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RESEARCH ARTICLE

Individual based modeling of fish migration in a 2-D river system: model description and case study

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Abstract
Context Diadromous fish populations in the Pacific Northwest face challenges along their migratory routes from declining habitat quality, harvest, and barriers to longitudinal connectivity. These stressors complicate the prioritization of proposed management actions intended to improve conditions for migratory fishes including anadromous salmon and trout.
Objectives We describe a multi-scale hybrid mechanistic–probabilistic simulation model linking migration corridor conditions to fish fitness outcomes. We demonstrate the model's utility using a case study of salmon and steelhead adults in the Columbia River migration corridor exposed to spatially- and temporally-varying stressors.
Methods The migration corridor simulation model is based on a behavioral decision tree that governs individual interactions with the environment, and an energetic submodel that estimates the hourly costs of migration. Emergent properties of the migration corridor simulation model include passage time, energy use, and survival.
Results We observed that the simulated fish's initial energy density, the migration corridor temperatures they experienced, and their history of behavioral thermoregulation were the primary determinants of their fitness outcomes. Insights gained from use of the model might be exploited to identify management interventions that increase successful migration outcomes.
Conclusions This paper describes new methods that extend the suite of tools available to aquatic biologists and conservation practitioners. We have developed a 2-dimensional spatially-explicit behavioral and physiological model and illustrated how it can be used to simulate fish migration within a river system. Our model can be used to evaluate trade-offs between

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