Study 33

Reducing Spring Water Temperatures Below Sack Dam

Final
2015 Monitoring and Analysis Plan

SAN JOAQUIN RIVER
RESTORATION PROGRAM

January 2015

1.0 Reducing Spring Water Temperatures Below Sack Dam

Theme(s):

- Adult Migration
- Rearing Habitat
- Flow Management

Related Question(s):

- AM-004: What actions are needed, and where are they needed, to reduce daily maximum water temperatures in reaches 4B and 5 to provide suitable temperatures for adult passage?
- RH-018: What can be done to reduce daily maximum water temperatures in reaches 4 and 5 in April and May?

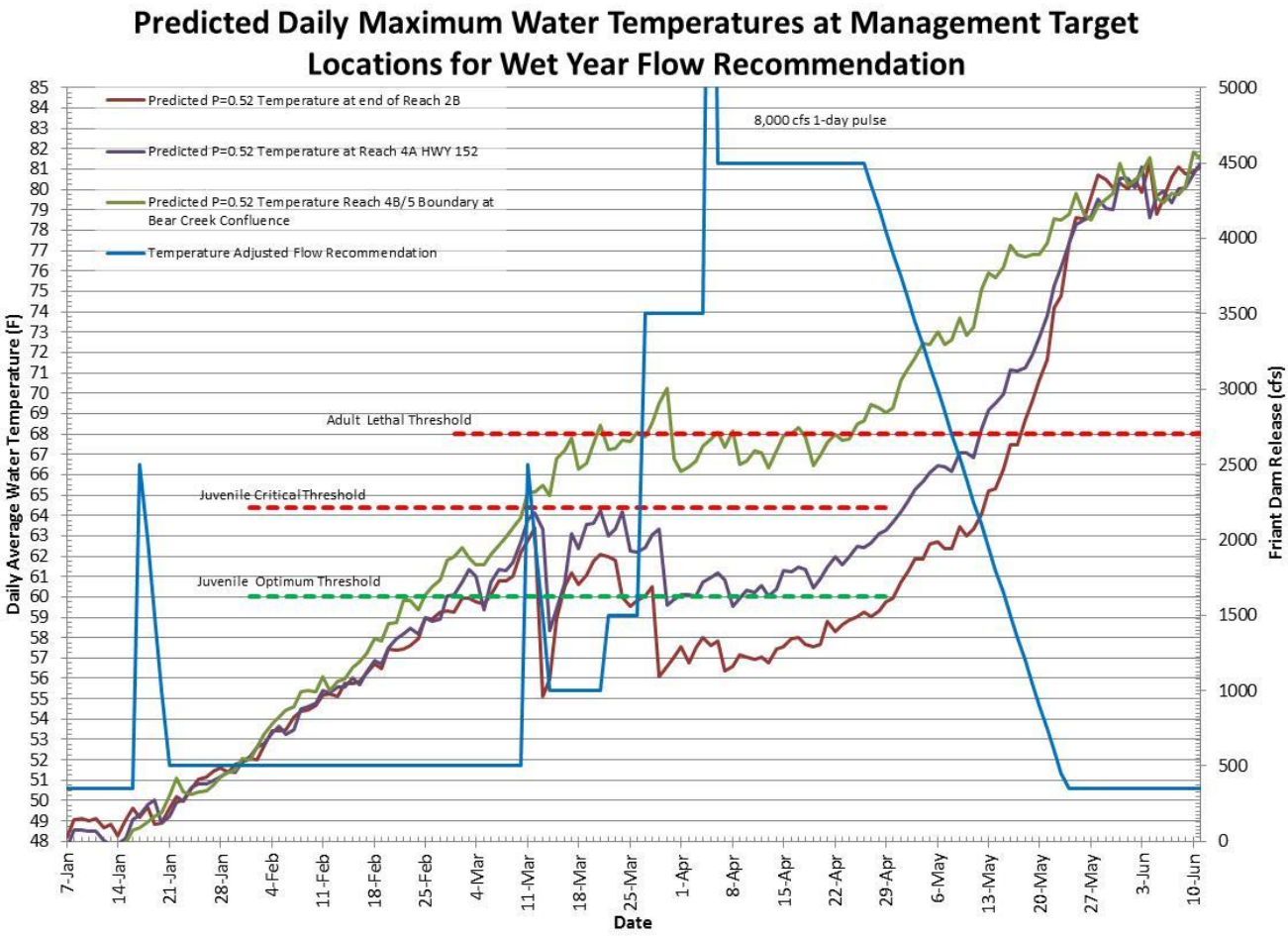
Flow Management: Questions not developed for this theme to date.

1.1 Statement of Need

Predictions from the initial HEC-5Q water temperature model (SJRRP, 2008a) suggest that the daily maximum water temperatures in reaches 4B and 5 will exceed the lethal threshold for adult spring-run Chinook salmon at a Friant release of 4,500 cfs by April 24 during median (Probability = 0.52 exceedance) meteorological conditions (Figure 1). When the model was recalibrated with 2009 to 2010 Interim Flow data, the lethal threshold was exceeded by April 28 (SJRRP, 2012). If the recalibrated model reflects current conditions, then only up to 30 percent of the adults may be able to migrate to Reach 1 based on migration timing data from Mill and Butte creeks (Johnson et al., 2006; Greg Blair, ICF, personal communication). During the same period, juveniles are also experiencing critical temperatures and few would be expected to survive (Figure 1). A consequence of using pulse flows in April and May for adults is the inability to release prolonged pulse flows earlier in the year to benefit juvenile salmon. If no more than 30 percent of the adults can successfully migrate to Reach 1 where they could spawn and flow for juvenile passage must be limited to brief pulses, restoration actions to cool temperatures may be needed to reach the population viability target. The objective of this study is to determine what restoration actions will be necessary to reduce spring water temperatures in Reaches 4B and 5 to the extent necessary to provide passage for adult spring-run through early May at flow releases of 4,500 cfs or less.

1.2 Background

The results of Phase 1 of this HEC-5Q analysis, which used forest microclimate data from small headwater streams in California (Moore et al., 2005), indicate that minimizing channel width from Highway 99 and the confluence with the Merced River and restoring a riparian tree canopy throughout the Restoration Area may reduce daily maximum water temperatures in Reach 4B (River Mile 140) by about 6°F in early-April, 5°F in late-April, and 4.5°F in mid-May (SJRRP, 2014a). The temperature reduction due to the riparian tree canopy alone ranged from 66 percent of the total reduction in early-April to 75 percent in mid-May, whereas there was relatively little benefit from narrowing the channel width. If both the riparian tree canopy is restored and the channel width minimized, then the mean daily maximum water temperature would be maintained below 68°F, which is the upper threshold for migration and survival for adult Chinook salmon (Table 3-1 in SJRRP, 2010), until April 29 to May 5 under average climate conditions. This is a substantial improvement compared to existing conditions which maintain the mean daily maximum water temperature below 68°F until about April 8 under during average conditions (SJRRP, 2014a).



Possible Wet Year flow recommendation designed to maximize adult spring-run passage and two brief pulse flows for juvenile passage relative to the predicted daily maximum water temperatures (SJRRP 2008a) during average meteorological conditions from 1980 to 2005 (P = 0.52 exceedance) just upstream of Mendota Pool (Reach 2B), at Highway 41 (Reach 4A), and the confluence with Bear Creek (Reach 4B-5 boundary). The lethal threshold for adult salmon is a 7-day mean daily maximum temperature of 68oF and so temperatures that exceed the threshold for fewer than 7 days would not be lethal. The water temperature predictions in reaches 4B and 5 in this figure may exceed actual temperatures by about 2oF in April and by 1-2oF in May (SJRRP 2012).

Figure 1. Predicted Daily Maximum Water Temperatures at Management Target Locations for Wet Year Flow Recommendations

The Phase 1 HEC-5Q analysis also indicates that the greater the length of the restored riparian forest, the greater will be the reduction in water temperatures in Reach 4B. If a forest was restored in only Reaches 2B and 4B, then the predicted reduction in mean daily maximum water temperatures at the tail of Reach 4B would range from 2.8°F in early April to 2.3°F in mid-May (SJRRP, 2014a). In comparison, restoring a continuous riparian forest from State Highway 99 to the confluence of the Merced River would reduce the mean daily maximum water temperatures at the tail of Reach 4B by about 4°F in early April to 3.33°F in mid-May (SJRRP, 2014a). These results also suggest that riparian forest microclimate effects are gradual and so reducing daily maximum water temperatures at Sack Dam will require the restoration of a riparian forest in Reach 2B and possibly further upstream.

The Phase 1 HEC-5Q analysis needs to be revised because it was based on riparian microclimate data from small headwater streams and those data do not represent conditions for a valley floor forest in the Restoration Area. Preliminary results from the 2014 Riparian Microclimate Study (SJRRP, 2014b) suggest that (1) riparian forests in the Restoration Area will need to much wider than those along headwater streams to reduce air temperatures by about 9°F, (2) valley floor forests reduce wind speeds by a far greater degree compared to headwater stream forests, and (3) wide valley floor forests may increase relative humidity levels by two to four times as much as the increases observed for headwater stream forests. Each of these differences has the potential to reduce the expected decline in water temperatures that would result from restoring riparian forests in the Restoration Area. The Riparian Microclimate Study will have to be continued through spring 2015 to provide the microclimate data needed for the Phase 2 HEC-5Q analysis.

1.3 Anticipated Outcomes

The results of these temperature analyses would be used to help plan design-level grading and revegetation approaches for the Reach 2B, Reach 4B, and Channel Capacity/Levee Stability projects. A critical evaluation factor for these projects is whether they provide suitable conditions for the passage of juvenile and adult salmon. Reach 4B currently does not provide suitable water temperatures for adult spring-run salmon later in the year and it is possible that the Reach 2B Project Description may need to be revised to help improve temperatures in Reaches 4B and 5. This study will also inform whether Channel Capacity projects should consider adding wide riparian forests, and potentially trigger subsequent studies to determine if levee setbacks would be needed to allow a sufficiently wide riparian forest to mature without impeding flood flow releases or Restoration Flow releases. The study will have the following specific outcomes:

- Estimate the potential to extend the springtime period when suitable water temperatures exist below Sack Dam for migrating adult spring-run and juvenile spring-run and fall-run Chinook salmon.

- Demonstrate the benefits of restoring the riparian forest in different reaches within the Restoration Area. It is likely that Reaches 2 through 5 will have to be reforested from levee toe to levee toe to provide substantial temperature reductions below Sack Dam.

- Compare the benefits of narrowing the low-flow channel to restoring a riparian forest on water temperatures in the Restoration Area.

1.4 Methods

Type of Study: modeling

Reach(es): The entire Restoration Area.

This Phase 2 study would modify the existing SJRRP HEC-5Q model to determine the combined effect of narrowing the base-flow channel and restoring a dense forest canopy from levee toe to levee toe on daily maximum water temperatures in the San Joaquin River Restoration Area based on microclimate data collected from valley floor forests. This Phase 2 study will use the modified HEC-5Q cross section data that reflects a minimal width trapezoidal base flow channel that was developed by MWH for the Phase 1 study. The modified model would be used to determine where channel narrowing and heavy planting would be required to create suitable water temperatures for adult spring-run salmon through mid-May in Reaches 4 and 5.

Phase 2 Tasks:

1. Modify HEC-5Q input data assuming that a mature riparian forest would be restored from levee toe to levee toe to shade all areas outside of the base-flow channel using air temperature, wind speed and relative humidity data from valley floor forests. This work will be done by Don Smith, Resource Management Associates (RMA), who developed the HEC-5Q for the Restoration Area.

2. Update HEC 5-Q model with data from Task 1 and perform period of record simulation. Compare results with temperature targets for adult and juvenile salmon in the Fisheries Management Plan.

3. Using the newly developed modeling system, perform sensitivity analysis to investigate the potential temperature improvements and channel narrowing from partial implementation of the management actions, identifying the most promising actions. For example, temperature reducing and base-flow channel width minimizing actions would be evaluated separately and combined. These actions could also be evaluated for two different scenarios: Reaches 2-5, and only the Reach 2B and Reach 4B projects.

4. Prepare a Technical Memorandum describing all data development, HEC5-Q input updates, results of comparisons with fishery temperature goals, development of new interface, and results of the sensitivity analysis.

1.5 Deliverables and Schedule

Work will begin on the Phase 2 studies after the Riparian Microclimate study has been completed in summer 2015. It should take about 6 months to conduct the Phase 2 analysis and produce the reports.

Deliverables include draft and final Technical Memorandums that will be posted to the SJRRP Data Reporting webpage.

1.6 Budget

The total cost estimate for 2015 is under development.

Table 1. Proposed 2015 Budget <<Under Development>>

Task	Cost
Modify HEC-5Q input data	
Update HEC 5-Q model	
Perform Sensitivity Analysis	
Prepare draft and final Technical Memoranda	
Total	

1.7 Point of Contact / Agency Principal Investigators

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1.8 References

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Moore R.D., D.L. Spittlehouse, A. Story. 2005. Riparian microclimate and stream temperature response to forest harvesting: a review. Journal of the American Water Resources Association, 41(4): 813-834.

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SJRRP. *See* San Joaquin River Restoration Program.

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