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Science for Environment Policy

How much phosphorus pollution makes lakes unsafe for recreation?

A target level of 20 micrograms of phosphorus per litre of lake water could help keep many lakes safe for recreation by restricting the growth of harmful algal blooms, European research suggests. The scientists analysed the relationship between phosphorus levels in medium- and high-alkalinity lakes, the growth of cyanobacteria blooms and the concentrations of cyanobacteria that trigger World Health Organization (WHO) warnings.

Toxic algal blooms may harm water quality in lakes, potentially making them unsafe for recreational activities and restricting their suitability as a source of water for drinking and irrigation. Algae can bloom, or grow excessively, in lakes, ponds and reservoirs that have been polluted with high levels of nutrients, such as nitrogen or phosphorus. These nutrients usually enter the water as runoff from agriculture and city sources.

One type of algal bloom is formed by cyanobacteria, also known as blue-green algae, which typically colour the water green and often form a visible layer on the surface, while also producing toxins. These toxins can cause a range of health problems, from minor skin irritations to severe stomach upsets, and can even lead to death. The WHO has issued a series of guideline values of cyanobacteria concentrations for low, moderate and high probabilities of negative health effects from recreational use of contaminated water, such as swimming.

In this study, the researchers estimated the maximum concentration of cyanobacteria likely to result from different levels of phosphorus in freshwater. These algae concentrations were then related to the likelihood that the WHO recreational heath alerts would be triggered. For their calculations, the researchers used data on cyanobacteria concentrations and total phosphorus (TP) levels from over 1500 lakes across Europe.

Cyanobacteria were typically not prevalent in low-alkalinity (low concentrations of carbonate and bicarbonate ions) lakes, mainly located in Northern Europe. The researchers therefore focused on the 800+ remaining medium- and high-alkalinity lakes.

The results suggest that low concentrations of TP (less than 35 micrograms per litre (µg L^{-1})) can cause sufficient growth of algal blooms that exceed the WHO's low and medium risk thresholds in 5% of medium and high-alkalinity lakes.

In general, increases in TP concentrations of up to 150 µg L^{-1} may encourage denser algal growth, with a maximum density of 30 mm^3 L^{-1}. After this concentration level, any additional increase in TP has little impact on algal growth. The researchers noted that, in about 50% of the surveyed lakes, TP concentrations over 100 µg L^{-1} did not result in cyanobacteria concentrations triggering the WHO low health alert. This suggests that there are other factors which influence bloom development, for example, low levels of nitrogen may be restricting growth.

This information can help water managers set TP limits for a water body. For example, the researchers suggest that a TP target of 20 µg L^{-1} should ensure that there is only a small probability (less than 10% likelihood) of triggering a WHO low health alert for recreational waters.

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