Liming to Accelerate the Recovery of Acidified Ecosystems: A Case Study in the Adirondack Mountains of New York

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The acidity of wet deposition in the Adirondack region of New York has declined sharply over the past 20 years.

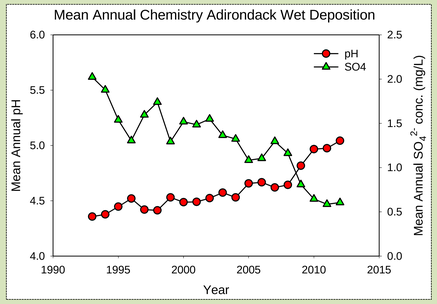


Figure 1 – Mean annual pH and SO_4^{2-} concentrations in wet deposition at three Adirondack National Trends Network sites, 1993 – 2012 (data from National Atmospheric Deposition Program; http://nadp.sws.uiuc.edu/).

The acidity of Adirondack lakes has also declined over the past 20 years, though the improvement in lake chemistry has been less than that of deposition. We hypothesize that recovery has been slowed by long-term losses of calcium from watershed soils that was accelerated by decades of acid deposition

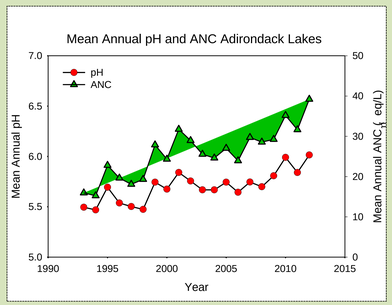


Figure 2 – Mean annual pH and ANC in 47 Adirondack lakes, 1993 – 2012 (data from Adirondack Lakes Survey Corporation; http://www.adirondacklakessurvey.org/).

Honnedaga Lake has a surface area of 312 ha., and is located in the southwestern Adirondack region of New York.

A heritage strain of brook trout resides in the lake, and a small population of these fish survived the worst period of acid rain in the 1970s and 80s.

Honnedaga Lake was acidic (pH<5) in the 1980s with high inorganic monomeric Al (Al_{IM}) concentrations, sufficient to be toxic to most fish species including the native brook trout. Since that time, pH has increased to >5.5, and Al_{IM} concentrations have declined sharply.

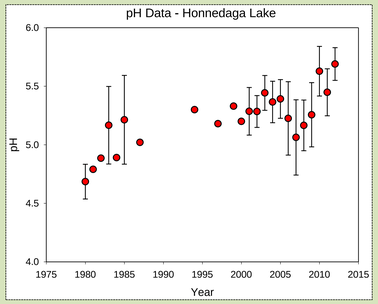


Figure 3a – Summer pH values in Honnedaga Lake, 1980 – 2012. Mean indicated by red symbol, and error bars represent standard deviation of the mean.

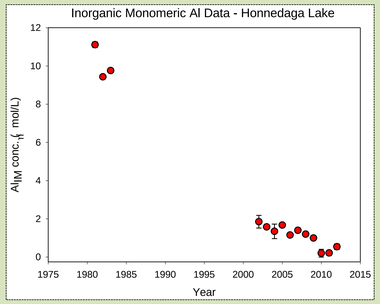


Figure 3b – Summer Al_{IM} concentrations in Honnedaga Lake, 1980 – 2012. Mean indicated by red symbol, and error bars represent standard deviation of the mean.

Despite the improvement in lake chemistry, most inlet tributaries remain acidic with high Al_{IM} concentrations.

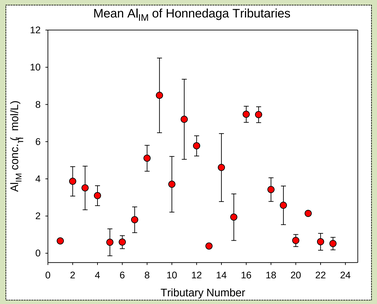


Figure 4a – Mean pH values of Honnedaga Lake inlet streams, 2008-2010.

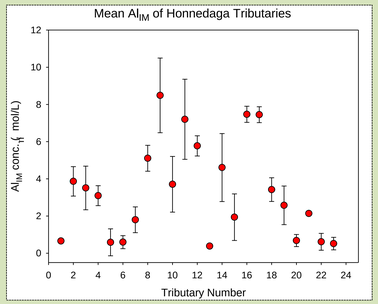


Figure 4b – Mean Al_{IM} concentrations of Honnedaga Lake inlet streams, 2010 - 2012

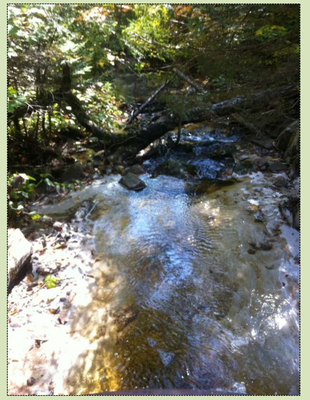
The Honnedaga Lake Liming Study

Objective: Test the efficacy of lime application to accelerate ecosystem recovery, which has been sluggish thus far, despite more than three decades of declines in the acidity of atmospheric deposition.

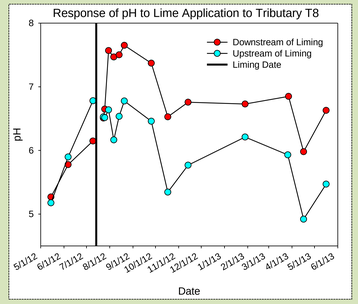
Approach: Two lime application methods are being explored in the current study –
(1) Direct application in two inlet tributaries to the lake (summer 2012 and 2013, spring 2014)
(2) Watershed application (fall 2013)

Data Collection: Measurements are occurring in the lake and in six stream watersheds, and include stream and lake chemistry, streamflow, soil and soil water chemistry, as well as assessments of fish, aquatic invertebrates, terrestrial vegetation, terrestrial invertebrates, and birds.

Stream after liming



After stream lime application, the pH of tributary T8 increased to >7 during summer 2012. The pH remained about one unit greater than upstream of liming for at least 11 months afterward.



A Possible Unintended Consequence: Will Liming Accelerate Mercury Bioaccumulation?

The Adirondack region is considered a "hot spot" where high levels of mercury (Hg) bioaccumulation have been measured in fish and birds. Much of this Hg originates from human activities such as coal burning, and is deposited from the atmosphere to ecosystems where it may be converted to the toxic methyl form and bio-magnified in aquatic and terrestrial food webs. The transport of Hg in the environment is associated with dissolved organic carbon (DOC), which binds Hg and may facilitate uptake into living cells. Application of lime to streams and watersheds will likely increase dissolved organic carbon (DOC), which may enhance the movement and uptake of Hg. As part of this study, we are quantifying Hg bioaccumulation associated with the lime applications in the Honnedaga Lake watershed.

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