1.C.2.2 Attachments to Comments of Oakdale Irrigation District, South San Joaquin Irrigation District, and Stockton East Water District

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ATTACHMENT A

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.

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[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.

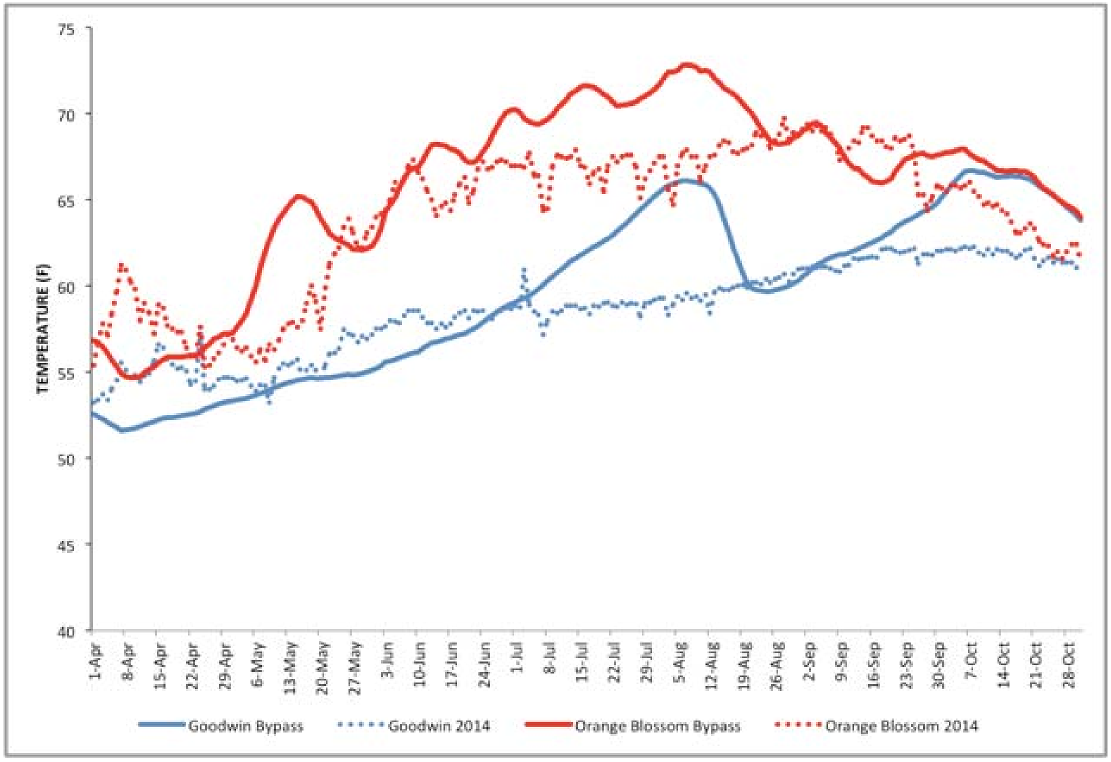


Figure 1. Projected 2015 7DADM water temperature and observed 2014 daily maximum water temperature at Goodwin Dam and OBB.

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.

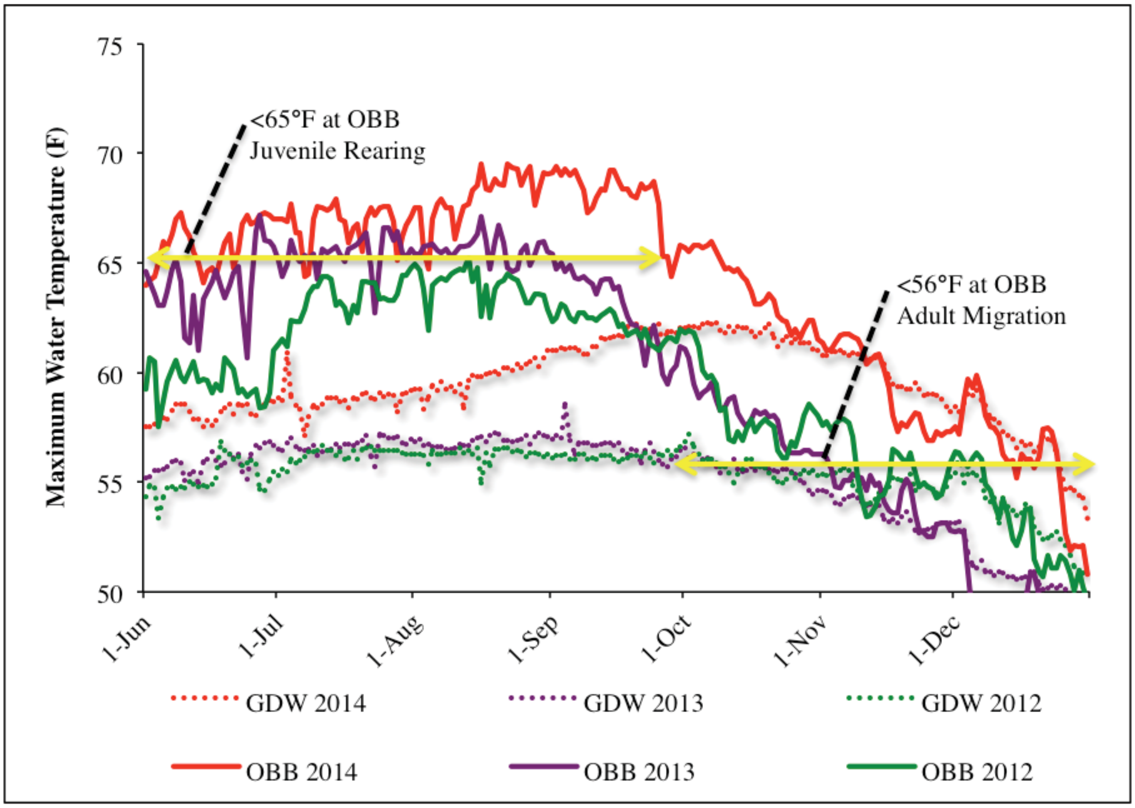


Figure 2. June 1 – December 31, 2012-2014 daily maximum water temperature at Orange Blossom Bridge and Goodwin Dam.

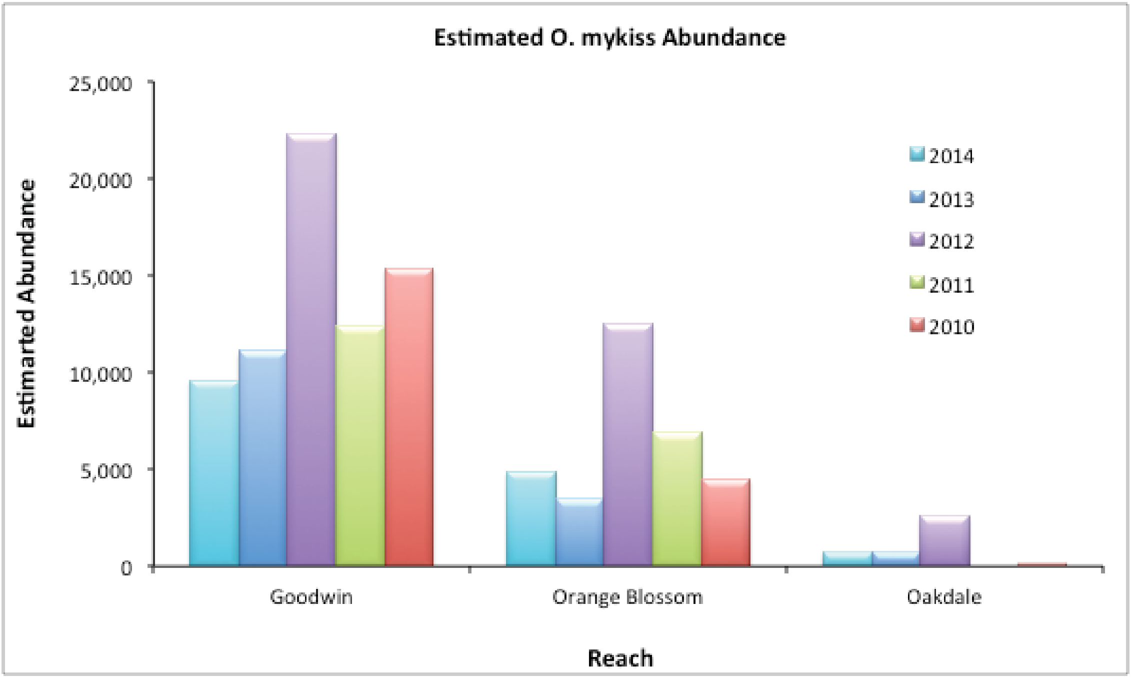


Figure 3. Distribution of *O. mykiss* in the Stanislaus River between Goodwin Dam and Oakdale during 2009-2014.

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

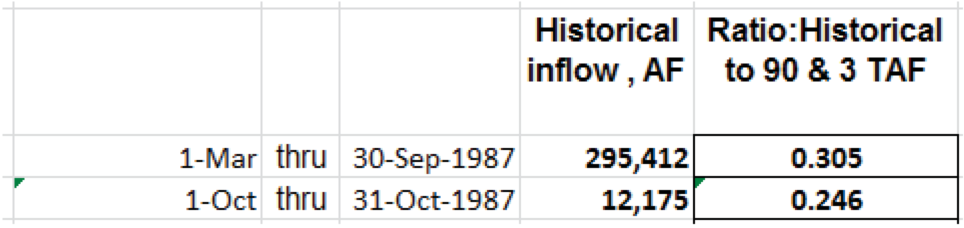
Review of snow pack data from several CDEC stations in or near the Stanislaus watershed indicates that the runoff this year will likely be the lowest of the past 30+ years (see Figure 3).

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

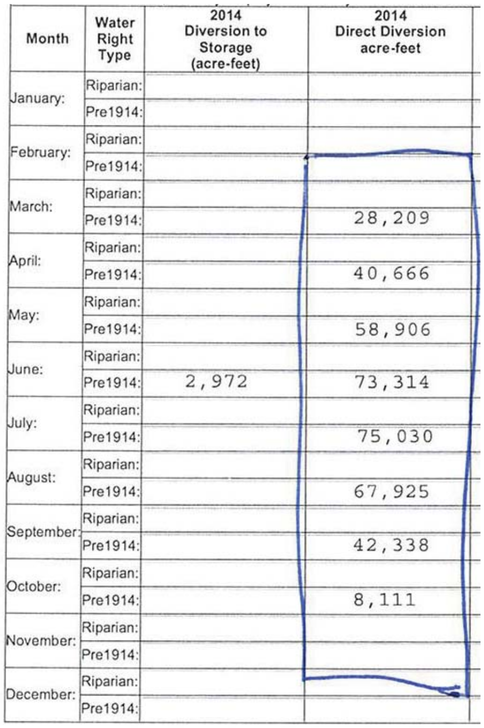
Then, set the New Melones storage to the current state (605,600 acre-feet on February 28), superimpose the release and diversion schedule that is currently being proposed (see Diversion and Release Schedule below), and operate the system accordingly.

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.

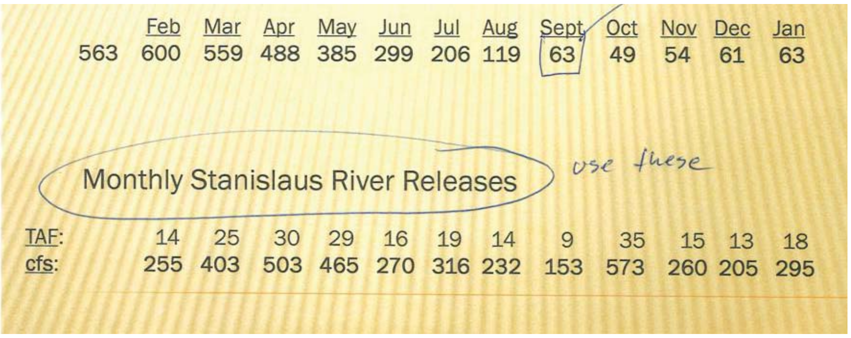
4. Diversion and Release Schedule

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

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan
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

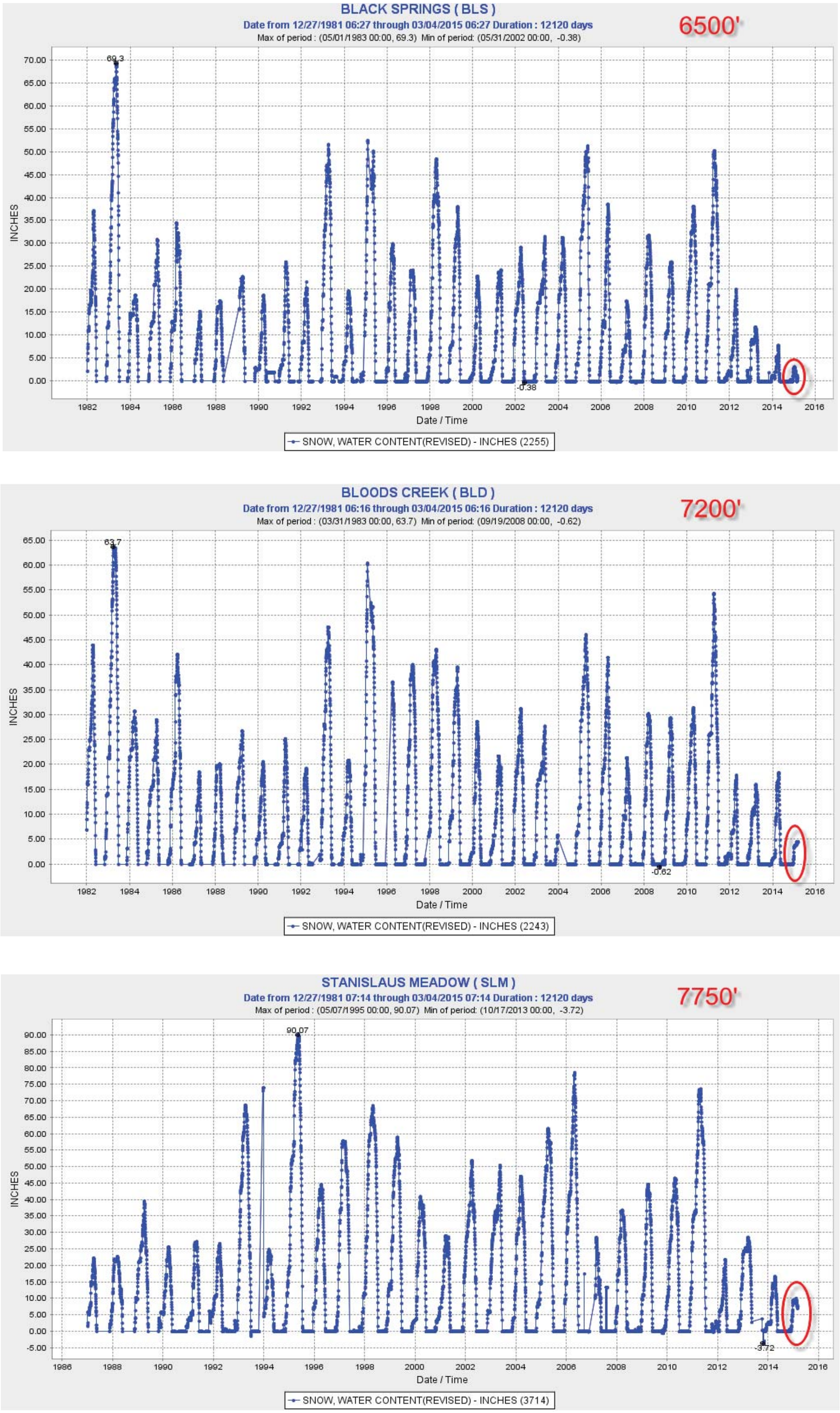


Figure 3: Snow Pack Data from Several CDEC Stations near the Stanislaus watershed

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).

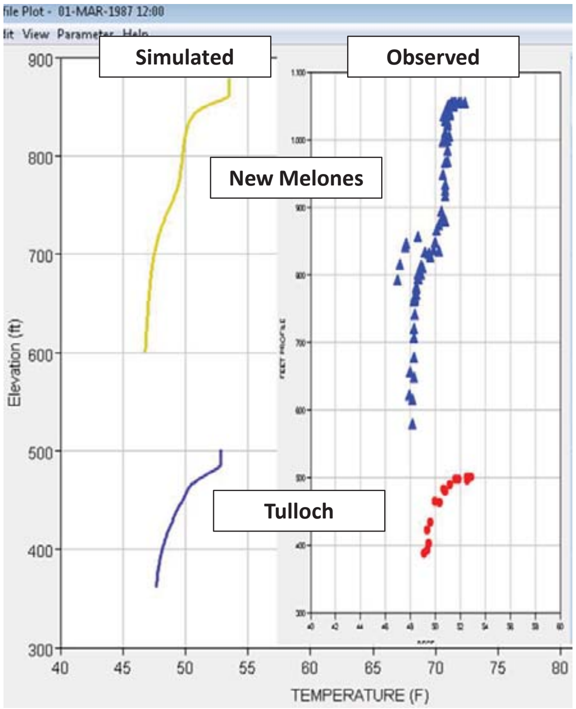


Figure 4: Computed and Observed Thermal Profiles in New Melones and Tulloch Reservoirs near March 1

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.

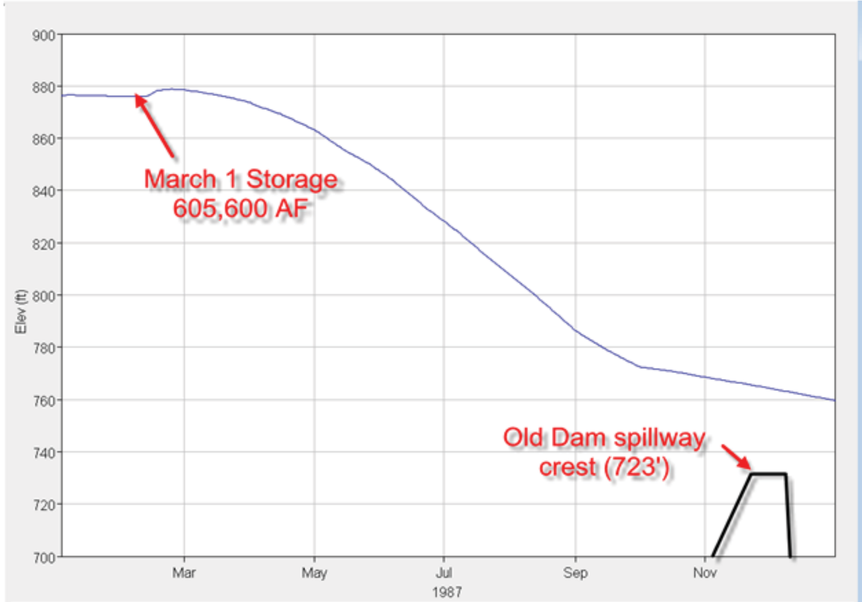


Figure 6: Projected New Melones Water Levels in 2015

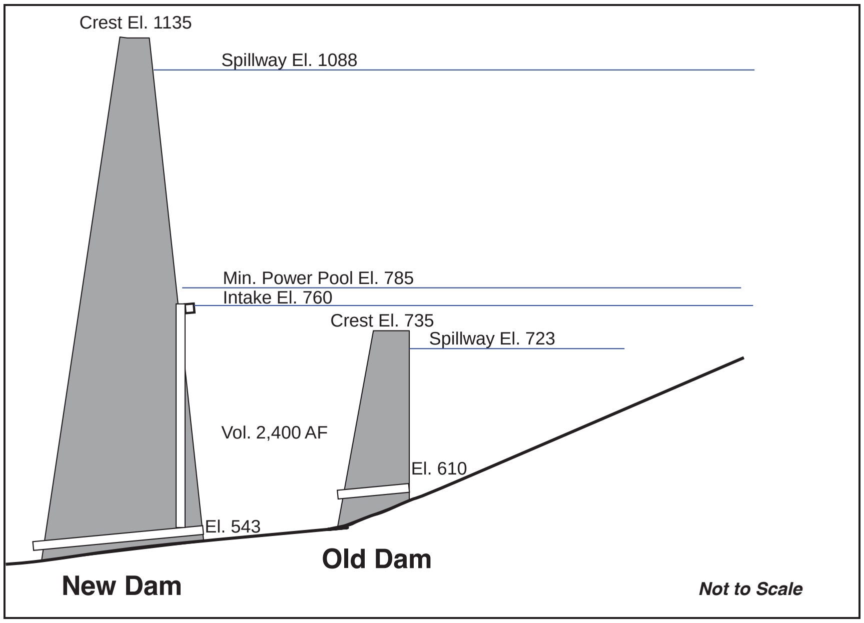


Figure 7: New-Old Dam Interaction

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).

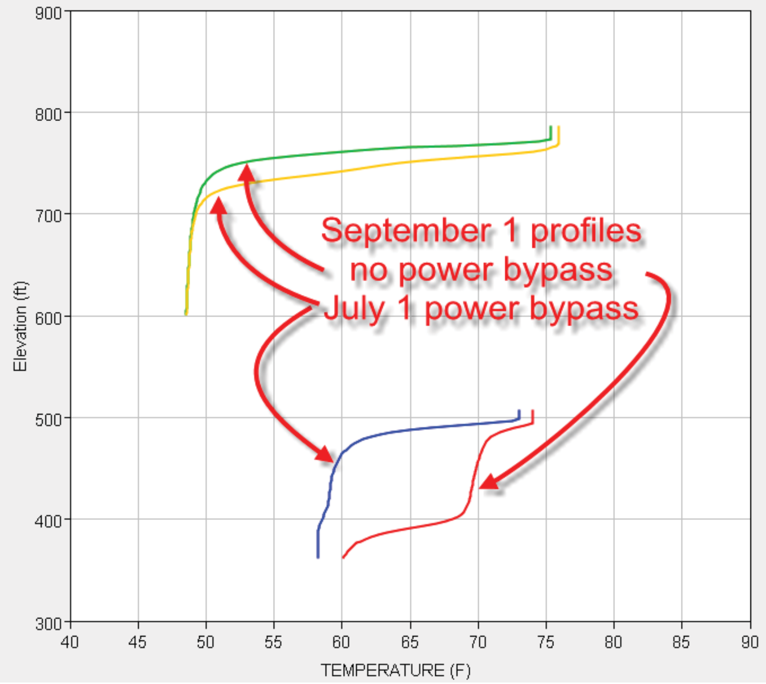


Figure 8: Temperature profiles in New Melones and Tulloch With and Without Bypass Operation

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:

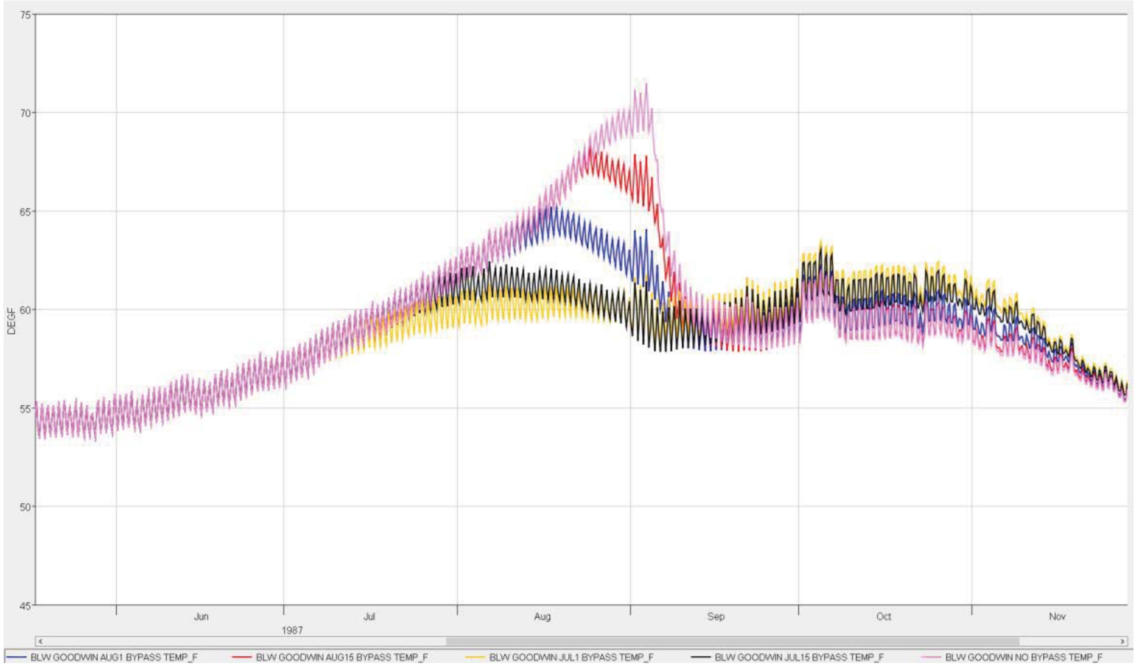


Figure 9: Effects of Power Bypass on Temperature Below Goodwin Dam

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.

AD Consultants

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

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

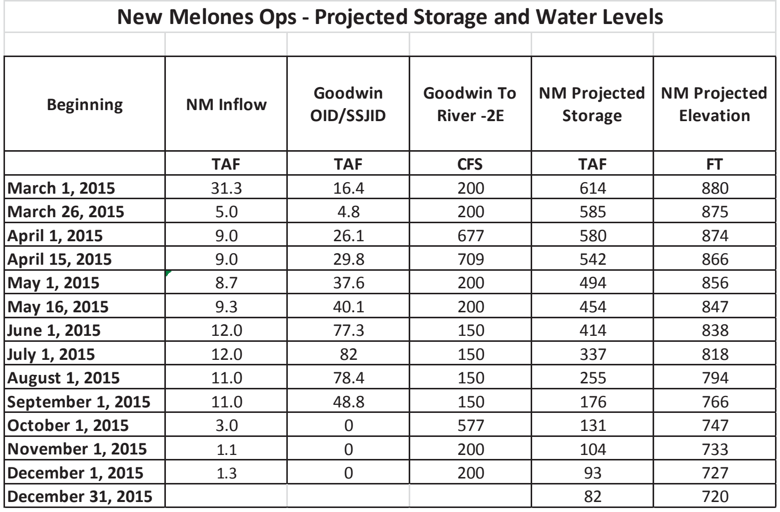
The HEC-5Q was run in two modes:

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

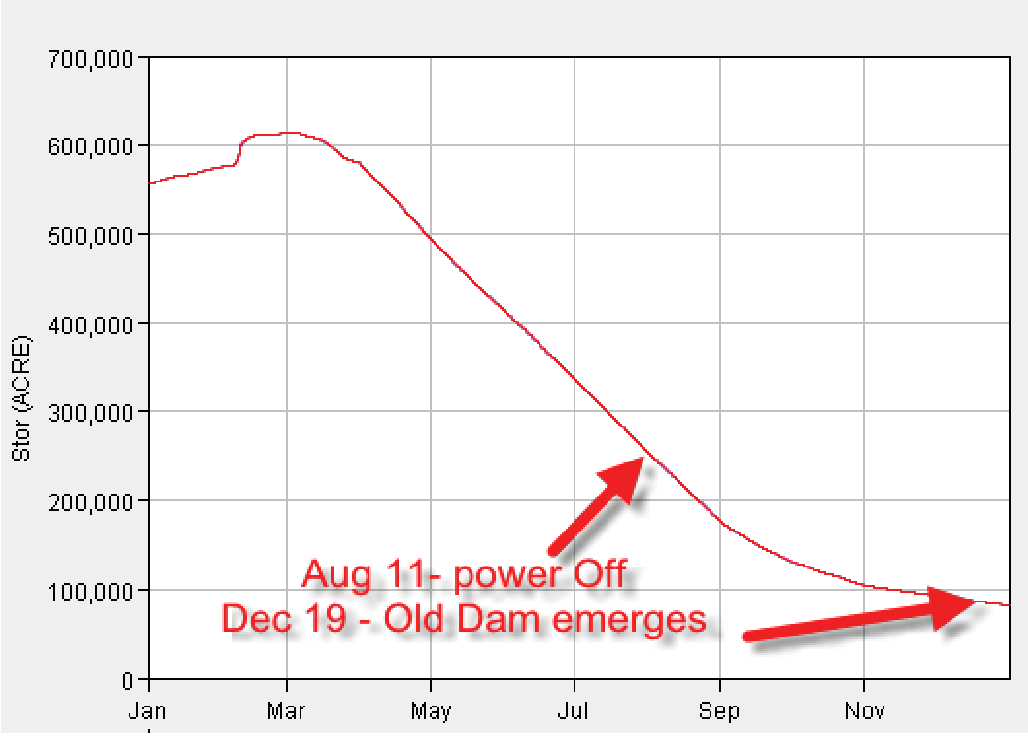
Beginning	NM Inflow	Goodwin OID/SSJID	Goodwin To River -2E	NM Projected Storage	NM Projected Elevation
	TAF	TAF	CFS	TAF	FT
March 1, 2015	31.3	16.4	200	614	880
March 26, 2015	5.0	4.8	200	585	875
April 1, 2015	9.0	26.1	677	580	874
April 15, 2015	9.0	29.8	709	542	866
May 1, 2015	8.7	37.6	200	494	856
May 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.



Aug 11- power Off
Dec 19 - Old Dam emerges

Figure 3: Projected New Melones Storage in 2015

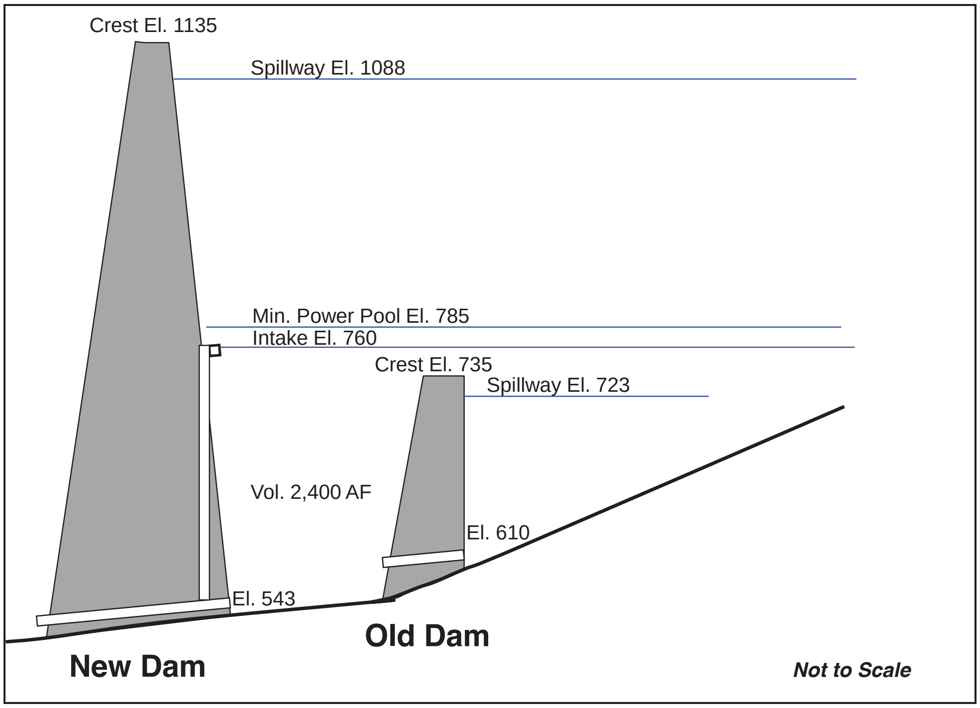


Figure 4: New-Old Dam Interaction

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).

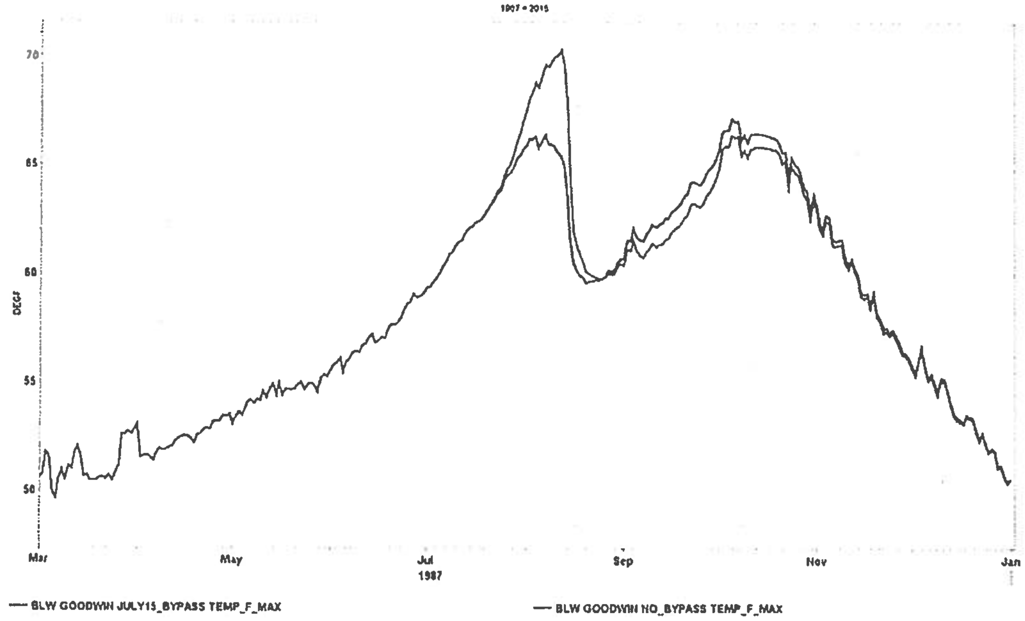


Figure 5 : Maximum Daily Temperatures below Goodwin Dam

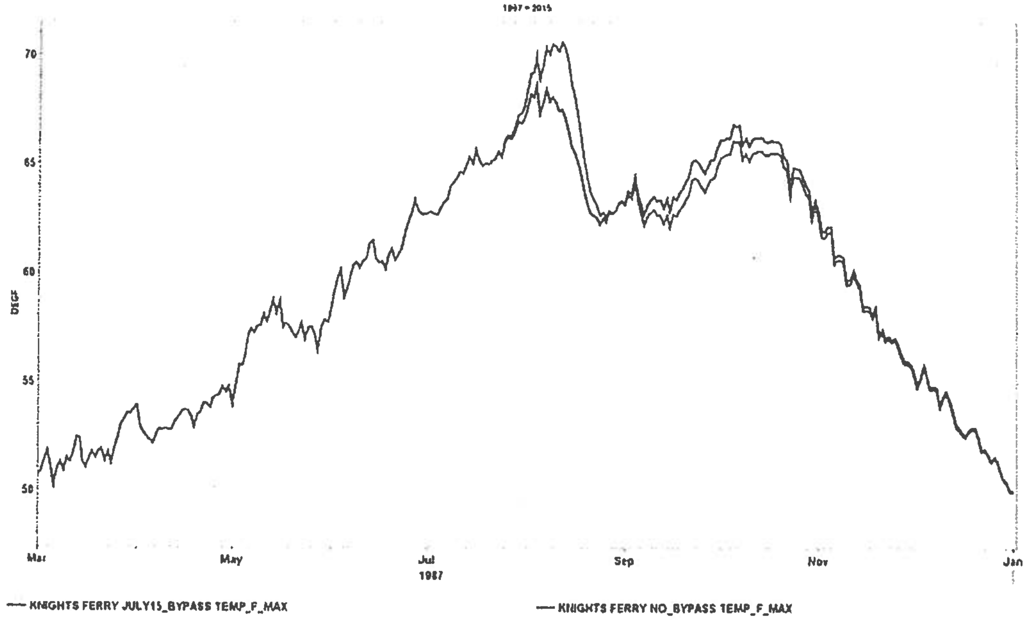


Figure 6 : Maximum Daily Temperatures at Knights Ferry

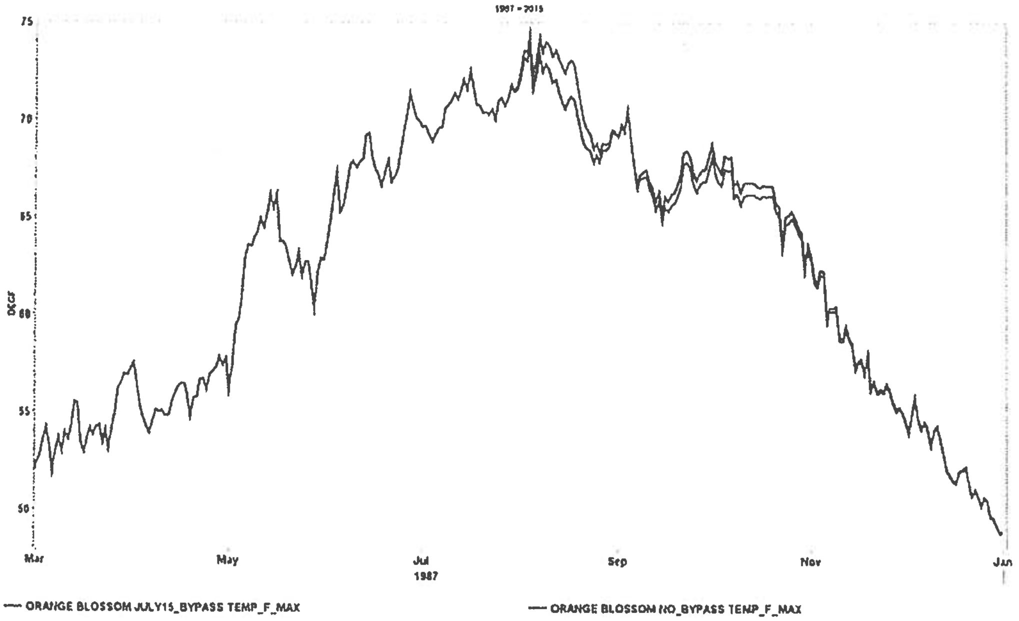


Figure 7 : Maximum Daily Temperatures at Orange Blossom Bridge

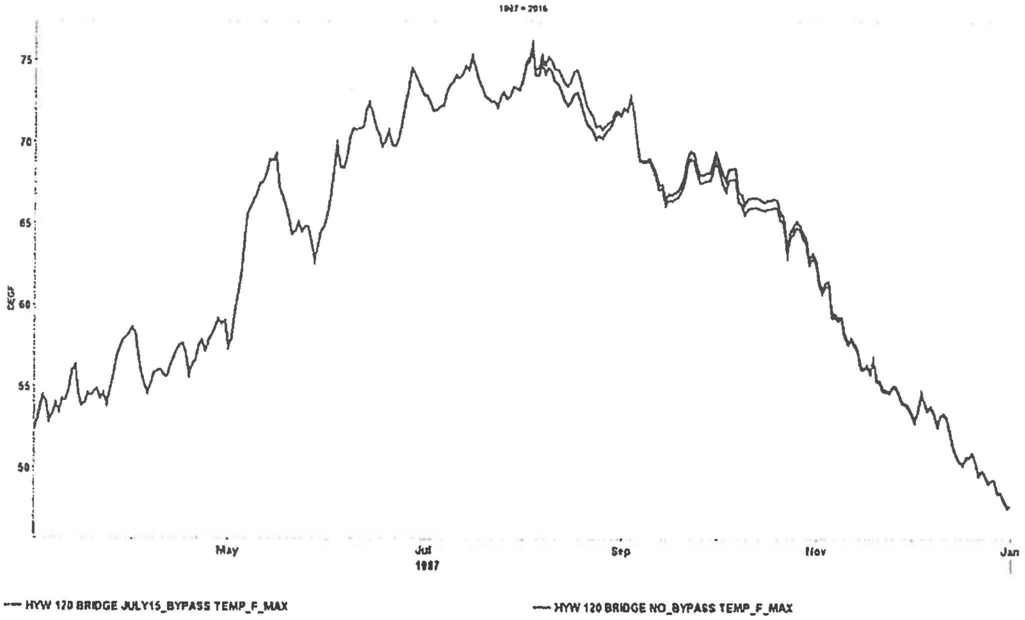


Figure 8 : Maximum Daily Temperatures below Highway 120 (Oakdale)

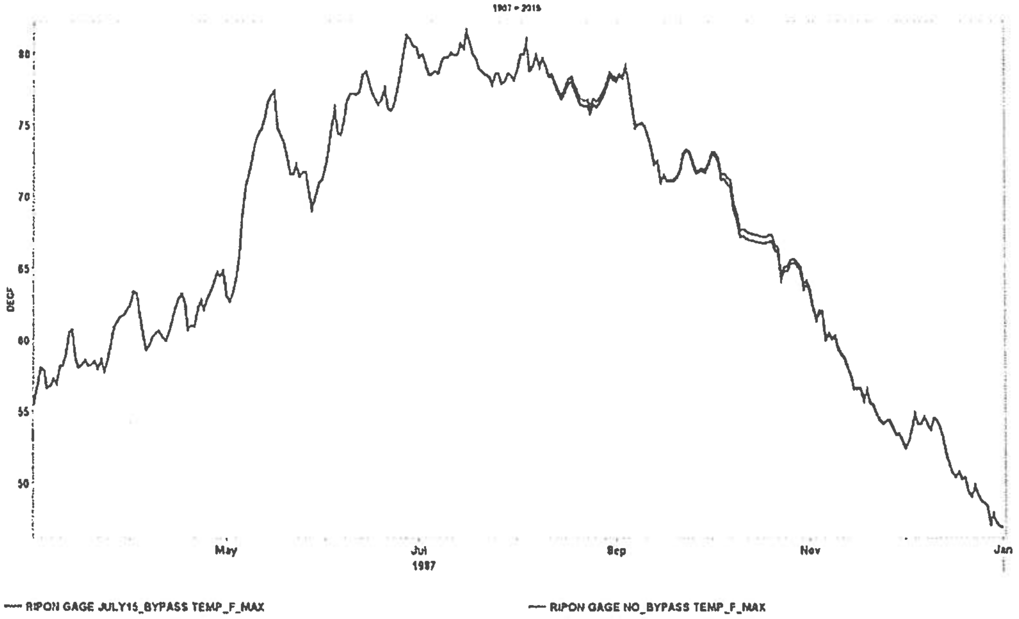


Figure 9 : Maximum Daily Temperatures at Ripon Gage (Highway 99)

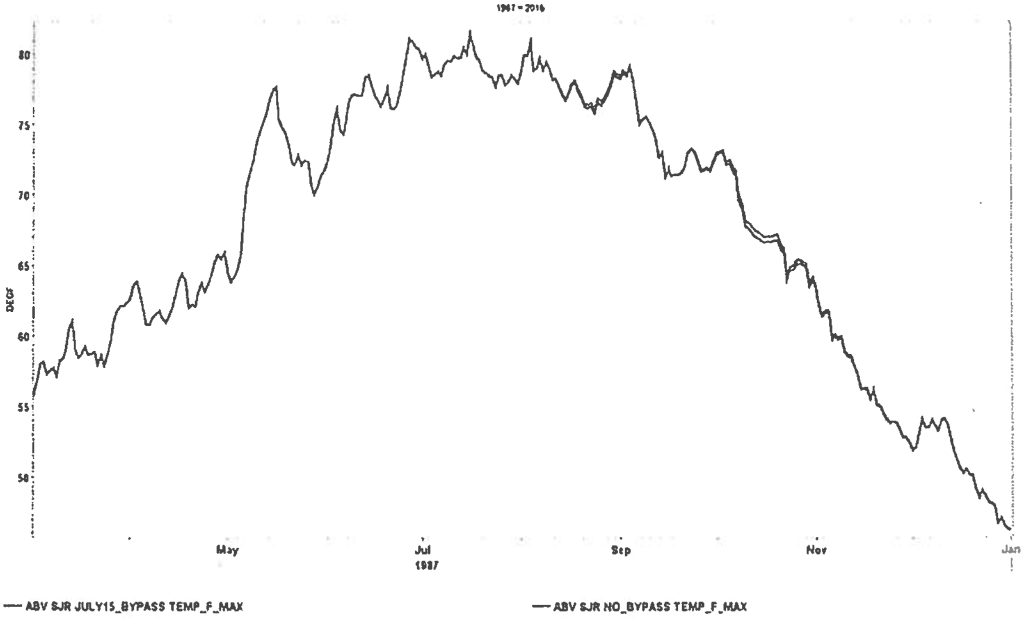


Figure 10 : Maximum Daily Temperatures above the Confluence with the San Joaquin River

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	63.6	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	76.7
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	68.3	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:

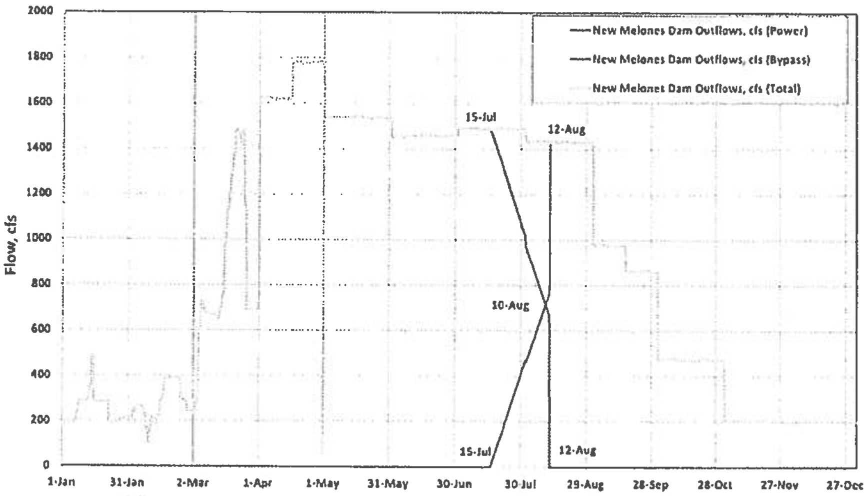


Figure 11: New Melones Power Bypass Operation

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:

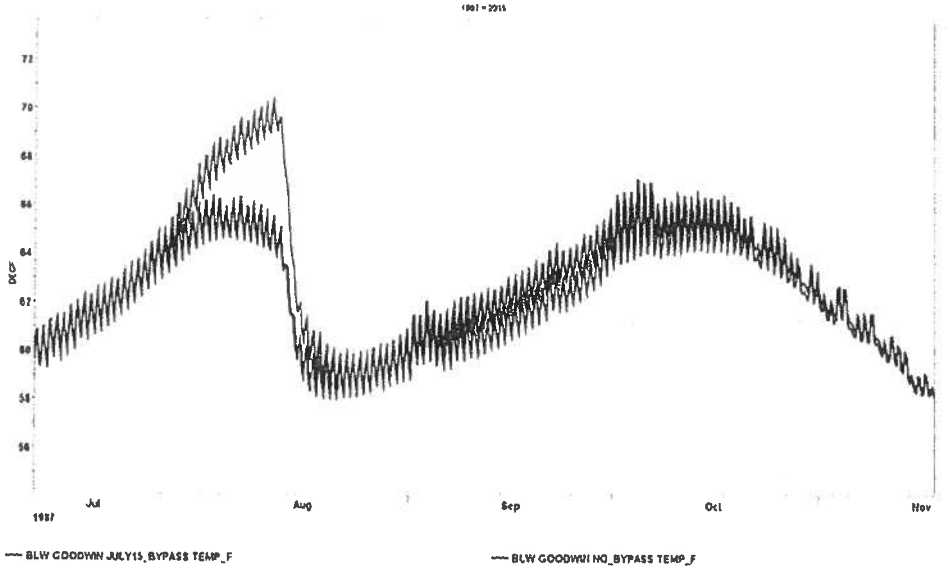


Figure 12: Effects of Power Bypass on Temperature Below Goodwin Dam

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	62.6	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	67.6	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	76.6
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	62.6	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	76.5	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	67.6	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	72.6	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	66.0	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 - 50°F range (late December 2011; Figure 4) to as high as 62 – 64°F range (mid October 2014; Figure 7). Most spawning activity during the other four seasons occurred between temperature ranges between 52°F and 56°F.

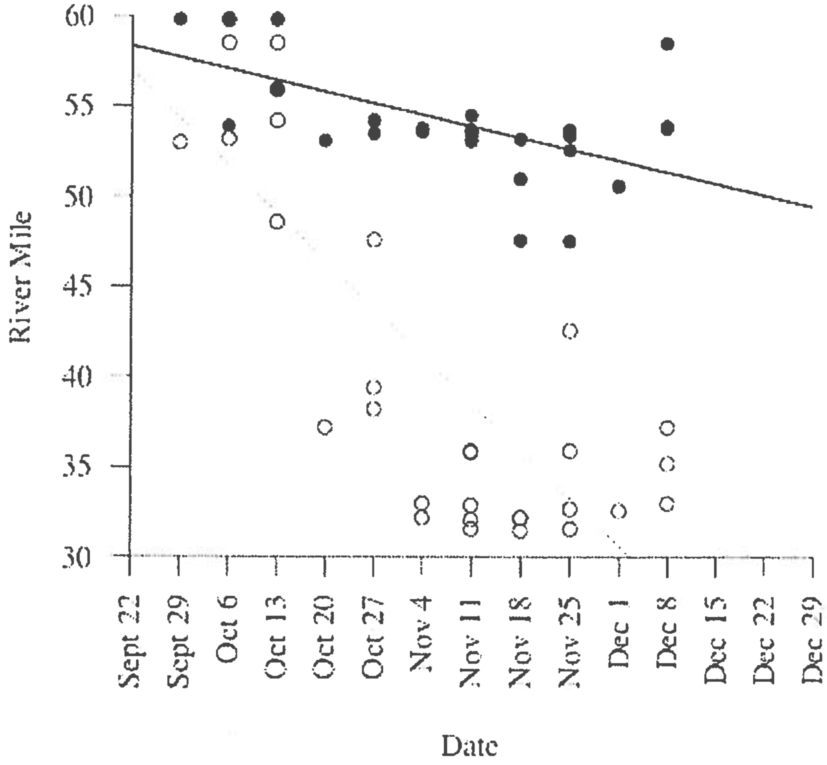


Figure 1. Relationship between median locations of Chinook redds (filled circles) and downstream-most locations (open circles) and date. Solid black line represents the best-fit line for the linear relationship between date and median locations (slope = -0.63; P < 0.001). Dotted line represents the best-fit 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.

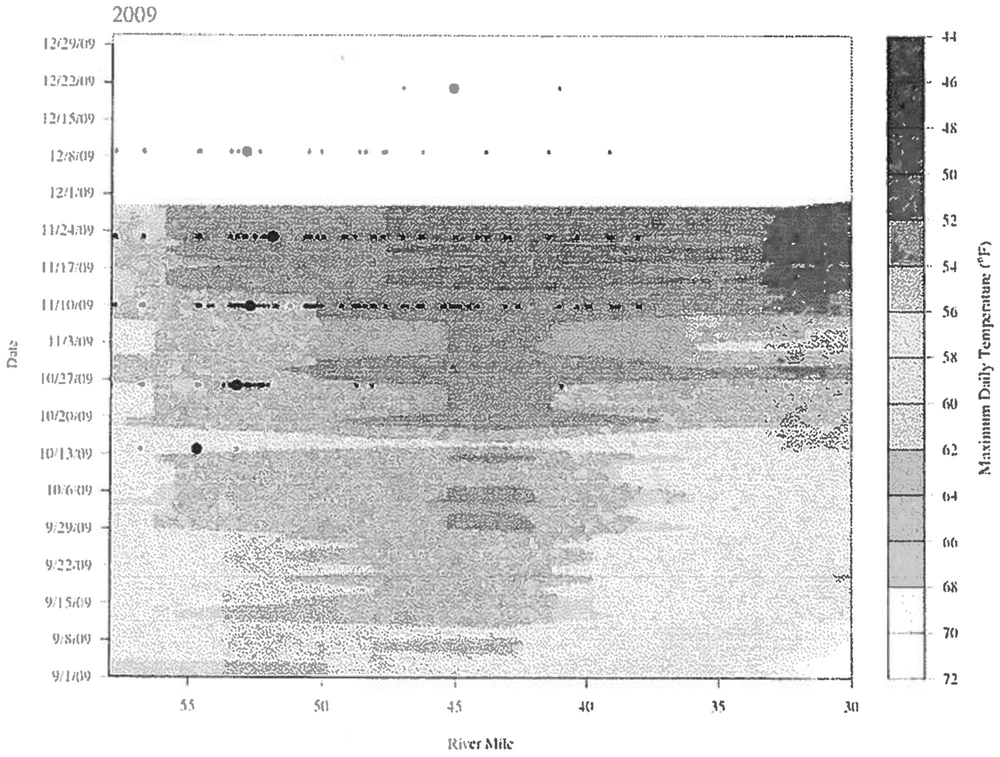


Figure 2. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2009. Water year type in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

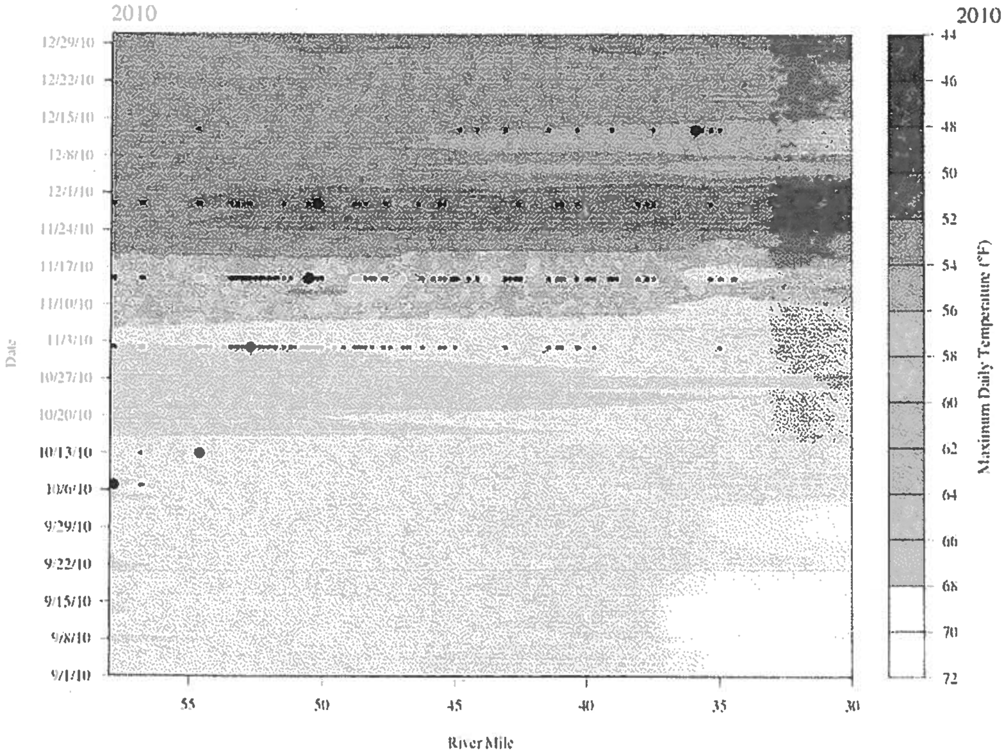


Figure 3. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2010. Water year type in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

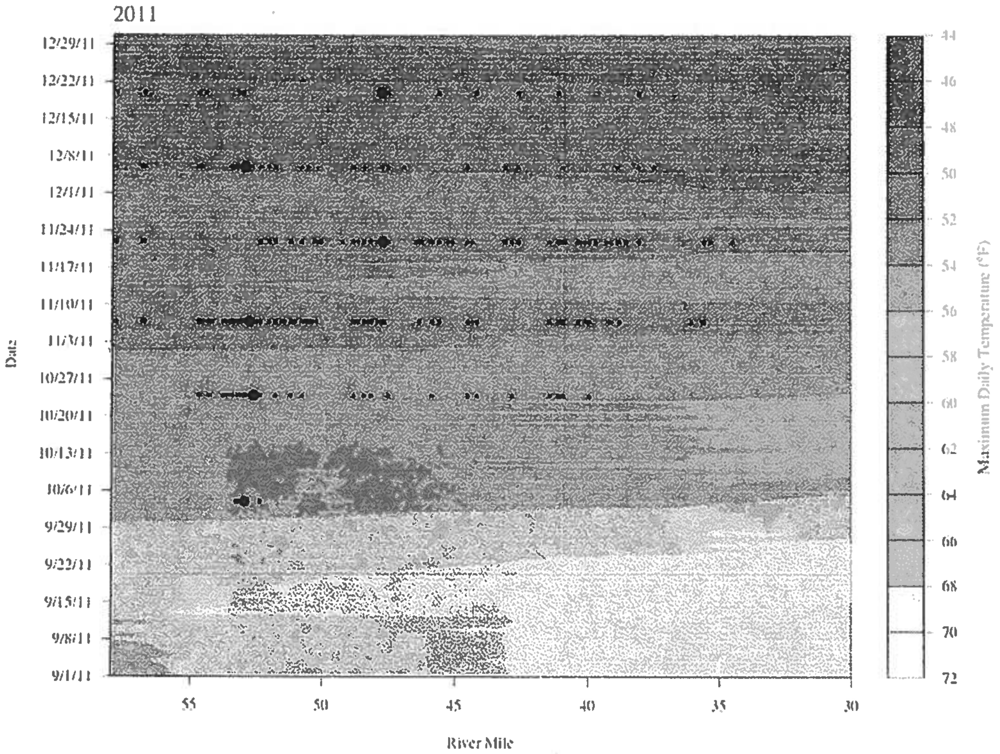


Figure 4. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2011. Water year type in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

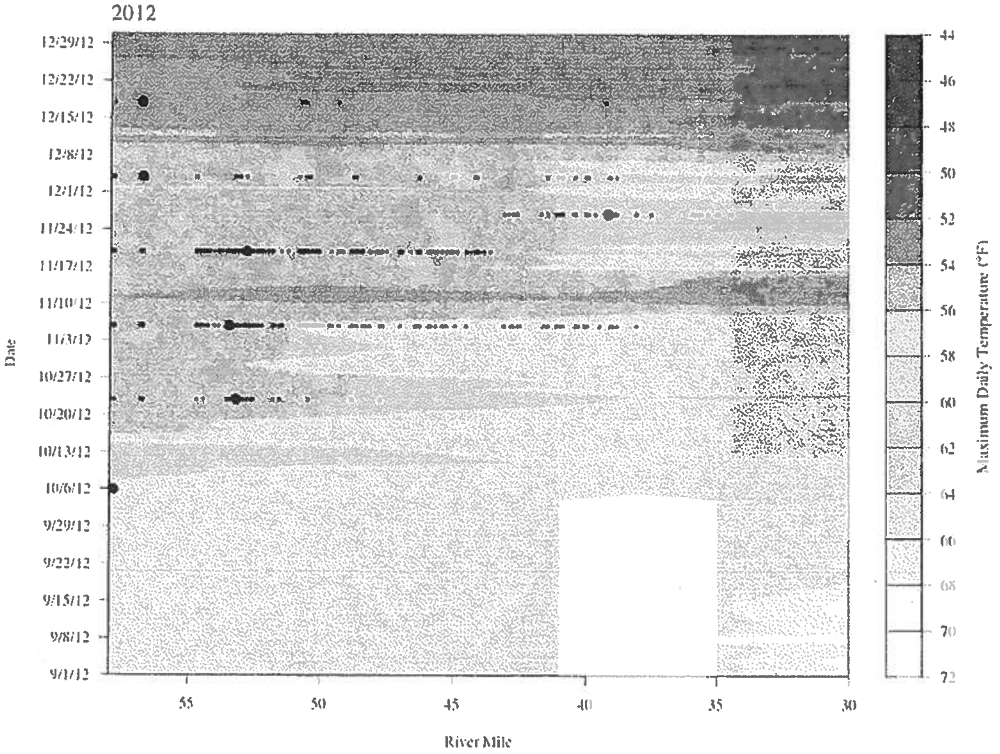


Figure 5. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2012. Water year type in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

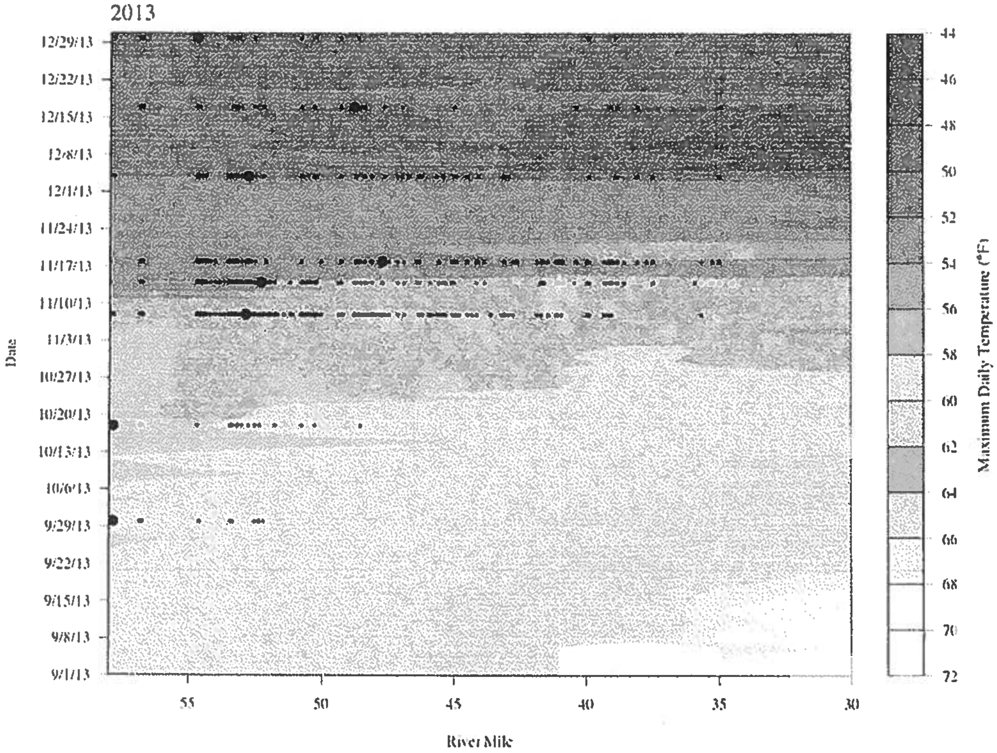


Figure 6. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2013. Water year type in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

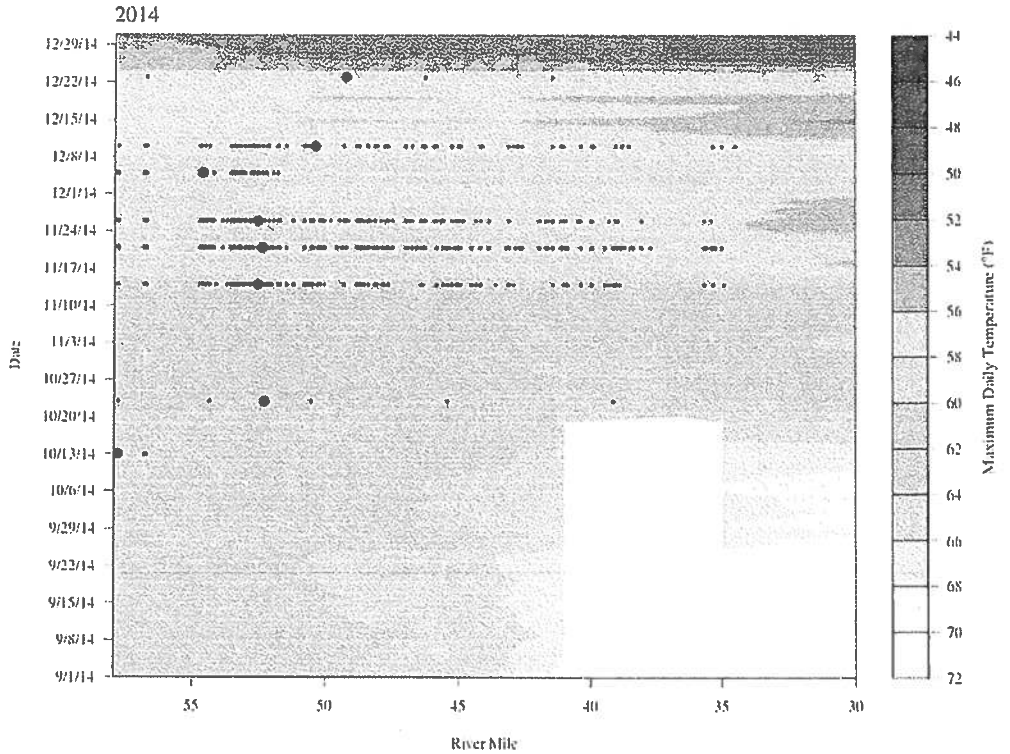
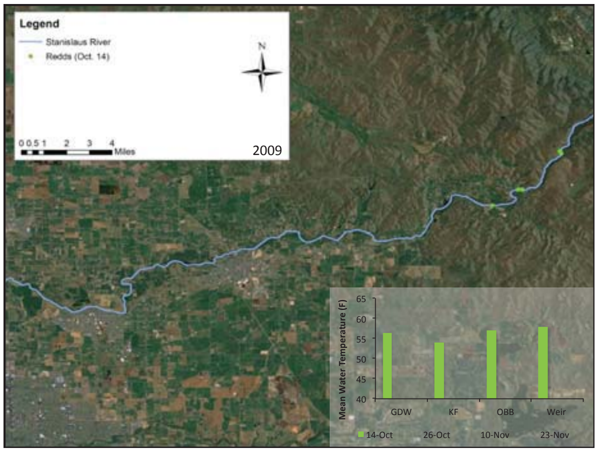
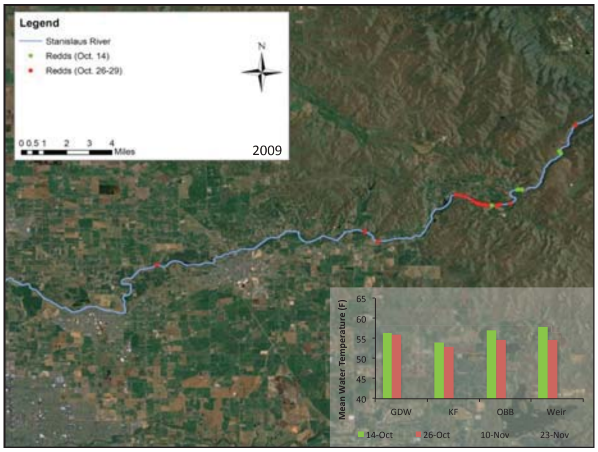
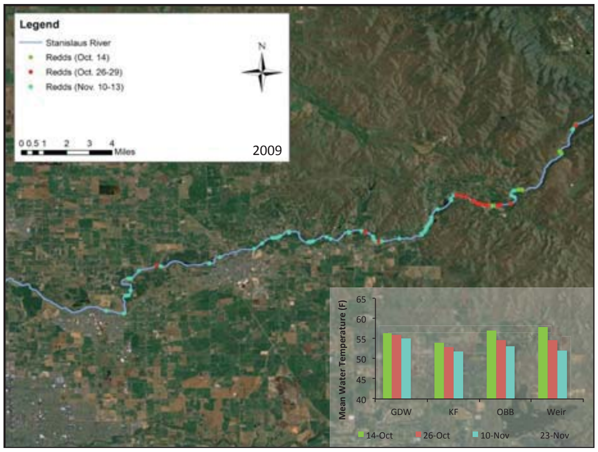
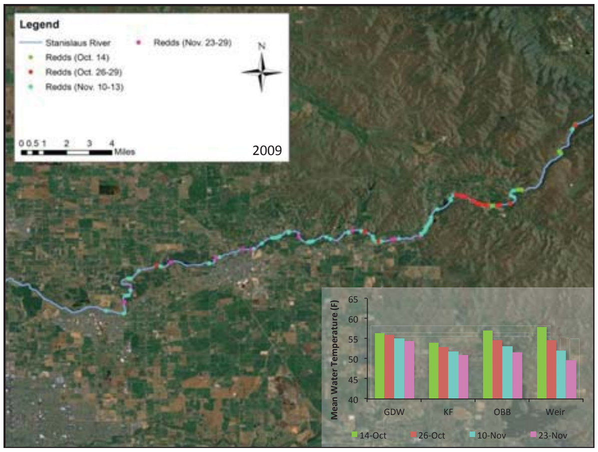


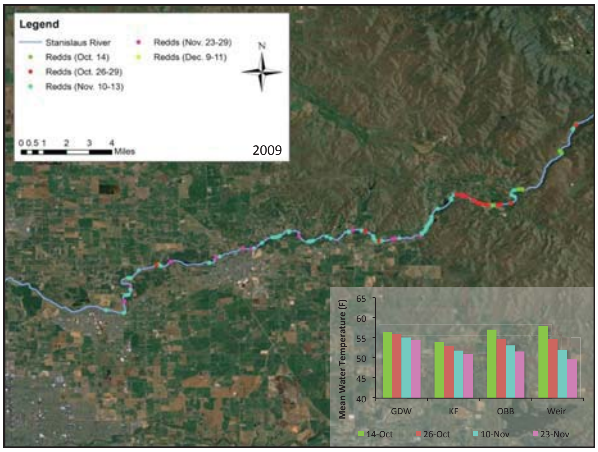
Figure 7. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2014. Water year type in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

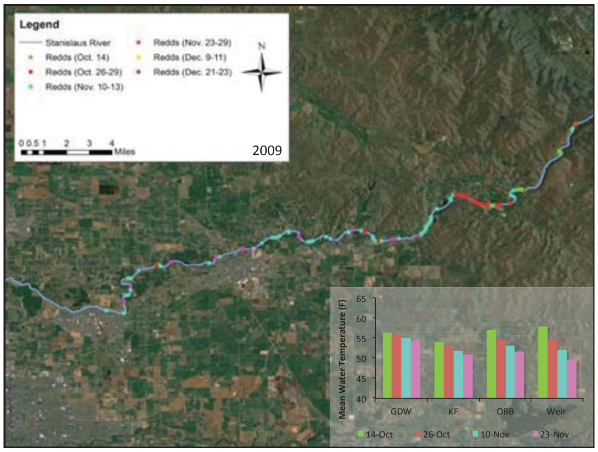

Legend
Stanislaus River
Redds (Oct. 14)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

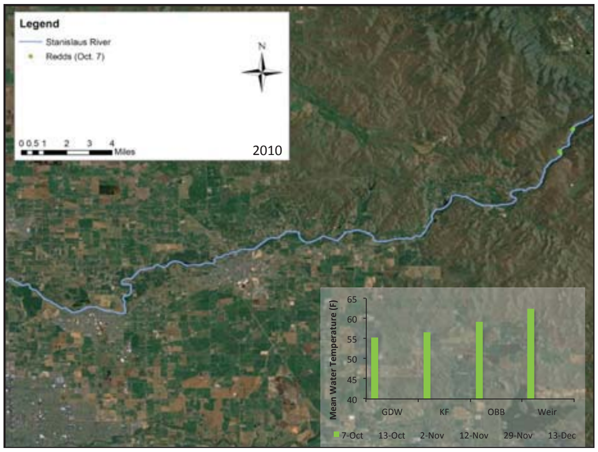

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

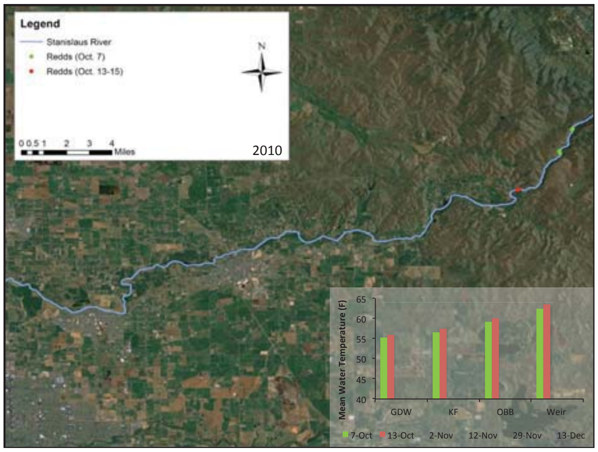

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

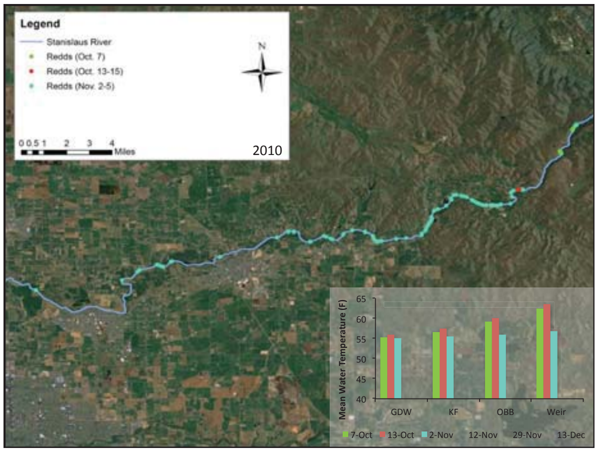

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

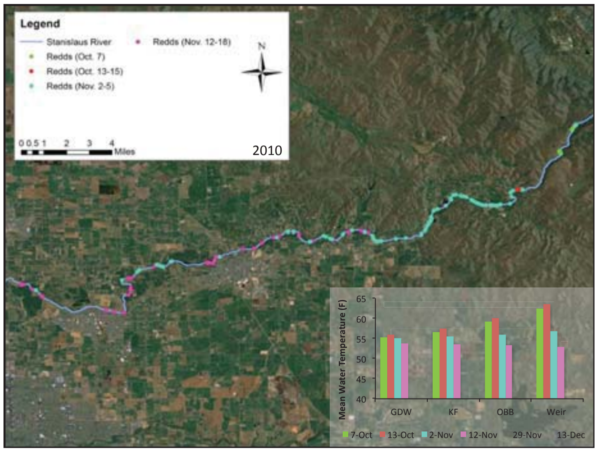

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
Redds (Dec. 9-11)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

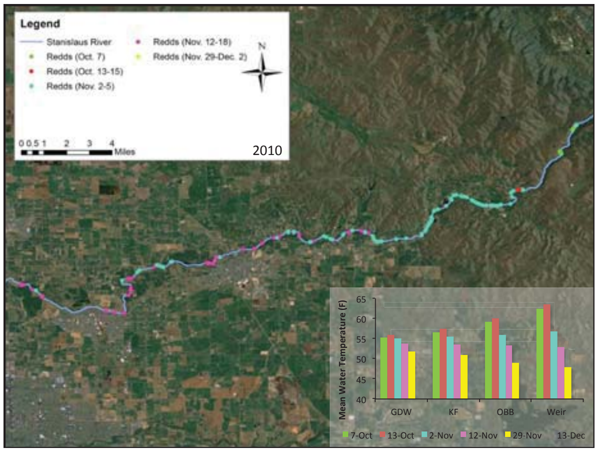

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
Redds (Dec. 9-11)
Redds (Dec. 21-23)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

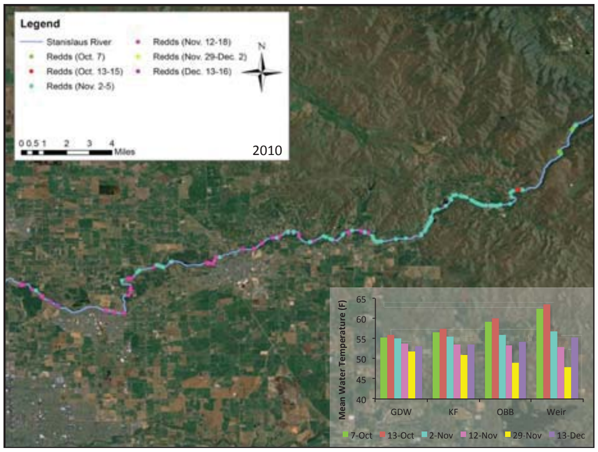

Legend
Stanislaus River
Redds (Oct. 7)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

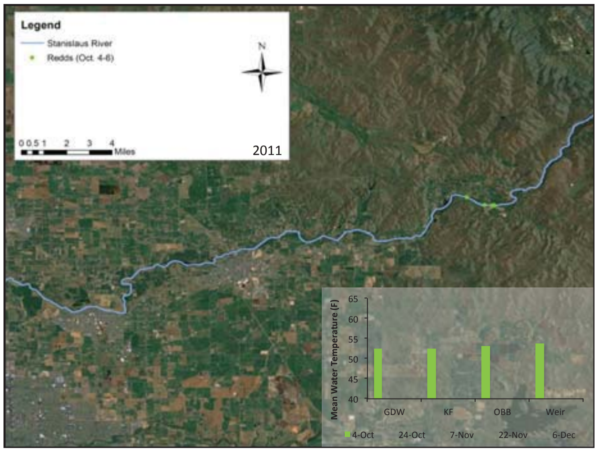

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

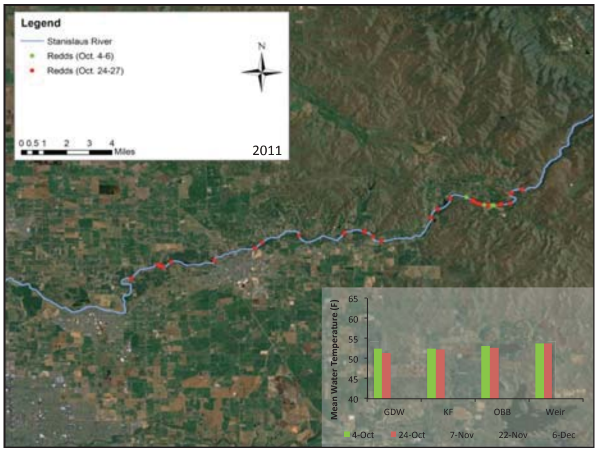

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

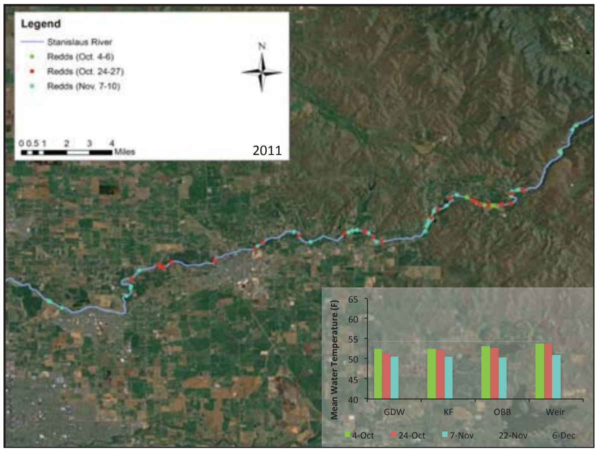

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

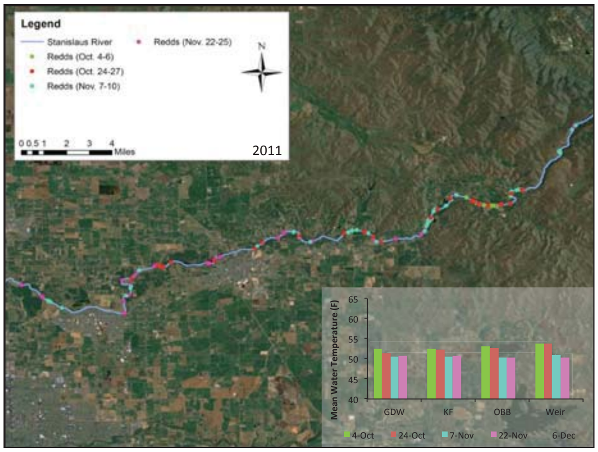

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
Redds (Nov. 29-Dec. 2)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

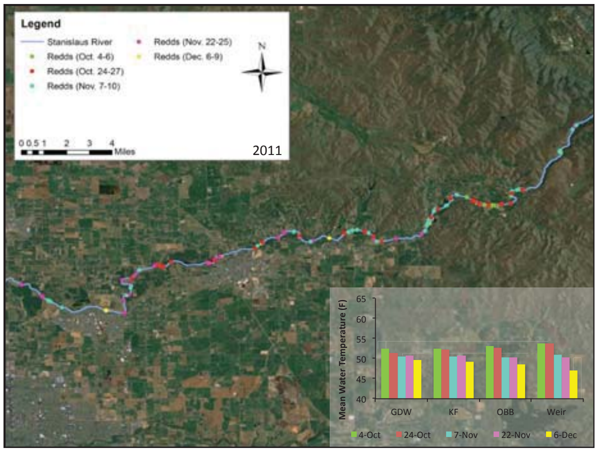

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
Redds (Nov. 29-Dec. 2)
Redds (Dec. 13-16)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec

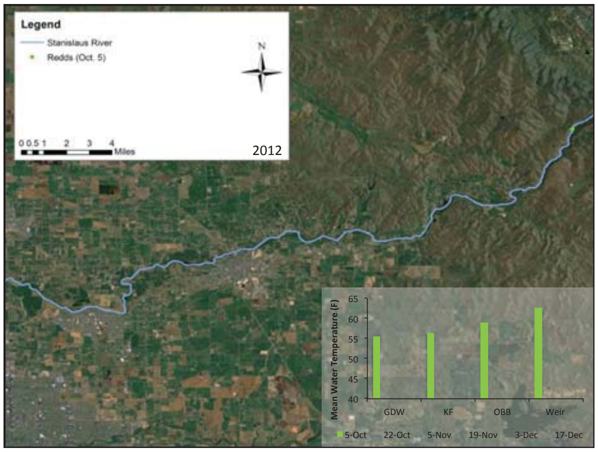

Legend
Stanislaus River
Redds (Oct. 4-6)
N
0 0.5 1 2 3 4 Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

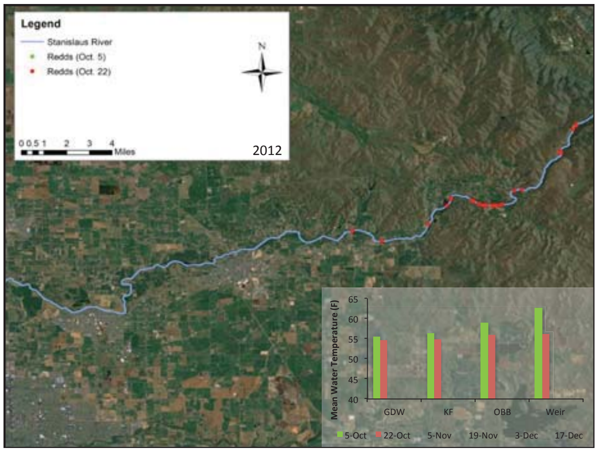

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
N
0 0.5 1 2 3 4 Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

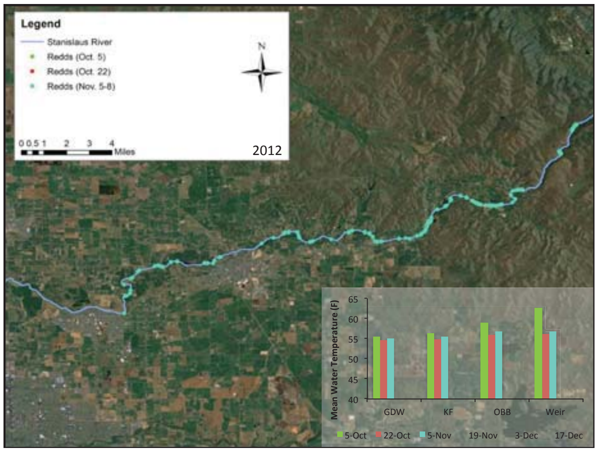

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
Redds (Nov. 7-10)
N
0 0.5 1 2 3 4 Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

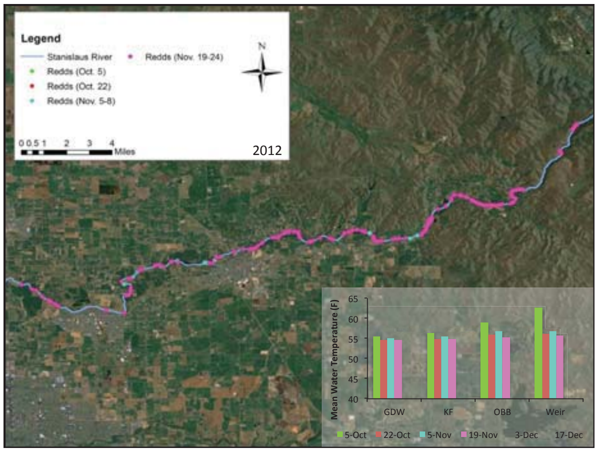

Legend
Stanislaus River
Redds (Nov. 22-25)
Redds (Oct. 4-6)
Redds (Oct. 24-27)
Redds (Nov. 7-10)
N
0 0.5 1 2 3 4 Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

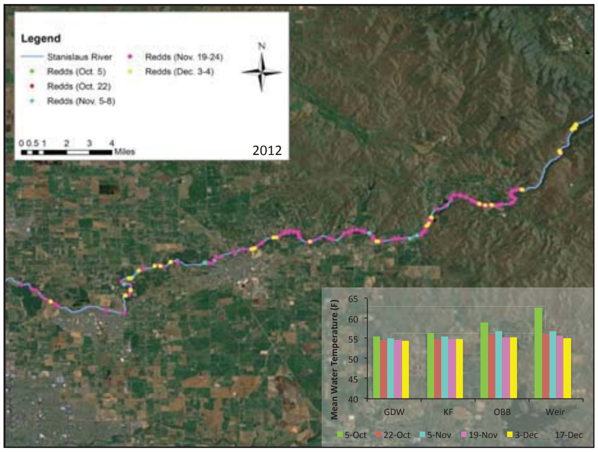

Legend
Stanislaus River
Redds (Oct. 4-6)
Redds (Oct. 24-27)
Redds (Nov. 7-10)
Redds (Nov. 22-25)
Redds (Dec. 6-9)
N
0 0.5 1 2 3 4 Miles
2011
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
4-Oct
24-Oct
7-Nov
22-Nov
6-Dec

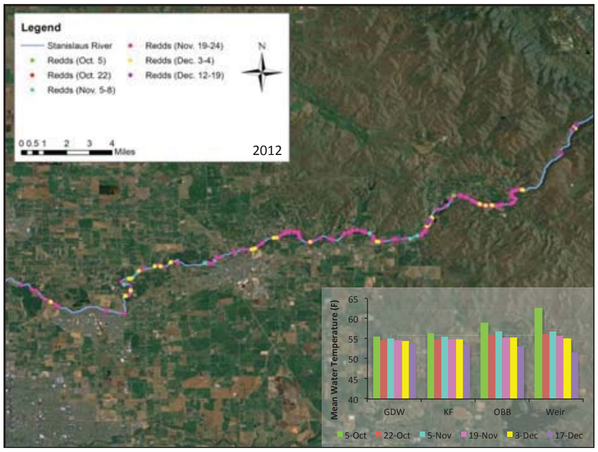

Legend
Stanislaus River
Redds (Oct. 5)
N
0 0.5 1 2 3 4 Miles
2012
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
5-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec


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
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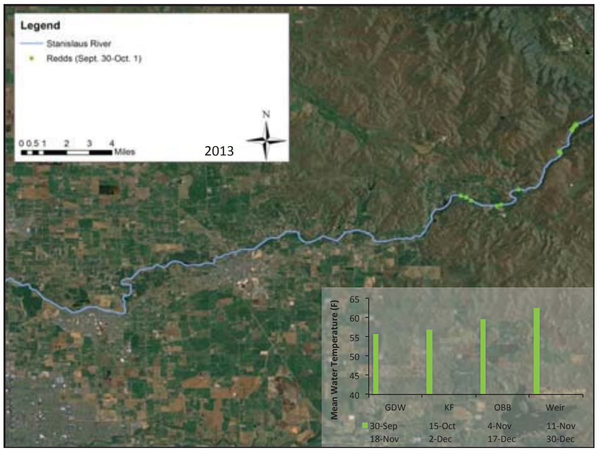
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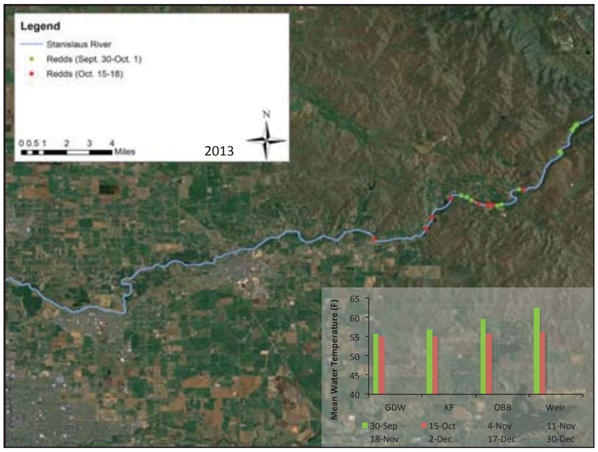
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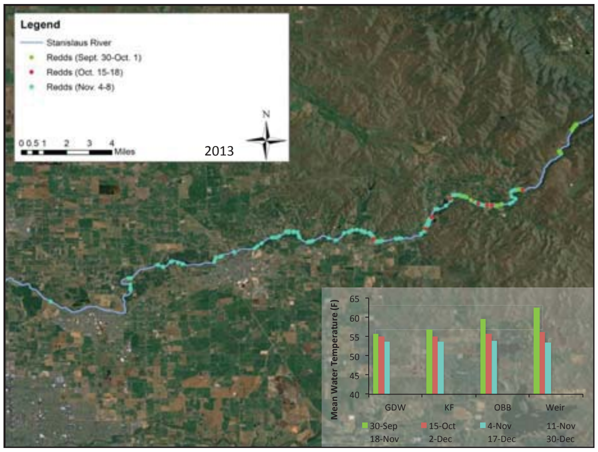
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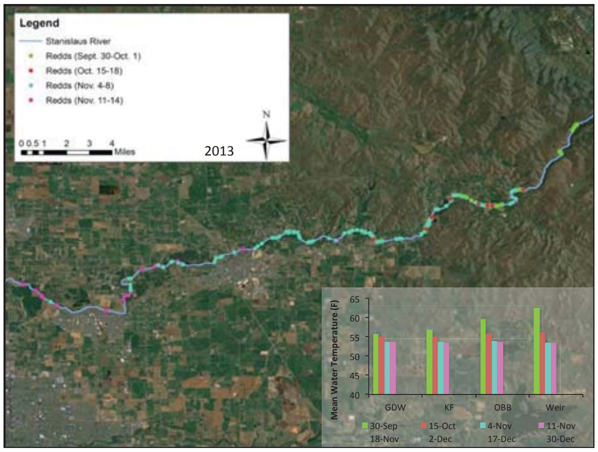
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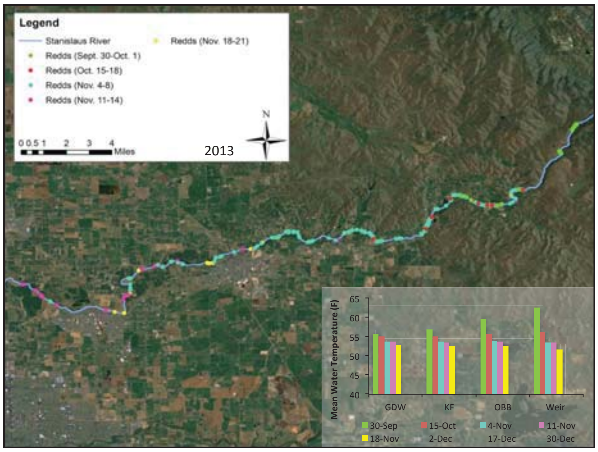
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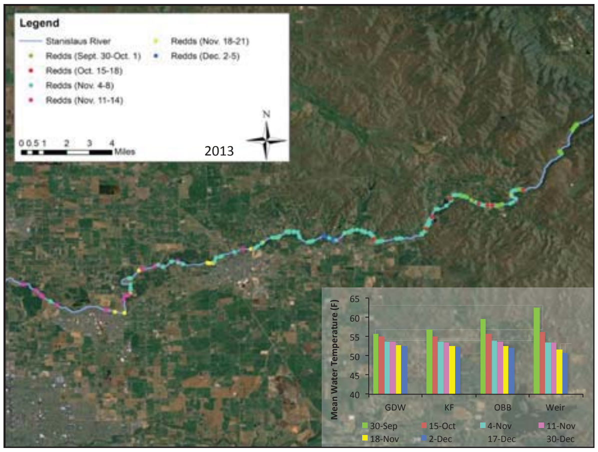
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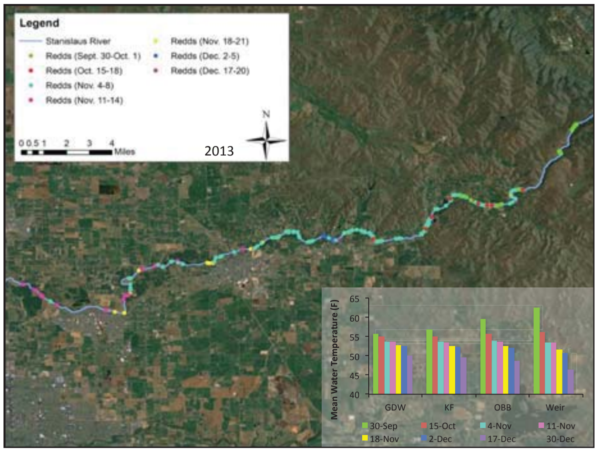
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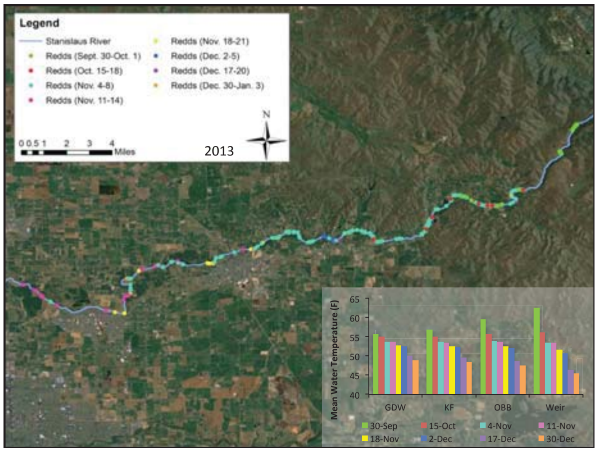
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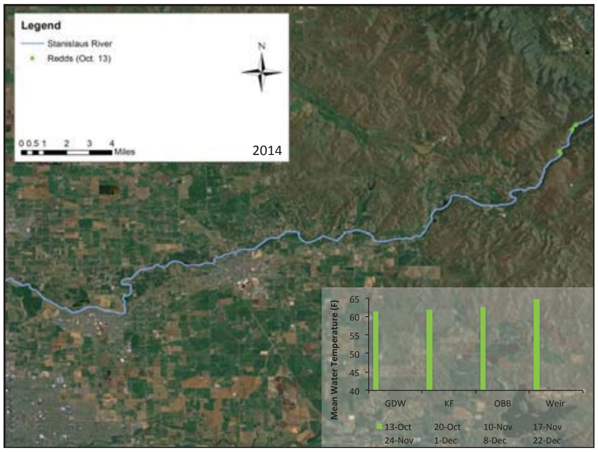
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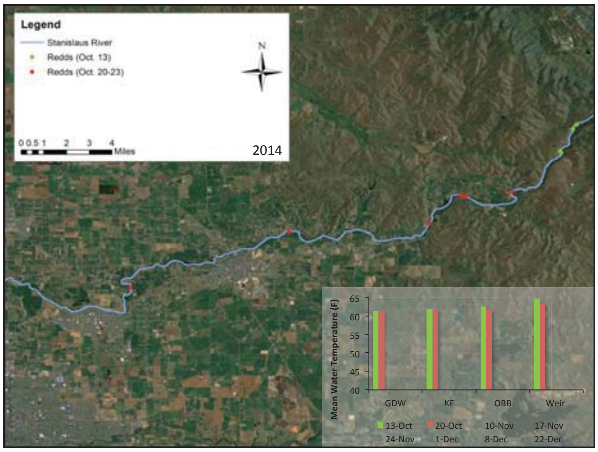
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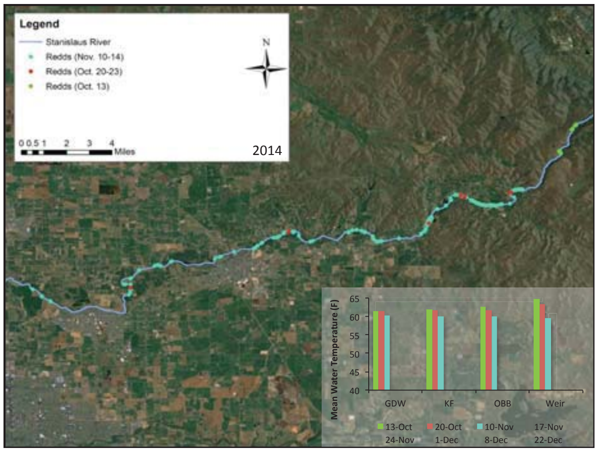
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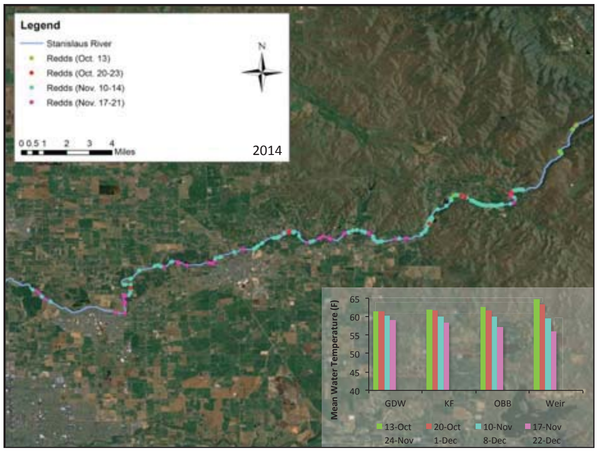
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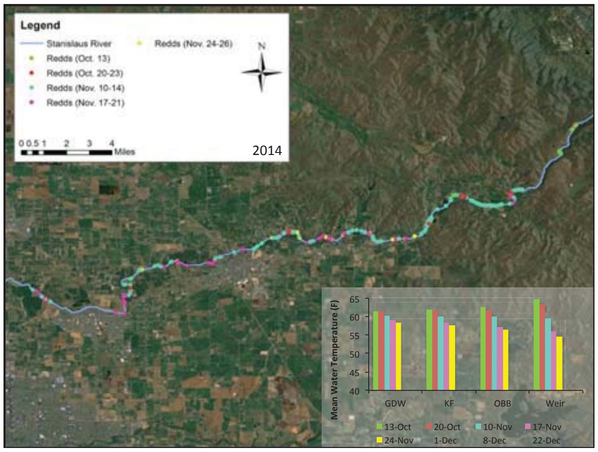
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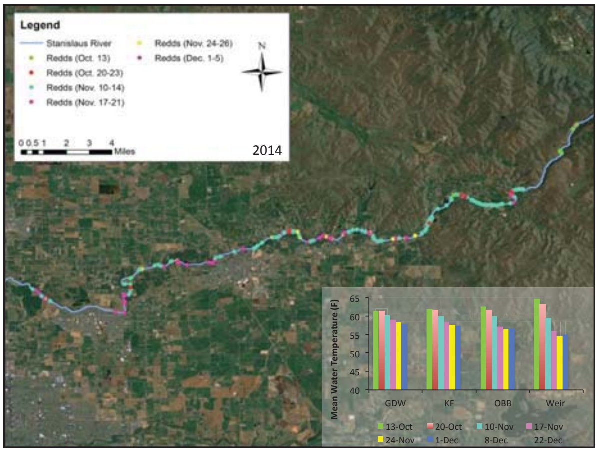
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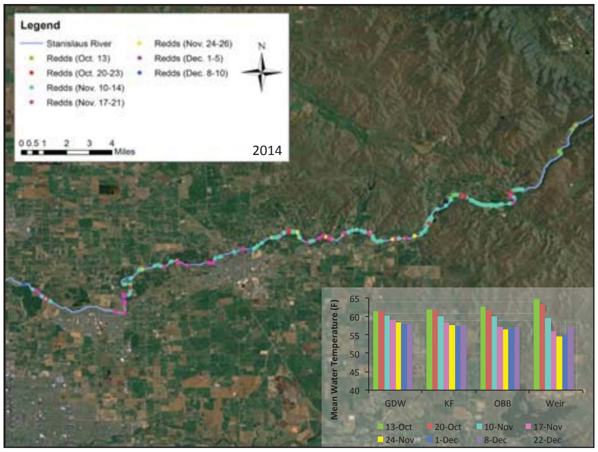
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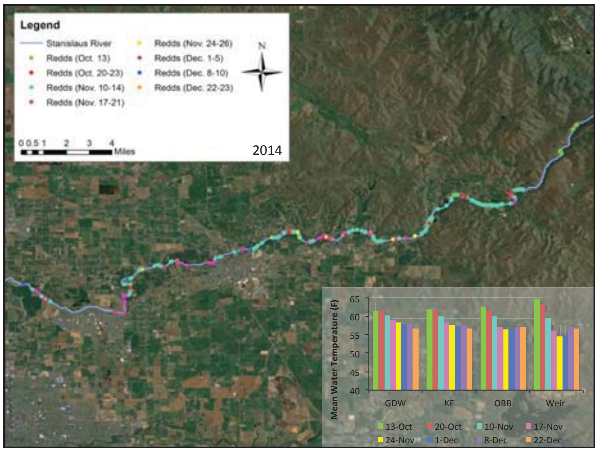
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ATTACHMENT B

Summary of Scientific Certainty Regarding San Joaquin Basin Chinook Salmon

Prepared for State Water Resources Control Board
Phase II Comprehensive Review Workshops
Workshop 2, “Bay-Delta Fisheries” to be held October 1-2, 2012

Prepared by
Doug Demko, Michael Hellmair, Matt Peterson, Shaara Ainsley,
Michele Palmer, and Andrea Fuller

On behalf of the
San Joaquin Tributaries Authority

September 14, 2012

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SPRING FLOWS

Scientific Certainty: High

- ***High, unmanaged spring flood flows (above 18,000 cfs), can increase smolt survival through the Delta.***
- ***Without the Head of Old River [Physical] Barrier in place, no significant relationship exists between spring flows in the managed range (below 7,000 cfs) and smolt survival through the Delta.***
- ***Flow related science relied upon by the SWRCB's Technical Report (2012) are flawed, have been discredited, are not the best available science, and should not be used as primary justification to modify flow objectives.***

Key Supporting Science

Existing scientific evidence does not support the conclusion that late winter and spring flow (February to June) in the San Joaquin River is the "primary limiting factor" to smolt survival and subsequent abundance.

- ➢ The VAMP independent scientific review panel determined that "simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta" (Dauble et al., 2010).
- ➢ NMFS (2009) states that "flows below approximately 5,000 cfs have a high level of variability in the adult escapement returning 2.5 years later, indicating that factors other than flow may be responsible for the variable escapement returns. Flows above approximately 5,000 to 6,000 cfs begin to take on a linear form and adult escapement increase in relation to flow."
- ➢ Baker and Morhardt 2001 indicates that there are no data points between 11,000-18,000 cfs, so there is no ability to identify a linear trend beginning at 5,000 cfs. Also, Baker and Morhardt (2001) state "when only the data below 10,000 cfs are considered, there appears to be a negative relationship between flow and smolt survival."
- ➢ "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable predation, appear to affect survival rates more than flow, by itself, and complicate the assessment of flow effects of on survival rates." (Dauble et al. 2010).
- ➢ Choice of emigration route may be more important to survival than flow (Perry et al. 2010).
- ➢ The VAMP Peer Review (Dauble et. al 2010) indicates that consideration should be given regarding the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook (i.e., life cycle model), including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta.

The SWRCB's Technical Report's (2012) conclusion that higher spring flows result in increased adult abundance is based almost exclusively on analyses that are flawed and have been discredited (e.g., DFG 2005, 2010a; Mesick et al 2007; Mesick 2009), as well as similar non-peer-reviewed analyses (e.g., various Mesick documents, AFRP 2005, TBI & NRDC 2010a-c).

- The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005, DFG 2010a) has been found to be flawed through both peer and professional reviews (Demko et. al 2010).
- Mesick, TBI & NRDC 2010a-c and AFRP 2005 references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model.
- At least two Mesick documents have been rejected previously by FERC (2009a-b) due to
    - the "fallacy of focusing entirely on flow" and failure to consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and
    - failing to consider other Central Valley populations, the effects of hatchery introductions on Tuolumne River Chinook salmon, and other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).
- No factors other than flow were investigated in a rigorous fashion in the models suggesting a causal relationship between spring flow and adult returns.
- Bay Delta Conservation Program and Delta Stewardship Council are not using these analyses and an independent review panel recently recommended that NMFS develop a life cycle model for CV salmonids to examine water management and Biological Opinion Reasonable and Prudent Actions (Rose et. al. 2011).

FLOODPLAIN

Scientific Certainty: High

- ***Floodplains with characteristics like those shown to provide benefits to Chinook salmon (i.e., large, continuous expanses of shallow-water habitat) cannot be created through managed flows in the San Joaquin Basin.***
- ***Juvenile steelhead are not are not likely to use floodplains and thus would not benefit from floodplain inundation, regardless of the season.***

Scientific Certainty: Deficient

- ***Benefits of floodplain habitat on Chinook abundance have not been quantified.***

Key Supporting Science

Floodplains in the San Joaquin Basin have different characteristics than the Yolo and Cosumnes and will not provide similar salmon growth and survival benefits.

- Floodplains in the Yolo and Cosumnes bypasses consist of virtually one large, continuous expanse of mostly shallow-water habitat; while the San Joaquin Basin consists of several disconnected, smaller areas of largely deep-water habitat (oxbow features). This deep-water habitat is similar to isolated pond habitats in the Yolo Bypass where alien fish dominate and no Chinook salmon were found (Feyrer et al. 2004).
- San Joaquin Basin inundation zones estimated by the cbec analysis (cbec 2010) represent the maximum area available under a range of flows, not the quality of that habitat for salmon (i.e., depth and velocities). Even though these estimates are a best-case scenario and include areas which would not be considered beneficial to rearing salmon (i.e., deep ox-bows), the total area is still dwarfed in comparison to the Yolo Bypass or Cosumnes Preserve.
- Growth differences between juveniles rearing in floodplains versus in-river were found after a two-week period (Jeffres et al. 2008). There is no data that supports the conclusion that similar benefits occur if rearing is less than a two-week inundation period.
- Increased growth on floodplains is likely related to several factors including warmer water temperatures resulting from shallower depths and greater surface area than found in-river, as well as lower velocities and better food sources (Sommer et al. 2001). Shallow water floodplain habitat is not prevalent in the San Joaquin Basin.

<u>Juvenile steelhead are not likely to use floodplains and thus would not benefit from floodplain inundation, regardless of the season.</u>

- Juvenile steelhead are not likely to use floodplains known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007).

<u>Floodplain rearing may help increase the size/weight of Chinook outmigrants, but has not been shown to increase the *abundance* of outmigrants or the *number of adult returns*.</u>

- No clear evidence that juvenile floodplain rearing increases adult recruitment.

<u>Floodplain inundation in the San Joaquin River tributaries only visually inferred from flow-area graphs by DFG (2010).</u>

- Wetted surface area increases more quickly between 3,000-5,000 cfs (Merced) and between 4,000-6,000 cfs (Tuolumne) indicating greater increases in width, which suggests bank overtopping or floodplain inundation; Stanislaus did not have a well-defined floodplain in the 100-10,000 cfs flow range examined (DFG 2010b, SWRCB Technical Report 2012).

<u>Tributary floodplain inundation thresholds exceed the SWRCB's Technical Report (2012) maximum monthly tributary target flows.</u>

- Maximum monthly target flows (i.e., median unimpaired) specified for each tributary in the SWRCB's Technical Report (2012) are 2,500 cfs for the Stanislaus River; 3,500 cfs for the Tuolumne River; and 2,000 cfs for the Merced River.
- Assuming minimum thresholds to begin inundating floodplains are 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River, all three of these minimums exceed the maximum flows proposed in the SWRCB's Technical Report (2012).

SWRCB's Technical Report (2012) emphasizes the need for creating more floodplain in the San Joaquin Basin through higher flows, but "floodplain habitat" is not defined nor quantified for the San Joaquin Basin.

- The attributes of "floodplain habitat," such as depth, velocity, cover, and water temperature, are not defined.
- No information/data is presented as to how much floodplain habitat exists in the San Joaquin Basin, how much could be gained at various flows, or what the benefit to Chinook salmon would be.

FLOW QUANTITY AND TIMING

Scientific Certainty: High

- ***Under specific conditions, salmon migration can be temporarily stimulated through flow management.***

Scientific Certainty: Deficient

- ***The benefit of temporary migratory stimulation on the survival of Chinook fry or smolts through the tributaries, lower San Joaquin River, and Delta is uncertain.***
- ***The importance of attraction flows to spawning migration and subsequent spawning success is uncertain.***

Key Supporting Science

Juvenile Chinook migration out of the upper tributaries is ***temporarily*** stimulated by changes in flow, but long duration pulse flows do not "flush" fish out of the tributaries.

- Juvenile Chinook migration can be stimulated by changes in flow, but the effect is short lived (few days) (Demko et al. 2001, 2000, 1996; Demko and Cramer 1995).

Higher flows increase fry (but not necessarily parr or smolt) survival in the tributaries; benefits to adult escapement are uncertain.

- Stanislaus River flows have a strong positive relationship with migration survival of Chinook fry, but weak associations with parr and smolt survival (Pyper and Justice 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data).
- Smolt survival indices in the San Joaquin River from the Merced River downstream to Mossdale indicate little relationship to flow (TID/MID 2007).
- The contribution of fry emigrants (Feb/March) to total salmon production in the San Joaquin Basin is uncertain (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).

<u>Fall flow pulses ***temporarily*** stimulate upstream migration of Chinook salmon into San Joaquin Basin tributaries, but no evidence that attraction flows are needed.</u>

- Prolonged, high-volume fall pulse flows are not warranted, since equivalent stimulation of adult migration may be achieved through modest pulses (Pyper and others 2006).
  - Relatively modest pulse-flow event (increase of ~200 cfs for 3 days) was found to stimulate migration, but only for a short duration (increased for 2-3 days).
- Migration rate and timing are not dependent upon flows, exports, water temperature or dissolved oxygen concentrations (Mesick 2001; Pyper and others 2006).
- No evidence that low flows (1,000 to 1,500 cfs) in the San Joaquin River are an impediment to migration (Mesick 2001).

<u>Flow does not explain low Delta survival of juvenile Chinook observed since 2003, so more flow is not likely the solution.</u>

- Flood flows of approximately 10,000 cfs and 25,000 cfs during outmigration in 2005 and 2006 did not increase survival near levels when flows were moderately high (5,700 cfs) in 2000 (SJRGA 2007b).
- Since recent smolt survival has been far lower than it was historically, models based on historical data are not representative of recent conditions and should not be used to predict future scenarios (VAMP Technical Team 2009).

WATER TEMPERATURE

<u>Scientific Certainty: High</u>

- ***Water temperatures in the San Joaquin River and South Delta are controlled by air temperatures.***
- ***Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.***
- ***San Joaquin River restoration flows will adversely affect water temperatures from the confluence of the Merced River downstream.***

Scientific Certainty: Deficient

- ***Salmon and steelhead survival benefits of releasing large quantities of water to decrease water temperatures in the tributaries are uncertain.***

Key Supporting Science

The dominant factor influencing water temperature is ambient air temperatures, not flow.

- Ambient air temperature is the primary factor affecting water temperature; by the end of May, water temperatures at Vernalis range between 65°F and 70°F regardless of flow levels between 3,000 cfs and 30,000 cfs. (SRFG 2004)

There is no evidence that water temperatures are unsuitable for adult Chinook upstream migration

- DFG demonstrated that pre-spawn mortality is quite low (i.e., 0%-4.5%) and appears to be density, not water temperature, dependent (Guignard 2005 through 2008).
- No associations between adult migration timing and conditions for water temperature, dissolved oxygen (DO), or turbidity (Pyper et. al 2006; Mesick 2001).
- San Francisco Bay water temperatures over 65°F in September when fish are migrating (CDEC; various stations) and water temperatures at Rough and Ready Island (RRI) are typically above 70°F during early migration season.

There is no evidence that water temperatures for juvenile rearing and migration need to be colder or maintained through June.

- Nearly all juvenile Chinook migrate prior to May 15, and <1% migrate after May 31, except in wet and above normal water years. 90-99% of non ad-clipped salvaged *O. mykiss* are encountered between January and May depending on water year type.
- Existing 7 Day Average Daily Maximum water temperatures are generally ≤68ºF (20°C) in the San Joaquin River and the eastside tributaries through May 15.

The restoration of the San Joaquin River upstream of the Merced River (San Joaquin River Restoration Program; SJRRP) will adversely affect water temperatures in the lower San Joaquin River during the spring and fall.

- The lower San Joaquin River downstream of the Merced River confluence is identified as temperature impaired (USEPA 2010). According to water temperature modeling conducted by AD Consultants, SJRRP flows will be the same as the ambient temperature (SJRGA 2007a).

Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.

- Increasing flows from the tributaries will not decrease water temperatures in the mainstem San Joaquin River downstream of the Merced confluence (SJRGA 2007a).

DISSOLVED OXYGEN

Scientific Certainty: High

- ***Low dissolved oxygen concentrations are limited to the DWSC and are the result of anthropogenic manipulation of channel geometry.***
- ***Existing DO concentrations do not impact salmon and steelhead migration.***

Key Supporting Science

Low dissolved oxygen (DO) concentrations are limited to the Deep Water Ship Channel (DWSC), and are the result of anthropogenic manipulation of channel geometry.

- The eastside rivers (Tuolumne, Stanislaus and Merced) discharge high-quality Sierra Nevada water which has low planktonic algal content and oxygen demand, and are not a major source of oxygen demand contributing to the low DO problem in the DWSC (Lee and Jones-Lee 2003).
- DO concentrations in the DWSC can be ameliorated by installation of the Head of Old River Barrier (Brunell et al. 2010).

Existing DO concentrations do not impact salmon and steelhead migration.

- Contrary to Hallock et al. (1970) indicating adult migration is prevented under low DO, migration has been observed at DO < 5mg/L (Pyper and others 2006). Adult upstream migration rate and timing is not dependent on DO concentrations (Pyper and others 2006).
- Smolt survival experiments indicate that juvenile salmon survival is not correlated with existing DO concentrations (SRFG 2004; SJRGA 2002 and 2003). Salmon and steelhead migrate in the upper portion of the water column where DO concentrations are highest (Lee & Jones-Lee 2003).

FOOD

Scientific Certainty: High

- ***Salmon and steelhead are not impaired by food availability in the San Joaquin Basin.***
- ***Projected food production from inundated areas will be realized in short inundation periods.***

Key Supporting Science

Out-migrating Chinook smolts are not food-limited during their 3-15 day migration through the lower San Joaquin River below Vernalis and the South Delta.

- The SWRCB's Technical Report (2012) provides evidence that, in other systems, unregulated rivers have more and better food resources than regulated rivers. However, the report does not provide any evidence that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state.
- Based on acoustic VAMP studies in 2008, Holbrook et al. (2009) found that smolts took 3-15 days (median 6-9 days) for migration through the lower San Joaquin River and South Delta, therefore the demand for food production over such a short duration is questionable.
- Increases in primary and secondary production due to restoration or changes in management likely occur over longer periods of time, rather than by short-term pulse flows.

CONTAMINANTS

Scientific Certainty: Moderate

- ***Influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increase in others.***
- ***Providing a percent of unimpaired flows may increase contaminant concentrations.***

Key Supporting Science

No evidence supports the idea that higher inflows reduce contaminant concentrations.

- The SWRCB's Technical Report (2012, p. 3-29) states, "Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and ***reducing contaminant concentrations***" but does not provide any references or further discussion to support this statement.
- The SWRCB's Technical Report (2012) may infer that higher flows act to dilute suspended contaminants. However, the influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increases may occur in others.

Unimpaired flows may increase contaminant concentrations.

- High flows can increase contaminant concentrations through resuspension of contaminants in sediments (McBain and Trush, Inc 2002). These resuspended contaminants can enter the food web and have longer residence times in rivers and estuaries than water (Bergamaschi et al. 1997).
- Pesticides and herbicides were found in every sample of surface water sites along the

San Joaquin River and in the Old River before, during and after the VAMP month-long pulse flow and some contaminants increased throughout these three periods (Orlando and Kuivila 2005).

- "Perhaps the greatest risks to potential restoration actions within the San Joaquin River study reaches relate to uncertainties regarding remobilization of past deposits of […] pesticides, i.e., DDT and mercury" (McBain and Trush 2002).

TRANSPORT OF SEDIMENTS, BIOTA AND NUTRIENTS

Scientific Certainty: High

- ***Transport of sediment, biota, and nutrients benefits are closely linked to the availability and connectivity of floodplain habitat, and cannot be expected in a highly modified system such as the San Joaquin Basin.***

Key Supporting Science

Transport benefits from floodplain habitat are not realized in the South Delta and lower San Joaquin River because the majority of the floodplain in the lower San Joaquin River has been eliminated or is isolated behind levees.

- Transport of sediment, biota, and nutrients is directly related to the floodplains of a river-floodplain complex, which has nearly been eliminated from the lower San Joaquin River and its tributaries (cbec 2010; Williams 2006).
- "[F]ormer floodplains now behind manmade levees will remain isolated from the river, assuming no long-term changes in flood stages or flood protection policy" (Junk et al. 1989).
- "In unaltered large river systems with floodplains […], the overwhelming bulk of the riverine animal biomass derives directly or indirectly from production within the floodplains and not from downstream transport of organic matter produced elsewhere in the basin" (Junk et al. 1989).
- The FPC focuses on the lateral exchange of water, nutrients and organisms between the river channel and the connected floodplain. The floodplain is considered as an integral part of the system (Junk and Wantzen 2003).

Transport of sediment, biota, and nutrients differs between the large river-floodplain systems described by Junk et al. (1989) and the anthropogenic, leveed river channels of the South Delta.

- Under natural conditions, sediments would be downstream from upper tributaries, but dams limit natural sediment inputs such as gravels (Schoellhamer et al. 2007).
- Human activities (mining, urbanization and agriculture) have increased erosion and the supply of fine river sediments (Schoellhamer et al. 2007).
- Schoellhamer et al. (2007) states that the present day modified system, "would tend to

transport more sediment to the Delta because 1) the flood basins were a sink for fine sediments, and 2) the leveed channels will experience greater bed shear stress because more flow is kept in the channel. . . It follows that levee setbacks and floodplain restoration would tend to decrease sediment supply to the Delta by promoting floodplain deposition along upstream reaches."

- ➢ Sediment inputs into the South Delta from the San Joaquin River are the result of increases in suspended sediments from run-off events and are generally not associated with managed flow pulses (SJRG 2004).

VELOCITY

Scientific Certainty: High

- ***No significant relationship exists between mean smolt migration time and San Joaquin River flow.***

Key Supporting Science

No evidence that higher spring flows "facilitate transport."

- ➢ The SWRCB's Technical Report (2012) did not define "facilitate transport so it is unclear by what mechanisms spring flows may facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level, duration, turbidity, etc. The SWRCB's Technical Report (2012) may be suggesting that increased flows result in increased ***velocity***, which may lead to decreased juvenile salmonid travel time through the region, thus 'facilitating transport'.

"It seems intuitively reasonable that increased flows entering the Delta from the San Joaquin River at Vernalis would decrease travel times and speed passage, with concomitant benefits to survival. The data, however, show otherwise" (Baker and Morhardt 2001).

- ➢ No significant relationships at the 95% confidence level between mean smolt migration times from three locations (one above and two below the HORB to Chipps Island) and San Joaquin River flow (average for the seven days following release), but
- ➢ Smolt migration rate increases with **size** of released smolts (Baker and Morhardt 2001).

Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998).

- ➢ Movements of juvenile salmonids depend on their species and size, water temperature and local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

- Baker and Morhardt (2001) provide an example of a study which compared the speed of smolt passage to that of tracer particles (particle tracking model - PTM), "in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months."
- Chinook released at Mossdale traveled to Chipps Island 3.5 times faster than the modeled particles (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

Results from VAMP studies (using acoustic tags) have generally shown short travel times between reaches, suggesting active swimming.

- In 2009, mean travel times were reported for each reach, and all were under 2.5 days (SJRGA 2009).

Increased flows may slightly increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.

- Velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs San Joaquin River flow, but additional flow provides little to no change IN velocity (<0.5 ft/s) at other stations in the South Delta (Paulsen et al. 2008).

PHYSICAL HABITAT

Scientific Certainty: High

- ***Physical habitat has been substantially reduced by non-flow measures (e.g., land reclamation activities, levees).***
- ***Shallow water rearing habitat (important for almost all native fish), has virtually been eliminated from the Delta.***
- ***Restoring the Delta and mainstem San Joaquin River shallow water habitat cannot be accomplished through flow management.***
- ***Non-native species thrive in the highly altered San Joaquin Basin.***

Key Supporting Science

Physical habitat for San Joaquin Basin and Delta native fishes has been substantially reduced and altered.

- Diverse habitats historically available in the Delta have been simplified and reduced by development of the watershed (Lindley et al. 2009).
- Spawning and rearing habitat have been severely reduced, total abundance and salmon diversity reduced from past alterations (McEvoy, 1986; Yoshiyama et al., 1998, 2001; Williams 2006).
- Major change in system is loss of shallow rearing habitat (Lindley et al. 2009).
- 95% of wetlands/floodplains lost to levee construction and agricultural conversion since the mid 1800s (TBI 2003, Williams 2006).
- Only ~10% of historical riparian habitat remains, with half of the remaining acreage

disturbed or degraded (Katibah 1984).

- Shallow water habitats are essentially non-existent since the "current configuration of largely rip-rapped, trapezoidal channels in the Delta provides little habitat for covered species and contributes to a high degree of predation." (Essex 2009).

Levees and off-channel oxbows restrict ability to create shallow water habitat with increased flows.

- The primary purpose of levees is to provide flood protection and prevent high flows from entering adjacent floodplains. There are approximately 443 miles of levees in the lower San Joaquin River downstream of the Stanislaus River confluence and South Delta.
- Inundation of off-channel oxbows creates deep water instead of shallow water habitat.

Habitat alterations are linked with invasive species expansions.

- *Egeria densa* (Brazilian waterweed) expansion has increased habitat and abundance of largemouth bass and other invasive predators (Baxter et al. 2008).
- Current habitat structure benefits exotic predators more than natives (Brown 2003).

Habitat influences growth, survival and reproduction.

- Estuaries provide important rearing habitat for Chinook; salmon fry in Delta grew faster than in river (Healey 1991, Kjelson et al. 1982).
- Shallow water habitats support high growth of juvenile Chinook (Sommer et al. 2001; Jeffres et al. 2008; Maslin et al. 1997, 1998, 1999; Moore 1997). However, as mentioned above, there is little presently available.

Water quality aspect of habitat is highly variable.

- Variability in habitat likely causes regional differences in relationship between Delta smelt abundance and water quality (Baxter et al. 2008).
- Reduced pumping lowered salinity in Western Delta (as desired), but led (unexpected) result of increased salinity in Central Delta (Monsen et al. 2007).

Improving habitat for increased abundance of native fishes.

- Habitat quantity, quality, spatial distribution and diversity must be improved to promote life history diversity that will increase resilience and stability of salmon populations (Lindley et al. 2009).

GEOMORPHOLOGY

Scientific Certainty: High

- ***Managed flow range is insufficient to provide channel mobilizing flows in the San Joaquin River Basin.***
- ***In leveed systems, true channel mobilization flows are not possible because of flood control.***

Scientific Certainty: Deficient

- ***Releasing large quantities of water for channel mobilizing flows in the tributaries for uncertain benefits to salmon and steelhead.***

Key Supporting Science

Under natural conditions, channel formation and maintenance is directly influenced and modified by flow; however, the morphology of leveed rivers cannot be modified by flow (Jacobson and Galat 2006).

- The "five critical components of the ["natural," i.e., unaltered by humans] flow regime that regulate ecological processes in river ecosystems are the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (Poff et al. 1997, Poff and Ward 1989, Richter et al. 1996, Walker et al.1995).
- In [a highly modified] a system, flow-related factors like timing of floods, water temperature, and turbidity may be managed; but, in absence of a "naturalized morphology, or flow capable of maintaining channel-forming processes, the hydrologic pulses will not be realized in habitat availability."

Due to land use changes, higher flows do not necessarily provide the channel maintenance that would occur under natural conditions.

- In leveed systems, true channel mobilization flows are not possible because of flood control. In fact, higher flows can result in increased detrimental incision in upstream tributary areas (like the Stanislaus River) where existing riparian encroachment is armored and cannot be removed by high flow events, limiting "river migration and sediment transport processes" (Kondolf et al. 2001, page 39).
- Urban and agricultural developments have encroached down to the 8,000 cfs line, "effectively limiting the highest flows to no more than the allowable flood control" (i.e., 8,000 cfs, Kondolf et al. 2001).
- Where flood pulses are not available to provide maintenance of channel habitat, "mimicking certain geomorphic processes may provide some ecological benefits" (Poff et al. 1997) [e.g., gravel augmentation, stimulate recruitment of riparian trees like cottonwoods with irrigation].

In the absence of floodplain connectivity, the functions attributed to higher "pulse flows" cannot be achieved.

- Historically, the San Joaquin River was a channel connected with its floodplain. Flood pulses in the winter and spring would have provided the beneficial functions of floodplains identified by Junk et al. (1989) and by Junk and Wantzen (2003). However, anthropomorphic changes in the lower river (e.g., levees), particularly below Vernalis (the focus of the 2012 Technical Report), have substantially reduced this floodplain connectivity and the region can no longer be considered a "large river-floodplain system."

HEAD OF OLD RIVER BARRIER

Scientific Certainty: High

- ***Salmon smolt survival can be increased through installation of the Head of Old River Barrier (HORB).***

Key Supporting Science

Operation of a rock barrier at the Head of Old River improves salmon smolt survival through the Delta by 16-61% (Newman 2008).

- HORB reduces entrainment into Old River from more than 58% to less than 1.5%.
- Physical (rock) HORB increases San Joaquin River flow.
- Installation of the HORB doubles through-Delta survival by directing juvenile salmonids through the San Joaquin River mainstem (compared to the Old River route, NMFS 2012).

In the absence of a rock barrier at the Head of Old River, a statistically significant relationship between San Joaquin River flow and salmon survival does not exist (Newman 2008).

- HORB cannot be installed or operated during high flow events
  - Temporary rock barrier requires flows less than 5,000 cfs for installation and flows less than 7,000 cfs for operation (SJRTC 2008).

Head of Old River Barrier Predation and "Hot Spots".

- Mean predation rate at HORB was 27.5% in 2009 and 23.5% in 2010.
- 2007 telemetry tracking found that 20% of released fish were potentially consumed by predators at three "hot spots": Stockton Water Treatment Plant, Tracy Fish Facility trashracks and Old River / San Joaquin River split.

PREDATION

Scientific Certainty: High

- ***Predation by non-native species (especially striped bass)) is a major impediment to salmon smolt survival through the lower San Joaquin River and Delta more than river flow.***
- ***Evidence from other basins (i.e., Columbia) indicates that predation can be easily and cost-effectively reduced.***

Key Supporting Science

The VAMP review panel concluded that "high and likely highly variable impacts of predation appear to affect survival rates more than the river flow" (Dauble et al. 2010).

- ➢ All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the Central Valley and recovery will not occur without significant reduction in their populations and/or predation rates (DFG 2011).

Recent San Joaquin Basin VAMP studies conducted from 2006–2010 provide direct evidence of high predation rates on Chinook salmon in the lower San Joaquin River and South Delta.

- ➢ In 2007, 20% of released fish were potentially consumed by predators at three "hotspots" (Stockton Treatment Plant, Tracy Fish Facility trashracks, and the HOR).
- ➢ In 2009, mortality rates (likely due to predation) between Durham Ferry and the HOR ranged from 25.2% to 61.6% (mean 40.8%), and predation rates at HOR ranged from 11.8% to 40% (mean 27.5) (Bowen et al. 2009).
- ➢ In 2010, mortality rates (likely due to predation) between Durham Ferry and the HOR ranged from 2.8% to 20.5% (mean 7.8%) and predation rates at HOR ranged from 17% to 37% (mean 23.5%) (Bowen and Bark 2010).

Reducing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival.

- ➢ High predation occurs at "hot spots," which can be the focus of a control program.
- ➢ Encouraging increased angling pressure on salmonid predators has successfully increased the number of adult returns in other basins on the West Coast (Radtke et al. 2004).
- ➢ Columbia River predator suppression program has cut predation on juvenile salmonids by 36% (Porter 2011).
- ➢ California Fish and Game Commission (CFGC 2012) rejected DFG's recommendation to amend striped bass sport fishing regulations, which included increasing bag limits and decreasing size limits.

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ATTACHMENT C

Review of Scientific Information Pertaining to SWRCB's February 2012 Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives

Prepared for State Water Resources Control Board
Phase II Comprehensive Review Workshops
Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012

Prepared by

Doug Demko, Michael Hellmair, Matt Peterson, Shaara Ainsley,
Michele Palmer, and Andrea Fuller

On behalf of the
San Joaquin Tributaries Authority

September 14, 2012

1. SPRING FLOWS

Overview

Increasing spring flows in the San Joaquin River (SJR) basin is one of the main goals in Section 3 of the February 2012 SJR Flow and Southern Delta Salinity Technical Report (SWRCB Technical Report 2012). Justifications for the increased flows are based on research conducted by Dr. Carl Mesick, California Department of Fish and Game (DFG; largely based on Mesick research), Anadromous Fish Restoration Program (AFRP; again largely based on Mesick research), The Bay Institute/ Natural Resources Defense Council (TBI/NRDC 2010a-c), and a variety of survival studies conducted from the early 1980s to 2010. Increased spring flows (occurring in the months of February through June) are thought to be the main factor influencing juvenile Chinook salmon (*Oncorhynchus tshawytscha*) survival and subsequent adult spawning abundance.

Research investigating the relationship between flows in the SJR, the Sacramento-San Joaquin Delta (Delta) and various aspects of Chinook salmon life history (e.g. smolt survival, escapement) has been conducted for nearly 35 years. Much of the research has been inconclusive and early studies are well summarized by Baker and Morhardt (2001) and more recently by the Vernalis Adaptive Management Program (VAMP) independent review panel (Dauble et al. 2010). Some key points from Dauble et al. (2010, pages 3 and 4) are:

- "Panel members are in agreement that simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta over time."
- "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow, by itself, and greatly complicate the assessment of effects of flow on survival rates of smolts."
- "Apparent downstream migration survival of juvenile Chinook salmon was very poor during 2005 and 2006 even though Vernalis flows were unusually high (10,390 cfs and 26,020 cfs, respectively). These recent data serve as an important indicator that high Vernalis flow, *by itself*, cannot guarantee strong downstream migrant survival."
- "Although some positive statistical associations between San Joaquin River flow and salmon survival have been identified, there is also very large variation in the estimated survival rates at specific flow levels and there is a disturbing temporal trend to reduced survival rates at all flows. This large variability and associated temporal decline in survival rates strongly supports a conclusion that survival is a function of a complex set of factors, of which San Joaquin River flow at Vernalis is just one."

In addition, Baker and Morhardt (2001) and Dauble et al. (2010) both identify data gaps, experimental deficiencies, and high variability in survival rates for specific flows. Both reach some similar conclusions: that more research should be conducted, the variable of flow is likely not the only factor, and that a precise flow target set by management policies would likely not provide reliable survival rates on a year-to-year basis. These two documents were "buried" deep within section 3 of the SWRCB's Technical Report (2012; pages 3-32 for Baker and Morhardt [2001] and pages 3-38 and 3-39 for Dauble et al. [2010]).

These findings are in contrast with much of the literature cited in the SWRCB's Technical Report (2012) related to flow. Specifically, much of the cited material is based on analyses conducted by DFG (2005, 2010a) and Mesick (Mesick and Marston 2007, Mesick et. al 2007, Mesick 2009), as well as similar analyses by TBI and NRDC (2010a-c) and AFRP (2005), which all generally conclude that increased spring flows would increase both smolt survival and future escapement. These analyses do not adequately account for variables other than flow that could affect smolt survival or adult escapement, and rely on improper interpretations of simplistic linear regression relationships between complex variables. The linear relationships suffer from poor fits and violate many standard assumptions of linear regression analyses (see Attachment 1 and Demko et al. 2010 for more detailed reviews).

SWRCB's Technical Report (2012) Assertions Regarding Relationship Between San Joaquin River Flows and Salmon Survival

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding the relationship between SJR flows and salmon survival, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1: The number of Chinook salmon spawners returning to the San Joaquin system are correlated with river flows during the February-June rearing and outmigration period 2 1/2 years earlier (pages 3-32 and 3-35).

- This flow/outmigration relationship was first mentioned during 1976 SWRCB proceedings by DFG (1976).
- Since 1976, this regression of flow and escapement 2.5 years later has been mentioned in numerous documents, which were cited throughout the SWRCB 2012 report. However, the statistical analyses used in these reports do not take into account the age composition of returning adults (made up of 2–5 year old adults). Instead, they lump all ages into age-3 adults, which are typically the dominant age group among returning adults in a given year. Therefore, simply grouping adult salmon of other ages into the escapement (the dependent variable in the relationship) is the incorrect way to conduct this type of analysis and adds additional uncertainty into the purported flow/outmigration relationship. For instance, using a simple example illustrating this issue, let us say that 1,000 adult salmon (made up of ages 2-5) return in 2011. For simplicity, let's also say that 10% of that escapement class is age-2 ("jacks"), 50% are age-3, 35% are age-4, and 5% are age-5. Using that age composition, there would be 100 age-2 salmon, 500 age-3 salmon, 350 age-4 salmon, and 50 age-5 salmon. Based on life history of fall-run Chinook salmon, that would mean that the 100 age-2 salmon that returned to spawn in Fall 2011 migrated to the ocean during the spring of approximately 1.5 years earlier, during the Spring of 2010. Similarly, the 500 age-

3 adult salmon entered the ocean approximately 2.5 years earlier (Spring of 2009), age-4 adult salmon entered approximately 3.5 years earlier (Spring of 2008), and age-5 adult salmon entered the ocean approximately 4.5 years earlier (Spring of 2007). The regression of flow and escapement 2.5 years later simply does not account for the well-known life history characteristics of fall-run Chinook salmon in the Central Valley (CV) and should not be used. A more appropriate cohort-specific analysis, would relate escapement of each age group with the conditions that each age group experienced in freshwater or during the outmigration period. Therefore, time-series data of escapement of age-2 salmon would need to be analyzed with the proper time-series data of outmigration conditions approximately 1.5 years earlier, not 2.5 years earlier. Similar corrections would need to be made with the older age groups as well. Due to this additional uncertainty, cohort-specific analyses and models (i.e., those that include age composition) should be used instead of the cited analyses. Flow management decisions should not be made using such potentially unreliable analyses.

SWRCB Assertion 2: In the SJR basin, it is recognized that the most critical life stage for salmonid populations is the spring juvenile rearing and migration period (DFG 2005, Mesick and Marston 2007, Mesick et al. 2007, and Mesick 2009) (pages 1-3 and 3-2).

- Most research from the Pacific Northwest suggests that the period after ocean entry is the most critical life stage for juvenile salmonids (i.e., where most of the mortality occurs) and largely determines year-class strength (or escapement, i.e., number of spawning adults in a given year) (Pearcy 1992, Gargett 1997, Beamish and Mahnken, 2001).
- The documents cited by SWRCB's Technical Report (2012) to support this claim are not peer reviewed and all based on work conducted by Mesick and others.

SWRCB Assertion 3: Analyses indicate that the primary limiting factor for salmon survival and subsequent abundance is reduced flows during the late winter and spring (February through June) when juveniles are completing the freshwater rearing phase of their life cycle and migrating from the SJR basin to the Delta (DFG 2005; Mesick and Marston 2007; Mesick et al. 2007; Mesick 2009) (page 3-28).

- The VAMP independent scientific review panel determined that "simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta" (Dauble et al., 2010).
- Based on Figure 11 from Baker and Morhardt (2001), NMFS (2009) states that "flows below approximately 5,000 cfs have a high level of variability in the adult escapement returning 2.5 years later, indicating that factors other than flow may be responsible for the variable escapement returns. Flows above approximately 5,000 to 6,000 cfs begin to take on a linear form and adult escapement increase in relation to flow."
    - However, Baker and Morhardt (2001) indicates that there are no data points between 11,000-18,000 cfs, so there is no ability to identify a linear trend beginning at 5,000 cfs. Also, Baker and Morhardt (2001) state,

    - "when only the data below 10,000 cfs are considered, there appears to be a negative relationship between flow and smolt survival."
- No factors other than flow (e.g., ocean conditions, predation, etc.) were investigated in a rigorous fashion in the models suggesting a causal relationship between spring flow and adult returns.
    - "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable predation, appear to affect survival rates more than flow, by itself, and complicate the assessment of flow effects of on survival rates." (Dauble et al. 2010).
    - Choice of emigration route may be more important to survival than flow (Perry et al. 2010).
- The documents cited by the SWRCB's Technical Report (2012) to support this claim are not peer reviewed and all based on work conducted by Mesick and others.
- Bay Delta Conservation Program and Delta Stewardship Council are not using these analyses and an independent review panel recently recommended that NMFS develop a life cycle model for CV salmonids to examine water management and Biological Opinion Reasonable and Prudent Actions (Rose et. al. 2011).

Other Potential Factors That Influence Survival of Juvenile Salmon Not Accounted for in SWRCB's Technical Report (2012) or in Analyses Cited

Timing of outmigration:

- Survival of later-migrating juvenile Chinook smolts in the Columbia and Snake Rivers generally decreases compared to early-migrating smolts (Anderson 2003, Figures 10 and 24).
- Smolt-to-adult survival (cohort-specific) related to migration timing. Chinook smolts that migrated earlier in outmigration season are more likely to survive to adulthood (Scheurell et al. 2009).
- Snake River fall-run Chinook survival to Lower Granite Rapids Dam had the highest correlation with release date and water quality parameters (water temperature), which co-vary (Anderson et al. 2000, NMFS 2000a).

Route-Specific Migration Probabilities and Survival Probabilities:

- Perry et al. (2010) clearly shows the complicated nature of estimating survival in a highly complex, dendritic water body such as the Delta. Perry's work adds additional uncertainty to the survival estimates used by Mesick. The variation in survival estimates in years with high flows may be due to the route(s) that fish selected instead of the actual flows themselves. Higher survival rates could be due to a higher proportion of CWT-tagged salmon migrating into a route with a higher reach-specific survival rate.

Ocean Conditions:

- The SWRCB's Technical Report (2012) largely ignores the great influence that ocean conditions can have on survival and year-class strength of CV salmon. This reflects the reliance of the SWRCB's document on analyses that largely dismisses the role of ocean conditions (Mesick and Marston 2007, Mesick et. al 2007, Mesick 2009, TBI and NRDC 2010a-c, AFRP 2005).

- Lindley et al. (2007) states that a "broad body of evidence suggests that anomalous conditions in the coastal ocean in 2005 and 2006 resulted in unusually poor survival of the 2004 and 2005 broods of the SRFC (Sacramento River Fall-run Chinook)."
- Both the 2004 and 2005 broods entered the ocean during a period of weak upwelling, warm sea surface temperatures, and low densities of prey items (Lindley et al. 2009).

Accumulated Thermal Units (ATUs) – or Thermal Experience:

- In the Columbia River, migration patterns (onset of outmigration) of Chinook smolts were most associated with accumulated thermal units (a positive relationship); while increasing flow had a negative influence (Sykes et al. 2009). Thermal experience was found to have more influence on migration than daily mean water temperature.

Distance Traveled:

- Hatchery Chinook smolt survival varied inversely with the distance traveled to Lower Granite Rapids Dam (Muir et al. 2001).
- Smolt survival in the Columbia and Snake Rivers depends on distance traveled more than travel time (Anderson 2003, Bickford and Skalski, 2000) or migration velocity (Anderson et. al. 2005).

Additional Information regarding Flow and Juvenile Salmon Survival Relationships

Central Valley:

- Survival estimates for acoustically-tagged late-fall Chinook in a December release group were lower than for the January release group despite higher discharge and shorter travel times (Perry et al. 2010, p. 151). Some of this difference, however, was due to the proportion of each group that migrated between three different routes.

Outside Central Valley:

- No consistent relationship was found between years for either flow (study used a flow exposure index) or change in flow and Chinook smolt survival from Lower Granite Dam and McNary Dam (Smith et al. 2002). However, median travel times in each year decreased with increased flow exposure index (Smith et al. 2002). There was no relationship between median travel times and survival.
- No correlation present between daily flow and daily smolt survival probabilities (spring-run Chinook) through one reach of the Columbia River (Skalski 1998).
- On the Columbia River (spring-run Chinook) - Increased survival rates in the 1990s compared to the mid to late 1970s was not a function of flows. No significant differences were found between mean daily flows between the two periods (Williams et al., 2001).

- No relationship between fall-run Chinook survival and flow-travel time (Giorgi et al., 1994).
- No within-year flow-survival relationship for spring-run Chinook salmon smolts (Smith et al. 1997a).
- No within-year flow-survival relationship for fall-run Chinook salmon smolts (Giorgi et al. 1997, Smith et al. 1997b).
- No flow-survival relationship for Snake River spring-run Chinook smolts (NMFS 2000a).

2. FLOODPLAIN HABITAT

Overview

Creation of floodplains, one of the functions supported by spring flows according to the SWRCB's Technical Report (2012), has the potential to affect salmonid populations in various ways. While the ecology of floodplains in temperate regions, particularly on salmonid bearing streams, has been poorly studied, and some literature indicates that floodplain rearing increases growth and survival of Chinook salmon. In addition, floodplains provide important ephemeral spawning and rearing habitat to which native fish fauna has adapted.

While potential floodplain benefits to salmon fry are relatively undisputed, the main issue on the SJR and its tributaries appears to be the lack of low lying areas that can be regularly inundated by elevated discharge to provide productive floodplain habitat, which SWRCB's Technical Report (2012) fails to recognize. Inundation projections from modeling exercises often derive their floodplain estimates based solely on inundated surface area, without giving consideration to characteristics of inundated habitat (depths, substrate, vegetation, etc.).

Citations presented in the SWRCB's Technical Report (2012) illustrating the benefit of floodplain to rearing fishes are based on research conducted in river basins that are not directly comparable to the SJR and its tributaries (e.g., Mississippi River, neotropical and Southeast Asia systems). While there is some supporting evidence regarding the positive effects of frequent, long duration inundation of shallow floodplains on Chinook fry rearing in California (e.g., Sommer et al 2001, 2005; Moyle et al. 2007), such habitat is extremely limited in the SJR due to extensive habitat alteration and levee construction (Essex 2009). It follows that potential implied benefits of a more variable flow regime outlined in SWRCB's Technical Report (2012) may not be realized or will be severely curtailed in the SJR basin.

SWRCB's Technical Report (2012) Assertions regarding Floodplain Habitat

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding floodplain habitat, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1. Warm, shallow-water floodplain habitats allow steelhead juveniles to grow faster (page 3-27).

- Juvenile steelhead are not known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007).
- Based on multi-year studies in the Cosumnes River, Moyle et al. (2007) concluded that steelhead were not adapted for floodplain use and the few steelhead observed were inadvertent floodplain users (i.e., uncommon and highly erratic in occurrence) that were "presumably…carried on to the floodplain by accident."

SWRCB Assertion 2. Successful Chinook salmon rearing is often associated with connectivity between river channel and riparian and floodplain habitat (page 3-19).

- Juvenile Chinook salmon are known to use floodplains, when available, for rearing. They benefit from floodplain use during the rearing phase through higher growth and greater feeding success (e.g. Sommer et al. 2001, Moyle et al. 2007).
- Chinook salmon have been documented to utilize the floodplain habitat in the Sutter Bypass, Yolo Bypass, and in the Cosumnes River (Feyrer et al. 2006, Sommer et al. 2001, Sommer et al. 2005, Moyle 2007).
    - In the Cosumnes River (annual floodplain inundation ranged from 6 to 158 days), Moyle et al. (2007) found that Chinook salmon were the most abundant species found in February and March. Likewise, Feyrer et al. (2006) found that juvenile Chinook salmon were common in the Sutter Bypass from January through May, but were relatively rare in June; on the Yolo Bypass they occurred primarily in March.

SWRCB Assertion 3. Floodplain rearing increases growth and survival in Chinook salmon (page 3-19).

- Chinook salmon that rear on floodplains have been shown to grow more rapidly than those rearing in the main river channel (Sommer et al. 2001).
- "1998 results *suggest* that in *some* years, survival *may* actually be substantially higher for salmon that migrate through the floodplain" (Sommer et al. 2005). However, clear conclusions regarding survival effects of juvenile floodplain use on adult recruitment are not available, and increased survival of these fish is often based on the inference that increased size at outmigration reduces mortality.

SWRCB Assertion 4. Floodplain inundation in the spring may benefit native species (pages 3-41 to 3-42).

- Historically, floodplains were important spawning and rearing habitats for at least some native fishes (e.g., obligate floodplain spawners, such as splittail), but their importance to river-spawners and slough residents (sucker and blackfish, respectively) is not well understood (Crain et. al 2004).
- "Today, floodplains appear important to native fishes mainly early in the season (February– April)" (Crain et. al 2004, page 15).
- Non-native species dominate the floodplain community later in the season (April-July) particularly permanent residents of ponds, ditches, and sloughs on the

floodplain) due to warmer water temperatures and lower flows (Crain et. al 2004). This is of special importance to floodplain management in the SJR Basin, as high abundances of non-native predators may benefit from floodplain inundation during proposed period, predominantly from April-June.

SWRCB Assertion 5. Shallow-water floodplain habitat provides rearing Chinook with refuge from predatory species (page 3-44).

- Shallow-water floodplains in the Sacramento River provide a refuge from large pelagic (i.e., open water) predators (e.g., Sacramento pikeminnow and striped bass) that, due to their pelagic nature, are unlikely to invade shallow, cover-rich habitats such as inundated fields of the Yolo Bypass.
- Much of the inundated floodplain habitat in the SJR that could be provided in the managed flow range are associated with oxbow features (cbec 2010), which are unlikely to provide predator refuge benefits because predation, particularly by ambush predators (e.g., largemouth bass), is expected to increase in such habitats (Saiki 1984, Brown 2000, Grimaldo et al. 2000, Feyrer & Healey 2003). These predators have been shown to be more efficient at capturing prey in complex habitat and in turbid conditions than pelagic piscivores (Greenberg et al. 1995, Nobriga & Feyrer 2007).
- The presence of high densities of exotic piscivorous fish in the perennial oxbows would likely result in heavy mortality of juvenile salmonids that entered the flooded oxbow areas.

SWRCB Assertion 6. "Floodplain inundation provides flood peak attenuation and promotes exchange of nutrients, organic matter, organisms, sediment, and energy between the terrestrial and aquatic systems" (SWRCB 2012, page 3-43).

- This is contradictory to the content of section 3.7.6 of the SWRCB's Technical Report (2012), which lists nutrients as a main factor contributing to poor water quality in the SJR and concludes that higher flows would serve to dilute this and other constituents of water quality:

> "Eutrophication from the dissolution of natural minerals from soil or geologic formations (e.g., phosphates and iron), fertilizer application (e.g., ammonia and organic nitrogen), effluent from sewage-treatment plants (e.g., nitrate and organic nitrogen), and atmospheric precipitation of nitrogen oxides may cause chronic stress to fish (McBain and Trush 2002). Algae and plant growth under eutrophic (high nutrient) conditions, along with their subsequent decomposition in the water column, lead to increase oxygen consumption and decreased dissolved oxygen conditions, reduced light penetration and reduced visibility. These conditions may render areas unsuitable for salmonid species, and favor other species (e.g., sucker, blackfish, carp, and shad)" (SWRCB 2012, page 3-49).

Clearly, the explanation of proposed benefits of changes to the flow regime with regards to nutrient supplementation (or dilution) is in need of refinement, and a more detailed evaluation of the relationship between proposed flow alterations and food web benefits is required.

SWRCB Assertion 7. Floodplain inundation provides benefits to downstream reaches in the form of nutrient supply (page 3-43).

- This assertion is erroneously attributed to Mesick (2009) by SWRCB's Technical Report (2012). Mesick (2009) did not study floodplains and their relationship to increased smolt survival, and did not investigate nutrient flow in the Tuolumne River.
- Levels of dissolved nutrients are seldom limiting factors for primary production in the main channel of rivers (Junk et al. 1989).
- The role of floodplains in nutrient cycling has not been extensively studied in California, but studies from other parts of the world indicate that floodplains can be both sources and sinks for nutrients, depending on geology, inundation duration, riverine nutrient loading, and many other factors (Junk et. al 1989). A study from the Cosumnes River suggests that floodplain inundation can reduce the amount of nitrate transported to downstream reaches (Sheibley et al. 2002).

Additional Information regarding Floodplain Inundation and Rearing of Juvenile Chinook in the SJR Basin

Floodplain conditions in the SJR Basin differ greatly from those in other river systems.

- Floodplains in the Yolo and Cosumnes bypasses consist of virtually one, large continuous expanse of mostly shallow-water habitat; while the San Joaquin Basin consists of several disconnected, smaller areas of largely deep-water habitat (oxbow features). This deep-water habitat is similar to isolated pond habitats in the Yolo Bypass where alien fish dominate and no Chinook salmon were found (Feyrer et al. 2004).
- Floodplains consisting of large expanses of shallow (mostly <1 m), slow velocity (mostly <0.3 mps) water have shown increased productivity of food organisms for fish and increased growth of juvenile Chinook salmon (Sommer et al. 2001). Limited studies in the Cosumnes River Preserve found that growth of juvenile Chinook was slower in isolated pond areas than in adjacent flooded pastures and woodlands (Jeffries et al. 2008).
- San Joaquin Basin inundation zones estimated by the cbec analysis (cbec 2010) only indicate the amount of maximum floodplain area available under a range of flows, but do not indicate the proportion of that habitat that could be used by salmon since they did not identify habitat quality (i.e., depth and velocities).
- Growth differences between juveniles rearing in floodplains versus in-river were found after a two-week period (Jeffres et al. 2008): expecting same benefits after less than two-week inundation period not warranted.
- Increased growth on floodplains is likely related to several factors including warmer water temperatures resulting from shallower depths and greater surface area than found in-river, as well as lower velocities and better food sources (Sommer et al. 2001).

Stranding risk associated with floodplain draining.

- Sommer et al. (2005) suggests that the majority of fish successfully emigrated from the Yolo Bypass because this particular floodplain drains fairly efficiently due to the low percentage of isolated pond area under both peak flood and draining periods; yet over 120,000 Chinook may have been stranded during that study (Sommer et al. 2005).
- Compared to the Yolo Bypass, where ponds are relatively rare and the Bypass is gradually sloped into a parallel toe drain, oxbow channel features characteristic of the lower SJR may not provide ideal rearing habitat for outmigrating salmonids and flooded oxbows are likely to result in significant stranding of juvenile salmon.

Achieving floodplain inundation is questionable under the maximum monthly target flows identified for each tributary by SWRCB (2012).

- DFG (2010c) visually inferred floodplain inundation from graphs of flow-area relationships
    - Wetted surface area increases on the graphs more quickly between 3,000-5,000 cfs (Merced) and between 4,000-6,000 cfs (Tuolumne) indicating greater increases in width, which suggests bank overtopping or floodplain inundation
    - The Stanislaus River channel did not appear to have a well-defined floodplain within the 100 to 10,000 cfs flow range examined (SWRCB 2012, DFG 2010); note: other unpublished studies of a small portion of the Stanislaus River (5.7 miles) indicates that a minimum of 3,000 cfs would be required for this portion of the river.
    - Therefore, minimum floodplain thresholds considered 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River.
- Assuming minimum floodplain thresholds above (i.e., 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River), all three minima exceed the maximum monthly target flows as specified for each tributary by the SWRCB's Technical Report (2012)(i.e., 2,500 cfs for the Stanislaus River; 3,500 cfs for the Tuolumne River; and 2,000 cfs for the Merced River). It is unknown at this time how the SWRCB's Technical Report (2012) intends that these maximum flow targets would be achieved (i.e., maximum daily amounts per month, or maximum average daily amounts per month), but if the SWRCB intends for these to be maximum daily targets, then floodplain inundation thresholds (3,000-4,000 cfs) exceed all targets.

Brief floodplain inundation (< two weeks) has not shown benefit.

- Assuming that floodplain does begin to inundate at these minimum floodplain inundation threshold flows identified above (i.e., 3,000-4,000 cfs, which is questionable), it remains to be discerned whether inundation periods <two-weeks are of sufficient duration to provide measurable benefits to rearing salmonids. Growth differences between floodplain-reared and in-river juveniles have been found after a two-week growth period in the Cosumnes River (Jeffres et al. 2008),

yet expecting similar growth increases in San Joaquin River floodplains after <2-week inundation periods is not warranted. Furthermore, Sommer et al. (2001) indicated that characteristics that possibly accounted for an increased growth rate on floodplain habitats included warmer water temperatures than in-river resulting from shallower depths and greater surface area, as well as lower velocities and better food sources (Sommer et al. 2001). Warmer water temperatures did not become apparent until ambient air temperatures began to increase, beginning in March. As mentioned previously, shallow water floodplain habitat is not prevalent in the San Joaquin Basin.

Late spring floodplain inundation.

- ➢ Increasing air temperatures in late spring (late May and June) are expected to lead to warmer water on the floodplains than in the river channels. According to Feyrer et al. (2006), the water temperatures on the Sutter and Yolo bypasses rose to about 24°C by June 2002 and 2004. These temperatures are approaching the chronic upper lethal limit for CV Chinook salmon (approximately 25°C) and according to Myrick and Cech (2001), juvenile Chinook salmon reared at water temperatures between 21 and 24°C were more vulnerable to striped bass predation than those reared at lower water temperatures.

SWRCB's Technical Report (2012) emphasizes the need for creating more floodplain in the San Joaquin Basin through higher flows, but "floodplain habitat" is not defined nor quantified for the San Joaquin Basin.

- ➢ The attributes of "floodplain habitat," such as depth, velocity, cover, and water temperature, are not defined.
- ➢ No information/data is presented as to how much floodplain habitat exists in the San Joaquin Basin, how much could be gained at various flows, or what the benefit to Chinook would be.

Recent Information Not Previously Available to the SWRCB

USBR technical feedback committee meeting SJRPP, July 2012.

Recent presentations at the USBR technical feedback committee meeting for the San Joaquin River Restoration Program (SJRRP) (USBR 2012), while summarizing the current state of salmon restoration science in the SJR, clearly illustrated the lack of specific information that is required for sound decision making.

Estimates of in-river habitat (including floodplain) requirements for successful rearing of enough juvenile salmon to meet management goals currently rely on many unrealistic assumptions, and are based on "territory size" required by juvenile salmonids at various developmental stages (e.g., fry require less "territory" than smolts). It should be noted that available suitable habitat (ASH) does not directly correspond to total habitat requirements, as it doesn't take into consideration the amount of river channel, riparian vegetation, sediment input, etc. needed to support the ASH.

Survival simulations indicate that, under current estimated mortality rates (based on other watersheds), the production goal of 44,000-1.6 million (spring run) and 63,000 – 750,000 (fall run) successful juvenile outmigrants would require 121 million spring-run and 173 million fall-run fry hatched at the spawning grounds. As juveniles move downstream and their sizes increase (and abundance decreases), territory size requirements are applied to abundance modeling based on a length-territory size relationship for salmonids from Grant and Kramer (1990). Preliminary estimates for maximum required suitable rearing habitat (in acres) are summarized in the table below:

Reach	**Spring-Run**	**Fall-Run**	**Both Runs**
Lower 1B	73	158	231
2A	121	276	397
3	59	183	242
4A	13	88	101
4B1	14	40	54
4B2	6	10	16
5	7	5	12
Total	**365**	**861**	**1226**

As SJR tributaries are deficient in shallow-water floodplain habitat, higher flows are proposed to reduce available habitat requirements, as fish are moved out of the system in a conveyor belt like fashion (Dr. Merz) and will therefore spend less time rearing in-river. However, note that data from other rivers in both the northern and southern CV are used to inform simulations for the SJR, which may not be applicable or sound. In addition, the model was purposely kept simple, and many potentially important habitat characteristics (variable flow timing) were not included in the simulations.

Available floodplain modeling for the SJR is also still in its infancy, and so far only three water year scenarios have been examined (dry, normal, wet), and overall results were far too variable to draw clear conclusions:

- Overall available habitat results varied wildly depending on levee alignment;
- For each different levee alignment, the results varied drastically dependent on flow;
- Results also varied dependent on vegetative cover options;
- Some scenarios resulted in a small surplus of adequate floodplain habitat; others resulted in a deficiency of thousands of acres.

Furthermore, definitions of vegetative cover are not sufficiently refined, as shrub cover (which perhaps comprises most of the available habitat) is not included in the model since it cannot be estimated from aerial photography.

Current results from physical and biological model integration were not presented, but will be made available on the SJRRP website in the near future.

Stanislaus River Floodplain Versus Flow Relationships- USFWS results March 7, 2012.

A brief description of Stanislaus Floodplain modeling was provided in a March 2012 report (USFWS 2012) and presented at a Stanislaus Operations Group (SOG) meeting in May 2012 (SOG 2012). The goal was to develop a two-dimensional hydraulic model to quantify the relationship between floodplain area and flow for the Ripon to Jacob Myers reach of the Stanislaus River (RM 17.2 to 34.7), for flows ranging from 250 to 5,000 cfs.

Floodplain was defined based on a modeled wetted area versus flow relationship. First, a graph of total wetted area versus flow was examined to determine the flow at which floodplain inundation begins, as indicated by an inflection point in the graph (the wetted area vs. flow graph from which the inflection point was determined is the figure supplied as part of the meeting notes, inundation begins at ~1250 cfs). Then, the total wetted area at higher flows is subtracted from the total wetted area at which floodplain inundation begins to determine the inundated floodplain area at each flow (meaning that floodplain is essentially considered 0 at ~1,250 and then accrues as flows increase above this amount). Based on this standard methodology, floodplain inundation is expected to encompass low flow channels since the inflection point is likely not observed until other areas also become inundated.

No floodplain depths were specified in the graph provided in the meeting notes. However, in the report, there is one figure that provides depths of floodplain (red) expected at 1,500 cfs, which ranged from 0-2 meters deep (0-6 feet). Due to the color codes used, it is difficult to ascertain whether these depths are closer to zero or closer to 6 feet, which would affect whether these inundated areas would provide good rearing habitat. USFWS is only interested in total floodplain area (macrohabitat level), so indicated that wouldn't be providing any additional depth related figures, nor will velocities and water temperatures (microhabitat level) be incorporated into the floodplain model since the floodplain analysis is being done on a macrohabitat basis and there is no consideration of microhabitat variability (e.g., velocity or water temperature). In addition, the model used is not suitable for microhabitat level analysis given its coarse spatial scale resolution, so any efforts to look at those variables would require a different model.

USFWS' results for the Orange Blossom Bridge to Knight's Ferry reach (7.4 miles) indicate that 35 acres of floodplain accrue between flows of 1,500 cfs to 3,000 cfs with an additional 32.1 acres between 3,000 cfs and 5,000 cfs.

USFWS' future plans include conducting hydraulic models for additional reaches (Jacob Myers to Orange Blossom Bridge and Ripon to SJR confluence), and the results for all four reaches probably won't be presented in a report until February or March of 2013.

3. FLOW QUANTITY AND TIMING

Overview

Managed flow pulses are frequently used to stimulate migration of salmonids in the San Joaquin Basin. Under specific conditions, migration of returning spawners, as well as emigrating juveniles, can be temporarily stimulated through increases in discharge. However, there is no evidence that such flows are required for successful adult migration or that they can reduce straying rates of natural-origin fish.

Higher flows increase fry survival in the tributaries, but not necessarily true for parr and smolts; and the benefits to adult escapement are uncertain. Fry migrants from SJR tributaries exhibit higher survival during periods of higher flows; however, our understanding of the contribution of fry to adult recruitment is quite limited. Since 2003, survival through the South Delta has been very low, and high flow events have failed to increase survival to levels observed when flows ranged between 5,000 and 6,000 cfs, despite flood flows of up to 25,000 cfs during the juvenile emigration period.

Relevant Information Regarding Flow Quantity and Timing

Juvenile Chinook migration out of the tributaries is *temporarily* stimulated by changes in flow, but long duration pulse flows do not "flush" fish out of the tributaries.

- Juvenile Chinook migration can be temporarily stimulated by changes in flow, but the stimulatory effect is short lived (few days) and only affects fish that are ready to migrate (Demko and Cramer 1995; Demko et al. 1996, 2000, 2001).
- Juvenile migration from the tributaries typically begins in January and nearly all juveniles migrate out of the tributaries by May 15 (SJRGA 2008).
- Except in wet and above normal years, 0.7% or less of total juvenile salmon (i.e., fry, parr, and smolts), and 0.8% or less of salmon smolt outmigrate during June.

Higher flows increase fry survival in the tributaries, but not necessarily true for parr and smolts; benefits to adult escapement are uncertain.

- Over a decade of rotary screw trap monitoring in the Stanislaus River shows that flow has a strong positive relationship with migration survival of Chinook fry (Pyper et al. 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data).
- Similarly, analyses of rotary screw trap data found that abundance ratios for parr and smolts were only weakly correlated with flows (Pyper and Justice 2006).
- Smolt survival indices in the San Joaquin River from the Merced River downstream to Mossdale indicate little relationship to flow (TID/MID 2007).
- The contribution of fry emigrants (Feb/March) to total salmon production in the San Joaquin Basin is unknown (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).
    - However, a sample (n=100) of Central Valley fall-run Chinook salmon (unknown tributary origins) captured in the 2006 ocean fisheries were comprised of an average 20.1% (± 5.4%) individuals that emigrated as fry in 2003 and 2004 (Miller et al. 2010).

A flow regime based upon 60% (or lower) of unimpaired flows in February or in June is not likely to provide the potential benefits that the SWRCB's Technical Report (2012) identified, and providing such flows in February and June is not

consistent with the States's policy to "achieve the highest water quality consistent with maximum benefit to the people of the state."

- See Palmer et. al (2012) and Fuller et. al (2012) for details.

Flow does not explain the low Delta survival of juvenile Chinook observed since 2003, so more flow is unlikely the solution.

- South Delta survival has been low since 2003. During this period, flood flows of approximately 10,000 cfs and 25,000 cfs during outmigration in two years (2005 and 2006) did not increase survival near levels when flows were moderately high (5,700 cfs) in 2000. It is unclear why smolt survival between 2003 and 2006 has been so low (SJRGA 2007b).
- Smolt survival during 2003-2006 was unexpectedly far lower than it was historically. Models based on historical data that do not accurately represent recent conditions (e.g., Newman 2008 and others) should not be used to predict future scenarios (VAMP Tech. Team 2009).

Fall flow pulses *temporarily* stimulate upstream migration of adult Chinook salmon into San Joaquin Basin tributaries, but no evidence that attraction flows benefit the species.

- Prolonged, high volume pulse flows in the fall are not warranted. Equivalent stimulation of adult migration may be achieved through relatively modest pulse flows (Pyper et. al 2006).
    - Relatively modest pulse-flow event (an increase of roughly 200 cfs for 3 days) was found to stimulate migration.
    - Stimulatory effect of both pulse-flow and attraction flows were short in duration (migration increased for 2-3 days).
- Adult migration rate and timing is not dependent upon water temperature or dissolved oxygen concentrations (Pyper et. al 2006).
    - No evidence that low flows (1,000 to 1,500 cfs) in the SJR are an impediment to migration.
- Migration appears to be stimulated by pulse flows, but no evidence that natural origin fish would stray or not migrate to San Joaquin tributaries if no pulse.
    - "Consistent movement patterns [Klamath fall Chinook migrants] with or without pulse flows is compelling evidence that these flows did not trigger upriver movement or otherwise substantially alter migration behavior" (Strange 2007).
    - No clear relationship between increased water flow and stimulated Atlantic salmon migration was found in River Mandalselva (southern Norway) (Thorstad and Heggberget 1998).
    - To attract adult Atlantic salmon migration into rivers, flows must occur in conjunction with other cues such as cooler weather or natural freshets (Mills 1991).
- Fall pulse flows may attract out-of-basin hatchery fish.
    - The Constant Fractional Marking Program, which began in 2007, is just now providing more complete information regarding straying rates, and

results indicate that hatchery straying may be substantial in the SJR Basin. In 2010, fall-run spawners in the Stanislaus River were 50% hatchery-origin despite the lack of a hatchery on the river; of those the majority came from either Nimbus Fish Hatchery fall-run net pen releases (31%), Mokelumne River Hatchery fall-run net pen releases (26%), or the Mokelumne River Hatchery fall-run trucked releases without net pen acclimation (23%)(Kormos et al. 2012).

4. WATER TEMPERATURE

Overview

The temperature tolerances of CV salmon stocks are likely distinct from those of other stocks in the Pacific Northwest, and the applicability of laboratory derived tolerance values to stocks that have evolved in (and are adapted to) habitats at the southernmost extent of the species' range is questionable. High growth and survival of natural Chinook stocks in the CV at temperatures considered higher than optimal for most stocks (based on data from northern stocks) indicate high thermal tolerance of these stocks. There is no clear evidence that San Joaquin Basin stocks are adversely impacted by the current temperature regime. Neither adult nor juvenile migration appear impeded by temperatures observed under current flow management, as indicated by the absence of high pre-spawn mortality or temperature dependent migration timing of adults. Furthermore, the vast majority of juveniles emigrate prior to increases in water temperature resulting from warming air temperatures (the main factor influencing water temperatures) in late spring.

Relevant Information Regarding Water Temperature

The dominant factor influencing water temperature is ambient air temperature.

- Ambient air temperature is the primary factor affecting water temperature.
- By the end of May, water temperatures at Vernalis range between 18 and 21°C (65°F and 70°F) regardless of flow levels between 3,000 cfs and 30,000 cfs (SRFG 2004).
    - On average, maximum daily water temperatures are at or above 20°C (68°F) at Vernalis, Mossdale, and RRI after May 15, and by June 16-30, even the coolest year on record (2005) was only slightly below 20°C at Vernalis, at 20°C at Mossdale, and above 20°C RRI.
- Based on data from the Western Regional Climate Center for Stockton during 1948-2006 (station 048558 WSO; http://www.wrcc.dri.edu), the average daily air temperature at Stockton during June is 22.6°C (72.7°F), and therefore the guideline used by the EPA, which is nearly 3°C cooler, will never be met during June.

Water temperature criteria from Pacific Northwest stocks do not apply to San Joaquin salmon and steelhead; and little is known about the responses of Central Valley species to in-river water temperatures.

- The SJR represents the southernmost extent of the current range of Chinook salmon. Southernmost stocks have evolved under much warmer and drier meteorological conditions than stocks in the Northwest; therefore, criteria based on northern stocks are not directly applicable.
- The applicability of thermal criteria derived from the laboratory has long been debated, and there has been no validation of the growth vs. water temperature relationship for any of the listed species in the CV to assess if laboratory results are transferable to these southern stocks (Myrick and Cech 2004).
- Wild Chinook salmon in the Central Valley often experience water temperatures higher than "optimal" (as based on northern stock data) yet still have high growth and survival. It is this flexibility that has made Chinook salmon so successful in the CV and able to thrive where less temperature tolerant salmonids cannot (Moyle 2005).
- Juvenile Chinook can survive exposure to water temperatures of 24ºC (75.2ºF), depending on their thermal history, availability of refuges in cooler water, and night-time water temperatures (Moyle 2005).
- While much information is available on lifestage-specific water temperature ranges of Chinook salmon and steelhead in the Pacific Northwest, little is known about the specific responses of CV species to water temperature (Williams et al. 2007).
- Water temperature standards are often based on a seven-day average of the daily maximums (7DADM) not to be exceeded; this approach does not reflect the duration of exposure and the range of temperatures that fish may experience. It is possible for Chinook salmon to maintain populations even when they experience periods of suboptimal or even near-lethal conditions. For example, the most productive spring-run Chinook salmon stream in California (i.e., Butte Creek) can experience daily maxima up to 24ºC (75.2ºF) with minima of 18-20ºC (64.4-68.0ºF) for short periods of time in pools where juveniles are rearing and adults are holding (Ward et al. 2003).
- Anecdotal evidence suggests that some species of CV salmonids are heat tolerant: "the high temperature tolerance of San Joaquin River fall run salmon, which survived temperatures of 80°F (26.7ºC), inspired interest in introducing those salmon into the warm rivers of the eastern and southern US (Yoshiyama 1996)."
- Historically, the San Joaquin Basin has had higher water temperatures than all the other rivers that support Chinook salmon and so it is possible that the San Joaquin race has evolved to withstand higher temperatures than 18.3ºC (65°F) (CALFED 1999).
- Additionally, southern steelhead stocks of the CV may have greater thermal tolerance than those in the Pacific Northwest (Myrick and Cech 2004).
- The optimum growth temperature for American River steelhead was nearly 3ºC (5ºF) warmer than the optimum growth temperature for more northern stocks (Wurtsbaugh and Davis 1977; Myrick and Cech 2004; Myrick and Cech 2001).

There is no evidence that temperatures are unsuitable for adult fall-run Chinook upstream migration in the San Joaquin Basin.

- Adult migration timing was unrelated to temperature, dissolved oxygen (DO), or turbidity conditions (Pyper et. al 2006).
- Although temperatures were exceptionally cool during September 2006, salmon did not migrate earlier than during 2003-2005. During September 2006, temperatures were as much as 3ºC (5ºF) cooler in the SJR at Rough and Ready Island (RM 37.9), Mossdale (RM 56.3), and Vernalis (RM 72.3), and as much as 5ºC (9°F) cooler in the Stanislaus River at Ripon (RM 15.7) as compared to monthly average temperatures at the same locations during 2003-2005. September flows in the Stanislaus and SJR exceeded average unimpaired flow conditions during all of these years (CDEC; Ripon gauge).
- Temperatures at Rough and Ready Island (RRI) typically above 21ºC (70°F) during early migration season; larger fraction of early migrants traveled under higher temperatures in 2003 than other years (Pyper et. al 2006).
- Managed flows in the San Joaquin Basin during September are higher than historic unimpaired (computed natural) flows. Natural SJR flows were lowest during September and flows were extremely low or nonexistent in dry years. During 1922-1992, the average unimpaired flows during September were 117 cfs in the Stanislaus River, 185 cfs in the Tuolumne River, 84 cfs in the Merced River, and 808 cfs in the SJR (CDWR 1994). Elevated discharge levels of cool water from reservoir storage actually increase flow and decreases temperature during these time intervals.
- If temperatures were a problem for adult migrants in the SJR Basin, high pre-spawn mortality would be expected. However, studies conducted by DFG demonstrated that the incidence of pre-spawn mortality is quite low (i.e., 0%-4.5%) and appears to be density, not temperature, dependent (Guignard 2005 through 2008).
- Bay temperatures over 18ºC (65°F) in September when fish are migrating (CDEC; various stations).

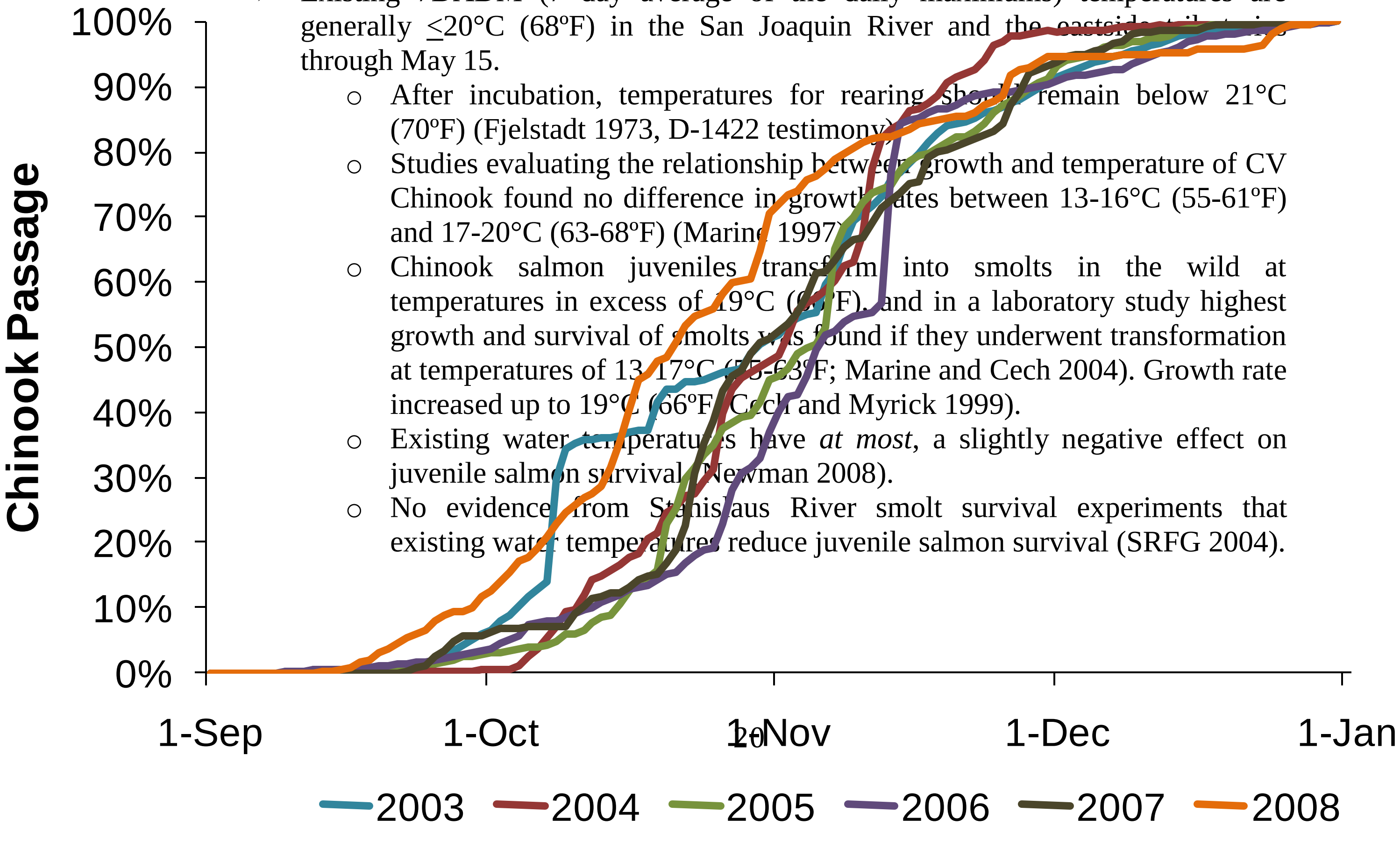

Figure 1. Cumulative upstream passage at the Stanislaus River Weir during 2003-2008 (FISHBIO 2009).

There is no evidence that temperatures for juvenile rearing and migration need to be colder than existing conditions or maintained through June 15.

- Nearly all juvenile Chinook migrate prior to May 15, and <1% migrate after May, except in wet and above normal water years. Also, 90-99% of non ad-clipped salvaged *O.mykiss* are encountered between January and May depending on water year type.
- Existing 7DADM (7 day average of the daily maximums) temperatures are generally ≤20°C (68ºF) in the San Joaquin River and the eastside tributaries through May 15.
  - After incubation, temperatures for rearing should remain below 21°C (70ºF) (Fjelstadt 1973, D-1422 testimony).
  - Studies evaluating the relationship between growth and temperature of CV Chinook found no difference in growth rates between 13-16°C (55-61ºF) and 17-20°C (63-68ºF) (Marine 1997).
  - Chinook salmon juveniles transform into smolts in the wild at temperatures in excess of 19°C (66ºF), and in a laboratory study highest growth and survival of smolts was found if they underwent transformation at temperatures of 13-17°C (55-63ºF; Marine and Cech 2004). Growth rate increased up to 19°C (66ºF; Cech and Myrick 1999).
  - Existing water temperatures have *at most*, a slightly negative effect on juvenile salmon survival (Newman 2008).
  - No evidence from Stanislaus River smolt survival experiments that existing water temperatures reduce juvenile salmon survival (SRFG 2004).

The restoration of the SJR upstream of the Merced River (San Joaquin River Restoration Program; SJRRP) will adversely affect water temperatures in the lower SJR during the spring and fall.

- The lower SJR downstream of the Merced River confluence is identified as temperature impaired (USEPA 2010). According to water temperature modeling conducted by AD Consultants (SJRGA 2007a), although the SJRRP flows will add more water in this reach, the travel time is such that when the new water reaches the Merced River confluence, it approaches equilibrium with ambient temperature. Even though it is anticipated that the water temperature at the confluence of the Merced and San Joaquin Rivers will be the same with and without the anticipated SJRRP flows, the SJRRP flows themselves are of such a large volume that it would take a comparatively large volume of water from the Merced River to reduce temperatures in the lower San Joaquin River downstream of the Merced confluence. Given the storage capacity of Lake McClure, it is not possible to provide the volume of releases that would be necessary to reduce these water temperatures without quickly exhausting the available water supply.

Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.

- Increasing flows from the tributaries will not decrease water temperatures in the mainstem SJR (SJRGA 2007a).

5. DISSOLVED OXYGEN

Overview

Low dissolved oxygen (DO) levels have been measured in the SJR, in particular in the Deep Water Ship Channel from the Port of Stockton seven miles downstream to Turner Cut. These conditions are the result of increased residence time of water combined with high oxygen demand in the anthropogenically modified channel, which leads to DO depletion, particularly near the sediment-water interface. Despite these conditions, salmon and steelhead migration are not adversely impacted, and has been observed at concentrations as low as 5 mg/L. In addition, salmonids migrate in the upper portions of the water column where DO concentrations are highest.

It has been shown that low DO conditions in the SJR can be ameliorated through installation of the Head of the Old River Barrier (which increases SJR flow and juvenile salmonid survival by preventing fish from entering the Old River and subsequent entrainment), but there is no basis for requiring year-round DO objectives for SJR tributaries (e.g., Stanislaus at Ripon), as fish and aquatic habitat that could benefit from these DO levels are located far upstream of the SJR confluence during the summer months.

Relevant Information regarding Dissolved Oxygen

Low dissolved oxygen concentrations are limited to the Deep Water Ship Channel (DWSC), and are the result of anthropogenic manipulation of channel geometry.

- The eastside rivers (Tuolumne, Stanislaus and Merced) discharge high-quality Sierra Nevada water to the SJR which has low planktonic algal content and oxygen demand, and are not a major source of oxygen demand contributing to the low DO problem in the DWSC (Lee and Jones-Lee 2003).
- The DWSC, starting at the Port of Stockton where the SJR drops from 8-10 feet deep to 35-40 feet deep, is a major factor in DO depletion below the water quality objective. If the DWSC did not exist, there would be few, if any, low DO problems in the channel.
- The critical reach of the SJR DWSC for low DO problems is approximately the seven miles just downstream of the Port to Turner Cut (Lee and Jones-Lee 2003).

Dissolved oxygen concentrations in the DWSC are influenced by Delta exports, but can be ameliorated by installation of the Head of Old River Barrier (Brunell et al. 2010).

- Delta export pumping artificially changes the flows in the South Delta, which results in more of the SJR going through Old River. Water diverted through Old River can significantly reduce the SJR flow through the DWSC, thereby directly contributing to low DO in the DWSC.
- The physical (rock) HORB is installed to improve DO levels in fall.

Existing dissolved oxygen concentrations do not impact salmon and steelhead migration.

- Migration rate and timing is not dependent upon existing dissolved oxygen concentrations.
  - Contrary to the often cited Hallock et al. (1970) report that indicates adult migration was impeded under low dissolved oxygen, migration has been observed at DO less than 5mg/L (Pyper et. al 2006).
- Salmon and steelhead migrate in the upper portion of the water column where DO concentrations are highest due to photosynthesis and atmospheric surface aeration (Lee and Jones-Lee 2003).
- Smolt survival experiments indicate that juvenile salmon survival is not correlated with existing DO concentrations (SRFG 2004; SJRGA 2002 and 2003).

DO objective for DWSC is inconsistent with U.S. EPA national standard.

- The current U.S. EPA national water quality criterion for DO allows for averaging and for low DO concentrations to occur near the sediment-water interface. Central Valley Regional Water Quality Control Board Basin Plan DO water quality objective does not include these adjustments (Lee and Jones-Lee 2003).
- DO concentrations near the bottom in the DWSC waters are sometimes 1-2 mg/L lower than those found in the surface waters (Lee and Jones-Lee 2003).

DO objective on the Stanislaus River at Ripon is not needed year round to protect the salmon or steelhead fishery.

- While the Stanislaus River contains native fish and aquatic habitat that benefit from a minimum DO concentration of 7.0 mg/L, such fish and aquatic habitat are located more than 30 miles upstream of the Ripon compliance point during the summer months.
- Salmonids migrate through the area during late September though May. Neither salmon nor steelhead are typically located anywhere in the Stanislaus River downstream of Orange Blossom Bridge from June through August each year.

Species	Stage	Timing	Geographic Location
Fall-run Chinook salmon			
	Adult Migration	Late September - December	Goodwin Dam to confluence
	Spawning	October – December	Goodwin Dam to Riverbank
	Egg Incubation	October – March	Goodwin Dam to Riverbank
	Juvenile Rearing	Mid December – May	Goodwin Dam to Riverbank
		June – mid December	Goodwin Dam to Orange Blossom Bridge
	Juvenile Migration	January – May	Goodwin Dam to confluence
Steelhead			
	Adult Migration	Late September - March	Goodwin Dam to confluence
	Spawning	December – March	Goodwin Dam to Riverbank
	Egg Incubation	December – July	Goodwin Dam to Riverbank
	Juvenile Rearing	Year-round	Goodwin Dam to Riverbank
	Juvenile Migration	February – May	Goodwin Dam to confluence

6. FOOD

Overview

The SWRCB’s Technical Report (2012) purports that increased flows in the early spring will improve food production for early spring salmon rearing (page 3-29): “These flows may also provide for increased and improved edge habitat (generally inundated areas with vegetation) in addition to increased food production for the remainder of salmon that are rearing in-river.”. Juvenile salmonids depend on a healthy aquatic food web to survive and grow rapidly. The SWRCB’s Technical Report (2012; page 3-42 to 3-43) makes the case that a more natural flow regime would shift the benthic macroinvertebrate community in favor of more palatable prey for fish. While they do not provide any evidence that salmonids are food limited in the SJR and South Delta, they provide evidence that in unregulated streams there are generally more beneficial algae and diatoms, and high winter flows reduce predator-resistant invertebrates. In contrast, the benthic communities of the regulated streams are species-poor, impaired, and with higher relative abundance of predator-resistant invertebrates. However, the report does not provide any support to show that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state. Furthermore, the Technical Report (2012) does not explain the temporal and spatial scales under consideration for food production.

Relevant Information Regarding Food

Outmigrating Chinook smolts are not food limited during their 3-15 day migration through the lower SJR below Vernalis and the South Delta.

- The SWRCB’s Technical Report (2012, page 3-42) provides evidence that, in northern California (unspecified location), ***unregulated*** rivers have more and better food resources than regulated rivers. However, the report does not provide any evidence that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state.
    - Furthermore, the SWRCB’s Technical Report (2012) does not define how it would measure changes in food production (quality or quantity) or the mechanisms thought to drive food production in response to short-term increases in flow.
- The SWRCB’s Technical Report (2012) also does not explain temporal and spatial scales under consideration for food production.
    - Based on acoustic VAMP studies in 2008, Holbrook et al. (2009) found that smolts took 3-15 days (median 6-9 days) for migration through the lower San Joaquin River and South Delta; demand for food production over such a short duration is questionable.
    - Increases in primary and secondary production that occur due to restoration or changes in management likely occur over longer periods of time, rather than that targeted by short-term pulse flows.
    - Spatial scale is important too, as impacts to food resources are generated at different rates and via different processes depending on where they are located in the river continuum.

7. CONTAMINANTS

Overview

According to the SWRCB's Technical Report (2012), contaminants are one of several "stressors" or "other factors" in the SJR Basin. One of the functions supported by spring flows according to the SWRCB's Technical Report (2012) is that higher inflows provide better water quality conditions by reducing contaminant concentrations. The influence of higher flows on contaminant concentrations in the SJR is variable and not well understood; dilution may occur in some instances but increases may occur in others (Orlando and Kuivila 2005). Dissolved contaminants and suspended contaminants respond differently to changes in flow. While higher flows may dilute some contaminants, such as selenium, mercury and DDT, contaminants in the bottom sediments of the SJR could also be remobilized during higher flows (McBain and Trush, Inc 2002). Citations were not presented in the SWRCB's Technical Report (2012) in support of the statement that higher inflows reduce contaminant concentrations.

The SWRCB's Technical Report (2012) also states that higher spring flows will reduce travel time and exposure of smolts to contaminants. Despite concerns over the threat contaminants may pose to threatened and endangered salmonid species, little is known regarding the effects of these contaminants on the health and survival of juvenile Chinook salmon in the Delta and its tributaries (Orlando et al. 2005). More studies are needed to determine the potential effects of short-term exposure to contaminants for outmigrating Chinook smolts, which pass through the South Delta relatively quickly.

Relevant Information Regarding Contaminants

No evidence or citations were provided to support the idea that higher inflows reduce contaminant concentrations.

- The SWRCB's Technical Report (2012; 3-29) states, "Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and ***reducing contaminant concentrations***" (Emphasis added; pages 48 & 49); however, the report does not provide any references or further discussion to support this statement.
- The SWRCB's Technical Report (2012) may be inferring that higher flows would act to dilute already suspended contaminants. However, the influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increases may occur in others.

SWRCB failed to consider that higher flows may also lead to increased suspended contaminant concentrations.

- High flows can also lead to increases in contaminant concentrations resulting from the resuspension of contaminants located in riverbed sediments. Contaminants in suspended sediments may affect the ecosystem differently from dissolved contaminants, since filter feeding organisms consume suspended sediments and organic material (allowing the contaminants in the sediments to enter into the food web) and may have longer residence times in the rivers and estuaries in comparison with water (Bergamaschi et al. 1997).

- Research has begun to focus on the relationship between freshwater flow and contaminant transport to and through the Delta. Although increased flows can result in reduced dissolved or suspended sediment concentrations of some contaminants, they can also lead to increased pesticide loading.
- In a study conducted just downstream of Vernalis, the U.S. Geological Survey (USGS) examined the concentrations of organic contaminants in surface water sites along the SJR and in the Old River before, during and after the VAMP month-long pulse flow (Orlando and Kuivila 2005).
    - Of the 13 total pesticides detected, diazinon and three herbicides (metolachlor, simazine, and trifluralin) were found in every sample.
    - Although it might be expected that the higher flows would dilute the contaminants, the results were mixed. Diazinon and simazine were highest at SJR and OR sites before VAMP (4/2/01 and 4/6/01), showed intermediate values during the VAMP period (5/14/01 and 5/18/01) and then reached lowest values during the post-VAMP period (5/31/01 and 6/4/01). Metolachlor showed the opposite trend at SJR and OR sites and increased throughout the three periods. Trifluralin showed a peak during the VAMP period for most sites. Suspended sediments were highest in the SJR during VAMP; however, the opposite was true for the Old River, suspended sediments were lower during VAMP compared to just before and after the VAMP period. This was likely influenced by the operations of the Head of the Old River Barrier (HORB), which was installed during the 2001 VAMP period. All six culvert slide gates were open from April 26 to May 26, allowing some water to pass into the Old River. Suspended sediment concentrations generally increase with increasing streamflow, but there are likely nonlinear relationships between streamflow, suspended sediment concentration, and contaminant concentration.
    - Limited conclusions can be drawn from a study with such a narrow spatial and temporal scope, however it is clear that increased flows do not necessarily lead to reduced contaminant concentrations. Undoubtedly, more research is needed to clarify this process.
- Furthermore, the relationship between flow and contaminants is not obvious upstream of Vernalis. As summarized in the Background Report for the San Joaquin River Restoration Study (McBain and Trush, Inc 2002), while higher flows may dilute some contaminants, such as selenium, mercury and DDT, contaminants in the bottom sediments of the SJR could also be remobilized during higher flows.
    - McBain and Trush (2002) found that “although water quality conditions on the SJR relating to conservative ions, (e.g., salt and boron), and some nutrients are likely to improve under increased flow conditions, it is unclear how these and other potential restoration actions will impact many of the current TMDL programs and existing contaminant load estimates. This is most true of constituents with complex oxidation reduction chemistry, and sediment/water/biota compartmentalization (e.g.,

> pesticides, trace metals). Perhaps the greatest risks to potential restoration actions within the San Joaquin River study reaches relate to uncertainties regarding remobilization of past deposits of organochlorine pesticides, i.e., DDT and mercury."

It remains unknown whether, or to what extent, migrating salmonids may be affected by suspended contaminants.

- It is generally recognized that contaminants can have a negative effect on aquatic ecosystems, however despite the extensive studies conducted in the field of toxicology, the direct ('acute toxicity' leading to death; or 'chronic' or 'sublethal toxicity' leading to decreased physical health; NMFS 2009a) and indirect effects (reduction of invertebrate prey sources, reducing energetically favorable prey species relative to less energetically profitable or palatable prey; Macneale et al. 2010) of pollutants on salmon in the wild are not well understood.
- Despite concerns over the threat contaminants may pose to threatened and endangered salmonid species, little is known regarding the effects of these contaminants on the health and survival of juvenile Chinook salmon in the Delta and its tributaries (Orlando et al. 2005).
- In a small scale, pilot study of contaminant concentrations in fish from the Delta and lower SJR, resident species were tested for some of the contaminants listed above; however, no salmonid species were tested (Davis et al. 2000).
    - The study found that 11 out of 19 adult largemouth bass sampled exceeded the mercury screening values, with a general pattern of lower concentrations downstream in the SJR toward the central Delta. DDT concentrations were exceeded in 6 of 11 white catfish, but only 1 of 19 largemouth bass. All samples above the DDT screening value were obtained from the South Delta or lower SJR watershed, indicating that the South Delta is still influenced by historic DDT use in the SJR basin. Two of the listed organophosphate pesticides were measured; diazinon was not detected in any sample and chlorpyrifos was detected in 11 of 47 samples analyzed, but at concentrations well below the screening value.
    - With regards to salmonids, however, it is important to consider that resident fish may experience chronic exposure to these chemicals, while outmigrating Chinook smolts pass through the South Delta in a relatively short period of time.
- A study by Meador et al. (2002) focused on estimating threshold PCB concentrations for juvenile Chinook salmon migrating through urban estuaries. PCBs were a concern because they had been shown to alter thyroid hormones important for the process of smoltification. During smoltification, salmonids tend to show declines in muscle lipids, the main lipid storage organ for salmonids, causing the PCBs to be redistributed to, and concentrated in, other organs (Meador et al. 2002).
    - Results of this study indicate that tissue concentrations below 2.4 mg PCB g-1 lipid should protect juvenile salmon migrating through urban estuaries from adverse effects specifically due to PCB exposure. This does not take

into account any effects of other contaminants likely to also be in estuarine waters such as the Delta.

Bioaccumulation, rather than exposure to dissolved contaminants, is likely the main concern for migrating juvenile Chinook.

- Pesticides in the water column may be dissolved contaminants or they may accumulate in suspended sediments associated with organic matter.
  - Dissolved contaminants can be absorbed through the gills or skin and this uptake may show more variability than the other exposure routes depending on concentrations, temperature and stress (Meador et al. 2002).
  - Contaminants that accumulate in riverbed sediments may be resuspended (Pereira et al. 1996), and enter the food chain through filter-feeding benthic or pelagic organisms, such as Corbicula clams. In turn, bottom feeder fish species (e.g., carp and catfish) consume filter-feeding invertebrates (Brown 1997). This process leads to bioaccumulation of the contaminants up the food chain.
  - Bioaccumulation, rather than exposure to dissolved contaminants, is likely the main concern for migrating juvenile Chinook (Meadnor et al. 2002). Factors that affect bioaccumulation include: variable uptake and elimination rates, reduced bioavailability, reduced exposure, and insufficient time for sediment–water partitioning or tissue steady state can affect (Meador et al. 2002).

8. VELOCITY

Overview

According to the SWRCB Technical Report (2012; page 3-29), higher spring flows “facilitate transfer of fish downstream” and “provide improved transport”. The term “facilitate transport” is undefined and is too vague to evaluate adequately. Although the SWRCB’s Technical Report (2012) cites DOI’s comments to the State Water Board (DOI 2010) regarding this function, there is no reference to “facilitate transport” anywhere in the DOI (2010) text. Therefore, it is unclear by what mechanisms spring flows facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level and duration.

Nonetheless, the SWRCB’s Technical Report (2012) may be suggesting that increased flows result in increased ***velocity***, which may lead to decreased juvenile salmonid travel time through the region, thus ‘facilitating transport’. Modeling suggests that velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs SJR flow, but the model predicts little to no change in velocity at other stations in the South Delta (Paulsen et al. 2008). Thus, increased flows may increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.

SWRCB's Technical Report (2012) Assertions Regarding Relationship Between San Joaquin River Flows and Velocity (Transport)

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding relationship between SJR flows and transport, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1. In the late winter and spring, increased flows provide or facilitate improved transport of fish downstream (page 3-29).

- No evidence is provided that higher spring flows "facilitate transport," or present any potential mechanisms by which "facilitation" could be measured.
- The term "facilitate transport" is undefined in the SWRCB's Technical Report (2012) and it is unclear by what mechanisms spring flows facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level, duration, turbidity, etc.
    - The SWRCB's Technical Report (2012) cites an early USFWS exhibit submitted to the SWRCB (USFWS 1987) in support of the hypothesis that increased SJR flows are positively related to smolt migration rates, "with smolt migration rates more than doubling as inflow increased from 2,000 to 7,000 cfs." However, the original reference does not specify how and when these data were gathered and analyzed.
    - Presumably, these data (USFWS 1987) are part of the work conducted by the USFWS as part of the Interagency Ecological Program for the Sacramento-San Joaquin Delta (IEP). As in other documents related to IEP and other early studies, data have often been misinterpreted, or there were factors not considered such as the potential for different sized fish to be released (different sized fish behave differently giving the appearance that migration rates were influenced by flows).
- In 2001, these hypotheses regarding flow and migration rates were already in question as evidenced by Baker and Morhardt (2001), which stated that "initially it seems intuitively reasonable that increased flows entering the Delta from the SJR at Vernalis would decrease travel times and speed passage, with concomitant benefits to survival. The data, however, show otherwise."
    - Baker and Morhardt (2001) examined the relationship between mean smolt migration times from three locations (one above and two below the Head of the Old River to Chipps Island) and San Joaquin flow (average for the seven days following release) and found no significant relationships at the 95% confidence level, and a significant relationship at the 90% confidence level for only Old River releases.
    - Although flows were not found to facilitate transport, there was evidence of an increase in smolt migration rate with increasing size of released smolts (Baker and Morhardt 2001), which again highlights the limitation of the "black box approach" and emphasizes a need for a better understanding of the mechanisms underlying the relationship of survival and flow. This increase in migration rate with increasing size may be explained by the one factor that definitely helps facilitate the transport of salmon through the Delta: the

    salmon itself. Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998), and the movements of juvenile salmonids depend on their species and size, water temperature, local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
  - Baker and Morhardt (2001) provide an example of a study which compared the speed of smolt passage to that of tracer particles (particle tracking model - PTM), “in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months.” According to documents filed in the Consolidated Salmon Cases (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167), simulations of PTM were compared to actual mark and recapture CWT data for Chinook salmon released at Mossdale on the SJR, and it was found that smolts traveled to Chipps Island 3.5 times faster than the modeled particles, with a significant difference in the time to first arrival (df=76, T=9.92, p<0.001).
- In recent years, VAMP has used acoustic tags to monitor smolt outmigration survival, therefore more detailed travel times have been estimated for the various SJR and South Delta reaches.
  - Results have generally shown short travel times between reaches, suggesting active swimming. In 2009, the average travel times were reported for each reach, and all were under 2.5 days (SJRGA 2010). For example, the average travel time between Lathrop and Stockton was only 2.29 days.
- Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998).
  - Movements of juvenile salmonids depend on their species, size, water temperature, local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
  - Recall the Baker and Morhardt (2001 example of a study, which compared the speed of smolt passage to that of tracer particles (i.e., PTM), discussed above.
  - Chinook released at Mossdale traveled to Chipps Island 3.5 times faster than the modeled particles (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
- Increased flows may slightly increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.
  - Modeling suggests that velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs SJR flow; however, the model predicts little to no change in velocity (<0.5 ft/s) at other stations in the South Delta (Paulsen et al. 2008).

9. PHYSICAL HABITAT

Overview

The historically diverse SJR and South Delta aquatic habitats have been substantially reduced, simplified and altered by development. One of the major changes in the system is the loss of shallow rearing habitat behind levees. Furthermore, aquatic vegetation growth and expansion over the past 20 years has increased water clarity by trapping suspended solids, affecting the composition of the fish communities (Nobriga et al. 2005). The current habitat structure now benefits introduced predators (Brown 2003).

The SWRCB's Technical Report (2012) maintains that the flow regime is the "master variable" that regulates the ecology of rivers, and the other habitat factors affecting community structure (e.g., temperature, water chemistry, physical habitat complexity), "are to some extent determined by flow (Moyle et al. 2011)." The report often refers to increases in physical habitat associated with increasing flow, however it lacks recognition of the limitations due to the substantially altered physical habitat. Much of the lower SJR and South Delta are banked by steep levees (about 443 miles downstream of Stanislaus River; Figure 2), limiting access to floodplain habitat and restricting true channel mobilization flows. For additional information see the discussions in the chapters "Floodplain Habitat" and "Geomorphology".

Relevant Information Regarding Physical Habitat

The physical habitat for native San Joaquin Basin and South Delta fishes has been substantially reduced and altered.

- Diverse habitats historically available in the Delta have been simplified and reduced by development of the watershed (Lindley et al. 2009).
- Spawning and rearing habitat have been severely reduced, salmon total abundance is down, and salmon diversity is reduced (McEvoy, 1986; Yoshiyama et al., 1998, 2001; Williams 2006).
- Major change in system is the loss of shallow rearing habitat (Lindley et al. 2009).
- An estimated 95% of wetlands/floodplains lost to levee construction and agricultural conversion since the mid 1800s (TBI 1998, Simenstad and Bollens 2003, Williams 2006).
- Only ~10% of historical riparian habitat remains, with half of the remaining acreage disturbed or degraded (Katibah 1984).
- Reduction in suitable physical habitat for delta smelt has reduced carrying capacity (Feyrer et al. 2007).

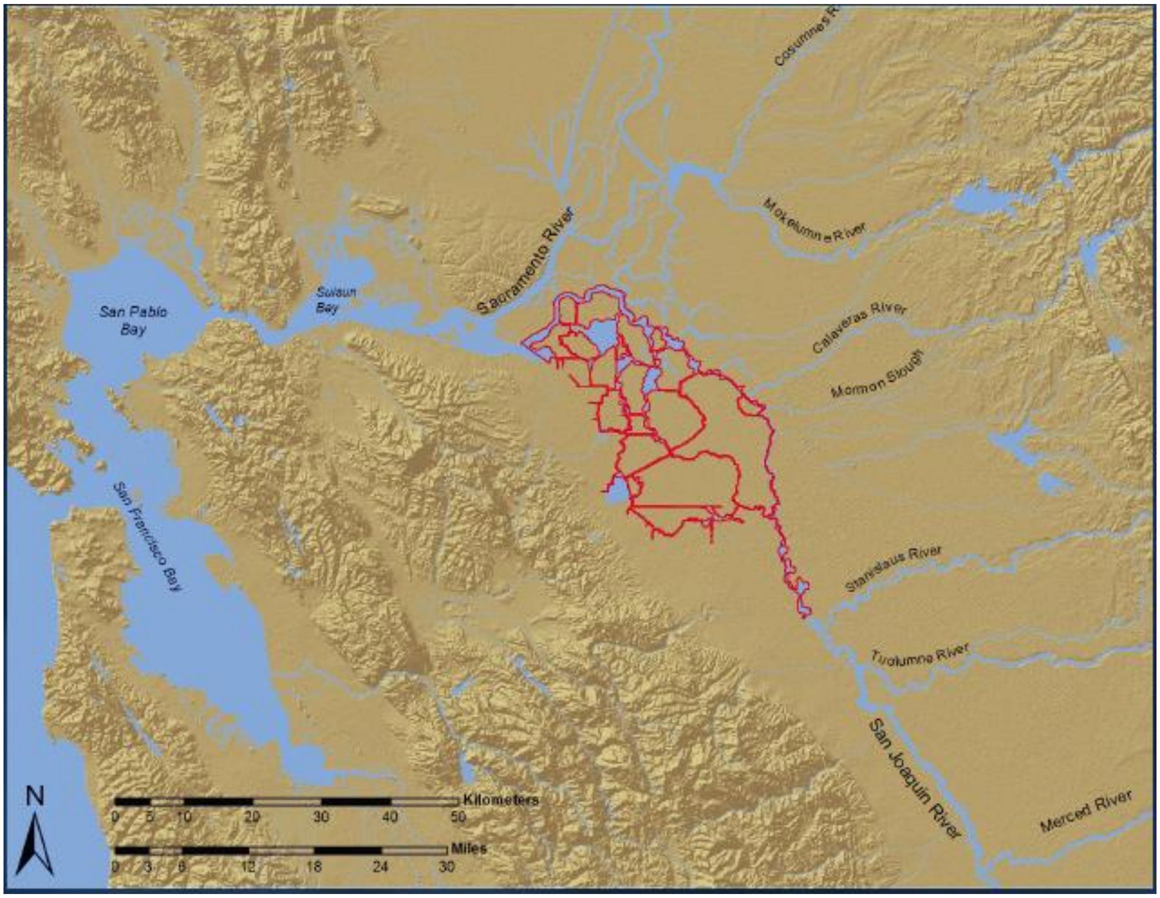

Figure 2. Levees in the South Delta and lower San Joaquin River downstream of the Stanislaus River confluence.

Habitat alterations are linked with invasive species expansions.

- *Egeria densa* (Brazilian waterweed) expansion has increased habitat and abundance of largemouth bass and other invasive predators (Baxter et al. 2008).
- The area near the CVP intake has significant amounts of *E. densa* (Baxter et al. 2008).

- Current habitat structure benefits introduced predators more than natives (Brown 2003).
- *Egeria* has strong influence on results of habitat alterations as different fish communities are found in its presence (Brown 2003).

Habitat influences growth, survival and reproduction through biological and physical mechanisms.

- Estuaries provide important rearing habitat for Chinook; salmon fry in Delta grew faster than in river (Healey 1991, Kjelson et al. 1982).
- Shallow water habitats support high growth in CV; juvenile Chinook had higher growth rates in small tributaries of Sacramento River than in the main Sacramento (Sommer et al. 2001; Jeffres et al. 2008; Maslin et al. 1997, 1998, 1999; Moore 1997).

Water quality aspect of habitat is highly variable.

- Aquatic vegetation increase, especially *E. densa*, over the past 20 years has increased water clarity by trapping suspended solids, with measurable effects on fish communities (Nobriga et al. 2005).
- Variability in habitat likely causes regional differences in the relationship between Delta smelt abundance and water quality (Baxter et al. 2008).
- Reduced pumping from the SWP in October of 2001 lowered salinity in western Delta (as desired), but led to opposite and unexpected result of increased salinity in central Delta (Monsen et al. 2007).

Improving habitat for increased abundance of native fishes.

- Increase productive capacity with access to floodplains, streams, and shallow wetlands (Lindley et al. 2009).
- Habitat quantity, quality, spatial distribution and diversity must be improved to promote life history diversity that will increase resilience and stability of salmon populations (Lindley et al. 2009).

10. GEOMORPHOLOGY

According to the SWRCB's Technical Report (2012), a more natural flow regime will improve geomorphic processes including scour and bed mobilization and will increase the number of turbidity events.

SWRCB's Technical Report (2012) Assertions Regarding Effects of Implementing a More Natural Flow Regime on Geomorphic Processes

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding effects of implementing a more natural flow regime on geomorphic processes, followed by supporting/contrary evidence, as follows:

Assertion 1. A more natural flow regime will improve bed scour and mobilization and provide associated benefits such as creating a "less homogenous channel with

structures that are important for fish habitat, such as meanders, pools, riffles, overhanging banks, and gravel substrates of appropriate sizes…and rejuvenate riparian forests and clean gravel for salmon…" (SWRCB Technical Report 2012; page 3-48).

The natural flow paradigm assumes that channel formation and maintenance is directly influenced and modified by flow, which is generally true under natural conditions; however, leveed rivers can be nearly independent of flow. Poff et al. (1997, page 770), identify "five critical components of the ["natural," i.e., unaltered by humans] flow regime that regulate ecological processes in river ecosystems: the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (Poff and Ward 1989, Richter et al. 1996, Walker et al.1995)." The authors also recognize that most rivers are highly modified and allude to the possibility that restoration of a natural flow regime may be limited "depending on the present extent of human intervention and flow alteration affecting a particular river (Poff et al. 1997, Page 780)." The natural flow paradigm assumes that channel form is directly influenced and modified by flow, which is generally true under natural conditions (a potential exception being a bedrock controlled channel); however, the morphology of a highly engineered river (e.g., levees) can be practically independent of flow (Jacobson and Galat 2006). In such a system, flow-related factors like timing of floods, water temperature, and turbidity may be managed; but, in absence of a "naturalized morphology, or flow capable of maintaining channel-forming processes, the hydrologic pulses will not be realized in habitat availability" (Jacobson and Galat 2006, page 250).

With minimal floodplains remaining in the San Joaquin Basin due to land use changes, higher flows do not necessarily provide the channel maintenance that would occur under natural conditions. In leveed systems such as the San Joaquin Basin, true channel mobilization flows are not possible because of flood control. In some instances, higher flows can actually result in increased detrimental incision in upstream tributary areas like the Stanislaus River where existing riparian encroachment is armored and cannot be removed by high flow events, which limits "river migration and sediment transport processes" (Kondolf et al. 2001, page 39). In addition, the ability to provide a more natural flow regime is hampered by "urban and agricultural developments that have encroached down to the 8,000 cfs line," which effectively limit the highest flows to no more than the allowable flood control (i.e., 8,000 cfs) (Kondolf et al. 2001, page 46). Also, in the case of the Stanislaus River, there is limited opportunity to provide mechanical restoration of floodplains due to private landowners and flood control. In instances where flood pulses can no longer provide functions such as ***maintenance of channel habitat***, Poff et al. (1997) states, "mimicking certain geomorphic processes may provide some ecological benefits [e.g., gravel augmentation, stimulate recruitment of riparian trees like cottonwoods with irrigation]."

In the absence of floodplain connectivity, the functions attributed to higher "pulse flows" cannot be achieved as described by the Flood Pulse Concept (FPC) (Junk et al. 1989; Junk and Wantzen 2003). Under natural conditions, the SJR was a river channel connected with its floodplain. Flood pulses in the winter and spring would have provided the functions identified by Junk et al. (1989) and by Junk and Wantzen (2003). However, anthropomorphic changes in the lower river (e.g., levees), particularly below Vernalis (the focus of the SWRCB's Technical Report 2012), have substantially reduced this floodplain connectivity and the region can no longer be considered a "large river-floodplain system." In fact, the extent of inundated floodplain in the SJR between the confluence of the Stanislaus River and Mossdale only exceeds 2,000 acres at the maximum modeled flow of 25,000 cfs (cbec 2010). In comparison, the Yolo Bypass is approximately 59,000-acres (Sommer et. al 2005) and the Cosumnes floodplain is about 1,200 acres (Swenson et al. 2003).

11. HEAD OF OLD RIVER BARRIER

Overview

Although the SWRCB's Technical Report (2012) mentions the Head of Old River Barrier (HORB) in several contexts, there is no cohesive discussion about the substantial impact that the HORB has on juvenile salmon survival through the lower SJR and South Delta.

Relevant Information Regarding Head of Old River Barrier

Operation of a rock barrier at the Head of Old River improves salmon smolt survival through the Delta by 16-61% (Newman 2008).

- HORB reduces entrainment into Old River from more than 58% to less than 1.5%.
- Survival appears to be lower in the Old River than it is in the main stem San Joaquin River (Newman, 2008).
- Physical (rock) HORB increases SJR flow.
- Installation of the HORB doubles through-Delta survival by directing juvenile salmonids through the SJR mainstem (compared to the Old River route, NMFS 2012).

Absence of Head of Old River Barrier

- In the absence of the physical (rock) HORB, a statistically significant relationship between flow and survival does not exist (Newman 2008); therefore there is no justification for increasing flows when the barrier is not in operation.
  - The temporary HORB rock barrier requires flows less than 5,000 cfs for installation and flows less than 7,000 cfs for operation (SJRTC 2008).

Head of Old River Barrier Timeline.

- Initiated as a part of the South Delta Temporary Barriers Project in 1991 to be a temporary rock-fill physical barrier to prevent juvenile Chinook salmon from entering Old River at the Head of the Old River (HOR).
- Installation of the HORB had been utilized each spring (except in high water years) from 1992-2007 (see status table below).
- Between 2008 and 2011, installation of the physical barrier was prohibited by a Federal Court decision by U.S. District Court Judge Wanger due to concerns for delta smelt.
- In 2009 and 2010, a non-physical barrier (Bio-Acoustic Fish Fence; BAFF) was installed to replace the spring time HORB.

- In 2012, the physical barrier was installed as a part of a Joint Stipulation order by US District Court Judge O'Neil.
- Installation status of HORB each spring since 1992 includes:

YEAR	Type of HORB Installed	Reason
2012	Rock	Court ruling (Joint stipulation)
2011	Not installed	High Flows
2010	BAFF	VAMP/BOR study
2009	BAFF	VAMP/BOR study
2008	Not installed	Court Ruling
1992-2007	Rock installed annually with exception of high flow years	Not installed 1993, 1995, 1998, 1999, 2005, and 2006 due to high flows

Salmon versus Delta smelt.

- The HORB physical barrier in spring stops the juvenile Chinook salmon from entering the Old River, avoiding entrainment in the state and federal pumps. But, USFWS has taken the position that the physical barrier causes a negative flow to occur in the Middle and Old Rivers (OMR), which creates a situation that elevates Delta smelt entrainment.
- USFWS contends that negative OMR flows up to 1,250 cfs do not increase entrainment of Delta smelt, but negative OMR flows greater than 1,250 cfs do.
- A Joint Stipulation issued by Judge O'Neil regarding the 2012 CVP and SWP operations includes flow restrictions for OMR flows in April between -1,250 and -3,500 cfs; in May between -1,250 and -5,000 cfs.

Head of Old River Bio-Acoustic Fish Fence (BAFF; Bowen et. al 2008, 2009a-b, 2010).

- Beginning in the Spring of 2009, a three-year study was initiated by the U.S. Bureau of Reclamation (USBR) to install and monitor the effectiveness of a non-physical barrier at the head of Old River called a Bio-Acoustic Fish Fence (BAFF). The BAFF was installed in 2009 and 2010, but was not installed in 2011 because of high water.
- The BAFF consisted of three parts: a sound emitting device, a bubble curtain and a light system of strobe hi-intensity LEDs.
- In 2009, when the BAFF was on it was over 80% efficient at deterring tagged salmon smolts from entering Old River. When the BAFF was off, only 25% of tagged salmon smolts did not enter Old River.
- In 2010, the alignment of the BAFF was changed; it was set out further in the channel, lengthened to 136 m, the angle changed to 30 degrees and the downstream end of the BAFF changed from a straight layout to a "hockey stick" configuration.
- It was thought that the 2009 alignment, while being efficient in deterring acoustically tagged smolts from entering Old River, may have guided them into or near the large scour hole immediately down the SJR of the HOR. Later, the USBR

biologists attributed the high mortality of the tagged smolt to low flows in 2009, stating that the low flow consolidated the smolt path "So, prey may have been forced into a smaller volume of water with predator*s*", thus increasing predation (Bowen 2009).

Comparison of HORB BAFF efficiencies in 2009 and 2010

	2009 Range (%)	2009 Mean (%)	2010 Range (%)	2010 Mean (%)
Mortality rates between Durham Ferry and HORB	25.2 to 61.6	40.8	2.8 to 20.5	7.8
Predation rates at HORB	11.8 to 40	27.5	17 to 37	23.5
Deterrence rate of Barrier		81.4 total		23.0 total
Protection Efficiency	14 to 62	31	31 to 60	43.1

Head of Old River Barrier Predation and "Hot Spots."

- Predation Rate at HORB
    - 2009 11.8 – 40% (mean 27.5%)
    - 2010 17 – 37% (mean 23.5%)

Head of Old River Flow conditions during VAMP releases and tracking period.

- 2009 – 75/25% split in flows; with 75% heading into Old River, 25% into the mainstem San Joaquin (dates of operation: 4/22 – 6/13/2009)
- 2010 – 58/42% split; with 58% heading into Old River 42% into the mainstem San Joaquin (dates of operation: 4/25 – 6/25/2010)

12. PREDATION

Overview

Numerous studies have found that striped bass and other piscivorous fish prey on outmigrating salmon (Shapovalov 1936, Stevens 1966, Thomas 1967, Pickard et al. 1982, Merz 2003, Gingras 1997, Tucker et al. 1998). While striped bass are likely the most significant predator of Chinook salmon and Delta smelt (Nobriga and Feyrer 2007), several other invasive predators occur in the Delta and may also contribute to the predation losses including white catfish, black crappie, smallmouth bass, and spotted bass. The predation appears to be patchy both seasonally and spatially, with higher levels of predation documented in the spring, in areas of anthropogenic influence such as near water diversion structures and dams (Gingras 1997, Tucker et al. 1998, Merz 2003, Clark et al. 2009). In recent years it has become clear that predation on salmon may significantly limit salmon recovery efforts (NMFS 2009b; Dauble et al., 2010). The NMFS Draft Recovery Plan (2009b) for Chinook salmon and CV steelhead considered "predation on juveniles" one of the most important specific stressors.

The SWRCB's Technical Report (2012) indicates that flow can operate indirectly through other factors that directly influence survival, including predation. The report makes several statements regarding the relationship between flows and predation, asserting that increased flows will reduce the impacts of predation on outmigrating salmonids.

Relevant Information Regarding Predation

The VAMP review panel concluded that "high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow" (Dauble et al. 2010).

- All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the CV and recovery will not occur without significant reduction in their populations and/or predation rates (DFG 2011).

Striped bass prey on juvenile Chinook.

- Many studies have found that striped bass eat salmon (Shapovalov 1936, Stevens 1966, Thomas 1967, Pickard et al. 1982, Merz 2003, Gingras 1997, Tucker et al. 1998).
- Striped bass stomachs have been collected with juvenile Chinook composing up to 65% (by volume) of the total contents (Thomas 1967).
- Waddell Creek stomach contents in April of 1935 found that large striped bass fed heavily on young salmon and trout (30.8% by number of occurrence) (Shapovalov 1936).
- In the Mokelumne River, 11 to 51% of the estimated salmon smolts were lost to striped bass predation in the Woodbridge Dam afterbay in 1993. Chinook were 24% (by volume) of juvenile bass stomach content in the spring in the Mokelumne River (Stevens 1966).
- Below Red Bluff Diversion Dam juvenile salmon outweighed other food types in striped bass stomach samples by a three to one margin (Tucker et al. 1998).
- Almost any fish occurring in the same habitat as striped bass will appear in the bass diet (Moyle 2002).
- There are roughly 1 million adult striped bass in the Delta and their abundance remains relatively high despite curtailment of a stocking program in 1992 (CDFG 2009).
- Recent concerns about the survival of endangered winter-run Chinook salmon in the Sacramento River have focused on the impacts of striped bass predation on outmigrants and the effects of striped bass population enhancement on winter-run Chinook population viability (Lindley and Mohr 1999). It was estimated that at a population of 765,000 striped bass adults, 6% of Sacramento River winter Chinook salmon outmigrants would be eaten each year (Lindley and Mohr 1999, 2003).

- "CDFG documented in their 2002 annual report to NMFS that an adult striped bass (420 mm) collected in May 2002 at Miller Ferry Bridge had 39 juvenile salmonids in its stomach (DFG022703)." (Hanson 2009).

Striped bass in the San Joaquin River and South Delta prey on juvenile Chinook to such an extent that they significantly reduce the number of Chinook returning to the San Joaquin Basin.

- High predation losses at the State Water Project (SWP) are particularly detrimental to SJR Chinook salmon populations since over 50% of juvenile salmon from the SJR travel through Old River on their way to the ocean, exposing them to predation at Clifton Court Forebay (CCF) and causing substantially reduced survival.
- Predation rates in CCF are as high as 66-99% of salmon smolts (Gingras 1997; Buell 2003; Kimmerer and Brown 2006).
- Striped bass are generally associated with the bulk of predation in CCF since their estimated populations have ranged between 30,000 and 905,000 (Healey 1997; Cohen and Moyle 2004); however, studies indicate that six additional invasive predators occur in the CCF (i.e., white catfish, black crappie, largemouth bass, smallmouth bass, spotted bass, redeye bass) with white catfish being the most numerous, having estimated populations of 67,000 to 246,000 (Kano 1990).
- Yoshiyama et al. (1998) noted that "[S]uch heavy predation, if it extends over large portions of the Delta and lower rivers, may call into question current plans to restore striped bass to the high population levels of previous decades, particularly if the numerical restoration goal for striped bass (2.5 to 3 million adults; USFWS 1995; CALFED 1997) is more than double the number of all naturally produced CV Chinook salmon (990,000 adults, all runs combined; USFWS 1995)."
- Hanson (2005) conducted a pilot investigation of predation on acoustically tagged steelhead ranging from 221-275mm, and estimated that 22 of 30 (73%) were preyed upon.
- Nobriga and Feyrer (2007) state: "Striped bass likely remains the most significant predator of Chinook salmon, *Oncorhyncus tschawytscha* (Lindley and Mohr 2003), and threatened Delta smelt, *Hypomesus transpacificus* (Stevens 1966), due to its ubiquitous distribution in the Estuary and its tendency to aggregate around water diversion structures where these fishes are frequently entrained (Brown et al. 1996)."

Recent San Joaquin Basin VAMP studies conducted from 2006–2010 provide direct evidence of high predation rates on Chinook salmon in the lower San Joaquin River and South Delta.

- An acoustic tag monitoring study was conducted from 2006 – 2010 to evaluate survival of salmon smolts emigrating from the SJR through the Delta (SJRGA 2011).
    - In 2006, results indicated that without the, "Head of Old River Barrier in place and during high-flow conditions many (half or more) of the acoustic-tagged fish, released near Mossdale, migrated into Old River."

    - In 2007, a total of 970 juvenile salmon were tagged with acoustic transmitters and were detected by a combination of receivers:
        - Mobile tracking found that 20% of released fish (n=192) were potentially consumed by predators at three "hotspots" located near Stockton Treatment Plant (n=116), just upstream of the Tracy Fish Facility trashracks (n=57), and at the head of Old River flow split downstream of Mossdale (n=19).
        - Stationary detections indicate an average 45% loss, potentially attributable to predation, which does not account for losses at the largest "hotspot" at Stockton Treatment Plant, nor in the greater Delta past Stockton and Hwy 4.
    - In 2008, the only tagged fish entering Old River to survive were fish collected (salvaged) at two large water conveyance projects and transported through the Delta by truck (Holbrook et al. 2009).
    - In 2009, the combined loss rate from Durham Ferry to the HORB and the loss rate in the vicinity of the HORB (BAFF in) combined to show a loss rate between 60 -76% of the seven groups released at Durham Ferry (SJRGA 2010).
        - Mortality rates (likely due to predation) between Durham Ferry and the BAFF ranged from 25.2% to 61.6% (mean 40.8%) (Bowen et al. 2009).
        - Predation rates near the BAFF ranged from 11.8% to 40% (mean 27.5) (Bowen et al. 2009).
    - In 2010, Old River supplemental smolt releases concluded of 162 of 247 (65.6%) tags were classified as coming from a predator rather than a smolt (SJRGA 2011).
        - Mortality rates (likely due to predation) between Durham Ferry and the BAFF ranged from 2.8% to 20.5% (mean 7.8%) (Bowen and Bark 2010).
        - Predation rates near the BAFF ranged from 17% to 37% (mean 23.5%) (Bowen and Bark 2010).

Significant predation losses are also occurring in the San Joaquin Basin tributaries due to non-native predators.

- Radio tracking studies conducted during May and June of 1998 and 1999, respectively (Demko et. al 1998; FISHBIO unpublished data), indicated that the survival of large, naturally produced and hatchery juveniles (105 to 150 mm fork length) was less than 10% in the Stanislaus River downstream of the Orange Blossom Bridge.
- Individual based, spatially explicit model – Piscivores consume an estimated 13-57% of fall-run Chinook in Tuolumne River (Jager et al. 1997).
- Significant numbers of striped bass migrate into the Stanislaus River each spring, as detected at the weir (Anderson et. al 2007; FISHBIO unpublished data), and are thought to prey heavily on outmigrating Chinook smolts.

The overwhelming majority of predation on juvenile Chinook is the result of non-native predators that were intentionally stocked by CDFG, and whose abundance can be reduced to minimize the impacts on Chinook.

- Most of the non-native fish species (69%) in California, including major predators, were intentionally stocked by CDFG for recreation and consumption beginning in the 1870s. All of the top predators responsible for preying on native fish are currently managed to maintain or increase their abundance. Historically, the Delta consisted of approximately 29 native fish species, none of which were significant predators. Today, 12 of these original species are either eliminated from the Delta or threatened with extinction, and the Delta and lower tributaries are full of large non-native predators such as striped bass that feed "voraciously" throughout long annual freshwater stays (McGinnis 2006).
    - Lee (2000) found a remarkable increase in the number of black bass tournaments and angler effort devoted to catching bass in the Delta over the last 15 years.
    - According to Nobriga and Feyrer (2007), "largemouth bass likely have the highest per capita impact on nearshore fishes, including native fishes," and concludes that "shallow water piscivores are widespread in the Delta and generally respond in a density-dependent manner to seasonal changes in prey availability."
    - "In recent years, both spotted bass (*Micropterus punctulatus*) and redeye bass (*M. coosae*) have invaded the Delta. While their impact in the Delta has not yet been determined, the redeye bass has devastated the native fish fauna of the Cosumnes River Basin, a Delta tributary" (Moyle *et al.* 2003 as cited by Cohen and Moyle 2004).
    - Black crappie were responsible for a high level of predation during a 1966/67 CDFG study (Stevens 1966). As many as 87 recognizable fish were removed from the stomach of one crappie, and counts of 40 to 50 were common. Most of the fish were undigested, hence not in the stomachs for very long.
- A lawsuit by the Coalition for a Sustainable Delta against DFG was settled in April 2011. Under the settlement, a comprehensive proposal to address striped bass predation in the Delta must be developed by state and federal fishery management agencies. As part of the settlement DFG must make appropriate changes to the bag limit and size limit regulations to reduce striped bass predation on the listed species, develop an adaptive management plan to research and monitor the overall effects on striped bass abundance, and create a $1 million research program focused on predation of protected species.
    - DFG (2011) proposed changing striped bass regulations to include raising the daily bag limit for striped bass from 2 to 6 fish with a possession limit of 12, and lowering the minimum size for striped bass from 18 to 12 inches. Proposed regulations included a "hot spot" for striped bass fishing at Clifton Court Forebay with a daily bag limit of 20 fish, a possession limit of 40 fish and no size limit. Fishing the hot spot would require a report card to be filled out and deposited in an iron ranger or similar receptacle.
    - With significant pressure from striped bass fishing groups, the California Fish and Game Commission denied the changes proposed by agency biologists in favor of keeping striped bass protections (CFGC 2012).
- According to NMFS (2009b), Priority Recovery Actions (1.5.4) Implement programs and measures designed to control non-native predatory fish (e.g., striped

> bass, largemouth bass, and smallmouth bass), including harvest management techniques, non-native vegetation management, and minimizing structural barriers in the Delta, which attract non-native predators and/or that delay or inhibit migration.

Reducing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival.
High predation likely occurs at specific “hot spots”, which can be the focus of a control program. The predation on salmonids appears to be patchy both seasonally and spatially, with higher levels of predation documented in the spring, in areas of anthropogenic influence such as near water diversion structures and dams (Gingras 1997, Tucker et al. 1998, Merz 2003, Clark et al. 2009). Stevens (1966) reported a “highly localized” situation at the Paintersville Bridge; in June he found some of the highest predations rates for the region, when 90.7% of all bass with food in their stomachs had consumed Chinook salmon (198 salmon in 97 stomachs). In 1993, a diet study estimated that 11 to 28% of the natural production of salmon smolts in the Mokelumne River was lost to striped bass predation in the Woodbridge Dam afterbay (Merz 2003). Likewise, below Red Bluff Diversion Dam on the Sacramento River juvenile salmon were found in high numbers in the stomachs of striped bass (Tucker et al. 1998). In addition, striped bass are generally associated with the bulk of predation in Clifton Court Forebay, where pre-screen loss rate (attributed to predation) was estimated at 63-99% for juvenile Chinook salmon and 78-82% for steelhead migrating through the Clifton Court Forebay (Gingras 1997, Clark et al. 2009). Furthermore, during a study of predation on salvaged fish (that had already survived the Forebay) the researchers noted a lack of predators at the non-release, control sites, suggesting “that the salvaged fish releases at the release sites were the principal attractants of predators as opposed to some other factor such as the presence of a man-made structure” (Miranda et al. 2010).

The predatory fishes such as striped bass and largemouth bass prey on covered fish species and can be locally abundant at predation hot spots. Adult striped bass are pelagic predators that often congregate near screened diversions, underwater structures, and salvage release sites to feed on concentrations of small fish, especially salmon. Striped bass are a major cause of mortality of juvenile salmon and steelhead near the SWP south Delta diversions (Clark et al. 2009). Largemouth bass are nearshore predators associated with beds of invasive aquatic vegetation (BDCP 2012).

Targeted predator removal at hot spots would reduce local predator abundance, thus reducing localized predation mortality of covered fish species. Predator hot spots include submerged structures, scour holes, riprap, and pilings. Removal methods will include electrofishing, gill netting, seining, and hook and line (BDCP 2012).

Altered Delta habitat has benefited non-native predator species and increased the vulnerability of outmigration juvenile salmonids.

> “The structure of the Delta, particularly in the central and southern Delta, has been significantly altered by construction of manmade channels and dredging, for shipping traffic and water conveyance. Intentional and unintentional

introductions of non-native plant and animal species have greatly altered the Delta ecosystem. Large predatory fish such as striped bass and largemouth bass have increased the vulnerability of emigrating juveniles and smolts to predation, while infestations of aquatic weeds such as *Egeria densa* have diminished the useable near- shore, shallow water habitat needed by emigrating salmonids for rearing (NMFS 2011)."

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Attachment A

Technical Memorandum

Review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010)

TO: Tim O'Laughlin

FROM: Doug Demko, Michele Palmer, Andrea Fuller

DATE: January 30, 2012

SUBJECT: Review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010)

This memorandum has been developed to present results of a review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010). We focused our review on those references that were used in one or both documents to support the position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline including, in chronological order, Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, DFG 2005a, DFG 2009, Mesick and Marston 2007, Mesick et al. 2007, Mesick 2008, Mesick 2009, Mesick 2010a-e, and USDOI 2010. In addition, we examined peer reviews conducted on the SWRCB (2011) and DFG (2010) documents (Quinn et al. 2011 and Gross et al. 2010, respectively). A summary of key points is provided below followed by a detailed discussion of the findings of our review.

Summary of Key Points

- **References used by the SWRCB and DFG to support their position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline are NOT the best available science for evaluating current flow/survival relationships due to a variety of reasons including:**
    - All references prior to 2008 (i.e., Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) are outdated and lack recent data reflecting major anthropogenic changes to the Delta ecosystem resulting in a regime shift in about 2000-2001; and are also statistically limited and have been superseded by superior Bayesian analyses conducted by Newman (2008)[1].

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[1] In 2008, a more robust Bayesian analysis was designed and conducted by Newman using data from 1985 through 2006 (Newman 2008) to address the limitations of all the previous coded wire tag data analyses presented in pre-2008 reports.

  - The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005a, DFG 2009) has been found to be flawed through both peer and professional reviews, as identified in previous comments submitted to the SWRCB (Demko et. al 2010).
  - Mesick references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model.
  - At least two Mesick documents have been rejected previously by FERC because the authors
    - presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and
    - improperly analyzed the Tuolumne River in isolation of other Central Valley populations, did not consider effects of hatchery introductions on Tuolumne River Chinook salmon, and discounted other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).
  - Additionally, Mesick 2009 and supporting references (Mesick et al. 2009 a, b) have apparently been rejected for publication.
- **Currently, the best available science that should be used to evaluate potential flow/survival relationships, which were mentioned in the SWRCB technical reports but were inappropriately applied, include the following:**
  - Newman 2008 has been subject to extensive peer-review and is a published work (unlike Mesick documents); and uses higher quality information (paired releases versus non-paired releases used in other Mesick analyses).
  - VAMP Peer Review indicates that consideration should be given regarding the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook, including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta.
- **Peer review of SWRCB's final technical report indicates several areas for improvement, which are consistent with our previously and presently submitted comments and peer review comments are also applicable to the DFG QBO report:**
  - Due to limited review time, it is likely that Peer reviewers for the SWRCB's final technical report were not aware of previous findings regarding DFG's SJRFRCS Model or of this model's similarity to the Mesick analyses, which may have affected their comments.

  - Nonetheless, even with limited information and review time, Peer reviewers found several areas for improvement including, but not limited to:
    - Implausibly high linkage of higher spring flows to adult escapement;
    - Other processes besides flow have likely contributed to declines, and will continue to hinder salmon recovery;
    - Holistic view (considering other factors besides flow) would be more tenable;
    - Contradictory statements regarding influence of ocean conditions;
    - Relies too heavily on secondary sources;
    - Several figures are not clear and could be better expressed with different analyses, or some figures do not support statements.

- **Peer review of DFG's QBO report indicates several areas for improvement, which are consistent with our previously and presently submitted comments, and peer review comments are also applicable to the SWRCB's technical reports:**
    - Using the best available science means:
      - Agencies may not manipulate their decisions by unreasonably relying on some sources to the exclusion of others.
      - Agencies may not disregard scientifically superior evidence.
    - Many concerns about the use (or lack of use) of citations.
      - Citations are to support an argument, not establish a fact.
      - References must be accurately and clearly cited.
      - Peer-reviewed literature preferred.
      - Frequent use of some references to exclusion of scientifically superior sources.
    - Uncertainties and assumptions are not provided.
    - Assumption that flow alone will restore fish populations is poorly founded.
    - Salmon objectives do not distinguish between hatchery and naturally produced fish.

REVIEW OF FINDINGS

1. References used by the SWRCB and DFG to support their position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline are NOT the best available science for evaluating current flow/survival relationships due to a variety of reasons including:

- **All studies prior to 2008 (i.e., Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) are outdated and lack recent data reflecting major anthropogenic changes to the Delta ecosystem resulting in a regime shift in**

about 2000-2001; and are also statistically limited and have been superseded by superior Bayesian analyses conducted by Newman (2008)[2].

Three of the references cited prior to 2001 (Kjelson et al 1981, Kjelson and Brandes 1989, AFRP 1995) present regressions of spring flow at Vernalis vs. escapement 2.5 years later, and it is hypothesized from these regressions that smolt survival is positively correlated with river flow. Since smolt survival in the San Joaquin River was not measured, the influence of river flow on smolt survival could not be assessed.

In 2001, the first multi-year analyses of smolt survival data from mark-recapture studies was conducted to estimate salmon survival relative to flow at Vernalis were conducted by Baker and Morhardt (2001) and Brandes and McLain (2001). While Brandes and McLain (2001) identified a statistically significant relationship between smolt survival from Dos Reis to Chipps Island and river flow at Stockton, Baker and Morhardt (2001) concluded that "smolt survival through the Delta may be influenced to some extent by the magnitude of flows from the San Joaquin River, but this relationship has not been well quantified yet, especially in the range of flows for which such quantification would be most useful." Baker and Morhardt (2001) noted several weaknesses in the available data including low recapture numbers which generated imprecise estimates of survival, a lack of control of flow and export conditions during individual experiments, and lack of a statistical design in combinations of flows and exports.

The Vernalis Adaptive Management Plan (VAMP) studies were designed to address these weaknesses in previous CWT data and provided additional data through 2006. CWT data continued to be analyzed in piecemeal fashion through 2006 and the analyses were eventually superseded in 2008 by superior Bayesian analyses conducted by Newman (2008).[1] During the VAMP studies an abrupt, downward shift in smolt survival was documented.

- **The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005a, DFG 2009) has been found to be flawed through both peer and professional reviews, as identified in previous comments submitted to the SWRCB (Demko et. al 2010).**

Both the SWRCB and DFG refer to the SJRFRCS Model to support the idea that more spring flows are necessary to create more Chinook salmon in the San Joaquin Basin. As identified in our previous comments (Demko et al. 2010), which the SWRCB has not incorporated into their final technical report, the SJRFRCS Model uses inappropriate statistical models that do not represent the best available science; two versions of the SJRFRCS Model have been reviewed and found to contain substantial flaws (DFG 2005a version reviewed by Deas et al. 2006 and Pyper et al. 2006, and DFG 2009 version reviewed by Lorden and Bartoff 2010).

Demko et al. (2010) stated that

> The most recent version of the DFG [SJRFRCS] model (DFG 2009) is still considered inappropriate for use by the SWRCB for a number of reasons, including the previously mentioned incomplete revisions and the lack of peer-review. Our comments, highlighting the problems with the statistical validity of the current DFG model, are summarized under the next 12 issue statements. Details regarding these statements are provided in Attachment 1 [of Demko et.al. 2010].

- DFG Model Issue 1. It is clear that in order to have a statistically sound model for escapement, one needs to incorporate environmental variables other than, or in addition to flow, such as dissolved oxygen, exports, and water temperature.
- DFG Model Issue 2. The proposed simple linear regression model of escapement versus flow is inconsistent with the most recent data from 1999-2009, which shows a negative correlation between flow and escapement.
- DFG Model Issue 3. The proposed model is inconsistent over different flow ranges. For example, when dividing the range of flow observations into 4 equally sized bins, one of the bins shows a negative correlation between flow and escapement.
- DFG Model Issue 4. There are a small number of overly influential observations in the flow versus escapement data. For example, if one selects a moderately sized subset of these paired observations at random, the model fit varies widely and one frequently observes a negative correlation between flow and escapement.
- DFG Model Issue 5. The Ecological Fallacy: The well-known phenomenon that averaging over subgroups (as has been done with the flow data) falsely inflates the strength of a linear relationship.
- DFG Model Issue 6. Outliers are present in the flow versus escapement data.
- DFG Model Issue 7. The residuals from the flow versus escapement model exhibit non-normality.
- DFG Model Issue 8. Heteroscedasticity: The estimated errors in the flow versus escapement model exhibit a non-constant error rate.
- DFG Model Issue 9. Nonlinearity is observed in the flow versus escapement data.
- DFG Model Issue 10. The estimated errors in the flow versus escapement model exhibit dependence.
- DFG Model Issue 11. The flow versus escapement model has a low R_2 value of around 0.27.
- DFG Model Issue 12. The Regression Fallacy: That correlation implies causation.

- **Mesick references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model. Not peer-reviewed/similar analyses to DFG's SJRFRCS Model**. The SWRCB and DFG rely on several Mesick documents to support the position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline (i.e., both rely on Mesick 2009; Mesick et al. 2007; SWRCB also relies on Mesick 2001 and Mesick 2010a-e; and DFG also relies on Mesick 2008 and Marston 2007) as well as the SJRFRCS Model (DFG 2005, 2008, and 2009. Mesick documents have not been peer-reviewed, and their analyses are the same/similar to those used in DFG's SJRFRCS Model (DFG 2005a, DFG 2009).

Peer-reviewed literature is preferred since supporting evidence for an argument or position is stronger as a result of independent experts critical reviews of the papers; while citations to agency reports (e.g., Mesick documents) frequently provide weaker supporting evidence because they have not been independently reviewed by recognized experts (Gross et al. 2010).

As indicated in the previous section, DFG's SJRFRCS Model (DFG 2005a, DFG 2009) has been found to be flawed through peer (Deas et al. 2006) and professional (Pyper et al. 2006, Lorden and Bartoff 2010) reviews. Mesick references are largely based on the same linear regression approach used in DFG's SJRFRCS Model, and this approach continues to be re-packaged with slight variations by Mesick, as well as by DFG (2005a, 2009), and the U.S. Fish and Wildlife Service's (USFWS) Anadromous Fish Restoration Program (AFRP 2005). Although the regressions indicate a correlation between flow at Vernalis and escapement 2 ½ years later, the use of linear regressions to assess these effects is too simple an approach particularly given the fact that all authors include violations of simple linear regression; inadequate inclusion of other environmental factors (e.g., temperature) that are clearly important (e.g., predation, temperature); and the tendency for other factors to be correlated with each other (Lorden and Bartroff 2010). Some of the major problems with the linear regression approaches used by all of these authors include:

- Averaging (such as over months of flows) reduces variation that may exist (masking biologically important variations in flow) and has potential to falsely inflate the strength of linear relationship or make one appear when there is a more complex relationship or none at all. Authors have a responsibility to show that the variation lost in averaging does not affect the inferred relationship.
- Lack of robustness in the linear regression model fit does not support a cause-effect relationship between flow and escapement.
- Small number of data points overly influence and inflate the linear relationship between escapement and flows.
- Analysis assumes that escapement is normally distributed, but it is been shown to be non-normally distributed.
- Assumes that escapement is subject to random variations whose scale is constant and which averages out to zero; however, residual plots indicate both a bias (non-zero average) and non-constant scale of variations. Also, there are outliers contributing to the bias.
- Correlation does not imply causation (Lorden and Bartroff 2010).

Therefore, although linear regression relationship results suggest that flow may affect juvenile survival, the results do not imply a direct cause-effect relationship between juvenile salmon survival and flow, or that increasing flow will cause juvenile salmon survival to increase.

- **At least two Mesick documents have previously been rejected by FERC because the authors**
    - **presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and**
    - **improperly analyzed the Tuolumne River in isolation of other Central Valley populations, did not consider effects of hatchery introductions on Tuolumne River Chinook salmon, and discounted other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).**

Tuolumne River Limiting Factors Analysis (Mesick et al. 2007) Rejected by FERC. During recent FERC proceedings (FERC 2009a) regarding the operation of the New Don Pedro Project on the Tuolumne River, FERC rejected the findings of the Limiting Factors Analysis conducted as part of the Tuolumne River Management Conceptual Model by Mesick et al. (2007) because the authors presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (e.g., Delta exports, ocean conditions, and unscreened diversions). Key points made by FERC in a FERC Order issued July 16, 2009 (FERC 2009a) regarding the problems associated with Mesick et al. (2007) analyses include the following:

- Page 20, ¶70. Mesick et al. (2007) identifies Tuolumne River flows as having the greatest impact on juvenile Chinook salmon survival… however, they do not include any studies to ascertain the influence of other possible limiting factors, such as pumping at the state and federal water projects in the San Francisco Bay Delta, ocean conditions, and unscreened diversions in the Tuolumne River and in the Delta. In response to these concerns, we find that it may be inappropriate to focus on flow-related studies to the exclusion of other, possibly significant, limiting factors.
- Page 29, ¶74. Our review of the Limiting Factor Analysis does not suggest that the recent collapse of the Tuolumne River fall-run Chinook salmon can be attributed to the Article 37 flow regime. Rather, the analysis simply shows that, up to a point, higher flows produce more fish. This is not surprising. However, no significant increase in run size could occur if conditions outside the river system are unfavorable. Because fall-run Chinook salmon failed in the entire Sacramento and San Joaquin River system, it seems likely that one or more factors common to all of these runs may have caused the collapse. Further, we note that in recent Congressional testimony, NMFS agreed with this conclusion, stating that "the cause of the decline is likely a survival factor common to salmon runs from different rivers and consistent with the poor ocean conditions hypothesis being the major causative factor.
- Page 29, ¶75. The Limiting Factor Analysis states that Tuolumne River spring flows in excess of 3,000 cfs are necessary to ensure successful Chinook returns. However, the fallacy of focusing entirely on flows is illustrated by the fact that

the average spring flow in 2006 and 2007 (from February 1 through May 31) exceeded 3,500 cfs, yet the returns of both jack and adult fall-run Chinook salmon in 2008 and 2009 were extremely low.

- Page 31, ¶78. The Limiting Factor Analysis also discounts the effects of ocean conditions on the Tuolumne River stock. A report by the National Oceanic and Atmospheric Administration in 2006 and a recent report prepared for the Pacific Fishery Management Council in 2009 document that poor ocean conditions in 2005 and 2006 were the primary cause for the collapse of the Sacramento River Basin fall-run Chinook salmon.

Tuolumne River Risk of Extinction Analysis (Mesick 2009) Rejected by FERC. Mesick (2009) was originally submitted to FERC as Exhibit No. FWS-50 and was reviewed by Noah Hume (Senior Aquatic Ecologist at Stillwater Sciences, a scientific consulting firm). Hume testified that Mesick's (2009) risk of extinction analysis was improperly applied and pointed out that San Joaquin salmon populations have dropped well below the minimums necessary to maintain genetic viability in several periods in the past but have rebounded within a few years. Although Hume indicated that he did not have enough time to thoroughly review Mesick's document, he pointed out the following: (1) analyzing the population demographics and trends of the Tuolumne River population in isolation of other San Joaquin and Sacramento basin populations is suspect because the Tuolumne River population is not recognized as a distinct population segment (DPS) but is part of the Central Valley faIl/late fall-run Chinook evolutionary significant unit (ESU), which is not listed as endangered or threatened [status: Species of Special Concern]; (2) no consideration was given regarding the effects of hatchery introductions on Tuolumne Chinook salmon and the influence of inbreeding; and (3) no basis was given for discounting the influence of other factors (e.g., Delta and ocean conditions).

Based on Hume's testimony and corroborating testimony from Dr. Peter Moyle (professor at the University of California, Davis), FERC found

> the Tuolumne Chinook salmon population may be subject to extirpation, but is not at risk of extinction pending relicensing. Recent declines in Chinook salmon escapement levels are comparable to those occurring in other San Joaquin River tributaries and based on past patterns of high and low spawning returns, escapement levels in the Tuolumne River and other tributaries, are likely to rebound. More monitoring is needed to determine what factors, in addition to instream flows, are adversely impacting the salmon. (FERC 2009b, ¶275)

These findings are also applicable to other San Joaquin basin populations (i.e., Stanislaus and Merced).

- **Additionally, Mesick 2009 and supporting references (Mesick et al. 2009 a, b) have apparently been rejected for publication.**

  According to Carl Mesick's Curriculum Vitae (CSPA_exh8 Carl Mesick CV), he submitted several reports to the *California Fish and Game Scientific Journal* for publication in October 2009 (i.e., Mesick 2009 and Mesick et al. 2009a, b). However, none of these papers has been published in this journal as of their Summer 2011 issue, which indicates that these papers were not adequate for publication.

  Despite being rejected for publication and by FERC, these papers were used directly (i.e., Mesick 2009) or as sub-references to other Mesick documents within the SWRCB technical report including:

  (1) Mesick et al. 2009a, b, were used as basis for risk of extinction analyses in Mesick 2009;
  (2) Mesick 2009 used as supporting evidence for the risk of extinction of Tuolumne River salmon in Mesick 2010d;
  (3) Mesick et al. 2009a used as the basis for analyses regarding the relationship of flow, temperature and exports with adult recovery rates in Mesick 2010c; and
  (4) Mesick 2009 and Mesick et al. 2009a, b used in a synthesis of these analyses in Mesick 2010a, e.

2. Currently, the best available science that should be used to identify flow/survival relationships, which were mentioned in the SWRCB technical reports but were inappropriately applied, include the following:

- **Newman 2008.** Various analyses (e.g., Mesick 2010c, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) regarding smolt survival through the San Joaquin River Delta are used instead of superior analyses (i.e., Newman 2008). As an example, there are several reasons why the analyses presented in Mesick 2010c are inferior to Newman 2008, including the following:

  - Newman 2008 was subject to extensive peer-review and is a published work; unlike Mesick 2010c, which has not been peer-reviewed.
  - Mesick's approach does not use paired releases to address the effects of differences in sampling effort or the influence of conditions beyond the San Joaquin Delta. The quality of the information from the 35 paired releases used by Newman is superior to the 158 non-paired releases used by Mesick.
  - There are several problems with the way the Mesick 2010c analysis is presented including:
    - Basic statistics to describe the fit or significance of trend lines shown for each regression are noticeably absent from Mesick 2010c. For instance, there are no r^2 values reported for what appear to be very poor fits.
    - It is not clear whether the 13 instances of zero recoveries shown in Table 1 were included the analyses.

  - The y-axis scale of 0-3% used for the graphs is an attempt to exaggerate the purported influence of flow and water temperature on recovery rates. This is an extremely narrow range, particularly when one considers expected noise in the data, and the potential effects of sampling effort.

Besides being inferior to Newman (2008), Mesick 2010c does not support the statement on pages 3-26 and 3-51 that "numerous studies indicate the primary limiting factor for FRCS tributary abundances is reduced spring flow, and that populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows". Mesick 2010c does not support the first part of this statement because in order to identify a primary limiting factor for FRCS tributary abundances, one would need to explore the relative impacts of all factors affecting each lifestage of FRCS in the tributaries, the San Joaquin River Delta, and in the ocean. For instance, Mesick 2010c did not explore whether survival during smolt outmigration is more limiting than ocean harvest. This analysis also did not explore whether river flow is the primary factor influencing smolt survival through the San Joaquin River Delta, since the recovery rates used were inclusive of smolt survival beyond Chipps Island and adult survival.

Similarly, Mesick 2010c also does not support the statement that "populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows". This analysis did not explore how population abundance, presumably escapement, may be correlated with flow. The analysis attempted to focus on the influence of San Joaquin River Delta flow on adult return rates, however the method used did not isolate smolt survival through the Delta from survival in the Bay, the Ocean, and during adult upstream migration.

- **Vamp Peer Review.** While the Technical Report discusses findings of a peer review of the VAMP conducted in 2010 (Dauble et al. 2010), an important recommendation to the SWRCB was omitted, which provides context for interpretation of the flow and survival relationships in terms of revision to the flow objectives. Specifically, the Panel was asked "*How can the results from the VAMP to date be used to inform the SWRCB's current efforts to review and potentially revise the San Joaquin River flow objectives and their implementation?*" The first part of their response, which was not included in the SWRCB's Technical Report, states that "In our answer to question 1, we attempted to summarize the scientific information obtained from the VAMP studies related to salmon survival through the Delta and the three factors of flow, exports, and the HORB. For several reasons, it is not straightforward to use that information to inform the Board's current efforts to review and revise San Joaquin River flow objectives. Because our review focused on the survival and passage of salmon smolts through the Delta, we did not evaluate other factors that may be limiting future salmon production. In setting flow objectives, we believe the Board **should consider the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook, including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta** [emphasis added] (SJRTC 2008)." The Technical Report fails to address this recommendation.

3. Peer review of SWRCB's final technical report indicates several areas for improvement, which are consistent with our previously and presently submitted comments and are also applicable to the DFG QBO report:

Peer reviewers were given a short time frame (30 days) to review the SWRCB's final technical report and were likely not aware of previous findings regarding DFG's SJRFRCS Model (i.e., peer review by Deas et al. 2006, Pyper et al 2006, Lorden and Bartroff 2010); or of the model's similarity to the Mesick analyses, which may have affected their comments.

Even in absence of this background material, peer reviewers for SWRCB's final technical report found areas for improvement including:

- Relies too heavily on secondary sources.
- Several figures are not clear, could be better expressed with different analyses, or do not support statements.
- Implausibly high linkage of higher spring flows to adult escapement.
- Other processes besides flow have likely contribute to declines, and will continue hinder their recovery.
- Holistic view (considering other factors besides flow) would be more tenable.
- Contradictory statements regarding influence of ocean conditions.

Relevant excerpts from peer reviewers are provided in Attachment 1.

4. Peer review of DFG's QBO indicates several areas for improvement, which are consistent with our previously and presently submitted comments, and are applicable to the SWRCB's technical reports:

- "Using the best available scientific information" means (page 3):
  - Agencies may not manipulate their decisions by unreasonably relying on some sources to the exclusion of others.
  - Agencies may not disregard scientifically superior evidence.
- Many concerns about the use (or lack of use) of citations.
  - Citations are to support an argument, not establish a fact. "Citations, even to the peer-reviewed literature, are not like theorems in mathematics, and do not establish validity."(page 3)
  - References must be accurately and clearly cited.
  - "Whenever possible, references should be to peer-reviewed literature, not internal technical reports or testimony." (page 6)
  - "Frequently relies on some sources to the exclusion of scientifically superior sources… it cites outdated analyses by Kjelson and Brandes instead of superior analyses (Newman and Rice 2002; Newman 2003)… It relies on an unpublished work by Marston [i.e., Marston 2007] and ignores superior studies by Newman [i.e., Newman 2008] and others involved with VAMP, and by Terry Speed (1993). It fails to cite many relevant, more recent papers (Appendix A3), including a long review on

Central Valley Chinook and steelhead (Williams 2006) that would have drawn DFG's attention to the superior sources just noted." (page 6)

- "Does not acknowledge the uncertainty associated with most of the modeling work referred to in the Draft." (page 6)
- "Critical assumptions and areas of major uncertainty are not described." (page 6)
- "assum[tion] that flow alone will restore natural processes and restore/reconnect critical habitats for [many] species… is poorly founded." (page 7)
- "objectives for salmon fail to distinguish hatchery and naturally produced fish" (page 9)

Relevant excerpts from peer reviewers are provided in Attachment 1.

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ATTACHMENT 1

EXCERPTS FROM A PEER REVIEW OF THE STATE WATER RESOURCES CONTROL BOARD'S FINAL TECHNICAL REPORT ON THE SCIENTIFIC BASIS FOR ALTERNATIVE SAN JOAQUIN RIVER FLOW AND SOUTHERN DELTA SALINITY OBJECTIVES

[Quinn, T., J.D. Olden, and M.E. Grismer]. 2011. External Peer Review of: State Water Resources Control Board California Environmental Protection Agency "Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives"

Quinn, Page 5
In general the report relies too heavily on secondary sources (e.g., Moyle 2002; NMFS 2009a, 2009b; Williams 2006). There is nothing wrong with these references *per se* but their use compels the reader to get that reference and find the relevant place in it. In cases where the secondary source is lengthy or not readily available, this is no small task. In addition, the referencing of work outside the basin and outside California is limited. I understand that the report has a sharp focus on the San Joaquin River but there are a number of places where work done elsewhere would be relevant.

In terms of conclusions, the report makes a strong case that the shortages of salmon and steelhead are in large part related to the heavy modification of this river system. The mean flows and variances in flow that are normal in rivers of this region and for which the fish evolved have been radically altered (see more detailed comments below). It seems likely, however, that other processes have played a role over the years in the decline of these fishes, and will continue to hinder their recovery. Some of these processes may be synergistic with flows such as, perhaps, chemical contaminants or predation in streams, whereas other may operate independently such as fisheries management, ocean conditions, predation by marine mammals, etc.

Quinn, Page 7
The use of olfaction to locate natal streams deserves better citations than (NMFS 2009a, DFG 2010a). It would be better to cite Hasler and Scholz (1983) or perhaps Dittman and Quinn (1996).

[TR] P. 70 The statement "However, if natal streams have low flows and salmon cannot perceive the scent of their natal stream, straying rates to other streams typically increases." demands more details. There should be information on this important feature of the adult phase and appropriate references. I was surprised to find that there have been no tracking studies on the movements and travel rate of salmon in this system. Can this be true, and if so, why have none been done? This is off-the-shelf technology and clearly important to inform

management in many ways.
I also have some sense (though I confess to not being sure precisely where I learned it) that there are much higher straying rates from the SJR than are considered normal, and that these result from transportation of hatchery juveniles downstream, and also from the difficulties that returning adults experience in detecting odors, given the altered flow regimes. Forgive me if I am mistaken in this regard but if there is any truth to the statement that straying is more prevalent than is normal, this certainly merits more attention in the report. There should be coded wire tagging data from the main hatcheries, I would think, and the analysis of them should be simple.

Quinn, Page 8
The statement that "streamflow alteration, dictated by the dams on the major SJR tributaries, affect [sic] the distribution and quantity of spawning habitat " seems to call for more information. Presumably, the dams have reduced the sediment transport patterns but some detail and references to this would be helpful, or at least an explanation of the processes. The peak flows will play a role in these kinds of sediment transport processes. Is there a loss of intermediate gravel sizes, leaving cobbles and silt? Has the gravel become embedded and so less suitable?

Figure 3.1, which seems to be copied from the NMFS BiOp, needs a proper caption; as is, it is hard to interpret.

Figure 3.2 is quite interesting. Are there similar data for other years, and if so, perhaps a summary table or figure could be produced. Are the redd counts referring to new redds, or all that were counted on each survey? Were they flagged, and so how does the total redd count relate to the number of live fish? Were there tagging studies of stream life and generation of "area-under-the-curve" estimates? In general, I find myself wanting more detail about this kind of data.

Quinn, Page 9
"... since 1952, the average escapement of fall-run Chinook salmon has shown a steady decline. "
This statement is contradicted by the figure (3.5) associated with it. There is no obvious trend downward but rather there are a series of pronounced peaks (a pair of peaks around 1954 and 1960, then discrete ones around 1970, 1985, and 2003). Each of the peaks lasted about 8 years, with distinct "troughs" in between. I think the conclusion that this was a "steady decline" is not supported. Can there be some more sophisticated analyses? What we have seems like a visual examination. What can we make of these peaks and troughs?

Quinn, Page 11
[TR] Page 80 "The limited data that do exist indicate that the steelhead populations in the SJR basin continue to decline (Good et al. 2005) and that none of the populations are [sic] viable at this time (Lindley et al. 2007)."

This latter is a very strong statement and could use some elaboration. Presumably, the implication is that only exchange with resident trout maintains the steelhead phenotype. This should be stated more explicitly, and the biological basis for this exchange merits discussion. I am surprised that the interesting recent papers on California *O. mykiss* were not cited (e.g., those by Satterthwaite, Mangel and co-authors), nor relevant papers from elsewhere (e.g., Narum and Heath). This is not merely a matter of getting some additional references but it is fundamental to the status and recovery prospects for these fish. If the anadromous life history is latent in the resident trout then changes in environmental conditions may allow it to express itself, whereas if the forms are very discrete, as is the case with sockeye salmon and kokanee (the anadromous and non-anadromous forms of *O. nerka*: e.g., Taylor et al. 1996), then the loss of one form is likely more permanent. This extent of plasticity is directly relevant to the efforts to address the chronic environmental changes to which these fishes have been subjected, and the prospects for recovery.

It is also worth noting that the migratory behavior of steelhead differs markedly from that of sub- yearling Chinook salmon. Sub-yearlings spend a lot more time in estuaries and littoral areas whereas steelhead seem to migrate more rapidly (as individuals), exit estuaries quicker (as a population), and occupy offshore waters to a much greater extent. There was extensive sampling in the Columbia River system by Dawley, McCabe and co-workers showing this, and many references to the use of estuaries.

The summary of the importance of spring flows for Chinook salmon seems very reasonable but it would be good to actually see more of the data on which these statements are based. What relationship might there be to pre-spawning mortality or incomplete spawning of adults, or egg- fry survival?

Quinn, Page 12
Figure 3.8 would be better expressed after adjustment for the size of the parent escapement and some density-dependence. Plotting numbers of smolts vs. flow suggests a connection but I would think that multi-variate relationships should be explored.

[TR] Page 84-85. “In a 1989 paper, Kjelson and Brandes once again reported a strong long term correlation (*R2* of 0.82) between flows at Vernalis during the smolt outmigration period of April through June and resulting SJR basin fall-run Chinook salmon escapement (2.5 year lag) (Kjelson and Brandes 1989).

This relationship should be easy to update and I would like to see the recent data. Frankly, I find this correlation implausibly high. There are so many factors affecting marine survival that even a perfect estimate of the number of smolts migrating to sea will not have an R2 of 0.82 with total adult return, much less with escapement (including both process and measurement error). I do not doubt that higher flows make for speedier passage and higher survival, but to link them so closely with adult escapement is stretching it. Indeed, it would seem that NMFS (2009) came to a similar conclusion. After acknowledging the shortcomings in this approach, it seems odd to see Figure 3.10, which is a time-series with flow during the smolt period and lagged escapement. If we much have escapement as the metric rather than smolt survival, can we not at least plot flow on the x-axis rather than date, and some form of density-adjusted recruit per spawner metric on the y-axis? I find it very difficult to see the relationship when plotted as time series.

Figure 3.12. This figure is a poor quality reproduction, and the y-axis is not defined. What is CDRR? (It is not in the list of acronyms). This report is pretty dense in terms of jargon and acronyms and abbreviation, so any effort to state things in plain English will be appreciated.

The text on the Importance of Flow Regime (3.7) is very sensible. It would be helpful to know what sources of the salmon mortality are most directly affected by flow reduction but, given the obvious data gaps, this seems unlikely. Thus overall correlations with survival and basic ecological principles have to carry the day. The text on fish communities, however, is rather confusing. I expected to see information of species composition, comparative tolerances to warm and cool water by various native and non-native fishes, ecological roles with respect to salmon, etc. However, there was a shift to population structure and importance of genetic and life history diversity for the success of salmon. This text (which would benefit from basic references such as Hilborn et al. 2003 for sockeye salmon, and the more recent papers by Moore and by Carlson on salmon in areas more extensively affected by humans) is fine but the reference to variable ocean conditions and marine survival seems to contradict the earlier statements that only smolt number going to sea really matter. Overall, I think this holistic view is more tenable than one only emphasizing the link between flow and smolt production. There is no question that marine survival varies from year to year but all you can ask from a river is that it produce juvenile salmon.

With respect to water temperature, the relationships between physical factors (local air temperature, water depth, solar radiation, groundwater, and heat loss, etc.) are quite well understood so it should be possible to hind-cast the thermal regime that would have occurred in the SJR and its tributaries had the dams and diversions not taken place.

Quinn, Page 13
Delta Flow Criteria
“Finally, the relationship between smolts at Chipps Island and returning adults to Chipps Island was not significant, suggesting that perhaps ocean conditions or other factors are responsible for mortality during the adult ocean phase. ” This statement, referring to DFG data, also seems to contradict the earlier statements that marine conditions do not matter and that flow is all that matters. It would seem more correct to state that flow is the most important, among the things under our control.

On Table 3.15, it would be very helpful to present the status quo, so we can see the difference between the flows that DFG concluded are needed to double smolt production from present levels.

[TR] Page 105 “State Water Board determined that approximately 60 percent of unimpaired flow during the February through June period would be protective of fish and wildlife beneficial uses in the SJR. It should be noted that the State Water Board acknowledged that these flow criteria are not exact, but instead represent the general timing and magnitude of flow conditions that were found to be protective of fish and wildlife beneficial uses when considering flow alone."

This would seem to be a critical, overall conclusion: Higher and more variable flows are needed, and can be ca. 60% of unimpaired flows. This is logical and well supported by basic ecological principles, as these flows would provide benefits specific to salmon at several life history stages, and broader ecosystem benefits a well. The various exceedance plots (Figures 3.15 to 3.20) indicate that there is substantial improvement from flow at the 60% level whereas 20% and 40% achieve much less in the important late winter and early spring periods. As the report correctly notes, this is inevitably a bit arbitrary (why 60% - might 59% not do just as well?). Just as with agriculture and wildlife, fish production depends on complex interactions among a number of factors, of which flow is very important but not the only one. Extrapolation from lab studies to the field, where so many things go on at once and where history cannot be played back in a different scenario. So, one can pick at this value, just as one might pick at any specific value, and ask whether the fish can get by with a little less overall, or at some time of the year. Likewise, how much water do crops really need? Can we give the farmers less without hurting production? Obviously, that would depend on soil, temperature, distribution of the water, insects (beneficial and otherwise), and many other factors too. I think that this value (60%) is well- supported, given these kinds of uncertainties.

Olden, Page 4
Time series for fall-run Chinook salmon escapement exceed 50 years in length, highlighting steady declines since 1952 (Figure 3.5), and evidence is presented that hatchery-produced fish constitute a majority of the natural fall-run spawners in the Central Valley (Figure 3.6). The Technical Report and scientific papers discussed within collectively highlight the decadal long declines in Chinook salmon and steelhead trout (albeit limited data in the latter case) in the San Joaquin River basin. The Technical Report also correctly emphasizes that escapement numbers for the three tributaries are comparable in many years, thus suggesting the importance of coordinating flow management across the tributary systems. Indeed, discrete contributions from different tributaries may provide a portfolio effect by decreasing inter-annual variation in salmon runs across the entire system, thus stabilizing the derived ecosystem services (*sensu* Schindler et al. 2010, but within basins).

Olden, Page 6
The benefits of flow restoration may be enhanced if riverine thermal regimes are also considered. One example supporting this notion is in the lower Mississippi River where research has shown that growth and abundance of juvenile fishes are only linked to floodplain inundation when water temperatures are greater than a particular threshold. Schramm and Eggleton (2006) reported that the growth of catfishes (*Ictaluridae* spp.) was significantly related to the extent of floodplain inundation only when water temperature exceeded 15°C; a threshold temperature for active feeding and growth by catfishes. Under the current hydrographic conditions in the lower Mississippi River, the authors report that the duration of floodplain inundation when water temperature exceeds the threshold is only about 1 month per year) on average. Such a brief period of time is believed to be insufficient for

floodplain-foraging catfishes to achieve a detectable energetic benefit (Schramm and Eggleton 2006). These results are consistent with the ‘thermal coupling’ hypothesis offered by Junk et al. (1989) whereby the concordance of both hydrologic and thermal cycles is required for maximum ecological benefit.

Grismer, Page 2

Overall, this subject is difficult scientifically in terms of appropriate data collection and analyses. For example, the curve in Figure 3.8 on p.3-27 is practically meaningless given the few points available; perhaps this why no R2 value is provided. I suggest simply eliminating the curve. In Figure 3.10, there is extremely low fish “escapement” from the Merced River during 1950-1968 that would seem to “skew” results. Is there any explanation for this dearth of salmon in this period? Is it real or an artifact of sampling? In Figure 3.11, there is clearly an increase in recovered salmon as a function of the number released as might be expected, but the statistical interpretation is strained. Basically, averaging the 2-3 data points per number released indicates that approximately 2.5% salmon ‘recovery’ at releases of ~50,000 and 2.8% ‘recovery’ at releases twice as great (~100,000), leading to the possible observation that for releases up to ~100,000 fish recoveries between 2.5-3% might be expected. The single point at large value release (~128,000) suggests a greater recovery fraction (~5%), but it is only one point. Given the wide variability in the recovery numbers, I suspect that these recovery fractions are not statistically different. Perhaps a different analysis is more appropriate here.

ATTACHMENT 2

EXCERPTS FROM A PEER REVIEW OF THE CALIFORNIA DEPARTMENT OF FISH AND GAME'S QUANTIFIABLE BIOLOGICAL OBJECTIVES AND FLOW CRITERIA FOR AQUATIC AND TERRESTRIAL SPECIES OF CONCERN DEPENDENT ON THE DELTA

Gross, W.S., G.F. Lee, C.A. Simenstad, M. Stacey, and J.G. Williams. 2010. Panel Review of the CA Department of Fish and Game's Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta.

Gross et al. 2010, Page 3
We interpreted "using the best available scientific information" in terms of the following statements (from NRC 2004-a):

1) The agencies may not manipulate their decisions by unreasonably relying on some sources
to the exclusion of others;
2) The agencies may not disregard scientifically superior evidence;
3) Relatively minor flaws in scientific data do not render the data unreliable;
4) The agencies must use the best data available, not the best data possible;
5) The agencies must rely on even inconclusive or uncertain information is that is the best available at the time of the decision;
6) The agencies cannot insist on conclusive data to make a decision;
7) The agencies are not required to conduct independent research to improve the pool of available data.

…citation is supporting an argument, not establishing a fact. Citations, even to the peer-reviewed literature, are not like theorems in mathematics, and do not establish validity. For example, Stevens and Miller (1983) is in a peer-reviewed journal, but commits an elementary statistical error that vitiates its findings about the effects of Delta inflows on juvenile Chinook salmon (probably the authors and the reviewers missed the error because it was masked by the use of an index).

Gross et al. 2010, Page 4
Thinking of citations as supporting an argument explains why citations to the peer-reviewed literature are preferred. They provide stronger support for an argument because independent people thought to be qualified are supposed to have read the papers carefully. Citations to agency reports provide weaker support, even if the reports are conceptually and technically sound, because they are not independently reviewed. Citations to personal communications generally provide even weaker support, unless the person cited is a recognized authority, etc.

Gross et al. 2010, Page 6

- References must be accurately cited. It is the responsibility of the authors to ensure that they are correctly citing facts, results or conclusions from particular references and attributing them correctly. There are a number of examples in the Draft (discussed below in section 4.4.1) where a conclusion or fact is attributed incorrectly to a particular reference, which leaves the statement without a scientific basis.
- References must be clearly cited. Relying on references that are "personal communication" or obscurely cited ("NMFS 3 in SWRCB 2010") makes it difficult to evaluate the underlying science.
- Whenever possible, references should be to peer-reviewed literature, not internal technical reports or testimony. In many cases, this will require that the authors trace back through the literature to determine the original source of the information, but that is part of providing BAS.
- The Draft frequently relies on some sources to the exclusion of scientifically superior sources. As three examples, it cites outdated analyses by Kjelson and Brandes instead of superior analyses (Newman and Rice 2002; Newman 2003). It cites an outdated study by Brett (1952) and a consulting report and testimony by Alice Rich on the temperature tolerance of juvenile salmon instead of scientifically superior studies by Myrick and Cech (2001, 2002, 2004) and Marine and Cech (2004). It relies on an unpublished work by Marston and ignores superior studies by Newman2 and others involved with VAMP, and by Terry Speed (1993). It fails to cite many relevant, more recent papers (Appendix A3), including a long review on Central Valley Chinook and steelhead (Williams 2006) that would have drawn DFG's attention to the superior sources just noted.
- The Draft refers to a vague source (DFG 2010a) on key points, such as "Random rare and unpredictable poor ocean conditions may cause stochastic high mortality of juvenile salmon entering the ocean, but the overwhelming evidence is that more spring flow results in higher smolt abundance, and higher smolt abundance equates to higher adult production (DFG 2010a)" at p. 47. This sentence is also misleading; it is true that rare ocean conditions can cause high mortality of juvenile salmon entering the ocean, but so can more common conditions. This claim seems to be an attempt to defend the Marston results from the criticism that fitting models to smolt-adult survival data without taking variable ocean survival into account will give misleading results (a claim that is dubious to start with, but even more so without a supporting reference).

Gross et al. 2010, Page 7

- For many species, the Draft seems to assume that flow alone will restore natural processes and restore/reconnect critical habitats for these species. This assumption is poorly founded.
- Similarly, hypothesized responses by species and species assemblages should have been placed in context of DRERIP conceptual models (see: http://science.calwater.ca.gov/drerip/drerip_index.html for peer-reviewed models and documentation; these models are being prepared for future publication in *San Francisco Estuary and Watershed Science*).

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- The basic (not necessarily the Delta-specific) information on coastal wetland requirements and use by juvenile Chinook salmon is relatively parochial and out of date. There has been considerable information emerging over the past decade that continues to validate at least two relevant aspects of their life history:
    - Life history diversity of Chinook salmon, whether genetic or tactical, is influenced by habitat diversity and opportunity and is considered important to population resilience; and,
    - Several life history types express strong fidelity toward prolonged estuarine wetland occupancy, fidelity toward particularly geomorphic habitat features and specific locations, and selectivity toward particular estuarine food web pathways. Miller et al. (2010) provide evidence that a substantial proportion of juvenile Central Valley fall Chinook leave fresh water at <56 mm fork length. Given that most Central Valley fall Chinook are hatchery fish, as shown by Barnett-Johnson et al. (2005) and the proportion of marked fish observed in the 2009 carcass surveys, and that fish leaving fresh water at < 56 mm are unlikely to be hatchery fish, juveniles that leave fresh water before they reach “smolt” size may be the dominant part of the naturally produced fraction of the run. The objectives in the Draft ignore these fish.

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- The objectives for salmon fail to distinguish hatchery and naturally produced fish. The objectives refer to the salmon protection water quality objective, which seems to be: “Water quality conditions shall be maintained, together with other measures in the watershed, sufficient to achieve a doubling of natural production of Chinook salmon from the average production of 1967-1991, consistent with the provisions of State and federal law.” There is a key phrase in this language, “natural production,” that is defined in the CVPIA. This excludes hatchery-reared salmon. The Draft does not deal with the difference between hatchery and natural production of salmon and steelhead.
- The first three objectives embody the notion that river flows “transport salmon smolts through the Delta.” As discussed in Ch. 6 of Williams (2006), the migration of juvenile salmon is much more complicated than this and for most juvenile Chinook life history types cannot, and should not, be separated from rearing in the Delta.

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Year-to-year variability to meet biological objectives is missing, or is based on water year type. If we are to use functional flows, then the water year type should not be a factor – the biological requirements should be independent of the hydrology. If there is a need for year-to-year variability, then this should be stated as such (this is something that Fleenor et al. (2010) did very well). The biological objectives and required flows should not depend on the specific realization of hydrologic flows. To be clear, if we have 10 straight wet years, or 10 straight dry years, the required flows for meeting the biological objectives will be incorrect. It is possible that the DFG was using criteria based on water year type to create year-to-year variability, but the scientific basis for this approach is not established. To built this up scientifically, the authors would need to (a) define what degree of year-to-year variability in flows benefits the species (not done in the Draft); (b) establish the temporal variability of year types in the historical record (also not done here, but analysis exists); and (c) develop projections of the frequency of water year types for future conditions (the CASCaDE project the USGS has been pursuing may inform this).

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- The connection between Delta water temperatures and river flows is not established in the literature. The criterion proposed here (flows >5000 cfs in April-May keep Delta water temperatures below 65 F) does not have any scientific citation associated with it (in the Draft this criterion is based on testimony from the Bay Institute). Exploration of temperature in the Delta and the connection to flows has been pursued in a fundamental sense by Monismith et al. (2008) and in view of the effects of climate change in a paper that is in review by Wagner et al. (part of the USGS CASCaDE project).

Gross et al. 2010, Page 13-14

The use of testimony (unavailable for review – or at least difficult to track down) or another unreviewed technical report (SWRCB 2010) is not enough to justify conclusions. In one case (for the flow requirement to prevent flow reversal at Georgiana Slough), a fact is attributed to the SWRCB report, but in that report the fact is referenced to "personal communication" or to some testimony that is unavailable for review. Other examples include references to Snider and Titus (DFG technical reports), Allen and Titus (which is actually a proposal!) and testimony from groups like American Rivers or the Natural Heritage Institute. To ensure scientific transparency, references should be given to their original source. Otherwise, a personal communication or a proposal begins to have the appearance of a reviewed scientific reference.

Gross et al. 2010, Page 14

- Statements without scientific references are sprinkled throughout the Draft. One example lies in the statement that as natural flows have been reduced, flow conditions have become more favorable to non-native species. While this might be true, the inclusion of the modifier "flow" on "conditions" makes it a more specific statement than is likely to be defensible scientifically (i.e., the more vague statement "…as natural flows have been reduced, conditions have become more favorable to non-native species" is probably better established in the literature). As a second example, the discussion of the decline in San Joaquin River Chinook from 26000 to 13000 states "Flow related conditions are likely to be a major cause of this decline," but there is no reference to support the statement. Further, the use of non-peer-reviewed information undermines much of the results presented. The flows required to prevent salmon entrainment at Georgiana Slough, for example, are referenced from Perry et al. 2008 and 2009, but these are just technical reports, and have not been peer-reviewed; at least some of this work has been published and that should be cited.
- In most cases the report does not clarify the degree of scientific certainty/uncertainty associated with individual flow objectives. Therefore it is not clear to what extent each individual objective is supported scientifically.
- Minimal detail of relevant modeling studies has been provided. In any case where flow criteria have been based in part upon modeling studies, the modeling studies should be

briefly described in the Draft. Direct references of relevant papers and reports should be provided.

- There are a number of cases where the actual sources of a piece of information are inaccurately referenced – at times in ways that are quite deceiving. For example, the Draft attributes population declines since 1985 to flows based on Fleenor et al. (2010). Fleenor et al. (2010) do not make that statement. (It is bad enough that such a fundamental point to this whole process is being based on an unreviewed document.). They do compare 1949-1968 ('when fish were doing better') to 1986-2005 ('when fish were doing poorer') and note that the flows have changed – but they do ***not*** conclude that this is causative.
- In the first paragraph of page 75, an entrainment loss estimate of up to 40% was attributed to "PTM results" by Kimmerer (2008). The bulk of the entrainment losses estimated in Kimmerer (2008) were estimated based on survey observations, flow observations and several assumptions. Figure 16 and a small part of the text discuss particle tracking model results which estimate percent loss to the population. However, it should be noted that this is assuming no natural mortality. Kimmerer (2008) also estimates population losses by a more complete method which does take account of natural mortality but does not utilize any particle tracking results. These (lower) estimates are more appropriate to cite, preferably noting that the estimated error bounds for the calculated population losses are quite large.
- It is not entirely clear in which cases the Biological Objectives and Flow Criteria have been directly adopted from other documents such as the ERP Plan or OCAP (NMFS 2008). This should be clarified for each Biological Objective and Flow Criteria.
- The report commonly references SWRCB 2010 and DFG 2010a. SWRCB 2010 refers to the State Water Resources Control Board document. Some of the information in that document is associated with an information proceeding. This document summarizes existing information and scientific understanding. DFG 2010a refers to the participation of CDFG in the State Water Resources Control Board Informational Proceeding. Whenever possible original scientific literature should be cited as opposed to summary documents.

Gross et al. 2010, Page 15

- Fleenor et al. (2010) is referenced frequently when the citation should have been to the original scientific source material, especially when this was a peer-reviewed journal publication.
- The Draft misinterprets several important references. For example, at p. 40: "Based on the mainly oceantype life history observed (*i.e.*, fall-run), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry." The first clause in this sentence is incorrect; MacFarlane and Norton (2002) were contrasting their results with those from other ocean-type populations of Chinook. Moreover, MacFarlane and Norton (2002) defined the estuary in terms of salinity, rather than tidal influence, so their study applies only to the bays, not to the Delta. Further, their data collection did not begin until late spring, whereas most naturally produced fall

Chinook move into the Delta in winter or early spring.

- A large section of text regarding salmon (pp 36-39) that contain errors and poor scholarship, including the misreading just discussed, was taken from the 2009 OCAP BO without attribution. The Draft does note that "Much of this section is excerpted and adapted from DFG (2010a, 2010b) and SWRCB (2010)," and indeed much of the language also appears in SWRCB (2010). It does not seem, however, that the language was original with DFG, as suggested by the reference to DFG (2010a; 2010b), which were submissions to the process resulting in SWRCB (2010). We realize that Section 85084.5 directs DFG to develop its recommendations to the SWRCB in consultation with NMFS, but this is carrying consultation too far, and violates ordinary standards for scientific writing.