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Hydrologic and hydraulic characteristics of effective sea lamprey barriers
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ABSTRACT:

A network of 494 lowermost barriers on tributaries of the Laurentian Great Lakes prevents invasive sea lamprey (*Petromyzon marinus*) from accessing upstream spawning habitat and is critical to the success of the sea lamprey control program. The design goal of purpose-built barriers for sea lamprey control at low-head dams was to maintain a minimum vertical separation of 45 cm between the crest and downstream water level and a 15 cm overhanging lip. Due to physical site constraints limiting barrier design height and fluctuating stream water levels, many barriers cannot meet the design criteria. However, some barriers continue to block the passage of the sea lamprey even when the design criteria are not fulfilled. We conducted a physical modeling study of three sea lamprey barriers of varying historical efficacies to better understand the hydrologic and hydraulic characteristics of effective barriers. Results showed that time-averaged and horizontally-averaged streamwise velocity, energy dissipation rate, and eddy length scale in the vertical direction strongly correlate with barrier efficacy. We combined the resulting variables into a dimensionless Barrier number that can be used to categorize barrier efficacy. Ineffective barriers generally had higher Barrier numbers than effective barriers. Our experimental investigation suggests that the fluid flow and turbulence conditions near the riverbed are not as crucial to barrier efficacy as those above the riverbed at 50% of the crest height. Our work improves understanding of how existing barriers block sea lamprey movement, which could aid in the design of future sea lamprey barriers.