

Study 31

The Effects of a Riparian Forest on Water Temperatures in the Restoration Area

**Final
2015 Monitoring and Analysis Plan**



1.0 The Effects of a Riparian Forest on Water Temperatures in the Restoration Area

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

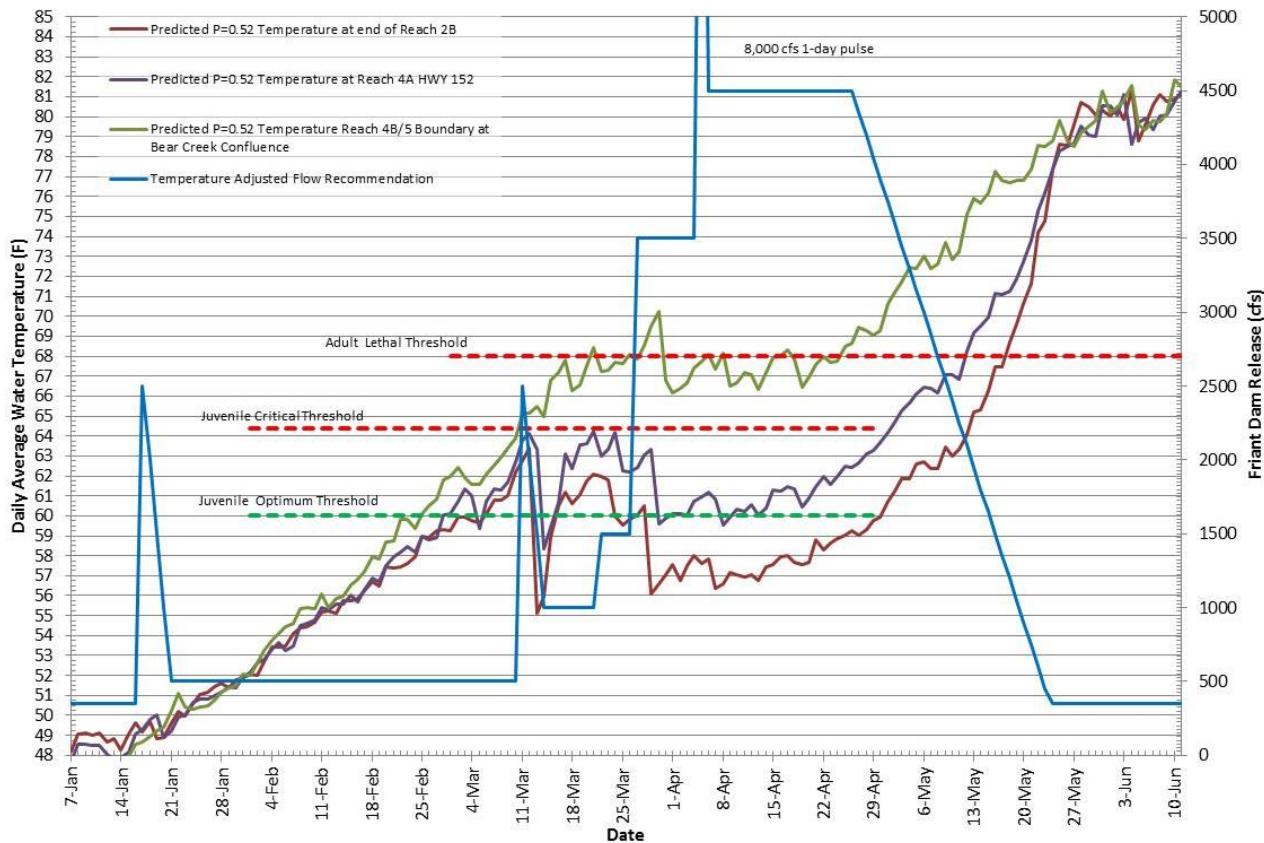
Predictions from the initial HEC-5Q water temperature model (SJRRP, 2008) suggest that the daily maximum water temperatures in Reaches 4B and 5 will exceed the lethal threshold for adult spring-run Chinook salmon at a Friant Dam release of 4,500 cfs by April 24 during median (Probability = 0.52 exceedance) meteorological conditions (Figure 1). In a separate study, water temperature modeling will be conducted to evaluate different actions that may reduce water temperatures in Reaches 4B and 5. Those modeling analyses will require estimates of the effects of a mature riparian forest on solar radiation, air temperature, wind speed, and relative humidity that reflect conditions in the Restoration Area. Published studies on these effects have all been done on small headwater streams. It will be necessary to conduct studies on the San Joaquin River to calibrate the data for the water temperature modeling.

1.2 Background

Studies in small headwater streams indicate that a 30-meter wide riparian tree canopy reduced above stream air temperatures by 8.6°F compared to sites without riparian trees (Moore et al., 2005). The rate of decline in air temperature due to riparian tree canopies is highest up to a width of 30 meters and only 0.36°F for each additional 10 meters of

width. It would be possible to use estimates of air temperature reduction, increases in humidity, and reduction in wind speed in a conceptual modeling analysis based on the data provided in Moore et al. (2005). However, there is a lack of meteorological data that could be used to quantify the effects of riparian canopy width along the San Joaquin River below Mendota Pool where the river flows toward the North.

Preliminary results from the 2014 Riparian Microclimate Study, which included large forested sites on the Stanislaus River, indicate that 150-meter wide riparian forests may be needed on each riverbank to achieve an air temperature reduction of about 9°F in the Restoration Area (SJRRP, 2014). The preliminary data also suggest that valley floor forests reduce wind speeds and increase relative humidity levels to a greater degree than those reported for small headwater streams (Moore et al., 2005). Additional data will be needed in 2015 to assess the effects of flow below Sack Dam in the Restoration Area and to collect data during the spring when spring-run Chinook salmon would be expected to migrate in the Restoration Area. Riparian surveys are also needed for the Stanislaus River study sites and the San Joaquin National Wildlife Refuge to determine whether forest species composition or canopy density affect microclimates and water temperatures. The riparian forests in Reaches 4B and 5 within the San Luis National Wildlife Refuge are predominately Goodding's Willow (*Salix gooddingii*). The Stanislaus River sites have a high diversity of tree species and a much denser tree canopy. The San Joaquin National Wildlife Refuge has a range of restored forests, some of which are quite mature (Julie Rentner, Director of Special Projects, River Partners, Modesto, personal communication, 2014).



Notes: 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, 2008) 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 68°F 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 2°F in April and by 1 to 2°F in May (SJRRP, 2012).

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

1.3 Anticipated Outcomes

Monitoring microhabitat climates in different riparian habitats along the San Joaquin River and its tributaries will provide data needed to calibrate water temperature models that reflect restored riparian conditions in the Restoration Area. The greater the accuracy of the water temperature models, the greater the likelihood that model predictions will result in effective restoration actions needed for water temperature management.

Botanical surveys will provide data that will help develop revegetation plans needed to reduce water temperatures during the spring migration period; optimize floodplain productivity during the winter; provide cover on the floodplains for juvenile salmon; and provide roughness estimates needed for fluvial geomorphic assessments. Tree species that shed their leaves in winter should provide sunlight that promotes floodplain productivity in winter and shade that reduces water temperatures in spring. The

herbaceous layer may affect the relative humidity and wind speed in the forest and so it may affect water temperatures.

1.4 Methods

Type of Study: Field Study

Reach(es): 1, 4B, and 5, Caswell Memorial State Park on the Stanislaus River, USACE Park Ripon River Crossing on the Stanislaus River, and the San Joaquin National Wildlife Refuge/Dos Reis Ranch/Hidden Valley Ranch.

Fifteen Onset weather stations, established in summer 2014, will continue to monitor air temperature, wind speed, relative humidity, and solar radiation at paired sites in Reach 4B, Caswell Memorial State Park, and the USACE Park Ripon River Crossing on the Stanislaus River. Up to three new paired sites will be established at the San Joaquin National Wildlife Refuge, Dos Reis Ranch, and Hidden Valley Ranch where River Partners has restored over 2,000 acres of riparian forest and owns property yet to be restored. Each paired site includes an area with a mature riparian tree canopy at least 60 meters wide and another nearby area with a minimal tree canopy representative of typical conditions in the SJRRP Restoration Area. Caswell State Park and the USACE Park will be particularly useful, because they have dense, old growth woodlands that are at least 150 meters wide on each side of the river. The San Joaquin National Wildlife Refuge has large restored forests on one side of the river, where air temperature sensors could be established in the middle of the forest. Microclimate data will be collected at 15-minute intervals with battery operated units at all sites. Cattle exclusion fences will be constructed and maintained at the Reach 4B study sites. The data will be downloaded at weekly intervals. The weather stations were purchased in 2014 and USFWS staff will collect the weather station data. Some of the microclimate sensors may need to be periodically returned to Onset for calibration.

Reclamation's Technical Service Center botanists will characterize the riparian forest at new study sites according to the crown density of the forest overstory as determined with hemispherical photos. They will also identify the primary species in the riparian forest overstory and herbaceous layer at each study site along a single transect marked with t-posts. USFWS staff will take all hemispherical photos of the riparian tree canopy.

1.5 Deliverables and Schedule

Data collection at the Restoration Area will be continuous. A draft report will be produced by October 31, 2015 and a final report by December 31, 2015.

1.6 Budget

The total cost estimate is \$117,319 for 2015. Weather station data collection includes 40 days for weekly data downloads, 10 days to install new weather stations, and 22 days to take hemispherical photos.

Table 1. Proposed 2015 Budget

Task	Cost
USFWS Weather Station Data Collection	\$64,089
Reclamation's Technical Service Center Botanical Surveys	\$49,730
Weather Station Repairs & Calibration	\$3,500
Total	\$117,319

1.7 Point of Contact / Agency Principal Investigator

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1.8 References

- 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.
- SJRRP. 2008. Temperature Model Sensitivity Analyses Sets 1 & 2. Draft Technical Memorandum, February 2008.
- _____. 2014. Effects Of A Riparian Forest On Water Temperatures In The Restoration Area. 2014 Mid-Year Data Reporting. Available at <<http://restoresjr.net/flows/data-reporting>>.

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