Study 27

Effect of Scour and Deposition on Incubation Habitat in Reach 1A

Public Draft
2013 Monitoring and Analysis Plan

SAN JOAQUIN RIVER RESTORATION PROGRAM

September 2012

27.0 Effect of Scour and Deposition on Incubation Habitat in Reach 1A

27.1 Statement of Need

The Healthy Fry Production Problem Statement lists intragravel flow, DO, and emergence as some of the limiting factors to successful fry production (SJRRP, 2009). A potential limiting factor not included in the problem statement is excessive scour that potentially could expose buried eggs to abrasive flows and predation, thereby reducing the productivity of a redd. Presumably this was not included due the assumption of low bed mobility at incubation season flow levels.

This study plan is intended to examine the role that discharge plays in influencing successful incubation and emergence. The discharge level affects the ability of the flow to transport and deposit bed material. As mentioned previously, erosive scouring of the bed material can expose incubating eggs to abrasive flows and predation. Deposition, on the other hand, can both (1) reduce the ventilation of incubating eggs, and (2) entomb emerging fry. Sediment deposition can occur either with a change in bed surface elevation when sediment deposits over a redd or with no elevation change as fine material (i.e., sand and silt) fills the interstitial spaces between the coarse framework particles overlying the redd. Both depositional processes are capable of entombing fry and reducing egg pocket ventilation. Furthermore, post-scour deposition alters the texture of the material overlying the remaining egg pocket (Haschenburger, 1999; Lapointe, et al., 2000; May, et al., 2009). Therefore, predicting the flow levels that encourage these processes and the magnitude of the adverse affect to the redd environment is of critical importance for managing flow releases for salmon production.

27.2 Background

Ideal salmon spawning sites are expected to be characterized by flows of sufficient depth and velocity, and with bed material of adequate textural composition, among other things. Such conditions are expected to be located within and proximal to riffles. Riffles are found to be limited in the spawning reach making up only 2 percent of the channel area and 4.5 percent of the total length of upper Reach 1A (2010 ATR, Appendix G). Additionally, the majority of these riffle environments may be unsuitable for spawning salmon given their lack of bed mobility (MEI, 2009), thereby making available spawning locations a potential limiting factor to the success of the Restoration program.

Stream bed erosion and deposition vary with location, bed and supply texture, and proximity to sediment sources. Generally, locations closer to coarse sediment sources are more likely to experience deposition that results in net bed elevation gain. Sand and silt are likely to be transported longer distances per discharge event and therefore have the ability to affect a redd environment further downstream. Sources of sediment to the spawning reach of the San Joaquin River appear to be mostly local from within or along the channel: including the stream bed, bars, banks, scour channels, terrace erosion, and the floodplain. Additional sources of fine sediment potentially include two intermittent tributaries (Cottonwood Creek and Little Dry Creek) that connect with the San Joaquin River in Reach 1A (Tetra Tech, 2011). Given the predominantly local sources of sediment supply, discharge level within the reach is likely to be the main factor contributing to sediment deposition with differences in sediment influx likely to be relatively minimal for similar sized discharge events.

In general, stream bed scour/erosion is driven by the discharge level, where the higher the discharge the greater the capability of the flow to mobilize bed material and scour the bed surface. Previous studies suggest that even at the highest planned Restoration Flow levels most of the channel's bed material will be immobile (MEI, 2002; JSA and MEI, 2002; McBain and Trush, 2002; Stillwater Sciences, 2003). However, results from an ongoing field investigation (2010 ATR, Attachment A1) measured both net bed scour and deposition in excess of 1 foot resulting from flows with a maximum peak discharge of approximately 1,700 cfs (Figures 27-1 and 27-2). This finding is especially relevant given the fact that it occurred in a section of the channel anticipated to be used as spawning habitat.

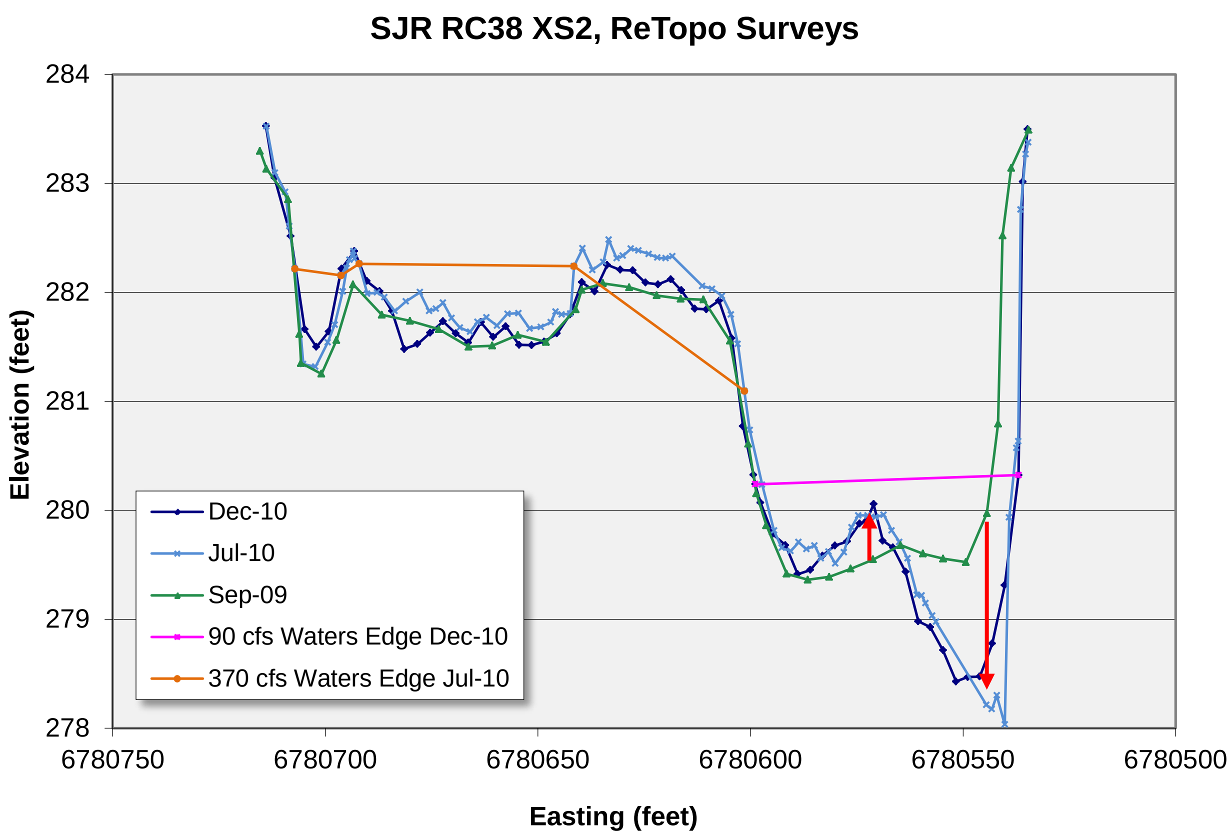

Figure 27-1.
Repeated Channel Profile Topographic Surveys at Cross-Section 2 of Riffle Cluster 38 Located at RM 260.7 from September 2009 Through December 2010

After a peak flow of 1,700 cfs on April 12, 2010, approximately 2 feet of bed material were scoured from the low-flow channel. Note, the right-bank water edge elevation was not measured for the 370 cfs flow, but it can be reasonably extrapolated from the left bank of the mid-channel bar.

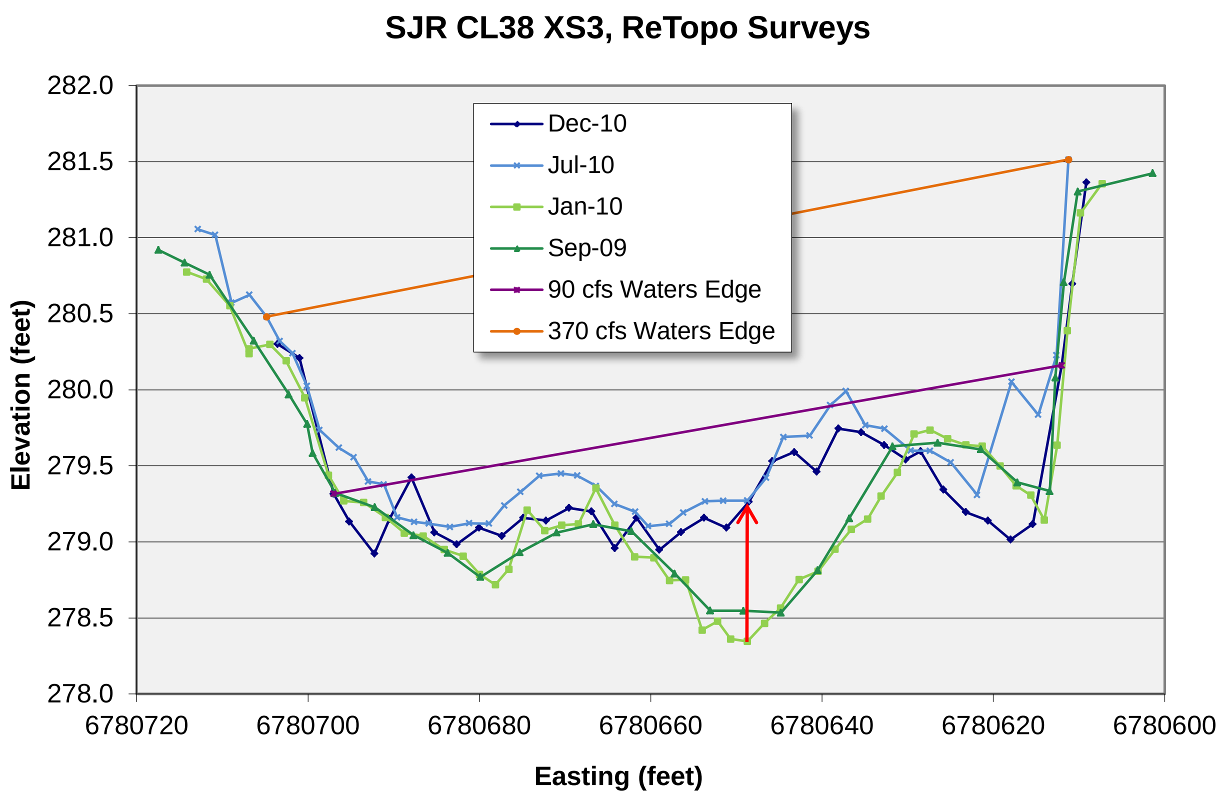

Figure 27-2.
Repeated Channel Profile Topographic Surveys at Cross-Section 3 of Riffle Cluster 38 Located at RM 260.7 from September 2009 Through December 2010

After a peak flow of 1,700 cfs on April 12, 2010, approximately 1 foot of material was locally deposited.

A field investigation indicates that there is a significant volume of sand and fine sediment stored in the channel in Reach 1 (Tetra Tech, 2011). Therefore, there is potential for infiltration and accumulation of sand and finer material into the redds' gravel framework, which can significantly affect the quality of the incubation habitat (Kondolf, 2000). However, flow conditions that would have access to fine sediment supplies, have the ability to transport fine sediment, and allow for it to accumulate on the bed and infiltrate the bed material are not known.

27.3 Anticipated Outcomes

This study is intended to investigate the affect of discharge on habitat quality over the life span of a redd. It is intended to define (1) discharge levels that encourage fine sediment deposition into the gravel framework of artificially constructed redds; (2) a rate of fine sediment accumulation within a redd with respect to discharge level, (3) flow conditions capable of scouring the redd framework gravels, and (4) depositing coarse sediment over the redd. Collaboration with Reclamation, USFWS, and DFG will combine studies to additionally measure intragravel flow, DO, and temperature in the redd interstices, as well as including salmon eggs for quantifying survivorship over time.

27.4 Methods

Approximately five sites will be selected where studies on the influence of fine sediment infiltration into redds will be conducted. These sites will be chosen to span the anticipated spawning habitat in upper Reach 1A and evaluate for a gradient in fine sediment accumulation relative to proximity to sediment sources and/or distance downstream. The baseline task required to establish this monitoring program will include artificially constructed redd and scour chain monitoring. Tasks performed to characterize site conditions will include bed material size analysis, scour chain installation, flow profile surveys, bedload sampling, and repeated permeability measurements. Each portion of this investigation and the decision-making process is presented as a flow diagram in Figure 27-3.

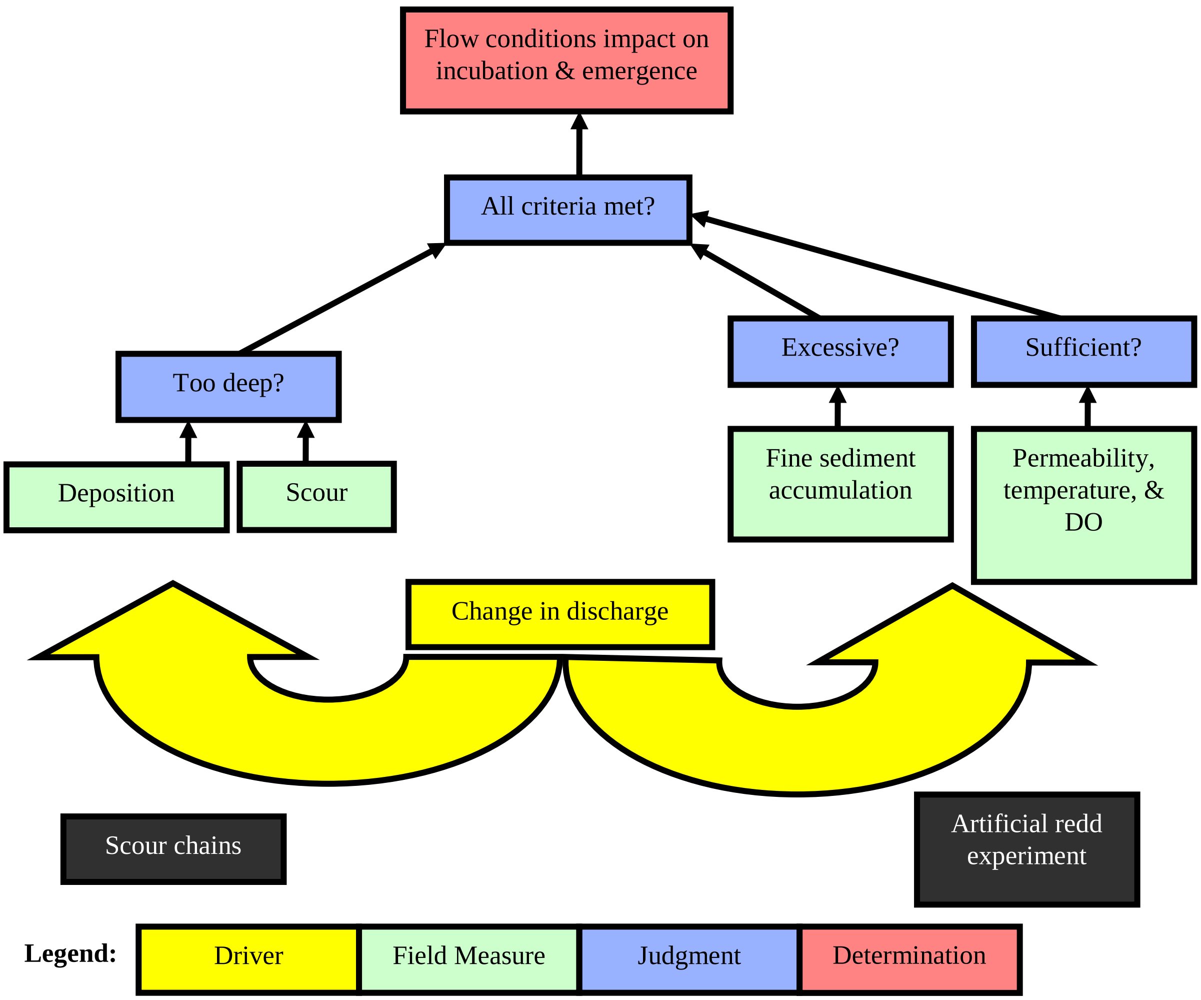

Figure 27-3.
Steps Toward Developing a Model for Predicting Sand Accumulationand Scour from Flow Level and Duration

27.4.1 Artificial Redd Experiment

Pairs of redds will be constructed with the intention of sampling each over time. Upon completing each artificial red, a collapsed sediment retrieval bag will be inserted beneath the material where the egg pocket would be located. The bag will allow retrieval of the redd framework particles and accumulated fines. Each sample will be oven dried and sieved in laboratory , to 6.35 mm, using sieves approximately scaled to ½-phi intervals. Sampled material finer than the smallest field sieve will be sieved at ½-phi intervals to 0.063 mm. Mass retained in each sieve will be weighed and recorded.

Additionally, at least four perforated pipes will be inserted into each redd for subsequent permeability, temperature, and DO measurements from within the redd (Lisle and Eads, 1991). Each pipe will be screened from 10.5 to 13.5 inches below the top end of the pipe so as to measure permeability at that depth below the surface of the bed. The pipes will allow these measurements with minimal disturbance of subsequently deposited fine sediment. It is intended that collaborators from Reclamation, USFWS, and/or DFG will perform temperature and DO measurement activities as part of companion studies detailed in other sections of this document.

Ideally, one redd from each pair will be sampled midway through an incubation period and the other sampled after the incubation cycle has completed. This will allow for deposition rates to be determined under a fluctuating discharge regime. Experiments will be repeated with the intention of capturing accumulation rates for different discharge levels.

27.4.2 Bedload Sampling

A handheld bedload sampler with a 3-inch square opening and 1.4 expansion ratio will be used to collect samples of sediment greater than 0.15 mm in diameter transported on the bed surface. Samples will be collected over approximately 30 minutes at each site. The 0.150 mm mesh sample bag will be emptied of sample material into a sealable bag, marked with sample date and location, and transported to the lab for drying and sieving. The dried sample's weight will be recorded. The transport rate will be compared to the fine sediment accumulated within the clean interstices of the artificial redd's gravel framework. In addition, the accumulation rate will be compared with the change in hydraulic variables (i.e. discharge, flow velocity), redd permeability, and location.

27.4.3 Scour Chain Monitoring

Scour chains will be installed in the vicinity of the artificial redds with the intention of measuring the total scour depth and deposition. Each chain will be fitted with a duck bill anchor to avoid chain loss due to erosional forces. Each chain will be driven into the stream bed with hand tools to a depth of approximately 3 feet. The number of remaining links exposed on the bed surface will be noted and the link closest to the bed's surface will be marked with a hog ring. No other marking will be used so as to avoid potential hampering by interested citizens.

27.5 Schedule

Permission has been granted to install the scour chains and artificial redds. Installation activities began in September 2011. This third round of the redd experiment monitoring will begin in November 2012 and last through December 2012, which spans the anticipated spawning and incubation periods for fall-run Chinook salmon. Upon redd installation, one from each pair will sampled after approximately 30 days and the second after approximately 60 days. Sampling will be dependent on flow conditions that allow safe access to each location.

27.6 Deliverables

A report detailing investigation activities, analysis, results, and conclusions will be presented as an appendix of 2013 ATR. Similarly, data collected as a part of this investigation will be presented as an attachment of the 2013 ATR.

27.7 Point of Contact/Agency

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27.8 References

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