Lake Champlain Long-Term Water Quality and Biological Monitoring Program

Summary of Program Activities During 2012

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Prepared by:

Vermont Department of Environmental Conservation
Watershed Management Division
1 National Life Drive, Main Bldg, Second Floor
Montpelier, VT 05620-3522

and

New York State Department of Environmental Conservation
Region 5
P.O. Box 296
Ray Brook, NY 12977-0296

Submitted to:

Lake Champlain Basin Program
P.O. Box 204
54 West Shore Rd.
Grand Isle, VT 05458

Purpose of Report

The workplan for the Lake Champlain Long-Term Water Quality and Biological Monitoring Program approved by the Lake Champlain Basin Program specifies the following annual reporting requirements:

An annual report will consist of a summary of the history and purpose of the (program), description of the sampling network, summary of field sampling and analytical methods, parameter listings, and data tables. The purposes of this annual report will be achieved by maintaining an up-to-date Program Description document, graphical presentations of the data, and an interactive database, including statistical summaries, on the project website…… In addition, the quarterly report produced in April each year will provide a summary of program accomplishments for the calendar year just ended, including the number of samples obtained and analyzed at each site by parameter.

The Program Description document, interactive access to the project data, and graphical and statistical summaries of the data are available on the program webpage:
http://www.anr.state.vt.us/dec/waterq/lakes/htm/lp_longterm.htm

The purpose of this report is to provide a summary of sampling activities and other accomplishments during 2012.

Sampling Activities During 2012

Table 1 lists the number of sampling visits to each lake and tributary station in relation to the target frequencies specified in the project work plan. Table 2 lists the number of samples collected and analyzed for each monitoring parameter. The New York lake and tributary field sampling was conducted by the Lake Champlain Research Institute at SUNY Plattsburgh under an MOU between NYSDEC and SUNY. The frequency of lake sampling exceeded workplan targets at all stations during 2012. The frequency of tributary sampling was below the workplan targets for all stations. The number of tributary samples obtained each year depends to some extent on the number and timing of high flow events, since sampling is geared toward capturing the highest flow conditions when loading of phosphorus and other materials is greatest. There is little value in obtaining more samples under low or moderate flow conditions simply to meet workplan targets since low flow data do not contribute significantly to improving the precision of annual loading estimates. Figure 1 shows that sampling at each tributary captured most peak flow events during 2012.

Table 1. Number of sampling visits during 2012 at each lake and tributary station in comparison with workplan targets.

Number of Lake Sampling Visits					Number of Tributary Sampling Visits				
Lake Station	NY	VT	Total	Workplan Target[1]	Tributary Station	Crew	All Parameters TP, DP, TSS, Cl, TN	Total Phosphorus	Workplan Target[2]
2	10	11	21	12	AUSA01	NY	10	17	14/24
4	10	11	21	12	BOUQ01	NY	11	17	14/24
7	9	9	18	12	GCHA01	NY	11	17	14/24
9	9	6	14	12	LAMO01	VT	10	23	14/24
16	10	9	19	12	LAPL01	VT	9	19	14/24
19	9	8	17	12	LAUS01	NY	11	17	14/24
21	10	9	19	12	LCHA01	NY	11	17	14/24
25	9	10	19	12	LEWI01	VT	9	19	14/24
33	10	9	18	12	LOTT01	VT	9	20	14/24
34	10	10	20	12	METT01	VT	10	13	14/24
36	10	9	19	12	MISS01	VT	10	23	14/24
40	10	10	21	12	OTTE01	VT	10	20	14/24
46	9	9	18	12	PIKE01	VT	6	8	14/24
50	10	9	17	12	POUL01	VT	10	13	14/24
51	9	8	16	12	PUTN01	VT	10	13	14/24
					ROCK02	VT	10	22	14/24
					SALM01	NY	11	17	14/24
					SARA01	NY	11	17	14/24
					WINO01	VT	8	21	14/24
					JEWE02	VT	6	18	14/24
					STEV01	VT	8	20	14/24
					MILL01	VT	8	20	14/24

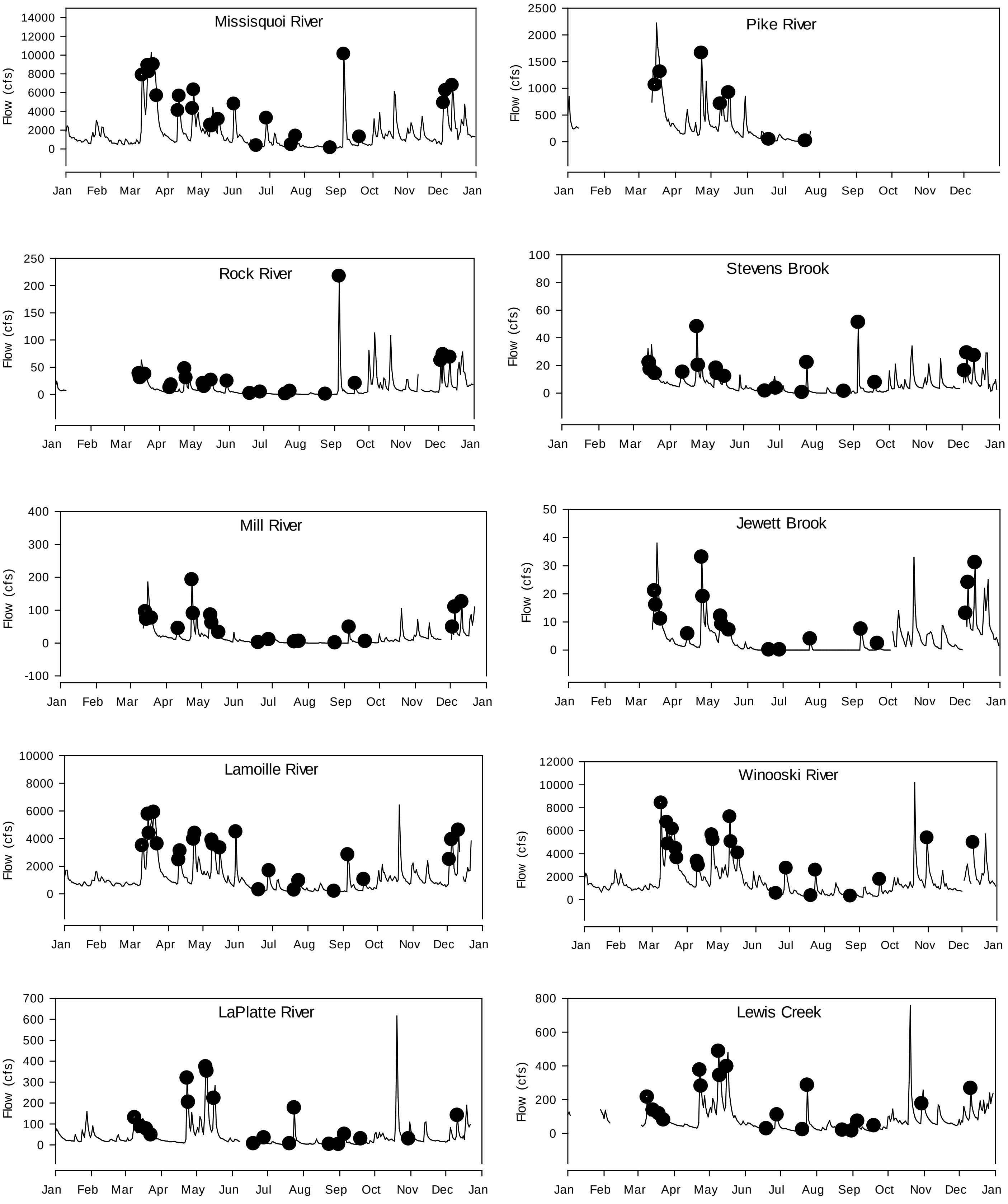
[1] Workplan target for lake sampling (12) applies to most chemical parameters and to phytoplankton, zooplankton, and zebra mussel veligers (at a subset of lake stations only). Sampling for zebra mussel juveniles in Lake Champlain and for veligers in tributaries and inland lakes is done once annually.

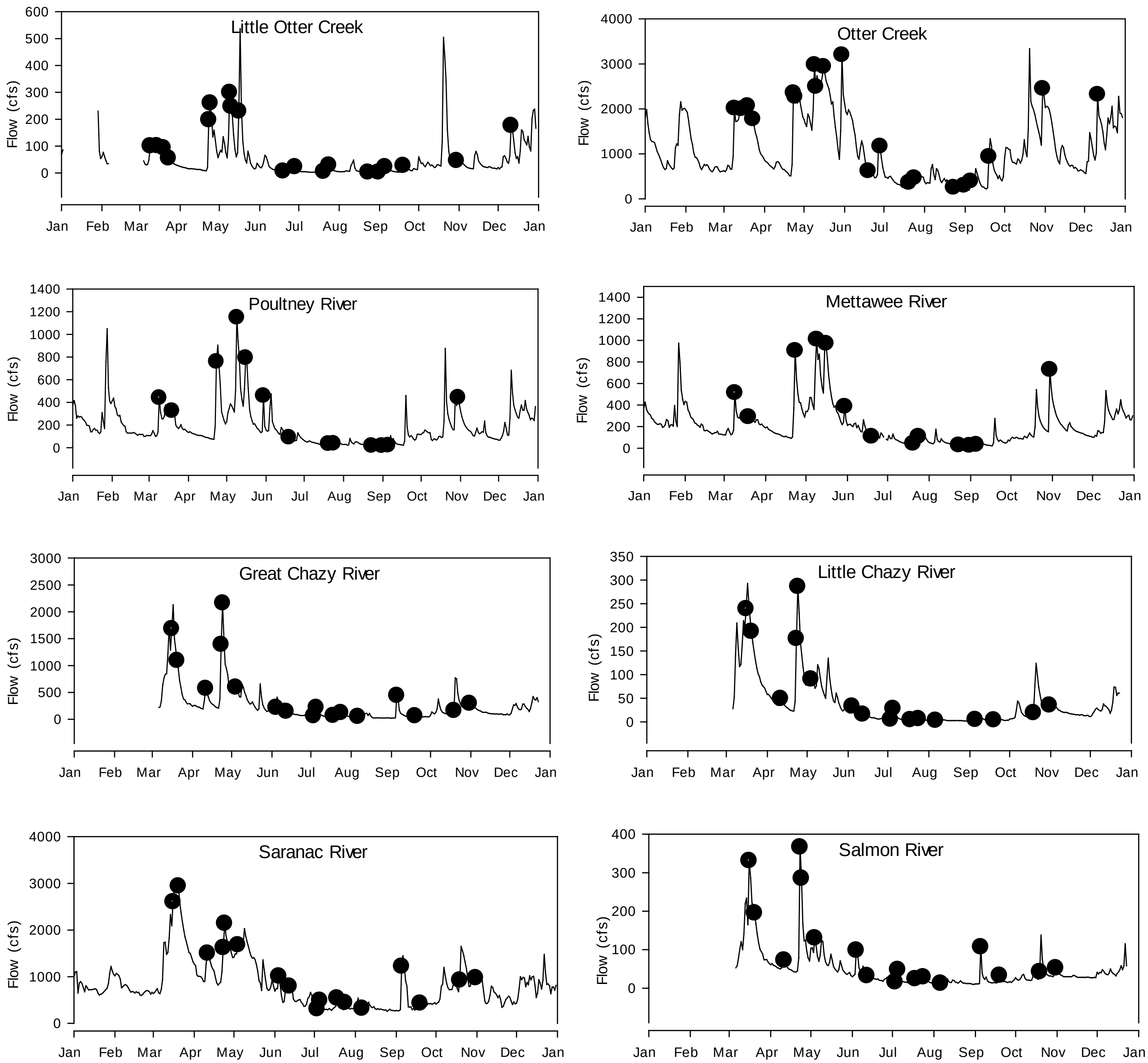
[2] The project workplan calls for 14 samples per year for most chemical parameters, including 10 samples at high flow and four samples at low flow. Additional sampling for total phosphorus only should occur on 10 other dates under high flow conditions, for a target of 24 samples per year for total phosphorus.

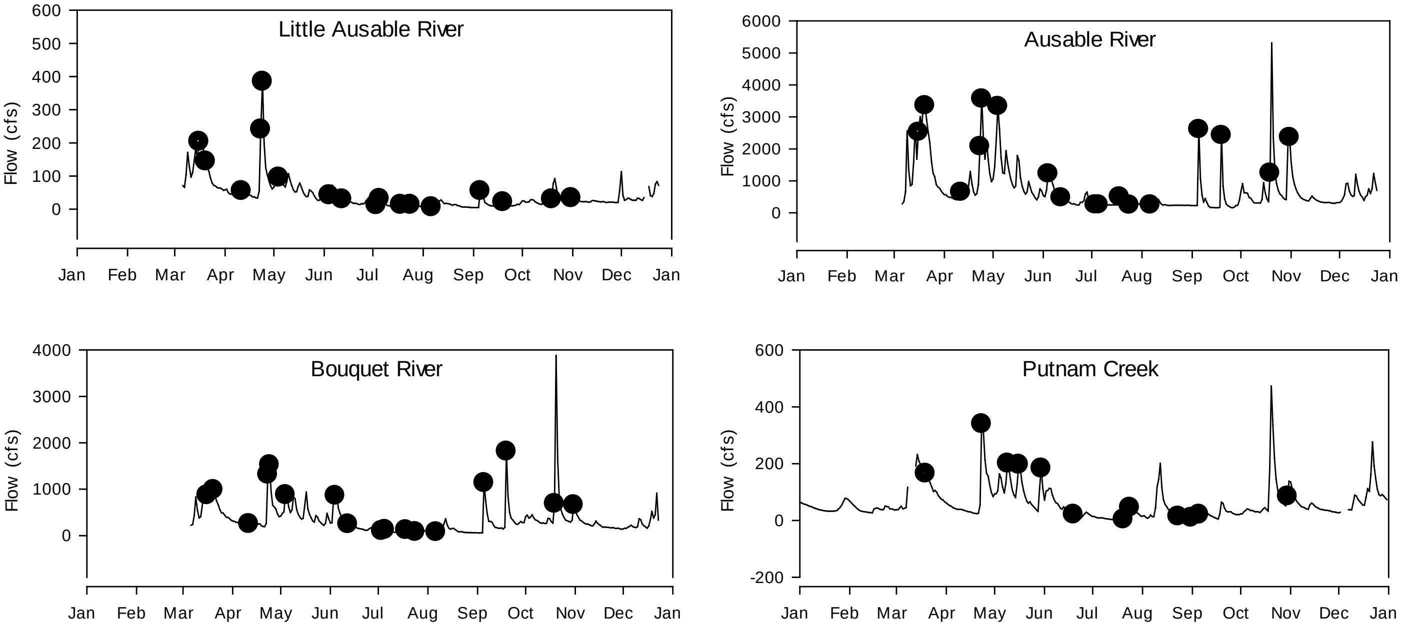
Table 2. Number of samples collected and analyzed for each monitoring parameter during 2012. Earth metals analysis (Ca, K, Na, Mg) is pending as of February 2013.

Parameter	**Lake**	**Tributaries**	**Total**
TP	410	473	883
DP	409	303	712
Cl	410	249	659
TN	410	251	661
Ca	56	65	111
SiO_2	410	-	410
K	56	65	111
Na	56	65	111
Mg	56	65	111
Alkalinity	55	75	130
DO (Winkler)	447	-	447
Chl-a	315	-	315
TSS	-	248	248
Temperature	277	271	548
Conductivity	-	248	248
pH	-	240	240
Secchi depth	277	-	277
Multiprobe depth profiles	260	-	260
Zebra mussel veligers	129	2	131
Zebra mussel settled juveniles	8	-	8
Mysids	132	-	132
Zooplankton	146	-	146
Phytoplankton	150	-	150

Figure 1. Sampling dates during 2012 in relation to daily flows at each tributary station. Daily flows are shown by lines, and sampling dates are shown by dots.




Little Otter Creek
Otter Creek
Poultney River
Mettawee River
Great Chazy River
Little Chazy River
Saranac River
Salmon River
Flow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan



Data Quality Assurance Results

As described in the program's Quality Assurance Project Plan, field equipment blanks and field duplicate samples are obtained on each sampling run. The results for the blank samples are summarized in Table 3. Three of the 203 blank samples analyzed during 2012 (1.5%) had concentrations above the analytical detection limits. The results for field duplicate samples are summarized in Table 4 for the chemical analyses. The results from laboratory and field duplicate analyses run on phytoplankton samples obtained during 2006-2011 are shown in Table 5. Mean relative percent differences among field duplicates were in the 39-45% range during 2011 for cell density and biovolume measurements. Metals results from 2012 are not yet available.

Table 3. Field equipment blank results during 2012 for lake and tributary samples.

Test	**Detection Limit**	**Units**	**Number of Blanks Obtained**	**Number of Blanks Above Limit**	**High Blank Values**
Alk	1.0	mg/l	7	0	
Cl	2.0	mg/l	32	0	
TN	0.1	mg/l	31	0	
TP	5.0	µg/l	40	1	5.14
DP	5.0	µg/l	38	1	12.1
Chl-a	0.5	µg/l	15	1	0.53
TSS	1.0	mg/l	18	0	
SiO2	0.2	mg/l	14	0	
Ca	0.25	mg/l	2		
Na	0.25	mg/l	2		
K	0.25	mg/l	2		
Mg	0.01	mg/l	2		
Total			203	3	

Table 4. Field duplicate results for chemical tests during 2012 showing the number of duplicates obtained (N) and the mean relative percent difference (RPD) between duplicate pairs. Metals analysis has not been completed.

	Lake		Tributaries	
Test	**N**	**Mean RPD**	**N**	**Mean RPD**
Chl-a	17	11.1	--	--
Cond	--	--	28	1.9
Cl	19	1.1	20	2.6
DP	18	7.7	27	7
pH	--	--	29	1.8
Alk	2	0.6	6	1.5
TN	19	9.8	26	5.6
TP	19	6.3	28	6.7
TSS	--	--	20	15.5
SiO2	19	1.5	--	--
Ca				
Na				
K				
Mg				

Table 5. Phytoplankton duplicate results for 2006–2011 showing the number of pairs (N) and the mean relative percent difference (RPD) between pairs. 2012 data are not available at this time.

Test	Year	N	Sample Type	Mean RPD
Field duplication	2006	8	Biovolume	38.1
			Cell Density	43.7
	2007	9	Biovolume	42.2
			Cell Density	23.6
	2008	17	Biovolume	47.8
			Cell Density	29.3
	2009	19	Biovolume	37.6
			Cell Density	40.9
	2010	14	Biovolume	35.7
			Cell Density	31.4
	2011	11	Biovolume	44.3
			Cell Density	44.8
Lab duplication	2006	17	Biovolume	14.4
			Cell Density	28.2
	2007	13	Biovolume	37.5
			Cell Density	38.6
	2008	18	Biovolume	50.7
			Cell Density	32.5
	2009	16	Biovolume	30.7
			Cell Density	33.7
	2010	16	Biovolume	36.7
			Cell Density	35.7
	2011	15	Biovolume	44.0
			Cell Density	39.3

Phytoplankton and Zooplankton Database

All phytoplankton data from 2006-2011 have been incorporated into the main Lake Champlain Monitoring Program database. Zooplankton data are currently available for the project period of 1993-2010. The data available for download from the web interface include phytoplankton cell densities and biovolumes, and zooplankton densities grouped by major taxonomic category. Counts by individual taxa will eventually be added to the web page, but are currently available only by request.

Webpage Use

Tracking of the number of web hits between 1/1/12 and 12/31/12 indicated that the program webpage received a total of 1,530 data queries from 189 different external users representing an average of 29 data queries per week during 2012.

Invasive Species Tabulation

Routine monitoring for spiny water flea (SWF) *Bythotrephes longimanus* began in the Champlain Canal in 2009, following confirmed presence of this organism in Greater Sacandaga Lake, NY. In 2010, program staff documented SWF in the Stewart's Bridge Reservoir, the last ponded waterbody in the Sacandaga River before its confluence with the Hudson River, connected to Lake Champlain by the Champlain Feeder Canal.

SWF was confirmed in Lake George in 2012, with the population considered well established throughout the lake. Because there is a direct hydrological link between Lake George and Lake Champlain via the LaChute River, biological sampling was initiated by SUNY Plattsburgh in the river and Lake Champlain beginning in 2012

Monitoring was conducted using two 10 minute zooplankton net tows (153 micron and 500 micron) from selected sites along the system. SWF was detected at the Glens Falls Feeder Canal (N=1) and the Champlain Canal at Baldwins Corners (N=6) on June 12, 2012. Once SWF was detected at these locations an intensive sampling effort using multiple techniques was conducted to determine the full extent of the invasion (Table 6, Figure 2). SWF was again detected in the Glens Falls Feeder Canal on June 26, 2012 (N=2) and July 25, 2012 (N=1). No SWF were found in the LaChute River or Lake Champlain stations. In total 232 samples were scanned for SWF presence.

No species of concern were noted in 42 plankton samples taken at 20 Vermont inland lakes which were analyzed by VTDEC monitoring program staff in 2012.

Table 6. SWF monitoring stations in the Lake Champlain Basin.

Station	Lat	Long	SWF found	Date Detected	# of sample events	# of samples
Station 9	44.2422	73.3292	No	NA	9	12
Station 7	44.1258	73.4127	No	NA	9	13
Station 4	43.9516	73.4075	No	NA	10	19
LaChute River at Montcalm St.	43.8479	73.4272	No	NA	4	9
LaChute River at Alexandria Ave.	43.836	73.4292	No	NA	4	8
Station 3A (LaChute River Mouth)	43.8343	73.3934	No	NA	5	12
Station 2	43.7148	73.3827	No	NA	10	31
Station 1 at Lock 12 Marina	43.5598	73.4002	No	NA	2	14
Champlain Canal Rt. 4 at Whitehall	43.54948	73.40181	No	NA	10	21
Champlain Canal, Rt. 22, Comstock	43.4566	73.4409	No	NA	5	11
Champlain Canal, Clay Hill Rd., Fort Ann	43.4129	73.485	No	NA	3	5
Champlain Canal, Baldwins Corners	43.38991	73.48615	Yes	6/12/12	9	15
Champlain Canal, Rt. 149, Smiths Basin	43.3579	73.4933	No	NA	2	4
Champlain Canal, New Swamp Road	43.3317	73.5107	No	NA	8	10
Champlain Canal, Rt. 196, Dunham Basin	43.3039	73.5392	No	NA	2	4
Glens Falls Feeder Canal at Burgoyne Ave.	43.2979	73.5698	No	NA	4	9
Glens Falls Feeder Canal, Richardson St.	43.2918	73.6636	Yes	6/12/12	9	35

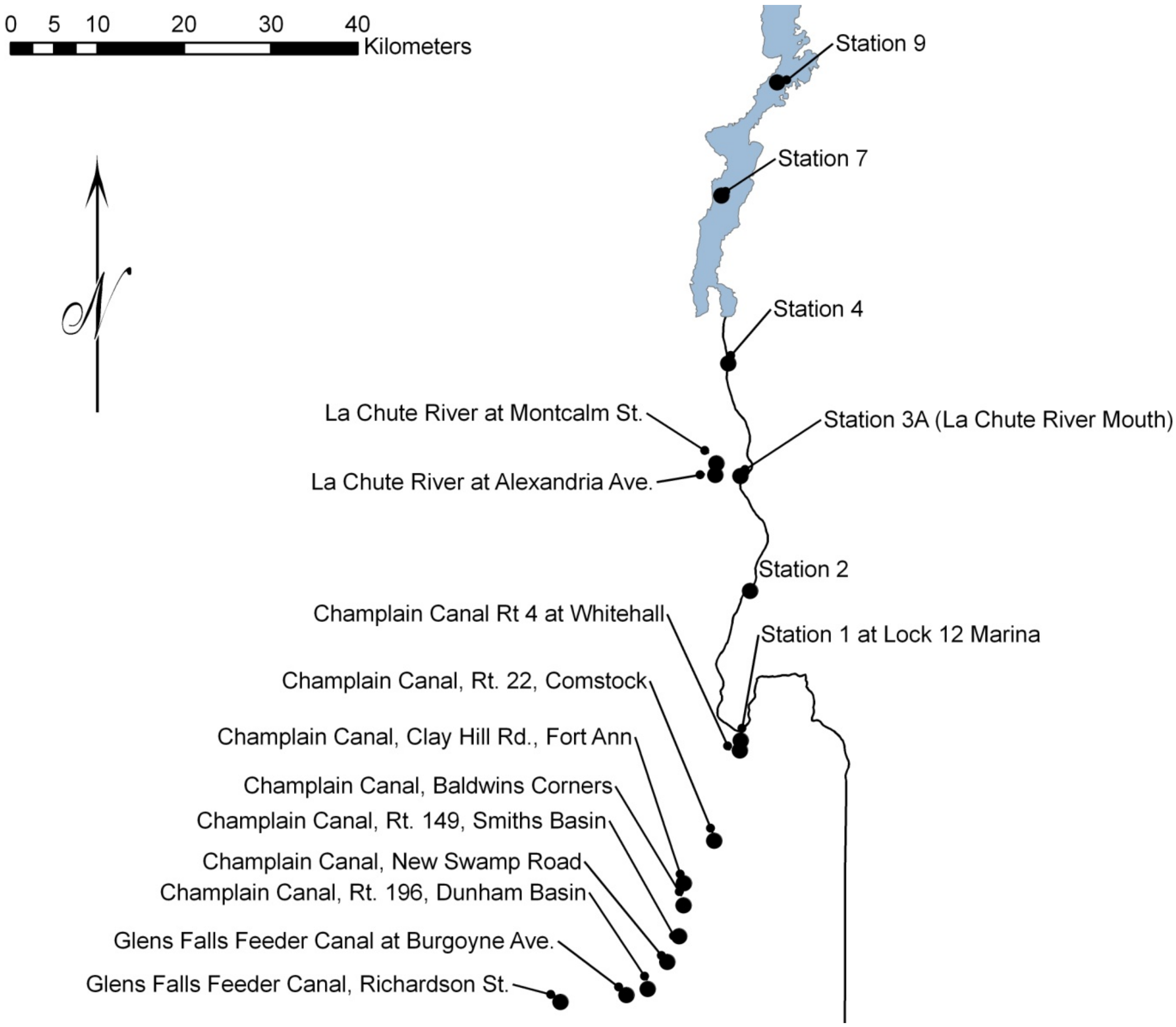


Figure 2. Map of Lake Champlain SWF Monitoring Locations

Wastewater Phosphorus Discharge Data

The project workplan requires an annual compilation of wastewater phosphorus discharge data for all treatment facilities in the Vermont and New York portions of the Lake Champlain Basin. Data on annual mean flow, total phosphorus concentration, and phosphorus load at each facility have been compiled for 2012 along with data from previous years, and are available electronically in spreadsheet form on request. The total loads and flows from Vermont and New York wastewater treatment facilities during 2007-2012 are summarized in Table 6.

Table 6. Total phosphorus load to Lake Champlain from wastewater treatment facilities in Vermont and New York from 2007-2012.

State	Number of Facilities	Year	Total Phosphorus Load (mt/yr)	Total Flow (mgd)
Vermont	60	2007	20.9	43.5
	60	2008	21.1	45.1
	60	2009	20.3	40.5
	60	2010	18.4	39.7
	59	2011	19.3	45.5
	59	2012	16.9	37.6
New York	29	2007	28.5	33.2
	29	2008	26.5	34.3
	29	2009	20.9	31.5
	29	2010	22.0	32.8
	29	2011	23.0	34.4
	29	2012	Not available	Not available

Method Changes

Evaluation of Azide Reagent Elimination in the Winkler Dissolved Oxygen Method

As noted in the 2012 QAPP for this program, the Vermont DEC Laboratory discontinued the use of azide reagents used in the Winkler dissolved oxygen (DO) reagent #2 beginning in 2011 because of its hazards and high cost for proper disposal. The Laboratory had researched whether azide could be eliminated from the reagent without significantly affecting the results of the standard azide modification of the Winkler titration method, but found that there has been no research done on this by EPA. The potential concern is for low-DO samples where nitrite might be present and could oxidize the added iodide reagent to iodine. This could result in a positive bias because the iodine generated during the Winkler procedure is assumed to be stoichiometrically equal to the DO present in the original sample. The azide modification prevents this bias by destroying any nitrite present.

In order to check for this possible positive bias, DO measurements made using HydroLab probes were compared with concurrent Winkler titration results. Results from the two methods were compared using data obtained during 2007-2010 when the azide reagent was in use, and during 2011-2012 when the azide reagent was not used. The comparison was done using all data from Malletts Bay (Station 25) which had the largest range of DO concentrations of any lake station, including the lowest hypolimnetic DO concentrations found in the lake during late summer.

The results of this comparison are shown in Figure 3. During both time periods (2007-2010 and 2011-2012), there was a positive bias in the Winkler results relative to the HydroLab results at the low DO concentration end, and a negative bias at the high DO end. The residuals plots for the 1:1 lines illustrate this clearly.

The effect of the azide method change on the Winkler results was evaluated using analysis of covariance (ANCOVA, Grabow et al., 1998) using the HydroLab results as the covariate. The linear regressions in Figure 3 (bottom plot) show that the intercept was higher by about 0.5 mg/L for the without-azide results. The ANCOVA analysis for these regressions confirmed that the intercept was significantly higher and the slope was significantly lower for the without-azide results ($p < 0.01$).

The reasons for the differences between the Winkler and HydroLab results are not clear, but these results suggest that data from these two DO methods should not be pooled when conducting long-term trend analyses because apparent trends could be artifacts of method bias. The positive bias (elevated regression intercept) seen in the without-azide samples at low DO concentrations is consistent with possible nitrite interference, but could also have resulted from differences between the two DO methods. Appropriate caution with an awareness of the Winkler method change starting in 2011 should be used in conducting long-term DO trend analyses from this dataset.

Reference:

Grabow, G.L., J. Spooner, L.A. Lombardo, and D E. Line. 1998. Detecting water quality changes before and after BMP implementation: Use of a spreadsheet for statistical analysis. North Carolina State University Water Quality Group Newsletter. No. 92. Raleigh, NC. http://www.bae.ncsu.edu/programs/extension/wqg/issues/92.pdf

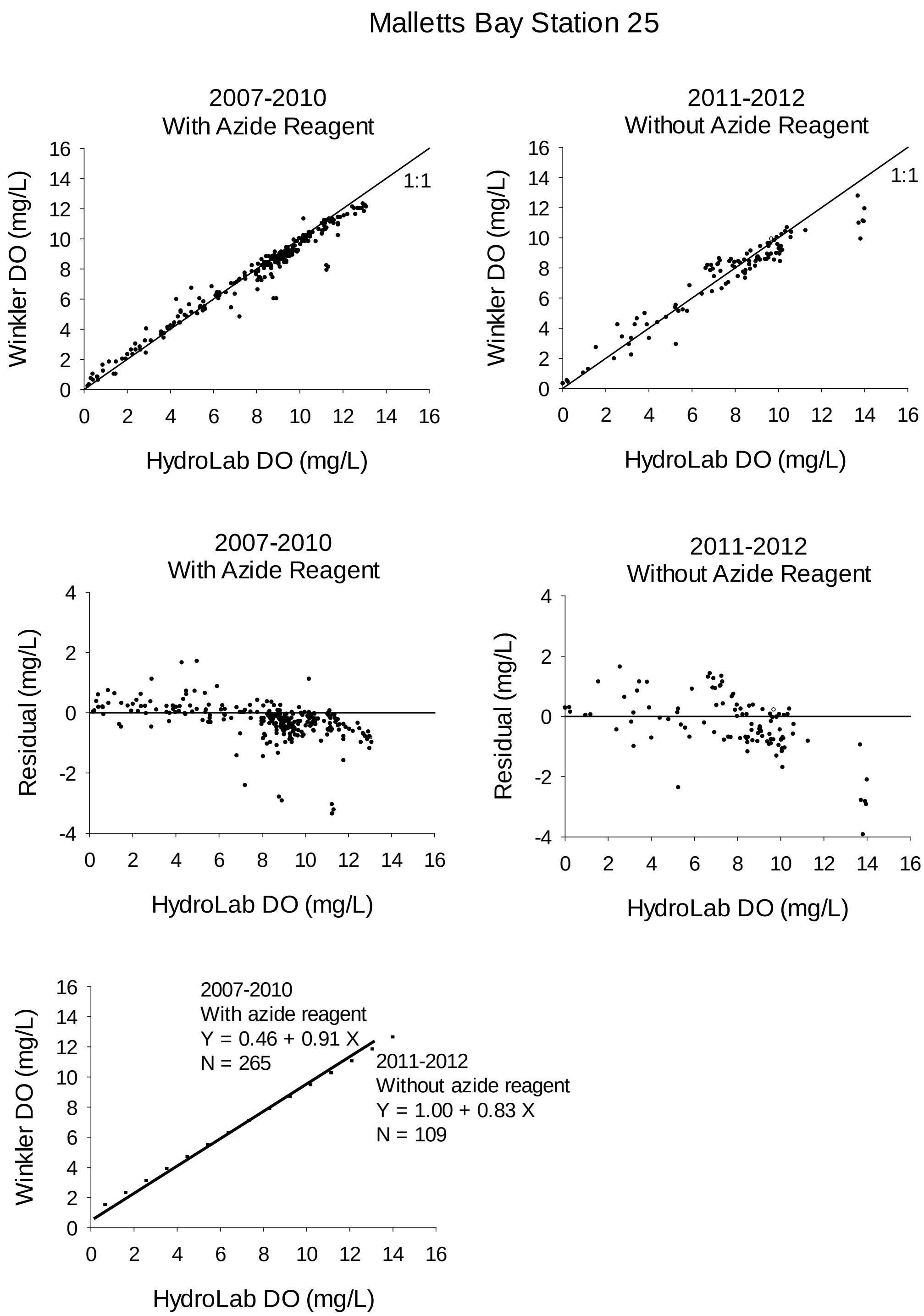


Figure 3. Comparison of DO results from Malletts Bay (Station 25) with and without use of azide reagent during two different time periods. Top row: Scatterplots of Winkler results vs. HydroLab results showing 1:1 lines. Middle row: Plots of residuals around the 1:1 lines. Bottom row: Linear regressions of Winkler vs. HydroLab results with azide (solid line) and without azide (dotted line).