

Relationships Between Flow And Water Temperature In The  
Stanislaus, Tuolumne, And Merced Rivers Near Their Confluences  
With The San Joaquin River And In The San Joaquin River Near  
Mossdale From March 15 To May 15

Prepared by

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## INTRODUCTION

Historical conditions were used to determine the flow releases from the upstream reservoirs in the Stanislaus, Tuolumne, and Merced rivers needed to maintain mean water temperatures near 59 degrees Fahrenheit (F; 15 degrees Celsius) and maximum temperatures below 65°F to the mouths of these rivers during the spring. Water temperatures greater than 59°F impair smoltification and increase the risk of disease (Table 1 in EPA 2003). Impaired smoltification delays the migration of smolts from the tributaries until late spring when many succumb to the combined effects of high water temperatures, disease, unsuitable water quality (pesticides, ammonia, selenium, low dissolved oxygen, etc.), and high predation rates in the Delta (Section 4.2 in FMWG 2009).

## METHODS

The flow releases needed to maintain mean water temperatures near 59°F and maximum temperatures below 65°F throughout the tributaries to the confluence with the San Joaquin River were assessed by plotting the historical conditions of water temperatures versus flow releases for two-week time periods from March 15 to May 15. Plots were also assessed for the San Joaquin River at Mossdale. The flow releases from Goodwin Dam on the Stanislaus River, La Grange Dam on the Tuolumne River, and Crocker Huffman Dam on the Merced River as well as the flows in the San Joaquin River at Mossdale were estimated by AD Consultants and others (2009). The HEC-5Q computer simulation model was used to generate estimates of water temperature at each of the study sites at 12 AM, 6 AM, 12 PM, and 6 PM each day (AD Consultants and others 2009). The period assessed was from 1984 to 2004.

## RESULTS

The flows in the table below provide water temperatures near 59°F and maximum temperatures below 65°F from March 15 to May 15 in the tributaries downstream to the confluence with the San Joaquin River based on the following Excel plots of the data Excel generated trendlines from 1984 to 2004. The trendlines were used as an estimate of the mean temperature.

	Stanislaus River	Tuolumne River	Merced River
March 15-31	1,000 cfs	1,000 cfs	1,000 cfs
April 1-15	1,500 cfs	1,500 cfs	1,500 cfs
April 16-31	2,000 cfs	2,000 cfs	2,000 cfs
May 1-15	2,500 cfs	2,500 cfs	2,500 cfs
May 16-June 15	≥ 2,500 cfs	≥ 2,500 cfs	≥ 2,500 cfs

### Mar 15 to 31

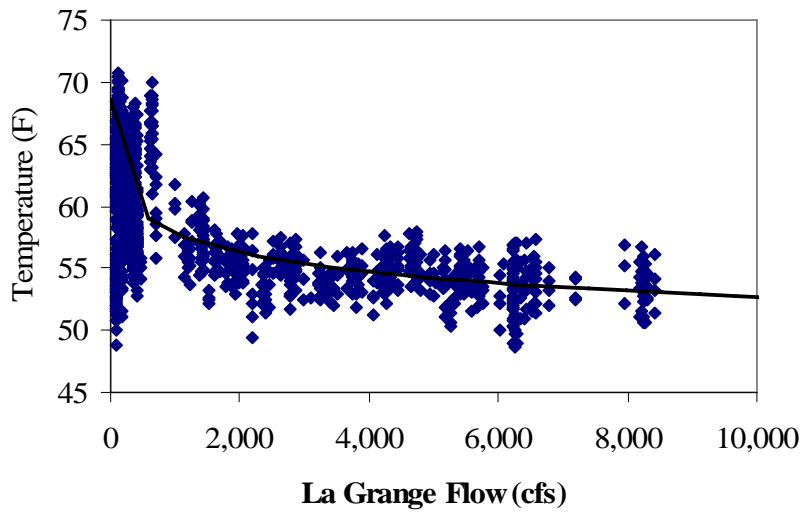


Figure 1. Relation between flows released at La Grange Dam relative to the water temperature in the Tuolumne River near the confluence with the San Joaquin River from 1984 to 2004 between March 15 and March 31. A flow of 1,000 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Apr 1-15

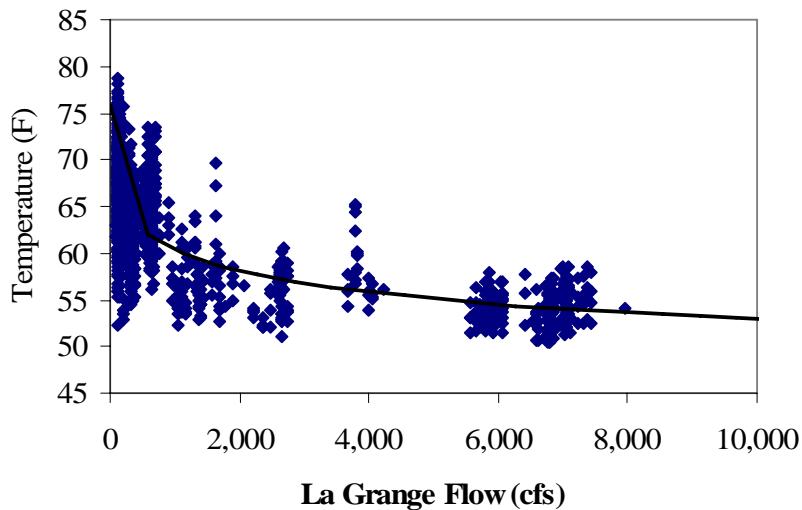


Figure 2. Relation between flows released at La Grange Dam relative to the water temperature in the Tuolumne River near the confluence with the San Joaquin River from 1984 to 2004 between April 1 and April 15. A flow of 1,500 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Apr 16-30

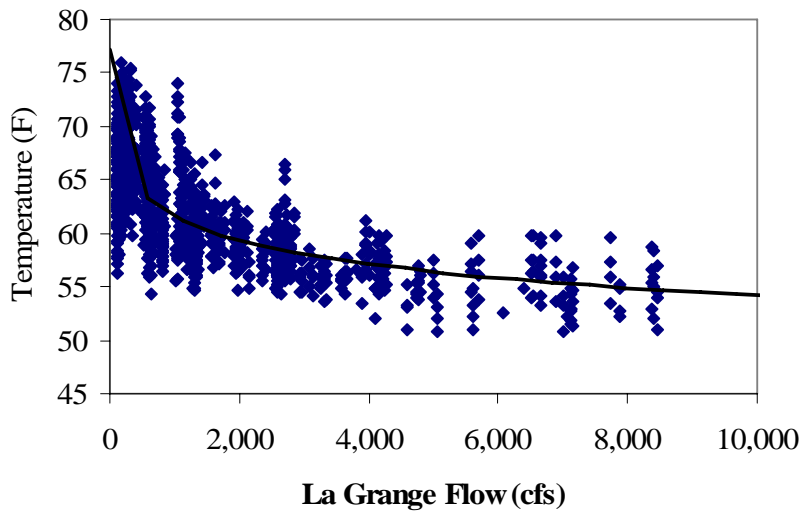


Figure 3. Relation between flows released at La Grange Dam relative to the water temperature in the Tuolumne River near the confluence with the San Joaquin River from 1984 to 2004 between April 16 and April 30. A flow of 2,000 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### May 1-15

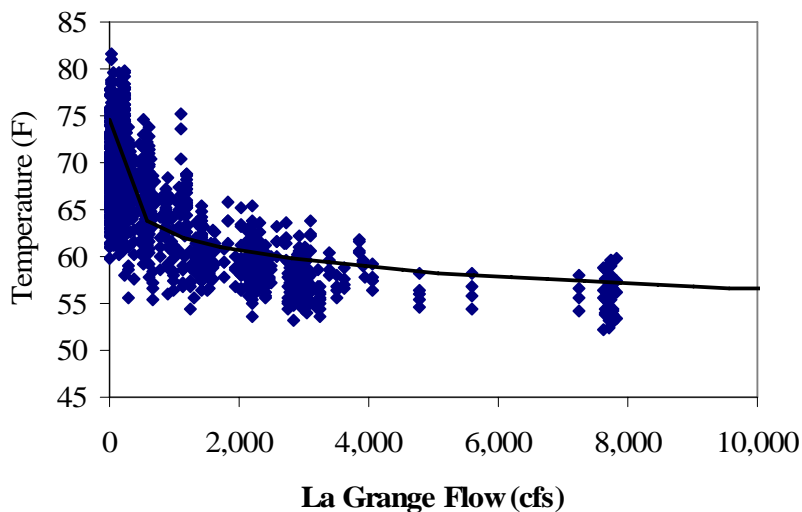


Figure 4. Relation between flows released at La Grange Dam relative to the water temperature in the Tuolumne River near the confluence with the San Joaquin River from 1984 to 2004 between May 1 and May 15. A flow of 2,500 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Mar 15 to 31

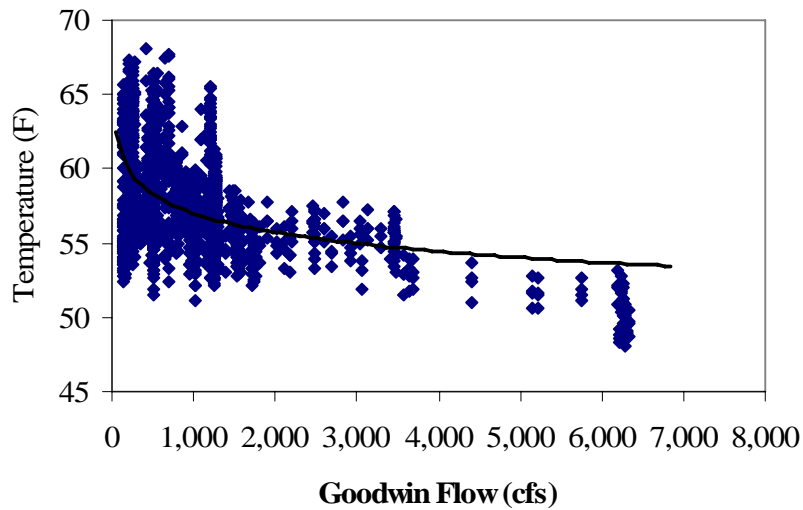


Figure 5. Relation between flows released at Goodwin Dam relative to the water temperature in the Stanislaus River near the confluence with the San Joaquin River from 1984 to 2004 between March 15 and March 31. A flow of 1,000 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Apr 1 - 15

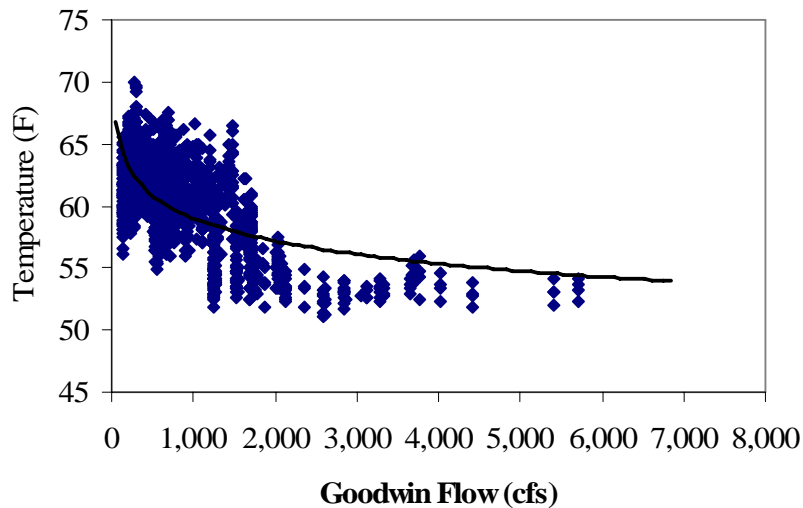


Figure 6. Relation between flows released at Goodwin Dam relative to the water temperature in the Stanislaus River near the confluence with the San Joaquin River from 1984 to 2004 between April 1 and April 15. A flow of 1,500 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Apr 16 -31

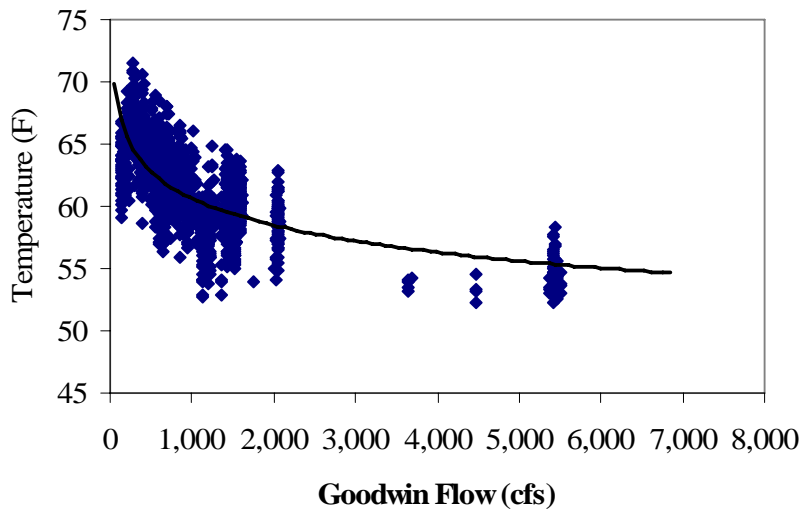


Figure 7. Relation between flows released at Goodwin Dam relative to the water temperature in the Stanislaus River near the confluence with the San Joaquin River from 1984 to 2004 between April 16 and April 30. A flow of 2,000 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### May 1-15

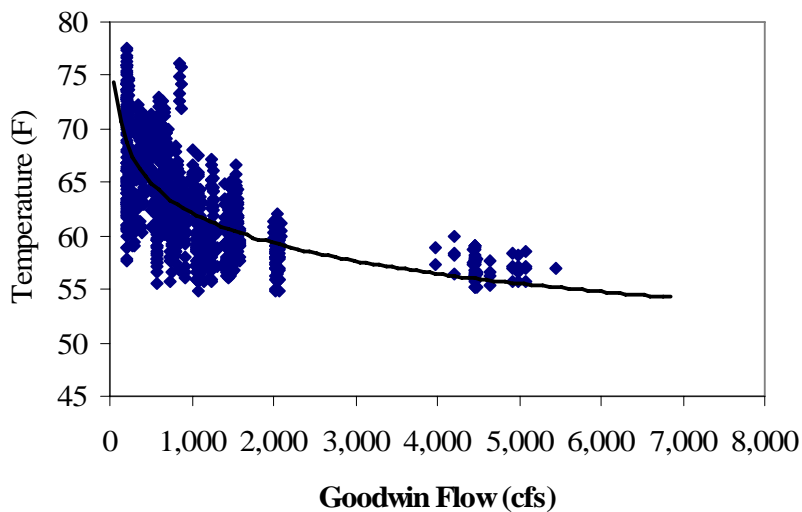


Figure 8. Relation between flows released at Goodwin Dam relative to the water temperature in the Stanislaus River near the confluence with the San Joaquin River from 1984 to 2004 between May 1 and May 15. A flow of 2,500 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Mar 15 to 31

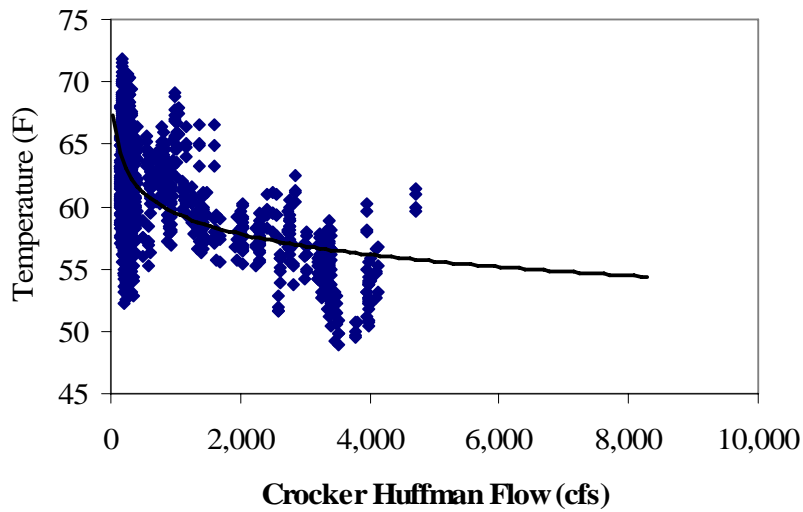


Figure 9. Relation between flows released at Crocker Huffman Dam relative to the water temperature in the Merced River near the confluence with the San Joaquin River from 1984 to 2004 between March 15 and March 31. A flow of 1,000 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Apr 1-15

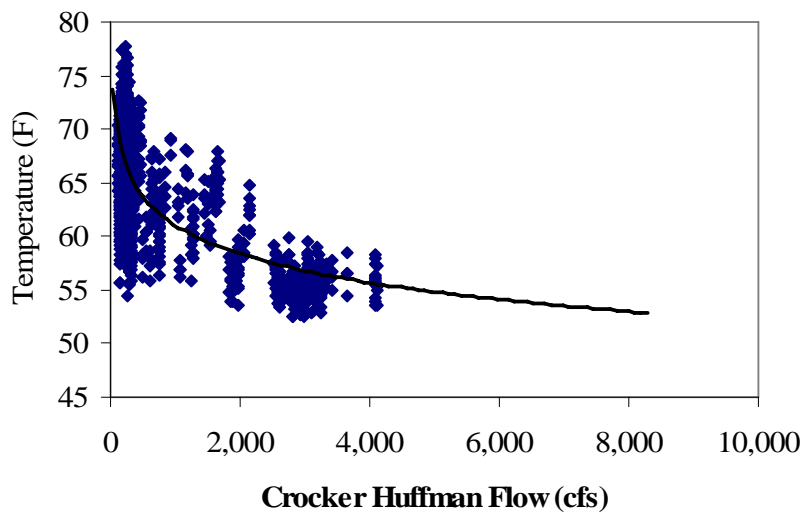


Figure 10. Relation between flows released at Crocker Huffman Dam relative to the water temperature in the Merced River near the confluence with the San Joaquin River from 1984 to 2004 between April 1 and April 15. A flow of 1,500 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### Apr 16-30

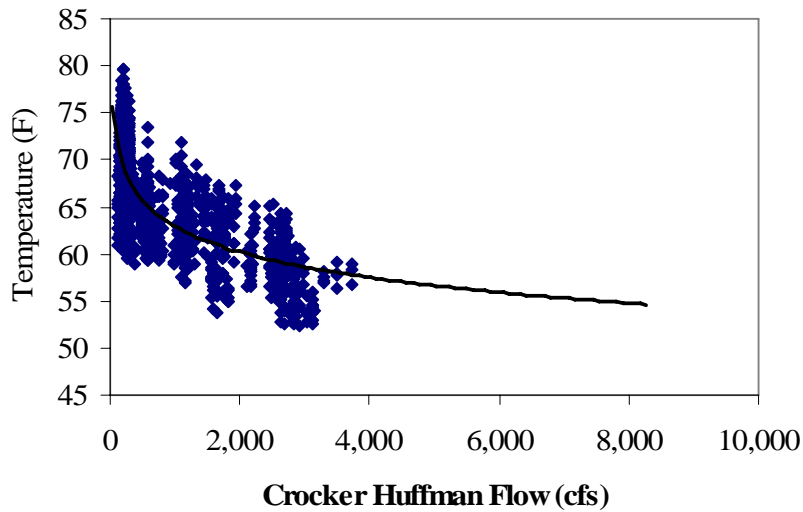


Figure 11. Relation between flows released at Crocker Huffman Dam relative to the water temperature in the Merced River near the confluence with the San Joaquin River from 1984 to 2004 between April 16 and April 31. A flow of 2,000 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.

### May 1-15

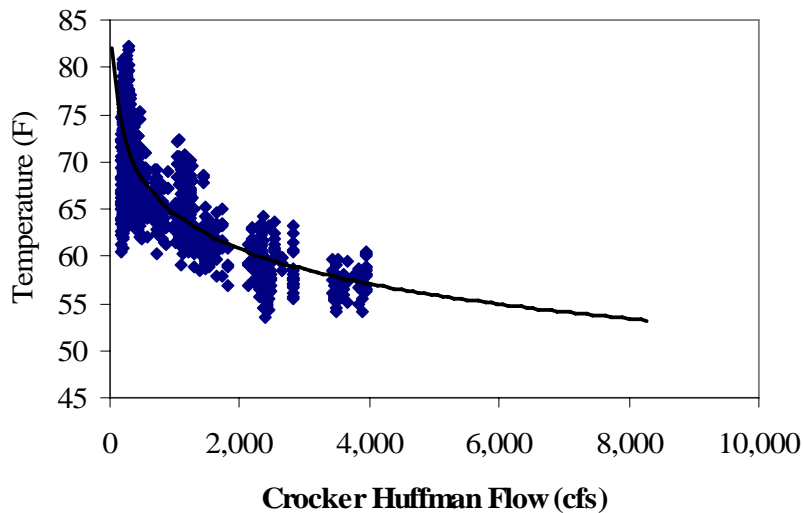


Figure 11. Relation between flows released at Crocker Huffman Dam relative to the water temperature in the Merced River near the confluence with the San Joaquin River from 1984 to 2004 between May 1 and May 15. A flow of 2,500 cfs was judged to provide mean temperatures less than 59°F and maximum temperatures less than 65°F during most years.



### Mar 15 to 31

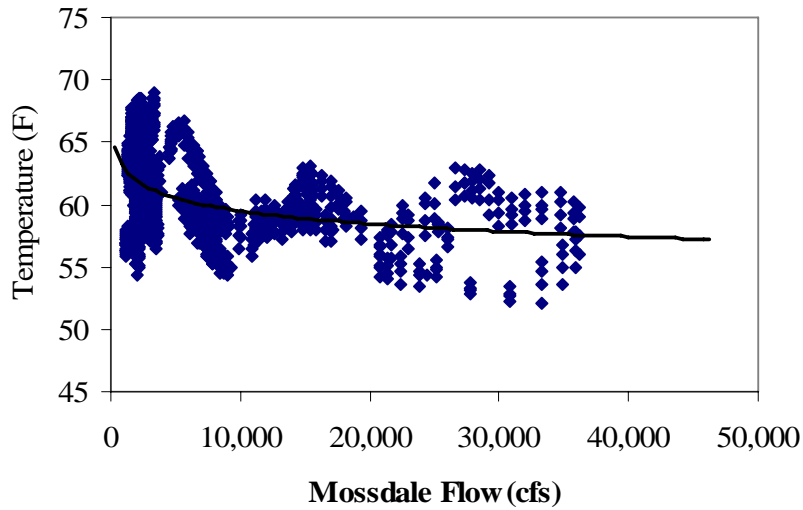


Figure 11. Relation between flows relative to the water temperature in the San Joaquin River near Mossdale from 1984 to 2004 between March 15 and March 31. At a flow of 3,000 cfs at Mossdale, the mean water temperature would be about 62°F.

### Apr 1-15

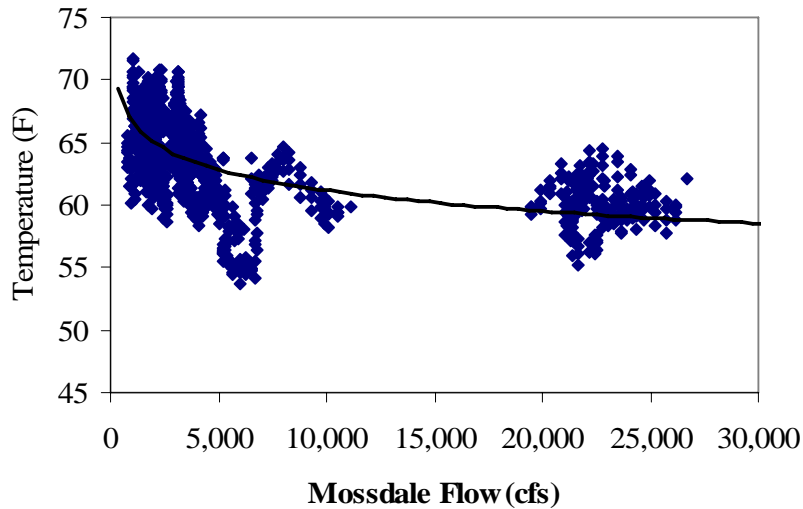


Figure 11. Relation between flows relative to the water temperature in the San Joaquin River near Mossdale from 1984 to 2004 between April 1 and April 15. At a flow of 4,500 cfs at Mossdale, the mean water temperature would be about 63°F.

### Apr 16-30

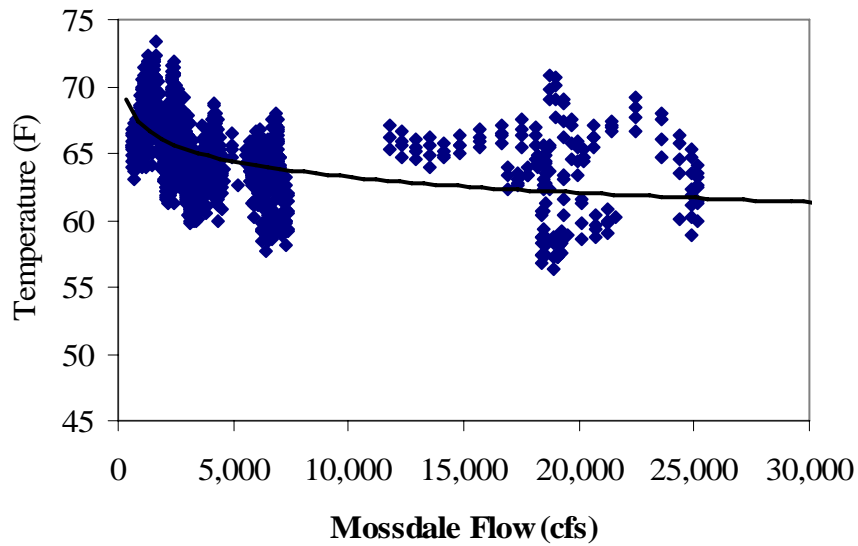


Figure 11. Relation between flows relative to the water temperature in the San Joaquin River near Mossdale from 1984 to 2004 between April 16 and April 30. At a flow of 6,000 cfs at Mossdale, the mean water temperature would be about 64°F.

### May 1-15

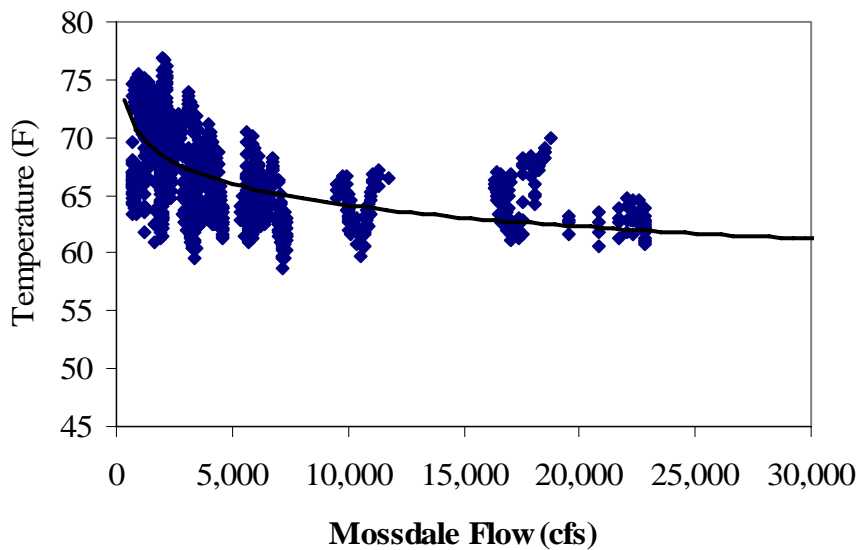


Figure 12. Relation between flows relative to the water temperature in the San Joaquin River near Mossdale from 1984 to 2004 between May 1 and May 15. At a flow of 4,500 cfs at Mossdale, the mean water temperature would be about 65°F.

## REFERENCES

AD Consultants, Resource Management Associates, Inc., and Watercourse Engineering, Inc. 2009. San Joaquin River Basin water temperature modeling and analysis. Prepared for CALFED, ERP-06D-S20. Moraga, California. October 2009.

[EPA] U.S. Environmental Protection Agency. 2003. *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards*. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

Fisheries Management Work Group [FMWG]. 2009. Conceptual models of stressors and limiting factors for San Joaquin River Chinook salmon. San Joaquin River Restoration Program Technical Memorandum. 178 pages. June 2009. Available at: [http://www.restoresjr.net/program\\_library/03-Tech\\_Memoranda/index.html](http://www.restoresjr.net/program_library/03-Tech_Memoranda/index.html)