

TURBULENCE IN GRAVEL BED RIVERS AND ITS RELEVANCE TO FISH
PASSAGE TECHNOLOGIES

Abstract

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December 2002

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Hydroelectricity is the second most widely used form of power for the United States and provides a relatively continuous, clean source of renewable energy. However, in countries with migratory fish species such as the United States, China, and Australia the dams that provide the potential energy for power generation also act as obstacles to fish passage. While the barriers imposed on adult fish have generally been mitigated through the introduction of fish ladders, losses of juveniles due to passage through turbines and spillways remains a primary source of mortality (NOAA, 2000). Successful guidance of juvenile salmonids to surface collectors would increase passage efficiencies significantly.

Juvenile salmonids typically migrate at night (ISRP, 1996) using their lateral line organ as the primary guidance sensor for movement. It is therefore necessary to understand the turbulent flow experienced by the juveniles during their emigration if active guidance of juveniles is to be achieved. It has been the goal of this study to determine turbulence characteristics in the natural migration corridors of the Clearwater River Basin and reproduce those characteristics in the laboratory for guidance of migrating juvenile salmonids.

The first task in this project was to determine the turbulence characteristics in the natural corridors of the Clearwater River Basin. An Acoustic Doppler Velocimeter was used to characterize turbulence in two gravel bed rivers. Results were collected in unobstructed flow and were compared with data from recent investigations. Mean flow velocity, turbulent kinetic energy (TKE), strain, Reynolds shear stress tensors, and eddy length scales downstream from large rocks deviate from unobstructed flow results, but similar turbulence patterns are found behind each boulder.

The second task was to reproduce the turbulence characteristics recorded in the Clearwater River Basin in a controlled environment indicative of typical reservoirs. Various jets and mixers were tested to reproduce the TKE, strain, and eddy length scales found in the Clearwater River Basin. One jet and one mixer were selected that best reproduced the turbulence parameters recorded in the first task. Results from these jets, mixers, and natural corridors, are compared to turbulence parameters upstream from the Bonneville Prototype Surface Collector (PSC). The Bonneville PSC was selected as a typical manmade fishway to demonstrate the applicability of this research to fish passage technologies. Without final data on fish collection efficiencies substantial conclusions cannot be made, however, preliminary data suggests that if TKE, strain, and eddy length scales are properly reproduced fish collection efficiencies may be increased.