

# EVALUATION OF STEELHEAD PASSAGE FLOWS USING HYDRAULIC MODELING ON AN UNREGULATED COASTAL CALIFORNIA RIVER

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## ABSTRACT

Passage and habitat connectivity flows for steelhead *Oncorhynchus mykiss* through depth sensitive natural, low gradient, critical riffle sites were investigated in the unregulated Big Sur River, California. The River2D two-dimensional hydraulic habitat model, along with quantitative passage metrics and species-specific and lifestage-specific depth criteria, were used to evaluate and compare predicted fish passage flows with flows derived by a traditional empirical critical riffle fish passage method. Passage flows were also compared with historical unimpaired natural hydrology patterns to assess the frequency and duration of suitable passage flows under the naturally variable flow regimes characteristic of Central California coastal rivers. A strong relationship ( $r^2 = 0.93$ ) was observed between flows predicted by hydraulic modeling and flows identified by the empirical critical riffle method. River2D provided validation that the flows derived using the traditional critical riffle methodology provided for contiguous passable pathways of suitable hydraulic (depth and velocity) conditions through complex cobble-dominated riffle sites. Furthermore, steelhead passage flows were spatially and temporally consistent between lagoon and upstream riffles for adults, and were generally indicative of a river system in equilibrium with a naturally variable flow regime and associated intact ecological processes. An analysis of 25 years of continuous flow data indicated sufficient flows for upstream passage by young-of-year and juvenile steelhead were produced between 37% and 100% and between 1% and 95% of the time, respectively. September and October are the most challenging months for natural flows to meet young-of-year and juvenile passage and habitat connectivity flows. Careful consideration of seasonal and interannual flow variability dynamics, therefore, are critical components of an effective flow management strategy for the maintenance and protection of passage and habitat connectivity flows between lagoon and upriver habitats.

key words: passage; habitat connectivity; steelhead; River2D; critical riffle analysis

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