Summary of Spring Pulse Modeling, Miles Daniels, 4-19-2019

The primary goals of simulating of a spring pulse of 10,000 cfs at Wilkins slough were 1) to estimate the spring pulse impact on winter-run temperature dependent egg mortality and 2) to estimate the water cost associated with conducting a spring pulse originating from Shasta Reservoir. To achieve these goals required the use of hydrological models simulating water discharge and temperature in the Shasta/Sacramento system as well as a biological model of temperature-dependent egg mortality. Further details of the modeling methods can be found at Daniels et al. 2018. The text below outlines the primary modeling methods, assumptions, and findings from simulating a spring pulse.

In assessing the impacts of a spring pulse, we were interested in accounting for variable meteorology, hydrology, and reservoir operations. Therefore, we choose to use an ensemble-based approach by simulating the spring pulse over a 16-year period (2000-2015) assuming this represented a reasonable range of meteorology, hydrology, and operations. During the pulse time window, on each day from May 1st to May 15th for a given simulation year, we estimated the volume of water required for Wilkins Slough discharge to equal 10,000 cfs for three continuous days, followed by a 15% daily ramping down rate to historic conditions. This volume of water represented the additional amount of water required from Shasta Reservoir for the pulse to occur. The variation in hydrology over the 16-year period resulted in a range of water required for a pulse (i.e. water cost), such that in some years, i.e. 2006, flow at Wilkins Slough was above 10,000 cfs in May and thus water cost was zero, while in other years, i.e. 2015, flow at Wilkins was below 10,000 cfs and a pulse was required. Since we ran this calculation for each day in the pulse time window we were able to assess the sensitivity of the water cost associated with the day the pulse started and estimated a range of potential water cost values. Specifically, we had 15 estimates of water cost for each simulation year.

With water cost calculated, we ran two scenarios through the hydrological and biological models for each simulation year, a “pulse” and “no pulse” scenario. The no pulse model used observed conditions for all model inputs and was considered the baseline model. The pulse model used observed conditions, except for when it came to simulating discharge from Shasta and Keswick reservoirs, and in the Sacramento River during the time period when a pulse was considered. During that time period we perturbed the model to simulate a pulse. We chose the starting pulse date from the 15 potential start dates that had the highest water cost so that the modeling going forward would represent an upper bound of water required for a spring pulse for a given year. After running the models, the outputs between the pulse and no pulse scenarios were compared.

Primary assumptions behind these modeling efforts relate to reservoir operations and water gains and losses in the Sacramento River. For example, both the pulse and no-pulse models used the exact same TCD gate operations for the Shasta Reservoir model, which were based on observed conditions. Additionally, in simulating a pulse from Shasta down to Wilkins Slough we assumed the same rate of accretions and depletions would have occurred based on historical data. Additional modeling assumptions can be found in Daniels et at. 2018.

Output from the simulations can be summarized as follows:

1) The simulated effect of the spring pulse varied by water year type, with the largest impact occurring during dry and critical years
2) The water cost associated with a spring pulse varied from zero TAF during wet hydrological year to as much as 50 TAF during drier hydrological years. In most years the water cost was < 30 TAF.
3) The simulated increase in Shasta discharge temperature associated with the spring pulse was often < 0.5 °F, but could be as much as 1 °F.
4) Simulated winter-run temperature dependent egg mortality increase associated with the spring pulse was often < 2%, but could be as high at 8% when considering the 75th percentile estimate.

Daniels, Miles E., Vamsi K. Sridharan, Sara N. John, and Eric M. Danner. 2018. Calibration and validation of linked water temperature models for the Shasta Reservoir and the Sacramento River from 2000 to 2015. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-597.https://doi.org/10.7289/V5/TM-SWFSC-597