Managing aquatic plants: Why doing nothing is also an option

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Macrophyte mass developments occur worldwide and are often perceived as a nuisance. We studied six sites across different climate zones, including lakes, reservoirs, and rivers with different trophic levels and uses. Macrophytes included submerged, emergent, and free-floating plants, which were either native or non-native species. Photos [from (i) to (vi)]: S. Schneider, J. Köhler, A. Padial, S. Hilt, B. Misteli, A. Petruzzella. Credit: *Science of The Total Environment* (2024). DOI: 10.1016/j.scitotenv.2024.172960

Aquatic plants in lakes and rivers are important refuges for animals, bring oxygen into the water and remove nutrients. However, they are not

universally popular: some people find them a nuisance when swimming or doing water sports, and they also change the hydrology of aquatic systems. When aquatic plants grow in large numbers, they are often removed.

Researchers involving the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) have conducted field experiments in six freshwater ecosystems in five countries to investigate why such mass developments occur and what the consequences of removing them are. The evaluation of different management approaches showed that the "do nothing" option can also be considered when dealing with aquatic plants.

According to the study, mass developments of aquatic plants primarily impair the recreational value of a water body, while they are often beneficial for other ecosystem services. The study is published in the journal *Science of The Total Environment*.

Aquatic plants, also called macrophytes, can grow in a variety of ways: some float freely on the surface without roots, others take root at the bottom and form floating leaves that rise above the water, while others remain completely submerged.

Under optimal conditions, they can spread en masse. This is the case when growth-promoting factors such as high levels of nutrients, light and carbon, and warm temperatures are present. And when disturbances that inhibit plant growth—such as strong currents, flooding, drought, and herbivory—become less frequent or absent.

River Spree and Lake Kemnader: Regulated flow favors aquatic plant growth

Such natural disturbances are absent in straightened and flow-regulated

watercourses—for example, regulation has turned the German River Spree into a slow-flowing river whose nutrient content favors the growth of various native submerged aquatic plants.

In the case of Lake Kemnader, a reservoir near Bochum in Germany, the regulation of the River Ruhr has created a nutrient-rich lake with large shallow water zones whose dynamics are little changed by floods or dry periods, thus promoting the mass development of the non-native narrow-leaved waterweed.

"Mass development of macrophytes in nutrient-rich, summer-warm, regulated rivers is a well-known phenomenon. However, the risk of mass development of aquatic plants should also be considered when regulating nutrient-poor, cold rivers. Regulation makes the system less dynamic because the water flow is more uniform. This alone can promote mass development, even if the nutrient content is low," said IGB researcher Dr. Sabine Hilt, co-author of the study.

More than half of residents and users find aquatic plants bothersome

But how do local people perceive aquatic plants? Not surprisingly, the surveys of local residents and water users conducted as part of the study revealed that the denser the aquatic plants, the more often they are perceived as a nuisance—in terms of vegetation area and growth height. The point at which a nuisance is perceived depends on the type of water body and the user group surveyed.

In the River Spree study area, 80% of local residents, but only 63% of temporary water users, perceived the mass development of native aquatic plants as disturbing. Both groups were concerned about biodiversity. However, local residents were more concerned about the

impact of mass development on biodiversity than recreational users.

"This is surprising because native aquatic plants promote biodiversity. But people don't seem to realize that," said Hilt.

At the Hartbeespoort Dam in South Africa, where the researchers also conducted surveys, more than 90% of visitors and residents found the massive spread of non-native water hyacinth disturbing. People were primarily concerned about biodiversity, and only secondarily about boating and the beauty of the landscape.

"The high perception of disturbance could be related to the fact that people there have been aware of water hyacinth control for decades, combined with the great importance of this freshwater ecosystem for the whole country," said Hilt, interpreting the different results.

Effects of aquatic plant removal on the water body

A common measure for controlling aquatic plants is the mowing or mechanical removal with mowing boats. In before-and-after field experiments on the six lakes, reservoirs and rivers, the research team investigated the effects of plant mowing on ecology, water quality and the water balance.

"As aquatic plants also provide important ecosystem services for us humans, it is important to know the possible negative consequences of removal and to weigh these up conscientiously in water management according to good professional practice," said IGB researcher Dr. Jan Köhler, also co-author of the study.

Water balance: Water levels can drop—this can be good or bad

In rivers and streams, dense stands of aquatic plants narrow the cross-sectional area of flow and induce turbulence around stems and leaves, slowing river flow. As a result, dense stands of plants increase the water level upstream. The researchers analyzed long-term data on discharge, water level and aquatic plant biomass in order to calculate the impounding effect.

In the studied section of the River Spree, rooted aquatic plants elevated the mean water level by 60 to 90 centimeters (averages June and July 2011–2021) and slowed the mean flow velocity by 35%. Depending on the type of watercourse, this effect can be beneficial or detrimental.

"When river discharge is high, this impounding effect may locally increase flood risk. In rivers and streams with low to moderate discharge, however, the impounding effect of aquatic plants may be beneficial. The high water level in the river also raises the groundwater level in the adjacent floodplain. In the Spree, changes in the river water level are reflected in the groundwater within a few hours. This can mitigate periods of drought. The greater heterogeneity also provides additional habitats and can promote biodiversity," explains Jan Köhler.

The exact effect of plant removal on water level depends on the spatial extent and intensity of removal. Complete prevention of any impounding effect would require the total removal of all macrophytes in a sufficiently long river section.

In the River Spree, for example, macrophytes have been mowed every summer since 2002, in some years along the whole 34 km river stretch, in others in sections of 3–8 km length. River water levels dropped by 20–30 cm in the mowed sections, but only for some weeks, until regrowth.

Carbon and nutrient cycle: Fewer plants, more nutrients

The removal of aquatic plants can increase the nutrient load. In the field experiments, the water chemistry in control and affected areas was measured before, one week after and six weeks after the removal of aquatic plants. These before-and-after measurements showed an increase in nutrient concentrations at several locations, including the Spree and Lake Kemnade.

This is because aquatic plants absorb nutrients. They also filter particles out of the water and promote the sedimentation of floating matter. However, the nutrient load can also increase if nutrients are released from the sediment during removal.

Control of non-native species: Other species fill the gap

"Non-native aquatic plant species can threaten local aquatic biodiversity through resource competition or habitat alteration. This is actually a good argument for their removal. However, studies such as ours have shown that the targeted removal of non-native aquatic plants is no guarantee that the perceived nuisance problem will be solved. Other native or non-native species can then colonize the habitat and cause similar problems for the ecosystem users," said Hilt.

One example: In the field experiment at the Hartbeespoort Reservoir in South Africa, the mass development of the non-native, free-floating water hyacinth was controlled biologically by releasing insects that specifically target on the water hyacinth while leaving other plant species untouched. The researchers found the first signs of another invasive free-floating plant species, the common salvinia, taking over when water

hyacinth cover was reduced.

Biodiversity: Structurally rich habitats can be lost

Aquatic plants generally provide a high level of structural complexity which provides habitat and/or refuge. Further, they are an important food source for other aquatic organisms. Despite a high variability of results, various studies show that macrophyte-dominated shallow lakes generally have a higher diversity of zooplankton, invertebrates, fish and birds.

In the current study, the results were not so clear; at some sites, biodiversity was even lower or there was no discernible difference when aquatic vegetation was abundant.

"This might be explained by the occurrence of dense monospecific macrophyte mats, which can repress more diverse native macrophyte vegetation. This leads to a homogenization of aquatic communities and in some cases to anoxic conditions with a subsequent negative impact on aquatic biodiversity," explained Hilt.

Management of aquatic plants primarily benefits the recreational value of a water body

As the causes of the mass development of aquatic plants are often difficult to combat, considerable resources are spent each year on their removal, although this only has a short-term effect. The aim of removal may be to prevent flooding of adjacent properties or clogging of hydroelectric power stations and water pipes, or to facilitate recreational activities such as boating, swimming and fishing.

"When deciding whether or not to mow aquatic plants, the concept of

ecosystem services provides a suitable framework. In this study, we identified twelve ecosystem services of water bodies that are affected by mass developments of aquatic plants—either positively or negatively. By expressing the ecosystem services in monetary units per unit of area and time, we were able to sum them up and estimate their total economic value," said Hilt. The research team calculated the respective value for three scenarios: do nothing, current management practice with partial removal of plants, and maximum removal.

Overall, it was found that ecosystem services for recreation—such as fishing, swimming, boating—dominate the overall social value of aquatic plant management. However, few recreationists were willing to pay for more intensive aquatic plant removal. This is consistent with other studies, which often only look at individual forms of recreation such as angling and use non-monetary approaches.

Clear conflict of objectives in the River Spree: Agricultural benefits vs. biodiversity

In the case of the River Spree, the researchers identified a clear trade-off between different ecosystem services: Scenario 3 with maximum plant removal led to a higher value of fodder production from the agricultural floodplain meadows (+40%), because the lower groundwater level increased the production capacity of the floodplain.

At the same time, however, the lowering of the water table also led to a decline in biodiversity (-50%), probably particularly in red-listed wetland plant species in the floodplain reserves.

"Our research shows that management decisions have often been based on the needs of a particular user group. However, the overall societal benefit of removing aquatic plants is no greater than allowing them to

grow. The option of 'doing nothing' when dealing with aquatic plants that are perceived as a nuisance should therefore not be discarded too quickly," Hilt said.

More information: Susanne C. Schneider et al, Causes of macrophyte mass development and management recommendations, *Science of The Total Environment* (2024). DOI: 10.1016/j.scitotenv.2024.172960

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