Unravelling the complex relationship between artificial flow fluctuations and cyprinid fish: a comprehensive analysis

Daniel S. Hayes[1], Stefan Auer[1], Stefan Schmutz[1], Bernhard Zeiringer[1], Franz Greimel[1], Jeremy Piggott[2], Simon Führer[1]

[1] University of Natural Resources and Life Sciences, Vienna, Department of Water, Atmosphere and Environment, Institute of Hydrobiology and Aquatic Ecosystem Management, Gregor-Mendel-Straße 33, 1180 Wien, Austria
[2] School of Natural Sciences, Trinity College Dublin, The University of Dublin, Dublin 2, Ireland

Email corresponding author: daniel.hayes@boku.ac.at

ABSTRACT: The anticipated increase in renewable energy usage to reduce reliance on fuel-based sources will add further strain to riverine ecosystems. As wind and solar energy production fluctuates, hydropower, particularly storage hydropower, will play a more significant role in maintaining grid stability. However, such operations introduce unnatural sub-daily flow fluctuations that can have negative ecological impacts on fish, including drift and stranding. The effects of these fluctuations, known as hydropeaking, have been studied extensively in relation to salmonid fish, while cyprinid fish have received little attention in this area of research.

Our work seeks to address gaps in our understanding of the impact of sub-daily flow fluctuations on cyprinid fish. We aim to achieve this through two approaches. Firstly, by leveraging a vast database to model the effects of hydropeaking on selected cyprinid species on the national level of Austria. Secondly, by conducting hydropeaking experiments using unique nature-like channels that specifically focus on early cyprinid life stages. By operating on both a macro and meso level, the project adopts an integrative approach.

Here, we synthesize results from database assessments and various experimental setups to gain a comprehensive understanding of the impact of (a) hydro-morphological stressors and (b) hydropeaking flow data on fish populations. The database assessments provide insights into the population status, considering hydro-morphological stressor groups and hydropeaking flow data combined with other relevant stressor data. The mesocosm and flume experiments quantify stranding in response to (a) down-ramping rate, (b) daytime, (c) river bank slope, (d) bar morphology, (e) fish species, and (f) fish size/developmental stage.

The results have significant relevance due to the broad distribution of cyprinid fish. They could help establish mitigation strategies in river systems facing hydrological stress, thereby improving ecological integrity in rivers worldwide.