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Annual Report to

USGS WRD WRRI, Reston, VA and US EPA, Corvallis OR

May, 2008

Determining the effectiveness of the Clean Air Act and Amendments on the recovery of surface waters in the northeastern US

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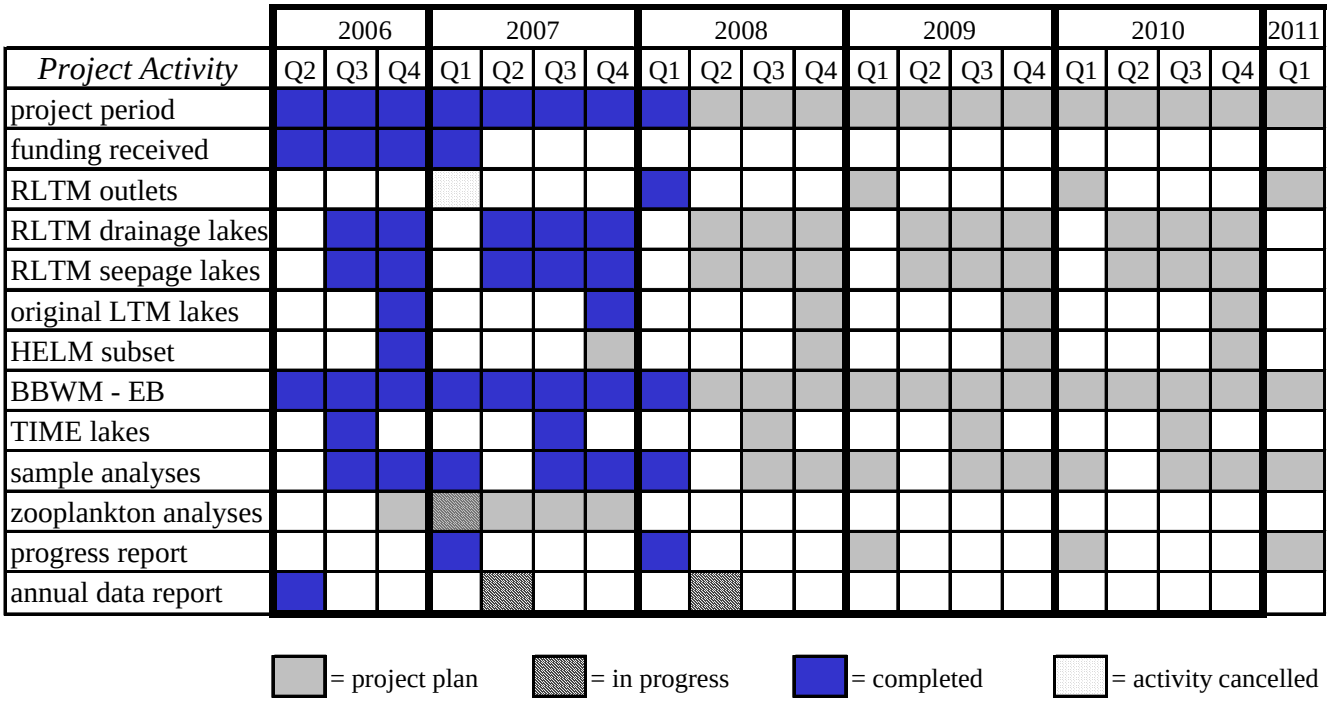
Overview of activities this period

A schematic summary of progress on the project plan is provided below and discussed on the following pages.



Project overview

Objectives. This proposed research is part of the EPA program to collect long-term data on the trends and patterns of response in surface waters sensitive to acidic deposition. The goals and methods are hierarchical from intensive site-specific to regional statistical populations. The objectives are to:

1) document the changes and patterns in aquatic chemistry for defined sub-populations and sites that are known to be susceptible to acidification or recovery;
2) evaluate linkages in changes in surface waters, if any, to changes in deposition that are related to regulatory goals;
3) characterize the effectiveness of the Clean Air Act Amendments in meeting goals of reducing acidification of surface waters and improving biologically-relevant chemistry in the northeastern US; and
4) provide information for assessment of the need for future reductions in atmospheric deposition based on the rate of recovery (or not) of the systems under study.

In 2008, we will also evaluate changes in biological condition using zooplankton collected in 2004 from 145 ELS-II lakes in the northeast, as part of our 20th anniversary re-analysis of the Eastern Lake Survey.

Approach. The schedule of tasks ranges from weekly to annual, continuing data records that now range from 12 to 22 years. We will evaluate chemistry on a weekly basis year-round at the small watershed-scale at BBWM, weekly during the spring melt period at LTM lake outlets, quarterly in LTM, and during an annual index period for the HELM and TIME lakes. These project components provide a *statistical framework* for inferring regional chemical patterns using TIME and LTM (and ELS-II under separate funding). The *long-term records* of LTM, HELM and BBWM provide information on seasonal and annual variability , and provide a seasonal context for the annual surveys.

Expected Results. This information is fundamental for EPA to meet the Congressional mandate for reporting on the effectiveness of the Clean Air Act Amendments (CAAA). The highly effective combination of site-specific data within the regional context will provide for the recognition and understanding of declining SO_4, base cation depletion, and changes in N-saturation or DOC contributions to acid-base status. The results are also central to the decisions on additional emission reductions that may be needed to produce recovery.

Project Status

Field sampling. All project field objectives in the summer and fall of 2007 and early 2008 were accomplished as planned. Sample collection and analysis has continued despite delays in obtaining finding each year. Spring sampling of drainage lake outlets was prioritized for spring 2008 due to near-record snowpack in the region. However, lack of rainfall during snowmelt limited the excursions in magnitude of runoff. No evidence of major acidification events is expected in the data.

Analytical. Analyses are complete for all samples collected through the spring 2008, except for a few aluminum samples. The PSU laboratory now has an operational AAS HGA instrument for

analysis of Al. Periodic inter-laboratory comparisons, and audit comparisons, continue between PSU, UNH, and UMaine.

Samples from East Bear Brook at BBWM, which are collected on a regular basis year around, are being analyzed in a contract laboratory at UMaine.

Zooplankton analyses. Zooplankton samples from 2004 have been counted (to genus level for cladocerans and groups for copepods) and images taken for body size spectra. Zooplankton samples collected in 1986 have been archived. We have taken images for body size spectra on about 1/3 of the lakes and plan to finish up the remaining samples in June. An Access database that includes all zooplankton samples, queries for body size and abundance metrics, and associated lake morphometry and water chemistry data has been built. The 2004 samples have been sent to Dr. Jim Haney's lab at UNH; the 1986 samples will be transferred shortly. Haney is replacing former collaborator Rich Stemberger, who passed away in late 2007. His lab will examine species composition of the cladoceran community in the two years during the summer of 2008. The EPA lab in Chelmsford has made arrangements for a permanent archiving of the zooplankton samples at Yale University.

Data reporting. All data collected through 2005 have been delivered to EPA. The next delivery of data to EPA is expected in June 2008, after evaluation of inter-laboratory comparisons and regular QA analyses by PSU and UMaine.

Presentation of findings. Several publications and presentations have resulted from this project since the final report for the previous LTM/TIME grant, listed at the end of this report. The next paper in preparation is a 20 year mass-balance analysis for the second book to be published from the Bear Brook Watershed in Maine. We published a paper on Maine high elevation lakes in Lakeline (Baumann and Kahl, 2007). These results will be incorporated in Baumann's MS thesis to be completed in late 2008. The regional scope of the thesis expands the analyses for this project to Maine and NH high elevation lakes.

Funding status: We have requested funding for field season 2008, and are in fiscal limbo until the funding arrives. Fortunately, the institutions allow us to continue operations despite not having new money, and technically not being able to spend existing money.

New developments: Co-PI Webster is leaving UMaine, and will continue her role as a science advisor and author as a Research Professor at Plymouth State University. Dr. Sarah Nelson of the Mitchell Center at UMaine has assumed the co-PI role in Maine. PI Kahl and Nelson will now oversee the field work.

Two Maine LTM ponds have recently been protected by conservation efforts. The New England Forestry Foundation acquired the entire watershed of Second Pond in Dedham. Kahl spoke at a 2007 fundraiser for the purchase. The Forest Society of Maine acquired the entire watershed of Partridge Pond in a 5,000 acre purchase. Kahl contributed to the funding proposal for the effort.

Recent publications and presentations *using related project information*
(new listings since the last report are in **bold)**

Baumann, A.J. and J.S. Kahl, 2007. Chemical trends in Maine High Elevation Lakes. LakeLine 27:30-34.

Campbell, J, J. Hornbeck, M. Mitchell, M. Adams, M. Castro, C. Driscoll, J.S. Kahl, and others, 2004. Input-output budgets for inorganic nitrogen for 24 watersheds in the northeastern United States. Water Air Soil Pollut., 151:373-396.

Dupont, J., T. Clair, C. Gagnon, D. Jeffries, J.S. Kahl, S. Nelson, and J Peckenham, 2005. Estimation of critical loads of acidity in the northeastern US and eastern Canada. Environ. Monit. Assess. 109:275-291.

Hunt, K., J.S. Kahl, J. Rubin, and D. Mageean, 2007. Assessing the science-based needs of stakeholders; a case study on acid rain research and policy. Journal of Contemporary Water Research and Education, 136: 68-79.

Kahl, J.S., J. Stoddard, R. Haeuber, S. Paulsen, R. Birnbaum, F. Deviney, D. DeWalle, C. Driscoll, A. Herlihy, J. Kellogg, P. Murdoch, K. Roy, W. Sharpe, S. Urquhart, R. Webb, and K. Webster, 2004. Response of surface water chemistry to changes in acidic deposition: implications for future amendments to Clean Air Act. Environmental Science and Technology, Feature Article 38:484A-490A.

Lawler, J., J. Rubin, B.J. Cosby, I. Fernandez, J.S. Kahl, S. Norton, 2005. Predicting recovery from acidic deposition: Applying a modified TAF (Tracking Analysis Framework) Model to Maine' High Elevation Lakes, Water Air Soil Pollut. 164:383-389.

Norton, S., I. Fernandez, J.S. Kahl, and R. Reinhardt, 2004. Acidification trends and the evolution of neutralization mechanisms through time at the Bear Brook Watershed, Maine, USA. Water, Air, Soil, Pollution Focus 4:289-310.

Rosfjord, C., K. Webster, J.S. Kahl, S.A. Norton, I. Fernandez, and A. Herlihy, 2007. Anthropogenically-driven changes in chloride complicate interpretation of base cation trends in lakes recovering from acidic deposition. Environ Sci Technol, 41:7688 -7693.

Rosfjord, C., J.S. Kahl, K. Webster, S. Nelson, I. Fernandez, L. Rustad, and R. Stemberger, 2006. Acidic deposition-relevant changes in lake chemistry in the EPA Eastern Lake Survey, 1984-2004. Final report to USDA NSRC, Durham, NH. 69 p.

Recent presentations using project information

Kahl, J.S., 2008 (invited). Twenty year changes in spatial patterns of Cl distribution in the northeastern US. NH Water Conference, April, 2008)

Kahl, J.S., 2007 (invited). Using societal-based incentives to address new threats to New England Lakes. Day-long short course in New England Lake Science Academy, Camp Kieve, Maine. July, 2007.

Kahl, J.S. 2006 (invited). Acid rain in New England: using high elevation lakes as sentinels of change. Maine Mountain Conference, October 21, 2006. Rangeley, Maine

Kahl, J.S., *et al*., 2006 (invited). The design of a national mercury monitoring network: Learning from the EPA acid rain experience. The Eighth International Mercury Conference, Madison WI, August 8, 2006.

Kahl, J.S. *et al*., 2006. Obfuscation of trends in base cations by regional salt contamination. Hubbard Brook Committee of Scientists annual meeting, July 12, 2006.

Kahl, J.S., 2006 (invited). 'Natural and human-derived sources of acidity in Maine Atlantic Salmon Rivers'. Atlantic Salmon Commission workshop on acidity, Bangor ME. April 10, 2006.

Kahl, J.S., 2005 (invited). The intersection of environmental science and environmental policy. NH Charitable Foundation Lakes Region annual meeting, Meredith, NH, September, 2005.

Kahl, J.S., 2005 (invited). Tracking response and recovery in surface waters in the northeastern US. Annual meeting of the Ecological Society of America, Montreal, August, 2005.

Kahl, J.S., and Catherine Rosfjord, 2005 (invited). Acid rain and the Clean Air Act in the northeastern US. Annual meeting of the NH-ME Androscoggin River Watershed Council, Bethel, June, 2005

Kahl, J.S., 2005 (invited). Developing a lake research agenda for NH. NSF workshop on lake research infrastructure in the northeast, Colby Sawyer College, April 2005.

Kahl, J.S., S. Nelson, and A. Grygo, 2004. Surface water chemistry data for the northeastern US for interpreting climate and acid rain trends. Northeast Ecosystems Research Consortium meeting, Durham, NH, October, 2004.

Kahl, J.S., K. Webster, M. Diehl, and C. Rosfjord, 2004. Successes of the Clean Air Act Amendments of 1990. Maine Water Conference invited plenary talk, Augusta, ME, 2004.

Kahl, J.S. and K. Johnson, 2004. Acid-Base Chemistry and Historical Trends in Downeast Salmon Rivers. Maine Water Conference, Augusta ME, April 2004.

Kahl, J.S., 2004 (invited). The Clean Air Act Amendments of 1990; testing a program designed to evaluate environmental policy. Lecture, Colby College. April, 2004