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Comparison between natural and impacted Alpine lakes six years after hydropower exploitation has ceased

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Abstract: Many lakes in mountain regions have been used for hydropower generation since the 1950s. It has been estimated that as many as 79% of the rivers in the Alps have been affected by the presence of hydropower plants. In this context, the shutting down of hydropower plants on a group of Alpine lakes represented a good opportunity to study the ecological impact on them. We selected nine lakes that had been affected and nine that had not, and analysed the differences in environment, littoral diatoms and zoobenthos, phytoplankton, zooplankton, and fish. Results showed that benthic biota –diatoms and zoobenthos– were the most affected by water-level drawdown during winter months. Even six years after the end of hydroelectric operations, diatom species richness and diversity were lower in impacted lakes. Assemblage structure was different for both diatoms and zoobenthos. Phytoplankton and zooplankton were similar in impacted and unaffected lakes in terms of both species richness (and diversity) and assemblage structure. The degree of impact on fish was unclear because illegal stocking of lakes with allochthonous fish species had taken place. This study showed that compared to limnetic biota, littoral communities were the most affected by the decrease in water volume every winter. Six years after the end of hydroelectric operations, diatoms, and to lesser extent zoobenthos, were still different compared to those in natural (unaffected) lakes. Planktic communities seem to be either more resistant to the disturbances, or else able to recover more quickly to their former condition.

Key words: littoral diatoms; littoral zoobenthos; phytoplankton; zooplankton; Water-Level Fluctuations (WLF).

Introduction

As a consequence of their morphology, the Alps are the main hydropower reserve of Europe. Since the inter-war period a multitude of hydropower projects have been realized in this area. It has been calculated that 79% of Alpine rivers have been affected by hydropower operations (Tödter 1998). Hydropower plants need dams, water diversions and reservoirs (natural, semi-natural and, artificial), all of which are associated with severe environmental problems, such as the interruption of the ecological continuum, modification of the water level in lakes, hydropeaking, the flooding of landscapes, and alterations in biogeochemical cycling (Friedl & Wüest 2002; Truffer et al. 2003; Wantzen et al. 2008; Strayer & Findlay 2010; Sutela et al. 2013). Such physical changes have already drastically altered the conditions of aquatic ecosystems which, when left undisturbed, harbour an exceptionally high number of species (Dudgeon et al. 2006).

In recent years, the water stored for hydropower exploitation has attracted other stakeholders, such as those interested in producing artificial snow (Marnezy 2008). The production of artificial snow has become increasingly important in many of the world's ski areas (OECD 2007). As with hydroelectric production, water is drawn down in winter and collected during the other seasons. Where lakes or dams are not available, small headwater reservoirs are designed for water storage, and their number has recently grown.

The ecological consequences of hydropower and/or artificial snow production on lakes and reservoirs are well documented in scientific literature (e.g., Cott et al. 2008). The main impact occurs during periods when the lake level is naturally low, and drawdown takes place at an unnatural rate. This leads to artificial water-level fluctuations (WLF), which in turn affect –to varying degrees– all the taxonomic groups inhabiting these lentic habitats (Wantzen et al. 2008).

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