

The ecological effects of sub-daily flow variability on riverine fishes – a systematic review

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ABSTRACT: The contribution of renewable energy to the global energy portfolio is increasing. The flexibility of hydropower to support increased integration of intermittent renewable energy production such as solar and wind makes it an attractive option for power producers responding to grid demands for electricity on a short timescale. Operating hydropower dams to respond to real-time energy market conditions can result in rapid and abnormal fluctuations in downstream flow, called hydropeaking. Hydropeaking alters the timing, magnitude, and rate of change of natural flow regimes by decoupling seasonal climate and flow patterns and rapidly changing river discharge via pulses of water from upstream reservoirs. Consequently, hydropeaking can affect wetted width, temperature, habitat quality and availability, and other biotic and abiotic river characteristics downstream of hydropower facilities. In this systematic review, we summarize and synthesize the growing body of literature on the ecological effects of sub-daily flow variability on riverine fishes associated with hydroelectric power production. Specifically, we characterize the magnitude and direction of the suite of reported impacts of hydropeaking on fish and the techniques and metrics used to assess these impacts. We also identify research opportunities to address knowledge gaps and explore emergent dynamics. Findings from this review will help illuminate the generality of hydropeaking impacts on fish and inform hydropower operation strategies that balance flexible hydropower production with downstream ecosystem integrity.