Movement behavior during simulated hydropeaking – An imaging-based tracking approach

Robert Mario Naudascher

Swiss Federal Institute of Technology  
Zürich Switzerland

Luiz G. M. Silva

Swiss Federal Institute of Technology  
Zürich Switzerland

Robert Boes

Swiss Federal Institute of Technology  
Zürich Switzerland

Roman Stocker

*Swiss Federal Institute of Technology  
Zürich Switzerland*

**Abstract:** High head storage hydropower is deemed to be the ideal renewable energy source to meet the increasing demand for daily peak electrical energy. However, downstream of such facilities hydropeaking causes rapid alterations in discharge that threaten, in particular, the early life-stages of riverine fish species. These life-stages generally utilize habitats broadly characterized by low water depths and low flow velocities, which are spatially relocated during hydropeaking events. The rate at which habitat relocation occurs is related to hydromorphological characteristics such as gravel bed inclination and the slope of the rising and falling limb (ramping rate) of the river hydrograph. The ability of early life-stages to respond to hydropeaking is strongly linked to the capacity of relocating along spatial gradients of flow depths and velocities during the rapid change in discharge. This capacity is determined by sensorial and locomotory traits that provide fish with a suite of behavioral tools to identify triggers and respond to these discharge changes. However, studies aiming at identifying fine scale movement behavior responses of early life-stages of fish under varying discharges are scant. Traditionally, the effects of hydropeaking have been quantified by counting the number of drifted or stranded individuals in hydraulic flume experiments. Hence there is a limited understanding with respect to hydrodynamic cues that trigger fish responses to hydropeaking.  In this study, we use imaging-based tracking techniques and a novel semi-artificial gravel bed to quantify fine scale movement behavior of 2-month-old brown trout (Salmo trutta) in a laboratory flume. Using state-of-the-art tracking software, we quantified hydrodynamic space use, head orientation, relocation speed and tailbeat frequency for two distinct hydropeaking scenarios and compared the fine-scale movement behavior of wild and hatchery reared brown trout. We found that certain combinations of flow-depth and flow velocity trigger relocation and were able to derive critical relocation time scales. This work contributes to provide a mechanistic understanding of fish movement behavior in drastically altered river flows to determine hydrodynamic conditions that trigger fish relocation and factors contributing to stranding or drift of individuals.