

## Long-term research to understand impact of perturbations on lakes: the example of Lake Maggiore

Perturbations linked to the direct and indirect impacts of human activities during the so-called Anthropocene, affect the structure and functioning of lake ecosystems to varying degrees. To understand the patterns and mechanisms of these anthropogenic effects and the extent to which they may drive irreversible changes in ecosystem services, long-term research is required. Studies on the long-term dynamics of plankton may be particularly useful for large and deep lakes whose overall productivity is dominated by pelagic processes. In the open-waters of such lakes, planktonic organisms link and interact with both abiotic and biotic compartments. Here we will analyse 60 years of data on the plankton of the large, deep, subalpine, Lake Maggiore, tracing changes in the pelagic food web which occurred during different phases of the lake's recent evolution. We will document short- to- medium response times by different trophic levels, from microbes, to primary producers and secondary consumers. We will revisit results of past studies based on contemporary and paleolimnological studies and present new analyses to: i) identify any tipping points of the lake trophic evolution, ii) discern effects of recent climatic change, iii) quantify whether inter-annual variability has changed perhaps in responses to changes in thermal stratification regime and warming. By supplementing structural with functional descriptions of long term changes in phyto- and zooplankton communities, we aim to test competing mechanisms underpinning the decade-scale changes we observed.

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