



**Lake Champlain
Basin Program**

Long-Term Water Quality and Biological Monitoring Project for Lake Champlain

Cumulative Report for Project Years
1992-1996

Prepared by
VT Dept. of Environmental Conservation and
NYS Dept. of Environmental Conservation

for
Lake Champlain Basin Program

March 1998

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Prepared for the

**Lake Champlain Basin Program
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This technical report is the twenty-sixth in a series of reports prepared under the Lake Champlain Basin Program. Those in print are listed below.

Lake Champlain Basin Program Technical Reports

1. *A Research and Monitoring Agenda for Lake Champlain.* Proceedings of a Workshop, December 17-19, 1991, Burlington, VT. Lake Champlain Research Consortium. May, 1992.
2. *Design and Initial Implementation of a Comprehensive Agricultural Monitoring and Evaluation Network for the Lake Champlain Basin.* NY-VT Strategic Core Group. February, 1993.
3. (A) *GIS Management Plan for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc., and Associates in Rural Development. March, 1993.

(B) *Handbook of GIS Standards and Procedures for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.

(C) *GIS Data Inventory for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.
4. (A) *Lake Champlain Economic Database Project. Executive Summary.* Holmes & Associates. March 1993.

(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin.* Holmes & Associates. March 1993

(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin. Appendices.* Holmes & Associates. March 1993

(C) *Potential Applications of Economic Instruments for Environmental Protection in the Lake Champlain Basin.* Anthony Artuso. March 1993.

(D) *Conceptual Framework for Evaluation of Pollution Control Strategies and Water Quality Standards for Lake Champlain.* Anthony Artuso. March 1993.
5. *Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1.* Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.

Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1. Executive Summary. Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.
6. (A) *Lake Champlain Nonpoint Source Pollution Assessment.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

(B) *Lake Champlain Nonpoint Source Pollution Assessment. Appendices A-J.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

7. *Internal Phosphorus Loading Studies of St. Albans Bay. Executive Summary.* VT Dept of Environmental Conservation. March 1994.

(A) *Dynamic Mass Balance Model of Internal Phosphorus Loading in St. Albans Bay, Lake Champlain.* Eric Smeltzer, Neil Kamman, Karen Hyde and John C. Drake. March 1994.

(B) *History of Phosphorus Loading to St. Albans Bay, 1850 - 1990.* Karen Hyde, Neil Kamman and Eric Smeltzer. March 1994.

(C) *Assessment of Sediment Phosphorus Distribution and Long-Term Recycling in St. Albans Bay, Lake Champlain.* Scott Martin, Youngstown State University. March 1994.
8. *Lake Champlain Wetlands Acquisition Study.* Jon Binhammer, VT Nature Conservancy. June 1994.
9. *A Study of the Feasibility of Restoring Lake Sturgeon to Lake Champlain.* Deborah A. Moreau and Donna L. Parrish, VT Cooperative Fish & Wildlife Research Unit, University of Vermont. June 1994.
10. *Population Biology and Management of Lake Champlain Walleye.* Kathleen L. Newbrough, Donna L. Parrish, and Matthew G. Mitro, Fish & Wildlife Research Unit, University of Vermont. June 1994.
11. (A) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin. Executive Summary.* Yellow Wood Associates, Inc. January 1995.

(B) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin.* Yellow Wood Associates, Inc. January 1995.

(C) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin. Appendices.* Yellow Wood Associates, Inc. January 1995.
12. (A) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program. Executive Summary.* Holmes & Associates and Anthony Artuso. March 1995

(B) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program.* Holmes & Associates and Anthony Artuso. March 1995
13. *Patterns of Harvest and Consumption of Lake Champlain Fish and Angler Awareness of Health Advisories.* Nancy A. Connelly and Barbara A. Knuth. September 1995.
14. (A) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program. Executive Summary - Part 2.* Holmes & Associates and Anthony Artuso. November 1995

(B) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program - Part 2.* Holmes & Associates and Anthony Artuso. November 1995
15. *Zebra Mussels and Their Impact on Historic Shipwrecks.* Lake Champlain Maritime Museum. January 1996.
16. *Background Technical Information for Opportunities for Action: An Evolving Plan for the Future of the Lake Champlain Basin.* Lake Champlain Basin Program. June 1996

17. (A) *Executive Summary. Economic Analysis of the Draft Final Plan for the Lake Champlain Management Conference.* Holmes & Associates and Anthony Artuso. July 1996

(B) *Economic Analysis of the Draft Final Plan for the Lake Champlain Basin Management Conference.* Holmes & Associates and Anthony Artuso. July 1996
18. *Catalog of Digital Spatial Data for the Lake Champlain Basin .* Vermont Center for Geographic Information, Inc. September 1996.
19. *Hydrodynamic and Water Quality Modeling of Lake Champlain.* Applied Science Associates, Inc. July 1996.
20. *Understanding Phosphorus Cycling, Transport and Storage in Stream Ecosystems as a Basis for Phosphorus Management.* Dr. James P. Hoffmann, Dr. E. Alan Cassell, Dr. John C. Drake, Dr. Suzanne Levine, Mr. Donald W. Meals, Jr., Dr. Deane Wang. December 1996.
21. *Bioenergetics Modeling for Lake Trout and other Top Predators in Lake Champlain.* Dr. George W. LaBar and Dr. Donna L. Parrish. December 1996
22. *Characterization of On-Farm Phosphorus Budgets and Management in the Lake Champlain Basin.* Robert D. Allshouse, Everett D. Thomas, Charles J. Sniffen, Kristina Grimes, Carl Majewski - Miner Agricultural Research Institute. April 1997
23. (A) *Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 11. Executive Summary.* Alan McIntosh, Mary Watzin and Erik Brown, UVM School of Natural Resources. October 1997

(B) *Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 11.* Alan McIntosh, Mary Watzin and Erik Brown, UVM School of Natural Resources. October 1997
24. *Development of Land Cover/Land Use Geographic Information System Data Layer for the Lake Champlain Basin and Vermont Northern Forest Lands Project Areas.* Dr. Thomas Millette. October 1997
25. *Urban Nonpoint Pollution Source Assessment of the Greater Burlington.* Urban Stormwater Characterization Project. James Pease, VT Dept. of Environmental Conservation. December 1997
26. *Long-Term Water Quality and Biological Monitoring project for Lake Champlain.* Cumulative Report for Project Years 1992- 1996

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CONTENTS

Acknowledgments	i
Introduction	1
Methods	2
Project Database	8
Results	9
Cumulative Statistical Summary	9
Precision of Field Duplicate Samples	9
Inter-Laboratory Comparison of Analytical Results	9
Dissolved Oxygen Method Comparison	12
Point Source Phosphorus Loading	14
Trends in Lake Total Phosphorus Concentration	17
Tributary Response to Point Source Phosphorus Reductions	19
Summary of Findings and Recommendations	31
References	33
Appendix A. Cumulative statistical summary of lake sampling results, 1992-1996	A1
Appendix B. Cumulative statistical summary of tributary sampling results, 1990-1996	B1

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Introduction

The Long-Term Water Quality and Biological Monitoring Project for Lake Champlain began in 1992 and has continued through 1997. The project has been conducted by the New York State Department of Environmental Conservation, the University of the State of New York Biological Survey and New York State Freshwater Institute, and the Vermont Department of Environmental Conservation, with funding provided by the Lake Champlain Basin Program and the two states.

The current monitoring program grew from the Lake Champlain Diagnostic-Feasibility Study conducted by Vermont DEC and New York State DEC (1997). The Diagnostic-Feasibility Study focused primarily on the measurement of phosphorus and chloride concentrations and loading rates in the lake and its tributaries, but also provided vertical water column profile data on several other water quality parameters at deep water stations.

The purposes and scope of the current monitoring project have been described in annual work and quality assurance project plans (e.g. New York State DEC, University of the State of New York and New York State Freshwater Institute, and Vermont DEC, 1996). The monitoring project used a subset of the lake and tributary sampling station network established for the previous Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York State DEC, 1997), and extended the program to include a broader range of chemical and biological parameters.

One of the original purposes of the project was to provide a current limnological survey of Lake Champlain, including a data set that would support the development of hydrodynamic, eutrophication, and food web models for the lake. The project data have been used to support research projects funded by the Lake Champlain Basin Program, including work by HydroQual, Inc. (1995) and Levine et al. (1997).

In 1995, the primary purpose of the project was redefined to be the detection of long-term environmental change in the lake, and the sampling program was modified to more efficiently serve this purpose. The list of sampling parameters was narrowed to include those lake and tributary constituents judged by the Lake Champlain Technical Advisory Committee to be the most meaningful for assessing the long-term effects of management actions and other changes in the environment. Optimum sampling frequencies were determined from a statistical power analysis (New York State DEC, University of the State of New York and New York State Freshwater Institute, and Vermont DEC, 1996). The power analysis was conducted to ensure that sample sizes would be adequate, but not excessive, for the purpose of statistically documenting the anticipated magnitude of water quality changes in the lake and its tributaries over time.

Comprehensive project databases are maintained by both the Vermont DEC and the New York State DEC. The data are available to researchers, state agencies, and the general public. The purpose of this report is to document the database and provide a cumulative statistical summary of the sampling results for the 1992-1996 project period. In addition, some specific aspects of the results relating to data quality and phosphorus loading trends were chosen for special analysis and interpretation.

Methods

Detailed descriptions of the field sampling and analytical methods and quality assurance procedures can be found in the annual work and quality assurance project plans (e.g. New York State DEC, University of the State of New York and New York State Freshwater Institute, and Vermont DEC, 1996). A brief summary of methods is provided here.

The sampling station network includes a core set of 12 lake stations and 18 tributary stations shown in Figure 1 and listed in Table 1. The tributary stations are located as near to the river mouths as possible on rivers which have continuously operating U.S. Geological Survey flow gages. These lake and tributary stations have been sampled consistently during the entire 1992-1996 project period. Other lake stations listed in Vermont DEC and New York State DEC (1997) have been sampled during short-term synoptic surveys each year for a limited number of parameters.

The 12 core lake stations were sampled for most chemical parameters using Kemmerer or Van Dorn water bottle devices, with discrete depth samples combined to form vertical water column composites. When thermal stratification existed, separate composite samples were obtained from both the epilimnion and hypolimnion layers. Temperature and dissolved oxygen concentrations were measured in vertical profile at discrete depths. Chlorophyll-a was sampled as a vertically integrated composite of the euphotic zone. Close-interval, *in situ* vertical profiles for temperature, dissolved oxygen, pH, specific conductance, total dissolved solids, turbidity, and reduction-oxidation potential were also obtained at some sites using a Hydrolab™ multi-probe sonde unit (Hydrolab, Inc., 1991).

Quantitative biological sampling in the lake for phytoplankton, zooplankton, benthic invertebrates, Mysids, and zebra mussel adults has been conducted by the University of the State of New York Biological Survey with field assistance from Vermont DEC and New York State DEC project staff. The biological data are not yet available and are not included in the project database or presented in this report.

Tributary samples were obtained from bridges using depth and velocity integrating sampling devices. An effort was made to obtain as high a proportion of samples as possible under high flow conditions in order to improve the precision of tributary annual mass loading estimates (Vermont DEC and New York State DEC, 1997).

Chemical analyses were conducted by the Vermont DEC Laboratory, the New York State Department of Health Laboratory, and the University of the State of New York Biological Survey. Analytical results are exchanged annually between the two states. A list of the chemical analytical methods used and the laboratories in which the analyses were conducted is given in Table 2.

A list of the parameters sampled regularly in the lake and the tributaries during each year of the project is given in Table 3. The numbers of actual sampling dates for each station during each year are listed in Table 4. The tributary stations were sampled during 1990-1992 for total phosphorus, dissolved phosphorus, and chloride for the Lake Champlain Diagnostic-Feasibility Study using the same sampling and analytical methods (Vermont DEC and New York State DEC,

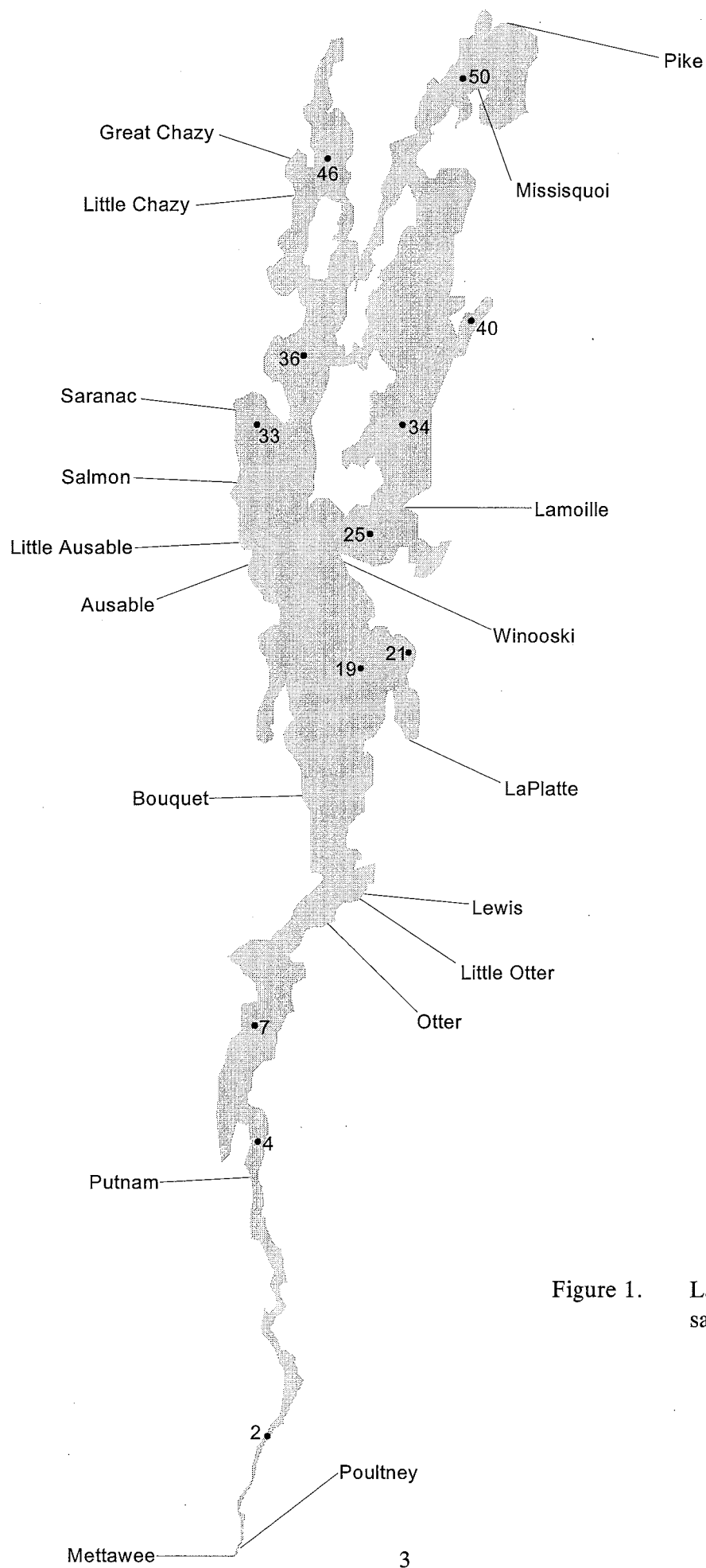


Figure 1. Lake and tributary sampling stations.

Table 1. List of lake and tributary sampling stations and their locations.

Lake Station	Latitude	Longitude	Tributary Station	Latitude	Longitude
02	43° 42.89'	73° 22.98'	Winooski (WINO01)	44° 31.52'	73° 15.41'
04	43° 57.10'	73° 24.47'	Otter (OTTE01)	44° 09.94'	73° 15.40'
07	44° 07.56'	73° 24.77'	Missisquoi (MISS01)	44° 55.23'	73° 07.63'
19	44° 28.26'	73° 17.95'	Lamoille (LAMO01)	44° 37.96'	73° 10.39'
21	44° 28.49'	73° 13.90'	Poultney (POUL01)	43° 34.24'	73° 23.53'
25	44° 34.92'	73° 16.87'	Pike (PIKE01)	45° 07.38'	73° 04.18'
33	44° 42.07'	73° 25.09'	Lewis (LEWI01)	44° 14.80'	73° 14.77'
34	44° 42.49'	73° 13.61'	Little Otter (LOTT01)	44° 12.24'	73° 15.11'
36	44° 45.37'	73° 21.30'	LaPlatte (LAPL01)	44° 22.21'	73° 13.01'
40	44° 47.12'	73° 09.73'	Saranac (SARA01)	44° 41.52'	73° 27.19'
46	44° 56.90'	73° 20.40'	Ausable (AUSA01)	44° 33.63'	73° 26.95'
50	45° 00.80'	73° 10.43'	Mettawee (METT01)	43° 33.33'	73° 24.10'
			Great Chazy (GCHA01)	44° 58.81'	73° 25.96'
			Bouquet (BOUQ01)	44° 21.84'	73° 23.41'
			Little Ausable (LAUS01)	44° 35.65'	73° 29.79'
			Salmon (SALM01)	44° 38.40'	73° 29.70'
			Putnam (PUTN01)	43° 57.35'	73° 25.99'
			Little Chazy (LCHA01)	44° 54.12'	73° 24.88'

Table 2. List of analytical parameters, methods and laboratories. The parameter code "-NY" indicates analysis by New York State Department of Health or Biological Survey Laboratories.

Parameter	Database Code	Analytical Method ¹	Laboratory ²
Total phosphorus	TP, TP-NY	APHA 4500-PF, USEPA 365.1	VT DEC, NYS DOH
Dissolved phosphorus	DP, DP-NY	APHA 4500-PF, USEPA 365.1	VT DEC, NYS DOH
Ortho-phosphorus	OP	APHA 4500-PF, USEPA 365.1	VT DEC
Chloride	TCL, TCL-NY	APHA 4500-Cl ⁻ E, USEPA 325.1	VT DEC, NYS DOH
Dissolved silica	DSI, DSI-NY	APHA 4500-Si F, USEPA 370.1	VT DEC, NYS DOH
Alkalinity	ALK	APHA 2320 B	VT DEC
Total nitrogen	TN	Ameel et al. (1993), D'Elia et al. (1977), Ebina et al. (1983), USEPA 353.2	VT DEC
Total Kjeldahl nitrogen	TKN-NY	USEPA 351.2	NYS DOH
Total nitrate/nitrite	TNOX, TNOX-NY	USEPA 353.2	VT DEC, NYS DOH
Total ammonia	TNH3, TNH3-NY	USEPA 350.1	VT DEC, NYS DOH
Total suspended solids	TSS, TSS-NY	APHA 2540 D	VT DEC, NYS DOH
Total organic carbon	TOC-NY	USEPA 415.2	NYS DOH
Dissolved organic carbon	DOC-NY	USEPA 415.2	NYS DOH
Dissolved inorganic carbon	DIC-NY	APHA 4500 CO ₂	NYS DOH
Metals	FE-NY, CA-NY, MG-NY, NA-NY, K-NY, PB-NY	USEPA 200.7	NYS DOH
Dissolved oxygen	DO	APHA 4500 OC	VT DEC
Chlorophyll-a	CHA, CHA-NY	APHA 10200H.3	VT DEC, SUNY BS
Temperature	TEMP		Field measurement
Conductivity	COND		Field measurement
pH	PH		Field measurement
Secchi depth	SECCHI		Field measurement

¹ APHA = American Public Health Association (1989)
USEPA = U.S. Environmental Protection Agency (1983)

² VT DEC = Vermont Department of Environmental Conservation Laboratory
NYS DOH = New York State Department of Health Laboratory
SUNY BS = University of the State of New York Biological Survey

Table 3. List of lake and tributary parameters sampled by year. See Table 2 for a definition of parameter codes.

Parameter	Lake					Tributaries						
	1992	1993	1994	1995	1996	1990	1991	1992	1993	1994	1995	1996
TP	X	X	X	X	X	X	X	X	X	X	X	X
TP-NY				X	X						X	X
DP	X	X	X	X	X	X	X	X	X	X	X	X
DP-NY				X	X						X	X
OP	X	X	X					X	X	X		
TCL	X	X	X	X	X	X	X	X	X	X	X	X
TCL-NY				X	X						X	X
DSI	X	X	X	X	X							
DSI-NY				X	X							
ALK	X	X	X	X	X			X	X	X		
TN	X	X	X	X	X			X	X	X	X	X
TKN-NY	X	X						X	X			
TNOX			X						X	X		
TNOX-NY	X	X	X					X	X			
TNH3			X							X		
TNH3-NY	X	X	X					X	X			
TSS	X	X	X	X	X			X	X	X	X	X
TSS-NY				X	X						X	X
TOC-NY	X	X	X	X	X			X	X	X	X	X
DOC-NY	X	X	X	X	X			X	X	X	X	X
DIC-NY	X	X	X									
Metals	X	X	X	X	X			X	X	X	X	X
DO	X			X	X							
CHA				X	X						X	X
CHA-NY	X	X	X	X	X							
TEMP	X	X	X	X	X						X	X
COND	X		X	X	X						X	X
PH	X	X	X	X	X							
SECCHI	X	X	X	X	X							

Table 4. Project sampling frequencies (actual number of sampling dates per year) for the lake and tributary stations during calendar years 1990-1996. Not all parameters were sampled on all dates.

Lake Station	1992	1993	1994	1995	1996	Tributary Station	1990	1991	1992	1993	1994	1995	1996
02	11	14	11	10	12	Winooski	71	30	9	12	10	8	12
04	13	13	12	10	11	Otter	72	31	11	14	12	9	12
07	12	12	10	9	11	Missisquoi	64	30	7	11	12	6	14
19	13	14	9	8	11	Lamoille	65	27	10	11	11	8	12
21	13	13	10	6	12	Poultney	59	26	9	14	12	8	10
25	12	13	9	9	16	Pike	61	24	4	10	9	4	10
33	12	13	9	7	13	Lewis	68	26	11	16	11	9	9
34	13	13	11	10	15	Little Otter	69	26	8	15	12	9	11
36	12	13	9	7	14	LaPlatte	69	24	12	19	13	9	11
40	12	14	10	10	14	Saranac	36	27	17	13	9	12	10
46	12	14	11	10	14	Ausable	35	27	16	12	9	10	10
50	10	14	8	10	14	Mettawee	60	26	10	15	12	9	13
						Great Chazy	35	22	15	11	7	9	9
						Bouquet	35	26	15	13	9	8	8
						Little Ausable	35	26	16	11	7	10	10
						Salmon	36	25	15	11	8	10	10
						Putnam	22	13	14	14	13	5	5
						Little Chazy	36	25	16	11	7	9	9

1997). These tributary data have been added to the project database and are included in summaries given in Tables 3 and 4.

Project Database

A common project database is maintained by both Vermont DEC and New York State DEC on their respective computer network systems, using the commercial database program Paradox™. Regular tape backup is provided. The data are available on request in either electronic or hard copy form to other government agencies, researchers, consultants, and the general public.

Sample documentation in the database includes the station name (see Table 1) and the date and time of collection. For lake samples, the sampling depth in meters is recorded for discrete depth samples, and the depth layer is noted for composite samples using the following codes: COM = composite sample, E = epilimnion layer, H = hypolimnion layer, U = unstratified conditions. The field names in the database correspond with the parameter codes indicated in Tables 2 and 3, with accompanying measurement units (e.g. "TP, mg/l). Each chemical parameter in the database has an associated remark field (e.g. "TP-R") in which "less than" or "greater than" signs (<, >) are entered where necessary for results below or above analytical detection limits.

Vertical profile *in situ* sampling results obtained using the Hydrolab™ multi-probe sonde are also included in the project database and documented in the same manner, without remark fields. Hydrolab™ measurements recorded in the database fields include temperature (Temp, C), pH, specific conductance (Cond, mS/cm), total dissolved solids (TDS, Kmg/l), dissolved oxygen (DO, % sat. and mg/l), turbidity (Turb, NTU), and reduction-oxidation potential (Redox, mV).

Beginning in 1996, effluent monitoring data from all permitted wastewater treatment facilities discharging phosphorus in the Lake Champlain Basin were included in the project database. These data will serve as the basis for periodic reporting to the Lake Champlain Steering Committee on progress by Vermont and New York toward the target phosphorus loads specified in the phosphorus reduction agreement for Lake Champlain (Lake Champlain Management Conference, 1996).

In Vermont, monthly average flows and effluent total phosphorus concentrations reported during 1996 by the operators were compiled for each facility from Vermont DEC Wastewater Management Division files. In New York, monthly average flows and effluent total phosphorus concentrations reported during 1996 by the operators were compiled for each facility from New York State DEC Wastewater Facility Discharge Monitoring Reports. In addition, for all facilities not required by permit to monitor for effluent total phosphorus concentrations, New York State DEC sampling results were used to provide a complete monthly record for all New York facilities.

Results

Cumulative Statistical Summary

Order statistics (range and inter-quartile values) for each lake and tributary sampling station and each monitored parameter are provided in Appendix A and B. The summary statistics given in Appendix A and B apply to the cumulative data obtained from 1992-1996. Results for tributary parameters (total phosphorus, dissolved phosphorus and chloride) that were sampled by Vermont DEC and New York State DEC (1997) during 1990-1992 using identical methods are also included in the cumulative statistics given in Appendix B.

Precision of Field Duplicate Samples

The project quality assurance procedures include the regular collection of field duplicate samples to assess the precision of the individual sample values. Precision was calculated as the mean relative percent difference (RPD) between duplicate pairs, where the RPD is the absolute value of the difference expressed as a percentage of the mean of the paired results. The mean RPD values for each parameter over the entire monitoring period are listed in Table 5. The mean RPD values listed in Table 5 include both field and laboratory analytical sources of variability.

The mean relative percent differences were highest for parameters that included particulate fractions, such as total phosphorus, total and Kjeldahl nitrogen, total suspended solids, and total organic carbon. The greatest precision was obtained for the more conservative substances such as chloride, dissolved silica, alkalinity, and the earth metals. Precision was better for the tributary results than for the lake results for most parameters, probably because of the improved analytical precision possible at the higher concentration ranges found in the tributaries. Duplicate samples were not obtained for chlorophyll analysis.

Inter-Laboratory Comparison of Analytical Results

The primary purpose of the long-term monitoring program is to detect water quality changes in Lake Champlain and its tributaries over time. For this reason, it is essential that sampling and analytical methods remain consistent from year to year.

Laboratories in both Vermont and New York have provided analytical services to the program during the past few years, as indicated in Tables 2 and 3. In many cases, both laboratories performed analyses on splits of the same sample for parameters including total phosphorus, dissolved phosphorus, chloride, dissolved silica, total suspended solids, and chlorophyll-a. The split sample results were analyzed to determine whether any systematic differences existed in the results produced by the two laboratories.

All lake and tributary sample results for each parameter analyzed in common were pooled for the inter-laboratory comparison. The New York and Vermont laboratory results are compared in Figure 2. Overall bias between the split sample results from the two laboratories was tested by comparing the mean values for each parameter using a paired t-test. The data were \log_{10} -transformed prior to analysis to improve normality. As indicated in Figure 2, statistically

Table 5. Project quality assurance results showing the mean relative percent difference (RPD) between field duplicate samples. "N" indicates the numbers of duplicate pairs obtained. See Table 2 for definitions of parameter codes.

Parameter	Lake		Tributaries	
	RPD	N	RPD	N
TP	15.5	41	8.4	186
TP-NY	22.9	22	6.1	12
DP	22.4	31	11.2	147
DP-NY	14.8	13	27.5	10
OP	25.3	18	15.3	21
TCL	2.3	42	1.3	173
TCL-NY	4.3	12	4.0	10
DSI	3.1	42		
DSI-NY	5.2	12		
ALK	1.2	30	2.2	51
TN	8.1	43	6.2	66
TKN-NY	26.6	17	21.2	32
TNOX	6.7	7	1.8	19
TNOX-NY	43.1	17	26.1	32
TNH3	15.6	3	7.8	7
TNH3-NY	41.6	15	45.7	29
TSS	19.3	39	21.8	60
TSS-NY	41.4	11	19.7	8
TOC-NY	23.6	43	11.6	58
DOC-NY	19.8	43	11.3	53
DIC-NY	14.3	17		
FE-NY	30.4	28	16.1	52
CA-NY	5.2	28	6.3	52
MG-NY	3.7	25	5.2	51
NA-NY	2.1	28	8.5	52
K-NY	9.5	23	12.5	41
PB-NY	40.6	7	24.8	13
DO	7.6	5		
COND	1.9	4	1.7	6
PH	1.4	8	0.5	2

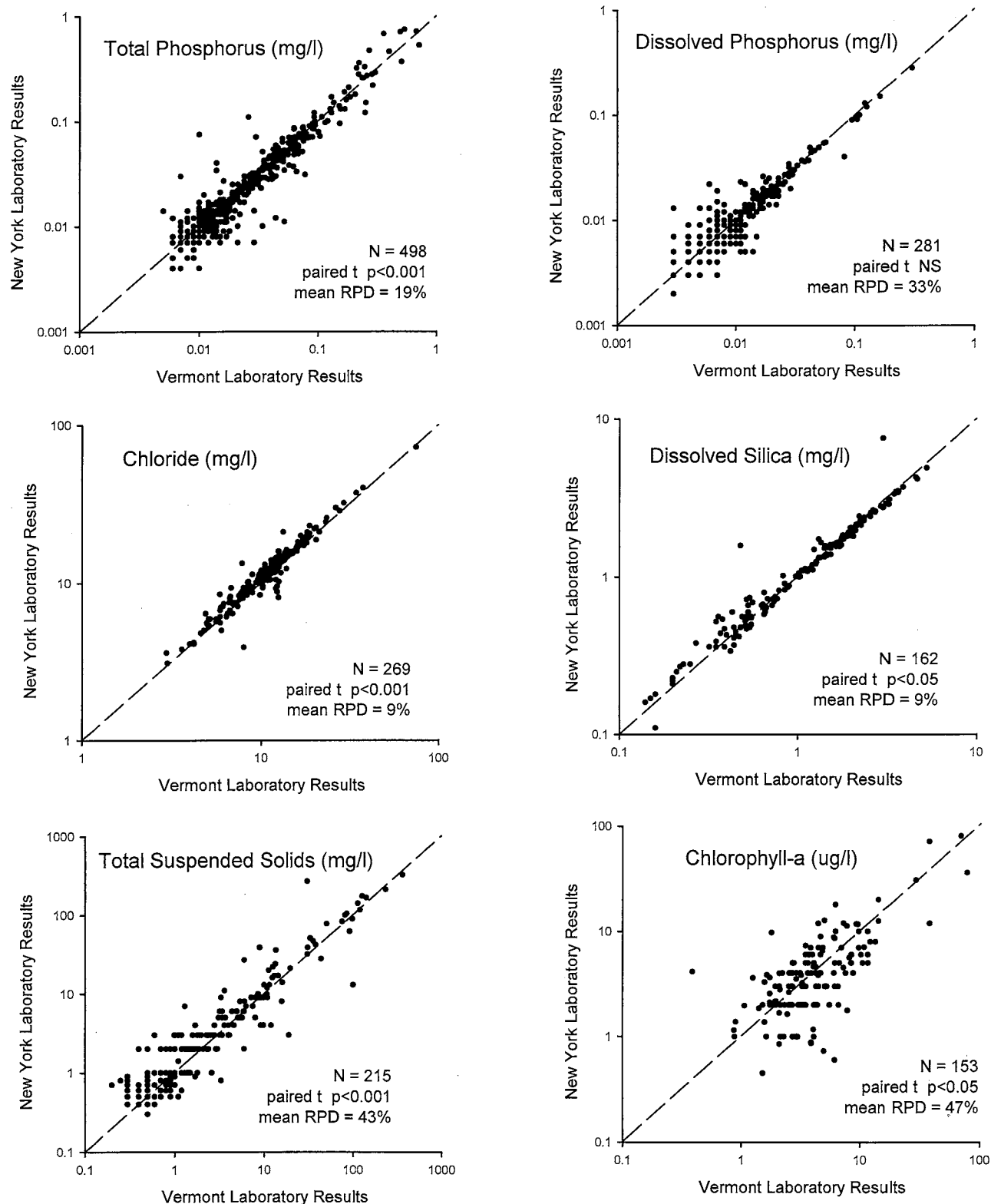


Figure 2. Inter-laboratory comparison of analytical results. Dotted lines represent 1:1 relationships. The significance levels for the paired t-tests are indicated (NS = not significant at $p < 0.05$).

significant differences existed between the mean values for all parameters except dissolved phosphorus. The New York laboratory mean value was slightly higher than the Vermont mean for total phosphorus, chloride, dissolved silica, and total suspended solids. For the chlorophyll-a analysis, the Vermont laboratory produced a higher mean concentration value than the New York laboratory.

The mean relative percent difference (RPD) between split sample results was also calculated for each parameter (non-transformed data) and indicated in Figure 2. The inter-laboratory results were the most consistent for chloride and dissolved silica (mean RPD = 9%). Mean RPD values for total and dissolved phosphorus were 19% and 33%, respectively. The largest average inter-laboratory differences occurred for total suspended solids (43%) and chlorophyll-a (47%).

The residuals about the 1:1 lines in Figure 2 are plotted in Figure 3. A regression of the residuals (\log_{10} -transformed data) against the Vermont laboratory results indicated significant residual dependence (based on an F-test for linear regression) for dissolved phosphorus, dissolved silica, total suspended solids, and chlorophyll-a. These findings indicate that there is a systematic difference between the inter-laboratory results for these four parameters that is a function of the concentration value of the results.

The analysis of the inter-laboratory results showed that there were statistically significant differences in the data produced by the two laboratories for all six parameters analyzed in common. These findings indicate that interpretation of trends in the long-term monitoring data could be compromised if changes in the state laboratory used to perform a particular analysis occur in the future. Such laboratory changes should be made only when absolutely necessary, and only with further analysis of the sources of the observed systematic differences in the inter-laboratory results.

The finding of significant inter-laboratory differences also indicates that the results for parameters analyzed in common should not be pooled into a single field in the project database. Separate database fields will continue to be maintained (as in Appendix A and B) for the Vermont and New York laboratory results.

Dissolved Oxygen Method Comparison

Vertical profiles of dissolved oxygen concentration have been obtained at the deep water lake stations during the course of the monitoring program using two different sampling methods. Vermont project field staff obtain samples for dissolved oxygen analysis using a Kemmerer water bottle device followed by titration analysis at the laboratory using the azide modification of the standard Winkler method (American Public Health Assoc., 1989). New York field staff employ the Hydrolab™ device with a membrane electrode for *in situ* dissolved oxygen measurement (American Public Health Assoc., 1989; Hydrolab, Inc., 1991).

Vermont DEC and New York State DEC (1997) compared dissolved oxygen results obtained in Lake Champlain during 1990-1991 by the Winkler titration and membrane electrode methods. The Winkler titration results were consistently higher than the membrane electrode data by up to 2 mg/l for samples obtained deep in the water column, although near-surface results compared well. Pressure effects on gas diffusion across the membrane were suspected as a possible explanation for the difference in the results at depth.

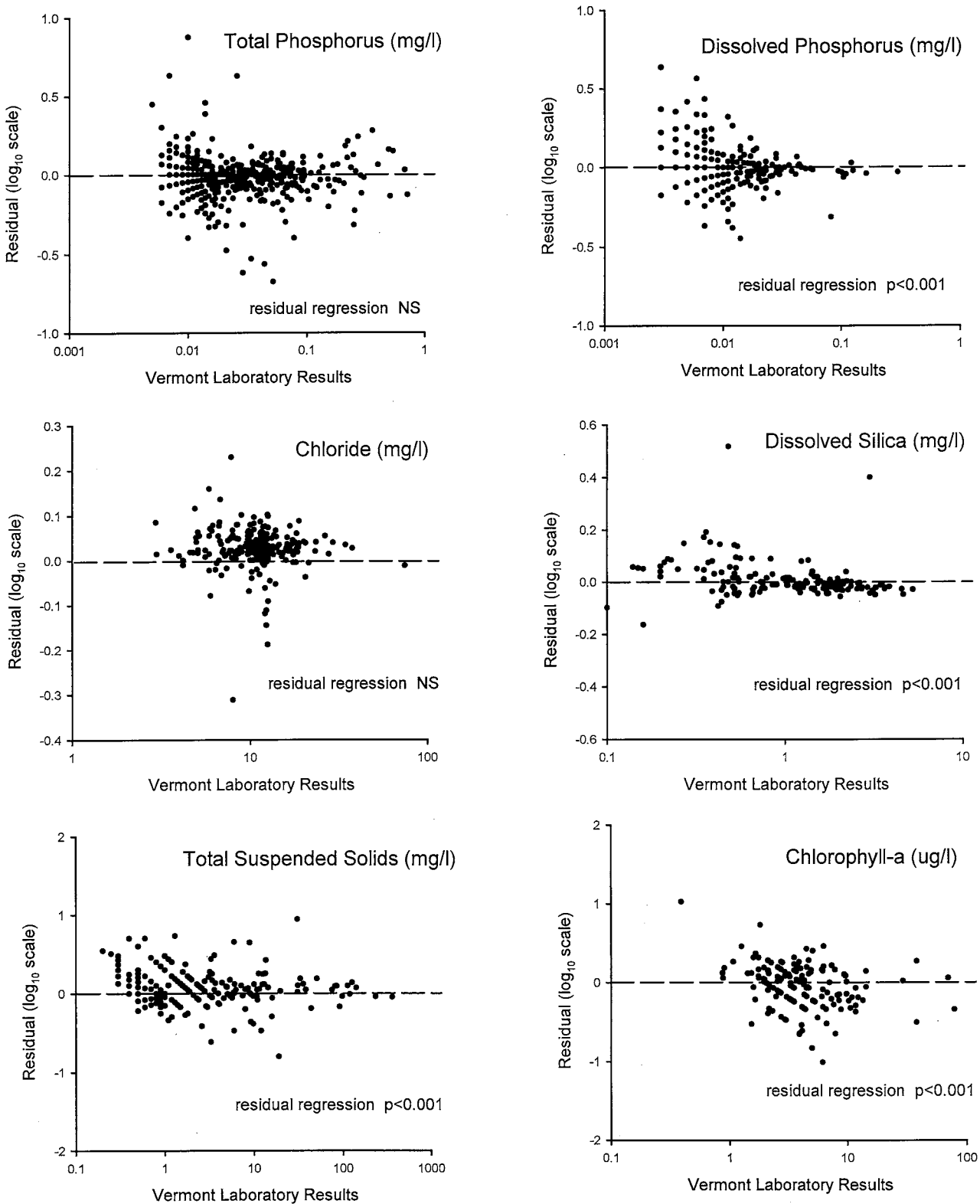


Figure 3. Residuals plots for inter-laboratory comparison of analytical results. Dotted lines show the zero baselines. The significance levels for the regressions of the residuals are indicated (NS = not significant at $p < 0.05$).

Figure 4 compares dissolved oxygen results obtained from the two methods under the current monitoring program. The data shown in Figure 4 include paired measurements made during 1995-1996 at the same station, date, and depth within seven vertical water column profiles. The overall mean dissolved oxygen concentration from the Hydrolab™ method was significantly higher than the mean from the Winkler titration method (paired t-test, \log_{10} transformed data). The mean RPD between the results of the two methods was 10%.

The plots of residuals about the 1:1 line in Figure 4 show a statistically significant and strong residual dependence on concentration, with a positive bias (Hydrolab™ > Winkler) at the low concentration range and a negative bias at high concentrations. No significant residual dependence was found with depth, however, in contrast with the findings from the earlier work (Vermont DEC and New York State DEC, 1997). A change in instruments used by New York State DEC for dissolved oxygen analysis since the 1990-1991 study may have eliminated the depth bias problem.

The data shown in Figure 4 illustrate a serious discrepancy between the results of the two dissolved oxygen measurement methods in the Lake Champlain monitoring data. Dissolved oxygen is a critical limnological parameter in which small changes over time may reveal fundamental shifts in lake trophic state and biological community metabolism. It is essential that dissolved oxygen levels be measured consistently and accurately over time. However, consistency between the membrane electrode and Winkler titration methods has not been achieved for any Lake Champlain sampling program in which the results from both methods were compared.

In practice on Lake Champlain, the membrane electrode dissolved oxygen method has been subject to several sources of error including field calibration problems, instrument drift, and possible pressure effects at depth. The azide modification of the Winkler titration method, while more time-consuming, has the advantage of being subject to few relevant interferences or biases. If titrant solutions are prepared accurately in the laboratory, and if samples are obtained and handled properly in the field, the Winkler method results should be reproducible without bias during all future years of monitoring. For these reasons, the Lake Champlain Monitoring Program should employ the Winkler titration method as the primary method for long-term monitoring of trends in dissolved oxygen concentrations in the lake. The membrane electrode data should be used for more qualitative purposes such as defining the shape of vertical dissolved oxygen profiles in fine depth detail.

Point Source Phosphorus Loading

A list of annual mean flows, total phosphorus concentrations, and phosphorus loads for the 58 wastewater phosphorus discharges in the Vermont portion of the Lake Champlain Basin is given in Table 6. The data were compiled from monthly effluent monitoring records maintained by the Vermont DEC Wastewater Management Division.

Effluent monitoring for total phosphorus (TP) concentration is currently required at 33 of the 58 facilities in Vermont, usually on a monthly basis. The 1996 monitoring results for these 33 facilities are reported in Table 6 as "1996 measured mean TP" concentrations. Phosphorus data for the other Vermont facilities were derived from monitoring results from past years, which are limited or outdated in many cases. These values are reported in Table 6 as "estimated mean TP" concentrations, and were obtained from Vermont DEC and New York State DEC (1997). In order

Dissolved oxygen

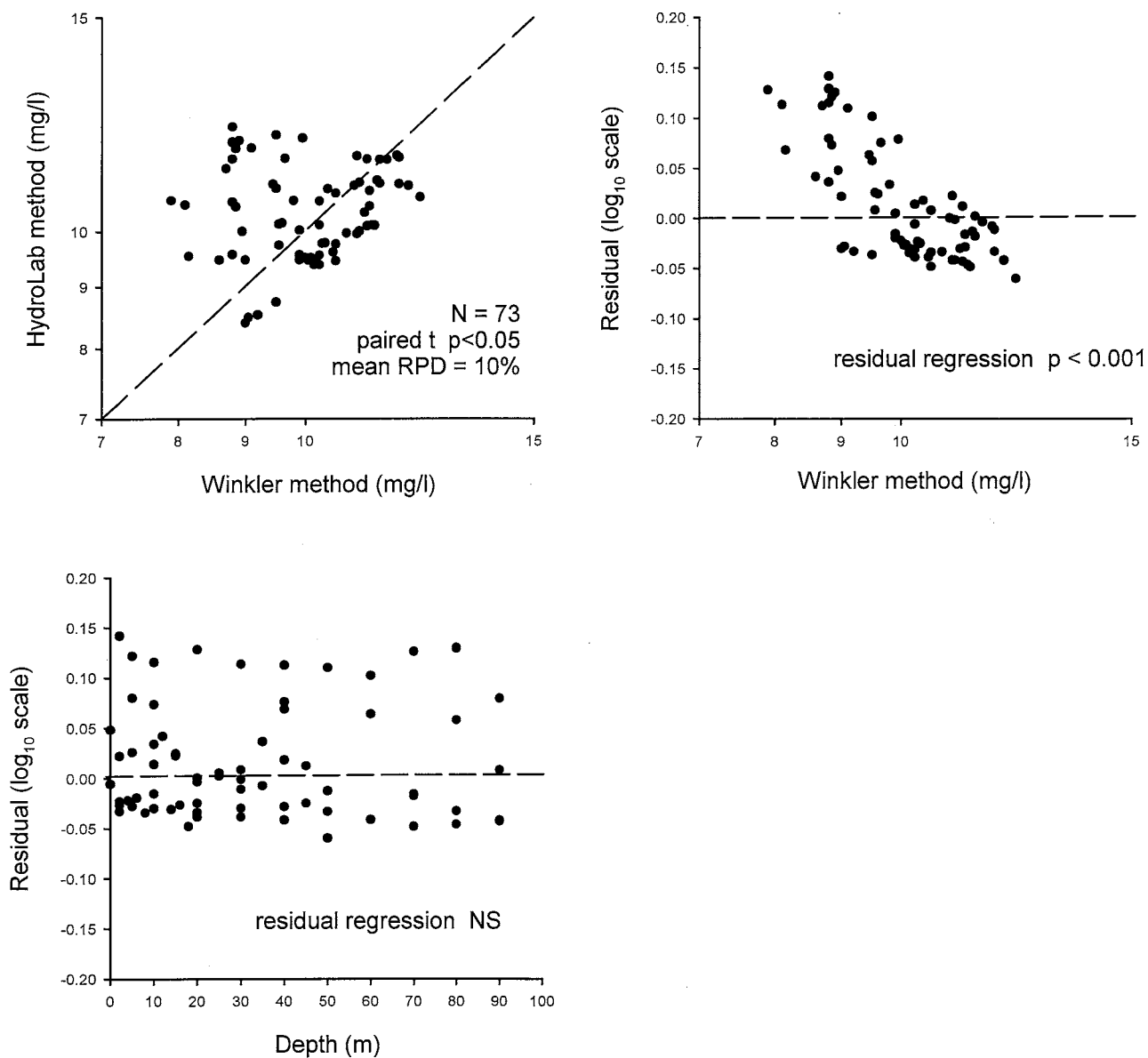


Figure 4. Comparison of dissolved oxygen results from the Hydrolab™ *in-situ* membrane electrode method and the Winkler titration method. The significance levels for the paired t -test and residual regressions are indicated (NS = not significant at $p < 0.05$).

Table 6. Vermont 1996 Lake Champlain Basin point source total phosphorus monitoring results.

Facility	Lake Segment	1996 Mean Flow (mgd)	1996 Measured Mean TP (mg/l)	Estimated ¹ Mean TP (mg/l)	1996 TP Load (mt/yr)	1995 ¹ TP Load (mt/yr)
Benson	South Lake B	0.008		4.340	0.048	0.051
Castleton	South Lake B	0.337	1.934		0.900	0.812
Fair Haven	South Lake B	0.344	2.318		1.102	1.285
Poultney	South Lake B	0.448	2.543		1.572	0.845
West Pawlet	South Lake B	0.014		6.300	0.124	0.099
Orwell	South Lake A	0.026		2.000	0.071	0.060
Brandon	Otter Creek	0.443	1.701		1.041	0.437
Green Mt. Trout Farm	Otter Creek			0.080		0.016
Middlebury	Otter Creek	1.180	7.008		11.418	4.893
Otter Valley Union High School	Otter Creek	0.010				
Pittsford	Otter Creek	0.061		2.630	0.223	0.163
Pittsford Fish Hatchery	Otter Creek	2.196		0.100	0.303	0.691
Proctor	Otter Creek	0.259		2.180	0.781	0.689
Rutland City	Otter Creek	5.840	0.233		1.882	1.669
Vergennes	Otter Creek	0.438	0.212		0.128	0.157
Wallingford	Otter Creek	0.158		2.980	0.651	0.444
West Rutland	Otter Creek	0.260		2.000	0.717	0.606
Barre City	Main Lake	2.817	0.364		1.416	6.305
Burlington East	Main Lake	0.766	0.543		0.574	0.277
Burlington Electric	Main Lake	0.159	0.046		0.010	
Burlington North	Main Lake	1.112	0.480		0.737	0.708
Cabot School	Main Lake	0.002				
Essex Junction	Main Lake	1.806	0.545		1.359	1.406
IBM	Main Lake	3.187	0.439		1.931	0.736
Marshfield	Main Lake	0.016		3.940	0.085	0.094
Montpelier	Main Lake	2.185		2.520	7.603	5.398
Northfield	Main Lake	0.592	2.538		2.075	1.423
Plainfield	Main Lake	0.076		4.290	0.450	0.332
Richmond	Main Lake	0.127	9.017		1.581	0.782
South Burlington Airport Park.	Main Lake	1.474	0.624		1.271	1.029
Stowe	Main Lake	0.151	0.345		0.072	0.030
Waterbury	Main Lake	0.307		4.950	2.098	1.668
Weed Fish Culture Station	Main Lake	6.423	0.037		0.331	0.529
Williamstown	Main Lake	0.086		2.110	0.251	0.257
Winooski	Main Lake	0.895	0.586		0.724	0.585
Hinesburg	Shelburne Bay	0.205	0.630		0.179	0.185
Shelburne #1	Shelburne Bay	0.314	0.334		0.145	0.138
Shelburne #2	Shelburne Bay	0.392	0.464		0.251	0.210
South Burlington Bart. Bay	Shelburne Bay	0.702	0.351		0.340	0.188
Burlington Main	Burlington Bay	4.496	0.424		2.634	2.188
Fairfax	Malletts Bay	0.046		3.950	0.251	0.216
Hardwick	Malletts Bay	0.240		2.750	0.911	0.563
Jeffersonville	Malletts Bay	0.034		2.000	0.094	0.113
Johnson	Malletts Bay	0.178	0.664		0.163	0.458
Milton	Malletts Bay	0.169		0.560	0.131	0.105
Morrisville	Malletts Bay	0.340	1.584		0.743	1.034
Vermont Whey	Malletts Bay	0.401	0.276		0.153	0.239
Northwest State Correctional	St. Albans Bay	0.030	0.183		0.008	0.007
St. Albans City	St. Albans Bay	2.697	0.217		0.807	1.614
Enosburg Falls	Missisquoi Bay	0.341	4.924		2.319	3.032
Newport Center	Missisquoi Bay	0.015		0.100	0.002	0.002
North Troy	Missisquoi Bay	0.052		1.900	0.137	0.171
Richford	Missisquoi Bay	0.244		1.040	0.351	0.396
Rock Tenn	Missisquoi Bay	0.266	1.511		0.555	0.100
Sheldon Springs	Missisquoi Bay	0.037		2.040	0.105	0.093
Swanton	Missisquoi Bay	0.652	0.289		0.260	0.220
Troy/Jay	Missisquoi Bay	0.053		10.200	0.740	1.003
Alburg	Isle LaMotte	0.002	0.028		0.000	0.005
TOTAL		46.097			54.807	46.759

¹ From Vermont DEC and New York State DEC (1997).

to improve the Vermont point source phosphorus database for the Lake Champlain Basin, the Vermont DEC will require effluent phosphorus monitoring at all the facilities listed in Table 6 as their individual discharge permits are renewed over the next five years.

Table 6 shows that the total point source load to Lake Champlain from Vermont during 1996 was estimated to be 54.8 mt/yr. This value represents an 8.0 mt/yr increase over the 1995 value of 46.8 mt/yr reported in Vermont DEC and New York State DEC (1997). There was no single facility responsible for the net load increase. Loading from the Middlebury facility increased by 6.5 mt/yr from 1995 to 1996 as a result of increasing phosphorus concentrations in the effluent. However, this increase was partly offset by a 4.9 mt/yr reduction at Barre City where a new phosphorus removal process came on line. Phosphorus loading from Middlebury and ten other Vermont facilities will decline over the next several years as the state statute requiring phosphorus removal to a 0.8 mg/l effluent level is fully implemented (Vermont Agency of Natural Resources, 1996).

A list of annual mean flows, total phosphorus concentrations, and phosphorus loads for the 28 wastewater phosphorus discharges in the New York portion of the Lake Champlain Basin is given in Table 7. The data were compiled from effluent monitoring records maintained by the New York State DEC Region 5 Water Quality Office located in Raybrook, NY. Monthly effluent monitoring for total phosphorus concentration is currently a permit requirement at 12 of the 28 facilities in New York. The remaining facilities were sampled monthly during 1996 for total phosphorus concentration by New York State DEC staff.

Table 7 shows that the total point source phosphorus load to Lake Champlain from New York during 1996 was estimated to be 32.3 mt/yr. This value represents a 0.7 mt/yr increase over the 1995 value of 31.7 mt/yr. However, the 1995 total phosphorus load listed in Table 7 is 1.7 mt/yr lower than the 1995 total load reported in Vermont DEC and New York State DEC (1997). The reason for this disparity was the use of incomplete data when calculating the 1995 total phosphorus load for the Lake Placid facility in the Vermont DEC and New York State DEC (1997) report, resulting in an erroneously high load estimate for Lake Placid. Also, the 1996 mean flow value for the Crown Point facility listed in Table 7 is probably somewhat over-estimated.

Trends in Lake Total Phosphorus Concentration

Substantial reductions in phosphorus loading to many Lake Champlain segments occurred between 1991 and 1995 as a result of the implementation of point and nonpoint source controls in Vermont and New York (Lake Champlain Management Conference, 1996). The total load of phosphorus to Lake Champlain was estimated to have declined by 21% between 1991 and 1995. The lake monitoring data were examined statistically to determine whether in-lake total phosphorus concentrations have declined in response to the recent loading reductions.

In order to extend the trend analysis as far back in time as possible, total phosphorus data from the current monitoring program (Vermont laboratory results only) were combined with data from the 1990-1991 Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York State DEC, 1997) for the 12 core lake monitoring stations. Although the Diagnostic-Feasibility Study used somewhat different methods of vertical sampling and compositing, the results should be comparable because of the lack of strong vertical stratification of phosphorus concentrations in

Table 7. New York 1996 Lake Champlain Basin point source total phosphorus monitoring results.

Facility	Lake Segment	1996 Mean Flow (mgd)	1996 Measured Mean TP (mg/l)	Estimated ¹ Mean TP (mg/l)	1996 TP Load (mt/yr)	1995 ¹ TP Load (mt/yr)
Fort Ann	South Lake B	0.062	2.324		0.199	0.147
Granville	South Lake B	0.825	1.716		1.955	1.693
Great Meadows Correctional	South Lake B	0.366	0.859		0.434	0.193
Washington Correctional	South Lake B	0.128	0.328		0.058	0.080
Whitehall	South Lake B	0.726	0.916		0.918	0.597
Crown Point	South Lake A	0.050 ²	2.782		0.192	0.058
International Paper Co.	South Lake A	16.783	0.275		6.374	6.314
Ticonderoga	South Lake A	0.932	1.205		1.551	0.652
Port Henry	Port Henry	0.695	2.102		2.017	2.512
Westport	Port Henry	0.111	1.446		0.222	0.140
Ausable Forks	Main Lake	0.070	4.331		0.419	0.494
Keeseville	Main Lake	0.290	1.650		0.661	0.964
Lake Placid	Main Lake	1.298	1.062		1.904	2.396 ⁴
Peru	Main Lake	0.261	0.760		0.274	0.638
Valcour	Main Lake	0.003	1.511		0.006	0.002
Wadhams	Main Lake	0.007 ³	3.351		0.032	0.027
Willsboro	Main Lake	0.017	4.810		0.113	0.431
Adirondack Fish Culture Station	Cumberland Bay	3.017	0.026		0.108	0.108
Dannemora	Cumberland Bay	0.895	2.604		3.219	2.238
Plattsburgh City	Cumberland Bay	8.058	0.614		6.833	7.236
Plattsburgh/Champlain Park	Cumberland Bay	0.083	2.718		0.312	0.193
Saranac Lake	Cumberland Bay	1.791	0.932		2.305	1.884
St. Armand	Cumberland Bay	0.039	4.208		0.227	0.189
Altona Correctional	Isle LaMotte	0.081	0.486		0.054	0.078
Champlain	Isle LaMotte	0.384	0.191		0.101	0.630
Rouses Point	Isle LaMotte	0.930	1.376		1.767	1.646
Wyeth-Ayerst, Chazy	Isle LaMotte	0.038	1.075		0.056	0.054
Wyeth-Ayerst, Rouses Point	Isle LaMotte	> 1.0				0.072
TOTAL		37.940			32.311	31.666

¹ From Vermont DEC and New York State DEC (1997).

² Crown Point flow value is probably over-estimated.

³ Wadhams flow is an approximate estimate.

⁴ Lake Placid 1995 load value is corrected from value given in Vermont DEC and New York State DEC (1997).

Lake Champlain. For those stations (7, 19, 25, 34, 36) sampled in complete vertical profile during 1990-1991, only epilimnion data (≤ 20 meters) were used, averaged by date. Data used for the analysis from the current monitoring program included only epilimnion composites or samples obtained under unstratified conditions.

All data were \log_{10} -transformed prior to analysis to improve the normality of the within-year distributions of phosphorus concentrations at each sampling station. Figures 5 and 6 show trends in the geometric mean total phosphorus concentration at each lake station during 1990-1996, in comparison with the in-lake water quality criterion established for the corresponding lake segment (Lake Champlain Management Conference, 1996).

A linear regression analysis of the geometric means vs. year was used to test the statistical significance of any apparent linear trends in Figures 5 and 6. A statistically significant positive trend in mean phosphorus concentration (F-test for linear regression, $p < 0.05$) was found for Station 25 (Malletts Bay) during 1990-1996. No significant phosphorus trends in either positive or negative directions were found at any other lake station.

The absence of a statistically significant response in the lake to the recent phosphorus loading reductions may have been the result of long residence times and resulting time lags in the larger volume lake segments (e.g. the Main Lake). Insufficient years of monitoring and resulting low-power statistical tests could also be a factor. In either case, continued monitoring in future years should eventually succeed in documenting phosphorus changes of 15% or greater, if such changes actually occur in the lake (New York State DEC, University of the State of New York and New York State Freshwater Institute, and Vermont DEC, 1996).

The reasons for the significant positive trend in Malletts Bay are not clear. Phosphorus loads to Malletts Bay were estimated to have declined by about 10% between 1991 and 1995 (Lake Champlain Management Conference, 1996). Hazards of multiple statistical comparisons may be a factor in producing a significant result for one of the 12 lake stations tested (Snedecor and Cochran, 1969). It is unlikely that the recent phosphorus increase detected in Malletts Bay indicates an environmental trend of management significance, but the results of continued monitoring should be closely watched.

Tributary Response to Point Source Phosphorus Reductions

There have been large reductions in point source phosphorus discharges to two Vermont rivers in recent years. As shown in Figure 7, treatment plant upgrades or other operational changes at the Hinesburg, Middlebury and Rutland City facilities have resulted in sharply reduced phosphorus loadings to the LaPlatte River and Otter Creek.

The Hinesburg Wastewater Treatment Facility began advanced treatment for phosphorus removal in August 1992. The phosphorus load discharged by this facility to the LaPlatte River declined from the pre-treatment mean value of 12.9 kg/day down to an average of 0.96 kg/day since the upgrade.

Phosphorus reductions also occurred at Rutland City in July 1993 as a result of a plant upgrade, and at Middlebury beginning in July 1994, primarily as the result of operational changes

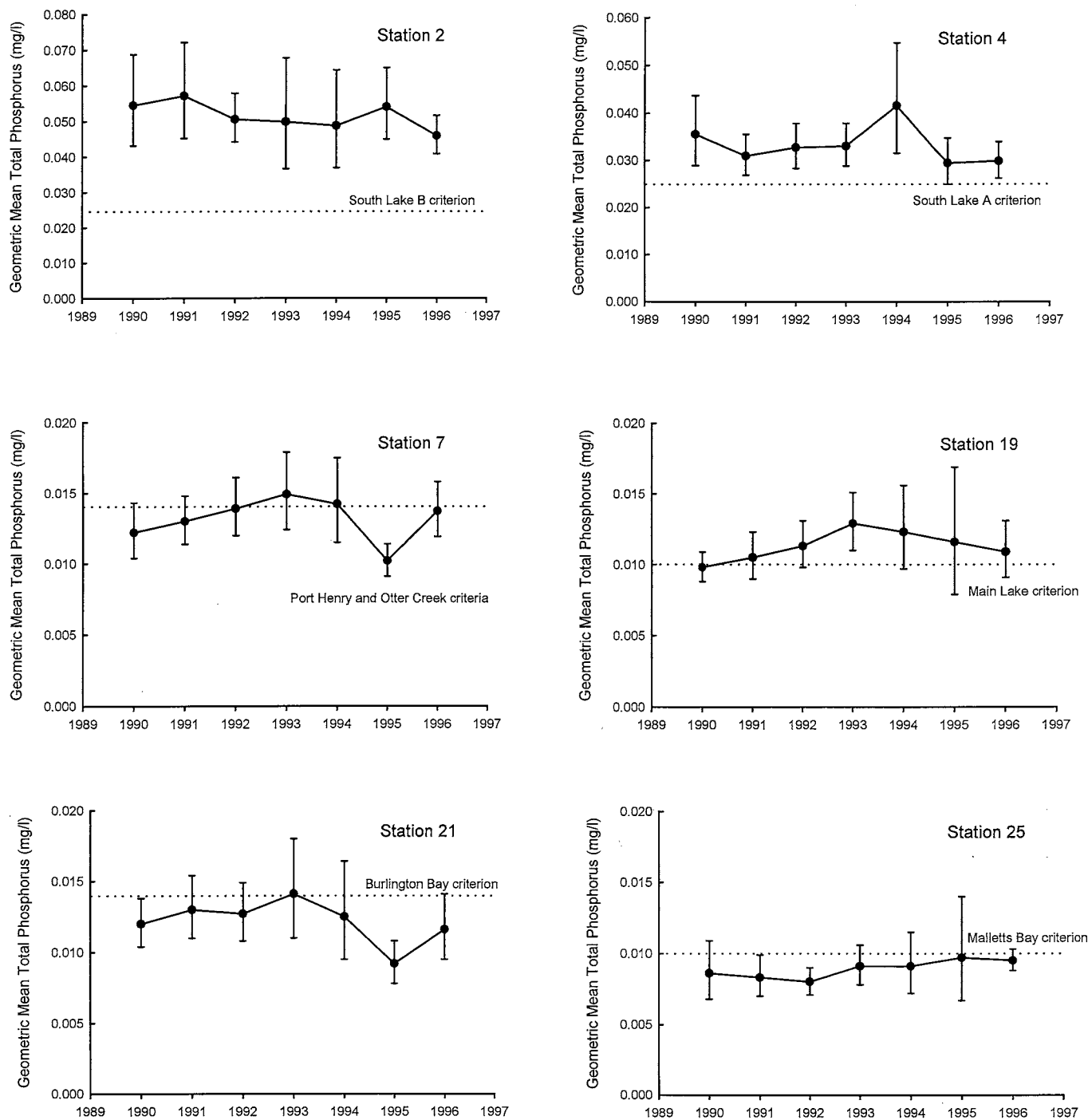


Figure 5. Trends in mean total phosphorus concentration at lake stations 2, 4, 7, 19, 21, and 25 during 1990-1996. Error bars are 95% confidence intervals for the annual geometric means, calculated on \log_{10} -transformed data. Dotted lines represent the in-lake total phosphorus criterion for the corresponding lake segment (Lake Champlain Management Conference, 1996).

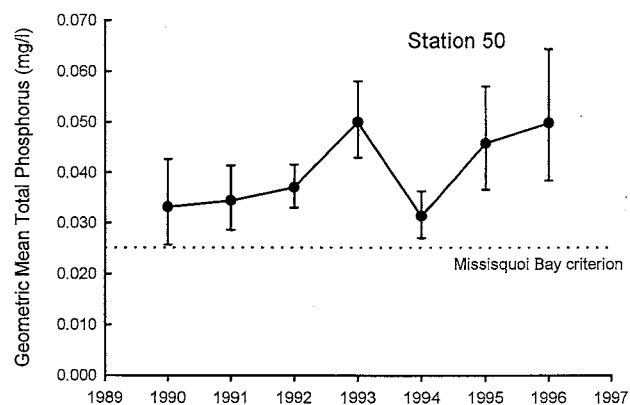
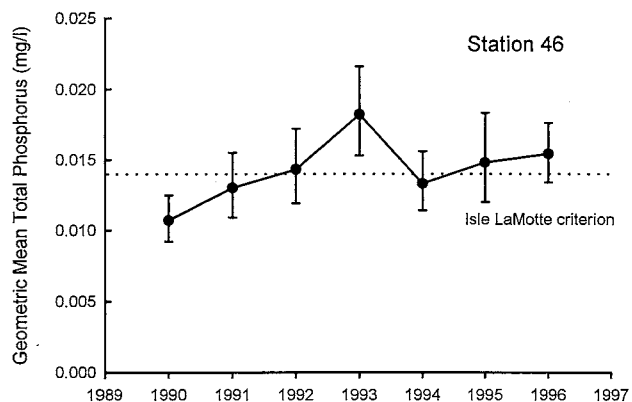
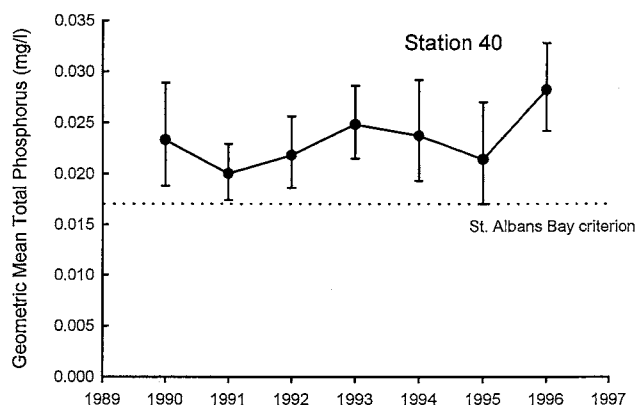
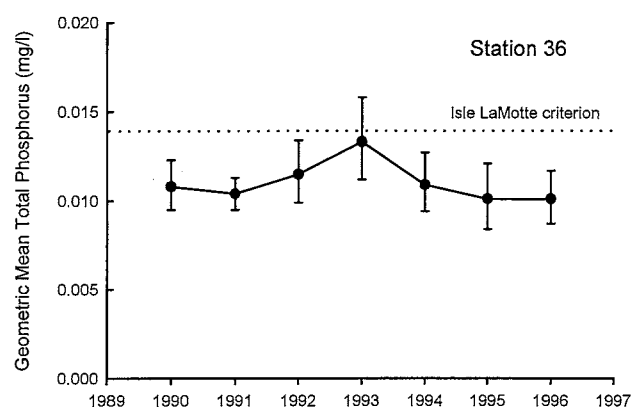
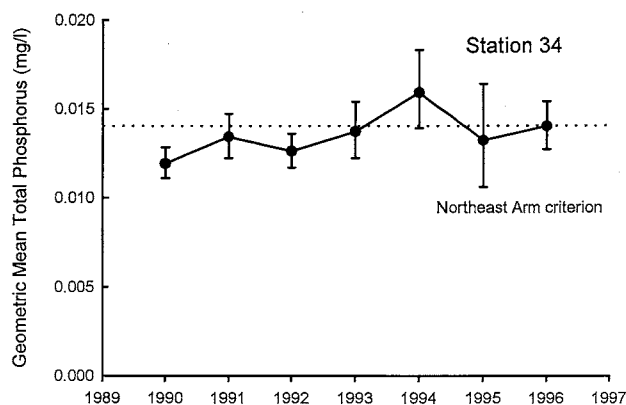
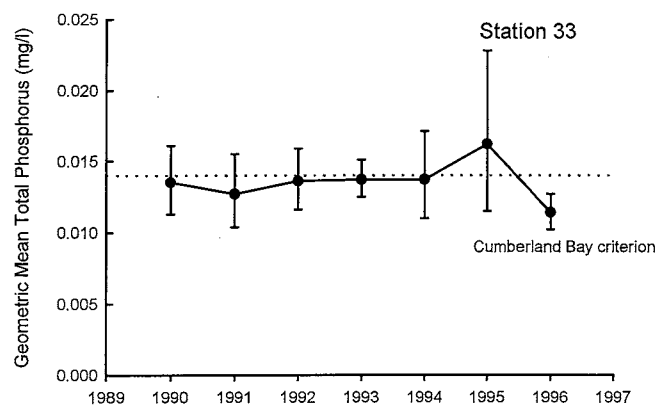


Figure 6. Trends in mean total phosphorus concentration at lake stations 33, 34, 36, 40, 46, and 50 during 1990-1996. Error bars are 95% confidence intervals for the annual geometric means, calculated on \log_{10} -transformed data. Dotted lines represent the in-lake total phosphorus criterion for the corresponding lake segment (Lake Champlain Management Conference, 1996).

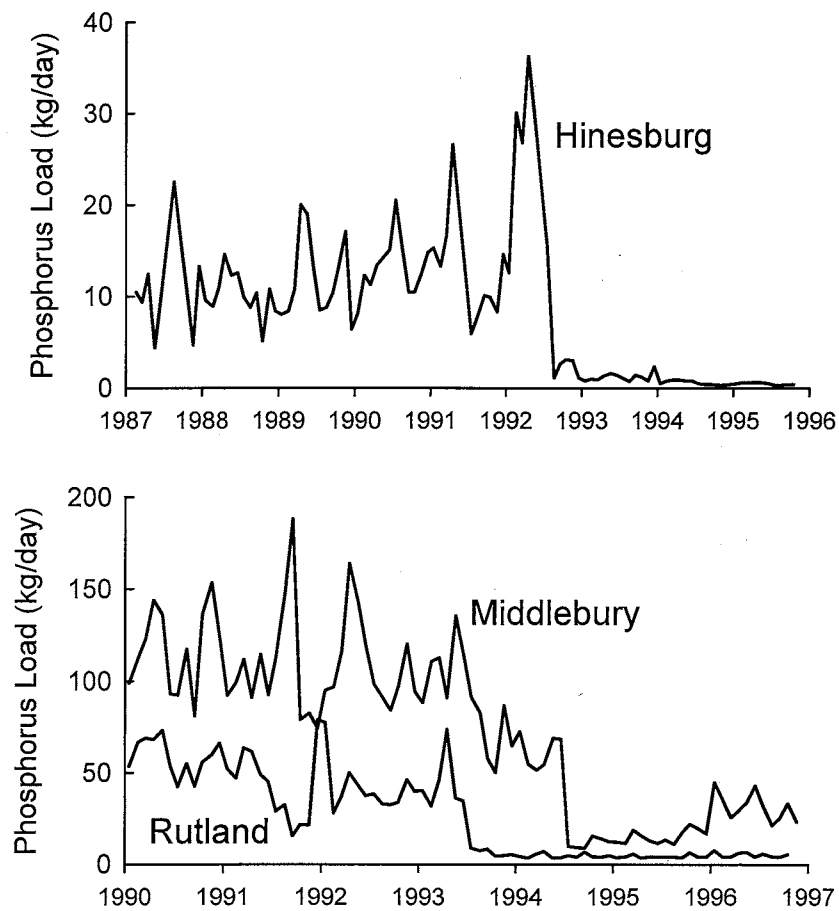


Figure 7. Monthly average total phosphorus loading from the Hinesburg, Middlebury, and Rutland wastewater treatment facilities. Data are from Vermont DEC Wastewater Management Division files.

at the Agrimark, Inc. plant which discharges to the municipal facility. The combined phosphorus loading to Otter Creek from these two facilities declined from a mean value of 158.3 kg/day prior to June 1993 down to a mean load of 25.2 kg/day recorded since July 1994. Further phosphorus reductions will occur at Middlebury in the future when a new wastewater treatment facility is constructed and operated to attain a permitted effluent phosphorus concentration of 0.8 mg/l or less.

The tributary monitoring data were examined to determine whether the phosphorus load reductions at these upstream point sources have produced measurable loading changes at the monitoring stations located near the mouths of these rivers. Sampling data obtained by the monitoring program on the LaPlatte River and Otter Creek during 1992-1996 were combined for the analysis with data obtained during 1990-1992 by the Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York State DEC, 1997), using identical sampling methods.

Total phosphorus concentrations in Lake Champlain tributaries are often strongly correlated with stream flow. Therefore, a statistical comparison of the sample concentration results before and after the treatment plant upgrades might be misleading if the flow conditions under which the samples were obtained are not considered in the analysis.

Average daily stream flow records for the period of March 1990 to September 1996 were obtained from the U.S. Geological Survey for gages on the LaPlatte River at Shelburne Falls, the Otter Creek at Middlebury, and the New Haven River at Brooksville. The New Haven River is a tributary of the Otter Creek, and the daily flows for the Otter Creek gage at Middlebury and the New Haven River were summed to improve the estimates of the total daily flows in Otter Creek near its mouth, as was done for the Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York State DEC, 1997).

Trends in total phosphorus concentration in the LaPlatte River and Otter Creek are shown in Figure 8. A linear regression analysis was used on \log_{10} -transformed data to test for the presence of monotonic trends during the monitoring period. Total phosphorus concentrations in the LaPlatte River showed a significant decreasing trend, while no significant trend was found for Otter Creek.

The phosphorus concentration trends were adjusted for the effect of flow by plotting the residuals from the \log_{10} concentration vs. \log_{10} flow relationship against time (Hirsch et al., 1982). A regression of the concentration-flow residuals was used to test for the presence of a trend in concentration that was independent of possible flow effects. However, the concentration vs. flow relationships for the entire 1990-1996 period were not statistically significant for either river (F-test for linear regression using $p < 0.05$ criterion), and the residuals plots in Figure 8 produced the same statistical results as the regressions using unadjusted concentration values.

The relationships between the total phosphorus concentration and the average daily stream flow on the day of sampling are shown for the LaPlatte River and Otter Creek in Figure 9. Figure 9 compares the concentration vs. flow relationships for the periods before and after the treatment plant upgrades. In both rivers, the concentration vs. flow relationship changed after the point source loads were reduced. The difference was greatest at the low end of the flow range, where phosphorus concentrations in both rivers were substantially lower after the treatment plant upgrades. Under high flow conditions, the phosphorus concentrations were similar before and after

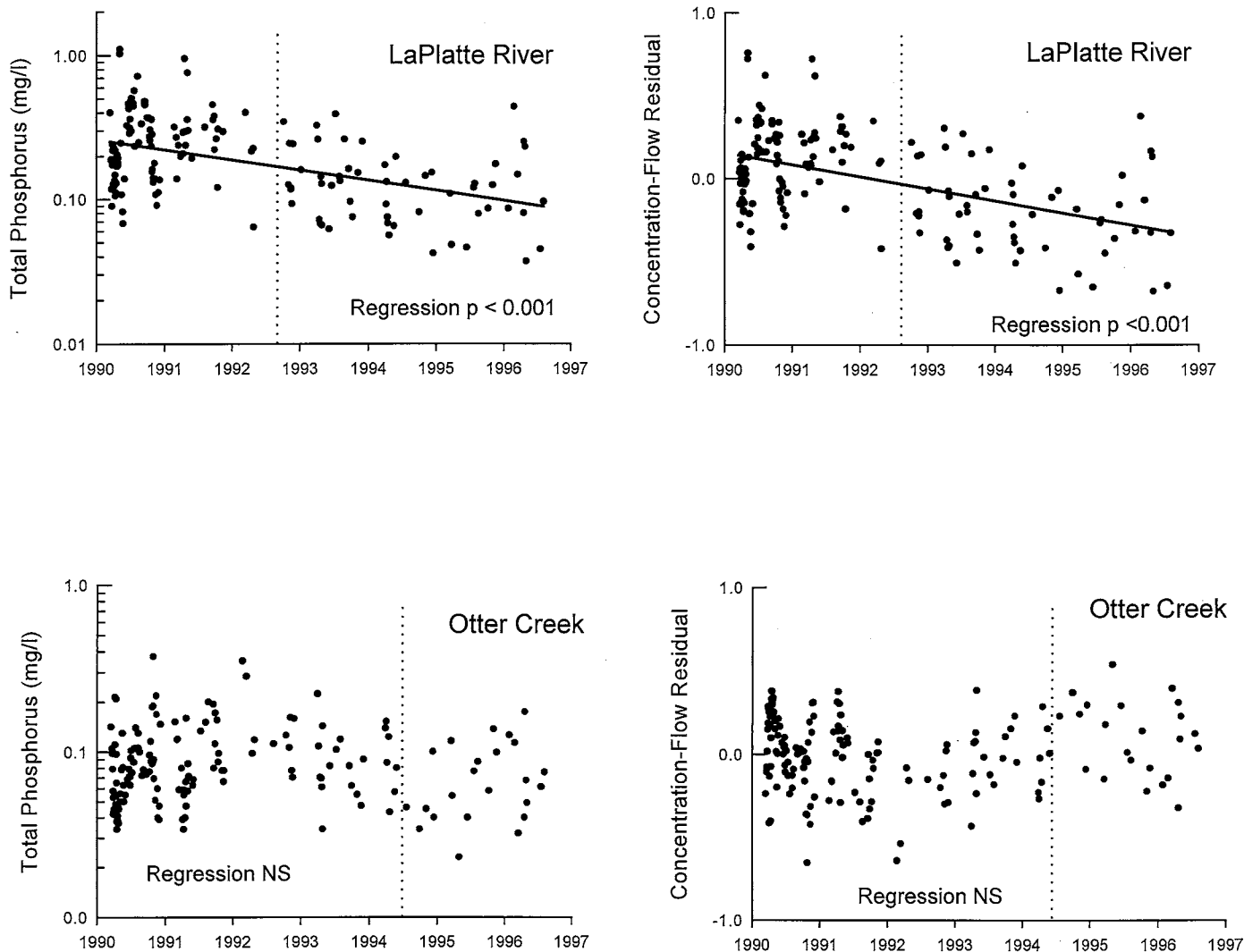


Figure 8. Trends in total phosphorus concentration in the LaPlatte River and Otter Creek, 1990-1996. Left-hand plots show regressions of \log_{10} -transformed concentrations vs. time (days). Right-hand plots show regressions of concentration-flow residuals (\log_{10} -transformed data) vs. time. The significance levels for the regressions are indicated (NS = not significant at $p < 0.05$). Dotted lines show when point source phosphorus reductions occurred.

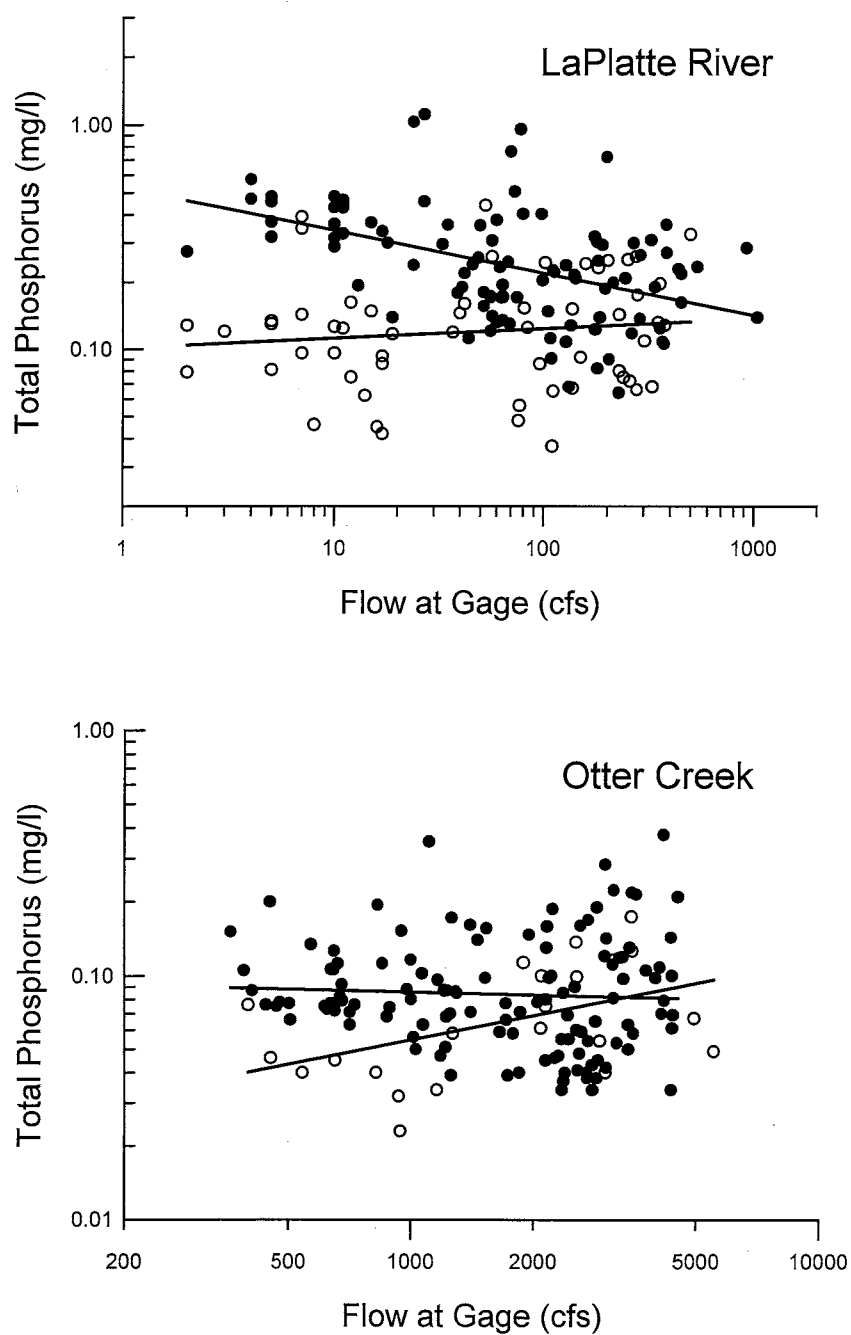


Figure 9. Total phosphorus concentration vs. average daily flow regression relationships for the LaPlatte River and Otter Creek, before (closed circles) and after (open circles) point source phosphorus loading reductions.

the point source reductions. The slopes and intercepts of the linear regression lines shown in Figure 9 were significantly different between the "before" and "after" data sets for the LaPlatte River ($p < 0.05$, \log_{10} transformed data), but were not statistically different for Otter Creek.

The shifts in the concentration vs. flow relationships shown in Figure 9 are consistent with a point source reduction effect. Under low flow conditions, the continuous point source discharges represented a relatively high proportion of the total phosphorus load carried by each river, especially prior to the treatment plant upgrades. The greatest sensitivity to point source load reductions would therefore be expected under low flow conditions.

The data were used to determine the magnitude of the phosphorus loading changes in the rivers that resulted from the point source reductions. The river loads were estimated using the FLUX program methods previously applied for the Lake Champlain Diagnostic-Feasibility Study (Walker, 1987; Walker, 1990; Vermont DEC and New York State DEC, 1997). The FLUX program application used concentration vs. flow regression relationships such as those shown in Figure 9 with a continuous daily flow record for a specified time period to produce an estimate of the mean load for the time period.

It was necessary for this analysis to define a single hydrologic time period for each stream for the before vs. after loading comparison. Otherwise, hydrologic differences between two different time periods would interfere with the comparison of the loads before and after the point source reductions. The time period since the point source reductions occurred in each river was chosen for this purpose. Essentially, the analysis compares the observed mean loading rate in each river after the point source reductions with the loading rate that would have occurred during the same time period if the concentration vs. flow relationship had remained the same as during the pre-upgrade period.

The flow and sample date ranges used with the FLUX program regression-based load estimation procedure are indicated in Table 8. The regression results and the mean loads estimated for the before and after point source treatment situations are also shown in Table 8. The flow values from the gage stations were increased by a factor equal to the mouth/gage drainage area ratio so that the resulting load estimates would represent the loads delivered to the lake at the river mouths. The coefficient of variation (CV) values given in Table 8 for the mean loading rates were produced by the FLUX program error analysis procedure.

As shown in Figure 10, the observed phosphorus loading rate in the LaPlatte River after the Hinesburg treatment plant upgrade was significantly lower than the loading rate that would have been expected without the upgrade. The mean loading estimates for the river mouth before and after the upgrade differed by 12.9 kg/day, which is essentially equivalent to the 12.0 kg/day point source reduction measured at the treatment plant.

In Otter Creek, the estimated post-treatment mean loading rate was 79 kg/day less than the rate that would have been expected without the point source reductions at Middlebury and Rutland (Figure 10). However, the difference in mean loading estimates before and after the point source reduction was not statistically significant. The 79 kg/day reduction estimated for the mouth of Otter Creek was less than the combined reduction of 133 kg/day from the two upstream treatment plants.

Table 8. Summary of FLUX program total phosphorus load estimates for the LaPlatte River and Otter Creek, before and after point source reductions. Flow values reported for the river mouths were calculated using mouth/gage drainage area ratios of 1.18 for the LaPlatte River and 1.28 for Otter Creek. CV values are the coefficients of variation for the mean loading estimates. Parameters for the concentration (mg/l) vs. flow (cfs) regressions and their standard errors (SE) were calculated for log₁₀ transformed data.

	LaPlatte River		Otter Creek	
	Before	After	Before	After
Hydrologic period for load estimate	8/1/92-9/30/96	8/1/92-9/30/96	7/1/94-9/30/96	7/1/94-9/30/96
Hydrologic period duration (yrs)	4.17	4.17	2.25	2.25
Sample date range for regression	3/15/90-4/24/92	10/3/92-8/2/96	3/15/90-6/4/93	7/19/94-8/2/96
Number of samples	97	57	122	23
Mean flow at mouth (10 ⁶ m ³ /day)	0.115	0.115	3.81	3.81
Mean load at mouth (kg/day)	29.8	16.9	367.0	287.9
CV of mean load	0.063	0.094	0.055	0.122
Regression slope	-0.190	0.0481	-0.0397	0.297
SE of slope	0.0392	0.0476	0.0687	0.136
Regression intercept	-0.278	-1.003	-0.948	-2.164
SE of intercept	0.075	0.085	0.222	0.436

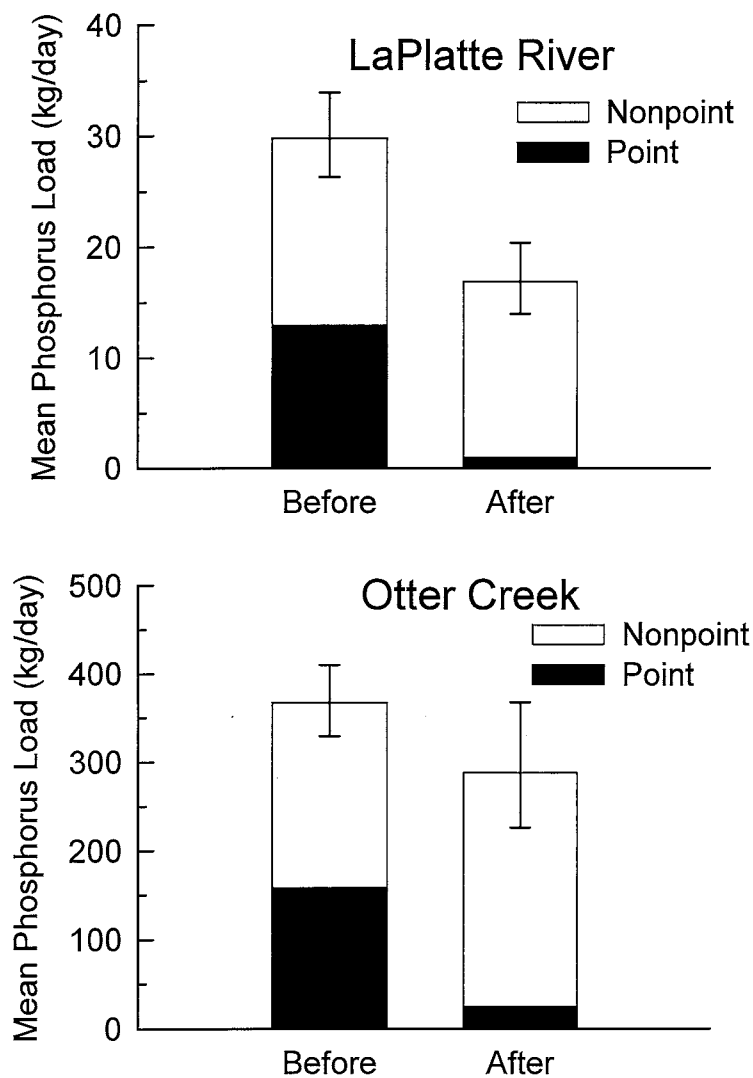


Figure 10. Total point and nonpoint source phosphorus loading in the LaPlatte River and Otter Creek, before and after point source phosphorus loading reductions. Error bars represent 95% confidence intervals for the total load, calculated from FLUX program procedures (Walker, 1987).

There are several possible reasons why the LaPlatte River responded more strongly to the upstream point source reductions than Otter Creek. First, the post-treatment time period has been longer for the LaPlatte River, where the point source reduction occurred in 1992. In Otter Creek, the point source reduction at Middlebury did not occur until 1994, and effluent phosphorus levels have been increasing at that facility in recent years (Figure 7). As a result, the available data for the post-treatment period are more limited for Otter Creek, which would limit the precision and statistical power of the before and after comparison.

Time lags resulting from phosphorus storage and cycling between biotic and abiotic compartments in the stream channel may also be a factor in delaying the full load reduction response at the mouth of Otter Creek. The Rutland and Middlebury wastewater discharges are located well upstream, with Middlebury at 41 km and Rutland at 115 km from the river mouth. In contrast, the Hinesburg discharge is only 19 km upstream of the mouth of the LaPlatte River. It would therefore be expected that in-stream processes could delay the response at the mouth of Otter Creek much longer than in the LaPlatte River. The full loading reduction in Otter Creek may eventually be realized and documented by continued monitoring.

Another possible factor contributing to the incomplete response of Otter Creek to upstream point source reductions is the existence of several dams and small impoundments along its course. Phosphorus trapping in the sediments of these impoundments could create a situation where the loading change measured at the river mouth was less than the loading reduction at the upstream point sources.

These results have a number of important implications for phosphorus management in the Lake Champlain Basin, as discussed below.

- **It is possible with the current monitoring program design to statistically detect substantial phosphorus loading changes in Lake Champlain tributaries.** The recent point source reductions in the LaPlatte River and Otter Creek represented a large portion of the total phosphorus load in these rivers. The 12 kg/day point source reduction in the LaPlatte River was 37% of the total load estimated for the 1991 hydrologic base year (Vermont DEC and New York State DEC, 1997). In Otter Creek, the 133 kg/day point source reduction represented 44% of the 1991 base year load estimate. A statistical power analysis conducted as part of the current monitoring program design (New York State DEC, University of the State of New York Biological Survey and New York State Freshwater Institute, and Vermont DEC, 1996) indicated that, in general for Lake Champlain tributaries, the minimum detectable change in phosphorus loading would be about 27% after 8-10 years of monitoring. The findings presented here for the LaPlatte River and Otter Creek are consistent with the results of the previous power analysis, and indicate that the monitoring program will be useful in tracking progress toward the phosphorus reduction goals for Lake Champlain established by the Lake Champlain Management Conference (1996).
- **The time lag between an upstream phosphorus source reduction and the response at the river mouth may be no more than a few years.** A significant phosphorus load reduction was documented at the mouth of the LaPlatte River within only three years after the reduction in loading from the point source located 19 km upstream. These findings are consistent with the analysis by Hoffman et al. (1996) who concluded that the in-stream system in the LaPlatte

River was not a long-term repository for stored phosphorus. The total in-stream stock of phosphorus in all biotic and abiotic compartments in the LaPlatte River was estimated by Hoffman et al. (1996) to be approximately equal to the annual loading at the river mouth. These findings indicate that the turnover of stored phosphorus in the stream system is fairly rapid, and long time lags would not be expected between an upstream source reduction and the loading response measured at the river mouth. An exception might be a river with a large impoundment in which a net release of stored sediment phosphorus occurs following a load reduction.

- **Reductions in upstream phosphorus sources can produce nearly equivalent reductions in the load delivered to Lake Champlain at the river mouth.** The change in phosphorus loading at the mouth of the LaPlatte river after the upgrade of the Hinesburg Treatment Plant was essentially equivalent to the load reduction at the point source. Hoffman et al. (1996) concluded that in-stream phosphorus attenuation, while important on a seasonal basis, was not likely to alter the phosphorus mass balance for a stream over a complete annual cycle. Distance upstream should therefore not be a primary criterion for targeting phosphorus reduction efforts. However, in rivers where impoundments exist, there is the potential for long-term phosphorus storage and attenuation. Continued collection and analysis of the monitoring data for Otter Creek will determine whether the full response to upstream phosphorus reductions will occur in this river with its several small impoundments.
- **The benefits of nonpoint source phosphorus control practices applied in the Lake Champlain Basin need to be critically evaluated through water quality monitoring.** The finding of a significant load reduction in the LaPlatte River in response to the treatment plant upgrade is important in relation to the results of the previous LaPlatte River and St. Albans Bay watershed studies (Meals, 1996). Widespread implementation of agricultural nonpoint source best management practices (BMPs) during the 1980s did not produce statistically detectable reductions in phosphorus loading at the outlets of these watersheds, in spite of intensive water quality monitoring efforts. Time lags in the soil-stream system was one of several possible factors suggested by Meals (1996) for the lack of response in the earlier watershed studies. However, the present analysis and the results of Hoffman et al. (1996) indicate that the lack of watershed level phosphorus response from agricultural BMP implementation was probably more related to factors involving the nature, timing, and level of treatment, or to a lack of follow-up maintenance of the practices (Meals, 1996). There remains a need to conduct demonstration and water quality monitoring projects so that nonpoint source BMPs applied in the Lake Champlain Basin can be critically evaluated and future phosphorus reduction efforts can be implemented in the most effective manner.

Summary of Findings and Recommendations

1. The Lake Champlain Long-Term Water Quality and Biological Monitoring Program has provided a continuous data record since 1992 for a variety of water quality sampling parameters in the lake and its tributaries. The data are maintained in documented computer databases at the Vermont DEC and the New York State DEC, and are available on request to management agencies, researchers, consultants, and the general public.
2. Biological sampling results for phytoplankton, zooplankton, benthic invertebrates, and Mysids have not yet been reported or made available by the University of the State of New York Biological Survey.
3. Comparison of split-sample results for six parameters analyzed in common by Vermont and New York laboratories indicated that there were statistically significant differences in the results produced by the two laboratories. To maintain consistency for trend analysis using the long-term monitoring data, the primary laboratory used for analysis of each parameter should remain the same during future years of the program. Data for parameters analyzed in common by the two laboratories should not be pooled in the project database.
4. Comparison of dissolved oxygen vertical profile data produced by the Winkler titration method and the *in situ* membrane electrode method indicated that there were serious systematic differences between the results of the two methods. The more stable and reproducible Winkler titration method should be used as the primary method for documenting long-term changes in dissolved oxygen concentrations in Lake Champlain. The membrane electrode method should be used for more qualitative purposes such as defining the shape of vertical profiles of dissolved oxygen in fine depth detail, concurrently with *in situ* measurements of temperature and other parameters.
5. Effluent total phosphorus concentrations and discharge loads for all Vermont and New York wastewater treatment facilities in the Lake Champlain Basin were compiled for 1996. Point source phosphorus loading data will continue to be reported annually in the future as part of the Lake Champlain Monitoring Program. The total point source phosphorus load from Vermont increased from 46.8 mt/yr in 1995 to 54.8 mt/yr in 1996, although net reductions will occur in Vermont in future years as additional facilities are upgraded for phosphorus removal. The total point source phosphorus load from New York increased from 31.7 mt/yr in 1995 to 32.3 mt/y in 1996.
6. Statistically significant trends in annual mean total phosphorus concentrations from 1990-1996 were found at only one of the 12 core lake stations monitored. A significant increasing trend in total phosphorus concentration was found at the Malletts Bay station, although the cause and interpretation of the trend are uncertain. Additional years of monitoring data will be necessary before the response of Lake Champlain to phosphorus management programs can be reliably documented.

7. A statistically significant reduction in phosphorus loading to Lake Champlain from the LaPlatte River was found in response to the 1992 upgrade of the Hinesburg Wastewater Treatment Facility. The magnitude of the in-stream phosphorus load reduction (12.9 kg/day) was approximately equal to the reduction measured at the point source discharge. The phosphorus data for Otter Creek also suggested that changes in the concentration-flow relationship in this river may have begun to occur in response to the more recent point source phosphorus reductions at the Rutland City and Middlebury facilities. However, the post-upgrade data for Otter Creek are more limited, and the apparent loading reductions in Otter Creek were not statistically significant.
8. The results of the phosphorus loading analysis for the LaPlatte River indicate that if management efforts are successful in substantially reducing phosphorus loadings to Lake Champlain tributaries, then the current monitoring program design should be capable of statistically detecting loading reductions at the river mouths, even when the reductions occur well upstream.
9. The major purpose of the Lake Champlain Monitoring Program is to detect water quality changes over time. Methods for statistical trend analysis suitable for the Lake Champlain monitoring data should be further developed and applied to phosphorus and other parameters in the lake and its tributaries. Nonparametric methods (e.g. Hirsch et al., 1982) should be explored in addition to the parametric procedures applied in this report. Expertise from the U.S. Geological Survey and elsewhere should be sought to assist in developing methods for water quality trend analysis in Lake Champlain.
10. Researchers in the Lake Champlain Basin and elsewhere should be encouraged to obtain and make use of the data provided by the current monitoring program in order to enhance scientific understanding of water quality relationships in Lake Champlain.

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Appendix A. Cumulative statistical summary of lake sampling results, 1992-1996. Results shown for lake stratum "E" include both epilimnion samples and samples obtained under unstratified conditions. Results for lake stratum "H" represent hypolimnion samples. Test codes are as indicated in Tables 2 and 3.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
TP, mg/l	2	E	59	0.011	0.042	0.051	0.059	0.125
	4	E	61	0.020	0.027	0.030	0.038	0.074
	4	H	11	0.020	0.021	0.024	0.026	0.034
	7	E	62	0.008	0.011	0.013	0.016	0.027
	7	H	32	0.006	0.012	0.013	0.015	0.041
	19	E	58	0.007	0.010	0.011	0.014	0.029
	19	H	35	0.006	0.010	0.011	0.012	0.018
	21	E	55	0.007	0.010	0.011	0.015	0.030
	21	H	7	0.006	0.008	0.009	0.012	0.018
	25	E	61	0.006	0.008	0.009	0.010	0.021
	25	H	39	0.004	0.007	0.007	0.009	0.019
	33	E	58	0.008	0.011	0.013	0.016	0.034
	34	E	65	0.009	0.012	0.013	0.015	0.022
	34	H	36	0.009	0.016	0.018	0.023	0.031
	36	E	59	0.005	0.010	0.011	0.013	0.022
	36	H	36	0.006	0.009	0.010	0.011	0.019
	40	E	62	0.014	0.019	0.024	0.032	0.044
	46	E	62	0.009	0.012	0.015	0.018	0.030
	50	E	57	0.026	0.032	0.042	0.052	0.092
TP-NY, mg/l	2	E	28	0.011	0.037	0.047	0.060	0.070
	4	E	28	0.019	0.026	0.030	0.033	0.110
	7	E	24	0.008	0.010	0.012	0.013	0.018
	7	H	12	0.007	0.010	0.012	0.013	0.014
	19	E	28	0.006	0.008	0.010	0.012	0.019
	19	H	17	0.005	0.007	0.009	0.011	0.013
	21	E	26	0.007	0.008	0.009	0.011	0.014
	25	E	30	0.004	0.007	0.008	0.011	0.030
	25	H	21	0.005	0.007	0.008	0.008	0.012
	33	E	26	0.007	0.009	0.010	0.013	0.020
	34	E	31	0.008	0.011	0.014	0.017	0.030
	34	H	18	0.007	0.013	0.019	0.023	0.030
	36	E	27	0.007	0.009	0.011	0.012	0.075
	36	H	19	0.004	0.008	0.009	0.010	0.014
	40	E	30	0.012	0.017	0.024	0.029	0.051
	46	E	28	0.008	0.011	0.014	0.017	0.040
	50	E	27	0.026	0.029	0.040	0.057	0.088

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
DP, mg/l	2	E	55	0.006	0.012	0.014	0.018	0.051
	4	E	57	0.005	0.008	0.010	0.012	0.026
	4	H	11	0.007	0.007	0.008	0.010	0.015
	7	E	59	<0.003	0.005	0.006	0.008	0.018
	7	H	29	<0.003	0.007	0.009	0.012	0.019
	19	E	55	<0.003	0.005	0.006	0.007	0.011
	19	H	32	0.003	0.007	0.008	0.010	0.018
	21	E	51	<0.003	0.005	0.006	0.007	0.012
	21	H	6	0.004	0.004	0.005	0.006	0.006
	25	E	52	<0.003	0.003	0.004	0.005	0.015
	25	H	33	<0.003	0.003	0.004	0.005	0.011
	33	E	51	0.003	0.005	0.007	0.008	0.017
	34	E	58	<0.003	0.006	0.007	0.008	0.011
	34	H	30	0.003	0.009	0.015	0.020	0.023
	36	E	53	0.003	0.005	0.006	0.006	0.019
	36	H	31	0.003	0.005	0.007	0.008	0.011
	40	E	55	0.005	0.008	0.010	0.012	0.019
	46	E	56	0.004	0.006	0.007	0.008	0.015
	50	E	51	0.006	0.013	0.017	0.025	0.040
DP-NY, mg/l	2	E	19	0.006	0.012	0.014	0.018	0.028
	4	E	19	0.007	0.009	0.011	0.014	0.020
	7	E	16	0.004	0.005	0.006	0.007	0.013
	7	H	9	0.004	0.006	0.007	0.008	0.012
	19	E	21	0.003	0.004	0.005	0.007	0.022
	19	H	14	0.004	0.006	0.007	0.008	0.012
	21	E	17	0.003	0.004	0.005	0.005	0.007
	25	E	18	0.003	0.003	0.004	0.005	0.007
	25	H	13	0.002	0.003	0.004	0.005	0.006
	33	E	16	<0.005	0.005	0.005	0.006	0.014
	34	E	20	<0.005	0.005	0.005	0.007	0.012
	34	H	12	0.005	0.008	0.012	0.019	0.022
	36	E	17	0.003	0.005	0.005	0.007	0.015
	36	H	14	0.004	0.005	0.006	0.007	0.010
	40	E	18	0.005	0.008	0.009	0.011	0.019
	46	E	18	0.003	0.006	0.007	0.008	0.019
	50	E	17	0.008	0.014	0.016	0.017	0.032

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
OP, mg/l	2	E	28	0.002	0.005	0.007	0.009	0.042
	4	E	30	<0.002	0.003	0.004	0.006	0.017
	4	H	6	0.002	0.002	0.003	0.004	0.004
	7	E	30	<0.002	0.002	0.003	0.007	0.015
	7	H	15	<0.002	0.005	0.007	0.009	0.011
	19	E	22	<0.002	0.002	0.004	0.007	0.011
	19	H	12	0.004	0.006	0.007	0.008	0.012
	21	E	16	<0.002	0.002	0.002	0.005	0.008
	25	E	21	<0.002	<0.002	0.002	0.003	0.004
	25	H	11	<0.002	<0.002	0.002	0.002	0.003
	33	E	18	<0.002	0.002	0.003	0.004	0.007
	34	E	27	<0.002	0.002	0.002	0.003	0.006
	34	H	15	<0.002	0.003	0.010	0.016	0.031
	36	E	19	<0.002	<0.002	0.002	0.003	0.005
	36	H	13	<0.002	0.004	0.004	0.007	0.008
	40	E	22	<0.002	0.002	0.004	0.006	0.009
	46	E	28	<0.002	<0.002	0.003	0.004	0.007
	50	E	26	<0.002	0.005	0.009	0.014	0.026
PH	2	E	33	6.58	7.56	7.70	7.90	8.58
	4	E	32	6.83	7.99	8.19	8.33	8.65
	4	H	9	7.01	7.48	7.60	8.01	8.39
	7	E	29	6.83	7.71	7.80	8.00	8.80
	7	H	14	6.21	7.31	7.56	7.78	7.97
	19	E	16	7.05	7.77	7.92	8.21	8.70
	21	E	12	7.64	7.80	8.07	8.22	8.67
	25	E	19	7.26	7.54	7.84	8.07	8.60
	25	H	10	7.10	7.20	7.37	7.58	7.69
	33	E	7	7.61	7.86	8.04	8.28	8.50
	34	E	20	7.36	7.78	8.09	8.16	8.60
	34	H	11	7.05	7.36	7.44	7.55	7.62
	36	E	8	7.21	7.84	7.96	8.18	8.94
	36	H	6	7.64	7.65	7.69	7.77	8.38
	40	E	16	7.60	8.09	8.40	8.60	8.96
	46	E	24	6.52	7.76	7.96	8.15	8.57
	50	E	36	5.85	7.54	7.81	8.20	9.61

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
TCL, mg/l	2	E	55	9.5	12.1	14.5	16.0	19.0
	4	E	57	9.6	14.1	16.8	20.7	31.8
	4	H	11	11.5	13.4	13.7	14.8	18.2
	7	E	59	10.8	11.7	11.9	12.2	12.8
	7	H	29	11.0	11.4	11.7	11.9	12.3
	19	E	55	10.7	11.3	11.5	11.8	12.5
	19	H	32	11.1	11.4	11.8	12.0	12.3
	21	E	52	11.1	11.5	11.6	12.0	12.6
	21	H	6	11.1	11.4	11.6	11.7	11.8
	25	E	54	9.3	9.9	10.3	10.9	11.3
	25	H	33	8.8	9.6	10.2	10.4	11.0
	33	E	53	9.2	10.8	11.0	11.4	12.1
	34	E	59	9.4	9.6	9.7	9.8	10.4
	34	H	31	9.4	9.6	9.8	9.8	10.0
	36	E	54	10.5	11.0	11.2	11.5	12.1
	36	H	31	11.0	11.3	11.4	11.8	12.3
	40	E	56	9.7	10.2	10.5	11.0	12.8
	46	E	57	10.0	10.9	11.2	11.5	12.6
	50	E	51	4.3	7.3	7.9	8.4	10.7
TCL-NY, mg/l	2	E	22	9.1	14.9	16.4	18.3	21.0
	4	E	22	11.6	16.0	19.2	22.2	28.5
	7	E	18	3.5	12.6	12.9	13.6	14.2
	7	H	8	11.9	12.5	12.8	13.6	14.4
	19	E	23	8.1	12.2	12.6	13.2	15.8
	19	H	13	11.7	12.5	12.5	13.4	13.5
	21	E	18	8.8	12.2	12.8	13.3	13.6
	25	E	20	9.0	9.6	10.4	11.3	11.9
	25	H	12	9.0	9.4	10.7	11.1	13.1
	33	E	18	9.2	11.5	11.8	12.6	13.1
	34	E	22	9.7	10.0	10.6	10.8	11.3
	34	H	11	9.8	10.2	10.6	11.0	11.1
	36	E	19	10.5	11.7	12.3	12.8	13.3
	36	H	13	9.5	12.2	12.6	13.0	13.3
	40	E	21	9.3	11.0	11.4	12.0	15.4
	46	E	21	10.2	11.7	12.3	12.8	13.3
	50	E	20	6.9	7.7	8.3	9.2	9.9

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
TN, mg/l	2	E	52	0.31	0.45	0.54	0.67	0.95
	4	E	55	0.27	0.36	0.40	0.48	0.71
	4	H	11	0.27	0.31	0.35	0.45	0.81
	7	E	57	0.22	0.37	0.43	0.48	0.72
	7	H	29	0.39	0.45	0.48	0.52	0.61
	19	E	52	0.24	0.38	0.41	0.47	0.69
	19	H	32	0.37	0.46	0.50	0.54	0.67
	21	E	48	0.25	0.38	0.43	0.46	0.58
	21	H	6	0.36	0.37	0.40	0.43	0.48
	25	E	52	0.26	0.31	0.38	0.41	0.54
	25	H	33	0.27	0.46	0.50	0.54	0.70
	33	E	49	0.29	0.38	0.42	0.48	0.61
	34	E	55	0.21	0.31	0.33	0.39	0.53
	34	H	31	0.27	0.37	0.44	0.47	0.64
	36	E	50	0.25	0.36	0.39	0.49	0.58
	36	H	31	0.26	0.42	0.46	0.52	0.91
	40	E	51	0.25	0.38	0.42	0.47	0.67
	46	E	52	0.18	0.34	0.38	0.42	0.54
	50	E	48	0.15	0.57	0.68	0.80	1.18
TKN-NY, mg/l	2	E	22	0.17	0.19	0.24	0.30	0.43
	4	E	24	0.15	0.19	0.23	0.26	0.43
	7	E	30	0.06	0.15	0.17	0.24	0.42
	7	H	14	0.08	0.13	0.16	0.20	0.42
	19	E	30	0.09	0.12	0.14	0.18	0.32
	19	H	19	0.10	0.12	0.13	0.19	0.33
	21	E	26	0.07	0.14	0.19	0.22	0.41
	25	E	24	0.02	0.12	0.16	0.18	0.28
	25	H	21	0.06	0.13	0.18	0.22	0.34
	33	E	27	0.08	0.14	0.18	0.22	0.43
	34	E	30	0.11	0.16	0.18	0.20	0.27
	34	H	16	0.11	0.13	0.17	0.25	0.43
	36	E	28	0.05	0.13	0.16	0.22	0.58
	36	H	17	0.06	0.12	0.13	0.18	0.25
	40	E	25	0.10	0.18	0.20	0.23	0.46
	46	E	24	0.08	0.14	0.18	0.22	0.38
	50	E	22	0.15	0.20	0.23	0.29	0.54

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
TNH3, mg/l	2	E	10	<0.020	<0.020	0.027	0.069	0.103
	4	E	11	<0.020	<0.020	<0.020	0.034	0.058
	7	E	10	<0.020	<0.020	<0.020	<0.020	0.025
	7	H	7	<0.020	<0.020	<0.020	<0.020	<0.020
	19	E	7	<0.020	<0.020	<0.020	<0.020	0.026
	21	E	9	<0.020	<0.020	<0.020	<0.020	0.025
	25	E	8	<0.020	<0.020	<0.020	<0.020	0.024
	33	E	8	<0.020	<0.020	<0.020	<0.020	0.033
	34	E	9	<0.020	<0.020	<0.020	0.028	0.043
	36	E	8	<0.020	<0.020	<0.020	<0.020	0.056
	40	E	8	<0.020	<0.020	<0.020	<0.020	0.048
	46	E	9	<0.020	<0.020	<0.020	<0.020	0.050
	50	E	7	<0.020	<0.020	<0.020	<0.020	0.033
TNH3-NY, mg/l	2	E	21	0.007	0.029	0.061	0.087	0.180
	4	E	22	<0.005	0.015	0.033	0.044	0.140
	7	E	26	<0.005	<0.005	0.008	0.022	0.075
	7	H	14	<0.005	<0.005	<0.005	0.006	0.054
	19	E	26	<0.005	0.007	0.012	0.018	0.048
	19	H	19	<0.005	<0.005	<0.005	0.008	0.021
	21	E	23	<0.005	0.008	0.016	0.027	0.045
	25	E	23	<0.005	0.007	0.010	0.016	0.059
	25	H	20	<0.005	<0.005	0.006	0.017	0.034
	33	E	23	<0.005	0.010	0.016	0.029	0.100
	34	E	26	<0.005	<0.005	0.007	0.017	0.040
	34	H	16	<0.005	<0.005	0.005	0.013	0.096
	36	E	24	<0.005	0.011	0.018	0.029	0.064
	36	H	17	<0.005	<0.005	0.006	0.010	0.058
	40	E	22	<0.005	0.007	0.016	0.028	0.064
	46	E	21	<0.005	0.009	0.013	0.025	0.058
	50	E	20	<0.005	0.034	0.051	0.095	0.140

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
DSI, mg/l	2	E	53	0.25	1.77	2.37	3.42	6.70
	4	E	55	0.18	0.75	1.43	2.06	3.78
	4	H	11	0.54	1.24	1.46	1.84	2.71
	7	E	57	<0.10	0.36	0.59	1.26	2.48
	7	H	29	0.39	0.62	1.39	1.71	2.17
	19	E	51	<0.10	0.22	0.48	0.77	2.00
	19	H	32	0.27	0.60	0.96	1.62	2.02
	21	E	48	<0.10	0.16	0.40	0.62	2.02
	21	H	6	0.2	0.50	0.59	0.68	1.00
	25	E	51	0.7	1.46	2.02	2.31	4.24
	25	H	33	0.46	3.17	4.13	5.37	6.72
	33	E	49	<0.10	0.57	0.81	1.48	2.55
	34	E	55	<0.10	0.28	0.49	0.94	2.12
	34	H	31	0.37	1.23	2.05	2.61	3.68
	36	E	50	<0.10	0.33	0.62	0.88	2.15
	36	H	31	0.17	0.55	0.78	1.54	1.72
	40	E	51	<0.10	0.19	0.58	0.91	1.94
	46	E	52	<0.10	0.65	0.91	1.28	2.15
	50	E	47	<0.10	0.91	1.57	2.71	3.96
DSI-NY, mg/l	2	E	19	0.28	1.75	2.28	3.91	5.44
	4	E	19	0.37	1.16	1.57	1.99	3.42
	7	E	15	0.23	0.45	0.56	0.66	1.96
	7	H	8	0.47	0.59	0.67	1.26	1.73
	19	E	19	<0.05	0.32	0.49	0.84	1.79
	19	H	13	0.36	0.60	1.51	1.67	1.70
	21	E	16	0.06	0.25	0.38	0.69	1.79
	25	E	17	1.56	1.83	2.06	2.15	3.62
	25	H	12	2.42	3.34	3.82	4.24	7.60
	33	E	15	0.22	0.63	0.74	1.01	3.18
	34	E	18	0.08	0.79	1.14	1.62	2.10
	34	H	11	0.78	1.63	2.38	2.85	3.49
	36	E	16	0.16	0.40	0.57	0.76	1.83
	36	H	13	0.27	0.66	1.54	1.59	1.72
	40	E	18	0.21	0.67	0.95	1.42	1.92
	46	E	18	0.46	0.55	0.97	1.31	2.11
	50	E	17	0.43	1.25	1.54	2.43	2.89

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
TSS, mg/l	2	E	50	0.2	7.9	11.5	16.0	36.9
	4	E	51	1.0	4.9	6.3	9.3	21.4
	4	H	9	1.9	2.8	3.4	4.8	7.6
	7	E	54	<1.0	<1.0	1.0	1.4	4.4
	7	H	28	<1.0	<1.0	1.0	1.0	2.8
	19	E	50	<1.0	<1.0	1.0	1.1	1.9
	19	H	31	<1.0	<1.0	<1.0	1.0	1.3
	21	E	48	<1.0	<1.0	1.0	1.1	2.8
	21	H	6	<1.0	<1.0	1.1	1.3	4.4
	25	E	52	<1.0	<1.0	1.0	1.1	1.8
	25	H	33	<1.0	<1.0	1.0	1.1	6.4
	33	E	46	<1.0	<1.0	1.0	1.2	2.9
	34	E	55	<1.0	<1.0	1.0	1.1	2.6
	34	H	30	<1.0	<1.0	<1.0	1.0	2.5
	36	E	49	<1.0	<1.0	1.0	1.0	1.9
	36	H	31	<1.0	<1.0	<1.0	1.0	1.6
	40	E	51	<1.0	1.2	1.8	2.1	4.5
	46	E	52	<1.0	<1.0	1.0	1.3	2.7
	50	E	46	<1.0	2.2	2.9	4.5	24.0
TSS-NY, mg/l	2	E	18	5.0	11.3	14.5	20.8	39.0
	4	E	19	2.0	5.0	7.0	9.0	17.0
	7	E	15	0.6	0.9	1.0	1.0	2.0
	7	H	8	0.6	1.0	1.2	2.0	3.0
	19	E	19	0.5	0.7	0.9	1.0	2.0
	19	H	13	<1.0	<1.0	<1.0	<1.0	1.0
	21	E	15	0.5	0.7	0.8	1.0	2.0
	25	E	17	0.5	1.0	1.0	2.0	7.0
	25	H	12	0.4	0.8	1.0	1.3	2.0
	33	E	13	0.6	0.7	1.0	2.0	2.0
	34	E	19	0.5	0.7	1.0	1.0	2.0
	34	H	11	0.4	0.6	0.7	0.8	2.0
	36	E	15	0.4	0.7	0.8	1.0	2.0
	36	H	13	0.3	0.7	0.8	1.0	2.0
	40	E	18	0.6	1.0	2.0	2.0	4.0
	46	E	18	<1.0	<1.0	1.0	1.0	2.0
	50	E	17	1.0	2.0	3.0	5.0	8.0

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
TOC-NY, mg/l	2	E	57	3.2	4.0	5.0	5.5	117.0
	4	E	61	2.9	4.3	5.0	6.2	1340.0
	4	H	11	3.2	4.0	4.1	5.1	128.0
	7	E	61	2.6	3.5	3.9	5.1	345.0
	7	H	34	2.7	3.2	3.7	4.2	56.9
	19	E	60	1.8	3.2	3.5	4.3	7.0
	19	H	41	1.9	3.1	3.3	4.1	5.7
	21	E	55	2.2	3.1	4.1	5.0	7.5
	21	H	9	3.0	3.3	3.8	4.3	6.2
	25	E	60	2.2	3.2	3.6	4.1	8.1
	25	H	47	1.7	2.9	3.1	3.7	6.8
	33	E	56	2.0	3.5	4.3	5.0	74.0
	34	E	62	2.2	3.5	4.0	4.6	18.0
	34	H	39	2.1	3.3	3.6	3.9	11.0
	36	E	56	1.9	3.2	3.6	4.3	11.0
	36	H	42	1.8	3.1	3.3	4.0	22.0
	40	E	59	2.4	4.2	4.5	5.0	38.0
	46	E	60	2.3	3.6	4.1	4.7	85.5
	50	E	55	3.7	5.1	6.1	7.5	120.0
DOC-NY, mg/l	2	E	57	0.7	3.6	4.3	5.2	456.0
	4	E	61	2.9	4.2	4.8	5.4	477.0
	4	H	11	2.8	3.5	4.4	6.2	155.0
	7	E	61	1.8	3.3	3.7	4.5	1650.0
	7	H	34	2.5	3.0	3.4	4.0	208.0
	19	E	60	1.8	3.0	3.4	4.2	7.1
	19	H	41	2.0	2.8	3.1	3.7	5.0
	21	E	55	2.2	3.0	3.6	4.1	22.0
	21	H	9	3.0	3.3	3.6	4.1	5.3
	25	E	60	2.2	2.9	3.4	3.8	23.3
	25	H	47	2.4	2.8	3.1	3.5	7.7
	33	E	56	1.8	3.3	3.8	4.2	62.0
	34	E	62	2.2	3.3	3.8	4.5	109.0
	34	H	39	2.2	3.1	3.5	3.8	10.0
	36	E	56	2.1	3.0	3.4	4.0	28.0
	36	H	43	1.9	2.9	3.1	3.8	12.4
	40	E	59	2.5	3.8	4.3	4.9	1330.0
	46	E	60	2.2	3.4	3.8	4.6	97.6
	50	E	55	3.2	5.1	5.7	7.3	416.0

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
ALK, mg/l	2	E	40	69	83	87	92	105
	4	E	42	56	70	74	78	89
	4	H	7	55	67	71	72	74
	7	E	42	52	54	55	55	61
	7	H	24	51	51	52	53	54
	19	E	42	46	51	51	52	55
	19	H	25	49	51	52	52	53
	21	E	38	49	51	52	53	56
	25	E	39	30	34	35	37	39
	25	H	23	31	33	34	35	38
	33	E	37	40	45	48	50	53
	34	E	42	39	46	47	47	49
	34	H	22	45	46	46	47	48
	36	E	39	45	48	49	50	54
	36	H	23	47	50	51	51	52
	40	E	38	46	48	48	51	55
	46	E	39	44	48	49	50	54
	50	E	34	21	35	39	45	51
DIC-NY, mg/l	2	E	29	11.4	18.0	20.6	23.0	25.0
	4	E	32	8.3	16.0	17.8	19.1	22.0
	4	H	6	13.0	16.4	17.9	18.5	19.3
	7	E	33	6.2	12.0	13.0	13.0	14.4
	7	H	22	7.7	11.9	12.2	13.0	15.6
	19	E	27	4.1	8.8	12.0	12.0	13.2
	19	H	22	3.5	9.2	12.0	13.0	13.0
	21	E	28	0.4	8.4	12.0	12.0	12.5
	25	E	26	0.3	6.4	7.9	8.5	9.3
	25	H	22	2.3	7.1	8.1	9.1	11.0
	33	E	24	4.7	7.7	10.5	11.4	12.0
	34	E	31	1.8	10.0	11.0	11.0	13.0
	34	H	19	6.7	9.8	11.0	11.9	13.0
	36	E	27	3.3	8.0	11.0	11.6	13.0
	36	H	20	4.8	7.6	11.0	12.0	13.0
	40	E	28	4.3	9.7	11.0	12.0	13.0
	46	E	32	4.1	11.0	12.0	12.0	23.5
	50	E	26	4.8	7.6	9.1	11.0	14.0

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
CHA, ug/l	2	E	21	2.7	4.5	7.3	9.6	15.6
	4	E	19	2.3	4.5	5.1	8.7	13.7
	7	E	15	1.3	1.9	3.2	4.0	6.1
	19	E	9	1.8	2.7	3.9	4.0	8.8
	21	E	12	0.9	2.1	2.9	3.6	8.4
	25	E	15	1.5	1.9	2.3	3.0	3.7
	33	E	11	1.1	2.2	2.7	3.7	6.6
	34	E	16	1.6	2.9	3.8	4.3	6.1
	36	E	11	1.4	2.3	3.0	3.5	4.5
	40	E	17	0.9	2.8	3.9	6.7	12.3
	46	E	17	0.4	2.2	3.2	5.2	9.7
	50	E	21	2.7	7.6	10.2	19.7	79.0
CHA-NY, ug/l	2	E	38	2.0	4.1	6.9	9.5	18.3
	4	E	41	0.7	3.4	6.5	9.6	16.4
	7	E	46	0.5	3.0	3.9	5.6	13.8
	19	E	50	0.8	2.7	4.0	5.6	11.3
	21	E	45	1.0	3.0	4.0	6.1	9.3
	25	E	49	1.1	2.1	3.4	4.0	5.9
	33	E	54	1.0	3.0	4.7	6.1	7.9
	34	E	50	0.6	2.8	4.3	6.0	11.6
	36	E	50	1.6	2.9	3.8	5.2	11.9
	40	E	51	1.2	4.6	8.0	10.9	26.9
	46	E	43	1.4	3.0	4.0	5.4	10.7
	50	E	41	1.8	4.9	10.2	20.0	80.0

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
SECCHI, m	2	E	55	0.2	0.5	0.6	0.9	2.8
	4	E	60	0.2	0.7	0.9	1.1	6.0
	7	E	48	1.8	3.3	4.2	5.0	6.3
	19	E	50	3.0	4.4	5.3	6.0	8.6
	21	E	51	2.0	4.0	4.8	5.6	8.0
	25	E	56	2.3	3.9	4.5	5.5	8.6
	33	E	51	2.0	3.2	4.0	4.7	6.5
	34	E	57	3.0	4.4	5.0	5.6	7.6
	36	E	51	3.0	4.5	5.0	5.6	7.6
	40	E	60	1.5	2.1	2.6	3.0	5.5
	46	E	58	2.0	3.0	3.6	4.6	6.2
	50	E	55	0.6	1.3	1.7	2.3	3.5
DO, mg/l	4	P	47	6.25	7.85	8.30	8.70	13.30
	7	P	155	6.70	9.08	9.85	11.15	13.40
	19	P	85	7.80	9.45	10.40	11.20	13.80
	25	P	88	1.05	6.71	8.60	9.06	10.75
	34	P	153	3.25	6.65	8.45	9.45	12.00
	36	P	107	6.65	9.20	9.85	10.58	12.30
COND, uS/cm	2	E	28	110	181	201	252	369
	4	E	30	112	200	227	249	337
	4	H	6	155	199	218	277	335
	7	E	17	98	135	162	181	331
	7	H	12	117	135	143	159	184
	19	E	8	112	143	177	184	191
	21	E	7	118	164	182	188	193
	25	E	8	64	102	111	123	212
	34	E	14	103	112	122	138	288
	34	H	8	98	119	132	187	260
	40	E	13	96	133	148	171	204
	46	E	17	105	135	147	168	315
	50	E	28	69	101	119	131	898

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
CA-NY, mg/l	2	E	43	19.8	27.2	29.3	31.8	60.2
	4	E	47	13.1	23.0	25.9	27.4	44.9
	4	H	7	19.7	22.7	23.2	24.7	25.0
	7	E	48	9.3	17.4	18.2	18.7	36.8
	7	H	24	15.6	17.1	17.8	18.2	35.6
	19	E	50	15.7	16.9	17.3	17.8	41.8
	19	H	31	15.9	17.1	17.5	19.9	39.6
	21	E	43	15.4	16.9	17.6	18.5	43.8
	21	H	6	16.2	17.8	20.8	32.8	39.8
	25	E	44	9.9	12.2	12.8	14.1	36.7
	25	H	35	10.6	11.8	12.4	16.0	36.9
	33	E	44	13.4	15.7	16.7	20.0	46.7
	34	E	48	15.1	16.1	16.9	18.4	40.7
	34	H	27	15.4	16.3	16.7	18.6	24.2
	36	E	45	14.8	16.1	16.8	18.9	35.3
	36	H	32	15.6	16.7	17.3	21.1	36.4
	40	E	43	15.3	16.9	17.8	19.1	27.5
	46	E	45	14.9	16.3	16.6	17.5	35.2
	50	E	36	8.3	13.2	14.2	14.9	19.0
MG-NY, mg/l	2	E	43	4.3	5.6	6.0	6.5	7.3
	4	E	47	2.9	4.9	5.1	5.5	6.3
	4	H	7	4.4	4.8	5.1	5.2	5.3
	7	E	48	2.2	3.8	4.1	4.2	5.4
	7	H	24	3.6	3.8	3.9	4.1	5.0
	19	E	50	3.5	3.7	3.8	3.9	4.1
	19	H	31	3.4	3.7	3.8	4.0	4.2
	21	E	43	3.1	3.7	3.8	4.0	4.4
	21	H	6	3.6	3.7	3.9	4.0	4.1
	25	E	44	1.8	2.3	2.3	2.4	2.6
	25	H	35	2.1	2.2	2.3	2.3	2.5
	33	E	44	3.0	3.4	3.6	3.7	4.2
	34	E	48	3.1	3.2	3.3	3.4	3.8
	34	H	27	3.1	3.2	3.3	3.3	3.5
	36	E	45	3.2	3.5	3.5	3.7	4.1
	36	H	32	3.3	3.6	3.8	3.8	4.1
	40	E	43	3.1	3.3	3.4	3.6	4.0
	46	E	45	3.2	3.5	3.6	3.8	8.8
	50	E	36	1.7	2.7	3.0	3.2	3.9

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
NA-NY, mg/l	2	E	43	5.3	7.3	8.5	9.6	11.6
	4	E	47	5.2	9.3	12.3	15.7	24.4
	4	H	7	8.2	8.9	9.2	10.8	11.0
	7	E	48	3.7	7.0	7.3	7.7	10.2
	7	H	24	6.2	7.0	7.2	7.5	8.4
	19	E	50	6.2	6.8	7.1	7.5	8.0
	19	H	31	5.8	7.0	7.2	7.5	8.6
	21	E	43	5.8	6.9	7.2	7.4	8.1
	21	H	6	6.9	7.2	7.3	7.4	8.1
	25	E	44	4.8	5.5	6.1	6.5	7.3
	25	H	35	4.4	5.4	6.0	6.3	6.9
	33	E	44	5.7	6.5	6.8	7.3	8.0
	34	E	48	3.9	5.3	5.5	5.7	6.3
	34	H	27	4.2	5.3	5.6	5.8	6.4
	36	E	45	5.5	6.5	6.9	7.3	10.9
	36	H	32	5.6	6.8	7.1	7.4	8.1
	40	E	43	4.6	5.8	6.0	6.5	7.5
	46	E	45	5.9	6.5	6.7	7.3	12.0
	50	E	36	3.6	4.1	4.5	5.1	5.8
K-NY, mg/l	2	E	43	0.7	1.3	1.4	1.7	2.5
	4	E	47	0.9	1.4	1.5	1.7	2.1
	4	H	7	1.1	1.3	1.4	1.6	1.7
	7	E	48	0.9	1.2	1.3	1.4	1.8
	7	H	24	1.0	1.3	1.4	1.5	1.6
	19	E	50	0.9	1.2	1.3	1.4	1.9
	19	H	31	1.0	1.3	1.4	1.5	1.5
	21	E	43	0.9	1.3	1.4	1.5	1.6
	21	H	6	1.1	1.2	1.3	1.3	1.5
	25	E	44	<1.0	1.1	1.2	1.3	1.5
	25	H	35	<1.0	1.1	1.2	1.3	1.5
	33	E	44	0.7	1.1	1.3	1.4	1.6
	34	E	48	1.4	1.6	1.8	1.8	2.3
	34	H	27	1.4	1.6	1.7	1.8	2.0
	36	E	45	0.8	1.2	1.3	1.4	1.7
	36	H	32	0.9	1.1	1.3	1.4	1.7
	40	E	43	1.4	1.7	1.8	1.9	2.2
	46	E	45	0.9	1.2	1.3	1.4	1.6
	50	E	36	0.8	1.2	1.4	1.6	2.0

Appendix A continued. Cumulative statistical summary of lake sampling results, 1992-1996.

Test	Station	Stratum	N	Minimum	25th	Median	75th	Maximum
FE-NY, ug/l	2	E	43	60	437	716	961	2370
	4	E	47	92	231	373	583	1650
	4	H	7	98	184	210	264	488
	7	E	48	<10	25	57	104	575
	7	H	24	<10	25	35	74	466
	19	E	50	<10	16	32	50	151
	19	H	32	<10	20	30	52	147
	21	E	42	<10	20	31	55	317
	21	H	6	11	45	104	137	223
	25	E	44	12	24	54	91	226
	25	H	34	13	27	51	83	178
	33	E	43	16	36	55	80	231
	34	E	47	<10	13	19	44	121
	34	H	27	11	19	22	52	75
	36	E	45	<10	17	30	52	109
	36	H	32	<10	21	35	46	149
	40	E	42	<10	43	53	74	139
	46	E	44	<10	29	39	53	288
	50	E	36	68	109	157	209	534
PB-NY, ug/l	2	E	43	<10	<10	<10	<10	39
	4	E	47	<10	<10	<10	<10	11
	4	H	7	<10	<10	<10	<10	<10
	7	E	48	<10	<10	<10	<10	13
	7	H	24	<10	<10	<10	<10	<10
	19	E	50	<10	<10	<10	<10	26
	19	H	32	<10	<10	<10	<10	33
	21	E	43	<10	<10	<10	<10	25
	21	H	6	<10	<10	<10	11	27
	25	E	44	<10	<10	<10	<10	28
	25	H	35	<10	<10	<10	<10	36
	33	E	44	<10	<10	<10	<10	38
	34	E	49	<10	<10	<10	<10	41
	34	H	27	<10	<10	<10	<10	24
	36	E	43	<10	<10	<10	<10	19
	36	H	32	<10	<10	<10	<10	42
	40	E	44	<10	<10	<10	<10	22
	46	E	45	<10	<10	<10	<10	82
	50	E	36	<10	<10	<10	<10	11

Appendix B. Cumulative statistical summary of tributary sampling results, 1990-1996. Test codes are as indicated in Tables 2 and 3.

Test	Station	N	Minimum	25th	Median	75th	Maximum
TP, mg/l	AUSA01	119	0.007	0.013	0.020	0.047	0.712
	BOUQ01	114	0.004	0.010	0.026	0.101	0.508
	GCHA01	108	0.007	0.022	0.035	0.068	0.496
	LAMO01	145	0.009	0.015	0.021	0.040	0.300
	LAPL01	156	0.037	0.121	0.184	0.298	1.110
	LAUS01	114	0.012	0.030	0.047	0.083	0.712
	LCHA01	113	0.014	0.035	0.057	0.092	0.512
	LEWI01	151	0.008	0.025	0.043	0.087	0.772
	LOTT01	150	0.029	0.061	0.093	0.139	0.426
	METT01	149	0.014	0.044	0.061	0.101	0.720
	MISS01	144	0.015	0.027	0.041	0.080	0.570
	OTTE01	162	0.023	0.055	0.078	0.113	0.498
	PIKE01	122	0.016	0.057	0.094	0.172	0.795
	POUL01	140	0.015	0.029	0.045	0.114	0.343
	PUTN01	88	0.004	0.008	0.014	0.023	0.359
	SALM01	115	0.006	0.013	0.018	0.043	0.286
	SARA01	122	0.010	0.017	0.022	0.028	0.104
	WINO01	151	0.009	0.027	0.043	0.090	0.548
TP-NY, mg/l	AUSA01	18	0.009	0.022	0.048	0.145	0.660
	BOUQ01	15	0.008	0.058	0.079	0.195	0.620
	GCHA01	18	0.018	0.037	0.080	0.278	0.710
	LAUS01	20	0.017	0.043	0.073	0.105	0.720
	LCHA01	18	0.017	0.049	0.074	0.135	0.350
	METT01	10	0.028	0.071	0.145	0.310	0.750
	POUL01	8	0.028	0.049	0.071	0.285	0.470
	PUTN01	10	0.006	0.016	0.027	0.067	0.680
	SALM01	19	0.007	0.022	0.045	0.081	0.240
	SARA01	21	0.013	0.021	0.031	0.042	0.580

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1990-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
DP, mg/l	AUSA01	107	<0.003	0.005	0.007	0.009	0.033
	BOUQ01	103	<0.003	0.005	0.007	0.011	0.110
	GCHA01	95	0.005	0.012	0.018	0.028	0.242
	LAMO01	130	0.003	0.006	0.008	0.012	0.070
	LAPL01	137	0.014	0.068	0.116	0.211	1.040
	LAUS01	103	0.009	0.017	0.024	0.037	0.480
	LCHA01	100	0.009	0.021	0.038	0.066	0.360
	LEWI01	131	0.005	0.011	0.015	0.022	0.238
	LOTT01	132	<0.003	0.036	0.053	0.091	0.194
	METT01	132	0.006	0.016	0.023	0.031	0.105
	MISS01	127	0.007	0.012	0.015	0.023	0.098
	OTTE01	144	0.010	0.029	0.043	0.061	0.250
	PIKE01	105	0.006	0.031	0.048	0.068	0.484
	POUL01	122	0.005	0.010	0.016	0.024	0.114
	PUTN01	83	<0.003	0.004	0.005	0.007	0.044
	SALM01	102	0.005	0.007	0.010	0.013	0.161
	SARA01	111	0.003	0.007	0.008	0.010	0.099
	WINO01	135	0.004	0.008	0.010	0.014	0.098
DP-NY, mg/l	AUSA01	18	0.004	0.005	0.008	0.011	0.018
	BOUQ01	15	0.003	0.008	0.011	0.015	0.100
	GCHA01	18	0.010	0.018	0.028	0.087	1.400
	LAUS01	20	0.008	0.021	0.035	0.073	0.280
	LCHA01	18	0.012	0.031	0.046	0.086	0.230
	METT01	8	0.008	0.017	0.025	0.050	0.095
	POUL01	6	0.008	0.012	0.019	0.023	0.029
	PUTN01	10	0.002	0.003	0.006	0.008	0.025
	SALM01	19	0.004	0.010	0.013	0.019	0.037
	SARA01	21	0.005	0.007	0.011	0.013	0.019

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
OP, mg/l	LAMO01	19	<0.002	0.004	0.006	0.008	0.024
	LAPL01	26	0.018	0.030	0.059	0.100	0.150
	LEWI01	24	0.003	0.007	0.008	0.014	0.027
	LOTT01	26	0.016	0.025	0.037	0.056	0.177
	METT01	21	0.006	0.016	0.026	0.029	0.053
	MISS01	19	0.002	0.010	0.013	0.020	0.076
	OTTE01	24	0.009	0.017	0.022	0.043	0.115
	PIKE01	17	0.010	0.028	0.039	0.062	0.117
	POUL01	21	0.004	0.007	0.013	0.026	0.036
	PUTN01	19	<0.002	0.002	0.003	0.004	0.007
	WINO01	19	0.005	0.006	0.007	0.010	0.014
ALK, mg/l	AUSA01	36	6.3	10.5	14.7	24.9	55.9
	BOUQ01	38	0.0	17.9	36.8	45.0	61.4
	GCHA01	34	22.6	35.2	53.3	63.2	86.3
	LAMO01	29	14.7	21.5	27.9	37.5	47.5
	LAPL01	41	13.1	79.9	124.6	159.0	231.0
	LAUS01	34	27.1	55.7	71.6	90.2	117.0
	LCHA01	34	47.0	81.8	96.7	113.0	127.0
	LEWI01	38	39.3	67.7	82.5	102.5	125.0
	LOTT01	35	32.6	95.3	121.0	167.5	194.0
	METT01	38	45.1	61.6	73.5	91.7	113.0
	MISS01	28	12.2	18.1	27.1	36.6	47.4
	OTTE01	35	35.9	53.6	65.4	77.8	94.4
	PIKE01	23	39.0	58.4	72.9	88.5	145.4
	POUL01	33	31.5	62.0	75.7	103.6	133.5
	PUTN01	43	29.7	51.5	73.7	123.0	186.6
	SALM01	34	19.8	40.5	59.0	67.2	85.4
	SARA01	40	10.3	21.2	24.7	30.0	49.4
	WINO01	29	22.3	27.1	36.7	44.9	59.2

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1990-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
TCL, mg/l	AUSA01	116	2.2	3.9	5.7	7.9	18.9
	BOUQ01	112	3.8	6.9	9.9	12.8	21.0
	GCHA01	105	4.2	9.6	11.9	16.1	32.9
	LAMO01	145	3.7	6.3	8.8	10.8	20.5
	LAPL01	155	7.9	17.5	25.8	46.7	180.0
	LAUS01	112	4.3	8.0	10.7	12.6	29.2
	LCHA01	110	7.7	12.7	15.6	18.4	37.5
	LEWI01	151	3.8	6.6	7.5	9.0	14.1
	LOTT01	151	5.5	9.3	11.4	14.3	28.5
	METT01	148	5.8	10.3	12.1	14.5	29.6
	MISS01	144	3.1	5.5	6.6	8.0	12.5
	OTTE01	162	5.4	8.4	9.9	11.3	33.0
	PIKE01	122	4.8	10.2	12.5	15.1	29.8
	POUL01	139	3.1	8.9	10.7	14.1	27.7
	PUTN01	88	2.6	5.0	6.5	9.0	16.8
	SALM01	111	1.3	4.8	5.9	7.4	18.2
	SARA01	121	3.0	4.7	5.6	6.7	37.5
	WINO01	151	4.7	9.3	11.9	14.9	29.3
TCL-NY, mg/l	AUSA01	18	1.3	4.1	5.5	9.7	14.8
	BOUQ01	15	4.3	5.6	8.0	13.2	20.6
	GCHA01	18	7.2	10.7	12.2	17.5	29.8
	LAUS01	20	7.1	9.8	11.8	15.8	32.0
	LCHA01	18	11.1	14.7	17.0	18.0	37.1
	METT01	8	8.2	10.0	13.4	16.2	17.4
	POUL01	6	9.3	12.0	14.9	16.6	22.2
	PUTN01	10	1.6	5.5	6.4	11.2	19.9
	SALM01	19	3.9	5.3	6.8	8.6	20.9
	SARA01	21	2.9	6.4	7.5	8.9	39.9

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
TN, mg/l	AUSA01	47	0.20	0.36	0.50	0.66	1.83
	BOUQ01	45	0.18	0.28	0.43	0.65	2.37
	GCHA01	42	0.25	0.57	0.69	1.00	2.45
	LAMO01	47	0.25	0.41	0.47	0.60	0.78
	LAPL01	59	0.37	0.61	0.79	1.11	3.24
	LAUS01	44	0.34	0.54	0.68	0.95	4.50
	LCHA01	42	0.37	0.76	0.93	1.68	3.41
	LEWI01	54	0.22	0.39	0.53	0.70	1.78
	LOTT01	53	0.41	0.60	0.71	1.20	2.24
	METT01	59	0.29	0.74	0.92	1.15	3.47
	MISS01	46	0.38	0.51	0.68	0.86	1.52
	OTTE01	55	0.34	0.52	0.63	0.85	1.88
	PIKE01	35	0.73	1.46	1.87	2.29	7.24
	POUL01	51	0.24	0.44	0.54	0.66	0.89
	PUTN01	50	0.22	0.27	0.33	0.43	1.38
	SALM01	44	0.20	0.33	0.45	0.67	1.41
	SARA01	51	0.33	0.42	0.52	0.63	1.15
	WINO01	47	0.28	0.47	0.57	0.71	5.40
TKN-NY, mg/l	AUSA01	27	0.05	0.16	0.18	0.24	0.37
	BOUQ01	27	0.09	0.16	0.19	0.31	0.61
	GCHA01	25	0.15	0.18	0.27	0.31	0.61
	LAMO01	20	0.09	0.15	0.18	0.20	0.37
	LAPL01	32	0.14	0.25	0.31	0.44	1.10
	LAUS01	24	0.20	0.23	0.25	0.33	0.85
	LCHA01	26	0.16	0.24	0.34	0.43	0.88
	LEWI01	27	0.11	0.16	0.23	0.29	0.49
	LOTT01	25	0.16	0.26	0.30	0.37	0.64
	METT01	30	0.13	0.16	0.23	0.30	0.49
	MISS01	18	0.11	0.17	0.22	0.29	0.48
	OTTE01	26	0.04	0.20	0.23	0.27	0.53
	PIKE01	13	0.20	0.25	0.30	0.35	0.45
	POUL01	23	0.11	0.20	0.25	0.29	0.48
	PUTN01	31	0.09	0.12	0.14	0.17	0.28
	SALM01	24	0.13	0.18	0.23	0.28	0.45
	SARA01	28	0.11	0.18	0.21	0.25	0.51
	WINO01	20	0.06	0.16	0.19	0.26	0.46

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
TNOX, mg/l	AUSA01	11	0.087	0.135	0.189	0.252	0.519
	BOUQ01	12	0.042	0.068	0.078	0.097	0.189
	GCHA01	9	0.067	0.229	0.248	0.325	0.393
	LAMO01	13	0.138	0.252	0.284	0.327	0.381
	LAPL01	16	<0.020	0.196	0.258	0.330	0.459
	LAUS01	10	0.074	0.188	0.220	0.291	0.658
	LCHA01	10	0.250	0.411	0.481	0.660	0.962
	LEWI01	14	<0.020	0.201	0.243	0.320	0.366
	LOTT01	17	<0.020	0.020	0.235	0.360	1.060
	METT01	17	0.264	0.398	0.530	0.630	0.717
	MISS01	13	0.131	0.322	0.346	0.372	0.411
	OTTE01	15	0.082	0.234	0.321	0.358	0.536
	PIKE01	11	0.120	0.692	0.872	1.595	3.020
	POUL01	16	0.048	0.190	0.242	0.277	0.385
	PUTN01	16	0.039	0.055	0.066	0.129	0.197
	SALM01	10	<0.020	0.042	0.084	0.148	0.257
	SARA01	12	0.080	0.114	0.164	0.204	0.267
	WINO01	12	0.173	0.248	0.293	0.299	0.380
TNOX-NY, mg/l	AUSA01	27	<0.05	0.11	0.16	0.20	0.33
	BOUQ01	26	<0.05	<0.05	0.08	0.11	0.41
	GCHA01	25	<0.05	0.09	0.17	0.30	1.31
	LAMO01	20	0.06	0.14	0.18	0.21	0.68
	LAPL01	32	<0.05	0.06	0.13	0.22	28.90
	LAUS01	24	<0.05	0.07	0.12	0.32	0.79
	LCHA01	26	0.04	0.18	0.34	0.64	1.78
	LEWI01	27	<0.05	0.05	0.17	0.28	2.39
	LOTT01	25	<0.05	<0.05	0.08	0.30	3.43
	METT01	29	0.12	0.26	0.39	0.45	1.25
	MISS01	18	<0.05	0.12	0.23	0.37	1.14
	OTTE01	26	<0.05	0.16	0.25	0.32	2.15
	PIKE01	13	0.34	0.53	0.58	0.70	1.01
	POUL01	23	<0.05	0.10	0.16	0.25	12.00
	PUTN01	31	<0.05	0.06	0.12	0.15	0.63
	SALM01	23	<0.05	0.07	0.09	0.17	0.27
	SARA01	28	0.05	0.11	0.15	0.22	3.59
	WINO01	20	0.16	0.20	0.27	0.29	0.40

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
TNH3, mg/l	AUSA01	7	<0.020	<0.020	<0.020	<0.020	<0.020
	BOUQ01	7	<0.020	<0.020	<0.020	<0.020	0.035
	GCHA01	5	<0.020	0.022	0.039	0.043	0.046
	LAMO01	9	0.022	0.024	0.028	0.028	0.045
	LAPL01	9	<0.020	<0.020	0.037	0.060	0.091
	LAUS01	5	0.015	0.016	0.021	0.038	0.043
	LCHA01	5	0.026	0.032	0.043	0.059	0.316
	LEWI01	9	<0.020	<0.020	<0.020	<0.020	0.024
	LOTT01	10	<0.020	<0.020	<0.020	0.022	0.141
	METT01	10	<0.020	0.026	0.039	0.059	0.078
	MISS01	9	0.018	0.024	0.024	0.032	0.086
	OTTE01	9	<0.020	<0.020	<0.020	0.042	0.048
	PIKE01	8	<0.020	0.025	0.052	0.100	0.379
	POUL01	10	<0.020	<0.020	<0.020	0.027	0.041
	PUTN01	11	<0.020	<0.020	<0.020	<0.020	0.077
	SALM01	5	<0.020	<0.020	<0.020	<0.020	<0.020
	SARA01	7	<0.020	<0.020	<0.020	0.022	0.033
	WINO01	8	0.034	0.042	0.050	0.058	0.127
TNH3-NY, mg/l	AUSA01	27	<0.005	0.007	0.014	0.025	0.053
	BOUQ01	27	<0.005	0.007	0.011	0.029	0.100
	GCHA01	25	<0.005	0.010	0.024	0.042	0.430
	LAMO01	20	<0.005	<0.005	0.025	0.045	0.150
	LAPL01	32	<0.005	0.008	0.029	0.079	0.280
	LAUS01	24	<0.005	0.010	0.018	0.086	0.960
	LCHA01	26	<0.005	0.023	0.040	0.178	0.860
	LEWI01	27	<0.005	<0.005	<0.005	0.018	0.110
	LOTT01	25	<0.005	0.005	0.012	0.050	0.510
	METT01	30	<0.005	0.012	0.028	0.061	0.210
	MISS01	18	<0.005	0.014	0.033	0.091	0.190
	OTTE01	26	<0.005	<0.005	0.015	0.043	0.250
	PIKE01	13	<0.005	0.023	0.071	0.110	0.290
	POUL01	23	<0.005	0.009	0.026	0.045	0.096
	PUTN01	31	<0.005	<0.005	0.005	0.013	0.068
	SALM01	24	<0.005	<0.005	0.012	0.032	0.260
	SARA01	28	<0.005	0.014	0.022	0.039	0.110
	WINO01	20	<0.005	0.008	0.035	0.070	0.200

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
TOC-NY, mg/l	AUSA01	54	2.90	4.22	5.10	6.07	16.00
	BOUQ01	50	2.70	4.30	5.00	6.98	17.00
	GCHA01	49	3.90	6.40	7.40	8.40	14.00
	LAMO01	40	2.50	3.18	3.95	5.80	180.00
	LAPL01	54	3.60	5.50	7.00	9.60	220.00
	LAUS01	52	3.00	6.30	8.30	9.33	19.00
	LCHA01	50	4.30	7.30	8.05	9.67	49.00
	LEWI01	48	2.70	3.70	4.65	5.63	180.00
	LOTT01	48	5.70	7.28	8.85	12.00	190.00
	METT01	58	1.80	3.10	4.05	5.98	130.00
	MISS01	39	2.90	4.00	4.70	6.60	75.10
	OTTE01	48	2.50	4.20	4.90	5.93	140.00
	PIKE01	30	5.20	7.67	8.75	13.00	300.00
	POUL01	47	2.00	3.05	4.70	6.40	130.00
	PUTN01	51	2.60	3.70	4.20	5.25	61.60
	SALM01	51	3.90	5.55	6.90	8.35	16.00
	SARA01	58	3.80	5.43	6.55	7.40	16.00
	WINO01	40	2.10	2.60	3.05	4.60	93.00
DOC-NY, mg/l	AUSA01	53	2.2	3.9	4.6	5.1	16.0
	BOUQ01	50	2.8	4.0	4.8	6.0	19.0
	GCHA01	49	3.8	5.9	7.1	7.9	12.0
	LAMO01	40	2.3	3.2	3.8	6.3	86.0
	LAPL01	54	3.5	5.9	7.5	9.9	100.0
	LAUS01	52	2.2	6.0	7.5	9.0	16.0
	LCHA01	51	4.9	7.2	8.0	9.1	19.0
	LEWI01	48	2.9	3.9	4.6	5.1	180.0
	LOTT01	48	5.7	7.6	8.8	12.0	140.0
	METT01	57	1.7	3.0	4.0	5.5	200.0
	MISS01	38	2.7	3.8	4.5	6.6	207.0
	OTTE01	48	2.5	3.9	4.6	5.5	200.0
	PIKE01	30	4.5	7.0	9.0	11.9	120.0
	POUL01	47	2.0	3.1	4.2	5.5	140.0
	PUTN01	51	2.6	3.4	4.2	4.6	12.9
	SALM01	52	3.7	4.9	6.4	8.0	14.0
	SARA01	58	3.1	5.1	5.8	7.1	14.0
	WINO01	39	1.9	2.4	2.8	4.8	110.0

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

<u>Test</u>	<u>Station</u>	<u>N</u>	<u>Minimum</u>	<u>25th</u>	<u>Median</u>	<u>75th</u>	<u>Maximum</u>
TSS, mg/l	AUSA01	44	<1.0	1.7	7.3	23.6	114.0
	BOUQ01	42	<1.0	2.1	17.0	63.8	152.0
	GCHA01	39	0.4	4.0	7.6	23.1	141.3
	LAMO01	47	<1.0	3.4	6.4	15.1	112.0
	LAPL01	58	<1.0	3.3	10.3	30.3	271.0
	LAUS01	41	<1.0	2.3	7.4	13.0	113.5
	LCHA01	39	<1.0	2.0	3.6	7.1	50.8
	LEWI01	54	0.2	2.5	9.4	29.5	307.0
	LOTT01	53	1.1	6.9	12.6	23.2	110.0
	METT01	57	0.5	9.1	17.4	45.6	421.0
	MISS01	46	1.9	5.7	20.5	40.3	146.0
	OTTE01	54	1.2	7.3	12.3	32.3	196.0
	PIKE01	35	<1.0	7.0	26.4	37.1	166.0
	POUL01	50	1.7	8.7	22.3	85.3	517.0
	PUTN01	47	<1.0	1.4	3.1	10.0	59.4
	SALM01	41	<1.0	1.0	4.0	15.2	105.9
	SARA01	48	<1.0	2.0	3.2	7.8	40.0
	WINO01	48	0.6	6.9	22.3	66.7	442.0
TSS-NY, mg/l	AUSA01	15	1.0	7.0	11.0	83.5	382.0
	BOUQ01	12	2.0	17.3	43.0	116.3	284.0
	GCHA01	17	3.0	5.0	12.0	112.0	166.0
	LAUS01	17	2.0	4.0	13.0	26.0	141.0
	LCHA01	16	2.0	3.0	6.0	23.3	78.0
	METT01	6	4.0	17.5	85.5	190.3	446.0
	POUL01	5	8.0	8.0	21.0	210.0	323.0
	PUTN01	7	1.0	7.5	24.0	39.5	398.0
	SALM01	16	0.7	2.0	23.5	43.0	145.0
	SARA01	19	2.0	4.0	7.0	12.5	393.0

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
CHA, ug/l	LAMO01	7	0.46	1.30	1.76	3.33	4.95
	LAPL01	9	0.23	1.60	2.96	3.51	5.25
	LEWI01	9	0.09	0.53	0.99	1.44	3.70
	LOTT01	9	0.96	1.11	2.10	2.96	4.67
	METT01	7	0.19	1.37	2.62	5.11	12.25
	MISS01	7	1.11	2.55	3.51	5.56	8.75
	OTTE01	8	0.48	2.21	3.34	9.04	26.24
	PIKE01	5	0.74	1.60	3.68	5.85	10.73
	POUL01	7	0.99	2.91	3.50	3.94	4.68
	WINO01	7	1.11	1.63	3.75	7.88	75.82
TEMP, C	LAMO01	15	0.5	3.3	6.5	10.5	22.0
	LAPL01	15	1.4	3.3	6.8	20.1	27.5
	LEWI01	14	2.8	4.5	6.7	16.9	24.8
	LOTT01	15	1.8	3.6	7.7	16.6	24.7
	METT01	13	2.2	4.0	6.2	19.0	23.0
	MISS01	16	0.3	2.2	3.4	9.1	21.0
	OTTE01	16	1.5	3.9	7.1	11.6	19.0
	PIKE01	12	0.5	1.4	3.3	8.2	19.8
	POUL01	12	2.0	4.6	7.7	18.2	22.7
	WINO01	16	1.5	3.4	7.3	11.0	20.3
COND, uS/cm	LAMO01	17	49	60	97	128	197
	LAPL01	17	130	192	230	383	1639
	LEWI01	14	57	131	162	222	509
	LOTT01	16	124	180	246	298	514
	METT01	13	133	140	173	218	269
	MISS01	17	43	54	95	128	165
	OTTE01	16	87	130	154	173	270
	PIKE01	12	125	146	165	205	299
	POUL01	11	113	126	161	205	353
	WINO01	17	67	78	123	144	265

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
CA-NY, mg/l	AUSA01	49	4.0	5.3	7.6	10.4	25.0
	BOUQ01	45	6.1	8.6	11.9	14.6	20.8
	GCHA01	46	7.8	12.7	17.3	21.7	88.5
	LAMO01	32	5.2	7.9	10.6	13.8	16.8
	LAPL01	44	14.9	25.2	34.8	39.5	51.2
	LAUS01	48	7.3	17.9	20.9	26.8	33.5
	LCHA01	47	16.1	25.3	31.6	36.1	44.1
	LEWI01	40	12.0	18.8	23.4	27.6	30.7
	LOTT01	38	12.1	25.7	29.9	38.6	48.4
	METT01	48	15.5	22.7	25.2	29.1	36.6
	MISS01	30	5.4	7.3	9.2	12.8	15.3
	OTTE01	39	11.5	15.7	19.3	21.0	25.6
	PIKE01	24	17.5	26.2	31.9	39.4	54.3
	POUL01	40	11.3	22.7	25.8	32.5	42.6
	PUTN01	47	11.7	18.1	21.6	38.3	61.2
	SALM01	48	7.2	13.5	18.3	19.9	31.6
	SARA01	54	4.2	7.5	9.2	11.7	18.2
	WINO01	31	9.7	11.6	14.1	17.1	24.4
MG-NY, mg/l	AUSA01	49	0.9	1.1	1.4	2.2	12.7
	BOUQ01	45	1.6	2.0	2.9	3.6	5.8
	GCHA01	46	2.1	3.5	4.8	5.8	8.7
	LAMO01	32	1.0	1.5	2.0	2.5	3.2
	LAPL01	44	5.2	7.5	11.6	14.2	20.1
	LAUS01	48	1.5	5.0	6.3	8.0	10.0
	LCHA01	47	3.9	6.7	8.1	9.4	11.7
	LEWI01	40	4.3	6.7	7.7	9.3	10.7
	LOTT01	38	5.1	10.5	13.8	18.2	22.5
	METT01	48	3.4	4.5	5.8	6.8	8.4
	MISS01	30	<2.0	<2.0	2.3	3.0	3.5
	OTTE01	39	3.5	5.0	6.4	6.9	8.9
	PIKE01	24	2.7	3.8	5.5	6.3	9.2
	POUL01	40	1.7	4.8	6.0	7.6	10.1
	PUTN01	47	1.8	3.0	3.8	7.5	14.5
	SALM01	48	1.9	3.4	4.9	5.6	7.1
	SARA01	54	1.0	2.0	2.2	2.5	4.9
	WINO01	31	1.4	1.8	2.3	2.8	4.9

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
NA-NY, mg/l	AUSA01	49	1.7	2.4	3.2	4.7	9.3
	BOUQ01	45	2.3	3.5	5.3	7.8	11.5
	GCHA01	46	3.3	4.8	7.6	9.0	13.3
	LAMO01	32	2.3	3.8	5.5	7.0	10.5
	LAPL01	44	5.5	9.4	18.6	34.8	149.0
	LAUS01	48	2.4	4.9	6.4	7.6	11.1
	LCHA01	47	3.8	6.7	8.4	10.4	22.0
	LEWI01	40	2.3	4.0	5.0	5.6	7.3
	LOTT01	38	4.2	6.2	8.9	10.3	14.2
	METT01	48	3.6	4.7	6.5	8.7	12.6
	MISS01	30	2.1	3.0	4.2	5.3	6.8
	OTTE01	39	3.6	5.3	6.2	7.3	9.4
	PIKE01	24	2.5	4.5	4.9	6.4	15.1
	POUL01	40	1.8	5.3	6.7	10.1	14.6
	PUTN01	47	1.6	3.0	3.9	6.0	8.6
	SALM01	48	1.6	3.3	3.7	4.2	8.1
	SARA01	54	2.0	3.5	3.8	4.5	9.6
	WINO01	31	3.7	5.6	6.5	9.2	15.1
K-NY, mg/l	AUSA01	49	<1.0	<1.0	<1.0	<1.0	1.6
	BOUQ01	45	<1.0	<1.0	<1.0	1.1	3.1
	GCHA01	46	0.9	1.4	1.7	2.2	4.3
	LAMO01	32	0.6	0.9	1.1	1.4	2.5
	LAPL01	44	1.8	2.3	3.4	4.2	9.5
	LAUS01	48	<1.0	1.5	1.7	2.1	6.1
	LCHA01	47	1.3	1.8	2.4	3.0	11.2
	LEWI01	40	<1.0	1.3	1.5	2.0	3.3
	LOTT01	38	1.3	2.6	3.3	4.0	6.9
	METT01	48	1.0	1.4	1.8	2.1	6.1
	MISS01	30	<1.0	1.0	1.1	1.5	2.5
	OTTE01	39	1.0	1.2	1.5	1.8	2.5
	PIKE01	24	1.6	2.2	2.7	3.7	6.4
	POUL01	40	<1.0	1.4	1.7	2.3	3.8
	PUTN01	47	<1.0	<1.0	<1.0	1.0	1.7
	SALM01	48	<1.0	1.0	1.1	1.3	3.0
	SARA01	54	<1.0	<1.0	<1.0	<1.0	1.9
	WINO01	31	0.7	0.9	1.1	1.3	2.2

Appendix B continued. Cumulative statistical summary of tributary sampling results, 1992-1996.

Test	Station	N	Minimum	25th	Median	75th	Maximum
FE-NY, ug/l	AUSA01	49	174	242	403	826	7160
	BOUQ01	45	161	288	809	2040	8540
	GCHA01	46	158	268	375	746	4290
	LAMO01	32	152	370	460	811	2740
	LAPL01	44	128	304	537	1225	6400
	LAUS01	48	147	357	472	674	2550
	LCHA01	47	134	212	335	468	2660
	LEWI01	40	167	270	467	1860	7750
	LOTT01	38	84	580	802	1245	5030
	METT01	48	90	511	950	3303	10600
	MISS01	30	173	445	1035	1470	5100
	OTTE01	39	<10	337	661	1080	4540
	PIKE01	24	108	559	1090	1705	6820
	POUL01	40	264	422	1225	5100	14000
	PUTN01	47	76	120	225	291	1450
	SALM01	48	175	301	369	714	3070
	SARA01	54	230	319	384	514	6840
	WINO01	31	210	489	1450	2445	15800
PB-NY, ug/l	AUSA01	49	<10	<10	<10	<10	16
	BOUQ01	45	<10	<10	<10	<10	19
	GCHA01	46	<10	<10	<10	<10	21
	LAMO01	32	<10	<10	<10	12	27
	LAPL01	45	<10	<10	<10	<10	34
	LAUS01	48	<10	<10	<10	<10	20
	LCHA01	47	<10	<10	<10	<10	26
	LEWI01	40	<10	<10	<10	<10	21
	LOTT01	38	<10	<10	<10	<10	42
	METT01	49	<10	<10	<10	11	67
	MISS01	30	<10	<10	<10	14	81
	OTTE01	39	<10	<10	<10	12	77
	PIKE01	24	<10	<10	<10	<10	43
	POUL01	40	<10	<10	<10	16	62
	PUTN01	47	<10	<10	<10	<10	51
	SALM01	48	<10	<10	<10	<10	22
	SARA01	54	<10	<10	<10	<10	18
	WINO01	31	<10	<10	<10	13	28