Most lakes continuously release nitrogen into the atmosphere

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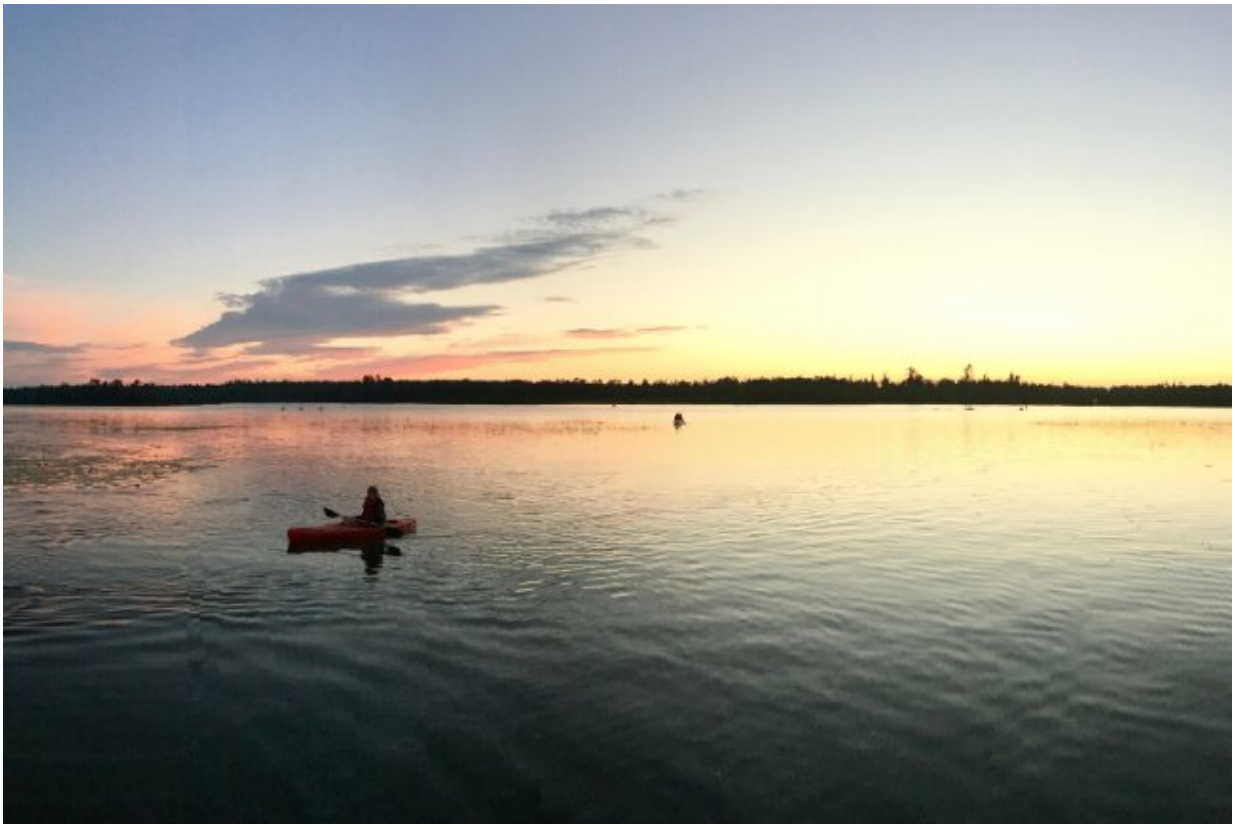

Lake Itasca in Clearwater County, Minnesota. Credit: Jim Cotner

In a process that may help lakes maintain healthy levels of nutrients, new research from the University of Minnesota College of Biological Sciences shows that a majority of the lakes examined are continuously

shedding nitrogen into the atmosphere. Nitrogen, along with phosphorus, is a nutrient that can be found in excess in some lakes. This excess can cause algal blooms that can overwhelm a lake and also produce toxins that can harm fish, local wildlife and people that use water from lakes.

In the research published in the *Proceedings of the National Academy of Sciences*, scientists set out to examine if lakes were gaining nitrogen from or losing nitrogen to the atmosphere. They examined the saturation of gaseous nitrogen in 34 lakes in the Upper Midwest of the United States. Researchers found approximately 86% of the 247 water column samples from lakes were supersaturated with gaseous nitrogen. These findings suggest:

- lakes are continuously releasing nitrogen into the atmosphere;
- the loss of gaseous nitrogen in the lakes is not adequately offset by nitrogen fixation, the process by which nitrogen changes from a gas into compounds such as nitrate or ammonium; and
- terrestrial nitrogen inputs may be needed to balance nitrogen cycling.

"Basically, lakes are constantly leaking nitrogen back into the atmosphere," said Bri Loeks-Johnson, a graduate student who worked on the study through Professor Jim Cotner's laboratory.

Researchers say their results show that lakes are able to get rid of excess nitrogen through a process of denitrification and that the process can be important in most lakes, most of the time.

"We already knew that lakes are a source of carbon dioxide to the atmosphere, most of the time, but nobody had looked at whether lakes take up gaseous nitrogen from the atmosphere or release it," said Cotner, whose expertise is in biogeochemistry, and biological limnology and oceanography. "We were surprised that they so consistently released it."

Loeks-Johnson and Cotner are working to determine if lakes that receive high concentrations of nitrogen from the neighboring landscape—as would be the case in an agricultural setting—might release more nitrogen back to the atmosphere than other lakes. In addition, they are attempting to determine what fraction of nitrogen released to the atmosphere is as nitrous oxide, which is a greenhouse gas that is over 300 times more potent than carbon dioxide in terms of warming the Earth's atmosphere.

More information: Brianna M. Loeks-Johnson et al. Upper Midwest lakes are supersaturated with N2, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.1921689117

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