Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Versuchsanstalt für Wasserbau,
Hydrologie und Glaziologie

Master's Thesis
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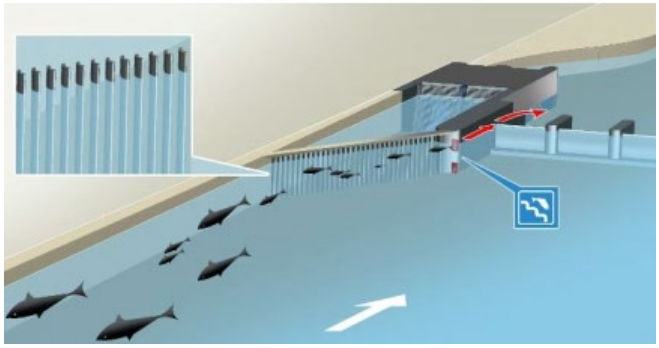
Optimization of electrified fish protection and guidance structures

Downstream moving fish in rivers pass multiple run-of-river hydropower plants (HPPs), where turbine or spillway passage can result in high injury and mortality rates. 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) to protect fish from turbine passage and guide them towards a bypass, to ensure safe downstream passage at HPPs. CBR provides high fish protection and guidance efficiency for spirlin, barbel, nase and salmon parr, whereas its efficiency for brown trout and eel is relatively low. An HBR with small bar spacings < 20 mm provides a good protection for certain size of fish species, but larger bar spacings are desirable to reduce the need for maintenance and cleaning without impact on fish protection.
To improve the protection and guidance efficiencies of CBR and possibly increase bar spacing for HBR, we are analyzing the possibility to electrify the racks with a low voltage pulsed direct current, creating an electric field which keeps fish away from the racks. The first results from the live-fish tests of both electrified CBR (Fig. 1b) and HBR at VAW are promising for European eel and brown trout.



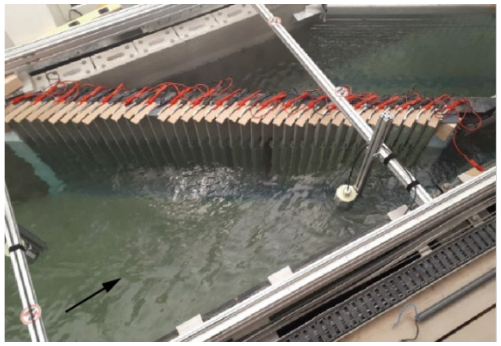


Fig. 1: Overview of concept and picture of the electrified CBR tested in the flume

This Master's thesis will include participation in electrofishing and conducting live-fish tests of electrified CBR and HBR. The student will work closely together with one of the supervisors as there are always two persons required to conduct experiments. The fish reaction is observed directly through a glass wall of the flume and a video-based fish-tracking system. The student will take measurements of the electric field before starting the live fish tests. Data analysis will include visual observations, digital fish tracks as well as measured and simulated electric field data and hydraulic data, i.e. flow velocities and flow fields. The obtained results will allow the student to identify the effectiveness of the rack as a fish protection and guidance structure and possible improvements of the setup. 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.