Study 40

San Joaquin River Spawning Habitat Suitability

Final
2015 Monitoring and Analysis Plan

1.0 San Joaquin River Spawning Habitat Suitability

Theme(s):

- Spawning and incubation;

Related Question(s):

- SI-001a: Is spawning habitat quality in Reach 1A sufficient to support adequate egg survival and healthy emergent fry for both spring- and fall-run Chinook salmon?

- SI-002: Where do spring- and fall-run Chinook salmon choose to spawn? What are the spawning habitat conditions in those locations?

- SI-003: Given the current and/or potential future habitat quality in Reach 1A, is the amount and distribution of spawning habitat sufficient to support spring-run Interim (2,500 adults) and Growth population Goals (30,000 spring-run & 10,000 fall-run adults) in the first four miles downstream of Friant Dam, as well as a self-sustaining population of fall- run spawners further downstream of the dam?

- SI-003a: Are there locations within Reach 1A with sufficient spawning-sized gravels? Where are they located?

- SI-013: Are river temperatures appropriate, both spatially and temporally, for spawning and incubation of spring-run Chinook salmon?

- SI-015b: What is quantity of existing spawning gravel in Reach 1?

1.1 Statement of Need

The San Joaquin River Restoration Program (SJRRP) Restoration Goal is to “restore and maintain fish populations in good condition in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish.” The SJRRP Fisheries Management Plan identifies spawning and incubation as a life stage to be supported for successful completion of the salmon life cycle. SJRRP’s current understanding of the system is that sufficient availability and quality of spawning habitat within Reach 1A of the San Joaquin River is imperative to sustaining a population of Chinook salmon. Several uncertainties exist as to the suitability of existing spawning gravels within Reach 1A and how sediment transport may affect efforts aimed at improving spawning and incubation habitat. In addition, there is a need to understand relationships between Friant Dam flow releases and microhabitat for Chinook salmon to help the Restoration Administrator recommend Restoration Flow releases. Initial flow management needs focus on flow-habitat relationships for spawning habitat (including redd desiccation), but as adult escapement and juvenile production increases, flow management will also be improved by having flow-habitat relationships for adult holding and juvenile rearing. This study aims to coalesce data collection efforts with hydraulic modeling results to initially quantify "potential spawning habitat" and analyze the suitability of the spawning habitat with GIS parameterization of attributes directly associated with spawning habitat quality, such as water temperature, gravel size distributions, flow depth and velocity, cover, hyporheic temperature and dissolved oxygen, fine sediment accumulation, gravel permeability, and adult refugia. The models can be expanded in the future to also assess other life stages, such as adult holding, juvenile rearing, and others.

1.2 Background

Multiple studies are currently underway or have been completed to help identify the quality of the hyporheic environment as it relates to successful spawning and fry emergence (current efforts summarized in Section 3.2 of 2014 MAP; SJRRP, 2013a). These include efforts to evaluate water quality within the hyporheic zone (DO [USBR, 2012], water temperature effects [USBR, 2012a], fine sediment accumulation [SJRRP, 2010a; SJRRP, 2013b]), egg survival (SJRRP, 2012), mesohabitat characterization (SJRRP, 2010a), spawning habitat use by transported fall-run Chinook (SJRRP, 2011; SJRRP, 2013c), bed material size and mobility (Tetra Tech, 2012a,b; SJRRP, 2012; SJRRP, 2013d), scour and deposition (SJRRP, 2011), channel morphology changes associated with alteration to the flow regime (SJRRP, 2011; SJRRP, 2012; SJRRP, 2013e), and sand storage/source distribution (Tetra Tech 2012a, 2012b). In addition, bedload and suspended load monitoring have been conducted within the reach since 2010 (Graham, Mathews & Associates, 2012; USBR, 2013). These efforts are ongoing and will continue to be utilized to understand existing conditions, and eventually, planning and design of projects to improve conditions.

1.3 Anticipated Outcomes

The study will result in several outcomes:

- Improved understanding of the spatial and temporal suitability of Reach 1A for spawning of fall and spring-run Chinook salmon.

- Improved understanding of the amount and distribution of spawning habitat to evaluate the river's ability to support spring-run Interim (2,500 adults) and Growth population Goals (30,000 spring-run & 10,000 fall-run adults) in the first four miles downstream of Friant Dam, as well as a self-sustaining population of fall- run spawners further downstream of the dam.

- Development of a strategy to expand localized physical and biological variables (e.g. fine sediment accumulation, permeability, sediment mobilization) measured at specific sites across the entirety of Reach 1A.

- A map illustrating "potential spawning areas" based upon facies mapping, mesohabitat mapping, and modeled hydraulic conditions.

- Improved tool to assist the Restoration Administrator and the SJRRP in flow management, including,

    - Relationships between Friant Dam flow releases and spawning habitat in different riffles within Reach 1A, and

    - Improved understanding of the relationship between spawning location and the effect of flow changes on redd desiccation and spawning habitat changes.

- Improved understanding of the sensitivity of predicted spawning habitat to topographic point density, substrate suitability criteria, and cover suitability criteria.

1.4 Methods

Type of Study: Combination of modeling, field studies, and literature review will be utilized in this study.

Reach(es): Reach 1A from Friant Dam to Highway 99

To accomplish this study most efficiently, the tasks have been divided into two phases. The first phase is intended to identify areas of "potentially suitable spawning habitat" and the second phase will refine those areas based upon measured parameters of spawning and incubation habitat quality. Almost all of the Phase 1 tasks can be accomplished with existing information and modeling. Some tasks in Phase 2, such as determining the cover available at each site where hydraulics and bed material are suitable, may require field work.

Phase 1- Coarsely identify areas of potentially suitable spawning habitat.

1. <u>Develop continuous generalized map of bed material in Reach 1A</u>
    a. Facies mapping was conducted between Friant Dam and HW 99 in June 2012. The field maps have been digitized into polygons. These polygons will be overlaid by all available bed material data. From this data, a range of gradations representing each facies category will be developed. In addition a representative D_{16}, D_{50}, and D_{84}/D_{90} or D_{max} will be identified for each facies category.

    b. This task will require input from the Spawning and Incubation Subgroup (SIG) to determine which facies should be considered potentially spawnable. The Fisheries Management Workgroup (FMWG) developed a list of criteria for depths, velocities, and spawning-sized bed material from existing literature for spring and fall run Chinook (SJRRP, 2010b), which may be the basis for this determination. Most of these reported data were not specific to the San Joaquin River, and therefore consensus needs to be reached on which criteria will be used.
2. Develop two-dimensional (2D) hydraulic model in Reach 1A- *Completed*
    a. Two 2D hydraulic models of Reach 1A were developed and calibrated with all available water surface information (Reclamation, 2014). Reach 1A_01 model extends from Friant Dam to HW41 while the Reach 1A_02 model extends from HW 41 to HW 99. Simulated flows between 270 cfs to 7,650 cfs (used in model calibration) were processed based upon habitat suitability information from the Stanislaus River. Depths ranging between 0.7 to 3.7 feet and velocities between 0.8 to 3.4 ft/s were considered suitable based upon input from the FMWG, and polygons around areas meeting both of these criteria were developed for each simulated flow.
    b. Flows during spawning season will not likely exceed 2,000 cfs. Therefore, additional flows may be simulated and processed to bracket the full range of anticipated flows potentially influencing spawning habitat conditions.
3. Conduct 2-D hydraulic and micro-habitat modeling with more detailed information at three subreaches in Reach 1A
    a. In consultation with the SIG, select 3 sites that are between 1,000 ft to 2,000 ft long that are likely to be highly used by fall-run Chinook salmon spawning based on 2013 spawner distribution map.
    b. Conduct water surface and velocity measurements in Fall 2014 during Riparian Release (160 cfs) to enable low flow model calibration and validation
    c. Conduct more detailed mapping of suitable substrate and cover based on “good” criteria developed by the SIG
    d. Conduct supplemental topographic surveys within the low flow channel to provide more detailed topography as the basis for the 2-D model in each subreach
    e. Conduct spawning habitat modeling in subreaches using this more detailed topography, suitable substrate and suitable cover information, and compare with modeling results in Step 2 above to assess model sensitivity to the more detailed data.

4. Develop report and geodatabase of polygons representing mesohabitat mapped riffles, suitable bed material, velocities, and depths to delineate "potential spawning locations"

Phase 2- Refine Potential Spawning Locations based on Quality Parameters

5. Further refine suitability of spawning habitat locations.
    a. SIG members will help determine spawning habitat suitability of each potential spawning habitat site based on the availability of nearby adult refugia and cover. Examples of adult refugia include adjacent pool habitat, surface turbulence, overhanging or accumulations of large wood, or shade.
    b. Incorporate sediment mobility information into geodatabase to further refine quality. Based upon field studies conducted by DWR, the Shield's value for incipient entrainment is consistently 0.020 $\pm$ 0.003 (Matt Meyers, DWR, personal communication, 07/14/14). Therefore, model results and bed material data can be combined to assess how much of each spawning area should experience entrainment for each flow scenario.
6. Estimate suitability of egg incubation habitat
    a. Incorporate findings from egg survival study, fine sediment accumulation and transport, hyporheic water temperature and DO, sand source mapping, and other physical and ecological attributes determined to be important in defining egg incubation habitat suitability. Sand transport thresholds may also provide useful information, and a time series analysis of when flood control releases exceed sand transport thresholds during the time frame of egg incubation (September to January) will be conducted.
    b. Develop methodology to integrate incubation habitat quality data into the Geodatabase. FMWG members recommended using fine sediment accumulation and transport data/models to determine incubation habitat quality. Chinook salmon create high quality incubation habitat during redd construction, but fine sediment intrusion following redd construction degrades incubation habitat quality.
7. Identify Remaining Data Gaps
    a. This step will require the spawning and incubation subgroup to identify data needs to completely answer remaining questions relating to spawning habitat as outlined in SJRRP, 2013. In addition to identification of the data gaps, a plan to acquire the necessary data to fill the gaps will be developed. This task will be completed in coordination with the Fisheries Management Group.

Existing information available:

a. 2D depth and velocity mapping (Elaina Gordon)

b. Meso habitat mapping (Matt Bigelow)
c. Facies mapping (Andy Shriver)
d. Sediment atlas data (Andy Shriver)
e. Bed mobility data (Matt Meyers)
f. Coarse and fine bedload transport data at Ledger Island (RA/TAC)
g. Fine bedload transport data at a variety of locations in upper Reach 1A (Matt Meyers)
h. Sand Infiltration Data/ fine sediment accumulation data (Erica, Andy, Matt, Matt, Mark N?)
i. Egg survival mapping and data (may be similar to f)
j. Permeability data (Andy Shriver)
k. Escapement data (Andy Shriver)
l. Fine sediment storage/accumulation mapping (TetraTech, DWR)
m. Hyporheic monitoring data (DO, temperature, etc. collected by Mark Nelson)
n. Surveyed redd data (Matt Bigelow)
o. Vegetation data to access cover/adult refugia
p. Temperature monitoring data (Erica Meyers)
q. Temperature modeling data (Katrina Harrison)

1.5 Deliverables and Schedule

Deliverables for this effort will consist of a technical memorandum documenting methods utilized to complete the tasks in Phase 1, and will propose a framework for moving forward with Phase 2 to incorporate egg incubation and survival, hyporheic quality, adult refugia quality parameter, bed mobility, sand storage/accumulation, and any other pertinent information. In addition, a geodatabase and map will be delivered that includes feature classes of GIS information that is relevant to the study. This will include polygons delineating potential spawning areas, results of hydraulic modeling, and updated Facies/bed material characterizations. A schedule to accomplish the proposed tasks in Phase 1 is provided below. Some of Phase 2 tasks are uncertain at this point due to a substantial amount of input required from other SIG and FMWG members. Additional uncertainties in the timeframe include other higher priority program needs that could delay the schedule.

Proposed Task	Date
Phase 1	
Task 1: Develop continuous map of bed material	October 30, 2014
a. Overlay with bed material data to determine gradation for each facies	January 30, 2014
b. Determine which facies are potentially spawnable	March 1, 2014
Task 2: Complete 2D modeling	
a. Additional simulations to bracket spawning flows and process results	December 15, 2014

Task 3. Conduct detailed 2D modeling at three subreaches	
a. Select three detailed study sites	October 15, 2014
b. Collect 160 cfs water surface and velocities (DWR, TAC, CDFW)	November 15, 2014
c. Conduct supplemental substrate and cover surveys (CDFW, TAC)	November 15, 2014
d. Conduct supplemental topographic surveys (DWR, TAC)	November 15, 2014
e. Prepare topographic surface, cover polygons, and substrate polygons (DWR, TAC)	December 1, 2014
f. Develop refined meshes for subreaches and perform test runs of 2D models (BOR)	February, 2015
g. Verify/ calibrate refined models using newly acquired velocity and wse data (DWR, TAC)	March, 2015
Task 4: Develop report and maps to document "potential spawning areas"	April 30, 2015
Phase 2	
Task 5. Further refine spawning habitat location	
a. Qualify potential spawning locations based upon cover and refugia characteristics	TBD
b. Incorporate sediment mobility information into geodatabase	March 30, 2015
Task 6. Estimate suitability of egg incubation habitat	
a. incorporate findings from incubation studies	TBD
b. Develop methodology to integrate incubation habitat quality data into the Geodatabase.	September 30, 2015
Task 7. Identify data gaps	September 30, 2015

1.6 Budget

The total cost estimate is $28,000 for 2015.

Task	Cost
Task 1: Develop continuous map of bed material in Reach 1A	$3,000
a. Overlay with bed material data to determine gradation for each facies	$3,000
b. Determine which facies are potentially spawnable	$1,000
Task 2: Complete 2D modeling	
a. Additional simulations to bracket spawning flows and process results	$5,000
Task 3: Conduct detailed 2D modeling at three subreaches	
a. Select three detailed study sites	$0 (in kind)

b. Collect 160 cfs water surface and velocities (DWR, TAC, CDFW)	$0 (in kind)
c. Conduct supplemental substrate and cover surveys (CDFW, TAC)	$0 (in kind)
d. Conduct supplemental topographic surveys (DWR, TAC)	$0 (in kind)
e. Conduct additional 2-D modeling at subreaches	
Task 4: Develop report and maps to document "potential spawning areas"	$8,000
Phase 2	
Task 5. Further refine spawning habitat location	
a. Qualify potential spawning locations based upon cover and refugia characteristics	TBD
b. Incorporate sediment mobility information into geodatabase	$2,000
Task 6. Estimate suitability of egg incubation habitat	
a. incorporate findings from incubation studies	TBD
b. Develop methodology to integrate incubation habitat quality data into the Geodatabase.	$5,000
Task 7. Identify data gaps	$1,000

1.7 Point of Contact / Agency Principal Investigator

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