Study 22

San Joaquin River Tributary Sediment Transport Study

Final
2015 Monitoring and Analysis Plan

SAN JOAQUIN RIVER RESTORATION PROGRAM

January 2015

1.0 San Joaquin River Tributary Sediment Transport Study

Theme(s):
Spawning and incubation;

Related Question(s):

- SI-003b – Is gravel recruitment sufficient for spawning habitat in Reach 1A?
- SI-008 – If new spawning habitat is created, or existing spawning habitat rehabilitated, will future sand (fine bedload) quickly infiltrate spawning habitat and reduce the quality (longevity) of spawning habitat? How frequently would gravel improvements be needed?
- SI-009a – Is existing sand storage contributing to the infiltration into gravels in Reach 1, thereby negatively affecting the health and survival of fry?
- SI-009b – Will future Restoration Flows alter the fine sediment budget in Reach 1? Will this increase or reduce sand storage and fine sediment infiltration into redds?
- SI-009c – Does sedimentation negatively impact spawning in Reach 1? If so, are there strategies available to reduce its impacts (e.g., sedimentation basins, sediment removal, watershed rehabilitation)?
- SI-015 – What are the bed transport rates at various flows? How would this change with the addition of new spawning habitat or rehabilitation of existing habitat? How would you schedule gravel augmentation with different flows and quantities of gravel in the system?
- SI-015a – Is Cottonwood Creek supplying useful spawning gravels to Reach 1?

1.1 Statement of Need

The purpose of this study is to quantify the sediment input from two major tributaries, Cottonwood Creek and Little Dry Creek (Figure 1), to the San Joaquin River downstream from Friant Dam. The amount and type of sediment contributed from the two major tributaries is not well understood, however, given the lack of upstream sediment supply due to Friant Dam, their contribution will likely play a substantial role in the sediment budget of the San Joaquin River,. The amount and timing of fine and coarse sediment contributed by these tributaries can be critically important for aquatic and riparian species, which are a focus of the SJRRP.

1.2 Background

One of the main concerns with respect to tributary sediments on the San Joaquin River downstream from Friant Dam is the potential adverse effect on salmonids. The effects of fine sediment supply on salmonids depend primarily on the size of the sediment and the timing of its addition to the channel (Chapman, 1988; Kondolf, 2000). While coarse sediment between the range of 10 mm to 55 mm is needed for spawning by adults (Chapman, 1988; Kondolf and Wolman, 1993) and for cover by juveniles (review in Kondolf 2000), fine sediment and sand can have a detrimental effect, both on emergence and juvenile rearing quality (Chapman, 1988; Kondolf, 2000; Suttle et al., 2004). In particular, the timing of sediment supply is important, since the eggs must incubate for several months before emergence (Chapman, 1988), which makes them susceptible during this time. If it is supplied after egg deposition, fine sediment and sand can filter down through the framework gravels to plug pore spaces, decreasing permeability and inhibiting the flow of adequate water to eggs or alevins located in the redd (Kondolf, 2000). Relatively small amounts of fines, 10 percent to 30 percent, can significantly decrease incubation survival and emergence rates (Chapman, 1988). The size of fine sediment that significantly decreases survival of incubating eggs varies, but is generally considered to be less than 1 mm (Kondolf, 2000), though sizes up to 9.5 mm have also been found to decrease survival rates (Chapman, 1988). Herein, fine sediment is defined as that finer than 0.063 mm, sand-size sediment range from 0.063 to 2 mm, and coarse sediment is defined as larger than 2 mm.

At a larger reach scale, tributary sediment inputs below dams can create sediment continuity issues in the main stem stream, particularly associated with the creation of delta deposits at the tributary mouth (because flood flows that could transport tributary sediments have been reduced or eliminated). For example, on the Trinity River below the Trinity and Lewiston dams in Northern California, the Rush Creek tributary created a delta that resulted in a pool several kilometers long and was a significant barrier to main stem bedload continuity (Wilcock et al., 1996). In addition, tributary inputs can influence bar dynamics and downstream bedload transport by supplying fine and coarse sediment inputs and altering downstream bed grain size distributions.

The proposed study will focus on quantifying the sediment inputs from Little Dry Creek and Cottonwood Creek because these two tributaries have large watersheds, approximately 188 square kilometers and 130 square kilometers, respectively (Figure 1). As such, these tributaries have potentially large sediment loads that could significantly influence sediment dynamics on the main stem San Joaquin River below Friant Dam. The primary research objective of this study is to quantify the rate, timing, and grain size distribution of sediment entering the main stem San Joaquin from these two tributaries. As part of this primary objective, we will also examine potential sediment continuity issues in the tributaries (e.g., capture by gravel pits) as well as the main stem (e.g., deltas at tributary mouths).

In late water year 2011, the USGS initiated a sediment supply study of these tributaries. During the study, the USGS collected bathymetric and channel data as well as a limited amount of suspended sediment samples during low flows. These data were used to create

1D and 2D hydraulic models capable of simulating sediment transport. However, the storm events which occurred during the study period were small and produced flows with very low sediment transport capacity (and which do not represent the full range of flows these tributaries historically produce). Sediment samples from higher flows are needed to extend the sediment transport curves and to calibrate the hydraulic models, both of which are needed to obtain reliable calculations of sediment contribution from these important tributaries.

1.3 Anticipated Outcomes

This study will answer many of the questions related to sediment delivery from the tributaries into the mainstem San Joaquin River. In particular, results from this study will help to refine the sediment budget regarding fine sediment contributions to the Reach 1A of the San Joaquin River.

1.4 Methods

Type of Study: Field

Reach(es): Cottonwood Creek, and Little Dry Creek (primary tributaries to Reach 1A)

Sand and coarse sediment transport will be sampled using a combination of Bunte-type samplers (Bunte et al. 2007) to trap bedload sediment and automatic Isco samplers (Teledyne Isco Inc., 2012) to collect samples of suspended sediment. Both of these sampling techniques will work well on these flashy tributaries, as they can be deployed for lengthy periods of time (up to several days) and do not require active human presence. Potential sites for the Bunte and Isco samplers include the tributaries immediately upstream of their confluences with the San Joaquin, as well as the discharge weir on Little Dry Creek near the North Friant Road Bridge. In addition, one hydrophone station will be installed on each of the tributary creeks to collect additional information on the timing and relative quantity of coarse sediment discharge. Study 18 of the 2015 MAP provides additional information on the methods used for the hydrophones.

The tributary sediment supply study will continue for FY2014-2018 but at reduced funding compared to WY2011-2013. The focus on the proposed study will be remotely monitored sediment supply with occasional site visits for equipment maintenance and sediment sample collection. For each tributary, suspended sediment will be monitored with at least one auto-sampler (similar to those deployed in WY2011-2013), water levels will be measured with several recording pressure transducers (similar to those deployed in WY2011-2013), and coarse bedload (i.e. gravel- and cobble-sized sediment) mobilization will be estimated using a hydrophone station (hydrophones are presently deployed in WY2014). In addition to the monitoring system, discrete sediment samples and longitudinal water-level measurements will be taken if a large flow occurs. The combination of the above data sources will allow calibration of the hydraulic models, and will extend the sediment transport curves from which rates of sediment supply can be calculated. The sediment data from the tributaries will provide crucial information about the sediment dynamics and sediment supply to the San Joaquin River, which will be particularly useful for maintaining fish habitat downstream of the dam and for designing flows to move the sediment.

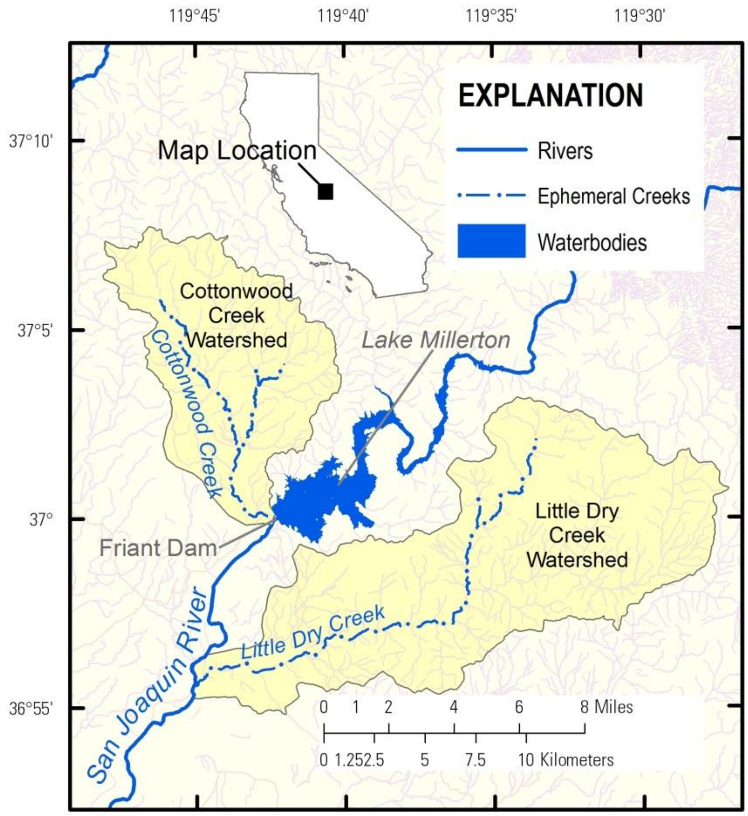

Figure 1. Map of Study Area Showing Locations of Cottonwood Creek and Little Dry Creek and their Respective Watersheds

This study initially covered WY2011-2013; however due to the dry water years during the initial study, the study will continue for three additional years (WY2015-WY2017) to attempt to collect data which is representative of medium-high flow years. Sediment samplers will be deployed during the winter wet season in all three years. If a medium or high flow event occurs, additional site visits will be conducted during the event to collect samples for further processing and analysis. Data analysis and transport calculations will occur in the summer and fall of each year following the winter/spring field work.

1.5 Deliverables and Schedule

A report (USGS report or journal article) will be prepared documenting the study results following the third year of field work (due Sep 30, 2017). Information and presentations will be provided to SJRRP staff on an ongoing basis (pending new data collection from any significant high-flow events) that will be timed to provide adequate information for flow release planning for each water year.

A USGS Open-File or Scientific Investigation report to document the methods used in the data collection and hydraulic model. Sediment transport data may be documented in supplemental reports, such as USGS Open-File, Data-Series reports, or website.

1.6 Budget

The total cost estimate is $65,129 for 2015.

Table 1-1. Proposed 2015 Budget

Task	Cost
Labor/benefits	$29,220
Travel/shipping	$2,484
Sediment lab analysis	$2,630
Equipment and supplies	$950
Subtotal	$35,284
Indirect costs	$29,845
Total	$65,129

1.7 Point of Contact / Agency Principal Investigator

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1.8 References

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