Stream ecology in Alpine streams: does management overwhelm climate change?

Bruno M.C., Maiolini B., Carolli M., Siviglia A., and Zolezzi G.

Abstract Flow and temperature regimes are the main driving forces influencing habitat structure and ecological functions in lotic ecosystems. The five major components of flow regime: magnitude, duration, frequency, timing and rate of change regulate the ecological processes in river ecosystems. The natural temperature regimes of rivers provide thermal cues that stimulate responses in many aquatic species, and affect many physical and chemical processes which play a crucial role for community composition of stream macroinvertebrate communities and for individual species. In Alpine streams, the presence of hydropower plants can significantly alter the hydrological and thermal regimes. Water is abstracted from headwaters, stored in artificial, high elevation reservoirs, used to produce hydropower and finally released downstream in the form of "hydropeaking" (i.e. sharp releases of water which, in Italian rivers, can increase the discharge of 10x the baseflow). On a yearly time scale, hydropower production has been impacting the temperature and flow regime of most Italian Alpine rivers from the middle of the last century. In general, a progressive flattening in the hydrograph occurred. The alterations in temperature are represented by a decrease of water temperatures from the beginning of spring to the end of summer downstream of the point where hypolimnetic waters are released, and a warming of the receiving waterbody from the beginning of autumn to early spring. Examples from rivers of different typology are presented to show the alterations of the thermal and discharge regime, and their ecological effects, based on the results of our research. In Alpine streams, the impacts of climate change will sum to those of management. Because the hydrological cycle will be enhanced under warmer climatic conditions, the current distribution, seasonality, and amount of precipitation will undergo significant changes. Due to the forecasted glacier retreat, in glacierized basins a temporal shift of discharge peaks due to increase of snowmelt vs glaciermelt towards early summer instead than mid summer will occur; as a consequence, there will be an increase of water to be abstracted and stored in reservoirs in the short term, but less water in the long term when smaller glaciers will disappear. Due to reduced snowfall, more water will be needed for production of artificial snow. In view of the forecasted climate change and consequent increase in water demand in the Alps, it is crucial to direct Alpine research to a better understanding of the changes occurring in freshwater ecosystems in order to produce new ecologically sustainable management recommendations.

Corresponding Author:
Maria Cristina Bruno
Fondazione Edmund Mach, Research and Innovation Centre
e-mail: cristina.bruno@fmach.it