir storage levels and initial reservoir water temperatures, and system or equipment outages. The temperature model studies initially assume average meteorological conditions, although each month is updated with new initial conditions as the season progresses. Experience has shown that April through October represents the primary period when air temperatures and reservoir release temperatures can potentially adversely influence the Sacramento River temperatures. Outside of these months, atmospheric conditions generally keep the river cooler than the required SWRCB temperature objective.

The SRTTG meets on a regular basis (May 15 – October 15) during the temperature control season, typically monthly, but more frequently as conditions warrant. Typical discussions in the regular meetings include an assessment of the temperature control operations, forecast of operations for the remainder of the season, and fishery updates. The temperature control evaluations include a continuing assessment of the capability to meet the temperature objective at the TCP. The target temperature at Jellys Ferry was reevaluated as the season progresses and more measured data regarding the cold water resources becomes available, and the SWRCB was notified of any proposed changes in TCP location. The objective of the SRTTG is to balance the cold water supply in Shasta Reservoir with the needs of winter-run, spring-run, and fall-run Chinook salmon spawning at different times in the upper Sacramento River using real-time fish survey data and year-to-year salmon abundance as guidance.

TABLE 1

TEMPERATURE OPERATING OBJECTIVES FOR 2010

Initial Point of Compliance: 56.0 degrees F. at Jellys Ferry effective May 25, 2011, until further notice.

Modification to Point of Compliance: As the year progresses, numerous unforeseen factors may indicate that changing the compliance point temperature will be necessary to continue maintaining 56 degrees F at the desired location. In the event that a compliance point change is required (based upon a combination of experience and modeling), Reclamation will present this information to the SRTTG. If the SRTTG concurs, Reclamation will modify this plan and re-submit it to the SWRCB. In the event that the SRTTG does not concur, Reclamation will forward the SRTTG position to the SWRCB along with Reclamation's recommendations, and the SWRCB may then select the preferred option.

Modeled Forecasted Temperatures for the Sacramento and Trinity Rivers. Initial Compliance at 56.0 degrees F at Jellys Ferry.

	Jun	Jul	Aug	Sep	Oct	Nov
Keswick	51.4	50.3	51.8	53.6	54.7	53.2
Airport Rd	52.6	52.1	53.0	54.2	54.5	52.1
Balls Ferry	54.3	54.0	54.6	55.2	54.9	51.6
Jellys Ferry	55.8	55.8	55.9	56.0	55.1	51.1
Bend Bridge	56.3	56.6	56.8	56.3	55.2	51.0
Red Bluff	57.3	58.4	58.1	57.2	55.4	51.1

	Jul	Aug	Sep	Oct	Nov
Lewiston	50.4	50.5	48.7	48.1	47.1
Douglas City	56.2	57.8	54.4		
Conf. N. Fork				53.0	48.8

Sacramento River Temperature Analysis: The temperature projections were estimated using Reclamation's daily temperature model, and based on conditions shown in Reclamation's May 2010 forecast of operations for the Central Valley Project (CVP), which includes the Sacramento River and the Trinity River operations, as well as diversions to the Sacramento River from the Trinity River.

Trinity Reservoir began the temperature control season with below average storage levels. Shasta Reservoir began the temperature control season with an almost full reservoir. Forecasted inflow through the 2010 water year and this year's regulatory and contractual obligations will

probably result in good carryover storage for Shasta Reservoir, and significantly improved carryover storage for Trinity Reservoir. The best current estimates of end-of-September carryover storages are approximately 2.9 maf for Shasta Reservoir and 1.3 maf for Trinity Reservoir based on the May 90% forecast of operations.

The Sacramento River Temperature Task Group will continue to monitor the temperature operations and fishery resource status and evaluate the need for revising the temperature objectives.

Appendix B

BIOLOGICAL ANALYSIS OF 2011 TEMPERATURE CONTROL OPERATIONS

Winter-run Chinook Salmon

The initial plan developed by the Sacramento River Temperature Task Group (SRTTG) for the 2011 season was to set the TCP at 56 ºF at Balls Ferry from April 15 thru May 15 consistent with the NMFS 2009 Biological Opinion (RPA Action 1.2.3 for March – May 14 period) to protect the early segment of the pre-spawning and spawning periods for winter run adult Chinook salmon. Initial temperature modeling showed Reclamation could meet a TCP further downstream at Jellys Ferry all year. However, due to a late snow runoff and warm tributary inflows from Cottonwood, Battle, and Cow creeks, the water temperature at the Jellys Ferry TCP would likely be exceeded. Therefore, from May 15 to May 31, the TCP was kept at Balls Ferry to conserve cold water in Shasta Reservoir. After May 31, the SRTTG recommended moving the TCP downstream to Jellys Ferry based on very high storage levels in Shasta Reservoir and water temperature model runs that indicated there was a high likelihood of being able to maintain the 56 ºF standard through the remaining pre-spawning, spawning, and egg incubation periods. Note: the initial water year type was forecasted to be a "wet year" type and storage in Shasta Reservoir was 3.98 maf on April 1st.

Aerial redd surveys conducted by CDFG in 2011, showed very few (18 redds by 7/14) winter-run Chinook salmon redds in the upper Sacramento River, and all were above the Balls Ferry TCP. In addition, low abundance of adult spawners was observed in the carcass surveys. This increased the concern for winter-run spawning to provide as much habitat as possible, as far downstream as possible (see SRTTG decision tree in Appendix C). Given the wet year conditions, the SRTTG recommended keeping the TCP as far downstream as possible (Jellys Ferry) for the remainder of the temperature control season. Based on historical winter-run spawning distributions, it is expected that a TCP at Jellys Ferry should provide the highest level of protection as most adults should spawn upstream of that point.

Spring-run and Fall-run Chinook Salmon

Reclamation's water temperature model (based on the May 90% probability of exceedance forecast of operations) predicted that daily average water temperature at Jellys Ferry could be maintained below 56 ºF for the May 15th – October 31st period as required in the NMFS 2009 Biological Opinion (RPA Action 1.2.4). Generally, at this early stage, modeling results for the late summer and fall are fairly uncertain. Any differences between modeled meteorological assumptions, or real time operations, and actual conditions can markedly affect temperature control downstream of Keswick Reservoir as much as seven months out. It is therefore expected that through adaptive real-time management by the SRTTG, water temperature conditions throughout the upper Sacramento River will minimize adverse effects on the reproduction and

survival for spring and fall-run Chinook salmon in the Sacramento River in 2011. By keeping the TCP at Jellys Ferry this year, it is anticipated that enough cold water should be available for spring-run and fall-run later in the year based on Reclamation's temperature modeling results.

Appendix C

Decision Criteria for Sacramento River Water Temperature Management

Management Goals
Water temperatures in the Sacramento River between Keswick Dam and Bend Bridge will be managed to provide suitable habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead through an annual adaptive management process. The process will be initiated by Reclamation in consultation with NOAA Fisheries, utilizing input from the Sacramento River Temperature Task Group (SRTTG).

Water temperatures will be managed in the mainstem river from April 15 through October 1 to provide maximum protection for winter-run spawning and egg incubation. As the timing and distribution of spawning, and the coldwater pool available, are variable from year to year, the objective of temperature control from April 15 through October 1 is to protect a minimum of 90% of the winter-run population throughout 90% of the spawning and rearing period. If sufficient cool water is available following October 1, temperatures will be managed as practical for the protection of spring and fall-run Chinook spawning through October 31.

The following decision criteria are intended to serve as guidelines that apply under most water year conditions, consistent with requirements in the 2004 NOAA Biological Opinion on the OCAP and the SWRCB Water Right Order No. 90-5. In any year when the February 15 annual conditions forecast predicts severely low storage levels and runoff into Shasta Reservoir, the SRTTF will meet in late February to discuss adaptive management alternatives to meeting conditions in the 2004 Biological Opinion.

To ensure the accuracy of temperature data, QA/QC protocols will be followed by Reclamation for stream and reservoir temperature monitoring procedures and equipment. Monitoring equipment will be calibrated regularly throughout the temperature control season.

Time periods for temperature management are:

April 15 – May 7	Winter-run Chinook migrate upstream and hold prior to spawning. Temperature concerns are for holding adults and unspawned eggs.
May 8 – July 31	Winter-run Chinook spawning, egg incubation, and early rearing occur between Keswick and Red Bluff Diversion Dams. Spawning timing and distribution determined by weekly aerial redd surveys, carcass surveys. Peak timing and distribution is variable. Temperature concerns are for spawning, egg incubation, and early rearing.
August 1 – Sept. 30	Winter-run Chinook egg incubation and early rearing occur. Potential spring-run spawning and egg incubation occur in September.

October 1 – Oct. 31 Fall-run and potential spring-run spawning, egg incubation, and early rearing occur.

Decision Criteria

April 15 – May 7

In this period, winter-run Chinook migrate upstream and hold prior to spawning. Winter-run spawning typically does not begin until the second week of May, although some spawning may begin during this period. Temperature concerns are primarily for holding adults and unspawned eggs. The 2004 Biological Opinion requires temperatures not in excess of 56 F at compliance locations between Balls Ferry and Bend Bridge beginning on April 15. In the April 15-May 7 pre-spawning period, the SRTTG believes that the coldwater pool could be conserved by setting the temperature compliance requirement at Balls Ferry. Temperature requirements for upstream migration and holding are less stringent than for spawning and egg incubation. The temperature compliance location will therefore be set at Balls Ferry in all years, unless predicted storage conditions at Shasta Reservoir are severe.

May 8 – July 31

Winter-run Chinook spawning, egg incubation, and early rearing occurs in this period between Keswick and Red Bluff Diversion Dams. Spawn timing and distribution are determined by weekly aerial redd surveys, and secondarily by carcass surveys. Peak timing and distribution is variable. Water temperature concerns are for spawning, egg incubation, and juvenile rearing. The 2004 Biological Opinion requires temperatures not in excess of 56 F at compliance locations between Balls Ferry and Bend Bridge throughout this period.

By May 1, the SRTTG will establish the initial 56 F temperature compliance point at Balls Ferry, Jellys Ferry, or Bend Bridge to start on May 8. Establishment of the initial compliance point will be based on an assessment of the coldwater pool volume available in Shasta Reservoir and the anticipated spawning distribution based on previous year's data. Priority will be given early in this period to provide the maximum spatial protection for winter-run spawning and egg incubation. The following coldwater pool volume criteria (NOAA 2004) will be considered in the selection of an initial compliance point, but will not be the only factor considered.

May 1, Shasta cold water volume below 52 F:	Compliance Target
< 3.3 MAF	Balls Ferry
> 3.3 MAF but < 3.6 MAF	Jellys Ferry
> 3.6 MAF	Bend Bridge

At two week intervals from May 8 through July 31, the SRTTF will reassess the location of the temperature compliance point based on:

- Bi-weekly reservoir temperature profiles (documenting the size of the remaining coldwater pool volume),
- Modeled daily water temperatures in the upper river for the remainder of the temperature control season,
- Weekly aerial redd survey data (documenting the distribution of winter-run spawning),
- Carcass survey data (documenting the distribution of carcasses and estimated run size).

If there are expected problems with maintaining the compliance point at the current location throughout the temperature control season, and impacts on winter-run spawning and egg incubation are expected to be low based on real-time survey data, the SRTTG may adjust the compliance location upstream as appropriate. A significant consideration in the decision to move the compliance point during this period will be the ability to control cold water releases through the end of the temperature control season.

August 1 – Sept. 30

Winter-run Chinook egg incubation and early rearing occurs in this period. Spring-run spawning and egg incubation may occur in September. Water temperature concerns are for winter-run egg incubation and juvenile rearing, and spring-run spawning and egg incubation. The 2004 Biological Opinion requires temperatures not in excess of 56 F at compliance locations between Balls Ferry and Bend Bridge throughout this period.

By July 31, the SRTTG will discuss strategies for temperature control during the August 1 – September 30 period. Location of the temperature compliance point will be established based on:

- Size of the remaining coldwater pool volume (determined by the end of July temperature profile),
- Modeled daily water temperatures in the upper river for the remainder of the temperature control season.
- Spatial and temporal distribution of Chinook salmon redds.

During this period, data from weekly aerial redd surveys (documenting the distribution of Chinook spawning), will be used to assess temperature impacts on Chinook spawning and egg incubation. In past years, when low numbers of new Chinook redds were observed in the month of September, and coldwater pool volume was low, variances have been allowed in temperature compliance, in order to conserve cold water for Chinook spawning in October.

October 1 – November 30

Fall and spring-run spawning, egg incubation, and early rearing occur in this period. The 2004 Biological Opinion requires temperatures not in excess of 60 F at compliance locations between Balls Ferry and Bend Bridge from October 1 – 31. Water temperature concerns are for fall and spring-run spawning and egg incubation. By September 25, the SRTTG will discuss strategies

for temperature control during October and November. Temperature management throughout the period will be consistent with SWRCB Order 90-5 and the water quality basin plan. Location of the temperature compliance point for the 60 F requirement will be based on:

- Size of the remaining coldwater pool volume (determined by the end of September temperature profile),
- Modeled daily water temperatures in the upper river for October.

In many years, the remaining coldwater pool volume will be low during October. Based on aerial redd survey data, water temperatures will be managed to provide maximum benefit to the greatest number of spawners.