The Bureau of Reclamation (BOR) has proposed to operate New Melones Reservoir to try to meet a water temperature target of 65°F (7 day average daily max; 7DADM) at Goodwin Dam from April 1, 2015 through October 31, 2015. This target would be in lieu of the water temperature objectives recommended by the BiOp. Flows downstream of Goodwin Dam would be those described in table 2e of the BiOP, and no additional water would be released for temperature management. Tri-Dam Project, OID, and SSJID are providing this memorandum and information in support of BOR's proposed operations.

Water temperatures downstream of Goodwin Dam were modeled based on BOR's proposed operating strategy and this information is provided as Attachment 1. Two scenarios were considered with regard to power generation. A base case run assumed all released water passes through the generators until power generation ceases when reservoir elevation falls below the power intake. In an alternate run, power generation is gradually bypassed as the water surface elevation in New Melones Reservoir approaches the elevation of the powerhouse inlet. This allows for blending of warmer surface water released through the powerhouse with cooler water released through the low level outlet.

The model runs predict that water temperatures at Goodwin Dam would reach approximately 70°F in early August under the base case, and would then abruptly drop to approximately 60°F when power generation ceases due to the reservoir elevation falling below the power intake. These extremes can be moderated by gradually bypassing power generation as simulated in the alternate run. Gradually bypassing power generation as the reservoir elevation approaches the elevation of the powerhouse inlet allows for blending of warm water released through the powerhouse with colder water released through the low level outlet. Bypassing power generation through the entire summer would quickly deplete the coolest water stored in the reservoir, resulting in higher water temperatures than the alternate run.

Under the alternate run which reduces temperature extremes by gradually bypassing power generation, BOR's proposed target of 65°F at Goodwin Dam is generally met from April through October[1]. End of September storage under this scenario is projected to be approximately 130,000 AF. A second set of base case and alternate power bypass runs were made assuming higher carryover storage of approximately 200,000 AF to explore the potential influence of higher carryover storage on release temperatures. Comparison of the two sets indicated no apparent improvement in temperature conditions during October with higher carryover storage.

What does this mean for fish?

BOR's proposal would target 65°F at Goodwin for spring outmigration, *O. mykiss* oversummering, and for adult upstream migration during the fall. Each of these periods is discussed in the following sections with regard to the BiOp water temperature objectives, projected temperature conditions, and potential impacts to fish.

[1] Projected water temperatures range from 65.2°F to 66.1°F during July 31 through August 13.

Spring outmigration conditions

The BiOp includes water temperature objectives of 52°F at Knights Ferry and 55°F at Orange Blossom Bridge (OBB) January 1 through May 31 for *O. mykiss* smoltification. Water temperature modeling in Attachment 1, and also reflected in Figure 1, demonstrate that these objectives cannot be met in 2015 since water temperatures at release from Goodwin Dam are expected to exceed the objectives. Modeled temperatures at Goodwin Dam are slightly cooler than observed temperatures during April and May 2014.

A pulse flow intended by the BiOp to provide outmigration flow cues to enhance likelihood of anadromy and for conveyance and maintenance of downstream migratory habitat quality, occurred during March 24 through April 2. No *O. mykiss* smolts were captured in the rotary screw traps and no untagged *O. mykiss* smolts were captured at the Mossdale trawl in response to the 1,500 cfs pulse flow. Similarly, there was no apparent response of Chinook salmon to the pulse flow, likely due to the timing being in the lull between fry and smolt migrations. A second pulse flow of larger volume is scheduled to occur April 7 through April 19 for the same purpose.

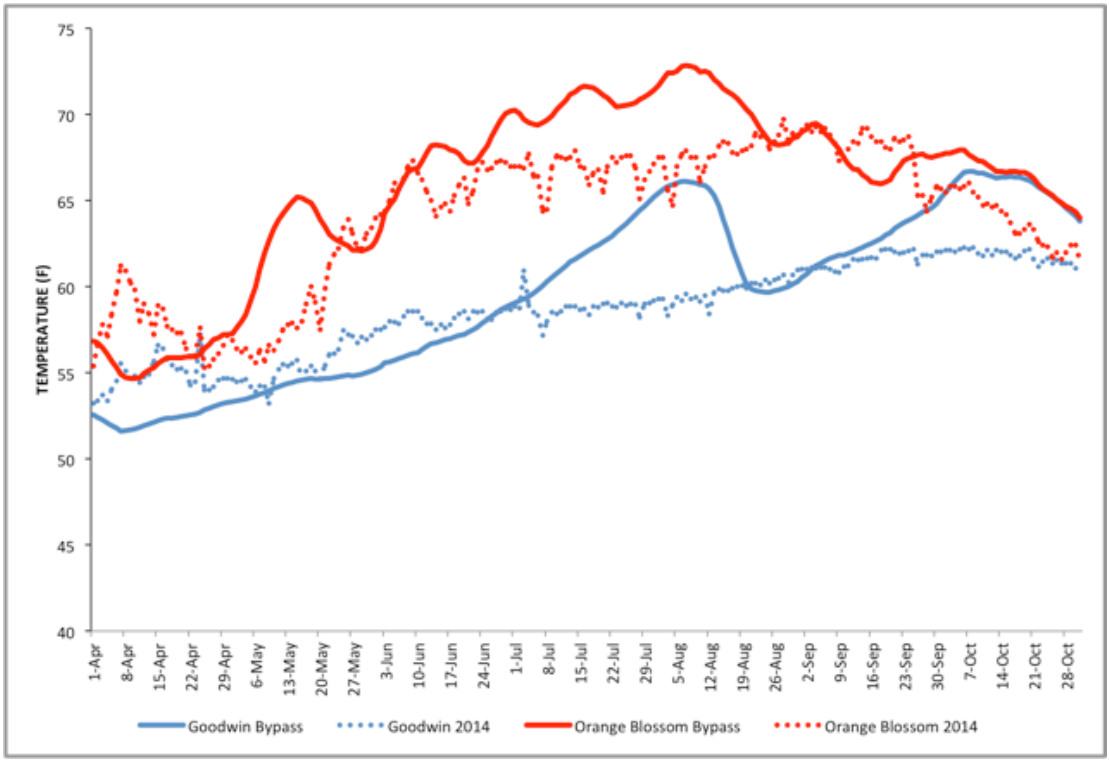

Figure 1. Projected 2015 7DADM water temperature and observed 2014 daily maximum water temperature at Goodwin Dam and OBB.

Oversummering conditions

The BiOp includes an oversummering water temperature objective of 65°F at OBB June 1 through September 30. This objective has consistently been exceeded during the past three years,

and the objective was not met on a single day during 2014 (Figure 2). The Stanislaus River Operations Group (SOG) report showed that June-September 2014 maximum water temperatures at OBB approached, but did not exceed 70°F (SOG 2014).

Summer water temperatures during July and August 2015 are projected to be warmer than during 2014. Temperatures are expected to decrease during September to levels similar to 2014 as releases would be made entirely through the low level outlet. However, this reduction in temperature is short-lived as temperatures are projected to rise in October when cold water storage behind New Melones Dam is depleted. BOR's proposed target of 65°F at Goodwin is projected to generally be met during the oversummering period. Projected water temperatures range from 65.2°F to 66.1°F during July 31 through August 13.

Annual surveys of *O. mykiss* abundance and distribution conducted annually by the Districts since 2009 have documented a relatively stable population (Figure 3). River-wide abundance estimates from 2009 to 2014 have averaged just over 20,220 *O. mykiss* (all life stages combined) and have never been estimated to be less than about 14,000 (2009). High index densities of *O. mykiss* have been consistently observed in the Goodwin Canyon reach over the past six monitoring seasons. This reach can be generally classified as a high gradient reach that contains a higher relative amount of fast-water habitats (riffles and rapids). Relative to the lower reaches of the Stanislaus River, the Goodwin Canyon reach has more, smaller units (about 22 habitat units per mile). The number of habitat units in this reach may provide more habitat complexity than other reaches of the Stanislaus River. Key factors that may contribute to higher-than-average abundances on the Stanislaus (relative to other San Joaquin River tributaries) include high gradient reaches that are typically associated with higher amount of fast-water habitats, especially in Goodwin Canyon. Surveys planned for 2015 will provide data to detect any changes from baseline abundance and distribution that may occur in response to the ongoing drought.

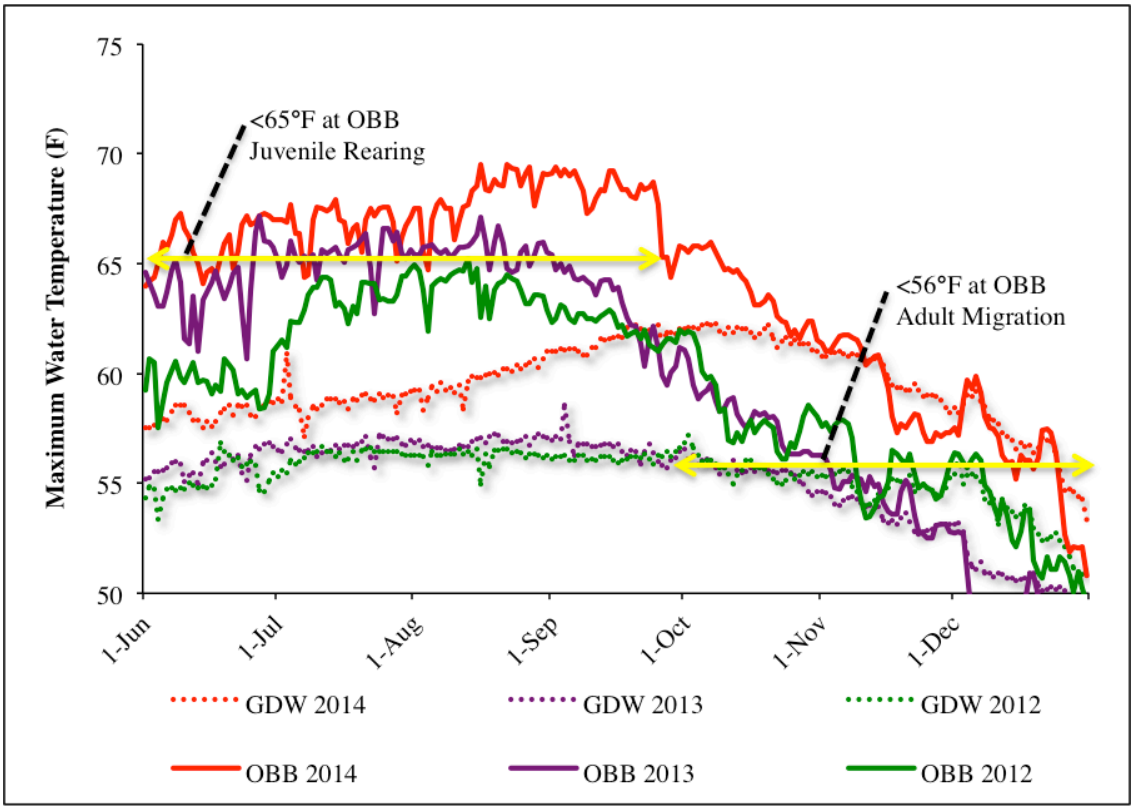

Figure 2. June 1 – December 31, 2012-2014 daily maximum water temperature at Orange Blossom Bridge and Goodwin Dam.

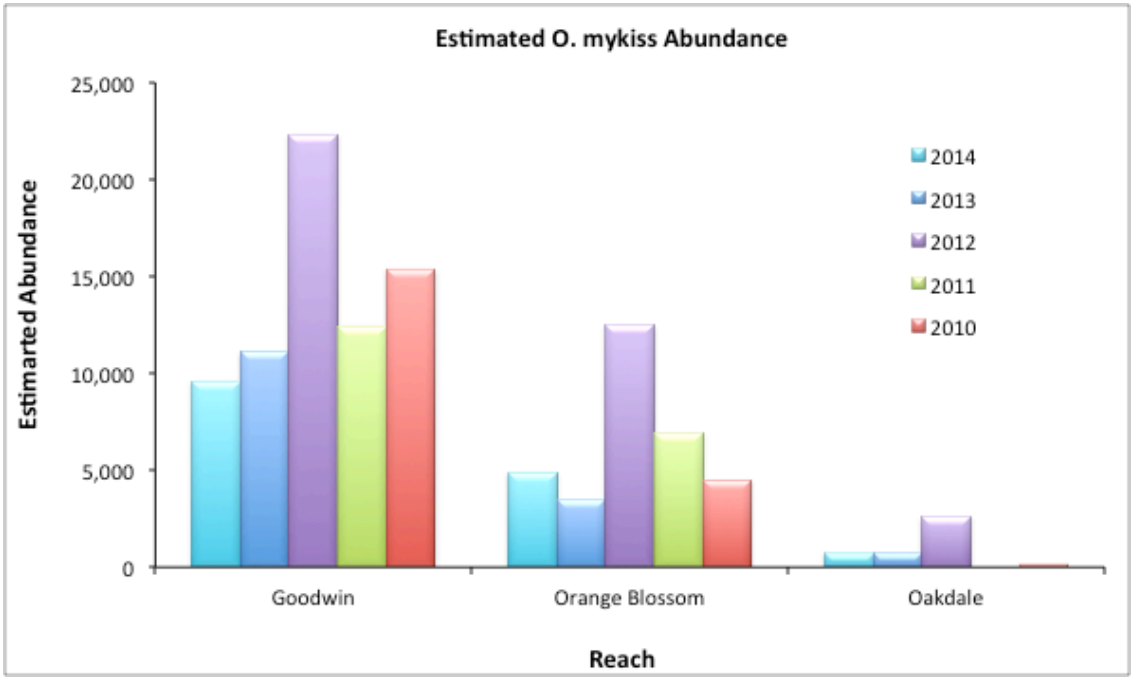

Figure 3. Distribution of *O. mykiss* in the Stanislaus River between Goodwin Dam and Oakdale during 2009-2014.

Fall conditions

The BiOp includes an adult *O. mykiss* migration water temperature objective of 56°F at OBB during October 1 through December 31. Release temperatures at Goodwin exceeded this objective until December during 2014 (Figure 2). Water temperatures are projected to be warmer during October 2015 than observed during October 2014 (Figure 1). BOR's proposed target of 65°F at Goodwin is projected to be met through October.

Any upstream migrating adult *O. mykiss* or Chinook salmon would have already migrated through much warmer water temperatures downstream in the San Joaquin River and Delta. October is also early for *O. mykiss* upstream migration. At the Stanislaus River weir, migration of *O. mykiss* > 16 inches has been observed as early as October 8 and median passage typically occurs during late December.

Fall-run Chinook salmon are not protected under the ESA, and there are currently no water temperature objectives for fall-run in the Stanislaus River. However, the fall pulse flows and water temperature objectives in the BiOp were largely based on the purported needs of fall-run Chinook as a proxy for *O. mykiss*. Based on redd surveys conducted by FISHBIO, peak spawning typically occurs in November with roughly 7% of spawning occurring prior to November 1. During late-September and early October, median redd location is typically near the upper end of Goodwin Canyon where temperatures are coolest (Attachment 2). By late October, spawning increases in downstream locations as water temperatures decrease due to decreasing ambient air temperatures, and median redd location is typically Knights Ferry. While the warm release temperatures at Goodwin Dam predicted by the model will decrease the incubation success of eggs deposited by any early arriving fall-run Chinook salmon that may spawn during October, this is a consequence of the unprecedented drought conditions which would have likely resulted in no flow under unimpaired conditions. During November as ambient air temperatures decrease, the stream begins to cool naturally as it flows downstream from Goodwin Dam. While this is expected to provide for greater success of fall-run Chinook salmon spawning in November and December relative to October, temperature impacts to incubating fall-run Chinook salmon during fall 2015 are now unavoidable.

Summary

There is a difficult management decision to be made at New Melones this year. BOR can operate in the traditional method through the powerhouse and water temperatures at Goodwin will exceed 65°F during the summer. If the powerhouse and bypass are blended 65°F at Goodwin can mostly be achieved during the summer. However, using the bypass in July or August depletes the coldwater mass behind New Melones resulting in elevated water temperatures for fall-run Chinook that arrive in the Stanislaus River before November 1. The amount of carryover storage in the two runs, 200,000AF and 115,000AF, indicate no apparent improvement in water temperatures in October.

ATTACHMENT 1

Stanislaus River Water Temperature Model Results

Stanislaus Temperature Modeling
2015 Proposed Operations

1. Objective

The objective of this work is to assess, using the HEC-5Q Model, the expected temperature conditions at discrete points along the Stanislaus River, given the currently proposed water release schedule from New Melones through the end of 2015.

2. Background

Review of snow pack data from several CDEC stations in or near the Stanislaus watershed indicates that the runoff this year will likely be the lowest of the past 30+ years (see Figure 3).

The Tri-Dam Project is estimating that the total inflow to New Melones from March 1 to September 30 of this year will be in the order of 90,000 acre-feet with the majority of the inflow occurring in March, April and May. For modeling purposes, it is also assumed that the inflow in October will be in the order of 3,000 acre-feet.

The closest historical hydrologic condition to the current year appears to be the dry year of 1987 and even then, the historical inflow to New Melones exceeded the current runoff projection.

3. Modeling Approach

The modeling approach under this scope of work is to use 1987 as an example year in terms of the climate conditions and pattern of runoff, yet to scale down the historical inflow to New Melones to match the 90,000 and 3,000 acre-feet projections, as follows:

			Historical inflow , AF	Ratio:Historical to 90 & 3 TAF
1-Mar	thru	30-Sep-1987	**295,412**	**0.305**
1-Oct	thru	31-Oct-1987	**12,175**	**0.246**

Figure 1: Scaling Factors from Historical Inflow to Projected Inflow

Then, set the New Melones storage to the current state (605,600 acre-feet on February 28), superimpose the release and diversion schedule that is currently being proposed (see Diversion and Release Schedule below), and operate the system accordingly.

This approach will enable estimating the temperature conditions that might be experienced at various locations along the Stanislaus (e.g., below Goodwin Dam, Knights Ferry, Orange Blossom Bridge and Oakdale) through the end of 2015.

It should be noted that given the extremely low water level in New Melones at the present time, it is probable that the old Melones Dam will be exposed, similar to what had

happened in the drought of 1987-1992. The model will simulate the old-new dam interaction, including the switch from power plant flow to low-level outlet release and the ramification of this kind of operation on the temperature response below Goodwin Dam and downriver.

4. Diversion and Release Schedule

The proposed diversion schedule from the Goodwin Pool to OID and SSJID and the release to the river from Goodwin Dam, as obtained from the stakeholders, are as follows:

Month	Water Right Type	2014 Diversion to Storage (acre-feet)	2014 Direct Diversion acre-feet
January:	Riparian:		
	Pre1914:		
February:	Riparian:		
	Pre1914:		
March:	Riparian:		
	Pre1914:		28,209
April:	Riparian:		
	Pre1914:		40,666
May:	Riparian:		
	Pre1914:		58,906
June:	Riparian:		
	Pre1914:	2,972	73,314
July:	Riparian:		
	Pre1914:		75,030
August:	Riparian:		
	Pre1914:		67,925
September:	Riparian:		
	Pre1914:		42,338
October:	Riparian:		
	Pre1914:		8,111
November:	Riparian:		
	Pre1914:		
December:	Riparian:		
	Pre1914:		

(Note: Diversion to Storage is ignored)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan
563	600	559	488	385	299	206	119	63	49	54	61	63

Monthly Stanislaus River Releases — use these

TAF:	14	25	30	29	16	19	14	9	35	15	13	18
cfs:	255	403	503	465	270	316	232	153	573	260	205	295

Figure 2: Proposed Diversion and Release Schedule

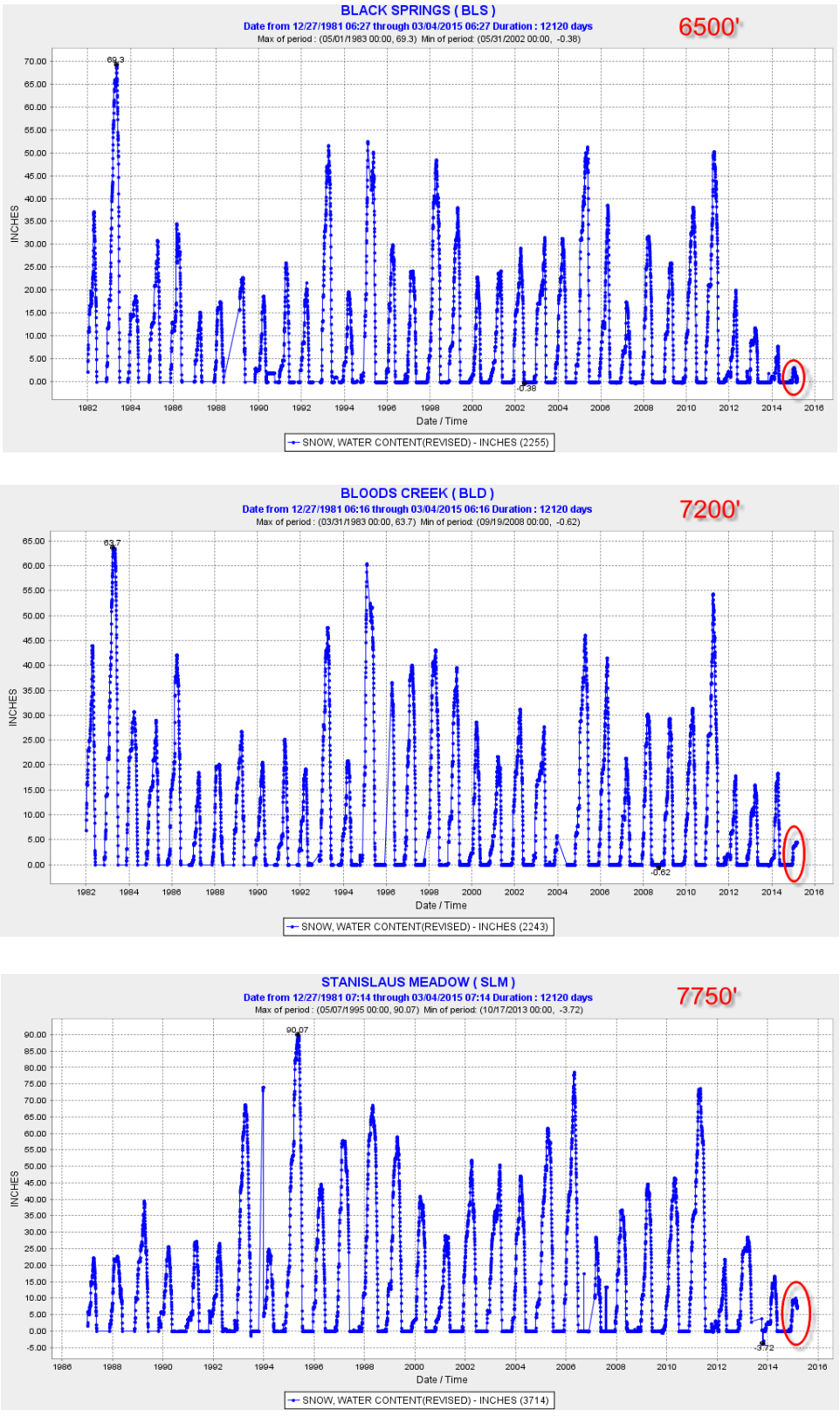

Figure 3: Snow Pack Data from Several CDEC Stations near the Stanislaus watershed

5. Tasks:

1. Set up the data to run a year similar to 1987:
   a. Process the hydrological and meteorological data.
   b. Define volume such that the storage at the end of February 28 is 605,600 acre-feet.
   c. Scale down the May - September flow & October flows by the ratios shown in Figure 1.
   d. Assume monthly average diversion and New Melones outflow, as specified the Diversion and Release Schedule in Figure 2.
   e. Prepare DSS inputs for the above.
2. Set up the model to run the modified 1987.
3. Run the model - generate output as directed.
4. QA/QC of results with emphasis on new-old dam interaction.
5. Analyze the results in terms of the expected temperatures at the specified locations along the Stanislaus River from day 1 of the simulation to end-of-year 2015.
6. Evaluate the merit of different strategies for switching from power plant flow to low-level outlet release from New Melones.
7. Compile a short write up about study findings.
8. Present results to the client.

Modeling, Analysis and Findings

1. Model Setup

The HEC-5Q was set to simulate a single year similar to 1987 in terms of the pattern of inflow to New Melones except that the rate of the inflow was scaled down in accordance with Figure 1 above. The meteorological conditions were also set to match the historical conditions in 1987.

In order to prime the model, the simulation started on January 1, 1987 where by New Melones storage was set in such a way that by February 28 the total volume of water in the reservoir would equal to the observed volume on that date, i.e., 605,600 acre-feet. The computed temperature profiles in New Melones and Tulloch were then compared with observed data near March 1 from other years (see Figure 4 below) to ensure that the boundary condition as far as the thermal structures in the reservoirs are reasonable (note that in Figure 4 the New Melones elevation is completely different, however the temperature ranges and profile shapes are similar in both reservoirs).

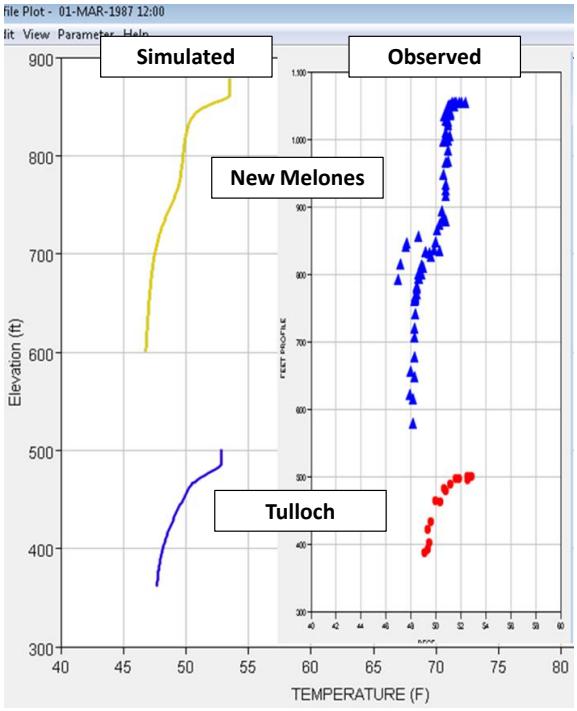

Figure 4: Computed and Observed Thermal Profiles in New Melones and Tulloch Reservoirs near March 1

2. Simulation Modes

The HEC-5Q was run in two modes:

a) No-Bypass Operation – under this mode, New Melones was operated in a way where the water is released through the power plant until the water level in the reservoir reaches the minimum power pool elevation.

b) Bypass Operation – under this mode, New Melones was operated in a way where the release is switched gradually from power release to low-level outlet release in advance of reaching minimum power pool elevation.

For the latter, several strategies for bypass operation were analyzed in terms of the starting date and the rate of transitioning from no-bypass to full-bypass operation, as explained below.

3. Projected New Melones Storage

The effect on New Melones Storage is essentially the same for the two operation modes described above. Mass-balance calculation on New Melones for the period March 1 through Oct 31, 2015 is shown in Figure 5 below:

	Release to River	Diversion (OID & SSJID)	Total Outflow	NM Storage	NM Elev
Beginning:	(CFS)	(CFS)	(TAF)	(TAF)	(FT)
Mar	200	459	41	605	879
Apr (1)	200	683	26		
Apr (16)	500	683	35		
May (1)	500	958	43		
May (16)	150	958	35		
Jun	150	1,232	82		
Jul	150	1,220	84		
Aug	150	1,105	77		
Sep	150	712	51		
Oct	175	132	19		
Nov				181	768
Total (TAF)	124	394	494		
Projected Inflow to NM			93		
Reduction in storage in NM (excluding evap and local runoff)			401		
Reduction in storage in NM (including evap and local runoff)			424		

Figure 5: Mass balance on New Melones for the period March 1 to October 31, 2015

The figure shows that the projected storage in New Melones on November 1 is 181 TAF corresponding to El. 768. This reduction in storage takes into consideration the net effect of New Melones and Tulloch evaporation, including local runoff to Tulloch (which was assumed to be similar to 1987).

The gradual decline of water levels in the reservoir from March through December is shown in Figure 6 below. The figure shows that given the assumed inflow to New

Melones and proposed outflow (diversion plus release to river), the water will probably not recede to the point where the submerged old Melones Dam will be exposed. However, the depressed water levels in the reservoir will greatly affect the water temperatures downstream as the warm water epilimnion (the top-most layer) will be discharged from the reservoir through the power intake. It should be noted that in both operation modes power flow will cease as the reservoir reaches the minimum power pool at El. 785 (usually around September 1) and water will be discharged at that point thorough the low-level outlet in New Melones Dam.

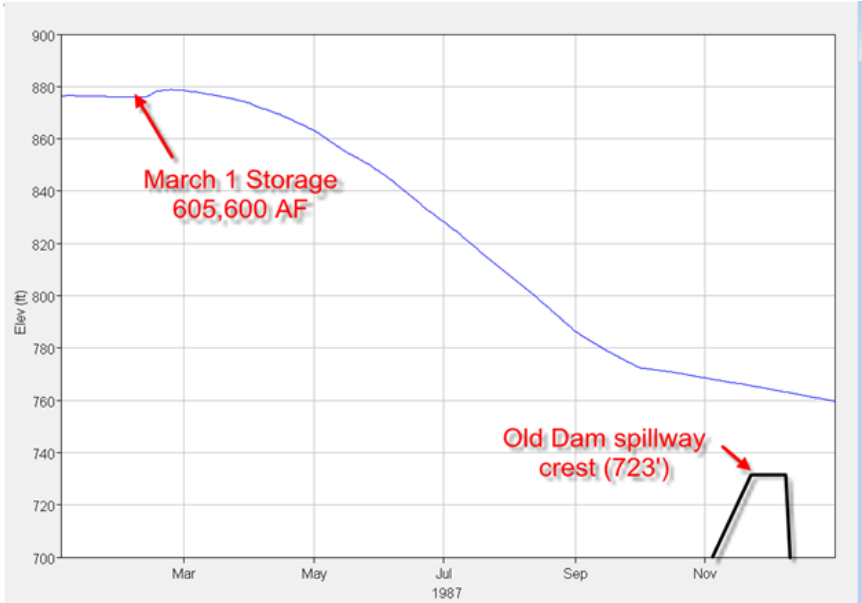

Figure 6: Projected New Melones Water Levels in 2015

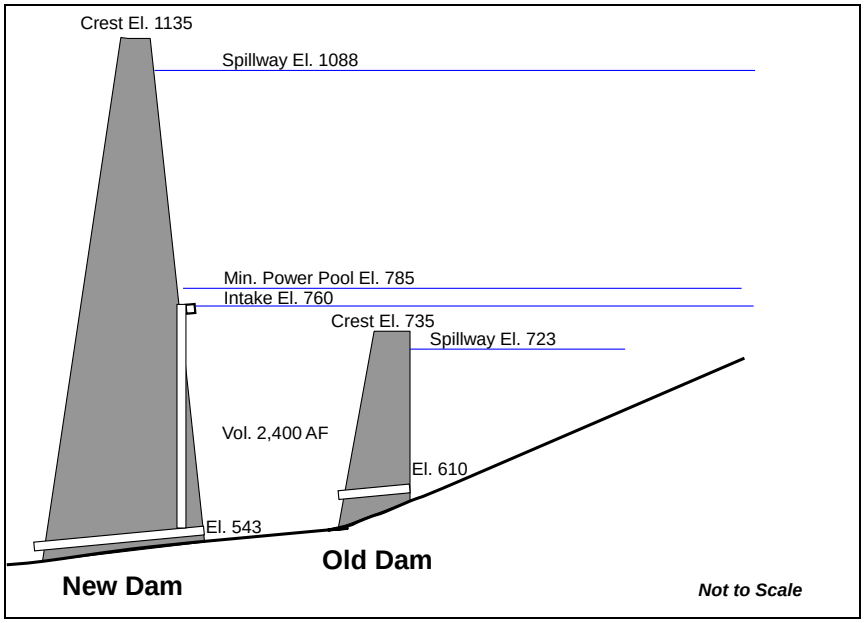

Figure 7: New-Old Dam Interaction

4. Projected Downriver Temperature Response – No-Bypass Operation

The following tables show the results for the temperature response at six discrete points along the Stanislaus River:

1) Below Goodwin Dam
2) Knights Ferry
3) Orange Blossom Bridge
4) Highway 120 Bridge (Oakdale)
5) Ripon Gage (Highway 99)
6) Above the confluence with the San Joaquin River

The results are presented in terms of the 7-Days Average of Daily Maximums (7DADM). In other words, each number in the table is the sum of the maximum daily temperatures in past seven days divided by 7. This term is consistent with EPA's recommended criterion for assessing fish viability.

Notice the precipitous drop of temperatures (almost 10 Deg-F below Goodwin Dam) from September on. This is due to the abrupt switch from no-bypass to full-bypass operation on September 1 (due to power constraints).

Table 1: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.5	50.6	52.2	52.3	55.4	55.6
2-Mar	50.6	50.8	52.5	52.5	55.7	55.9
3-Mar	50.8	51.1	53.0	53.1	56.4	56.6
4-Mar	50.8	51.2	53.3	53.5	56.9	57.1
5-Mar	50.7	51.2	53.4	53.8	57.2	57.5
6-Mar	50.7	51.3	53.6	54.1	57.5	57.8
7-Mar	50.8	51.4	53.8	54.4	57.9	58.2
8-Mar	50.9	51.5	53.9	54.6	58.1	58.4
9-Mar	51.0	51.5	54.0	54.7	58.4	58.6
10-Mar	51.0	51.5	54.0	54.7	58.4	58.7
11-Mar	51.3	51.7	54.1	54.8	58.6	58.8
12-Mar	51.6	52.0	54.6	55.2	59.2	59.3
13-Mar	51.8	52.2	54.9	55.6	59.7	59.8
14-Mar	51.8	52.2	54.9	55.7	59.9	59.9
15-Mar	51.9	52.3	54.8	55.7	60.0	60.0
16-Mar	51.9	52.3	54.8	55.6	60.0	60.1
17-Mar	52.0	52.4	54.9	55.6	60.0	60.2
18-Mar	52.0	52.4	54.8	55.6	59.8	60.1
19-Mar	51.9	52.3	54.6	55.3	59.5	59.8
20-Mar	51.9	52.3	54.4	55.1	59.1	59.5
21-Mar	52.0	52.3	54.4	55.0	58.9	59.3
22-Mar	52.1	52.5	54.6	55.1	58.9	59.3
23-Mar	52.2	52.5	54.5	55.0	58.8	59.1
24-Mar	52.2	52.5	54.5	55.0	58.7	58.9
25-Mar	52.3	52.7	54.7	55.2	58.8	59.0
26-Mar	52.5	52.8	55.0	55.5	59.2	59.3
27-Mar	52.6	53.0	55.3	55.9	59.5	59.7
28-Mar	52.8	53.3	55.8	56.4	60.1	60.3
29-Mar	52.9	53.5	56.2	56.9	60.5	60.7
30-Mar	53.1	53.8	56.8	57.5	61.1	61.4
31-Mar	53.3	54.1	57.3	58.0	61.7	61.9
1-Apr	53.3	54.3	57.7	58.6	62.2	62.5
2-Apr	53.4	54.4	58.0	59.0	62.7	62.9
3-Apr	53.4	54.5	58.2	59.3	63.1	63.2
4-Apr	53.4	54.5	58.3	59.5	63.4	63.5
5-Apr	53.3	54.6	58.4	59.6	63.7	63.8
6-Apr	53.3	54.6	58.5	59.8	64.1	64.2
7-Apr	53.3	54.7	58.7	60.0	64.7	64.7
8-Apr	53.3	54.8	58.8	60.2	65.2	65.2
9-Apr	53.4	54.8	58.9	60.4	65.7	65.7
10-Apr	53.4	54.9	59.0	60.6	66.1	66.3
11-Apr	53.5	55.0	59.1	60.8	66.5	66.7
12-Apr	53.7	55.1	59.4	61.1	66.9	67.2
13-Apr	53.8	55.3	59.7	61.4	67.4	67.7
14-Apr	53.9	55.5	60.0	61.8	67.9	68.3
15-Apr	53.8	55.5	60.1	62.0	68.4	68.8
16-Apr	53.8	55.4	60.0	61.9	68.8	69.4
17-Apr	53.8	55.4	59.8	61.7	69.0	69.9
18-Apr	53.7	55.2	59.4	61.3	68.8	69.9
19-Apr	53.6	55.1	59.0	60.8	68.4	69.8
20-Apr	53.5	54.9	58.6	60.3	67.8	69.4
21-Apr	53.5	54.8	58.1	59.7	67.2	68.9
22-Apr	53.5	54.7	57.9	59.3	66.4	68.2
23-Apr	53.6	54.7	57.7	59.0	65.6	67.4
24-Apr	53.7	54.8	57.8	58.9	65.1	66.7
25-Apr	53.8	55.0	58.1	59.2	65.1	66.6
26-Apr	53.9	55.2	58.4	59.6	65.3	66.7
27-Apr	54.0	55.4	58.7	60.0	65.8	67.0
28-Apr	54.1	55.4	58.8	60.2	66.0	67.2
29-Apr	54.2	55.5	59.0	60.3	66.3	67.4
30-Apr	54.2	55.6	59.0	60.4	66.5	67.6

Table 2: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	54.2	55.5	58.9	60.3	66.4	67.6
2-May	54.2	55.5	58.8	60.2	66.4	67.5
3-May	54.2	55.4	58.7	60.0	66.1	67.3
4-May	54.1	55.4	58.5	59.8	65.8	67.0
5-May	54.1	55.4	58.6	59.8	65.7	67.0
6-May	54.2	55.5	58.7	59.9	65.8	67.0
7-May	54.2	55.6	58.9	60.2	66.1	67.3
8-May	54.3	55.8	59.2	60.5	66.6	67.8
9-May	54.4	55.9	59.4	60.9	67.1	68.3
10-May	54.5	56.1	59.8	61.3	67.7	68.9
11-May	54.6	56.2	60.1	61.6	68.2	69.4
12-May	54.7	56.3	60.2	61.9	68.6	69.9
13-May	54.8	56.4	60.4	62.1	69.0	70.3
14-May	54.8	56.5	60.6	62.3	69.4	70.7
15-May	54.9	56.6	60.7	62.5	69.7	71.1
16-May	55.0	56.8	60.8	62.6	69.8	71.1
17-May	55.0	56.9	61.1	62.8	69.8	71.1
18-May	55.1	57.2	61.5	63.1	69.8	71.0
19-May	55.1	57.4	61.8	63.4	69.8	70.8
20-May	55.1	57.4	61.9	63.6	69.5	70.5
21-May	55.2	57.7	62.3	63.9	69.4	70.2
22-May	55.2	57.9	62.7	64.3	69.5	70.0
23-May	55.2	58.0	63.1	64.9	69.8	70.0
24-May	55.2	58.0	63.3	65.3	70.2	70.3
25-May	55.2	58.1	63.5	65.6	70.5	70.6
26-May	55.2	58.1	63.5	65.7	70.7	70.7
27-May	55.1	58.0	63.4	65.7	70.9	70.8
28-May	55.2	58.0	63.4	65.8	71.0	71.0
29-May	55.2	58.0	63.4	65.8	71.2	71.1
30-May	55.2	58.1	63.5	65.9	71.4	71.4
31-May	55.3	58.2	63.7	66.0	71.7	71.6
1-Jun	55.3	58.3	64.0	66.3	72.0	72.0
2-Jun	55.4	58.6	64.6	66.9	72.8	72.8
3-Jun	55.6	59.1	65.4	67.8	73.9	73.8
4-Jun	55.6	59.2	65.7	68.3	74.5	74.4
5-Jun	55.6	59.3	66.0	68.7	74.9	74.8
6-Jun	55.6	59.4	66.3	69.1	75.4	75.3
7-Jun	55.7	59.6	66.7	69.6	76.0	75.9
8-Jun	55.8	59.7	67.0	69.9	76.4	76.4
9-Jun	55.8	59.7	67.0	70.1	76.6	76.6
10-Jun	55.9	59.8	67.0	70.1	76.6	76.6
11-Jun	56.0	60.0	67.3	70.4	76.9	76.9
12-Jun	56.2	60.3	67.8	70.8	77.4	77.4
13-Jun	56.3	60.5	68.1	71.2	77.8	77.8
14-Jun	56.3	60.5	68.2	71.4	77.9	77.9
15-Jun	56.4	60.5	68.1	71.3	77.9	77.8
16-Jun	56.4	60.5	68.0	71.3	77.8	77.7
17-Jun	56.4	60.4	67.8	71.1	77.6	77.6
18-Jun	56.5	60.4	67.7	70.9	77.5	77.5
19-Jun	56.5	60.3	67.5	70.7	77.4	77.3
20-Jun	56.5	60.1	67.1	70.4	77.0	77.0
21-Jun	56.6	60.1	66.9	70.1	76.7	76.7
22-Jun	56.7	60.2	66.9	70.0	76.6	76.6
23-Jun	56.8	60.3	67.1	70.0	76.6	76.7
24-Jun	57.0	60.6	67.5	70.4	77.0	77.0
25-Jun	57.1	60.8	67.9	70.8	77.4	77.5
26-Jun	57.2	61.1	68.3	71.3	77.9	78.0
27-Jun	57.3	61.4	68.8	71.9	78.6	78.6
28-Jun	57.4	61.6	69.2	72.5	79.3	79.2
29-Jun	57.5	61.7	69.6	72.9	79.9	79.8
30-Jun	57.6	61.8	69.7	73.2	80.2	80.2

Table 3: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	57.7	61.9	69.7	73.3	80.3	80.3
2-Jul	57.8	61.8	69.5	73.1	80.2	80.2
3-Jul	57.8	61.7	69.1	72.7	79.8	79.8
4-Jul	57.9	61.6	68.9	72.4	79.5	79.5
5-Jul	58.1	61.7	68.8	72.1	79.2	79.3
6-Jul	58.2	61.7	68.7	71.9	78.9	79.0
7-Jul	58.4	61.9	68.8	71.9	78.9	78.9
8-Jul	58.6	62.0	69.0	72.0	78.9	78.9
9-Jul	58.7	62.2	69.2	72.2	78.9	78.9
10-Jul	58.9	62.5	69.5	72.5	79.1	79.1
11-Jul	59.1	62.6	69.8	72.8	79.3	79.3
12-Jul	59.2	62.9	70.0	73.0	79.5	79.4
13-Jul	59.4	63.1	70.3	73.3	79.8	79.7
14-Jul	59.6	63.2	70.5	73.5	79.9	79.8
15-Jul	59.7	63.4	70.7	73.8	80.2	80.0
16-Jul	59.8	63.5	70.7	73.9	80.3	80.2
17-Jul	59.9	63.5	70.6	73.8	80.3	80.2
18-Jul	60.1	63.5	70.5	73.7	80.2	80.2
19-Jul	60.2	63.5	70.3	73.5	80.1	80.0
20-Jul	60.3	63.4	70.1	73.2	79.8	79.8
21-Jul	60.4	63.4	69.9	72.9	79.5	79.5
22-Jul	60.6	63.3	69.6	72.5	79.1	79.1
23-Jul	60.7	63.3	69.3	72.1	78.6	78.7
24-Jul	60.9	63.4	69.3	71.9	78.4	78.5
25-Jul	61.1	63.6	69.4	71.9	78.3	78.3
26-Jul	61.2	63.7	69.4	71.8	78.1	78.2
27-Jul	61.4	63.8	69.4	71.8	78.0	78.1
28-Jul	61.6	64.0	69.6	71.9	78.0	78.1
29-Jul	61.8	64.1	69.7	72.0	78.0	78.1
30-Jul	62.0	64.3	69.9	72.2	78.1	78.1
31-Jul	62.1	64.5	70.0	72.3	78.1	78.1
1-Aug	62.3	64.7	70.3	72.5	78.3	78.3
2-Aug	62.5	64.9	70.6	72.8	78.6	78.6
3-Aug	62.8	65.2	70.9	73.2	79.0	79.0
4-Aug	62.9	65.2	70.9	73.2	79.0	79.1
5-Aug	63.1	65.4	71.0	73.3	79.0	79.2
6-Aug	63.3	65.6	71.2	73.5	79.3	79.4
7-Aug	63.5	65.7	71.2	73.6	79.3	79.4
8-Aug	63.6	65.8	71.2	73.5	79.2	79.3
9-Aug	63.8	65.8	71.2	73.4	79.1	79.2
10-Aug	63.9	65.8	71.0	73.2	78.8	78.8
11-Aug	64.2	66.0	71.1	73.1	78.7	78.7
12-Aug	64.4	66.1	71.0	73.0	78.5	78.5
13-Aug	64.5	66.0	70.8	72.8	78.2	78.1
14-Aug	64.7	66.1	70.6	72.5	77.8	77.8
15-Aug	64.9	66.1	70.5	72.3	77.5	77.5
16-Aug	65.1	66.3	70.5	72.2	77.3	77.3
17-Aug	65.4	66.5	70.6	72.2	77.3	77.3
18-Aug	65.7	66.6	70.6	72.2	77.2	77.2
19-Aug	65.9	66.8	70.6	72.2	77.0	77.1
20-Aug	66.3	67.0	70.7	72.2	76.9	76.9
21-Aug	66.6	67.2	70.8	72.2	76.9	76.9
22-Aug	67.0	67.4	70.9	72.2	76.8	76.8
23-Aug	67.3	67.6	70.8	72.1	76.6	76.5
24-Aug	67.6	67.8	70.9	72.1	76.4	76.3
25-Aug	68.0	68.0	70.9	72.1	76.3	76.2
26-Aug	68.3	68.4	71.2	72.2	76.3	76.2
27-Aug	68.6	68.7	71.5	72.4	76.5	76.4
28-Aug	68.9	69.1	71.9	72.8	76.7	76.6
29-Aug	69.2	69.5	72.3	73.2	77.1	77.0
30-Aug	69.5	69.9	72.8	73.6	77.6	77.4
31-Aug	69.7	70.1	73.1	74.0	77.9	77.7

Table 4: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	70.0	70.5	73.5	74.5	78.3	78.1
2-Sep	70.2	70.7	73.8	74.8	78.7	78.4
3-Sep	70.5	70.9	74.2	75.2	79.0	78.8
4-Sep	70.6	71.0	74.3	75.4	79.2	78.9
5-Sep	70.3	70.9	74.1	75.3	79.0	78.7
6-Sep	69.6	70.6	73.7	74.9	78.5	78.3
7-Sep	68.7	70.2	73.4	74.5	78.1	77.9
8-Sep	67.5	69.7	73.0	74.1	77.7	77.5
9-Sep	66.3	69.0	72.5	73.7	77.3	77.0
10-Sep	64.9	68.1	71.8	73.1	76.6	76.4
11-Sep	63.6	67.1	71.2	72.5	76.0	75.9
12-Sep	62.6	66.2	70.5	71.9	75.5	75.4
13-Sep	61.9	65.4	70.0	71.5	75.2	75.1
14-Sep	61.4	64.6	69.2	70.8	74.7	74.6
15-Sep	61.1	63.9	68.5	70.2	74.2	74.1
16-Sep	60.8	63.2	67.7	69.5	73.6	73.5
17-Sep	60.6	62.7	67.1	68.9	73.2	73.1
18-Sep	60.5	62.3	66.6	68.3	72.8	72.7
19-Sep	60.4	62.1	66.3	67.9	72.6	72.6
20-Sep	60.3	61.9	66.0	67.6	72.4	72.4
21-Sep	60.3	61.9	66.1	67.6	72.6	72.7
22-Sep	60.3	61.9	66.1	67.7	72.7	72.8
23-Sep	60.3	61.9	66.1	67.8	72.9	73.0
24-Sep	60.2	61.8	66.1	67.8	72.9	73.1
25-Sep	60.1	61.7	65.9	67.7	72.8	73.1
26-Sep	60.1	61.7	65.8	67.6	72.8	73.0
27-Sep	60.1	61.6	65.7	67.4	72.6	72.9
28-Sep	60.0	61.4	65.4	67.2	72.3	72.6
29-Sep	60.0	61.3	65.2	66.9	72.1	72.4
30-Sep	60.1	61.3	65.1	66.8	72.0	72.3
1-Oct	60.3	61.4	65.2	66.7	72.0	72.3
2-Oct	60.6	61.5	65.3	66.8	72.1	72.4
3-Oct	60.7	61.6	65.4	66.9	72.2	72.5
4-Oct	61.0	61.8	65.6	67.1	72.3	72.7
5-Oct	61.2	62.0	65.8	67.3	72.6	72.9
6-Oct	61.4	62.1	65.9	67.4	72.7	73.1
7-Oct	61.4	62.1	65.7	67.3	72.5	72.9
8-Oct	61.2	62.1	65.5	67.0	72.2	72.7
9-Oct	61.0	61.9	65.2	66.6	71.8	72.3
10-Oct	60.8	61.8	64.9	66.2	71.4	72.0
11-Oct	60.5	61.5	64.5	65.7	70.8	71.4
12-Oct	60.3	61.3	64.0	65.2	70.1	70.8
13-Oct	60.1	61.0	63.5	64.5	69.3	70.1
14-Oct	60.1	60.8	63.2	64.1	68.8	69.6
15-Oct	60.1	60.7	63.0	63.8	68.3	69.1
16-Oct	60.1	60.6	62.9	63.5	67.9	68.7
17-Oct	60.1	60.5	62.7	63.3	67.5	68.3
18-Oct	60.1	60.5	62.6	63.2	67.1	67.9
19-Oct	60.1	60.5	62.5	63.1	66.8	67.5
20-Oct	60.0	60.4	62.3	62.9	66.5	67.1
21-Oct	60.0	60.3	62.2	62.7	66.2	66.8
22-Oct	59.8	60.0	61.7	62.3	65.7	66.1
23-Oct	59.9	59.9	61.5	62.0	65.4	65.7
24-Oct	59.9	59.8	61.3	61.7	65.0	65.3
25-Oct	59.9	59.7	61.2	61.5	64.8	65.0
26-Oct	59.9	59.6	61.0	61.3	64.5	64.7
27-Oct	59.9	59.6	60.9	61.2	64.3	64.5
28-Oct	59.8	59.6	60.8	61.0	64.1	64.3
29-Oct	59.8	59.6	60.8	61.0	64.1	64.2
30-Oct	59.7	59.5	60.7	60.9	63.9	64.1
31-Oct	59.6	59.4	60.5	60.7	63.7	63.9

5. Projected Downriver Temperature Response – Bypass Operation

Bypass operation changes the thermal structure of both New Melones and Tulloch reservoirs and the temperature release below Goodwin, as such. The best way to explain this phenomenon is by way of example:

Figure 8 shows the computed temperature profiles in New Melones and Tulloch reservoirs on September 1 for two cases: A no-bypass case and a bypass case beginning on July 1.

- In the no-bypass case, warmer water outflow from New Melones resulting in little cool water remaining in Tulloch.
- In the bypass case, blending of colder water through the low-level outlet result in a larger warm water epilimnion in New Melones and cooler water in Tulloch (warm water remains in New Melones and not in the river below Goodwin).

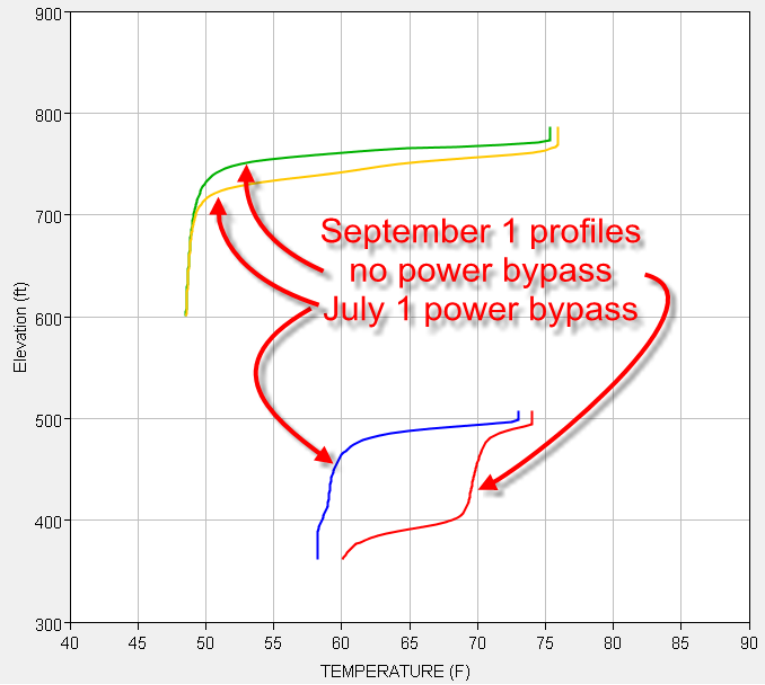

Figure 8: Temperature profiles in New Melones and Tulloch With and Without Bypass Operation

Four options for bypass operations have been considered:

1) Bypass starting July 1
2) Bypass starting July 15
3) Bypass starting August 1
4) Bypass starting August 15.

In all cases, the bypass operation was done gradually (assumed linear transition) from the specified starting date until full bypass by early September when New Melones reached its minimum power pool elevation.

The ramification of the bypass operation is a reduction in water temperature below Goodwin Dam (and downriver) in comparison with the no-bypass case, as illustrated in Figure 9 below:

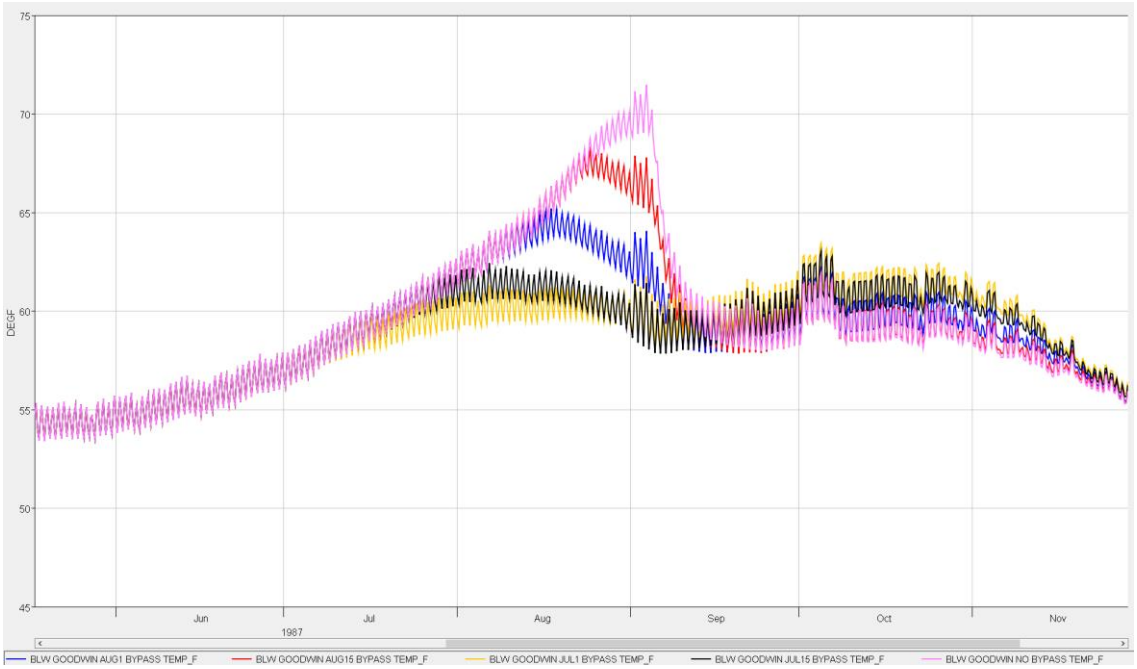

Figure 9: Effects of Power Bypass on Temperature Below Goodwin Dam

Figure 9 shows, that the most dramatic reduction in temperature in late August and early September could be achieved by starting the bypass operation on July 1. However, this type of operation would deplete cold water in New Melones, resulting in elevated water temperature in October. The question which of those bypass operation options provides the most thermal benefit should be dealt with in the context of impact on fish which is not the subject of this analysis.

In addition, the loss of energy production due to the power bypass should also be considered. A simplified power analysis related to this issue is provided below.

Based on visual inspection of the results, the July 15 bypass case was selected as the representative bypass case as it shows an overall moderation of temperatures throughout the bypass period. The results for this case in terms of 7DADM are presented in the following tables:

Table 5: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.5	50.6	52.2	52.3	55.4	55.6
2-Mar	50.6	50.8	52.5	52.5	55.7	55.9
3-Mar	50.8	51.1	53.0	53.1	56.4	56.6
4-Mar	50.8	51.2	53.3	53.5	56.9	57.1
5-Mar	50.7	51.2	53.4	53.8	57.2	57.5
6-Mar	50.7	51.3	53.6	54.1	57.5	57.8
7-Mar	50.8	51.4	53.8	54.4	57.9	58.2
8-Mar	50.9	51.5	53.9	54.6	58.1	58.4
9-Mar	51.0	51.5	54.0	54.7	58.4	58.6
10-Mar	51.0	51.5	54.0	54.7	58.4	58.7
11-Mar	51.3	51.7	54.1	54.8	58.6	58.8
12-Mar	51.6	52.0	54.6	55.2	59.2	59.3
13-Mar	51.8	52.2	54.9	55.6	59.7	59.8
14-Mar	51.8	52.2	54.9	55.7	59.9	59.9
15-Mar	51.9	52.3	54.8	55.7	60.0	60.0
16-Mar	51.9	52.3	54.8	55.6	60.0	60.1
17-Mar	52.0	52.4	54.9	55.6	60.0	60.2
18-Mar	52.0	52.4	54.8	55.6	59.8	60.1
19-Mar	51.9	52.3	54.6	55.3	59.5	59.8
20-Mar	51.9	52.3	54.4	55.1	59.1	59.5
21-Mar	52.0	52.3	54.4	55.0	58.9	59.3
22-Mar	52.1	52.5	54.6	55.1	58.9	59.3
23-Mar	52.2	52.5	54.5	55.0	58.8	59.1
24-Mar	52.2	52.5	54.5	55.0	58.7	58.9
25-Mar	52.3	52.7	54.7	55.2	58.8	59.0
26-Mar	52.5	52.8	55.0	55.5	59.2	59.3
27-Mar	52.6	53.0	55.3	55.9	59.5	59.7
28-Mar	52.8	53.3	55.8	56.4	60.1	60.3
29-Mar	52.9	53.5	56.2	56.9	60.5	60.7
30-Mar	53.1	53.8	56.8	57.5	61.1	61.4
31-Mar	53.3	54.1	57.3	58.0	61.7	61.9
1-Apr	53.3	54.3	57.7	58.6	62.2	62.5
2-Apr	53.4	54.4	58.0	59.0	62.7	62.9
3-Apr	53.4	54.5	58.2	59.3	63.1	63.2
4-Apr	53.4	54.5	58.3	59.5	63.4	63.5
5-Apr	53.3	54.6	58.4	59.6	63.7	63.8
6-Apr	53.3	54.6	58.5	59.8	64.1	64.2
7-Apr	53.3	54.7	58.7	60.0	64.7	64.7
8-Apr	53.3	54.8	58.8	60.2	65.2	65.2
9-Apr	53.4	54.8	58.9	60.4	65.7	65.7
10-Apr	53.4	54.9	59.0	60.6	66.1	66.3
11-Apr	53.5	55.0	59.1	60.8	66.5	66.7
12-Apr	53.7	55.1	59.4	61.1	66.9	67.2
13-Apr	53.8	55.3	59.7	61.4	67.4	67.7
14-Apr	53.9	55.5	60.0	61.8	67.9	68.3
15-Apr	53.8	55.5	60.1	62.0	68.4	68.8
16-Apr	53.8	55.4	60.0	61.9	68.8	69.4
17-Apr	53.8	55.4	59.8	61.7	69.0	69.9
18-Apr	53.7	55.2	59.4	61.3	68.8	69.9
19-Apr	53.6	55.1	59.0	60.8	68.4	69.8
20-Apr	53.5	54.9	58.6	60.3	67.8	69.4
21-Apr	53.5	54.8	58.1	59.7	67.2	68.9
22-Apr	53.5	54.7	57.9	59.3	66.4	68.2
23-Apr	53.6	54.7	57.7	59.0	65.6	67.4
24-Apr	53.7	54.8	57.8	58.9	65.1	66.7
25-Apr	53.8	55.0	58.1	59.2	65.1	66.6
26-Apr	53.9	55.2	58.4	59.6	65.3	66.7
27-Apr	54.0	55.4	58.7	60.0	65.8	67.0
28-Apr	54.1	55.4	58.8	60.2	66.0	67.2
29-Apr	54.2	55.5	59.0	60.3	66.3	67.4
30-Apr	54.2	55.6	59.0	60.4	66.5	67.6

Table 6: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	54.2	55.5	58.9	60.3	66.4	67.6
2-May	54.2	55.5	58.8	60.2	66.4	67.5
3-May	54.2	55.4	58.7	60.0	66.1	67.3
4-May	54.1	55.4	58.5	59.8	65.8	67.0
5-May	54.1	55.4	58.6	59.8	65.7	67.0
6-May	54.2	55.5	58.7	59.9	65.8	67.0
7-May	54.2	55.6	58.9	60.2	66.1	67.3
8-May	54.3	55.8	59.2	60.5	66.6	67.8
9-May	54.4	55.9	59.4	60.9	67.1	68.3
10-May	54.5	56.1	59.8	61.3	67.7	68.9
11-May	54.6	56.2	60.1	61.6	68.2	69.4
12-May	54.7	56.3	60.2	61.9	68.6	69.9
13-May	54.8	56.4	60.4	62.1	69.0	70.3
14-May	54.8	56.5	60.6	62.3	69.4	70.7
15-May	54.9	56.6	60.7	62.5	69.7	71.1
16-May	55.0	56.8	60.8	62.6	69.8	71.1
17-May	55.0	56.9	61.1	62.8	69.8	71.1
18-May	55.1	57.2	61.5	63.1	69.8	71.0
19-May	55.1	57.4	61.8	63.4	69.8	70.8
20-May	55.1	57.4	61.9	63.6	69.5	70.5
21-May	55.2	57.7	62.3	63.9	69.4	70.2
22-May	55.2	57.9	62.7	64.3	69.5	70.0
23-May	55.2	58.0	63.1	64.9	69.8	70.0
24-May	55.2	58.0	63.3	65.3	70.2	70.3
25-May	55.2	58.1	63.5	65.6	70.5	70.6
26-May	55.2	58.1	63.5	65.7	70.7	70.7
27-May	55.1	58.0	63.4	65.7	70.9	70.8
28-May	55.2	58.0	63.4	65.8	71.0	71.0
29-May	55.2	58.0	63.4	65.8	71.2	71.1
30-May	55.2	58.1	63.5	65.9	71.4	71.4
31-May	55.3	58.2	63.7	66.0	71.7	71.6
1-Jun	55.3	58.3	64.0	66.3	72.0	72.0
2-Jun	55.4	58.6	64.6	66.9	72.8	72.8
3-Jun	55.6	59.1	65.4	67.8	73.9	73.8
4-Jun	55.6	59.2	65.7	68.3	74.5	74.4
5-Jun	55.6	59.3	66.0	68.7	74.9	74.8
6-Jun	55.6	59.4	66.3	69.1	75.4	75.3
7-Jun	55.7	59.6	66.7	69.6	76.0	75.9
8-Jun	55.8	59.7	67.0	69.9	76.4	76.4
9-Jun	55.8	59.7	67.0	70.1	76.6	76.6
10-Jun	55.9	59.8	67.0	70.1	76.6	76.6
11-Jun	56.0	60.0	67.3	70.4	76.9	76.9
12-Jun	56.2	60.3	67.8	70.8	77.4	77.4
13-Jun	56.3	60.5	68.1	71.2	77.8	77.8
14-Jun	56.3	60.5	68.2	71.4	77.9	77.9
15-Jun	56.4	60.5	68.1	71.3	77.9	77.8
16-Jun	56.4	60.5	68.0	71.3	77.8	77.7
17-Jun	56.4	60.4	67.8	71.1	77.6	77.6
18-Jun	56.5	60.4	67.7	70.9	77.5	77.5
19-Jun	56.5	60.3	67.5	70.7	77.4	77.3
20-Jun	56.5	60.1	67.1	70.4	77.0	77.0
21-Jun	56.6	60.1	66.9	70.1	76.7	76.7
22-Jun	56.7	60.2	66.9	70.0	76.6	76.6
23-Jun	56.8	60.3	67.1	70.0	76.6	76.7
24-Jun	57.0	60.6	67.5	70.4	77.0	77.0
25-Jun	57.1	60.8	67.9	70.8	77.4	77.5
26-Jun	57.2	61.1	68.3	71.3	77.9	78.0
27-Jun	57.3	61.4	68.8	71.9	78.6	78.6
28-Jun	57.4	61.6	69.2	72.5	79.3	79.2
29-Jun	57.5	61.7	69.6	72.9	79.9	79.8
30-Jun	57.6	61.8	69.7	73.2	80.2	80.2

Table 7: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	57.7	61.9	69.7	73.3	80.3	80.3
2-Jul	57.8	61.8	69.5	73.1	80.2	80.2
3-Jul	57.8	61.7	69.1	72.7	79.8	79.8
4-Jul	57.9	61.6	68.9	72.4	79.5	79.5
5-Jul	58.1	61.7	68.8	72.1	79.2	79.3
6-Jul	58.2	61.7	68.7	71.9	78.9	79.0
7-Jul	58.4	61.9	68.8	71.9	78.9	78.9
8-Jul	58.6	62.0	69.0	72.0	78.9	78.9
9-Jul	58.7	62.2	69.2	72.2	78.9	78.9
10-Jul	58.9	62.5	69.5	72.5	79.1	79.1
11-Jul	59.1	62.6	69.8	72.8	79.3	79.3
12-Jul	59.2	62.9	70.0	73.0	79.5	79.4
13-Jul	59.4	63.1	70.3	73.3	79.8	79.7
14-Jul	59.6	63.2	70.5	73.5	79.9	79.8
15-Jul	59.7	63.4	70.7	73.8	80.2	80.0
16-Jul	59.8	63.5	70.7	73.9	80.3	80.2
17-Jul	59.9	63.5	70.6	73.8	80.3	80.2
18-Jul	60.1	63.5	70.5	73.7	80.2	80.2
19-Jul	60.2	63.5	70.3	73.5	80.1	80.0
20-Jul	60.3	63.4	70.1	73.2	79.8	79.8
21-Jul	60.4	63.4	69.9	72.9	79.5	79.5
22-Jul	60.6	63.3	69.6	72.5	79.1	79.1
23-Jul	60.7	63.3	69.3	72.1	78.6	78.7
24-Jul	60.9	63.4	69.3	71.9	78.4	78.5
25-Jul	61.0	63.5	69.3	71.9	78.3	78.3
26-Jul	61.1	63.6	69.4	71.8	78.1	78.2
27-Jul	61.3	63.8	69.4	71.8	78.0	78.1
28-Jul	61.4	63.9	69.6	71.9	78.0	78.1
29-Jul	61.5	64.0	69.7	72.0	78.0	78.1
30-Jul	61.6	64.2	69.9	72.2	78.1	78.1
31-Jul	61.7	64.3	70.0	72.3	78.1	78.1
1-Aug	61.7	64.4	70.2	72.5	78.3	78.3
2-Aug	61.8	64.6	70.5	72.7	78.6	78.6
3-Aug	61.9	64.8	70.8	73.1	79.0	79.0
4-Aug	61.9	64.7	70.7	73.1	79.0	79.1
5-Aug	62.0	64.8	70.7	73.2	79.0	79.1
6-Aug	62.1	64.9	70.9	73.4	79.3	79.4
7-Aug	62.1	64.9	70.9	73.4	79.3	79.4
8-Aug	62.1	64.9	70.8	73.3	79.2	79.3
9-Aug	62.1	64.8	70.7	73.2	79.1	79.2
10-Aug	62.1	64.7	70.4	72.9	78.7	78.8
11-Aug	62.2	64.8	70.5	72.8	78.7	78.7
12-Aug	62.2	64.7	70.4	72.7	78.5	78.5
13-Aug	62.1	64.6	70.1	72.4	78.1	78.1
14-Aug	62.1	64.4	69.8	72.1	77.8	77.8
15-Aug	62.0	64.4	69.6	71.8	77.4	77.5
16-Aug	62.0	64.3	69.5	71.6	77.2	77.3
17-Aug	62.0	64.3	69.5	71.5	77.2	77.3
18-Aug	62.0	64.3	69.4	71.5	77.0	77.1
19-Aug	61.9	64.2	69.3	71.4	76.9	77.0
20-Aug	61.9	64.2	69.3	71.3	76.8	76.9
21-Aug	61.9	64.2	69.3	71.3	76.7	76.8
22-Aug	61.8	64.1	69.2	71.2	76.6	76.7
23-Aug	61.7	64.0	69.0	71.0	76.3	76.4
24-Aug	61.6	63.9	68.8	70.8	76.1	76.2
25-Aug	61.5	63.8	68.7	70.7	76.0	76.1
26-Aug	61.4	63.8	68.8	70.7	76.0	76.1
27-Aug	61.3	63.8	68.8	70.8	76.1	76.2
28-Aug	61.2	63.8	69.0	70.9	76.3	76.4
29-Aug	61.1	63.8	69.1	71.2	76.7	76.8
30-Aug	61.0	63.9	69.4	71.4	77.1	77.2
31-Aug	60.9	63.9	69.5	71.7	77.4	77.4

Table 8: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	60.9	63.9	69.7	71.9	77.7	77.8
2-Sep	60.9	63.8	69.8	72.1	78.0	78.1
3-Sep	61.0	63.9	70.0	72.4	78.3	78.4
4-Sep	60.9	63.8	70.0	72.4	78.4	78.5
5-Sep	60.8	63.5	69.6	72.2	78.2	78.3
6-Sep	60.7	63.2	69.1	71.7	77.7	77.8
7-Sep	60.6	62.9	68.7	71.2	77.3	77.4
8-Sep	60.4	62.6	68.2	70.7	76.8	77.0
9-Sep	60.4	62.4	67.8	70.2	76.3	76.5
10-Sep	60.2	62.1	67.1	69.5	75.6	75.9
11-Sep	60.1	61.8	66.6	68.8	75.0	75.3
12-Sep	60.1	61.6	66.1	68.3	74.4	74.7
13-Sep	60.1	61.6	65.9	68.0	74.0	74.4
14-Sep	60.1	61.5	65.6	67.5	73.4	73.9
15-Sep	60.2	61.4	65.3	67.1	72.9	73.3
16-Sep	60.2	61.2	64.9	66.7	72.3	72.8
17-Sep	60.2	61.2	64.7	66.4	71.8	72.3
18-Sep	60.3	61.2	64.6	66.1	71.4	71.9
19-Sep	60.3	61.3	64.7	66.0	71.3	71.7
20-Sep	60.4	61.3	64.7	66.0	71.1	71.6
21-Sep	60.5	61.5	65.1	66.3	71.4	71.8
22-Sep	60.6	61.7	65.3	66.6	71.6	71.9
23-Sep	60.7	61.9	65.6	66.9	71.8	72.2
24-Sep	60.7	61.9	65.7	67.1	72.0	72.3
25-Sep	60.7	61.9	65.7	67.2	72.0	72.3
26-Sep	60.8	62.0	65.7	67.2	72.0	72.3
27-Sep	60.8	62.0	65.7	67.2	72.0	72.3
28-Sep	60.8	61.9	65.5	67.0	71.8	72.1
29-Sep	60.8	61.9	65.4	66.9	71.6	71.9
30-Sep	60.9	61.9	65.4	66.8	71.6	71.9
1-Oct	61.2	62.0	65.5	66.9	71.7	71.9
2-Oct	61.5	62.2	65.7	67.0	71.9	72.1
3-Oct	61.7	62.3	65.8	67.1	72.0	72.2
4-Oct	62.0	62.5	66.0	67.4	72.3	72.5
5-Oct	62.3	62.8	66.3	67.6	72.5	72.8
6-Oct	62.5	63.0	66.5	67.8	72.7	73.0
7-Oct	62.5	63.0	66.3	67.7	72.5	72.8
8-Oct	62.4	63.0	66.1	67.5	72.3	72.7
9-Oct	62.2	62.9	65.8	67.1	71.9	72.3
10-Oct	62.1	62.8	65.6	66.7	71.5	72.0
11-Oct	61.8	62.6	65.2	66.3	70.9	71.5
12-Oct	61.7	62.3	64.8	65.7	70.3	70.9
13-Oct	61.5	62.1	64.3	65.2	69.6	70.3
14-Oct	61.5	62.0	64.1	64.8	69.0	69.8
15-Oct	61.6	61.9	63.9	64.5	68.5	69.3
16-Oct	61.6	61.9	63.8	64.3	68.2	68.9
17-Oct	61.7	61.9	63.7	64.1	67.8	68.5
18-Oct	61.7	61.8	63.6	64.0	67.5	68.1
19-Oct	61.7	61.9	63.5	63.9	67.2	67.8
20-Oct	61.7	61.8	63.4	63.7	66.9	67.4
21-Oct	61.7	61.7	63.3	63.6	66.6	67.0
22-Oct	61.5	61.5	62.8	63.1	66.1	66.4
23-Oct	61.6	61.4	62.6	62.8	65.8	66.0
24-Oct	61.6	61.2	62.4	62.6	65.4	65.6
25-Oct	61.6	61.2	62.3	62.4	65.2	65.3
26-Oct	61.6	61.1	62.1	62.2	64.9	65.0
27-Oct	61.6	61.1	62.0	62.0	64.7	64.7
28-Oct	61.5	61.1	61.9	61.9	64.5	64.6
29-Oct	61.5	61.1	61.9	61.9	64.5	64.5
30-Oct	61.4	61.1	61.8	61.8	64.3	64.4
31-Oct	61.4	61.0	61.7	61.6	64.1	64.2

6. Projected Energy Loss Due to Bypass Operation

A simplified hydropower calculation was performed to estimate the energy loss due to the bypass operation. The no-bypass case was compared with the July 15 bypass case, as follows:

	No Bypass	July 15 Bypass	Energy Loss
	MWh	MWh	MWh
Jan			
Feb			
Mar	13,296	13,296	0
Apr	20,728	20,728	0
May	25,176	25,176	0
Jun	23,731	23,731	0
Jul	22,891	21,124	(1,768)
Aug	18,471	7,423	(11,047)
Sep	0	0	0
Oct	0	0	0
Nov	0	0	0
Dec	0	0	0
Total	134,546	121,731	(12,815)

Figure 10: Projected Energy Loss Due to Bypass Operation

Figure 10 shows that the energy loss during the bypass period, July 15 through August 31, 2015, will be in the order of 12,815 MWh. Based on PG&E SRAC (Short-Term Avoided Cost) for qualifying facilities, the cost per KWh in July and August of 2014 was approximately 5 cents. If we use the same price rate for this year, the loss of energy could amount to $640,747.

Stanislaus Temperature Modeling
2015 Proposed Operations
Water Allocation Schedule – March 25, 2015

General:

The objective of this work is to assess, using the HEC-5Q Model, the expected temperature conditions at discrete points along the Stanislaus River, given the most recent projections of inflow to New Melones Reservoir and the proposed water release schedule from March 25, 2015 through the December 31, 2015.

Tasks:

1. Set up the data to run a year similar to 1987:
   a. Prime the model by setting New Melones to the March 25 condition (storage and temperature profile wise).
   b. Disaggregate the estimated monthly NM inflow to daily (see the New Melones Inflow, Diversion and Release Schedule below).
   c. Assume monthly average diversion for OID/SSJID and for Goodwin release to river, as specified in the New Melones Inflow, Diversion and Release Schedule below.
   d. Prepare DSS inputs for the above.
2. Run the model in two modes:
   - No Hydro Bypass
   - Hydro Bypass starting July 15
3. Analyze the results in terms of the expected temperatures (7DADM) at the specified locations along the Stanislaus River from day 1 of the simulation to end-of-year 2015.
4. Estimate the energy loss due to Hydro Bypass operation

New Melones Inflow, Diversion and Release Schedule:

Beginning	NM Inflow	Goodwin OID/SSJID	Goodwin To River -2E
	TAF	TAF	CFS
March 1, 2015	31.3	16.4	200
March 26, 2015	5.0	4.8	200
April 1, 2015	9.0	26.1	677
April 15, 2015	9.0	29.8	709
May 1, 2015	8.7	37.6	200
May 16, 2015	9.3	40.1	200
June 1, 2015	12.0	77.3	150
July 1, 2015	12.0	82	150
August 1, 2015	11.0	78.4	150
September 1, 2015	11.0	48.8	150
October 1, 2015	3.0	0	577
November 1, 2015	1.1	0	200
December 1, 2015	1.3	0	200
December 31, 2015			

Figure 1: Estimated New Melones Inflow and Water Allocation in 2015

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Modeling, Analysis and Findings

1. Priming the Mode

The HEC-5Q was set to simulate a single year similar to 1987 in terms of the pattern of inflow to New Melones except that the volume of the inflow was scaled down to match the monthly estimates specified in Figure 1 above. The meteorological conditions were also set to match the historical conditions in 1987.

In order to prime the model, the simulation started on January 1, 1987 where by New Melones storage was set in such a way that by March 25 the total volume of water in the reservoir equaled approximately to the observed volume on that date, i.e., 584,600 acre-feet. The computed temperature profiles in New Melones and Tulloch were also set to match typical conditions for these reservoirs during this time of the year.

2. Simulation Modes

The HEC-5Q was run in two modes:

a) No-Bypass Operation – under this mode, New Melones was operated in a way where the water was released through the power plant until the water level in the reservoir reached the minimum power pool elevation. At that point the release was switched to the low-level outlet in the dam.

b) Bypass Operation – under this mode, New Melones was operated in a way where the release was switched gradually from power release to low-level outlet release in advance of reaching the minimum power pool elevation.

3. Projected New Melones Storage

From the storage prospective, there is no difference between the two operations modes described above. Mass-balance calculation for New Melones for the period March 1 through December 31, 2015 is shown in Figure 2 below.

New Melones Ops - Projected Storage and Water Levels

Beginning	NM Inflow	Goodwin OID/SSJID	Goodwin To River -2E	NM Projected Storage	NM Projected Elevation
	TAF	TAF	CFS	TAF	FT
March 1, 2015	31.3	16.4	200	614	880
March 26, 2015	5.0	4.8	200	585	875
April 1, 2015	9.0	26.1	677	580	874
April 15, 2015	9.0	29.8	709	542	866
May 1, 2015	8.7	37.6	200	494	856
May 16, 2015	9.3	40.1	200	454	847
June 1, 2015	12.0	77.3	150	414	838
July 1, 2015	12.0	82	150	337	818
August 1, 2015	11.0	78.4	150	255	794
September 1, 2015	11.0	48.8	150	176	766
October 1, 2015	3.0	0	577	131	747
November 1, 2015	1.1	0	200	104	733
December 1, 2015	1.3	0	200	93	727
December 31, 2015				82	720

Figure 2: Mass balance for New Melones: March 1 to December 31, 2015

The figure shows that the projected storage in New Melones on November 1 is 104 TAF corresponding to El. 733. This reduction in storage takes into consideration the net effect of New Melones and Tulloch evaporation, including local runoff to Tulloch (which was assumed to be similar to 1987).

The gradual decline of water levels in the reservoir from March through December is shown in Figure 3 below. The figure shows that given the assumed inflow to New Melones and proposed outflow (diversion plus release to river), the water will probably recede to the point where the submerged old Melones Dam will emerge around December 19.

In addition, the depressed water levels in the reservoir will greatly affect the water temperatures downstream as the warm water epilimnion (the top-most layer) will be discharged from the reservoir through the power intake. It should be noted that in both operation modes power flow will cease as the reservoir reaches the minimum power pool at El. 785 (around end-of-day August 11) and water will be discharged at that point thorough the low-level outlet in the New Melones Dam.

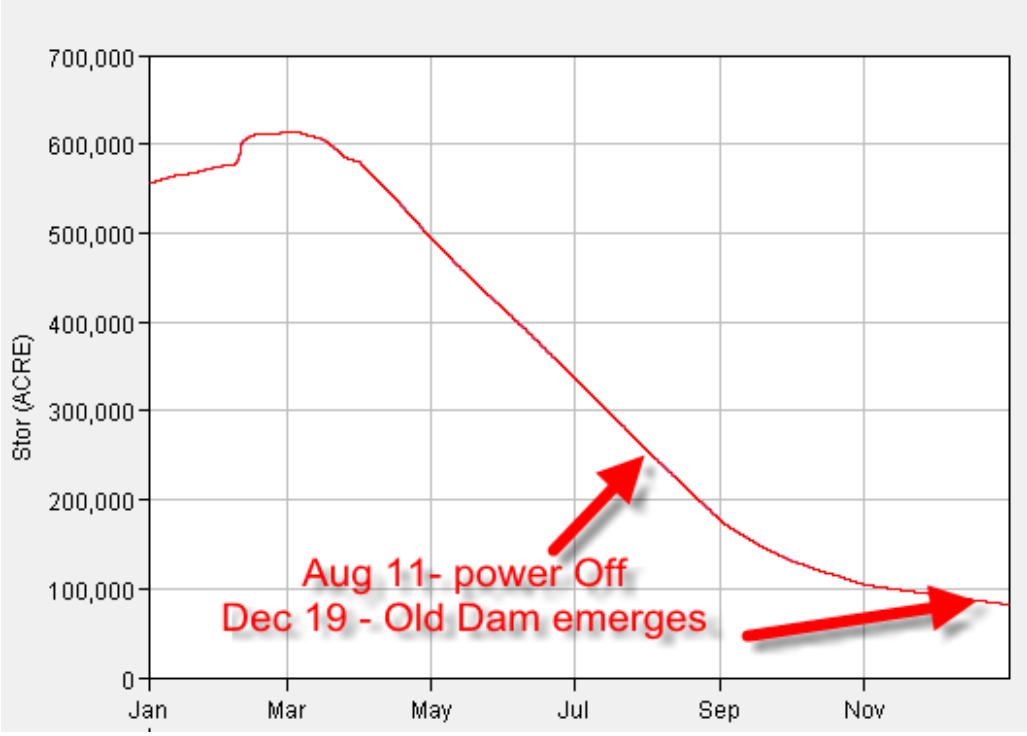


Figure 3: Projected New Melones Storage in 2015

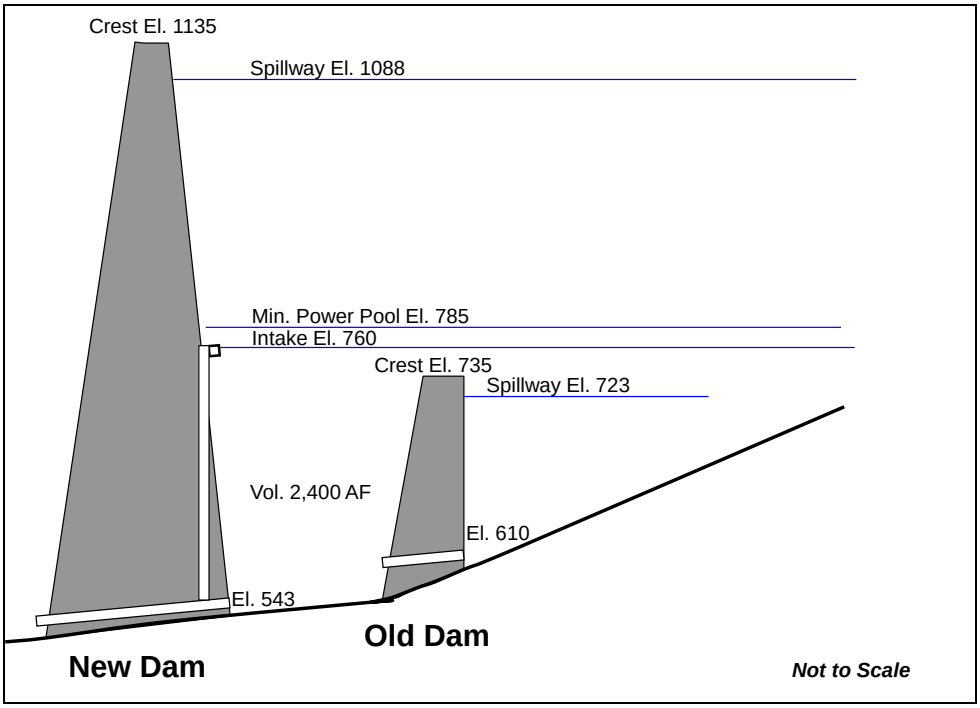


Figure 4: New-Old Dam Interaction

4. Projected Downriver Temperature Response – No-Bypass Operation

The following figures and tables show the results for the temperature response at six discrete points along the Stanislaus River:

1) Below Goodwin Dam
2) Knights Ferry
3) Orange Blossom Bridge
4) Highway 120 Bridge (Oakdale)
5) Ripon Gage (Highway 99)
6) Above the confluence with the San Joaquin River

The results are presented in two ways:

A. Graphical form - showing the daily maximum temperatures

B. Tabular form - showing the 7-Days Average of Daily Maximums (7DADM).

Notice the precipitous drop of temperatures (almost 10 Deg-F below Goodwin Dam) in mid-August under the No-Bypass mode. This is due to the abrupt switch from no-bypass to full-bypass operation on August 11 (due to power shutoff).

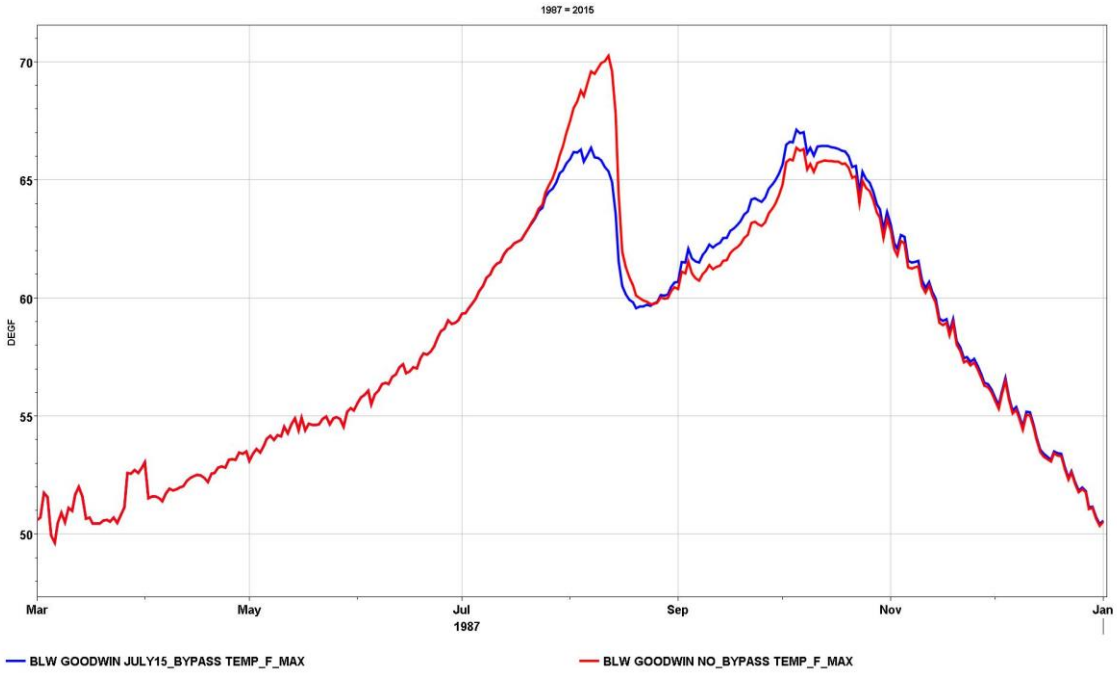


Figure 5 : Maximum Daily Temperatures below Goodwin Dam

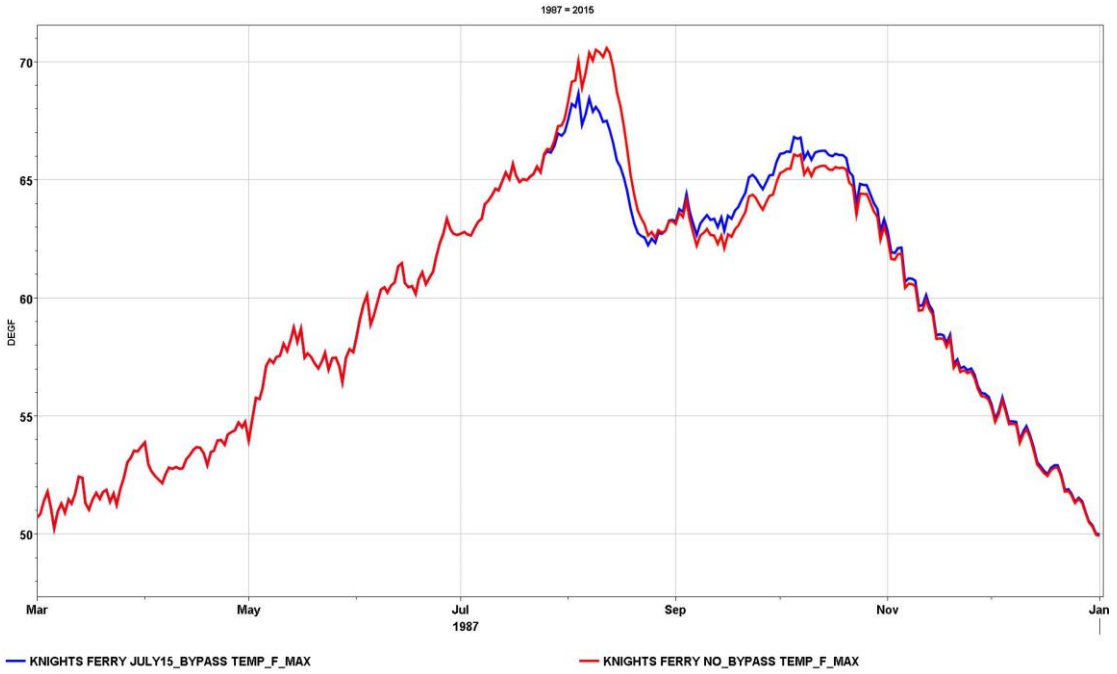


Figure 6 : Maximum Daily Temperatures at Knights Ferry

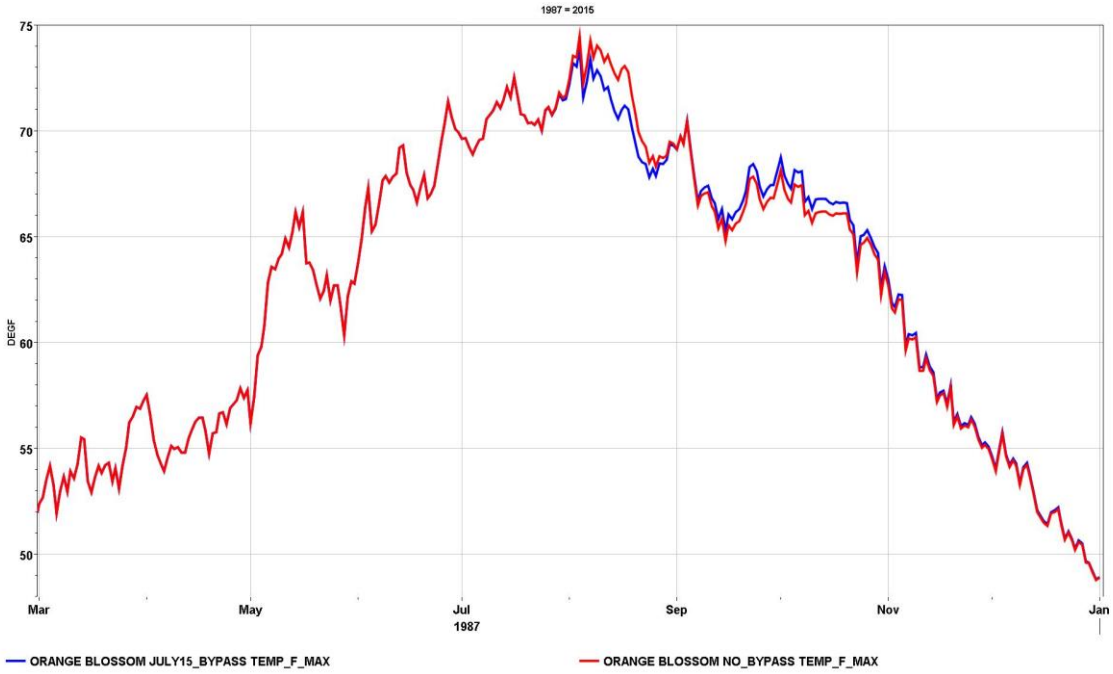


Figure 7 : Maximum Daily Temperatures at Orange Blossom Bridge

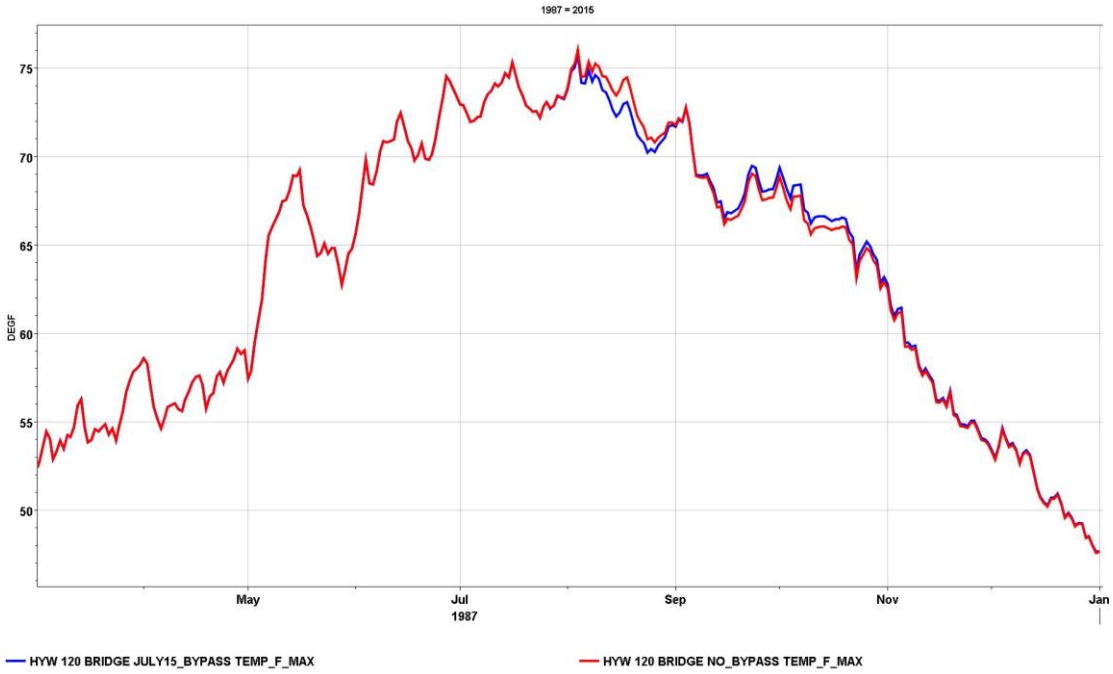


Figure 8 : Maximum Daily Temperatures below Highway 120 (Oakdale)

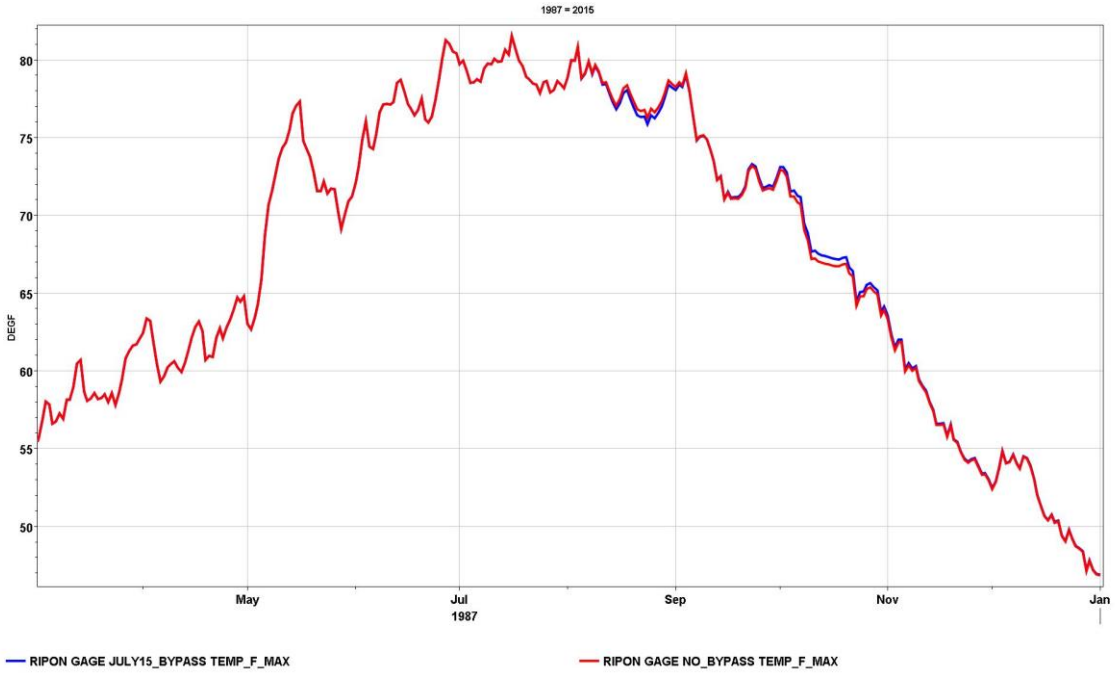


Figure 9 : Maximum Daily Temperatures at Ripon Gage (Highway 99)

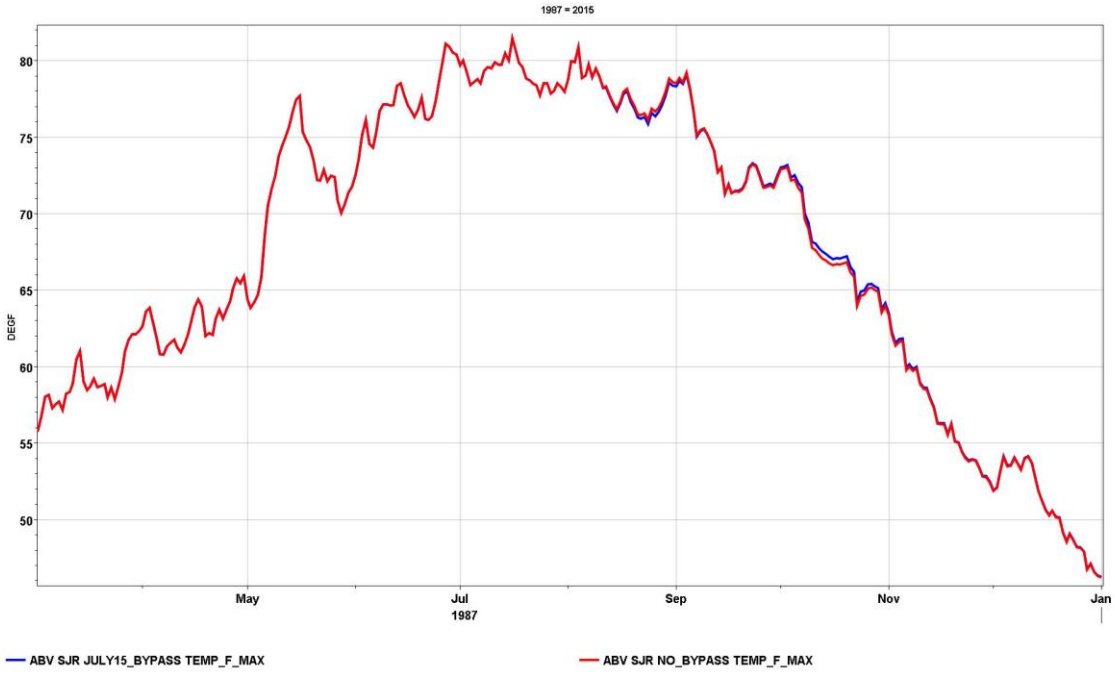


Figure 10 : Maximum Daily Temperatures above the Confluence with the San Joaquin River

Table 1: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.2	50.1	51.5	51.5	54.2	54.5
2-Mar	50.4	50.3	51.9	51.9	54.7	54.9
3-Mar	50.8	50.7	52.4	52.4	55.4	55.6
4-Mar	50.8	50.9	52.8	52.9	56.0	56.2
5-Mar	50.7	50.9	52.8	53.1	56.4	56.6
6-Mar	50.7	51.0	53.0	53.3	56.7	57.0
7-Mar	50.7	51.1	53.2	53.6	57.0	57.3
8-Mar	50.7	51.1	53.2	53.7	57.2	57.5
9-Mar	50.6	51.1	53.3	53.8	57.4	57.7
10-Mar	50.5	51.0	53.2	53.7	57.4	57.8
11-Mar	50.8	51.1	53.3	53.8	57.5	57.9
12-Mar	51.1	51.4	53.8	54.2	58.1	58.3
13-Mar	51.2	51.6	54.2	54.7	58.7	58.8
14-Mar	51.2	51.6	54.2	54.8	58.9	59.0
15-Mar	51.2	51.7	54.1	54.8	59.0	59.2
16-Mar	51.1	51.7	54.1	54.8	59.0	59.3
17-Mar	51.1	51.7	54.2	54.8	59.1	59.4
18-Mar	50.9	51.7	54.1	54.8	59.0	59.4
19-Mar	50.7	51.6	53.9	54.6	58.7	59.1
20-Mar	50.6	51.5	53.8	54.4	58.4	58.8
21-Mar	50.5	51.5	53.8	54.4	58.3	58.6
22-Mar	50.5	51.6	53.9	54.5	58.3	58.7
23-Mar	50.5	51.6	53.9	54.5	58.3	58.6
24-Mar	50.6	51.6	53.9	54.5	58.3	58.5
25-Mar	50.7	51.7	54.1	54.7	58.4	58.6
26-Mar	51.0	51.9	54.3	54.9	58.8	59.0
27-Mar	51.3	52.1	54.7	55.3	59.2	59.4
28-Mar	51.6	52.4	55.2	55.8	59.7	60.0
29-Mar	51.8	52.7	55.6	56.3	60.2	60.5
30-Mar	52.2	53.0	56.2	56.9	60.8	61.1
31-Mar	52.5	53.3	56.6	57.5	61.3	61.7
1-Apr	52.5	53.4	56.8	57.8	61.9	62.2
2-Apr	52.4	53.3	56.7	57.9	62.2	62.6
3-Apr	52.3	53.2	56.5	57.7	62.3	62.8
4-Apr	52.1	53.1	56.1	57.3	62.1	62.7
5-Apr	51.9	52.9	55.7	56.8	61.8	62.5
6-Apr	51.8	52.7	55.3	56.4	61.4	62.3
7-Apr	51.6	52.5	54.9	56.0	61.1	62.1
8-Apr	51.7	52.5	54.7	55.6	60.7	61.8
9-Apr	51.7	52.6	54.7	55.5	60.3	61.5
10-Apr	51.8	52.6	54.7	55.5	60.1	61.3
11-Apr	51.8	52.7	54.7	55.6	60.0	61.2
12-Apr	51.9	52.8	55.0	55.8	60.2	61.3
13-Apr	52.0	52.9	55.1	56.0	60.4	61.5
14-Apr	52.1	53.0	55.3	56.2	60.7	61.7
15-Apr	52.2	53.2	55.5	56.4	61.1	62.1
16-Apr	52.3	53.3	55.7	56.7	61.4	62.4
17-Apr	52.4	53.4	55.9	56.9	61.8	62.8
18-Apr	52.4	53.4	55.9	56.9	61.9	63.0
19-Apr	52.4	53.4	55.9	56.9	61.9	63.1
20-Apr	52.5	53.5	55.9	56.9	61.9	63.1
21-Apr	52.5	53.5	55.9	56.9	61.9	63.1
22-Apr	52.6	53.6	56.0	57.0	61.9	63.1
23-Apr	52.6	53.6	55.9	56.9	61.7	62.9
24-Apr	52.7	53.7	56.1	57.0	61.7	62.8
25-Apr	52.8	53.9	56.4	57.4	62.1	63.2
26-Apr	52.9	54.0	56.6	57.7	62.5	63.6
27-Apr	53.1	54.2	56.9	58.0	63.1	64.1
28-Apr	53.1	54.3	57.0	58.2	63.4	64.5
29-Apr	53.2	54.4	57.2	58.4	63.7	64.8
30-Apr	53.3	54.4	57.2	58.4	63.9	65.0

Table 2: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	53.3	54.5	57.3	58.4	63.8	65.0
2-May	53.4	54.7	57.6	58.6	63.9	65.0
3-May	53.4	54.9	58.0	58.9	63.9	64.9
4-May	53.5	55.1	58.4	59.3	64.1	64.9
5-May	53.5	55.5	59.2	60.1	64.7	65.4
6-May	53.6	55.9	60.0	61.0	65.5	66.0
7-May	53.8	56.3	61.0	62.2	66.7	67.1
8-May	53.9	56.7	62.0	63.5	68.2	68.3
9-May	54.0	57.0	62.7	64.5	69.6	69.6
10-May	54.1	57.3	63.4	65.5	71.1	71.1
11-May	54.2	57.5	63.9	66.3	72.3	72.4
12-May	54.3	57.7	64.3	66.9	73.3	73.4
13-May	54.4	57.9	64.6	67.3	74.1	74.2
14-May	54.4	58.0	64.9	67.7	74.9	75.1
15-May	54.5	58.2	65.2	68.1	75.6	75.8
16-May	54.6	58.2	65.2	68.2	75.7	76.0
17-May	54.6	58.1	65.0	68.1	75.7	76.1
18-May	54.7	58.1	64.8	67.9	75.6	76.0
19-May	54.6	57.9	64.5	67.5	75.2	75.7
20-May	54.6	57.7	63.9	66.8	74.5	75.0
21-May	54.7	57.6	63.5	66.2	73.7	74.3
22-May	54.7	57.4	63.0	65.6	73.0	73.6
23-May	54.7	57.3	62.8	65.2	72.5	73.1
24-May	54.8	57.3	62.6	64.9	72.1	72.8
25-May	54.8	57.3	62.5	64.8	71.8	72.5
26-May	54.8	57.3	62.4	64.6	71.5	72.2
27-May	54.8	57.2	62.1	64.3	71.1	71.8
28-May	54.9	57.2	62.1	64.2	70.9	71.6
29-May	54.9	57.2	62.1	64.1	70.7	71.4
30-May	55.0	57.3	62.2	64.2	70.7	71.4
31-May	55.1	57.5	62.3	64.3	70.7	71.4
1-Jun	55.2	57.7	62.6	64.6	70.9	71.5
2-Jun	55.4	58.1	63.3	65.2	71.6	72.2
3-Jun	55.6	58.6	64.3	66.2	72.6	73.0
4-Jun	55.6	58.8	64.7	66.9	73.2	73.6
5-Jun	55.7	59.0	65.1	67.5	73.7	74.0
6-Jun	55.8	59.3	65.7	68.1	74.3	74.5
7-Jun	55.9	59.6	66.2	68.8	74.9	75.1
8-Jun	56.0	59.8	66.7	69.4	75.5	75.6
9-Jun	56.1	59.9	66.8	69.7	75.8	75.9
10-Jun	56.2	59.9	66.9	69.8	76.0	76.0
11-Jun	56.4	60.2	67.3	70.2	76.4	76.4
12-Jun	56.5	60.5	67.8	70.7	77.0	77.0
13-Jun	56.7	60.7	68.2	71.2	77.5	77.4
14-Jun	56.8	60.8	68.2	71.4	77.7	77.6
15-Jun	56.8	60.8	68.2	71.4	77.7	77.6
16-Jun	56.9	60.8	68.1	71.3	77.7	77.5
17-Jun	57.0	60.7	68.0	71.2	77.6	77.4
18-Jun	57.1	60.8	67.9	71.0	77.5	77.4
19-Jun	57.2	60.7	67.7	70.9	77.3	77.3
20-Jun	57.2	60.6	67.3	70.5	77.0	76.9
21-Jun	57.3	60.6	67.2	70.2	76.7	76.7
22-Jun	57.5	60.7	67.2	70.1	76.6	76.6
23-Jun	57.7	60.9	67.4	70.2	76.6	76.7
24-Jun	57.9	61.2	67.8	70.5	77.0	77.0
25-Jun	58.1	61.5	68.2	71.0	77.4	77.5
26-Jun	58.3	61.8	68.7	71.5	78.0	78.0
27-Jun	58.5	62.1	69.2	72.2	78.7	78.6
28-Jun	58.6	62.4	69.7	72.8	79.3	79.3
29-Jun	58.8	62.6	70.0	73.2	79.9	79.8
30-Jun	58.9	62.8	70.2	73.5	80.2	80.2

Table 3: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	59.0	62.8	70.2	73.6	80.4	80.4
2-Jul	59.2	62.8	70.1	73.5	80.3	80.3
3-Jul	59.3	62.7	69.7	73.1	79.9	79.9
4-Jul	59.4	62.7	69.5	72.8	79.6	79.6
5-Jul	59.6	62.8	69.4	72.6	79.3	79.3
6-Jul	59.8	62.9	69.4	72.4	79.0	79.0
7-Jul	60.0	63.1	69.5	72.4	79.0	79.0
8-Jul	60.3	63.3	69.7	72.5	79.0	78.9
9-Jul	60.5	63.5	69.9	72.7	79.0	79.0
10-Jul	60.8	63.8	70.3	73.0	79.3	79.2
11-Jul	61.0	64.0	70.5	73.3	79.4	79.3
12-Jul	61.2	64.3	70.8	73.5	79.6	79.5
13-Jul	61.4	64.5	71.2	73.9	79.9	79.8
14-Jul	61.6	64.7	71.3	74.1	80.0	79.8
15-Jul	61.8	64.9	71.6	74.4	80.3	80.1
16-Jul	62.0	65.0	71.7	74.5	80.4	80.3
17-Jul	62.1	65.1	71.6	74.5	80.4	80.3
18-Jul	62.3	65.2	71.5	74.4	80.4	80.2
19-Jul	62.4	65.2	71.4	74.2	80.2	80.1
20-Jul	62.6	65.1	71.1	73.9	80.0	79.9
21-Jul	62.8	65.2	70.9	73.6	79.7	79.6
22-Jul	63.0	65.2	70.7	73.2	79.3	79.2
23-Jul	63.2	65.2	70.4	72.9	78.8	78.8
24-Jul	63.5	65.3	70.5	72.7	78.6	78.6
25-Jul	63.8	65.5	70.5	72.7	78.5	78.5
26-Jul	64.1	65.7	70.6	72.7	78.4	78.3
27-Jul	64.4	65.9	70.7	72.7	78.3	78.2
28-Jul	64.8	66.2	70.9	72.8	78.3	78.2
29-Jul	65.2	66.5	71.0	72.9	78.3	78.2
30-Jul	65.6	66.8	71.3	73.1	78.3	78.2
31-Jul	66.0	67.1	71.5	73.2	78.4	78.3
1-Aug	66.5	67.5	71.8	73.5	78.6	78.5
2-Aug	67.0	67.9	72.2	73.9	78.9	78.8
3-Aug	67.4	68.4	72.7	74.3	79.3	79.2
4-Aug	67.8	68.6	72.8	74.5	79.3	79.2
5-Aug	68.2	69.0	73.0	74.6	79.4	79.4
6-Aug	68.6	69.4	73.4	74.9	79.6	79.6
7-Aug	68.8	69.6	73.5	75.1	79.7	79.6
8-Aug	69.1	69.8	73.6	75.1	79.6	79.6
9-Aug	69.3	70.0	73.6	75.1	79.5	79.4
10-Aug	69.5	70.0	73.4	74.9	79.2	79.0
11-Aug	69.7	70.2	73.6	74.9	79.2	79.0
12-Aug	69.8	70.4	73.6	74.8	79.0	78.8
13-Aug	69.5	70.3	73.4	74.6	78.6	78.4
14-Aug	68.8	70.1	73.3	74.4	78.4	78.1
15-Aug	67.7	69.7	73.1	74.2	78.0	77.8
16-Aug	66.5	69.3	73.0	74.1	77.9	77.7
17-Aug	65.2	68.7	72.9	74.1	77.9	77.6
18-Aug	63.8	68.0	72.7	74.0	77.8	77.5
19-Aug	62.4	67.1	72.3	73.8	77.7	77.4
20-Aug	61.3	66.2	71.9	73.6	77.6	77.3
21-Aug	60.7	65.5	71.5	73.4	77.5	77.3
22-Aug	60.4	64.7	71.0	73.1	77.4	77.2
23-Aug	60.1	64.1	70.3	72.6	77.2	76.9
24-Aug	60.0	63.6	69.8	72.1	76.9	76.7
25-Aug	59.9	63.2	69.3	71.7	76.8	76.6
26-Aug	59.9	63.0	69.0	71.4	76.7	76.6
27-Aug	59.9	62.9	68.8	71.2	76.8	76.7
28-Aug	59.9	62.8	68.7	71.2	77.0	76.9
29-Aug	59.9	62.8	68.8	71.2	77.2	77.3
30-Aug	60.0	62.9	68.9	71.3	77.5	77.6
31-Aug	60.1	63.0	68.9	71.4	77.7	77.8

Table 4: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	60.3	63.1	69.1	71.6	78.0	78.2
2-Sep	60.5	63.2	69.2	71.8	78.2	78.4
3-Sep	60.7	63.4	69.5	72.0	78.5	78.7
4-Sep	60.8	63.4	69.5	72.1	78.5	78.7
5-Sep	60.9	63.4	69.2	71.8	78.2	78.4
6-Sep	61.0	63.2	68.8	71.4	77.7	77.9
7-Sep	61.0	63.2	68.5	71.0	77.2	77.4
8-Sep	61.0	63.0	68.1	70.5	76.7	77.0
9-Sep	61.1	63.0	67.8	70.0	76.2	76.5
10-Sep	61.1	62.8	67.2	69.4	75.5	75.8
11-Sep	61.1	62.7	66.8	68.9	74.9	75.3
12-Sep	61.2	62.6	66.5	68.4	74.3	74.7
13-Sep	61.3	62.6	66.4	68.2	73.9	74.4
14-Sep	61.4	62.6	66.1	67.8	73.4	73.8
15-Sep	61.5	62.6	65.9	67.5	72.8	73.3
16-Sep	61.6	62.5	65.6	67.1	72.3	72.7
17-Sep	61.7	62.5	65.5	66.8	71.8	72.3
18-Sep	61.8	62.6	65.5	66.7	71.5	71.9
19-Sep	62.0	62.8	65.6	66.6	71.3	71.7
20-Sep	62.2	62.9	65.7	66.7	71.2	71.6
21-Sep	62.4	63.2	66.1	67.0	71.5	71.8
22-Sep	62.6	63.5	66.4	67.4	71.7	72.0
23-Sep	62.7	63.7	66.7	67.7	72.0	72.2
24-Sep	62.9	63.8	66.9	68.0	72.2	72.4
25-Sep	63.0	63.9	67.0	68.1	72.2	72.4
26-Sep	63.1	64.0	67.0	68.2	72.3	72.4
27-Sep	63.3	64.1	67.1	68.2	72.3	72.4
28-Sep	63.4	64.1	66.9	68.1	72.1	72.2
29-Sep	63.6	64.2	66.9	68.0	72.0	72.1
30-Sep	63.8	64.4	67.0	68.0	72.0	72.1
1-Oct	64.2	64.6	67.0	68.0	72.1	72.2
2-Oct	64.6	64.8	67.1	68.0	72.2	72.4
3-Oct	64.9	65.0	67.1	67.9	72.1	72.4
4-Oct	65.3	65.3	67.2	67.9	72.1	72.5
5-Oct	65.6	65.5	67.3	67.9	72.0	72.5
6-Oct	65.9	65.7	67.3	67.8	71.7	72.3
7-Oct	66.0	65.7	67.0	67.5	71.2	71.9
8-Oct	66.0	65.7	66.8	67.2	70.6	71.3
9-Oct	65.9	65.6	66.7	66.9	69.8	70.5
10-Oct	65.9	65.6	66.6	66.8	69.2	69.9
11-Oct	65.8	65.6	66.4	66.5	68.6	69.2
12-Oct	65.7	65.5	66.2	66.3	68.1	68.5
13-Oct	65.7	65.4	66.1	66.0	67.5	67.9
14-Oct	65.7	65.5	66.1	66.0	67.2	67.5
15-Oct	65.7	65.5	66.0	65.9	67.0	67.1
16-Oct	65.8	65.5	66.1	66.0	66.9	67.0
17-Oct	65.8	65.5	66.1	66.0	66.9	66.9
18-Oct	65.8	65.5	66.1	66.0	66.8	66.8
19-Oct	65.7	65.5	66.1	66.0	66.8	66.7
20-Oct	65.6	65.4	66.0	65.8	66.7	66.6
21-Oct	65.5	65.3	65.8	65.7	66.6	66.5
22-Oct	65.3	65.0	65.4	65.3	66.2	66.1
23-Oct	65.2	64.9	65.2	65.1	66.0	65.8
24-Oct	65.0	64.7	65.0	64.9	65.7	65.6
25-Oct	64.8	64.5	64.9	64.7	65.5	65.3
26-Oct	64.6	64.3	64.7	64.5	65.2	65.1
27-Oct	64.4	64.2	64.5	64.3	65.1	64.9
28-Oct	64.2	64.0	64.3	64.2	64.9	64.8
29-Oct	64.0	63.8	64.2	64.1	64.8	64.7
30-Oct	63.7	63.6	64.0	63.9	64.7	64.6
31-Oct	63.5	63.4	63.7	63.6	64.5	64.4

5. Projected Downriver Temperature Response – Bypass Operation

For the purpose of this analysis, the bypass operation started on July 15 and decreased at a rate of 1.0 percent per day, as illustrated in Figure 11 below:

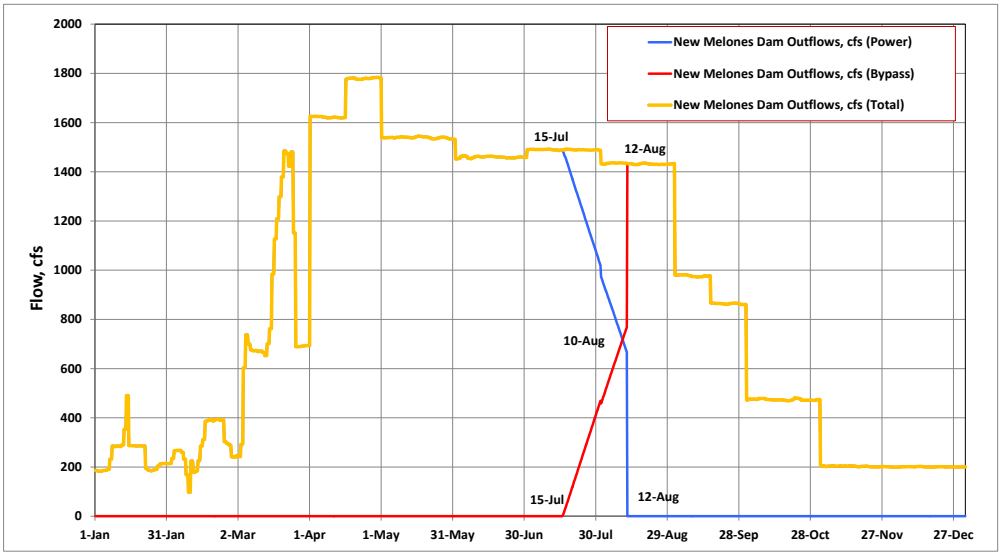


Figure 11: New Melones Power Bypass Operation

The rational for selecting 1.0 percent reduction of power flow per day when transitioning to bypass flow, is that it provides an overall moderation of temperatures throughout the bypass period. This would also keep the peak temperature in early August at approximately the same level as the peak temperature in early October, as illustrated in Figure 12 below:

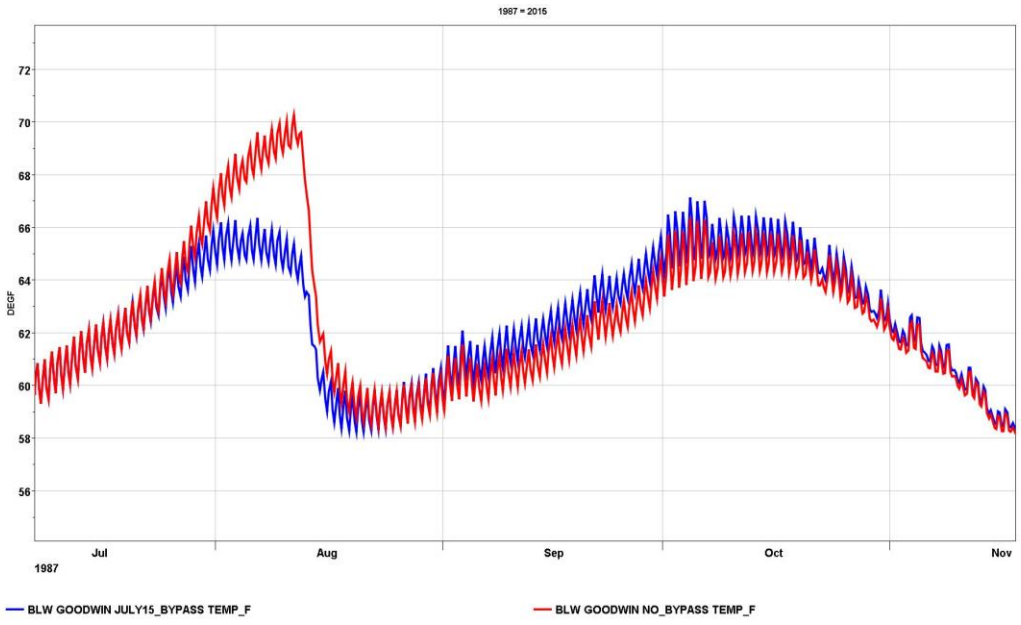


Figure 12: Effects of Power Bypass on Temperature Below Goodwin Dam

The results for the bypass case in terms of 7DADM are presented in the following tables:

Table 5: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.2	50.1	51.5	51.5	54.2	54.5
2-Mar	50.4	50.3	51.9	51.9	54.7	54.9
3-Mar	50.8	50.7	52.4	52.4	55.4	55.6
4-Mar	50.8	50.9	52.8	52.9	56.0	56.2
5-Mar	50.7	50.9	52.8	53.1	56.4	56.6
6-Mar	50.7	51.0	53.0	53.3	56.7	57.0
7-Mar	50.7	51.1	53.2	53.6	57.0	57.3
8-Mar	50.7	51.1	53.2	53.7	57.2	57.5
9-Mar	50.6	51.1	53.3	53.8	57.4	57.7
10-Mar	50.5	51.0	53.2	53.7	57.4	57.8
11-Mar	50.8	51.1	53.3	53.8	57.5	57.9
12-Mar	51.1	51.4	53.8	54.2	58.1	58.3
13-Mar	51.2	51.6	54.2	54.7	58.7	58.8
14-Mar	51.2	51.6	54.2	54.8	58.9	59.0
15-Mar	51.2	51.7	54.1	54.8	59.0	59.2
16-Mar	51.1	51.7	54.1	54.8	59.0	59.3
17-Mar	51.1	51.7	54.2	54.8	59.1	59.4
18-Mar	50.9	51.7	54.1	54.8	59.0	59.4
19-Mar	50.7	51.6	53.9	54.6	58.7	59.1
20-Mar	50.6	51.5	53.8	54.4	58.4	58.8
21-Mar	50.5	51.5	53.8	54.4	58.3	58.6
22-Mar	50.5	51.6	53.9	54.5	58.3	58.7
23-Mar	50.5	51.6	53.9	54.5	58.3	58.6
24-Mar	50.6	51.6	53.9	54.5	58.3	58.5
25-Mar	50.7	51.7	54.1	54.7	58.4	58.6
26-Mar	51.0	51.9	54.3	54.9	58.8	59.0
27-Mar	51.3	52.1	54.7	55.3	59.2	59.4
28-Mar	51.6	52.4	55.2	55.8	59.7	60.0
29-Mar	51.8	52.7	55.6	56.3	60.2	60.5
30-Mar	52.2	53.0	56.2	56.9	60.8	61.1
31-Mar	52.5	53.3	56.6	57.5	61.3	61.7
1-Apr	52.5	53.4	56.8	57.8	61.9	62.2
2-Apr	52.4	53.3	56.7	57.9	62.2	62.6
3-Apr	52.3	53.2	56.5	57.7	62.3	62.8
4-Apr	52.1	53.1	56.1	57.3	62.1	62.7
5-Apr	51.9	52.9	55.7	56.8	61.8	62.5
6-Apr	51.8	52.7	55.3	56.4	61.4	62.3
7-Apr	51.6	52.5	54.9	56.0	61.1	62.1
8-Apr	51.7	52.5	54.7	55.6	60.7	61.8
9-Apr	51.7	52.6	54.7	55.5	60.3	61.5
10-Apr	51.8	52.6	54.7	55.5	60.1	61.3
11-Apr	51.8	52.7	54.7	55.6	60.0	61.2
12-Apr	51.9	52.8	55.0	55.8	60.2	61.3
13-Apr	52.0	52.9	55.1	56.0	60.4	61.5
14-Apr	52.1	53.0	55.3	56.2	60.7	61.7
15-Apr	52.2	53.2	55.5	56.4	61.1	62.1
16-Apr	52.3	53.3	55.7	56.7	61.4	62.4
17-Apr	52.4	53.4	55.9	56.9	61.8	62.8
18-Apr	52.4	53.4	55.9	56.9	61.9	63.0
19-Apr	52.4	53.4	55.9	56.9	61.9	63.1
20-Apr	52.5	53.5	55.9	56.9	61.9	63.1
21-Apr	52.5	53.5	55.9	56.9	61.9	63.1
22-Apr	52.6	53.6	56.0	57.0	61.9	63.1
23-Apr	52.6	53.6	55.9	56.9	61.7	62.9
24-Apr	52.7	53.7	56.1	57.0	61.7	62.8
25-Apr	52.8	53.9	56.4	57.4	62.1	63.2
26-Apr	52.9	54.0	56.6	57.7	62.5	63.6
27-Apr	53.1	54.2	56.9	58.0	63.1	64.1
28-Apr	53.1	54.3	57.0	58.2	63.4	64.5
29-Apr	53.2	54.4	57.2	58.4	63.7	64.8
30-Apr	53.3	54.4	57.2	58.4	63.9	65.0

Table 6: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	53.3	54.5	57.3	58.4	63.8	65.0
2-May	53.4	54.7	57.6	58.6	63.9	65.0
3-May	53.4	54.9	58.0	58.9	63.9	64.9
4-May	53.5	55.1	58.4	59.3	64.1	64.9
5-May	53.5	55.5	59.2	60.1	64.7	65.4
6-May	53.6	55.9	60.0	61.0	65.5	66.0
7-May	53.8	56.3	61.0	62.2	66.7	67.1
8-May	53.9	56.7	62.0	63.5	68.2	68.3
9-May	54.0	57.0	62.7	64.5	69.6	69.6
10-May	54.1	57.3	63.4	65.5	71.1	71.1
11-May	54.2	57.5	63.9	66.3	72.3	72.4
12-May	54.3	57.7	64.3	66.9	73.3	73.4
13-May	54.4	57.9	64.6	67.3	74.1	74.2
14-May	54.4	58.0	64.9	67.7	74.9	75.1
15-May	54.5	58.2	65.2	68.1	75.6	75.8
16-May	54.6	58.2	65.2	68.2	75.7	76.0
17-May	54.6	58.1	65.0	68.1	75.7	76.1
18-May	54.7	58.1	64.8	67.9	75.6	76.0
19-May	54.6	57.9	64.5	67.5	75.2	75.7
20-May	54.6	57.7	63.9	66.8	74.5	75.0
21-May	54.7	57.6	63.5	66.2	73.7	74.3
22-May	54.7	57.4	63.0	65.6	73.0	73.6
23-May	54.7	57.3	62.8	65.2	72.5	73.1
24-May	54.8	57.3	62.6	64.9	72.1	72.8
25-May	54.8	57.3	62.5	64.8	71.8	72.5
26-May	54.8	57.3	62.4	64.6	71.5	72.2
27-May	54.8	57.2	62.1	64.3	71.1	71.8
28-May	54.9	57.2	62.1	64.2	70.9	71.6
29-May	54.9	57.2	62.1	64.1	70.7	71.4
30-May	55.0	57.3	62.2	64.2	70.7	71.4
31-May	55.1	57.5	62.3	64.3	70.7	71.4
1-Jun	55.2	57.7	62.6	64.6	70.9	71.5
2-Jun	55.4	58.1	63.3	65.2	71.6	72.2
3-Jun	55.6	58.6	64.3	66.2	72.6	73.0
4-Jun	55.6	58.8	64.7	66.9	73.2	73.6
5-Jun	55.7	59.0	65.1	67.5	73.7	74.0
6-Jun	55.8	59.3	65.7	68.1	74.3	74.5
7-Jun	55.9	59.6	66.2	68.8	74.9	75.1
8-Jun	56.0	59.8	66.7	69.4	75.5	75.6
9-Jun	56.1	59.9	66.8	69.7	75.8	75.9
10-Jun	56.2	59.9	66.9	69.8	76.0	76.0
11-Jun	56.4	60.2	67.3	70.2	76.4	76.4
12-Jun	56.5	60.5	67.8	70.7	77.0	77.0
13-Jun	56.7	60.7	68.2	71.2	77.5	77.4
14-Jun	56.8	60.8	68.2	71.4	77.7	77.6
15-Jun	56.8	60.8	68.2	71.4	77.7	77.6
16-Jun	56.9	60.8	68.1	71.3	77.7	77.5
17-Jun	57.0	60.7	68.0	71.2	77.6	77.4
18-Jun	57.1	60.8	67.9	71.0	77.5	77.4
19-Jun	57.2	60.7	67.7	70.9	77.3	77.3
20-Jun	57.2	60.6	67.3	70.5	77.0	76.9
21-Jun	57.3	60.6	67.2	70.2	76.7	76.7
22-Jun	57.5	60.7	67.2	70.1	76.6	76.6
23-Jun	57.7	60.9	67.4	70.2	76.6	76.7
24-Jun	57.9	61.2	67.8	70.5	77.0	77.0
25-Jun	58.1	61.5	68.2	71.0	77.4	77.5
26-Jun	58.3	61.8	68.7	71.5	78.0	78.0
27-Jun	58.5	62.1	69.2	72.2	78.7	78.6
28-Jun	58.6	62.4	69.7	72.8	79.3	79.3
29-Jun	58.8	62.6	70.0	73.2	79.9	79.8
30-Jun	58.9	62.8	70.2	73.5	80.2	80.2

Table 7: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	59.0	62.8	70.2	73.6	80.4	80.4
2-Jul	59.2	62.8	70.1	73.5	80.3	80.3
3-Jul	59.3	62.7	69.7	73.1	79.9	79.9
4-Jul	59.4	62.7	69.5	72.8	79.6	79.6
5-Jul	59.6	62.8	69.4	72.6	79.3	79.3
6-Jul	59.8	62.9	69.4	72.4	79.0	79.0
7-Jul	60.0	63.1	69.5	72.4	79.0	79.0
8-Jul	60.3	63.3	69.7	72.5	79.0	78.9
9-Jul	60.5	63.5	69.9	72.7	79.0	79.0
10-Jul	60.8	63.8	70.3	73.0	79.3	79.2
11-Jul	61.0	64.0	70.5	73.3	79.4	79.3
12-Jul	61.2	64.3	70.8	73.5	79.6	79.5
13-Jul	61.4	64.5	71.2	73.9	79.9	79.8
14-Jul	61.6	64.7	71.3	74.1	80.0	79.8
15-Jul	61.8	64.9	71.6	74.4	80.3	80.1
16-Jul	62.0	65.0	71.7	74.5	80.4	80.3
17-Jul	62.1	65.1	71.6	74.5	80.4	80.3
18-Jul	62.3	65.2	71.5	74.4	80.4	80.2
19-Jul	62.4	65.2	71.4	74.2	80.2	80.1
20-Jul	62.6	65.1	71.1	73.9	80.0	79.9
21-Jul	62.8	65.2	70.9	73.6	79.7	79.6
22-Jul	63.0	65.1	70.7	73.2	79.3	79.2
23-Jul	63.2	65.2	70.4	72.9	78.8	78.8
24-Jul	63.4	65.3	70.5	72.7	78.6	78.6
25-Jul	63.7	65.5	70.5	72.7	78.5	78.5
26-Jul	63.9	65.7	70.6	72.7	78.4	78.3
27-Jul	64.2	65.8	70.7	72.7	78.3	78.2
28-Jul	64.4	66.1	70.9	72.8	78.3	78.2
29-Jul	64.7	66.3	71.0	72.9	78.3	78.2
30-Jul	64.9	66.5	71.2	73.1	78.3	78.2
31-Jul	65.2	66.7	71.4	73.2	78.4	78.3
1-Aug	65.4	67.0	71.7	73.4	78.6	78.5
2-Aug	65.6	67.3	72.0	73.8	78.9	78.8
3-Aug	65.8	67.6	72.4	74.2	79.2	79.2
4-Aug	65.9	67.7	72.4	74.3	79.3	79.2
5-Aug	66.0	67.8	72.5	74.4	79.4	79.3
6-Aug	66.1	68.0	72.8	74.7	79.6	79.6
7-Aug	66.1	68.1	72.8	74.7	79.6	79.6
8-Aug	66.1	68.0	72.8	74.7	79.6	79.5
9-Aug	66.0	68.0	72.7	74.6	79.5	79.4
10-Aug	65.9	67.8	72.4	74.3	79.1	79.0
11-Aug	65.9	67.9	72.5	74.2	79.1	78.9
12-Aug	65.7	67.8	72.4	74.1	78.9	78.7
13-Aug	65.3	67.5	72.0	73.8	78.5	78.4
14-Aug	64.7	67.2	71.8	73.5	78.2	78.1
15-Aug	63.9	66.8	71.5	73.2	77.9	77.7
16-Aug	63.1	66.4	71.3	73.0	77.7	77.6
17-Aug	62.3	66.0	71.2	72.9	77.6	77.5
18-Aug	61.5	65.5	70.9	72.7	77.5	77.4
19-Aug	60.7	64.9	70.6	72.6	77.4	77.3
20-Aug	60.2	64.4	70.3	72.4	77.3	77.2
21-Aug	59.9	63.9	70.0	72.2	77.2	77.1
22-Aug	59.8	63.5	69.6	71.9	77.1	77.0
23-Aug	59.7	63.1	69.2	71.5	76.8	76.7
24-Aug	59.7	62.8	68.8	71.2	76.5	76.5
25-Aug	59.7	62.6	68.4	70.8	76.4	76.4
26-Aug	59.8	62.5	68.3	70.6	76.3	76.3
27-Aug	59.8	62.5	68.2	70.6	76.4	76.4
28-Aug	59.9	62.6	68.3	70.6	76.6	76.7
29-Aug	60.0	62.7	68.4	70.7	76.9	77.0
30-Aug	60.1	62.8	68.6	71.0	77.2	77.3
31-Aug	60.3	62.9	68.7	71.1	77.4	77.6

Table 8: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	60.5	63.1	69.0	71.4	77.7	77.9
2-Sep	60.7	63.3	69.1	71.6	78.0	78.2
3-Sep	61.0	63.5	69.4	71.9	78.3	78.5
4-Sep	61.2	63.6	69.5	72.0	78.3	78.5
5-Sep	61.4	63.6	69.3	71.8	78.0	78.2
6-Sep	61.5	63.5	68.9	71.4	77.5	77.7
7-Sep	61.7	63.5	68.6	71.0	77.1	77.3
8-Sep	61.7	63.4	68.3	70.5	76.6	76.9
9-Sep	61.8	63.4	68.0	70.1	76.2	76.4
10-Sep	61.8	63.3	67.5	69.5	75.5	75.8
11-Sep	61.9	63.2	67.1	69.0	74.8	75.2
12-Sep	62.0	63.2	66.8	68.6	74.3	74.6
13-Sep	62.2	63.3	66.8	68.4	73.9	74.4
14-Sep	62.3	63.3	66.5	68.0	73.4	73.8
15-Sep	62.4	63.3	66.3	67.7	72.8	73.3
16-Sep	62.5	63.2	66.1	67.4	72.3	72.7
17-Sep	62.7	63.3	66.0	67.2	71.9	72.3
18-Sep	62.8	63.4	66.0	67.0	71.5	71.9
19-Sep	63.0	63.5	66.1	67.0	71.4	71.7
20-Sep	63.1	63.7	66.2	67.1	71.3	71.6
21-Sep	63.4	64.0	66.6	67.4	71.6	71.9
22-Sep	63.6	64.3	67.0	67.8	71.9	72.1
23-Sep	63.7	64.5	67.3	68.2	72.1	72.3
24-Sep	63.9	64.7	67.5	68.4	72.3	72.5
25-Sep	64.0	64.8	67.6	68.6	72.4	72.5
26-Sep	64.2	64.9	67.6	68.6	72.5	72.5
27-Sep	64.3	65.0	67.7	68.7	72.5	72.5
28-Sep	64.4	65.0	67.6	68.6	72.3	72.3
29-Sep	64.6	65.1	67.5	68.4	72.2	72.2
30-Sep	64.8	65.2	67.6	68.4	72.2	72.2
1-Oct	65.1	65.4	67.7	68.5	72.3	72.3
2-Oct	65.5	65.6	67.8	68.5	72.4	72.5
3-Oct	65.8	65.8	67.8	68.4	72.4	72.6
4-Oct	66.1	66.1	67.9	68.4	72.3	72.6
5-Oct	66.4	66.3	67.9	68.5	72.2	72.7
6-Oct	66.6	66.4	67.9	68.4	72.1	72.6
7-Oct	66.7	66.4	67.6	68.1	71.6	72.1
8-Oct	66.7	66.4	67.5	67.8	70.9	71.6
9-Oct	66.6	66.4	67.3	67.5	70.2	70.9
10-Oct	66.6	66.3	67.3	67.4	69.7	70.3
11-Oct	66.5	66.3	67.1	67.1	69.1	69.6
12-Oct	66.4	66.2	66.9	66.9	68.6	68.9
13-Oct	66.3	66.1	66.7	66.6	68.0	68.3
14-Oct	66.4	66.1	66.7	66.6	67.7	67.9
15-Oct	66.4	66.1	66.6	66.5	67.5	67.6
16-Oct	66.4	66.1	66.7	66.5	67.4	67.4
17-Oct	66.4	66.1	66.7	66.5	67.3	67.3
18-Oct	66.3	66.1	66.7	66.5	67.3	67.2
19-Oct	66.3	66.1	66.6	66.5	67.3	67.2
20-Oct	66.1	65.9	66.5	66.4	67.2	67.0
21-Oct	66.0	65.8	66.3	66.2	67.0	66.9
22-Oct	65.8	65.5	65.9	65.8	66.6	66.5
23-Oct	65.6	65.3	65.7	65.5	66.3	66.2
24-Oct	65.4	65.2	65.5	65.3	66.0	65.9
25-Oct	65.3	65.0	65.3	65.1	65.8	65.6
26-Oct	65.0	64.7	65.0	64.9	65.6	65.4
27-Oct	64.8	64.6	64.9	64.7	65.4	65.2
28-Oct	64.6	64.4	64.7	64.5	65.2	65.0
29-Oct	64.3	64.2	64.5	64.4	65.1	65.0
30-Oct	64.1	64.0	64.3	64.2	65.0	64.9
31-Oct	63.8	63.7	64.0	63.9	64.7	64.6

6. Projected Energy Loss Due to Bypass Operation

A simplified hydropower calculation was performed to estimate the energy loss due to the bypass operation. The no-bypass case was compared with the July 15 bypass case, as follows:

	No Bypass	July 15 Bypass	Energy Loss
	MWh	MWh	MWh
Jan			
Feb			
Mar	16,497	16,497	0
Apr	31,130	31,130	0
May	27,797	27,797	0
Jun	24,097	24,097	0
Jul	23,811	21,969	(1,842)
Aug	5,625	3,419	(2,206)
Sep	0	0	0
Oct	0	0	0
Nov	0	0	0
Dec	0	0	0
Total	128,958	124,910	(4,048)

Figure 13: Projected Energy Loss Due to Bypass Operation

Figure 13 shows that the energy loss during the bypass period, July 15 through August 11, 2015, will be in the order of 4,048 MWh. Based on PG&E SRAC (Short-Term Avoided Cost) for qualifying facilities, the cost per KWh in July and August of 2014 was approximately 5 cents. If we use the same price rate for this year, the loss of energy could amount to $202,381.

ATTACHMENT 2

Fall-run Chinook salmon redd distribution and water temperatures in the Stanislaus River during 2009-2014.

Spatial distribution of fall-run Chinook salmon redds on the Stanislaus River

Methods

Annual redd surveys on the Stanislaus River have been conducted since 2007 to estimate the spawning distribution of fall-run Chinook salmon. In general, the entire spawning area is surveyed every other week (occasionally more frequently) to document the number of new redds. The results below represent preliminary data analyses to describe the relationship of redd deposition (a proxy for spawning activity) throughout the reproductive season (time) and by river location (river mile [RM]; space). For these particular analyses, six seasons of distribution data was used. Daily water temperatures throughout the Stanislaus River have been monitored concurrently, allowing an assessment of spawning distribution in relation to daily water temperatures. Water temperature recorders were located at seven stations, Goodwin Dam, Knights Ferry, Lover's Leap Restoration Area, Honolulu Bar, Orange Blossom Bridge, Oakdale, and at the Stanislaus River Weir.

We used a combination of graphical analyses and linear regression analyses to describe the spawning distributions of Chinook salmon from 2009 to 2014. For each season, the median location and downstream-most location of redds was summarized for each survey week. Water temperatures were often negatively related to the location of the water temperature logger (i.e. more upstream locations had cooler water temperatures with a predictable increase with increased distance downstream). However, this relationship occasionally did not remain constant or predictable throughout the spawning season. Therefore, we interpolated daily maximum water temperatures at the seven stations over the spawning season.

Results

As illustrated in Figure 1, spawning distribution was limited early in the season (i.e., redds only observed in the upper few river miles), but expanded to lower reaches as the spawning season progressed. Median locations of redd distribution decreased (in river mile [RM]) over the first five surveys during each year (Figure 1). During the late-September and early October, median locations were located near the upper end of Goodwin Canyon. However, by late October, median locations were typically centered around RM 54 (around Knights Ferry). Similarly, the downstream-most redd locations decreased in river mile over the first five surveys of each season. The decrease was more drastic than the decrease in median locations. New redds were typically observed as low as RM 32 (Riverbank) until early December. Results from linear regression analyses indicated statistically significant relationships between median locations and date (slope = -0.63; $P < 0.001$) *and* between downstream-most locations (slope = -2.64; $P << 0.001$; Figure 1).

Figures 2 through 7 each represent the interpolated daily maximum water temperatures at each station. The interpolations provide a general pattern in water temperatures across both time and space. The addition of the redd distributions show the timing and locations of spawning activity in relation to the water temperature regime during and prior each survey week. Overall daily maximum water temperatures were coolest during the 2011 spawning season (Figure 4) and were the warmest during 2014 (Figure 7). Spawning activity (i.e., new redds were observed) occurred from the 48 - 50ºF range (late December 2011; Figure 4) to as high as 62 – 64ºF range (mid October 2014; Figure 7). Most spawning activity during the other four seasons occurred between temperature ranges between 52ºF and 56ºF.

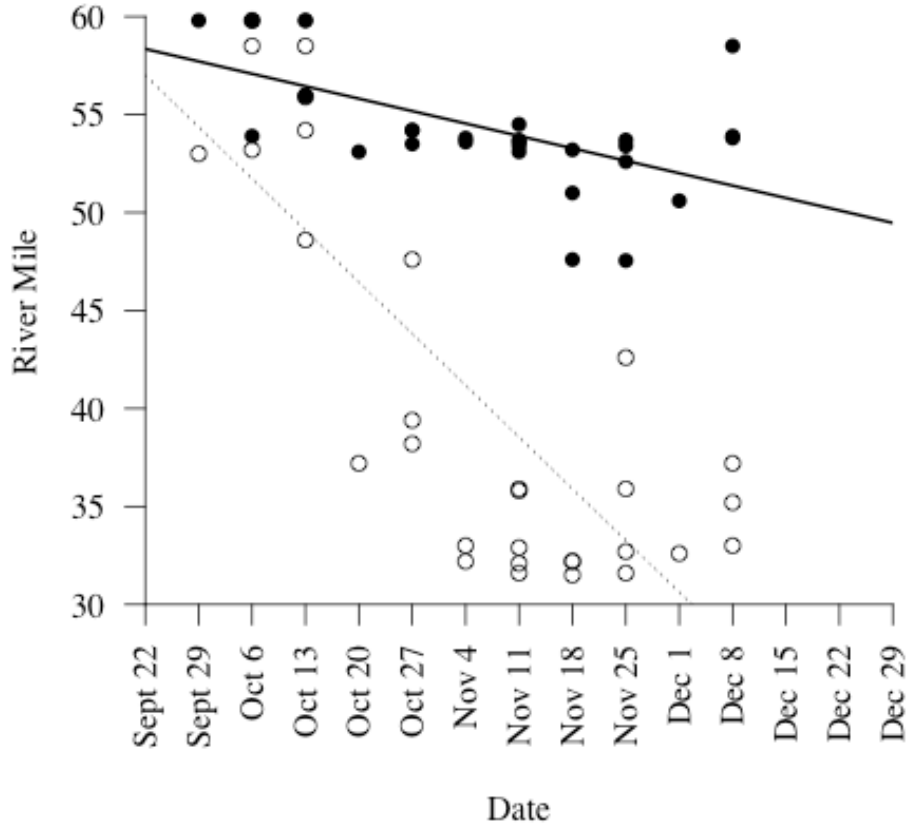


Figure 1. Relationship between median locations of Chinook redds (filled circles) and downstream-most locations (open circles) and date. Solid black line represents the best-fit line for the linear relationship between date and median locations (slope = -0.63; P < 0.001). Dotted line represents the best-fit line for the linear relationship between date and downstream-most locations (slope = -2.64; P << 0.001). For reference, Goodwin Dam is located at RM 60.

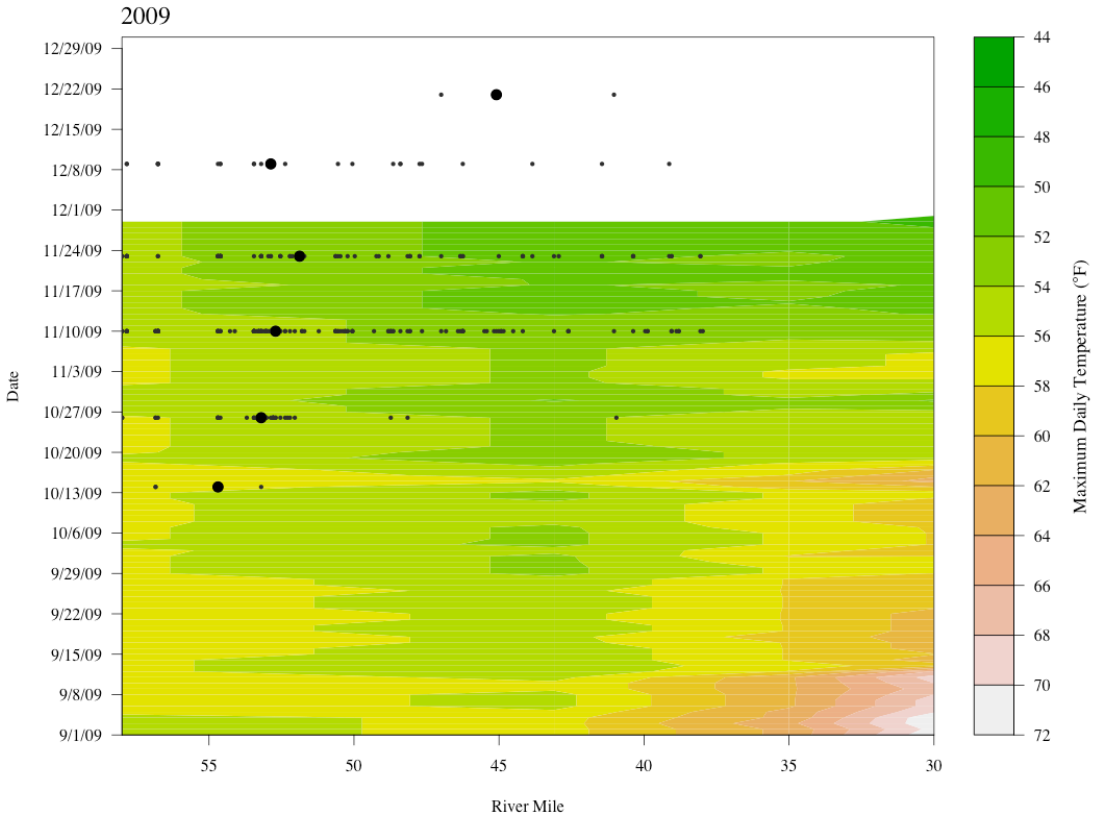


Figure 2. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2009. Water year type in 2009 was below normal (BN). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

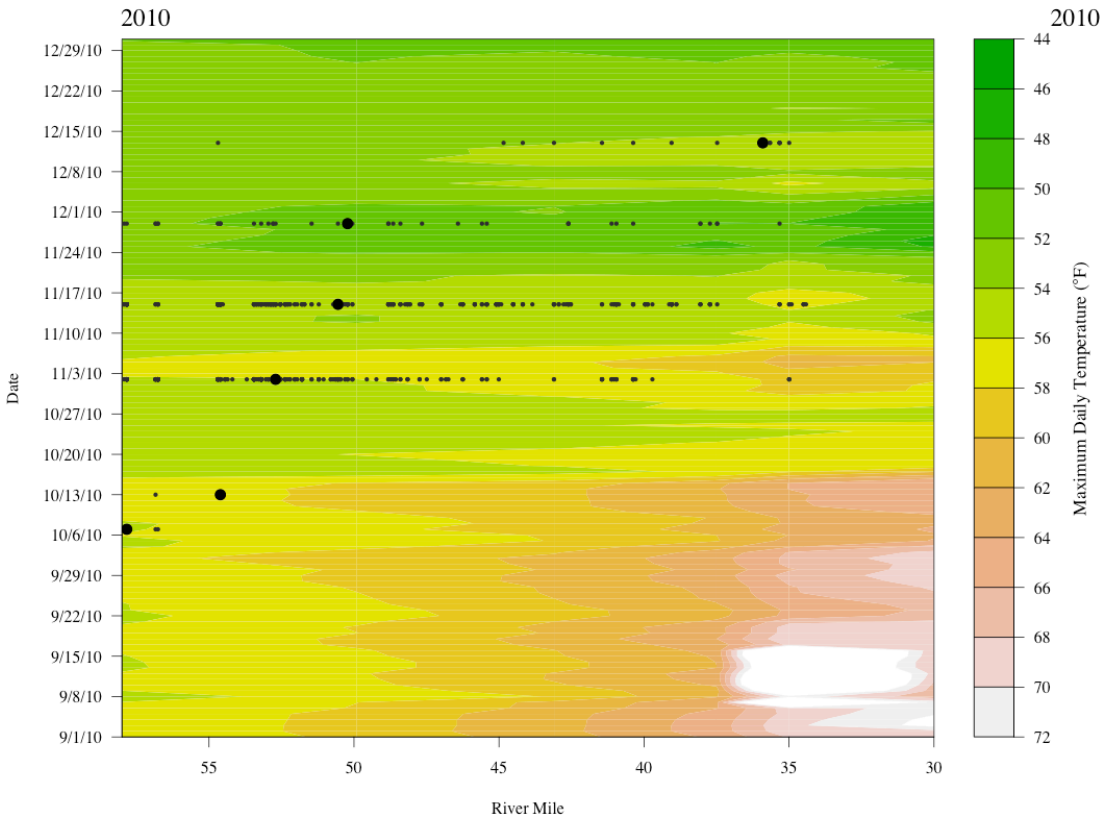


Figure 3. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2010. Water year type in 2010 was above normal (AN). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

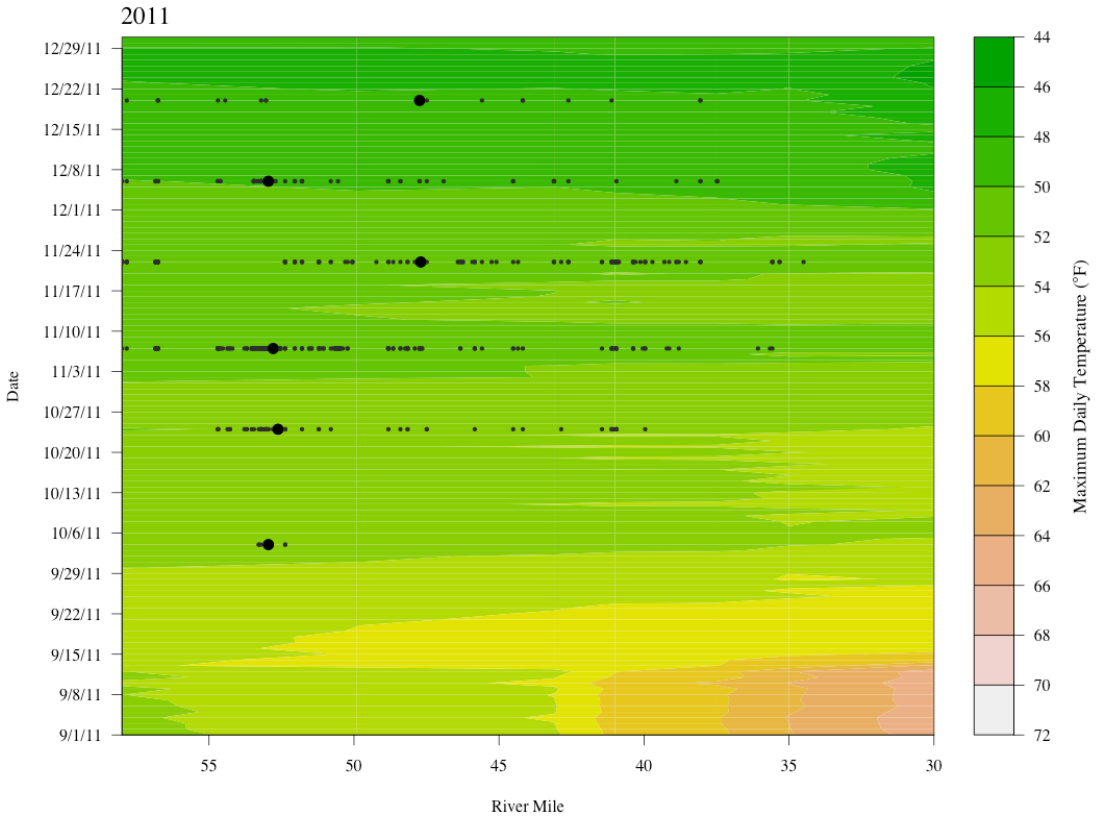


Figure 4. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2011. Water year type in 2011 was wet (W). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

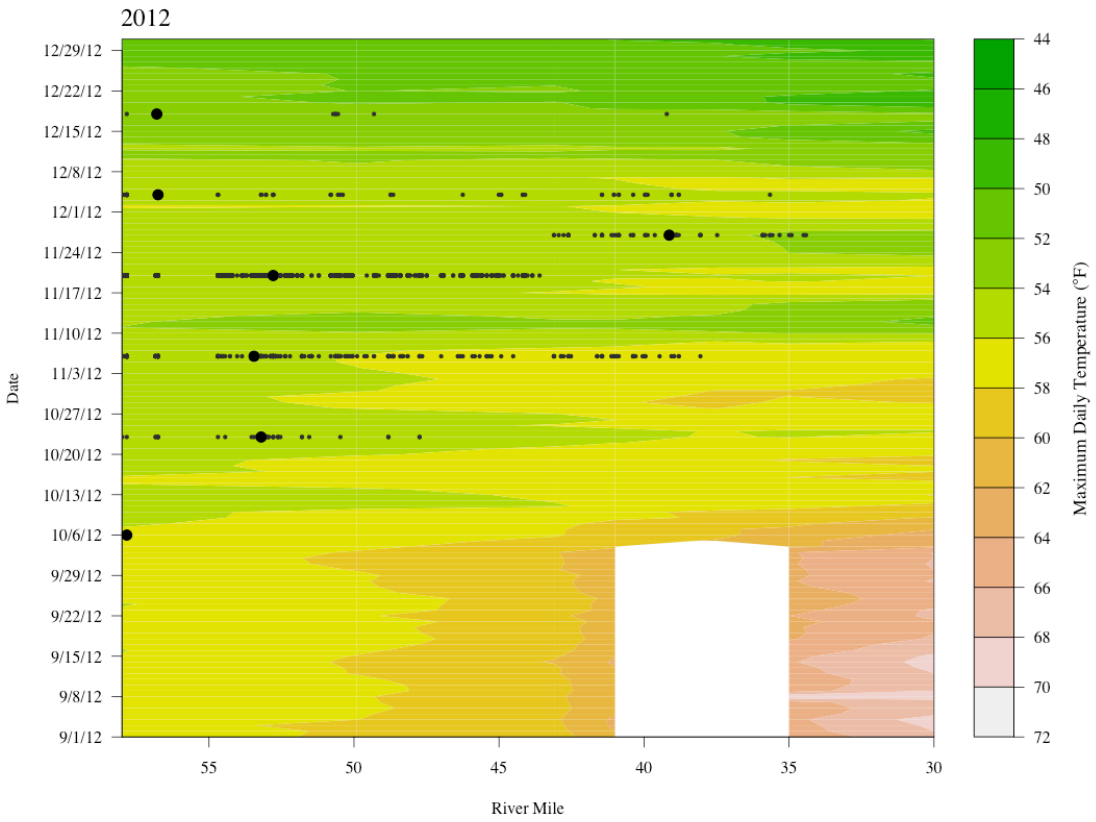


Figure 5. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2012. Water year type in 2012 was dry (D). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

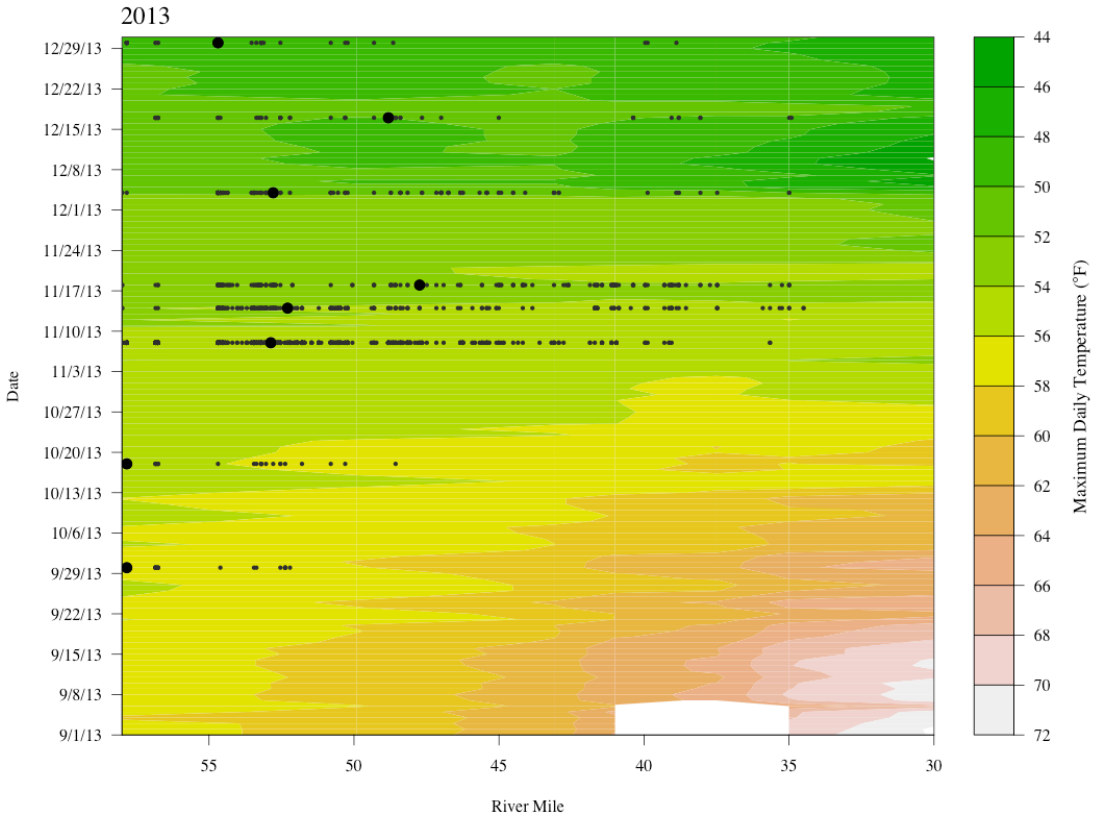


Figure 6. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2013. Water year type in 2013 was critically dry (CD). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

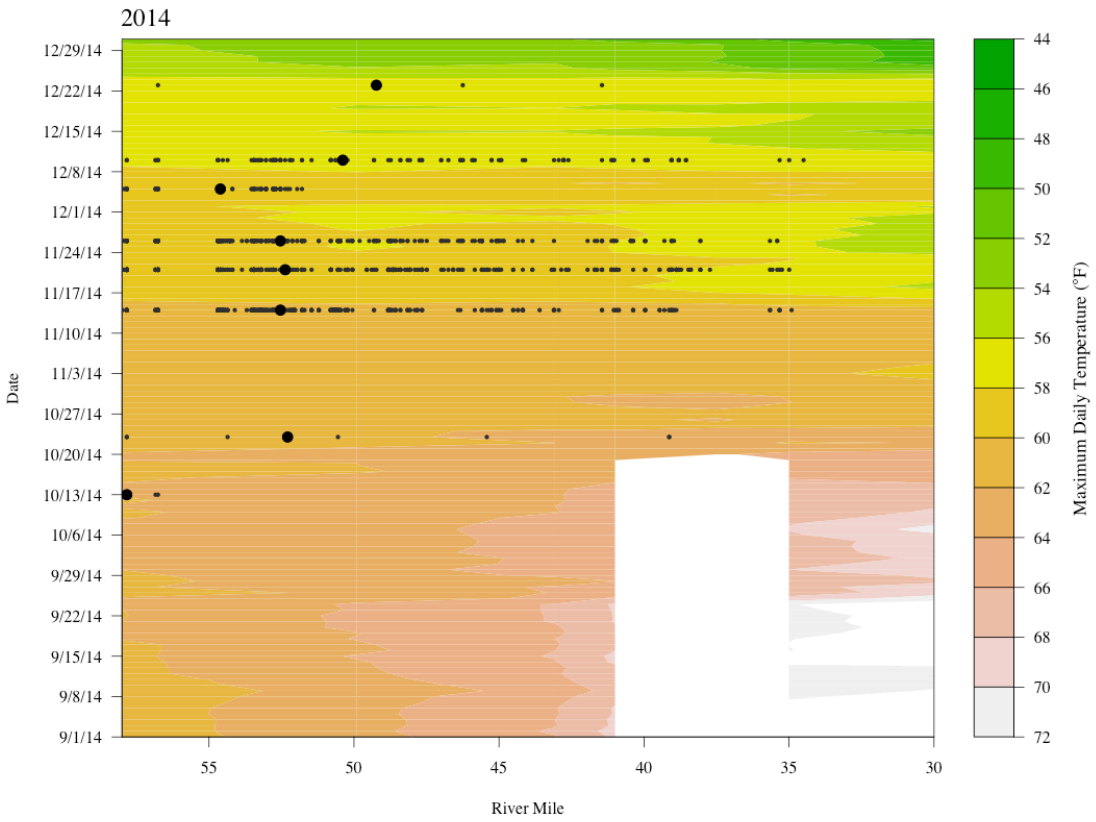
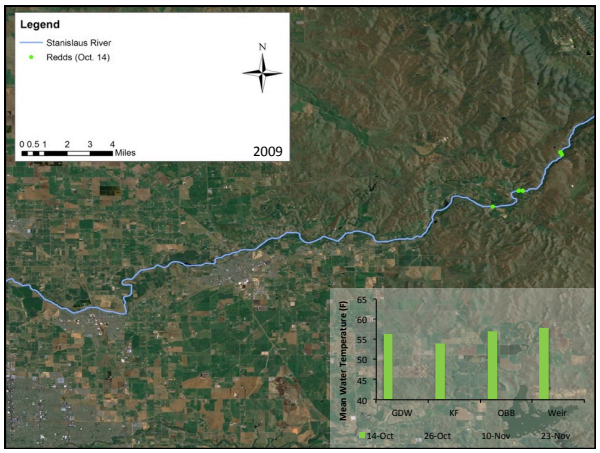
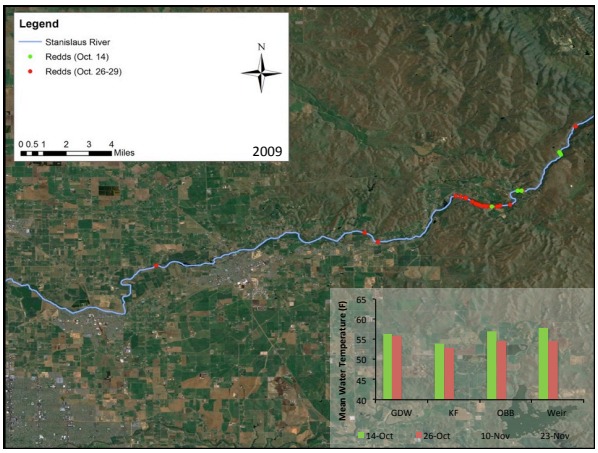
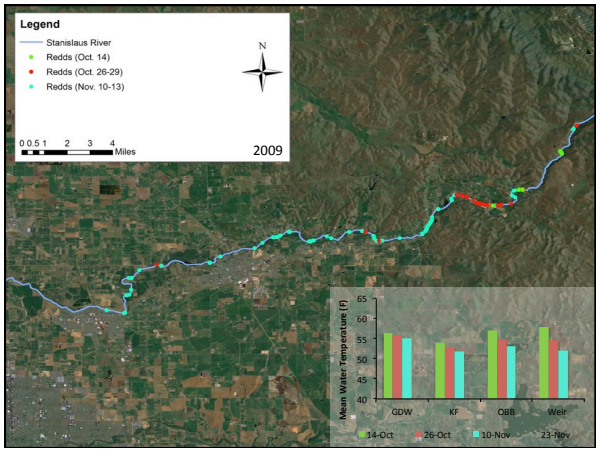
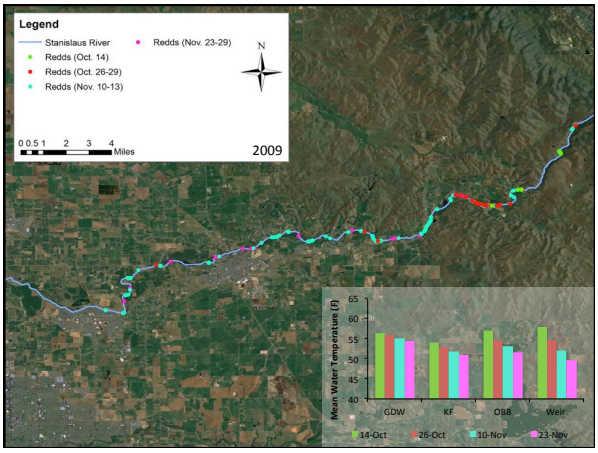


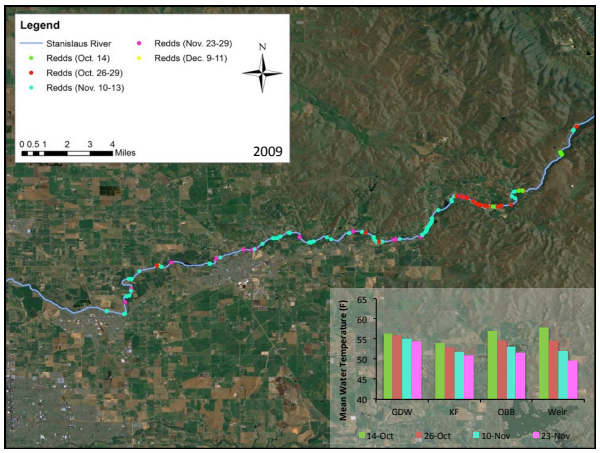
Figure 7. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2014. Water year type in 2014 was critically dry (CD). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

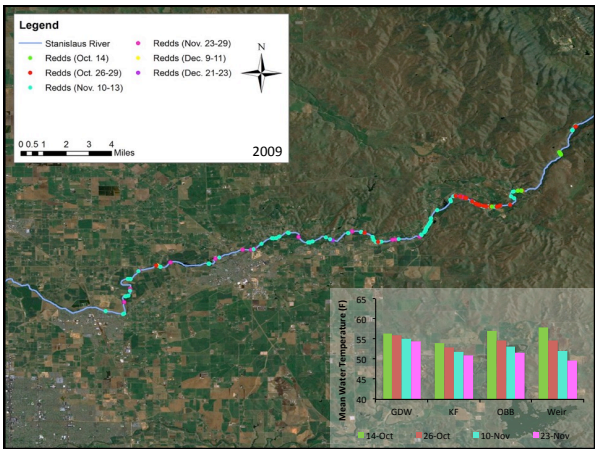

Legend
Stanislaus River
Redds (Oct. 14)
N
0 0.5 1 2 3 4
Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

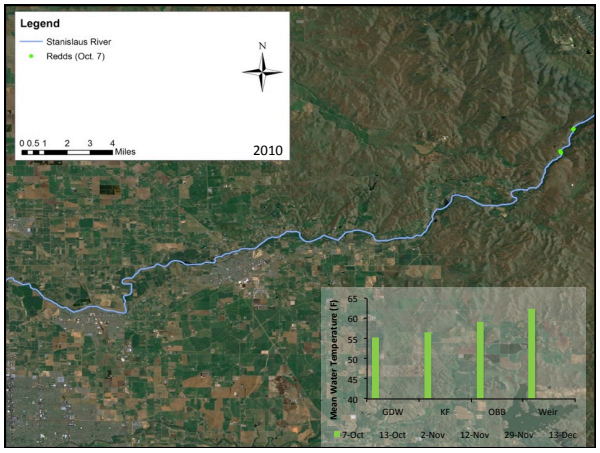

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
N
0 0.5 1 2 3 4
Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

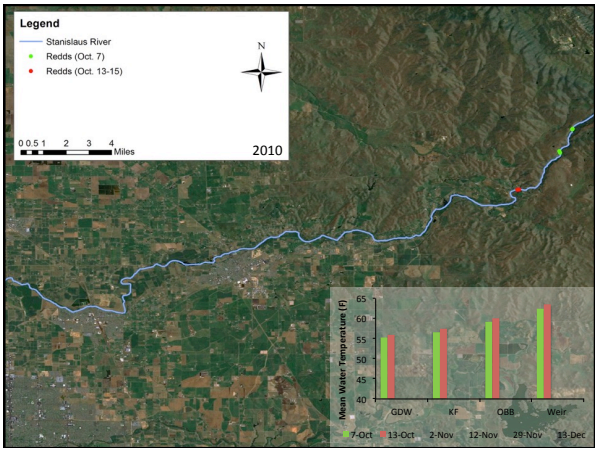

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
N
0 0.5 1 2 3 4
Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

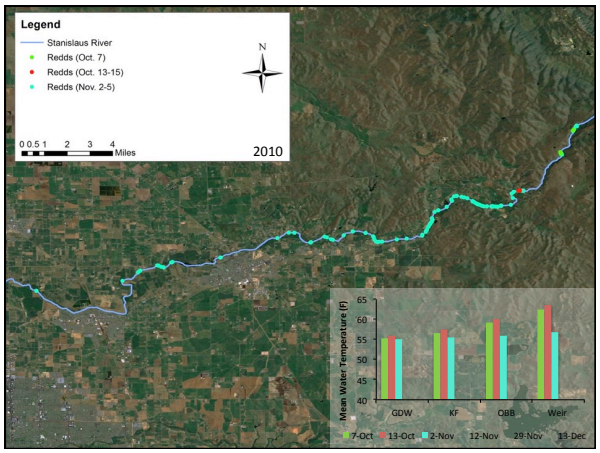

Legend
Stanislaus River
Redds (Nov. 23-29)
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
N
0 0.5 1 2 3 4
Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

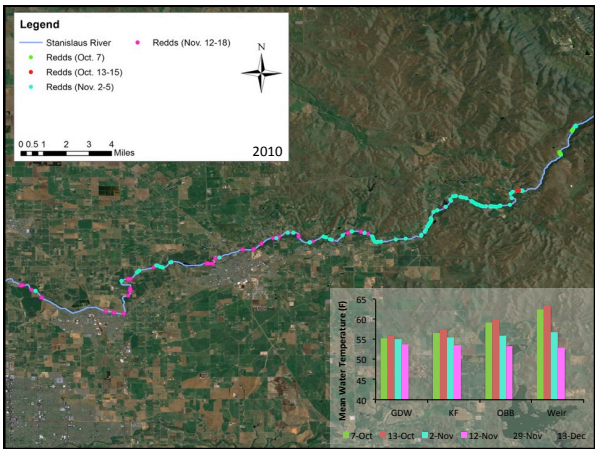

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
Redds (Dec. 9-11)
N
0 0.5 1 2 3 4
Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

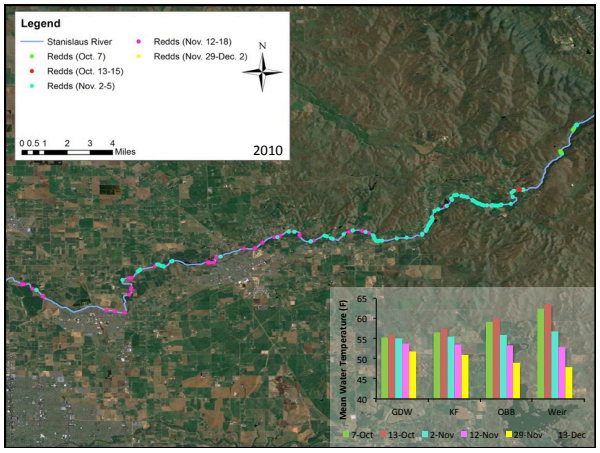

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
Redds (Dec. 9-11)
Redds (Dec. 21-23)
N
0 0.5 1 2 3 4
Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

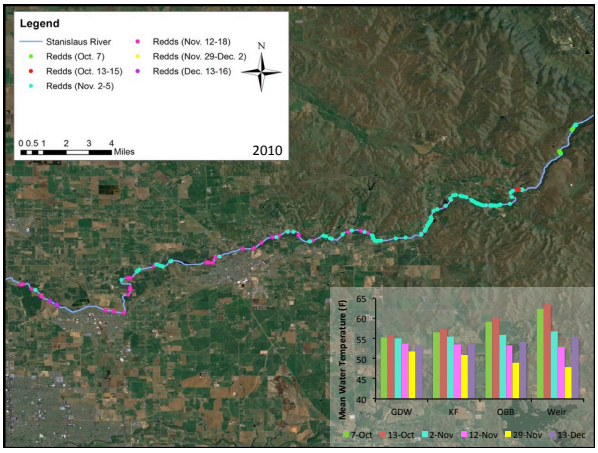

Legend
Stanislaus River
Redds (Oct. 7)
N
0 0.5 1 2 3 4
Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

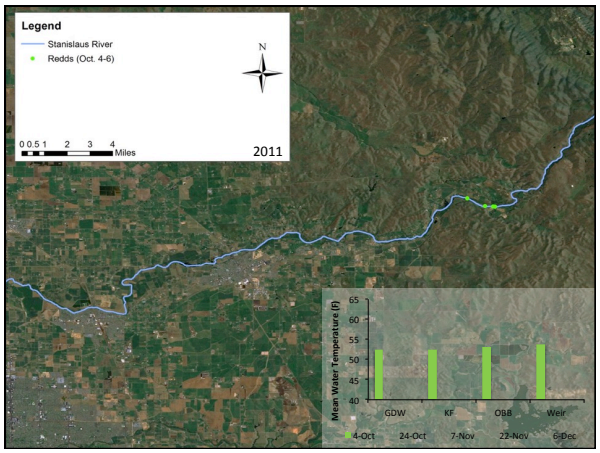

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
N
0 0.5 1 2 3 4
Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

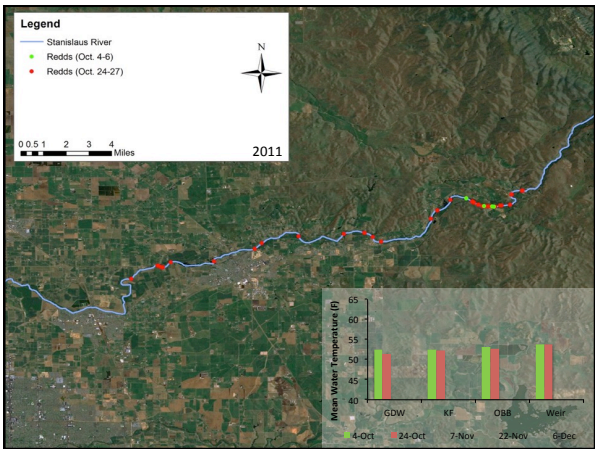

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
QBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

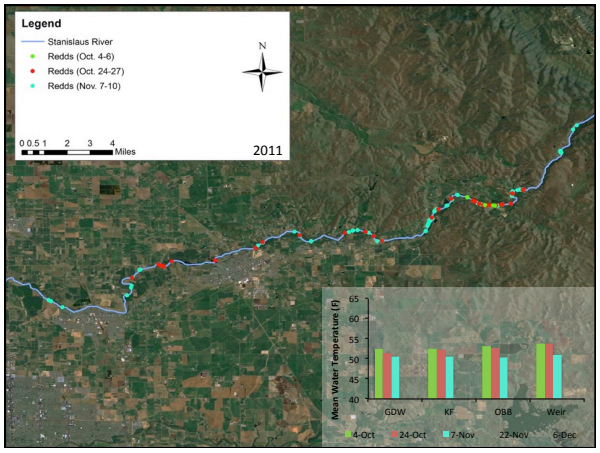

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
QBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

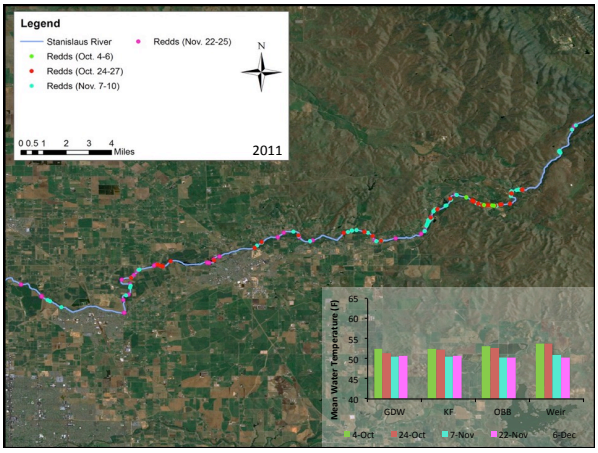

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
Redds (Nov. 29-Dec. 2)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
QBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

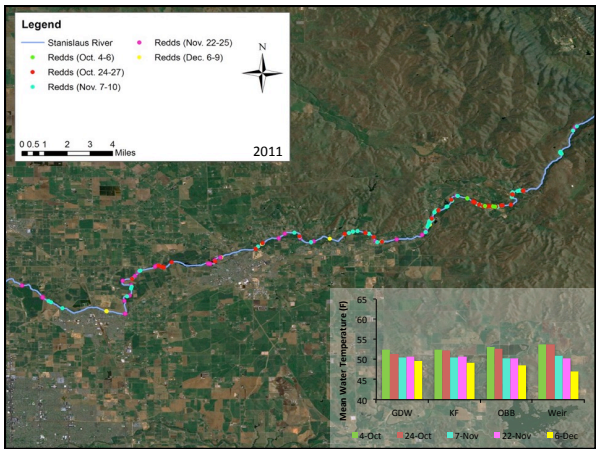

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
Redds (Nov. 29-Dec. 2)
Redds (Dec. 13-16)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
QBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

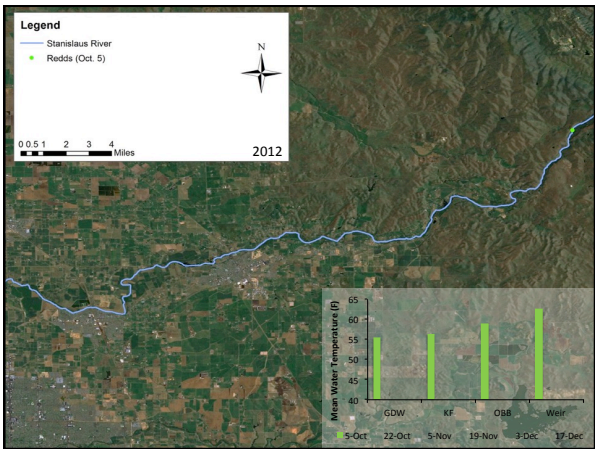

Legend
Stanislaus River
Redds (Oct. 4-6)
N
0 0.5 1 2 3 4
Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

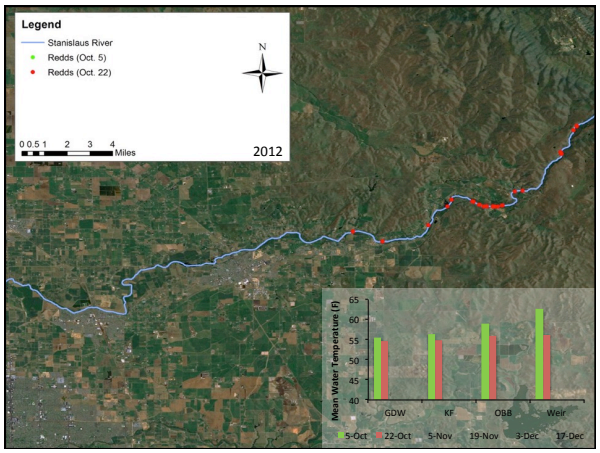

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
N
0 0.5 1 2 3 4
Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

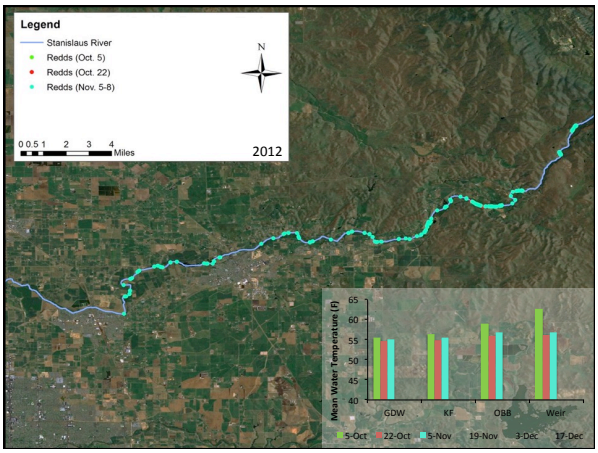

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
Redds (Nov. 7-10)
N
0 0.5 1 2 3 4
Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

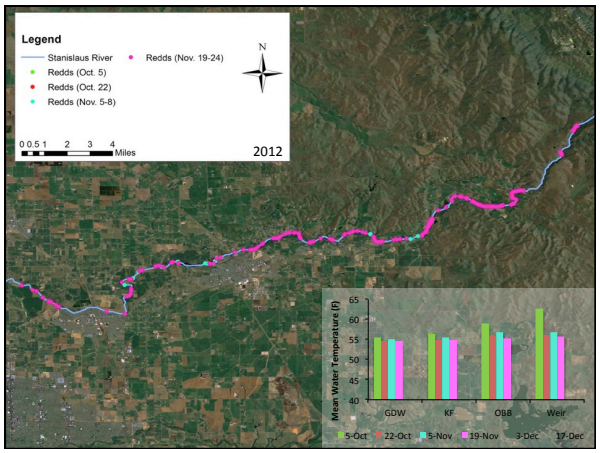

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
Redds (Nov. 7-10)
Redds (Nov. 22-25)
N
0 0.5 1 2 3 4
Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

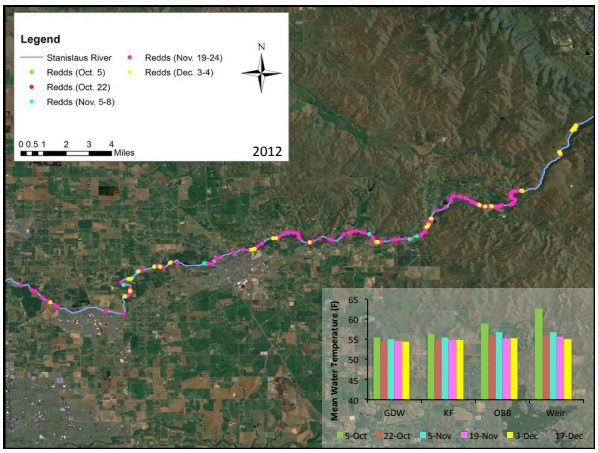

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
Redds (Nov. 7-10)
Redds (Nov. 22-25)
Redds (Dec. 6-9)
N
0 0.5 1 2 3 4
Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

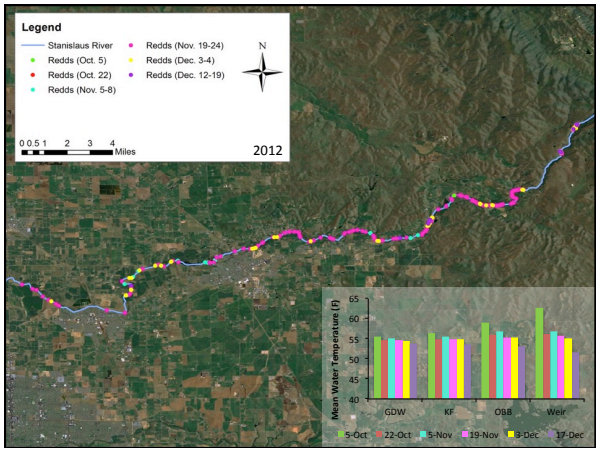

Legend
Stanislaus River
Redds (Oct. 5)
N
0 0.5 1 2 3 4
Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec

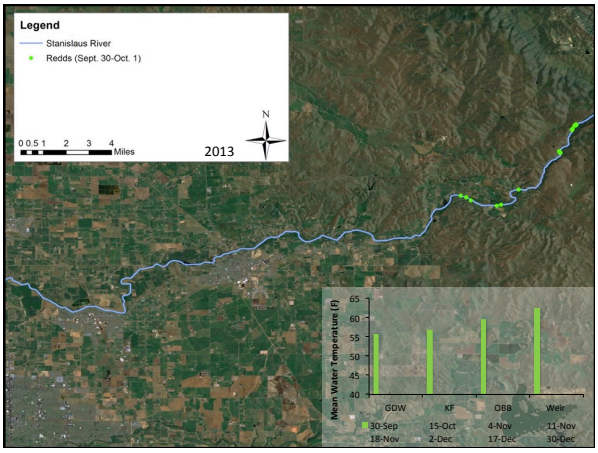

Legend
Stanislaus River
Redds (Oct. 5)
Redds (Oct. 22)
N
0 0.5 1 2 3 4
Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec

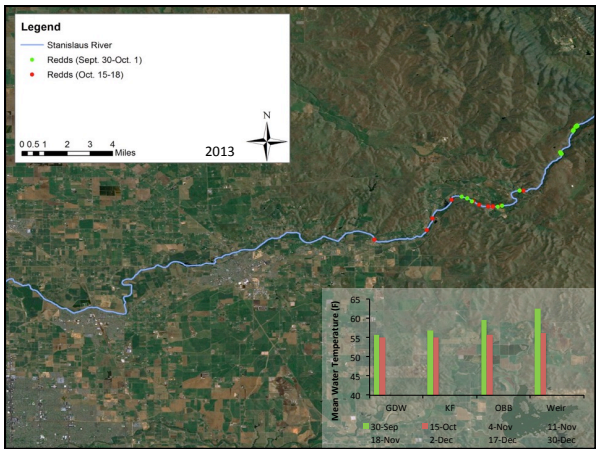

Legend
Stanislaus River
Redds (Oct. 5)
Redds (Oct. 22)
Redds (Nov. 5-8)
N
0 0.5 1 2 3 4
Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec


Legend
Stanislaus River
Redds (Oct. 5)
Redds (Oct. 22)
Redds (Nov. 5-8)
Redds (Nov. 19-24)
N
0 0.5 1 2 3 4
Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec


Legend
Stanislaus River
Redds (Oct. 5)
Redds (Oct. 22)
Redds (Nov. 5-8)
Redds (Nov. 19-24)
Redds (Dec. 3-4)
N
0 0.5 1 2 3 4
Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec


Legend
Stanislaus River
Redds (Oct. 5)
Redds (Oct. 22)
Redds (Nov. 5-8)
Redds (Nov. 19-24)
Redds (Dec. 3-4)
Redds (Dec. 12-19)
N
0 0.5 1 2 3 4
Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec


Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
N
0 0.5 1 2 3 4
Miles
2013
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec


Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
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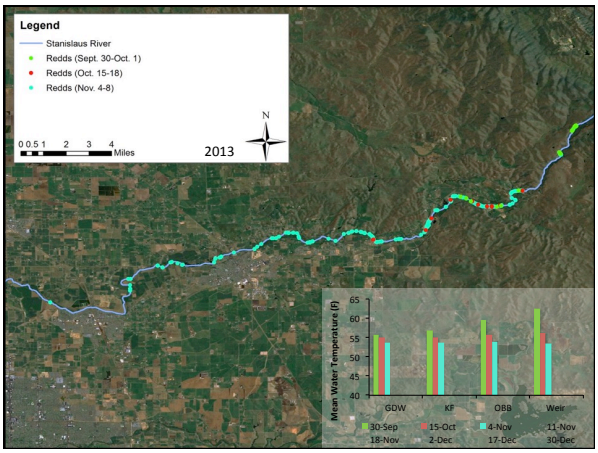
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec


Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
Redds (Nov. 4-8)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
45
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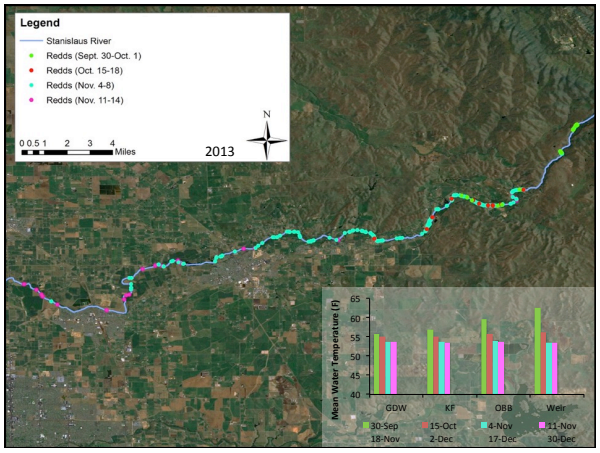
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec


Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
Redds (Nov. 4-8)
Redds (Nov. 11-14)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
45
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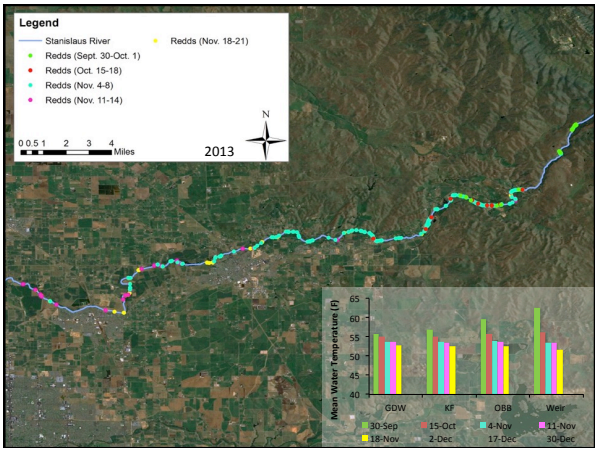
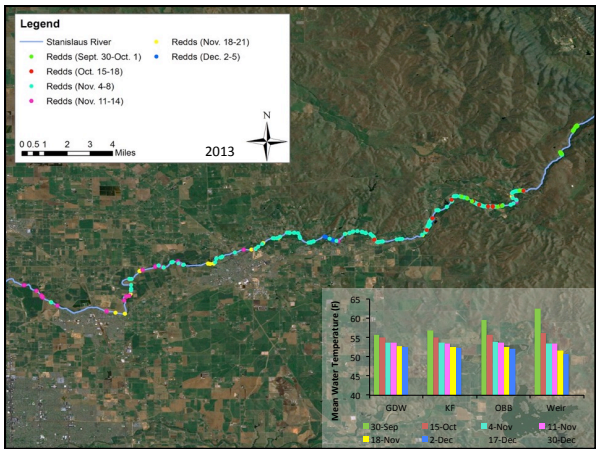
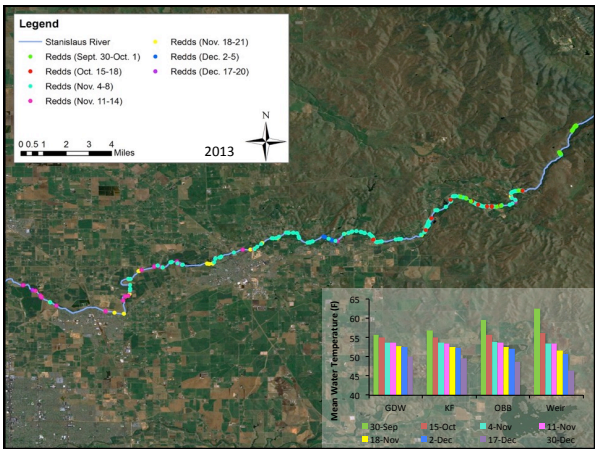
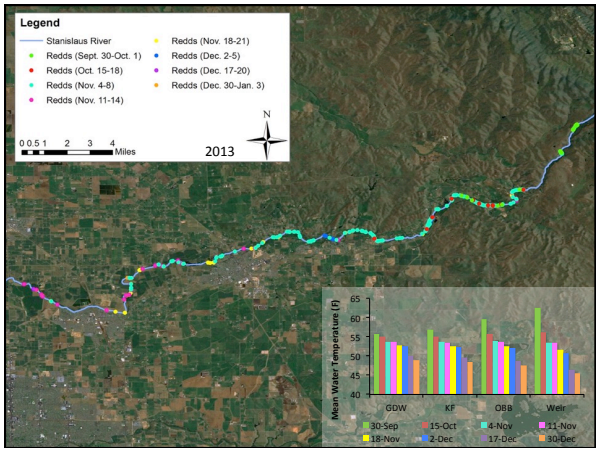
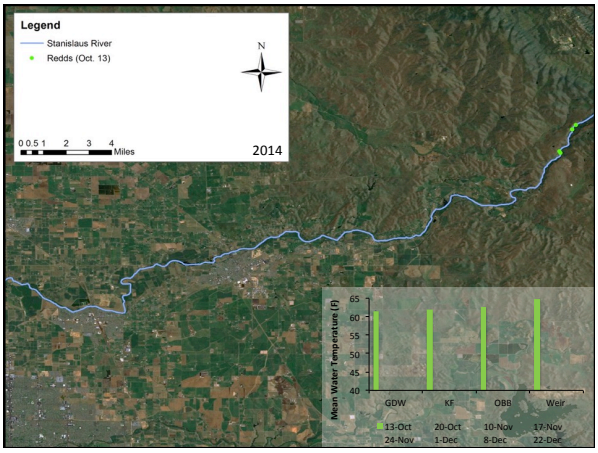
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec

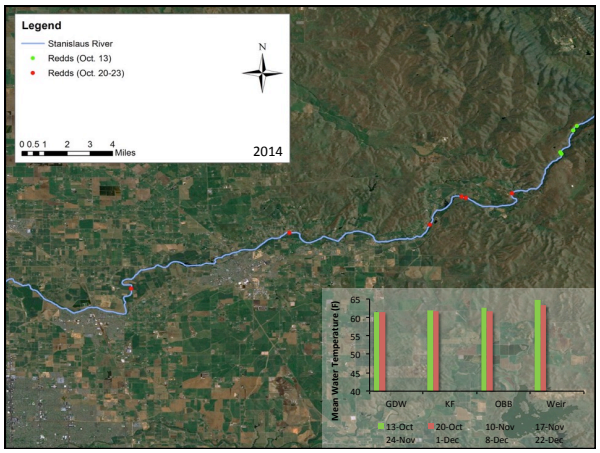

Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
Redds (Nov. 4-8)
Redds (Nov. 11-14)
Redds (Nov. 18-21)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec

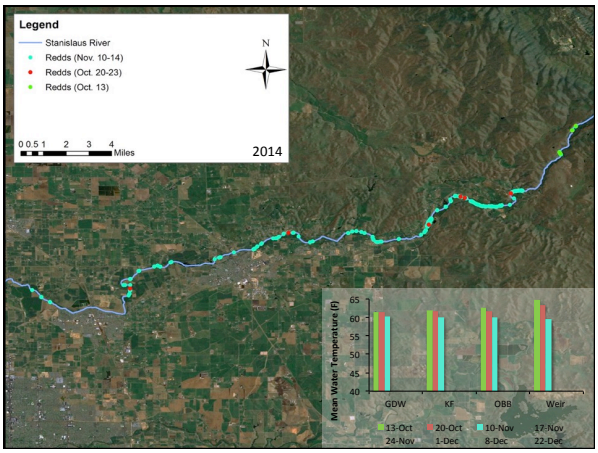

Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
Redds (Nov. 4-8)
Redds (Nov. 11-14)
Redds (Nov. 18-21)
Redds (Dec. 2-5)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec

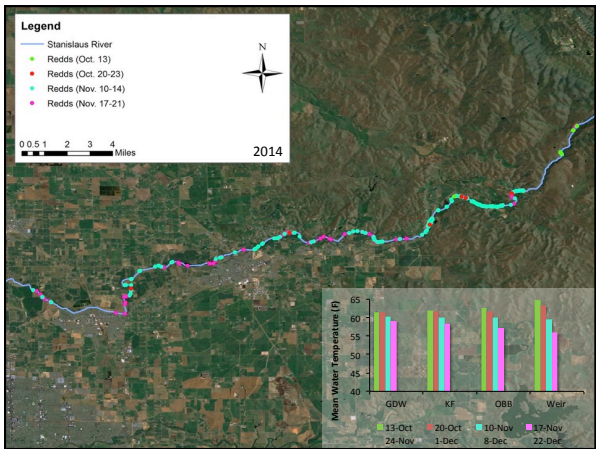

Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
Redds (Nov. 4-8)
Redds (Nov. 11-14)
Redds (Nov. 18-21)
Redds (Dec. 2-5)
Redds (Dec. 17-20)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec

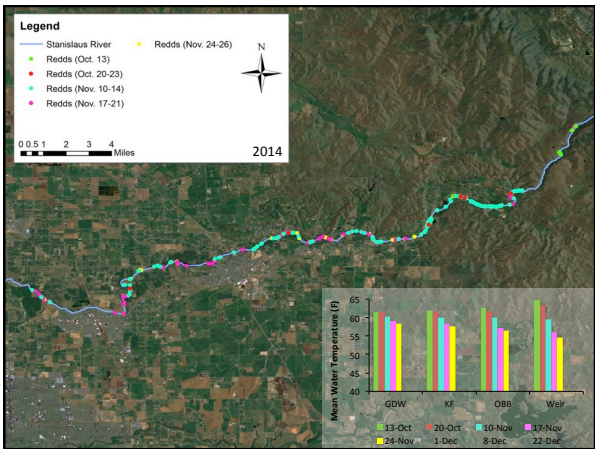

Legend
Stanislaus River
Redds (Sept. 30-Oct. 1)
Redds (Oct. 15-18)
Redds (Nov. 4-8)
Redds (Nov. 11-14)
Redds (Nov. 18-21)
Redds (Dec. 2-5)
Redds (Dec. 17-20)
Redds (Dec. 30-Jan. 3)
0 0.5 1 2 3 4 Miles
N
2013
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
30-Sep
15-Oct
4-Nov
11-Nov
18-Nov
2-Dec
17-Dec
30-Dec

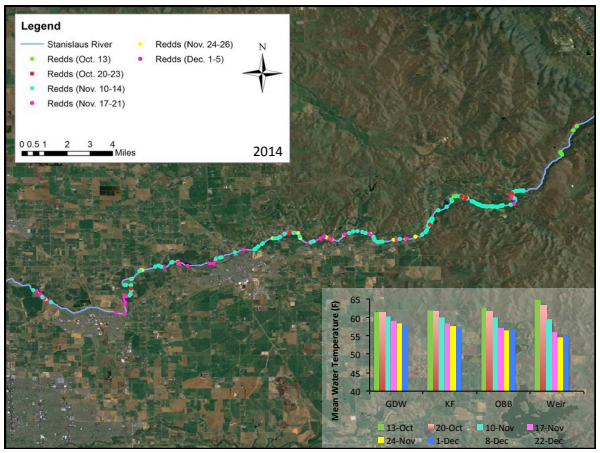

Legend
Stanislaus River
Redds (Oct. 13)
0 0.5 1 2 3 4 Miles
N
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec

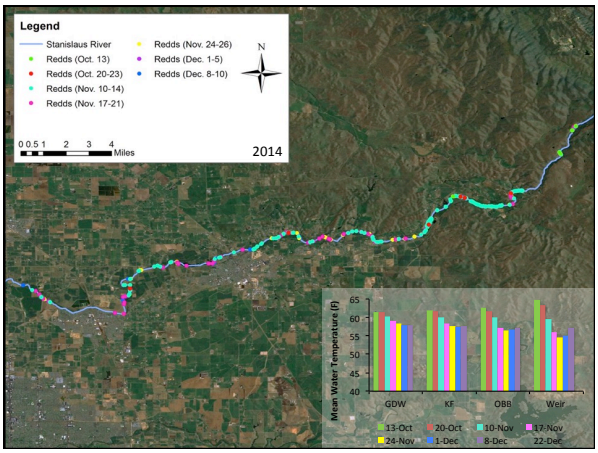

Legend
Stanislaus River
Redds (Oct. 13)
Redds (Oct. 20-23)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec

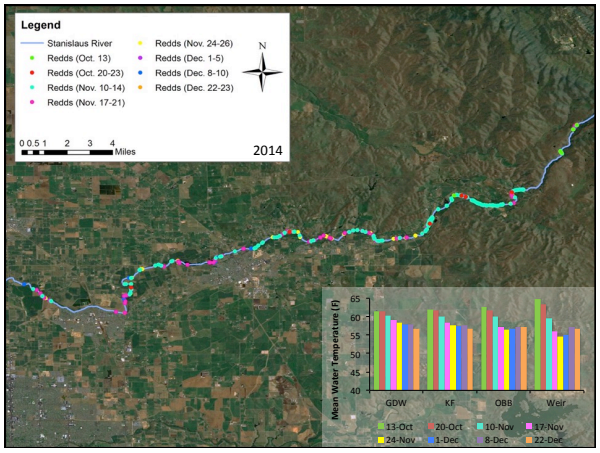

Legend
Stanislaus River
Redds (Nov. 10-14)
Redds (Oct. 20-23)
Redds (Oct. 13)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec


Legend
Stanislaus River
Redds (Oct. 13)
Redds (Oct. 20-23)
Redds (Nov. 10-14)
Redds (Nov. 17-21)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec


Legend
Stanislaus River
Redds (Nov. 24-26)
Redds (Oct. 13)
Redds (Oct. 20-23)
Redds (Nov. 10-14)
Redds (Nov. 17-21)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec


Legend
Stanislaus River
Redds (Oct. 13)
Redds (Oct. 20-23)
Redds (Nov. 10-14)
Redds (Nov. 17-21)
Redds (Nov. 24-26)
Redds (Dec. 1-5)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec


Legend
Stanislaus River
Redds (Oct. 13)
Redds (Oct. 20-23)
Redds (Nov. 10-14)
Redds (Nov. 17-21)
Redds (Nov. 24-26)
Redds (Dec. 1-5)
Redds (Dec. 8-10)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec


Legend
Stanislaus River
Redds (Oct. 13)
Redds (Oct. 20-23)
Redds (Nov. 10-14)
Redds (Nov. 17-21)
Redds (Nov. 24-26)
Redds (Dec. 1-5)
Redds (Dec. 8-10)
Redds (Dec. 22-23)
N
0 0.5 1 2 3 4
Miles
2014
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
13-Oct
20-Oct
10-Nov
17-Nov
24-Nov
1-Dec
8-Dec
22-Dec