Assessing Long-Term Monitoring Programs for Sulfur, Nitrogen, and Mercury Deposition and Impacts in New York State

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Introduction

Air pollutants such as nitrogen oxides, sulfur dioxide, and mercury have had significant impacts on the quality of precipitation, lakes, rivers, soils, biota, and tree health throughout the Northeastern US. Some areas of New York State are particularly susceptible to environmental degradation, such as the Adirondack and Catskill regions, which receive some of the highest rates of acid and mercury deposition in the country. Long-term monitoring efforts have produced data sets that have been extremely valuable for evaluating changes over time in air pollution loads and effects on the environment.

It is important to evaluate long-term monitoring programs to ensure that these programs remain efficient and effective. To our knowledge, a comprehensive evaluation of state-wide long-term monitoring of acid and mercury deposition has never been undertaken in New York State. We are working with stakeholders to inventory long-term monitoring efforts in New York State, including monitoring of wet deposition, lakes, streams, soils, vegetation, and biota. These monitoring efforts include projects implemented by a variety of federal and state agencies, private non-profit organizations, and academic institutions. Additionally, we are working to identify key science and policy questions to which the findings from long-term monitoring efforts can be applied. This project will be completed in August 2012.

Research Questions

This project will evaluate monitoring efforts used to inform both science and policy in New York. The major questions we will be addressing in this assessment include:

Science-based questions:

1. *Describing trends*: Have levels of pollutants or variables affected by levels of pollutants been increasing or decreasing over time? How much information is needed to detect a change?
2. *Describing uncertainty:* What confidence is provided by current monitoring programs? Are there major gaps or redundancies in coverage?

Policy-based questions:

1. *Describing trends*: Are we meeting the goals of specific legislation (e.g. Cross-State Air Pollution Rule, MATS, CAAA of 1990, NOx Budget Program)? Do we have the information necessary to evaluate whether policies are effective?
2. *Describing uncertainty*: What level of confidence is required to make policy decisions?

Atmospheric Deposition

Atmospheric concentrations and deposition of S and N are intensively monitored in New York state. Atmospheric deposition is monitored by a variety of agencies and organizations throughout New York (Fig.1). Monitoring stations are located relatively evenly around the state, however, it is important to consider elevation and other landscape features when assessing the coverage of these monitoring sites. We plan to use wet deposition data available through NYSDEC, EPA CASTNet, and NADP to describe state-wide trends and to look at uncertainty in measurements at similar sites around the state.

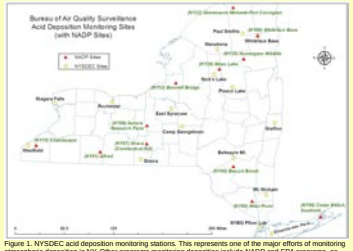

Figure 1. NYSDEC acid deposition monitoring stations. This represents one of the major efforts of monitoring atmospheric deposition in NY. Other programs monitoring deposition include NADP and EPA programs, as well as monitoring stations run by academic and research institutes, for example SUNY Albany, the Cary Institute, and the ALSC. (*Figure courtesy of NYSDEC.*)

Lakes

Rates and effects of deposition on lakes in the Adirondacks have been monitored extensively for many years by several programs. The EPA funds the Temporally Integrated Monitoring of Ecosystems (TIME) and theLong Term Monitoring (LTM) projects (Fig. 1), which are conducted in collaboration with the Adirondack Lake Survey Corporation (ALSC). Additional monitoring is conducted by the Adirondack Effects Assessment Program (AEAP) at RPI and by researchers associated with other academic institutions. In this project, we will utilize these rich data sets to address possible alternative sampling schemes that may be used in the future.

Figure 2. Map of lakes monitored by the EPA TIME and ALTM program. These data are available online to the public.

Streams

Streams are important indicators of terrestrial ecosystem health. In this project, we are considering both abiotic variables such as solute concentrations, as well as biotic indicators where available. Using long-term records, such as for USGS sites like Biscuit Brook in the Catskills and Buck Creek in the Adirondacks, it is possible to simulate alternate sampling schemes to assess how much information is lost when sampling efforts are reduced (Figs. 3 and 4). If researchers are comfortable with higher uncertainty in trends, it may be preferable to redirect sampling effort and cost to expand stream monitoring to additional sites.

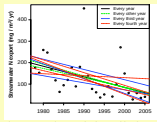

Figure 3. Annual export of N from Hubbard Brook W6 (black circles) and regressions based on all years or subsamples of all years.

Figure 4. Uncertainty in the slope of stream N export over time for various sampling intensities.

Soils and Vegetation

Soils are notoriously difficult to survey due to their spatial heterogeneity. Because of this heterogeneity, it can be difficult to detect changes in soils over time. There have been some resampling efforts in the Adirondacks that have been used to assess change over time in soils. A large effort to monitor deposition effects on soils is currently being coordinated by the Northeastern Soil Monitoring Cooperative (NSMC) with participating sites in New York state. Vegetation resampling is conducted regularly throughout New York State by the USDA Forest Inventory and Analysis (FIA). Recently, the FIA Forest Health Monitoring program has begun to also include soils data.

Figure 5. Map of New York showing forested areas >2 hectares.

Animals

Mercury and acid deposition have had severe impacts on biota. It has been known for many years that methylHg bioaccumulates in terrestrial and aquatic biota, resulting in death and disease in fish and birds. Additionally, there are important human health implications when fish in these areas are consumed by people. Increases in acidity in lakes has impacted fish communities in the Adirondacks and elsewhere. We hope to use available data to determine whether current monitoring programs are adequate for assessing both the ecological and health-related impacts of deposition on biota. Although we are starting to see chemical recovery of S and N, it is important to have monitoring efforts in place to determine if we are seeing biological recovery as well.

Photo Credit: S. Boljkac

Figure 6. Common loons (*Gavia immer*) accumulate high levels of methylmercury in the Northeastern US. They are particularly susceptible due to their position at the top of the food chain.

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