New York State Energy Research and Development Authority

A Long-Term Monitoring Program for Evaluating Changes in Water Quality in Selected Adirondack Waters

Program Summary

Program Summary Report 2012

November 2013

Report Number 13-26

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A Long-Term Monitoring Program for Evaluating Changes in Water Quality in Selected Adirondack Waters

Program Summary

Program Summary Report 2012

Prepared for:

New York State Energy Research and Development Authority

Gregory Lampman
Project Manager

Prepared by:

Adirondack Lakes Survey Corporation

Karen M. Roy
New York State Department of
Environmental Conservation

James Dukett and Nathan Houck
Adirondack Lakes Survey Corporation

Gregory B. Lawrence
U.S. Geological Survey

NYSERDA Report 13-26 NYSERDA Contract 25352 November 2013

About the Adirondack Lakes Survey Corporation

The Adirondack Lakes Survey Corporation (ALSC) was established in 1983 to undertake comprehensive biological and chemical surveys of Adirondack waters; to study the water quality and the effect of acid rain; and to disseminate this information and contribute to scientific understanding through studies and reports. For over 30 years the ALSC has carried out this scientific and technical mission by conducting monitoring of surface water chemistry and fish; making these data available to the public and scientific community; and contributing to studies regarding acidification in the Adirondacks. The ALSC operates out of the New York State Department of Environmental Conservation (NYSDEC) Region 5 headquarters in Ray Brook, New York. To conduct its mission, the ALSC receives support from three sources: the New York Energy Research and Development Authority (NYSERDA), NYSDEC, and the United States Environmental Protection Agency (USEPA).

The ALSC remains current and responds to the needs of the scientific community through improvements in its field, laboratory and data processing capabilities. Field sampling is conducted year round throughout the Adirondack Park under a variety of field conditions. Staff is experienced in the collection of fish, sediment cores, and water samples for routine chemistry and ultra-clean sampling for mercury analysis. The laboratory is equipped to analyze over 20 chemical parameters. The data processing department is skilled in the analysis and delivery of a wide range of digital products.

Acknowledgments

This report is possible through the efforts of the ALSC field, laboratory, data management and administrative staff. We thank: Jeff Brown, Sara Burke, Michael Cantwell, Sue Capone, Korey Devins, Elizabeth Faucher, Matthew Kelting, Monica Schmidt, Phil Snyder and Christopher Swamp for their dedication. We also thank Paul Casson and Pamela Corey for their years of dedicated service and professionalism as they depart to pursue new adventures. This work is jointly supported by the NYSDEC, NYSERDA, USEPA, and USGS. This report has not been reviewed by the sponsoring agencies, and should not be construed to represent their practices and policies.

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Acronyms and Abbreviations

µeq L^{-1}	microequivalent per liter
µg kg^{-1}	microgram per kilogram
µg m^{-2}	microgram per square meter
µmol C L^{-1}	micromole carbon per liter
µmol L^{-1}	micromole per liter
µS cm^{-1}	microsiemens per centimeter
AEAP	Adirondack Effects Assessment Program
Al IM	inorganically complexed aluminum
Al OM	organically complexed aluminum
ALS	Adirondack Lakes Survey (1980s)
ALSC	Adirondack Lakes Survey Corporation
Al TD	total dissolved aluminum
Al TM	total monomeric aluminum
ALTM	Adirondack Long Term Monitoring Program
ANC	Acid Neutralizing Capacity
ASRC	Atmospheric Sciences Research Center
BCS	base cation surplus

C_A	summed concentration of acid anions
Ca^{2+}	calcium ion
$CaCl_2$	calcium chloride
CASTnet	Clean Air Status and Trends Network
CB	summed concentration of base cations
CEC	cation exchange capacity
Cl^-	chloride ion
cmolesc kg^{-1}	centimoles of charge per kilogram
DDRP	Direct/Delayed Response Project
DIC	Dissolved Inorganic Carbon
DOC	Dissolved Organic Carbon
ECASS	East-Central Adirondack Stream Survey (see WASS)
ELS	Eastern Lakes Survey
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency (U.S.)
eq	equivalent
eq ha^{-1} yr^{-1}	equivalent per hectare per year
eq L^{-1}	equivalent per liter
ERP	Episodic Response Project
F^-	fluoride ion
g	grams
GIS	Geographic Information System
H^+	hydrogen ion
ha	hectare
Hg	elemental mercury
K^+	potassium ion
kg	kilogram
km	kilometer
LABPH	laboratory pH
LTM	Long Term Monitoring Program
LWC	liquid water content
m	meter
MADPro	Mountain Cloud Acid Deposition Program
MDN	Mercury Deposition Network
$MeHg^+$	methyl mercury
mg L^{-1}	milligrams per liter
mg L^{-1}-C	milligrams per liter as carbon
mg m^{-3}	milligrams per cubic meter
Mg^{2+}	magnesium ion
mL	milliliter
mm	millimeter
mmol L^{-1}	millimole per liter

NA	not available
Na^+	sodium ion
NADP	National Atmospheric Deposition Program
NAPAP	National Acid Precipitation Assessment Program
$ng\ g^{-1}$	nanograms per gram
NH_4^+	ammonium ion
NO_3^-	nitrate ion
NOAA	National Oceanic and Atmospheric Administration
NTN	National Trends Network
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority
pH	negative logarithm of hydrogen ion concentration
Pt Co	platinum cobalt
RILWAS	Regional Integrated Lake-Watershed Acidification Study
SCONDUCT	specific conductivity
SiO_2	silica
SO_2	sulfur dioxide
SO_4^{2-}	sulfate ion
TIME	Temporally Integrated Monitoring of Ecosystems
TOC	total organic carbon
TRUECOLOR	color defined on the platinum cobalt scale
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WASS	Western Adirondack Stream Survey
Water year	The period between October 1st of one year and September 30th of the next

Program Overview

The goal of the Adirondack Long Term Monitoring Program (ALTM) is to provide surface water chemistry data in the Adirondack region in response to changes in atmospheric deposition of acid rain precursors. The ALTM provides for increased understanding of the processes involved in lake and stream acidification recovery in several ways, including: the interpretation of the chemistry trends across lake classes; additional snowmelt sampling; periodic fisheries surveys; and other biological measurements. It also provides for participation in more intensive investigations at some sites by acquisition of supplemental data and/or by conducting additional field sampling. The monitoring objectives of the current component of the ALTM are: continued sampling and analysis of 52 lakes on a monthly basis; periodic lake fisheries resurveys; annual summer sampling 43 lakes as part of a cooperative project with USEPA under the Temporally Integrated Monitoring of Ecosystems (TIME); stream monitoring at four locations on a bi-weekly basis as part of a cooperative project with USGS; summer cloud water sampling and analysis from measurements made at the summit of Whiteface Mountain; weekly wet deposition sampling at Wanakena, NY; and analysis of selected lake samples for regional fisheries management. We also briefly report on major additional stream sampling conducted with the USGS during the years 2003-2011. We advise the reader that stream results are reported at water year intervals (i.e. Oct 1 - Sept 30) in contrast with lakes results which are reported on calendar year (i.e. Jan 1- Dec 31) intervals.

Data are posted on the ALSC website (www.adirondacklakessurvey.org), following appropriate quality assurance checks and clearance by the ALSC Program Manager and the NYSDEC Research Manager. This report describes the major core areas of work contained in the 2007–2012 program plan and the data available through December 2011. This report is intended as an update on the ongoing ALTM work that will include updated datasets. Still, there is an inherent time lag in the analysis of the data and the reporting of the data. For each program element, site selection and sampling design as well as highlights of recent results are provided along with key references. Questions on this report can be directed to the address below.

Karen Roy
NYSDEC Adirondack Research Manager
Research Scientist 3
New York State Department of Environmental Conservation
Ray Brook, New York 12977.0296
kmroy@gw.dec.state.ny.us
518.897.1354

The report is available online at: http://nyserda.ny.gov/publications and http://www.adirondacklakessurvey.org.

Adirondack Long Term Monitoring (ALTM) Lakes

The Adirondack Long Term Monitoring (ALTM) program was initiated in 1982 to evaluate monthly chemistry of 17 Adirondack lakes. The lakes were selected from the Regionalization of the Integrated Lake Watershed Acidification Study (RILWAS) (Driscoll and van Dreason 1993). From 1984 to 1987 an intensive chemical and biological survey of 1469 lakes within the Adirondack Park was undertaken by the Adirondack Lakes Survey Corporation (ALSC). Following the completion of the interpretive analysis the ALTM was expanded to 52 lakes to provide a better representation of lakes across the region (Figure 1) (Baker et al. 1990). The expanded lake set was, in part, based on the lake classification system developed by Newton and Driscoll (1990). Monthly sampling of the 52 lakes began in June 1992 (Table 1).

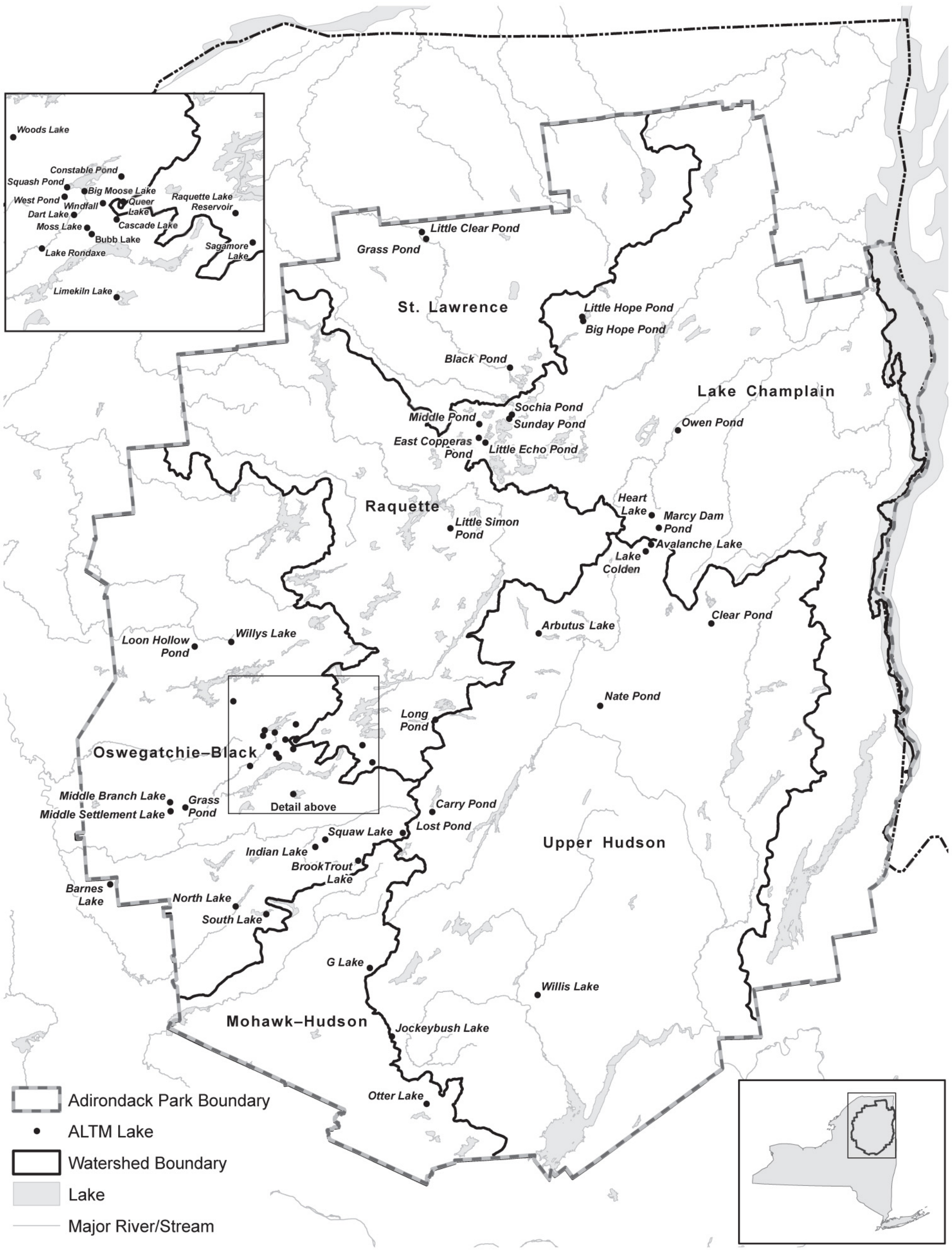


Figure 1. Location of 52 ALTM lakes sampled monthly by the ALSC

Table 1. ALTM lake characteristics and identification of lakes included in: the original 17 ALTM lakes (Record Start 1982); lakes sampled during the Adirondack Lakes Survey (1984–1987)(ALS survey); and the EPA TIME/LTM project cross over lakes (TIME).

Ref #	ALTM Pond Name	Record Start 1982	Classification	DOC[a]	Lake Elev (m)	Surface Area (ha)	ALS Survey	Limed	TIME	Outlet Pair	Snowmelt
050684	Arbutus Lake	X	Medium Till Drainage	low	516	48.9					
050707	Avalanche Lake		Thin Till Drainage	low	873	4.4	A				
040905	Barnes Lake	X	Mounded Seepage	high	395	2.9	A	L			
020059	Big Hope Pond		Medium Till Drainage	high	517	8.9	A		T		S
040752	Big Moose Lake	X	Thin Till Drainage	low	558	512.5					
030255	Black Pond Stream	X	Thick Till Drainage	low	495	29.0	A			O	
040874	Brook Trout Lake		Thin Till Drainage	low	724	28.7	A				
040748	Bubb Lake Stream	X	Thin Till Drainage	low	554	18.2	A			O	S
050669	Carry Pond		Mounded Seepage	low	652	2.8	A				
040747	Cascade Lake Stream	X	Medium Till Drainage	low	557	40.4	A			O	
050458	Clear Pond	X	Thick Till Drainage	low	584	70.4	A				
040777	Constable Pond Stream	X	Thin Till Drainage	low	580	20.6	A			O	
040750	Dart Lake	X	Thin Till Drainage	low	537	51.8	A				
020138	East Copperas Pond		Thin Till Drainage	high	480	3.6	A				S
070859	G Lake		Thin Till Drainage	low	620	32.2					
030171	Grass Pond		Mounded Seepage	high	381	1.6	A				
040706	Grass Pond		Medium Till Drainage	low	549	5.3	A				
020264	Heart Lake	X	Medium Till Drainage	low	661	10.7	A				S
040852	Indian Lake		Thin Till Drainage	low	654	33.2	A		T		
050259	Jockeybush Lake		Thin Till Drainage	low	599	17.3	A				
050706	Lake Colden		Thin Till Drainage	low	843	15.4	A				
040739	Lake Rondaxe	X	Thin Till Drainage	low	524	90.5	A				
040826	Limekiln Lake		Medium Till Drainage	low	575	186.9	A				
030172	Little Clear Pond		Mounded Seepage	low	381	1.9	A	L			
020126	Little Echo Pond	X	Mounded Seepage	high	482	0.8					S
020058	Little Hope Pond		Medium Till Drainage	high	517	2.8	A				
060182	Little Simon Pond		Medium Till Drainage	low	546	58.1	A	L			
050649	Long Pond		Thin Till Drainage	high	574	1.7	A				
040186	Loon Hollow Pond		Thin Till Drainage	low	605	5.7	A				
040887	Lost Pond		Thin Till Drainage	high	717	4.4	A				
020265	Marcy Dam Pond		Thin Till Drainage	low	720	1.2	A				
040707	Middle Branch Lake		Thin Till Drainage	low	496	17.0	A				
020143	Middle Pond		Carbonate Influenced	high	483	24.3	A				S
040704	Middle Settlement Lake		Thin Till Drainage	low	526	15.8	A				
040746	Moss Lake	X	Medium Till Drainage	low	536	45.7	A				S
050577	Nate Pond		Medium Till Drainage	high	613	8.3	A				
041007	North Lake		Thin Till Drainage	low	555	176.8	A		T		
070728	Otter Lake Stream	X	Thin Till Drainage	low	505	14.8				O	
020233	Owen Pond		Thick Till Drainage	low	514	7.6	A				S
060329	Queer Lake		Thin Till Drainage	low	597	54.5	A				
060315A	Raquette Lake Reservoir		Medium Till Drainage	high	564	1.5	A				S
060313	Sagamore Lake		Medium Till Drainage	high	580	68.0	A				S
020197	Sochia Pond		Mounded Seepage	low	495	1.6	A				
041004	South Lake		Thin Till Drainage	low	617	197.4			T		
040754	Squash Pond Stream	X	Thin Till Drainage	high	653	3.3	A			O	
040850	Squaw Lake		Thin Till Drainage	low	646	36.4	A		T		
020188	Sunday Pond		Mounded Seepage	low	495	4.0	A				S
040753	West Pond Stream	X	Thin Till Drainage	low	581	10.4	A			O	S
050215	Willis Lake		Medium Till Drainage	low	400	14.6	A				
040210	Willys Lake (Horseshoe)		Thin Till Drainage	low	632	24.3	A		T		
040750A	Windfall Pond Stream	X	Carbonate Influenced	low	591	2.4	A			O	
040576	Woods Lake		Thin Till Drainage	low	605	24.7		L			

[a] Dissolved Organic Carbon

Site Description

Descriptions of the Adirondack region, the ALTM study sites, sample collection and analytical procedures are available in Driscoll and van Dreason (1993), Driscoll et al. (2003), and Chen and Driscoll (2005). Eight of the original 17 lakes (1982) were sampled, not directly on the lake outlet, but at varying distances downstream in proximity to an access road. In June 1993, sampling was initiated at the upstream lake outlet sites at these eight locations. Seven of the 52 ALTM lakes (Little Echo Pond, Woods Lake, Big Moose Lake, South Lake, Arbutus Lake, Otter Lake, and G Lake) were not part of the intensive survey performed in 1984–1987 but were added or remained either because they were part of the original 17 ALTM lakes or due to other intensive studies. Within this 52 lake set, the NYSDEC regional fisheries staff actively manage fish stocks in about half of these waters (ALSC 2003). Four lakes (Barnes Lake, Woods Lake, Little Simon Pond, and Little Clear Pond) have a recent history of lake liming and are not included in time series analysis of chemistry data. Table 1 provides a summary of selected lake characteristics, management and sampling information.

The Adirondack region is also one of the USEPA lake water chemistry study areas in the TIME program (Stoddard et al. 2003) described in a separate section of this report. Under this program, the ALSC conducts summer sampling of 43 lakes of which six lakes are common between TIME and ALTM. These are Big Hope Pond, Indian Lake, North Lake, South Lake, Squaw Lake, and Willys Lake (see Table 1). Some of these 43 lakes are also part of the NYSDEC fisheries management lakes.

Sampling Design

The ALTM lakes are sampled monthly. Lakes with no outlets and those accessed by helicopter are sampled at the deepest part of the lake at a depth of 0.5 m with a Kemmerer sampler. All other sites are sampled at the outlet by surface grab method. All samples are collected in high density polyethylene bottles. Samples are transported from the field in chilled coolers to the ALSC laboratory in Ray Brook, New York (ALSC 2002).

Samples are analyzed for the following parameters: pH, ANC, specific conductance, color, nitrate, sulfate, chloride, fluoride, calcium, magnesium, potassium, sodium, silica, ammonium, dissolved organic carbon, dissolved inorganic carbon, total dissolved aluminum, total monomeric aluminum, total organic monomeric aluminum, total inorganic monomeric aluminum (calculated), and starting in October 2008, for total phosphorus and chlorophyll a. Analytical procedures follow USEPA standards developed and described elsewhere (Morrison et al. 1991; ALSC 2002a; Driscoll and van Dreason 1993; Burns et al. 2006).

Results

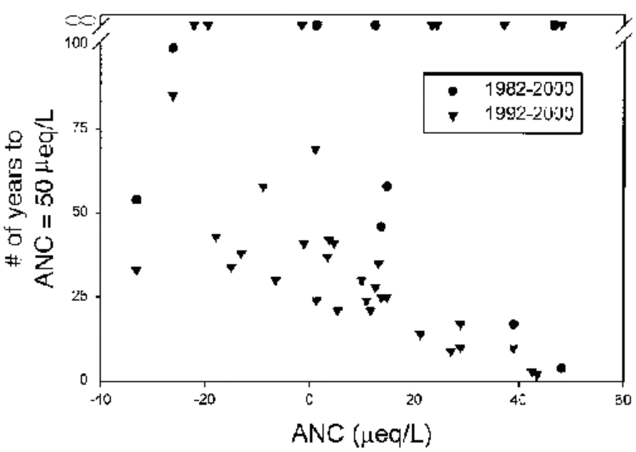
Since baseline monitoring was initiated in 1982, several lake chemistry time series analyses were conducted with the idea of evaluation of changes in atmospheric deposition. These evaluations are a snapshot of changes in chemistry that are attributed, for the most part, to changes in the acidic precursor emissions based upon the potential need for additional action for improvement from a policy framework. The following represents a synopsis of published ALTM chemistry results. These analyses and others were the foundation for assessing acid deposition effects to lake chemistry in the Adirondack region in recent decades. Responses are evaluated relative to lake classes and relationships among parameters. Depending on the length of the time period evaluated, trends in lake chemistry were found to vary as deposition patterns changed.

Chemistry Trends Reported Based Upon 1982 to 1997 Sampling (17 lakes)

There were a total of three time periods analyzed for the original 17 lakes and the results are summarized in this section. The first time series conducted for the period 1982 to 1991 found most lakes exhibiting declines in sulfate concentrations consistent with decreases in SO_2 emissions and SO_4 in precipitation. ANC levels were continuing to decline in several lakes thought to be due to increasing concentrations of NO_3 (Driscoll and van Dreason 1993). The next time series conducted for 1982–1994 found continued decline in lake sulfate concentrations, but at rates considerably less than the rate of decline anticipated from atmospheric deposition. The delays in sulfate response were thought to be due to the release of stored sulfate in watershed soils. Lake nitrate concentrations did not show significant trends. No systematic increases in pH or ANC were detected (Driscoll et al. 1995). Similar patterns were observed in time series analysis on the same lakes during 1982–1997. The limited response of lake water ANC and pH were thought to be attributable to several factors, including: the depletion of base cations in soils; additional inputs of sulfate; elevated leaching of nitrates; and/or pH buffering associated with elevated levels of aluminum (Driscoll et al. 1998).

Chemistry Trends 1992–2000 (48 lakes)

The first time series analysis on the expanded 48 ALTM lakes for the 1992–2000 time period found all lakes exhibiting significant decreases in sulfate concentrations that coincided with decreases in atmospheric sulfur deposition. Although atmospheric nitrogen deposition did not change over this period, some lakes exhibited decreases in nitrate concentrations. These declines contributed to increases in ANC and pH in over half of the lakes. Increasing DOC concentrations were observed in 20% of the lakes. In some lakes, monomeric aluminum shifted from toxic inorganic species to less toxic organic forms. Nevertheless, in 2000, 16 out of 48 lakes showed inorganic monomeric aluminum concentrations above 2 μmol L^{-1}, a value known to be toxic to many organisms including juvenile forms of Adirondack fish. Extrapolation of rates of lake ANC increase (Figure 2) suggested that the time frame of chemical recovery is on the order of decades at current rates of decrease in acidic deposition (Driscoll et al. 2003).



Time for lakes to reach ANC values of 50 μeq L^{-1} as a function of ANC value in the year 2000. These values are extrapolated based on the slope of ANC change from time series analysis assuming a linear rate of change. The extrapolation was done for two intervals, 1982–2000 (six lakes) and 1992–2000 (28 lakes) for those waters where ANC trends were significant. Lakes with 50 μeq L^{-1} or greater in 2000 are not shown here. The rates of ANC increase were generally greater when calculated over the later interval (example Big Moose Lake long interval rate is ~45 years, but over the shorter record is only 25 years to achieve 50 μeq L^{-1}).

Figure 2. Time for ANC to reach critical value of 50 μeq L^{-1}.

Chemistry Trends 1992–2004

Four years later, time series showed continued decreases in precipitation sulfate and hydrogen ions and decreases in lake water sulfate continuing at an average 2.2 μeq L^{-1} yr^{-1}. This rate is similar to values reported in eastern North America and Europe. The lake sulfate decreases were not uniform over the monitoring period coinciding with reduced rates of SO_2 emissions and wet sulfate deposition. Lake nitrate concentrations are declining in 27 lakes and increasing in three. The mechanism contributing to the apparent increase in lake watershed nitrogren retention is not evident. ANC and pH are increasing in 34 and 31 lakes, respectively. Base cations are decreasing in half of the lakes, largely due to decreases in calcium concentrations (Figure 3). Decreases in monomeric aluminum concentrations are largely occurring in thin till lakes. DOC changes are less distinct decreasing in 15 lakes while increasing in four lakes (Driscoll *et al.* 2007).

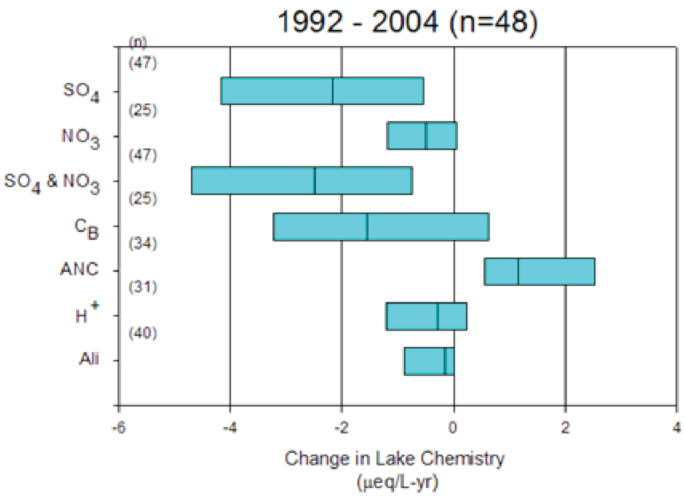


Figure 3. Mean rates of change in solute concentrations 1992–2004.

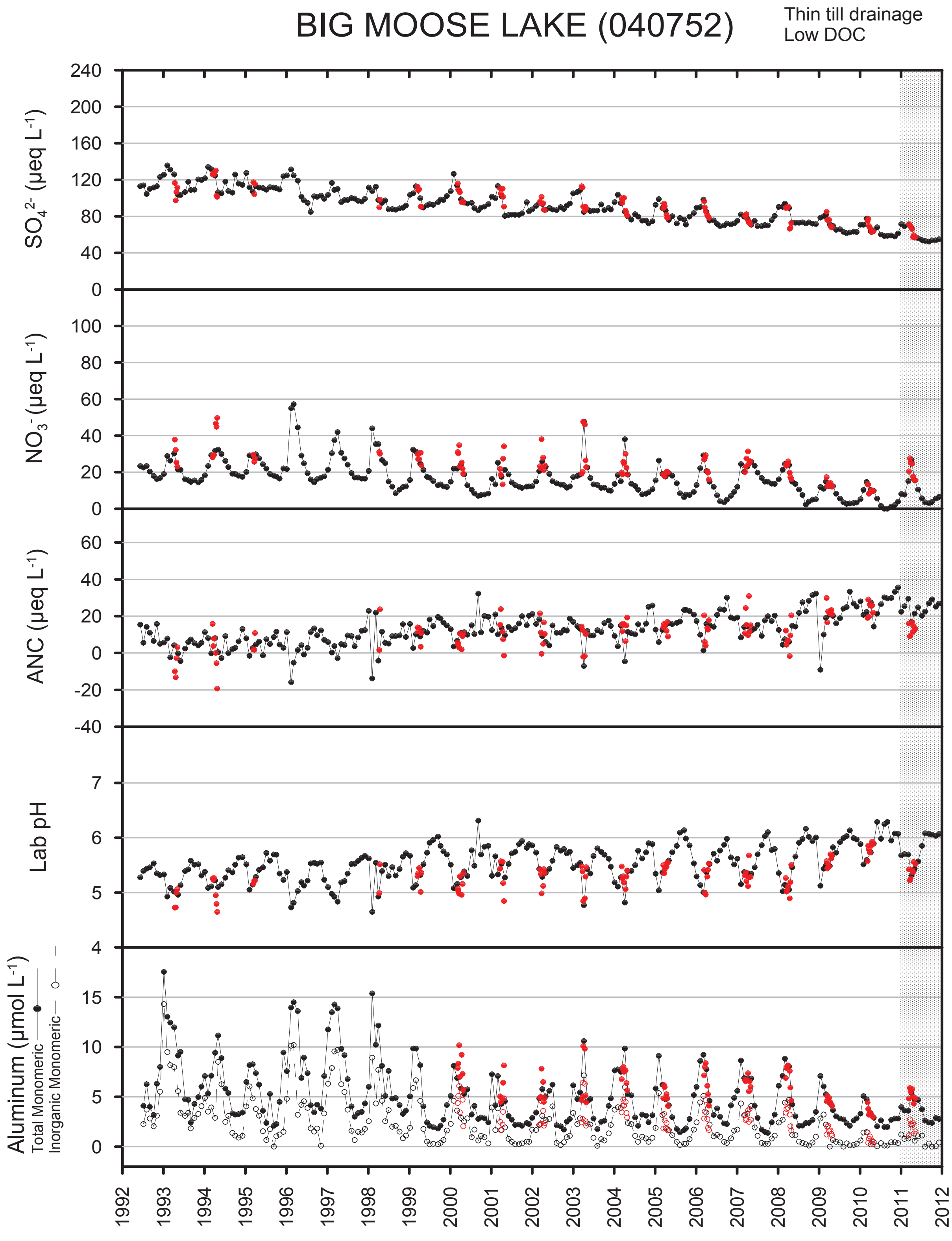


Figure 4. Monthly time series plots for Big Moose Lake. Values in µeq L^{-1} except total and inorganic monomeric aluminum, which are in µmol L^{-1}. Shaded area represents most recent (2011) data.

Chemistry Trends 1992–2008 and Ongoing

In 2012, the ALTM program conducted Seasonal Kendall tests (SKT) on all lake water solute concentrations according to methods described in Raynal et al. 2004. This was done in collaboration with C.T. Driscoll and K.M. Driscoll. Appendix A provides results of SKT time-series analysis for the 48 ALTM lakes through 2000 and 2004 and annually to 2011. The values are expressed as a rate of change (median slope as μeq L^{-1} yr^{-1}; for Aluminum, DIC, DOC, SiO_2 as μmol L^{-1} yr^{-1}). Only statistically significant trends ($p < 0.05$) are reported. The 2000 and 2004 results cover the time period from June 1992 to December, tracking the published papers. The annual updates beginning in 2005 cover the time period from June 1992 to May of the following year. Generally, the time series patterns have been consistent over recent years, however the rates of change have been declining (e.g. sulfate, nitrate and ANC). The number of lakes with significant levels of increasing DOC increased from 18 in 2009 to 30 lakes in 2011 (Appendix A). Table 2 contains a summary of trends (1992 - 2011) for selected parameters:

Table 2. Summary of trends (1992-2011) for selected parameters.

Parameter	Lakes Increasing	Lakes Decreasing	Range Low	High	Mean	Units
Sulfate		48	-0.76	-4.09	-2.48	μeq L^{-1} yr^{-1}
Nitrate		29	-0.03	-1.23	-0.42	μeq L^{-1} yr^{-1}
CB		42	0.33	-3.06	-1.54	μeq L^{-1} yr^{-1}
CB	1		0.33			μeq L^{-1} yr^{-1}
ANC	38		2.01	0.39	0.93	μeq L^{-1} yr^{-1}
Lab pH		1	0.12			units yr^{-1}
Lab pH	29		0.12	-0.76	0.02	units yr^{-1}
Al IM		41	0.0	-0.65	-0.11	μmol L^{-1} yr^{-1}
Al TM		32	-0.02	-0.64	-0.17	μmol L^{-1} yr^{-1}
DOC		4	-1.44	-9.37	-5.49	μmol L^{-1} yr^{-1}
DOC	30		14.57	-9.37	4.07	μmol L^{-1} yr^{-1}

Plots of selected chemical parameters for Big Moose Lake are provided (Figure 4). The plots are updated through December 2011 and include weekly data (red) collected during snowmelt (March and April). In 2009, despite the lowest concentrations of sulfate and nitrate observed since the onset of sampling in 1982, the ANC values remain below 20 and pH below 6 for the first half of the year, which coincides with the detection of toxic inorganic monomeric aluminum. However, an additonal year of data (shaded area on right of Figure 4) shows that in the last two years (2010 and 2011) the monthly and the weekly snowmelt values (red) have been chemically more benign to biota with pH staying generally above 5.5 and Al IM levels around or below 2 μmol L^{-1}, a critical threshold for aquatic biota. For nitrate, snowmelt nitrate peaks are near 20 μeq L^{-1} and late summer base flow concentrations are nearing detection limits.

Lake Outlet Paired Sampling

Eight of the original 17 lakes used as part of the ALTM have water quality sampling locations at substantial distances downstream from the physical lake outlet (Table 3). These original eight sites were historically sampled by Syracuse University from 1982 to 1992. All sampling locations were chosen at the most accessible sites to allow completion of sampling within a 1–2 day interval.

Table 3. ALTM lakes with paired outlet/pond sampling sites.

Pond Number	Pond Name	Lake Type	Distance Between Sampling Pairs (km)
030256	Black Pond	Thick till drainage low DOC	0.3
040748	Bubb Lake	Thin till drainage low DOC	1.1
040747	Cascade Lake	Medium till drainage low DOC	2.0
040777	Constable Pond	Thin till drainage low DOC	2.7
070729	Otter Lake	Thin till drainage low DOC	0.5
040754	Squash Pond	Thin till drainage high DOC	0.6
040753	West Pond	Thin till drainage low DOC	0.3
040750A	Windfall Pond	Carbonate influenced	2.0

In July 1993, with respect to the eight original Syracuse sites, the ALSC established additional sampling locations at each lake. The intention was to standardize the sampling locations of all 52 lakes, with the goal of conducting sampling at the paired locations for a period of time sufficient to evaluate if there are site differences or locational dependence in chemistry of these waters.

In 2006, a comparison of monthly data at these eight paired sampling sites during 1993-2004 found that the Black Pond and Black Pond Outlet sites were statistically similar and therefore one of the sites could be discontinued. As a result, the upstream site was discontinued in December 2006 (Cirmo et al. 2007). Since the seven additional, unique sites are being continued, the names of the original downstream sites have been augmented with the addition of STREAM in the name label (Appendix A).

Base Cation Surplus

In 2012, the ALSC added base cation surplus (BCS) results to t he parameters reported for the ALTM lakes. Researchers may use BCS along the same lines they use ANC, such as critical load discussions and evaluating ecosystem recovery from acid deposition. As with various critical ANC limits used by state and federal agencies, the BCS threshold of 0 μeq L-1 provides a critical limit, which corresponds to harmful biological effects. Furthermore, the effects of variable DOC concentrations on the mobilization of toxic aluminum can be addressed through the BCS, a chemical index that explicitly includes strongly acidic organic anions (Lawrence et al. 2013, Lawrence et al. 2008a, Lawrence et al. 2007). Like ANC_{Gran} and $ANC_{Calc,}$ the BCS relates closely to IMAl below a threshold value, but unlike ANC_{Gran} and ANC_{Calc}, the BCS threshold of 0 μeq L^{-1} doesn't shift with varying DOC concentrations (Lawrence et al. 2013, Lawrence. et al. 2008b, Lawrence et al. 2007). Values of BCS above zero provide a measure of base-cation availability and indicate how close a water is to the toxic Al mobilization threshold. Therefore, similar to using ANC as an ecological indicator of overall health of an ALTM lake (United States Environmental Protection Agency 2009), the BCS result provides a useful reference point for evaluating acidification recovery in the presence of increasing DOC concentrations (Lawrence et al. 2013).

In 2011, average annual BCS results were higher than 1994 results in 88% of the ALTM waters. The 12% of ALTM waters that did not show average results higher in 2011 represent seven waters that historically have chemistry of moderate or low concern ANC > 50 μeq L^{-1}) (Burns et al. 2011), and/or, waters that have a history of lime application (Table 4). Additionally, nearly 60% of ALTM waters had an average BCS below 0 μeq L^{-1} in 1994, whereas in 2011, approximately 35% of the waters showed values below this critical threshold. This comparison suggests that ALTM lakes have become considerably less acidic since 1994 (Lawrence et al. 2013).

Table 4. Average annual BCS values for 59 ALTM waters in 1994 and 2011.

SITE	PNAME	STATION	1994	2011	2011-1994 Δ
020058	LITTLE HOPE POND	1	13.40	51.82	38.42
020059	BIG HOPE POND	1	21.60	64.68	43.08
020126	LITTLE ECHO POND	1	-74.43	-49.17	25.27
020138	EAST COPPERAS POND	1	-43.60	-31.29	12.32
020143	MIDDLE POND	1	94.60	107.81	13.21
020188	SUNDAY POND	1	-6.78	-3.76	3.02
020197	SOCHIA POND	1	-36.79	-21.02	15.77
020233	OWEN POND	1	111.38	110.98	-0.40
020264	HEART LAKE	1	43.04	50.65	7.61
020265	MARCY DAM POND	1	7.44	27.15	19.71
030171	GRASS POND	1	-37.94	-25.36	12.58
030172	LITTLE CLEAR POND	1	-26.28	67.16	93.44
030255	BLACK POND STREAM	1	210.33	203.29	-7.04
040186	LOON HOLLOW POND	1	-89.32	-39.75	49.57
040210	WILLYS LAKE	1	-69.46	-22.84	46.62
040576	WOODS LAKE	1	10.55	17.51	6.96
040704	MIDDLE SETTLEMENT LAKE	1	-26.72	16.01	42.73
040706	GRASS POND	1	-22.10	6.48	28.59
040707	MIDDLE BRANCH LAKE	1	40.00	51.01	11.02
040739	LAKE RONDAXE	1	19.84	45.91	26.07
040746	MOSS LAKE	1	66.56	87.04	20.48
040747	CASCADE LAKE	1	39.82	56.65	16.83
040747A	CASCADE LAKE STREAM	1	74.14	88.19	14.05
040748	BUBB LAKE	1	36.60	53.43	16.83
		2	31.29	53.57	22.29
040750	DART LAKE	1	-11.12	19.59	30.71
040750A	WINDFALL POND	1	28.51	60.93	32.42
		2	95.52	113.81	18.29
040752	BIG MOOSE LAKE	1	-22.25	14.60	36.85
040753	WEST POND	1	-19.84	-6.21	13.63
		2	-12.28	0.63	12.91
040754	SQUASH POND	1	-81.28	-46.38	34.90
		2	-79.55	-46.84	32.72
040777	CONSTABLE POND	1	-38.69	-3.19	35.50
		2	-57.55	-16.32	41.23
040826	LIMEKILN LAKE	1	3.42	45.78	42.36
040850	SQUAW LAKE	1	-1.61	25.89	27.50
040852	INDIAN LAKE	1	-42.40	-9.88	32.52
040874	BROOKTROUT LAKE	1	-40.64	-0.76	39.88
040887	LOST POND	1	-33.72	-4.97	28.75
040905	BARNES LAKE	1	-2.39	-41.90	-39.52
041004	SOUTH LAKE	1	-30.32	9.06	39.38
041007	NORTH LAKE	1	-32.02	2.71	34.72
050215	WILLIS LAKE	1	41.52	70.53	29.01
050259	JOCKEYBUSH LAKE	1	-27.81	3.35	31.16
050458	CLEAR POND	1	108.48	102.38	-6.09

Table 4 continued.

SITE	PNAME	STATION	1994	2011	2011-1994 Δ
050577	NATE POND	1	63.79	53.68	-10.11
050649	LONG POND	1	-53.94	-24.68	29.26
050669	CARRY POND	1	-26.56	-11.11	15.45
050684	ARBUTUS LAKE	1	76.86	73.66	-3.20
050706	LAKE COLDEN	1	-30.83	-4.79	26.03
050707	AVALANCHE LAKE	1	-46.50	-14.95	31.55
060182	LITTLE SIMON POND	1	75.16	67.38	-7.79
060313	SAGAMORE LAKE	1	15.63	34.76	19.13
060315A	RAQUETTE LAKE RESERVOIR	1	-11.06	21.24	32.30
060329	QUEER LAKE	1	-10.34	16.33	26.68
070728	OTTER LAKE STREAM	1	-15.79	7.83	23.62
070729	OTTER LAKE	1	-25.03	-1.47	23.56
070859	G LAKE	1	-26.74	7.94	34.68

Snowmelt Sampling

In 1993, weekly sampling was initiated in a few ALTM lakes to capture more chemistry during snowmelt. The purpose of collecting more frequent data during the snowmelt period is to assess worse-case conditions to biota during this typically most acidic time of year. The intent was to sample more frequently each spring a total of 10 to 12 waters on a rotating basis from year to year. Sampling commenced at the onset of snowmelt, ended with the disappearance of the snowpack, lasted anywhere from three to eight weeks, and was adjusted with staff availability. Beginning in 2002, the lakes and sampling periods were standardized. The same 12 lakes were sampled each year: Little Echo; East Copperas, Middle, Sunday, Owen, Heart, Moss, Bubb, Big Moose, West, Sagamore; and Raquette Lake Reservoir (Table 1). Sampling begins in the first week of March and ends in the first week of May. All 12 lakes are sampled on the same day each week. The selected lakes generally represent all lake classes throughout the region at elevations ranging between 482 m (Little Echo) and 661 m (Heart). These are typically lakes within easy access of year-round roads so that they can be sampled with available field staff all in one day. Plots of weekly snowmelt and monthly data for the 12 lakes are updated through 2010 and provided in Appendix C. The weekly snowmelt chemistry data for all lakes (1993 - 2011) were posted to www.adirondacklakessurvey.org in 2012.

In 2011, Dr. Charles Driscoll of Syracuse University, continued an analysis of the influence of snowmelt on ALTM lake chemistry including examinations of the processes that contribute to snowmelt acidification and of trends over all and during the snowmelt period.

We also began a preliminary examination of the 12 individual snowmelt lakes with respect to what additional information was provided by more frequent sampling. About half of the lakes seem to show little additional information with increased sampling (Middle Pond, Owen Pond, Heart Lake, East Copperas Pond, Little Echo Pond, and Sunday Lake). Big Moose Lake also does not show significant additional information with the weekly sampling. The remaining lakes (Moss Lake, Bubb Lake, West Pond, Sagamore Lake, and Raquette Lake Reservoir) show additional acidic depressions during the weekly sampling and provide valuable documentation of biologically stressful conditions during this critical time of year. Plots of weekly snowmelt and monthly data for the 12 lakes are provided in Appendix C.

Snowpack Sampling

During 1999 and 2000, mass-balance studies at three ALTM lakes (Grass, Constable, and G) by Myron Mitchell with SUNY College of Environmental Science and Forestry included snow core sampling at these watersheds. When measureable snow was present, monthly samples of snowpack were collected and melt water was analyzed by the ALSC laboratory at each of these watersheds.

Snowpack data from January 1999 through March 2011 was released to the website on 8/20/12. This data release is comprised of three files found at www.adirondacklakessurvey.org. The file 1999-2011ALTM.SNOWPACK.metadata.R.rtf contains description of the snowpack data. The file 1999-2011.ALTM.SNOWPACK.R.xlsx contains the data for the Adirondack Long—Term Monitoring (ALTM) snow core (snowpack) sample sites and site identification information. The support file: 2011-1992.DL.R.xlsx contains detection limit values for chemistry parameters.

ALTM Chemistry Data Reported to Date

Data currently available from this ALTM lake study include the 52 lakes and additional sampling collected at seven outlet pair locations. In 2012, annual mean concentrations of the parameters measured for the 52 lakes from January 1993 through December 2012 and the monthly chemistry data from June 1992 through December 2012 were posted to the ALSC website (http://www.adirondacklakessurvey.org). Data from the additional seven outlet pair locations are also included within these files.

Fisheries Surveys in ALTM Lakes

In 1994, the ALSC began fisheries surveys in ALTM waters. Lake chemistry improvements were anticipated from the 1990 Clean Air Act Amendments increasing interest in aquatic biota sampling. The ALSC had extensive experience with fisheries surveys. A majority of the ALTM lakes had been surveyed as part of the 1984–1987 ALSC survey. The resurveys were conducted following ALSC methods at a rate of 4–8 surveys per year (ALSC 2002a). In 2007, a preliminary analysis of those comparisons indicated that modest changes were detectible in some lakes. As a result, another round of survey was planned for 2008–2012. This new survey also presented an opportunity to evaluate fish tissue mercury concentrations in selected fish populations.

The rationale for fish mercury analysis was based, in part, on the findings of the NYSERDA study conducted during 2003–2005 by NYSDEC in collaboration with ALSC. In their statewide survey of mercury in fish in 131 lakes and reservoirs, Simonin et al. 2008 found the Adirondack and Catskill Park regions containing higher levels of mercury in fish than in other parts of the state. Of the chemical and physical characteristics of lakes examined, lake acidity (pH) was the most important variable associated with high mercury levels in fish. Species sampled included: yellow perch; small and largemouth bass; and walleye. While brook trout are an important sport fish for the Adirondacks, relatively few mercury data are available in part because this species is considered less prone to accumulating mercury.

Sampling Design

The current ALTM fisheries resurvey was concluded in 2012. It included total and methyl mercury analysis in yellow perch and brook trout. All fish were analyzed for total mercury, whereas a subset were analyzed for methyl mercury. All lake water samples were analyzed for total mercury and methyl mercury. The resurvey schedule was based on the interval between the two previous surveys and existing staff levels. Table 5 shows the dates of the surveys, the years between surveys, and the number of target species caught and analyzed for mercury.

Table 5. Five-year schedule of ALTM lakes resurvey 2008–2012.

							Analyzed		Caught	
			ALS Dates	LTM Dates	Scheduled Year	Date Sampled	Yellow	Brook	Total	Total
Year	Pond No.	Pond Name	dd/mm/yyyy	dd/mm/yyyy	yyyy	dd/mm/yyyy	Perch	Trout	YP	ST
2008	020059	Big Hope Pond	22/05/1984	17/05/1994	2008	12/11/2008	0	24	0	25
	020233	Owen Pond	13/09/1984	24/05/1994	2008	25/09/2008	0	1	0	1
	030172	Little Clear Pond	09/10/1984	23/05/1994	2008	09/10/2008	0	7	0	7
	030171	Grass Pond	09/10/1984	15/06/1998	2008	09/10/2008	0	0	0	0
	040887	Lost Pond	12/09/1984	23/06/1994	2008	23/10/2008	0	6	0	6
	070859	G Lake		14/06/1994	2008	01/10/2008	0	31	0	32
	050669	Carry Pond	24/09/1987	23/06/1994	2008	16/10/2008	0	24	0	39
	040850	Squaw Lake	18/09/1984	17/10/1994	2008	21/08/2008	0	12	0	12
	040852	Indian Lake	17/09/1984	17/10/1994	2008	15/10/2011	0	1	0	1
2009	020058	Little Hope Pond	22/05/1984	15/05/1995	2009	15/10/2009	0	7	0	7
	020197	Sochia Pond	10/05/1984	22/05/1995	2009	24/06/2009	0	0	0	0
	040748	Bubb Lake	21/05/1986	19/09/1995	2009	24/09/2009	0	8	0	8
	040750A	Windfall Pond	07/06/1985	24/05/1995	2009	12/05/2009	0	0	0	0
	050458	Clear Pond	20/10/1987	24/04/1995	2009	28/10/2009	0	2	0	2
	050259	Jockeybush Lake	02/09/1987	17/07/1996	2009	08/10/2009	0	27	0	36
	040576	Woods Lake		27/05/1997	2009	19/05/2009	0	0	0	23
	020126	Little Echo Pond		28/05/1998	2009	29/06/2009	0	0	0	0
	020138	East Copperas Pond	19/07/1984	27/05/1998	2009	17/06/2009	0	0	0	0
	020143	Middle Pond	16/05/1984	27/05/1998	2009	10/09/2009	22	0	37	0
	040754	Squash Pond	29/05/1986	17/06/1998	2009	15/06/2009	0	0	0	0
	040752	Big Moose Lake	25/09/2000	25/09/2000	2009	22/10/2009	25	4	28	4
	040739	Lake Rondaxe	07/10/1986	18/10/2000	2009	18/09/2009	13	4	23	4
2010	050649	Long Pond	09/09/1987	15/06/1998	2010	21/06/2010	0	0	0	0
	030256	Black Pond	10/10/1985	15/07/1998	2010	25/10/2010	0	21	0	25
	040706	Grass Pond	18/09/1984	18/05/1999	2010	07/10/2010	0	0	0	0
	040747	Cascade Lake	12/06/1984	16/06/1999	2010	27/09/2010	25	1	82	1
	040753	West Pond	06/06/1985	26/05/1999	2010	23/06/2010	0	0	0	0
	040777	Constable Pond	11/06/1984	24/05/1999	2010	14/10/2010	25	6	109	6
	060329	Queer Lake	22/05/1986	14/06/1999	2010	20/10/2010	0	13	0	13
	070729	Otter Lake		22/07/1999	2010	28/06/2010	0	0	0	0
	040746	Moss Lake	23/09/1986	21/08/2000	2010	26/10/2010	25	0	48	1
	040750	Dart Lake	23/09/1986	27/09/2000	2010	19/10/2010	25	2	40	2
	020188	Sunday Pond	11/10/1984	07/06/2000	2010	09/09/2010	0	14	0	14
2011	050215	Willis Lake	09/09/1987	21/05/2001	2011	08/09/2011	5	0	14	0
	041004	South Lake	16/09/1986	25/06/2001	2011	27/09/2011	0	20	0	28
	041007	North Lake	16/09/1986	25/06/2001	2011	26/08/2011	20	0	119	0
	050684	Arbutus Lake	na	27/06/2001	2011	06/10/2011	0	20	0	20
	060313	Sagamore Lake	09/10/1986	18/06/2001	2011	15/09/2011	19	10	19	11
	060315A	Raquette Lake Reservoir	10/10/1985	19/06/2001	2011	21/09/2011	0	16	0	18
	040186	Loon Hollow Pond	18/06/1985	28/05/2002	2011	23/05/2011	0	0	0	0

Table 5 continued.

Year	Pond No.	Pond Name	ALS Dates dd/mm/yyyy	LTM Dates dd/mm/yyyy	Scheduled Year yyyy	Date Sampled dd/mm/yyyy	Analyzed Yellow Perch	Analyzed Brook Trout	Caught Total YP	Caught Total ST
	040905	Barnes Lake	06/09/1985	29/10/2002	2011	19/05/2011	0	0	0	0
	020264	Heart Lake	07/05/1985	26/05/2004	2012	13/10/2011	0	15	0	16
	050706	Lake Colden	20/10/1987	29/09/2004	2012	13/06/2011	0	0	0	0
	050707	Avalanche Lake	22/10/1987	29/09/2004	2012	13/06/2011	0	0	0	0
	060182	Little Simon Pond	14/05/1985	19/06/2002	2011	17/10/2011	0	14	0	14
2012	020265	Marcy Dam Pond	14/05/1985	25/05/2004	2012	10/05/2012	0	12	0	12
	040704	Middle Settlement Lake	18/09/1984	18/06/2003	2012	09/13/2012	0	7	0	7
	040707	Middle Branch Lake	19/09/1984	16/06/2004	2012	09/12/2012	0	3	0	3
	040826	Limekiln Lake	15/10/1985	06/10/1997	2012	10/18/2012	20	22[1]	29	22[1]
	040210	Willys Lake (Horseshoe)	06/06/1984	28/05/2005	2012	05/07/2012	0	0	0	0
	050577	Nate Pond	28/10/1987	18/10/2005	2012	09/26/2012	0	8	0	8
	040874	Brook Trout Lake	29/06/1984	26/06/2002	2012	10/17/2012	0	19	0	18

[1] Splake

As part of this effort, a lake water chemistry sample and other field parameters are also collected at the time of the fish survey (fall or spring). In July a more extensive lake water sample was collected from all waters scheduled for fish survey for that calendar year. All mercury water samples collected for mercury analyses were taken according to "Clean Hands/Dirty Hands" protocol. Samples are kept cool and shipped overnight to Frontier Global Sciences in Seattle, WA for analysis of mercury in lake water.

ALSC follows ALS fisheries survey protocols conducting fish surveys in the spring or fall, with no surveys during July and August. Experimental gill nets are the primary equipment used along with minnow gill nets and minnow traps. The number of gill nets set in each survey is based on the surface area of the lake. Nets are set according to previous surveys for comparability. All sport fish and yellow perch are weighed, have lengths measured, and have scale samples and opercular bones taken for aging individuals. Fish are processed at the NYSDEC laboratory at Hale Creek by ALSC staff according to the NYSDEC Bureau of Habitat Fish Preparation Procedures for Contaminant Analysis (Simonin et al. 2008). The samples are processed, frozen and shipped to Cebam Analytical, Inc. in Seattle, WA, for analysis of mercury in fish tissue.

Field collections have been completed in all ALTM lakes. Fish and water samples have been analyzed. In all, yellow perch were found in 11 lakes with 224 individuals analyzed for mercury. Brook trout were found in 33 lakes with 381 individuals analyzed for mercury. Fish speciments were processed at the NYSDEC hale Creek Laboratory and anlyzed by Cebam Analytical for total and methyl mercury. Water samples were analyzed by Frontier Global Sciences for total and methyl mercury.

Seven lakes were surveyed for fish in 2012. Marcy Dam Pond was not surveyed in 2011 due to a dam breach following a high water event, however it was surveyed in 2012. The survey included a mercury water sample in July and brook trout were collected in October by angling. Splake in Limekiln Lake were analyzed for mercury as a surrogate for brook trout. All seven waters had water samples collected in July and analyzed by Frontier Global Sciences, Inc. One yellow perch, five brook trout and one splake population were caught and analyzed for mercury from six of the seven lakes (Table 5). The 2012 fish specimens were processed in November at the NYSDEC Hale Creek Laboratory by ALSC staff and analyzed by Cebam Analytical in December 2012.

Results

Preliminary results indicate that changes in fish populations between 1984–1987 and 1994–2005 are highly variable. There are signs of response/recovery in the number of fish species in some lakes over the average 14-year interval, but they are modest and mixed. Overall, the recent survey netted 169 fish populations compared to 141 populations from the same lakes in the earlier survey (Table 5). The greatest species gains occurred in moderately sized lakes with pH 5.5 – 6.0. Fish response patterns were generally consistent with ANC, NO_3^- and Al IM trends. Preliminary results were presented at the 2009 NYSERDA EMEP Conference: http://www.nyserda.ny.gov/Page-Sections/Environmental-Research/EMEP/Conferences/2009-EMEP-Conference.aspx. The median, mean, and maximum number of fish species (populations) per lake and are shown in Tables 6a, 6b and 7. Lakes arranged by fish response classes show the greatest changes in medium sized lakes with 5.5–5.7 pH (Table 6a).

Table 6a. Fish population changes in 42 ALTM lakes between 1984–1987 and 1994–2005 survey.

Period of Study	Fish Populations Total all Lakes	Median per Lake	Mean	Maximum
1984-1987	141	3	3.36	10
1994-2005	169	4	4.02	12
Change	+28	+1	<1	+2

Table 6b. Changes in fish communities in Adirondack lakes between 1984–1987 and 1994–2005.

Category	n	Median pH	Volume (10^4 m^3)	Species Richness 1984 - 1987	Species Richness 1994 - 2005	Δ
No fish	10	4.7 - 4.7	46	0	0	0
No change	8	5.3 - 5.5	100	2.0	2.0	0
Only gained	15	5.5 - 5.7	198	4.1	6.0	+1.9
Only lost	4	6.3 - 6.3	56	3.0	1.75	-1.25
Gained and lost	8	6.2 - 6.5	350	7.1	7.0	+0.9

Table 7. Cascade Lake was one of 15 lakes that only gained species between the 1984 and 1999 surveys.

Cascade Lake - ALS Survey 1984

pH=6.48

Species n=4	Val =1	Val=1-2	Min pH	Serial Number
Brown Bullhead	1	1	4.49	2.5
Yellow Perch	1	1	4.53	4.0
Brook Trout	1	1	4.64	8.0
White Sucker	1	1	4.64	8.0
Total	4	4	18.30	22.5
Median	—	—	4.59	6.0

Cascade Lake - Resurvey 1999

pH=6.73

Species n=8	Val =1	Val=1-2	Min pH	Serial Number
Brown Bullhead	1	1	4.49	2.5
Golden Shiner	1	1	4.49	2.5
Yellow Perch	1	1	4.53	4.0
Pumpkinseed	1	1	4.59	5.0
Brook Trout	1	1	4.64	8.0
Creek Chub	1	1	4.64	8.0
White Sucker	1	1	4.64	8.0
Common Shiner	1	1	4.86	14.5
Total	8	8	36.88	52.5
Median	—	—	4.62	6.5

During 2011, fisheries analysis continued on a closer examination of fish management records (e.g., stocking), fish community indices (Tables 6a and 6b).

Fish tissue mercury results from 2008-2012 surveys found total mercury concentrations in yellow perch and brook trout ranging from 81 to 3155 ng g^{-1} and 5 to 1008 ng g^{-1} on a wet weight basis, respectively (Tables 8a and 8b).

Table 8a. Total Mercury concentrations (ng g^{-1} wet weight) measured during 2008-2012 in the two target fish species collected. Results are aggregated from Adirondack Long Term Monitoring lakes.

	Total Mercury (ng g^{-1}) Range			
Species	**n**	**Min**	**Max**	**Average**
Brook Trout	**359**	**5.50**	**1008.44**	**220.22**
Yellow Perch	**215**	**81.30**	**3155.95**	**454.10**

Table 8b. Methyl Mercury concentrations (ng g^{-1} wet weight) measured during 2008-2012 in the two target fish species collected. Results are aggregated from Adirondack Long Term Monitoring lakes.

	Total Mercury (ng g-1) Range			
Species	**n**	**Min**	**Max**	**Average**
Brook Trout	**71**	**4.35**	**734.17**	**215.02**
Yellow Perch	**43**	**63.92**	**3039.56**	**441.98**

Data Reported to Date

The fisheries survey data are currently being analyzed. It is anticipated that the data along with the fish tissue mercury results will be available at the end of the project period and reported in the next annual report.

Temporally Integrated Monitoring of Ecosystems (TIME) Lakes

The Temporally Integrated Monitoring of Ecosystems (TIME) program began as part of a northeastern lakes survey in the early 1990s. Under the auspices of the USEPA Environmental Monitoring and Assessment Program (EMAP), TIME was a statistically-based rotating sampling program (Whittier et al. 2002) that collected lake chemistry and biological data on nearly 250 lakes in New England, New York, and New Jersey during 1991–1996 (USEPA 1993a; USEPA 1993b).

The purpose of EMAP was to monitor ecological indicators of U.S. natural resources across a spectrum of issues including eutrophication and acid deposition over several types of landscape features such as forests, wetlands, arid areas, including surface waters (lakes and streams). The approach was statistically based to assess current status, geographic extent, proportion of the resource population affected, the trends and probable causes (Whittier and Paulsen 1992). For lakes, EMAP Surface Waters evaluated biotic integrity, trophic condition, and fishability of lakes and streams. The sampling time frame was every four years. The framework is described (Whittier and Paulsen 1992) as consisting of 40 km^2 hexagons in a triangular spaced grid representing approximately 12,500 points for the conterminous US. The grid density was increased three-fold in two high elevation acid sensitive areas of the Northeast, the Adirondack Mountain region and the southern Green Mountains/north central Massachusetts/ southwestern New Hampshire Uplands subregion (Whittier and Paulsen 1992).

TIME is a statistically based sampling program that enables population estimates of low ANC lakes to be developed from 43 sites in the Adirondacks. There are approximately 1,000 low ANC (less than 100 $\mu eq\ L^{-1}$) lakes in the region out of a total population of 1,830 lakes with a surface area greater than one ha (Stoddard et al. 2003). This monitoring program enables researchers to monitor sensitive lakes over time. The goal of the program is to track the effectiveness of the 1990 Clean Air Act Amendments in the reduction of acidified surface waters. In addition to the 43 Adirondack lakes sampled once each year in the late summer/ early fall, 30 New England lakes and 31 Appalachian streams are sampled by other investigators. An overview of these varied regional monitoring efforts and their relevance to developing scientifically-supported national policies to abate atmospheric emissions are provided by EPA (USEPA 1995). The TIME sampling design and tests of its ability to detect trends in ANC and sulfate are provided by Stoddard et al. (1996).

In the eastern US, the core of the EPA acid rain effects monitoring effort are the TIME and Long Term Monitoring (EPA LTM) programs. Both programs are operated in collaboration with academic institutions, state agencies, or other federal agencies (Stoddard et al. 2003). Two aspects of the TIME program include the design based probability sample called the TIME survey sites and the model-based aspect using a non-random group of lakes. The second group of lakes is sampled more frequently (8 – 16 times per year) to build links between chronic and episodic acidification (Stoddard et al. 1996). These long term monitoring (EPA LTM) efforts began in the early 1980s including lakes from Vermont, Maine, and 17 Adirondack lakes that became known as the Adirondack Long Term Monitoring (ALTM) lakes (Figure 5). These provide a characterization of seasonal or episodic acidification. In many of the regions, the sites include some higher ANC sites (i.e. greater than 100 $\mu eq\ L^{-1}$ ANC) to help separate effects of disturbances (e.g. climate) other than acidic deposition (Stoddard et al. 2003).

This probability-based survey allowed inferences to be made on the entire population of lakes in the Northeast, which numbered 10,381 in New York and New England combined. The survey was conducted in late summer during low flow conditions, so ANC values are expected to be the highest. Lakes were divided into biologically relevant ANC classes where: ANC levels of $< 0\ \mu eq\ L^{-1}$ are acute concern or chronically acidic; ANC > 0 and $< 50\ \mu eq\ L^{-1}$ are elevated concern or susceptible to episodic acidification; and ANC values > 50 and $< 100\ \mu eq\ L^{-1}$ are moderate concern. Results from the Adirondack region representing a population of 1,812 lakes (surface area greater than one ha) found 10% had ANC values of $< 0\ \mu eq\ L^{-1}$ (chronically acidified) and an additional 31% of all lakes where critically acidified with values of ANC > 0 and $< 50\ \mu eq\ L^{-1}$ bringing the total population of lakes with elevated or acute concern to 41% (Driscoll et al. 2001). A charge-balance technique for evaluating the nature of the acid inputs to these lakes found 83% of the acid sensitive lakes (ANC $<50\ \mu eq\ L^{-1}$) were dominated by inorganic anions with sulfate constituting 82% of the total anionic charge (Driscoll et al. 2001).

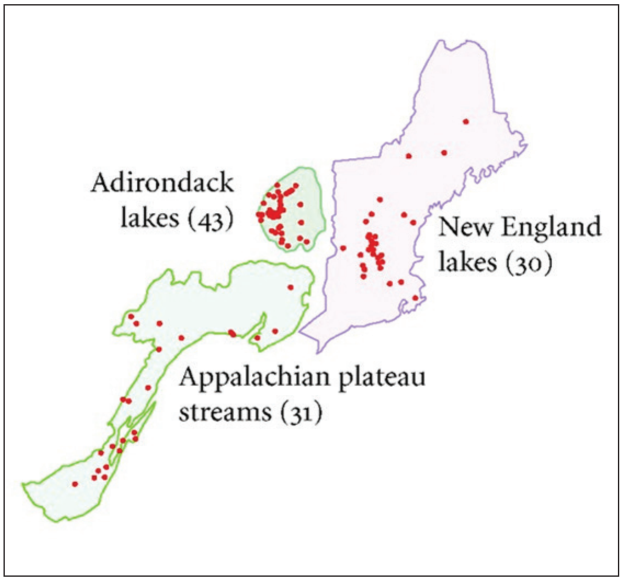


Figure 5. TIME Regional Surveys 1991–2000.

Site Description

EMAP lake sampling in the Adirondack region began in 1991 with a selection of different lakes each year: 1991 (26 lakes); 1992 (41 lakes); 1993 (23 lakes) and 1994 (27 lakes) for a total 117 lakes. In 1999, one set of 43 lakes was selected for annual sampling, which has been ongoing.

Table 9 identifies TIME/EMAP lake name and identification number, the NYSDEC/ALSC lake name and identification number. The surface area data were derived from the ALSC survey 1984–1987 and from NYSDEC sources for the 13 lakes that were not part of the survey. The lake classification is based on Newton and Driscoll (1990) developed from the ALSC survey. For non-ALSC surveyed lakes, chemistry data from the 1991–1994 EMAP were used. Of these 43 lakes, six are cross-over lakes with the ALTM program (Table 1).

Table 9. Adirondack TIME lake characteristics.

EMAP Ref #	ALSC Ref #	TIME/EMAP Pond Name	ALS/DEC Pond Name	Elev. (m)	Classification	Area (ha)
NY012L	020059	Hope Pond	Big Hope Pond	517	Medium till drainage High DOC	8.9
NY250L	030101	Twin Pond (E)	Upper Twin Pond	403	Thin till drainage, Low DOC	6.0
NY033L	030128	Dry Channel Pond	Dry Channel Pond	497	Thin till drainage, Low DOC	27.4
NY297L	030273	Bickford Pond	Bickford Pond	532	Thin till drainage, Low DOC	4.4
NY299L	030276	Pd. Near Spitfire Lake	Unnamed Pond	495	Flow through seepage, High DOC	2.1
NY278L	030331	Parmeter Pond	Parmeter Pond	351	Flow through seepage, High DOC	7.1
NY515L	030360	Wolf Pond	Wolf Pond	451	Thin till drainage, Low DOC	8.9
NY285L	030373	Horseshoe Pond	Horseshoe Pond	466	Thin till drainage, Low DOC	10.4
NY284L	030374	Boottree Pond	Boottree Pond	464	Flow through seepage, Low DOC	6.2
NY527L	040137	Rocky Lake	Rock Lake	424	Thin till drainage, Low DOC	8.2
NY790L	040203	Lower Beech Ridge Pond	Unnamed Pond	630	Thin till drainage, Low DOC	9.3
NY789L	040210	Willys Lake	Willys Lake	632	Thin till drainage, Low DOC	24.3
NY275L	040424	Taylorville Pond	Taylorville Res.	326	Medium till drainage Low DOC	37.5
NY277L	040426	Effley Falls Pond	Effley Falls Res.	354	Thin till drainage, Low DOC	121.5
NY791L	040515	Dismal Pond	Dismal Pond	624	Mounded seepage, Low DOC	21.5
NY792L	040518	No Name	Cat Pond	532	Thin till drainage, High DOC	6.7
NY788L	040528	Witchhopple Lake	Witchhopple Pond	536	Thin till drainage, Low DOC	37.6
NY029L	040566	Little Lilly Pond	Unnamed Pond	596	Thin till drainage, High DOC	6.5
NY280L	040573	Razorback Pond	Razorback Pond	675	Thin till drainage, Low DOC	5.3
NY281L	040579	Snake Pond	Snake Pond	589	Thin till drainage, Low DOC	7.3
NY794L	040620	Payne Lake	Payne Lake	383	Flow through seepage, High DOC	7.0
NY030L	040769	Upper Sister Lake	Upper Sister Lake	590	Thin till drainage, High DOC	32.0
NY014L	040850	Squaw Lake	Squaw Lake	646	Thin till drainage, Low DOC	36.4
NY015L	040852	Indian Lake	Indian Lake	654	Thin till drainage, Low DOC	33.2
NY798L	050607	Little Moose Pond	Little Moose Lake	695	Thin till drainage, Low DOC	11.3
NY282L	041004	South Lake	South Lake	615	Thin till drainage, Low DOC	197.4
NY279L	041007	North Lake	North Lake	555	Thin till drainage, Low DOC	176.8
NY536L	050131A	Miner Mill Vly	Miner Mill Vly	479	Medium till drainage, High DOC	3.3
NY256L	050182	Bennett Lake	Bennett Lake	356	Thin till drainage, Low DOC	14.8
NY505L	050197	Lixard Pond	Lixard Pond	528	Thick till, Low DOC	11.7
NY013L	050298	Second Pond	Second Pond	681	Thin till drainage, Low DOC	18.0
NY526L	050715	Henderson Lake	Henderson Lake	553	Thin till drainage, Low DOC	102.1
NY782L	060039	McCuen Pond	McCuen Pond	456	Thin till drainage, High DOC	2.6
NY288L	060074	Seven Sisters Pond	Seven Sisters Pond	469	Mounded seepage, Low DOC	3.0
NY287L	060126	Antediluvian Pond	Antediluvian Pond	532	Thin till drainage, High DOC	5.3
NY291L	060127	Doctors Pond	Doctors Pond	556	Thin till drainage, Low DOC	10.2
NY286L	060129	Rock Pond	Rock Pond	525	Thin till drainage, High DOC	112.2
NY767L	060146	Trout Pond	Trout Pond	545	Thin till drainage, Low DOC	63.4
NY292L	070717	Canada Lake	Canada Lake	472	Salt impacted	217.7
NY017L	070790	Big Alderbed	Big Alderbed	549	Thin till drainage, Low DOC	17.7
NY018L	070823	Long Lake	Long Lake	667	Thin till drainage, Low DOC	21.7
NY507L	070885	No Name	Castor Pond	700	Thin till drainage, High DOC	5.3
NY797L	070936	Whitney Lake	Whitney Lake	752	Thin till drainage, Low DOC	42.6

Sampling Design

TIME sites were selected using methods developed for the EMAP investigation (Hughes et al. 2000). The 43 Adirondack TIME lakes are sampled once in late summer/early fall each year (Figure 6). Samples are collected at a depth of 1.5 m (0.5 m if lake depth is less than 2.0 m), using a Van Dorn sampler. The samples, collected in two 60-mL syringes and two 1-liter Nalgene high density polyethylene bottles, are transported from the field on ice and shipped overnight to the EPA designated laboratory for analysis (ALSC 2002b). Water samples are also collected in separate bottles for speciated aluminum analysis by the ALSC laboratory since 2006. Samples are delivered directly to the laboratory in Ray Brook, New York.

Samples are analyzed by the EPA-designated laboratory for the following parameters: pH, ANC, specific conductance, color, nitrate, sulfate, chloride, fluoride, calcium, magnesium, potassium, sodium, silica, ammonium, dissolved organic carbon, dissolved inorganic carbon, and total aluminum. The ALSC laboratory provides total dissolved aluminum, total monomeric aluminum, total organic monomeric aluminum, and total inorganic monomeric aluminum (calculated). Analytical procedures follow EPA standards developed and described elsewhere (Morrison et al. 1991; ALSC 2002a; Driscoll and van Dreason 1993; Burns et al. 2006).

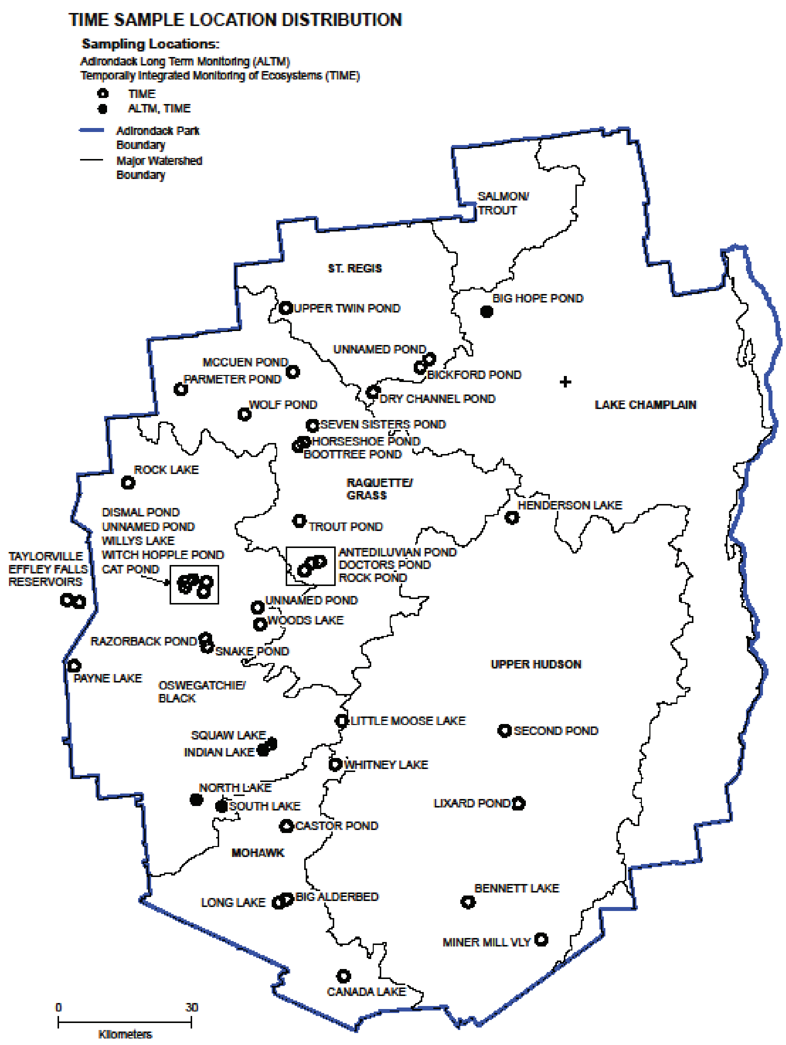
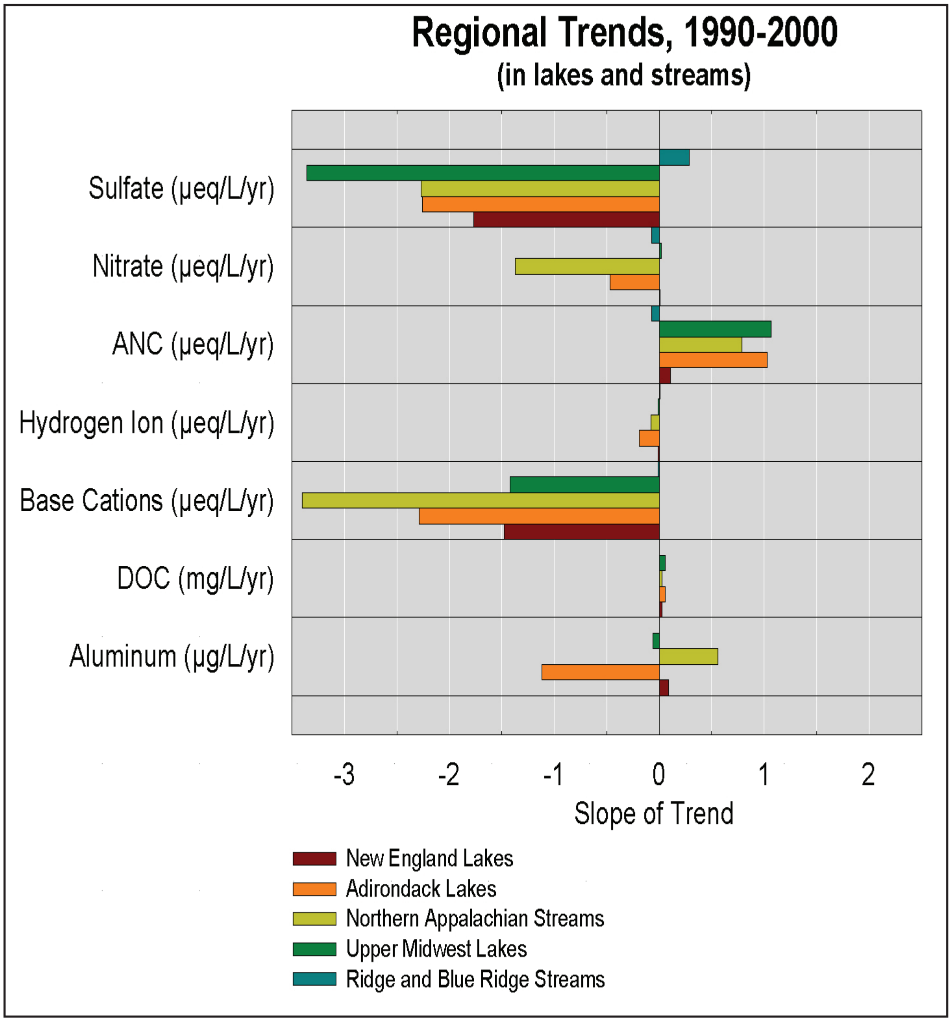


Figure 6. TIME and LTM sample locations.

Results

Chemistry Trends 1990–2000

Using EMAP, TIME, and EPA LTM surface water chemistry, Stoddard analyzed regional trends in five sensitive areas of the eastern US over the time period 1990–2000 (Stoddard et al. 2003). The EPA LTM lakes in the Adirondack region are referred to as the ALTM lakes. Trend analysis was conducted on 48 ALTM lakes (non-limed) sampled on monthly basis (Figure 6). Includes both drainage and seepage lakes in the ANC range -50 to 100 µeq L^{-1} with three lakes in the >100 but < 200 µeq L^{-1} range (Stoddard et al. 2003). In three regions (Adirondacks, Northern Appalachian Plateau, and Upper Midwest) ANC increased at a rate of 1–2 µeq L^{-1} yr^{-1} despite a decrease in base cations. In the Adirondacks, declines in sulfate occurring in nearly all lakes (2.5 µeq L^{-1} yr^{-1}) and in some lakes declines in nitrates (0.5 µeq L^{-1} yr^{-1}). This combination resulted in pH increases in many lakes (Figure 7). In evaluating lake chemistry responses to atmospheric deposition trends, only sulfate was closely examined because changes in nitrate emissions and deposition were insignificant. During this period 1990–2000, the rate of decline in precipitation sulfate concentrations compared with surface water concentrations varies among the regions. In the Adirondacks, New England, and the Northern Appalachians, declines in precipitation were greater than declines in surface water concentrations, suggesting a lagged response. The five factors identified as important in determining response/recovery in surface water chemistry are: base cations, nitrogen deposition, natural organic acidity, climate fluctuations, and lag in response (Stoddard et al. 2003).



Regional trends in surface water chemistry response from five sensitive areas of the US during 1990–2000. Source: Stoddard et al. 2003. Response of Surface Water Chemistry to the Clean Air Act Amendments of 1990.

Figure 7. Regional trends in surface water chemistry.

Chemistry Trends 1990–2007 and Ongoing

EPA's 1990–2007 update of regional trends in four sensitive areas of the eastern US found continued sulfate declines in surface water chemistry in three of the regions including the Adirondacks where declines averaged 2.2 µeq L^{-1} yr^{-1}. Nitrate declines in some Adirondack lakes occurred at a rate of 0.2 µeq L^{-1} yr^{-1}. ANC increases occurred in the same three regions with Adirondack trends averaging 0.77 µeq L^{-1} yr^{-1} (EPA Acid Rain Program 2008 Progress Report found at http://www.epa.gov/airmarkets/progress/arp08.html). In the Adirondack region, all significant trend slopes (rates of change) have diminished from the previous 1990–2000 assessment.

EPA conducted another assessment during this time period examining 156 northeastern US lakes monitored in the TIME and LTM programs. ANC changes were evaluated between 1992–1994 and 2004–2007. Adirondack lakes were included in this data set. Lakes with ANC levels below 0 µeq L^{-1} are considered of acute concern because aquatic biota in these ecosystems are severely compromised. The evaluation found lakes with 3-year average ANC values below 0 µeq L^{-1} occurred in 30% of the total population in 1992–1994. The percentage of lakes in the same category had diminished to 18% by 2004–2007(http://www.epa.gov/airmarkets/progress/arp08.html).

The EPA Clean Air Markets Division published a series of reports in 2010 under Acid Rain Program 2009 Progress Reports (http://www.epa.gov/airmarkets/progress/). The ALTM lakes data were featured prominently in Environmental Results (October 2010) and Highlights: 15 Years of Results (December 2010). Critical loads for sulfur and nitrogen deposition were established for Northeast and Adirondack lakes. Calculations of critical loads exceedences for two time periods 1989-1991 and 2007-2009 were compared for each region. In the Adirondacks, 37% of lakes with exceedences in the earlier time period no longer were receiving critical loads considered threatening to those lakes. The region, however, remained among the areas with the highest concentration of lakes where acid deposition exceeded the critical loads.

During 2010, two analyses were conducted on Adirondack TIME chemistry, with manuscripts under preparation for both. One was a comparison of the TIME and ALTM results using the six cross-over lakes in common with both projects. Chemistry trends (1992-2008) for sulfate, nitrate, base cations, dissolved organic carbon, hydrogen ion, ANC, and aluminum found sulfate and base cations better represented in the annual TIME data than the other parameters associated with seasonal variability. Seasonal concentrations of total and inorganic aluminum were also examined relative to annual only data. The second analysis involved a broader time series (1991-2007) examination of all the TIME waters with a focus on two measures of ANC and the change in ANC sensitivity classes over the record.

The two manuscripts were accepted in 2011. Civerolo et al. (2011) found at the six crossover lakes (Figure 8) (Big Hope, Squaw, Indian, Willys, South, and North) key chemical parameters paired in time and analyzed by different laboratories generally agreed well Figure 9 (sulfate and ANC plots).

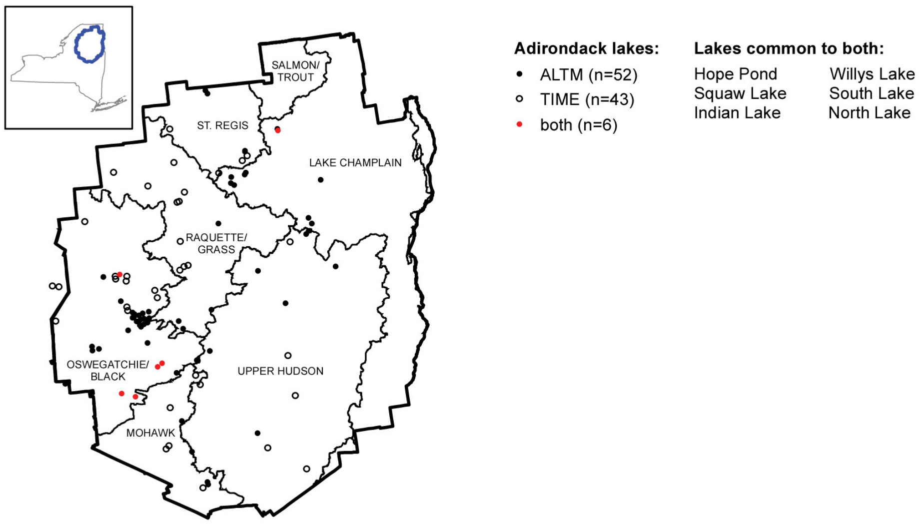


Figure 8. Location of 52 ALTM (black) and 43 TIME (open circles) and the six crossover lakes (red) common to both projects.

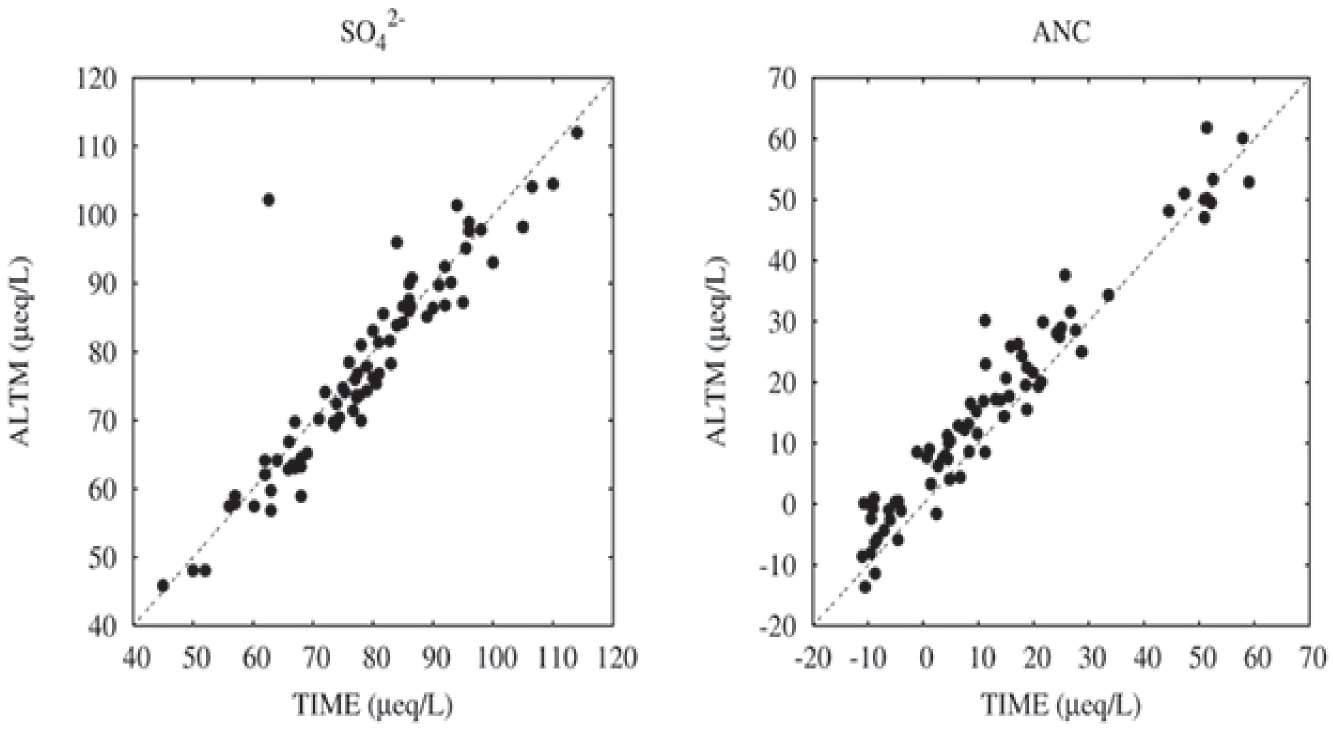


Figure 9. Comparison of sulfate and ANC from TIME and ALTM at six crossover lakes during 1992-2008.

Comparison of monthly ALTM sampling trends with annual TIME trends were consistent for sulfate and the sum of the base cations but not very consistent for ANC and total aluminum (Table 10).

Table 10. The range of long term trends from TIME and ALTM at six crossover lakes using Mann-Kendall for TIME and Seasonal Kendall for ALTM during 1992 - 2008. The number of lakes with significant trends ($p<0.05$) are shown with the range of slopes.

	TIME	ALTM
SO_4^{2-}, µeq L^{-1} yr^{-1}	-3.44 to -2.03 (n=6)	-3.36 to -2.11 (n=6)
ΣCB,µeq L^{-1} yr^{-1}	-2.41 to -1.05 (n=5)	-2.48 to -0.98 (n=5)
NO_3^-, µeq L^{-1} yr^{-1}	-1.16 to -0.81 (n=3)	-1.10 to -0.22 (n=5)
DOC, µmol L^{-1} yr^{-1}	+6.25 to +9.44 (n=2)	+3.60 to +6.74 (n=3)
H^+, µeq L^{-1} yr^{-1}	-0.17 (n=2)	-0.31 to -0.04 (n=5)
ANC, µeq L^{-1} yr^{-1}	+0.65 to +1.49 (n=2)	+0.70 to +2.08 (n=6)
Total Al, µmol L^{-1} yr^{-1}	Non-significant	-0.56 to -0.17 (n=4)
Al_{IM}, µmol L^{-1} yr^{-1}	N/A	-0.65 to -0.01 (n=5)

ANC, nitrate, DOC and pH exhibited varying degrees of consistency in magnitude and statistical significance of trends (Table 10). Because these parameters along with aluminum have substantial seasonal variability (Figure 10) and are biologically relevant to aquatic biota, the authors concluded that both projects/approaches are needed to assess the full impacts of acidification.

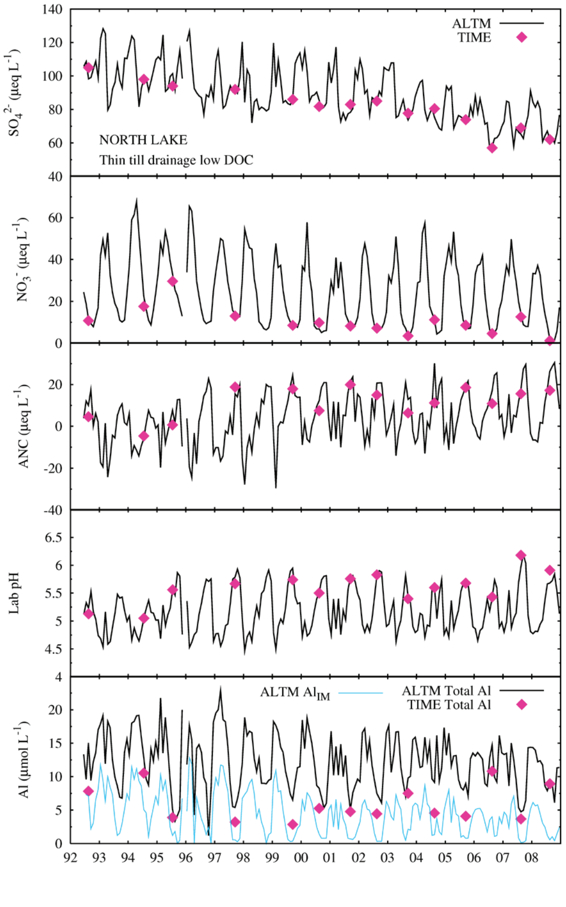


Figure 10. Time series of selected parameters at North lake (1992 - 2008) from ALTM and annual (diamonds) from TIME.

Waller et al. (2012) used the NADP NTN and TIME to evaluate response of lake watersheds to changes in sulfur and nitrogen oxides from 1991 to 2007. Decreases in wet sulfate deposition corresponded to decreases in lake sulfate. Lake ANC changes resulted in shifts among lake ANC classes. The percentage of acidic lakes (ANC < 0 ueq L-1) decreased from 15.5% (284 lakes) to 8.3% (152 lakes) over the period. ANC determined by Gran plot analysis and by calculation of major ion chemistry showed dissimilar values likely due to increases in naturally occurring organic acids. These differences are important to understanding surface water recovery (Waller et al. 2012). The once-per-year population-based TIME study and the monthly ALTM study with seasonal data and aluminum speciation together provide complementary measurements to assess the full impacts of acidification in the Adirondack region.

Data Reported to Date

Data currently available from this TIME lake study (this section) include the original EPA EMAP data for the lakes (available at http://www.epa.gov/emap/html/data/surfwatr/data/nelakes.html). The EPA LTM/TIME program is responsible for making available the TIME lake chemistry data. Additional chemistry data (i.e., speciated aluminum) analyzed by the ALSC laboratory for the 43 lakes were provided to EPA for the 2006-2009 sampling seasons. In 2012, the ALSC collected water samples from the 43 lakes, and provided speciated aluminim chemistry for the same lakes sampled in 2011. Additional data may be available by contacting the NYSDEC Research Manager.

Stream Chemistry

The streams component of the ALTM program began in June 1992 at the completion of the USEPA Episodic Response Project (ERP). The ERP examined the chemistry and biological effects of episodes, defined as a period of time when Acid Neutralizing Capacity (ANC) values decreased to less than or equal to 0 μeq L^{-1}, in 13 streams from the fall of 1988 through the spring of 1990 in three study regions: the Catskill and Adirondack Mountains of New York, and the Northern Appalachian region of Pennsylvania. The Adirondacks were represented by four streams: Buck Creek, Bald Mountain Brook, Seventh Lake Inlet, and Fly Pond Outlet. The streams are located in the southwestern highlands area within the Oswegatchie-Black watershed (Figure 11). The bedrock, surficial geology, and soils in these watersheds are considered typical of the region. Fly Pond Outlet is the only stream with a small pond as headwater, and is the reference stream for biological studies (Wigington et al. 1996a).

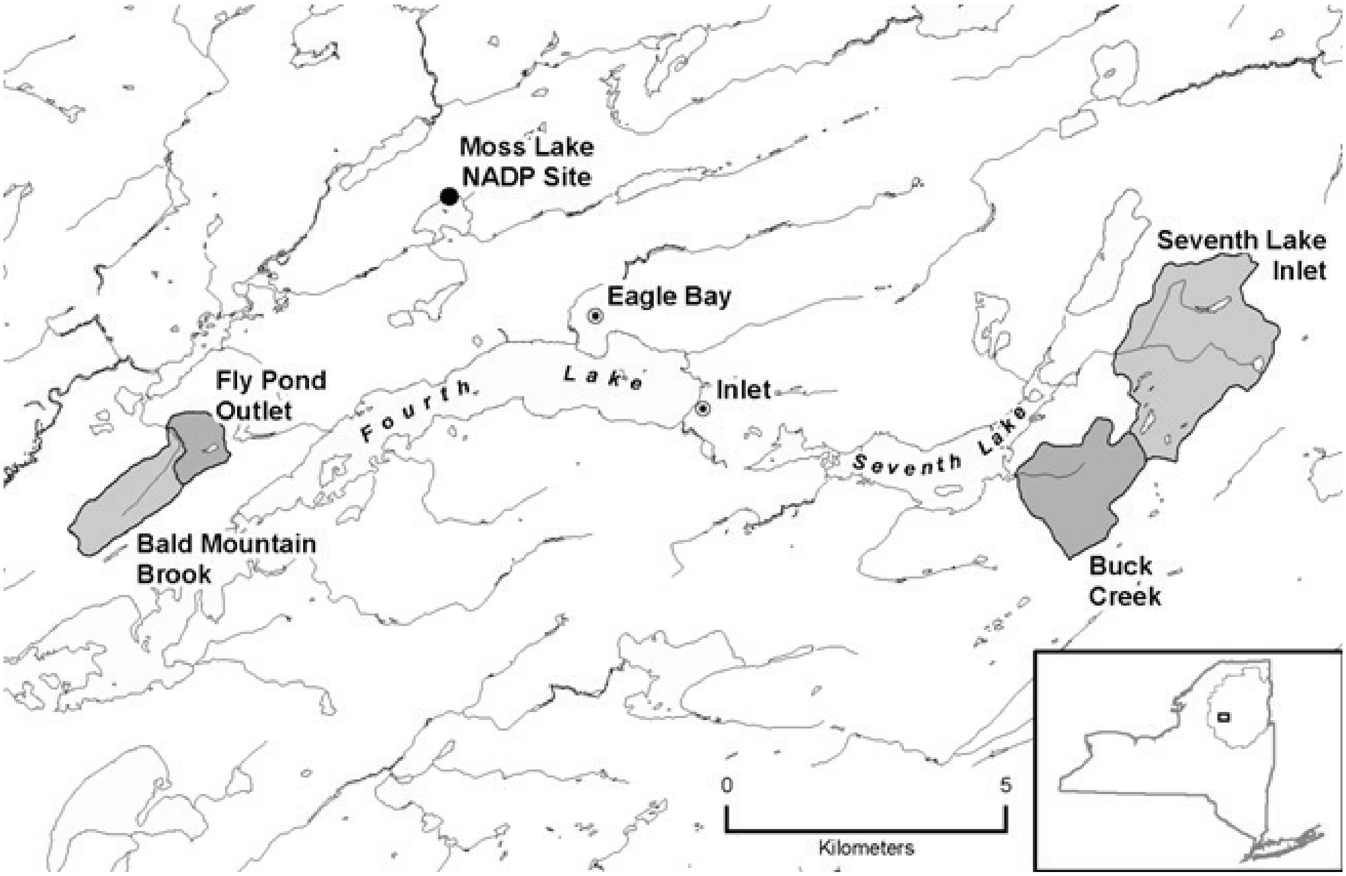


Figure 11. Stream watersheds of original four ERP streams: Buck Creek, Bald Mountain Brook, Fly Pond Outlet and Seventh Lake Inlet.

The ERP investigators produced a series of articles published in Ecological Applications 1996 Issue 6. Wigington found none of the Adirondack streams chronically acidic during the study period 1988-1990, however, during high flow, Bald Mountain Brook and Buck Creek exhibited critical chemistry with median ANC values less than -10 μeq L^{-1} (Wigington et al. 1996a). More detailed episodic chemistry was examined by Wigington et al. (1996b). This additional analysis found acid episodes within the 90th percentile with ANC decreases of up to 200 μeq L^{-1}, decreases of pH of up to one unit, and increases in inorganic monomeric aluminum of up to 15 μmol L^{-1}. Others reported negative responses of wild brook trout and native forage fish to changes in chemistry (Van Sickle et al. 1996; Baker et al. 1996).

Site Description

The ALSC continued to sample Buck Creek, Bald Mountain Brook, and Fly Pond Outlet on a weekly basis beginning in June 1992. Stream gaging that took place during the ERP was discontinued. Weekly surface grab samples were analyzed for Lab pH, Air Equilibrated pH, ANC, and specific conductivity. In May 1997, the ALSC started analyzing the samples collected during the first week of each month for the full suite of chemical parameters analyzed as they are for the ALTM lakes, namely: Lab pH, Air Equilibrated pH, ANC, specific conductivity, color, nitrate, sulfate, chloride, fluoride, calcium, magnesium, potassium, sodium, silica, ammonium, dissolved organic carbon, dissolved inorganic carbon, total dissolved aluminum, total monomeric aluminum, total organic aluminum, and total inorganic aluminum (calculated).

Following an analysis by Lawrence et al. (2004), in September of 2006 the stream sampling interval was changed to bi-weekly sampling of Buck Creek and Bald Mountain Brook. Sampling at Fly Pond outlet was continued on a monthly basis. All samples are analyzed for full complement chemistry.

Starting in 1998, the United States Geological Survey (USGS) with support from the Adirondack Effects Assessment Program (AEAP), conducted bi-weekly and event-driven chemistry and flow monitoring at two upstream tributaries of Buck Creek referred to as the North Tributary and the South Tributary. Additional sampling started at the main stem of Buck Creek in 2001. All samples were analyzed for the full suite of analytes. At all three locations, USGS collected bi-weekly samples and selected storm event samples collected by automated samplers. The USGS effort included soil temperature and moisture monitoring at a location adjacent to the stream sites. An assessment of episodic acidification in Buck Creek watershed in relation to atmospheric deposition and soil chemistry during 1998–2000 is discussed by Lawrence (2002). Diatom community dynamics and water chemistry were assessed from May 2000 through July 2003 (Passy et al. 2006; Passy 2006). Buck Creek is also one of eight research sites across the Northeast examined in 2000 by the USGS and others (Ross et al. 2004) for patterns of soil nitrogen accumulation. Sampling methods and site characteristics of the Buck Creek watershed are detailed by Lawrence et al. (2002); Ross et al. (2004); Passy (2006); Passy et al. (2006).

In response to funding reductions at the AEAP, in September 2006, the USGS consolidated efforts with the ALSC at Buck Creek and the ALSC assumed responsibility for sample collections at the tributaries and main channel. The ALSC continues bi-weekly sampling at the North Tributary (AB), South Tributary (BB) and the main channel of Buck Creek (BCK). Discharge monitoring also continues at both tributaries and the main channel of Buck Creek, with 5–7 event based samples analyzed each year. Laboratory analysis of the samples collected for these discharge events is based on the guidance of Greg Lawrence (USGS). Bald Mountain Brook and Fly Pond outlet sampling continues on a bi-weekly basis. Chemistry analysis are performed by the ALSC laboratory in Ray Brook.

Buck Creek was a critical calibration site during the Western Adirondack Stream Survey (WASS) conducted during 2003–2005 (Lawrence et al. 2008a; Lawrence et al. 2008b). Buck Creek is the only stream within the Oswegatchie River and Black River drainages monitored for year-round flow and chemistry. During the WASS, Buck Creek served as an index stream to place results within the context of variations throughout the year.

Monitoring of stream discharge and chemistry in the Buck Creek watershed has supported research that has provided valuable information on (1) trends in stream chemistry over the last two decades, (2) methods to improve the ability to distinguish between acid rain effects and natural acidity, and (3) sensitivity of aquatic organisms to low levels of inorganic aluminum. The incorporation of historic vegetation and soil chemistry data and continuation of sampling/analysis at these sites provide critical information on the linkages between (soil acidification) terrestrial condition/status and the hydrologic and aquatic chemistry conditions.

Sampling Design

Descriptions of the stream study sites (Table 11), and laboratory and field methods are provided by Kretser et al. (1992). The surface grab samples are collected in high density polyethylene bottles and analyzed bi-weekly for the following parameters: color, nitrate, sulfate, chloride, fluoride, calcium, magnesium, potassium, sodium, silica, ammonia, dissolved organic carbon, dissolved inorganic carbon, total dissolved aluminum, total monomeric aluminum, total organic aluminum, and total inorganic aluminum (calculated). Event based samples for discharge monitoring are collected in ISCO samplers, maximum of 24 bottles, and analyzed for all of the above parameters except dissolved inorganic carbon, color, and specific conductivity.

All three sites at Buck Creek received an upgrade to a CR850 data logger on July 31, 2012. This upgrade included new housing for the data logger, improvements to the solar panels, and enables the data to be downloaded using a flash drive.

Table 11. Physical characteristics of the four ERP study streams in the Adirondack Mountains of New York.

Characteristic	Study Stream Buck Creek[a]	Bald Mountain Brook[a]	Fly Pond Outlet[b]	Seventh Lake Inlet[c]
Stream gage				
Latitude	43° 44' 39" N	43° 45' 03" N	43° 45' 05" N	43° 45' 49" N
Longitude	074° 43' 20" W	074° 54' 39" W	074° 54' 34" W	074° 42' 11" W
Watershed				
Area (km2)	3.1	1.8	0.9	6.4
Maximum elevation (m)	775	715	710	725
Minimum elevation (m)	560	570	563	570
Lake or pond present	No	No	Yes	Yes
Wetland present	Minor	Yes	Yes	Yes
Soil series	Becket-Lyman Becket-Sherry	Lyman Becket	Lyman Becket	Lyman Becket-Sherry Becket-Lyman Adams-Croghan
Stream				
Order	2	1	1	2
Length (km)	2.1	2.2	0.8	3.7
Gradient ($m\ km^{-1}$)	50	25	9	31

a. continued bi-weekly sampling
b. continued monthly sampling
c. discontinued after 1991

Results

Trend Analysis 1991–2001

In 2004, the ALTM Program performed a time series analysis of these three streams, Buck Creek, Bald Mountain Brook, and Fly Pond Outlet, for the period October 1991-September 2001. Examining monthly pH values during these 10 years found that Buck Creek is acidic, Bald Mountain Brook is moderately well buffered and Fly Pond Outlet is well buffered. Concentrations of dissolved organic carbon (DOC) were similar among the three streams. Total and inorganic monomeric aluminum concentrations were at or near detection limits in Bald Mountain Brook and Fly Pond Outlet, and higher in Buck Creek. While similar increasing trends in ANC and pH were found in all three streams, the trends changed uniquely for each stream when the effect of flow variation was removed (Figure 12). In Buck Creek, the increasing trend in ANC was no longer observed if flow effect was removed. In Bald Mountain Brook, a downward trend in ANC from 1991–1995, followed by an upward trend from 1996 to 2001 was evident. In Fly Pond Outlet, ANC increased abruptly in 1997, with no clear trend before or after. These comparisons indicate the importance of long-term flow data for interpreting long term stream chemistry trends (Lawrence et al. 2004).

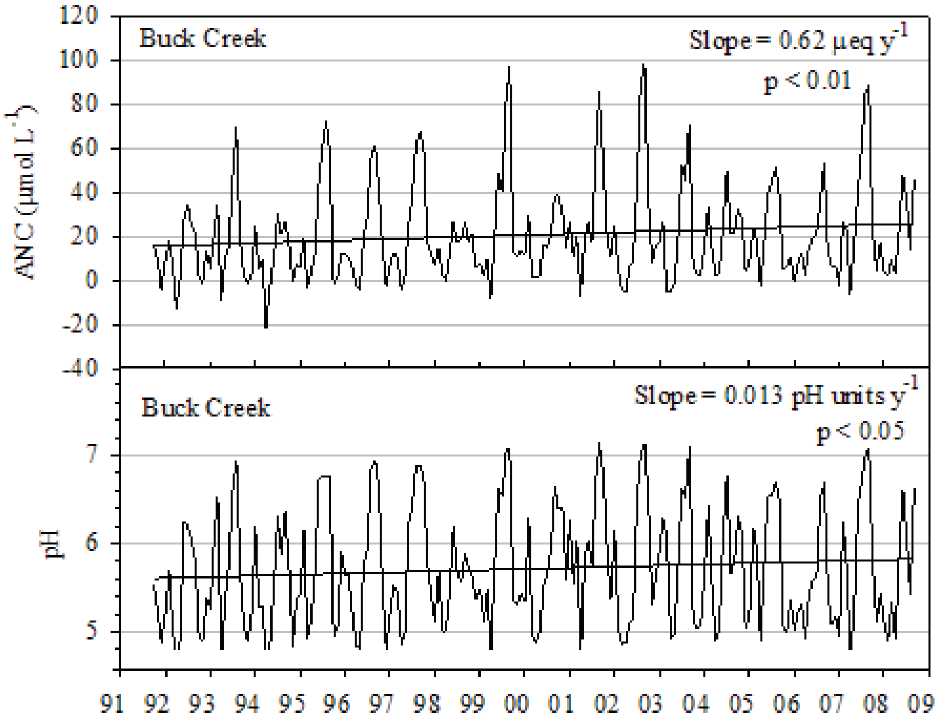


Figure 12. Trend 1991–2008 Buck Creek.

Examination of flow variation within the year identified five periods: the month of April with pronounced snowmelt peak; spring and early summer (May-July); a late summer minimum (Aug–Sept) that results from a soil moisture deficit over the course of the growing season; a rise in flow in the fall (October through Novemeber) after the growing season; and a relatively stable period (December through March) during the winter months (Lawrence et al., 2004)

Trend Analysis 1991–2008

An updated time series analysis is currently underway for the period October 1991–September 2008. In Buck Creek, measurements of ANC and pH show limited but statistically significant increases over the 17-year period (Figure 12). Extending the average annual rate of increase (slope shown in Figure 12) over the 17 years resulted in a total increase in ANC of 10 µeq L^{-1} and a total increase in pH of 0.22 pH units.

In Bald Mountain Brook, measurements of ANC and pH also showed overall increases that were statistically significant (Figure 13). Extending the average annual rate of increase (slope shown in Figure 13) over the 17 years resulted in a total increase in ANC of 31 µeq L^{-1} and a total increase in pH of 0.8 pH units. The average annual rate of increase of ANC and pH in Bald Mountain Brook (1.8 µeq L^{-1} y^{-1}, 0.047 pH units y^{-1}, respectively) was approximately 3–4 times the rate of increase of ANC and pH in Buck Creek (0.62 µeq L^{-1} y^{-1}, 0.013 pH units yr^{-1}, respectively). The temporal patterns of both measurements in Bald Mountain Brook show a decrease over the first three years, followed by a pronounced increase over the next 5–6 years, then small to moderate decreases over the final seven to eight years (Figure 13).

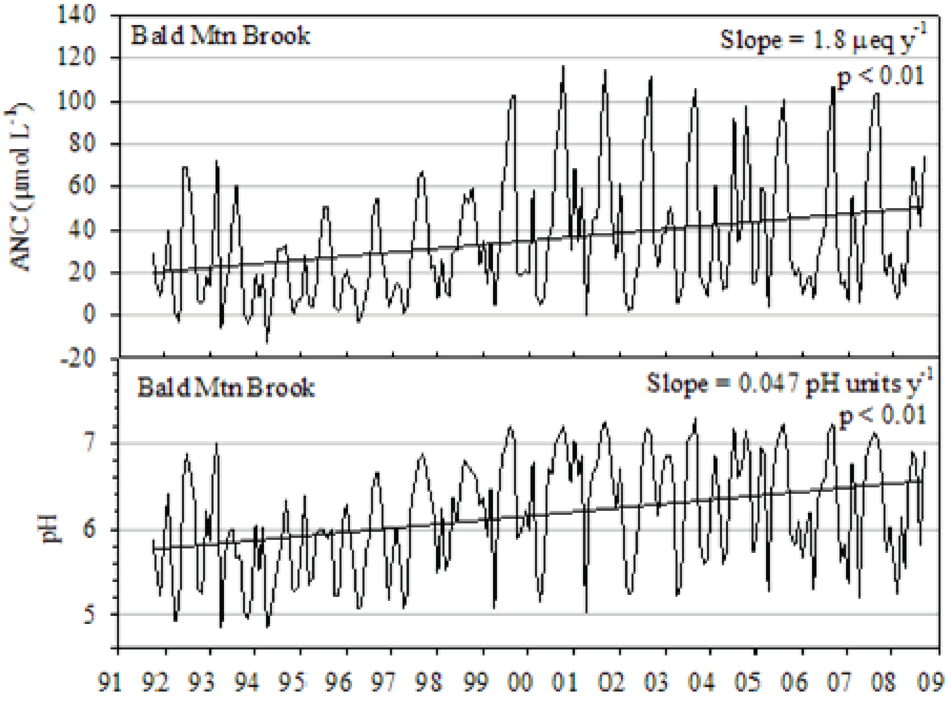


Figure 13. Trend 1992–2008 Bald Mountain Brook.

With respect to conditions for aquatic biota, in general, values of ANC less than 50 µeq L^{-1}, pH less than 6.0, and inorganic aluminum concentration greater than 2.0 µmol L^{-1} indicate that species are at risk from acidification (Driscoll 2001). The average annual rate of increase of ANC and pH in Bald Mountain Brook suggests a moderate degree of recovery over this period, whereas the rate in Buck Creek suggests relatively minimal recovery. The average annual rate of increase for pH and ANC in both streams is less than the rate reported by Lawrence et al. (2004) for the water year 1992–2001, which indicates that the rate of recovery has slowed over the past seven years. The overall trends for Bald Mountain Brook were considerably stronger than those observed for Buck Creek, but also more erratic. Buck Creek continues to exhibit episodic depressions in ANC (< 0 µeq L^{-1}) and pH (< 5.0) at values inhospitable to acid-sensitive aquatic species (Driscoll et al. 2001) (Figure 12).

In summary the updated analysis includes an extension of the 10-year stream monitoring results presented in Lawrence et al. (2004) and includes results from the two tributary streams (North Tributary and South Tributary) within the Buck Creek (Tables 12a-d) watershed that was initiated in 1998. The paper evaluated: the record of Bald Mountain Brook and Buck Creek extended from 10 to 17 years; the 10-year record of the North and South tributaries including a more in-depth evaluation of biogeochemical processes related to recovery; and compared the chemistry of 12 streams sampled in the early 1980s with samples collected in 2003 - 2005 from the same streams. A significant (50%) reduction in atmospheric deposition of sulfur occurred over this period (1998 to 2008). Results for Buck Creek and Bald Mountain Brook are shown in Figures 12 and 13. The North Tributary had high DOC and showed sulfate concentrations decreased at a rate of 2.0 µmol L^{-1} y^{-1}. The neighboring South Tributary with low DOC, showed a decrease of only 0.73 µmol L^{-1} y^{-1}. In the 12 streams over 23 years, overall increases in pH of only 0.28 and ANC of 13 µeq L-1 were observed. Although consistent with the range of chemistry changes reported for Adirondack lakes, results from the group of streams presented are highly variable with a more muted recovery response (Lawrence et al. 2011).

Current Trend Analysis Through 2012

During water years 2011 and 2012, the North Tributary of Buck Creek (Tables 12a and 13a) showed minimal seasonality in measures of acidity (ANC, pH, and BCS), but did exhibit seasonal variations in DOC (highest in spring/summer, late summer and fall) and NO_3^- (highest during winter and snowmelt and lowest during fall). Seasonal patterns were more pronounced in the South Tributary of Buck Creek (Tables 12b and 13b), Buck Creek (Tables 12c and 13c) and Bald Mountain Brook (Tables 12d and 13d), which had the lowest values of ANC, pH and BCS during snowmelt and the highest values during late summer. However, during 2011, BCS values for the Buck Creek tributaries and Buck Creek were negative during all seasons, whereas positive values were measured during all seasons except snowmelt in Bald Mountain Brook. In water year 2012, the North Tributary of Buck Creek remained chronically acidic, but BCS values in Buck Creek and the South Tributary were positive during spring/summer and late summer. Stream chemistry was similar in Bald Mountain Brook during both years, but in the other three streams, 2012 was considerably less acidic. As is normally observed, winter and snowmelt periods tended to be the most acidic period and late summer tended to be the least acidic period.

Table 12a-d. Median stream concentrations for October 2010 through September 2011 (water year 2011) in the North Tributary of Buck Creek (a), the South Tributary of Buck Creek (b), Buck Creek (c) and Bald Mountain Brook (d), for fall (October-November),winter (December-March), snowmelt (April), spring/summer (May-July) and late summer (August-September). All concentrations are expressed as μmol L^{-1} except ANC and BCS (μeq L^{-1}), and pH (pH units).

Table 12a.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	4	10	6	6	8
SO_4^{2-}	32.8	40.1	25.0	20.4	19.0
NO_3^-	1.3	16.3	18.4	7.6	6.0
Cl^-	13.2	11.0	5.6	6.8	7.0
ANC	-41.2	-40.7	-40.2	-46.5	-51.2
DOC	1389.4	1233.7	1218.1	1726.3	1852.7
Si	112.7	137.4	65.9	74.1	84.0
Ca^{2+}	20.6	22.2	17.3	19.9	21.3
Mg^{2+}	8.4	9.6	7.2	7.1	6.9
Na^+	28.4	29.7	19.5	18.2	15.4
K^+	2.0	2.7	5.2	2.8	3.6
NH_4^+	0.4	0.6	0.9	1.2	0.9
Total Al	32.2	26.2	25.1	32.8	32.3
Total Monomeric Al	17.3	15.9	16.1	17.5	17.5
Organic Monomeric Al	12.3	9.6	10.5	12.7	13.8
Inorganic Monomeric Al	5.2	5.5	5.5	4.8	4.1
pH	4.3	4.4	4.3	4.3	4.3
BCS	-89.1	-91.9	-85.7	-99.3	-108.9

Table 12b.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	4	12	6	10	10
SO_4^{2-}	35.6	34.9	26.6	36.9	30.6
NO_3^-	32.0	75.5	85.3	21.1	31.3
Cl^-	8.6	8.4	6.6	7.6	7.4
ANC	4.1	4.7	-12.3	8.0	10.0
DOC	302.0	207.6	351.2	262.3	471.5
Si	88.4	97.4	63.2	90.2	87.8
Ca^{2+}	26.6	32.0	24.1	22.6	35.3
Mg^{2+}	7.2	9.6	6.3	7.6	9.1
Na^+	26.8	29.6	17.8	22.6	27.2
K^+	3.7	4.8	6.5	5.3	4.5
NH_4^+	0.3	0.5	1.1	0.5	0.1
Total Al	12.3	16.1	20.9	13.6	10.0
Total Monomeric Al	8.1	8.3	12.4	6.2	8.2
Organic Monomeric Al	4.2	2.9	4.2	3.3	5.1
Inorganic Monomeric Al	4.1	5.5	8.6	2.1	2.9
pH	5.0	5.1	4.7	5.1	5.2
BCS	-33.7	-48.9	-74.5	-31.6	-19.1

Table 12c.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	8	14	19	12	10
SO_4^{2-}	38.7	43.3	28.9	37.1	35.3
NO_3^-	15.6	48.7	40.6	13.6	16.8
Cl^-	10.0	10.0	7.1	7.7	7.4
ANC	7.7	10.4	-5.9	6.3	19.1
DOC	669.4	364.5	535.6	531.1	787.9
Si	106.7	120.7	70.2	93.9	118.1
Ca^{2+}	33.8	40.7	27.5	26.2	41.4
Mg^{2+}	9.8	13.1	8.1	8.6	11.3
Na^+	27.4	35.2	19.5	26.0	28.4
K^+	4.7	6.2	5.9	5.6	5.5
NH_4^+	0.6	0.5	2.1	1.1	0.7
Total Al	16.3	11.3	18.7	13.3	14.9
Total Monomeric Al	10.4	6.3	10.7	7.7	9.3
Organic Monomeric Al	7.5	3.8	6.8	5.2	6.7
Inorganic Monomeric Al	3.2	2.6	3.8	2.8	2.3
pH	5.0	5.4	4.8	5.2	5.5
BCS	-26.4	-19.2	-46.1	-31.3	-2.6

Table 12d.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	4	9	2	6	5
SO_4^{2-}	38.3	42.9	29.7	39.2	35.3
NO_3^-	20.6	39.6	41.1	28.1	22.9
Cl^-	9.6	8.6	6.8	8.1	9.7
ANC	26.0	40.0	0.9	32.3	71.0
DOC	313.0	207.0	348.0	256.5	378.6
Si	150.8	161.3	75.3	160.7	167.7
Ca^{2+}	35.0	40.9	26.1	32.3	43.2
Mg^{2+}	13.9	17.6	8.7	15.9	18.9
Na^+	37.9	40.8	22.3	43.6	43.9
K^+	4.9	6.4	5.7	5.6	6.2
NH_4^+	0.4	0.4	0.4	0.6	0.1
Total Al	7.1	5.9	12.5	5.6	4.9
Total Monomeric Al	3.6	2.7	7.9	2.7	2.5
Organic Monomeric Al	3.2	2.2	4.1	2.4	2.4
Inorganic Monomeric Al	0.6	0.3	3.8	0.4	0.1
pH	6.2	6.2	4.9	6.3	6.5
BCS	12.2	14.4	-32.3	7.9	55.6

Table 13a-d. Median stream concentrations for October 2011 through September 2012 (water year 2012) in the North Tributary of Buck Creek (a), the South Tributary of Buck Creek (b), Buck Creek (c) and Bald Mountain Brook (d), for fall (October-November),winter (December-March), snowmelt (April), spring/summer (May-July) and late summer (August-September). All concentrations are expressed as µmol L^{-1} except ANC and BCS (µeq L^{-1}), and pH (pH units).

Table 13a.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	5	9	4	9	7
SO_4^{2-}	26.6	34.5	26.8	28.2	18.5
NO_3^-	2.4	22.5	19.5	10.5	10.4
Cl^-	13.1	9.5	6.6	12.8	12.1
ANC	-36.6	-39.9	-34.5	-38.1	-23.9
DOC	1518.8	1255.8	1365.2	1531.5	1480.3
Si	101.2	130.8	75.2	80.3	92.9
Ca^{2+}	19.5	20.4	20.8	23.6	21.7
Mg^{2+}	8.4	9.4	8.3	8.6	8.7
Na^+	25.6	26.8	22.5	23.9	21.4
K^+	3.4	4.9	6.8	5.3	10.7
NH_4^+	0.6	0.7	1.1	1.8	1.5
Total Al	30.6	28.0	28.8	29.3	23.7
Total Monomeric Al	16.0	17.0	16.8	16.7	15.5
Organic Monomeric Al	13.1	12.0	11.7	11.2	8.3
Inorganic Monomeric Al	4.1	5.4	5.6	5.5	6.1
pH	4.4	4.3	4.4	4.4	4.5
BCS	-91.3	-97.9	-85.4	-85.3	-65.7

Table 13b.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	**5**	**9**	**3**	**10**	**4**
SO_4^{2-}	35.9	30.5	31.6	36.7	45.5
NO_3^-	41.1	92.8	84.5	32.5	21.0
Cl^-	8.4	7.5	8.0	10.2	9.9
ANC	6.9	-0.3	-2.1	34.3	112.6
DOC	259.3	209.6	270.5	252.6	238.4
Si	115.2	96.3	98.0	140.8	228.6
Ca^{2+}	31.5	31.5	35.1	43.6	60.0
Mg^{2+}	10.4	8.8	9.3	14.9	22.6
Na^+	33.3	27.4	25.7	44.4	63.9
K^+	4.1	4.8	6.1	7.2	8.1
NH_4^+	0.2	0.3	0.6	1.3	0.6
Total Al	8.8	19.8	19.9	7.2	4.2
Total Monomeric Al	5.1	10.3	9.6	4.2	2.1
Organic Monomeric Al	3.7	3.5	3.4	3.2	2.0
Inorganic Monomeric Al	2.0	6.3	6.2	0.7	0.3
pH	5.6	5.0	5.0	6.4	6.8
BCS	-15.5	-58.2	-43.3	23.3	99.6

Table 13c.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	**5**	**9**	**4**	**12**	**4**
SO_4^{2-}	43.4	37.2	33.4	43.2	49.1
NO_3^-	20.3	60.4	51.8	20.3	14.7
Cl^-	9.8	9.1	8.5	10.3	10.6
ANC	13.3	10.7	6.2	37.5	79.5
DOC	474.2	365.2	540.9	479.9	452.4
Si	137.8	119.8	100.2	158.1	199.6
Ca^{2+}	37.4	39.5	37.3	50.0	57.3
Mg^{2+}	13.3	12.4	11.0	16.9	20.5
Na^+	39.1	32.2	27.6	46.1	54.8
K^+	5.8	6.0	6.9	8.4	9.4
NH_4^+	0.3	0.3	1.1	1.4	0.9
Total Al	9.7	13.7	17.8	12.2	7.1
Total Monomeric Al	5.1	8.0	9.6	6.0	3.3
Organic Monomeric Al	4.9	4.9	5.1	4.4	2.6
Inorganic Monomeric Al	1.1	2.7	4.8	1.5	0.8
pH	5.7	5.3	5.1	6.0	6.5
BCS	-0.5	-26.0	-32.5	25.9	69.0

Table 13d.

Season	Fall	Winter	Snowmelt	Spring/summer	Late Summer
Number of samples	4	9	2	7	4
SO_4^{2-}	38.4	36.8	32.8	36.5	49.6
NO_3^-	33.7	57.3	47.4	35.6	26.2
Cl^-	9.7	8.2	7.4	9.2	10.4
ANC	39.6	19.4	15.7	49.7	115.2
DOC	222.8	216.5	344.7	230.2	209.8
Si	182.1	140.6	114.6	175.2	211.1
Ca^{2+}	41.1	37.6	34.6	47.3	62.1
Mg^{2+}	19.5	15.3	13.5	18.6	29.0
Na^+	49.4	36.8	31.3	50.2	63.7
K^+	6.8	6.0	6.4	7.9	11.1
NH_4^+	0.1	0.5	0.7	1.1	0.6
Total Al	4.6	7.8	8.9	4.9	3.4
Total Monomeric Al	2.5	4.2	6.2	2.6	1.4
Organic Monomeric Al	2.4	3.3	4.3	2.4	1.4
Inorganic Monomeric Al	0.2	1.3	1.9	0.2	0.1
pH	6.5	5.8	5.7	6.6	7.0
BCS	39.9	-1.8	-8.9	51.9	108.6

Trends in concentrations of SO_4^{2-} from water years 2006 to 2012 showed a seasonal pattern of highest concentrations in winter and lowest concentrations in summer (Figure 14). This pattern was most pronounced in the North Tributary of Buck Creek. All sites showed a general downward trend over the measurement period, which was also most pronounced in the North Tributary of Buck Creek. There were no clear trends in concentrations of NO_3^-, but concentrations during winter and snowmelt periods in 2007, 2011 ,a nd 2012 were anomalously high (Figure 15). Seasonality of NO_3^- concentrations was very consistent despite large year-to-year variations in concentrations. An increasing trend in DOC was observed in the North Tributary of Buck Creek and in Buck Creek, but no trend was apparent in the South Tributary of Buck Creek or Bald Mountain Brook (Figure 16). Values of BCS increased considerably over the measurement period from less than -100 µeq L^{-1} to approximately -60 in the North Tributary of Buck Creek (Figure 17). There was no clear trend for BCS in the other three streams. Most median values were below zero throughout the seven years in Buck Creek and the South Tributary, whereas most values in Bald Mountain Brook were above zero. Concentrations of Ca^{2+} decreased in all four streams up through 2011, but a large increase was observed in the spring/summer and late summer values of 2012 (Figure 18). A similar increase was observed in the summer of 2007. Overall, indications of chemical recovery of these streams was minimal. Decreases in SO_4^{2-} were offset to some degree by decreases in Ca^{2+} concentrations. Elevated NO_3^- concentrations remain an acidifying factor during winter and snowmelt periods, and to a lesser extent during the spring/summer period.

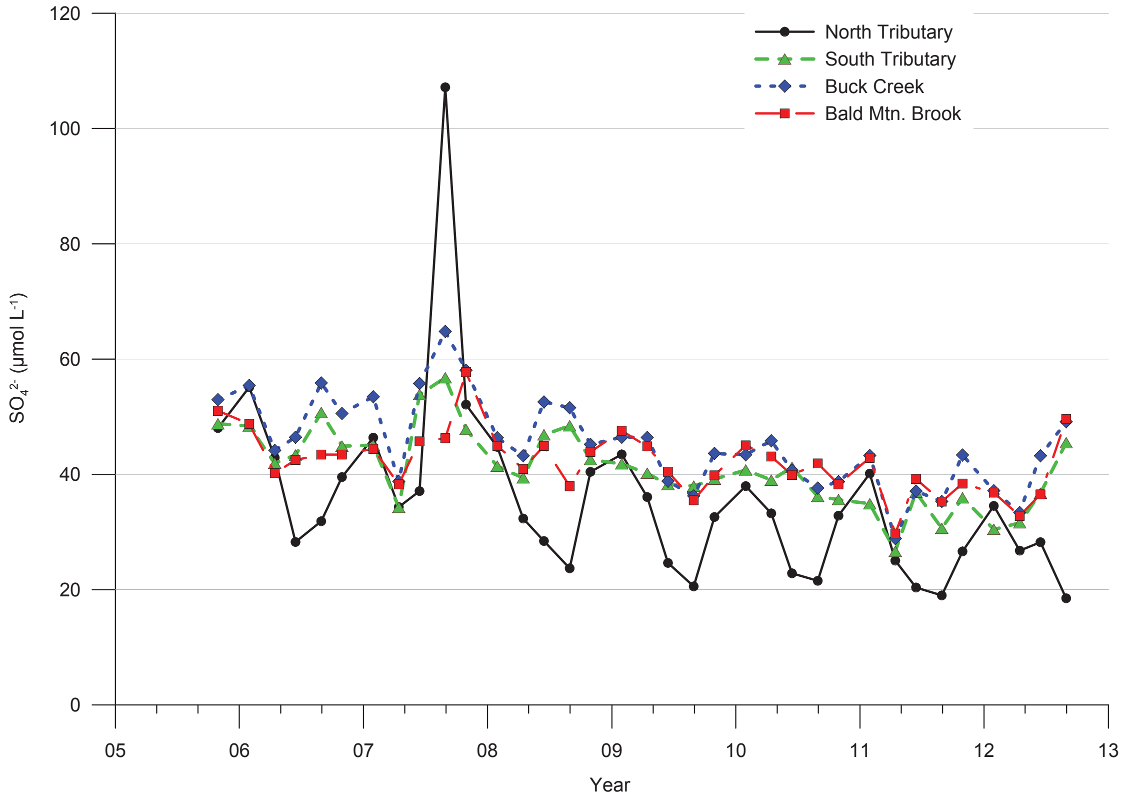


Figure 14. Seasonal median concentrations of SO42- for the North and South Tributaries of Buck Creek, Buck Creek, and Bald Mountain Brook for water years 2006 to 2012.

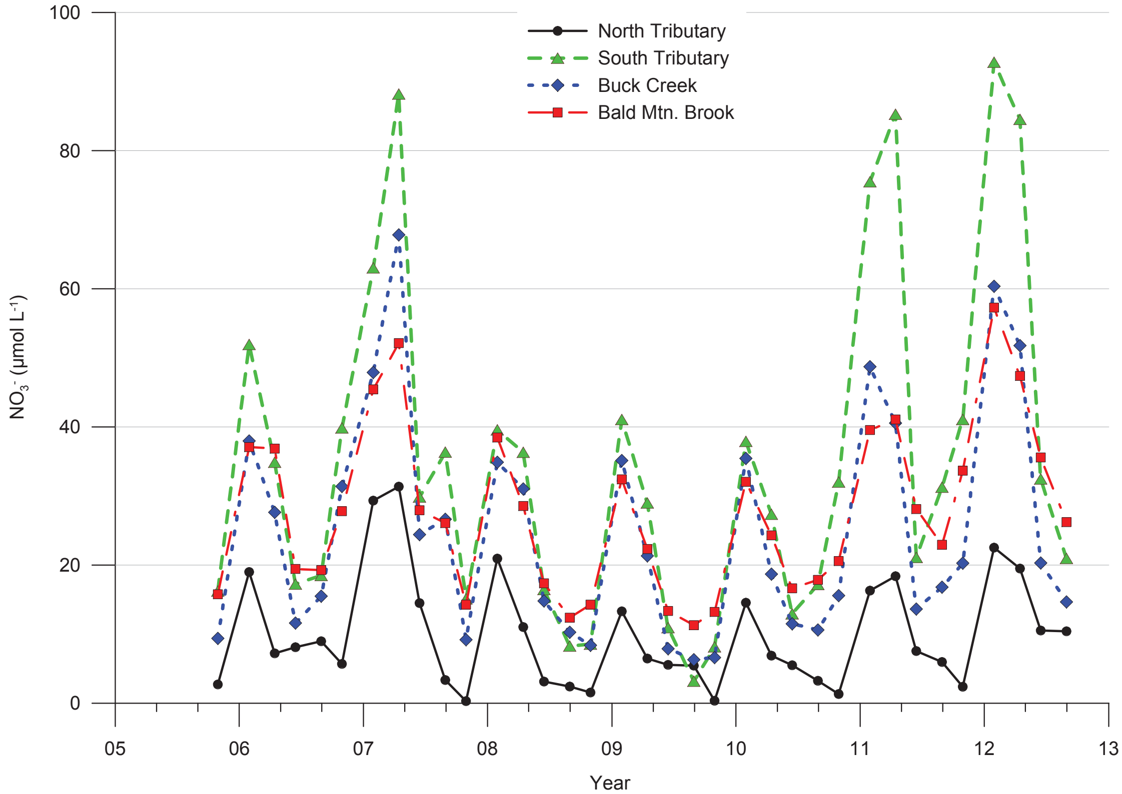


Figure 15. Seasonal median concentrations of NO3- for the North and South Tributaries of Buck Creek, Buck Creek, and Bald Mountain Brook for water years 2006 to 2012.

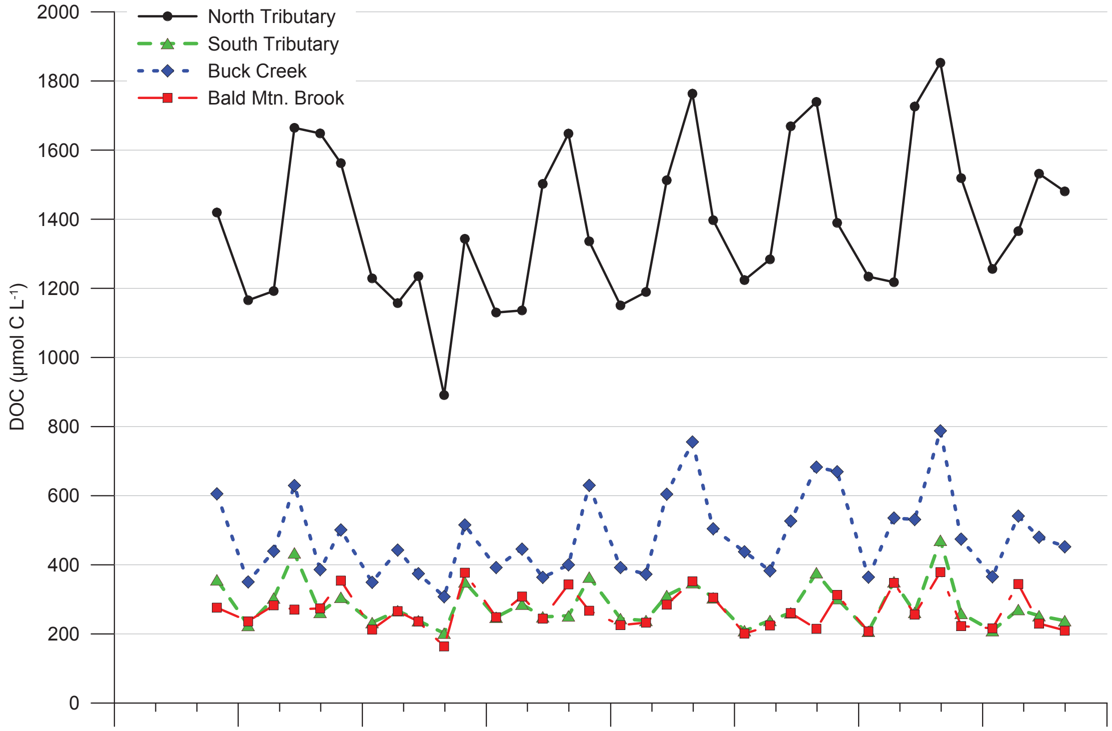


Figure 16. Seasonal median concentrations of dissolved organic carbon (DOC) for the North and South Tributaries of Buck Creek.

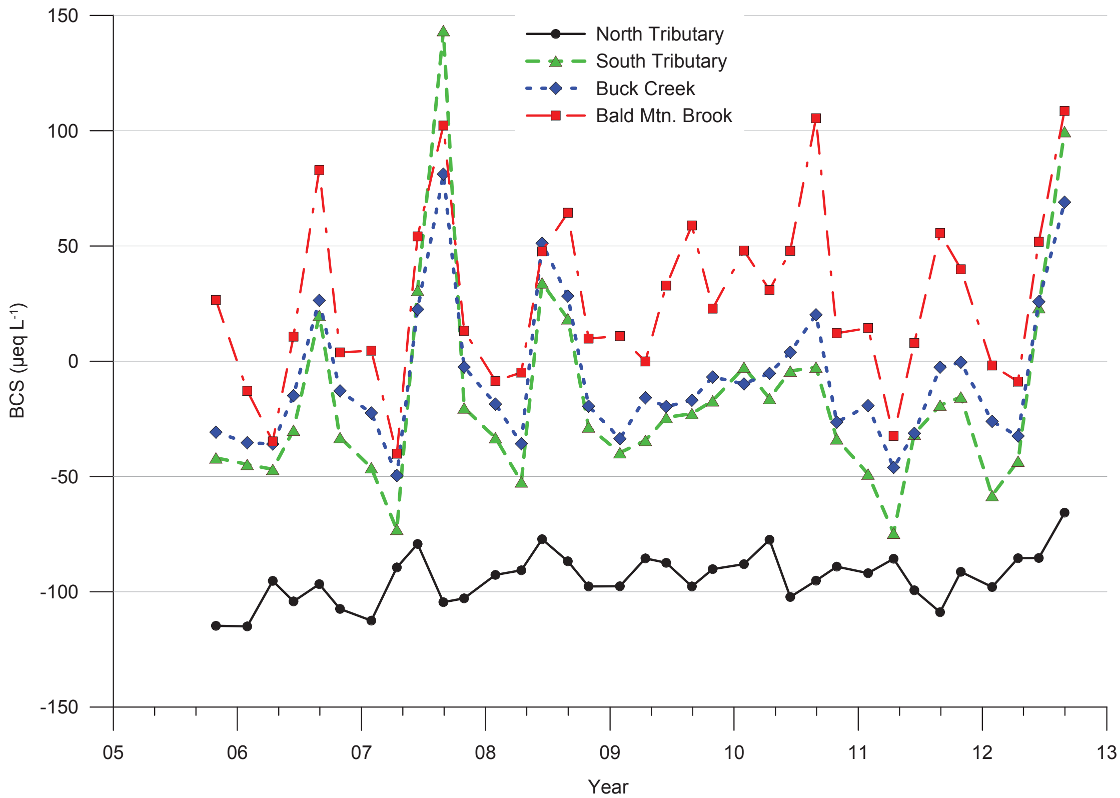


Figure 17. Seasonal median concentrations of the base cation surplus (BCS) for the North and South Tributaries of Buck Creek, Buck Creek, and Bald Mountain Brook for water years 2006 to 2012.

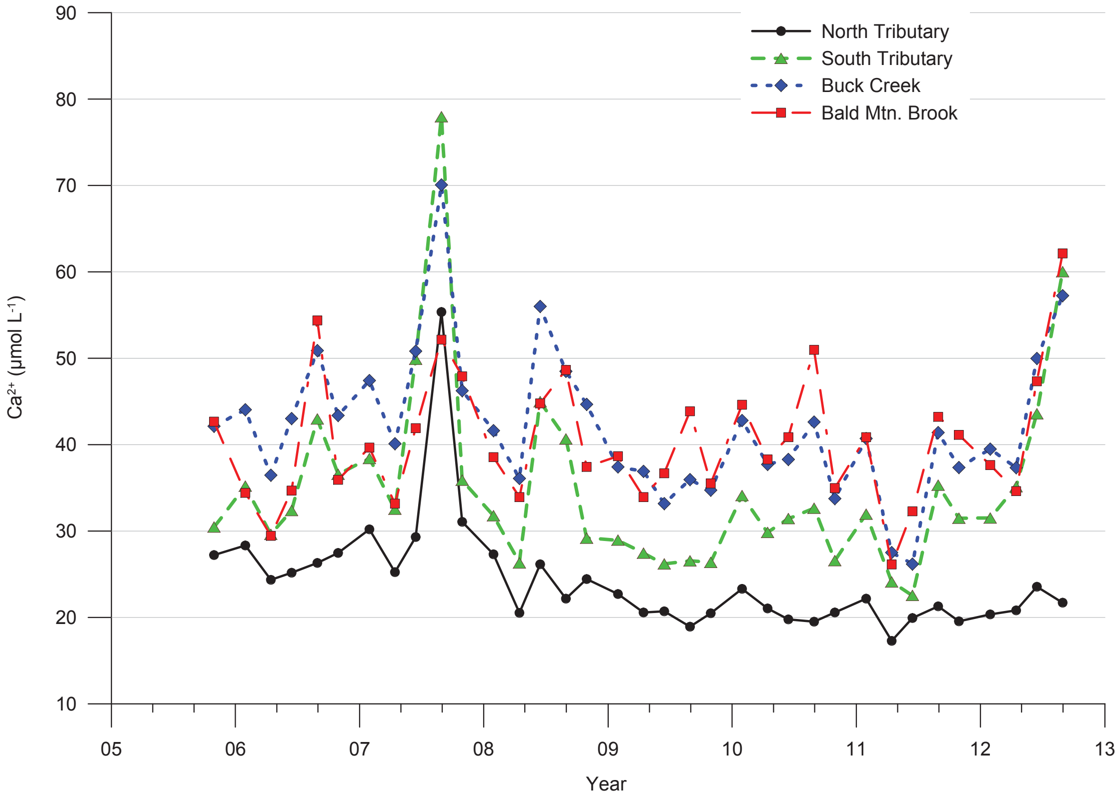


Figure 18. Seasonal median concentrations of Ca2+ for the North and South Tributaries of Buck Creek, Buck Creek, and Bald Mountain Brook for water years 2006 to 2012.

Buck Creek – Vegetation and Soils Studies

Data Reported to Date

Data currently available from this stream study (this section) include chemistry from Fly Pond Outlet, Bald Mountain Brook, and Buck Creek. Weekly concentrations of the parameters measured for Fly Pond Outlet, Bald Mountain Brook, and main stem of Buck Creek collected from June 1992 through December 2004, and reported seasonally since then through September 2008 are posted to the ALSC website at http://www.adirondacklakessurvey.org. Seasonal medians for Buck Creek and Bald Mountain Brook are provided in Appendix B. Additional data may be available by contacting the NYSDEC Research Manager.

North and South Tributary – Trees

Vegetation plots were established in the Buck Creek watershed by USGS in 2000. Fifteen vegetation plots (254 m^2 area each) were established in both the North Tributary and the South Tributary (Figure 19). Tree measurements are collected at five year intervals. Soil chemistry measurements were collected at 27 locations throughout the North Tributary watershed in 2009–2010.

In the North Tributary watershed, the predominant tree species were red spruce, red maple, and American beech. Most tree species showed an increase in total basal area over the 10-year measurement period (2000 – 2010), with the notable exception of red spruce, which showed a pronounced decrease as a result of unusually high mortality between 2005 and 2010 of trees in all size classes (Figure 20). This decrease in red spruce resulted in an overall decrease in basal area for the watershed. The cause of the elevated mortality in red spruce is not known.

In the South Tributary watershed, American beech, the dominant tree species, showed an increase in basal area over the 10-year period (Figure 20). This occurred despite beech bark disease in virtually all beech trees in the watershed and elevated mortality of large beech trees. Increases in basal area of yellow birch, sugar maple, and red spruce also occurred during this period. Most striped maple over 5 cm diameter died over the 10 years without being replaced.

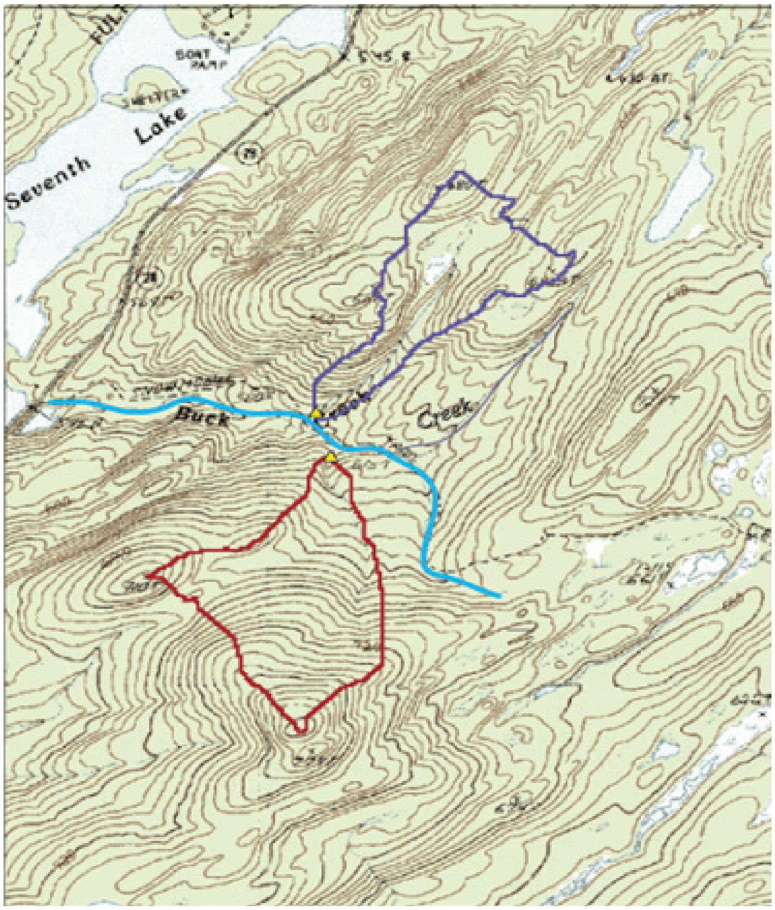


Figure 19. Watersheds of the North Tributary (navy) and the South Tributary (red) within the Buck Creek watershed.

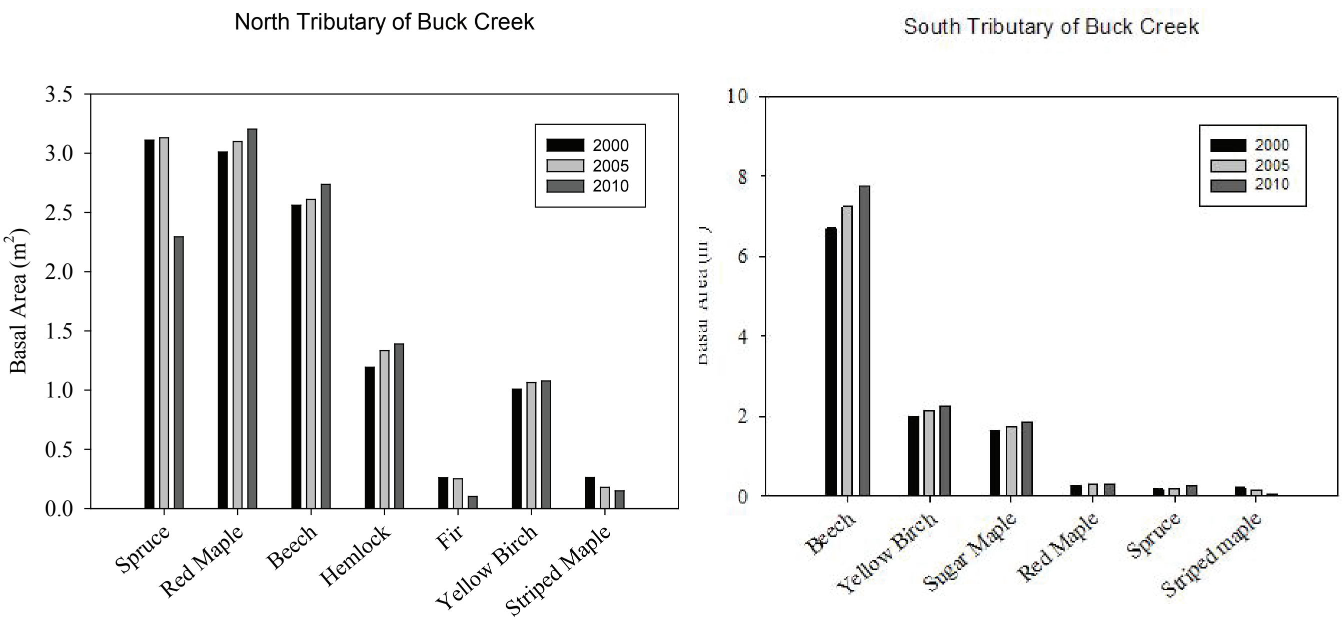


Figure 20. Basal area of major tree species (with diameter breast height (dbh) greater than 5 cm) in the North and South Tributary watershed of Buck Creek, in 2000, 2005 and 2010, based on measurements in 15 plots per watershed (each plot is 254 m² in area).

North Tributary – Soils

Soil samples were collected from the Oe horizon, Oa horizon, and upper 10 cm of the B horizon at 27 locations throughout the North Tributary watershed of Buck Creek. Soils had thick Oa horizons, which are common in forests with a large component of coniferous trees. Low pH in the Oe and Oa horizons reflect the strong influence of natural organic acidity that derives from the decomposition of organic matter (Table 14). Relatively low concentrations of exchangeable bases (Ca, Mg, K and Na) and high concentrations of exchangeable aluminum in the upper B horizon are consistent with stream chemistry data for this watershed that indicates calcium depletion by acidic deposition. Low base saturation in the Oa and upper B horizon provides minimal buffering of soil water acidity. A manuscript that includes soils data is underway (estimated completion date December 2013).

Table 14. Mean values of soil chemistry measurements of samples collected in 2009-2010 from Oe horizon, Oa horizon and upper 10 cm of the B horizon in the North Tributary watershed of Buck Creek.

Horizon	units	Oe Horizon	Oa Horizon	Upper B Horizon
thickness	cm	5.5	14.7	-----
exchangeable Ca	cmolesc kg^{-1}	16.5	8.1	0.41
exchangeable Mg	cmolesc kg^{-1}	2.7	1.3	0.10
exchangeable K	cmolesc kg^{-1}	1.5	0.4	0.09
exchangeable Na	cmolesc kg^{-1}	0.06	0.04	0.023
exchangeable Al	cmolesc kg^{-1}	0.8	7.4	8.55
exchangeable H	cmolesc kg^{-1}	9.9	13.1	1.44
base saturation	fraction of CEC	0.65	0.32	0.06
carbon	percent	513	465	91.4
nitrogen	percent	24.6	20.1	3.61
C:N	g g^{-1}	21	23	26
Organic matter	percent	92.7	83.2	17.9
pH (0.01 $CaCl_2$)		3.16	2.74	3.53

Regional Stream Surveys

Western Adirondack Stream Survey

Despite the stream sampling efforts of the ALTM, AEAP, and other occasional Adirondack stream studies, prior to 2003 there was insufficient information to assess the current regional status of streams with regard to acidification. The Western Adirondack Stream Survey (WASS) was conducted to assess the chemical and biological conditions of streams in the region of the Adirondacks considered most impacted. Because regional stream assessments that included episodic acidification had not been previously conducted, this project was implemented as a pilot study to evaluate methods for possible future use. The effort was undertaken by program staff of the ALSC, NYSDEC (Air Resources and Fish and Wildlife) as well as USGS.

The WASS was conducted in the 4,585 km^2 Oswegatchie-Black River region of the Adirondack ecological zone with the following objectives: 1) develop an improved method for distinguishing between the chemical effects of acidic deposition and those of naturally-derived acidity, 2) determine the extent of acidic deposition effects on stream chemistry and biota in this region, 3) evaluate the role of soil chemistry as a control of stream chemistry, and 4) determine to the extent possible, changes in stream chemistry over the past two decades.

Five seasonal surveys were conducted between summer 2003 and spring 2005. There were several major findings. Of the 565 streams assessed, 66% (718 km of stream reaches) were identified as prone to acidification, i.e. likely to be acidified to levels harmful to biota. Of these, approximately half were likely to be episodically acidified and half were likely to be chronically acidified. The percentage of streams determined to be moderately to severely impacted by acidic deposition on the basis of the diatom data ranged from 66% to 89% over four surveys. Macroinvertebrate communities were moderately to severely impacted in 52% of assessed streams. The approach of seasonal sampling survey conducted within three-day periods throughout the study region was successful for capturing the episodic and seasonal variability of stream chemistry. When indexed to a site with both episodic and long-term monitoring data (i.e. Buck Creek), this approach was an effective method for the regional assessment of episodic acidification. More information is available in other reports (NYSERDA Report 08-22 at http://www.nyserda.ny.gov/en/Page-Sections/Environmental-Research/EMEP (Lawrence et al. 2008a and Baldigo et al. 2009). In 2012, data from the WASS and Buck Creek were included in several articles and presentations including a synthesis paper on the ecological effects of air pollution from nitrogen and sulfur (Greaver et al. 2012), a soil calcium gradient analysis in northern hardwoods (Beier et al. 2012) and a regional forest soil nitrogen analysis (Ross et al. 2012).

East-Central Adirondack Stream Survey

Following the completion of the WASS, a second survey was conducted for the remaining portion of the Adirondack region. The East-Central Adirondack Stream Survey (ECASS) was designed as a similar flow-synchronized sampling of 200 first-order streams over a 3-day period. Three sampling seasons were proposed to take place during 2010-2012. The first round of sampling was conducted on August 9-11, 2010 at 208 stream sites. Additionally, 10 high-elevation streams were sampled during September.

The second and third (final) rounds of sampling were successfully completed in 2011. Spring sampling included: 269 sites during April 18 - 20; 10 high elevation sites during April 25 - May 5; and five historic sites sampled weekly during April 4 - May 2. The fall sampling included 230 sites during October 31-November 2. Additional collections included periphytic diatoms at each site to be analyzed by S.Passy (University of Texas Arlington) and macroinvertebrates at 40 stream sites. Preliminary chemistry assessments based on April 2011 results indicate that over one third of streams are prone to acidification. The ECASS study region encompasses nearly 20,000 km^2 (approximately 80%) of the Adirondack region.

Together the WASS and ECASS stream projects have covered essentially the entire Adirondack region. This total of eight seasonal surveys collected between summer 2003 and fall 2011 now stands as the largest survey in North America to evaluate stream chemistry over varying stream flows, which is essential for evaluating acidification. The work provides important data on the current conditions that will be available to more thoroughly assess ecosystem recovery.

Whiteface Mountain Cloud Monitoring

Title IV of the federal 1990 Clean Air Act Amendments (CAAA) required a two phase nationwide reduction in sulfur dioxide (SO_2) emissions by approximately 10 million tons. The first phase was implemented in 1995 when large electric generating facilities reduced emissions. The second phase began in 2000 by targeting other power plants. Title IX of the CAAA mandated the deployment of a comprehensive research and monitoring program, which would evaluate emission reduction program effects on deposition, air quality, and changes in affected ecosystems. In response to this mandate, the USEPA implemented the Clean Air Status and Trends Network (CASTNet) in 1991.

The Mountain Cloud Acid Deposition Program (MADPro) was initiated in 1993 as part of the research necessary to support CASTNet objectives. The two main objectives of MADPro were to develop cloud water measurement systems useful in a network-monitoring environment and to update the Appalachian Mountain cloud water concentration and deposition data collected by the National Acid Precipitation Assessment Program (NAPAP) during the 1980s. MADPro measurements were conducted between May and October of 1994 – 1999 at three permanent mountaintop sampling stations. These sampling stations were located at Whiteface Mountain, New York; Clingmans Dome, Tennessee/North Carolina; and Whitetop Mountain, Virginia. A mobile manual sampling station was also operated at two locations in the Catskill Mountains of New York during 1995, 1997, and 1998.

Beginning in June 200,1 the ALSC commenced field operations and provided laboratory analyses of cloud water from the Whiteface site. Operation included, all quality assurance/quality control activities, data processing and review, analytical chemistry, and data delivery. The ALSC objective has been to continue the cloud-monitoring program as run under the CASTNet program. The mountaintop site at Whiteface has changed little since the cloud collection system was installed in 1994. The system has proven to be quite durable, having survived several lightning strikes and harsh weather conditions.

Site Description

Located in the northeastern part of the New York State Adirondack Park, Whiteface Mountain has an elevation of 4,867 feet and is the fifth highest peak in the Adirondacks. The site is the only high peak within the Adirondack Park with a summit that is road accessible and has AC power. The cloud collection system is installed on the roof of the summit observatory building operated and maintained by the SUNY Albany Atmospheric Sciences Research Center. In addition to the cloud monitor, the summit building also houses several gas monitors, meteorological sensors, and a high volume air sampler. The summit is reached in warm weather months, from late May to early October, via the Veterans Memorial Highway.

Sampling Design

The collector is an omni-directional passive collector that is also known as an Atmospheric Sciences Research Center (ASRC) or Mohnen collector (Falconer and Falconer 1980; Mohnen 1989). The collector consists of two disks separated by vertical bars with Teflon filament strung between the disks. The principle of operation for collecting cloud water samples is relatively simple. As winds blow clouds through the collector, cloud water condenses on the filaments and gravity draws the cloud water down to a funnel. Tubing attached to the bottom of the funnel runs into the observatory and delivers cloud water to an accumulator. The accumulator collects cloud water until it is full, the site clears, or the top of the hour is reached. At the top of each hour, a distributor arm dispenses the accumulated sample into one of 24 refrigerated indexed carousel bottles (Baumgardner et al. 1997).

The cloud water collector is deployed from its protective housing only after the following conditions are met: the air liquid water content reaches 0.05 grams per cubic meter or greater indicating the presence of cloud; the temperature is two degrees Celsius or greater to prevent freezing; the wind speed is two meters per second or greater to assure the movement of clouds through the collector; and a heated grid rain sensor indicates no rain is present to limit sampling from precipitating clouds.

Samples are analyzed for the following parameters: Lab pH, specific conductance, nitrate, sulfate, chloride, calcium, magnesium, potassium, sodium, and ammonium. The primary meteorological parameters collected are: liquid water content (LWC), wind direction, wind speed, and temperature.

Results

Fossil fuel combustion, which is the oxidation of sulfur and nitrogen oxides in the atmosphere to sulfuric acid (H_2SO_4) and nitric acid (HNO_3) are the primary sources of anthropogenic acidity in cloudwater.

The major ions found in clouds at Whiteface Mountain are sulfate, hydrogen, nitrate, and ammonia. There is a strong coefficient of determination ($R^2 = 0.87$) between hydrogen and sulfate + nitrate (Figure 21).

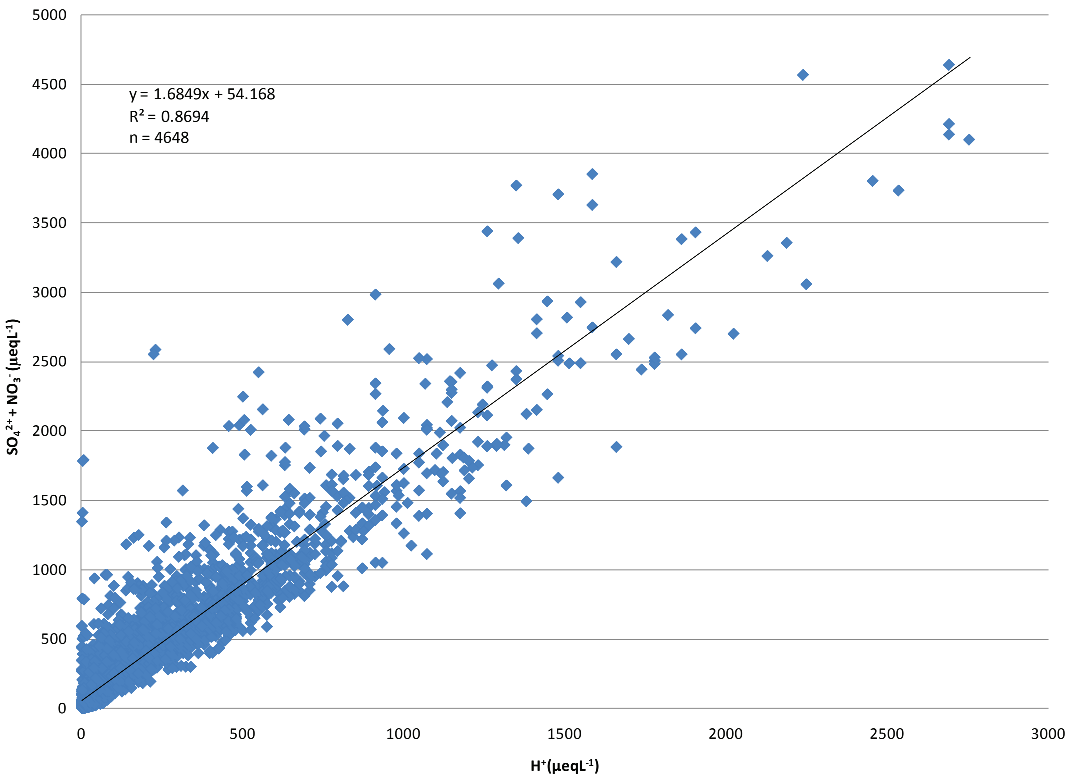


Figure 21. Hydrogen Ion versus sulfate + nitrate.

Compared with precipitation, cloud water exhibits significantly higher concentrations of major ions (Khwaja et al. 1995). Cloud water depositions have been reported at 14 to 28 times rainwater depositions during the summer season (Aleksic et al. 2009). The pH of cloud water below approximately 5.0 is assumed to be influenced by anthropogenic pollution (Li and Aneja 1992; Dukett et al. 2011). For samples collected 1994–2011, approximately 86% of the cloud water samples analyzed are below pH 5.0 or $H^+ > 10.00$ μeq L^{-1}. For samples collected 2008–2011, approximately 76% are below pH 5.0 or $H^+ > 10.00$ μeq L^{-1}.

In 2009, clean air target values were established based on 4,185 cloud water samples collected for the period 1994–2009, and 263 of those values were used to identify a clean air target pH range (Dukett et al. 2011). For this report, additional data collected through 2011 has been incorporated into the analysis, which is based on 4,648 cloud water samples, with 303 of those values identifying the clean air target pH range. Additionally, for each major ion (SO_4^{2-}, NO_3^-, H^+, and NH_4^+), results were compared against the reference clean air value by calculating simple ratios of all annual data versus the reference clean air value. Figure 22 shows these ratios, as well as, a relative comparison since the first year (1994) of the record to the last year (2011). As illustrated in Figure 22, the red horizontal line at ratio 1 indicates the best case clean air level. Ratios above 1 are influenced by anthropogenic pollution. In 1994, ratios were 26.3, 12.8, 29.8, and 12.5 times above the clean air concentration threshold for SO_4^{2-}, NO_3^-, H^+, and NH_4^+ respectively. For 2011, SO_4^{2-}, NO_3^-, H^+, and NH_4^+ ratios were respectively 3.8, 2.7, 3.9, and 3.1 times above 1 (Figure 22). In other words, a comparison of results from 2011 and 1994 as well as all samples that meet criteria outlined in Dukett et al. (2011) suggest the following anthropogenic reductions of 86%, 79%, 86%, and 76% for SO_4^{2-}, No_3^-, H^+, and NH_4^+, respectively. Details may be found in Dukett et al. 2011.

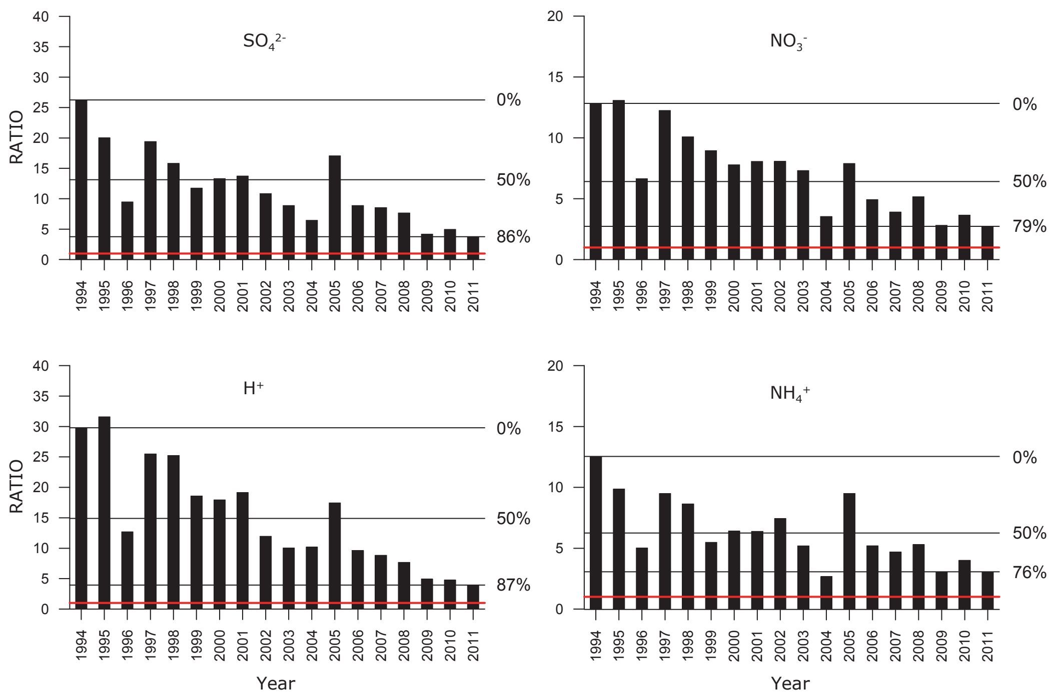
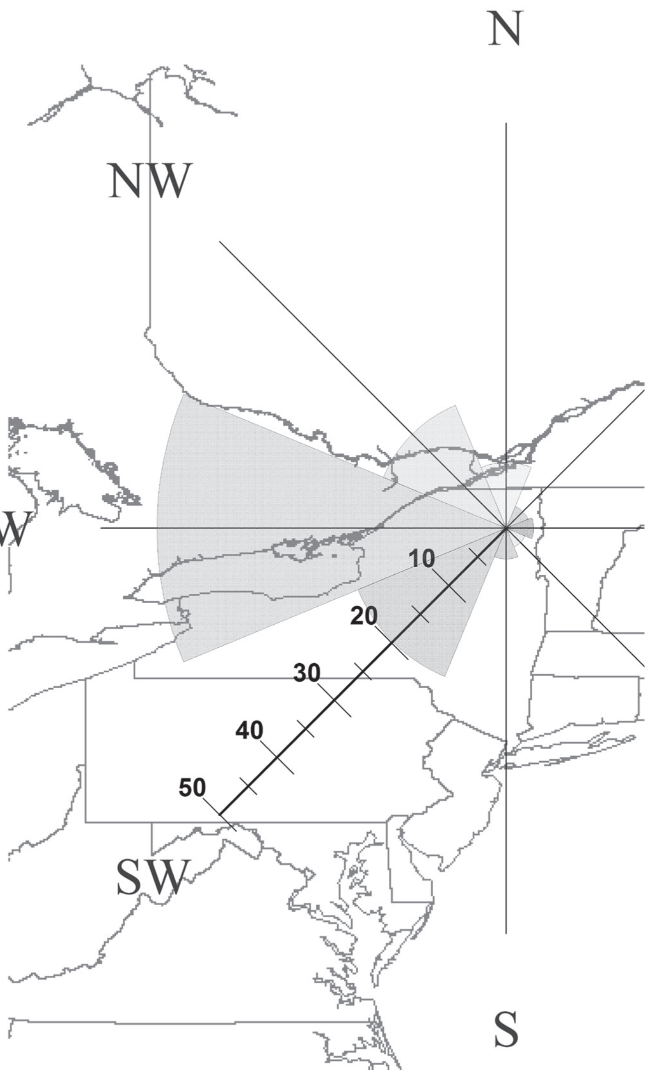


Figure 22. Ratios of all annual data versus clean air target values 1994–2011.

Distribution

The origin of cloud water acidity is assumed to be based on both local and regional emission sources. Given the frequency distribution (Figure 23), it is suggested that clouds at Whiteface may pass over the Ohio Valley and Canadian Provinces. Factors such as wind speed and orographic effects help shape the movement and ion content of clouds (Baumgardner et al. 2003). ALTM lakes at higher elevations (>600 m) may have higher nitrate concentrations and acidity than lower elevation lakes (Aleksic et al. 2009). The majority of the cloud water samples collected at Whiteface Mountain arrive from a southwesterly (19.8%), westerly (43.1%), and northwesterly (16.4%) direction (Figure 23).



Octant	Percent
N	8.1
NE	2.9
E	3.4
SE	2.5
S	3.8
SW	19.8
W	43.1
NW	16.4
n =	4,648

Figure 23. 1994-2011 wind distribution by octant.

Data Reported to Date

Data currently available from this mountain cloud study include hourly and 3-hr composites of the chemical parameters in cloud water and the meteorological data associated with those samples. As of June 2012, chemistry and meteorological data collected during the 2001–2010 sampling seasons are posted to the ALSC website at http://www.adirondacklakessurvey.org. Additional data may be available by contacting the NYSDEC Research Manager.

Data Summary Statistics

Summary statistics for the 2011 cloud sampling season can be found in Appendix E. These statistics are based on 'Valid' sample data criteria. The criteria for valid samples are:

- Passes MADPro Ion balance test.
- Must be analyzed for all four major ions (H^+, SO_4^{2-}, NO_3^-, NH_4^+).
- Is a valid composite sample.
- Sample does not contain rain.

Additional information can be found in the '2011 WFC MetaData' worksheet located at the Whiteface links at www.adirondacklakessurvey.org.

2009 Pilot Studies

In 2009, the ALSC participated in two pilot studies to look at mercury and carbon in clouds. A mercury pilot project began on 7/7/09 and ended on 9/23/09. A second cloud collector was installed to allow for the collection in mercury specific sample bottles. A total of 21 samples were collected and shipped to Syracuse University for total mercury analysis. Bradley Blackwell, Syracuse University, used the data in his 2011 NYSERDA EMEP persentation: Deposition and Fate of Mercury in Forests of the Adirondacks (Bradley et al. 2011). A carbon species pilot project collected 11 samples on 9/23/09 and 9/24/09. Samples were shipped to Rutgers University for analysis of highly polar organic compounds (HPOC). The ALSC also analyzed total organic carbon (TOC) on these samples. Carbon analysis, both at the species (HPOC) and fraction (TOC) level, provides a deeper understanding of the organic acids in cloud water; and may help increase the level of scientific understanding that clouds serve as a climate driver (National Academics 2008).

2011 Pilot Study

The carbon species pilot project started in 2009 concluded in 2011. In 2011, a total of 54 samples were shipped to Rutgers University for highly polar organic complex analysis. The ALSC also analyzed 278 total organic carbon (TOC) samples in 2011. Jessica Sagona, Rutgers University, required TOC concentrations as a necessary preliminary step to guide HPOC analysis. Dr. Sagona's analysis of TOC and HPOC data was accepted in her 2013 dissertation: Highly Polar Organic Compounds in Atmospheric Fine Particles and Cloud Water: A Study in the Northeastern United States (Sagona 2013).

Wet Deposition Monitoring

Site Description

The ALSC collects weekly precipitation and meteorological data from the NYSDEC wet deposition monitoring station located in St. Lawrence County at the Wanakena Ranger School in Fine, New York. The station, Wanakena Ranger School (Air Monitoring Location 4458–05), is located at an elevation of 458 m.

Sampling Design

The station was established as part of the NYSDEC Acid Deposition Monitoring Network in January 1987. The network consists of 20 monitoring sites located throughout New York State. Wanakena is a rural site that supports Type 3 instrumentation, which included a tipping bucket rain/snow gage to measure the amount of precipitation, and a Viking Hyetometer, which is a bucket type collector designed to collect samples under wet or dry conditions http://www.dec.ny.gov/chemical /8409.html.

Data Reported to Date

The analyzed chemistry and meteorological data are posted on the NYSDEC Division of Air Resources Air Quality Surveillance website (www.dec.ny.gov).

Regional Fisheries Chemistry

Since 1992, the ALSC has provided laboratory services to fisheries staff in NYSDEC Regions 5 and 6 (Adirondack Region) for lake chemistry analyses. A large number of these waters are included in the DEC Lake Liming Program where annual data are needed to assess the acid-base condition of lakes. These samples are collected by regional fisheries staff. The results provide a snapshot of lake chemistry relative to the viability of fisheries in areas beyond the ALTM and TIME lakes. The average number of lake water samples analyzed each year is 130.

Data Reported to Date

The lake chemistry data from this section are provided annually to NYSDEC Region 5 and 6 fisheries staff. Additional information may be available by contacting the NYSDEC Research Manager.

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Appendix A: ALTM Trend Results; Seasonal Kendall Test

LTM SITE		Site No.	Type	DOC	SO4 ueq L^{-1} yr^{-1}									NO3 ueq L^{-1} yr^{-1}								
					2011	2010	2009	2008	2007	2006	2005	2004	2000	2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond		020058	Medium Till Drainage		-2.76	-2.70	-2.59	-2.39	-2.66	-2.50	-2.14	-1.97		-0.03								
Big Hope Pond		020059	Medium Till Drainage	high	-2.57	-2.41	-2.29	-2.12	-2.05	-1.80	-1.49	-1.42										
Little Echo Pond	Original	020126	Mounded Seepage	high	-1.32	-1.23	-1.11	-0.94	-1.14	-1.10	-1.15	-1.15	-2.12							0.02		
East Copperas Pond		020138	Thin Till Drainage	high	-1.51	-1.44	-1.30	-1.08														
Middle Pond		020143	Carbonate Influenced		-2.12	-2.08	-2.04	-2.17	-2.21	-2.02	-1.70	-1.56		-0.04								
Sunday Pond		020188	Mounded Seepage	low	-0.76	-0.59	-0.46		-0.49	-0.49		-0.55	-1.04	-0.03	-0.03						-0.04	
Sochia Pond		020197	Mounded Seepage	low	-1.24	-1.16	-1.22	-1.11	-1.12	-1.00	-1.04	-1.01	-1.67									
Owen Pond		020233	Thick Till Drainage	low	-3.88	-3.75	-3.70	-3.79	-3.71	-3.40	-3.43	-3.24	-4.74			0.47	0.71	0.67	0.53			
Heart Lake	Original	020264	Medium Till Drainage	low	-1.93	-1.83	-1.78	-1.84	-1.84	-1.77	-1.75	-1.78	-2.23				0.08	0.07		0.09		
Marcy Dam Pond		020265	Thin Till Drainage	low	-2.12	-2.06	-2.01	-2.03	-2.01	-1.85	-1.77	-1.76	-2.71				0.53	0.47				
Grass Pond		030171	Mounded Seepage	high	-1.22	-1.15	-1.09	-1.04	-1.15	-1.11	-1.04	-1.09	-1.67									
Black Pond Outlet	Original	030255	Thick Till Drainage	low	-2.43	-2.41	-2.39	-2.37	-2.34	-2.15	-1.87	-1.87	-1.67									
Loon Hollow Pond		040186	Thin Till Drainage	low	-2.38	-2.15	-2.03	-1.71	-2.01	-1.97	-2.08	-2.23		-0.54	-0.54	-0.49	-0.26	-0.34	-0.34			
Willys Lake (Horseshoe)		040210	Thin Till Drainage	low	-3.34	-3.20	-3.07	-2.87	-2.87	-2.87	-3.01	-3.15	-3.54	-1.23	-1.24	-1.20	-0.91	-0.98	-0.98	-1.12	-1.18	
Middle Settlement Lake		040704	Thin Till Drainage	low	-2.14	-2.11	-2.03	-2.01	-1.99	-1.84	-1.88	-1.87	-1.74	-0.12	-0.14	-0.15	-0.12	-0.13	-0.14	-0.15	-0.15	
Grass Pond		040706	Medium Till Drainage	low	-2.00	-1.94	-1.92	-1.97	-1.96	-1.82	-1.78	-1.79	-1.98									-0.87
Middle Branch Lake		040707	Thin Till Drainage	low	-1.68	-1.67	-1.52	-1.55	-1.49	-1.35	-1.37	-1.39		-0.13	-0.13	-0.12	-0.07	-0.09	-0.10	-0.12	-0.12	
Lake Rondaxe	Original	040739	Thin Till Drainage	low	-2.64	-2.58	-2.49	-2.50	-2.63	-2.58	-2.58	-2.52	-2.71	-0.67	-0.70	-0.65	-0.57	-0.63	-0.72	-0.70	-0.73	-0.94
Moss Lake	Original	040746	Medium Till Drainage	low	-2.22	-2.13	-2.12	-2.21	-2.19	-2.03	-1.96	-1.96	-2.19	-0.63	-0.64	-0.60	-0.50	-0.61	-0.72	-0.75	-0.82	-1.27
Cascade Lake Outlet	Original	040747A	Medium Till Drainage	low	-2.16	-2.03	-2.02	-1.99	-2.01	-1.79	-1.72	-1.70	-2.29	-0.52	-0.50	-0.45			-0.58	-0.59	-0.73	-1.45
Bubb Lake	Original	040748	Thin Till Drainage	low	-1.96	-1.96	-2.05	-2.29	-2.37	-2.44	-2.62	-2.71	-2.94	-0.19	-0.23	-0.22						-0.40
Dart Lake	Original	040750	Thin Till Drainage	low	-2.91	-2.87	-2.80	-2.80	-2.91	-2.78	-2.81	-2.81	-3.18	-0.85	-0.86	-0.77	-0.60	-0.71	-0.72	-0.70	-0.75	
Windfall Pond	Original	040750A	Carbonate Influenced		-3.20	-3.20	-3.21	-3.21	-3.46	-3.33	-3.45	-3.54	-4.01	-0.30	-0.37	-0.38						
Big Moose Lake	Original	040752	Thin Till Drainage	low	-2.96	-2.89	-2.83	-2.83	-2.93	-2.87	-2.92	-2.91	-2.91	-0.90	-0.92	-0.84	-0.68	-0.80	-0.79	-0.76	-0.82	
West Pond	Original	040753	Thin Till Drainage	low	-2.63	-2.44	-2.23	-2.32	-2.54	-2.48	-2.77	-2.73	-2.97	-0.19	-0.21	-0.20		-0.18		-0.19	-0.23	
Squash Pond	Original	040754	Thin Till Drainage	high	-2.62	-2.42	-2.23	-1.87	-2.17	-1.91	-1.88	-1.87	-2.86		-0.20	-0.22						
Constable Pond	Original	040777	Thin Till Drainage	low	-3.38	-3.33	-3.33	-3.25	-3.30	-3.24	-3.05	-3.33	-3.85	-0.58	-0.61	-0.59	-0.51	-0.52	-0.59	-0.57	-0.58	
Limekiln Lake		040826	Medium Till Drainage	low	-2.88	-2.74	-2.71	-2.71	-2.71	-2.58	-2.57	-2.55	-2.89	-0.53	-0.55	-0.48	-0.35	-0.42	-0.42	-0.40	-0.38	
Squaw Lake		040850	Thin Till Drainage	low	-3.13	-3.15	-3.28	-3.59	-3.75	-3.70	-3.90	-3.96	-4.93	-0.40	-0.40	-0.34		-0.34				-1.13
Indian Lake		040852	Thin Till Drainage	low	-3.08	-3.08	-3.07	-2.94	-3.05	-2.79	-2.68	-2.71	-3.79	-0.27	-0.29	-0.27		-0.26	-0.34	-0.43	-0.41	-1.13
Brook Trout Lake		040874	Thin Till Drainage	low	-2.84	-2.78	-2.77	-2.83	-2.98	-2.91	-3.12	-3.20	-4.52	-0.49	-0.52	-0.49			-0.65	-0.91	-1.01	-1.77
Lost Pond		040887	Thin Till Drainage	high	-1.52	-1.51	-1.61	-1.55	-1.58	-1.38	-0.97	-0.88		-0.20	-0.23	-0.21			-0.31		-0.46	-1.61
South Lake		041004	Thin Till Drainage	low	-2.24	-2.15	-2.09	-2.05	-2.05	-1.94	-1.92	-1.92	-1.98	-0.90	-0.94	-0.87	-0.75	-0.87	-0.82	-0.85	-0.86	
North Lake		041007	Thin Till Drainage	low	-2.57	-2.49	-2.39	-2.23	-2.23	-2.04	-2.01	-2.01	-2.01	-0.66	-0.67	-0.62	-0.45	-0.52	-0.55	-0.63	-0.76	
Willis Lake		050215	Medium Till Drainage	low	-2.19	-2.04	-1.85	-1.72	-1.58	-1.45	-1.44	-1.23					0.02					
Jockeybush Lake		050259	Thin Till Drainage	low	-2.39	-2.28	-2.22	-2.23	-2.23	-2.08	-2.14	-2.11	-2.29									
Clear Pond	Original	050458	Thick Till Drainage	low	-2.53	-2.42	-2.43	-2.44	-2.29	-2.06	-1.75	-1.77	-1.90				0.05	0.04	0.05	0.08	0.05	
Nate Pond		050577	Medium Till Drainage	high	-2.89	-2.81	-2.74	-2.70	-2.57	-2.29	-2.21	-2.14		-0.06								
Long Pond		050649	Thin Till Drainage	high	-3.06	-2.91	-2.64	-2.25	-2.44	-2.21	-2.24	-2.22	-3.75	-0.03	-0.03	-0.03						
Carry Pond		050669	Mounded Seepage	low	-2.28	-2.52	-2.53	-2.21	-1.87	-1.54	-1.21	-1.11										
Arbutus Lake	Original	050684	Medium Till Drainage	low	-2.76	-2.60	-2.47	-2.29	-2.08	-1.73	-1.53	-1.59	-2.62	-0.19	-0.19	-0.18			-0.15			
Lake Colden		050706	Thin Till Drainage	low	-2.66	-2.50	-2.34	-2.13	-2.15	-1.89	-1.74	-1.85										
Avalanche Lake		050707	Thin Till Drainage	low	-3.07	-2.89	-2.69	-2.57	-2.73	-2.50	-2.30	-2.40	-3.93									
Sagamore Lake		060313	Medium Till Drainage	high	-3.35	-3.25	-3.23	-3.22	-3.21	-2.98	-3.00	-3.00	-3.96	-0.55	-0.57	-0.58		-0.57	-0.69	-0.77	-0.81	-1.21
Raquette Lake Reservoir		060315A	Medium Till Drainage	high	-4.09	-4.14	-4.18	-4.12	-4.16	-4.09	-4.16	-4.16	-4.19	-0.35	-0.39	-0.39	-0.32	-0.32	-0.40	-0.38	-0.38	
Queer Lake		060329	Thin Till Drainage	low	-2.63	-2.56	-2.57	-2.65	-2.71	-2.61	-2.73	-2.77	-2.97	-0.64	-0.65	-0.55	-0.38	-0.48	-0.41	-0.36	-0.34	
Otter Lake Outlet	Original	070728	Thin Till Drainage	low	-2.58	-2.46	-2.40	-2.50	-2.46	-2.27	-2.29	-2.43	-2.25						-0.18	-0.14	-0.16	
G Lake		070859	Thin Till Drainage	low	-2.24	-2.13	-2.06	-1.96	-1.87	-1.63	-1.60	-1.53	-1.35									
SITES WITH RECENT LIMING HISTORY																						
Little Clear Pond		030172	Limed	low	-1.30	-1.23	-1.16	-1.12	-1.08	-1.04	-1.02	-0.97	-1.15									
Woods Lake		040576	Limed	low	-3.02	-3.01	-3.05	-3.03	-3.14	-3.06	-3.03	-2.94	-3.75									
Barnes Lake	Original	040905	Limed	high	-1.14	-0.99	-0.83							-0.05	-0.04							
Little Simon Pond		060182	Limed	low	-2.79	-2.68	-2.61	-2.58	-2.50	-2.36	-2.45	-2.46	-3.14	-0.47	-0.41							
UPSTREAM SITES																						
Cascade		040747			-2.35	-2.18	-2.12	-1.83	-1.46	-1.25				-0.65	-0.62	-0.55						
Bubb		040748.2			-1.91	-1.87	-1.98	-2.24	-2.33	-2.33												
Windfall		040750A.2			-3.30	-3.26	-3.33	-3.42	-3.20	-3.03				-0.62	-0.72	-0.73	-0.47	-0.71	-0.67			
West		040753.2			-2.81	-2.53	-2.29	-2.71	-2.52	-2.93				-0.09	-0.10							
Squash		040754.2			-2.56	-2.36	-2.08	-1.87	-1.67	-1.53												
Constable		040777.2			-3.36	-3.29	-3.23	-3.12	-2.91	-2.86				-0.73	-0.76	-0.75	-0.57	-0.74	-0.75			
Otter		070729			-2.24	-2.65	-2.60	-2.60	-2.22	-2.43												

LTM SITE	Cl ueq L^{-1} yr^{-1}									F ueq L^{-1} yr^{-1}								
	2011	2010	2009	2008	2007	2006	2005	2004	2000	2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond				-0.17	-0.24	-0.25	-0.28	-0.28		-0.03	-0.03	-0.03						
Big Hope Pond		-0.89	-1.08	-1.41	-1.61	-1.78	-1.98	-2.07	-3.38						0.03			
Little Echo Pond	0.19	0.18	0.21	0.23	0.21	0.22	0.20	0.24	0.33									-0.01
East Copperas Pond													0.02					
Middle Pond		-0.12	-0.15	-0.19	-0.19	-0.14	-0.09											
Sunday Pond				0.00														
Sochia Pond	0.09	0.12	0.14	0.17	0.16	0.19	0.19	0.19				0.01	0.02	0.02	0.02			
Owen Pond																		
Heart Lake																		
Marcy Dam Pond											0.01	0.01	0.01	0.02				
Grass Pond (030171)	-0.05	-0.03				-0.05												
Black Pond Outlet	-0.06	-0.05	-0.04		-0.05	-0.06	-0.06											
Loon Hollow Pond	-0.11	-0.12	-0.11	-0.08	-0.09	-0.09	-0.12	-0.14		-0.02	-0.02	-0.02						
Willys Lake (Horseshoe)	-0.09	-0.08	-0.07	-0.06	-0.08	-0.08	-0.09	-0.09		-0.08	-0.08	-0.08	-0.07	-0.05	-0.05	-0.07	-0.07	-0.07
Middle Settlement Lake	-0.05	-0.05								-0.02	-0.02	-0.02						
Grass Pond (040706)	-0.07	-0.06								-0.03	-0.03	-0.03						
Middle Branch Lake	-0.10	-0.09	-0.09	-0.09	-0.09	-0.09	-0.10	-0.09		-0.02	-0.02	-0.03						
Lake Rondaxe										-0.04	-0.04	-0.04	-0.03	-0.04				
Moss Lake										-0.04	-0.04	-0.04	-0.05					
Cascade Lake Outlet										-0.06	-0.05	-0.06	-0.08	-0.10	-0.08			
Bubb Lake	-0.08									-0.05	-0.05	-0.05	-0.05	-0.05			-0.04	
Dart Lake										-0.04	-0.04	-0.04						
Windfall Pond	-0.11	-0.10								-0.06	-0.06	-0.07	-0.06	-0.07	-0.05	-0.04		
Big Moose Lake										-0.04	-0.04	-0.03	-0.03	-0.03				-0.05
West Pond	-0.10	-0.10	-0.09	-0.07						-0.04	-0.04	-0.04				-0.04	-0.05	-0.12
Squash Pond	-0.11	-0.10	-0.08							-0.03	-0.02	-0.02						-0.04
Constable Pond	-0.14	-0.13	-0.11							-0.06	-0.05	-0.06	-0.04	-0.05	-0.04		-0.04	
Limekiln Lake	-0.32	-0.38	-0.47	-0.59	-0.65	-0.66	-0.64	-0.63		-0.03	-0.03	-0.02						
Squaw Lake	-0.13	-0.12	-0.11	-0.08	-0.07				-0.16	-0.02	-0.02	-0.02						
Indian Lake	-0.14	-0.12	-0.10							-0.02	-0.02	-0.02						
Brook Trout Lake	-0.09	-0.09	-0.07	-0.04					-0.12	-0.02	-0.02	-0.02						-0.04
Lost Pond	-0.10	-0.10	-0.09															
South Lake	-0.09	-0.09								-0.02	-0.02	-0.02						
North Lake	-0.11	-0.10	-0.09							-0.02	-0.02	-0.01						
Willis Lake	0.24														0.02			
Jockeybush Lake	-0.11	-0.09	-0.08							-0.02	-0.02	-0.01				-0.01		
Clear Pond	-0.08	-0.06	-0.04							0.01	0.01	0.01	0.01	0.01	0.02		0.01	
Nate Pond	-0.13	-0.11	-0.08							-0.03	-0.03	-0.03						
Long Pond	-0.12																	
Carry Pond																		
Arbutus Lake	-0.10									-0.03	-0.03							
Lake Colden	-0.06																	
Avalanche Lake	-0.11	-0.11	-0.09															
Sagamore Lake	-0.11	-0.09								-0.03	-0.03	-0.02	-0.03					
Raquette Lake Reservoir	-0.14	-0.12								-0.04	-0.04	-0.04	-0.04	-0.04	-0.03			
Queer Lake	-0.12	-0.10	-0.08	-0.06	-0.07					-0.03	-0.03	-0.03						
Otter Lake Outlet										-0.01	-0.01							
G Lake	-0.11	-0.11	-0.09							-0.02	-0.02	-0.02						
SITES WITH RECENT LIMING HISTORY																		
Little Clear Pond	-0.07	-0.06	-0.06	-0.07	-0.07	-0.08	-0.09	-0.08	-0.14	-0.01	-0.01	-0.01						
Woods Lake	-0.08	-0.07	-0.05							-0.02	-0.02	-0.02				-0.02		
Barnes Lake	-0.09	-0.08	-0.08	-0.09	-0.09		-0.09			-0.01	-0.01	0.00						-0.02
Little Simon Pond	-0.09	-0.06								-0.03	-0.03	-0.03						
UPSTREAM SITES																		
Cascade	-0.09	-0.07	-0.05							-0.05	-0.05	-0.06	-0.04					
Bubb	-0.08									-0.05	-0.05	-0.06		-0.08	-0.07			
Windfall	-0.09	-0.09								-0.03	-0.04	-0.04						
West	-0.10	-0.09	-0.10							-0.04	-0.03	-0.03	-0.05	-0.04				
Squash	-0.09	-0.09	-0.07							-0.02	-0.02	-0.01						
Constable	-0.17	-0.16	-0.14							-0.06	-0.06	-0.05						
Otter		-0.11									-0.02				0.03			

LTM SITE	ANC ueq L^{-1} yr^{-1}									DIC umol L^{-1} yr^{-1}								
	2011	2010	2009	2008	2007	2006	2005	2004	2000	2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond	1.52	1.60	1.53	1.46	1.53	1.55	1.89	1.89							-1.87	-1.66	-1.39	
Big Hope Pond	2.01	2.09	2.08	2.10	2.17	2.18	2.44	2.54	2.98	1.49	1.67	1.52	1.17					
Little Echo Pond	1.01	1.06	1.01	1.07	1.25	1.36	1.32	1.46	2.53									
East Copperas Pond	0.48	0.50	0.51	0.61	0.69	0.68				2.50	2.77	3.01	3.08	3.33	4.16	4.17	4.35	
Middle Pond																		
Sunday Pond										-0.63	-0.73	-0.83	-0.85	-0.70			-0.64	
Sochia Pond	1.02	1.09	1.27	1.37	1.44	1.46	1.71	1.70	1.93									
Owen Pond	0.82	0.92	1.03			1.41	1.80	2.00										
Heart Lake																		
Marcy Dam Pond	0.70	0.64	0.63	0.61			0.76	0.83		0.37								
Grass Pond (030171)	0.39	0.45	0.37	0.36			0.62	0.71	1.57									
Black Pond Outlet														-2.39	-2.71			
Loon Hollow Pond	0.87	0.87	0.84	0.90	0.84	0.84	1.11	1.22	1.65									
Willys Lake (Horseshoe)	0.72	0.76	0.72	0.64	0.60	0.60	0.76	0.73	1.01								-0.56	
Middle Settlement Lake	0.95	0.95	0.87	0.74	0.67	0.68	0.64		1.32									
Grass Pond (040706)	0.74	0.87	0.75	0.82	0.68	0.95												
Middle Branch Lake																		
Lake Rondaxe	1.10	1.15	1.11	1.27	1.08	1.18	1.58	1.35		0.95	0.90	0.94	1.25	1.03	1.11		1.50	
Moss Lake	1.11	1.07	0.95			0.71												
Cascade Lake Outlet																		
Bubb Lake							1.15	1.26	1.91									
Dart Lake	1.25	1.27	1.20	1.21	1.28	1.35	1.36	1.41	1.41	0.81	0.72	0.69	0.62	0.71	0.83	0.71	0.74	
Windfall Pond	1.03	1.04	0.79	0.78		0.84	1.13											
Big Moose Lake	1.09	1.09	1.01	0.90	1.00	0.99	1.08	0.95	1.44	0.53								
West Pond	0.44	0.43																
Squash Pond	0.75	0.74	0.72	0.81	0.72	0.73	0.81	0.74	0.90									
Constable Pond	0.89	0.98	0.93	1.01	0.94	1.23	1.46	1.46	2.03									
Limekiln Lake	1.53	1.47	1.40	1.49	1.56	1.70	1.82	1.85	2.51	1.14	1.09	0.98	1.19	1.06	1.46	1.67	1.82	2.68
Squaw Lake	0.81	0.80	0.75	0.79	0.83	0.88	0.95	1.01	2.03	0.56	0.64	0.77	0.83	0.83	1.08	1.11	0.69	
Indian Lake	0.80	0.82	0.80	0.76	0.73	0.76	0.81	0.80		1.04	1.04	1.04	1.06	1.25	1.25	1.30	1.11	
Brook Trout Lake	0.74	0.77	0.81	0.89	1.01	1.16	1.41	1.47	2.10	0.68	0.65	0.58		0.54	0.65			
Lost Pond	0.75	0.69	0.47	0.61	0.56	0.65	0.74	0.73										
South Lake	1.11	1.13	1.07	1.10	1.20	1.28	1.40	1.50	1.64	0.66	0.62	0.56				0.65		
North Lake	0.96	0.96	0.90	0.77	0.84	0.84	0.87	0.92		0.42								
Willis Lake	0.95	1.03		1.15	1.32	1.48				2.93	3.12	2.78						
Jockeybush Lake	0.87	0.88	0.83	0.77	0.77	0.80	0.84	0.90	1.26									
Clear Pond														-1.67				
Nate Pond																		
Long Pond	1.19	1.20	1.00	0.74	0.75	0.93	1.25	1.32		2.35	2.60	2.83	2.64	2.08	2.00	2.08	2.43	
Carry Pond	1.27	1.41	1.53	1.62	1.56	1.26	0.95	0.88										
Arbutus Lake																		
Lake Colden	0.75	0.74	0.69	0.63	0.60	0.58	0.73	0.79	1.10									
Avalanche Lake	0.78	0.78	0.74	0.71	0.68	0.63	0.73	0.73	0.71									
Sagamore Lake	0.65	0.74	0.71			0.66												
Raquette Lake Reservoir	0.79	0.83	0.79	0.85	0.74	0.93				1.77	1.77	1.87	1.74	1.96	1.94	2.66	2.79	
Queer Lake	1.10	1.13	1.06	0.99	1.11	1.03	1.03	1.03	1.05	0.42	0.46	0.45						
Otter Lake Outlet	0.85	0.86	0.85	0.78	0.70	0.83	0.74	0.74	1.32									
G Lake	0.71	0.74	0.72	0.79	0.72	0.85	1.05	1.11										
SITES WITH RECENT LIMING HISTORY																		
Little Clear Pond						10.28	13.26	14.73	25.86						7.68	####	####	20.85
Woods Lake																		-3.33
Barnes Lake	-0.57	-0.55	-0.52	-0.63	-0.84	-1.02	-1.16	-1.34	-2.15	-1.46	-1.54	-1.39		-1.55	-1.67	-1.67	-1.85	
Little Simon Pond				1.42	1.76													-6.66
UPSTREAM SITES																		
Cascade	0.87	0.84	0.71		0.92													
Bubb													-1.25	-1.63	-1.23			
Windfall																		
West	0.82	0.80	0.71	0.66	0.86	1.12				0.83	0.62	0.62		1.11	1.67			
Squash	1.07	1.06	0.93	0.98	1.08	1.09												
Constable	0.83	0.89	0.86	0.89	1.05	1.14				1.07	0.83	0.83	1.11	1.11	1.31			
Otter	0.89	0.71	0.86	0.82	0.65	0.70	0.67			0.92		0.84	0.92					

LTM SITE		Site No.	Type	DOC	DOC umol L^{-1} yr^{-1} 2011	2010	2009	2008	2007	2006	2005	2004	2000	SiO2 umol L^{-1} yr^{-1} 2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond		020058	Medium Till Drainage		-9.37	-10.29	-10.40							1.53	1.68	1.92	2.00	2.32	2.00	1.73	1.91	3.16
Big Hope Pond		020059	Medium Till Drainage	high										0.92	0.96	1.02	0.89	0.95	0.83	0.66		
Little Echo Pond	Original	020126	Mounded Seepage	high							12.74									0.55		
East Copperas Pond		020138	Thin Till Drainage	high	12.55	13.86	16.62	18.2	19.90	18.86		9.07										
Middle Pond		020143	Carbonate Influenced				-2.65															
Sunday Pond		020188	Mounded Seepage	low	-5.90	-6.88	-7.72	-7.9	-6.89	-7.22	-7.27	-7.20		-0.07	-0.07	-0.05						
Sochia Pond		020197	Mounded Seepage	low	4.91	4.85	4.63	4.8	6.74	7.93	9.68	11.01								0.23		0.31
Owen Pond		020233	Thick Till Drainage	low																		
Heart Lake	Original	020264	Medium Till Drainage	low	-1.44	-1.94	-2.19	-2.1	-2.01	-1.91		-2.41										2.89
Marcy Dam Pond		020265	Thin Till Drainage	low																1.20	1.59	
Grass Pond		030171	Mounded Seepage	high	9.54	9.25	10.47	12.7	14.80	14.74	14.18	14.41				0.12						0.46
Black Pond Outlet	Original	030255	Thick Till Drainage	low																	3.39	
Loon Hollow Pond		040186	Thin Till Drainage	low										-0.67	-0.67	-0.62	-0.55					
Willys Lake (Horseshoe)		040210	Thin Till Drainage	low	7.73	7.58	7.61	5.9						-1.43	-1.45	-1.37	-1.27	-1.17	-1.17	-1.32	-1.32	
Middle Settlement Lake		040704	Thin Till Drainage	low	3.41	3.18	2.90	2.7	2.58	2.52												
Grass Pond		040706	Medium Till Drainage	low														1.10	1.36	1.98	2.05	
Middle Branch Lake		040707	Thin Till Drainage	low										0.57								2.03
Lake Rondaxe	Original	040739	Thin Till Drainage	low	4.23	3.74	3.52	3.4	4.35		4.36			-0.56	-0.46	-0.39	-0.43	-0.49				
Moss Lake	Original	040746	Medium Till Drainage	low										-0.59	-0.62	-0.72	-0.79					
Cascade Lake Outlet	Original	040747A	Medium Till Drainage	low									13.68									2.89
Bubb Lake	Original	040748	Thin Till Drainage	low															-1.15	-1.45	-1.51	
Dart Lake	Original	040750	Thin Till Drainage	low	5.15	4.46	4.42	4.4	5.70		5.69	4.87		-0.61	-0.55	-0.54						
Windfall Pond	Original	040750A	Carbonate Influenced					2.9	4.59	4.72	6.15	6.13		-0.85	-0.89	-0.88						
Big Moose Lake	Original	040752	Thin Till Drainage	low	5.59	5.27	5.18	5.1	6.53	5.48	6.66			-0.58	-0.50	-0.57	-0.52					
West Pond	Original	040753	Thin Till Drainage	low	6.43									-0.45	-0.50	-0.62	-0.67					
Squash Pond	Original	040754	Thin Till Drainage	high	4.81	4.21													0.54	0.60		
Constable Pond	Original	040777	Thin Till Drainage	low	5.23	5.35	5.49	6.0	5.94	5.04	6.33	5.56		-0.96	-0.95	-0.91	-0.74	-0.55				
Limekiln Lake		040826	Medium Till Drainage	low	3.57	3.34	3.62	3.8	3.85	3.29	3.36	3.68				0.53	0.75	0.90	1.00	0.00	1.03	
Squaw Lake		040850	Thin Till Drainage	low				4.3	5.54	5.00	5.51	6.05					0.94	1.10	1.31	1.54	1.71	3.00
Indian Lake		040852	Thin Till Drainage	low	4.44	4.29																
Brook Trout Lake		040874	Thin Till Drainage	low	6.05	6.43	6.89	8.7	10.94	13.22	16.02	17.44	20.33	-1.00	-0.95	-0.97	-0.87	-0.70	-0.67	-0.78	-0.83	
Lost Pond		040887	Thin Till Drainage	high																		
South Lake		041004	Thin Till Drainage	low	4.11	3.80	3.51	4.0	4.68	4.29	4.41	4.74		-0.46								
North Lake		041007	Thin Till Drainage	low										-0.53	-0.45	-0.50						
Willis Lake		050215	Medium Till Drainage	low	-5.25	-4.80	-5.18															
Jockeybush Lake		050259	Thin Till Drainage	low	1.89			1.3						0.50	0.41	0.37	0.41	0.36				
Clear Pond	Original	050458	Thick Till Drainage	low	2.23	2.04	2.34	2.3	2.82													
Nate Pond		050577	Medium Till Drainage	high	4.03	3.55	3.50		5.19	4.01												
Long Pond		050649	Thin Till Drainage	high	14.57	14.57	15.62	17.1	22.13	19.24	21.19			0.79	0.85			1.27				
Carry Pond		050669	Mounded Seepage	low	7.16	7.41	7.12	5.0														
Arbutus Lake	Original	050684	Medium Till Drainage	low										-0.70	-0.70	-0.71	-0.93		-0.78			
Lake Colden		050706	Thin Till Drainage	low	4.05	3.31															1.14	
Avalanche Lake		050707	Thin Till Drainage	low	3.47																	
Sagamore Lake		060313	Medium Till Drainage	high	5.52	5.13								-0.62								
Raquette Lake Reservoir		060315A	Medium Till Drainage	high	6.72	7.31	7.35	8.0	9.21	10.25	10.66	12.41		-1.61	-1.62	-1.50						
Queer Lake		060329	Thin Till Drainage	low	4.43	4.10	4.19	4.2	4.36							0.19	0.31	0.30	0.33			
Otter Lake Outlet	Original	070728	Thin Till Drainage	low	2.12	1.55																
G Lake		070859	Thin Till Drainage	low																		
SITES WITH RECENT LIMING HISTORY																						
Little Clear Pond		030172	Limed	low									13.84						0.17	0.23		0.44
Woods Lake		040576	Limed	low										-1.04	-1.04	-1.13	-1.33	-1.39	-1.34	-1.22	-1.11	
Barnes Lake	Original	040905	Limed	high				-10.3	-11.83	-12.62	-12.77	-14.67	-11.92									
Little Simon Pond		060182	Limed	low	2.25													0.67	0.94	0.91	0.94	
UPSTREAM SITES																						
Cascade		040747			3.20	2.36	2.55	3.7	3.12									0.69	1.00			
Bubb		040748.2																				
Windfall		040750A.2			3.74	4.16	4.87	4.2	4.15	3.40				-0.69	-0.82	-0.95	-1.00	-1.00				
West		040753.2			8.10	7.18	6.21	7.3	7.18	9.73												
Squash		040754.2			8.32	8.17	8.08												0.33			
Constable		040777.2			9.25	9.43	9.42	10.6	10.47	9.64				-1.22	-1.29	-1.25	-0.74	-0.62				
Otter		070729			4.30		3.70	3.32	3.77	3.44	3.86											

LTM SITE	Site No.	Ca ueq L^{-1} yr^{-1} 2011	2010	2009	2008	2007	2006	2005	2004	2000	Mg ueq L^{-1} yr^{-1} 2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond	020058	-0.69	-0.60	-0.60	-0.80						-0.24								
Big Hope Pond	020059		0.47	0.51				0.75									0.41	0.49	
Little Echo Pond	020126										0.20	0.21	0.21	0.27	0.37	0.46	0.49	0.55	
East Copperas Pond	020138	-0.39									-0.09	-0.08							
Middle Pond	020143	-1.06	-1.00	-0.91		-1.38					-0.30								
Sunday Pond	020188	-0.73	-0.65	-0.62	-0.70	-0.75	-0.83	-0.78	-0.80	-1.16	-0.50	-0.49	-0.51	-0.51	-0.52	-0.53	-0.55	-0.55	-0.82
Sochia Pond	020197																		
Owen Pond	020233	-2.12	-1.93	-1.83	-2.00	-2.16					-0.61	-0.55	-0.47						
Heart Lake	020264	-1.58	-1.50	-1.50	-1.69	-1.71	-1.71	-1.50	-1.57	-2.83	-0.27	-0.24	-0.24	-0.27	-0.27	-0.25			
Marcy Dam Pond	020265	-0.94	-0.93	-0.86						-2.50									
Grass Pond	030171										-0.08			0.00					
Black Pond Outlet	030255	-1.54	-1.50	-1.78	-2.40	-2.73	-2.74	-2.22	-2.63	-4.24	-0.62	-0.54	-0.59	-0.66	-0.67				
Loon Hollow Pond	040186	-0.66	-0.63	-0.61	-0.57	-0.67	-0.67	-0.62	-0.64	-1.00	-0.21	-0.21	-0.21	-0.16	-0.18	-0.16	-0.16	-0.16	
Willys Lake (Horseshoe)	040210	-1.43	-1.40	-1.37	-1.35	-1.41	-1.41	-1.41	-1.50	-1.75	-0.33	-0.31	-0.30	-0.27	-0.25	-0.25	-0.21	-0.24	-0.33
Middle Settlement Lake	040704	-0.43	-0.41	-0.45	-0.54	-0.62	-0.60	-0.58	-0.60		-0.16	-0.16	-0.16	-0.18	-0.18	-0.16	-0.18	-0.18	
Grass Pond	040706	-0.68	-0.56	-0.65	-0.89	-1.08	-1.00	0.00	-0.93	-1.41	-0.23		-0.22						
Middle Branch Lake	040707	-0.78	-0.78	-0.83	-0.93	-1.15	-1.12	-1.00	-0.90		-0.27	-0.24	-0.24		-0.27				
Lake Rondaxe	040739	-1.12	-1.08	-1.10	-1.16	-1.43	-1.32	-1.00	-1.19		-0.34	-0.33	-0.33		-0.33				
Moss Lake	040746	-1.23	-1.25	-1.38	-1.75	-2.00	-1.85	-1.65	-1.75	-2.62	-0.31	-0.30	-0.31	-0.37	-0.41				
Cascade Lake Outlet	040747A	-1.50	-1.50	-1.88	-2.08	-2.50	-2.44	-2.33	-2.71	-4.62	-0.41	-0.36	-0.43	-0.45	-0.55				
Bubb Lake	040748	-1.06	-1.12	-1.27	-1.34	-1.44	-1.25	-0.87	-1.00	-1.75	-0.41	-0.41	-0.47	-0.49	-0.55	-0.48	-0.41	-0.41	
Dart Lake	040750	-1.16	-1.16	-1.16	-1.25	-1.43	-1.33	-1.09	-1.25	-2.59	-0.37	-0.35	-0.36	-0.31	-0.34	-0.27			
Windfall Pond	040750A	-1.37	-1.44	-1.75	-1.75	-2.25	-2.00	-1.47	-1.79		-0.41	-0.41	-0.44		-0.41		-0.21		
Big Moose Lake	040752	-1.12	-1.05	-1.12	-1.25	-1.41	-1.37	-1.15	-1.37	-2.00	-0.35	-0.33	-0.35	-0.33	-0.34	-0.27	-0.27	-0.27	
West Pond	040753	-1.18	-1.14	-1.25	-1.58	-1.71	-1.75	-1.75	-1.84	-3.29	-0.41	-0.37	-0.41	-0.49	-0.55	-0.51	-0.51	-0.55	-1.23
Squash Pond	040754	-0.83	-0.83	-0.83	-0.81	-0.92	-0.87	-0.75	-0.83	-1.60	-0.24	-0.22	-0.22	-0.18	-0.21	-0.14			
Constable Pond	040777	-1.61	-1.60	-1.65	-1.64	-1.75	-1.64	-1.30	-1.50		-0.41	-0.41	-0.41	-0.37	-0.41	-0.27			
Limekiln Lake	040826	-0.96	-0.95	-1.00	-1.00	-1.05	-0.93	-0.75	-0.73		-0.35	-0.34	-0.35	-0.27	-0.27				
Squaw Lake	040850	-1.66	-1.71	-1.83	-2.06	-2.20	-2.25	-2.25	-2.25	-3.59	-0.49	-0.49	-0.55	-0.59	-0.62	-0.57	-0.55	-0.55	-0.82
Indian Lake	040852	-1.45	-1.49	-1.50	-1.69	-1.85	-1.91	-1.92	-1.94	-3.08	-0.38	-0.38	-0.41	-0.41	-0.41	-0.41	-0.36	-0.37	-0.82
Brook Trout Lake	040874	-1.14	-1.07	-1.06	-1.05	-1.10	-1.10	-1.00	-1.00	-1.67	-0.32	-0.27	-0.27	-0.21	-0.19				
Lost Pond	040887	-1.16	-1.25	-1.33	-1.41	-1.50	-1.62	-1.50	-1.56	-3.24	-0.34	-0.37	-0.41	-0.41	-0.41	-0.41	-0.33	-0.33	-0.82
South Lake	041004	-0.75	-0.75	-0.75	-0.75	-0.75	-0.64			-1.25	-0.30	-0.27	-0.30	-0.25					
North Lake	041007	-1.09	-1.14	-1.19	-1.28	-1.33	-1.25	-1.21	-1.25	-2.10	-0.35	-0.33	-0.35	-0.33	-0.31				
Willis Lake	050215										-0.25	-0.21	-0.21						
Jockeybush Lake	050259	-0.87	-0.85	-0.80	-0.87	-0.95	-1.00	-0.87	-0.80	-1.00	-0.27	-0.27	-0.27	-0.21	-0.24	-0.21	-0.16		
Clear Pond	050458	-2.00	-2.00	-2.22	-2.54	-2.78	-2.66	-2.40	-2.50	-4.99	-0.35	-0.33	-0.34	-0.33	-0.33				
Nate Pond	050577	-1.50	-1.21	-1.22	-1.25	-1.33					-0.62	-0.55	-0.55						
Long Pond	050649	-0.45								-1.75	-0.37	-0.32							
Carry Pond	050669	-0.64	-0.64	-0.62	-0.50					-1.06	-0.21	-0.24	-0.26	-0.25	-0.25	-0.21			
Arbutus Lake	050684	-1.63	-1.50	-1.50	-1.46	-1.50				-3.31	-0.59	-0.55	-0.55	-0.47	-0.48				
Lake Colden	050706	-1.11	-0.99	-0.86	-0.79	-0.92					-0.21	-0.18							
Avalanche Lake	050707	-1.28	-1.12	-1.04	-1.00	-1.11				-2.62	-0.30	-0.27	-0.24						
Sagamore Lake	060313	-1.80	-1.77	-1.90	-2.25	-2.41	-2.25	-2.15	-2.16	-2.91	-0.55	-0.50	-0.51	-0.55	-0.58				
Raquette Lake Reservoir	060315A	-2.13	-2.22	-2.38	-2.50	-2.77	-2.74	-2.70	-2.92	-3.24	-0.79	-0.82	-0.82	-0.82	-0.82	-0.72	-0.59	-0.64	
Queer Lake	060329	-0.89	-0.84	-0.89	-1.00	-1.07	-1.00	-1.00	-0.98	-2.25	-0.32	-0.29	-0.31	-0.27	-0.27	-0.25	-0.22	-0.22	
Otter Lake Outlet	070728	-0.95	-0.91	-0.91	-1.00	-1.14	-1.19	-1.16	-1.28		-0.31	-0.29	-0.27	-0.24	-0.27				
G Lake	070859	-0.92	-0.87	-0.87	-0.80	-0.87	-0.78												
SITES WITH RECENT LIMING HISTORY																			
Little Clear Pond	030172						6.79	8.88	9.73	16.66						3.29	4.20	4.81	8.39
Woods Lake	040576	-2.00	-1.91	-2.00	-2.00	-2.25	-2.25	-2.25	-2.28	-4.74	-0.23	-0.21	-0.22	-0.16	-0.16				
Barnes Lake	040905	-1.60	-1.66	-1.71	-1.81	-1.87	-1.87	-1.66	-1.75	-2.99	-0.12	-0.13	-0.14	-0.14	-0.14	-0.13	-0.14	-0.14	
Little Simon Pond	060182									-6.53	-0.66	-0.64	-0.66	-0.64	-0.68	-0.66	-0.69	-0.72	-1.44
UPSTREAM SITES																			
Cascade	040747	-1.01	-0.94	-1.00	-1.10	-0.87					-0.39	-0.33	-0.33						
Bubb	040748.2	-0.81	-0.86	-1.00	-1.04	-1.06	-0.97				-0.37	-0.39	-0.45	-0.51	-0.55	-0.55			
Windfall	040750A.2	-2.44	-2.58	-2.85	-2.89	-2.58	-2.66				-0.55	-0.55	-0.60	-0.55	-0.47	-0.41			
West	040753.2	-1.00	-0.90	-0.90	-1.21	-1.16	-1.21				-0.27	-0.21	-0.22	-0.37	-0.27				
Squash	040754.2	-0.50	-0.50	-0.45	-0.42	-0.37					-0.18	-0.15	-0.14						
Constable	040777.2	-1.43	-1.40	-1.40	-1.33	-1.22	-1.00				-0.41	-0.41	-0.41	-0.37	-0.27				
Otter	070729		-0.92	-0.82	-0.80	-1.00	-1.16	-1.16			-0.33		-0.31	-0.29	-0.31	-0.27	-0.24		

LTM SITE	Site No.	Na ueq L^{-1} yr^{-1} 2011	2010	2009	2008	2007	2006	2005	2004	2000	K ueq L^{-1} yr^{-1} 2011	2010	2009	2008	2007	2006	2005	2004
Little Hope Pond	020058										-0.21	-0.21	-0.21					
Big Hope Pond	020059		-0.51	-0.65	-0.87	-1.03	-1.14	-1.16	-1.16	-1.96	-0.25	-0.25	-0.26	-0.21	-0.21			
Little Echo Pond	020126	0.24	0.22	0.24	0.27	0.29	0.31	0.30	0.33	0.22		-0.06						
East Copperas Pond	020138			0.05	0.08	0.10	0.12	0.11	0.11									
Middle Pond	020143							0.44	0.50		-0.14	-0.13	-0.12					
Sunday Pond	020188	0.02	0.02	0.00	0.00													
Sochia Pond	020197	0.09	0.10	0.10	0.12	0.12	0.14	0.12	0.11					0.05	0.05			
Owen Pond	020233							0.58	0.64									
Heart Lake	020264				0.24	0.24	0.25	0.29	0.29		-0.02	-0.02	-0.01					
Marcy Dam Pond	020265							0.43	0.44									
Grass Pond	030171	0.04	0.05	0.06	0.08	0.07					-0.12	-0.12	-0.10	-0.09	-0.09			
Black Pond Outlet	030255																	
Loon Hollow Pond	040186				0.13	0.14					-0.12	-0.12	-0.12					
Willys Lake (Horseshoe)	040210				0.14	0.17	0.17	0.17										
Middle Settlement Lake	040704					0.20	0.25	0.25	0.25									
Grass Pond	040706						0.50											
Middle Branch Lake	040707								0.33									
Lake Rondaxe	040739				0.33	0.31	0.37	0.37	0.44		-0.09	-0.07						
Moss Lake	040746						0.33				-0.10	-0.09	-0.09		-0.06	-0.06		
Cascade Lake Outlet	040747A										-0.09	-0.09	-0.09		-0.09	-0.09	-0.13	-0.09
Bubb Lake	040748										-0.10	-0.09	-0.08					
Dart Lake	040750				0.26	0.31	0.39	0.40	0.44		-0.13	-0.11	-0.09	-0.05	-0.06	-0.04		
Windfall Pond	040750A										-0.09							
Big Moose Lake	040752				0.26	0.32	0.39	0.39	0.44		-0.11	-0.09	-0.06					
West Pond	040753										-0.10	-0.10	-0.10					
Squash Pond	040754						0.27	0.26	0.27		-0.06	-0.06	-0.06					
Constable Pond	040777										-0.13	-0.11						
Limekiln Lake	040826										-0.09	-0.08	-0.07	-0.04				
Squaw Lake	040850						0.19	0.22	0.22		-0.06	-0.05						
Indian Lake	040852															-0.06	-0.07	-0.09
Brook Trout Lake	040874					0.21	0.26	0.29	0.29		-0.04	-0.04	-0.04	-0.03	-0.03	-0.03		
Lost Pond	040887						0.30	0.44	0.44									
South Lake	041004						0.36	0.44	0.44		-0.09	-0.09	-0.07	-0.04	-0.04			
North Lake	041007							0.34			-0.06	-0.06	-0.06	-0.05	-0.05	-0.06	-0.07	-0.09
Willis Lake	050215	0.24	0.25	0.22														
Jockeybush Lake	050259					0.22	0.25	0.29	0.31		-0.05	-0.05						
Clear Pond	050458										-0.02	-0.03	-0.02					
Nate Pond	050577							0.43	0.44		-0.11	-0.09						
Long Pond	050649						0.30	0.33	0.33									
Carry Pond	050669				0.07						0.13	0.14	0.17	0.23	0.18	0.13		
Arbutus Lake	050684										-0.14	-0.13	-0.12	-0.07	-0.09	-0.10		
Lake Colden	050706					0.25	0.31	0.40	0.44			-0.04						
Avalanche Lake	050707							0.29	0.31									
Sagamore Lake	060313																	
Raquette Lake Reservoir	060315A																	
Queer Lake	060329				0.16	0.19	0.22	0.22	0.24		-0.13	-0.13	-0.10	-0.06	-0.06	-0.06	-0.07	-0.07
Otter Lake Outlet	070728								0.29									
G Lake	070859						0.33	0.43	0.44		-0.07	-0.08	-0.06		-0.05	-0.06	-0.08	-0.09
SITES WITH RECENT LIMING HISTORY																		
Little Clear Pond	030172	0.03	0.04	0.04	0.05													
Woods Lake	040576																	
Barnes Lake	040905										-0.09	-0.10	-0.11	-0.13	-0.14	-0.16	-0.17	-0.19
Little Simon Pond	060182				0.29	0.33	0.39	0.44	0.44		-0.13	-0.11	-0.10	-0.06	-0.07	-0.06		
UPSTREAM SITES																		
Cascade	040747				0.36	0.43	0.55				-0.10	-0.08	-0.06	-0.04	-0.03			
Bubb	040748.2						0.29											
Windfall	040750A.2					0.14	0.19							0.06	0.06	0.09		
West	040753.2																	
Squash	040754.2					0.29	0.33											
Constable	040777.2					0.22	0.27				-0.14	-0.10						
Otter	070729						0.29	0.35				-0.07		0.05				

LTM SITE		Site No.	Type	DOC	2000	NH4 ueq L⁻¹ yr⁻¹ 2011	2010	2009	2008	2007	2006	2005	2004	2000	Al TD umol L⁻¹ yr⁻¹ 2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond		020058	Medium Till Drainage	`											-0.15	-0.16	-0.15						
Big Hope Pond		020059	Medium Till Drainage	high		-0.07	-0.07	-0.07															
Little Echo Pond	Original	020126	Mounded Seepage	high							0.04												
East Copperas Pond		020138	Thin Till Drainage	high	-0.43										0.01		0.01		0.02	0.03	0.03	0.03	
Middle Pond		020143	Carbonate Influenced													-0.03	-0.03				-0.05	-0.05	
Sunday Pond		020188	Mounded Seepage	low																			
Sochia Pond		020197	Mounded Seepage	low								0.63	0.62										
Owen Pond		020233	Thick Till Drainage	low			-0.05	-0.06	-0.03														
Heart Lake	Original	020264	Medium Till Drainage	low																			
Marcy Dam Pond		020265	Thin Till Drainage	low											-0.13	-0.14	-0.12			-0.18	-0.22	-0.20	
Grass Pond		030171	Mounded Seepage	high											0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.04
Black Pond Outlet	Original	030255	Thick Till Drainage	low																			
Loon Hollow Pond		040186	Thin Till Drainage	low											-0.20								-0.91
Willys Lake (Horseshoe)		040210	Thin Till Drainage	low											-0.56	-0.57	-0.55	-0.56	-0.63	-0.63	-0.70	-0.72	-0.88
Middle Settlement Lake		040704	Thin Till Drainage	low			-0.08	-0.11	-0.08	-0.11		-0.09			-0.09	-0.10	-0.11	-0.13	-0.12	-0.14	-0.15	-0.13	-0.30
Grass Pond		040706	Medium Till Drainage	low											-0.11	-0.13							
Middle Branch Lake		040707	Thin Till Drainage	low																			
Lake Rondaxe	Original	040739	Thin Till Drainage	low																			
Moss Lake	Original	040746	Medium Till Drainage	low																			
Cascade Lake Outlet	Original	040747A	Medium Till Drainage	low										-0.03	-0.07	-0.07							
Bubb Lake	Original	040748	Thin Till Drainage	low											-0.04								
Dart Lake	Original	040750	Thin Till Drainage	low											-0.10	-0.11	-0.11			-0.17	-0.21	-0.20	
Windfall Pond	Original	040750A	Carbonate Influenced												-0.11	-0.10							
Big Moose Lake	Original	040752	Thin Till Drainage	low			-0.04								-0.13	-0.14	-0.14	-0.14		-0.17	-0.22		
West Pond	Original	040753	Thin Till Drainage	low								0.10	0.07										
Squash Pond	Original	040754	Thin Till Drainage	high				-0.05		-0.04				-0.16	-0.11								
Constable Pond	Original	040777	Thin Till Drainage	low		-0.03	-0.04	-0.04							-0.26	-0.25	-0.21	-0.22	-0.23	-0.28	-0.28	-0.25	
Limekiln Lake		040826	Medium Till Drainage	low					-0.03						-0.04	-0.04							
Squaw Lake		040850	Thin Till Drainage	low	-0.15									-0.17									
Indian Lake		040852	Thin Till Drainage	low	-0.15										-0.20	-0.20	-0.20	-0.21	-0.18	-0.22	-0.23		
Brook Trout Lake		040874	Thin Till Drainage	low											-0.16	-0.18	-0.19		-0.29	-0.35	-0.42	-0.46	-0.75
Lost Pond		040887	Thin Till Drainage	high	-0.19										-0.16	-0.17	-0.14	-0.13	-0.13	-0.13	-0.11		
South Lake		041004	Thin Till Drainage	low											-0.15	-0.17	-0.17	-0.18	-0.22	-0.27	-0.30	-0.29	-0.46
North Lake		041007	Thin Till Drainage	low	-0.13										-0.22	-0.20	-0.19	-0.20		-0.20	-0.20		
Willis Lake		050215	Medium Till Drainage	low											-0.03	-0.03	-0.04	-0.04					
Jockeybush Lake		050259	Thin Till Drainage	low		-0.07	-0.07	-0.06						0.13	-0.12	-0.13	-0.13			-0.22	-0.27	-0.28	
Clear Pond	Original	050458	Thick Till Drainage	low			-0.03								0.06	0.06	0.06	0.06	0.07	0.06			
Nate Pond		050577	Medium Till Drainage	high	-0.26																		
Long Pond		050649	Thin Till Drainage	high		0.06									0.19	0.20	0.24	0.28	0.39	0.33	0.36	0.29	
Carry Pond		050669	Mounded Seepage	low											0.03								
Arbutus Lake	Original	050684	Medium Till Drainage	low	-0.26	-0.04											-0.01						
Lake Colden		050706	Thin Till Drainage	low											-0.25	-0.23	-0.22	-0.28	-0.20	-0.23	-0.33	-0.34	
Avalanche Lake		050707	Thin Till Drainage	low											-0.23	-0.20	-0.17				-0.33	-0.31	
Sagamore Lake		060313	Medium Till Drainage	high																			
Raquette Lake Reservoir		060315A	Medium Till Drainage	high							0.03				-0.19	-0.16	-0.14						
Queer Lake		060329	Thin Till Drainage	low	-0.13	-0.05	-0.05	-0.05	-0.03						-0.08	-0.09	-0.08	-0.07	-0.10	-0.12			
Otter Lake Outlet	Original	070728	Thin Till Drainage	low		0.03	0.02								-0.11	-0.12	-0.12	-0.12	-0.12	-0.17			
G Lake		070859	Thin Till Drainage	low																			
SITES WITH RECENT LIMING HISTORY																							
Little Clear Pond		030172	Limed	low												-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	
Woods Lake		040576	Limed	low		0.04										-0.05	-0.05	-0.07		-0.08			
Barnes Lake	Original	040905	Limed	high	-0.19	-0.19	-0.20	-0.20	-0.11	-0.11	-0.10	-0.10	-0.13	-0.31	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03		
Little Simon Pond		060182	Limed	low																			
UPSTREAM SITES																							
Cascade		040747				-0.03	-0.03	-0.02	-0.03														
Bubb		040748.2																					
Windfall		040750A.2				-0.08	-0.11	-0.12	-0.07	-0.07													
West		040753.2													-0.06								
Squash		040754.2																					
Constable		040777.2				-0.06	-0.07	-0.08	-0.05						-0.24	-0.21	-0.19		-0.25				
Otter		070729				0.02		0.02							-0.13		-0.13	-0.13		-0.16			

LTM SITE	Al TM umol L⁻¹ yr⁻¹ 2011	2010	2009	2008	2007	2006	2005	2004	2000	Al OM umol L⁻¹ yr⁻¹ 2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond	-0.16	-0.18	-0.19	-0.21	-0.20	-0.20	-0.24	-0.25		-0.10	-0.12	-0.13	-0.15	-0.14	-0.14	-0.17	-0.16	
Big Hope Pond	-0.04	-0.06	-0.06	-0.07	-0.07	-0.08	-0.10	-0.10										
Little Echo Pond	-0.07	-0.09	-0.10	-0.13	-0.13	-0.13	-0.12	-0.14			-0.06	-0.07	-0.10	-0.10	-0.10	-0.10	-0.11	
East Copperas Pond	-0.05	-0.06	-0.07	-0.09	-0.09	-0.10	-0.11	-0.10					-0.04	-0.05	-0.06	-0.06	-0.05	
Middle Pond		-0.03	-0.04	-0.06	-0.06	-0.06	-0.07	-0.07					-0.04					
Sunday Pond				-0.03	-0.03	-0.03	-0.03											0.09
Sochia Pond			-0.03	-0.04	-0.04	-0.04	-0.04											0.09
Owen Pond																		
Heart Lake																		
Marcy Dam Pond	-0.10	-0.11	-0.11	-0.11	-0.11	-0.13	-0.17	-0.16		-0.03	-0.04	-0.04	-0.06	-0.06	-0.06	-0.07	-0.07	
Grass Pond (030171)				-0.04	-0.04	-0.04	-0.05	-0.05					-0.03					
Black Pond Outlet				-0.04	-0.04													
Loon Hollow Pond	-0.47	-0.46	-0.44	-0.44	-0.51	-0.62	-0.72	-0.78	-1.19									
Willys Lake (Horseshoe)	-0.64	-0.66	-0.66	-0.67	-0.78	-0.78	-0.88	-0.93	-1.07									
Middle Settlement Lake	-0.09	-0.10	-0.10	-0.11	-0.11	-0.13	-0.14	-0.14	-0.20									
Grass Pond (040706)	-0.08	-0.10	-0.10	-0.11	-0.11	-0.13	-0.16	-0.15	-0.26	-0.03	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.05	
Middle Branch Lake				-0.03									-0.03		-0.03			
Lake Rondaxe	-0.03	-0.04	-0.04	-0.06	-0.05	-0.07	-0.06	-0.07										
Moss Lake				-0.04		-0.05												
Cascade Lake Outlet		-0.03																
Bubb Lake	-0.02	-0.02	-0.03	-0.04		-0.04		-0.05										
Dart Lake	-0.12	-0.14	-0.13	-0.15	-0.16	-0.19		-0.22										
Windfall Pond	-0.06	-0.07	-0.06	-0.07		-0.08				-0.03	-0.04	-0.04	-0.05		-0.05			
Big Moose Lake	-0.16	-0.18	-0.17	-0.19	-0.20	-0.22	-0.20	-0.26										
West Pond	-0.15	-0.15	-0.16	-0.18	-0.19	-0.23	-0.22	-0.24				-0.06	-0.08	-0.08	-0.10	-0.11	-0.12	
Squash Pond	-0.41	-0.40	-0.37	-0.37	-0.41	-0.44	-0.39	-0.49	-0.65									
Constable Pond	-0.33	-0.34	-0.33	-0.36	-0.37	-0.45	-0.42	-0.49	-0.52									
Limekiln Lake	-0.03	-0.03	-0.03	-0.04	-0.05	-0.06	-0.06	-0.06										
Squaw Lake						-0.03												
Indian Lake	-0.26	-0.27	-0.26	-0.26	-0.26	-0.31	-0.34	-0.34	-0.38									
Brook Trout Lake	-0.13	-0.15	-0.15	-0.20	-0.23	-0.28	-0.35	-0.37	-0.58									
Lost Pond	-0.20	-0.21	-0.19	-0.21	-0.24	-0.26	-0.30	-0.33	-0.47					-0.06	-0.07	-0.10	-0.10	
South Lake	-0.12	-0.14	-0.14	-0.17	-0.19	-0.23	-0.26	-0.26	-0.32									
North Lake	-0.27	-0.27	-0.27	-0.28	-0.30	-0.33	-0.34	-0.33	-0.44			-0.04	-0.06	-0.06	-0.06	-0.07	-0.07	
Willis Lake			-0.04	-0.05	-0.06	-0.06	-0.06					-0.04	-0.05	-0.05				
Jockeybush Lake	-0.12	-0.13	-0.13	-0.15	-0.17	-0.22	-0.26	-0.27	-0.37									
Clear Pond																		0.08
Nate Pond																		
Long Pond	-0.10	-0.10																
Carry Pond		-0.03	-0.04	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	0.05	0.04	0.04	0.03					
Arbutus Lake																		
Lake Colden	-0.36	-0.37	-0.38	-0.39	-0.36	-0.41	-0.50	-0.51	-0.47							-0.09		
Avalanche Lake	-0.42	-0.42	-0.41	-0.41	-0.42	-0.47	-0.57	-0.59	-0.47									
Sagamore Lake	-0.07	-0.09	-0.09				-0.16											
Raquette Lake Reservoir	-0.18	-0.18	-0.17	-0.18	-0.17	-0.19											0.04	
Queer Lake	-0.07	-0.08	-0.08	-0.09	-0.11	-0.12	-0.13	-0.14										
Otter Lake Outlet	-0.08	-0.09	-0.09	-0.10	-0.09	-0.13	-0.09	-0.13	-0.19									
G Lake	-0.06	-0.06	-0.06	-0.07	-0.07	-0.09	-0.10	-0.09										
SITES WITH RECENT LIMING HISTORY																		
Little Clear Pond	-0.02	-0.03	-0.04	-0.06	-0.06	-0.06	-0.07	-0.07	-0.04			-0.03	-0.05	-0.04	-0.04	-0.05	-0.04	
Woods Lake				-0.04														
Barnes Lake			-0.04	-0.05	-0.05	-0.05	-0.06	-0.05										
Little Simon Pond				-0.04									-0.04					
UPSTREAM SITES																		
Cascade					-0.04													
Bubb																		
Windfall																		
West	-0.06	-0.07	-0.06															
Squash	-0.29	-0.28	-0.24	-0.22	-0.28	-0.30												
Constable	-0.28	-0.28	-0.28	-0.27	-0.35	-0.40												
Otter	-0.09	-0.06	-0.10	-0.10	-0.09	-0.11	-0.11											

LTM SITE	AL IM umol L⁻¹ yr⁻¹ 2011	2010	2009	2008	2007	2006	2005	2004	2000	Lab pH 2011	2010	2009	2008	2007	2006	2005	2004
Little Hope Pond	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.09	-0.07		0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
Big Hope Pond	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.04	-0.03		0.02	0.03	0.02	0.03	0.03	0.03	0.04	0.04
Little Echo Pond	0.00	0.00	0.00				-0.04	-0.07		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
East Copperas Pond	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.07	-0.04									
Middle Pond	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	-0.01									
Sunday Pond	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.03	-0.04	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02
Sochia Pond	-0.02	-0.02	-0.02	-0.02	-0.03	-0.04	-0.05	-0.04	-0.05	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
Owen Pond																	0.01
Heart Lake								-0.02									
Marcy Dam Pond	-0.06	-0.06	-0.06	-0.05		-0.06	-0.09	-0.07		0.01	0.01	0.01					
Grass Pond (030171)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.04										
Black Pond Outlet	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.03									
Loon Hollow Pond	-0.47	-0.44	-0.42	-0.40	-0.44	-0.51	-0.58	-0.63	-1.09	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Willys Lake (Horseshoe)	-0.65	-0.67	-0.67	-0.65	-0.75	-0.75	-0.83	-0.89	-1.15	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Middle Settlement Lake	-0.08	-0.08	-0.08	-0.08	-0.09	-0.11	-0.14	-0.11	-0.20	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
Grass Pond (040706)	-0.05	-0.06	-0.05	-0.06		-0.07	-0.11		-0.21	0.01	0.02		0.02		0.02	0.03	0.03
Middle Branch Lake	0.00																
Lake Rondaxe	-0.02	-0.03	-0.02	-0.02	-0.02	-0.03	-0.04	-0.06	-0.06	0.01	0.01						
Moss Lake	-0.01																
Cascade Lake Outlet	-0.01																
Bubb Lake	-0.01							-0.02									
Dart Lake	-0.11	-0.12	-0.11	-0.12	-0.14	-0.16	-0.13	-0.17	-0.25	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.03
Windfall Pond	-0.03	-0.02								0.01	0.01	0.01			0.01	0.01	
Big Moose Lake	-0.14	-0.15	-0.14	-0.14	-0.16	-0.18	-0.15	-0.20	-0.27	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03
West Pond	-0.10	-0.09	-0.08	-0.09	-0.10	-0.10											
Squash Pond	-0.40	-0.37	-0.36	-0.32	-0.36	-0.36	-0.27	-0.38	-0.51	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Constable Pond	-0.29	-0.29	-0.27	-0.28	-0.30	-0.35	-0.33	-0.36	-0.41	0.02	0.02	0.01	0.01		0.02	0.02	0.02
Limekiln Lake	-0.02	-0.02	-0.01	-0.01	-0.01	-0.02	-0.04	-0.02		0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02
Squaw Lake	-0.01	-0.01	-0.01			-0.01	-0.04			0.02	0.01						
Indian Lake	-0.28	-0.28	-0.28	-0.27	-0.28	-0.30	-0.33	-0.32	-0.38	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02
Brook Trout Lake	-0.13	-0.14	-0.14	-0.16	-0.21	-0.25	-0.36	-0.35	-0.67	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05
Lost Pond	-0.15	-0.15	-0.13	-0.13	-0.14	-0.17	-0.19	-0.20	-0.30	0.01							
South Lake	-0.13	-0.14	-0.14	-0.16	-0.19	-0.23	-0.28	-0.28	-0.43	0.04	0.04	0.03	0.03	0.04	0.04	0.05	0.05
North Lake	-0.24	-0.23	-0.22	-0.22	-0.25	-0.26	-0.27	-0.26	-0.38	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02
Willis Lake	0.00	0.00					-0.03					0.00		0.01	0.02	0.02	0.02
Jockeybush Lake	-0.13	-0.14	-0.13	-0.14	-0.15	-0.19	-0.24	-0.24	-0.39	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.03
Clear Pond	-0.01	-0.01	-0.01					-0.02	-0.31			0.00	0.00				
Nate Pond																	
Long Pond	-0.14	-0.14	-0.13	-0.10	-0.08	-0.08				0.01	0.01	0.01	0.01		0.01	0.01	0.01
Carry Pond	-0.05	-0.06	-0.06	-0.07	-0.07	-0.07	-0.08	-0.08		0.03	0.04	0.04	0.04	0.04	0.03	0.02	0.02
Arbutus Lake	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02				-0.01	-0.01	-0.01			
Lake Colden	-0.37	-0.36	-0.34	-0.35	-0.33	-0.37	-0.43	-0.43	-0.54	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02
Avalanche Lake	-0.39	-0.37	-0.35	-0.34	-0.35	-0.36	-0.42	-0.42	-0.41	0.01	0.01	0.01	0.01	0.01		0.01	0.01
Sagamore Lake	-0.05	-0.05	-0.05				-0.08										
Raquette Lake Reservoir	-0.13	-0.13	-0.11	-0.10	-0.09	-0.10	-0.14					0.00					
Queer Lake	-0.07	-0.07	-0.07	-0.07	-0.09	-0.11	-0.13	-0.13	-0.24	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Otter Lake Outlet	-0.07	-0.07	-0.07	-0.07	-0.07	-0.09	-0.09	-0.12	-0.22	0.02	0.02	0.02	0.02		0.02	0.02	
G Lake	-0.05	-0.05	-0.04	-0.05	-0.05	-0.06	-0.11	-0.08	-0.11	0.02	0.02	0.02	0.02		0.02	0.03	0.03
SITES WITH RECENT LIMING HISTORY																	
Little Clear Pond			0.00	0.00	0.00	0.00	-0.04	0.00						0.07	0.09	0.11	0.12
Woods Lake	-0.01	-0.01	-0.01				-0.03	-0.02									
Barnes Lake	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.03	-0.03		-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.05
Little Simon Pond	-0.01	-0.01	-0.01				-0.02										
UPSTREAM SITES																	
Cascade	-0.01	-0.01	-0.01							0.01							
Bubb																	
Windfall						-0.01											
West	-0.07	-0.07	-0.06							0.01	0.01						
Squash	-0.28	-0.25	-0.20	-0.15						0.01	0.01	0.01	0.01	0.01	0.01		
Constable	-0.32	-0.32	-0.29	-0.32	-0.36	-0.39				0.01	0.01			0.02	0.02		
Otter	-0.05	-0.10	-0.10		-0.11					0.02	0.02	0.01					

SCONDUCT µS cm^{-1} yr^{-1}

LTM SITE		Site No.	Type	DOC	2000	2011	2010	2009	2008	2007	2006	2005 NA	2004 NA	2000 NA
Little Hope Pond		020058	Medium Till Drainage			-0.32	-0.30	-0.29	-0.28	-0.29	-0.26			
Big Hope Pond		020059	Medium Till Drainage	high		-0.21	-0.20	-0.20	-0.21	-0.23	-0.21			
Little Echo Pond	Original	020126	Mounded Seepage	high	0.02	-0.24	-0.25	-0.24	-0.26	-0.27	-0.25			
East Copperas Pond		020138	Thin Till Drainage	high		-0.12	-0.12							
Middle Pond		020143	Carbonate Influenced			-0.20	-0.19	-0.18						
Sunday Pond		020188	Mounded Seepage	low		-0.10	-0.07							
Sochia Pond		020197	Mounded Seepage	low	0.03	-0.28	-0.27	-0.29	-0.29	-0.28	-0.25			
Owen Pond		020233	Thick Till Drainage	low		-0.32	-0.27	-0.23						
Heart Lake	Original	020264	Medium Till Drainage	low		-0.23	-0.21	-0.21	-0.19	-0.19	-0.17			
Marcy Dam Pond		020265	Thin Till Drainage	low		-0.21	-0.19	-0.16	-0.10					
Grass Pond		030171	Mounded Seepage	high	0.01	-0.14	-0.13	-0.11						
Black Pond Outlet	Original	030255	Thick Till Drainage	low		-0.22	-0.19	-0.22	-0.20	-0.19				
Loon Hollow Pond		040186	Thin Till Drainage	low	0.03	-0.51	-0.48	-0.45	-0.40	-0.43	-0.44			
Willys Lake (Horseshoe)		040210	Thin Till Drainage	low	0.02	-0.63	-0.60	-0.58	-0.53	-0.52	-0.52			
Middle Settlement Lake		040704	Thin Till Drainage	low	0.05	-0.23	-0.23	-0.23	-0.23	-0.22	-0.21			
Grass Pond		040706	Medium Till Drainage	low	0.06	-0.20	-0.20	-0.19	-0.16	-0.16	-0.15			
Middle Branch Lake		040707	Thin Till Drainage	low	0.02	-0.20	-0.19	-0.18	-0.16	-0.17	-0.15			
Lake Rondaxe	Original	040739	Thin Till Drainage	low		-0.26	-0.25	-0.23	-0.19	-0.20	-0.18			
Moss Lake	Original	040746	Medium Till Drainage	low		-0.24	-0.23	-0.24	-0.24	-0.24	-0.22			
Cascade Lake Outlet	Original	040747A	Medium Till Drainage	low		-0.25	-0.24	-0.26	-0.24	-0.28	-0.25			
Bubb Lake	Original	040748	Thin Till Drainage	low		-0.24	-0.25	-0.25	-0.24	-0.24	-0.19			
Dart Lake	Original	040750	Thin Till Drainage	low		-0.36	-0.35	-0.33	-0.29	-0.31	-0.29			
Windfall Pond	Original	040750A	Carbonate Influenced			-0.34	-0.35	-0.36	-0.30	-0.33	-0.30			
Big Moose Lake	Original	040752	Thin Till Drainage	low		-0.38	-0.36	-0.34	-0.31	-0.32	-0.30			
West Pond	Original	040753	Thin Till Drainage	low	-0.04	-0.32	-0.31	-0.29	-0.28	-0.28	-0.28			
Squash Pond	Original	040754	Thin Till Drainage	high		-0.46	-0.43	-0.41	-0.34	-0.35	-0.32			
Constable Pond	Original	040777	Thin Till Drainage	low		-0.48	-0.47	-0.45	-0.40	-0.41	-0.41			
Limekiln Lake		040826	Medium Till Drainage	low		-0.32	-0.32	-0.32	-0.29	-0.29	-0.25			
Squaw Lake		040850	Thin Till Drainage	low	0.05	-0.37	-0.37	-0.37	-0.38	-0.39	-0.38			
Indian Lake		040852	Thin Till Drainage	low		-0.47	-0.46	-0.45	-0.43	-0.43	-0.43			
Brook Trout Lake		040874	Thin Till Drainage	low	0.08	-0.39	-0.39	-0.38	-0.37	-0.40	-0.42			
Lost Pond		040887	Thin Till Drainage	high		-0.33	-0.33	-0.33	-0.30	-0.29	-0.28			
South Lake		041004	Thin Till Drainage	low	0.06	-0.35	-0.34	-0.32	-0.29	-0.29	-0.26			
North Lake		041007	Thin Till Drainage	low		-0.40	-0.39	-0.36	-0.31	-0.31	-0.28			
Willis Lake		050215	Medium Till Drainage	low		-0.12	-0.09							
Jockeybush Lake		050259	Thin Till Drainage	low	0.05	-0.34	-0.33	-0.30	-0.27	-0.28	-0.29			
Clear Pond	Original	050458	Thick Till Drainage	low		-0.29	-0.27	-0.28	-0.25	-0.24	-0.20			
Nate Pond		050577	Medium Till Drainage	high		-0.32	-0.27	-0.26	-0.21	-0.19				
Long Pond		050649	Thin Till Drainage	high		-0.39	-0.35	-0.31	-0.21	-0.17	-0.18			
Carry Pond		050669	Mounded Seepage	low		-0.39	-0.43	-0.43	-0.40	-0.34	-0.27			
Arbutus Lake	Original	050684	Medium Till Drainage	low		-0.33	-0.30	-0.29	-0.22	-0.20				
Lake Colden		050706	Thin Till Drainage	low	0.02	-0.39	-0.35	-0.32	-0.25	-0.22				
Avalanche Lake		050707	Thin Till Drainage	low		-0.45	-0.43	-0.37	-0.30	-0.28				
Sagamore Lake		060313	Medium Till Drainage	high		-0.38	-0.36	-0.35	-0.32	-0.32	-0.27			
Raquette Lake Reservoir		060315A	Medium Till Drainage	high		-0.51	-0.51	-0.50	-0.44	-0.44	-0.42			
Queer Lake		060329	Thin Till Drainage	low		-0.32	-0.31	-0.30	-0.27	-0.28	-0.26			
Otter Lake Outlet	Original	070728	Thin Till Drainage	low	0.04	-0.29	-0.27	-0.25	-0.24	-0.24	-0.25			
G Lake		070859	Thin Till Drainage	low	0.05	-0.27	-0.25	-0.22	-0.15	-0.14	-0.11			
SITES WITH RECENT LIMING HISTORY														
Little Clear Pond		030172	Limed	low	0.25									
Woods Lake		040576	Limed	low		-0.35	-0.35	-0.35	-0.31	-0.33	-0.31			
Barnes Lake	Original	040905	Limed	high	-0.08	-0.20	-0.21	-0.21	-0.20	-0.17	-0.14			
Little Simon Pond		060182	Limed	low		-0.33	-0.27	-0.25						
UPSTREAM SITES														
Cascade		040747				-0.30	-0.26	-0.26	-0.20	-0.13	-0.09			
Bubb		040748.2				-0.24	-0.24	-0.27	-0.28	-0.29	-0.23			
Windfall		040750A.2				-0.49	-0.51	-0.55	-0.48	-0.44	-0.44			
West		040753.2				-0.32	-0.29	-0.27	-0.27	-0.25	-0.28			
Squash		040754.2				-0.50	-0.48	-0.43	-0.36	-0.34	-0.34			
Constable		040777.2				-0.52	-0.50	-0.48	-0.40	-0.43	-0.42			
Otter		070729				-0.27	-0.28	-0.26	-0.24	-0.26	-0.26			-0.21

Lab H^+

LTM SITE	2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond	-0.13	-0.15	-0.14	-0.16	-0.16	-0.17	-0.21	-0.20	
Big Hope Pond	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	
Little Echo Pond	-0.76	-0.79	-0.78	-0.90	-1.05	-1.09	-1.02	-1.21	-1.95
East Copperas Pond									
Middle Pond									
Sunday Pond	0.12	0.18	0.23	0.29	0.27	0.28	0.25	0.25	
Sochia Pond	-0.60	-0.63	-0.74	-0.87	-0.94	-1.01	-1.18	-1.21	-1.44
Owen Pond								-0.01	
Heart Lake									
Marcy Dam Pond	-0.03	-0.02	-0.02						
Grass Pond									-0.08
Black Pond Outlet									
Loon Hollow Pond	-0.55	-0.53	-0.49	-0.51	-0.55	-0.64	-0.83	-0.87	-1.52
Willys Lake (Horseshoe)	-0.39	-0.38	-0.33	-0.27	-0.30	-0.30	-0.39	-0.37	-0.72
Middle Settlement Lake	-0.15	-0.15	-0.15	-0.15	-0.15	-0.16	-0.16	-0.15	-0.31
Grass Pond	-0.03	-0.04	-0.03	-0.04		-0.05	-0.06	-0.06	-0.14
Middle Branch Lake									-0.02
Lake Rondaxe	-0.01	-0.01							
Moss Lake									
Cascade Lake Outlet									
Bubb Lake									
Dart Lake	-0.12	-0.13	-0.12	-0.12	-0.13	-0.16	-0.18	-0.16	
Windfall Pond	-0.01	-0.01	-0.01			-0.01	-0.01		
Big Moose Lake	-0.17	-0.17	-0.16	-0.16	-0.18	-0.20	-0.22	-0.20	
West Pond									0.74
Squash Pond	-0.54	-0.51	-0.47	-0.45	-0.43	-0.39	-0.44	-0.45	
Constable Pond	-0.21	-0.21	-0.16	-0.16		-0.25	-0.32	-0.27	
Limekiln Lake	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05	
Squaw Lake	-0.04	-0.03							-0.12
Indian Lake	-0.34	-0.33	-0.31	-0.30	-0.29	-0.34	-0.39	-0.38	
Brook Trout Lake	-0.21	-0.23	-0.22	-0.25	-0.31	-0.36	-0.43	-0.46	-0.75
Lost Pond	-0.16								
South Lake	-0.23	-0.24	-0.24	-0.28	-0.31	-0.35	-0.39	-0.39	-0.55
North Lake	-0.23	-0.20	-0.19	-0.17	-0.18	-0.20	-0.21	-0.20	
Willis Lake					-0.03	-0.03	-0.03	-0.03	
Jockeybush Lake	-0.27	-0.28	-0.26	-0.24	-0.26	-0.31	-0.35	-0.36	-0.68
Clear Pond			0.00	0.00					
Nate Pond									
Long Pond	-0.59	-0.61	-0.52	-0.42		-0.57	-0.69	-0.75	
Carry Pond	-0.57	-0.64	-0.68	-0.70	-0.70	-0.63	-0.49	-0.45	
Arbutus Lake			0.01	0.01	0.01				
Lake Colden	-0.28	-0.27	-0.26	-0.24	-0.21	-0.22	-0.29	-0.30	-0.34
Avalanche Lake	-0.28	-0.26	-0.22	-0.20	-0.19		-0.25	-0.26	
Sagamore Lake									
Raquette Lake Reservoir									
Queer Lake	-0.11	-0.11	-0.11	-0.11	-0.12	-0.14	-0.15	-0.14	
Otter Lake Outlet	-0.10	-0.10	-0.10	-0.10		-0.13	-0.15		-0.25
G Lake	-0.07	-0.07	-0.06	-0.07		-0.08	-0.11	-0.10	-0.02
SITES WITH RECENT LIMING HISTORY									
Little Clear Pond					-0.06	-0.10	-0.20	-0.26	-0.93
Woods Lake									
Barnes Lake	0.33	0.31	0.29	0.29	0.32	0.36	0.36	0.42	0.50
Little Simon Pond									
UPSTREAM SITES									
Cascade	-0.01								
Bubb									
Windfall									
West	-0.09	-0.09							
Squash	-0.73	-0.70	-0.63	-0.66	-0.73	-0.75			
Constable	-0.25	-0.24			-0.34	-0.40			
Otter	-0.07	-0.18	-0.16						-2.97

SO4 + NO3 ueq L^{-1} yr^{-1}

LTM SITE	2011	2010	2009	2008	2007	2006	2005 NA	2004	2000
Little Hope Pond	-2.89	-2.82	-2.66	-2.48	-2.70	-2.56		-1.92	
Big Hope Pond	-2.68	-2.51	-2.36					-1.45	
Little Echo Pond	-1.39	-1.30	-1.15	-0.97	-1.20	-1.15		-1.25	-2.09
East Copperas Pond	-1.60	-1.54	-1.52	-1.13					
Middle Pond	-2.23	-2.21	-2.12	-2.24	-2.28	-2.12		-1.68	
Sunday Pond	-0.85	-0.72	-0.55		-0.61	-0.63		-0.74	
Sochia Pond	-1.33	-1.27	-1.28	-1.17	-1.20	-1.00		-0.98	-1.49
Owen Pond	-3.81	-3.54	-3.28	-3.10	-3.02	-3.00		-2.92	
Heart Lake	-2.02	-1.90	-1.79	-1.75	-1.75	-1.70		-1.69	-2.07
Marcy Dam Pond	-1.90	-1.75	-1.55	-1.27	-1.13	-1.29		-1.61	-2.66
Grass Pond	-1.29	-1.21	-1.15	-1.05	-1.20	-1.13		-1.93	-1.66
Black Pond Outlet	-2.59	-2.56	-2.49	-2.46	-2.47	-2.32		-1.93	-1.87
Loon Hollow Pond	-3.12	-2.91	-2.63	-2.24	-2.46	-2.42		-2.72	-3.95
Willys Lake (Horseshoe)	-4.76	-4.67	-4.51	-4.04	-4.14	-4.14		-4.67	-5.11
Middle Settlement Lake	-2.34	-2.34	-2.28	-2.28	-2.26	-2.08		-2.14	-1.91
Grass Pond	-2.15	-2.16	-2.08	-2.05	-2.02	-2.10		-1.15	-3.33
Middle Branch Lake	-1.94	-1.92	-1.75	-1.79	-1.76	-1.65		-1.78	
Lake Rondaxe	-3.27	-3.24	-3.11	-3.00	-3.20	-3.22		-3.21	-3.47
Moss Lake	-2.85	-2.72	-2.66	-2.71	-2.81	-2.80		-2.84	-3.33
Cascade Lake Outlet	-2.73	-2.59	-2.53	-2.38	-2.51	-2.54		-2.59	-3.94
Bubb Lake	-2.21	-2.26	-2.29	-2.42	-2.44	-2.51		-2.77	-3.04
Dart Lake	-3.80	-3.74	-3.62	-3.42	-3.70	-3.60		-3.60	-4.31
Windfall Pond	-3.60	-3.72	-3.73	-3.45	-3.62	-3.83		-3.98	-4.30
Big Moose Lake	-3.86	-3.82	-3.68	-3.49	-3.80	-3.71		-3.73	-4.26
West Pond	-2.84	-2.68	-2.47	-2.46	-2.66	-2.65		-2.94	-3.43
Squash Pond	-2.86	-2.68	-2.39	-1.90	-2.11	-1.90		-1.97	-3.66
Constable Pond	-4.21	-4.20	-4.16	-3.96	-3.96	-4.03		-4.08	-4.18
Limekiln Lake	-3.42	-3.32	-3.20	-3.09	-3.17	-2.99		-2.93	-3.34
Squaw Lake	-3.61	-3.61	-3.66	-3.92	-4.16	-4.17		-4.53	-6.01
Indian Lake	-3.73	-3.74	-3.69	-3.50	-3.70	-3.61		-3.69	-5.31
Brook Trout Lake	-3.37	-3.35	-3.32	-3.30	-3.59	-3.77		-4.31	-6.52
Lost Pond	-2.35	-2.39	-2.46	-2.41	-2.51	-2.51		-2.30	-4.04
South Lake	-3.18	-3.11	-3.03	-2.89	-2.99	-2.83		-2.93	-3.12
North Lake	-3.27	-3.21	-3.10	-2.71	-2.82	-2.55		-2.70	-3.26
Willis Lake	-2.22	-2.07	-1.86	-1.68	-1.55	-1.46		-1.23	-0.72
Jockeybush Lake	-2.75	-2.63	-2.45	-2.18	-2.39	-2.44		-2.45	-2.48
Clear Pond	-2.54	-2.44	-2.43	-2.34	-2.23	-1.97		-1.65	-1.95
Nate Pond	-3.09	-2.99	-2.84	-2.67	-2.53	-2.33		-2.21	-1.60
Long Pond	-3.12	-2.96	-2.73	-2.32	-2.47	-2.25		-2.21	-3.65
Carry Pond	-2.34	-2.63	-2.64	-2.23	-1.91	-1.55		1.07	-1.39
Arbutus Lake	-3.00	-2.83	-2.65	-2.36	-2.20	-1.93		-1.69	-2.65
Lake Colden	-3.03	-2.71	-2.35	-1.82	-1.74				-2.63
Avalanche Lake	-3.39	-3.13	-2.76	-2.18	-2.17	-1.98			-3.79
Sagamore Lake	-3.88	-3.76	-3.73	-3.56	-3.63	-3.59		-3.77	-5.15
Raquette Lake Reservoir	-4.55	-4.67	-4.72	-4.58	-4.52	-4.60		-4.69	-4.65
Queer Lake	-3.30	-3.24	-3.15	-3.01	-3.17	-3.05		-3.08	-3.34
Otter Lake Outlet	-2.71	-2.60	-2.48	-2.45	-2.46	-2.61		-2.67	-2.59
G Lake	-2.46	-2.35	-2.17	-1.80	-1.67	-1.53		-1.44	-2.19
SITES WITH RECENT LIMING HISTORY									
Little Clear Pond	-1.37	-1.29	-1.21	-1.17	-1.14	-1.07		-1.04	-0.97
Woods Lake	-3.21	-3.25	-3.28	-3.06	-3.28	-3.21		-2.95	-3.37
Barnes Lake	-1.30	-1.15	-0.90						0.46
Little Simon Pond	-3.24	-3.07	-2.89	-2.69	-2.78	-2.62		-2.48	-3.25
UPSTREAM SITES									
Cascade	-3.04	-2.77	-2.64	-2.30	-2.13	-1.93		NA	NA
Bubb	-2.04	-2.05	-2.09	-2.25	-2.31	-2.39		NA	NA
Windfall	-4.00	-4.06	-4.10	-4.01	-4.06	-3.70		NA	NA
West	-3.01	-2.72	-2.45	-2.74	-2.69	-3.13		NA	NA
Squash	-2.77	-2.55	-2.24	-1.75	-1.59	-1.44		NA	NA
Constable	-4.33	-4.25	-4.11	-3.73	-3.73	-3.65		NA	NA
Otter	-2.46	-2.80	-2.68	-2.48	-2.61	-2.71		NA	-0.99

CB ueq L^{-1} yr^{-1}

LTM SITE	2011	2010	2009	2008	2007	2006	2005	2004	2000
Little Hope Pond	-1.11	-0.95							
Big Hope Pond									
Little Echo Pond	0.33	0.34							
East Copperas Pond	-0.37								
Middle Pond	-1.38	-1.30	-1.21						
Sunday Pond	-1.19	-1.11	-1.07	-1.12	-1.16	-1.28	-2.20	-1.33	-2.02
Sochia Pond									
Owen Pond	-2.76	-2.47	-2.19						
Heart Lake	-1.80	-1.67	-1.62	-1.77	-1.80	-1.73	-1.44	-1.58	-3.27
Marcy Dam Pond	-1.06	-1.02							
Grass Pond									
Black Pond Outlet	-2.15	-1.97	-2.23	-2.97	-3.26	-2.97			
Loon Hollow Pond	-0.96	-0.94	-0.91	-0.69	-0.78	-0.77			
Willys Lake (Horseshoe)	-1.77	-1.69	-1.63	-1.48	-1.48	-1.48	-1.48	-1.55	-2.11
Middle Settlement Lake	-0.51	-0.51	-0.57	-0.57	-0.61		-0.54	-0.57	
Grass Pond	-0.96								
Middle Branch Lake	-0.98	-0.94	-0.97		-1.31				
Lake Rondaxe	-1.58	-1.45	-1.45		-1.57				
Moss Lake	-1.53	-1.48	-1.68	-2.06	-2.29	-1.99	-1.67	-1.74	
Cascade Lake Outlet	-1.83	-1.77	-2.21	-2.39	-2.88	-2.67	-2.54	-3.23	-5.14
Bubb Lake	-1.50	-1.54	-1.76	-1.71	-1.85	-1.49	-1.18		
Dart Lake	-1.61	-1.55	-1.57	-1.35	-1.55				
Windfall Pond	-1.94	-2.00	-2.23	-2.05	-2.64	-2.15			
Big Moose Lake	-1.57	-1.47	-1.51	-1.38	-1.55	-1.38	-1.19		
West Pond	-1.69	-1.58	-1.68	-1.93	-2.25	-2.20		-2.29	-4.68
Squash Pond	-1.12	-1.12	-1.10	-0.86	-0.92		-2.55		-2.07
Constable Pond	-2.17	-2.14	-2.18	-1.83	-1.93	-1.66			
Limekiln Lake	-1.54	-1.55	-1.63	-1.55	-1.58	-1.24			
Squaw Lake	-2.22	-2.25	-2.40	-2.53	-2.68	-2.60	-1.28	-2.57	-4.67
Indian Lake	-1.85	-1.88	-2.01	-2.05	-2.21	-2.13	-2.10	-2.11	-4.27
Brook Trout Lake	-1.54	-1.43	-1.37	-1.22	-1.20	-1.09	-0.91	-0.92	-2.02
Lost Pond	-1.55	-1.66	-1.91	-1.89	-1.92	-1.89	-1.68	-1.81	-4.56
South Lake	-1.13	-1.07	-1.08	-0.91					
North Lake	-1.45	-1.47	-1.52	-1.50	-1.53	-1.28			
Willis Lake									
Jockeybush Lake	-1.16	-1.12	-1.02	-0.85	-0.95	-0.87	-0.66		
Clear Pond	-2.44	-2.34	-2.60	-2.77	-3.06	-2.69	-2.32		-5.67
Nate Pond	-2.37	-1.88	-1.86						
Long Pond									
Carry Pond	-0.70	-0.69	-0.63						-1.55
Arbutus Lake	-2.57	-2.25	-2.23	-1.98					-5.00
Lake Colden	-1.39	-1.19	-0.99						
Avalanche Lake	-1.67	-1.51	-1.38						
Sagamore Lake	-2.49	-2.33	-2.38	-2.68	-2.85	-2.31			
Raquette Lake Reservoir	-3.06	-3.15	-3.28	-3.15	-3.43	-3.22	-2.86	-3.15	
Queer Lake	-1.36	-1.30	-1.33	-1.30	-1.33	-1.20	-1.08	-1.05	-3.26
Otter Lake Outlet	-1.26	-1.15	-1.12	-1.06	-1.32	-1.25	-1.28	-1.43	
G Lake	-1.24	-1.17	-1.14						
SITES WITH RECENT LIMING HISTORY									
Little Clear Pond						10.29	13.04	14.40	24.94
Woods Lake	-2.39	-2.32	-2.39	-2.10	-2.40	-2.33	-2.23	-2.21	-5.04
Barnes Lake	-1.82	-1.94	-2.02	-2.14	-2.22	-2.22	-1.98	-2.13	-3.44
Little Simon Pond	-2.10								-8.06
UPSTREAM SITES									
Cascade	-1.48	-1.21	-1.33						
Bubb	-1.21	-1.24	-1.43	-1.43	-1.57	-1.33			
Windfall	-3.08	-3.17	-3.40	-3.22	-3.03	-2.95			
West	-1.28	-1.06	-1.09	-1.41					
Squash	-0.65	-0.58							
Constable	-2.08	-2.00	-2.00	-1.53	-1.32				
Otter	-1.24	-0.99	-0.95	-1.07	-1.07	-1.03			

Appendix B: Seasonal Medians; ALTM Streams 2005–2012

Winter	December through March	**BCK**	Buck Creek
Snowmelt	April	**BMB**	Bald Mountain Brook
Springsummer	May through July	**AB**	Acid Buck Creek a.k.a. North Tributary
Latesummer	August through September	**BB**	Basic Buck Creek a.k.a. South Tributary
Fall	October through November		

Each value is the median for the particular season and year.

STREAM	Water Year	Year Season	Date (seasonal midpoint)	SO4 µmol L^{-1}	NO3 µmol L^{-1}	DOC µmol L^{-1}	CA µmol L^{-1}	BCS µEq L^{-1}	n
AB07	2006	2005 fall	2005.10.30	48.03	2.71	1419.56	27.23	-114.73	17
AB07	2006	2006 winter	2006.01.30	55.11	18.99	1165.26	28.33	-115.02	8
AB07	2006	2006 snowmelt	2006.04.15	42.91	7.23	1192.33	24.36	-95.24	6
AB07	2006	2006 springsummer	2006.06.15	28.29	8.11	1664.46	25.19	-104.19	24
AB07	2006	2006 latesummer	2006.08.30	31.88	8.99	1648.37	26.30	-96.70	4
AB07	2007	2006 fall	2006.10.30	39.54	5.70	1562.23	27.47	-107.39	5
AB07	2007	2007 winter	2007.01.30	46.36	29.34	1228.90	30.20	-112.51	8
AB07	2007	2007 snowmelt	2007.04.15	34.34	31.36	1157.06	25.24	-89.39	2
AB07	2007	2007 springsummer	2007.06.15	37.10	14.50	1234.92	29.32	-79.23	7
AB07	2007	2007 latesummer	2007.08.30	107.16	3.37	891.39	55.37	-104.52	1
AB07	2008	2007 fall	2007.10.30	52.10	0.31	1343.39	31.07	-102.81	5
AB07	2008	2008 winter	2008.01.30	44.76	20.94	1129.87	27.32	-92.64	8
AB07	2008	2008 snowmelt	2008.04.15	32.33	11.02	1136.29	20.54	-90.66	3
AB07	2008	2008 springsummer	2008.06.15	28.42	3.15	1502.05	26.16	-77.17	6
AB07	2008	2008 latesummer	2008.08.30	23.70	2.42	1647.87	22.17	-86.73	4
AB07	2009	2008 fall	2008.10.30	40.42	1.55	1336.11	24.45	-97.65	5
AB07	2009	2009 winter	2009.01.30	43.48	13.30	1150.54	22.70	-97.62	11
AB07	2009	2009 snowmelt	2009.04.15	36.05	6.49	1189.45	20.58	-85.52	2
AB07	2009	2009 springsummer	2009.06.15	24.63	5.57	1512.77	20.71	-87.38	15
AB07	2009	2009 latesummer	2009.08.30	20.56	5.45	1763.44	18.94	-97.69	11
AB07	2010	2009 fall	2009.10.30	32.60	0.37	1397.24	20.49	-90.13	4
AB07	2010	2010 winter	2010.01.30	37.96	14.55	1223.66	23.33	-87.98	10
AB07	2010	2010 snowmelt	2010.04.15	33.23	6.91	1283.96	21.05	-77.38	2
AB07	2010	2010 springsummer	2010.06.15	22.83	5.50	1669.15	19.77	-102.25	9
AB07	2010	2010 latesummer	2010.08.30	21.51	3.25	1739.41	19.52	-95.13	8
AB07	2011	2010 fall	2010.10.30	32.82	1.34	1389.37	20.57	-89.12	8
AB07	2011	2011 winter	2011.01.30	40.12	16.29	1233.71	22.17	-91.91	18
AB07	2011	2011 snowmelt	2011.04.15	25.04	18.38	1218.09	17.28	-85.67	6
AB07	2011	2011 springsummer	2011.06.15	20.36	7.55	1726.26	19.93	-99.33	6
AB07	2011	2011 latesummer	2011.08.30	19.00	5.97	1852.71	21.28	-108.85	8
AB07	2012	2011 fall	2011.10.30	26.63	2.40	1518.83	19.55	-91.30	5
AB07	2012	2012 winter	2012.01.30	34.53	22.52	1255.84	20.35	-97.92	9
AB07	2012	2012 snowmelt	2012.04.15	26.78	19.49	1365.17	20.82	-85.42	4
AB07	2012	2012 springsummer	2012.06.15	28.21	10.54	1531.52	23.56	-85.29	9
AB07	2012	2012 latesummer	2012.08.30	18.50	10.42	1480.32	21.70	-65.71	7
BB07	2006	2005 fall	2005.10.30	48.76	16.25	356.73	30.46	-41.89	8
BB07	2006	2006 winter	2006.01.30	48.41	51.95	224.51	35.19	-44.77	8
BB07	2006	2006 snowmelt	2006.04.15	41.93	34.90	303.60	29.62	-46.90	6
BB07	2006	2006 springsummer	2006.06.15	43.37	17.25	434.55	32.39	-29.96	24
BB07	2006	2006 latesummer	2006.08.30	50.72	18.50	262.07	42.97	19.96	4
BB07	2007	2006 fall	2006.10.30	44.90	39.85	306.08	36.59	-33.08	5
BB07	2007	2007 winter	2007.01.30	45.08	63.01	232.76	38.40	-46.16	8
BB07	2007	2007 snowmelt	2007.04.15	34.26	88.18	267.40	32.53	-72.97	2
BB07	2007	2007 springsummer	2007.06.15	53.87	29.86	238.36	49.88	30.77	7
BB07	2007	2007 latesummer	2007.08.30	56.75	36.35	201.95	77.95	143.39	4
BB07	2008	2007 fall	2007.10.30	47.79	15.12	350.44	35.88	-20.25	5
BB07	2008	2008 winter	2008.01.30	41.41	39.58	248.38	31.77	-33.19	8
BB07	2008	2008 snowmelt	2008.04.15	39.39	36.34	286.23	26.31	-52.33	3
BB07	2008	2008 springsummer	2008.06.15	46.86	16.46	249.26	44.99	34.00	6

STREAM	Water Year	Year	Season	Date (seasonal midpoint)	SO4 µmol L^{-1}	NO3 µmol L^{-1}	DOC µmol L^{-1}	CA µmol L^{-1}	BCS µEq L^{-1}	n
BB07	2009	2008	fall	2008.10.30	42.55	8.57	364.78	29.19	-28.50	10
BB07	2009	2009	winter	2009.01.30	41.81	41.08	244.57	28.94	-39.68	11
BB07	2009	2009	snowmelt	2009.04.15	40.19	29.00	238.99	27.45	-34.31	2
BB07	2009	2009	springsummer	2009.06.15	38.25	10.94	311.08	26.20	-24.43	14
BB07	2009	2009	latesummer	2009.08.30	37.98	3.18	348.39	26.57	-22.65	5
BB07	2010	2009	fall	2009.10.30	39.19	8.16	304.56	26.37	-17.19	4
BB07	2010	2010	winter	2010.01.30	40.76	37.91	209.24	34.11	-2.53	9
BB07	2010	2010	snowmelt	2010.04.15	39.00	27.36	239.03	29.83	-16.15	2
BB07	2010	2010	springsummer	2010.06.15	41.21	12.96	260.94	31.44	-4.24	8
BB07	2010	2010	latesummer	2010.08.30	36.18	17.19	377.14	32.66	-2.62	12
BB07	2011	2010	fall	2010.10.30	35.61	32.03	301.99	26.59	-33.69	12
BB07	2011	2011	winter	2011.01.30	34.89	75.50	207.60	31.96	-48.94	24
BB07	2011	2011	snowmelt	2011.04.15	26.63	85.27	351.21	24.12	-74.54	6
BB07	2011	2011	springsummer	2011.06.15	36.90	21.12	262.34	22.55	-31.59	10
BB07	2011	2011	latesummer	2011.08.30	30.62	31.28	471.45	35.31	-19.06	10
BB07	2012	2011	fall	2011.10.30	35.94	41.09	259.28	31.49	-15.52	5
BB07	2012	2012	winter	2012.01.30	30.45	92.80	209.58	31.51	-58.24	9
BB07	2012	2012	snowmelt	2012.04.15	31.59	84.51	270.53	35.14	-43.32	3
BB07	2012	2012	springsummer	2012.06.15	36.73	32.46	252.62	43.59	23.26	10
BB07	2012	2012	latesummer	2012.08.30	45.51	20.99	238.39	60.01	99.59	4
BC01	2006	2005	fall	2005.10.30	52.99	9.40	605.40	42.13	-30.77	28
BC01	2006	2006	winter	2006.01.30	55.42	37.96	350.54	44.05	-35.31	25
BC01	2006	2006	snowmelt	2006.04.15	44.16	27.65	439.31	36.47	-35.95	11
BC01	2006	2006	springsummer	2006.06.15	46.43	11.60	629.61	43.01	-14.90	41
BC01	2006	2006	latesummer	2006.08.30	55.87	15.49	386.29	50.88	26.41	9
BC01	2007	2006	fall	2006.10.30	50.56	31.38	501.47	43.37	-12.86	5
BC01	2007	2007	winter	2007.01.30	53.48	47.90	349.38	47.43	-22.44	8
BC01	2007	2007	snowmelt	2007.04.15	38.76	67.80	442.68	40.12	-49.53	2
BC01	2007	2007	springsummer	2007.06.15	55.75	24.42	374.81	50.83	22.49	7
BC01	2007	2007	latesummer	2007.08.30	64.80	26.65	308.04	70.07	81.18	4
BC01	2008	2007	fall	2007.10.30	58.06	9.18	515.55	46.25	-2.48	5
BC01	2008	2008	winter	2008.01.30	46.36	34.89	392.28	41.63	-18.60	8
BC01	2008	2008	snowmelt	2008.04.15	43.23	31.01	445.72	36.09	-35.76	3
BC01	2008	2008	springsummer	2008.06.15	52.59	14.81	363.61	56.01	51.16	6
BC01	2008	2008	latesummer	2008.08.30	51.56	10.29	399.90	48.49	28.26	5
BC01	2009	2008	fall	2008.10.30	45.21	8.40	630.14	44.66	-19.50	11
BC01	2009	2009	winter	2009.01.30	46.44	35.15	392.15	37.43	-33.55	13
BC01	2009	2009	snowmelt	2009.04.15	46.40	21.34	373.11	36.93	-15.80	2
BC01	2009	2009	springsummer	2009.06.15	38.83	7.90	604.56	33.18	-19.71	19
BC01	2009	2009	latesummer	2009.08.30	36.27	6.32	755.22	35.96	-16.93	16
BC01	2010	2009	fall	2009.10.30	43.61	6.62	504.83	34.73	-6.78	4
BC01	2010	2010	winter	2010.01.30	43.41	35.45	438.14	42.81	-9.85	15
BC01	2010	2010	snowmelt	2010.04.15	45.83	18.70	383.10	37.72	-5.24	2
BC01	2010	2010	springsummer	2010.06.15	40.72	11.50	526.56	38.30	3.97	16
BC01	2010	2010	latesummer	2010.08.30	37.61	10.61	682.77	42.61	20.22	14
BC01	2011	2010	fall	2010.10.30	38.73	15.58	669.42	33.75	-26.43	16
BC01	2011	2011	winter	2011.01.30	43.28	48.72	364.45	40.71	-19.23	28
BC01	2011	2011	snowmelt	2011.04.15	28.89	40.55	535.60	27.53	-46.11	19
BC01	2011	2011	springsummer	2011.06.15	37.10	13.63	531.11	26.19	-31.26	12
BC01	2011	2011	latesummer	2011.08.30	35.31	16.80	787.87	41.39	-2.60	10
BC01	2012	2011	fall	2011.10.30	43.35	20.26	474.20	37.35	-0.46	5
BC01	2012	2012	winter	2012.01.30	37.16	60.37	365.24	39.50	-26.03	9
BC01	2012	2012	snowmelt	2012.04.15	33.39	51.77	540.93	37.34	-32.46	4
BC01	2012	2012	springsummer	2012.06.15	43.21	20.32	479.91	49.97	25.86	12
BC01	2012	2012	latesummer	2012.08.30	49.12	14.66	452.42	57.26	68.98	4
BMB	2006	2005	fall	2005.10.30	51.04	15.79	276.03	42.66	26.56	9

STREAM	Water Year	Year Season	Date (seasonal midpoint)	SO4 µmol L^{-1}	NO3 µmol L^{-1}	DOC µmol L^{-1}	CA µmol L^{-1}	BCS µEq L^{-1}	n
BMB	2006	2006 winter	2006.01.30	48.75	37.08	236.45	34.43	-12.79	17
BMB	2006	2006 snowmelt	2006.04.15	40.21	36.87	282.74	29.44	-34.73	4
BMB	2006	2006 springsummer	2006.06.15	42.50	19.44	270.74	34.68	10.68	13
BMB	2006	2006 latesummer	2006.08.30	43.44	19.27	274.07	54.39	82.88	7
BMB	2007	2006 fall	2006.10.30	43.44	27.82	354.82	35.93	3.82	5
BMB	2007	2007 winter	2007.01.30	44.43	45.44	212.99	39.67	4.58	8
BMB	2007	2007 snowmelt	2007.04.15	38.28	52.13	266.16	33.18	-40.06	2
BMB	2007	2007 springsummer	2007.06.15	45.73	27.95	236.24	41.92	54.22	7
BMB	2007	2007 latesummer	2007.08.30	46.25	26.08	163.58	52.15	102.26	4
BMB	2008	2007 fall	2007.10.30	57.71	14.27	377.07	47.90	13.24	5
BMB	2008	2008 winter	2008.01.30	44.95	38.46	248.28	38.55	-8.53	8
BMB	2008	2008 snowmelt	2008.04.15	40.94	28.56	308.40	33.93	-4.97	3
BMB	2008	2008 springsummer	2008.06.15	44.95	17.35	244.37	44.79	47.72	6
BMB	2008	2008 latesummer	2008.08.30	37.92	12.40	343.32	48.65	64.40	5
BMB	2009	2008 fall	2008.10.30	43.91	14.27	267.36	37.43	9.86	4
BMB	2009	2009 winter	2009.01.30	47.55	32.42	225.41	38.67	10.96	9
BMB	2009	2009 snowmelt	2009.04.15	44.89	22.34	232.87	33.93	-0.11	2
BMB	2009	2009 springsummer	2009.06.15	40.49	13.36	285.11	36.68	32.78	6
BMB	2009	2009 latesummer	2009.08.30	35.50	11.32	352.21	43.86	58.95	5
BMB	2010	2009 fall	2009.10.30	39.82	13.22	304.87	35.51	22.85	4
BMB	2010	2010 winter	2010.01.30	45.03	32.06	200.97	44.61	47.98	9
BMB	2010	2010 snowmelt	2010.04.15	43.11	24.32	224.35	38.29	30.90	2
BMB	2010	2010 springsummer	2010.06.15	39.91	16.63	260.22	40.87	47.89	6
BMB	2010	2010 latesummer	2010.08.30	41.89	17.86	214.99	50.98	105.39	5
BMB	2011	2010 fall	2010.10.30	38.28	20.58	312.96	34.98	12.21	8
BMB	2011	2011 winter	2011.01.30	42.86	39.55	207.03	40.87	14.41	18
BMB	2011	2011 snowmelt	2011.04.15	29.72	41.09	347.95	26.14	-32.28	2
BMB	2011	2011 springsummer	2011.06.15	39.20	28.12	256.45	32.28	7.88	6
BMB	2011	2011 latesummer	2011.08.30	35.28	22.94	378.62	43.23	55.55	5
BMB	2012	2011 fall	2011.10.30	38.40	33.67	222.75	41.13	39.90	4
BMB	2012	2012 winter	2012.01.30	36.81	57.26	216.49	37.64	-1.83	9
BMB	2012	2012 snowmelt	2012.04.15	32.81	47.39	344.69	34.61	-8.87	2
BMB	2012	2012 springsummer	2012.06.15	36.53	35.59	230.16	47.33	51.87	7
BMB	2012	2012 latesummer	2012.08.30	49.60	26.24	209.76	62.14	108.62	4

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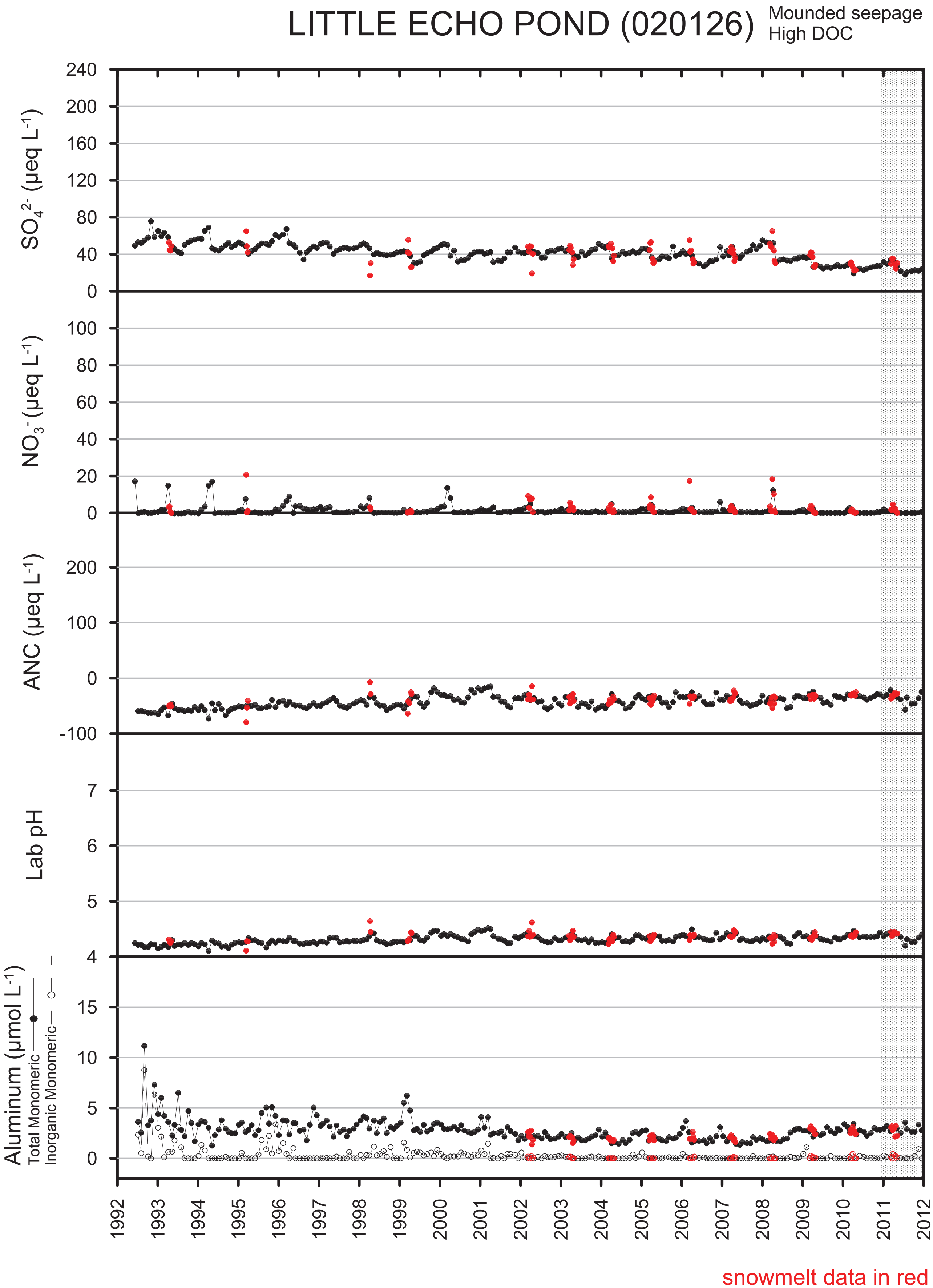
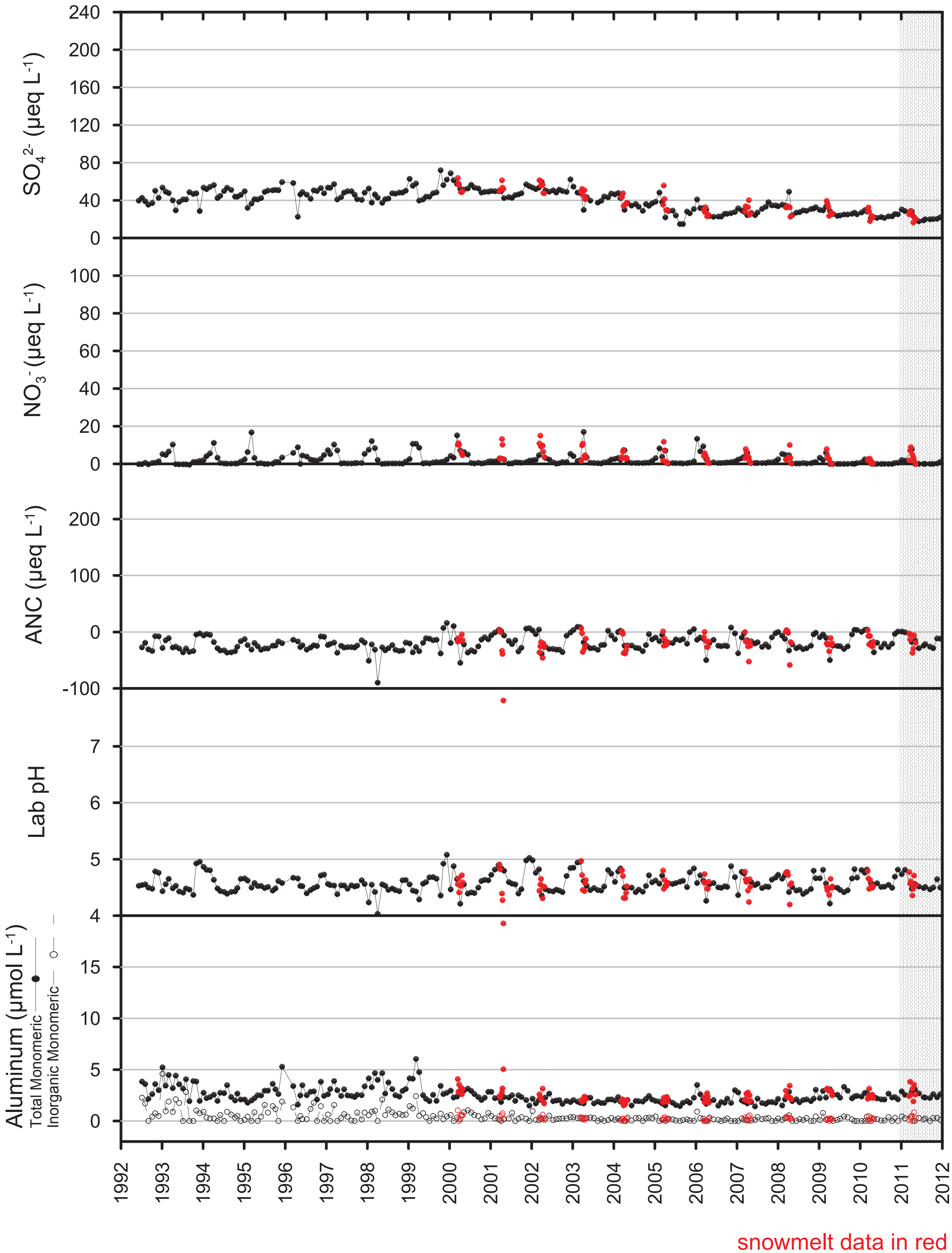

LITTLE ECHO POND (020126)
Mounded seepage
High DOC
SO_4^{2-} (µeq L^{-1})
240
200
160
120
80
40
0
NO_3^- (µeq L^{-1})
100
80
60
40
20
0
ANC (µeq L^{-1})
200
100
0
-100
Lab pH
7
6
5
4
Aluminum (µmol L^{-1})
Total Monomeric
Inorganic Monomeric
15
10
5
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
snowmelt data in red

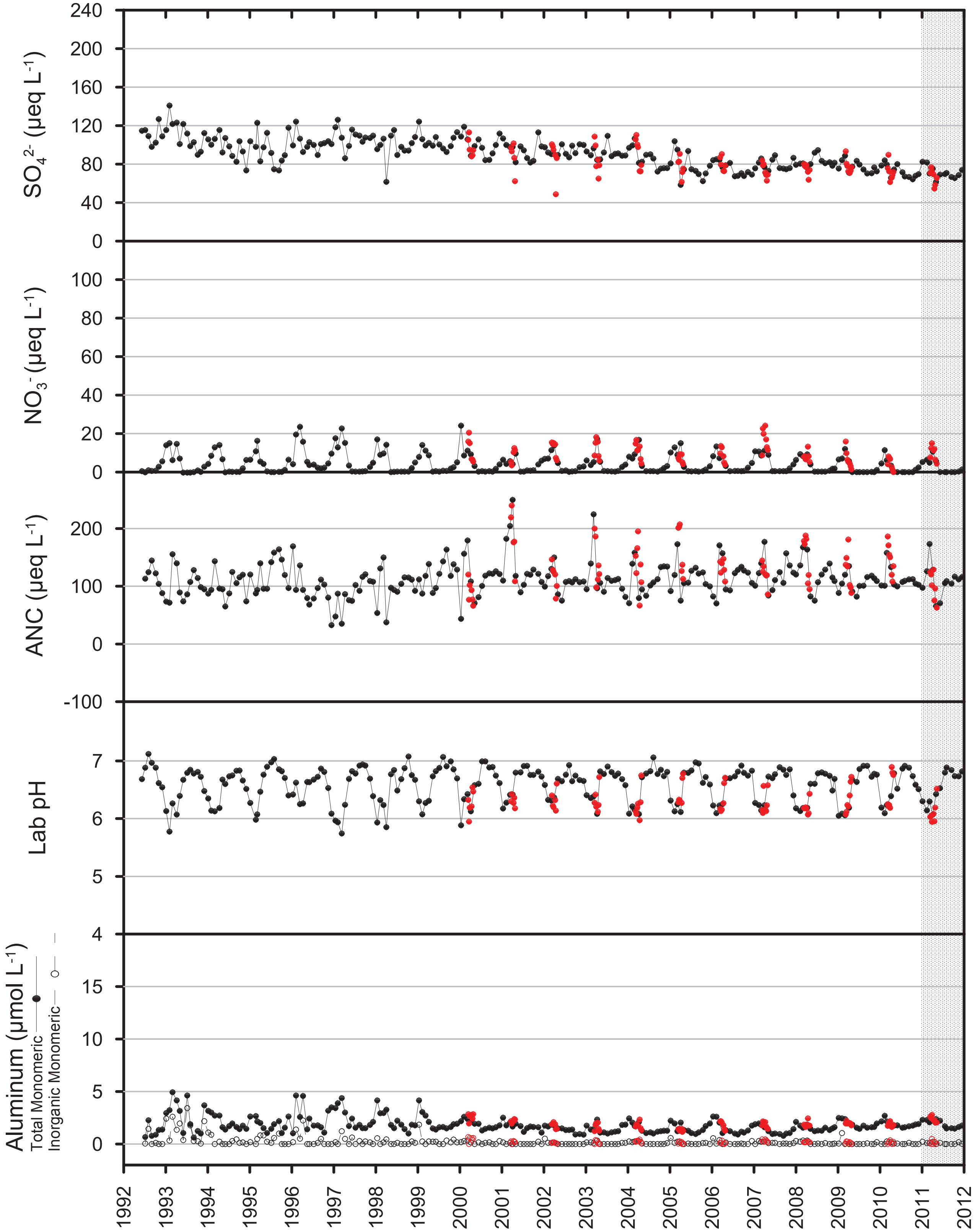
EAST COPPERAS POND (020138)

Thin till drainage
High DOC



MIDDLE POND (020143)

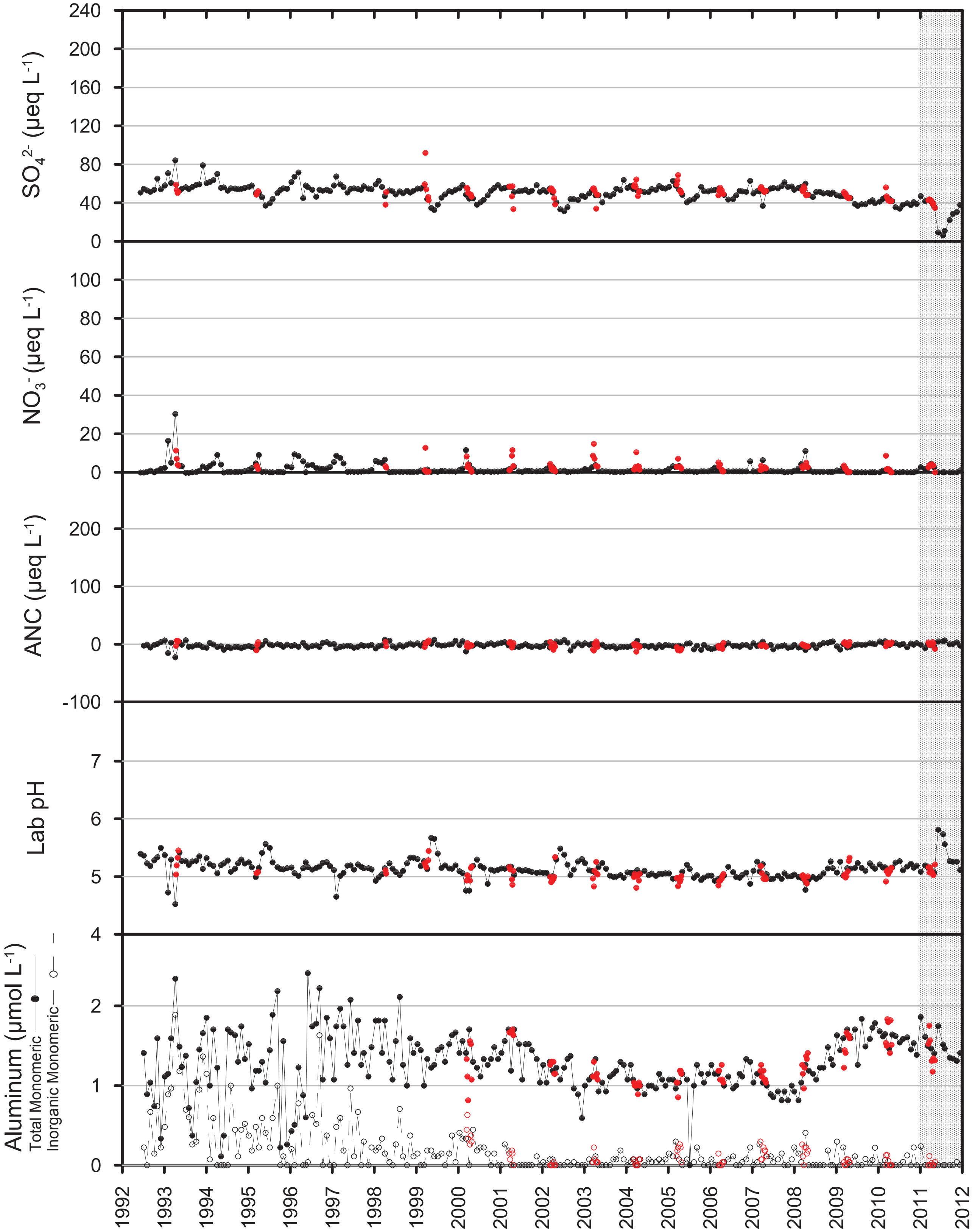
Carbonate influenced



snowmelt data in red

SUNDAY POND (020188)

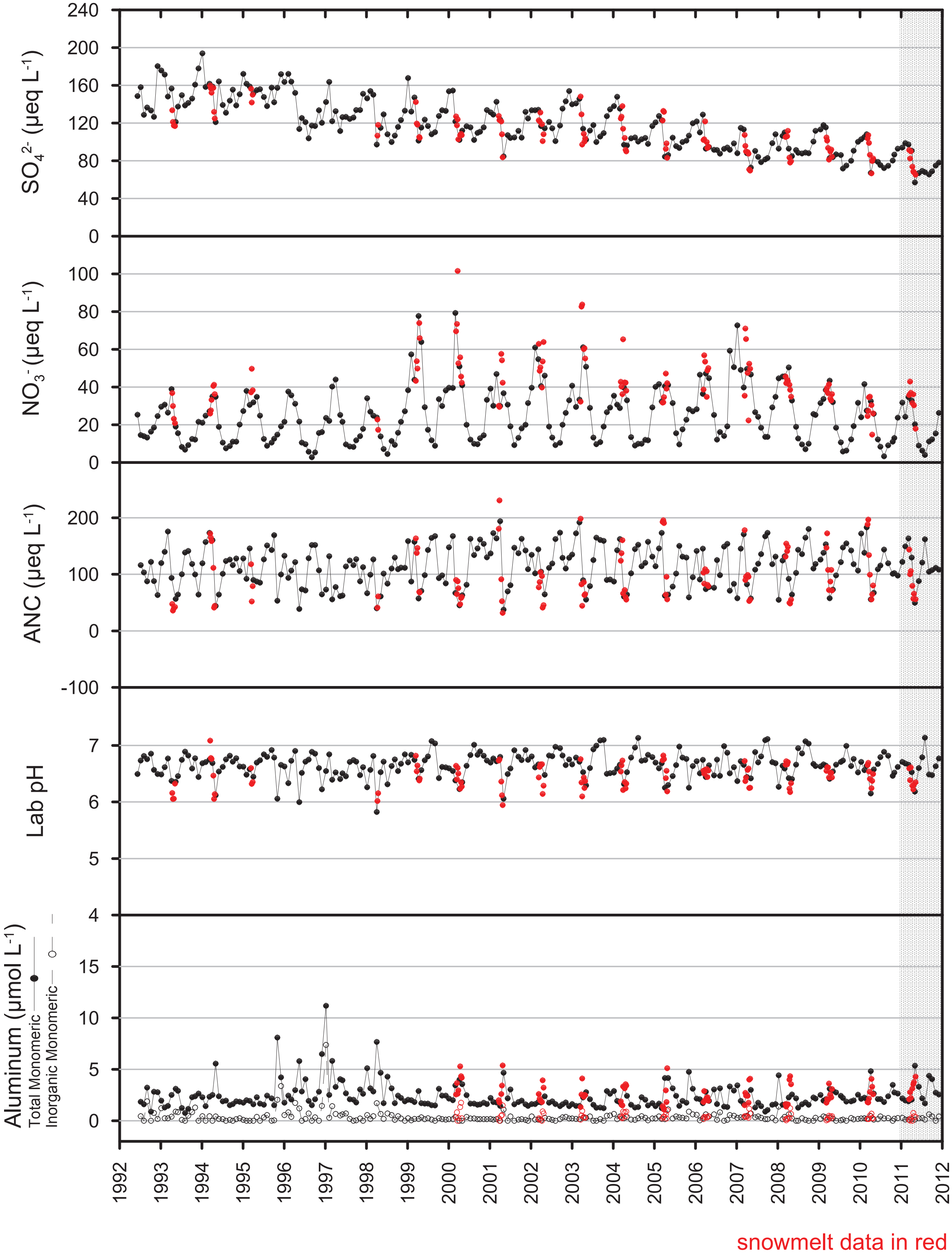
Mounded seepage
Low DOC



snowmelt data in red

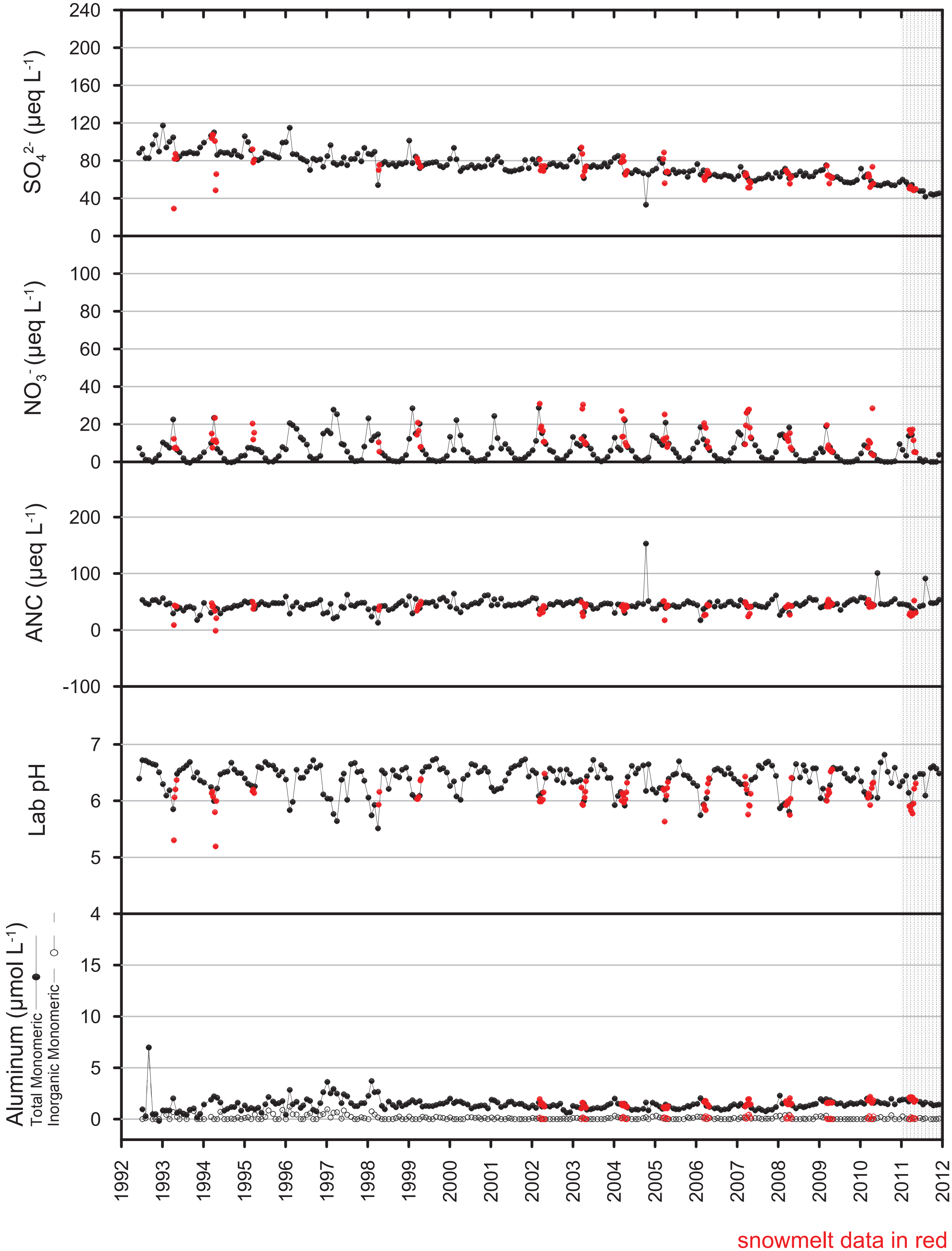
OWEN POND (020233)

Thick till drainage
Low DOC



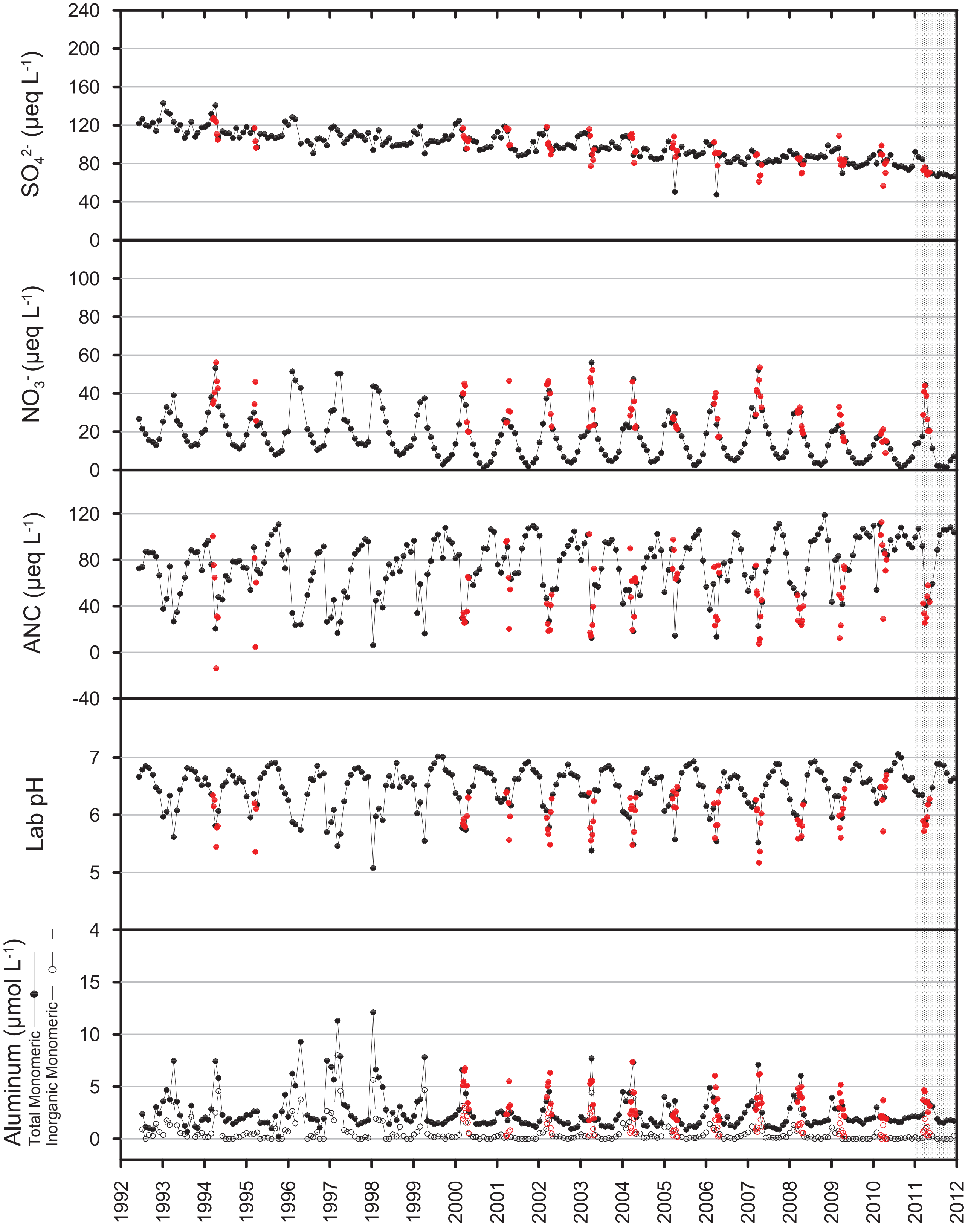
HEART LAKE (020264)

Medium till drainage
Low DOC



MOSS LAKE (040746)

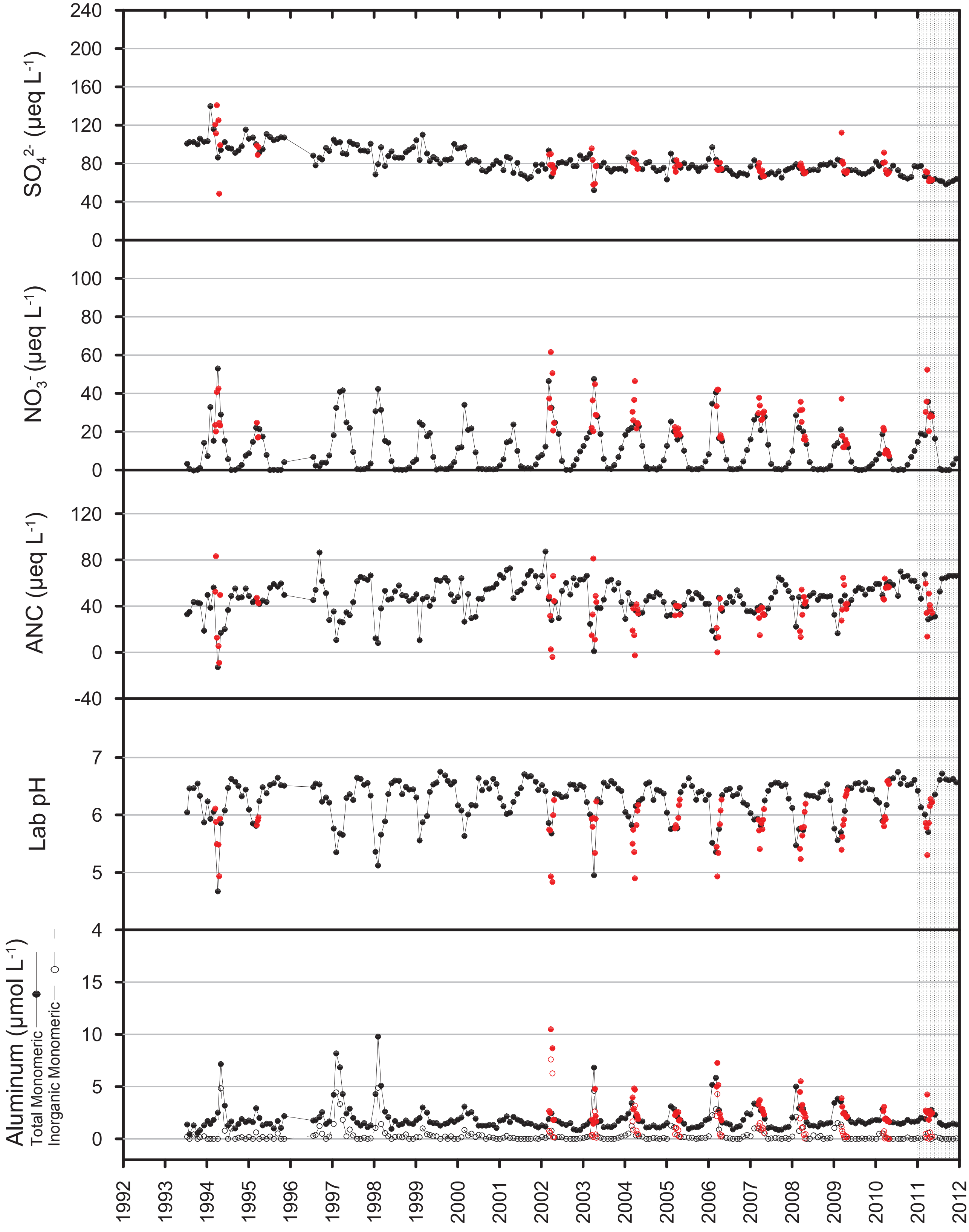
Medium till drainage
Low DOC



snowmelt data in red

BUBB LAKE (040748)

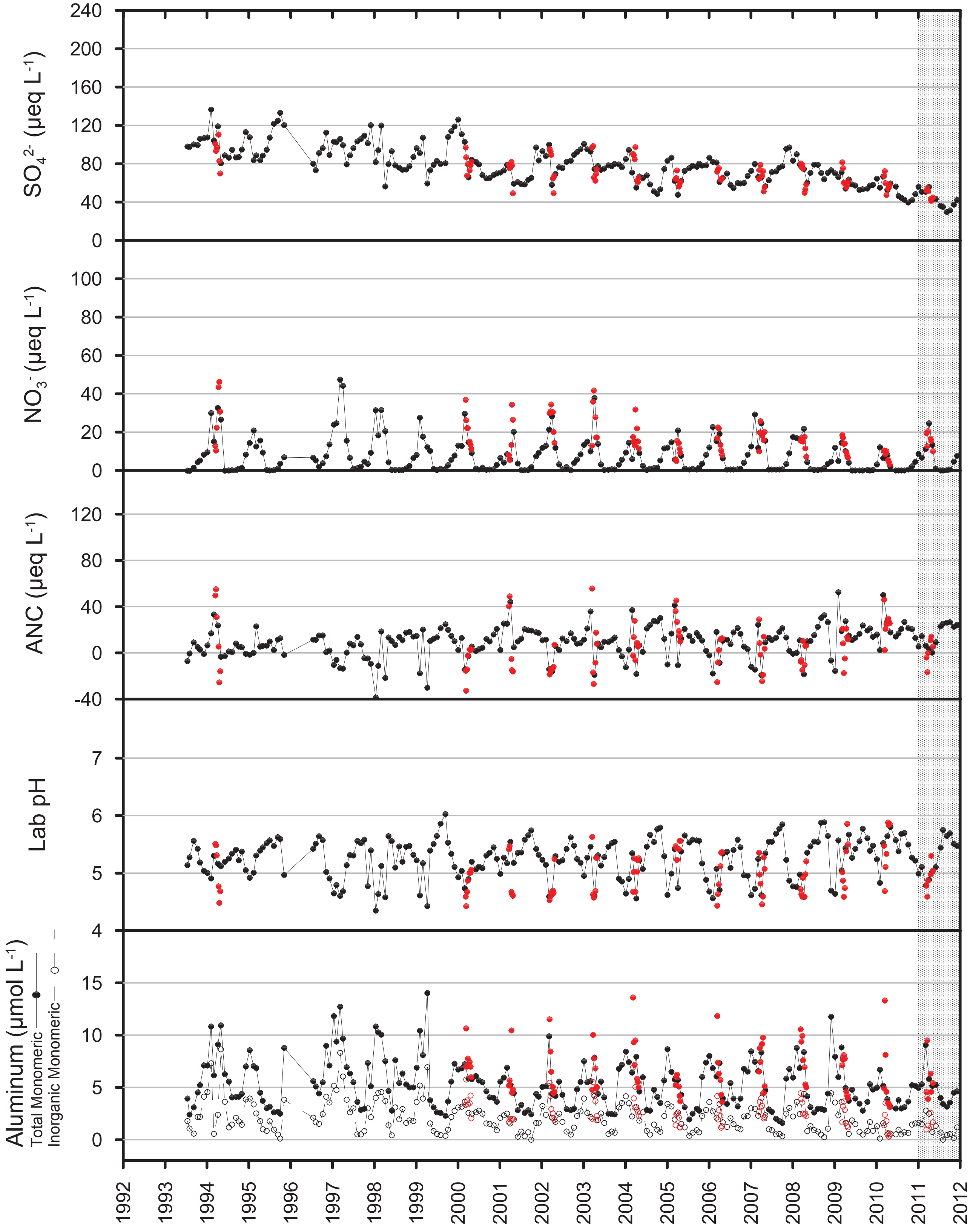
Thin till drainage
Low DOC



snowmelt data in red

WEST POND (040753)

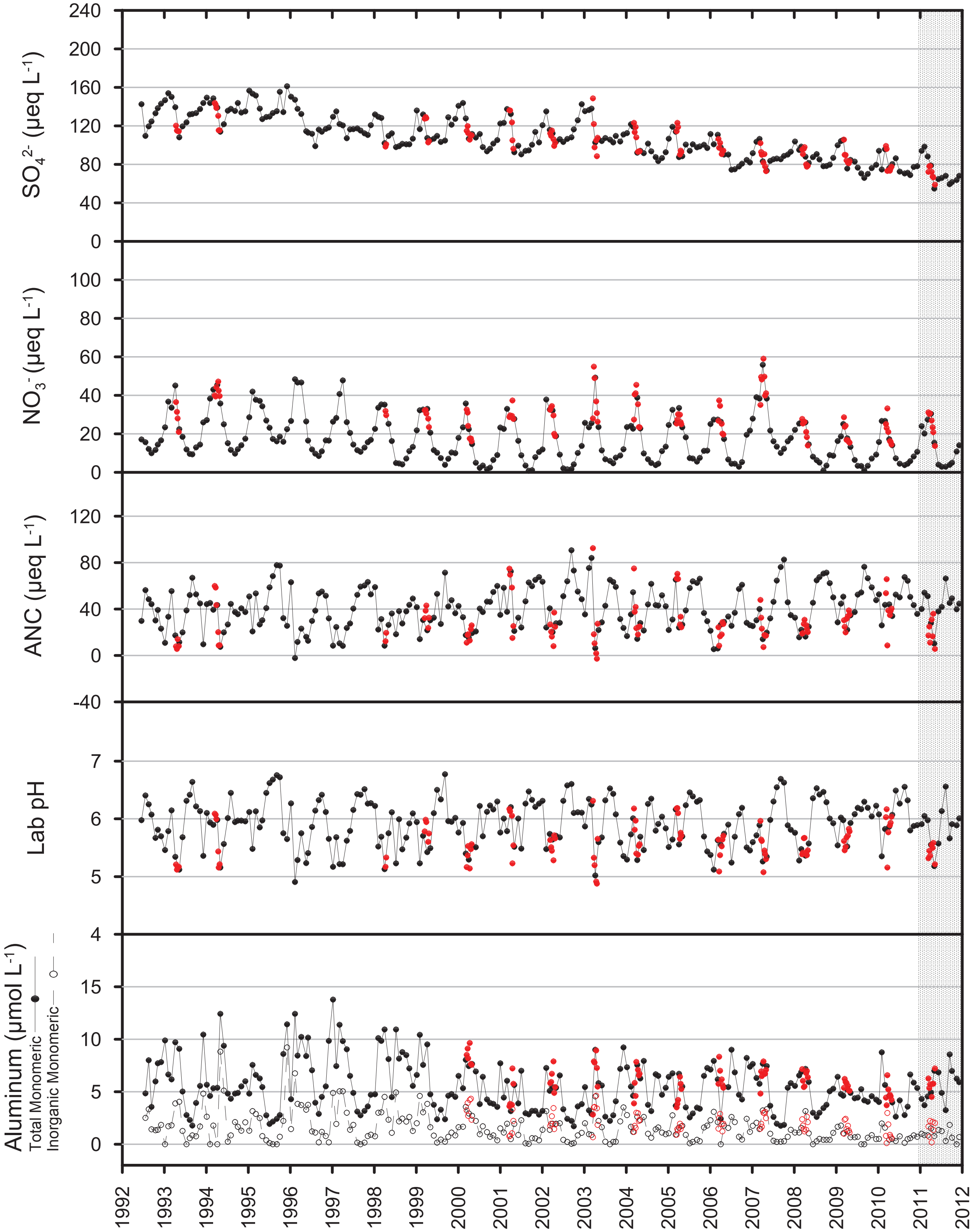
Thin till drainage
Low DOC



snowmelt data in red

SAGAMORE LAKE (060313)

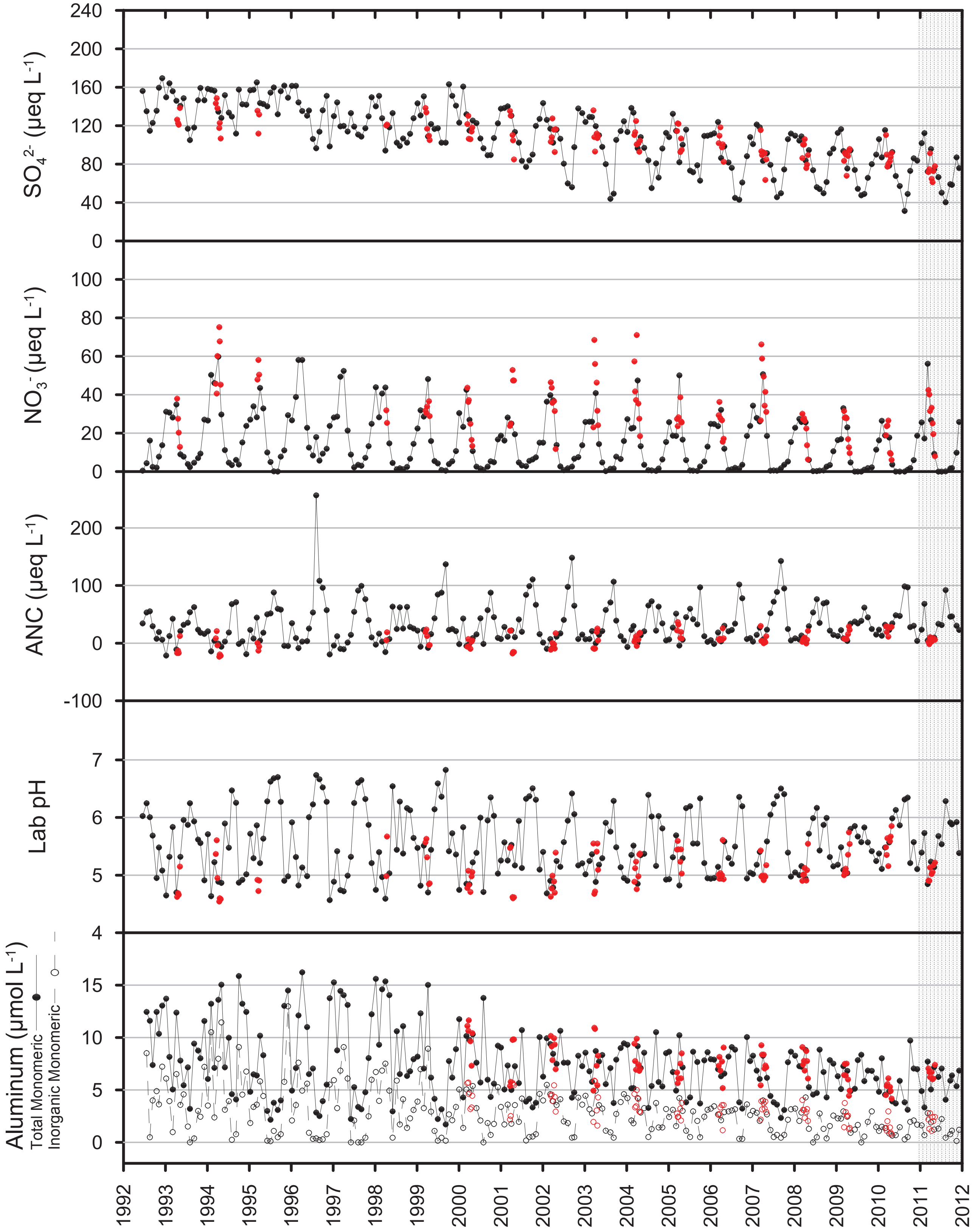
Medium till drainage
High DOC



snowmelt data in red

RAQUETTE LAKE RESERVOIR (060315A)

Medium till drainage
High DOC



snowmelt data in red

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Appendix D: Presentations, Reports, and Papers 2007–2012

LIST OF PRESENTATIONS, REPORTS, PAPERS January 2007 - December 2012

PRESENTATIONS

Date/Location	Presented at	Title	Prepared by	Presented by
September 14, 2012 Willsoboro, NY	Garden Club of America, Adirondack Conservation Field Program	Adirondack Park acid rain science and advocacy since the 1980s.	K.Roy	K.Roy
August, 2012	Saranac Lake Rotary Club	About the Adirondack Lakes Survey Corporation	J.Dukett	J.Dukett
August, 2012 Lake Placid & Wilmington, NY	PBS Mountain Lake Journal	What's falling from the sky	J.LaDuke, J.Dukett and M.Kelting	Television
July 10, 2012 Wilmington, NY	Atmospheric Sciences Research Center Summer Lecture Series	About the Adirondack Lakes Survey Corporation and the Whiteface Mountain Cloud project	J.Dukett	J.Dukett
May 21-25, 2012 Potsdam, Germany	North-Watch Workshop	Regulation of sulfur budgets of forested lake/watersheds in the Adirondack Mountains of New York State: Shift from atmospheric regulation to climate control	M.Mitchell, C.T.Driscoll, P.McHale, K.M.Roy, Z.Dong	Paper (M.Mitchell)
May 16-17, 2012 Lake Placid, NY	Adirondack Research Consortium Annual Meeting	Recent fish community changes and mercury in Adirondack long-term monitoring lakes	K.Roy,	K.Roy
May 16-17, 2012 Lake Placid, NY	Adirondack Research Consortium Annual Meeting	The Adirondack Lakes Survey Corporation: Where timely environmental monitoring data reaches the public	J.Dukett, N.Houck, P.Snyder and S.Capone	Poster (Dukett)
April 19, 2012 Ray Brook, NY	Earth Week Adirondack Park Agency Board Meeting	The Adirondack Long Term Monitoring Program: Recent trends and the latest data	K.Roy, J.Dukett, N.Houck, P.Snyder and S.Capone	K.Roy, J.Dukett, N.Houck, P.Snyder and S.Capone
March 7-8, 2012 Old Forge, NY	Ninth Annual Adirondack Research Forum	Program updates, deliverables, news and recent analysis associated with the Adirondack Lakes Survey Corporation	J.Dukett, and N.Houck	J.Dukett, and N.Houck

December 7, 2011 Albany, NY	New York State Department of Environmental Conservation (NYSDEC) PE Continuing Education Seminar	Adironback acid rain update - acid deposition impacts, monitoring and trends in Adirondack lakes and streams	K.Roy	K.Roy
November 15-16, 2011 Albany, NY	New York State Energy Research and Development Authority (NYSERDA) Environmental Monitoring, Evaluation, and Protection (EMEP) Program Linking Science and Policy Conference	A comparison of the Temporally Integrated Monitoring of Ecosystems and Adirondack long-term monitoring programs in the Adirondack mountain region of New York	K.Civerolo, and K.Roy	Poster (Civerolo)
November 15-16, 2011	NYSERDA EMEP Conference	Adirondack long term monitoring lakes: A compendium of site	K.Roy, N.Houck, P.Hyde,	Poster (Roy)
November 15-16, 2011 Albany, NY	NYSERDA EMEP Conference	Carbon observations from cloud water at Whiteface Mountain New York	J.Dukett, P.Snyder, S.Capone, N.Houck, N.Aleksic, M.Mazurek,	Poster (Dukett)
November 15-16, 2011	NYSERDA EMEP Conference	Fish community changes and mercury in Adirondack long term	K.Roy and A.Bulger	Poster (Roy)
November 15-16, 2011 Albany, NY	NYSERDA EMEP Conference	Understanding the molecular composition of highly polar organic compounds in cloudwater and fine particles in the Northeastern US	J.Sagona, M. Mazurek, and J.Dukett	Poster
July 29, 2011	The Greater Adirondack Resource Conservation and	The Adirondack Lake Survey Corporation	ALSC Staff	Poster
July 10-15, 2011 Lew-	The Gordon Conference, Bates College	The road to recovery of Adirondack lakes from acidic deposition:	C.T.Driscoll	C.T.Driscoll
June 8, 2011	First Annual Black River Watershed Conference	Ongoing research in the western Adirondacks, headwaters to the	G.Lawrence	G.Lawrence
June 6-7, 2011 Dur-	USEPA LTM/TIME Cooperators Workshop	Update Adirondack lakes LTM (monthly) trends; TIME (sum-	K.Roy	K.Roy
May 18-19,2011	Adirondack Research Consortium Annual Meeting	Progress toward clean coud water at Whiteface Mountain New	J.Dukett	J.Dukett
May 18-19, 2011	Adirondack Research Consortium Annual Meeting	Adirondack long term monitoring lakes: A compendium of site	K.Roy, N.Houck, P.Hyde,	Poster (Houck)

May 2011	Fifth USGS/NYSDEC Summit	Acidification of the Adirondack ecosystem: A park-wide assess-	G.Lawrence	G.Lawrence
April 26 and June 17, 2011 Tupper Lake, NY	Whiteface Mountain - Olympic Region Scenic Byways Natural History Interpretation Project - Wild Center discussion group	Research at Whiteface Mountain - discussion group	J.Dukett and K.Roy	J.Dukett
April 6-9, 2011 Albany, NY	Northeast Natural History Conference. Special session: Ecological Staus and Recovery of Acidified Adirondack Surface Waters	A comparison of the TIME (summer) and LTM (year-round) programs during 1992-2008	K.Civerolo and K.Roy	K.Roy
April 6-9, 2011 Albany, NY	Northeast Natural History Conference. Special session: Ecological Status and Recovery of Acidified Adirondack Surface Waters	Comparison of methods for estimating critical loads of acidic deposition in the western Adirondack region of New York	G.Lawrence	G.Lawrence
March 14, 2011 Al-	Office of the Attorney General - Briefing to scientific	Adirondack long-term monitoring to assess acid rain and emis-	G.Lampman, J.Dukett and	G.Lampman,
March 2, 2011	Eight Annual Adirondack Research Forum	Progress toward clean coud water at Whiteface Mountain New	J.Dukett	J.Dukett
January 14, 2011 Ray Brook / Albany teleconference	NYSDEC Bureau of Air Quality Analysis and Research (BAQAR) project overview presentations	Adirondack long term monitoring project - overview to BAQAR staff	K.Roy, J.Dukett, P.Snyder, N.Houck, and S.Capone	K.Roy, J.Dukett, P.Snyder, M.Cantwell, and
October 2010	USEPA Workshop “Interacting Effects of Climate and	Invited participant. Purpose: Review current science and infom	G.Lawrence	G.Lawrence
Fall 2010	American Geophysical Union Meeting	Highly polar organic compounds in summer cloudwater from	J.Sagona, J.Dukett, and	Poster presenta-
May 19, 2010	17th Annual Conference of the Adirondack Research	A comparison of contemporary cloudwater pH to pre-industrial	J.Dukett	J.Dukett
March 3, 2010	Seventh Annual Adirondack Research Forum	Trends in Adirondack lake chemistry	K.Roy	K.Roy
November 16, 2009	Atmospheric Sciences Research Center Student/Faculty	Impacts, monitoring and trends in Adirondack streams and lakes	K.Roy	K.Roy

October14-15, 2009	New York State Energy Research and Development Au-	Acid deposition impacts, monitoring and trends in Adirondack	K.Roy, G.Lawrence and	K.Roy
October14-15, 2009 Albany, NY	NYSERDA EMEP Conference	Chlorophyll a and total phosphorus: New to the compliment of chemical parameters analyzed by the Adirondack Long-Term Monitoring Program	J.E.Dukett, P.Snyder, N. Houck, S.Capone and K.Roy	Poster presenta-tion
October14-15, 2009	NYSERDA EMEP Conference	A Comparison of contemporary cloud water pH to pre-industrial	J.E.Dukett, N.Aleksic,	Poster presenta-
October 6-8, 2009	National Atmospheric Deposition Program (NADP) Fall	Changes in fish communities in Adirondack lakes	K.Roy, A.Bulger and	K.Roy
October 6-8, 2009 Saratoga Springs, NY	NADP Fall 2009 Annual Meeting and Science Sympo-sium	The response of acid-impacted lake-watersheds in the Adiron-dack region	C.Driscoll, K.Driscoll, K.Roy, Q.Zhao, T.Sullivan and M. Mitchell	C.Driscoll
October 6-8, 2009	NADP Fall 2009 Annual Meeting and Science Sympo-	Liquid water content and chemical composition in clouds at	N.Aleksic and J. Dukett	Poster presenta-
June 9, 2009 Albany, NY	New York State Department of Environmental Conser-vation (NYSDEC) Division of Air Resources (DAR) Seminar	Analysis of cloud and precipitation chemistry at Whiteface Mountain	N.Aleksic, K.Roy, G.Sistla, J.Dukett, N.Houck and P.Casson	N.Aleksic, K.Roy
June 3-4, 2009 College Park, PA	USEPA Temporally Integrated Monitoring of Ecosys-tems/Long Term Monitoring Cooperator Workshop	A regional perspective for the Adirondack Mountains	K.Roy, C.Driscoll, and G.Lawrence	K.Roy
May 15, 2009 Saranac Lake, NY	Focus Earth Series by Bob Woodruff video interview for “The Future of Coal Country” to be aired Summer 2009	Sampling for acid rain effects in the Adirondacks	K.Roy, P.Casson and J.Brown	Video interview
August 26, 2008	Whiteface Mountain Atmospheric Center Ray Falconer	Lakes, streams and cloud monitoring in the Adirondacks		K.Roy
June 2, 2008	North Country Public Radio (Canton, NY) interview	Subject: National air pollution cap and trade policies and the	K.Roy	Radio interview
May 21-22, 2008	Adirondack Research Consortium 15th Annual Confer-	Adirondack Long-Term Monitoring recent findings - lakes	K.Roy, J.Dukett,	K.Roy

May 13, 2008 Ray Brook, NY	Cornell Water Resources Institute Reactive Nitrogen Round Table Teleconference	Presentation of Adirondack long term monitoring sites and findings	K.Roy	K.Roy
February 14, 2008 Troy, NY	Meeting of The Nature Conservancy and USGS Research Scientists on Acid Deposition Research in New York State	Adirondack Long Term Monitoring Program - study sites	K.Roy	K. Roy
November 15-16, 2007 Albany, NY	New York State Energy Research and Development Authority (NYSERDA) Environmental Monitoring, Evaluation, and Protection (EMEP) Program Linking Science and Policy Conference	Changes in water quality of Adirondack lakes	K.Roy, J.Dukett, S.Capone, N.Houck and P. Snyder	K.Roy
September 30, 2007	NYSDEC Executive Staff regional visit	Adirondack Lakes Survey Corporation/Adirondack Long Term	K.Roy	K.Roy
May 22-24, 2007 Tupper Lake, NY	Adirondack Research Consortium 14th Annual Conference on Sustainability, Climate Change, and Protected Areas - Setting a Practical Research Agenda for the North Country	Recent acidification trends in Adirondack lakes	K.Roy, C.Driscoll, K.Driscoll, J.Dukett, N.Houck, P.Snyder, and S.Capone	K.Roy
May 4-6, 2007 Hamilton, NY	New York State Federation of Lake Association 24th Annual Conference	Recent acidification trends in Adirondack lakes	K.Roy, C.Driscoll, K.Driscoll, J.Dukett, N.Houck, P.Snyder, and	K.Roy
	NYSDEC Division of Air Resources, New Staff Orien-	The Adirondack Long Term Monitoring Program (surface water	K.Roy	K.Roy

PUBLISHED REPORTS AND ARTICLES

YEAR	Journal, Book or Other	Title	Authors
November 2012	Hydrological Processes	Lake/watershed sulfur budgets and their response to decreases in atmospheric sulfur deposition: Watershed and climate controls http://onlinelibrary.wiley.com/doi/10.1002/hyp.9670/abstract	M.Mitchell, C.T.Driscoll, P.McHale, K.M.Roy, Z.Dong

June 2012	Report to NYSERDA	A long-term monitoring program for evaluating changes in water quality in selected Adirondack waters: Core program 2007-2011 program summary report 2011. Report 12-26 NYSERDA 4915, Albany, NY www.nyserda.ny.gov/~/media/Files/Publications/Research/	K.Roy, J.Dukett, N.Houck, and G.Lawrence
July 2011	Environmental Pollution (2011) 159:2750-2758	Changes in the chemistry of acidified Adirondack streams from the early 1980s to 2008 http://dx.doi.org/10.1016/j.envpol.2011.05.016	G.B.Lawrence, H.A.Simonin, B.P.Baldigo, K.M.Roy and
August 2011	Report to NYSERDA	Adirondack long term monitoring lakes: A compendium of site http://www.nyserda.ny.gov/~/media/Files/Publications/Research/Environmental/11-12-altm-compendium.ashx?sc_database=web	K.Roy, N.Houck, P.Hyde,
August 2011	Atmospheric Environment 45(2011) 6669-6673	Progress toward clean cloud water at Whiteface Mountain, New York doi:10.1016/j.atmosenv.2011.08.070	J.Dukett, N.Aleksic, N.Houck, P.Snyder, P.Casson, and M.Cantwell
August 2011	Report to NYSERDA	A long-term monitoring program for evaluating changes in water quality in selected Adirondack waters: Core program 2007-2011 data summary report 2010. Report 11-20 NYSERDA 4915, Albany, NY http://www.nyserda.ny.gov/~/media/Files/Publications/Research/Environmental/11-20%20Water%20Quality%20in%20Selected%20Adirondack%20Waters%202010%20Summary%20Report.ashx?sc_database=web	K.Roy, J.Dukett, N.Houck, and G.Lawrence
August 2011	Water Air and Soil Pollution (2011) 222: 285-296	A comparison of the Temporally Integrated Monitoring of Ecosystems and Adirondack Long-Term Monitoring Programs in the Adirondack Mountain Region of New York doi: 10.1007/s11270-011-0823-8	K.L.Civerolo, K.M.Roy, J.L.Stoddard, and G.Sistla
December 2011	Atmospheric Environment 46 (2012) 56-64	Long term recovery of lakes in the Adirondack region of New York to decreases in acidic deposition http://www.sciencedirect.com/science/article/pii/S1352231011011058	K.Waller, C.Driscoll, J.Lynch, D.Newcomb and

December 2011	Office of Science and Technology Report National Science and Technology Council	National Acid Precipitation Assessment Program report to Congress 2011: An integrated assessment	D.A.Burns and others
2010	Atmospheric Research 98(2010) 2-4:400-405	Probabilistic relationship between liquid water content and ion concentrations in cloud water.	N.Alecksic, and J.Dukett
2010	Report to NYSERDA	A sampling design for the 2008-2012 fisheries resurvey of the 52 Adirondack Long-Term Monitoring (ALTM) lakes. NYS Department of Environmental Conservation and Adirondack Lakes Survey Corporation, Ray Brook, NY	K.Roy and S.Capone
2010	Report to NYSERDA	A long-term monitoring program for evaluating changes in water quality in selected Adirondack waters: Core program 2007-2011 data summary report 2009. Report 10-21 NYSERDA 4915, Albany, NY	K.Roy, J.Dukett, N.Houck, and G.Lawrence

REPORTS /POLICY DOCUMENTS UTILIZING ALTM/ALSC PROGRAM DATA

Year	Report or Other	Title	Authors
2011	Technical Report to NESCAUM	Steady-state critical loads and exceedance for terrestrial and aquatic ecosystems in the Northeastern United States Http://www.nescaum.org/activities/major-reports	E.K.Miller
2011	National Acid Precipitation Assessment Program Report to Congress	National Acid Precipitation Assessment Program report to Congress 2011: An integrated assessment. Http://ny.water.usgs.gov/projects/NAPAP/	D.A.Burns et al.
2011	Comments of the New York State Department of Environmental Conservation Division of Air Resources to the EPA Proposed Rule	Secondary national ambient air quality standards for oxides of nitrogen and sulfur federal register notice http://www.epa.gov/air/nitrogenoxides/actions.html#mar12	D.Shaw (NYSDEC) to R.Wayland and R.Haeuber (US EPA) April 3, 2012

2011	EPA Policy Document	Policy assessment for the review of the secondary national ambient air quality standards for oxides of nitrogen and oxides of sulfur, U.S. Environmental Protection Agency, Washington, D.C., EPA-452/R-11-005a.	USEPA
2010	EPA Report	Acid rain and related programs: 2009 highlights 15 years of results 1995 to 2009. EPA-430-R-10-014 Washington, DC http://www.epa.gov/airmarkets/progress/ARP09_4.html	USEPA Clean Air Markets Division
2010	EPA Report	Acid Rain and related programs: 2009 environmental results, Washington, DC http://www.epa.gov/airmarkets/progress/APR09.html	USEPA Clean Air Markets Division
2010	EPA Report	Policy assessment for the review of the secondary national ambient air quality standards for NOx and SOx: Second external review draft for the Clean Air Scientific Advisory Committee, Washington, DC	USEPA
2009	EPA Report	Risk and exposure assessment for review of secondary national ambient air quality standards for oxides of nitrogen and oxides of sulfur (Final report). U.S. Environmental Protection Agency, Washington, D.C., EPA-452/R-11-005a.	USEPA
2008	EPA Report	Integrated science assessment (ISA) for oxides of nitrogen and sulfur ecological criteria (Final report). U.S.Evironmental Protection Agency, Washington, D.C., EPA/600/R-08/082F.	USEPA

Appendix E: 2011 Whiteface Cloud Summary Data

Whiteface 2010 - 2011 Summary Data

A complete record of Whiteface Cloud data may be obtained at www.adirondacklakessurvey.org/ by selecting the Whiteface Info & Data menu tab.

2010

Parameter	Units	Count	Min	Max	Mean	Std. Dev.
Cloud Samples (n)		309				
Volume	mL	309	30.000	2887.000	661.741	551.694
LWC	g m^{-3}	309	0.053	1.170	0.520	0.265
SO_4^{2-}	µeq L^{-1}	309	0.331	725.592	98.723	132.558
NO_3^-	µeq L^{-1}	309	0.416	329.669	47.115	56.434
Cl^-	µeq L^{-1}	309	0.000	45.042	4.194	5.959
Ca^{2+}	µeq L^{-1}	309	-0.485	245.953	19.548	34.330
Mg^{2+}	µeq L^{-1}	309	0.152	48.925	5.535	7.547
Na^+	µeq L^{-1}	304	-0.419	81.995	3.752	9.000
K^+	µeq L^{-1}	304	-0.129	17.125	1.650	2.112
NH_4^+	µeq L^{-1}	309	0.497	749.280	91.281	120.703
TOC	µmol L^{-1}	83	9.182	2319.299	374.756	417.764
SCONDUCT	µS cm^{-1}	276	1.670	193.353	35.556	39.438
LabpH		309	3.471	6.071	—	—
H^+	µeq L^{-1}	309	0.849	338.065	50.191	58.920

2011

Parameter	Units	Count	Min	Max	Mean	Std. Dev.
Cloud Samples		268				
Volume	mL	268	30.000	3031.000	779.578	638.602
LWC	g m^{-3}	268	0.080	1.390	0.598	0.249
SO4	µeq L^{-1}	268	1.770	673.737	81.808	115.393
NO3	µeq L^{-1}	268	1.042	445.528	41.186	61.693
Cl	µeq L^{-1}	268	0.141	28.212	2.608	3.831
Ca	µeq L^{-1}	259	-3.548	312.622	15.797	33.077
Mg	µeq L^{-1}	259	0.151	52.308	4.388	7.037
Na	µeq L^{-1}	262	-0.598	44.984	1.442	4.062
K	µeq L^{-1}	264	-0.092	12.656	1.338	1.936
NH4	µeq L^{-1}	268	5.087	725.517	77.579	114.274
TOC	µMoles L^{-1}	219	15.558	1382.223	264.601	226.148
SCONDUCT	µS cm^{-1}	226	0.093	188.899	24.754	29.106
LABpH		268	3.458	6.157		
H^+	µeq L^{-1}	268	0.697	348.337	39.898	46.605

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New York State
Energy Research and
Development Authority

17 Columbia Circle
Albany, New York 12203-6399

toll free: 866 NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov

A Long-Term Monitoring Program for Evaluating Changes in Water Quality in Selected Adirondack Waters

Program Summary

Program Summary Report 2012
November 2013

State of New York
Andrew M. Cuomo, Governor

New York State Energy Research and Development Authority
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