

Agent-Based Simulation System of Juvenile Fish Dam Passage

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To facilitate the selection of improved fish bypass design measures at Lower Granite Dam on the Snake River, WA, game-theoretic agent-based behavioral rules were integrated with a Coupled Eulerian-Lagrangian (CEL) Hybrid Model and a computational fluid dynamics (CFD) model to elicit virtual 3-D movement behavior dynamics of outmigrating juvenile steelhead. Hydraulic patterns inherent in natural, free-flowing river reaches (wall-bounded flow) and at dams (free-shear flow), along with hydrostatic pressure, were used as agents to elicit behavior. The resulting simulation model, the Numerical Fish Surrogate (NFS), captures several distinct behaviors observed in 3-D field telemetry data collected in the forebay of Lower Granite Dam. In addition, the NFS captures the percentages with which juvenile steelhead use each of the available passage options around Lower Granite Dam. Agent-based behavior rules were formulated so as to be consistent with existing knowledge of fish mechanosensory systems and existing field data. The NFS, while using many existing concepts and mathematical formulations, is original code and can be easily extended to other aquatic species and ecosystems for which multi-dimensional physicochemical data exists.

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