A LONG-TERM MONITORING PROGRAM FOR EVALUATING CHANGES IN WATER QUALITY IN SELECTED ADIRONDACK WATERS: CORE PROGRAM 2007–2011

DATA SUMMARY REPORT 2009

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About the Adirondack Lakes Survey Corporation

The Adirondack Lakes Survey Corporation (ALSC) was established in 1983. The ALSC was established to undertake comprehensive biological and chemical surveys of waters in the Adirondacks; 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 25 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.

Acknowledgements

This report is possible through the efforts of the ALSC field, laboratory, data management and administrative staff. We thank: Jeff Brown, Sara Burke, Mike Cantwell, Sue Capone, Paul Casson, Scott Fitzgerald, Elizabeth Gage, Pam Hyde, Matthew Kelting, Monica Schmidt, Phil Snyder and Chris Swamp for their dedication. 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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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 5-year (2007–11) 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 three locations on a bi-weekly basis; 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.

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 2007–2011 program plan and the data available through December 2009. 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.

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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).

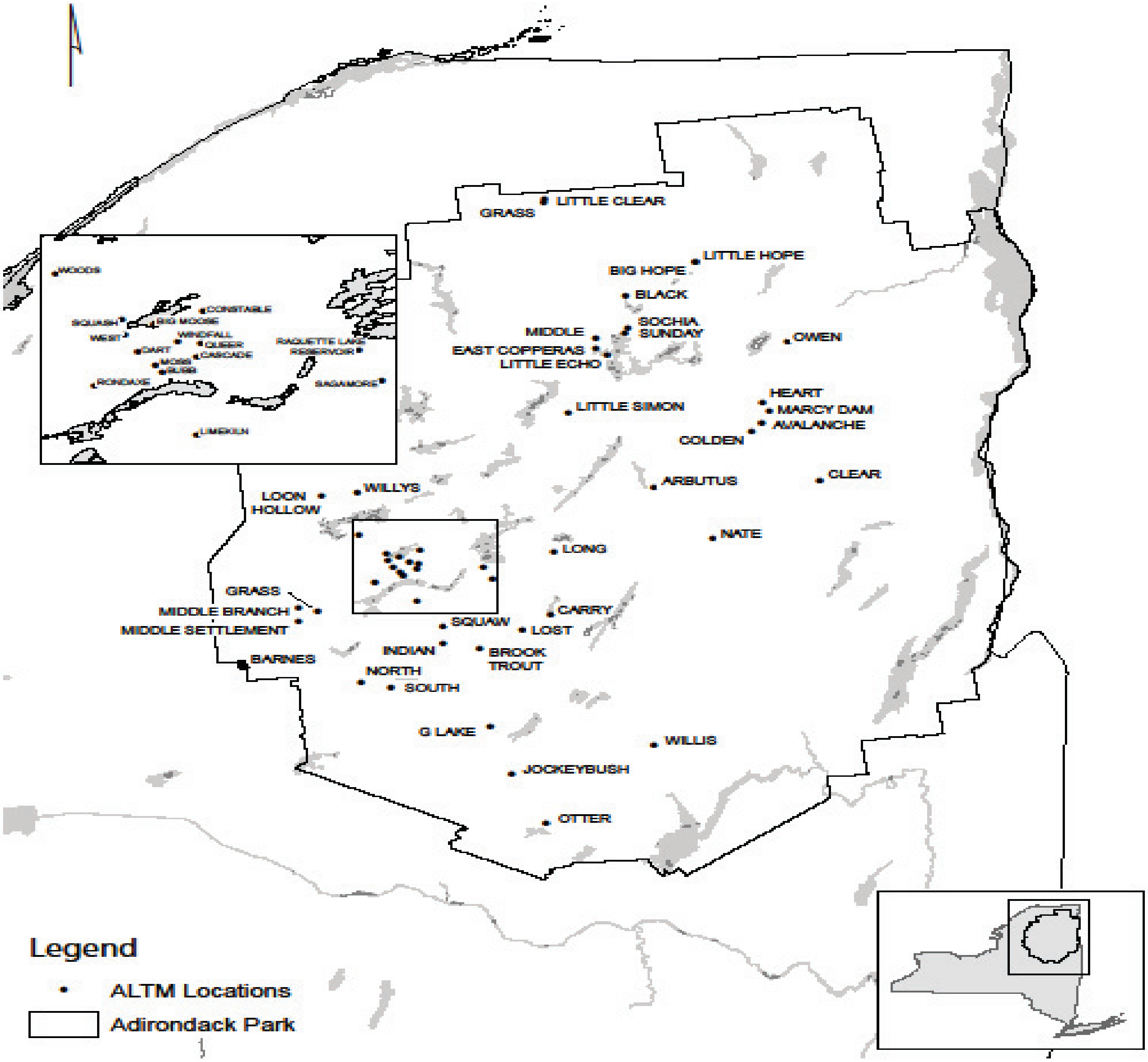


Figure 1. Location of 52 ALTM lakes sampled monthly by the ALSC.

Table 1. ALTM lake characteristics and identification of lakes included in: the original 17 ALTM lakes (1982); lakes sampled during the ALS(1984–87); and the EPA TIME project cross over lakes. ALTM lakes denoted as outlet pairs indicate the eight original lakes.

Ref #	ALTM Pond Name	Record Start 1982	Classification	DOC[1]	Lake Elev (m)	Surface Area (ha)	*ALS Survey*	*Limed*	*TIME*	*Outlet Pair*	*Snow Melt*
050684	Arbutus Lak	X	Medium Till Drainage	low	516	134.5					
050707	Avalanche Lake		Thin Till Drainage	low	873	14.63	A				
040905	Barnes Lake	X	Limed, Mounded Seepage	high	395	13.12	A	L			
020059	Big Hope Pond		Medium Till Drainage	high	517	51.58	A		T		S
040752	Big Moose Lake	X	Thin Till Drainage	low	558	3488.19					
030255	Black Pond Outlet	X	Thick Till Drainage	low	495	180.45	A			O	
040874	Brook Trout Lake		Thin Till Drainage	low	724	241.95	A				
040748	Bubb Lake	X	Thin Till Drainage	low	554	38.49	A			O	S
050669	Carry Pond		Mounded Seepage	low	652	6.17	A				
040747	Cascade Lake	X	Medium Till Drainage	low	557	173.45	A			O	
050458	Clear Pond	X	Thick Till Drainage	low	584	651.12	A				
040777	Constable Pond	X	Thin Till Drainage	low	580	43.48	A			O	
040750	Dart Lake	X	Thin Till Drainage	low	537	380.67	A				
020138	East Copperas Pond		Thin Till Drainage	high	480	14.83	A				S
070859	G Lake		Thin Till Drainage	low	620	143.73					
030171	Grass Pond		Mounded Seepage	high	381	7.83	A				
040706	Grass Pond		Medium Till Drainage	low	549	6.78	A				
020264	Heart Lake	X	Medium Till Drainage	low	661	54.46	A				S
040852	Indian Lake		Thin Till Drainage	low	654	98.11	A		T		
050259	Jockeybush Lake		Thin Till Drainage	low	599	78.55	A				
050706	Lake Colden		Thin Till Drainage	low	843	35.53	A				
040739	Lake Rondaxe	X	Thin Till Drainage	low	524	273.33	A				
040826	Limekiln Lake		Medium Till Drainage	low	575	1147.57	A				
030172	Little Clear Pond		Mounded Seepage	low	381	651.12	A	L			
020126	Little Echo Pond	X	Mounded Seepage	high	482	2.26					S
020058	Little Hope Pond		Medium Till Drainage	high	517	9.95	A				
060182	Little Simon Pond		Medium Till Drainage	low	546	631.33	A	L			
050649	Long Pond		Thin Till Drainage	high	574	3.34	A				
040186	Loon Hollow Pond		Thin Till Drainage	low	605	19.13	A				
040887	Lost Pond		Thin Till Drainage	high	717	3.21	A				
020265	Marcy Dam Pond		Thin Till Drainage	low	720	0.8	A				
040707	Middle Branch Lake		Thin Till Drainage	low	496	36.29	A				
020143	Middle Pond		Carbonate Influenced	high	483	36.91	A				S
040704	Middle Settlement Lake		Thin Till Drainage	low	526	54.46	A				
040746	Moss Lake	X	Medium Till Drainage	low	536	259.76	A				S
050577	Nate Pond		Medium Till Drainage	high	613	19.36	A				
041007	North Lake		Thin Till Drainage	low	555	1010.65	A		T		
070728	Otter Lake	X	Thin Till Drainage	low	485	34.11				O	
020233	Owen Pond		Thick Till Drainage	low	514	28.4	A				
060329	Queer Lake		Thin Till Drainage	low	597	596.01	A				
060315A	Raquette Lake Reservoir		Medium Till Drainage	high	564	2.38	A				S
060313	Sagamore Lake		Medium Till Drainage	high	580	713.09	A				S
020197	Sochia Pond		Mounded Seepage	low	495	4.95	A				
041004	South Lake		Thin Till Drainage	low	615	1630.16			T		
040754	Squash Pond	X	Thin Till Drainage	high	653	4.52	A			O	
040850	Squaw Lake		Thin Till Drainage	low	646	124.93	A		T		
020188	Sunday Pond		Mounded Seepage	low	495	21.85	A				S
040753	West Pond	X	Thin Till Drainage	low	581	15.15	A			O	S
050215	Willis Lake		Medium Till Drainage	low	400	22.89	A				
040210	Willys Lake (Horseshoe)		Thin Till Drainage	low	632	118.76	A		T		
040750A	Windfall Pond	X	Carbonate Influenced	low	591	7.8	A			O	
040576	Woods Lake		Limed, Thin Till Drainage	low	605	24.7		L			

[1] 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 1984–87 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

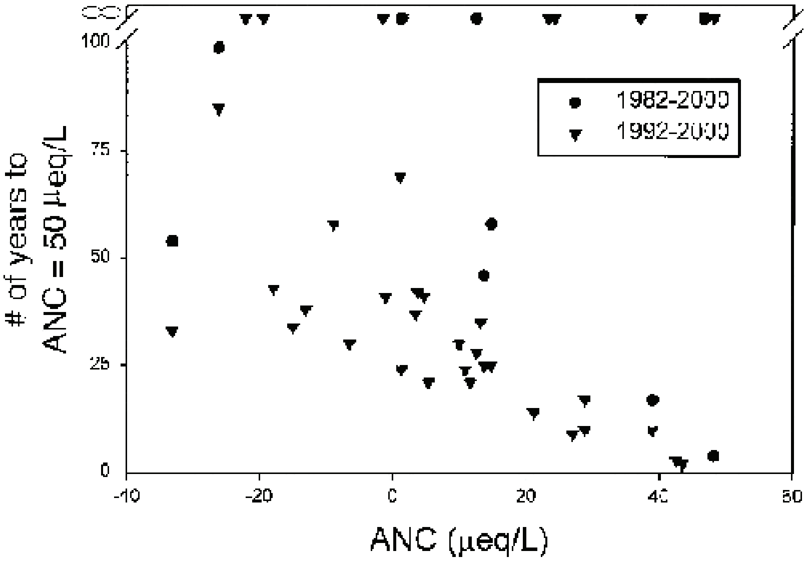
Since baseline monitoring was initiated in 1982 several lake chemistry time series analyses were conducted with the idea of evaluation of changes in atmospheric deposition. These evaluations are a snapshot of changes in chemistry that are attributed, for the most part, to changes in the acidic precursor emissions based upon the potential need for additional action for improvement from a policy frame work. 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 here. 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. While 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).

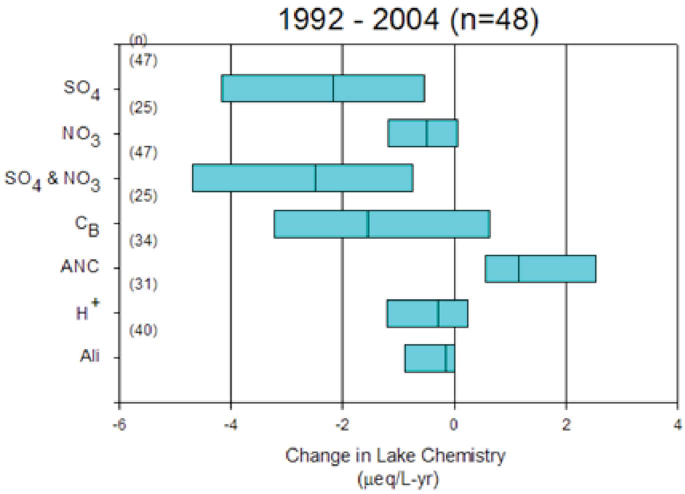


Time for lakes to reach ANC values of 50 µeq L^{-1} as a function of ANC value in the year 2000. These values are extrapolated based on the slope of ANC change from time series analysis assuming a linear rate of change. The extrapolation was done for two intervals, 1982–2000 (six lakes) and 1992–2000 (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 $\mu eq\ L^{-1}\ yr^{-1}$. 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 N 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).



Mean rates of change in solute concentrations in 48 ALTM lakes during 1992–2004. Minimum, mean and maximum changes in concentration and the number of lakes with significant trends are shown. All values in µeq L^{-1} year^{-1} except for concentrations of inorganic monomeric aluminum (Ali) which is µmol L^{-1} year^{-1}.

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

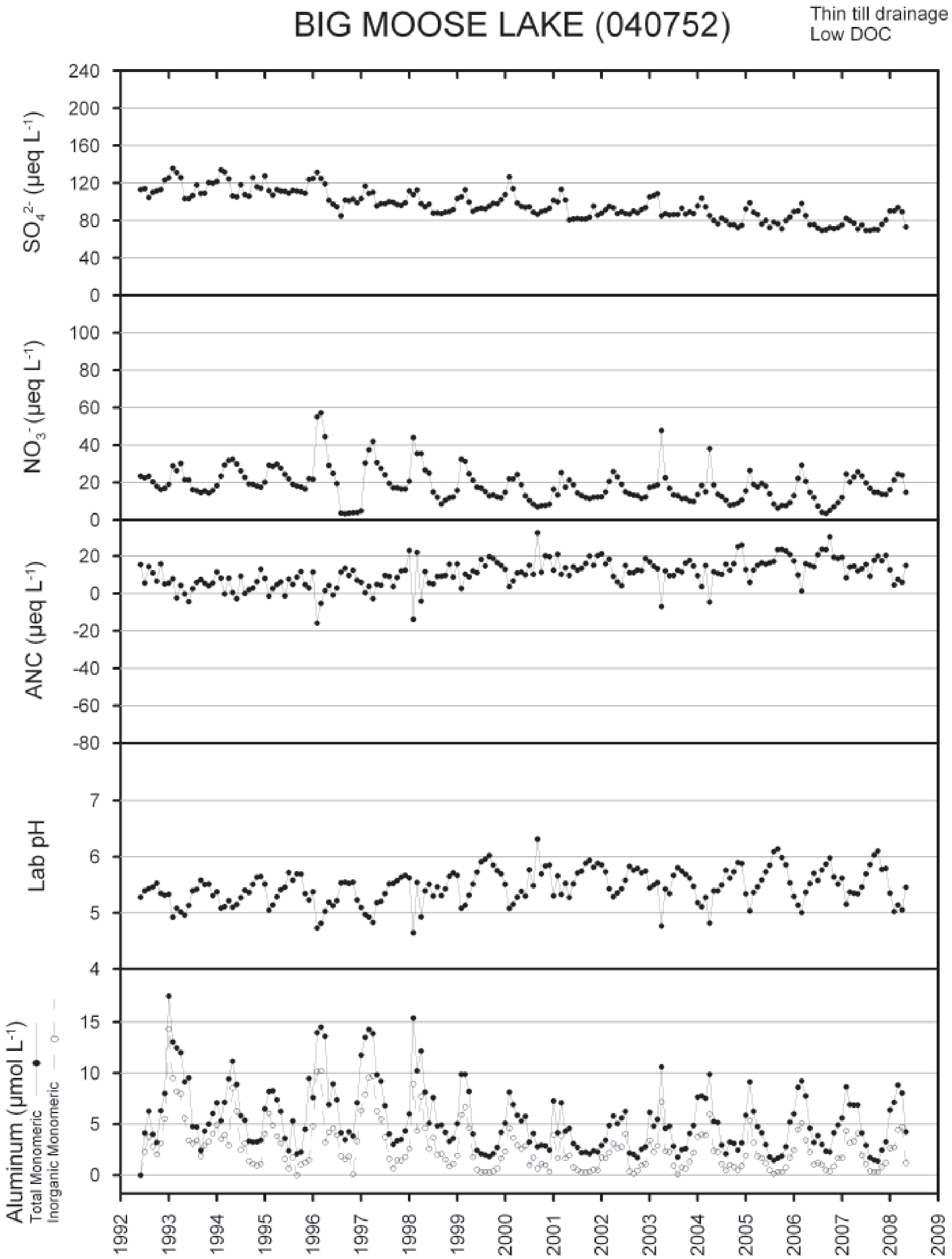


Figure 4. Monthly time series plots for Big Moose Lake. Values in µeq L^{-1} except total and inorganic monomeric aluminums, which are in µmol L^{-1}.

Chemistry Trends 1992–2008 (48 lakes)

In 2009, the ALTM program conducted Seasonal Kendall tests (SKT) on all lake water solute concentrations according to methods described in Driscoll 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 2008. The values are expressed as a rate of change (median slope as μeq L^{-1} yr^{-1}; for Al, 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) (Appendix A). Plots of selected chemical parameters for Big Moose Lake are provided (Figure 4).

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 2). 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 2. 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 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).

Snowmelt Sampling

In 1993, weekly sampling was initiated in a few ALTM lakes to capture more chemistry during snowmelt. 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 and ended with the disappearance of the snowpack and lasted anywhere from three to eight weeks. 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 analysis of these data is ongoing. These weekly data are being compiled and will be made available in the next data report.

During 1999 and 2000, mass-balance studies at three ALTM lakes (Grass, Constable and G) by M. Mitchell (SUNY College of Environmental Science and Forestry) included snow core plots 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. These collections have been ongoing since 1999. These monthly data are being compiled and will be made available in the next data report.

Data Reported to Date

Data currently available from this ALTM lake study (this section) include the 52 lakes and additional sampling collected at seven outlet pair locations. In 2010, annual mean concentrations of the parameters measured for the 52 lakes from January 1993 through December 2009 and the monthly chemistry data from June 1992 through May 2009 were posted to the ALSC website at 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 1984–87 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 includes total and methyl mercury analysis in yellow perch and brook trout. All lake water samples are analyzed for total mercury with a subset for methyl analysis. The resurvey schedule is based on the interval between the two previous surveys and existing staff levels. Table 3 shows the 5-year schedule of lakes resurvey, the years between surveys, along with an actual or estimated presence of target species (yellow perch and brook trout) for mercury analysis. The survey was planned for 2008–2012. If funding constraints require, the 2011 and 2012 field sampling will be compressed into one year, 2011, with reprioritizing the remaining waters. Under this scenario an estimated 10 to 12 lakes may not be resurveyed.

Table 3. Five-year schedule of ALTM lakes resurvey 2008–2012.

Year	Pond	Pond Name	ALS Dates	LTM Dates	"Proposed Date (14 yr time frame)	Scheduled Year	No. of Years Between Surveys	Yellow[a] Perch	Brook[a] Trout
2008									
	020059	BIG HOPE POND	05/22/84	05/17/94	May-08	Nov-08	14		24
	020233	OWEN POND	09/13/84	05/24/94	May-08	Sep-08	14		1
	030172	LITTLE CLEAR POND	10/09/84	05/23/94	May-08	Oct-08	14		7
	030171	GRASS POND	10/09/84	06/15/98	Jun-08	Oct-08	10		
	040887	LOST POND	09/12/84	06/23/94	Jun-08	Oct-08	14		6
	070859	G LAKE		06/14/94	Jun-08	Sep-08	14		31
	050669	CARRY POND	09/24/87	06/23/94	Jun-08	Oct-08	14		24
	040850	SQUAW LAKE	09/18/84	10/17/94	Oct-08	Aug-08	14		12
	040852	INDIAN LAKE	09/17/84	10/17/94	Oct-08	Oct-08	14		1
2009									
	020058	LITTLE HOPE POND	05/22/84	05/15/95	May-09	Oct-09	14		7
	020197	SOCHIA POND	05/10/84	05/22/95	May-09	Jun-09	14		
	040748	BUBB LAKE	05/21/86	09/19/95	May-09	Sep-09	14		8
	040750A	WINDFALL POND	06/07/85	05/24/95	Jun-09	May-09	14		0
	050458	CLEAR POND	10/20/87	04/24/95	Apr-09	Oct-09	14		2
	050259	JOCKEYBUSH LAKE	09/02/87	7/17/1996[b]	Sep-10	Oct-09	13		27
	040576	WOODS LAKE		05/27/97	May-11	May-09	12		
	020126	LITTLE ECHO POND		5/28/1998	May-12	Jun-09	11		
	020138	EAST COPPERAS POND	7/19/1984	5/27/1998	May-12	Jun-09	11		
	020143	MIDDLE POND	05/16/84	05/27/98	May-12	Sep-09	11	30	
	040754	SQUASH POND	05/29/86	06/17/98	May-12	Jun-09	11		
	040752	BIG MOOSE LAKE	09/25/00	09/25/00	Sep-14	Oct-09	9	26	4
	040739	LAKE RONDAXE	10/07/86	10/18/00	Oct-14	Sep-09	9	6	4
2010									
	050649	LONG POND	09/09/87	06/15/98	Jun-12	2010	12		
	030256	BLACK POND	10/10/85	7/15/1998[b]	Oct-12	2010	12		Y
	040706	GRASS POND	09/18/84	05/18/99	May-13	2010	11		Y
	040747	CASCADE LAKE	06/12/84	06/16/99	Jun-13	2010	11	Y	
	040753	WEST POND	06/06/85	05/26/99	Jun-13	2010	11		
	040777	CONSTABLE POND	06/11/84	05/24/99	Jun-13	2010	11	Y	Y
	060329	QUEER LAKE	05/22/86	06/14/99	Jun-13	2010	11		Y
	070729	OTTER LAKE		7/22/1999[b]	Jul-13	2010	11		
	040746	MOSS LAKE	09/23/86	08/21/00	Sep-14	2010	10	Y	
	040750	DART LAKE	09/23/86	09/27/00	Sep-14	2010	10	Y	
	020188	SUNDAY POND	10/11/84	6/7/2000[b]	Oct-14	2010	10		
2011									
	050215	WILLIS LAKE	09/09/87	05/21/01	May-15	2011	10	Y	
	041004	SOUTH LAKE	09/16/86	06/25/01	Jun-15	2011	10		Y
	041007	NORTH LAKE	09/16/86	06/25/01	Jun-15	2011	10	Y	
	050684	ARBUTUS LAKE		06/27/01	Jun-15	2011	10		Y
	060313	SAGAMORE LAKE	10/09/86	06/18/01	Jun-15	2011	10	Y	Y
	060315A	RAQUETTE LAKE RESERVOIR	10/10/85	06/19/01	Jun-15	2011	10		Y
	070728	OTTER LAKE OUTLET	09/27/95	06/12/01	Jun-15	2011	10		
	040186	LOON HOLLOW POND	06/18/85	05/28/02	May-16	2011	9		
	040905	BARNES LAKE	09/06/85	10/29/02	Oct-16	2011	9		
	060182	LITTLE SIMON POND	05/14/85	06/19/02	Jun-16	2011	9		Y
2012									
	040874	BROOK TROUT LAKE	06/29/84	06/26/02	Jun-16	2012	10		Y
	040704	MIDDLE SETTLEMENT LAKE	09/18/84	06/18/03	Jun-17	2012	9		Y
	020265	MARCY DAM POND	05/14/85	05/26/04	May-15	2012	8		Y
	020264	HEART LAKE	05/07/85	05/26/04	Jun-18	2012	8		Y
	040707	MIDDLE BRANCH LAKE	09/19/84	06/16/04	Jun-18	2012	8		Y
	040826	LIMEKILN LAKE	10/15/85	10/06/97	Jun-18	2012	8	Y	
	050706	LAKE COLDEN	10/20/87	09/29/04	Sep-18	2012	8		
	050707	AVALANCHE LAKE	10/22/87	09/29/04	Sep-18	2012	8		
	040210	WILLYS LAKE (HORSESHOE)	06/06/84	05/28/05	May-19	2012	7		
	050577	NATE POND	10/28/87	10/18/05	Oct-19	2012	7		Y

[a] Represents actual numbers of fish caught in 2008 and 2009 surveys.

Y= indicates likely to be present based on the earlier ALS or other survey.

[b] Indicates a DEC Fisheries survey.

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 is collected from all waters scheduled for fish survey for that calendar year. All water sample collections are 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 and 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 in accordance 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 for 2008 and 2009. The 2008 fish and water samples were analyzed. The 2009 water samples were analyzed. The 2009 fish specimens will be processed by spring 2010.

Results

Preliminary results indicate that changes in fish populations between 1984–87 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 4). Sensitive minnows (fallfish, fathead minnow and bluntnose minnow) were evaluated as possible indicator species. The greatest species gains occurred in moderately sized lakes with pH 5.5 – 6.0. Fish response patterns were generally consistent with ANC, NO3 and Al^{im} trends. Preliminary results were presented at the 2009 NYSERDA EMEP Conference: http://www.nyserda.com/programs/Environment/EMEP/conference_2009/presentations/Roy_K. Further analyses are being conducted and a manuscript is in preparation. The median, mean and maximum number of fish species (populations) per lake and are shown in Table 4.

Table 4. Fish population changes in 42 ALTM lakes between1984-87 and 1994–2005 survey.

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

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 by the end of the project period (December 2011).

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 like 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 (EMAP-SW) 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 km2 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 μeq L^{-1}) lakes in the region out of a total population of 1,830 lakes with a surface area greater than 1-ha (Stoddard et al. 2003). This monitoring program enables researchers to track 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 and other federal agencies. An overview is provided by Stoddard et al. (2003). The 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).

The EPA LTM is considered a complement to the statistically based TIME. They are sensitive lakes and streams with long term data dating back to the early 1980s. They can 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 μeq 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 with surface area greater than 1-ha occurring in New York and New England. 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 μeq L^{-1} are 'acute concern' or chronically acidic; ANC > 0 and < 50 μeq L^{-1} are 'elevated concern' or susceptible to episodic acidification; and ANC values > 50 and < 100

μeq L^{-1} are 'moderate concern'. Results from the Adirondack region representing a population of 1812 lakes (surface area greater than 1 ha) found 10% had ANC values of < 0 μeq L^{-1} (chronically acidified) and an additional 31% of all lakes where critically acidified with values of ANC > 0 and < 50 μeq 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 μeq L^{-1}) were dominated by inorganic anions with sulfate constituting 82% of the total anionic charge (Driscoll et al. 2001).

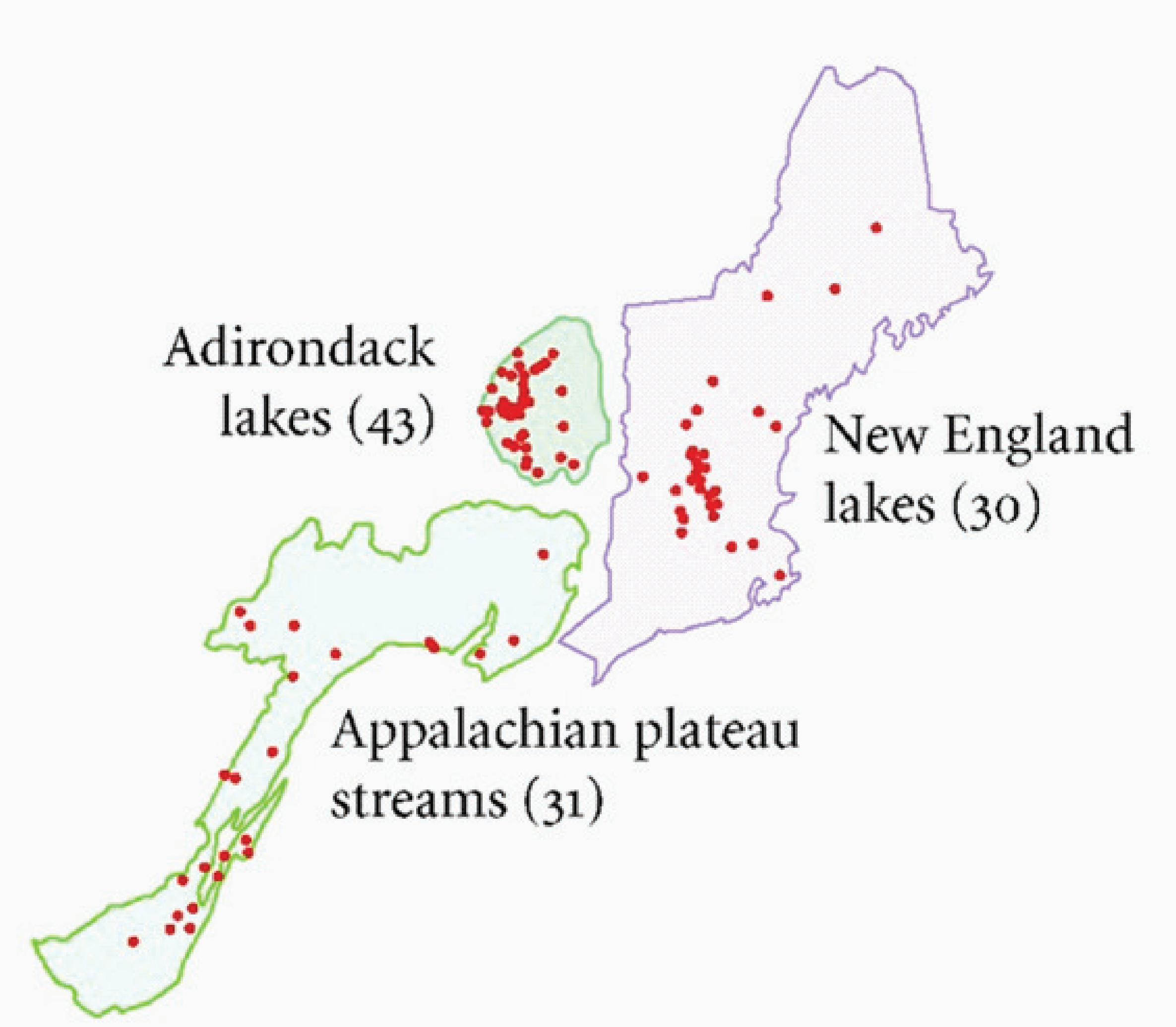


Figure 5. TIME Regional Surveys 1991–2000.

Site Description

EMAP lake sampling in the Adirondack region began in 1991 with a selection of different lakes each year: 1991 (10 lakes); 1992 (20 lakes); 1993 (6 lakes) and 1994 (10 lakes) for a total 46 lakes. Prior to initiating the first resurvey/ rotating lake round in 1995, three lakes (Middle Flow, Pear, Hamilton) were discontinued, bringing the total number of Adirondack lakes to 43. The resurvey began in 1995 with eight lakes that had been previously sampled in 1991. No lakes were sampled in 1996. In 1997, 39 lakes were surveyed followed by a year of no surveys. Since 1999, 43 Adirondack TIME lakes were surveyed on an annual basis.

Table 5 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 1984–87 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 5. Adirondack TIME lake characteristics.

EMAP Ref #	ALSC Ref #	TIME / EMAP Pond Name	ALS / DEC Pond Name	Elev. (m)	Classification	Surface Area (ha)
NY012L	020059	Hope Pond	Big Hope Pond	522	Medium till drainage High DOC	8.9
NY250L	030101	Twin Pond (E)	Upper Twin Pond	404	Thin till drainage, Low DOC	6
NY033L	030128	Dry Channel Pond	Dry Channel Pond	496	Thin till drainage, Low DOC	27.4
NY297L	030273	Bickford Pond	Bickford Pond	509	Thin till drainage, Low DOC	4.4
NY299L	030276	Pd. Near Spitfire Lake	Unnamed Pond	493	Flow through seepage, High DOC	2.1
NY278L	030331	Parmeter Pond	Parmeter Pond	347	Flow through seepage, High DOC	7.1
NY515L	030360	Wolf Pond	Wolf Pond	443	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	463	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	631	Thin till drainage, Low DOC	9.3
NY789L	040210	Willys Lake	Willys Lake	630	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	621	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	533	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	668	Thin till drainage, Low DOC	5.3
NY281L	040579	Snake Pond	Snake Pond	588	Thin till drainage, Low DOC	7.3
NY794L	040620	Payne Lake	Payne Lake	375	Flow through seepage, High DOC	7
NY030L	040769	Upper Sister Lake	Upper Sister Lake	588	Thin till drainage, High DOC	32
NY014L	040850	Squaw Lake	Squaw Lake	645	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	693	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	477	Medium till drainage, High DOC	3.3
NY256L	050182	Bennett Lake	Bennett Lake	354	Thin till drainage, Low DOC	14.8
NY505L	050197	Lixard Pond	Lixard Pond	529	Thick till, Low DOC	11.7
NY013L	050298	Second Pond	Second Pond	683	Thin till drainage, Low DOC	18
NY526L	050715	Henderson Lake	Henderson Lake	551	Thin till drainage, Low DOC	102.1
NY782L	060039	Mccuen Pond	McCuen Pond	454	Thin till drainage, High DOC	2.6
NY288L	060074	Seven Sisters Pond	Seven Sisters Pond	468	Mounded seepage, Low DOC	3
NY287L	060126	Antediluvian Pond	Antediluvian Pond	527	Thin till drainage, High DOC	5.3
NY291L	060127	Doctors Pond	Doctors Pond	552	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	542	Thin till drainage, Low DOC	63.4
NY292L	070717	Canada Lake	Canada Lake	472	Salt impacted	217.7
NY017L	070790	Big Alderbed	Big Alderbed	559	Thin till drainage, Low DOC	17.7
NY018L	070823	Long Lake	Long Lake	637	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	749	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. 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. Samples are delivered directly to the laboratory in Ray Brook, NY.

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).

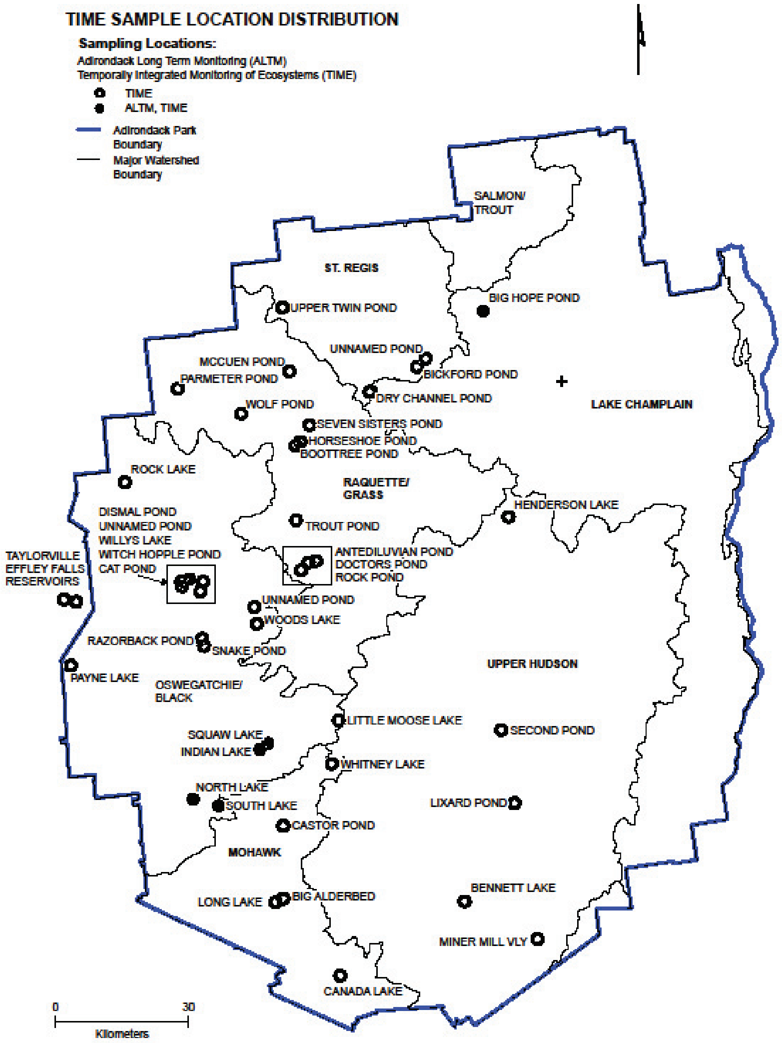


Figure 6. TIME and LTM sample locations.

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. Includes both drainage and seepage lakes in the ANC range -50 to 100 μeq L^{-1} with 3 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 (Data is scaled from EPA Chart).

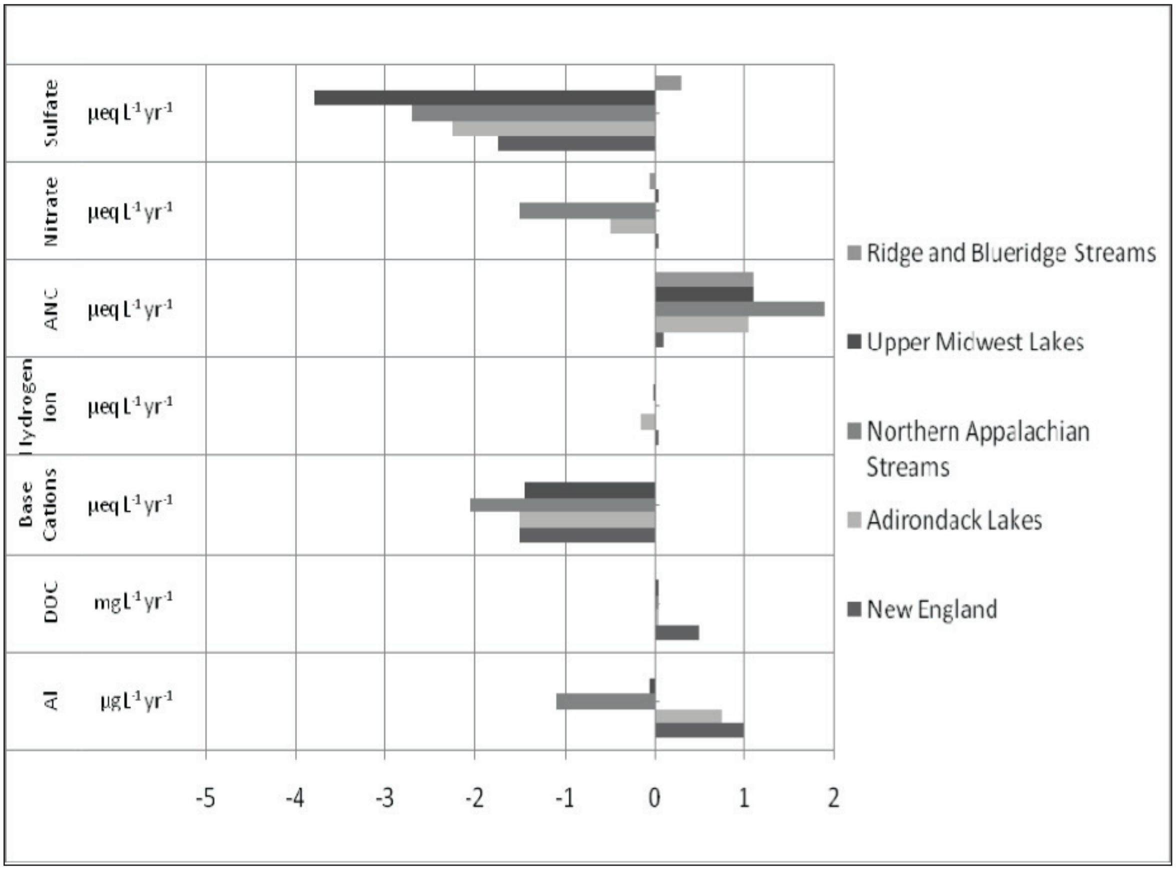


Figure 7. Regional trends in surface water chemistry.

Chemistry Trends 1990–2007

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 dataset. 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).

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 2006, 2007 and 2008 sampling season. 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 8). 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).

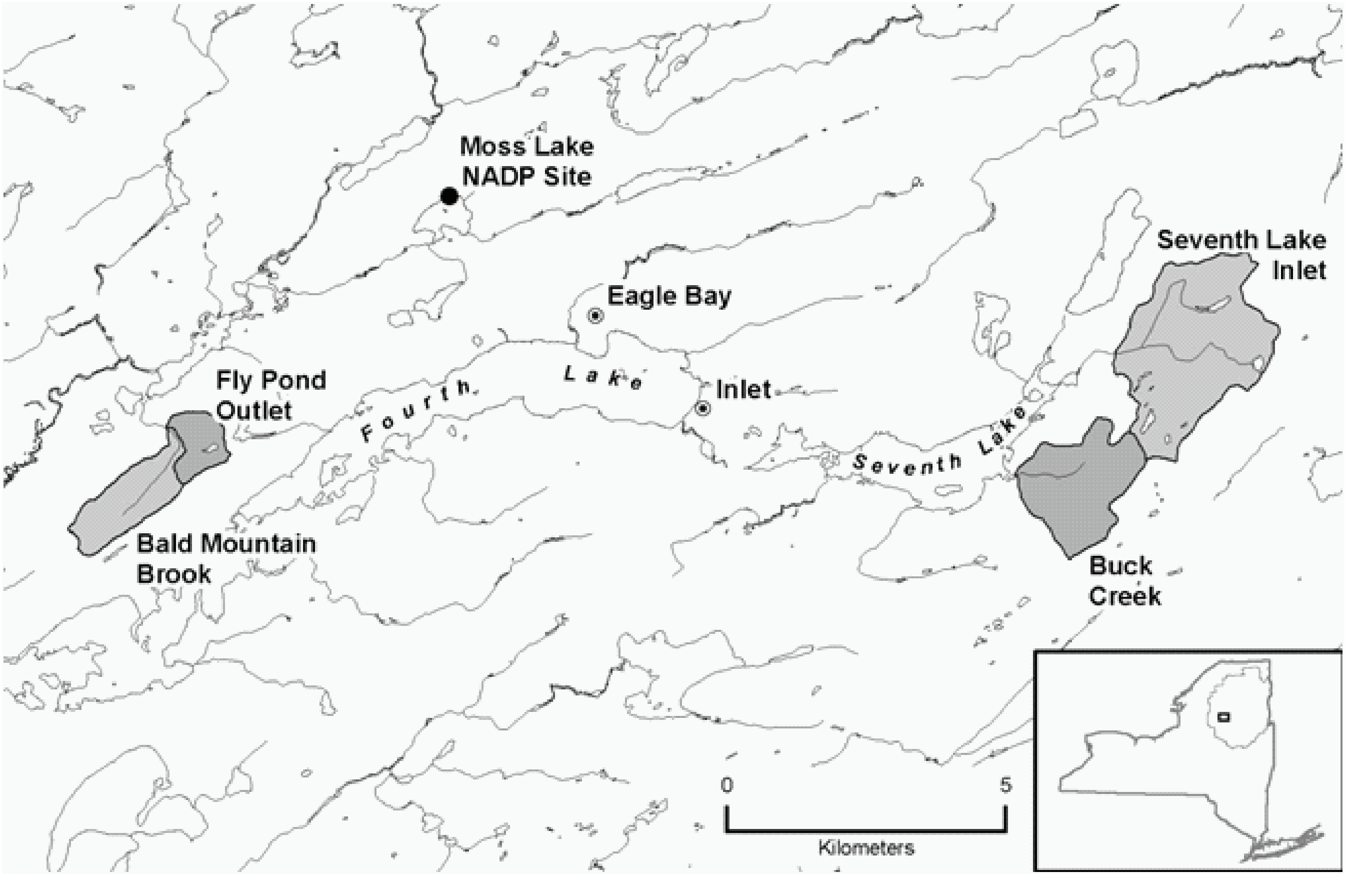


Figure 8. Stream sampling sub-watersheds.

The ERP investigators produced a series of articles published in Ecological Applications 1996 Issue 6. Wigington found none of the Adirondack streams chronically acidic, 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 Al 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 are analyzed for Lab pH, Air Equilibrated pH, ANC, and specific conductivity. In 1992, the ALSC started analyzing the first weekly samples 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, ammonum, dissolved organic carbon, dissolved inorganic carbon, total dissolved aluminum, total monomeric aluminum, total organic aluminum, and total inorganic aluminum (calculated).

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 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. 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).

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.

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 analyzes are performed by the ALSC laboratory in Ray Brook.

Sampling Design

Descriptions of the stream study sites, 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 weekly for Lab pH, Air Equilibrated pH, ANC, and specific conductivity. In addition, twice each month, the samples are analyzed for the following additional 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.

Table 6. 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 (Al) 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 9). 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).

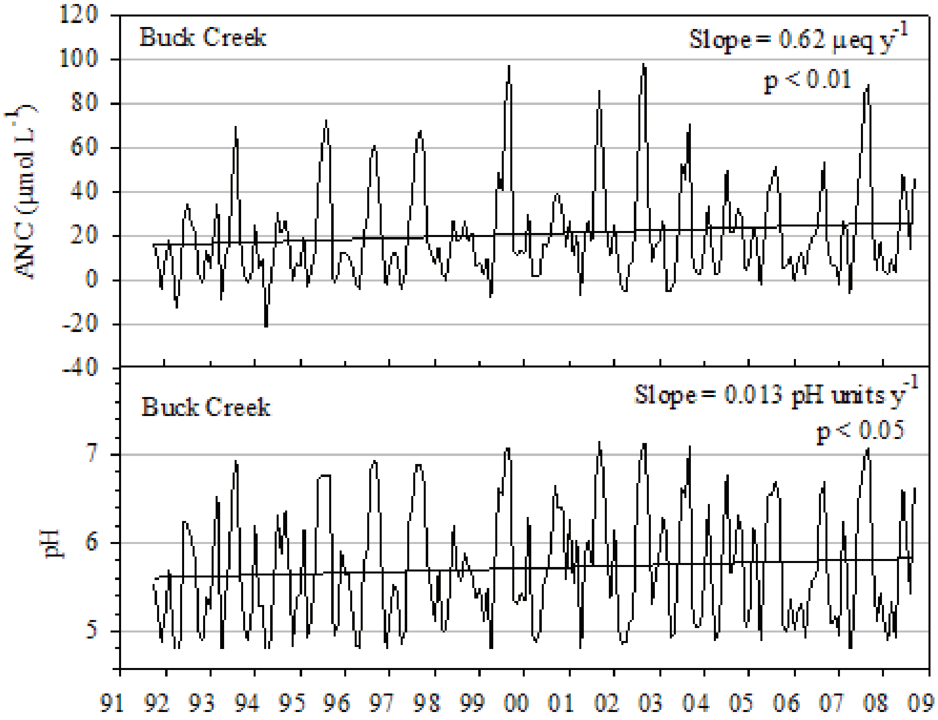


Figure 9. Trend 1991–2008 Buck Creek.

Examination of within annual flow variation 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 (Oct–Nov) after the growing season; and a relatively stable period (Dec–Mar) 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 9). Extending the average annual rate of increase (slope shown in Figure 10) 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 10). Extending the average annual rate of increase (slope shown in Figure 9) 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 y^{-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 7–8 years (Figure 10).

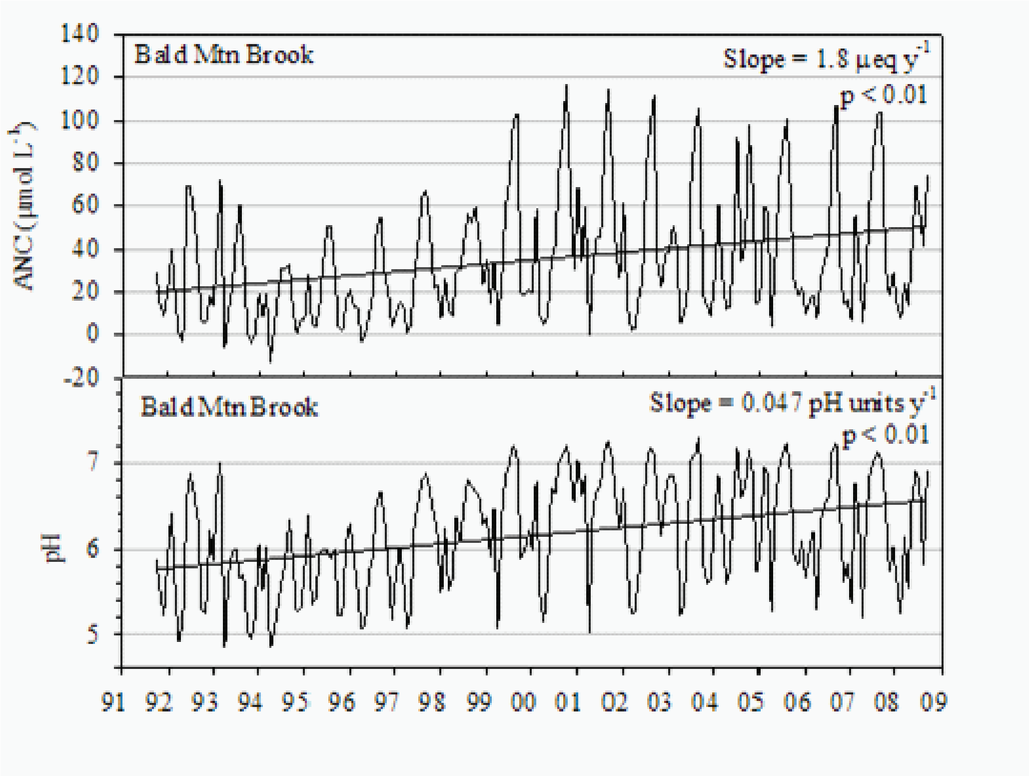


Figure 10. Trend 1992–2008 Bald Mountain Brook.

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 Al 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 9).

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.

Whiteface Mountain Cloud Monitoring

Title IV of the 1990 Clean Air Act Amendments (CAAA) required a two phase reduction in sulfur dioxide (SO2) 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 2001 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 ran 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, at an elevation of 4867 feet, 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, an omni-directional passive collector is also known as an 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 cloud 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 twenty-four 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: 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, the oxidation of sulfur and nitrogen oxides to sulfuric (H_2SO_4) and nitric acids (HNO_3) in the atmosphere, 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 11).

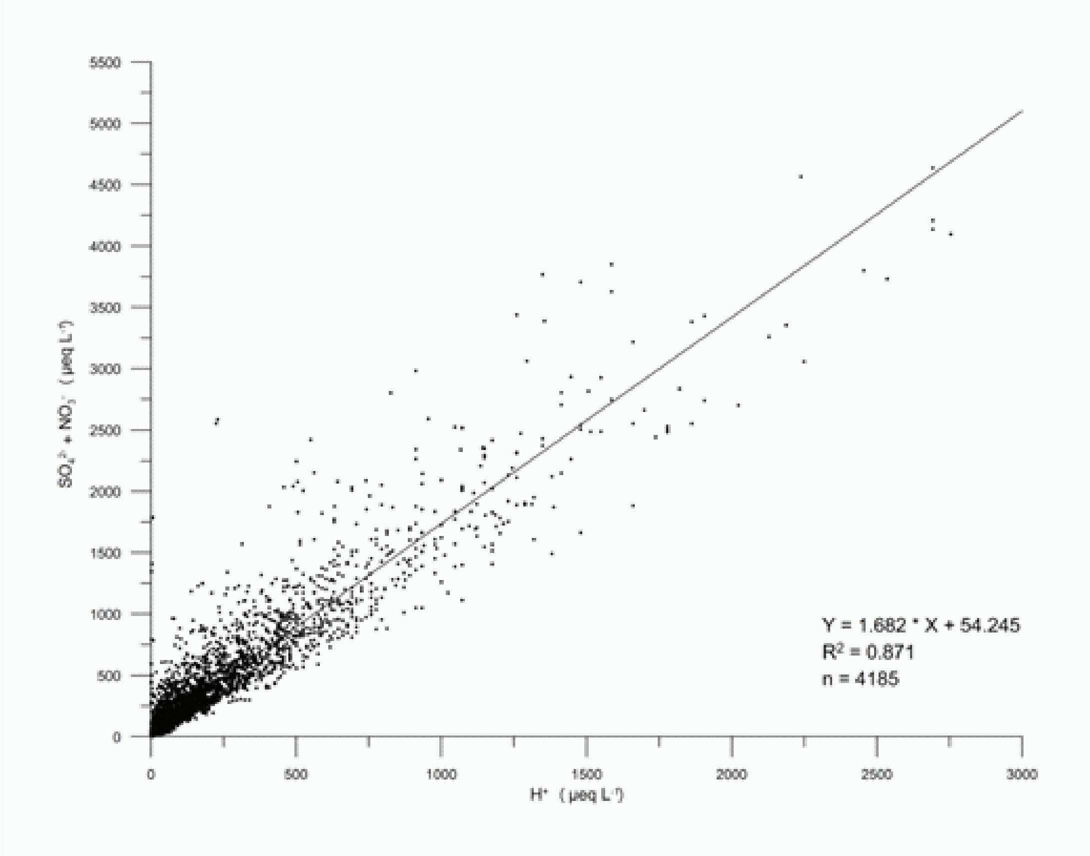


Figure 11. Hydrogen Ion versus sulfate + nitrate.

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 ~5.0 is assumed to be influenced by anthropogenic pollution (Li and Aneja 1992). For samples collected, 1994–2009, approximately 87% of the cloud water samples analyzed are below pH 5.0 or $H^+ > 10.00\ \mu eq\ L^{-1}$. And for samples collected, 2006–2009, approximately 76% are below pH 5.0 or $H^+ > 10.00\ \mu eq\ L^{-1}$ (Figure12). The criteria for samples determining the percentages in Figure 12 are:

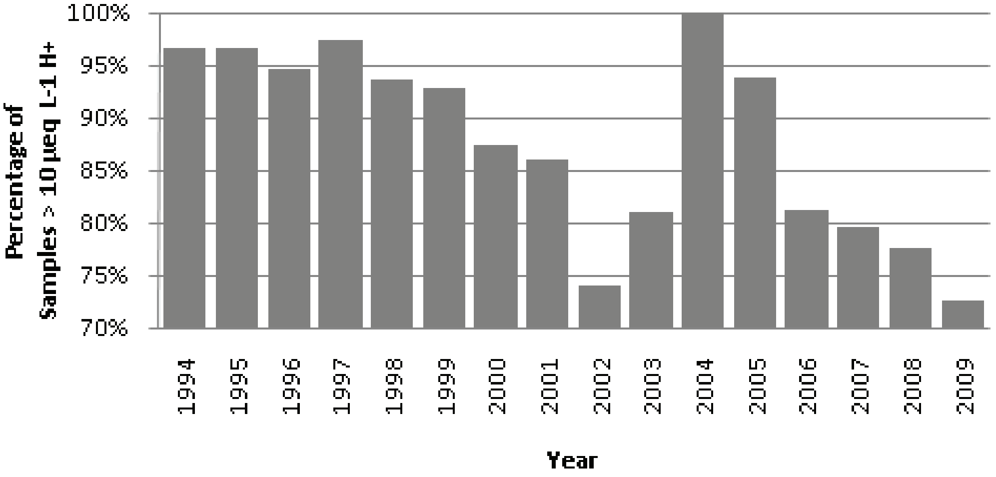


Figure 12. Percentage of samples > 10 µeq L^{-1} H^+ 1994–2009[1].

Cloud water samples have been collected at Whiteface Mountain as arriving primarily from the southwest to northwest direction (Figure 13).

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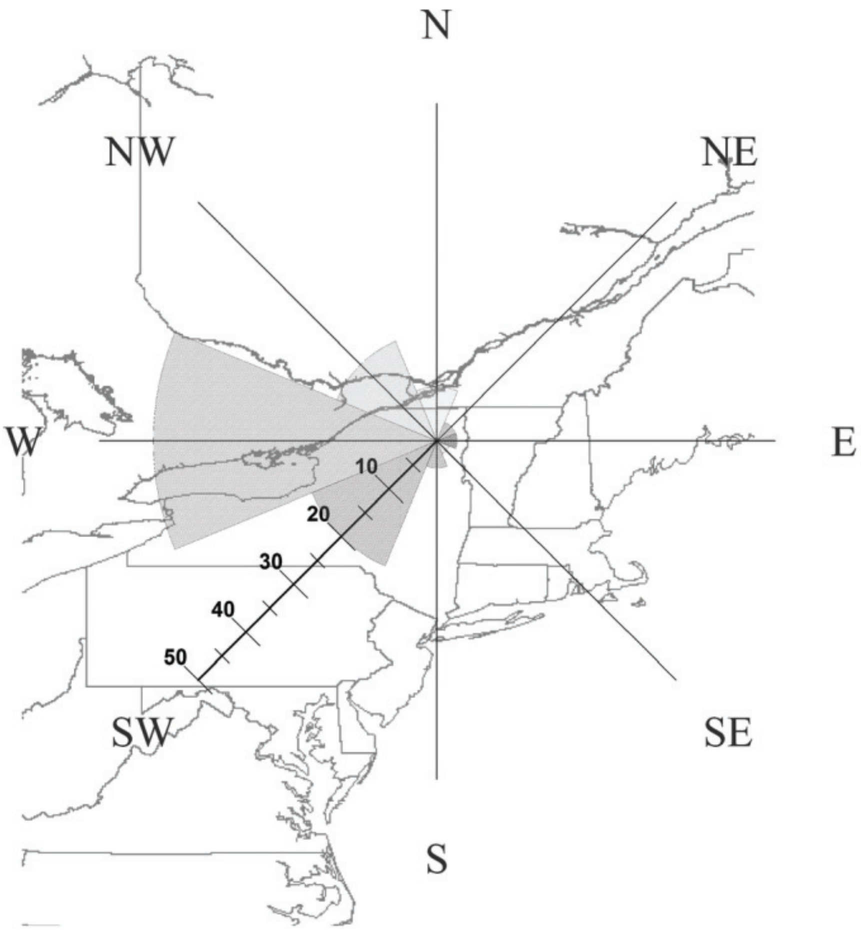
[1] In 2004, due to roof construction and an abbreviated sampling season, only 22 data points define the percentage shown in Figure 12.



Octant	Percent
N	8
NE	3
E	3
SE	2
S	4
SW	20
W	42
NW	16
n=	4185

Figure 13. 1994-2009 Wind distribution by octant.

Distribution

The origin of cloud water acidity is assumed to be based on both local and regional emission sources. Given the frequency distribution, it is suggested that clouds at Whiteface may pass over the Ohio Valley and Canadian Provinces. Factors such as wind speed and oragraphic 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).

Data Reported to Date

Data currently available from this mountain cloud study (this section) include hourly and 3-hr composites of the chemical parameters in cloud water and the meteorological data associated with those samples. As of July 2010, chemistry and meteorological data collected during the 2001–2006 sampling seasons are posted to the ALSC website at http://www.adirondacklakessurvey.org. Additional data may be available by contacting the NYSDEC Research Manager.

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, NY. 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. The most recent data for 2007 are available at http://www.dec.ny.gov/chemical/29155.html.

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

	SO4 ueq L^{-1} yr^{-1}						NO3 ueq L^{-1} yr^{-1}						Cl ueq L^{-1} yr^{-1}						F ueq L^{-1} yr^{-1}						ANC ueq L^{-1} yr^{-1}					
LTM Site	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**
LITTLE HOPE POND	-2.39	-2.66	-2.50	-2.14	-1.97								-0.17	-0.24	-0.25	-0.28	-0.28								1.46	1.53	1.55	1.89	1.89	
BIG HOPE POND	-2.12	-2.05	-1.80	-1.49	-1.42								-1.41	-1.61	-1.78	-1.98	-2.07	-3.38			0.03				2.10	2.17	2.18	2.44	2.54	2.98
LITTLE ECHO POND	-0.94	-1.14	-1.10	-1.15	-1.15	-2.12				0.02			0.23	0.21	0.22	0.20	0.24	0.33						-0.01	1.07	1.25	1.36	1.32	1.46	2.53
EAST COPPERAS POND	-1.08																		0.02						0.61	0.69	0.68			
MIDDLE POND	-2.17	-2.21	-2.02	-1.70	-1.56								-0.19	-0.19	-0.14	-0.09														
SUNDAY POND		-0.49	-0.49		-0.55	-1.04					-0.04		0.00																	
SOCHIA POND	-1.11	-1.12	-1.00	-1.04	-1.01	-1.67							0.17	0.16	0.19	0.19	0.19		0.02	0.02	0.02				1.37	1.44	1.46	1.71	1.70	1.93
OWEN POND	-3.79	-3.71	-3.40	-3.43	-3.24	-4.74	0.71	0.67	0.53																		1.41	1.80	2.00	
HEART LAKE	-1.84	-1.84	-1.77	-1.75	-1.78	-2.23	0.08	0.07		0.09																				
MARCY DAM POND	-2.03	-2.01	-1.85	-1.77	-1.76	-2.71	0.53	0.47											0.01	0.02					0.61			0.76	0.83	
GRASS POND (03)	-1.04	-1.15	-1.11	-1.04	-1.09	-1.67									-0.05										0.36			0.62	0.71	1.57
BLACK POND	-2.37	-2.34	-2.15	-1.87	-1.87	-1.67								-0.05	-0.06	-0.06														
LOON HOLLOW POND	-1.71	-2.01	-1.97	-2.08	-2.23		-0.26	-0.34	-0.34				-0.08	-0.09	-0.09	-0.12	-0.14								0.90	0.84	0.84	1.11	1.22	1.65
WILLYS LAKE (HORSESHOE)	-2.87	-2.87	-2.87	-3.01	-3.15	-3.54	-0.91	-0.98	-0.98	-1.12	-1.18		-0.06	-0.08	-0.08	-0.09	-0.09		-0.07	-0.05	-0.05	-0.07	-0.07	-0.07	0.64	0.60	0.60	0.76	0.73	1.01
MIDDLE SETTLEMENT LAKE	-2.01	-1.99	-1.84	-1.88	-1.87	-1.74	-0.12	-0.13	-0.14	-0.15	-0.15														0.74	0.67	0.68	0.64		1.32
GRASS POND (04)	-1.97	-1.96	-1.82	-1.78	-1.79	-1.98						-0.87													0.82	0.68	0.95			
MIDDLE BRANCH LAKE	-1.55	-1.49	-1.35	-1.37	-1.39		-0.07	-0.09	-0.10	-0.12	-0.12		-0.09	-0.09	-0.09	-0.10	-0.09													
LAKE RONDAXE	-2.50	-2.63	-2.58	-2.58	-2.52	-2.71	-0.57	-0.63	-0.72	-0.70	-0.73	-0.94							-0.03	-0.04					1.27	1.08	1.18	1.58	1.35	
MOSS LAKE	-2.21	-2.19	-2.03	-1.96	-1.96	-2.19	-0.50	-0.61	-0.72	-0.75	-0.82	-1.27							-0.05								0.71			
CASCADE LAKE	-1.99	-2.01	-1.79	-1.72	-1.70	-2.29			-0.58	-0.59	-0.73	-1.45							-0.08	-0.10	-0.08									
BUBB LAKE	-2.29	-2.37	-2.44	-2.62	-2.71	-2.94						-0.40							-0.05	-0.05			-0.04					1.15	1.26	1.91
DART LAKE	-2.80	-2.91	-2.78	-2.81	-2.81	-3.18	-0.60	-0.71	-0.72	-0.70	-0.75														1.21	1.28	1.35	1.36	1.41	1.41
WINDFALL POND	-3.21	-3.46	-3.33	-3.45	-3.54	-4.01													-0.06	-0.07	-0.05	-0.04			0.78		0.84	1.13		
BIG MOOSE LAKE	-2.83	-2.93	-2.87	-2.92	-2.91	-2.91	-0.68	-0.80	-0.79	-0.76	-0.82								-0.03	-0.03				-0.05	0.90	1.00	0.99	1.08	0.95	1.44
WEST POND	-2.32	-2.54	-2.48	-2.77	-2.73	-2.97		-0.18		-0.19	-0.23		-0.07									-0.04	-0.05	-0.12						
SQUASH POND	-1.87	-2.17	-1.91	-1.88	-1.87	-2.86																		-0.04	0.81	0.72	0.73	0.81	0.74	0.90
CONSTABLE POND	-3.25	-3.30	-3.24	-3.05	-3.33	-3.85	-0.51	-0.52	-0.59	-0.57	-0.58								-0.04	-0.05	-0.04		-0.04		1.01	0.94	1.23	1.46	1.46	2.03
LIMEKILN LAKE	-2.71	-2.71	-2.58	-2.57	-2.55	-2.89	-0.35	-0.42	-0.42	-0.40	-0.38		-0.59	-0.65	-0.66	-0.64	-0.63								1.49	1.56	1.70	1.82	1.85	2.51
SQUAW LAKE	-3.59	-3.75	-3.70	-3.90	-3.96	-4.93		-0.34				-1.13	-0.08	-0.07				-0.16							0.79	0.83	0.88	0.95	1.01	2.03
INDIAN LAKE	-2.94	-3.05	-2.79	-2.68	-2.71	-3.79		-0.26	-0.34	-0.43	-0.41	-1.13													0.76	0.73	0.76	0.81	0.80	
BROOK TROUT LAKE	-2.83	-2.98	-2.91	-3.12	-3.20	-4.52			-0.65	-0.91	-1.01	-1.77	-0.04					-0.12						-0.04	0.89	1.01	1.16	1.41	1.47	2.10
LOST POND	-1.55	-1.58	-1.38	-0.97	-0.88				-0.31		-0.46	-1.61													0.61	0.56	0.65	0.74	0.73	
SOUTH LAKE	-2.05	-2.05	-1.94	-1.92	-1.92	-1.98	-0.75	-0.87	-0.82	-0.85	-0.86														1.10	1.20	1.28	1.40	1.50	1.64
NORTH LAKE	-2.23	-2.23	-2.04	-2.01	-2.01	-2.01	-0.45	-0.52	-0.55	-0.63	-0.76														0.77	0.84	0.84	0.87	0.92	
WILLIS LAKE	-1.72	-1.58	-1.45	-1.44	-1.23		0.02														0.02				1.15	1.32	1.48			
JOCKEYBUSH LAKE	-2.23	-2.23	-2.08	-2.14	-2.11	-2.29																-0.01			0.77	0.77	0.80	0.84	0.90	1.26

	SO4 ueq L^{-1} yr^{-1}						NO3 ueq L^{-1} yr^{-1}						Cl ueq L^{-1} yr^{-1}						F ueq L^{-1} yr^{-1}						ANC ueq L^{-1} yr^{-1}					
LTM Site	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**
CLEAR POND	-2.44	-2.29	-2.06	-1.75	-1.77	-1.90	0.05	0.04	0.05	0.08	0.05								0.01	0.01	0.02		0.01							
NATE POND	-2.70	-2.57	-2.29	-2.21	-2.14																									
LONG POND	-2.25	-2.44	-2.21	-2.24	-2.22	-3.75																			0.74	0.75	0.93	1.25	1.32	
CARRY POND	-2.21	-1.87	-1.54	-1.21	-1.11																				1.62	1.56	1.26	0.95	0.88	
ARBUTUS LAKE	-2.29	-2.08	-1.73	-1.53	-1.59	-2.62			-0.15																					
LAKE COLDEN	-2.13	-2.15	-1.89	-1.74	-1.85																				0.63	0.60	0.58	0.73	0.79	1.10
AVALANCHE LAKE	-2.57	-2.73	-2.50	-2.30	-2.40	-3.93																			0.71	0.68	0.63	0.73	0.73	0.71
SAGAMORE LAKE	-3.22	-3.21	-2.98	-3.00	-3.00	-3.96		-0.57	-0.69	-0.77	-0.81	-1.21							-0.03								0.66			
RAQUETTE LAKE RESERVOIR	-4.12	-4.16	-4.09	-4.16	-4.16	-4.19	-0.32	-0.32	-0.40	-0.38	-0.38								-0.04	-0.04	-0.03				0.85	0.74	0.93			
QUEER LAKE	-2.65	-2.71	-2.61	-2.73	-2.77	-2.97	-0.38	-0.48	-0.41	-0.36	-0.34		-0.06	-0.07											0.99	1.11	1.03	1.03	1.03	1.05
OTTER LAKE	-2.50	-2.46	-2.27	-2.29	-2.43	-2.25			-0.18	-0.14	-0.16														0.78	0.70	0.83	0.74	0.74	1.32
G LAKE	-1.96	-1.87	-1.63	-1.60	-1.53	-1.35																			0.79	0.72	0.85	1.05	1.11	
Sites with Recent Liming History																														
LITTLE CLEAR POND	-1.12	-1.08	-1.04	-1.02	-0.97	-1.15							-0.07	-0.07	-0.08	-0.09	-0.08	-0.14									10.28	13.26	14.73	25.86
WOODS LAKE	-3.03	-3.14	-3.06	-3.03	-2.94	-3.75																-0.02								
BARNES LAKE													-0.09	-0.09		-0.09								-0.02	-0.63	-0.84	-1.02	-1.16	-1.34	-2.15
LITTLE SIMON POND	-2.58	-2.50	-2.36	-2.45	-2.46	-3.14																			1.42	1.76				
Upstream sites																														
CASCADE	-1.83	-1.46	-1.25																-0.04							0.92				
BUBB	-2.24	-2.33	-2.33																	-0.08	-0.07									
WINDFALL	-3.42	-3.20	-3.03				-0.47	-0.71	-0.67																					
WEST	-2.71	-2.52	-2.93																-0.05	-0.04					0.66	0.86	1.12			
SQUASH	-1.87	-1.67	-1.53																						0.98	1.08	1.09			
CONSTABLE	-3.12	-2.91	-2.86				-0.57	-0.74	-0.75																0.89	1.05	1.14			
OTTER	-2.59	-2.22	-2.43																	0.03					0.65	0.70	0.67			

Notes:

Slopes are reported for p<=0.05.

Blank = not significant at 95% Confidence Interval.

	DIC umol L^{-1} yr^{-1}						**DOC** umol L^{-1} yr^{-1}						**SIO2** umol L^{-1} yr^{-1}						**Ca** ueq L^{-1} yr^{-1}						**Mg** ueq L^{-1} yr^{-1}					
LTM Site	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**
LITTLE HOPE POND			-1.87	-1.66	-1.39								2.00	2.32	2.00	1.73	1.91	3.16	-0.80											
BIG HOPE POND	1.17												0.89	0.95	0.83	0.66						0.75						0.41	0.49	
LITTLE ECHO POND										12.74						0.55									0.27	0.37	0.46	0.49	0.55	
EAST COPPERAS POND	3.08	3.33	4.16	4.17	4.35		18.21	19.90	18.86		9.07																			
MIDDLE POND																				-1.38										
SUNDAY POND	-0.85	-0.70			-0.64		-7.96	-6.89	-7.22	-7.27	-7.20								-0.70	-0.75	-0.83	-0.78	-0.80	-1.16	-0.51	-0.52	-0.53	-0.55	-0.55	-0.82
SOCHIA POND							4.89	6.74	7.93	9.68	11.01					0.23		0.31												
OWEN POND																			-2.00	-2.16										
HEART LAKE							-2.13	-2.01	-1.91		-2.41							2.89	-1.69	-1.71	-1.71	-1.50	-1.57	-2.83	-0.27	-0.27	-0.25			
MARCY DAM POND																1.20	1.59							-2.50						
GRASS POND (03)							12.74	14.80	14.74	14.18	14.41							0.46							0.00					
BLACK POND		-2.39	-2.71														3.39		-2.40	-2.73	-2.74	-2.22	-2.63	-4.24	-0.66	-0.67				
LOON HOLLOW POND													-0.55						-0.57	-0.67	-0.67	-0.62	-0.64	-1.00	-0.16	-0.18	-0.16	-0.16	-0.16	
WILLYS LAKE (HORSESHOE)					-0.56		5.95						-1.27	-1.17	-1.17	-1.32	-1.32		-1.35	-1.41	-1.41	-1.41	-1.50	-1.75	-0.27	-0.25	-0.25	-0.21	-0.24	-0.33
MIDDLE SETTLEMENT LAKE							2.78	2.58	2.52										-0.54	-0.62	-0.60	-0.58	-0.60		-0.18	-0.18	-0.16	-0.18	-0.18	
GRASS POND (04)														1.10	1.36	1.98	2.05		-0.89	-1.08	-1.00	0.00	-0.93	-1.41						
MIDDLE BRANCH LAKE																		2.03	-0.93	-1.15	-1.12	-1.00	-0.90			-0.27				
LAKE RONDAXE	1.25	1.03	1.11		1.50		3.48	4.35		4.36			-0.43	-0.49					-1.16	-1.43	-1.32	-1.00	-1.19			-0.33				
MOSS LAKE													-0.79						-1.75	-2.00	-1.85	-1.65	-1.75	-2.62	-0.37	-0.41				
CASCADE LAKE												13.68						2.89	-2.08	-2.50	-2.44	-2.33	-2.71	-4.62	-0.45	-0.55				
BUBB LAKE															-1.15	-1.45	-1.51		-1.34	-1.44	-1.25	-0.87	-1.00	-1.75	-0.49	-0.55	-0.48	-0.41	-0.41	
DART LAKE	0.62	0.71	0.83	0.71	0.74		4.40	5.70		5.69	4.87								-1.25	-1.43	-1.33	-1.09	-1.25	-2.59	-0.31	-0.34	-0.27			
WINDFALL POND							2.98	4.59	4.72	6.15	6.13								-1.75	-2.25	-2.00	-1.47	-1.79			-0.41		-0.21		
BIG MOOSE LAKE							5.11	6.53	5.48	6.66			-0.52						-1.25	-1.41	-1.37	-1.15	-1.37	-2.00	-0.33	-0.34	-0.27	-0.27	-0.27	
WEST POND													-0.67						-1.58	-1.71	-1.75	-1.75	-1.84	-3.29	-0.49	-0.55	-0.51	-0.51	-0.55	-1.23
SQUASH POND															0.54	0.60			-0.81	-0.92	-0.87	-0.75	-0.83	-1.60	-0.18	-0.21	-0.14			
CONSTABLE POND							6.00	5.94	5.04	6.33	5.56		-0.74	-0.55					-1.64	-1.75	-1.64	-1.30	-1.50		-0.37	-0.41	-0.27			
LIMEKILN LAKE	1.19	1.06	1.46	1.67	1.82	2.68	3.80	3.85	3.29	3.36	3.68		0.75	0.90	1.00	0.00	1.03		-1.00	-1.05	-0.93	-0.75	-0.73		-0.27	-0.27				
SQUAW LAKE	0.83	0.83	1.08	1.11	0.69		4.31	5.54	5.00	5.51	6.05		0.94	1.10	1.31	1.54	1.71	3.00	-2.06	-2.20	-2.25	-2.25	-2.25	-3.59	-0.59	-0.62	-0.57	-0.55	-0.55	-0.82
INDIAN LAKE	1.06	1.25	1.25	1.30	1.11														-1.69	-1.85	-1.91	-1.92	-1.94	-3.08	-0.41	-0.41	-0.41	-0.36	-0.37	-0.82
BROOK TROUT LAKE		0.54	0.65				8.75	10.94	13.22	16.02	17.44	20.33	-0.87	-0.70	-0.67	-0.78	-0.83		-1.05	-1.10	-1.10	-1.00	-1.00	-1.67	-0.21	-0.19				
LOST POND																			-1.41	-1.50	-1.62	-1.50	-1.56	-3.24	-0.41	-0.41	-0.41	-0.33	-0.33	-0.82
SOUTH LAKE				0.65			4.04	4.68	4.29	4.41	4.74								-0.75	-0.75	-0.64			-1.25	-0.25					
NORTH LAKE																			-1.28	-1.33	-1.25	-1.21	-1.25	-2.10	-0.33	-0.31				
WILLIS LAKE																														
JOCKEYBUSH LAKE							1.30						0.41	0.36					-0.87	-0.95	-1.00	-0.87	-0.80	-1.00	-0.21	-0.24	-0.21	-0.16		

	DIC umol L^{-1} yr^{-1}						DOC umol L^{-1} yr^{-1}						SIO2 umol L^{-1} yr^{-1}						Ca ueq L^{-1} yr^{-1}						Mg ueq L^{-1} yr^{-1}					
LTM Site	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000
CLEAR POND		-1.67					2.34	2.82											-2.54	-2.78	-2.66	-2.40	-2.50	-4.99	-0.33	-0.33				
NATE POND								5.19	4.01										-1.25	-1.33										
LONG POND	2.64	2.08	2.00	2.08	2.43		17.19	22.13	19.24	21.19				1.27										-1.75						
CARRY POND							5.03												-0.50					-1.06	-0.25	-0.25	-0.21			
ARBUTUS LAKE													-0.93		-0.78				-1.46	-1.50				-3.31	-0.47	-0.48				
LAKE COLDEN																	1.14		-0.79	-0.92										
AVALANCHE LAKE																			-1.00	-1.11				-2.62						
SAGAMORE LAKE																			-2.25	-2.41	-2.25	-2.15	-2.16	-2.91	-0.55	-0.58				
RAQUETTE LAKE RESERVOIR	1.74	1.96	1.94	2.66	2.79		8.08	9.21	10.25	10.66	12.41								-2.50	-2.77	-2.74	-2.70	-2.92	-3.24	-0.82	-0.82	-0.72	-0.59	-0.64	
QUEER LAKE							4.21	4.36					0.31	0.30	0.33				-1.00	-1.07	-1.00	-1.00	-0.98	-2.25	-0.27	-0.27	-0.25	-0.22	-0.22	
OTTER LAKE																			-1.00	-1.14	-1.19	-1.16	-1.28		-0.24	-0.27				
G LAKE																			-0.80	-0.87	-0.78									
Sites with Recent Liming History																														
LITTLE CLEAR POND			7.68	10.41	10.77	20.85						13.84			0.17	0.23		0.44			6.79	8.88	9.73	16.66			3.29	4.20	4.81	8.39
WOODS LAKE						-3.33							-1.33	-1.39	-1.34	-1.22	-1.11		-2.00	-2.25	-2.25	-2.25	-2.28	-4.74	-0.16	-0.16				
BARNES LAKE		-1.55	-1.67	-1.67	-1.85		-10.36	-11.83	-12.62	-12.77	-14.67	-11.92							-1.81	-1.87	-1.87	-1.66	-1.75	-2.99	-0.14	-0.14	-0.13	-0.14	-0.14	
LITTLE SIMON POND						-6.66								0.67	0.94	0.91	0.94							-6.53	-0.64	-0.68	-0.66	-0.69	-0.72	-1.44
Upstream sites																														
CASCADE							3.72	3.12						0.69	1.00				-1.10	-0.87										
BUBB	-1.25	-1.63	-1.23																-1.04	-1.06	-0.97				-0.51	-0.55	-0.55			
WINDFALL							4.20	4.15	3.40				-1.00	-1.00					-2.89	-2.58	-2.66				-0.55	-0.47	-0.41			
WEST		1.11	1.67				7.32	7.18	9.73										-1.21	-1.16	-1.21				-0.37	-0.27				
SQUASH															0.33				-0.42	-0.37										
CONSTABLE	1.11	1.11	1.31				10.66	10.47	9.64				-0.74	-0.62					-1.33	-1.22	-1.00				-0.37	-0.27				
OTTER							3.77	3.44	3.86										-1.00	-1.16	-1.16				-0.31	-0.27	-0.24			

Notes:

Slopes are reported for $p<=0.05$.

Blank = not significant at 95% Confidence Interval.

	Na ueq L^{-1} yr^{-1}						K ueq L^{-1} yr^{-1}						NH4 ueq L^{-1} yr^{-1}						SCONDUCT µScm yr^{-1}						Lab H					
LTM Site	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005 NA	2004 NA	2000 NA	2008	2007	2006	2005	2004	2000
LITTLE HOPE POND																			-0.28	-0.29	-0.26				-0.16	-0.16	-0.17	-0.21	-0.20	
BIG HOPE POND	-0.87	-1.03	-1.14	-1.16	-1.16	-1.96	-0.21	-0.21											-0.21	-0.23	-0.21				-0.04	-0.05	-0.05	-0.06	-0.06	
LITTLE ECHO POND	0.27	0.29	0.31	0.30	0.33	0.22									0.04				-0.26	-0.27	-0.25				-0.90	-1.05	-1.09	-1.02	-1.21	-1.95
EAST COPPERAS POND	0.08	0.10	0.12	0.11	0.11							-0.43																		
MIDDLE POND				0.44	0.50																									
SUNDAY POND	0.00																								0.29	0.27	0.28	0.25	0.25	
SOCHIA POND	0.12	0.12	0.14	0.12	0.11		0.05	0.05								0.63	0.62		-0.29	-0.28	-0.25				-0.87	-0.94	-1.01	-1.18	-1.21	-1.44
OWEN POND				0.58	0.64								-0.03																-0.01	
HEART LAKE	0.24	0.24	0.25	0.29	0.29														-0.19	-0.19	-0.17									
MARCY DAM POND				0.43	0.44														-0.10											
GRASS POND (03)	0.08	0.07					-0.09	-0.09																						-0.08
BLACK POND																			-0.20	-0.19										
LOON HOLLOW POND	0.13	0.14																	-0.40	-0.43	-0.44				-0.51	-0.55	-0.64	-0.83	-0.87	-1.52
WILLYS LAKE (HORSESHOE)	0.14	0.17	0.17	0.17															-0.53	-0.52	-0.52				-0.27	-0.30	-0.30	-0.39	-0.37	-0.72
MIDDLE SETTLEMENT LAKE		0.20	0.25	0.25	0.25								-0.08	-0.11		-0.09			-0.23	-0.22	-0.21				-0.15	-0.15	-0.16	-0.16	-0.15	-0.31
GRASS POND (04)			0.50																-0.16	-0.16	-0.15				-0.04		-0.05	-0.06	-0.06	-0.14
MIDDLE BRANCH LAKE					0.33														-0.16	-0.17	-0.15									-0.02
LAKE RONDAXE	0.33	0.31	0.37	0.37	0.44														-0.19	-0.20	-0.18									
MOSS LAKE			0.33					-0.06	-0.06										-0.24	-0.24	-0.22									
CASCADE LAKE								-0.09	-0.09	-0.13	-0.09							-0.03	-0.24	-0.28	-0.25									
BUBB LAKE																			-0.24	-0.24	-0.19									
DART LAKE	0.26	0.31	0.39	0.40	0.44		-0.05	-0.06	-0.04										-0.29	-0.31	-0.29				-0.12	-0.13	-0.16	-0.18	-0.16	
WINDFALL POND																			-0.30	-0.33	-0.30						-0.01	-0.01		
BIG MOOSE LAKE	0.26	0.32	0.39	0.39	0.44														-0.31	-0.32	-0.30				-0.16	-0.18	-0.20	-0.22	-0.20	
WEST POND																0.10	0.07		-0.28	-0.28	-0.28									0.74
SQUASH POND			0.27	0.26	0.27									-0.04				-0.16	-0.34	-0.35	-0.32				-0.45	-0.43	-0.39	-0.44	-0.45	
CONSTABLE POND																			-0.40	-0.41	-0.41				-0.16		-0.25	-0.32	-0.27	
LIMEKILN LAKE							-0.04						-0.03						-0.29	-0.29	-0.25				-0.04	-0.04	-0.05	-0.05	-0.05	
SQUAW LAKE			0.19	0.22	0.22							-0.15						-0.17	-0.38	-0.39	-0.38									-0.12
INDIAN LAKE									-0.06	-0.07	-0.09	-0.15							-0.43	-0.43	-0.43				-0.30	-0.29	-0.34	-0.39	-0.38	
BROOK TROUT LAKE		0.21	0.26	0.29	0.29		-0.03	-0.03	-0.03										-0.37	-0.40	-0.42				-0.25	-0.31	-0.36	-0.43	-0.46	-0.75
LOST POND			0.30	0.44	0.44							-0.19							-0.30	-0.29	-0.28									
SOUTH LAKE			0.36	0.44	0.44		-0.04	-0.04											-0.29	-0.29	-0.26				-0.28	-0.31	-0.35	-0.39	-0.39	-0.55
NORTH LAKE				0.34			-0.05	-0.05	-0.06	-0.07	-0.09	-0.13							-0.31	-0.31	-0.28				-0.17	-0.18	-0.20	-0.21	-0.20	
WILLIS LAKE																										-0.03	-0.03	-0.03	-0.03	
JOCKEYBUSH LAKE		0.22	0.25	0.29	0.31													0.13	-0.27	-0.28	-0.29				-0.24	-0.26	-0.31	-0.35	-0.36	-0.68

LTM Site	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005	2004	2000	2008	2007	2006	2005 NA	2004 NA	2000 NA	2008	2007	2006	2005	2004	2000
CLEAR POND																			-0.25	-0.24	-0.20				0.00					
NATE POND				0.43	0.44							-0.26							-0.21	-0.19										
LONG POND			0.30	0.33	0.33														-0.21	-0.17	-0.18				-0.42		-0.57	-0.69	-0.75	
CARRY POND	0.07						0.23	0.18	0.13										-0.40	-0.34	-0.27				-0.70	-0.70	-0.63	-0.49	-0.45	
ARBUTUS LAKE							-0.07	-0.09	-0.10			-0.26							-0.22	-0.20					0.01	0.01				
LAKE COLDEN		0.25	0.31	0.40	0.44														-0.25	-0.22					-0.24	-0.21	-0.22	-0.29	-0.30	-0.34
AVALANCHE LAKE				0.29	0.31														-0.30	-0.28					-0.20	-0.19		-0.25	-0.26	
SAGAMORE LAKE																			-0.32	-0.32	-0.27									
RAQUETTE LAKE RESERVOIR															0.03				-0.44	-0.44	-0.42									
QUEER LAKE	0.16	0.19	0.22	0.22	0.24		-0.06	-0.06	-0.06	-0.07	-0.07	-0.13	-0.03						-0.27	-0.28	-0.26				-0.11	-0.12	-0.14	-0.15	-0.14	
OTTER LAKE					0.29														-0.24	-0.24	-0.25				-0.10		-0.13	-0.15		-0.25
G LAKE			0.33	0.43	0.44			-0.05	-0.06	-0.08	-0.09								-0.15	-0.14	-0.11				-0.07		-0.08	-0.11	-0.10	-0.02
Sites with Recent Liming History																														
LITTLE CLEAR POND	0.05																									-0.06	-0.10	-0.20	-0.26	-0.93
WOODS LAKE																			-0.31	-0.33	-0.31									
BARNES LAKE							-0.13	-0.14	-0.16	-0.17	-0.19	-0.19	-0.11	-0.11	-0.10	-0.10	-0.13	-0.31	-0.20	-0.17	-0.14				0.29	0.32	0.36	0.36	0.42	0.50
LITTLE SIMON POND	0.29	0.33	0.39	0.44	0.44		-0.06	-0.07	-0.06																					
Upstream sites																														
CASCADE	0.36	0.43	0.55				-0.04	-0.03					-0.03						-0.20	-0.13	-0.09									
BUBB			0.29																-0.28	-0.29	-0.23									
WINDFALL		0.14	0.19				0.06	0.06	0.09				-0.07	-0.07					-0.48	-0.44	-0.44									
WEST																			-0.27	-0.25	-0.28									
SQUASH		0.29	0.33																-0.36	-0.34	-0.34				-0.66	-0.73	-0.75			
CONSTABLE		0.22	0.27										-0.05						-0.40	-0.43	-0.42					-0.34	-0.40			
OTTER		0.29	0.35																-0.24	-0.26	-0.26									

Notes:

Slopes are reported for p<=0.05.

Blank = not significant at 95% Confidence Interval.

	Al TD umol L^{-1} yr^{-1}						Al TM umol L^{-1} yr^{-1}						Al OM umol L^{-1} yr^{-1}						AL IM umol L^{-1} yr^{-1}					
LTM Site	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**
LITTLE HOPE POND							-0.21	-0.20	-0.20	-0.24	-0.25		-0.15	-0.14	-0.14	-0.17	-0.16		-0.05	-0.06	-0.06	-0.09	-0.07	
BIG HOPE POND							-0.07	-0.07	-0.08	-0.10	-0.10								-0.02	-0.02	-0.02	-0.04	-0.03	
LITTLE ECHO POND							-0.13	-0.13	-0.13	-0.12	-0.14		-0.10	-0.10	-0.10	-0.10	-0.11					-0.04	-0.07	
EAST COPPERAS POND		0.02	0.03	0.03	0.03		-0.09	-0.09	-0.10	-0.11	-0.10		-0.04	-0.05	-0.06	-0.06	-0.05		-0.04	-0.04	-0.04	-0.07	-0.04	
MIDDLE POND				-0.05	-0.05		-0.06	-0.06	-0.06	-0.07	-0.07		-0.04						0.00	0.00	-0.00	-0.03	-0.01	
SUNDAY POND							-0.03	-0.03	-0.03	-0.03								0.09	-0.02	-0.02	-0.03	-0.04	-0.03	-0.04
SOCHIA POND							-0.04	-0.04	-0.04	-0.04								0.09	-0.02	-0.03	-0.04	-0.05	-0.04	-0.05
OWEN POND																								
HEART LAKE																							-0.02	
MARCY DAM POND			-0.18	-0.22	-0.20		-0.11	-0.11	-0.13	-0.17	-0.16		-0.06	-0.06	-0.06	-0.07	-0.07		-0.05		-0.06	-0.09	-0.07	
GRASS POND (03)	0.01	0.02	0.02	0.02	0.02	0.04	-0.04	-0.04	-0.04	-0.05	-0.05		-0.03						-0.01	-0.01	-0.01	-0.04		
BLACK POND							-0.04	-0.04											-0.01	-0.01	-0.01	-0.02	-0.03	
LOON HOLLOW POND						-0.91	-0.44	-0.51	-0.62	-0.72	-0.78	-1.19							-0.40	-0.44	-0.51	-0.58	-0.63	-1.09
WILLYS LAKE (HORSESHOE)	-0.56	-0.63	-0.63	-0.70	-0.72	-0.88	-0.67	-0.78	-0.78	-0.88	-0.93	-1.07							-0.65	-0.75	-0.75	-0.83	-0.89	-1.15
MIDDLE SETTLEMENT LAKE	-0.13	-0.12	-0.14	-0.15	-0.13	-0.30	-0.11	-0.11	-0.13	-0.14	-0.14	-0.20							-0.08	-0.09	-0.11	-0.14	-0.11	-0.20
GRASS POND (04)							-0.11	-0.11	-0.13	-0.16	-0.15	-0.26	-0.05	-0.05	-0.06	-0.06	-0.05		-0.06		-0.07	-0.11		-0.21
MIDDLE BRANCH LAKE							-0.03						-0.03		-0.03									
LAKE RONDAXE							-0.06	-0.05	-0.07	-0.06	-0.07								-0.02	-0.02	-0.03	-0.04	-0.06	-0.06
MOSS LAKE							-0.04		-0.05															
CASCADE LAKE																								
BUBB LAKE							-0.04		-0.04		-0.05												-0.02	
DART LAKE			-0.17	-0.21	-0.20		-0.15	-0.16	-0.19		-0.22								-0.12	-0.14	-0.16	-0.13	-0.17	-0.25
WINDFALL POND							-0.07		-0.08				-0.05		-0.05									
BIG MOOSE LAKE	-0.14		-0.17	-0.22			-0.19	-0.20	-0.22	-0.20	-0.26								-0.14	-0.16	-0.18	-0.15	-0.20	-0.27
WEST POND							-0.18	-0.19	-0.23	-0.22	-0.24		-0.08	-0.08	-0.10	-0.11	-0.12		-0.09	-0.10	-0.10			
SQUASH POND							-0.37	-0.41	-0.44	-0.39	-0.49	-0.65							-0.32	-0.36	-0.36	-0.27	-0.38	-0.51
CONSTABLE POND	-0.22	-0.23	-0.28	-0.28	-0.25		-0.36	-0.37	-0.45	-0.42	-0.49	-0.52							-0.28	-0.30	-0.35	-0.33	-0.36	-0.41
LIMEKILN LAKE							-0.04	-0.05	-0.06	-0.06	-0.06								-0.01	-0.01	-0.02	-0.04	-0.02	
SQUAW LAKE									-0.03												-0.01	-0.04		
INDIAN LAKE	-0.21	-0.18	-0.22	-0.23			-0.26	-0.26	-0.31	-0.34	-0.34	-0.38							-0.27	-0.28	-0.30	-0.33	-0.32	-0.38
BROOK TROUT LAKE		-0.29	-0.35	-0.42	-0.46	-0.75	-0.20	-0.23	-0.28	-0.35	-0.37	-0.58							-0.16	-0.21	-0.25	-0.36	-0.35	-0.67
LOST POND	-0.13	-0.13	-0.13	-0.11			-0.21	-0.24	-0.26	-0.30	-0.33	-0.47		-0.06	-0.07	-0.10	-0.10		-0.13	-0.14	-0.17	-0.19	-0.20	-0.30
SOUTH LAKE	-0.18	-0.22	-0.27	-0.30	-0.29	-0.46	-0.17	-0.19	-0.23	-0.26	-0.26	-0.32							-0.16	-0.19	-0.23	-0.28	-0.28	-0.43
NORTH LAKE	-0.20		-0.20	-0.20			-0.28	-0.30	-0.33	-0.34	-0.33	-0.44	-0.06	-0.06	-0.06	-0.07	-0.07		-0.22	-0.25	-0.26	-0.27	-0.26	-0.38
WILLIS LAKE	-0.04						-0.05	-0.06	-0.06	-0.06			-0.05	-0.05								-0.03		
JOCKEYBUSH LAKE			-0.22	-0.27	-0.28		-0.15	-0.17	-0.22	-0.26	-0.27	-0.37							-0.14	-0.15	-0.19	-0.24	-0.24	-0.39

	Al TD umol L^{-1} yr^{-1}						Al TM umol L^{-1} yr^{-1}						Al OM umol L^{-1} yr^{-1}						AL IM umol L^{-1} yr^{-1}					
LTM Site	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**	**2008**	**2007**	**2006**	**2005**	**2004**	**2000**
CLEAR POND	0.06	0.07	0.06															0.08					-0.02	-0.31
NATE POND																								
LONG POND	0.28	0.39	0.33	0.36	0.29														-0.10	-0.08	-0.08			
CARRY POND							-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	0.03						-0.07	-0.07	-0.07	-0.08	-0.08	
ARBUTUS LAKE																			-0.01	-0.01	-0.01	-0.02	-0.02	
LAKE COLDEN	-0.28	-0.20	-0.23	-0.33	-0.34		-0.39	-0.36	-0.41	-0.50	-0.51	-0.47				-0.09			-0.35	-0.33	-0.37	-0.43	-0.43	-0.54
AVALANCHE LAKE				-0.33	-0.31		-0.41	-0.42	-0.47	-0.57	-0.59	-0.47							-0.34	-0.35	-0.36	-0.42	-0.42	-0.41
SAGAMORE LAKE										-0.16												-0.08		
RAQUETTE LAKE RESERVOIR							-0.18	-0.17	-0.19								0.04		-0.10	-0.09	-0.10	-0.14		
QUEER LAKE	-0.07	-0.10	-0.12				-0.09	-0.11	-0.12	-0.13	-0.14								-0.07	-0.09	-0.11	-0.13	-0.13	-0.24
OTTER LAKE	-0.12	-0.12	-0.17				-0.10	-0.09	-0.13	-0.09	-0.13	-0.19							-0.07	-0.07	-0.09	-0.09	-0.12	-0.22
G LAKE							-0.07	-0.07	-0.09	-0.10	-0.09								-0.05	-0.05	-0.06	-0.11	-0.08	-0.11
Sites with Recent Liming History																								
LITTLE CLEAR POND	-0.02	-0.02	-0.02	-0.02	-0.03		-0.06	-0.06	-0.06	-0.07	-0.07	-0.04	-0.05	-0.04	-0.04	-0.05	-0.04		0.00	0.00	0.00	-0.04	0.00	
WOODS LAKE	-0.07		-0.08				-0.04															-0.03	-0.02	
BARNES LAKE	-0.03	-0.03	-0.03	-0.03			-0.05	-0.05	-0.05	-0.06	-0.05								-0.01	-0.01	-0.02	-0.03	-0.03	
LITTLE SIMON POND							-0.04						-0.04									-0.02		
Upstream sites																								
CASCADE								-0.04																
BUBB																								
WINDFALL																					-0.01			
WEST																								
SQUASH							-0.22	-0.28	-0.30										-0.15					
CONSTABLE		-0.25					-0.27	-0.35	-0.40										-0.32	-0.36	-0.39			
OTTER		-0.16					-0.09	-0.11	-0.11											-0.11				

Notes:

Slopes are reported for p<=0.05.

Blank = not significant at 95% Confidence Interval.

Appendix B: Seasonal Medians; ALTM Streams 2005–2008

Winter = Dec through March=
Snowmelt = April=
Springsummer = May through July=
Latesummer = August through September=
Fall = October through November
BCK = Buck Creek
BMB = Bald Mountain Brook
Each value is the median for that particular season and year.=

AL_TD= Total dissolved aluminum
AL_TM= Total monomeric aluminum
AL_OM= Organic monomeric aluminum
AL_IM= Inorganic monomeric aluminum

Stream	Year	Seasoncode	Season	SO4 mgL^{-1}=	NO3 mgL^{-1}=	Cl mgL^{-1}=	F mgL^{-1}=	ANC μeq L^{-1}=	DIC mgL^{-1}=	DOC mgL^{-1}=	SiO2 mg L^{-1}=	Ca mgL^{-1}=	Mg mgL^{-1}=	Na mgL^{-1}=	K mgL^{-1}=	NH4 mgL^{-1}=	AL_TD μgL^{-1}=	AL_TM μgL^{-1}=	AL_OM μgL^{-1}=	AL_IM μgL^{-1}=	LABORATORY PH	AIR EQUILIBRATED PH	SPECIFIC CONDUCTIVITY μScm^{-1}=
BCK=	2005=	1=	Winter=	5.01=	2.2625=	0.325=	0.0695=	16.41=	0.715=	4.7175=	7.09=	1.645=	0.355=	0.77=	0.25=	0.004=	366.5=	234=	124=	110=	5.536=	5.78=	24.95=
BCK=	2005=	2=	Snowmelt=	4.25=	3.907=	0.31=	0.073=	-2.265=	0.45=	5.151=	5.25=	1.58=	0.28=	0.56=	0.35=	-0.002=	501=	359=	151=	208=	4.9065=	4.895=	25.1=
BCK=	2005=	3=	Springsummer=	5.94=	1.603=	0.38=	0.069=	30.78=	0.82=	3.458=	11.41=	1.9=	0.44=	1.2=	0.36=	0.004=	204=	81=	64=	26=	6.066=	6.42=	23.64=
BCK=	2005=	4=	Latesummer=	5.345=	0.6765=	0.325=	0.054=	49.81=	0.655=	5.31=	9.555=	1.68=	0.355=	0.955=	0.22=	0.004=	285=	151=	104.5=	46.5=	6.301=	6.7=	25.84=
BCK=	2005=	5=	Fall=	5.2=	0.5725=	0.365=	0.057=	6.06=	0.625=	6.186=	8.91=	1.52=	0.34=	0.845=	0.245=	-0.0075=	412=	220.5=	139=	81.5=	5.015=	4.99=	22.32=
BCK=	2006=	1=	Winter=	4.64=	2.273=	0.29=	0.062=	8.7=	0.53=	4.335=	7.66=	1.52=	0.29=	0.75=	0.22=	0.0015=	396=	261=	119=	142=	5.148=	5.17=	24.07=
BCK=	2006=	2=	Snowmelt=	4.13=	2.549=	0.3=	0.063=	2.63=	0.39=	5.005=	5.19=	1.3=	0.24=	0.55=	0.28=	0.002=	510=	317=	135=	182=	4.92=	4.925=	23.215=
BCK=	2006=	3=	Springsummer=	5.01=	0.959=	0.34=	0.051=	15.19=	0.43=	4.401=	7.2=	1.52=	0.31=	0.76=	0.25=	0.004=	292=	192=	101=	91=	5.496=	5.52=	20.5=
BCK=	2006=	4=	Latesummer=	5.25=	0.753=	0.33=	0.064=	44.08=	0.8=	5.142=	9.86=	1.91=	0.41=	1.04=	0.3=	-0.003=	212=	94=	79=	15=	6.195=	6.54=	23.33=
BCK=	2006=	5=	Fall=	4.62=	1.986=	0.3=	0.058=	13.42=	0.51=	6.637=	6.83=	1.57=	0.3=	0.72=	0.21=	0.004=	367=	225=	156=	96=	5.307=	5.34=	22.32=
BCK=	2007=	1=	Winter=	5.065=	2.869=	0.3=	0.0625=	14.28=	0.605=	3.964=	7.845=	1.76=	0.365=	0.84=	0.29=	-0.0005=	341.5=	195=	106.5=	80.5=	5.4895=	5.515=	24.595=
BCK=	2007=	2=	Snowmelt=	3.905=	4.121=	0.265=	0.0765=	-6.565=	0.395=	5.183=	5.07=	1.43=	0.26=	0.55=	0.315=	0.001=	683=	381=	155.5=	225.5=	4.7745=	4.75=	25.9=
BCK=	2007=	3=	Springsummer=	5.17=	1.303=	0.33=	0.06=	35.87=	0.88=	4.358=	10.23=	1.78=	0.42=	1.19=	0.34=	0.003=	256=	105=	75=	31=	6.039=	6.31=	23.6=
BCK=	2007=	4=	Latesummer=	5.445=	1.4785=	0.355=	0.0655=	85.375=	1.41=	3.3585=	13.845=	2.47=	0.595=	1.85=	0.415=	0.003=	158.5=	56=	44.5=	12.5=	6.597=	7.07=	30.519=
BCK=	2007=	5=	Fall=	5.24=	0.517=	0.39=	0.065=	14.04=	0.46=	6.375=	7.7=	1.6=	0.35=	0.77=	0.23=	-0.002=	335=	206=	132=	84=	5.432=	5.49=	22.916=
BCK=	2008=	1=	Winter=	4.54=	2.265=	0.295=	0.068=	6.365=	0.525=	4.7465=	5.925=	1.5=	0.28=	0.595=	0.235=	0.0015=	474=	297=	145=	160.5=	5.051=	5.075=	22.253=
BCK=	2008=	2=	Snowmelt=	4.24=	1.859=	0.26=	0.054=	3.05=	0.43=	5.6=	5.28=	1.39=	0.25=	0.52=	0.25=	0=	477=	281=	149=	132=	5.024=	4.93=	20.806=
BCK=	2008=	3=	Springsummer=	5.115=	0.857=	0.34=	0.0595=	32.775=	0.705=	4.447=	8.47=	1.9=	0.365=	0.945=	0.285=	0.0005=	266=	110.5=	94=	29=	5.962=	6.175=	20.9125=
BCK=	2008=	4=	Latesummer=	4.95=	0.638=	0.33=	0.062=	41.29=	0.76=	4.799=	10.34=	1.92=	0.39=	0.99=	0.24=	0.006=	228=	102=	80=	22=	6.196=	6.5=	21.672=
BMB=	2005=	1=	Winter=	4.465=	2.312=	0.28=	0.075=	43.98=	0.67=	2.9275=	8.665=	1.635=	0.455=	0.915=	0.265=	0.003=	189=	97=	67=	31.5=	6.351=	6.8=	25.25=
BMB=	2005=	2=	Snowmelt=	3.99=	3.566=	0.29=	0.075=	3.455=	0.31=	3.445=	7.18=	1.53=	0.32=	0.6=	0.35=	-0.001=	320=	236=	98=	138=	5.283=	5.28=	20.945=
BMB=	2005=	3=	Springsummer=	4.42=	1.527=	0.29=	0.1=	65.27=	0.94=	2.899=	12.22=	1.76=	0.53=	1.27=	0.36=	0.003=	133=	44=	39=	9=	6.672=	6.93=	24.3=
BMB=	2005=	4=	Latesummer=	4.73=	0.907=	0.285=	0.0895=	88.54=	0.775=	3.162=	10.935=	1.63=	0.475=	1.075=	0.28=	0.0035=	119=	47.5=	44.5=	7=	6.777=	7.12=	26.83=
BMB=	2005=	5=	Fall=	4.9=	0.979=	0.365=	0.0765=	21.29=	0.79=	3.3125=	10.39=	1.71=	0.47=	1.005=	0.28=	-0.0095=	171.5=	85=	64=	21=	5.755=	5.8=	19.7=
BMB=	2006=	1=	Winter=	4.27=	2.347=	0.27=	0.062=	13.18=	0.4=	2.689=	9.24=	1.43=	0.36=	0.87=	0.21=	0.004=	209=	120=	73=	47=	5.771=	5.87=	22.24=
BMB=	2006=	2=	Snowmelt=	3.86=	2.286=	0.28=	0.068=	8.19=	0.27=	3.393=	5.44=	1.18=	0.25=	0.56=	0.26=	0.002=	363=	237=	91=	146=	5.3155=	5.31=	20.05=
BMB=	2006=	3=	Springsummer=	4.08=	1.205=	0.28=	0.049=	34.59=	0.38=	3.249=	9.15=	1.39=	0.39=	0.97=	0.22=	-0.002=	153=	79=	57=	18=	6.369=	6.51=	18.2=
BMB=	2006=	4=	Latesummer=	4.17=	1.195=	0.3=	0.103=	91.88=	1.33=	3.289=	11.73=	2.18=	0.62=	1.23=	0.35=	-0.005=	106=	39=	37=	3=	6.831=	7.15=	25.55=
BMB=	2006=	5=	Fall=	4.17=	1.725=	0.3=	0.063=	21.51=	0.41=	4.258=	8.6=	1.44=	0.37=	0.83=	0.25=	0.001=	198=	94=	72=	25=	5.919=	6.09=	20=
BMB=	2007=	1=	Winter=	4.72=	2.8175=	0.26=	0.068=	29.855=	0.52=	2.511=	9.71=	1.68=	0.475=	0.995=	0.295=	0.0005=	157=	67=	58=	11=	6.047=	6.195=	23.0365=
BMB=	2007=	2=	Snowmelt=	3.675=	3.232=	0.565=	0.0645=	5.93=	0.29=	3.194=	6.025=	1.33=	0.295=	0.63=	0.29=	0.0045=	380.5=	223.5=	97=	126.5=	5.2485=	5.215=	21.3=
BMB=	2007=	3=	Springsummer=	4.39=	1.733=	0.28=	0.091=	64.88=	1.01=	2.835=	11.52=	1.68=	0.53=	1.36=	0.37=	0.004=	133=	54.5=	46=	10=	6.593=	6.84=	24.3=
BMB=	2007=	4=	Latesummer=	4.44=	1.617=	0.305=	0.0995=	102.89=	1.565=	1.963=	12.46=	2.09=	0.705=	1.605=	0.42=	-0.0055=	71=	34=	28=	6=	6.8375=	7.085=	28.816=
BMB=	2007=	5=	Fall=	5.54=	0.885=	0.39=	0.076=	32.76=	0.52=	4.525=	9.55=	1.92=	0.53=	1=	0.3=	-0.005=	171=	87=	67=	20=	6.241=	6.52=	24.636=
BMB=	2008=	1=	Winter=	4.28=	2.409=	0.28=	0.068=	12=	0.42=	2.967=	6.77=	1.48=	0.35=	0.725=	0.245=	0.0015=	337.5=	159.5=	87.5=	71.5=	5.6045=	5.59=	21.1895=
BMB=	2008=	2=	Snowmelt=	3.93=	1.771=	0.22=	0.055=	13.77=	0.23=	3.701=	5.96=	1.36=	0.28=	0.62=	0.25=	0.001=	275=	164=	106=	65=	5.604=	5.55=	19.392=
BMB=	2008=	3=	Springsummer=	4.315=	1.0755=	0.28=	0.0895=	56.17=	0.86=	2.9325=	10.21=	1.795=	0.445=	1.045=	0.26=	0.002=	138=	47=	50=	4=	6.6085=	6.8=	20.5455=
BMB=	2008=	4=	Latesummer=	3.64=	0.769=	0.3=	0.092=	74.78=	1.08=	4.12=	11.14=	1.95=	0.49=	0.96=	0.21=	0.005=	150=	59=	58=	8=	6.663=	6.87=	20.5=

Appendix C: Presentations, Reports and Papers Delivered 2007–2009

January 2007 - December 2009

Date/Location	Presented at	Title	Prepared by	Presented by
November 16, 2009 Albany, NY	Atmospheric Sciences Research Center Student/Faculty Seminar, SUNY Albany	Impacts, Monitoring and Trends in Adirondack Streams and Lakes and Cloud Chemistry Trends at Whiteface Mounatin	K.Roy	K.Roy
October14-15, 2009 Albany, NY	New York State Energy Research and Development Authority (NYSERDA) Environmental Monitoring, Evaluation, and Protection (EMEP) Program Linking Science and Policy Conference	Acid Deposition Impacts, Monitoring and Trends in Adirondack Lakes and Streams	K.Roy, G.Lawrence and C.Driscoll	K.Roy
October14-15, 2009 Albany, NY	NYSERDA EMEP Conference	Mercury and Acid Deposition Research - A Recap of Current Efforts and Knowledge	C.T.Driscoll, K.M.Driscoll, K.Roy,Q. Zhao, A. Pourmokhtarian, T.Sullivan and M. Mitchell	C.T.Driscoll
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 1	Poster presentation

October14-15, 2009 Albany, NY	NYSERDA EMEP Conference	A Comparison of Contemporary Cloud Water pH to Pre-Industrial Values at Whiteface Mountain	J.E.Dukett, N. Aleksic, N. Houck, P.Casson and M. Cantwell	Poster presentation
October 6-8, 2009 Saratoga Springs, NY	National Atmospheric Deposition Program (NADP) Fall 2009 Annual Meeting and Science Symposium	Changes in Fish Communities in Adironack Lakes	K.Roy, A.Bulger and C.Driscoll	K.Roy
October 6-8, 2009 Saratoga Springs, NY	NADP Fall 2009 Annual Meeting and Science Symposium	The Response of Acid-Impacted Lake-Watersheds in the Adirondack Region	C.Driscoll, K.Driscoll, K.Roy, Q.Zhao, T.Sullivan and M. Mitchell	C.Driscoll
October 6-8, 2009 Saratoga Springs, NY	NADP Fall 2009 Annual Meeting and Science Symposium	Liquid Water Content and Chmical Composition in Clouds at Whiteface Mountain, NY	N.Aleksic and J. Dukett	Poster presentation
June 9, 2009 Albany, NY	New York State Department of Environmental Conservation (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 Ecosystems/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 Wilmington, NY	Whiteface Mountain Atmospheric Center Ray Falconer Summer Lecture Series	Lakes, Streams and Cloud Monitoring in the Adirondacks	K.Roy	K.Roy

June 2, 2008 Lake Placid, NY	North Country Public Radio (Canton, NY) interview with Brian Mann	Subject: National Air Pollution Cap and Trade Policies and the Battle to Stop Acid Rain in the Adirondacks	K. Roy	Radio interview
May 21-22, 2008 Lake Placid, NY	Adirondack Research Consortium 15th Annual Conference	Adirondack Long-Term Monitoring Recent Findings - Lakes	K.Roy, J.Dukett, S.Capone, N.Houck, and P.Snyder	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
November 15-16, 2007 Albany, NY	NYSERDA EMEP Conference	Biogeochemistry and Hydrology of an Adirondack Watershed: A Comparative Approach	M.Domser, M.Mitchell, K.Roy, N.Houck and P.McHale	Poster presentation
November 15-16, 2007 Albany, NY	NYSERDA EMEP Conference	Comparison of Cloud and Rain Chemistry Observations at Whiteface Mountain	N.Aleksic, K.Roy, G.Sistla, J.Dukett, N.Houck and P.Casson	Poster presentation
November 15-16, 2007 Albany, NY	NYSERDA EMEP Conference	Evaluating Changes in Water Quality in Adirondack Lakes from the Adirondack Long Term Monitoring (ALTM) Program	K.Roy, J.Dukett, , N.Houck, P. Snyder and S.Capone	Poster presentation

September 30, 2007 Ray Brook, NY	DEC Executive Staff regional visit	Adirondack Lakes Survey Corporation/Adirondack Long Term Monitoring Program Overview	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 13, 2007 Ray Brook, NY	Cornell University Nitrogen Round Table Teleconference Presentations	Presentation of Adirondack Long Term Monitoring Sites and Findings	K.Roy	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 S. Capone	K.Roy
January 10, 2007 Albany, NY	NYSDEC Division of Air Resources, Orientation for New Staff	The Adirondack Long Term Monitoring Program (Surface Water Acidification)	K.Roy	K.Roy

2008	New York State Energy Research and Development Authority Report No. 08-22	Results from the 2003-2005 Western Adirondack Stream Survey	G.B.Lawrence, B.P.Baldigo, K.M.Roy, H.A.Simonin, R.W.Bode, S.I. Passy, and S.B.Capone
2008	Journal of Environmental Quality 375/17/2010 2264-2274	Chronic and episodic acidification of Adirondack streams from acid rain in 2003 - 2005	G.B.Lawrence, K.M.Roy, B.P.Baldigo, H.A.Simonin, S.B.Capone, J.W.Sutherland, S.A. Nierszwici-Bauer and C.W.Boylen
2008	Environmental Pollution 154: 107-115	Lake variability: Key factors controlling mercury concentrations in New York State fish	H.A.Simonin, J.J.Loukmas, L.C.Skinner and K.M.Roy
2008	New York State Energy Research and Development Authority Report No. 08-11	Strategic Monitoring of Mercury in New York State Fish	H.Simonin, J.Loukmas, L.Skinner and K.Roy
2008	(submitted)	Biogeochemisty and hydrology of an Adirondack watershed	M.Domser, M.Mitchell, K.Roy, N.Houck and P.McHale

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2008	(submitted)	Biogeochemisty and hydrology of an Adirondack watershed	M.Domser, M.Mitchell, K.Roy, N.Houck and P.McHale

2007	Acid Rain in the Adirondacks: An Environmental History Cornell University Press, Ithaca, NY pp. 246	Acid Rain in the Adirondacks: An Environmental History	J.Jenkins, K.Roy, C.Driscoll, and C.Buerkett
2007	Applied Geochemistry 2007: 1181-1188	Changes in the chemistry of lakes in the Adirondack region of New York following declines in acidic deposition	C.T.Driscoll, K.M.Driscoll, K.M.Roy and J.Dukett

A Long-Term Monitoring Program for Evaluating Changes in Water Quality in Selected Adirondack Waters: Core Program 2007–2011

Data Summary Report 2009

State of New York
David A. Paterson, Governor

New York State Energy Research and Development Authority
Vincent A. DeIorio, Esq., Chairman
Francis J. Murray, Jr., President and Chief Executive Officer

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