

§1 EXECUTIVE SUMMARY:

Recent salmon restoration and rehabilitation efforts have focused on reintroducing spawning gravels to river systems whose sediment supplies have been blocked or altered by dams, in-stream mining, land-use changes and altered flow regimes. Few spawning habitat restoration and/or gravel augmentation projects have considered the fluvial processes that govern how spawning habitat is created, enhanced and maintained given the finite supply of spawning gravels introduced by such projects. East Bay Municipal Utility District (EBMUD) and the University of California at Davis recently embarked on a new approach to implementing salmonid rehabilitation projects to bridge the gap between habitat restoration and fluvial processes. Since 1990, EBMUD has placed over 7645 m³ (10,000 yd³) of gravel at 11 potential salmonid spawning sites on the lower Mokelumne River below Camanche Dam in California. In 1999, the largest of these projects to date was constructed with over 2450 m³ (3200 yd³) of gravel. At that time, UC Davis and EBMUD collaborated to use a 2-D hydrodynamic model and a habitat suitability model in a predictive mode to assess the performance of the ad-hoc design. Model results accurately simulated post project flows and predicted spawning habitat potential (Wang and Pasternack, 2001). That project established the validity of the model and its potential for use in a design context. In seek of a scientifically based, objective design process, UC Davis and EBMUD developed the Integrated Design Approach and employed it to design an instream spawning habitat enhancement project that EBMUD constructed in August of 2001.

A mechanistic 2-D hydrodynamic model, basic fluvial geomorphic principles, habitat and sediment mobility models and computer assisted drafting (CAD) were used to design a range of alternatives for EBMUD's 2001 Habitat Enhancement Project on the Mokelumne River below Camanche Dam. Reach scale 2-D hydrodynamic models can not only successfully model fine scale channel hydrodynamics, but have also proven useful as tools for assessing salmonid spawning habitat quality and quantity (Leclerc, 1995). Spawning habitat data collected on the Mokelumne River was used to develop a global habitat suitability index (GHSI) model, which allowed mapping and quantification of potential spawning habitat. Preference curves used in the GHSI suggested that optimal physical conditions for fall run chinook salmon occur at velocities near 0.87 m/s (2.8 ft/s) and at depths of about 0.38 m (1.3 ft). A sediment mobility index (SMI) model was used to predict areas of potential scour. A pre project empirical geomorphic analysis revealed hydraulic geometry trends, which suggested depth was the dominant hydraulic variable as discharge changes. The pre-project baseline condition was modeled and compared against eleven in-stream gravel placement alternatives, including alternate bars, flat riffles, braids, and more complex geometries. The final design consisted of a complex geometry gravel placement that was estimated to produce an additional 0.63 m² of spawning habitat per cubic meter of gravel with a design volume of 1169.7 m³ (1528 yd³) of gravel. In August of 2001, EBMUD had 999.32 tons of gravel delivered to the site and placed approximately 650 m³ (850 yd³) of gravel in the channel based on the final design. The post project model results estimate that the project produced an additional 0.24 m² of spawning habitat per cubic meter of gravel. Velocity and depth cross sections were collected for pre project and post project model validation. Partial redd surveys of the 2001 fall run show *Oncorhynchus tshawytscha* redd nests located within the constructed project correspond to predicted areas of high and optimal spawning habitat as well as pool-exit slopes.

The 2001 Habitat Enhancement Project has illustrated the application of the Integrated Design Approach at joining fluvial processes with ecologic function. The ultimate test of the Integrated Design Approach will be told in the long term monitoring efforts that EBMUD has begun and will continue to conduct on the lower Mokelumne. The Integrated Design Approach provides river managers with predictive and explanatory tools that river manager's can use adaptively throughout the monitoring of the project. Future habitat enhancement projects should incorporate lessons learned by this and other projects. Future projects may provide opportunities to test and further refine the Integrated Design Approach; thereby promoting more efficient and sustainable designs.