Design Tools to Assess Hydro---Turbine Biological Performance: Priest Rapids Dam Turbine Replacement Project

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Over the past two decades, there have been many studies describing injury mechanisms associated with turbine passage, the response of various fish species to these mechanisms, and the probability of survival through dams. Although developing tools to design turbines that improve passage survival has been difficult and slow, a more robust quantification of the turbine environment has emerged through integrating physical model data, fish survival data, and computational fluid dynamics (CFD) studies.

Grant County Public Utility District (GCPUD) operates the Priest Rapids Dam (PRD), a hydroelectric facility on the Columbia River in Washington State. The dam contains 10 Kaplan---type turbine units that are now almost 50 years old. The Utility District plans to refit all of these aging turbines with new turbines. The Columbia River at PRD is a migratory pathway for several species of juvenile and adult salmonids, so passage of fish through the dam is a major consideration when replacing the turbines.

In this presentation, a method for turbine biological performance assessment (BioPA) is introduced. Using this method, a suite of biological performance indicators is computed based on simulated data from a CFD model of a proposed turbine design. Each performance indicator is a measure of the probability of exposure to a certain dose of an injury mechanism. Using known relationships between the dose of an injury mechanism and frequency of injury (dose–response) from laboratory or field studies, the likelihood of fish injury for a turbine design can be computed from the performance indicator. By comparing the values of the indicators from proposed designs, the engineer can identify the more---promising alternatives. We will present application of the BioPA method for baseline risk assessment calculations for the existing Kaplan turbines at PRD that will be used as the minimum biological performance that a proposed new design must achieve.

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