CONSISTENT BUT SECONDARY INFLUENCE OF HYDROPEAKING ON STREAM FISH ASSEMBLAGES IN SPACE AND TIME

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Abstract

Hydropeaking corresponds to rapid artificial discharge fluctuations downstream of hydropower plants, designed to address sub-daily electricity needs. Hydropeaking causes numerous impacts on river ecosystems and will be increasingly used due to the growing demand for renewable energy. Although fish are sensitive to flow alteration, quantifying the ecological impacts of hydropeaking characteristics on fish assemblages in space and time remains challenging. In particular, few studies have focused on the influence of hydropeaking on annual variations in fish assemblages, and few described the responses of many species. An improved knowledge, based on comparable descriptions of hydropeaking events among rivers, is crucial to define efficient mitigation rules for hydropeaking management.We assembled a large database of annual fish density (3-12 years) and environmental characteristics collected in 44 reaches of 27 small to medium-sized French rivers subjected to hydropeaking. Among them, seven pairs of reaches were neighbouring reaches with contrasting hydropeaking pressure. Environmental characteristics included climatic and topographic variables as well as hydraulic and habitat-suitability information derived from hourly flow discharge data. Hydraulic variables allowed a comparable description among reaches of the history of flow increasing and decreasing events (natural or artificial) during the spring and summer seasons preceding fish sampling. We investigated how environmental characteristics explained the variability of fish-species densities between reaches (in space) and within reaches (over years), using multivariate (co-inertia) analysis.Between reaches, the structure of fish assemblages was mainly related to stream size and little correlated with flow annual variations. However, for the four pairs of reaches corresponding to larger streams among the seven pairs of neighbouring reaches, higher hydropeaking pressure was associated with higher density of species typical of headwater streams (i.e. Salmo trutta, Cottus gobio and Phoxinus phoxinus). Within reaches (over years), densities of almost all fish species decreased with increasing magnitude of floods. Fish assemblages were secondarily affected by a combined effect of hydropeaking characteristics and flood seasonality. In particular, years with more frequent hydropeaking events tended to be associated with higher density of headwater fish-species. These hydropeaking effects observed within reaches were consistent with those observed between reaches.Overall, in the range of regulated reaches and hydropeaking conditions studied here, hydropeaking had a secondary effect on the variability of fish assemblages but could provide hydraulic habitats more suitable for headwater fish species than for others.

Keywords
hydropower, fish densities, flood, hydraulic variables, habitat