ABSTRACT

In the Central Valley, California, overall abundance of Chinook salmon has decreased to less than 75% of their number in the 1950s (Yoshiyama et al., 2000). Gravel replenishment occurred in the Mokelumne River in the Central Valley to enhance Chinook salmonid spawning habitat below the Camanche Dam. Gravel replenishment raised bed elevations and created instream features such as pools, riffles, chutes, and bars. A two-dimensional (2D) finite-element hydraulic model was used to predict depths and velocities throughout the study reach. According to model validation efforts, the model generally over-predicted water depths and under-predicted flow velocities through the study reach.

A global habitat suitability index (GHSI) that incorporated depth and velocity preferences for spawning Chinook was applied to the finite element integration procedure, allowing maps of the spatial distribution of habitat suitability to be plotted for the replenishment area. In addition to the surveyed pre- and post-gravel replenishment conditions, four hypothetical alternative geomorphic scenarios were also modeled: 1) alternate bars, 2) a braided channel, 3) a combination of alternate bars + braided channel, and 4) boulder placement within study reach.

Gravel replenishment that decreased depth throughout the study area and minimized area of exposed features at low flow produced the greatest amount of higher quality spawning habitat. The regularly spaced boulder scenario produced the largest total area of medium and high quality spawning habitat. No bed sediment mobility was predicted for any of the six Mokelumne River gravel replenishment scenarios at bankfull flow. 2D hydraulic models can simulate lateral variability in velocity, depth, incipient sediment motion, and spawning habitat in streams, and can be used to design replenishment projects so that they have suitable depth and velocity distributions and are sustainable over the long term. The 2D hydraulic modeling of instream features incorporating habitat suitability indices for a single species may provide an initial template for successful design of river restoration projects.