Unpredictable ecosystem changes caused by fertilization of lakes pose challenges for ecologists

Posted 07/18/00

Unintentional fertilization of lakes by humans might be creating additional challenges for lake managers fighting to control increased algae, according to a new study by researchers at Dartmouth College, York University and the University of Regina.

The study, published in the July issue of the journal Ecology Letters, examines the effects of fertilization on lake algae. Water too rich with nutrients such as phosphorus and nitrogen will breed excessive algae, which in turn consume dissolved oxygen in the water. This can lead to oxygen deprivation and kill other lake organisms, including fish.

In the study's most startling discovery, researchers found algal composition and abundance fluctuated unpredictably from year to year in an experimentally fertilized lake, even though the level of phosphorus fertilization remained constant throughout the experiment.

"By comparing algal variability before and during experimental fertilization, we have shown for the first time that fertilization of lakes changes their fundamental properties to make them more erratic and much less predictable than in the past," said Kathryn Cottingham, lead researcher and Assistant Professor of Biology at Dartmouth. James Rusak of York University in Toronto and the University of Regina in Saskatechewan and Peter Leavitt, also from the University of Regina, were co-authors on the study.

Because algae levels did not have a direct relationship to the amount of added nutrients, lake managers, ecologists and others who monitor the health of lakes might not be able to make accurate predictions for use in planning management and research efforts, according to the study.

The study also shows that the negative effects of fertilization are a long-term problem: algal levels were just as erratic at the end of the study as during the first years of fertilization.

"This suggests that systems take a long time to stabilize, and that we cannot afford to delay making difficult management decisions in the hope that a disturbed system will achieve a new steady state," Cottingham said.

The researchers compared algae levels over nearly 50 years by analyzing samples from a sediment core taken from an experimental lake in northwestern Ontario. The study lake, which has been deliberately fertilized since 1969, stratifies during the summer, creating ideal conditions for the preservation of annual records of the algal community at the bottom of the lake. Study co-author Leavitt took a core from the lake bottom during winter while the lake was frozen, then analyzed the core in much the same way a botanist might analyze tree rings. Instead of using microscopes to identify the algae, the scientists

used high-performance liquid chromatography to determine what kinds of algae were present, and how abundant they were, in sediment layers for every year from 1943 to 1990.

Humans contribute to fertilization of lakes in a number of ways. Agricultural run-off is a major source of nutrients, but the burning of fossil fuels also contributes to the problem, since nitrates released into the air fall to earth in rain, said Cottingham.

Urbanization exacerbates the problem as well. When rain falls on cities, it typically flows directly from city streets and storm sewers into lakes and rivers, bypassing the natural filtering process that occurs when rain percolates through soil.

While this study only analyzed lake data, Cottingham suspects that other ecosystems could be experiencing similar phenomena.

"Virtually all ecosystems on Earth are currently being fertilized due to human activities. Using simulated data, we have shown that any human activity that causes increased year-to-year variability will also cause increased unpredictability. Consequently, if fertilization increases variability in other types of ecosystems, such as forests or estuaries, then our findings may hold quite generally," she said.

Furthermore, the study raises the broader issue of whether humans can accurately evaluate, predict and control their impact on the environment.

"Increased variability may be a widespread consequence of human activities that obscures impacts of long-term global climate change, diminishes bio-diversity and reduces the effectiveness of scientific experiments and management strategies," the report said.

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Last updated: 10/01/03