Study 31

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

Final
2014 Monitoring and Analysis Plan

November 2013

San Joaquin River Restoration Program

2014 Monitoring and Analysis Plan

The Effects Of A Riparian Forest On Water Temperatures In The Restoration Area

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 release of 4,500 cfs by April 24 during median (P = 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.

2. Background:

Studies in small headwater streams indicate that a 30-meter wide riparian tree canopy reduced above stream air temperatures by 8.6^{o}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^{o}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.

3. Anticipated Outcomes:

Monitoring microhabitat climates in different riparian habitats along the San Joaquin and Sacramento rivers 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 is not expected to affect water temperature; however, it should affect floodplain cover for juveniles and sediment transport. A particular concern is that a heavy herbaceous layer will increase sand deposition on the

floodplains and increase scour in the low-flow channel. This study will assess the relationship between tree canopy density and the herbaceous layer over a range of dry and wet years.

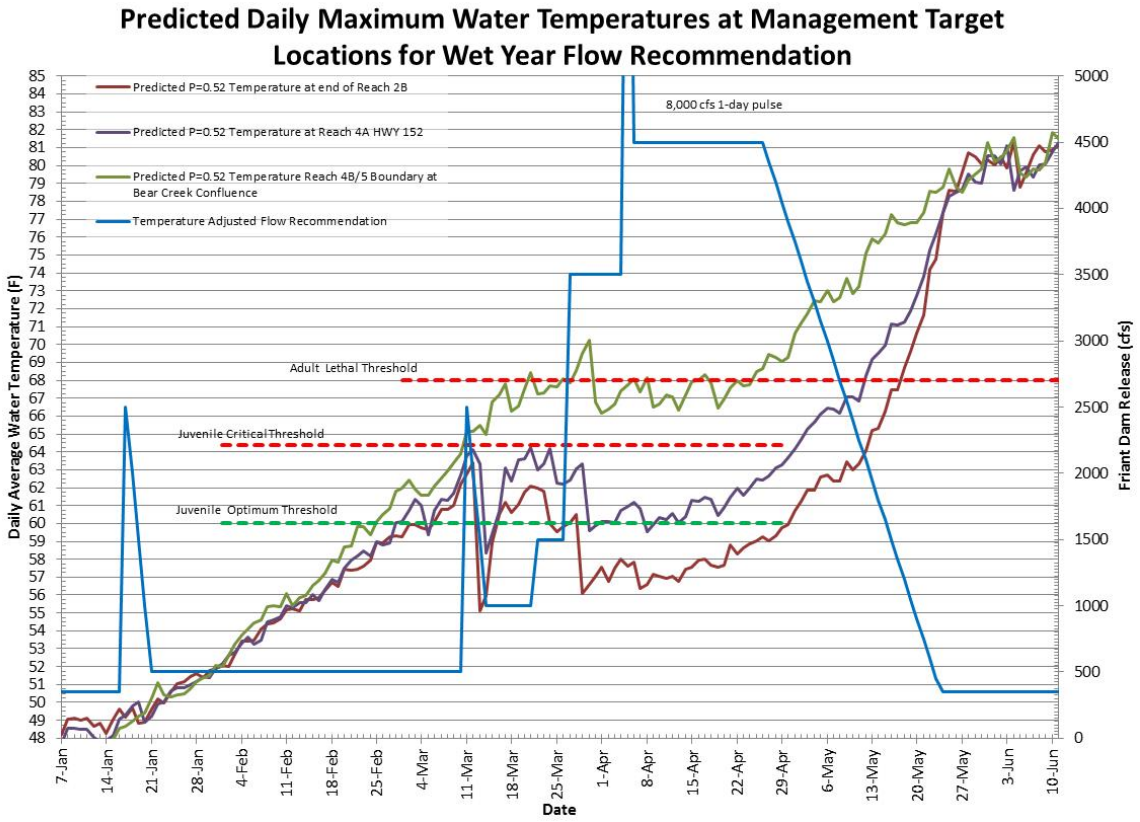

Figure 1. Possible Wet Year flow recommendation designed to maximize adult spring-run passage and two brief pulse flows for juvenile passage relative to the predicted daily maximum water temperatures (SJRRP 2008a) during average meteorological conditions from 1980 to 2005 (P = 0.52 exceedance) just upstream 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 68^{o}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^{o}F in April and by 1-2^{o}F in May (SJRRP 2012).

4. Methods:

Weather stations that can monitor solar radiation, air temperature, wind speed, relative humidity, and soil moisture will be installed on the riverbank of the San Joaquin River upstream of the confluence with the Tuolumne River and possibly along the Sacramento River upstream of Colusa to minimize the influence of Delta conditions. Two weather stations will be placed near the riverbank at up to 10 study sites, one in an area with a mature riparian tree canopy and another in a nearby area with a minimal tree canopy representative of typical conditions in the SJRRP Restoration Area. If possible, sites will be selected to represent tree canopy widths from 30 meters to 200 meters on one and preferably both sides of the river. The selection of study sites will depend on the presence of forested areas as well as landowner permission. The initial phase of this study will be to select up to 10 study sites. The data will be analyzed to determine the

mean difference in microhabitat conditions between forested and degraded sites relative to the canopy density and canopy width during each month of study.

Technical Service Center botanists, Greg Reed and Becci Siegle, will characterize the riparian forest according to the width of the forest overstory measured perpendicularly to the river, height and crown density of the forest overstory, and primary species in the riparian forest overstory and herbaceous layer at each study site. Seasonal changes in the canopy will be documented with a hemispheric camera in January, March, and May. The botanists will analyze the hemiphoto data.

Microclimate data will be collected continuously using cellular units where study sites are secure and for 48-hour periods on a bimonthly basis with battery operated units at sites where vandalism is possible. TSC staff will manage the weather station data collection and the hemispheric photography.

This study may continue annually until a wide range of weather conditions and riparian forest conditions have been monitored. Presumably, this may take as long as 5 years.

5. Schedule: Data collection should occur from March 15, 2014 through June 15, 2014. A draft report will be produced by October 31, 2014 and a final report by December 31, 2014.

6. Budget: The total cost estimate is $117,274 for 2014.

Task	Cost
Botanical Surveys/ Weather Station Deployment	$65,835
TSC Travel	$13,020
Weather Station Units Cellular (6)	$25,044
Weather Station Units Manual/Battery (6)	$13,375
Total	**$117,274**

7. Deliverables: Draft and final technical memorandums will be provided annually.

8. Point of Contact/ Agency PI: Katrina Harrison, Reclamation; Erica Meyers, CDFW; and Carl Mesick, USFWS.

9. References

Moore R.D., D.S. 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.