ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

VAW
Versuchsanstalt für Wasserbau,
Hydrologie und Glaziologie

Bachelor's Thesis
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Turbulent eddies to create paths for safe downstream migration for fish past 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. The knowledge on fish behavioral responses to turbulent eddies can be used to develop guidance systems that create alternative migration pathways for fish around HPPs and other water intakes. Via their sensory systems, fish can detect turbulent movements (eddies) in the flow and respond either by avoiding them or by exploiting the eddies for swimming. In the multi-disciplinary international FishPath project, these abilities of fish will be utilized to develop a turbulent eddies based guiding structures for salmon, trout and eel. Therefore, types of eddies created by different objects (e.g. cylinders, hydrofoils) and how the fish species respond to these different eddies will be explored. In the next step, a turbulent **E**ddies-based behavioral fish **G**uidance **S**ystem (EGS) based on a combination of such elements will be designed. The behavior of the eddies will be studied by numerical modelling and velocity experiments. The responses of fish to different turbulent eddies will be determined in a series of live-fish experiments. The operational aspects of these structures will be determined through physical hydraulic modelling to investigate **head loss**, clogging due to floating debris and maintenance plans.

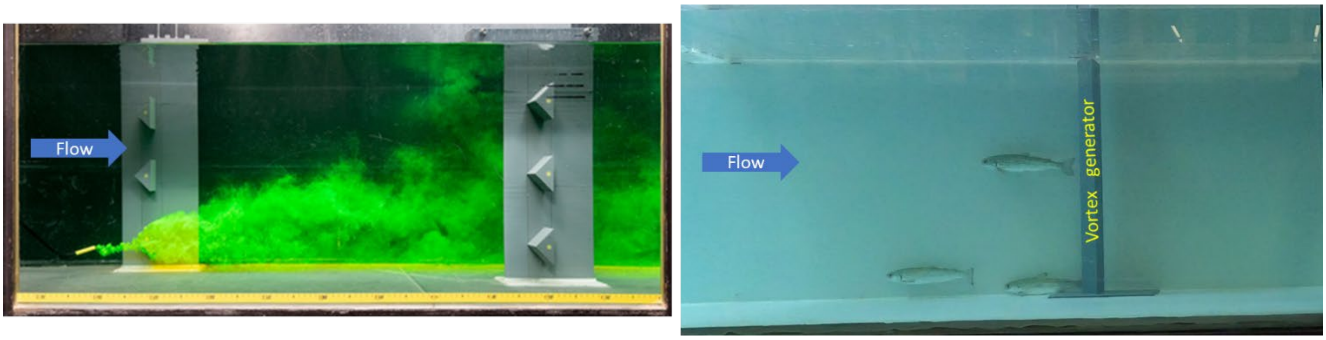

Fig. 1: Flow visualization of horizontal-axis vortex generator (left) and a photo of Atlantic salmon tests with vertical-axis vortex generating elements (right)

The project work as a part of the FishPath project, experimentally investigates head losses created by three different vortex generating elements in different sizes and visualizes flow field around those elements (Fig. 1). Water depth and velocity measurements will be conducted in a 0.5 m wide, 0.7 m deep and 13.5 m long glass-sided laboratory flume using a computer controlled Ultrasonic Distance Sensors (UDS) while flow visualization will be done using dye tracers. The obtained results will be used to develop a formula to estimate head losses for a wide range of geometric parameters and flow velocities. A basic knowledge on hydraulics, and knowledge of Matlab/Python is advantageous.

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Remarks: Experimental work with UDS,
Thesis communication and report in English.