Lake Champlain Long-Term Water Quality and Biological Monitoring Program

Summary of Program Activities During 2008

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Prepared by:

Vermont Department of Environmental Conservation
Water Quality Division
103 South Main St.
Waterbury, VT 05671-0408

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 2008.

Sampling Activities During 2008

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 frequency of lake sampling exceeded workplan targets at all stations during 2008. 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. However, an effort should be made to sample more high flow events each year whenever possible.

A better measure of the effectiveness of the tributary sampling effort is the percent of the total annual flow volume represented by the samples that were obtained each year. In order to assess this measure, the total flow volumes on days that were sampled for total phosphorus during the past three calendar years (2006-2008) at each tributary were obtained from the relevant U.S. Geological Survey flow gage records and compared with the total annual flow volumes recorded at these gages (Table 3). Daily flows since October 2007 were provisional with some missing records.

Table 3 shows that the percent of the total annual flow volume sampled averaged between 7-18% among the various tributary stations in recent years. The ability to sample a high proportion of the total annual flow volume in these tributaries will depend to some extent on individual watershed hydrology, as well as the sampling effort. While no program targets have been established for this data quality indicator, it is important to maintain and improve to the extent possible the proportion of annual flow volume represented by the samples collected.

Table 1. Number of sampling visits during 2008 at each lake and tributary station in comparison with workplan targets.

Lake Station	Number of Sampling Visits	Workplan Target[1]	Tributary Station	Number of Sampling Visits for All Parameters	Number of Sampling Visits for Total Phosphorus	Workplan Target[2]
2	21	12	AUSA01	6	12	14/24
4	21	12	BOUQ01	6	13	14/24
7	15	12	GCHA01	6	13	14/24
9	14	12	LAMO01	14	21	14/24
16	16	12	LAPL01	12	20	14/24
19	15	12	LAUS01	6	13	14/24
21	16	12	LCHA01	6	13	14/24
25	15	12	LEWI01	11	19	14/24
33	15	12	LOTT01	11	19	14/24
34	18	12	METT01	11	15	14/24
36	15	12	MISS01	14	21	14/24
40	18	12	OTTE01	11	19	14/24
46	19	12	PIKE01	9	11	14/24
50	21	12	POUL01	11	15	14/24
51	21	12	PUTN01	11	15	14/24
			ROCK02	14	20	14/24
			SALM01	6	13	14/24
			SARA01	6	13	14/24
			WINO01	14	20	14/24
			JEWE02[3]	1	1	--
			STEV01[3]	1	1	--

[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 is done six times per year. 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.

Table 2. Number of samples collected and analyzed for each monitoring parameter during 2008.

Parameter	Lake	Tributaries	Total
TP	408	333	741
DP	409	202	611
Cl	408	202	610
TN	409	204	613
Alkalinity	67	34	101
DO (Winkler)	509	--	509
Chl-a	290	--	290
TSS	--	198	198
Temperature	276	237	513
Conductivity	--	250	250
pH	--	249	249
Secchi depth	288	--	288
Multiprobe depth profiles	154	--	154
Zebra mussel veligers	99	--	99
Zebra mussel settled juveniles	6	--	6
Mysids	90	--	90
Zooplankton	112	--	112
Phytoplankton	168	--	168

Table 3. Proportion of total annual flow volume sampled in each tributary, 2006-2008.

Tributary	2006	2007	2008	Average
Ausable	0.08	0.13	0.11	0.11
Bouquet	0.08	0.12	0.14	0.11
Great Chazy	0.08	0.10	0.11	0.10
Lamoille	0.12	0.14	0.18	0.15
LaPlatte	0.15	0.24	0.16	0.18
Lewis	0.13	0.19	0.12	0.15
Little Ausable	0.07	0.10	0.09	0.08
Little Chazy	0.09	0.11	0.08	0.09
Little Otter	0.13	0.19	0.11	0.14
Mettawee	0.06	0.15	0.06	0.09
Missisquoi	0.12	0.16	0.15	0.14
Otter	0.07	0.08	0.07	0.07
Poultney	0.08	0.13	0.09	0.10
Putnam	0.11	0.14	0.11	0.12
Salmon	0.07	0.09	0.12	0.10
Saranac	0.06	0.07	0.07	0.07
Winooski	0.11	0.14	0.14	0.13

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. Only five of the 213 blank samples analyzed during 2008 had concentrations above the analytical detection limits, and the concentrations measured in these cases were only slightly above the detection limits. The results for field duplicate samples are summarized in Table 5 for the chemical analyses. The mean relative percent difference between duplicates obtained during 2008 was less than 10% for all tests. The results from laboratory and field duplicate analyses run on phytoplankton samples obtained during 2006-2008 are shown in Table 6. Mean relative percent differences among field duplicates were generally in the 10-20% range for cell density and biovolume measurements.

Table 4. Field equipment blank results during 2008 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	41	0	
TN	0.1	mg/l	41	0	
TP	5.0	µg/l	49	1	5.6
DP	5.0	µg/l	41	1	6.2
Chl-a	0.5	µg/l	19	0	
TSS	1.0	mg/l	16	3	1.2, 1.1, 1.5
Total			**213**	**5**	

Table 5. Field duplicate results for chemical tests during 2008, 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	23	8.0	--	--
Cond	--	--	17	4.4
Cl	25	1.7	17	1.1
DP	26	8.2	17	2.7
pH	--	--	16	0.7
Alk	4	1.8	2	0.6
TN	26	9.1	17	2.9
TP	26	8.9	26	2.8
TSS	--	--	16	6.8

Table 6. Phytoplankton duplicate results for 2006–2008, 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	8	Biovolume	20.8
			Cell Density	14.8
	2007	9	Biovolume	10.4
			Cell Density	9.4
	2008	17	Biovolume	14.0
			Cell Density	2.4
Lab duplication	2006	16	Biovolume	0.6
			Cell Density	7.9
	2007	13	Biovolume	15.8
			Cell Density	17.3
	2008	18	Biovolume	8.2
			Cell Density	1.8

Phytoplankton and Zooplankton Database

All processed phytoplankton and zooplankton data have been incorporated into the main Lake Champlain Monitoring Program database for the first time in project history. Previously, these data had been stored in spreadsheet format and were available only on request. Plankton data are now transferred annually into the main program database, run through a series of quality assurance checks, and added to the cumulative plankton data table. As a result, these data can now be downloaded from the web interface. 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.

Program Database Improvements

In 2008, a major reorganization of the database was initiated to improve the database design and replace three Microsoft Access® databases with a single SQL Server database. The use of the SQL Server database improves query performance and allows the use of the T-SQL database language to create more advanced queries.

The previous database format stored data in a wide column format, with all water quality parameters for a specific station and date located within one record. This was a less than ideal database structure, making it difficult to add new analytical parameters to the database, and resulting in increasingly cumbersome queries to check, store, and retrieve data. The new database format maintains each analytical result as a single record, linked through a combination of key fields.

As part of this upgrade, the data tables were normalized to conform to relational database requirements and new tables were added to store plankton data. The SQL Server database was made accessible from both the internal Vermont DEC Access front-end databases and the public web server Lake Champlain Monitoring Program application, which resulted in the elimination of multiple and duplicative Access databases.

This database upgrade has a number of benefits. Consolidation into a single database improves the efficiency of storing and updating data and protects the accuracy of the data since additions and changes need to be made in only one database. SQL Server views were created to increase the speed and functionality of the Lake Champlain Monitoring web application. Finally, the upgrade will facilitate the upload of project data to the USEPA's WQX national water quality archive.

The process that completed the transformation of the database involved the following operations.

1. Writing code to complete the transformation from a column-based format to a row-based format.
2. Designating new key fields to create unique record identifications.
3. Extensive checking for duplication and inconsistencies in the complete data set.
4. Rewriting queries to annually review and incorporate new data into the database.
5. Development of SQL views to populate the summary tables for the web interface.
6. Development of ColdFusion code to recreate and expand the web data interface.
7. Development of SQL views to facilitate internal staff use of the database.
8. Creation of a SQL database table and ColdFusion code to count the number of hits the interactive data portion of the webpage receives.

Under this new format, the database currently includes a total of 110,388 records for the water chemistry data and 30,068 records for the plankton data. Tracking of the number of web hits indicated that the webpage received a total of 200 individual data queries from 25 different external users during the first six-week period of 2/4/09 to 3/19/09, representing an average of over 30 external data queries per week.

We would like to thank Brenda Clarkson for the extraordinary skill and dedication she applied in making these database improvements for the program.

Invasive Species Tabulation

The project workplan requires an annual compilation of new invasive species arrivals in Lake Champlain. There were no new documented invasive species in Lake Champlain during 2008. However, two new species were documented on the borders of Lake Champlain. The Asian clam (*Corbicula fluminea*) was confirmed to be present in the Champlain Canal downstream to Fort Edward, NY. The spiny waterflea (*Bythotrephes longimanus*) was confirmed to be present in Great Sacandaga Lake, NY. The lake is connected to the Champlain Canal via the Hudson River and Glens Falls Feeder Canal. Both Asian clam and spiny water flea are considered to be significant threats to the Lake Champlain Basin.

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 2008 along with data from previous years, and are available electronically in spreadsheet form on request. The total loads from Vermont and New York wastewater treatment facilities during 2007 and 2008 are summarized in Table 7.

Table 7. Total phosphorus load to Lake Champlain from wastewater treatment facilities in Vermont and New York during 2007 and 2008.

State	Number of Facilities	Year	Total Phosphorus Load (mt/yr)
Vermont	60	2007	20.9
	60	2008	21.1
New York	29	2007	28.5
	29	2008	26.5