Assessment of the Structure and Function of Natural Hydraulic Jumps

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Executive Summary:
Hydraulic jumps in rivers are turbulent mixtures of air and water that are almost as ubiquitous in nature as flowing water itself. Because hydraulic jumps are features of natural rivers throughout California, it is necessary to consider their structure and function when attempting river restoration. Existing restoration practice primarily focuses on channel shape as identified through stream classification and secondarily on substrate conditions (Brooks, 1995; Rosgen, 1996). Ecologists and geomorphologists are beginning to recognize the important role of instream features, but so far basic research has only addressed large woody debris (Keller and MacDonald, 1995). Laboratory flume studies indicate that hydraulic jumps could significantly contribute to the practice of river restoration by enhancing water quality via oxygenation (Chanson, 1994; Moog and Jirka, 1999) and protecting stream beds and banks from erosion via energy dissipation (Hagar, 1992; Rajaratnam and Chamani, 1995). Hydraulic jumps also contribute instream habitat.

The overall objective of this research is to investigate hydraulic jump fluid mechanics in the natural setting and its relevance to fluvial geomorphology and river restoration. The hypotheses proposed herein will be tested by observing several natural hydraulic jumps on the Chili Bar section of the South Fork of the American River. The field campaign will involve measuring independent variables that are either constant or slowly varying with time as well as monitoring local flow response variables. Given the harsh field conditions present in and around natural hydraulic jumps, new technologies have been developed to enable in situ measurement. The central element of the measurement system is a portable shore-based "river truss" that provides a stable platform for measuring channel and water surface profiles as well as inserting vertical sensor arrays.

The primary result of this project will be a detailed quantitative description of the structure and function of natural hydraulic jumps. This information will enable river engineers to include scientifically-based instream features in river restoration designs, and thereby enhance water quality and improve habitat diversity. In addition, the implications of the study for safety in whitewater recreation will be shared with industry leaders and public regulators.