LAKE RESTORATION BY PERIPHYTON ON ARTIFICIAL SUBSTRATA

In consequence to increasing eutrophication of the aquatic environment, restoration techniques are of ongoing interest. In the present study, a novel method utilizing periphyton for the removal of excess nutrients was developed and investigated to asses the potential for lake restoration.

By a submerged exposure of artificial substrates in a large-scale experiment at a lake near Bonn, Germany, benthic algae showed an enhanced growth and phosphorus binding in competition with planktonic species. Thus, nutrients accumulated by the periphyton could efficiently be eliminated from the lake by removal of substrates.

In 2004, preparatory experiments aiming on optimal conditions for algal growth and phosphorus accumulation were carried out on small substrate sheets. Prior to the large-scale-experiment the trophic state of the lake was assessed as “eutroph 1” (trophic index 2.9) and, by that, was differing from its mesotrophic reference state (trophic index 2.3) which in general defines the goal for restoration measures.

A large-scale exposure of 6,700 m^2 of artificial substrate in a depth of 0 to 3.5 m was performed from May to November 2005. A colonization of the substrates by microalgae was observed. Substrate-immobilized periphyton competed successfully with phytoplankton for phosphorus as common resource. The total phosphorus concentration decreased from 50 µg L^{-1} to less than 20 µg L^{-1} in the epilimnion. From July on periphyton was able to grow on stored phosphorus reserves while phytoplankton density remained low. Increasing phosphorus concentrations caused by breakup of the stratification in September led to further phosphorus accumulation on the substrates. However, due to a lower seasonal light supply no further growth of substrate-immobilized periphyton was observed during autumn.

During the large-scale experiment the microalgal communities on substrates shifted from up to 50% planktonic species in June to the predominant abundance of benthic taxa in November at the end of the exposure period. In algal-dominated biofilms the proportions of diatoms increased with exposure time, whereas the proportion of green algae was found to be stable during the experiment. Cyanobacteria appeared in summer on the artificial substrates.

About 275 g phosphorus have been accumulated and removed from the lake by large-scale exposure using artificial substrates. This amount represents 50% of total phosphorus of the lake during circulation before the restoration was performed. The phosphorus concentration during stratification determines intensity of phytoplankton development with onset of growth season.

In 2006, one year after the large-scale experiment, the trophic state of the lakes was mesotroph with a trophic index of 2.5.

As demonstrated in the present study a relevant amount of phosphorus was removed from the lake. Therefore, it can be concluded that a large-scale exposure of artificial substrates can efficiently be applied as a method in lake restoration. To asses the sustainability of the restoration activities, a continuation of the current monitoring programme is recommended.