

RESPONSE OF FISH COMMUNITIES TO FLOW VARIATIONS IN HYDROPEAKING STREAM REACHES

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Hydropower plants managed by “hydropeaking” have a growing key role to play due to the expected future increase in energy demand, and the numerous advantages of these facilities (e.g. renewable energy, efficiency, rapid response to grid demand). However, mitigation measures have to be implemented to decrease their environmental impacts. These hydropower facilities use the available water reserves at the most opportune moment for the generation of electricity and release water stored in dam reservoirs by intermittence. Sudden changes in flow variations within the day or the week are induced in river reaches below plants. These variations are thus more frequent, intense and of shorter duration than natural flow variations related to floods for instance [1]. Hydropeaking cause significant variations in hydraulic parameters (water depth and current velocity) and increase near-bed shear stress. Those hydraulic parameters contributing to fish and macro-invertebrates habitat selection [2, 3], physical habitat attractiveness may change rapidly and frequently in river reaches located downstream hydropower plants. This can cause drift of organisms with low swimming ability [4] or stranding of organisms preferentially living close to the shoreline [5, 6]. Until today few studies have used flow metrics which describe flow alteration at the sub-daily time scale [7, 8] to quantify fish response to hydropeaking. Long-time series of hourly discharge data are generally unavailable. The few existing studies were only interested in salmonidae species [9, 10]. Moreover, the impact of hydropeaking on the structure and abundance of the whole fish community were described only qualitatively and were rarely related to hydropeaking characteristics [11, 12]. Thus, the goal of our study was to characterize the response of fish assemblages of twenty or so species to variation in discharge by using metrics calculated on series of hourly flow downstream two different dams. We tested if the more intense sub-daily fluctuations they are (in terms of frequency, magnitude, time, duration, ramping rate), a more severe the change in fish community is observed.

For this purpose, a monitoring of fish assemblages and flow conditions in two sites located in France (Mallemort on the Durance River and Eguzon on the Creuse River) was implemented. For each site, two river reaches were annually sampled using electrofishing during 6 to 10 years from 2006 to 2017. Hydropeaking metrics (e.g. number of flow increases, number of flow decreases, magnitude of flow alteration, average flow up-ramping and down-ramping rates) and flood metrics (e.g. number of floods before electrofishing, flood intensity and duration) were calculated. We performed a temporal within-site analysis of this dataset (17 reach \times year for Mallemort and 15 reach \times year for Eguzon). We studied the link between fish species, fish functional guilds (defined according to preferences in current velocity and water column position) and flow metrics. We used a co-inertia analysis between the principal components of within PCAs performed on (1) biological metrics and (2)

flow metrics. We found that both total and young-of-the-year fish abundances seemed to be affected by the number of increases in flow and their ramping rate in reaches located downstream the hydropower plant. This analysis has also shown a similar influence of these flow metrics on rheophilic and pelagic fish abundances on the one hand and on limnophilic, benthic and benthopelagic fish abundances on the other hand, despite the difference of morphological and hydropeaking characteristics.

As given flow values may have different hydraulic translations depending on the river morphology, studying flow variations alone did not allow us to accurately describe the perturbation experienced by fish. We have planned to characterise the responses of fish communities to water depth and current velocity fluctuations. However, in addition to those studies implemented at the communities scale, we will focus on the response of fish to high hydraulic conditions' variations at the individual scale. To improve our understanding of habitat selection strategies by fish during hydropeaking, we have planned to conduct an *in situ* monitoring of individuals in two different rivers. We expect that fish will avoid habitats which have high degree of attractiveness variation (e.g. river banks dewatered during base flow), and particularly species with low mobility abilities.

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