Lake Champlain Long-Term Water Quality and Biological Monitoring Program

Summary of Program Activities During 2010

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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.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 2010.

Sampling Activities During 2010

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. This year, lake sampling on behalf of New York was subcontracted to Dr. Tim Mihuc (SUNY Plattsburgh).

The frequency of lake sampling exceeded workplan targets at all stations during 2010. The frequency of tributary sampling was below the workplan targets. 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 most peak flow events during 2010 were sampled at each tributary.

Table 1. Number of sampling visits during 2010 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	9	11	20	12	AUSA01	NY	6	16	14/24
4	9	11	20	12	BOUQ01	NY	6	15	14/24
7	9	11	20	12	GCHA01	NY	8	17	14/24
9	8	9	17	12	LAMO01	VT	9	18	14/24
16	9	10	19	12	LAPL01	VT	11	20	14/24
19	8	10	18	12	LAUS01	NY	7	16	14/24
21	9	10	19	12	LCHA01	NY	8	16	14/24
25	8	11	19	12	LEWI01	VT	11	20	14/24
33	9	10	19	12	LOTT01	VT	11	20	14/24
34	9	10	19	12	METT01	VT	9	16	14/24
36	9	10	19	12	MISS01	VT	11	19	14/24
40	9	10	19	12	OTTE01	VT	10	21	14/24
46	9	11	20	12	PIKE01	VT	10	16	14/24
50	9	11	20	12	POUL01	VT	9	16	14/24
51	9	11	20	12	PUTN01	VT	9	16	14/24
					ROCK02	VT	10	18	14/24
					SALM01	NY	7	16	14/24
					SARA01	NY	6	15	14/24
					WINO01	VT	8	15	14/24
					JEWE02[3]	VT	8	20	14/24
					STEV01[3]	VT	11	20	14/24
					MILL01[4]	VT	1	3	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 Mysids was not done in 2009. 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.

[3] New stations on Jewett Brook and Stevens Brook in the St. Albans Bay watershed were added in October 2008.

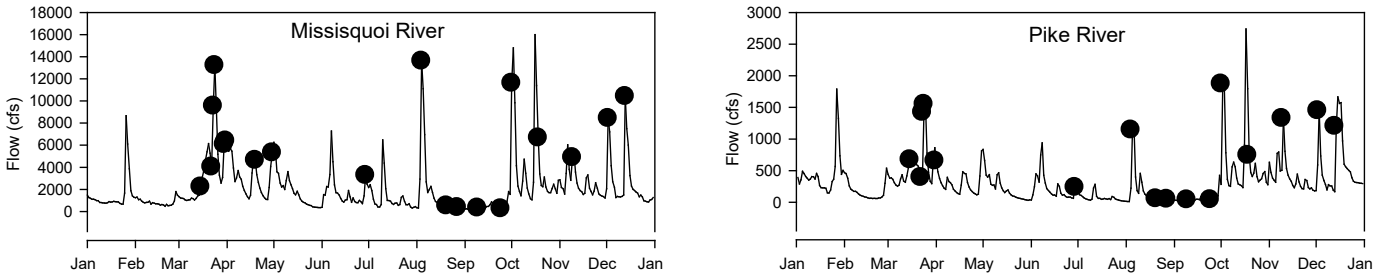
[4] New station on Mill River in the St. Albans Bay watershed was added in November 2010.

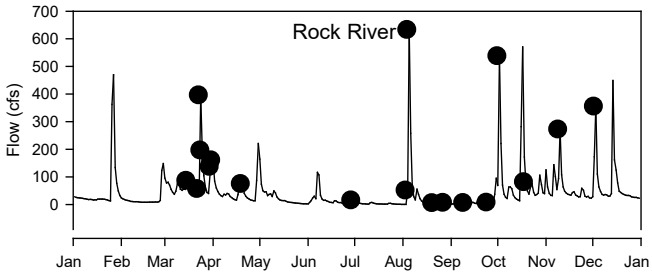
Table 2. Number of samples collected and analyzed for each monitoring parameter during 2010.

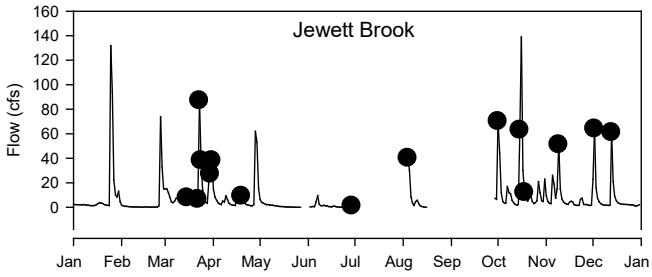
Parameter	Lake	Tributaries	Total
TP	421	420	841
DP	421	207	628
Cl	421	207	628
TN	421	227	648
Ca	59	46	105
Fe	59	46	105
K	59	46	105
Na	59	46	105
Mg	59	46	105
Alkalinity	59	46	105
DO (Winkler)	519	--	519
Chl-a	284	--	284
TSS	--	204	204
Temperature	204	281	485
Conductivity	--	260	260
pH	--	260	260
Secchi depth	288	--	288
Multiprobe depth profiles	226	--	226
Zebra mussel veligers	112	8	120
Zebra mussel settled juveniles	6	--	6
Mysids	9	--	9
Zooplankton	137	15[1]	152
Phytoplankton	182	--	182

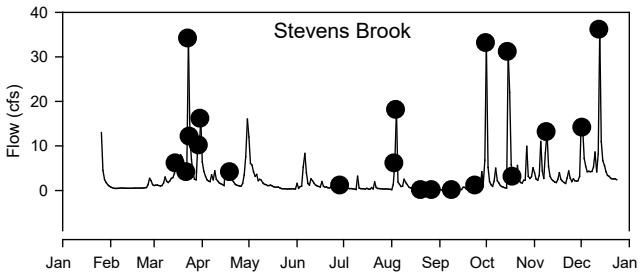
[1]Canal and Hudson River system monitoring for invasive zooplankton.

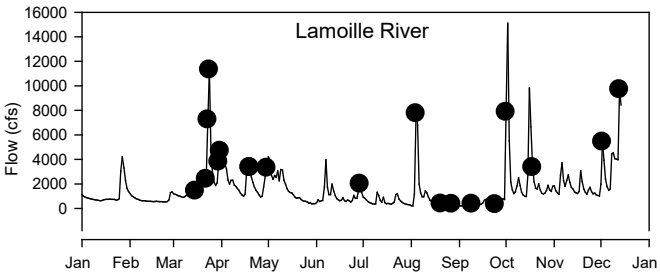
Figure 1. Sampling dates during 2010 in relation to daily flows at each tributary station. Daily flows are shown by lines, and sampling dates are shown by dots.

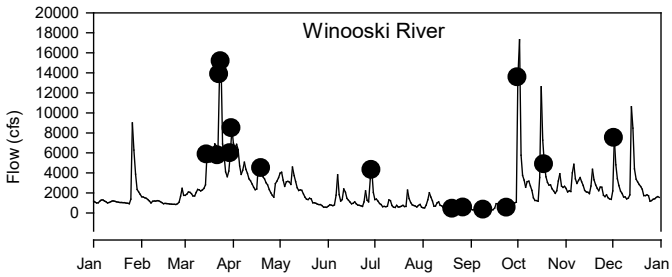


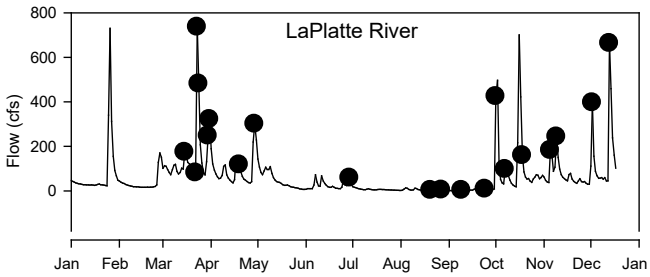

Rock River
Flow (cfs)
700
600
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

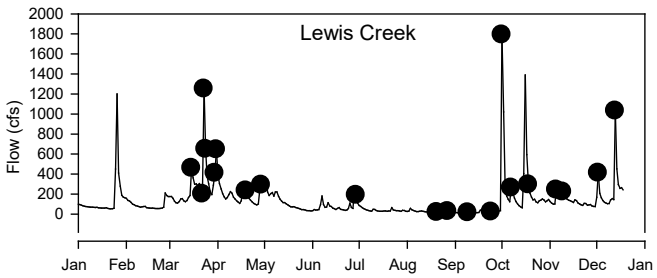

Jewett Brook
Flow (cfs)
160
140
120
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

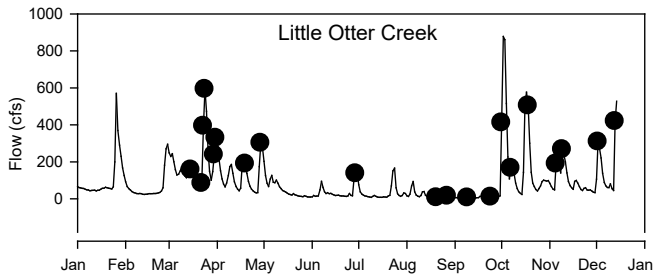

Stevens Brook
Flow (cfs)
40
30
20
10
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

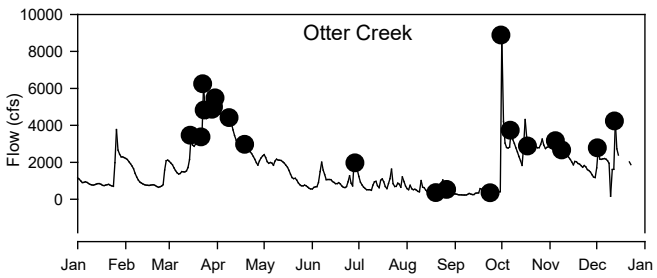

Lamoille River
Flow (cfs)
16000
14000
12000
10000
8000
6000
4000
2000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

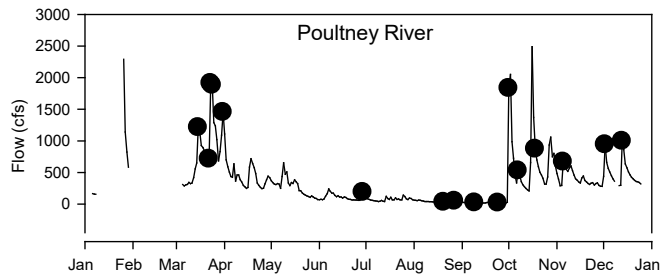

Winooski River
Flow (cfs)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

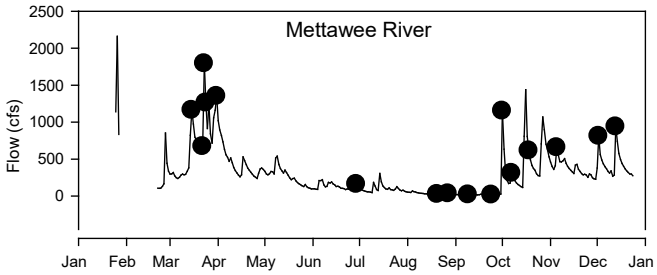

LaPlatte River
Flow (cfs)
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

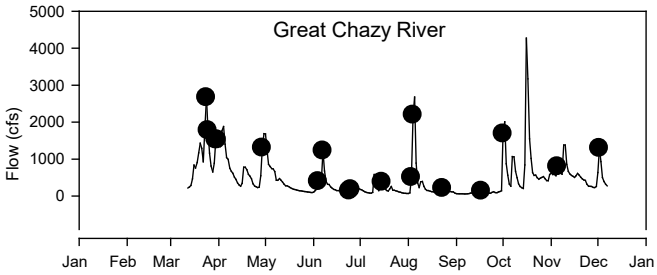

Lewis Creek
Flow (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

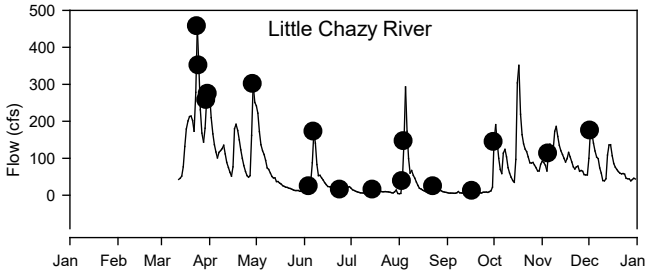

Little Otter Creek
Flow (cfs)
1000
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

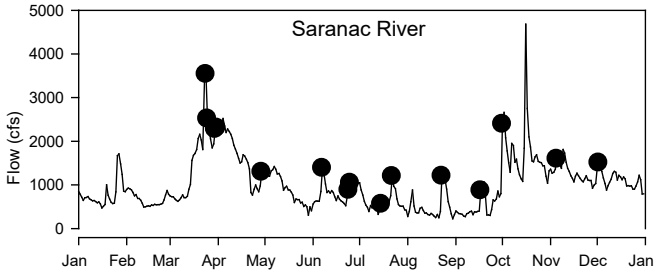

Otter Creek
Flow (cfs)
10000
8000
6000
4000
2000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

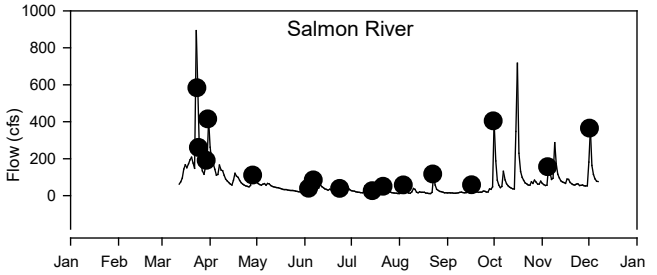

Poultney River
Flow (cfs)
3000
2500
2000
1500
1000
500
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

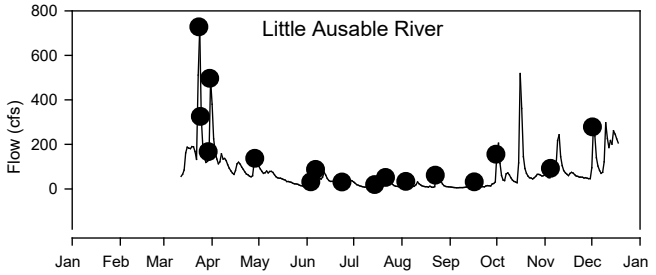

Mettawee River
Flow (cfs)
2500
2000
1500
1000
500
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

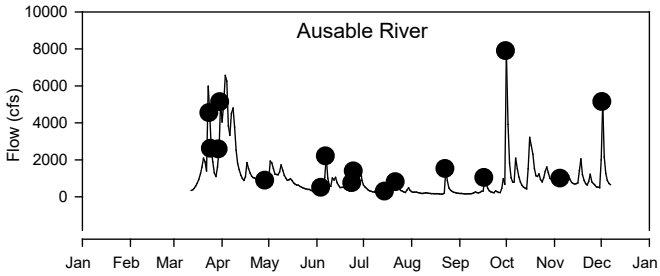

Great Chazy River
Flow (cfs)
5000
4000
3000
2000
1000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

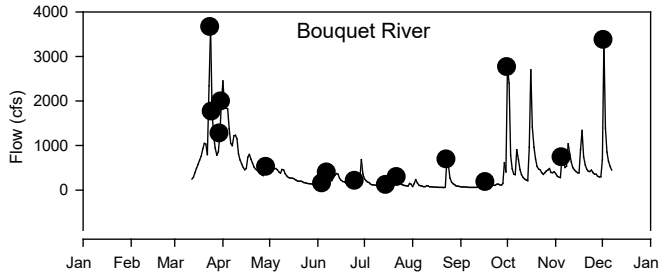

Little Chazy River
Flow (cfs)
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

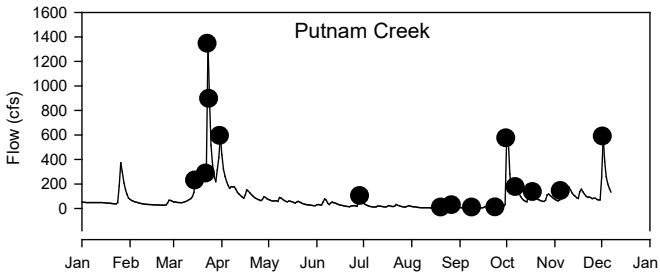

Saranac River
Flow (cfs)
5000
4000
3000
2000
1000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan


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


Little Ausable River
Flow (cfs)
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


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


Putnam Creek
Flow (cfs)
1600
1400
1200
1000
800
600
400
200
0
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. Seven of the 242 blank samples analyzed during 2010 had concentrations above the analytical detection limits. The results for field duplicate samples are summarized in Table 4 for the chemical analyses. The mean relative percent difference between duplicates obtained during 2010 was less than 4% for all tests. The results from laboratory and field duplicate analyses run on phytoplankton samples obtained during 2006-2009 are shown in Table 5. Mean relative percent differences among field duplicates were in the 37- 41% range during 2009 for cell density and biovolume measurements. Data from 2010 are not available at this time.

Table 3. Field equipment blank results during 2010 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	6	0	
Cl	2.0	mg/l	34	0	
TN	0.1	mg/l	35	0	
TP	5.0	µg/l	82	2	6.5 7.25
DP	5.0	µg/l	27	2	9.65 10.6
Chl-a	0.5	µg/l	17	0	
TSS	1.0	mg/l	15	0	
SiO2	0.2	mg/l	19	3	3.43 5.62 6.75
Ca	0.25	mg/l	1	0	
Na	0.25	mg/l	1	0	
K	0.25	mg/l	1	0	
Mg	.01	mg/l	1	0	
Fe	50	µg/l	3	0	
Total			242	7	

Table 4. Field duplicate results for chemical tests during 2010 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	16	5.4	--	--
Cond	--	--	23	2.8
Cl	20	0.8	16	2.5
DP	21	8.1	16	3.7
pH	--	--	23	0.1
Alk	3	2.1	4	1.6
TN	20	7.1	17	6.0
TP	20	7.1	32	1.8
TSS	--	--	16	16.4
SiO2	19	1.1	--	--
Ca	1	0.6	1	0
Na	1	0.9	1	0
K	1	5.0	1	0
Mg	1	0.6	1	0
Fe	2	0.5	3	1.9

Table 5. Phytoplankton duplicate results for 2006–2009 showing the number of pairs (N) and the mean relative percent difference (RPD) between pairs. 2010 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
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

Phytoplankton and Zooplankton Database

All phytoplankton data from 2006-2009 have been incorporated into the main Lake Champlain Monitoring Program database. Data from 2010 has not yet been incorporated due to software issues but should be in the main database and online by the end of May 2011. Zooplankton data are currently available for the project period of 1993-2008. The 2009 and 2010 data will be ready for upload to the main database by May 2011. 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 1/1/10 and 12/31/10 indicated that the program webpage received a total of 1,240 data queries from 154 different external users representing an average of over 24 external data queries per week during 2010.

Invasive Species Tabulation

Routine monitoring for spiny water flea (SPW) continued in the Champlain Canal. SPW were documented in the Stewart's Bridge Reservoir, the last ponded waterbody in the Sacandaga River before its confluence with the Hudson River. Additional biological sampling was conducted in the Canal system to check for presence/absence of invasive zooplankton. None were detected. Two zebra mussel veligers were found in a sample taken from Lake Carmi in Vermont. Snorkel surveys will be conducted there in 2011. No other species of concern were noted in lake plankton samples analyzed by monitoring program staff.

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 2010 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 2007-2010 are summarized in Table 6.

Table 6. Total phosphorus load to Lake Champlain from wastewater treatment facilities in Vermont and New York from 2007-2010.

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
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

Zebra Mussel Monitoring Recommendations

The arrival of zebra mussels in the lake during the mid-1990s was expected to strongly impact both water quality and the food web. The original goals of the zebra mussel monitoring program were to track the establishment of the species throughout Lake Champlain as well as monitor susceptible inland waters for evidence of spread. The primary goal of the Long-Term Monitoring Program (LTMP) is to detect environmental change, and to provide data that allows long-term assessment of the relationship between water quality, biological communities, and overall lake health. The LCBP also has a major role in the region as an advocate for spread prevention of known Aquatic Invasive Species (AIS) and detection of new AIS in the Basin. After 17 years of monitoring, with zebra mussels well established in all areas of the lake, it is appropriate to re-align zebra mussel monitoring efforts with the overall goals of the LTMP and the LCBP.

Monitoring of veligers and settled juveniles

Data from the Great Lakes and other locations have shown that the presence of zebra mussels can profoundly alter lake ecosystems through consumption of plankton and alteration of nutrient cycling pathways. Emerging data suggests that quagga mussels have an even more profound effect. Currently, there is no monitoring of adult zebra mussels due to logistical and fiscal constraints. Veliger and settled juvenile samples provide the only long-term data available to assess the overall health of the Champlain zebra mussel population and the extent to which it may impact the pelagic food web. Changes in the observed 'typical' veliger or settler patterns

may be the first indications of a decline in the existing mussel population or the onset of a quagga invasion. We recommend continuation of this sampling effort, with some modifications.

- Restore zebra mussel veliger sampling at the southern and central lake monitoring stations where veliger sampling was discontinued in 2006.
- Limit veliger sampling to the 12 original core stations, and Missisquoi Bay Central (STA 51) currently monitored for water quality parameters. While densities of adult mussels and hence veligers are greater in nearshore locations, the lack of concurrent water quality and plankton community data limits the usefulness of the data to the program's long-term goals.
- Limit settled plates to locations sampled in 2010 as these adequately represent the adult population present in the lake and are also locations where rates of successful retrieval have been highest. Nearshore water quality data is not necessary for interpretation of reproduction and recruitment success.

Spread prevention and detection of new aquatic invasive species

Since 1998, LTMP staff have collected and analyzed samples from susceptible lakes and rivers in Vermont for the presence of veligers. When veligers were detected, LTMP staff followed up with site visits to confirm the presence of adult mussels or established populations. This continues to be an important aspect of spread prevention within the Basin and should not be discontinued.

- In Vermont, responsibility for collection and analysis of inland samples transitioned to VTDEC staff in 2010. LTMP staff provided an oversight role and technical support for VTDEC staff during the transition. They will continue to provide that support in the future. Data will be presented in the LTMP annual report.

Phytoplankton and zooplankton samples are routinely evaluated by LTMP staff for the presence of new AIS. New York staff monitor within the Champlain Canal system for the presence of spiny water flea as part of early detection/eradication efforts. With quagga mussels firmly established in the Great Lakes and a new infestation documented during 2010 in the Finger Lakes region of New York (Canandaiga Lake), there is potential for this species to reach Lake Champlain. There is currently no routine assessment of adult mussel populations in the lake. However, LTMP staff document zebra mussel reproduction/recruitment strength through the annual use of settling plates. Continued placement and assessment of settling plates offers opportunity to detect quagga mussels should they reach Lake Champlain.

- LTMP will continue to evaluate settling plates for the presence of quagga mussels.

Evaluation of data on zebra mussels in Lake Champlain

LTMP data are available to all users via the web interface http://www.anr.state.vt.us/dec/waterq/lakes/htm/lp_lczebramon.htm Zebra mussel data currently are available on request. Vermont staff is currently working with Dr. Ellen Marsden, UVM, to write a book chapter on the Champlain zebra mussel monitoring effort and possible effects on water quality and plankton populations.

Effect on Budget and Staff

These recommended changes can be accomplished with existing personnel and within the existing budget. It represents an increase in veliger samples from 120 to 156. As part of the LTMP, the project QAPP and annual report would continue to include information on annual zebra mussel monitoring activities.