Abstract

During the past decades, many shallow lakes and ponds have been subject to a considerable degree of eutrophication, as a result of human activities, which can cause a transition to a turbid, phytoplankton-dominated state, often resulting in severe blooms of potentially toxic cyanobacteria. Brussels ponds in general show a considerable variation in phytoplankton biomass, despite the overall high nutrient concentrations (eutrophic to hypereutrophic when considering total phosphorus). Therefore, these ponds have a potential for restoration by means of biomanipulation.

The aim of this study was to investigate the ecological state of 13 Brussels ponds biomanipulated in 2005 – 2009 (i.e. pond drawdown and fish removal) by means of assessing changes in phytoplankton, zooplankton, macrophytic vegetation communities and main nutrient concentrations. In order to investigate the biomanipulated ponds within a broader context, 17 additional ponds were studied during the same period.

Initially, the biomanipulation brought positive results in all but one pond. Most of the biomanipulated ponds have shown a marked improvement in several aspects of their ecological quality. The biomanipulation results confirm the importance of fish in determining the ecological quality of eutrophic ponds and indicate that when pond ecosystems are impaired by eutrophication, a considerable degree of their ecological quality can be restored through manipulation of the fish community. Fish play a central role in structuring zooplankton and submerged macrophyte communities that, on their turn, play a crucial role in controlling phytoplankton in eutrophic ponds.

An important factor altering the positive result of biomanipulation on the longer term is the recolonization of fish. However, the reappearance of small zooplanktivorous fish did only have a significant effect on phytoplankton biomass in ponds with a submerged macrophyte cover of < 30%. This was not the case in ponds where submerged vegetation cover was > 30%, where, despite the considerable impact of fish on large Cladocera densities and length, phytoplankton biomass did not increase significantly upon fish recolonization. This highlights the importance of submerged vegetation recovery after biomanipulation, that, although it did not seem to provide sufficient shelter for large cladocerans, was able to control phytoplankton biomass if cover was > 30%. Taking into account the importance of submerged vegetation recovery, efforts should be made to enhance their restoration after biomanipulation.

Although submerged macrophytes have shown to be able to prevent a phytoplankton biomass increase after fish recolonization, nutrients should be limited to a certain extent. Above a certain threshold of nutrient concentration in the water column (a rough average TP concentration of 350 µg P L^{-1}), macrophytes are no longer able to efficiently control phytoplankton biomass during the whole summer, resulting eventually in their disappearance. Based on this threshold, a decision tree was developed as a guideline for choosing appropriate restoration measures for ponds, advising nutrient reduction before biomanipulation when the average TP concentration is more than 350 µg P L^{-1}. Once biomanipulation is performed, several steps are incorporated into the decision tree considering stabilization of the clear-water state, such as measures to stimulate macrophyte recovery or the addition of piscivorous fish. Regular monitoring of the successfully restored ponds is necessary in order to detect any deterioration of the situation and to enable additional adequate measures to be taken in order to avoid further deterioration of the system.