Evaluation of fish passage at whitewater parks using 2D and 3D hydraulic modeling

Travis L. Hardee[1], Peter A. Nelson[1], Matt C. Kondratieff[2], Brian P. Bledsoe[3]
[1]Department of Civil and Environmental Engineering, Colorado State University
[2]Colorado Parks and Wildlife
[3]College of Engineering, University of Georgia

Abstract. Whitewater parks (WWPs) are popular recreational amenities, especially in Colorado. These in-stream hydraulic structures typically create waves by constricting flow through a chute to increase velocities and form a hydraulic jump. These hydraulic conditions have been shown to potentially inhibit upstream fish movement. Here, we use hydraulic models to compute a continuous and spatially explicit description of velocity and depth along potential fish swimming paths in the flow field, and the ensemble of potential paths are compared to fish swimming performance data to predict fish passage via logistic regression analysis. While a 3D modeling approach has been shown to accurately predict trout movement through WWP structures, here we show that 2D methods can successfully provide a cost-effective and manager-friendly alternative to predicting fish passage at similar hydraulic structures. We also assess the applicability and transferability of these methods by applying them to a diverse range of structures recently constructed on the North Fork of the St. Vrain River at Lyons, Colorado. Using fine scale survey methods, we also investigate the extent to which gaps between boulders can be modeled and how these gaps may affect fish passage predictions. A general field protocol and modeling guidelines for the assessment of fish passage is developed, which can be useful to practitioners for a diverse range of WWP structures.