Northeastern lakes recovering from acid rain effects more rapidly

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Lakes in New England and the Adirondack Mountains are recovering from the effects of acid rain more rapidly now than they did in the 1980s and 1990s, according to a study led by a former University of Maine researcher.

Acid rain—which contains higher than normal amounts of nitric and sulfuric acid and is harmful to lakes, streams, fish, plants and trees—occurs when sulfur dioxide and nitrogen oxide in the atmosphere mix with water and oxygen.

In the United States, about two-thirds of sulfur dioxide and one-quarter of nitrogen oxide result from burning fossil fuels, including coal, says the U.S. Environmental Protection Agency.

Sulfate concentration in rain and snow dropped 40 percent in the 2000s and sulfate concentration in lakes in the Northeast declined at a greater rate from 2002 to 2010 than during the 1980s or 1990s, says Kristin Strock, a former doctoral student at UMaine, now an assistant professor at Dickinson College in Pennsylvania.

Also during the 2000s, nitrate concentration in rain and snow declined by more than 50 percent and its concentration in lakes also declined, Strock found.

The Clean Air Act enacted in the U.S. in 1970 has been modified several times, including amendments implemented in 1994 that regulated emissions, especially from coal-burning power plants. The Clean Air Interstate Rule issued in 2005 by the EPA sought to reduce sulfur dioxide and nitrogen oxides by 70 percent. Total emissions of sulfur and nitrogen in the U.S decreased by 51 and 43 percent, respectively, between 2000 and 2010, Strock says, which was twice the rate of decline for both in the 1990s.

Strock and the research team analyzed data collected since 1991 at 31 sites in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and southern New York and 43 sites in the Adirondack Mountains of New York.

The research team included Sarah Nelson, assistant research professor with the Senator George J. Mitchell Center and cooperating assistant research professor in Watershed Biogeochemistry in the UMaine School of Forest Resources; Jasmine Saros, associate director of the Climate Change Institute at UMaine and professor in UMaine's School of Biology & Ecology; Jeffrey Kahl, then-director of environmental and energy strategies at James Sewall Company; and William McDowell of the Department of Natural Resources and the Environment at the University of New Hampshire.

"Data collection for over two decades in this study is part of the EPA-LTM network, which also includes over 30 years of research and monitoring at 16 remote lakes in Maine, and over 25 years at the Bear Brook Watershed in Maine," Nelson says.

"These long-term monitoring data allow us to observe patterns like changes related to climate, as well as to evaluate the effectiveness of environmental regulations like the Clean Air Act. The new findings reported here underscore the importance of such long-term monitoring, which can often be difficult to keep funded."

While results reveal a recent acceleration in recovery, the researchers say continued observation is necessary due to variability of results. In New England, Strock says variability might be due to the effect of human development, including road salt, on lakes.

A number of other factors can affect watersheds and interact with acid rain, say the researchers, including depletion of calcium in forest soils, long-term increase in atmospheric carbon dioxide, long-term changes in air temperature, and changes in the frequency and intensity of extreme wet and dry seasons.

More information: "Decadal Trends Reveal Recent Acceleration in the Rate of Recovery from Acidification in the Northeastern U.S." Kristin E. Strock, et al. *Environ. Sci. Technol.*, 2014, 48 (9), pp 4681–4689. DOI: 10.1021/es404772n

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