Warming climate spurs harmful oxygen loss in lakes

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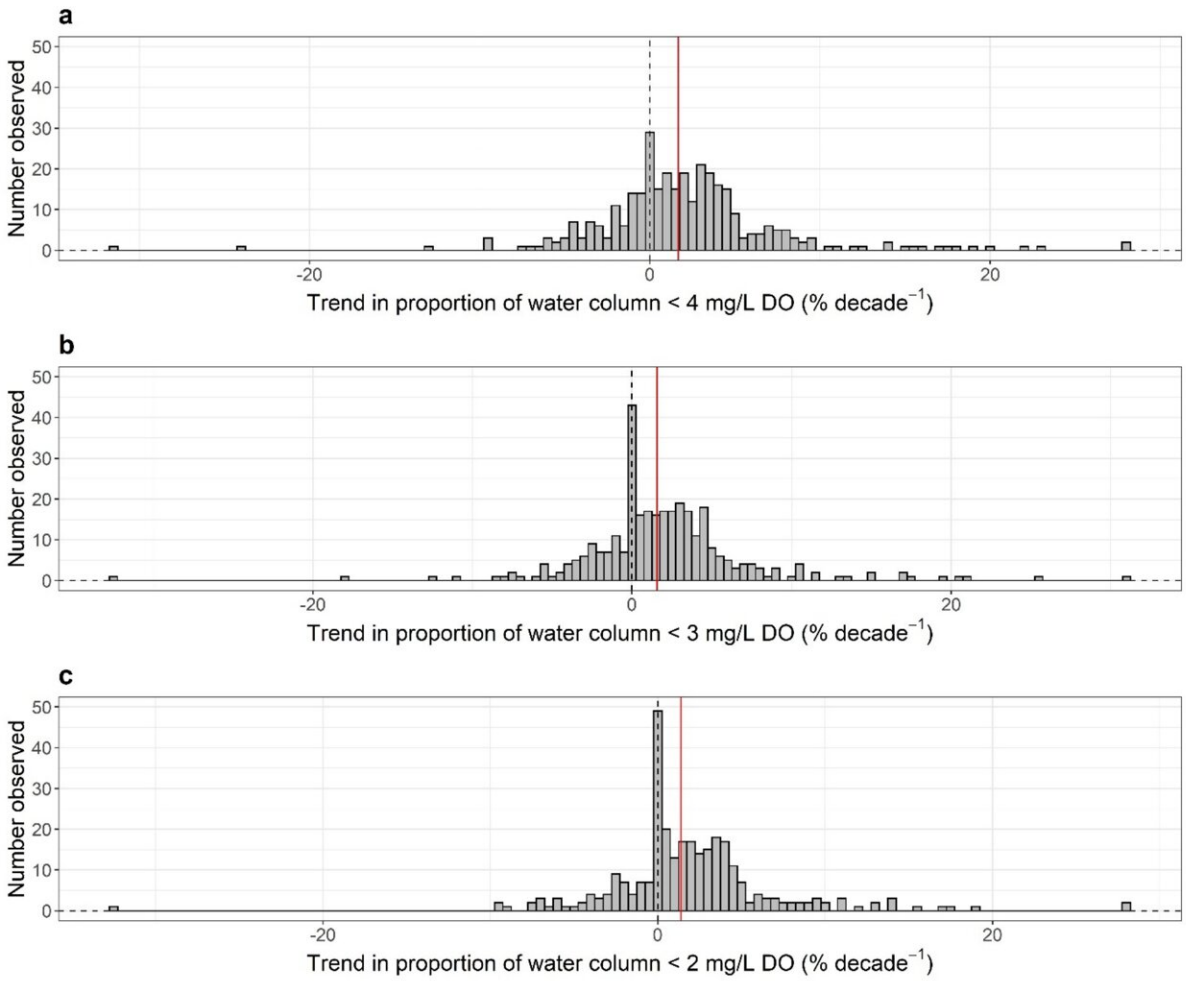

Trends in the proportion of the water column that is below a) 4 mg/L b) 3 mg/L and c) 2 mg/L during the summer period. Red line is the median trend. Credit: *Global Change Biology* (2022). DOI: 10.1111/gcb.16525

Rondaxe Lake in Herkimer County, New York, represents classic Adirondack Park waters. But over the last quarter-century, Rondaxe—like thousands of lakes in temperate zones around the world—has been losing a global-warming battle to maintain oxygen in its waters.

New research from Cornell University and Rensselaer Polytechnic Institute shows a continually warming world is leading to extended, late-summer weeks of water stratification, which prompts oxygen deprivation in the water—provoking conditions called hypoxia (low oxygen) and anoxia (no oxygen)—and negative consequences for fish and other species.

The work published Dec. 6 in the journal *Global Change Biology*.

"Lakes with dissolved oxygen losses strongly outnumber those with gains," said lead author Stephen Jane, a postdoctoral fellow at the Cornell Atkinson Center for Sustainability. "At large scales, aerobic organisms are losing available habitat as warming of lakes continues. This is particularly the case for organisms that rely on well-oxygenated cool waters deep in lakes to survive warm periods."

Jane and his colleagues examined about 25 years of data available for more than 400 lakes—mostly from the United States—to identify dissolved oxygen loss. In addition to Rondaxe Lake, the group studied New York's Neversink (Sullivan County) and Cannonsville (Delaware County) reservoirs, and Jockeybush and Sagamore lakes (Hamilton County).

In temperate climate lakes, the researchers found that the amount of low oxygen water is increasing by 0.9% to 1.7% per decade on average and found that the volume of lake water lacking oxygen has increased by more than 50% from three decades ago.

Reducing oxygen in lake water can have many effects. For example, anoxic portions of the water column might see a buildup of methane—a powerful greenhouse gas. Nutrients such as phosphorus from agricultural fertilizer, released from unsettled lake sediment, may enter the water column, which increases the likelihood of harmful algal blooms.

In a typical July or August, a lake surface may be about 70 degrees, while the lake bottom may be around 40 degrees. "Water temperature and density are related," Jane said. "So it becomes a situation where basically you have oil and vinegar, where strong water temperature differences between layers causes resistance to mixing—which is stratification."

The result is that oxygen from the atmosphere is prevented from replenishing dissolved oxygen in deep waters, Jane said. Because winter ends sooner than it did decades ago, seasonal stratification is starting earlier and ending later.

These stratification changes lead to more time for deoxygenation—the interruption of the natural oxygenation process—for deep-water habitats, he said.

"We show here that as warming is continuing, the amount of time that lakes exhibit stratification is increasing and this leads to increases in the amount of low-oxygen water in lakes," said co-author Kevin Rose, associate professor at Rensselaer Polytechnic Institute, Troy, New York. "The bad news is that given projected warming rates, we'll likely see even greater increases in the amount of oxygen-depleted water in lakes in the future."

More information: Stephen F. Jane et al, Longer duration of seasonal stratification contributes to widespread increases in lake hypoxia and anoxia, *Global Change Biology* (2022). DOI: 10.1111/gcb.16525

Provided by Cornell University