Rebuttal Report for

Michael L. Deas, P.E., Ph.D

I have reviewed the expert report and associated materials provided by Dr. Brown, Mr. Don Smith, Mr. T. Vermeyen, and Mr. M. Bender and considered the evidence presented therein. This information does not change my conclusion that flow and temperature can be managed consistent with the flow and temperature needs identified by Drs. Moyle and Kondolf (expert reports) for restoration of salmon in the San Joaquin River below Friant Dam. Outlined below are comments pertaining to the experts for the Federal defendants in the case *NRDC vs. Rogers*.

Russell Brown, Ph.D

Review of Dr Brown's expert report focused on model calibration and performance, as well as using the model to make several simulations under different assumptions.

Model Implementation and Calibration

Review of the model calibration and application work in the expert report, as well as the computer files indicates that, by and large, the application of CE-QUAL-W2 to Millerton reservoir has produced a useful tool for preliminary assessment of alternatives. Throughout the various expert reports, consideration of data limitations, time, and resources have all been identified as challenging issues associated with model development throughout the basin (above the Merced River). Nonetheless, the available models can provide useful insight into potential relationships between flow, meteorological conditions, operations, and temperature sufficiently to identify overall feasibility of various scenarios/operations.

With regard to the Millerton Reservoir model, appreciable effort has been invested in implementing and calibrating the model. Dr. Brown identifies model limitations, as well as limitations in inflow temperature, assumed sediment temperature, meteorological data, and potential withdrawal zone representation. Although these are dismissed as "minor" uncertainties, there is no comprehensive sensitivity testing presented in the report to support these conclusions.

As a point of clarification, it is not clear if Millerton Reservoir outflow temperatures were calibrated to observed river temperatures downstream of the dam or if the available data were derived from the fish hatchery temperature data set. This is potentially important because the fish hatchery blends water from the river outlets and Friant Kern canals. Thus such a data record may not fully represent the river outlet release temperature.

In addition to these identified uncertainties, no discussion of the effect of model spatial resolution is presented. Specifically, no testing of the segment length or layer thickness is presented - the process of incrementally refining the model grid (reducing layer thickness, reducing segment length) while holding all other parameters and conditions constant. Informal testing of the model indicates that reduction in layer thickness from

1.0 meter to 0.5 meters resulted in different simulated profile temperatures (Figure 1). These results are not intended to denote improvement in existing model performance under the refined grid – a recalibration would need to be completed – but that refinement may improve representation of the thermal regime. Although not completed as part of this rebuttal report, refinement of the segment length (longitudinal resolution) is also recommended. These refinements have not been completed due to time constraints.

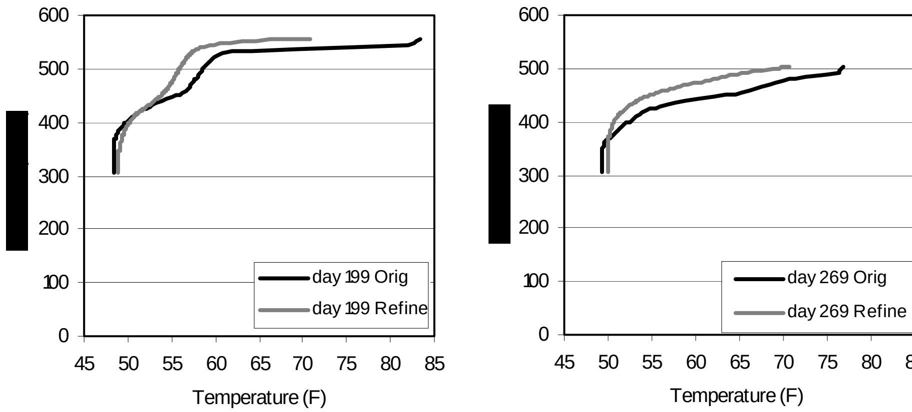


Figure 1. Comparison of simulated Millerton Reservoir profiles for a 1 meter layer thickness (“Orig”) and a 0.5 meter layer thickness (“Refine”)

The reduction in segment length, in addition to the value of testing the model as described above, would allow two key processes to possibly be included in a more representative fashion. First, due to model limitations, the Madera and Friant-Kern Canal withdrawal points are placed in model segments located well upstream of the dam from where these diversions actually occur. The Friant Kern Canal withdrawal is located in segment 20, over 2,200 feet upstream of the dam. The Madera Canal is located in segment 19, over 4,600 feet upstream of the dam. Reducing segment length would allow a more realistic representation of the canal intake locations. It is further suggested, that upon refinement of the model grid (segment length), that investigation of withdrawing water from a single segment (that both intakes withdrawing water from the same segment) be completed. The second key process that would potentially benefit from greater longitudinal resolution (as well as vertical resolution) would be to improve the representation of the uppermost reaches of Millerton Reservoir, where cool waters enter the reservoir and cooler, denser waters sink (“plunge”) below the thermocline during warmer periods of the year. Review of Ecological Analysts (1980) study suggest that this point occurred (at least in August 1979), in the middle of segment 2, which is over 5,400 feet – nearly one mile long. To represent this critical process of cold water inflows, greater resolution in this region of the reservoir would be beneficial. Although simulation times will increase markedly (run-time on a desktop 2.8 GHz Personal Computer is about 10 minutes under current configuration), this is a small price to pay for a more detailed representation of the system.

Another comment on the model calibration topic is the presentation of summary statistics to quantify model performance. Although graphical presentation of simulated versus observed values are provided, no statistics (e.g., bias, mean absolute error, root mean squared error) are included. The reader is left to interpret the narrative and graphical descriptions in a qualitative manner. Finally, additional data collection and model refinement efforts should continue to capture inter- and intra-annual variability.

The general conclusion that can be drawn from these findings is that a more refined, suitable geometric representation of the reservoir will potentially provide an improved capability to predict water temperatures within Millerton Reservoir as well as Millerton Reservoir release temperatures.

Model Testing and Application

Several simulations were completed using the CE-QUAL-W2 model provided by Dr. Brown. These include:

- simulation of the proposed Kondolf Dry-Normal release schedule
- reduced 2003 initial storage volume
- assessment of the impacts of a temperature control curtain at the upstream end of Millerton Reservoir
- utilizing the Friant Kern Canal to release waters to the San Joaquin River downstream of Friant Dam

These model simulations used the historic simulations as a baseline case, except as noted. Simulations were made only for the Dry-Normal hydrograph because these are the only years available from Dr. Brown's effort as represented by the CE-QUAL-W2 model files. No studies analyzing detailed re-operation or optimization of storage were examined, nor were different meteorological conditions assumed.

<u>Proposed Kondolf Dry-Normal Flow Schedule</u>

Assessment of the proposed Kondolf Dry-Normal (DN) Flow Schedule required modifying CE-QUAL-W2 files to reflect the flow regime specified by Dr. Kondolf. All parameters remained unchanged from the parameters used by Dr. Brown except as noted. The historic Friant-Kern and Madera Canal diversions were reduced equally by a fixed percentage in flow (approximately 18.3 percent and 24.4 percent in 2003 and 2004, respectively) to provide water for the proposed fish restoration hydrograph. Results for storage and Friant Dam river outlet release temperatures are presented in Figure 2 and Figure 3 for calendar year 2003 and 2004, respectively. Initial storage was assumed equal to the conditions for 2003 and 2004 as presented by Dr. Brown, unless noted.

The results show that reservoir storage deviates from the historical case during throughout both years with modest deceases in storage in the January through mid-March period; larger deviations from early spring through early summer as increased river releases reduce storage; and then higher than historic storage through late summer to early winter as reductions in Friant Kern and Madera Canals exceed, on average, increased releases from the river outlets (Figures 2 and 3).

Water temperatures at the river outlets deviates from historic, with temperature higher than historic from Mid-March onward. Temperatures peak in the November period as cool water supplies are diminished. This diminished cold water supply is within Millerton Reservoir proper, as well as the possibility of upstream storage sources running low on cold water as well. Maximum temperatures for the historic simulation were 53.0°F and 51.2°F for 2003 and 2004, respectively; for Kondolf -DN conditions 58.9°F and 58.4°F for 2003 and 2004, respectively, and Hanson conditions 61.4°F and 61.5°F for 2003 and 2004.

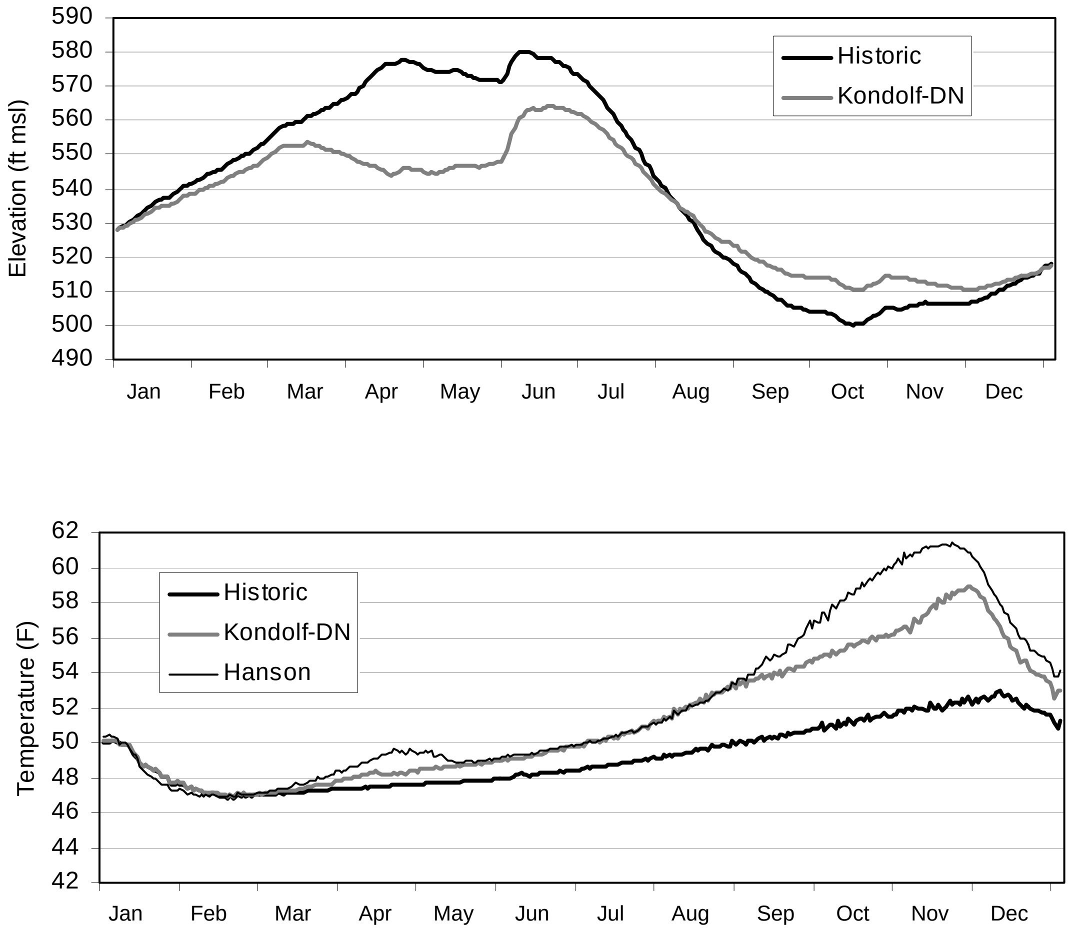


Figure 2. Simulated Millerton Reservoir water surface elevation (top) and Friant Dam river outlet release temperatures (bottom) for historic, Hanson, and Kondolf proposed Dry-Normal hydrograph: 2003

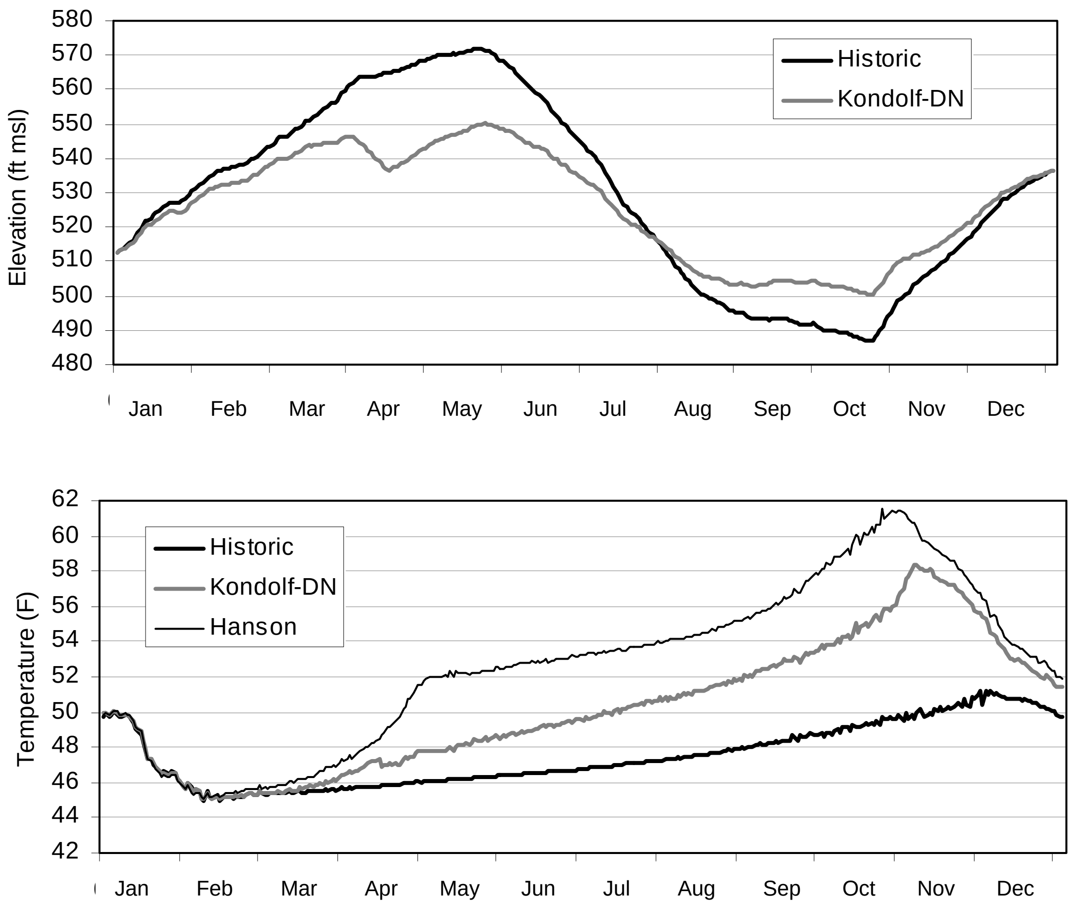


Figure 3. Simulated Millerton Reservoir water surface elevation (top) and Friant Dam river outlet release temperatures (bottom) for historic, Hanson, and Kondolf proposed Dry-Normal hydrograph: 2004

<u>Proposed Kondolf Dry-Normal Flow Schedule: Lower Initial Storage</u>
For the two years of simulation data (2003 and 2004) provided by Dr. Brown, the impacts of a potentially lower initial storage, calendar year 2003 was simulated with an initial elevation associated with a reduced storage by approximately 50,000 acre-feet – approximately 515 ft mean sea level (msl) versus approximately 528 ft msl. The calendar year 2003 was selected because Dr. Brown reduced historical initial storage for the Hanson hydrograph simulation by approximately 50,000 acre-feet “based on monthly operational modeling by Daniel Steiner, based on the USAN model” (Dr. Brown Report, pg 14). Thus, this Kondolf DN simulation with reduced initial storage allowed a more direct comparison of the Kondolf DN hydrograph with the Hanson hydrograph. Surface water elevation and Friant Dam river outlet release water temperatures are shown in Figure 4.

Impacts on release water temperatures are nearly the same for the Kondolf DN hydrograph with reduced and non-reduced initial storage throughout the year, with the exception of an approximately two-week period in November where temperatures are increased slightly above the Kondolf-DN year by up to approximately 0.8^{o}F. Carryover (i.e., initial) storage issues under these conditions are not critical because the initial storage is sufficiently high, and the fall storage conditions under these conditions do not differ significantly from the historical conditions. The reduction in cool water supplies in late fall correspond with seasonal cooling of the reservoir. Thus reservoir temperatures under the 50,000 acre-foot reduction remain similar to the baseline Kondolf DN hydrograph temperatures. The minimum storage level under the assumed lower 2003 initial storage condition was still some 10 feet above the minimum storage condition for 2004.

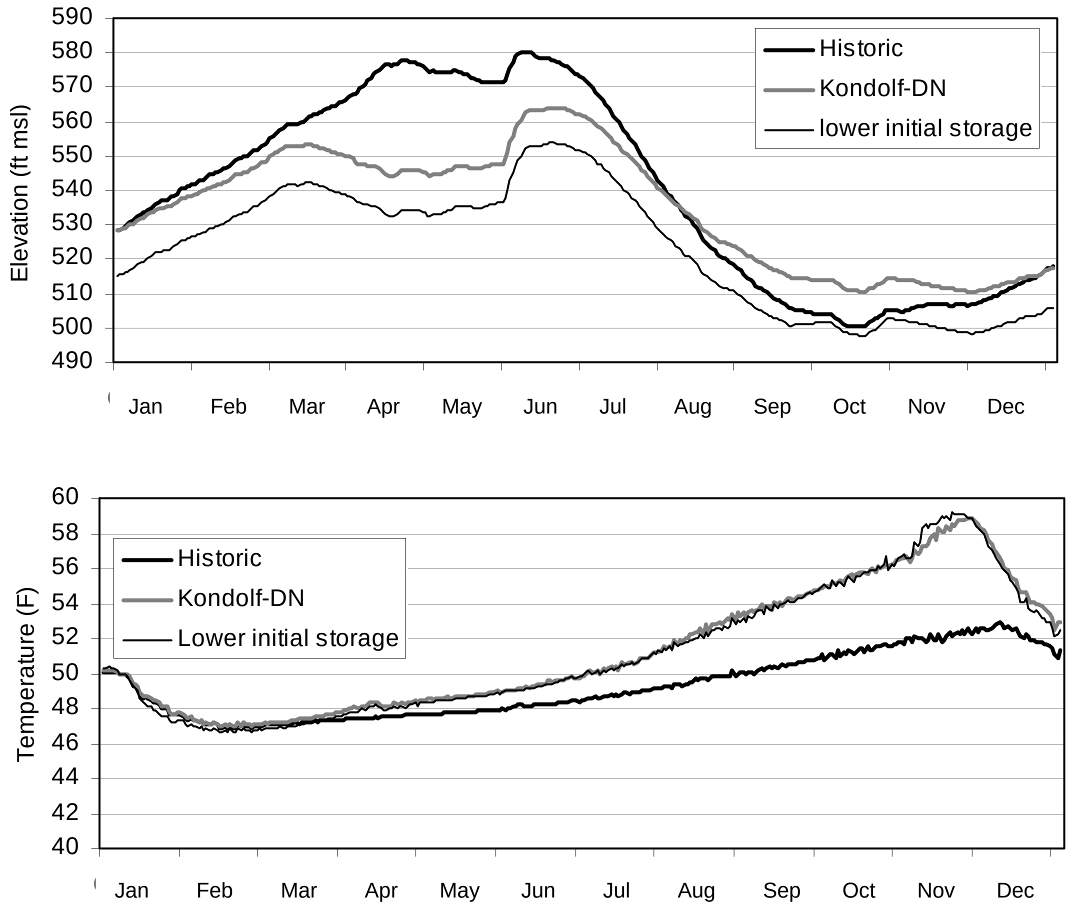


Figure 4. Simulated Millerton Reservoir water surface elevation (top) and Friant Dam river outlet release temperatures (bottom) for historic, Kondolf proposed Dry-Normal hydrograph, and Kondolf proposed Dry-Normal hydrograph with lower initial reservoir storage: 2003

Proposed Kondolf Dry-Normal Flow Schedule: Upstream temperature control curtain

Temperature control curtains take advantage of density differences between warm and cool waters. Cool waters are denser than warmer surface water and consequently, segregation of warm and cool waters results in thermal stratification during warmer periods of the year. The concept behind temperature control curtains is to preserve cold water inflows from the upper watershed as they transit the reservoir for downstream release by placing a curtain near the upstream end of the reservoir to force cool waters deeper into the reservoir (Figure 5). Other configurations can include curtains at the upstream and downstream end of the reservoir, effectively forcing inflowing waters below the thermocline, allowing them to pass through the lower layers of the reservoir to extend the cold water supply. Fundamental in the applications of temperature control curtains is a cold water source – either as a large reserve of winter water in the hypolimnion or a cold water source coming in at the inflow to the reservoir.

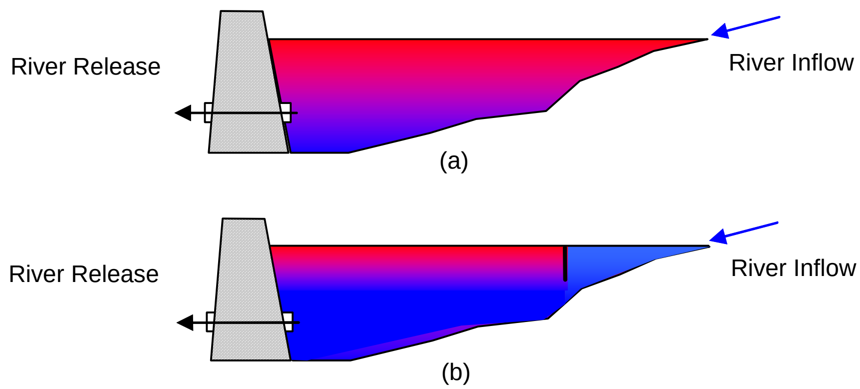
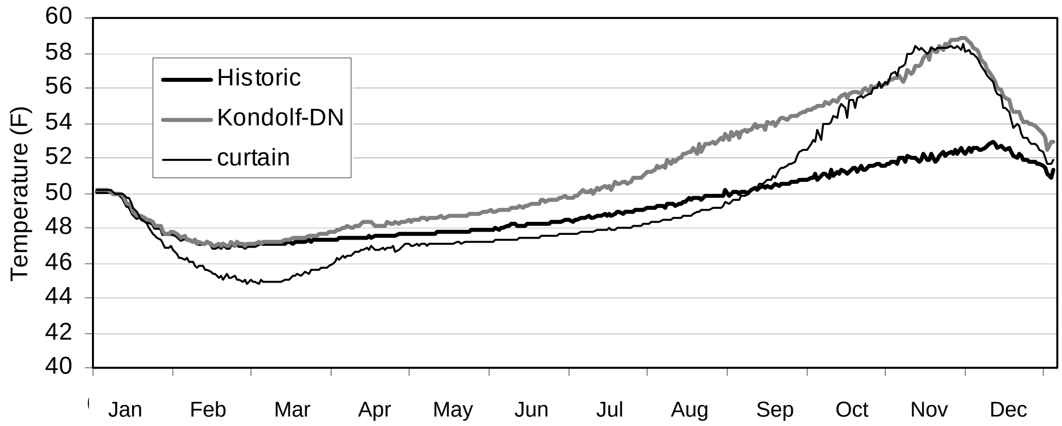


Figure 5. Theoretical representation of temperature control curtains (a) no curtains, (b) a single curtain near the headwaters

To assess the potential benefits of a temperature control curtain to take advantage of upstream cold water inflow, a curtain was assessed using the submerged weir feature in CE-QUAL-W2. An internal weir was placed in segment 6 extending downward from layer 2 through layer 70. Results, shown for 2003 and 2004 in Figure 6, indicate that there is the potential for considerable difference in temperatures of Friant outflow temperatures. During February, March and April periods, simulated temperatures are notably lower than historic temperatures. Conditions differ among 2003 and 2004 results from April through October. In 2003 river outlet release temperatures are comparable to historic conditions into September, then transition through October to temperatures that are on par with the Kondolf-DN conditions without a curtain in place. Reduced temperatures are more modest in 2004, tracking the Kondolf -DN conditions without a curtain scenario, by up to approximately 1^{o}F lower during summer periods before tracking the without curtain scenario through November 1. For the remainder of the year, river outlet release temperatures for the curtain scenario are warmer than the without curtain scenario by up to approximately 1^{o}F. Though this single curtain analysis represents a simplistic representation of a temperature control strategy, the findings suggest that there is potential for summer temperature control and the possibility for increased potential for cold water management. Additional detailed analysis and assessment of curtain location, size, and operation would allow quantification of thermal and water supply benefits associated with temperature control curtains.



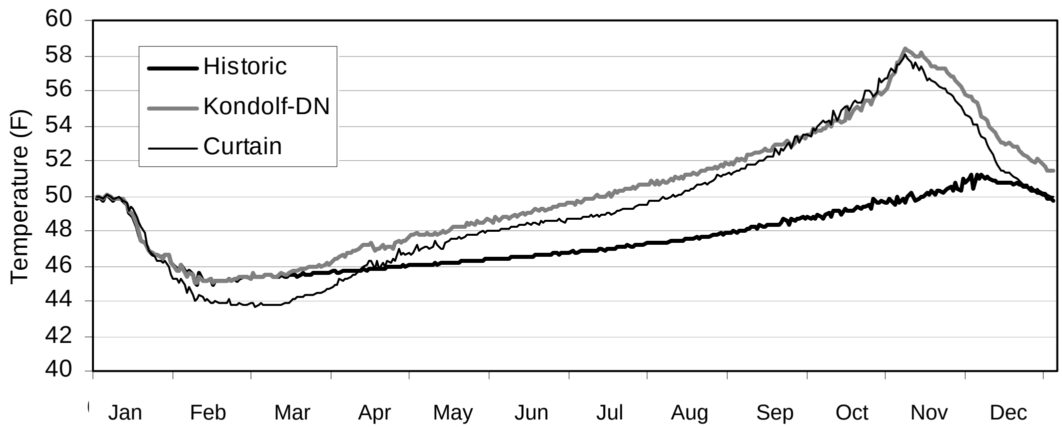


Figure 6. Simulated Millerton Reservoir Friant Dam river outlet release temperatures for historic, Kondolf proposed Dry-Normal hydrograph, and Kondolf proposed Dry-Normal hydrograph with upstream temperature control curtain: 2003 (top) and 2004 (bottom)

<u>Proposed Kondolf Dry-Normal Flow Schedule: Utilizing the Friant Kern Canal to Convey Millerton Reservoir waters to the San Joaquin River via Dry Creek</u>

Conservation of cold water supplies in Millerton reservoir was assessed through a re-operation of the Friant Dam complex, while taking advantage of existing facilities. Instead of releasing the full amount of proposed river releases through the river outlet to the reach immediately below Friant Dam, only the historical riparian releases were drawn from the river outlets. The balance or increment above the historical riparian releases (i.e., 350 cfs minus historical riparian releases) were diverted into the Friant-Kern Canal and assumed to be released from existing facilities in to Dry Creek, subsequently entering the San Joaquin River approximately 6 or 7 miles downstream of Friant Dam (Dry Creek enters at approximately RM 261) . The Friant-Kern to Dry Creek Bypass was used from June 1 to September 1. The purpose of this simulation was to illustrate how using warmer surface waters during the summer months could preserve cold water. Results are presented below.

Simulation results indicate that river releases were consistently on the order of 1°F to 2°F cooler through the late summer and fall (Figure 7). Friant Kern Canal release temperatures (at Friant Dam) are appreciably warmer during summer and fall (Figure 8).

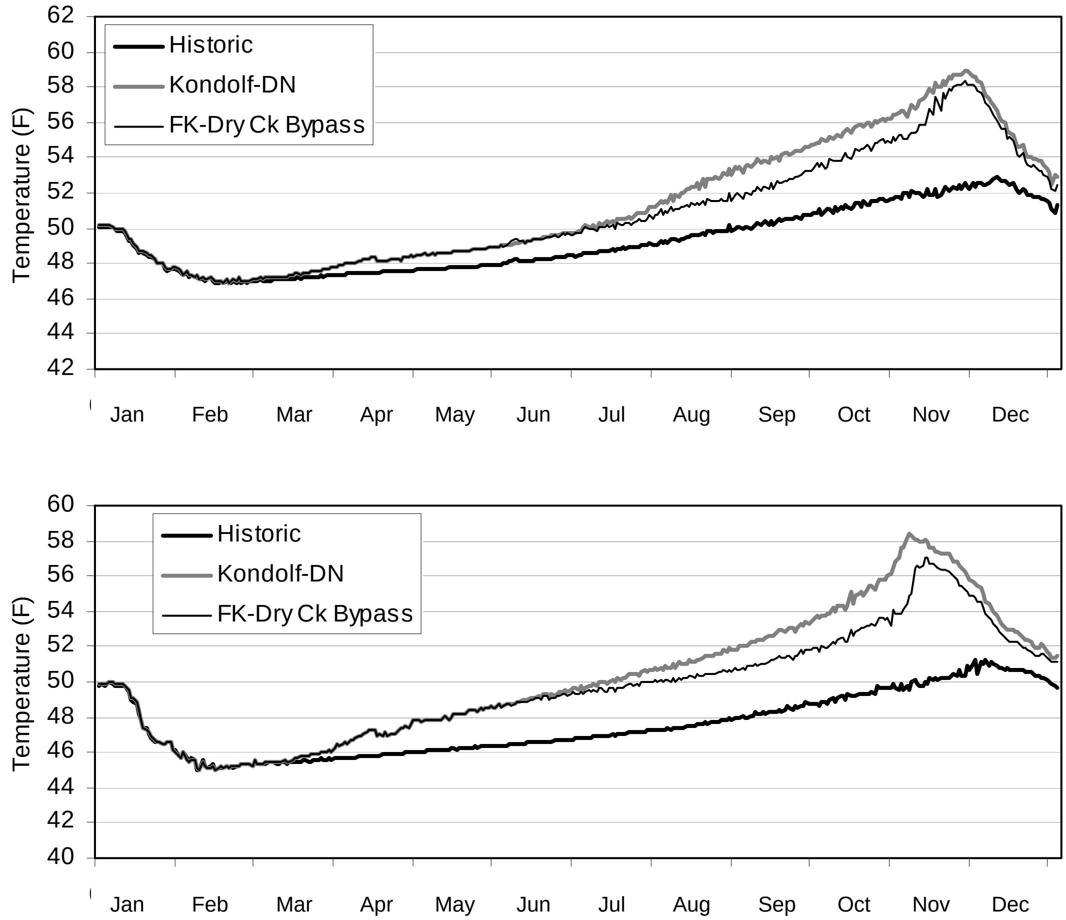


Figure 7. Simulated Millerton Reservoir Friant Dam river outlet release temperatures for historic, Kondolf proposed Dry-Normal hydrograph, and Kondolf proposed Dry-Normal hydrograph with release via Friant Kern Canal and Dry Creek: 2003 (top) and 2004 (bottom)

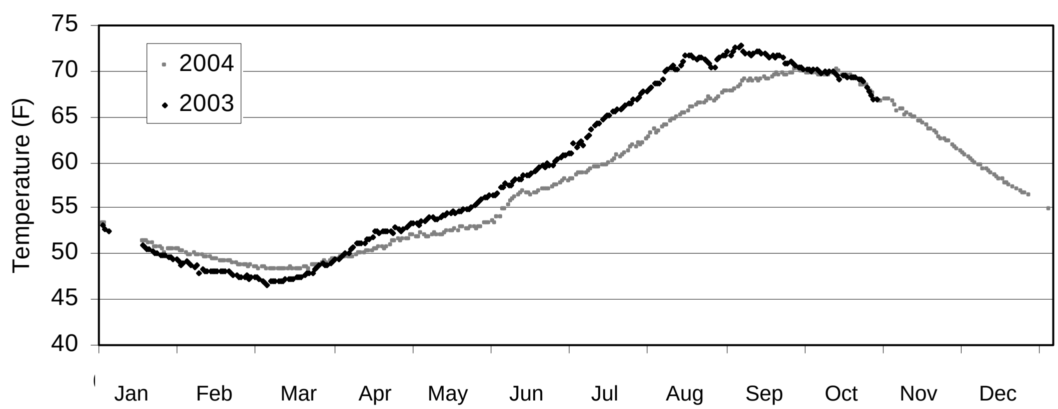


Figure 8. Friant-Kern Canal simulated outlet temperatures, 2003 and 2004 (where series of data points are absent, no canal flow on those days)

Temperature Control Options

Outlined below are several options that build off the above discussed model assessments.

Modifications to the Kondolf-DN hydrograph

As noted in Dr Kondolf's expert report of 2005, the flow proposed flow regimes are guidelines and not strict rules. Modification of the flow regime by even small amounts can lead to temperature benefits. Examples include:

- Dispensing with the 10 day (November 1 to 10) flow increase from 350 cfs to 700 cfs. This condition was simulated and removing this modest component reduced temperatures during that period by up to approximately 1^{o}F.
- Decreasing the summer flow regime from 350 cfs to 325 cfs or even 300 cfs would preserve additional cold water supplies in concept, but no simulations were completed.
- Given most riparian diversions occur downstream of Dry Creek, decrease the amount of the historical riparian water right released from the river outlets and pass it through the Friant Kern Canal to Dry Creek. Water temperature for these users is assumed to not be a critical issue.
- Using adaptive management to manage river releases in response to flow and thermal conditions and fish needs.

Temperature Control Operation and Facilities

In addition to the reoperation of facilities (Friant-Kern to Dry Creek bypass) and temperature control curtains, there are other approaches to controlling temperature. For example, increased carryover storage would potentially enlarge the cold water pool (Deas 1998(a), 1999(b)). In addition, the construction of a temperature control device (e.g., selective withdrawal) would potentially provide appreciable flexibility for temperature control management. Relocating or refurbishing the river outlet works deeper in the reservoir would also provide additional supply, by providing access to the very bottom waters in the reservoir.

Upstream Water Temperature Management

The concept of temperature control in the upper basin may play a pivotal role in the long-term restoration strategies of the San Joaquin River basin. There is appreciable storage in the upper basin (see Table, below), with much of the water traversing from higher elevations to lower elevations through penstocks instead of the natural river channel – potentially preserving cold water temperatures. The transfer of water from high elevations through penstocks results in a short transit time, reduced opportunities for heating through exposure to the atmosphere (meteorological conditions); and, where applicable, utilization of cold bottom waters instead of warm surface waters in storage reservoirs. With respect to this last point, an opportunity that should be explored is the implementation of temperature control strategies such as reoperation, selective withdrawal, and temperature control curtains in the upper basin reservoirs to efficiently used cold water supplies, while minimizing impacts to hydropower production. A full assessment of upstream water management options coupled with reoperation of Millerton Reservoir to manage water temperature in downstream river reaches would quantify the potential for additional temperature control.

Reservoir/Lake	**Capacity** (acre-feet)
Thomas A. Edison Lake	125,000
Florence Lake	64,000
Huntington Lake	89,000
Shaver Lake	136,000
Mammoth Pool	122,000
Redinger Lake	26,000
Crane Valley Reservoir	45,500
Kerckhoff Reservoir	4,188
	611,688
Source: U.S. Bureau of Reclamation, Millerton Lake Daily Operations Report (http://www.usbr.gov/mp/cvo/vungvari/sccao_mildop.pdf)	

Thus, there is a wide array of temperature control options and management strategies available for Millerton Reservoir and the downstream San Joaquin River reaches. One, or more likely, a suite of these alternatives could be implemented to most efficiently meet cold water objectives and water deliveries throughout the year. The CE-QUAL-W2 model identified herein is sufficiently flexible and has the necessary options to assess many of curtains, the modification of intake elevations, selective withdrawal, internal weirs and other potential temperature management faculties. In combination with available water supply models and downstream flow and temperature models, a wide range of flow, temperature, and operational alternatives can be assessed.

Donald J. Smith

In reviewing Mr. Smith’s report, several general comments are noted regarding seasonal variability, the role of meteorological influences, flow and other aspects. As noted by the author, water temperatures throughout the San Joaquin River are influenced by tributary inflow water temperatures (Friant Dam, Delta Mendota Canal, Mud and Salt Slough). However, it should be noted that once in the main river channel, local geometry, meteorological conditions, riparian shading, and in some reaches groundwater accretions, begin to play an important role in water temperature as distance from the source increases. Seasonal variability in meteorological conditions also plays a large role in the water temperature regime of the San Joaquin River.

The proposed river model may be an appropriate initial approach to assessing temperature conditions in response to various potential operations, but is presented as a work in progress. Flow regimes up to only 1000 cfs are included and results are generally limited to the reach from Friant Dam to approximately Gravelly Ford. Thus, given the limited range of flows and limited spatial scope it is difficult and inequitable to comment on specifics of the model at this time. The final representation of the entire river reach, all flow, temperature, and meteorological conditions would provide an opportunity to more completely assess this approach.

Acknowledging that the model is not finalized, the monthly average conditions presented in the expert report are averaged not only over the month, but also over several years. This approach, although useful to indicate general conditions, does not provide insight into the variability of the years or the variability within a month's time frame. During summer months this may be a modest impact; however, during the transition from summer to winter and winter to summer (e.g., October-November, and March-May) the difference between the first portion of the month and the last portion of the month can be considerable.

Tracy Vermeyen

Mr. Vermeyen's report states (Page 1, Bullet 2) that the limited thermal profiles and data gaps (period of record: 1952 to 1980 and 2003 through present) make it "very difficult to understand the seasonal thermal characteristics of Millerton Lake." Although long, uninterrupted time series of temperature observations are not persistent through time, the available data illustrates the vertical thermal regime under variable meteorological, hydrological, operational (including storage volumes) conditions over several decades, and are thus very useful.

The report also identifies the objective of the monitoring programs (Page 1, Bullet 3): to support development of a two-dimensional water quality computer model of the reservoir. It is noted that detailed reservoir operations and local meteorological data are limited or not available prior to March 2004. The California Department of Water Resources (DWR) web based California Data Exchange Center (CDEC) (http://cdec.water.ca.gov) includes many hydrologic and operational parameters for various data collection frequencies (hourly, daily, monthly) back into the 1990's (Table 1). A brief review of these data indicates that these records have appreciable data gaps on an hourly time frequency, but are largely complete at the daily level. Review of Dr. Brown's report indicates that the inflow and outflow files for the 2003 and 2004 period are based on daily average inflow and outflow conditions. In addition to the data identified below, Mr. Vermeyen provides daily data back into the 1970's for Millerton Reservoir. Overall there is an appreciable body of data available for assessment. An exception is peaking operations from Kerchoff Powerhouse – it would be desirable to have sub-daily information from this station. Review of PG&E's hydropower production schedule, if available, could be used to recreate this record.

Table 1. Data available for Millerton Reservoir from DWR's CDEC web site

Parameter	Frequency	Collection/Recording Method	Period of Record
DISCHARGE, SPILLWAY, cfs	daily	DATA XCHG-USBR	From 04/01/2000 to present.

DISCHARGE,CONTROL REGULATING, cfs	daily	DATA XCHG-USBR	From 04/01/2000 to present.
EVAPORATION, LAKE COMPUTED, cfs	daily	DATA XCHG-USBR	From 04/01/2000 to present.
FULL NATURAL FLOW, cfs	daily	DATA XCHG-USBR	From 05/31/1987 to present.
PRECIPITATION, INCREMENTAL, inches	daily	DATA XCHG-USBR	From 10/01/1997 to present.
RESERVOIR ELEVATION, feet	daily	DATA XCHG-USBR	From 01/01/1985 to present.
RESERVOIR INFLOW, cfs	daily	DATA XCHG-USBR	From 01/01/1994 to present.
RESERVOIR OUTFLOW, cfs	daily	DATA XCHG-USBR	From 06/20/1987 to present.
RESERVOIR STORAGE, af	daily	DATA XCHG-USBR	From 01/01/1985 to present.
RESERVOIR, STORAGE CHANGE, af	daily	DATA XCHG-USBR	From 10/04/1993 to present.
RESERVOIR, TOP CONSERV STORAGE, af	daily	DATA XCHG-USACE SAC	From 10/20/2000 to present.
RESERVOIR ELEVATION, feet	event	SATELLITE	From 01/01/1997 to present.
RESERVOIR STORAGE, af	event	SATELLITE	From 01/01/1997 to present.
RESERVOIR, SCHEDULED RELEASE, cfs	event	MANUAL ENTRY	From 10/01/1995 to present.
RESERVOIR ELEVATION, feet	hourly	SATELLITE	From 01/01/1997 to present.
RESERVOIR INFLOW, cfs	hourly	SATELLITE	From 01/01/1997 to present.
RESERVOIR OUTFLOW, cfs	hourly	SATELLITE	From 01/01/1997 to present.
RESERVOIR STORAGE, af	hourly	SATELLITE	From 01/01/1997 to present.
PRECIPITATION, ACCUMULATED, inches	monthly	MANUAL ENTRY	From 10/01/1905 to present.
RESERVOIR STORAGE, af	monthly	MANUAL ENTRY	From 10/01/1941 to present.

cfs – cubic feet per second
af – acre-feet

Further, although there appears to be limited meteorological data at Millerton Reservoir, there is sufficient nearby information available, as noted in Mr. Vermeyen's report, from the California Irrigation Management Information System (CIMIS) meteorological station in the Fresno area. Reservoir models have been applied throughout California, as well as other areas, with meteorological data derived from stations in the vicinity of, but not necessarily adjacent to, the projects. Where necessary minor adjustments to meteorological can be made to accommodate meteorological data that is not adjacent to the project (e.g., wind sheltering, Cole and Wells (2002)), lapse rates for temperature (e.g., after Linacre, 1992).

Overall, a significant effort was put forth in assembling existing data and implementing monitoring programs; however, the collection of data throughout the river system from Friant Dam to the Merced is incomplete. It is not clear in Mr. Vermeyen's report if there will be additional data collection (e.g., flow, temperature, cross sectional geometry, river gradient) in reaches downstream of Gravelly Ford to more completely assess restoration potential throughout the entire San Joaquin River reach from Friant Dam to the Merced River.

Merlynn Bender

The information presented in Mr. Bender's report with regard to model calibration suggests there is large uncertainty in the Millerton Reservoir model (CE-QUAL-W2). Review of calibration results presented Dr. Brown's report, and after review of the model files (as well as completing several simulations), I generally concur with Dr. Brown's statement that the CE-QUAL-W2 model provides a useful tool for preliminary assessment of potential temperature effects from changes in Millerton Lake operations (for additional details on Dr. Brown's report and the reservoir model, see comments above).

The discussion of "extreme mixing of cool fall inflows with warm Millerton Lake" waters (Page 3, Bullet 14, as well as Page 10, Conclusion), appears to be based on the author's personal experience. Although their may be mixing processes at this location, a variable flow regime, variable reservoir storage levels, and water temperature (density) differences between inflowing waters and Millerton Lake all play a role in this complex process. There is no argument that this may limit "the ability to transfer cool releases from upstream reservoirs for attempted cooling of Millerton Lake releases during late fall," but to what extent. Ecological Analysts, Inc. (1980) define a "plunge point[1]" for Millerton Reservoir, indicating that cool denser inflowing waters are not completely "lost" upon entering the reservoir. Weekly maximum and minimum temperatures (Ecological Analysts, 1980, Figure 10) indicate a range of temperatures between 57.2^{o}F (14^{o}C) and 62.6^{o}F (17^{o}C) for the month of August 1979. Further review of Appendix B of that report indicates that on August 15 and 16, 1979, water temperatures in Millerton Reservoir at the headwater were constant from top to bottom at 60.8^{o}F (16^{o}C). (see Figure 2, Appendix B). This information suggests that although there may be the potential for mixing at the upper end of Millerton Reservoir, the entire volume of the reservoir appears to be dominated by inflowing water. During such conditions, local mixing may not be as critical as identified in Mr. Bender's report. This does not mean that mixing does not occur. Peaking operations as well as dynamics at the plunge point may mix warm lake waters with Millerton Lake waters.

Five scenarios are presented under the "Discussion" portion of Mr. Bender's report, examining a range of operations; however, these represent a limited set of potential operations focused on preserving existing water deliveries and did not focus on exploring temperature control strategies. A broader range of alternatives, specifically designed to assess temperature needs associated with fisheries is presented in this rebuttal report under the section discussion Dr. Brown's comments.

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[1] The plunge point is the point or line in the reservoir where the colder, denser inflowing river water dives beneath the warmer, less dense surface water of the lake (Ecological Analysts, 1980).

Author Comment

In reviewing the additional evidence I have identified additional information that was previously unavailable. Namely the recent data associated with the storage-capacity tables; the elevations, diameter, and descriptions of the Friant-Kern and Madera Canal intake facilities; the elevation and description of the river outlet structure; descriptions of dead pool storage estimates; additional information concerning the flow and temperature conditions of inflows to Millerton Reservoir (below Kerchoff Powerhouse); as well as other data and opinions from other scientists and experts. I have considered this new information and consider that this information is consistent with the conclusions of my expert report dated August 15, 2005.

Dated: September 18, 2005

Michael L. Deas

Information Reviewed and Cited

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I also reviewed the electronic computer files provided by Dr. Brown with regards to the Millerton Lake Model and associated data.