Identifying turbulence features that alter trap efficiency of upstream-swimming lamprey

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ABSTRACT:

The development of stimuli to guide fish toward desirable areas (e.g., spawning grounds) or away from highmortality routes (e.g., powerplant intake) is a critical tool to both conserve native species and prevent the spread of invasive species. A promising stimulus that has the potential to both attract or repel fish relies on the manipulation of flowing water variation in variables such as velocity, turbulence, and eddy size can alter the swimming behavior and performance of fishes. Control of anguilliform fishes, such as eels and lamprey, could greatly benefit from a further examination of the hydrodynamic cues that drive their upstream-swimming behavior and aid in the development of this stimulus as a distractor (repellent). Our study sought to define whether turbulent flow could be used to attract or repel upstream-swimming anguilliform fishes into making a predictable choice into a specific waterway. We quantified the swimming behavior of migratory sea lamprey (*Petromyzon marinus*) in response to downstream turbulence created by structures of different sizes and orientations (2.54 cm or 5.08 cm vertical, horizonal and diagonal cylinders) within a laboratory flume. Individual lamprey were allowed 10 min to explore the laboratory flume which was designed as a two-choice maze with a downstream approach leading to two side-by-side channels which only differed by the type of downstream turbulence that lamprey would encounter. Data showed that lamprey choices are not simply based on preference of a single turbulence metric. For instance, lamprey were more likely to enter a channel containing a 2.54 cm diagonal structure more often than the control channel ($p < 0.05$), but were also less likely to enter a channel containing a 5.08 cm diagonal structure when the other channel had a 5.08 cm vertical structure ($p < 0.05$). Once within the channel, lamprey spent significantly more time within channels that contained horizontal structures when compared to a channel with either no structure, vertical structures or diagonal structures ($p < 0.05$). Our results suggest that lamprey display context-dependent

attraction to specific types of turbulent flows such that lamprey choose between competing flow conditions rather than focusing on a single flow characteristic.