PROJECT UPDATE

September 2006

New York State Energy Research and Development Authority

Environmental Monitoring, Evaluation, and Protection Program

Changes in Stream Chemistry and Aquatic Biota in Response to the Decreased Acidity of Atmospheric Deposition in the Neversink River Basin, Catskill Mountains, New York, 1987 to 2003

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Project Location

Catskill region outlined

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Keywords

- Acid deposition
- Acid neutralizing capacity (ANC)
- Indicator species
- Macroinvertebrates
- Periphyton

PROJECT FOCUS

This project returned in 2003 to a set of sites in the Neversink River, located in the Catskill Mountains, that were sampled in 1987 to examine changes in stream chemistry and biota in relation to recorded declines in the acidity of precipitation. The study's objective is to determine whether spatial patterns in species composition of aquatic macroinvertebrates, fish, and periphyton (algae) have changed as a function of surface water chemistry. Additionally, two stream reaches in zones of sharp pH transitions were sampled in order to clarify the relationship between biota and pH, acid neutralizing capacity (ANC), and aluminum concentrations in light of improvements in precipitation acidity.

CONTEXT

Fossil-fuel combustion sources are major emitters of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), precursors of the nitric and sulfuric acids that, through deposition, contribute to the acidification of lakes and streams. Several chemical criteria indicate conditions that pose a danger to aquatic biota. Biota are at risk from surface water acidification when surface water pH is less than 6.0, ANC is less than 50 µeq/L, or concentrations of toxic inorganic aluminum are greater than 2 µmol/L. These criteria are "biologically relevant indicators," the first level of data necessary for understanding and restoring aquatic ecosystem structure and function.

The Catskill Mountains of southeastern New York State (NYS) not only receive levels of acidic deposition that are among the highest in the U.S., but also are particularly susceptible to acidification owing to their geological and soil characteristics. As a result, the region contains numerous streams with low ANC. The Neversink River is the most acid-sensitive watershed in the Catskills region, and among the most sensitive in NYS. Numerous tributaries of this river and upper reaches of its East and West Branches have base-flow pH < 5.2 and ANC < 0 µeq/L. These acidic conditions and related high aluminum concentrations have affected fish populations in the watershed.

East Branch of the Neversink River – Kelly's Ledge

METHODOLOGY

At fifteen sites sampled on 16-18 September 2003, a stream reach of about 50 meters in length was defined. Four types of data were collected:

- Surface water chemistry
- Fish (species, weight, and length)
- Aquatic macroinvertebrates; and
- Periphyton gathered from all available habitats

Eleven of the sites sampled were the same as those sampled in 1987; four additional reaches were added at zones of sharp pH transitions or to fill in pH gaps from the earlier sample collection. An attempt was made to sample in 2003 at similar flow conditions to those of 1987, but 2003 was a much wetter summer than 1987. Therefore, the 2003 samples had to be collected at higher flow conditions than those of 1987.

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Robert Bode and Margaret Novak of the NYS DEC collecting a kick sample of stream macroinvertebrates on the East Branch Neversink River.
Photograph by: Karen Murray

Mayfly larvae are particularly sensitive to stream acidity.

Project Status

- Initiated 2003
- Completed 2006

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Since 1975, the New York State Energy Research and Development Authority (NYSERDA) has developed and implemented innovative products and processes to enhance the State's energy efficiency, economic growth, and environmental protection. One of NYSERDA's key efforts, the Environmental Monitoring, Evaluation, Protection (EMEP) Program, supports energy-related environmental research. The EMEP Program is funded by a System Benefits Charge (SBC) collected by the State's investor-owned utilities. NYSERDA administers the SBC program under an agreement with the Public Service Commission.

Stream chemistry and an acid-status index developed from macroinvertebrate data were compared through statistical tests. Changes in fish species habitat were evaluated qualitatively. An acid-status index was also developed from the 2003 diatom data, but the 1987 dataset was only qualitative, so statistical comparisons were not made between the 1987 and 2003 data.

In addition to the comparisons made between 1987 and 2003 data from samples collected during this study, trends in precipitation and stream chemistry were evaluated using Seasonal Kendall tests. The National Atmospheric Deposition Program site at Biscuit Brook was evaluated for precipitation chemistry trends during 1987 – 2003. Three stream sites in the Neversink River basin were evaluated for trends in stream chemistry during 1987 – 2003.

Karen Murray and Douglas Burns of the U.S. Geological Survey electroshocking a reach of the West Branch Neversink River to assess fish species diversity in September 2003.
Photograph by: Robert Bode

FINDINGS

Trends in precipitation and stream chemistry showed increases at all four continuous monitoring sites of +0.01 units/yr. Despite these trends, neither stream chemistry nor the macroinvertebrate acid-status index showed a significant difference between the 1987 and 2003 data. The higher flow conditions in 2003 likely resulted in more acidic conditions than would typically be found during summer low flow. Therefore, flow undoubtedly affected the 1987 – 2003 stream chemistry comparisons, and may have affected stream macroinvertebrate communities as well. Despite the higher flow in 2003 than 1987, the four most upstream and most acidic sites showed a statistically significant improvement in the acid-status invertebrate index that is consistent with the long-term decreases in acidity in the river. Additionally, adult brook trout were present at the most acidic stream site in 2003 but not previously in 1987 suggesting that brook trout may be expanding their habitat into areas that were previously too acidic to support them. Slimy sculpin, a species that is more sensitive to stream acidity than brook trout, showed no change in habitat over the 16-year sampling interval.

Overall, the changes through 2003 have been subtle, equivalent to an increased pH of about 0.2 during 1987 to 2003 at trend sites. This change in pH has not been great enough to result in large-scale changes in the biological communities, however, these data support early signs of improvement at the most acidic upstream reaches sampled.

PROJECT IMPLICATIONS

Emissions of SO_2 (and to a lesser extent NO_x) have decreased in the past two decades in response to implementation of the 1990 Clean Air Act Amendments, resulting in a decrease in the acidity of precipitation over this period. Widespread and large-scale recovery of affected stream biological communities was not evident in 2003 in the Neversink River. However, these data suggest small increases in stream pH during 1987 to 2003 and a small amount of improvement in stream macroinvertebrate communities in headwater stream reaches. This small emerging improvement in stream chemistry and biology may eventually result in greater magnitude recovery of affected streams. These data indicate that greater improvement in stream acidity will be necessary before large-magnitude improvement in macroinvertebrates and fish will be clearly evident in the Catskills.

East Branch of the Neversink River, above New Road Hill bridge.

Continued monitoring and study of the relation between emissions reductions and the rate of chemical and biological recovery will be critical in the process of evaluating the effects of current clean air policies and choosing optimal future cost-effective air pollution control measures. The data from this project provides a snapshot of improvement from 1987 to 2003. These 2003 data will also provide a benchmark against which future change in stream biological communities can be documented.