IMPLEMENTATION PLAN

IDENTIFICATION OF THE INSTREAM FLOW REQUIREMENTS FOR UPSTREAM MIGRATION OF CHINOOK SALMON IN BUTTE CREEK

Prepared for

CALIFORNIA DEPARTMENT OF FISH AND GAME
INSTREAM FLOW ASSESSMENT PROGRAM

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The implementation plan describes activities to be conducted in FY13 to FY16 to identify the instream flow requirements for upstream migrating adult Chinook salmon in Butte Creek. The primary objective of the project is to develop relationships between flow and upstream passage of adult Chinook salmon. The tasks to be completed for this project are: 1) project management; 2) habitat suitability criteria (HSC) development; 3) field reconnaissance and site selection; 4) hydraulic data collection; 5) construction and calibration of hydraulic and habitat simulation models; and 6) peer review of study report. Analytical procedures would involve the application of a two-dimensional hydraulic and habitat simulation model (River2D, Steffler and Blackburn 2001). The deliverable for this project would be a final report presenting the relationship between flow and upstream passage of Chinook salmon in Butte Creek. Butte Creek is a priority watershed under CDFG's Delta Tributaries implementation plan.

The schedule below is based on a 4 study cycle, with data collection in the first year, modeling in the second year, report peer review in the third year and issuance of the final report in the fourth year. Listed below are the tasks that are expected to take place in each federal fiscal year:

October 2012 through September 2013:

Field reconnaissance and site selection, hydraulic data collection and HSC development.

October 2013 through September 2014:

HSC development and construction and calibration of hydraulic and upstream passage simulation models.

October 2014 through September 2015:

Peer review of study report.

October 2016:

Issue final report.

Listed below are the tasks needed to fully complete the study. The general work to be completed is as follows:

Task 1. Habitat Suitability Criteria Development

The two dependent habitat suitability criteria metrics will be delay and percent blockage. Data collection for HSC, to be conducted in September through December 2013, would consist of detecting PIT-tagged adult fall-run Chinook salmon with fixed receivers located upstream and downstream of each study site from Task 2. Adult fall-run Chinook salmon would be captured in the Gorham Dam fish ladder, where a PIT tag would be injected into each fish with a syringe, and a floy tag would be attached to each fish to enable external identification of fish with PIT tags. Any other fish with PIT tags in Butte Creek, such as fish tagged at hatcheries, will also be used to assess upstream passage. For each fish that passes the receiver downstream of a study site, the delay time will be computed as the difference in time between passage at the upstream and downstream receivers. Percent blockage of fish at each site will be computed as the percentage of fish passing the lower receiver that do not pass the upper receiver. Additional parameters that will be computed include tag loss and detection probability at each receiver, using the program MARK (White and Burnham 1999). Carcass surveys will also examine fish for floy tags and PIT tags to further evaluate tag loss and detection probability. Delay time and percent blockage will be combined with results of the hydraulic modeling of the study sites and flow data from Butte Creek gages to develop predictive relationships between hydraulic parameters, such as those in Thompson (1972), and delay time and percent blockage.

Task 2. Field Reconnaissance and Study Site Selection

Field reconnaissance would involve wading the creek from Western Canal to Parrott Phelan Diversion Dam. At each critical riffle, the thalweg depth would be measured with a wading rod, the wetted width would be measured with an electronic distance meter, and the location of the critical riffle would be recorded with a Global Positioning System (GPS) unit. At least six to eight study sites would be selected. Sites would be located in areas with shallow thalwegs and wide wetted areas.

Task 3. Hydraulic Data Collection

Data would be collected on water surface elevations, bed topography, cover and substrate distribution for input into a 2-dimensional hydraulic and upstream passage model. Water surface elevations would be taken at three flows spanning at least an order of magnitude. Bed topography data will be collected using total stations and survey-grade Real-Time Kinematic (RTK) GPS units at a low flow by a series of lines across the channel and extending far enough onto the floodplain to include the entire area which would be inundated at the highest flow to be simulated. Each line would include a point at each change in bed slope, substrate or cover. The lines would be spaced close enough so that bed slope, substrate and cover uniformly change between the lines. The bed elevation and horizontal location of each point would be determined using either the total stations or RTK GPS units, and the substrate and cover of each point will be recorded. For areas which are not wadeable, data would be collected along lines across portions of the river deeper than 3 feet with an Acoustic Doppler Current Profiler (ADCP) and RTK GPS mounted on a small cataraft. The RTK GPS would be used to record the initial and final locations of each line, as well as the water surface elevation of each line, so that depths can be converted into bed elevations. An independent dataset of 50 random points would be collected for each site, to validate the physical predictions of the model. The bed elevation and horizontal location of each validation point would be determined using a total station or RTK GPS, the depth and velocity at each validation point would be measured, and the substrate and cover at each point will be recorded. Velocities collected by the ADCP on the lines discussed above will also be used to validate the physical predictions of the model.

Task 4. Modeling of Upstream Passage

Data collected in Task 3 would be used in a 2-dimensional hydraulic model (River2D, Steffler and Blackburn 2001) to predict the velocities and depths present in the study sites over a range of flows of at least one order of magnitude[1]. The topographic data would first be processed using the R2D_Bed software (Steffler 2001a), where breaklines are added to produce a smooth bed topography. The resulting dataset would then be converted into a computational mesh using the R2D_Mesh software (Steffler 2001b), with mesh elements sized to reduce the error in bed elevations resulting from the mesh-generating process to 0.1 foot where possible, given the computational constraints on the number of nodes. The resulting mesh is used in River2D to simulate depths and velocities at the flows to be simulated.

A Physical Habitat Simulation (PHABSIM) transect at the bottom of the site would be calibrated to provide the water surface elevations at the bottom of the site used by River2D. A second PHABSIM transect at the top of the site would be calibrated to provide the water surface elevations used to calibrate the River2D model. The initial bed roughnesses used by River2D would be based on the observed substrate sizes and cover types. A multiplier would be applied to the resulting bed roughnesses, with the value of the multiplier adjusted so that the water surface elevations generated by River2D at the top of the site match the water surface elevations predicted by the PHABSIM transect at the top of the site[2]. The River2D model would be run at the flow at which the validation dataset was collected, with the output used in a Geographic Information System (GIS) to determine the difference between simulated and measured velocities, depths, bed elevations, substrate and cover. If significant differences are found, the bed topography would be adjusted to correct the observed errors, and the models will be rerun. The final report would include these differences, how well the model predicts observations before

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[1] Discharges would be modeled under steady-state conditions. It is not expected that the study areas will include any areas with supercritical flow.

[2] This would be the primary technique used to calibrate the River2D model.

modification of the bed topography, and implications of interpretation based on potential bed topography adjustments.

The depths simulated by the River2D model, along with Habitat Suitability Criteria developed in Task 1, would be used to predict upstream passage over a range of discharges of at least one order of magnitude. This will allow for the assessment of the incremental benefits of increased flows (as measured by reduced blockage and delay).

<u>Task 5. Peer Review of Study Reports</u>

The draft report would be provided to at least two to three experts outside of the SFWO to review the technical adequacy of the report. The report would be revised in response to the reviews and a response-to-comments document would be enclosed with the report.

<u>Project Management</u>

Overall project management and administration including overseeing project coordination meetings, managing project finances (budgets, contracts, etc.), and preparing project progress reports.

<u>References</u>

Steffler, P. 2001a. River2D_Bed. Bed topography file editor - version 1.23. User's manual. University of Alberta, Edmonton, Alberta. 24 pp. http://bertram.civil.ualberta.ca/download.htm

Steffler, P. 2001b. R2D_Mesh - mesh generation program for River2D two dimensional depth averaged finite element hydrodynamic model - version 2.01. User's manual. University of Alberta, Edmonton, Alberta. 22 pp. http://bertram.civil.ualberta.ca/download.htm

Steffler, P. and J. Blackburn. 2001. River2D: Two-dimensional depth averaged model of river hydrodynamics and fish habitat. Introduction to depth averaged modeling and user's manual. University of Alberta, Edmonton, Alberta. 88 pp. http://bertram.civil.ualberta.ca/download.htm

Thompson, K. 1972. Determining stream flows for fish life. Presented at Pacific Northwest River Basins Commission Instream Flow Requirement Workshop. March, 1972. 20pp.

White, G. C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46: 120-139.