Report as of FY2004 for 2004ME27B: " Evaluating scope and trends for decreasing base cations (and increasing diluteness)"

Publications

- Other Publications:
  - Rosfjord, C., J.S. Kahl, K. Webster, C. Loftin, S. Nelson, 2004. Poster: A 20-Year Re-evaluation of Trends in a Statistical Population of Lakes in the Northeastern U.S. Maine Water Conference, Augusta, ME, April 2004.
- Dissertations:
  - Rosfjord, C. 2005. An Evaluation of 20 Year Changes in Chemistry in the EPA Eastern Lake Survey, a Statistical Population of Lakes in the Northeastern U.S. M.S. Thesis. University of Maine
- unclassified:
  - Rosfjord, C., J.S. Kahl, K. Webster, C. Loftin, S. Nelson, 2004. Poster: A 20-Year Re-evaluation of Trends in a Statistical Population of Lakes in the Northeastern U.S. Graduate Student Expo, University of Maine, Orono, ME, April 2004.

Report Follows

Critical regional water problem:
This proposed research addresses key questions that remain unanswered regarding the major freshwater resource issue of acid deposition and the ensuing changes in surface water chemistry. The 1990 Clean Air Act addressed the issue of acid deposition by mandating reductions in sulfate emissions. Over the past two decades, sulfate emissions have been reduced, and deposition of the anion in surface waters has decreased significantly. However, the expected rebound in pH following the decrease in acid deposition has not occurred. For many lakes in New England, a further increase in pH is necessary to support the full potential of aquatic biota.

The decline in base cation concentrations in surface waters of the northeast has been offered as an explanation for the lack of 'recovery' from acid rain. One of the universal responses of low acid neutralizing capacity (ANC) watersheds to acid deposition is the mobilization of base cations from soils (e.g. Galloway *et al.*, 1983). As rates of acidic deposition decline, the rates of cation mobilization are also expected to decrease, thereby slowing recovery from acid deposition.

Declines I base cations have been inferred from long-term monitoring of low ANC lakes and streams over thepast two decades (Stoddard *et al.* 1999;2003). Our research complements and broadens this monitoring by assessing the possible changes in base cations in high ANC lakes as well as low ANC. The observation of a widespread decline in base cations in the high ANC lakes of our study lakes would indicate similar processes of mobilization in both high and low ANC watersheds. Conversely, if base cation concentrations have *not* decreased in high ANC waters, it would indicate that the less sensitive watersheds have been buffered from acid rain and recovery will ensue at a faster rate.

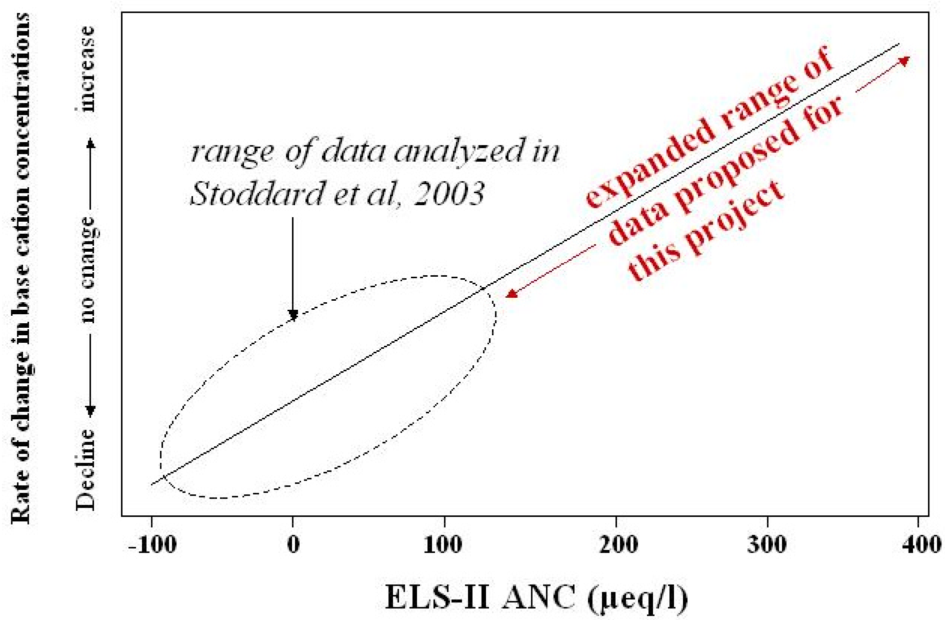
Statement of Results and Benefits:
This research is important to our interpretation of the responses of surface waters to past and future changes in atmospheric deposition. While the process of acidification has been observed and documented, it is now important to assess the reverse process of de-acidification and recovery. This study will shed light on the recovery processes in different types of watersheds, both sensitive and well buffered. It also provides information to interpret changes in zooplankton community structure over the past 18 years, funded through a separate funding source, which will provide further evidence to the biological recovery of lakes. This information is the bottom-line for the Clean Air Act: *has biological condition improved as a result of our investment in reduced sulfur emissions?* This study will allow policy makers to create protocol necessary to ensure recovery in regions with varying degrees of acid neutralizing capacity.

In addition, the responses in surface waters are key indicators for our interpretation of processes in forest soils. A widespread decline in base cations may indicate widespread cation depletion in forest soils, perhaps as a result of leaching by acidic deposition. This conclusion would have negative implications for forest health. Alternatively, the modest decline in precipitation acidity may be allowing soils to retain cations as ion-exchange sites are replenished. This conclusion would represent a recovery mode, which would be positive for forest health. There are other possibilities, such as increased forest growth due to climatic warming or fertilization from atmospheric deposition of CO_2 and N, that would lead to increased uptake of cations by forests (and thus declines in surface waters). These data will provide, via a statistical sub-population of lakes, significant new understanding of the scope, magnitude, and trends in base cations in surface waters of the Northeast.

Introduction:
One of the universal responses of surface waters in the past 10 to 15 years is a quantitatively important decline in base cations. This decline in base cations accompanies a ubiquitous decline in sulfate. As a result, pH and alkalinity in many northeastern waters have not recovered to the extent expected from reductions in sulfate. Some waters have acidified in the past decade, despite the decline in sulfate. Alkalinity and nitrate have also declined in many waters. The net result is an increasingly dilute nature for the investigated lakes.

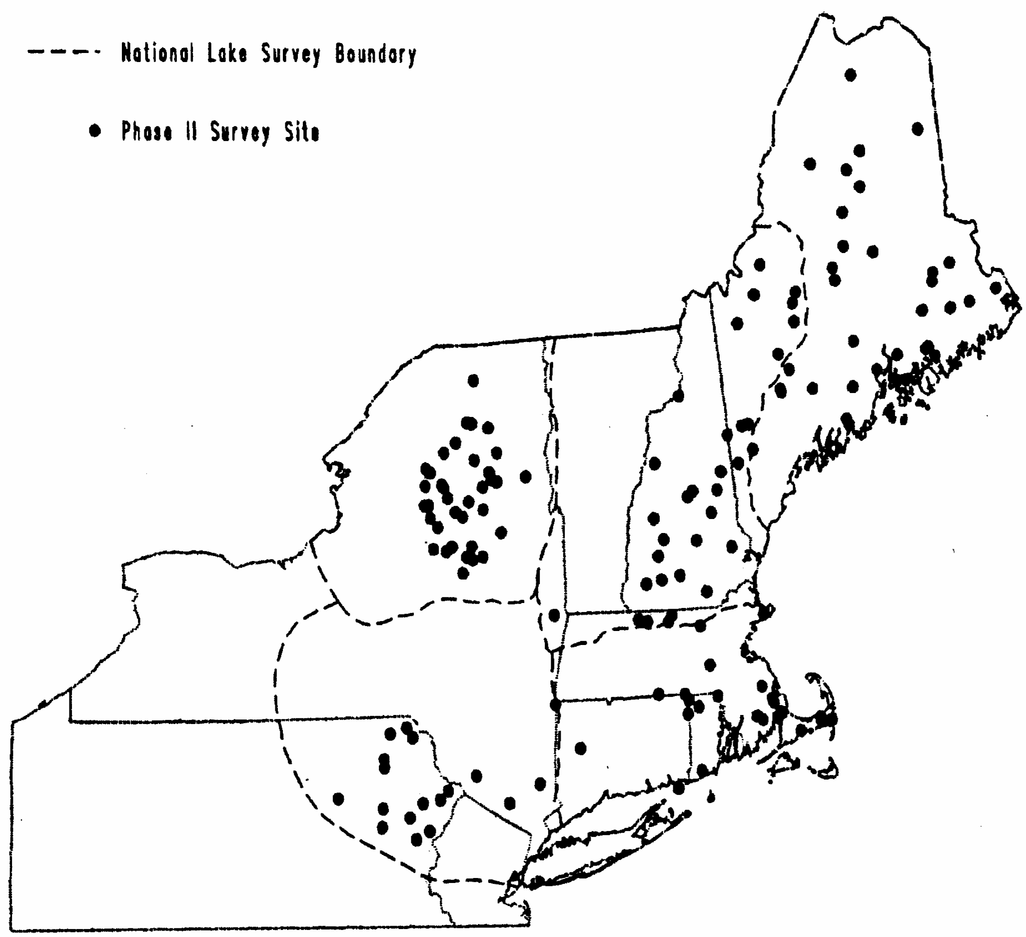
This re-sampling will provide information about the magnitude of base cation declines in both low and high alkalinity lakes. Where previous investigations have focused on low ANC waters of poorly buffered watersheds, this research will examine changes in base cations in higher ANC waters as well (Figure 1). This wider scope will provide important evidence in determining the cause of increased diluteness in surface waters.

Figure 1. Conceptual model of declining base cations in surface waters of the northeast



The cause of B_c decline has been attributed to factors ranging from increased nutrient cation uptake by aggrading forests, soil B_c depletion due to leaching from acid rain, B_c retention on soil exchange sites due to the decline in acid rain, and a decline in base cations in atmospheric deposition. We propose to evaluate the extent of base cation depletion over the past 20 years by re-sampling 145 lakes in the northeast. (See Figure 1)

<u>Figure 2:</u> Location and distribution of original 145 ELS-II lakes to be re-sampled for proposed research.



http://www.epa.gov/emap/html/dataI/surfwatr/data/napap/els.

Objectives:
The proposed joint USGS (proposed) and USDA (funded) research offers an unparalleled opportunity to provide a statistical assessment of change in surface water chemistry over the past 20 years. This is an opportune moment to conduct this assessment because of the major EPA assessment just completed (Stoddard et al., 2003) and the upcoming federal debate over future re-authorizations of the Clean Air Act. We will:

- Develop an empirical model for the change in base cation concentrations during the past 20 years as a function of alkalinity (or sum of base cations) as reported in 1984. We will determine if the decline in base cations is unique to small upland watersheds with poorly buffered waters, or if the decline is more widespread.
- Evaluate the changes over 20 years against model projections, using actual changes in deposition and water chemistry since the 1980s. The data will provide

information useable for evaluating several watershed geochemical models. Our results will be widely shared among the research community for this and other purposes.

This framework of this project will support two additional value-added components funded by other sources: EPA is funding an assessment of the biological trends in the same 145 lakes via a re-sampling of zooplankton populations that were originally sampled in ELS-II lakes. An acknowledged shortcoming of the Stoddard *et al* assessment was that no biological trend conclusions were possible due to lack of historical data and little collection of biological data for the LTM (Long-Term Monitoring) and TIME (Temporally Integrated Monitoring of Ecosystems) sites. A second supplemental will be a survey of mercury in these lakes, again funded by EPA. This will provide the first regional statistical assessment of mercury in lakes.

Project Timeline:

The central activity of the re-sampling of the 145 lakes will be between July 23rd and August 11th, 2004.

Timelines for two year project period (FY04 and FY05)	**2003 Q4**	**2004 Q1**	**Q2**	**Q3**	**Q4**	**2005 Q1**	**Q2**	**Q3**
Planning, preparation, site location	■	■	■					
Lake sampling (July-Aug 2004)				■				
Annual progress reports					■			
Sample analysis and quality assurance				■	■			
Data analysis and synthesis by team					■	■	■	
Participation at NERC meetings					■			■
Peer-review papers and thesis submitted						■	■	■
Final Report submitted								■

Impact of Project:

Responses and trends in surface waters are key indicators for our interpretation of processes in forest soils. A widespread decline in base cations in *both low and high* ANC lakes could be the result of: 1) a modest decline in precipitation acidity reducing the rate of soil base cation leaching, thus exporting fewer into the surface waters; 2) aggradation of forests due to climatic warming and nitrogen fertilization from deposition, resulting in increased uptake of base cations by vegetation; or 3) a decrease in acidic deposition accompanied by a decrease in deposition of base cations. Conversely, if our hypothesis proves to be correct that base cation concentrations have *not* decreased in high ANC waters as they have in low ANC waters (Stoddard, *et al.*, 2003), this would indicate that base cations in high ANC regions are able to return to pre-acidified levels, while leaching of low ANC soils has depleted the soils of base cations.

All of these possible causes relate to the health of forests and surface waters, and are thus issues of interest to the NSRC/NERC group. The data will include complete ion chemistry and will be widely useful as baseline data for evaluation of trends and changes

in ecosystems of the region. The most relevant conclusions are expected to be on 20 year changes in base cations and nitrogen in lakes from the region spanning Pennsylvania to Maine (Figure 2), with ANC up to 400 µeq/L.
There are scientific and policy implications for this project. The scientific impact will include an understanding of trends in major ion chemistry in a statistical population of lakes in the northeast, as well as new understanding of trends in cations and nutrients in a population of lakes with a broader range of chemistry than previously available. These results will contribute substantially to our understanding of watershed processes in the northeast as the deposition of acidic substances declines.

In addition to the scientific results from this project, our research has direct implications for the upcoming debate in Congress on future amendments to the Clean Air Act. The results will contribute to our interpretation of the responses of surface waters to past and future changes in atmospheric deposition. Comparisons of zooplankton populations over the past 18 years will provide further evidence to assess the biological recovery of lakes. This information is the bottom-line for future considerations for the Clean Air Act: *has biological condition improved as a result of our investment in reduced sulfur emissions?*

Methods:

The basic field protocols, laboratory methods, and quality assurance procedures are routine methods as part of ongoing EPA LTM and TIME research by several of the PIs for nearly 20 years. All work conducted in the project will therefore be consistent with EPA EMAP protocols and quality assurance methods (Peck, 1992), and the statistical methods used by the LTM and TIME programs (e.g. Stoddard *et al.*, 2003; Kahl *et al.*, 1993; Webster and Brezonik, 1995). All analytical work will be conducted in the George Mitchell Center's Water Research laboratory and in the Environmental Science laboratory at the University of Maine.

Summary of Related Research:

It is well documented that a common response of watersheds to acidic deposition is the mobilization of base cations from soils (e.g. Galloway *et al.*, 1983). As rates of acidic deposition decline, and the supply of acid anions to watershed soils decreases, the rates of cation mobilization are also expected to decrease. Lowered rates of cation mobilization from soils translate to downward trends in surface water base cation concentrations, a change widely observed in the northern hemisphere for more than a decade.

Many recent assessments have been made regarding trends in the deposition of acidifying substances, and the resultant response of surface (e.g. Stoddard *et al.*, 2003; Driscoll *et al.*, 2001; 1998; Evans and Monteith, 2001; Jeffries *et al.*, 2002; Skjelkvale *et al.*, 2001; Stoddard *et al.*, 1999; 1998a; 1998b; Watt *et al.*, 2000). These studies have universally reported declines in freshwater base cations in formerly glaciated terrain. For example, lakes in the northern and eastern U.S. exhibited significant declines in base cation [Ca^{2+} + Mg^{2+}] concentrations in the range of –1.5 to –2.5 µeq/L/year (Stoddard *et al.*, 2003).

The decline in base cation (B_c) concentrations in surface waters of the northeast has been offered as an explanation for the lack of 'recovery' from acid rain. The B_c decline offsets the decline in sulfate, thus reducing the increase in alkalinity that would otherwise result from the decline in sulfate. The rate of change in ANC appears to largely be the sum of changes in acid anions versus base cations, as represented by:

$$ANC = [Ca^{2+} + Mg^{2+}\ Na^{+} + K^{+}] \text{ minus } [SO_4^{2-} + NO_3^{-} + Cl^{-}]$$

Stoddard *et al.* (2003) reported that sulfate decreased at a rate of approximately –2.5 µeq/L/year (the mean of regional median slopes), and NO_3^- at a rate of –0.5 µeq/L/year. The sum of these rates of change set an upper limit to the expectation of ANC recovery of +3.0 µeq/L/yr (i.e., the sum of declines in SO_4 and NO_3). The ANC increase is about +1 µeq/L/year. The difference between the observed ANC trend and the maximum trend estimated from rates of acid anion change can be almost entirely explained by regional declines in base cations of about –1.8 µeq/L/year. At some sites, the decline in base cations has exceeded the decline in acid anions, and these sites have actually acidified.

Student Training:
The project will form the basis for a graduate student thesis (Rosfjord). She will gain substantial field, data, and laboratory skills, in addition to project management experience. In addition, other students in the acid rain research group at UMaine will be part of the field work, and will cite and use the results from this project in their own related research. Undergraduate students will also participate in laboratory and field work.

Expected Deliverables:

- Assessment of the spatial distribution of changes in acid-relevant chemistry in lakes with ANC up to 400µeq/L. No other 20-year assessment of a statistical population of lakes with this larger range of chemistry has been attempted.
- A dataset with major-ion chemistry will be available for this sub-population of lakes, with the key analytes of interest being base cations, anions, and ANC. These data will be made widely available for researchers and policy makers in the region.
- Annual report, student thesis, and presentation at Maine Water Conference
- Publication(s) in peer reviewed journals
- Water chemistry data will provide the baseline for the interpretation of a parallel re-surveys of zooplankton and mercury

Investigators Qualifications:
Kahl has conducted acid rain research on lakes for 24 years at the University of Maine and as an employee of Maine DEP. Webster, assistant professor of biology, conducted the Wisconsin acid rain research program until her arrival in Maine in 2001, where she has continued to collaborate in this research. Fernandez provides the soils connection for this water quality research, having conducted soils-relevant research on the effects of acid rain for 18 years. Rosfjord will focus on this project as the research component of her graduate program.

Project Management and Organization:
Kahl is responsible for overall project direction and management, and fiscal management. Rosfjord will handle day-to-day details of logistics and planning, and perform most of the field work, with other student assistants. Kahl and Rosfjord will interact with EPA on aspects of statistical design and data interpretation. Webster will provide interaction with the biological aspects of the related project (zooplankton) and participate in the data analysis for trends. Fernandez will participate in the data interpretation that relates water chemical trends to processes in soils, which is a key goal of the project.

Government Involvement:
Scientists at USEPA are central to the success of the project, and are co-PIs of the companion grant funded by USDA. They established the original statistical design of ELS and ELS-II, and this project will rely heavily on them for assistance in population statistics.

References:

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Evans, C.D., and D.T. Monteith. 2001. Chemical trends at lakes and streams in the UK Acid Waters Monitoring Network, 1988-2000: Evidence for recent recovery at a national scale. Hydrology and Earth Systems Sciences **5**:351-366.

Galloway, J.N., S.A. Norton, and M.R. Church. 1983. Freshwater acidification from atmospheric deposition of sulfuric acidL A conceptual model. Environmental Science and Technology **17**:541-545.

Jeffries, D.S., T.A. Clair, S. Couture, P.J. Dillon, J. Dupont, W. Keller, W.K. McNicol, M.A. Turner, R. Vet and R. Weeber. 2002. Assessing the recovery of lakes in southeastern Canada from the effects of acidic deposition. Ambio **32**:176-182.

Kahl, J. S., T. A. Haines, S. A. Norton, and R. B. Davis, 1993. Recent temporal trends in the acid-base chemistry of surface waters in Maine, USA. Water Air and Soil Pollution 67:281-300.

Peck, D. V. 1992. Environmental Monitoring and Assessment Program: Integrated Quality Assurance Project Plan for the Surface Waters Resource Group. EPA/600/X-91/080, U.S. EPA.

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Stoddard, J.L., C.T. Driscoll, J.S. Kahl, J.H. Kellogg,. 1998a. A regional analysis of lake acidification trends for the northeastern U.S., 1982-1994. Environmental Monitoring and Assessment **51:**399-413.

Stoddard, J.L., C.T. Driscoll, J.S. Kahl, J.H. Kellogg,. 1998b. Can sit-specific trends be extrapolated to a region? An acidification example for the Northeast. Ecological Applications **8**:288-299.

Stoddard, J.L., D.S. Jeffries, A. Lukewille, T.a. Clair, P.J. Dillon, C.T. Driscoll, M. Forsius, Murdoch, S. Patrick, A. Rebsdorf, B.L Skjelkvale, M.Stainton, T.Traaen, H.van Dam, K.E. Webster, J. Wieting, and A. Wilander. 1999. Regional trends in aquatic recovery from acidification in North America and Europe. Nature **401**:575-578.

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Watt, W. D., C. D. Scott, P. J. Zamora, and W. J. White. 2000. Acid toxicity levels in Nova Scotian rivers have not declined in synchrony with the decline in sulfate levels. Water Air and Soil Pollution **118**:203-229.

Webster, K. E. and P. L. Brezonik. 1995. Climate confounds detection of chemical trends related to acid deposition in upper Midwest lakes in the USA. Water, Air and Soil Pollution **85**:1575-1580

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PRESENT POSITIONS

Founder and Director	Mitchell Center for Environmental and Watershed Research (2000-);
Coordinator & founder	Water Resources graduate option (1998 -);
Coop. Assoc. Professor	Dept. of Civil and Environmental Engineering (2000 -)
Director	Maine USGS Water Resources Research Institute (1994 -)

EDUCATION

Ph.D. Watershed Geochemistry, University of Maine
M.S. Geological Sciences, University of Maine
B.A. Zoology (*Chemistry minor*), University of Maine, 1977.

RESEARCH INTERESTS: Regional and global patterns in environmental chemistry; limnology, watershed geochemistry, environmental monitoring methods; paleo-inferential methods; the intersection of science and public policy; information accessibility for the public.

HISTORY OF EXTRAMURAL SUPPORT: Principal Investigator on 45 extramural grants, funded at $8.2 million. Co-PI on 22 other grants, funded at an additional $7.7 million. These grants have supported 59 graduate students and countless undergraduates.

RECENT PROFESSIONAL EXPERIENCE

Sabbatical with EPA	*Co-leader*, Trend assessment report for the Clean Air Act (2002)
Development Advisor	Schoodic Education & Research Consortium (NPS, 2001-2003)
Assoc. Research Prof.	Department of Geological Sciences, University of Maine ('98-02).
Manager	Environmental Chemistry Laboratory, Univ. of Maine (1989-95).

STUDENT ADVISING: 43 graduate student committees since 1985

EXAMPLE AWARDS and RECOGNITION:

2003 President-elect, National Institutes for Water Resources
2003 Invited speaker, National Academy of Sciences panel on the future of water research
2002 Chair, review panel, Western Airborne Contaminants Assessment Project (NPS/EPA)
2002 *Environmental Policy Advisory Committee*, gubernatorial candidate John Baldacci
2001 UMaine *Research Honor Role* (top 25 ranking of 650 faculty).
2001 UMaine nomination, NSF Presidential award for student mentoring
2000 *Mercury Products Advisory Commission* (Gubernatorial appt, 2000 – 03)
1999 USGS ranking as one of the top four national water institutes of the past five years
1999 Governor's Award for Excellence in Environmental Education
1998 Legislative Proclamation for Achievement
1998 EPA New England Environmental Merit Award
1998 *River Flow Management Commission* (Gubernatorial appt, 1998 -)
1996 *Great Ponds Task Force*, 1995-97 (Gubernatorial appointment).

EXAMPLE PUBLICATIONS and REPORTS (n = 108)

Kahl, J.S. and S. Nelson (editors), 2004. Inferring regional patterns and responses in N and Hg biogeochemistry using two sets of gauged paired-watersheds. Special issue of Environmental Monitoring and Assessment (12 papers), in press.

Kahl, J.S., J. Stoddard, R. Haeuber, S. Paulsen, and others, 2004. Response of surface water chemistry to changes in acidic deposition: implications for the upcoming debate on the federal Clean Air Act. Environmental Science and Technology, Feature Article in review.

Kahl, J.S., and 19 co-authors, 2003. Inferring regional patterns and responses in N and Hg biogeochemistry using two sets of gauged paired-watersheds. Final report to EPA and National Park Service, Mitchell Center, University of Maine, Orono, ME. 171 p.

Peckenham, J., **J.S. Kahl**, and B. Mower, 2003. Background Mercury Concentrations in River Water in Maine, USA. Environ. Monitoring and Assessment, in press.

Norton, S., I. Fernandez, **J.S. Kahl**, and R. Reinhardt, 2003. Acidification trends and the evolution of neutralization mechanisms through time at the Bear Brook Watershed, Maine, USA. Water, Air, Soil, Pollut., in press.

Amirbahman, A. P. Ruck, I Fernandez, T. Haines, and **J.S. Kahl**, 2003. The effects of fire on mercury distribution in soils of Acadia National Park. Water Air, Soil Pollut., in review.

Fernandez, I, L. Rustad, S. Norton, **J.S. Kahl**, and B.J. Cosby, 2003. Experimental acidification causes soil base cation depletion at the Bear Brook Watershed in Maine. J. Soil Soc Assoc Am., in press.

Neilsen, M.G., and **J.S. Kahl**, 2003. Nutrient export from watersheds on Mount Desert Island; differences in export as a function of fire history. JAWARA, in review.

Amirbahman, A., A. Pearce, R. Bouchard, S. Norton, and **J.S. Kahl**, 2003. Control of hypolimnetic phosphorus release. Biogeochemistry, in review.

Campbell, J, J. Hornbeck, M. Mitchell, M. Adams, M. Castro, C. Driscoll, **J.S. Kahl**, and others, 2003. Input-output budgets for inorganic nitrogen for 24 watersheds in the northeastern United States. Water Air Soil Pollut., in press.

Amirbahman, A., A. Reid, T. Haines, **J.S. Kahl**, and C. Arnold, 2002. Association of Methylmercury with Dissolved Humic Acids. Environ. Sci. Technol. 36:690-695.

Pellerin, B., I Fernandez, S. Norton, and **J.S. Kahl**, 2002. Soil aluminum distribution in the near-stream zone at the Bear Brook Watershed in Maine. Water Air Soil Pollution 134:189-204.

Norton, S., B.J. Cosby, I. Fernandez, **J.S. Kahl**, and R. Church, 2001. Long-term and seasonal variations in CO_2: linkages to catchment alkalinity generation. Hydrol. Earth Science Systems 5:83-91.

Norton, S.A. and **J.S. Kahl**, 2001. Impacts of marine aerosols on surface water chemistry at Bear Brook Watershed, Maine. Verh. Internat. Verein. Limnol. (SIL) 27:1280-1284.

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Current Appointment:
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Past Appointments:
Aquatic Ecologist, Wisconsin Department of Natural Resources (1980 to 2001)
Honorary Fellow, Center for Limnology, University of Wisconsin (1998 to 2001)

Education:
1998 University of Wisconsin-Madison, Ph.D. Oceanography and Limnology
1983 University of Wisconsin-Madison, M.Sc. Zoology
1980 University of Wisconsin-Madison, M.Sc. Water Resources Management
1976 McGill University, Montreal, Canada, B.Sc. Biology/Ecology (with Great Distinction)

Research Interests: Regional limnology; long-term ecological research; hydrologic and biogeochemical cycles in lakes; lake-watershed interactions; temporal trends in aquatic ecosystems; effects of acid deposition and climate change on aquatic ecosystems

Selected Peer-Reviewed Publications:
Lillesand, T.M., J.L. Riera, J.W. Chipman, J. Schmaltz, J.D. Gage, M. Janson, J. Panuska, and K. Webster. 2001. Integrating multi-resolution satellite imagery into a satellite lake observatory. In: Proceedings: Annual meeting of the American Society for Photogrammetry and Remote Sensing, St. Louis, MO, April 23-27, 2001. CD-rom, 12 p.

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Baines, S.B., K.E. Webster, T.K. Kratz, S.R. Carpenter, and J.J. Magnuson. 2000. Synchronous behavior of temperature, calcium and chlorophyll in lakes of northern Wisconsin. *Ecology* 81:815-825.

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Kratz, T.K., K.E. Webster, C.J. Bowser, J.J. Magnuson, and B.J. Benson. 1997. The influence of landscape position on lakes in northern Wisconsin. *Freshwater Biology* 37:209-217.

Magnuson, J.J., K.E. Webster, R.A. Assel, C.J. Bowser, P.J. Dillon, J.G. Eaton, H.E. Evans, E.J. Fee, R.I. Hall, L.R. Mortsch, F.H. Quinn and D.W. Schindler. 1997. Potential effects of climate changes on aquatic systems: Laurentian Great Lakes and Precambrian Shield Region. *Hydrol. Proc.* 11:825-872.

Webster, K.E., T.K. Kratz, C.J. Bowser, J.J. Magnuson, and W.J. Rose. 1996. The influence of landscape position on lake chemical responses to drought in northern Wisconsin, USA. *Limnol. Oceanogr*. 41:977-984.

Krabbenhoft, D.P., and K.E. Webster. 1995. Transient hydrogeological controls on the chemistry of a seepage lake. *Water Resources Research*, 31:2295-2305.

Webster, K.E., and P.L. Brezonik. 1995. Climate confounds detection of chemical trends related to acid deposition in upper midwest lakes in the USA. *Water, Air, Soil Poll.*, 85:1575-80.

Webster, K.E., T.M. Frost, C.J. Watras, W.A. Swenson, M. Gonzalez, and P.J. Garrison. 1992. Complex biological responses to the experimental acidification of Little Rock Lake, Wisconsin (USA). *Environmental Pollution*. 78:73-78.

Webster, K.E., A.D. Newell, L.A. Baker, and P.L Brezonik. 1990. Climatically induced rapid acidification of a softwater seepage lake. *Nature*. 6291:374-376.

Grants:

USDA Cooperative State Research, Education and Extension Service (MAFES). *Application of a Landscape Framework for Evaluating the Impacts of Regional and Local Stressors on Lakes in Maine.* (Principal Investigator 2002-2005)

USGS, Water Resource Institute University of Maine. *Seepage Lakes as Indicators of Climate Change.* (Co-PI 2001-2003)

Professional Activities:

Journal peer reviewer for Environmental Science & Technology, Environmental Pollution, Limnology & Oceanography, J. NABS, Freshwater Biology, Climatic Change, Environmental Monitoring and Assessment

Proposal review panel: US EPA STAR program review panel, 1999 and 2000

Program and organizational committee for NALMS 2001 conference

Past President, American Water Resources Association, Wisconsin Section (2000-2001)

Member: ASLO, ESA, NABS, NALMS, AIBS

Teaching:

BIO 468 – Limnology (Fall 2001)

BIO 446 – Landscape Perspectives on Aquatic Ecosystems (Spring 2002)

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EDUCATION:

1981 - Ph.D. University of Maine - Forest Resources (Forest Soils)
1978 - M.S. University of Maine - Plant & Soil Sciences (Soil Chemistry)
1975 - B.A. Hartwick College - Biology (Plant Science)

EMPLOYMENT HISTORY:

1993 - Present	Professor of Soil Science and Cooperating Professor of Forest Resources - University of Maine, Orono, Maine
1997 – 2002	Chair - Department of Plant, Soil and Environmental Sciences
1990 - 1994	Chair - Department of Plant, Soil, and Environmental Sciences
1987 - 1990	Associate Professor of Soil Science and Cooperating Associate Professor of Forest Resources - University of Maine, Orono, Maine
l983 - 1987	Assistant Professor of Soil Science and Cooperating Assistant Professor of Forest Resources - University of Maine, Orono, Maine
1981 - l983	Research Forester - National Council of the Paper Industry for Air and Stream Improvement, 260 Madison Avenue, New York

PROFESSIONAL INFORMATION:

American Society of Agronomy

Certified Soil Scientist - State of Maine
Council for Agricultural Science and Technology
G. Peirce and Florence Pitts Webber Award for Outstanding Research
in Forest Resources (1997)
Member - Maine State Board of Certification
for Geologists and Soil Scientists
Member - Council of Soil Science Examiners (CSSE) of the
Soil Science Society of America
Member - Editorial Advisory Board for the journal Environmental Monitoring and Assessment
Member - US Environmental Protection Agency Scientific Advisory Board - Ecological Processes
and Effects Committee, Washington DC.National Atmospheric Deposition Technical Committee
(2000-2002)
National Wildlife Association
Natural Resources Council of Maine
Phi Kappa Phi
Sigma Xi
Society of American Foresters
Society of Soil Scientists of Northern New England
Soil Conservation Society of America
Soil Science Society of America (Chair-elect Div. S-7, Forest and Range Soils, 2003-2004)

PUBLICATIONS:

Articles

Amirbahman, Aria, Philip L. Ruck, Ivan J. Fernandez, Terry A. Haines, and Jeffery S. Kahl. 2004. The Effect of Fire on Mercury Cycling in the Soils of Forested Watersheds: Acadia National Park, Maine, USA. Water Air Soil Pollut. (in press).

Evans, Gordon C., Stephen A. Norton, Ivan J. Fernandez, Jeffrey s. Kahl, and Dennis Hanson. 2004. Changes in concentrations of major and trace metals in northeastern U.S.-Canadian sub-alpine forest floors. Water Air Soil Pollut. (in review).

Szillery, Johanna E., Ivan J. Fernandez, Stephen A. Norton, Lindsey E. Rustad, and Alan S. White. 2004. Soil solution dynamics in response to N and S treatments at the Bear Brook Watershed in Maine. J. Environ. Qual. (in review).

Venterea, Rodney T., Peter M. Groffman, Mark S. Castro, Louis V. Verchot, Ivan J. Fernandez, Mary Beth Adams, and Sultana Jefts. 2004. Soil emissions of nitric oxide gas in two forest watersheds subjected to persistent N inputs. Forest Ecology and Management (in review).

Jefts, Sultana, Ivan J. Fernandez, Lindsey E. Rustad, and D. Bryan Dail. 2004. Comparing methods for assessing forest soil net n mineralization and nitrification. Commun. Soil Sci. Plant Anal. (in review).

Jefts, Sultana, Ivan J. Fernandez, Lindsey E. Rustad, and D. Bryan Dail. 2003. Decadal responses in soil N dynamics at the Bear Brook Watershed in Maine, USA. Forest Ecology and Management (in press).

Elvir, J.A., G.B. Wiersma, A.S. White and I.J. Fernandez. 2003. Effects of chronic ammonium sulfate treatment on basal area increment in red spruce and sugar maple at the Bear Brook Watershed in Maine. Can J. For. Res. (in press).

Norton, S. A., Fernandez, I. J., Kahl, J. S and R. L. Reinhardt. 2003. Acidification trends and the evolution of neutralization mechanisms through time at the Bear Brook Watershed in Maine (BBWM). Water Air Soil Pollut. (in press).

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Education:
Vanderbilt University: 1995-1999; BA in psychology, BA in anthropology
University of North Carolina- Asheville: 2001-2003; environmental science

Research Interests:
Water pollution and remediation, acid deposition and recovery, water chemistry, limnology, long-term monitoring and trend analysis

Current Position:
Graduate research assistant at the Senator George J. Mitchell Center for environmental and watershed research. Responsible for sampling Regional Long-Term Monitoring (RLTM) and Temporally Integrated Monitoring of Ecosystems (TIME) sites in accordance with EPA sampling procedures. This includes measurements of a number of different parameters, including dissolved oxygen (DO), conductivity, and transparency. Responsible for laboratory analysis using protocols, laboratory methods, and quality assurance procedures that are the routine methods of EPA LTM and TIME research. This includes analysis of acid neutralizing capacity (ANC), air equilibrated and closed cell pH, exchangeable aluminum, and conductivity. Also responsible for supplemental laboratory analysis, such as ion chromatography.

Work Experience:

Summer 2002: Interned in the Great Smokey Mountains National Park with a botanist in the Rare Plants division of Inventory and Management. Worked with the forest ecologist on monitoring long-term plots within the Park. Tested the accuracy of a computer simulated models for predicting the occurrence of certain species. Responsible for assessing a number of parameters such as canopy cover, tree health, and identification of hundreds of herbaceous and woody species within the plot.

Summer 2001: Crew leader for the Student Conservation Association. Responsible for a crew of high school students who lived and worked in a valley of the eastern Sierras for seven weeks. Implemented a stream restoration project that was initiated by the National Forest Service. Worked in close conjunction with the USFS hydrologist and soil biologist to create a pattern of rock and brush dams in order to reduce erosion and prevent soil loss the following spring.

Spring and Fall of 1999 and 2000 Environmental educator for middle school students, both in the southern Appalachians of North Carolina and in the high chaparral of southern California. In both places, I taught an aquatic ecology class that focused on the hydrologic cycle, energy flow through trophic levels, human manipulation of water resources, and identification of certain aquatic species, both macro and microscopic.