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Establishing seasonal flow rules to mitigate adverse hydropeaking impacts on salmonid fish

Daniel Hayes (1,2), Miguel Moreira (3), Isabel Boavida (3), Melanie Haslauer (2), Günther Unfer (2), Bernhard Zeiringer (2), Franz Greimel (2), Stefan Auer (2), Teresa Ferreira (1), and Stefan Schmutz (2)

(1) CEF – Forest Research Center, Instituto Superior de Agronomia, University of Lisbon, Portugal, (2) IHG – Institute of Hydrobiology and Aquatic Ecosystem Management, Department of Water, Atmosphere and Environment, University of Natural Resources and Life Sciences, Vienna, (3) CERIS – Center for Engineering Research and Innovation for Sustainability, Instituto Superior Técnico, University of Lisbon, Portugal

Peak-operating hydroelectric power plants allow the production of flexible energy and are, therefore, considered the backbone of the energy grid. However, their operation regime – called hydropeaking – is one of the greatest stressors on riverine ecosystems, whereby aquatic biota and their life cycle stages can be affected by various components of the hydrograph. To aid in the establishment of ecologically efficient mitigation measures, we developed specific seasonal regulations aiming at protecting sensitive life cycle stages. We reviewed the hydropeaking literature and established a framework for hydrological mitigation based on life cycle stages of salmonid fish and their relationship with crucial parameters of the hydrograph: (1) Flows should be held relatively stable during migration and spawning, (2) and a flow cap should be implemented to avoid dewatering of spawning ground during later intra-gravel life cycle stages. Although eggs may be comparably tolerant to dewatering of the ramping zone, (3) post-hatch life cycle stages are very vulnerable, which requires minimizing the duration of hydropower production stops and allocating minimum environmental flows. (4) Emerging fry are especially sensitive to flow fluctuations, whereas fish become less vulnerable as they grow in size. Therefore, we propose an 'emergence window' where stringent ramping thresholds are enforced. (5) Furthermore, time of day, river morphology and temperature changes must be regarded. The presented mitigation framework may benefit the environmental enhancement of hydropeaking rivers while maintaining flexible energy generation.