Biological methods of water protection

# Keeping Algae Under Control

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**Human activity turns lakes into overfertilized sewage dumps. We are now learning how to deal with this problem using nature's own methods**

The human race's demand for water is constantly increasing and gives rise to discharged waters, polluted with domestic, industrial and agricultural wastes. Streams and rivers frequently become sewage gutters.

In response to this situation, after researching the feeding mode of various aquatic organisms, hydrobiologists developed a method of water quality protection which harnesses the natural feeding cycles of water--based plants and animals. This concept, called biomanipulation, first appeared in the 1970s in the United States as an idea for preventing oppressive "water blooms" - massive outbreaks of microscopic algae in over-fertilized waters, coloring them vivid green. Some of these floating aquatic plants, such as toxin-producing blue-green algae, can often disqualify a water supply from human use.

Research showed that the appearance of "water blooms" depended not only on the fertility of the environment but also on the impact of tiny animals - zooplankton - that feed on algae. This suggested that water could be biologically protected from the effects of over-fertilization by phytoplankton feeders. Filtrators, especially zooplankton crustaceans, are professionals in keeping "green biomass" at a low level, thus improving water quality.

Piotr Goss

Habitat variety is key to sustainable ecosystem management, i.e. shallow shore areas are highly important for fish reproduction

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Collecting samples of plankton - a mixture of tiny invertebrates and plants. Maintaining a balance between plankton and fish is the main goal of lake biomanipulation

In Poland, investigations into the practical value of the biomanipulation concept were initiated in the late 1980s at the Biological Aquaculture Station of the Karol Starmach Institute of Freshwater Biology, Polish Academy of Sciences (recently incorporated into the PAN Institute of Environmental Protection).

The Dobczyce Reservoir (970 ha and ca 110 million $m^3$) was selected for this research. Why? It supplies the city of Kraków with water, and the Regional Board of Water Management made it possible to apply the most modern methods of water protection there. The diversity of habitats and the recent rapid eutrophication (over--fertilization) of the reservoir suggested the idea of using biomanipulation to protect its waters. Biomanipulation puts the control of the ecosystem at the peak of the trophic pyramid, i.e. at the level of predatory fish - they feed on non-predatory species of Cyprinidae (bream, roach etc.), which in turn feed on plankton. This effect can be obtained by supporting predatory fish species feeding on zooplankton, hence the abundance of phytoplankton is indirectly affected by the fish. Owing to the crucial role of the zooplankton as the component of biocenosis controlled by fish, this method can be used in limiting water eutrophication. It must be borne in mind, however, that the above approach does not address the cause of the problem, only its effects.

Our investigations and practical measures applied to the Dobczyce Reservoir aimed to answer the following three basic questions: What species composition and age structure of predatory fish would be most efficient in the conditions of the Dobczyce? What ratio of the numbers and biomass of predatory and non-predatory fish should be established? What kind of fishery management should be introduced to limit the unfavorable effects of eutrophication?

## Fishy questions

In view of their feeding habits, spawning season and feeding areas, we decided to introduce pike, pike-perch and catfish to ensure the stability of the trophic level of predators, and exert constant pressure on non-predatory fish. Another aim of this decision was to fully utilize the accessible ecological niches of the reservoir, i.e. to ensure 24-hour preying activity, both along the shores and in the open water zone. The proper numerical ratios between predatory and non-predatory species have been a subject of recent discussion among ichthyologists. The opinion of the present author is that the average ratio of predators to non-predatory fish should be 1/3. In our studies in the Dobczyce Reservoir we are constantly analyzing the results of commercial catches, paying particular attention to the species composition and size of catches and the age of fish currently being caught. These data enable the effects of the farming operations applied to be verified.

## Water manager

Any purposeful interference with environmental processes should only be undertaken with profound knowledge of how they function. In the case of biomanipulation, the necessary information concerns the size of the biogenic load flowing into the reservoir, the annual variation of oxygen and nutrient content in the water, and data on the qualitative and quantitative changes within the phytoplankton, zooplankton, benthos and fish communities. Besides this, the manager should collect additional information such as how the fishery exploitation makes use of the production capacity of a given water body and how it affects the structure of the ichthyofauna. The above data, referred to as the exploitation analysis, should include the results of catches and an analysis of the intensity and effectiveness of such exploitation. The following data are indispensable: the size and structure of fish catches, the kind, number and work time of the applied fishery implements, and the density of populations of a given fish species. These data describing the results of commercial catches, compared with the results of research, determines further actions.

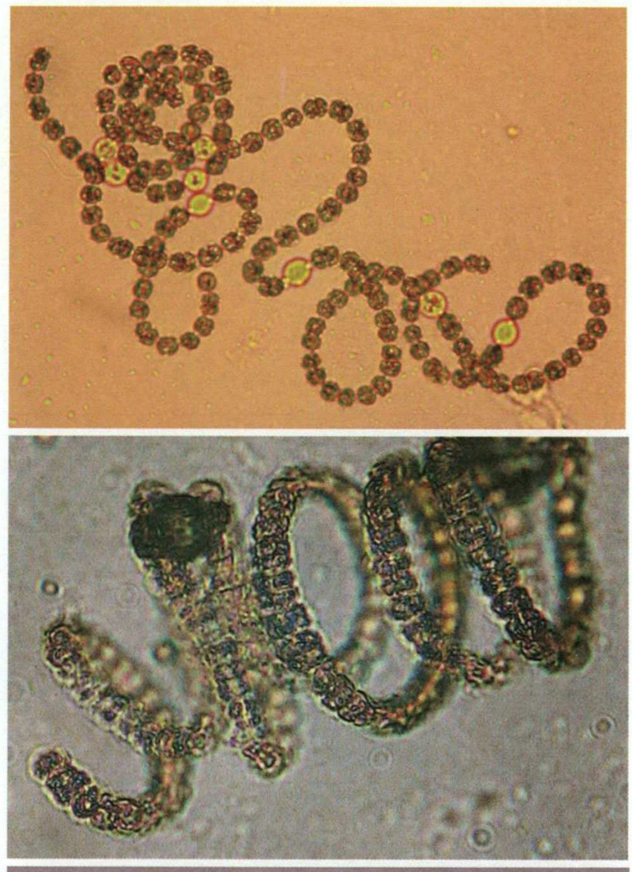
An additional advantage of this documentation is that it provides an easy way of judging the effectiveness of stocking. The complete information can be used as a basis for planning management measures. It facilitates rational fish farming, consisting of a few basic rules. One of them calls for the strict protection of the predatory fish population (particularly of younger classes) and their natural spawning grounds. Stocking with predatory species: pike, perch pike and catfish is also important. The maximum biologically tolerable, selective fishery of Cyprinidae increases the rotation of biomass, and at the same time intensive catches of Cyprinid spawners when they gather in the spawning grounds help to keep their population under control.

As a result of the policy described above, the Dobczyce Reservoir, with predatory fish representing 20% of its fish stock (unique in Poland), presents an example of rational fish farming as a measure of preventing eutrophication and maintaining the proper condition of water quality. Planning, arranging and applying appropriate management measures was made possible by knowledge and control of the abiotic and biotic spheres of this water environment. The success was due to the model cooperation - though rare here - between science and practical human endeavors. ■

**Further reading:**

Shapiro J., Wright D. J. (1984). Lake restauration by biomanipulation - Round Lake, Minnesota. *Freshwat. Biol.* 14, 371-383.

Starmach J., Jelonek M. (2000). Specialized Fishing Management - One of the Factors of Protecting Water Quality at Dobrczycki Reservoir [in Polish]. In: Starmach J., Mazurkiewicz-Boroń G. (eds), *Ecology-Eutrophication-Protection*. Kraków, Zakład Biologii Wód im. Karola Starmacha PAN. pp. 233-241.



Elżbieta Wilk-Woźniak

**Microscopic algae benefit from human-caused excesses of nutrients in the lake. Their massive growth results in oppresive "water blooms"**