



ICEP

International Conference on Environmental Pollution Web (Rome, Italy)

CONFERENCE DATES: 2018/09/28

Successful restoration of a tropical shallow eutrophic lake: Strong bottom-up but weak top-down effects recorded

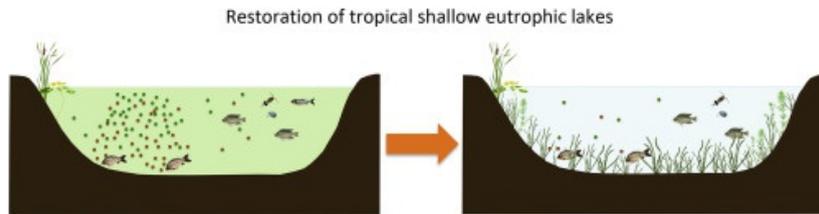
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Abstract

Fish manipulation has been used to restore lakes in the temperate zone. Often strong short-term cascading effects have been obtained, but the long term-perspectives are less clear. Fish manipulation methods are far less advanced for warm lakes, and it is debatable whether it is, in fact, possible to create a trophic cascade in warm lakes due to the dominance and high densities of fast-reproducing omnivorous fish. However, removal of benthic feeding fish also reduce disturbance of the sediment, which not only affects the nutrient level but also the concentration of suspended organic and inorganic matter with enhanced water clarity and potentially better growth conditions for submerged macrophytes. We conducted a biomanipulation experiment in one of the basins in Chinese Huizhou West Lake that have remained highly turbid after extensive nutrient loading reduction. Another basin was used as control (control-treatment pairing design). Removal of a substantial amount of plankti-benthivorous fish was followed by planting of submerged macrophytes and stocking of piscivorous fish. We found strong and relatively long-lasting effects of the restoration initiative in the form of substantial improvements in water clarity and major reductions in nutrient concentrations, particularly total phosphorus, phytoplankton and turbidity, while only minor effects were detected for crustacean zooplankton grazers occurring in low densities before as well as after the restoration. Our

results add importantly to the existing knowledge of restoration of warm lakes and are strongly relevant, not least in Asia where natural lakes frequently are used extensively for fish production, often involving massive stocking of benthivorous fish. With a growing economy and development of more efficient fish production systems, the interest in restoring lakes is increasing world-wide. We found convincing evidence that fish removal and piscivores stocking combined with transplantation of submerged macrophytes may have significant effects on water clarity in warm shallow lakes even if the zooplankton grazing potential remains low, the latter most likely as a result of high predation on the zooplankton.

Graphical abstract



Keywords

Lake restoration, Biomanipulation, Implantation of macrophytes, Tropical lake