To make lakes healthy, you first need the right recipe

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Many lakes worldwide suffer from 'green soup'. Restoration is costly and not always effective. Determining your type of lake could do the trick and helps to get the right recipe for your lake. Credit: Manqi Chang/NIOO-KNAW

Pollution of lakes is a worldwide problem. Restoration attempts take a lot of time and effort, and even then, they might backfire. A team of researchers led by the Netherlands Institute of Ecology (NIOO-KNAW) suggests a different approach: determine which of four different types

the lake is, according to their report in the August issue of *Science of the Total Environment*. Spatial differences are the key to a successful restoration recipe.

"Not all lakes are alike," says researcher and first author Annette Janssen. Even if their common problem is pollution, usually caused by too many nutrients. Instead of making a lake healthier, an oversupply of phosphorus or nitrogen will turn the water into "green soup," which is toxic, in many cases. "For an effective solution, you have to take into account the spatial differences between lakes." It's a factor that until now had been largely neglected.

Where and how do nutrients enter the lake? And where does the water originate? There are lakes with a single point of entry—e.g. a pipeline or a river feeding the lake—and lakes where the nutrients and/or the water enter in a more diffuse way: from groundwater or precipitation. Based on these spatial differences, the researchers distinguish between four types of lake, all of which would require a different restoration approach.

Type "Loosdrecht"

Take Lake Loosdrecht in the Netherlands. Its natural situation is for nutrients and phytoplankton to be relatively homogeneously distributed. It's a seepage lake, which means the water, too, enters in a relatively diffuse way. In lakes of this type, says Janssen, flushing with clean water often proves to be successful.

A lake that belongs to an entirely different category is Lake Taihu near the Chinese city of Shanghai, where Janssen did much of her Ph.D. research. Lake Taihu is fed by a river, and close to its mouth, a thick layer of smelly algae covers the water. At the outflow, on the other hand, the water is relatively clean. An attempt by the authorities to flush this

lake did not work out well. Janssen says, "In lakes of the type Taihu, flushing only spreads pollution across a larger area, like an oil spill." The same is true for lakes of the type "Pátzcuaro" (Mexico), which are point-loaded seepage lakes.

In lakes of the type "Tahoe" (United States), finally, flushing does work, as the highest concentration of nutrients is found at the outflow and would therefore leave the lake quite rapidly. But another promising approach—the removal of certain species of fish (bio-manipulation)—only seems to work in lakes of the same type as Lake Loosdrecht. There, it will help to give plants and animals that require clear water the space they need.

Reducing nutrients

"But the only thing that can lead to a permanent recovery in all four lake types," say the researchers, is "to reduce the supply of nutrients." That's tricky, to say the least. But thanks to a recent Veni grant from the Dutch Research Council, Annette Janssen will be getting down to work on this soon.

Provided by Netherlands Institute of Ecology