Eidgenössische Technische Hochschule Zürich
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Versuchsanstalt für Wasserbau,
Hydrologie und Glaziologie

Master's thesis
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Electrified fish protection structures: effect of electric and hydraulic parameters on fish behaviour

Downstream migrating fish in rivers have to pass multiple run-of-river hydropower plants (HPPs). Fish passage through turbines or over spillways of the HPPs can result in high injury and mortality rates, which may lead to a decline in fish populations. The revised Swiss Waters Protection Act (WPA) introduced in 2011 aims at restoring water bodies and eliminating negative impacts of HPPs as to fish migration by 2030. To this end, VAW has developed fish guidance structures with vertical curved bars (CBR, Fig. 1a)) and optimized fish guidance structures with horizontal bars (HBR). These bar racks aim at protecting fish from turbine passage and at guiding them towards an adjacent bypass, in order to ensure safe downstream passage at HPPs. In recent ethohydraulic laboratory studies, the CBR provided high fish protection and guidance efficiencies for spirlin, barbel, nase and salmon parr, whereas its efficiencies for brown trout and eel were relatively low. An HBR with small bar spacings ≤ 20 mm provides a good protection for certain sizes of fish species, but larger bar spacings are desirable in order to reduce the need for maintenance and cleaning without negatively impacting fish protection and guidance.
In order to improve the protection and guidance efficiencies of CBR and possibly increase bar spacing for HBR, these racks have been electrified with a low voltage pulsed direct current creating an electric field, which keeps fish away from the racks. The results from the live-fish tests of both electrified CBR (Fig. 1b) and HBR at VAW are promising for the European eel. Therefore, further tests with other fish species are planned to validate the protection and guidance efficiencies of the racks.

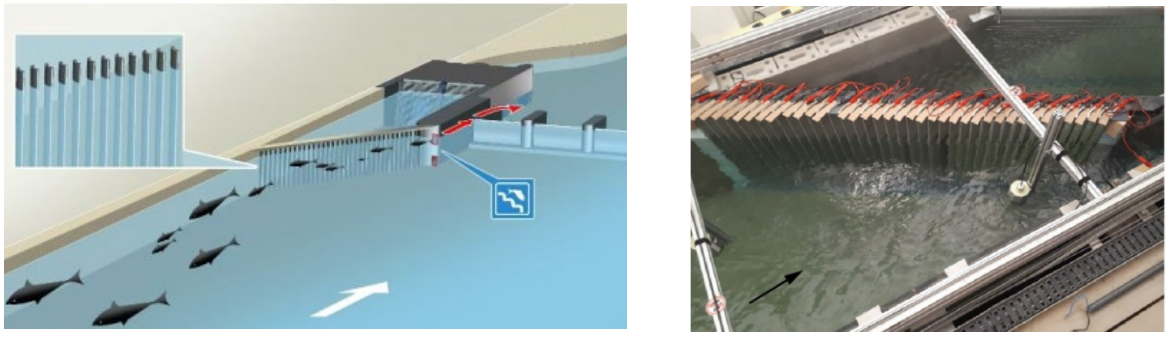

Fig. 1: Overview of bar rack- bypass concept and picture of the electrified CBR tested in a VAW flume

In this Master thesis, live-fish tests of electrified CBR and HBR will be conducted. A video based fish-tracking system will be used during the live-fish tests 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 electric field data as well as the hydraulic data of flow velocities. Finally, the obtained results will allow the student to identify the effects of the studied electric and hydraulic parameters on various fish reactions from indifference to avoidance or even narcosis and injury and to determine the optimum parameters for efficient fish protection and guidance. In order to work with the fish tracks, basic knowledge of Matlab or another programming language is advantageous.

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Particular information: Experimental work with fish and electricity,
Thesis can be written in German or English.