

Acid Rain Monitoring Project



FY14 Annual Report

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Introduction

This report covers the period July 1, 2013 to June 30, 2014, the thirteenth year of Phase IV of the Acid Rain Monitoring Project. Phase I began in 1983 when about one thousand citizen volunteers were recruited to collect and help analyze samples from nearly half the state's surface waters. In 1985, Phase II aimed to do the same for the rest of the streams and ponds¹ in Massachusetts. The third phase spanned the years 1986-1993 and concentrated on a subsample of streams and ponds to document the effects of acid deposition to surface waters in the state. Over 800 sites were followed in Phase III, with 300 citizen volunteers collecting samples and doing pH and ANC analyses. In 2001, the project was resumed on a smaller scale: about 60 volunteers are now involved to collect samples from approximately 150 sites, 26 of which are long-term sites with ion and color data dating back to Phase I. In the first years of Phase IV (2001-2003), 161 ponds were monitored for 3 years. Between Fall 2003 and Spring 2010, the project monitored 151 sites twice a year, mostly streams, except for the 26 long-term sites that are predominantly ponds. Since 2011, reduced funding eliminated our October sampling and monitoring now occurs in April only. In 2011, we also stopped monitoring some of the streams in order to add and revisit ponds that were monitored in 2001-2003. This year is the fourth year of monitoring for those added ponds.

Goals

The goals of this project are to determine the overall trend of sensitivity to acidification in Massachusetts surface waters and whether the 1990 Clean Air Act Amendment has resulted in improved water quality.

Methods

The sampling design was changed in 2011 to monitor both streams and ponds, and that design continues to date. In 2001-2003 mostly ponds were monitored. In Fall 2003 the sampling scheme switched to streams to evaluate their response to air pollution reductions. In 2011 the site list was modified to include both ponds and streams. Half of the streams monitored since 2003 were kept, and half of the ponds monitored in 2001-2003 were added back. The streams that were removed were chosen randomly within each county. Ponds that were reinstated on the sampling list were chosen at random within those counties and by ease of accessibility to replace the removed streams. Because those sites were chosen without a preconceived plan, they can be considered picked at random.

One collection took place this year, on April 6, 2014.

Methods were unchanged from previous years: Volunteer collectors were contacted six weeks before the collection to confirm participation. Clean sample bottles were sent to them in the mail, along with sampling directions, a field sheet/chain of custody form, and directions including latitude and longitude coordinates along with maps to the sampling sites. Volunteers collected a surface water sample at their sampling sites either from the bank or wading a short distance into the water body. They collected water one foot below the surface, upstream of their body, after rinsing their sample bottle three times with pond or stream water. If collecting by a bridge, they collected upstream of the bridge unless safety and access did not allow it. They filled in their field data sheet with date, time, and site code information, placed their samples on ice in a cooler and delivered the samples to their local laboratory right away. They were instructed to collect their samples as close to the lab analysis time as possible. In a few cases, samples were collected the day prior to analysis because the lab is not open on traditional "ARM Sunday." Previous studies by our research team have established that pH does not change significantly when the samples are refrigerated and stored in the dark.

Volunteer labs were sent any needed supplies (sulfuric acid titrating cartridge, electrode, buffers), two quality control (QC) samples, aliquot containers for long-term site samples, and a lab sheet one week to ten days before the collection. They analyzed the first QC sample (an unknown) in the week prior to the collection and called in their results to the Statewide Coordinator. If QC results were not acceptable, the volunteer analyst discussed possible reasons with the Statewide Coordinator and made modifications until the QC sample analysis gave acceptable results. On collection day or the day after, volunteer labs analyzed the second QC sample before and after the regular samples, and reported the results on their lab sheet along with the regular samples. Analyses were done on their pH-meters with KCl-filled combination pH electrodes. Acid neutralizing capacity (ANC) was measured with a double end-point

¹ Note: The term stream in this report refers to lotic waters (from creeks to rivers) and the term ponds refers to lentic waters (lakes and ponds, but not marshes)

titration to pH 4.5 and 4.2. Most labs used a Hach digital titrator for the ANC determination, but some used traditional pipette titration equipment. Aliquots were taken from 25 of the 26² long-term sites to fill two 50mL bottles and one 50mL tube per site for later analysis of ions and color. These aliquots were kept refrigerated until retrieval by UMass staff.

Aliquots, empty bottles, and results were collected by the ARM Statewide Coordinator between one and three days after the collection. The Cape Cod National Seashore lab mailed those in, with aliquot samples refrigerated in a cooler with dry ice.

The Statewide Coordinator reviewed the QC results for all labs and flagged data for any lab results that did not pass Data Quality Objectives (within 0.3 units for pH and within 3mg/L for ANC). pH and ANC data were entered by one ARM staff and proofread by another. Data were entered in a MS excel spreadsheet and uploaded into the web-based database at <http://63.135.115.71/acidrainmonitoring/>. Data were also posted on the ARM web page at <http://wrrc.umass.edu/research/acid-rain-monitoring-project>. Note that ARM data is also available on the national CUAHSI database, via Hydro Desktop (<http://cuahsi.org/HIS.aspx>).

Water Resources Research Center's Elizabeth Finn managed the Environmental Analysis Lab (EAL) and provided the QC samples for pH and ANC to all of the volunteer labs. EAL also provided analysis for pH and ANC for samples from Hampshire and Franklin Counties, and color analysis for the long-term site samples. The UMass Extension Soils Laboratory, under the direction of Solomon Kariuki analyzed the samples from the long-term sites for ions, and University of New Hampshire's Water Quality Analysis Laboratory, under the direction of Jody Potter, analyzed the samples from the long-term sites for chloride and silica.

Aliquots for 25 long-term sites were analyzed for color on a spectrophotometer within one day; chloride and silica within two months on an Ion Chromatograph; and ions within one month on an ICP at the UMass Extension Soils Laboratory on the UMass Amherst campus. The data was sent via MS Excel spreadsheet to the Statewide Coordinator who uploaded it into the web-based database.

The Statewide Coordinator and the Project Principal Investigator plotted the data to check for data inconsistencies and gaps. They then analyzed the April data from 1983 through 2014, using the statistical software JMP (<http://www.jmp.com/software/>) to run bivariate analyses of pH, ANC, ions, and color against date. This yielded trends analyses with a fitted X Y line, using a 95% confidence interval.

Results

1. There were 150 sites to be monitored, 77 ponds and 73 streams. Of those, 19 ponds and 7 streams are "long-term" sites that are sampled every year and analyzed for color and a suite of ions in addition to pH and ANC.
2. Sampling was completed for 134 sites (69 ponds and 65 streams) including 25 of our long-term sites. Cobble Mountain Reservoir was not sampled due to issues of volunteer access to the reservoir.
3. The only quality control problem this year was due to electrode failure at BCC. These analyses were re-done at UMass EAL. We had valid pH and ANC data for 134 sites. There was a setback in Bristol County sampling due to the death of long-time regional volunteer coordinator James Kennedy. Consequently, not all of Bristol County sites were sampled this year, but the long-term sites in the area were covered.
4. The network of volunteers was maintained and kept well informed on the condition of Massachusetts surface waters so that they would be able to participate effectively in the public debate. This was accomplished by e-mail and telephone communications, as well as through updates via an internet list-serv. 59 volunteers participated in this year's collection. Several new volunteer collectors were recruited to replace ill or retiring volunteers via several internet listservs and by word of mouth. There were 10 volunteer labs across the state, in addition to the EAL at UMass Amherst, in charge of pH and ANC analyses (Table 1).

² One long-term site was not sampled this year due to access problems

Table 1: Volunteer Laboratories

Analyst Name	Affiliation	Town
Joseph Ciccotelli	Ipswich Water Treatment Dept	Ipswich
Dorothy Scotten	Walden University	Acton
Sherrie Sunter	MDC Quabbin Lab	Belchertown
Dave Bennett	Cushing Academy	Ashburnham
Holly Bayley	Cape Cod National Seashore	South Wellfleet
Robert Caron	Bristol Community College	Fall River
Bob Bentley	Analytical Balance Labs	Carver
David Christensen	Westfield State University	Westfield
Jim Bonofiglio	City of Worcester Water Lab	Holden
Carmen DeFillippo	Pepperell Waste Water Treatment Plant	Pepperell
Beckie Finn, Brooke Andrew	University of Massachusetts Environmental Analysis Lab	Amherst

5. The ARM web site and searchable database were maintained and updated. 2014 pH, ANC, ions and color data that met data quality objectives were added to the web database via the uploading tool created in previous years. The database was evaluated for quality control and uploading errors were corrected.
6. The data collected was analyzed for trends in pH and ANC in April months (134 sites) and for color and ions (25 sites), using the JMP® Statistical Discovery Software (<http://www.jmp.com/software/>). Trend analyses (scatter plots, regression, and correlation) were run on pH, ANC, each ion, and color separately, predicting concentration vs. time.

Data Analysis Results

pH and ANC

Trend analysis for pH and ANC

Table 2 displays the number of sites out of a maximum of 134 that show a significant change over time for pH or ANC. If the difference was not statistically significant ($p > 0.05$), the sites are tabulated in the 'No Change' category.

Table 2: Trend analysis results for pH and ANC, April 1983 – April 2014

	All Sites		Ponds		Streams	
	pH	ANC	pH	ANC	pH	ANC
Increased	45	47	21	27	24	20
Decreased	4	1	0	0	4	1
No Change	85	86	48	42	37	44
Total	134	134	69	69	65	65

Those results are also graphed in Figure 1.

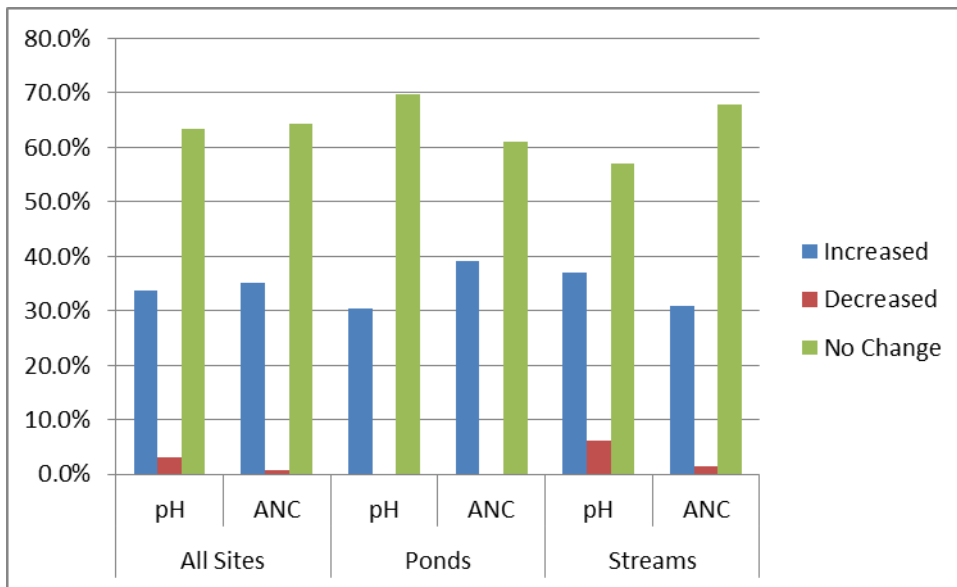


Figure 1. Percentage of site changes in pH and ANC, from trend analysis, April 1983-2014

This trend analysis indicates that for most sites, neither pH nor ANC changed significantly over time. However, for those sites that show a significant change, many more show an increase than a decrease in value: 34% of the sites saw an increase in pH and 35% had an increase in ANC.

We again note a difference between ponds and streams. More streams (37%) than ponds (30%) saw an increase in pH, while for ANC, more ponds (39%) than streams (31%) saw an increase. Very few sites showed a decrease in ANC: none for ponds and only 1% of streams.

Now in our fourth year of monitoring both ponds and streams, we continue to see a positive trend in ponds, which seem to be improving a little more each year. Streams show a lesser improvement, particularly for ANC, and this year, 4 streams out of 65 (6%) even showed a decrease in pH. For two years in a row now, we had a lingering snowpack and our sampling date of April 6 likely caught the snowmelt acid pulse that we try to document by sampling in early spring. It is possible that the acid pulse is more noticeable in streams than ponds due to the more rapid reaction of moving water to precipitation in streams than in ponds. This year in particular, there was a large snowpack that lasted later in the year (see photo below).



Underwood Brook, Heath, MA – April 6, 2014

Table 3: Comparison of percent of sites showing changes in pH and ANC, 2011-2014

2011	All Sites		Ponds		Streams	
	pH	ANC	pH	ANC	pH	ANC
Increased	28%	19%	22%	17%	35%	22%
Decreased	2%	1%	1%	0%	3%	3%
No Change	70%	79%	76%	83%	62%	75%
2012	All Sites		Ponds		Streams	
	pH	ANC	pH	ANC	pH	ANC
Increased	29%	21%	28%	33%	34%	23%
Decreased	2%	2%	1%	0%	4%	3%
No Change	69%	78%	71%	67%	62%	75%
2013	All Sites		Ponds		Streams	
	pH	ANC	pH	ANC	pH	ANC
Increase	35%	23%	38%	33%	32%	13%
Decrease	0%	2%	0%	0%	0%	4%
No Change	65%	75%	62%	67%	68%	82%
2014	All Sites		Ponds		Streams	
	pH	ANC	pH	ANC	pH	ANC
Increase	34%	35%	30%	39%	37%	31%
Decrease	3%	1%	0%	0%	6%	1%
No Change	63%	64%	70%	61%	57%	68%

Ions and Color

Trend analyses were run for the 25 long-term sites that were analyzed for thirteen ions and color.

Table 4 and Figure 2 show the results of the trend analysis for all parameters.

Table 4: Trend analysis results for ions and color April 1983 – April 2014

	Increase	Decrease	No Change
Mg	2	4	19
Si	0	5	20
Mn	0	3	22
Fe	0	5	20
Cu	0	4	20
Al	0	7	18
Ca	3	6	16
Na	7	0	18
K	5	0	20
Cl	11	0	14
NO₃	1	0	24
SO₄	1	21	3
Color	21	0	4

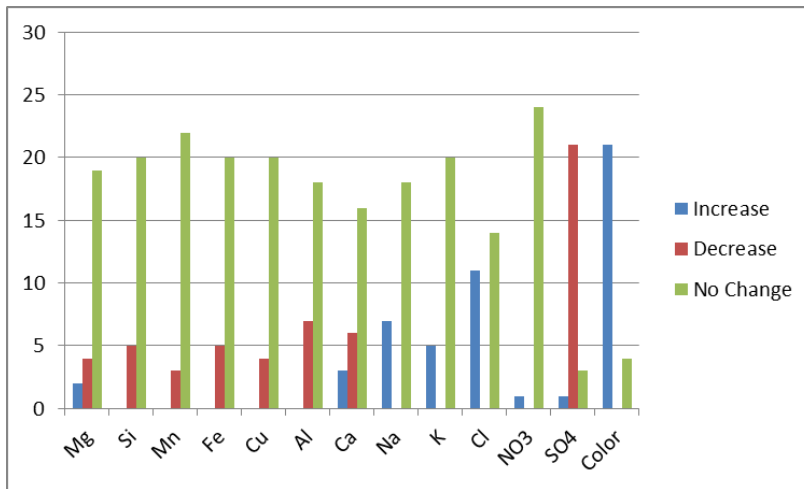


Figure 2: Results of trend analysis for ions and color for 25 long-term sites, April 1983-2014

Results are similar to previous years, with most cations showing no significant change over the years, or if they do, the change is a decrease more often than an increase, except for Sodium where half the sites show an increase. This is probably tied to the increase of Chloride, due to road salting practices in Massachusetts. A minor change this year is some increase in Aluminum and Potassium. We continue to see a very significant downward trend in Sulfate. While last year we saw more sites showing an increase in nitrate, this trend is not noticeable this year with only one site showing a significant increase. We will need several more years of data to confirm or disprove an increase in nitrates in our surface waters. Color continues to show a significant increase, a sign perhaps that natural alkalinity is recovering.

Discussion

This was our second year with new laboratories for the analysis of ions, and trends seem to be confirmed except in the case of nitrate. The continued trend in decreasing sulfate confirms that the Clean Air Amendment of 1990 is having a positive effect in the quality of the Commonwealth's surface water quality. Road salting in the winter continues to affect the concentration of sodium and calcium in the water bodies. Continued monitoring will help tease out whether nitrate pollution is countering the beneficial effect of decreased sulfates.

Acknowledgements

Thank you to all of the project's volunteers who make this project possible by collecting samples all over the state under any weather conditions, and who spend many hours in the lab analyzing samples. Special thoughts go out to the families and friends of long-term volunteers and friends of ARM who passed away this year. James Kennedy was the volunteer organizer for Bristol County for the last 30 years and was sampling right up until last year. Bill Elliot, former Lake Wyola Watershed Association President and veteran of ARM was also part of this project right from the beginning. Both losses are keenly felt in the sampling community.

Appendix

Table 4: April 2014 ARM Color and Ion Data

Name	Palsite	Color	Cl	NO3_N	SO4	Mg	Si	Mn	Fe	Cu	Al	Ca	Na	K
Shingle Island Brook	188	253.47	15.22	1.86	8.44	1.17	2.03	0.09	0.21	0.02	0.26	3.18	9.64	1.67
Belmont Res;Steam Sawmill	21010	136.97	0.65	1.27	3.80	0.16	1.71	0.04	0.03	ND	0.22	0.77	0.84	0.41
Hawley Reservoir	34031	80.68	14.51	1.99	5.76	0.62	3.68	0.03	0.04	0.05	0.10	2.95	8.32	0.64
Lake Wyola; Locks Pond	34103	82.72	5.78	1.27	4.43	0.32	2.63	0.04	0.05	ND	0.11	1.56	4.09	0.54
Upper Naukeag Lake	35090	65.91	13.69	3.20	2.37	0.22	0.37	0.01	0.01	ND	0.02	0.90	9.00	0.35
Crystal Lake	36043	46.22	1.03	1.24	1.22	0.13	0.03	0.03	0.01	ND	0.01	0.42	0.70	0.44
Lake Lorraine	36084	125.05	30.70	4.01	7.82	0.77	0.06	0.01	0.03	0.05	0.04	3.48	21.83	1.26
Quabbin Res.Station 202	36129	52.54	7.97	1.33	5.04	0.58	1.19	ND	ND	ND	ND	2.35	5.42	0.67
Nipmuck Pond	42039	57.44	11.92	1.17	4.38	0.35	2.67	0.02	ND	0.01	0.21	1.53	7.17	0.44
North Watuppa Lake	61004	158.30	17.58	1.11	5.20	0.62	1.12	0.16	0.11	ND	0.17	1.72	11.27	0.65
Ashby Reservoir	81001	63.71	17.13	1.19	4.56	0.49	2.14	0.01	0.06	0.01	0.04	1.79	11.40	0.72
Wright Pd; Upper Wright	81160	100.63	2.84	0.97	3.48	0.22	1.41	0.03	0.06	ND	0.11	1.17	2.24	0.42
Whitehall Reservoir	82120	76.57	21.90	1.22	3.58	0.89	0.23	ND	0.02	0.01	ND	3.05	13.57	1.04
Hedges Pond	94065	28.28	14.07	1.02	4.56	1.17	0.07	ND	ND	ND	0.01	1.01	7.86	0.72
College Pond	95030	65.21	6.33	0.94	4.21	0.71	0.10	ND	ND	ND	ND	0.81	4.39	0.46
Ezekiel Pond	95051	56.88	26.29	1.20	5.76	1.16	0.10	ND	0.01	0.01	ND	1.96	17.12	1.02
Little Sandy Pond	95092	53.44	19.86	1.16	4.41	0.90	0.05	0.02	ND	ND	0.01	1.26	12.00	1.10
Kinnacum Pond	96163	161.40	19.31	1.06	3.39	1.33	0.01	0.03	0.01	0.01	0.03	0.58	10.98	0.74
Cadwell Creek	3626575	86.55	8.02	0.94	5.22	0.41	3.36	0.02	ND	0.01	0.12	1.43	5.28	0.27
West Br Swift River	3626800	116.54	3.38	0.92	4.65	0.25	3.00	0.03	0.03	0.01	0.11	1.21	2.55	0.43
East Br Swift River	3627200	167.49	8.81	0.97	4.52	0.45	2.46	0.01	0.04	0.01	0.08	1.73	5.79	0.85
Rattlesnake Brook	6235125	222.30	9.64	0.86	6.68	0.56	2.74	0.04	0.14	ND	0.26	1.26	6.41	0.64
Angeline Brook	9560000	271.97	10.76	1.04	6.45	0.98	1.64	0.01	0.17	ND	0.47	1.70	7.32	0.85
Bread And Cheese Brook	9560150	252.65	40.24	2.01	7.92	1.49	2.27	0.04	0.17	ND	0.21	4.35	29.07	1.65
Hatches Creek	9661525	99.47	44.37	7.77	10.01	3.27	2.89	0.06	0.01	ND	ND	6.39	32.25	2.35

ND= Not Detected

Table 5: pH and ANC, all sampling sites, April 2014

PALSITE	NAME	TOWN	pH	Alkalinity
188	Shingle Island Brook	Freetown	5.62	1.1
11002	Cheshire Res. North	Cheshire	7.83	87
21010	Belmont Res;Steam Sawmill	Hinsdale	5.12	0.4
21040	Lake Garfield	Monterey	7.31	37
21062	Long Pond	Great Barrington	7.48	70.2
31042	Trout Pd 2; Demming Pd	Tolland	5.68	3.4
31044	Upper Spectacle Pond	Sandisfield	6.33	5.4
32012	Buck Pond	Westfield	6.62	20
33001	Ashfield Lake	Ashfield	7.09	22.9
33003	Bog Pond; Anthony Pond	Savoy	5.77	1.4
33017	Plainfield Pond	Plainfield	5.61	0.3
34011	Brass Mill Pond	Williamsburg	6.44	7.4
34023	Fiske Pond	Wendell	5.12	0.2
34031	Hawley Reservoir	Pelham	5.96	3.17
34080	Scarboro Pond	Belchertown	5.65	0.4
34103	Lake Wyola; Locks Pond	Shutesbury	5.72	1.7
35002	Bassett Pond	New Salem	5.57	1.4
35013	Cowee Pd;Marm Johns Pd	Gardner	4.97	-0.2
35017	Lake Denison	Winchendon	5.39	0.6
35026	Greenwood Pond	Templeton	5.25	0.6
35048	Moores Pond; Lake Moore	Warwick	4.98	-0.1
35085	Stump Pond	Gardner	4.82	-0.6
35089	Tully Pond	Orange	5.77	3
35090	Upper Naukeag Lake	Ashburnham	5.81	0.8
35095	Lake Watatic	Ashburnham	5.51	1
35107	L Rohunta; South Basin	Athol	5.91	2.9
36015	Bickford Pd;Ropers Res	Hubbardston	5.58	0.5
36036	Cloverdale Street Pond	Rutland	6.27	7.5
36043	Crystal Lake	Palmer	5.8	2.37
36084	Lake Lorraine	Springfield	6.6	6.4
36129	Quabbin Res.Station 202	Belchertown	6.5	6.11
36155	Thompsons Pond	Spencer	6.19	3.49
41014	East Brimfield Res	Brimfield	5.31	2.3
42039	Nipmuck Pond	Webster	5.45	2.01
51024	Coes Reservoir	Worcester	6.8	12.8
51063	Holden Res 1;Upper Hold	Holden	5.55	1.89
51090	Lynde Brook Reservoir	Leicester	6.64	7.29
51179	Wallis Res/Whitin Reservoir	Douglas	5.36	0
52032	Plain Street Pond	Mansfield	6.43	7.9
61004	N Watuppa Lake	Fall River	5.2	0.1
62048	County Road Pond	Berkley	6.23	5.1
62058	Deep Pond	Taunton	6.49	8.5
62097	Johnson Pd; Factory Pd	Raynham	5.52	
62213	Winnecunnet Pd	Norton	6.39	5.8
72039	Farm Pond	Sherborn	6.43	2.25
72088	Notch Pond	Medfield	4.65	-0.85

72095	Pleasant St. Pd;	Franklin	6.53	12.7
72113	Stony Brook Pond	Norfolk	6.68	14.3
81001	Ashby Reservoir	Ashby	6.13	2.5
81053	Grove Pond	Ayer	6.6	11.75
81056	Heald Pond	Pepperell	6.45	6.3
81100	Phoenix Pond; Double Pd	Shirley	6.5	13.5
81111	Robbins Pond	Harvard	7.09	43.8
81117	Sandy Pond	Ayer	6.3	8.7
81151	L Wampanoag; Nashua Res	Ashburnham	4.97	0
81160	Wright Pd; Upper Wright	Ashby	5.58	1.3
82120	Whitehall Reservoir	Hopkinton	6.21	4.6
84043	Mystic Pond	Methuen	6.85	18.2
84083	Duck Pond	Groton	6	4.35
94065	Hedges Pond	Plymouth	6.22	1.6
94072	Indian Pond	Kingston	6.67	9.7
95030	College Pond	Plymouth	6.73	1.7
95051	Ezekiel Pond	Plymouth	6.76	2.7
95092	Little Sandy Pond	Plymouth	6.01	1
95112	New Long Pond	Plymouth	6.48	3
95142	Spectacle Pond	Wareham	6.92	4.6
96117	Great Pond	Wellfleet	5.51	0.2
96163	Kinnacum Pond	Wellfleet	4.99	-0.6
96264	Round Pond	Brewster	6	1.2
2103725	Soda Creek	Sheffield	6.86	20.4
2104100	Williams River	West Stockbridge	7.75	114.4
2104200	Sleepy Hollow Brook	Richmond	7.77	116.1
2105350	Barton Brook	Dalton	7.26	20.8
2105425	Anthony Brook	Dalton	6.53	4.2
2105700	Kilburn Brook	Peru	6.84	3.6
2105725	Cady Brook	Washington	6.85	12.2
2105750	Bilodeau Brook	Hinsdale	7.01	14.6
3106825	Fox Brook	Granville	6.1	-0.4
3107375	Benton Brook	Otis	6.2	4
3107700	Valley Brook	Granville	6.7	2.2
3208725	Little River	Westfield	6.65	7
3210300	Walker Brook	Becket	6.84	8.6
3313175	Hinsdale Brook	Shelburne	7.37	42.9
3313850	Shingle Brook	Shelburne	6.78	45.7
3314100	North River	Colrain	6.75	12.4
3314450	Kinsman Brook	Heath	6.66	7.9
3314550	Vincent Brook	Colrain	7.24	12.4
3314650	Underwood Brook	Heath	6.72	4.9
3314925	East Oxbow Brook	Charlemont	6.34	3.2
3315075	Hartwell Brook	Charlemont	7.09	17.1
3315325	Bozrah Brook	Hawley	6.74	10.1
3316050	Todd Brook	Charlemont	6.59	3.2
3316550	Lord Brook	Rowe	7.6	67.2
3417750	Bagg Brook	West Springfield	7.15	27.3

3419825	Mill River	Conway	6.15	2.4
3522675	Black Brook	Warwick	5.68	0.4
3523750	Kenny Brook	Royalston	5	0
3523825	Beaman Brook	Winchendon	5.2	0.2
3523950	Wilder Brook	Gardner	5.51	1.7
3524050	Baker Brook	Gardner	5.29	0.4
3524200	Towne Brook	Royalston	5.28	0.2
3524250	Robbins Brook	Winchendon	6.27	4.29
3625975	Sucker Brook	New Braintree	6.42	4.13
3626475	Maynard Brook	Oakham	5.61	2.16
3626575	Cadwell Creek	Pelham	5.31	-0.2
3626800	West Br Swift River	Shutesbury	6.48	3.3
3627000	Hop Brook	New Salem	6.11	3.59
3627200	East Br Swift River	Barre	6.42	7.13
3627500	Flat Brook	Ware	5.91	1.2
3628175	West Br Ware River	Hubbardston	6.64	7.82
4230075	French River	Oxford	6.36	15.8
4230325	Wellington Brook	Oxford	5.88	2.99
5131275	Round Meadow Brook	Mendon	6.09	4
5131425	Aldrich Brook	Millville	6.88	11.4
5132600	Sewall Brook	Boylston	6.63	7.3
5132625	Cronin Brook	Grafton	6.85	21.4
5132700	Dorothy Brook	Worcester	6.73	18.2
5233750	Bungay River	North Attleborough	4.51	-2
6134700	Blossom Brook	Fall River	4.51	-1.8
6134725	King Phillip Brook	Fall River	4.6	-0.7
6235125	Rattlesnake Brook	Freetown	6.54	6.2
6235775	Mulberry Meadow	Easton	6.47	10.4
6235800	Beaver Brook	Easton	6.09	4
6236100	Bassett Brook	Raynham	6.8	7.5
8143675	Gulf Brook	Pepperell	7	18.8
8143825	Robinson Brook	Pepperell	5.03	-0.2
8146000	Bartlett Pond Brook	Leominster	6.97	17.7
8247475	Millham Brook	Marlborough	6.68	12.2
9253500	Ipswich River	Ipswich	6.58	10.8
9253700	Black Brook	Hamilton	6.68	8.8
9253925	Boston Brook	Middleton	4.42	
9560000	Angeline Brook	Westport	5.9	1.2
9560150	Bread And Cheese Brook	Westport	6.15	8.1
9661525	Hatches Creek	Eastham	5.62	1.1

Photos by MF Hatte