Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Versuchsanstalt für Wasserbau,
Hydrologie und Glaziologie

Head: Dr. Ismail Albayrak
Supervision: Dr. Armin Peter

Master's Thesis HS 2022
Project Based Research Work

Turbulent eddies to create paths for safe downstream migration for fish past hydro-power intakes

Downstream migrating fish in rivers have to pass multiple run-of-river hydropower plants (HPPs). Fish passage through turbine or spillway of the HPPs can result in high injury and mortality rates, which lead to a decline in fish populations. The knowledge of 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 will be utilized to develop a turbulent eddies based guiding structures for salmon, trout and eel. Therefore, eddies created by different objects (e.g. cylinders, hydrofoils) and how the fish species respond to different types of eddies will be explored. In a next step, a turbulent **E**ddies-based behavioral fish **G**uidance **S**ystem (EGS) based on a combination of such elements will be designed (Fig. 1). 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.

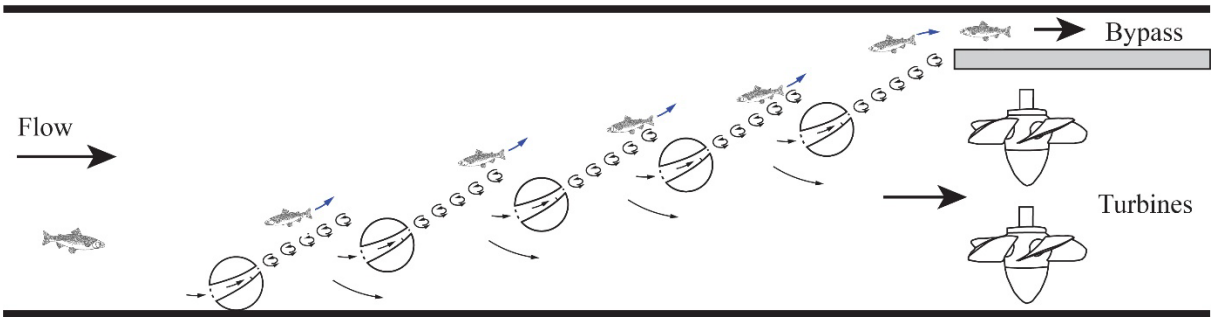

Figure 1: An illustration of the principle of an EGS design with a bypass for downstream migration

In this thesis as a part of the FishPath project, live-fish tests with European eel will be conducted in a small flume to explore the fish-eddy interaction. Therefore, the response of fish to the eddies created by different elements will be tested at different flow velocities. A video-based fish-tracking system will be used to record fish movements. The student will participate in live-fish tests in the laboratory and analyze visual observations, digital fish tracks and the measured and simulated hydraulic data, i.e. flow velocities or turbulence intensity. Finally, the obtained results will allow the student to identify the effects of different eddies on fish reaction. A basic knowledge of turbulent flows and knowledge of Matlab/Python or another programming language is advantageous.

Contact:

Ismail Albayrak
Hydraulic Engineering Division,
HIA – C55, +41 44 632 97 44
albayrak@vaw.baug.ethz.ch

Remarks:

Experimental work with fish in turbulent flows,
Project Based Research Work possible,
Thesis can be written in German or English.