How California Fishes Swim Upstream Past Rapids, Waterfalls and Human-Made Barriers

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Executive Summary:
Fishes that swim upstream are of great economic and recreational interest to the people of California. Many stream modifications, such as weirs and dams of different sizes, seriously interfere with reproduction and other important aspects of the life histories of fishes like the Pacific salmon species and steelhead trout. These problems are partially addressed by building fishways, such as fish ladders, to assist fishes in overcoming these obstacles. Most fishways are designed by engineers primarily to ease the passage of salmonids. Little attention has been given in these designs to other ecologically important fishes that share the streams and interact with the salmonids. Even less attention has been given to the behaviors of any of these fishes as they travel upstream past natural rapids and waterfalls as well as through fishways. Fishway design has traditionally been approached from engineering perspectives neglecting the biology of the animals that are supposed to use the fishway. To design optimal fishways, in terms of the fishes' ability to pass them and the economics of construction, we must better understand the behaviors of the fishes that will use that fishway. One important approach is to experimentally study fishes traveling up artificial rapids and waterfalls in controlled laboratory environments.

This study proposes to quantitatively describe several specific aspects of swimming behavior in selected species of California inland fishes as they travel upstream past laboratory rapids and waterfalls. Fishes will be introduced to a range of stream conditions (varying gradients and water flows). Their responses will be recorded with high speed video. These video sequences will then be analyzed with motion analysis computer software. An important emphasis in these analyses will be on the biomechanics of the responses of fishes to high speed, turbulent flows. The dynamics of water flow through the artificial stream system will also be analyzed and compared with the fishes' behaviors. The details of these outlined methods have only just become possible due to the recent availability of certain advanced technologies such as high speed motion analyses and digital flow visualization.

Increased understanding of how fishes travel up rapids and waterfalls, and of why they behave as they do when faced with such obstacles, is essential to the continuing survival of many California inland fishes. The results of this study will aid water resource management in protecting the complex fish assemblages of California watersheds.