

Demonstration Project to Test a New Interdisciplinary Approach to Rehabilitating Salmon Spawning Habitat in the Central Valley

Autumn 2005

This was the thirteenth quarter of this CALFED project to demonstrate the utility of the Spawning Habitat Integrated Design Approach (SHIRA). In the previous quarter the 2005 pilot project was designed and built on the Lower Mokelumne River. The key scientific goal was to assess the hydrodynamic outcome and salmon-spawning utilization after filling in a deep gravel-mining hole in the channel as part of the on-going longitudinal profile rehabilitation framework. An additional experiment at the hydraulic-unit spatial scale was set-up in which the site was designed to have 6 different combinations of depth, velocity, and substrate size to see if spawners showed any particular preference at a higher resolution than the predicted using the 2D model's global habitat suitability index method. This quarter the primary activity was performing post-project assessment and continuing the annual long-term monitoring of the 2000-2004 study sites.

Post project "as-built" assessment was carried out a few days after construction was completed. It involved high-resolution topographic surveying of the bed and banks, velocity and depth verification data gathering, eddy viscosity parameterization, bed roughness parameterization, spawning habitat characterization, and adult holding habitat characterization. Biological assessment was folded into the long-term monitoring reported next.

Annual long-term monitoring encompassing the 2000-2004 sites was performed partially during construction and throughout the quarter. A new topographic survey of the river was done from the fish fence all the way down around the first major bend to the end of the 2001 site where a major widening of the channel occurs artificially. A topographic survey was also done of the 2000 site farther downstream of that widening. No re-survey of the 2002 site was done due to a lack of access to the channel there due to new landowners. An updated digital elevation model (DEM) was programmed for the entire rehabilitated zone from the fish fence below the dam down to the end of the 2001 site. Using that DEM, a new 2D model simulation was obtained to characterize the hydrodynamic, sediment transport, and spawning habitat-quality regimes for this reach.

In addition to channel mapping, EBMUD performed its annual fish surveys, including locating all redds constructed in the river. Thanks to a new cooperation between EBMUD and CDFG, there were many more fish left in the stream to use the rehabilitated gravels. According to a preliminary report by EBMUD, over 10,500 fish were counted and over 2100 redd locations were GPS'd. Our analysis of the distribution of these data demonstrated a continuing positive trend in response to our rehabilitation projects. Even though the size of the spawning run varies from year to year, the fraction of spawning occurring on the sites rehabilitated using SHIRA 2003-2005 has gone from 7% pre-rehabilitation baseline (2002) to 11% after phase 1, 20% after phase 2, and now 22% after phase 3. Presently more than 1 out of every 5 spawners are using high-quality spawning SHIRA sites, and those sites represent only 2% of the total channel area over which all spawners are distributed in the lower Mokelumne. Thus, the data continues to support the hypothesis that focused financial investment in a few small sites and carefully

implemented using a balance of geomorphic and biological concepts sustains the population of wild spawners in a regulated river.

More data analysis and manuscript writing/revision was done this quarter in support of two manuscripts reported in quarter 11. One theme of this research project has been to evaluate the utility of 2D numerical models for use in rehabilitating regulated gravel-bed rivers. In one experiment, 2D and 3D models were compared for a classic riffle-pool unit to better understand the uncertainties in using 2D models for river rehabilitation. That study revealed that both the 2D and 3D models captured the important hydrogeomorphic processes responsible for pool-riffle self-sustainability. The 3D model provided more detailed information about additional processes and showed greater spatial variation, but 3D hydrogeomorphic processes have not yet been suitably linked to ecological functions for use in river rehabilitation yet. That manuscript has been tentatively accepted for publication in the top journal *Water Resources Research* pending one last minor revision, and it answers a central question in support of the on-going rehabilitation activities. The second study involved assessing the relative roles of discharge, backwater conditions, and riffle configuration in controlling the spatial pattern of habitat quality and riffle scour. As previously reported, backwater effects were discovered as a critical requirement for channel stability and high quality habitat, and the notched riffle is recommended over the steep diagonal bar as a tool for river habitat restoration. That manuscript was edited and submitted this quarter to the top journal *Water Resources Research* for peer review.

Data analyses and manuscript writing was also done on two brand new topics this quarter. The first involved an analysis and evaluation of the successes and failures of using rubber-tired front-loaders to place gravel into a channel according to complex SHIRA design specification. For the 2001-2005 projects, the design DEM and as-built DEM were differenced to identify the extent of deviation from designs. An analysis was made to determine the cause of each deviation from each design. Also, information was gathered on different types of front-loaders and their role in compacting placed sediment. Data analysis and writing are still on-going. Finally, a new overview manuscript was written in which advanced concepts, methods, and results from this project were integrated. This new manuscript will be a chapter in a new book to be published by the American Fisheries Society entitled "riverine salmonid spawning habitat: physical controls, biological responses and approaches to remediation."