Shasta Reservoir Operations Update
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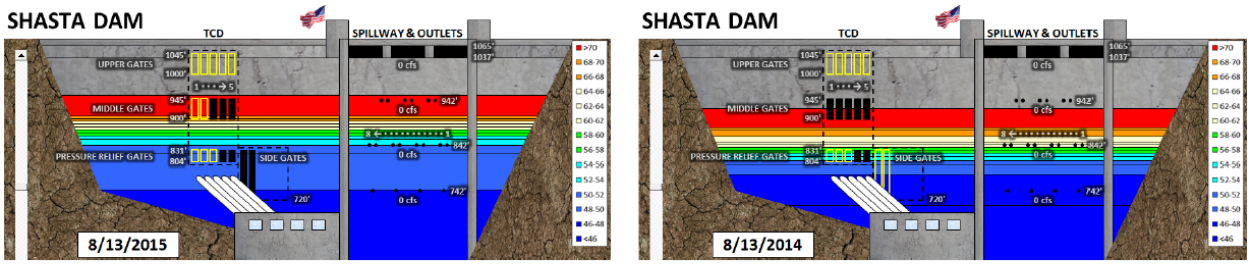
August 21, 2015

Cold water pool and comparison with operations between 2015 and 2014:

Handouts were distributed in preparation for the August 13, 2015, Sacramento River Temperature Task Group (SRTTG) meeting. The following table and graph provide a comparison of the Shasta temperature control device (TCD) gate configuration to date (as of August 13, 2015) compared to a year ago in 2014.

	August 13, 2015	August 13, 2014
# upper gates open	5	5
# middle gates open	2	0
# pressure relief gates open	3	3
# side gates open	0	2

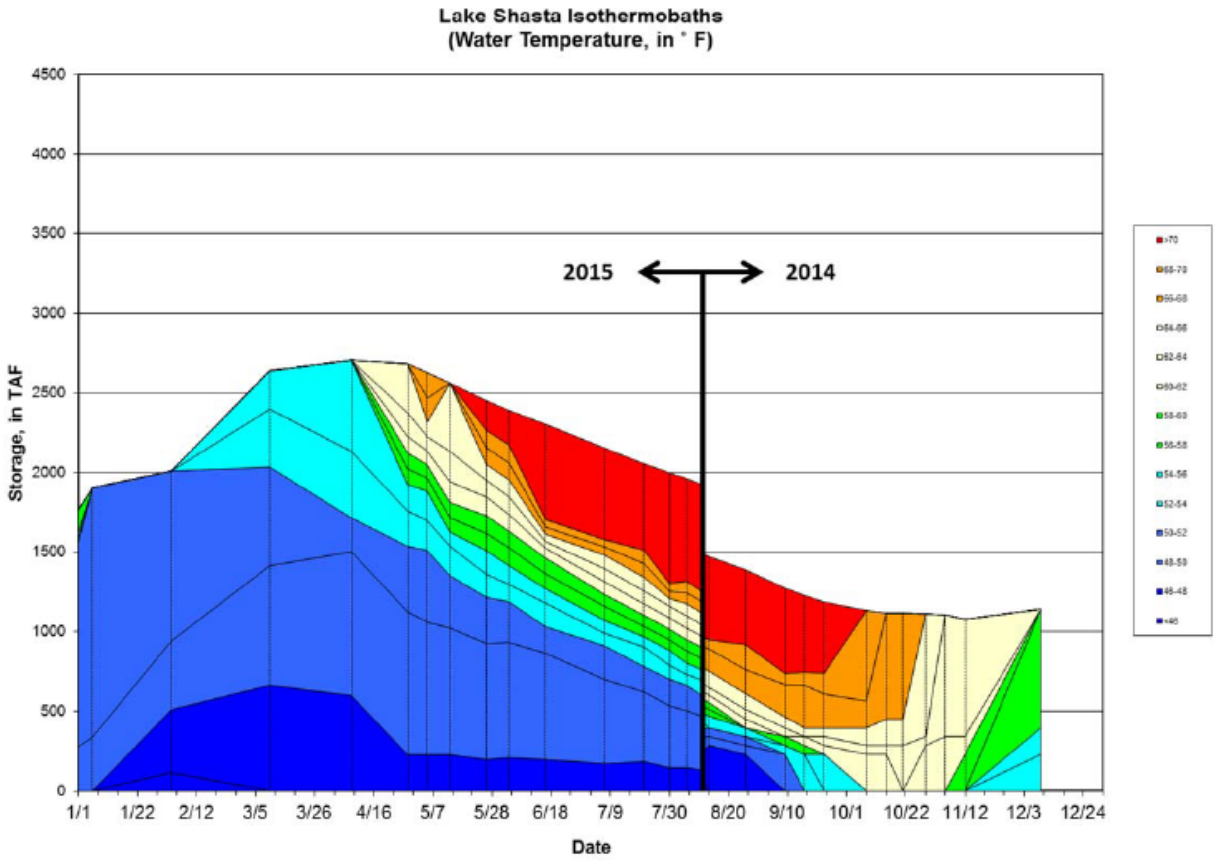


*NOTE: Yellow outline indicates open position, Solid Black indicates closed position.

As shown, at this time last year, full side gates were utilized to access the remaining cold water in Shasta Reservoir. This year, as a result of many factors (*e.g.*, operating to a daily average of 57°F, limiting Keswick releases, *etc.*), we are still able to blend the cold water from the pressure relief gates (PRG) with the warmer water from the middle gates to meet temperature compliance and not need to open the side gates or all of the PRG yet. The comparison of operations with last year is not a good one since we lost control of water temperatures last year when there was considerable winter-run egg and alevin incubation in the redds. Doing better than a disaster is not much of an indication that we are minimizing the adverse effects of high water temperatures on winter-run to the extent practical. Therefore, the relative comparison of operations needs to be coupled with other tools, as provided, below.

The following are isothermobaths at Shasta Reservoir, comparing the quantity and quality of water on approximately August 11 in 2015 and 2014. As shown on the graph, this year, Shasta Reservoir has:

- approximately 0.5 million acre-feet more volume than this time last year;
- more cold water volume than this time last year; and
- less volume of the coldest water than this time last year.

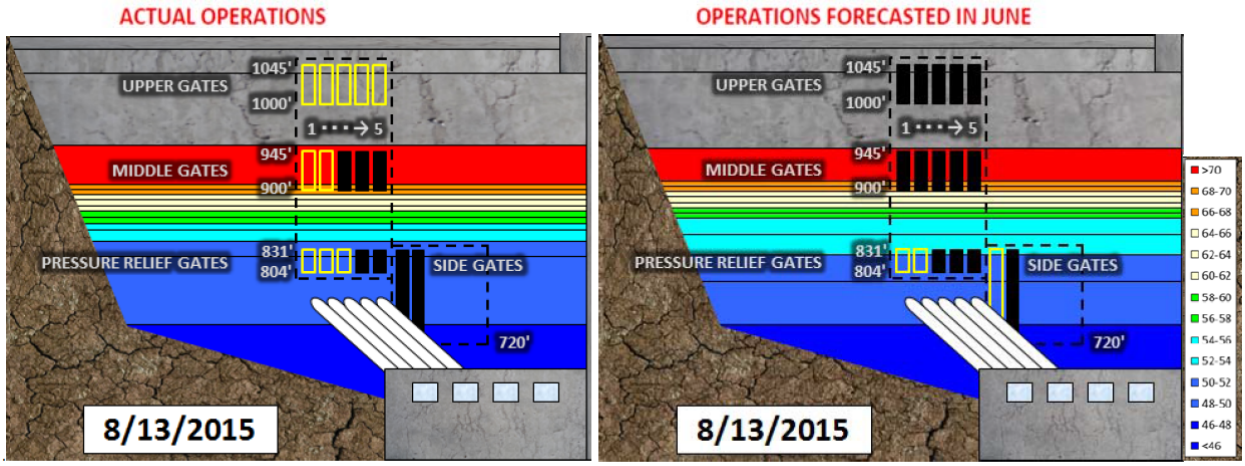


Cold water pool and comparison with operations as proposed in the June 25, 2015, Sacramento River temperature management plan (TMP)[1]

Handouts were distributed in preparation for the August 20, 2015, SRTTG meeting. The following table and graph provide a comparison of the Shasta TCD gate configuration to date (as of August 13, 2015) compared to the May 90% exceedance outlook in the June 25, 2015, Sacramento River TMP.

	Actual operations	Forecasted operations from June 2015
# upper gates open	5	0
# middle gates open	2	0
# pressure relief gates open	3	2
# side gates open	0	1

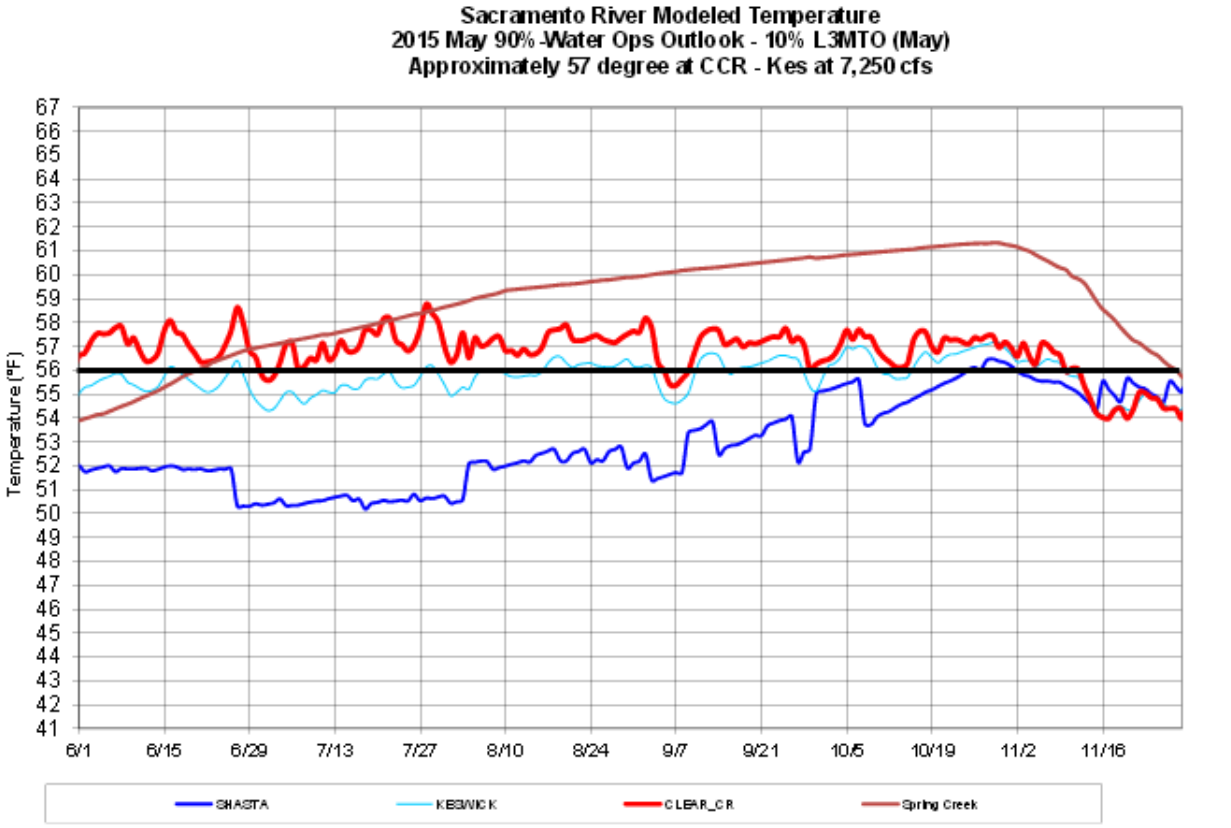
[1] Available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/bor_s_june_25__2015_request_for_nmfs_concurrence_on_contingency_plan_and_sac_tmp_for_july_through_november_2015.pdf



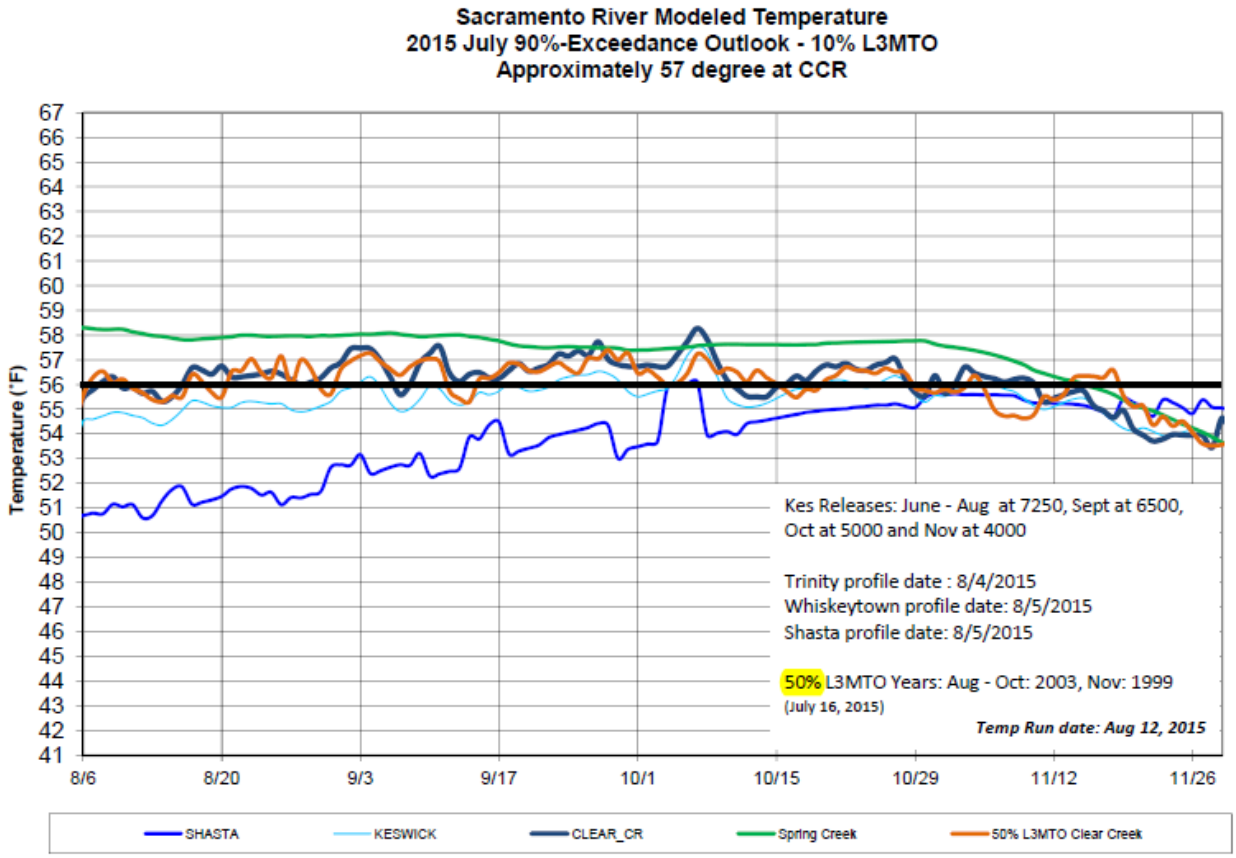
*NOTE: Yellow outline indicates open position, Solid Black indicates closed position.

As shown, actual operations of the TCD are better than forecasted in the Sacramento River TMP. By August 13, 2015, the forecast indicated that we would have had all of the middle gates closed, and opened one of the side gates.

The 10% Local 3-Month Temperature Outlook (L3MTO) temperature model run using the May 90% exceedance outlook in the Sacramento River TMP (see graph, below) indicated that full side gates would be accessed on approximately October 9, 2015, and the modeled operation would provide for sustained egg and alevin incubation habitat quality [daily average of 57°F at the Clear Creek temperature compliance point (CDEC gate *CCR* on the mainstem Sacramento River approximately 4 miles upstream of the confluence to Clear Creek)], however, with several temperature exceedances past 58°F.



The 10% L3MTO temperature model run at the 50% and 90% exceedance outlooks provided for the August 13, 2015, SRTTG meeting indicated that the daily average water temperature of 57°F, and not to exceed 58°F, will be maintained throughout the temperature control season. Full side gate access appears to be at approximately the same date as modeled in June, however, water temperatures at Shasta Dam are projected to be cooler upon release and at *CCR*. During the August 13, 2015, SRTTG meeting, Reclamation noted an error in the legend in the graph, below, that is, the highlighted text "50%" should be "10%" to reflect "10% L3MTO Years…"



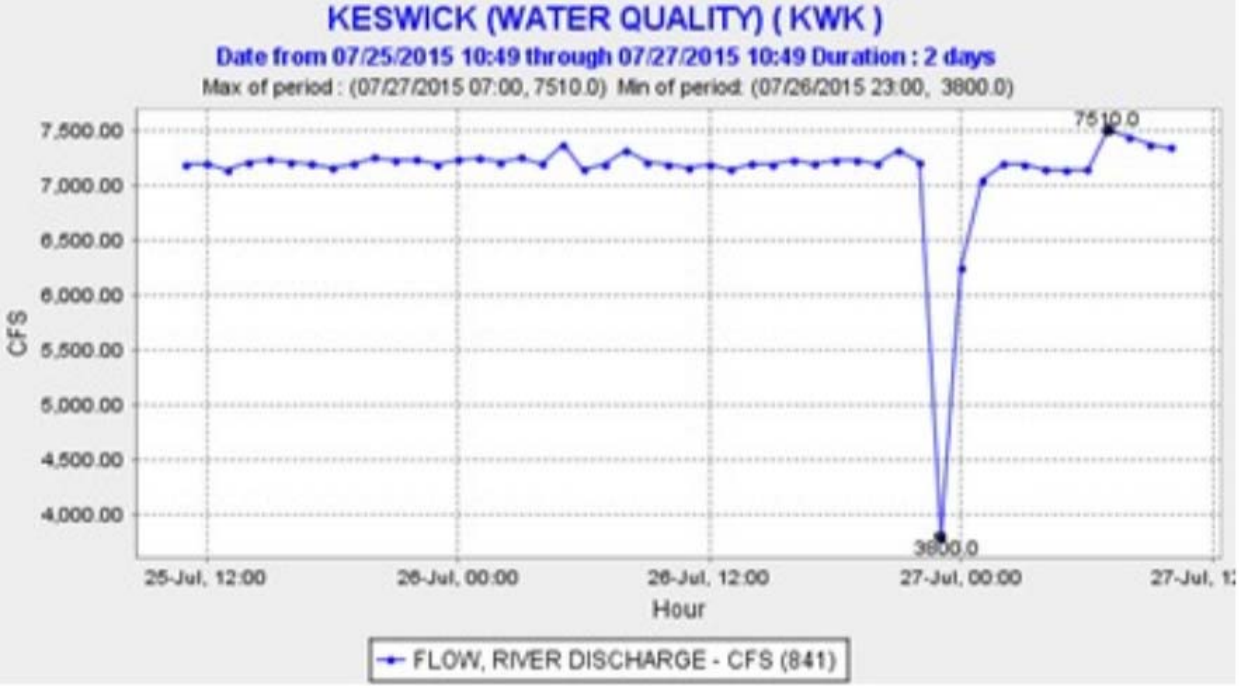
Summary of current Shasta operations to date:

Based on the above analysis of current operations compared to those modeled in the Sacramento River TMP, and also in comparison to operations in 2014, we will likely meet the operational objective of maintaining a daily average water temperature of 57°F (and not to exceed 58°F) throughout the winter-run egg and alevin incubation season in 2015.

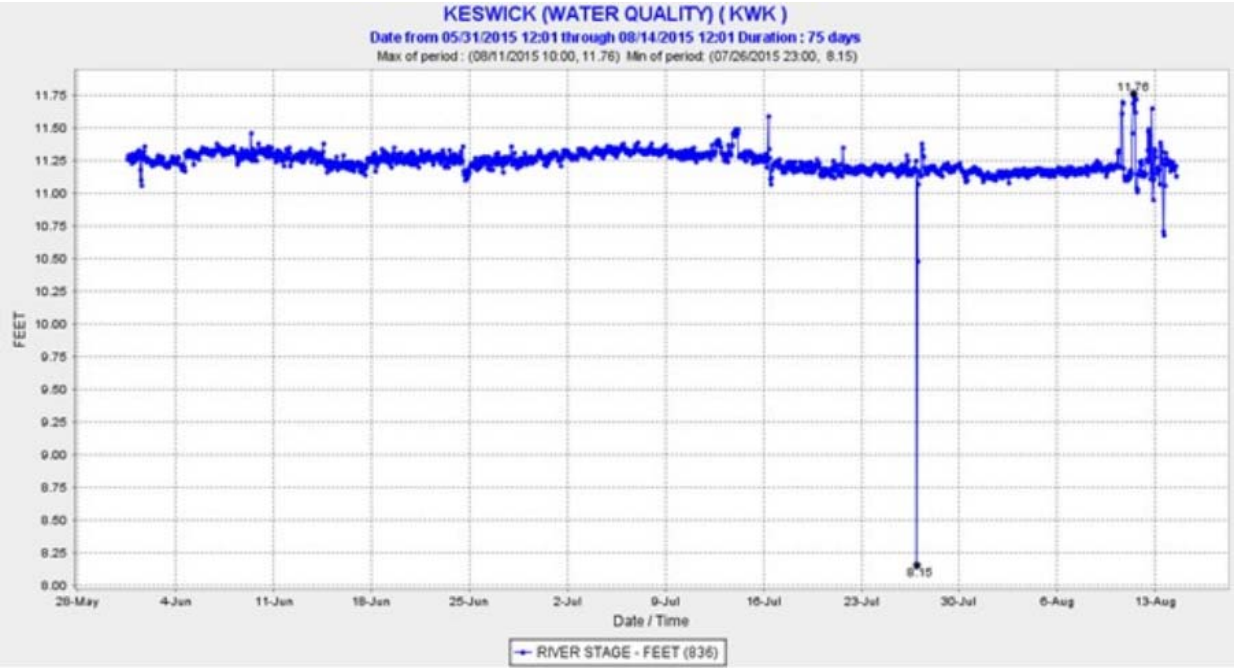
Intended and unintended changes in operation:

Flow fluctuation on July 26, 2015:

On July 27, 2015, the fish agencies found out about an extreme Keswick Dam release fluctuation, from 7,200 cfs to 3,800 cfs and back to 7,200 over a two-hour period around midnight, as provided in the following graph. This issue was discussed during the July 30, 2015, SRTTG meeting. Thuy Washburn (Reclamation operator of Shasta/Keswick dams) indicated that it was a failure of the Supervisory Control and Data Acquisition (SCADA) system (remote and monitoring system), that the "IT" group was investigating why the system failed and how to prevent it from failing again, and that Reclamation will distribute the investigation results of the SCADA issue once received. To date, the SRTTG has not been provided an update.



Because the extreme flow fluctuation was not a planned event, California Department of Fish and Wildlife field crews were not on the Sacramento River to evaluate the potential or extent of winter-run redd dewatering, stranding, or isolation. The river stage height change of 3.1 feet at the CDEC gage *KWK* (see graph, below) as a result of the flow reduction likely dewatered some winter-run redds constructed in shallower water, but we are not able to evaluate the extent of the effect (*e.g.*, did eggs or incubating alevin die as a result).



Installation of TCD curtains:

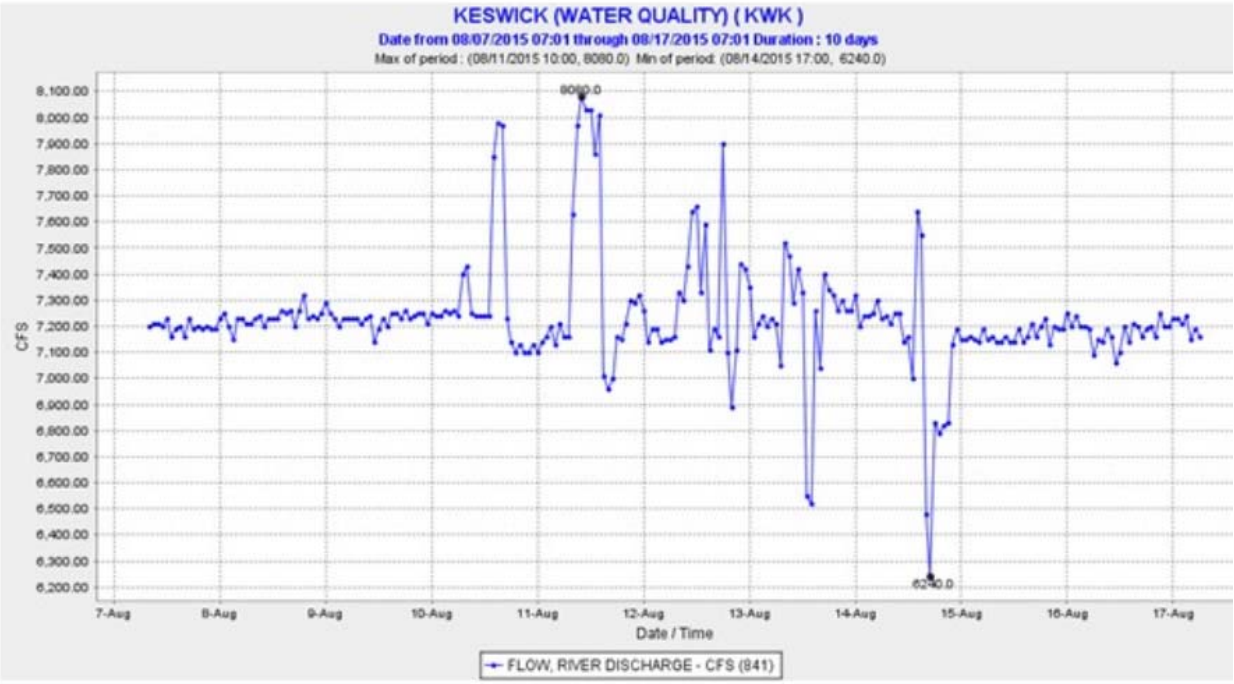
During the July 30, 2015, SRTTG meeting, Reclamation informed the group that beginning on August 3, 2015, geo membrane curtains would be installed to prevent or slow down the rate of warm water blending into the structural gaps in the TCD, and that the installation would take approximately 2 weeks. During the installation of the curtain, the units would be carefully operated to continue to have the temperature output meet the compliance point at *CCR*. At one point, Reclamation indicated that it was worth a try to gain (or conversely, draw down slower) cold water in Shasta Reservoir. The fish agencies thought the worst case scenario was no improvement in cold water pool. Over the course of multiple meeting in the following weeks, additional details were provided regarding the installation, including:

- No modeling (or if modeling was done, it was not distributed to the SRTTG) regarding the potential benefit of this effort.
- The middle gate that the curtain is being installed onto would have to be closed during the 2-3 day installation. The fish agencies were under the impression that another middle gate would/could be open during the installation, but as it turned out, through change orders, we found out that a PRG gate "had to be opened" when a middle gate was closed for curtain installation.
- The middle gates adjacent to the middle gate being worked on also had to be closed during curtain installation.
- Upon completion of curtain installation on any given gate, that middle gate could no longer be open for the remainder of the temperature control season.
- In summary, based on the above, the proposal was at risk of depleting the cold water pool considerably faster as a result of:
    - Closing middle gates and opening PRG gates unnecessarily only because of curtain installation
    - Not being able to open any of the middle gates if installation proceeded as planned (beginning on approximately August 14).
- As the fish agencies learned more about the process of TCD curtain installation, and its ramifications, we requested that curtain installation be postponed until the remainder of the middle gates are no longer needed for blending.
    - Prior to curtain installation (prior to August 3), the TCD gate configuration was upper gates all open, 2 middle gates open, 3 PRG gates open, and side gates closed.
    - If TCD curtain installation proceeded as planned, on approximately August 14, all 5 middle gates would be closed, and all 5 PRG gates would be open.
    - To date (August 21), all upper gates are open, 2 middle gates are open, 3 PRG gates are open, and the side gates are closed.

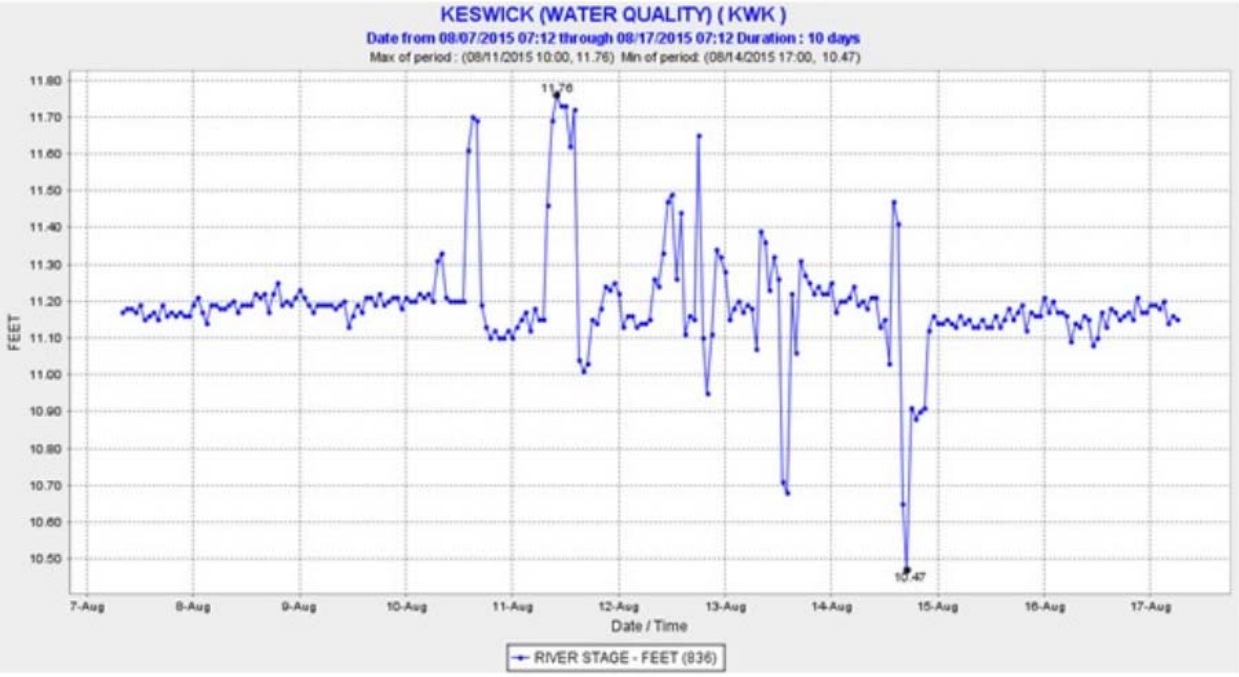
<u>NERC testing during the week of August 10, 2015:</u>

During the August 13, 2015, SRTTG, Reclamation informed the group that Western Electric Coordinating Council (WECC) Model Validation Testing started on August 10 and will be completed on August 15, at the latest. The testing is required to occur every four years by North American Electric Reliability Corporation (NERC). Reclamation advised that during testing, releases from Keswick Dam (*KWK*) fluctuated from approximately 6,200 cfs to 8,000 cfs, as

shown in the graph, below. Reclamation's Central Valley Operation's (CVO) office indicated that they were not aware that the testing was going on, despite coordination between NERC and Reclamation.



Unlike the extreme flow fluctuation on July 26, 2015, this testing was planned. However, because the SRTTG was not made aware of the testing until 4 days into it, California Department of Fish and Wildlife (CDFW) field crews were not able to go out on the Sacramento River to evaluate the potential or extent of winter-run redd dewatering, juvenile stranding, or isolation. The river stage height change of approximately 0.7 feet at the CDEC gage *KWK* (see graph, below) at the lowest release likely dewatered some winter-run redds constructed in shallower water, but we are not able to evaluate the extent of the effect (*e.g.*, did eggs or incubating alevin die as a result).



Summary of the intended and unintended changes in operation:

TCD curtain installation: Despite the lack of information, the fish agencies were able to advise Reclamation on the TCD curtain installation in time to avert premature closure of all of the middle gates and opening of all of the PRG gates and unnecessarily "draining" the Shasta Reservoir cold water pool.

Drastic reductions in Keswick Dam releases: Because of the unexpected nature of the Keswick Dam release reductions, CDFW field crews were not able to evaluate the extent of winter-run redd dewatering or juvenile stranding/isolations.