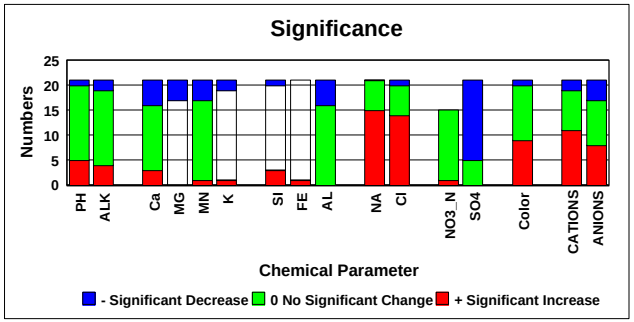
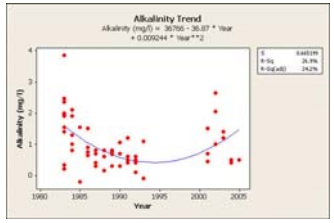
LONG-TERM CHANGE IN INDICATOR LAKES AND STREAMS IN MASSACHUSETTS

The Massachusetts Water Resources Research Center
Blaisdell House
University of Massachusetts
Amherst, MA
01003
545-2842
Email:
sdorner.tei.
umass.edu

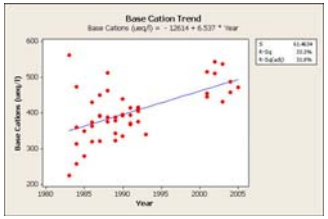
The Original Acid Rain Monitoring Project (ARM) began in 1983. At the time, it was an unusual combination of monitoring, science, university and volunteers that helped set a new tone for environmental monitoring for the next several decades. The innovative use of talent was strongly quality controlled, a fact eventually recognized by EPA and an important example to other volunteer efforts. In 1993, after ten years of developing a nearly comprehensive picture of all lakes and streams in Massachusetts and a long-term monitoring effort of a stratified random selection of lakes and streams for eight years, the project ended. A final report is available at http://www.umass.edu/tei/wrrc/WRRC2004/WRRCrecentpubs.html Publication No. 171. All of the sampling and QA/QC protocol are described there. In the final report, trend analyses were done using a method developed by Hirsch et al.(1982) that corrects for seasonal change and changes in hydrological events.



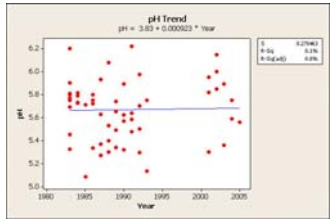
Significance of change in all parameters based on paired t-tests of data adjusted for season and hydrology.



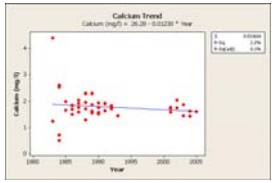
Alkalinity (ANC) represents the only obvious shift in trend slopes. In the first period it was declining and in the recent period, it is inclining. The quadratic trend analysis demonstrates this.

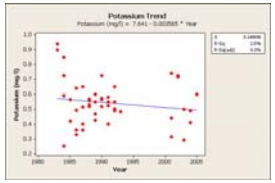


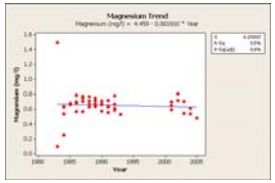
Unlike other New England and eastern Canadian monitoring sites, Massachusetts sites are showing a significant increase in base cations for most sites. However, this is a result of changes in sodium and not other base cations.



PH is highly scattered and shows no trend.







Base cations except sodium have either declined slightly or not at all.

Contact:
Paul Godfrey
Water Resources Research Center Emeritus Director
47 Harkness Road
Pelham, MA 01002
413-253-5686
Email: godfrey@tei.umass.edu

In 2001, ARM was resurrected for the purpose of evaluating the changes since the passage of the 1986 Massachusetts Clean Air Act and 1990 U.S. Clean Air Act Amendment. Many of the volunteers, 18 years later, eagerly started again. The current effort monitors 22 lakes and streams identified as the most likely to show water quality change with acid deposition change. An additional statistically representative 100 surface waters are being monitored for pH and ANC, but these data are not reported here. The current effort follows the same QA/QC and trend analysis procedures as before.

For this preliminary presentation, three types of statistical analyses have been conducted: simple scatter plots, paired t-tests of the seasonal/hydrology adjusted data to compare the 1983-93 period with the 2001-05 period and trend analysis of the raw data. In the earlier report, little difference was found between the analyses of raw data and adjusted data. the same was true for these extended analyses.

Location of all the 2001-05 sites.

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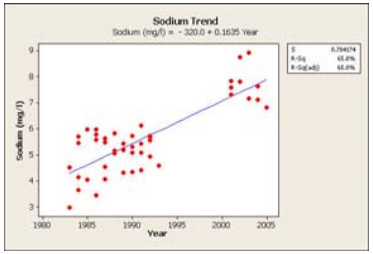
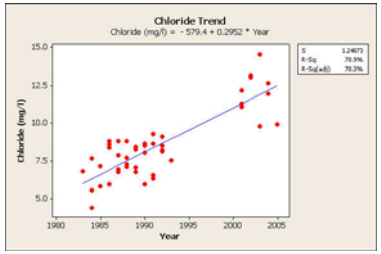
Massachusetts Department of Environmental Protection
Air Program Planning Unit
One Winter Street
Boston, MA 02108-4746
617-292-5500

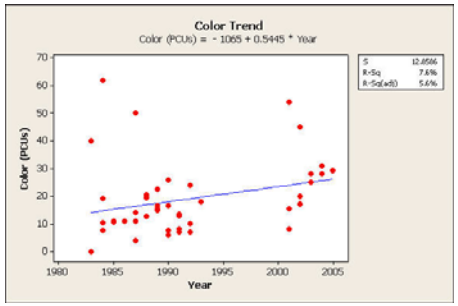




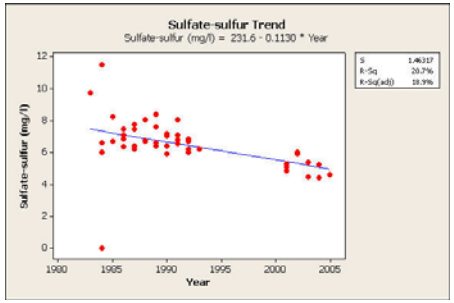
Sodium and Chloride have shown significant increases.

Base Cations

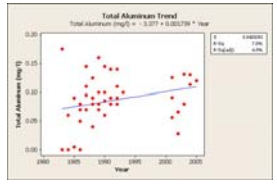
Lake/Stream	Pelsaris	Raw Mean 1983-93	Raw Mean 2001-5	Adj. Mean Residual 1983-93	Adj. Mean Residual 2001-5	Significance	Change	% Change from Original
Angeline Brook	9560000	466	1166	-226.9	652	**	+	150.2%
Ashby Reservoir	01001	646.7	770.1	-35.5	93.7	**	+	19.1%
Belmont Reservoir	21010	132.7	90.4	11.7	-25.6	ns	0	-31.9%
Bread and Cheese	9560150	1214	1709	-160	442	**	+	40.8%
Cadwell Creek	3626575	279.7	418	-31.2	100	**	+	49.4%
Cobble Mountain Reservoir	32018							
College Pond	95030	302.8	284	8.7	-21.05	*	-	-6.2%
Crystal Lake	36043	94.2	100.1	-1.4	-1.7	ns	0	6.3%
East Branch Swift River	3627200	446.8	524.2	-13.6	72.2	**	+	17.3%
Ezekial Pond	95051	530.5	744.3	-52	153.8	**	+	40.3%
Great Pond	96117	883.1	905	+9.6	34.3	*	+	2.5%
Hawley Reservoir	34031	398	422.1	-2	19.2	ns	0	8.2%
Hedges Pond	94065	432.9	487.5	-20.9	41	**	+	12.6%
Lake Lorraine	36084	1091	1272.9	-46	143.1	**	+	16.7%
Lake Wyola	34103	297.4	327.3	-6.8	23.4	ns	0	10.1%
Little Sandy Pond	95092	363.4	500.2	-34.1	116.3	**	+	37.6%
Nipmuck Pond	42039	317.5	517.2	-46.2	152	**	+	62.9%
North Watuppa Lake	61004	528	558	-21	65	ns	0	5.7%
Quabbin Reservoir	36129	326	343.5	-4.3	9.1	ns	0	5.4%
Naukeag Lake	35090	361.1	455	-24.1	59	ns	0	26.0%
Rattlesnake Brook	6235125	416	352	-1	-30	ns	0	-15.4%
West Branch Swift River	3626800	247.4	204.4	10.5	-43.6	**	-	-17.4%
Average	1689079.9	465.104762	578.628571	-33.9857142857143	97.8166666666667	0	0	20.0%



Color has shown a significant increase for many surface waters. This is predictable as a sign of decreasing acidity in waters that may have been more highly colored in the past, even though pH does not reflect a change. It helps explain why ANC seems to have changed less than expected because this alternate organic buffering system of naturally acidic surface waters appears to be rebuilding.



Sulfate shows a strong and significant decline.



Aluminum appears to be increasing but not significantly. Nitrate data (not shown) are insufficient for earlier years to draw conclusions.