Lake Champlain Long-Term Water Quality and Biological Monitoring Program

Summary of Program Activities During 2014

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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.watershedmanagement.vt.gov/lakes/htm/lp_longterm.htm. The purpose of this report is to provide a summary of sampling activities and other accomplishments during 2014.

Sampling Activities During 2014

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 2014. 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 2014.

Table 1. Number of sampling visits during 2014 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	8	18	12	AUSA01	NY	9	12	14/24
4	10	8	18	12	BOUQ01	NY	10	12	14/24
7	10	7	17	12	GCHA01	NY	10	13	14/24
9	10	5	15	12	LAMO01	VT	9	17	14/24
16	10	8	18	12	LAPL01	VT	10	18	14/24
19	10	6	16	12	LAUS01	NY	10	16	14/24
21	10	8	18	12	LCHA01	NY	10	16	14/24
25	10	8	18	12	LEWI01	VT	11	19	14/24
33	10	7	17	12	LOTT01	VT	10	12	14/24
34	10	7	17	12	METT01	VT	9	13	14/24
36	10	7	17	12	MISS01	VT	10	17	14/24
40	10	8	18	12	OTTE01	VT	11	19	14/24
46	9	7	16	12	PIKE01	VT	8	10	14/24
50	10	8	18	12	POUL01	VT	10	14	14/24
51	10	9	19	12	PUTN01	VT	10	13	14/24
					ROCK02	VT	9	15	14/24
					SALM01	NY	10	15	14/24
					SARA01	NY	10	14	14/24
					WINO01	VT	10	18	14/24
					JEWE02	VT	8	14	14/24
					STEV01	VT	9	15	14/24
					MILL01	VT	9	15	14/24

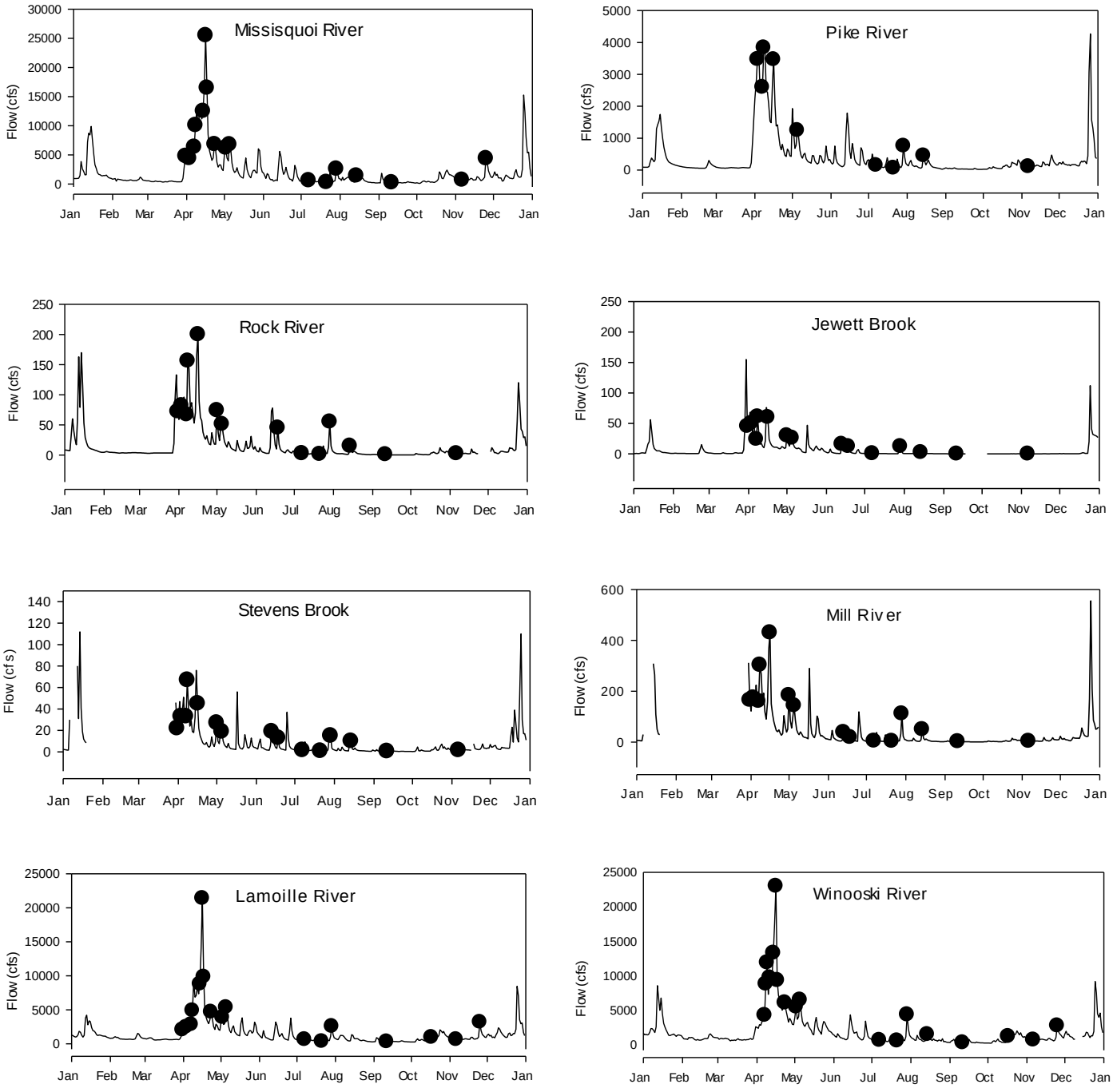
[1] Workplan target for lake sampling (12) applies to most chemical parameters and to phytoplankton, zooplankton, and zebra mussel veligers (at a subset of lake stations only). Sampling for zebra mussel juveniles in Lake Champlain and for veligers in tributaries and inland lakes is done once annually.

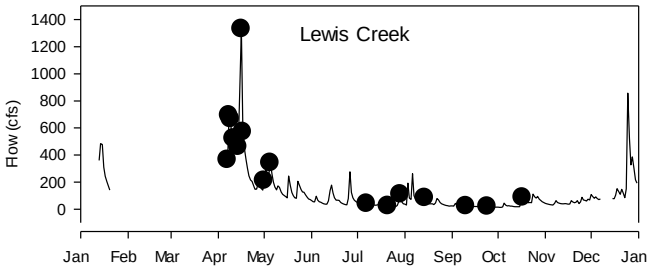
[2] The project workplan calls for 14 samples per year for most chemical parameters, including 10 samples at high flow and four samples at low flow. Additional sampling for total phosphorus only should occur on 10 other dates under high flow conditions, for a target of 24 samples per year for total phosphorus.

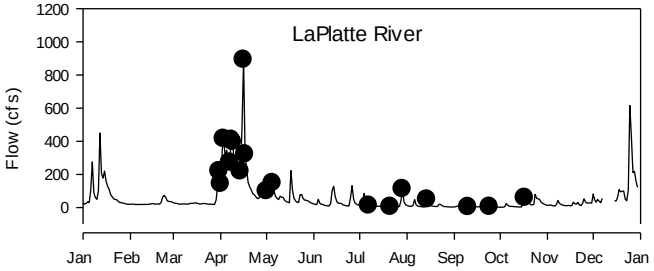
Table 2. Number of samples collected and analyzed for each monitoring parameter during 2014.

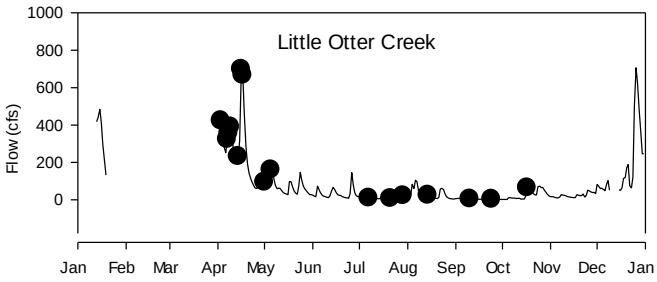
Parameter	Lake	Tributaries	Total
TP	382	390	772
DP	382	264	646
Cl	383	291	674
TN	383	275	658
Ca	60	61	121
SiO2	382	-	382
K	60	61	121
Na	60	61	121
Mg	60	61	121
Alkalinity	60	62	122
DO (Winkler)	350	-	350
Chl-a	294	-	294
TSS	-	250	250
Temperature	-	166	166
Conductivity	-	224	224
pH	-	234	234
Secchi depth	260	-	260
Multiprobe depth profiles	210	-	210
Zebra mussel veligers	129	2	131
Zebra mussel settled juveniles	5	-	5
Mysids	114	-	114
Zooplankton	150	-	150
Phytoplankton	150	-	150
Spiny waterflea	290	-	290

Figure 1. Sampling dates during 2014 in relation to daily flows at each tributary station. Daily flows are shown by lines, and sampling dates are shown by dots.




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


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


Little Otter Creek
Flow (cfs)
0
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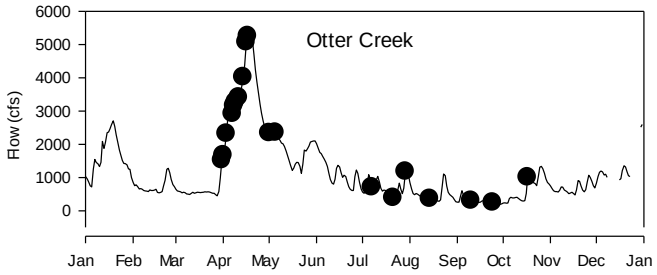
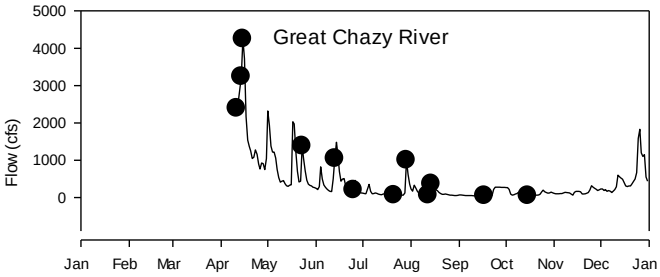
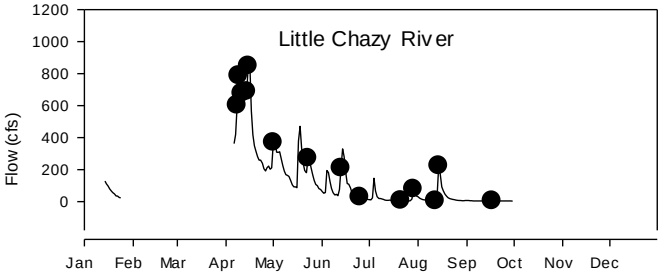
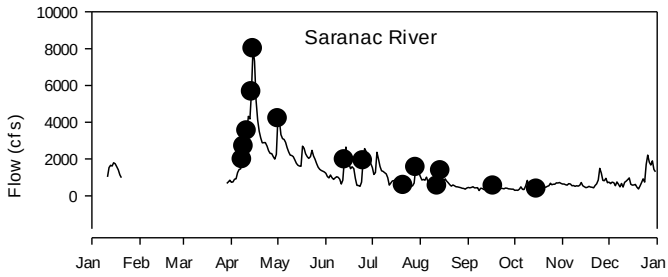
400
600
800
1000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


Otter Creek
Flow (cfs)
0
1000
2000
3000
4000
5000
6000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


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


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


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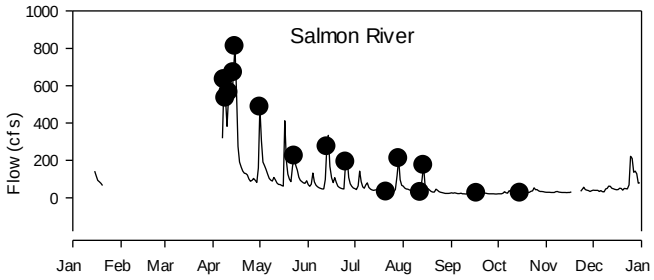
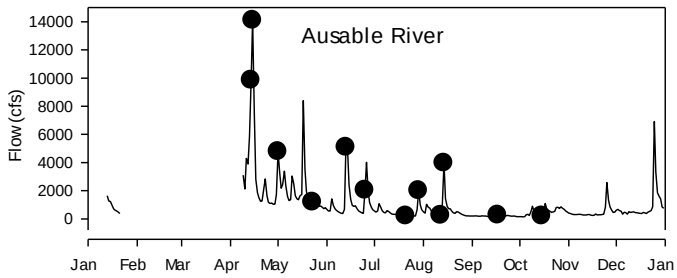
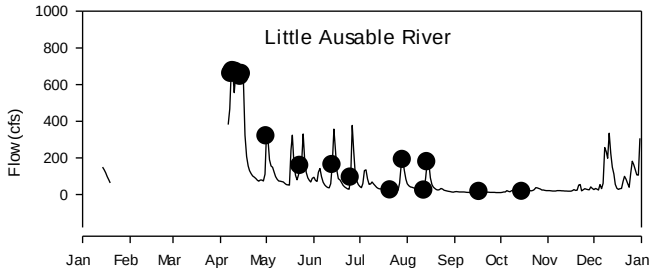
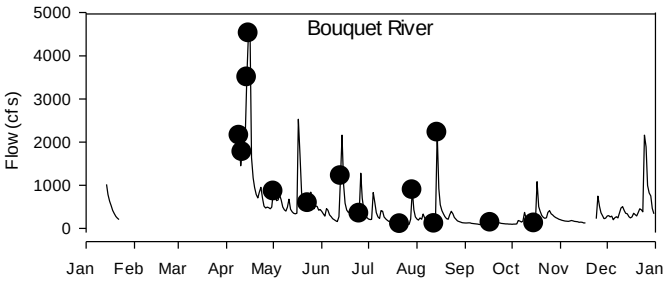
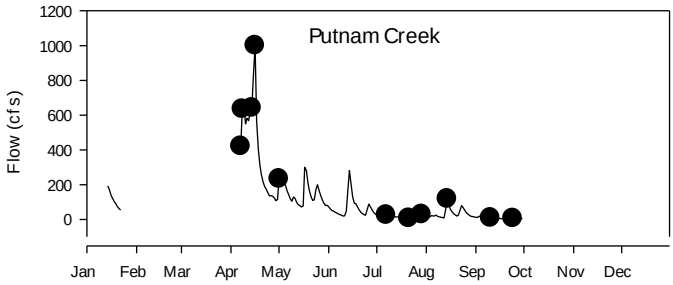
4000
6000
8000
10000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

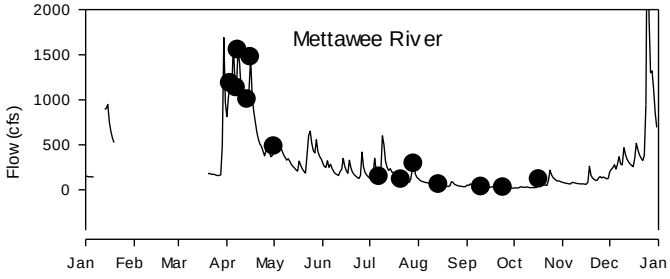

Salmon River
Flow (cfs)
0
200
400
600
800
1000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

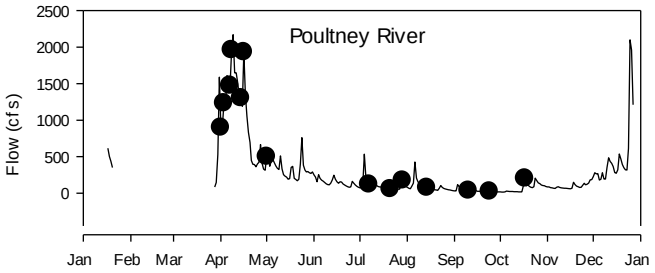












Data Quality Assurance Results

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 4. Eighteen of the 211 blank samples analyzed during 2014 (8.5%) had concentrations above the analytical detection limits. This is unusual for the project. Field supervisors will review protocols for the collection of blanks with their staff and ensure that adequate amounts of distilled water are available for rinsing equipment in the field.

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. Phytoplankton data are not yet finalized for 2014.

Table 4. Field equipment blank results during 2014 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	2	2.5 1.5
Cl	2.0	mg/l	30	0	
TN	0.1	mg/l	32	2	.46 .58
TP	5.0	µg/l	40	3	5.9 10.8 6.38
DP	5.0	µg/l	32	3	5.3 6.16 6.27
Chl-a	0.5	µg/l	12	2	.69 .99
TSS	1.0	mg/l	18	3	1.11 1.1 2.13
SiO2	0.2	mg/l	12	0	
Ca	0. 5	mg/l	7	1	.06
Na	0.5	mg/l	7	0	
K	0.5	mg/l	7	1	0.069
Mg	0.01	mg/l	7	1	.014
Total			211	18	

Table 5. Field duplicate results for chemical tests during 2014 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	18	12.4	--	--
Cond	--	--	20	3.4
Cl	18	2.2	20	2.9
DP	18	6.9	22	8
pH	--	--	30	1.2
Alk	2	1.3	5	0.8
TN	18	7.2	22	6.4
TP	18	7.6	29	7.5
TSS	--	--	16	17.2
SiO2	18	5.7	--	--
Ca	2	2.4	5	3.2
Na	2	2.9	5	2.4
K	2	3.5	5	18.5
Mg	2	1.4	5	2.4

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.

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 2014 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 2007-2014 are summarized in Table 7. 4

Table 7. Total phosphorus load to Lake Champlain from wastewater treatment facilities in Vermont and New York from 2007-2014.

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
	59	2014	18.8	40.7
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	22.9	30.3
	29	2014	24.7	30.3

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 issues grants to the Friends of Northern

Lake Champlain (FNLC) to support sample collection activities by trained local residents, and the DEC Laboratory conducts the sample analyses. The LCBP financially supports the laboratory analytical efforts, and supported the stream gaging through September 2014. The State of Vermont now supports the Rock River stream gage through a cooperative agreement with the USGS.

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.

There have been 257 upstream/downstream paired samples collected and analyzed for TP, DP, and TSS through 2014. 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.

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

Year	Number of Sample pairs
2008	10
2009	2
2010	18
2011	66
2012	55
2013	55
2014	51
TOTAL	**257**

Invasive Species Monitoring

Lake Champlain

A total of 290 zooplankton samples were scanned for *Bythotrephes longimanus* (spiny waterflea) in Lake Champlain and the Champlain Canal network (Table 9, Figure 2). Lake samples were collected at each LTM site by conducting whole column vertical tows with a 250 μm mesh net. One individual *Bythotrephes* specimen was positively identified in a sample taken from a non-LTM sampling site near Valcour Island (44.6077 N, 73.3833 W) on **7/22/14**, the first such recording in the lake. Following this initial recording, oblique horizontal tows were incorporated at each sampling site using a 50 cm. diameter, 250 μm mesh net towed at 1.5 knots for 3 minutes to determine the full extent of the invasion. *Bythotrephes* was first discovered at an LTM site in an oblique tow at station 9 (N = 32) on **8/27/14**. Biweekly vertical and oblique sampling continued through 10/31/14, during which time *Bythotrephes* was found in various densities in vertical net hauls at all sites except 50 and 51 (Figures 2-4).

Canals

Monitoring in the Champlain Canal and Glens Falls feeder canal network was conducted using two 15 minute zooplankton net tows (250 micron and 500 micron) from selected sites along the system. The entire contents of samples were poured into trays and scanned under dissecting microscopes. *Bythotrephes* was detected at the

Richardson Street sampling site on the Glens Falls Feeder Canal (N = 80) as well as at the Burgoyne Ave sampling site (N = 3) on **6/10/2014**. *Bythotrephes* was detected at the Comstock sampling site in the Champlain Canal (N = 7) on **6/18/2014** in a 5 minute horizontal tow conducted from a motorboat traveling at 3 knots. In total 72 canal samples were scanned for *Bythotrephes* presence. Canal sampling ceased once *Bythotrephes* was confirmed to be present throughout the main lake.

Table 9. Spiny waterflea (SWF) monitoring stations in the Lake Champlain Basin including dates and locations of SWF detection

Station	Lat	Long	SWF found	Date First Detected	# of sample events	# vertical samples	# oblique samples
51	45.0410	73.1290	No	Not Detected	9	9	0
50	45.0130	73.1740	No	Not Detected	10	10	1
46	44.9480	73.3400	Yes	9/12/2014	9	9	3
40	44.7850	73.1620	Yes	9/18/2014	10	10	4
36	44.7560	73.3350	Yes	9/8/2014	10	10	4
34	44.7080	73.2270	Yes	9/9/2014	10	9	4
33	44.7010	73.4180	Yes	9/6/2014	10	10	5
25	44.5820	73.2810	Yes	9/13/2014	10	10	2
21	44.4740	73.2320	Yes	9/8/2014	10	9	4
19	44.4710	73.2990	Yes	9/15/2014	10	9	3
16	44.4250	73.2220	Yes	9/19/2014	10	9	3
9	44.2420	73.3340	Yes	8/27/2014	10	10	4
7	44.1260	73.4120	Yes	8/27/2014	11	10	5
4	43.9540	73.4050	Yes	10/9/2014	10	10	5
3A	43.8343	73.3934	Yes	10/9/2014	9	4	8
2	43.7140	73.3830	Yes	9/29/2014	10	10	7
1	43.6577	73.4149	No	Not Detected	2	2	2
Valcour Trench	44.6077	73.3833	Yes	7/22/2014	2	2	1
Champlain Canal Lock 12	43.5581	73.4011	No	Not Detected	2	0	4
La Chute River at Montcalm St.	43.8479	73.4272	No	Not Detected	3	0	6
La Chute River at Alexandria Ave.	43.8360	73.4292	No	Not Detected	3	0	6
Champlain Canal Rt 4 at Whitehall	43.5495	73.4018	No	Not Detected	3	0	6
Champlain Canal, Baldwins Corners	43.3899	73.4862	No	Not Detected	4	0	9
Champlain Canal, New Swamp Road	43.3317	73.5107	No	Not Detected	4	0	9
Champlain Canal, Comstock	43.4563	73.4411	Yes	6/18/2014	1	0	3
Glens Falls Feeder Canal at Burgoyne Ave.	43.2979	73.5698	Yes	6/10/2014	3	0	6
Glens Falls Feeder Canal, Richardson St.	43.2918	73.6636	Yes	6/10/2014	3	0	18
Hudson Impoundment	43.2921	73.6655	No	Not Detected	3	0	6
						Total # of Samples	290

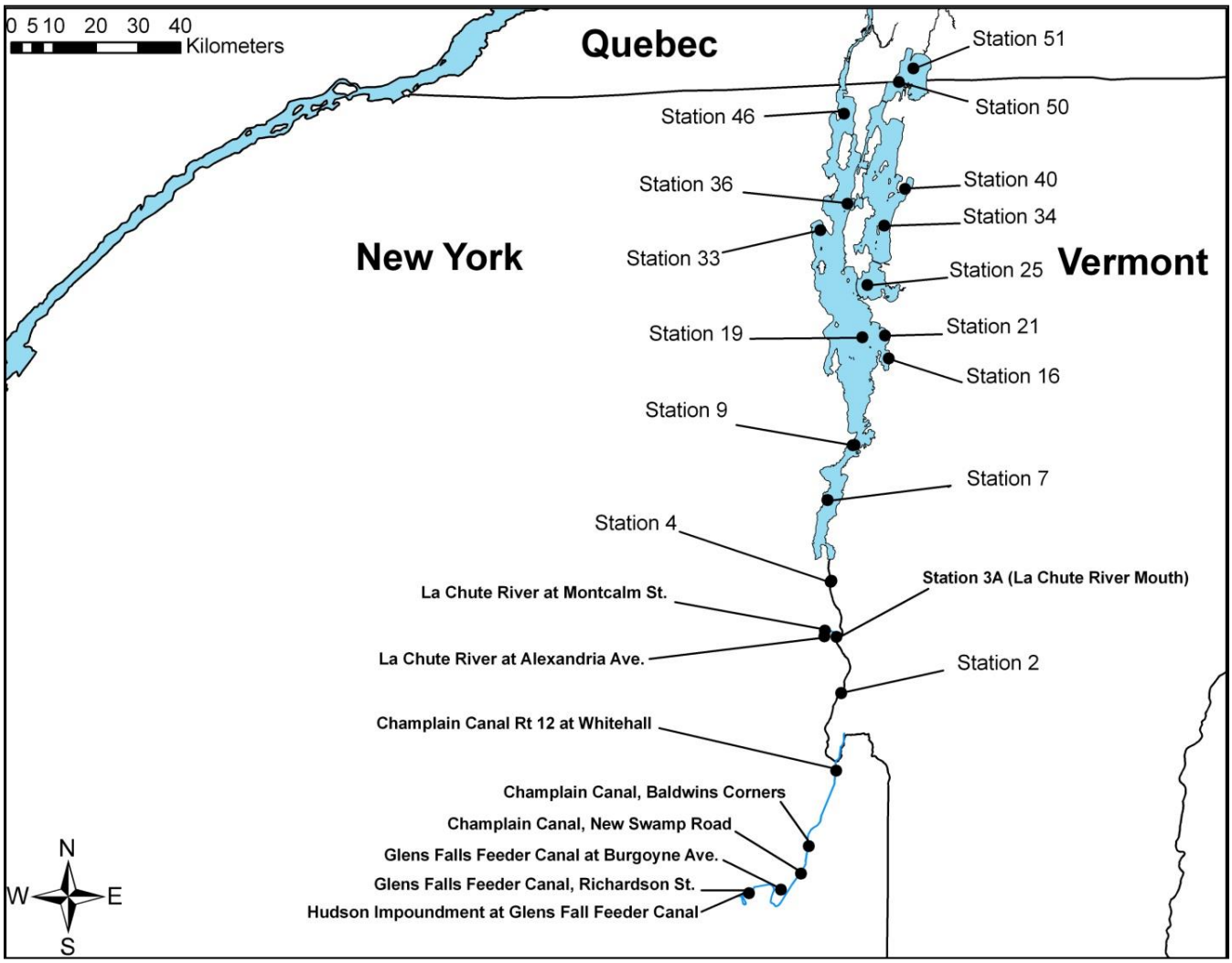


Figure 2. Map of Lake Champlain SWF Monitoring Locations with Canal sites

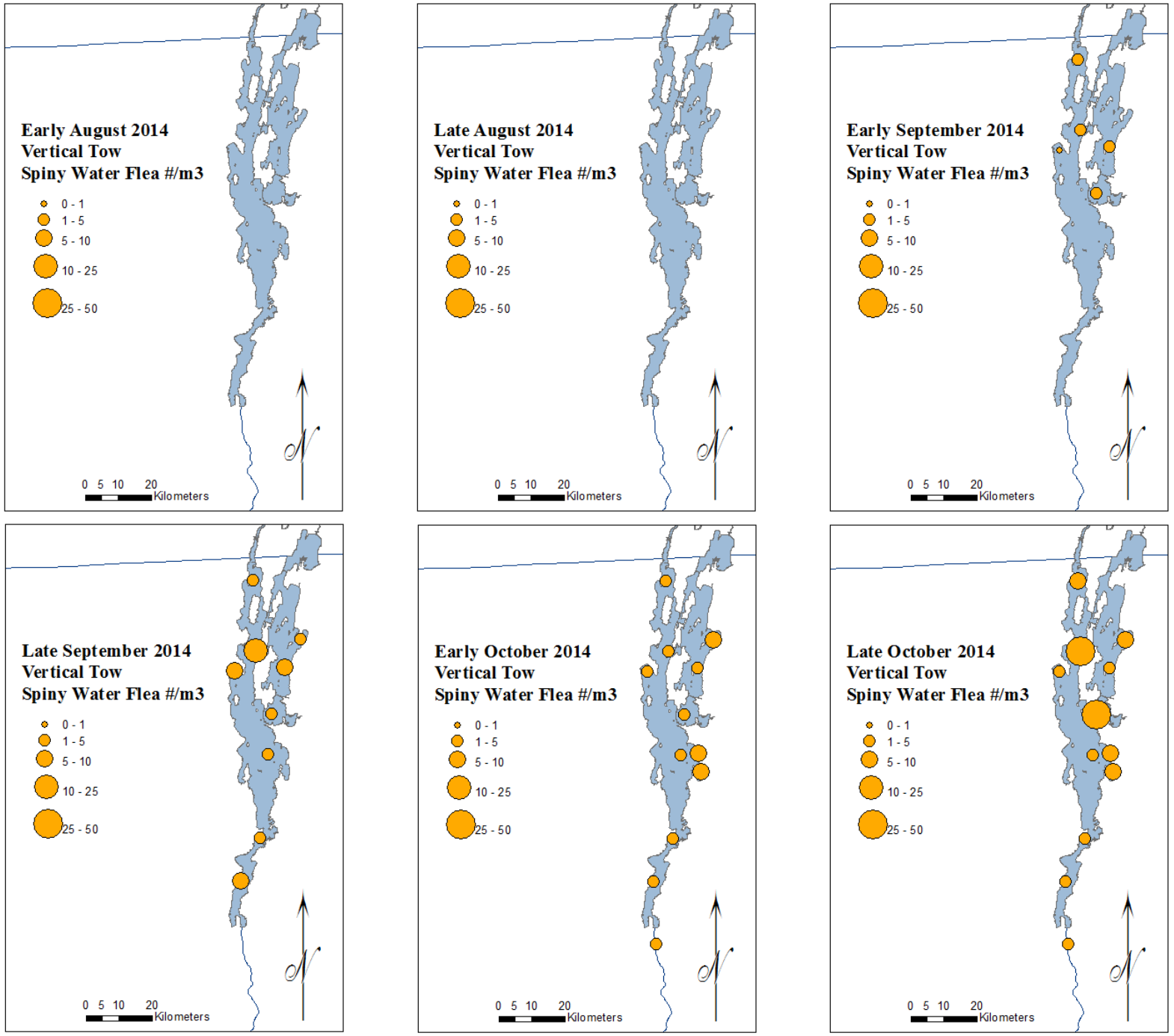


Figure 3. *Bythotrephes* densities from vertical tows in Lake Champlain from early August to late October.

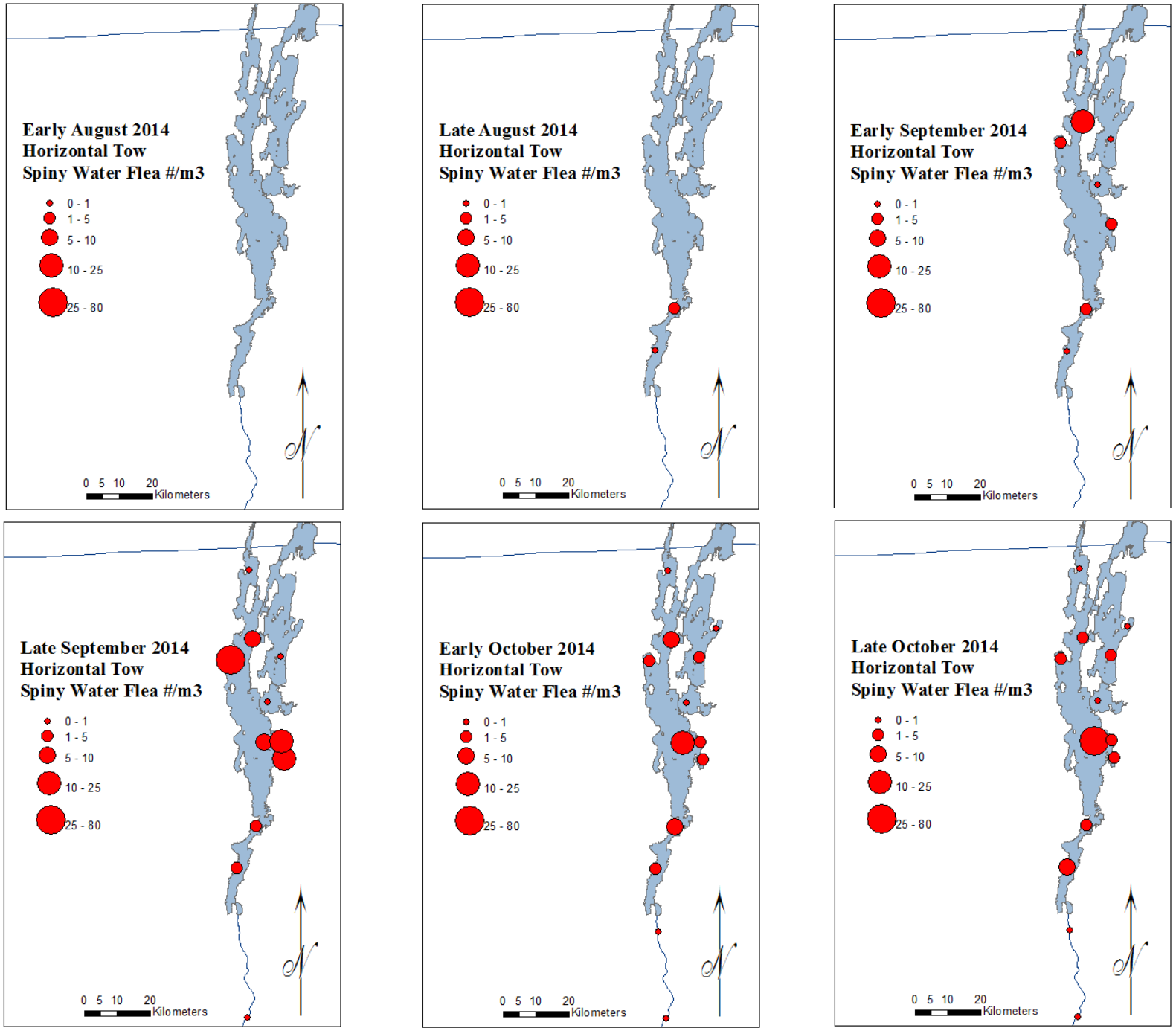


Figure 4. *Bythotrephes* densities from horizontal tows in Lake Champlain from early August to late October.

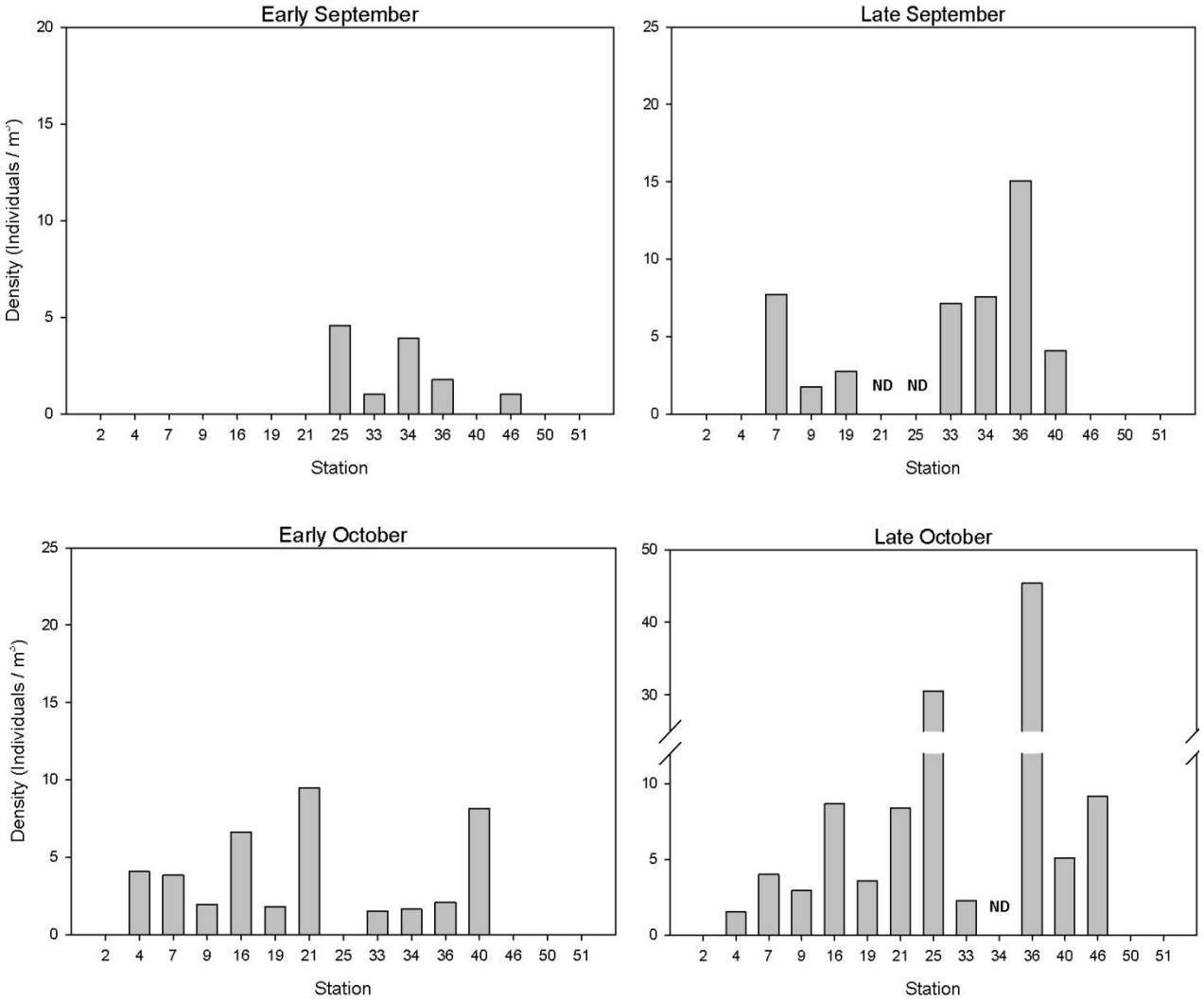


Figure 5. *Bythotrephes* densities from vertical tows at all LTM sites (clockwise): Early September, late September, late October, and early October. ND represents no data taken during that period. Sampling events at stations 2, 4, 7, 9, 16, 19, and 21 occurring between August 20 and August 31 are included in the early September sampling round.

Zooplankton and Mysid Sampling:

During the 2014 field season 150 zooplankton samples were collected from the 16 monitoring stations (Table 10). Zooplankton samples were analyzed using a compound microscope, identifying and counting zooplankton in the process. Bio-volumes were calculated for zooplankton samples from 5 lake stations (Stations 4, 19, 34, 36 and 50) throughout the field season. Ten percent of all samples were examined by a second identifier to ensure accuracy of counts and identification. Quality assurance was conducted on the same slide examined by the original identifier to control for natural variability in subsampling. In addition to zooplankton sampling, 114 samples of Mysids were collected and analyzed from 3 monitoring stations (Table 11). Mysid processing includes measuring body length, sexing, and dissecting brood pouch to count the number and developmental stage of the young.

Table 10. 2014 Lake Champlain LTM Zooplankton sample inventory.

Site	Sample Events
2	10
4	10
7	10
9	10
16	10
19	10
21	10
25	10
33	11
34	10
36	10
40	10
46	9
50	10
51	10
Total # of Samples	150

Table 11. 2014 Lake Champlain Mysid Samples

Site	Sample Events	# of Samples
10	3	18
19	11	66
62	5	30
	Total # of Samples	114