

Development of turbulent Eddies-based behavioral fish Guidance System (EGS) for safe fish passage at hydropower intakes

Downstream migrating fish in rivers need to pass over multiple run-of-river hydropower plants (HPPs). Fish passing through turbine or spillway of these HPPs can result in high injury and mortality rates, which lead to a decline in fish populations. In this multi-disciplinary international [FishPath project](#), a turbulent Eddies-based behavioral fish Guidance System (EGS) will be developed for a safe downstream fish passage at HPPs and other water intakes. The EGS has been developed based on the knowledge of fish behavioral responses to various types of turbulent eddies obtained from the previous tests for Atlantic salmon and European eel (Fig. 1a). Vertical and streamwise eddies were created using two different elements, namely vertical elements, and delta wings element. Different geometrical arrangements of these elements with a full depth bypass system were already tested with Salmon smolts. In this project, the best performing EGSs for Salmon will be tested with **European eel** in a large etho-hydraulic laboratory flume (Fig. 1b).

In this thesis, live-fish tests of the EGSs will be conducted at an inflow velocity of 0.60 m/s and the fish behavior along with fish guidance efficiency of the EGSs will be evaluated from the video recordings using a 3D fish tracking system and manual experimental observation notes. Flow fields will be determined using a 3D numerical model of the EGS for by the project partner, Vattenfall laboratory in Sweden. The student will participate in live-fish tests in the laboratory, analyze visual observations data, obtain digital track of the fish along with simulated hydraulic data i.e., flow velocities, vortex fields and turbulence intensity. The obtained results will be used to identify the effectiveness of the tested EGSs and suggested improvements. A basic knowledge on turbulent flows and knowledge of Matlab/Python or another programming language is advantageous.



Fig 1: Photo of live-fish tests with Atlantic salmon in spring 2023 (a) and representative photo of an EGS configuration (delta wing element) in the etho-hydraulic flume (b)

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Remarks: Project-oriented thesis;
Project can/must be continued with a follow-up project as part of the Master's thesis [if chosen as a Project Thesis] (possible for Civil Engineers only). Thesis communication and report in English.