Lake Champlain Long-Term Water Quality and Biological Monitoring Program

Summary of Program Activities During 2013

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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

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

Lake Champlain Research Institute
SUNY Plattsburgh-Hudson 136D
101 Broad Street
Plattsburgh, NY 12901

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 2013.

Sampling Activities During 2013

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 2013. 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 (with the exception of Pike River) captured most peak flow events during 2013.

Table 1. Number of sampling visits during 2013 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	6	16	12	AUSA01	NY	14	18	14/24
4	10	7	17	12	BOUQ01	NY	14	19	14/24
7	12	7	19	12	GCHA01	NY	13	17	14/24
9	9	4	13	12	LAMO01	VT	13	18	14/24
16	9	8	17	12	LAPL01	VT	10	13	14/24
19	10	4	14	12	LAUS01	NY	14	18	14/24
21	10	7	17	12	LCHA01	NY	14	18	14/24
25	10	6	16	12	LEWI01	VT	10	13	14/24
33	10	6	16	12	LOTT01	VT	9	12	14/24
34	10	7	17	12	METT01	VT	7	9	14/24
36	10	6	16	12	MISS01	VT	13	20	14/24
40	10	7	17	12	OTTE01	VT	10	13	14/24
46	9	6	15	12	PIKE01	VT	2	3	14/24
50	9	7	16	12	POUL01	VT	7	10	14/24
51	9	7	16	12	PUTN01	VT	7	10	14/24
					ROCK02	VT	10	14	14/24
					SALM01	NY	14	18	14/24
					SARA01	NY	14	18	14/24
					WINO01	VT	14	18	14/24
					JEWE02	VT	8	13	14/24
					STEV01	VT	11	16	14/24
					MILL01	VT	11	16	14/24

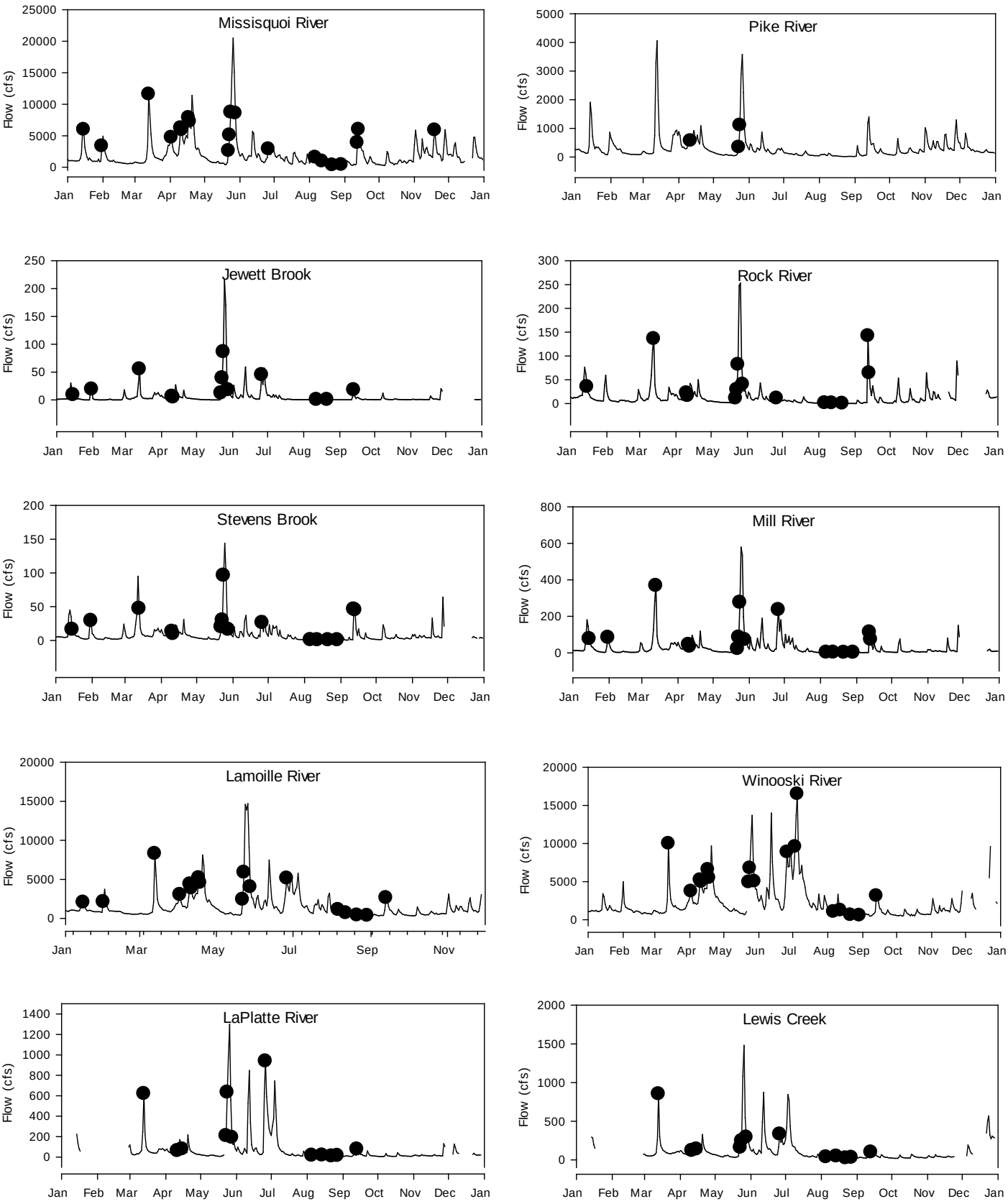
[1] Workplan target for lake sampling (12) applies to most chemical parameters and to phytoplankton, zooplankton, and zebra mussel veligers (at a subset of lake stations only). Sampling for zebra mussel juveniles in Lake Champlain and for veligers in tributaries and inland lakes is done once annually.

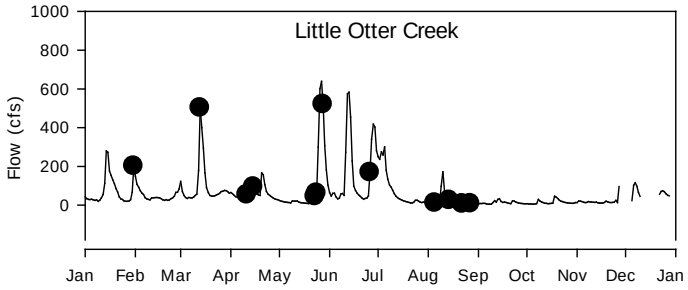
[2] The project workplan calls for 14 samples per year for most chemical parameters, including 10 samples at high flow and four samples at low flow. Additional sampling for total phosphorus only should occur on 10 other dates under high flow conditions, for a target of 24 samples per year for total phosphorus.

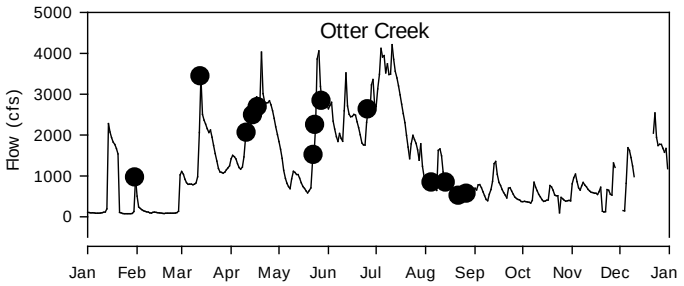
Table 2. Number of samples collected and analyzed for each monitoring parameter during 2013.

Parameter	Lake	Tributaries	Total
TP	340	376	716
DP	340	253	593
Cl	340	217	557
TN	339	275	614
Ca	38	43	81
SiO2	339	-	339
K	38	43	81
Na	38	43	81
Mg	38	43	81
Alkalinity	38	44	82
DO (Winkler)	264	-	264
Chl-a	270	-	270
TSS	-	209	209
Temperature	226	211	437
Conductivity	-	198	198
pH	-	197	197
Secchi depth	242	-	242
Multiprobe depth profiles	232	-	232
Zebra mussel veligers	110	2	112
Zebra mussel settled juveniles	5	-	5
Mysids	138	-	138
Zooplankton	149	-	149
Phytoplankton	170	-	170

Figure 1. Sampling dates during 2013 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
Flow (cfs)
1000
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Otter Creek
Flow (cfs)
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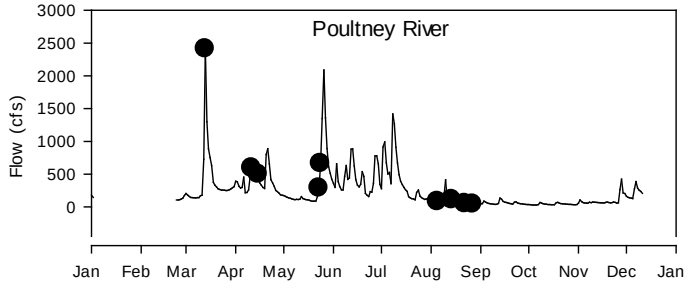
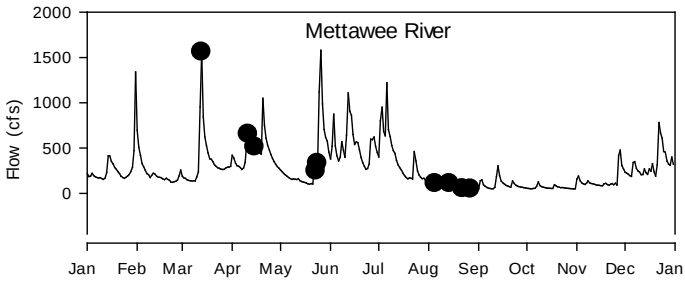
4000
3000
2000
1000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Poultney River
Flow (cfs)
3000
2500
2000
1500
1000
500
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan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Flow (cfs)
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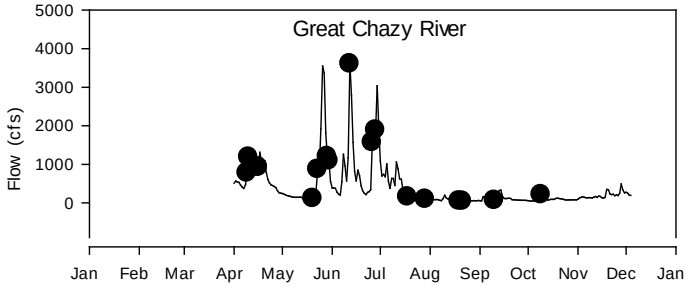
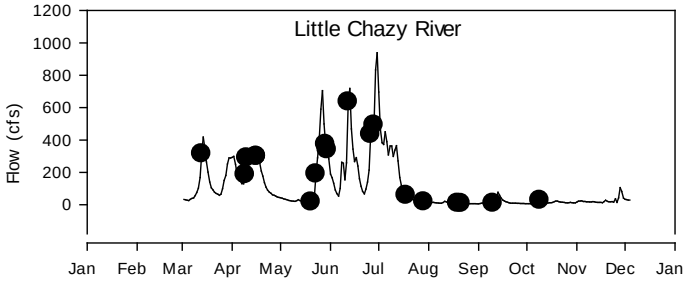
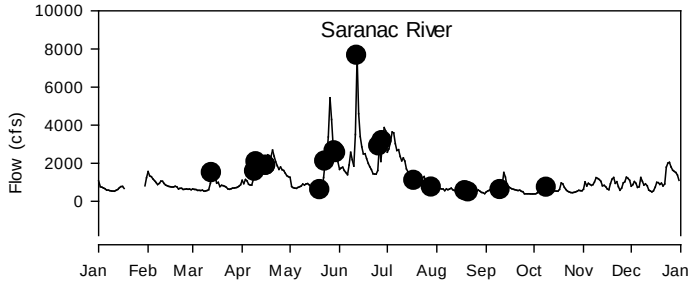
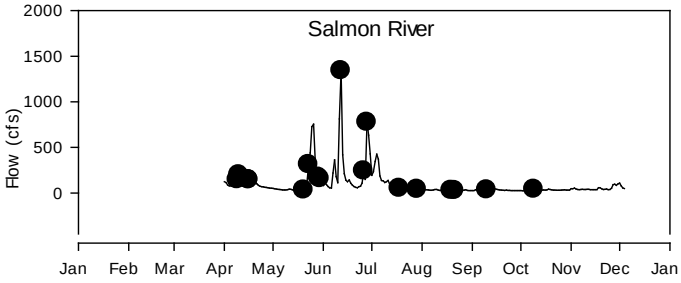
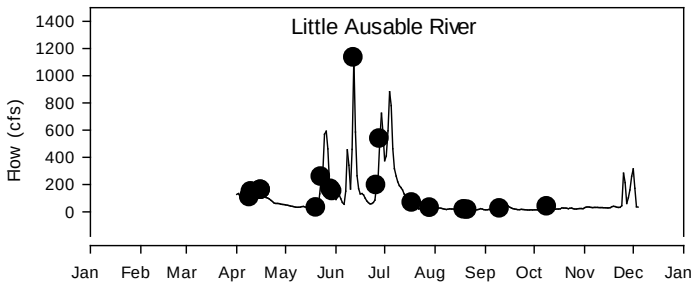
1500
1000
500
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

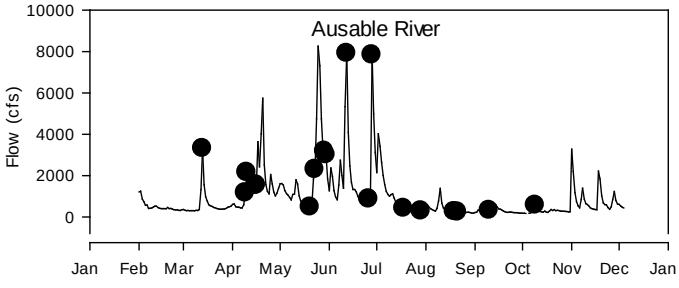

Great Chazy River
Flow (cfs)
5000
4000
3000
2000
1000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

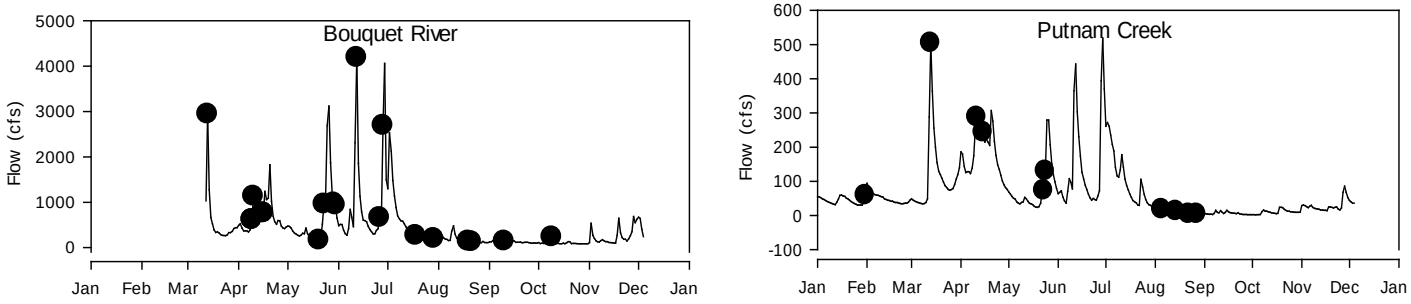

Little Chazy River
Flow (cfs)
1200
1000
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Saranac River
Flow (cfs)
10000
8000
6000
4000
2000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Salmon River
Flow (cfs)
2000
1500
1000
500
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Little Ausable River
Flow (cfs)
1400
1200
1000
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Ausable River
Flow (cfs)
10000
8000
6000
4000
2000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan



Invasive Species Monitoring

Monitoring for the Invasive spiny water flea (SWF) *Bythotrephes longimanus* continued in the Champlain Canal and Glens Falls Feeder Canal network during 2013. Monitoring was conducted using two 15 minute zooplankton net tows (250 micron and 500 micron) from selected sites along the system. Two individual SWF were detected at the Glens Falls Feeder Canal on June 12, 2013. Once SWF was detected at these locations an intensive sampling effort using multiple techniques was conducted to determine the full extent of the invasion (Figure 2, Table 3). A single SWF was again detected in the Glens Falls Feeder Canal on June 26, 2013. In total, 260 samples were scanned for SWF presence.

Figure 2. Map of Lake Champlain SWF Monitoring Locations

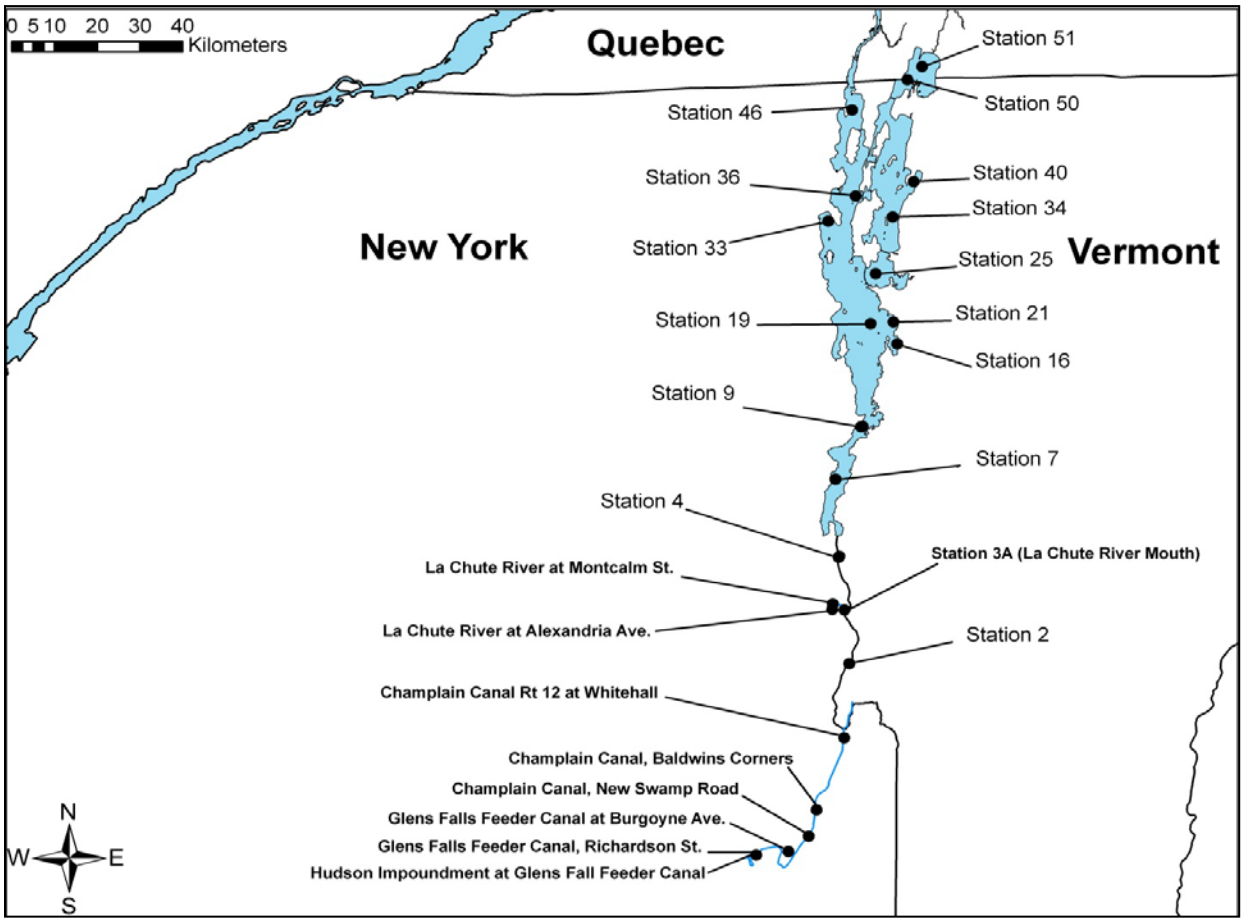


Table 3. SWF monitoring stations in the Lake Champlain Basin including dates and locations of SWF

Station	Lat	Long	SWF found	Date Detected	# of sample events	# of samples
51	45.0410	73.1290	No	Not Detected	10	10
50	45.0130	73.1740	No	Not Detected	10	10
46	44.9480	73.3400	No	Not Detected	10	10
40	44.7850	73.1620	No	Not Detected	10	10
36	44.7560	73.3350	No	Not Detected	10	10
34	44.7080	73.2270	No	Not Detected	9	9
33	44.7010	73.4180	No	Not Detected	10	10
25	44.5820	73.2810	No	Not Detected	9	9
21	44.4740	73.2320	No	Not Detected	11	11
19	44.4710	73.2990	No	Not Detected	10	10
16	44.4250	73.2220	No	Not Detected	10	10
9	44.2420	73.3340	No	Not Detected	10	10
7	44.1260	73.4120	No	Not Detected	9	9
4	43.9540	73.4050	No	Not Detected	11	11
3A	43.8343	73.3934	No	Not Detected	11	11
2	43.7140	73.3830	No	Not Detected	10	10
La Chute River at Montcalm St.	43.8479	73.4272	No	Not Detected	5	10
La Chute River at Alexandria Ave.	43.8360	73.4292	No	Not Detected	5	10
Champlain Canal Rt 4 at Whitehall	43.5495	73.4018	No	Not Detected	5	10
Champlain Canal, Baldwins Corners	43.3899	73.4862	No	Not Detected	5	10
Champlain Canal, New Swamp Road	43.3317	73.5107	No	Not Detected	5	10
Glens Falls Feeder Canal at Burgoyne Ave.	43.2979	73.5698	No	Not Detected	5	10
Glens Falls Feeder Canal, Richardson St.	43.2918	73.6636	Yes	6/12/2013 & 6/26/2013	5	30
Hudson Impoundment	43.2921	73.6655	No	Not Detected	5	10
					Total # of Samples	**260**

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 4. Three of the 190 blank samples analyzed during 2013 (1.6%) had concentrations above the analytical detection limits. The results for field duplicate samples are summarized in Table 5 for the chemical analyses. The results from laboratory and field duplicate analyses run on phytoplankton samples obtained during 2006-2013 are shown in Table 6. Mean relative percent differences among field duplicates were 34 and 28% in 2013 for cell density and

biovolume measurements, respectively. Mean relative percent differences among lab duplicates were 37 and 27% in 2013 for cell density and biovolume measurements, respectively.

Table 4. Field equipment blank results during 2013 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	5	0	
Cl	2.0	mg/l	28	0	
TN	0.1	mg/l	30	0	
TP	5.0	µg/l	35	2	7.02, 5.07
DP	5.0	µg/l	32	0	
Chl-a	0.5	µg/l	15	1	2.56
TSS	1.0	mg/l	14	0	
SiO2	0.2	mg/l	15	0	
Ca	0.25	mg/l	4	0	
Na	0.5	mg/l	4	0	
K	0.5	mg/l	4	0	
Mg	0.25	mg/l	4	0	
Total			190	3	

Table 5. Field duplicate results for chemical tests during 2013 showing the number of duplicates obtained (N) and the mean relative percent difference (RPD) between duplicate pairs.

	Lake		Tributaries	
Test	N	Mean RPD	N	Mean RPD
Chl-a	14	18.9	--	--
Cond	--	--	19	2.5
Cl	16	1.4	16	9.4
DP	15	5.5	19	14.1
pH	--	--	18	1.4
Alk	1	1.4	4	1.1
TN	15	6.7	17	5.1
TP	16	11.2	19	12.7
TSS	--	--	16	17.2
SiO2	15	1.3	--	--
Ca	1	2.5	4	1.2
Na	1	2.9	4	2.1
K	1	3.2	4	3.4
Mg	1	2.0	4	1.2

Table 6. Phytoplankton duplicate results for 2006–2013 showing the number of pairs (N) and the mean relative percent difference (RPD) between pairs.

Test	Year	N	Sample Type	Mean RPD
Field duplication	2006	9	Biovolume	22.9
			Cell Density	32.7
	2007	9	Biovolume	25.8
			Cell Density	23.6
	2008	17	Biovolume	51.3
			Cell Density	32.5
	2009	19	Biovolume	37.8
			Cell Density	40.9
	2010	14	Biovolume	41.7
			Cell Density	31.4
	2011	11	Biovolume	44.4
			Cell Density	44.8
	2012	12	Biovolume	42.3
			Cell Density	55.4
	2013	8	Biovolume	27.9
			Cell Density	33.4
Lab duplication	2006	18	Biovolume	29.9
			Cell Density	33.6
	2007	13	Biovolume	23.6
			Cell Density	38.9
	2008	18	Biovolume	32.2
			Cell Density	29.3
	2009	16	Biovolume	34.5
			Cell Density	33.7
	2010	16	Biovolume	32.4
			Cell Density	41.3
	2011	15	Biovolume	32.1
			Cell Density	39.3
	2012	19	Biovolume	28.3
			Cell Density	27.5
	2013	12	Biovolume	26.9
			Cell Density	37.1

Phytoplankton and Zooplankton Database

All phytoplankton data from 2006-2013 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.In 2013, VT DEC was informed of a discrepancy in biovolume provided for Lake Champlain phytoplankton and literature values for some taxa.

Review of the calculations found an error, resulting in recalculation of all phytoplankton data. The database has been corrected and values in Table 6 recalculated using the corrected data.

Webpage Use

Tracking of the number of web hits between 1/1/13 and 10/8/13 indicated that the program webpage received a total of 1,040 data queries from 155 different IP addresses representing an average of 26 data queries per week during 2013. The tracking ended on October 9th when a different application to display our data online was initiated. The new application does not give the detail of the previous version, therefore this will not be reported in the future.

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 7. 2013 data should be available by late spring and will be updated in the online version http://www.vtwaterquality.org/lakes/htm/lp_longterm.htm

Table 7. Total phosphorus load to Lake Champlain from wastewater treatment facilities in Vermont and New York from 2007-2013.

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
	59	2013	17.1	40.6
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	22.6	30.4
	29	2013	Not available	Not available

Rock River Monitoring Project

A Rock River Watershed Targeted Best Management Practice (BMP) Implementation Project was initiated in 2010 with funding provided by the Lake Champlain Basin Program (LCBP) and with oversight provided by a coordinating committee including the U.S. Natural Resource Conservation Service (NRCS), the Vermont Agency of Agriculture, Food, and Markets (AAFM) and the Vermont Department of Environmental Conservation (DEC). The purpose of the project is to demonstrate water quality improvements from a focused agricultural BMP implementation effort in a small watershed where very high rates of phosphorus loading to Lake Champlain have been documented. Most of the identified BMP implementation projects were expected to begin in 2013 or 2014.

In order to document water quality improvements resulting from the targeted BMP implementation in the Rock River watershed, the Vermont DEC established monitoring stations immediately upstream and downstream of the BMP implementation area in late 2010, and funded the construction and operation of a U.S. Geological Survey (USGS) stream flow gage at the downstream site. The DEC issued a grant to the Friends of Northern Lake Champlain (FNLC) to support sample collection activities by trained local residents, and the DEC Laboratory has been conducting the sample analyses. The LCBP now financially supports the sampling, stream gaging, and laboratory analytical efforts.

The area targeted for BMP implementation is approximately 13.5 km^2 in size on the upper Rock River in the towns of Highgate and Franklin, VT. Nearly all of the BMP implementation area is contained within the catchment area between the upstream monitoring station (RR20) and the downstream station (RR14). The implementation area occupies about 90% of the 15.1 km^2 drainage area between the upstream and the downstream stations. A USGS continuous stream flow gage is co-located with the downstream sampling station (RR14).

Samples are obtained manually as grab samples from the center of the river on each date for analysis of total phosphorus (TP), total dissolved phosphorus (DP), and total suspended solids (TSS). Sampling is conducted biweekly year-round except during the winter months when snow and ice in the river make sampling impossible. Additional sampling is conducted during high-flow events.

The study was designed as an upstream/downstream – before/after analysis, which is a type of a paired watershed design. It is anticipated that Analysis of Covariance (ANCOVA) will be used to test for statistically significant differences in TP, DP, and TSS concentrations at the downstream station before vs. after BMP implementation. If BMP implementation is more gradual without clear before/after periods, other regression methods with time as the independent variable may need to be employed.

The sampling effort to date has produced good coverage across all seasons and flow conditions (Figure 3). There have been 200 upstream/downstream paired samples collected and analyzed for TP, DP, and TSS through 2013. This total includes some samples obtained during 2008-2009 by Vermont DEC as part of a previous study. The numbers of paired samples obtained each year are shown in Table 8.

Figure 3. Distribution of sampling effort in the Rock River with respect to flow, 2010-2013.

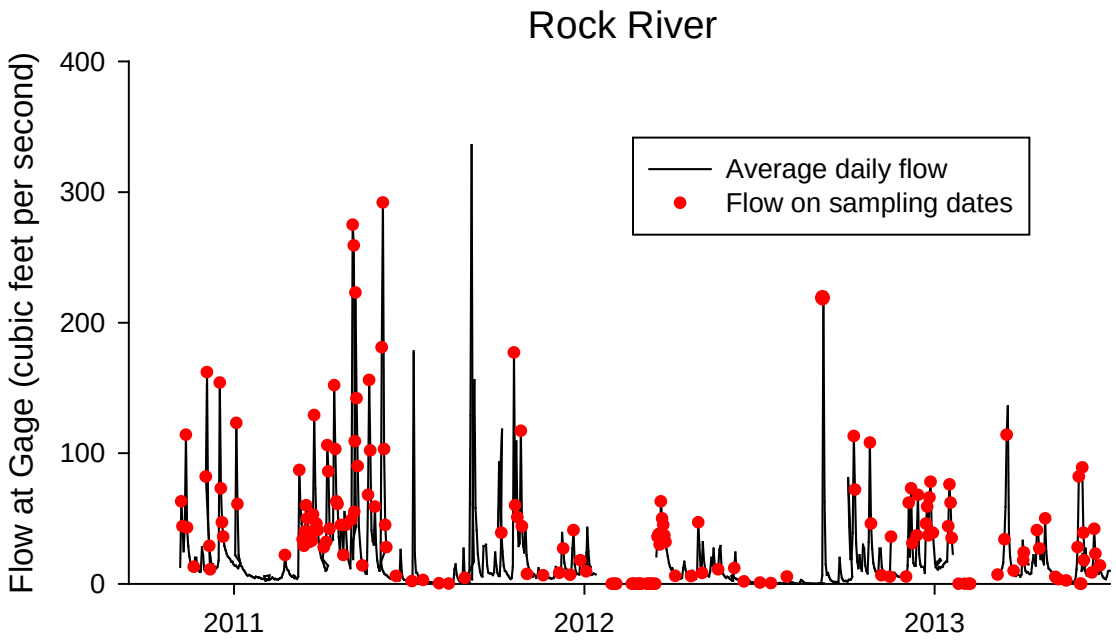


Table 8. Number of sample pairs obtained by year in the Rock River.

Year	Number of Samples
2008	10
2009	2
2010	18
2011	66
2012	54
2013	50
TOTAL	**200**