FINAL REPORT

on

THE LAKE GEORGE INSHORE CHEMICAL MONITORING PROGRAM

Submitted to
The Lake George Association Fund

by

Eichler, L. W. and C. W. Boylen
Rensselaer Fresh Water Institute
Rensselaer Polytechnic Institute
Troy, NY 12180-3590

January, 1988

FWI #88-3

REPORT ON THE LAKE GEORGE INSHORE CHEMICAL MONITORING PROGRAM
JULY 1987 - OCTOBER 1987

Submitted to

The Lake George Association Fund

by

Eichler, L. W. and C. W. Boylen
Rensselaer Fresh Water Institute
Rensselaer Polytechinc Institute
Troy, NY 12180-3590

January, 1988

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Inshore Chemical Monitoring Program was instituted in 1986 and designed to evaluate near-shore water quality and quantify the effects of various land uses on near-shore water chemistry. Sampling locations for the 1986 program were selected to be representative of predominant land uses in the basin; including areas with high human population density, high density commercial usage, marina operations, and little or no human impact. During 1987, the sampling programs was moved to a geographically restricted area (Bolton Bay) in order to reduce between-basin effects. Between-basin effects observed during 1986 were found to make interpretation of results difficult.

Results from the current season of sampling indicate slightly higher levels of orthophosphorus and total phosphorus than found at offshore sites. Sites characterized as marinas and commerical land use displayed higher levels of nutrients than either residential or undeveloped areas. Soluble silica concentrations were less at inshore sites while other nutrient levels (nitrogeneous compounds) were comparable to offshore levels. Whether differences in nutrient levels are due to resuspension from the sediments in the shallow water areas where the sampling sites were found or increased impact from terrestrial runoff is not known at the present time. Efforts to determine sources for various types of nutrients and to better quantify the impact of various land uses will be necessary in future programs. The means to better evaluate sources of nutrients and their impacts will involve additional sampling locations and some precipitation event based sampling efforts.

INTRODUCTION

The source of the elevated levels of nutrients in the South basin of Lake George has been the subject of a number of studies (Gibble, 1974; Ferris and Clesceri, 1975; Aulenbach, 1979; Wood and Fuhs, 1979; Sutherland et al., 1983; and Dillon, 1983). Although estimates vary on the precise amounts of nutrient loading from a variety of sources, all investigators agree that atmospheric deposition (rain, snow, and dryfall) and surface runoff are the major sources of nitrogen and phosphorus to the lake. The Lake George Chemical Monitoring Program was instituted in 1980 to document any long term changes in nutrient dynamics. The seven years of data collection indicate stable levels of the principle plant nutrients (nitrogen and phosphorus) in the open waters of the lake. Low levels of dissolved oxygen in the deeper water of the south basin over the last few years may be a signal of impending change. This observation, coupled with results from the Coliform Monitoring Program, strongly suggests the need for more intensive study of the inshore waters to detect changes in nutrient levels at an earlier stage.

During the winter of 1985 - 1986, data generated by the Lake George Chemical and Coliform Monitoring Programs over the previous six years was reviewed to assess the ability of these programs to monitor and protect the "health" of Lake George. Although long-term goals were being met by the scope of present programs, there was the need to document short-term chemical effects of human activities (e.g., nutrient additions such as nitrogen, silica and phosphorus) along the lake shore; to compliment coliform data collected by the Fresh Water Institute (FWI, 1984; 1985; 1986; 1987). These discussions resulted in the formulation of a near-shore chemical monitoring effort.

The Inshore Chemical Monitoring Program was instituted in 1986 and designed to evaluate near-shore water quality and quantify the effects of various land uses on near-shore water chemistry. Sampling locations were selected to be representative of predominant land uses in the basin; including areas with high human population density, high density commercial usage, marina operations, and little or no human impact. Samples were collected in water depths of one meter or less to maximize the ability to detect shoreline inputs and reduce the effects of dilution. Although precipitation "event"-based sampling is generally considered a more effective method for observing rapid changes in nutrient concentrations associated with surface runoff, fixed time interval sampling was used in this program. Event-based sampling required a much larger committment of staff and equipment than was available during the summer of 1987. In addition, fixed time interval sampling may better reflect "ambient" chemical water quality. Event-based sampling, at least on a small scale, may be used in future years if deemed appropriate.

Results from the initial season of sampling indicated slightly higher levels of orthophosphorus and total phosphorus than found at offshore sites. Soluble silica concentrations were lower at inshore sites while other nutrient levels (nitrogeneous compounds) were comparable to offshore levels. Whether differences in nutrient levels were due to resuspension from the sediments in the shallow water areas where these sampling sites were located or to increased impact from terrestrial runoff was not known.

During 1986, inshore sites in the north basin were found to be different chemically than sites with comparable land uses in the south basin. Differences in the concentrations of various chemical constituents, notably phosphorus and nitrogen compounds, in the surface waters of the two basins of Lake George have been well documented (FWI; 1981-1988). These between-basin differences were found to make interpretation of results from the selected shoreline land use categories difficult. In order to reduce between-basin effects, the sampling program was moved to a geographically restricted area (Bolton Bay) in 1987.

Results of the 1987 sampling season form the basis for this report.

SAMPLING SITES AND METHODS

Eight sampling sites were selected to be representative of predominant land uses in the basin; including areas with high human population density, high density commercial usage, marina operations, and little or no human impact. The sites were characterized as to adjacent land use, and a description of each site is included (Table 1 and Figure 1).

At each site, two stations were established; one where water depth was 0.5 meters and a second where the depth was 1.0 meter. Where possible, sampling sites were located in areas adjacent to the open water sites used in the Lake George Chemical Monitoring Program (FWI, 1988). Sites were sampled biweekly from July 1 through October 1, 1987. This sampling period coincides with summer stratification of Lake George. At each site, surface grab samples were collected for analysis of a variety of chemical constituents.

Sample preparation and analytical techniques have been discussed at length in previous reports (FWI, 1986). A list of analytical techniques employed in this study is included as Appendix 1.

Table 1. Sampling Site Names and Locations. All sites are located in the Town of Bolton.

Site Name	Type	Location
Bolton Landing	C,HD MARINA	Situated on the west shore of Bolton Bay, 250 meters south of the Green Island Bridge. Adjacent to a marina operation with high density commercial uses.
Sweetbriar Bay	C, HD MARINA	Situated on the west shore of the bay on the property line of a marina and a restaurant. Moderate sized paved areas drain into the lake in this area.
East Huddle Bay	R, HD	On the east shore of Huddle Bay, 200 meters north of the southeast corner of the bay. A vegetated zone (lawn and trees) is maintained along the shoreline.
Stewart Brook	R, HD	On the west shore of Bolton Bay, 150 meters south of the Town of Bolton Pier. An area of moderate to high residential development.
West Huddle Bay	C, MD	On the west shore of Huddle Bay, 100 meters north of the mouth of Huddle Bay Brook. Moderate commercial (motels) and residential use characterizes this site.
West Bolton Bay	C, MD	On the west shore of Bolton Bay, in a small bay with moderate commercial use (motels), shallow slope and large lawn areas.
Green Island	U	On the west shore of Green Island approximately 100 meters north of the DEC facility. This section of the island has a maintained trail system but no habitation.
Clay Island	R, LD	On the northwest tip of the island. Relatively undisturbed land with a flat slope and no vehicular traffic.

R = Residential; C = Commercial; HD = High Density; U = Undeveloped
MD = Moderate Density; LD = Low Density

RESULTS

Precipitation records from the FAA station at the Glens Falls Airport are included as Figure 2.* The period of this study, July through October 1987, had higher than average precipitation in June followed by less than average precipitation in July. August and September displayed slightly higher than average precipitation. Overall, summer precipitation (June through September) was 53% greater than average.

The pH results for all inshore samples were near neutral (pH = 7). Values ranged from a low of 6.94 at the Bolton Landing 0.5 meter site to a high of 7.94 found at both the Green Island 0.5 and 1.0 meter sites (Appendix 3 and Figure 3). The average pH for each of the 0.5 meter sites was less than the average pH for their associated 1.0 meter sites. The 0.5 meter samples at marina sites (Bolton Landing and Sweetbriar Bay) and the West Huddle Bay site were somewhat lower in pH than other inshore sites (means of 7.41, 7.42 and 7.48, respectively). The pH values for inshore sampling sites however, were not substantially different from those reported for adjacent offshore sites (FWI; 1988),

Conductivity results ranged from 95 to 126 umhos (Appendix 3 and Figure 4). Conductivity values were generally higher at all 0.5 meter sites relative to their associated 1.0 meter sites. The marina sites, Bolton Landing and Sweetbriar Bay, and the 0.5 meter

* All Figures are included as Appendix 2. All Tables are included as Appendix 3.

site at West Huddle Bay generally had higher conductivity results than other sites. A single conductivity of 126.0 umhos at the West Huddle Bay 0.5 meter site on September 22nd however, may have unduly biased this result, since the mean for this site, when this single high value is ignored, is comparable to other non-marina sites (102.8 umhos). A bloom of zooplankton was also observed at the West Huddle Bay site on September 22nd. The 0.5 meter site in Sweetbriar Bay routinely displayed highest conductivity values with a marked reduction observed between the 0.5 and 1.0 meter stations at this site. The specific conductance of samples from inshore sites was slightly higher than for comparable offshore sites.

Chloride concentrations were highest at the Sweetbriar Bay 0.5 meter site (range 7.6 - 14.3 ppm Cl). Lowest chloride concentrations (range 5.9 - 7.6 ppm Cl) were reported for the West Huddle Bay 1.0 meter site (Appendix 3 and Figure 5). An increase in chloride concentration from the 0.5 to the 1.0 meter sites at East Huddle Bay, Clay Island and South Green Island was observed while all other sites displayed a decrease in chloride concentration from the 0.5 to the 1.0 meter sites. Lowest chloride concentrations were observed on August 12th with higher concentrations preceeding and following this date.

Nitrate and ammonia concentrations (Appendix 3 and Figures 6 and 7) were routinely below the limit of detection for our laboratory (0.01 ppm as N). Early in the sampling season (July

* All Figures are included as Appendix 2. All Tables are included as Appendix 3.

1st through 15th) detectable levels of nitrate were present at the Bolton Landing and West Huddle Bay sites. This condition is generally observed in deeper waters only prior to summer stratification, with nitrate concentrations dropping to below detection limits by the time stratification occurs (mid-June).

Concentrations of total phosphorus (TP) were highest at the 0.5 meter sites in Sweetbriar Bay, West Huddle Bay and Bolton Landing (Appendix 3 and Figure 8). TP concentrations ranged from 2 to 22 ppb phosphorus at all inshore sites. With the exception of West Huddle Bay, the 1.0 meter sites contained TP concentrations which were comparable to results from the adjacent deeper water (0-2 m and 0-10 m) sites in the Chemical Monitoring Program. Most 0.5 meter sites had higher TP concentrations than the associated 1.0 meter sites. The 1.0 meter site at Green Island (mean = 4.0 ppb) had the lowest average TP concentration. The 0.5 and 1.0 meter sites at Clay Island, also had relatively low concentrations of TP, with means of 4.4 and 4.9 ppb, respectively. Both Green Island and Clay Island sites are relatively undeveloped areas.

Total filterable phosphorus (TFP) concentrations were highest at the West Huddle Bay 0.5 and 1.0 meter sites (mean = 2.9 and 3.1 ppb, respectively), followed by the 0.5 meter sites at Bolton Landing and Sweetbriar Bay (Appendix 3 and Figure 9). The relation of the inshore sites to comparable offshore sites was variable.

Orthophosphorus (OP) concentrations (Appendix 3 and Figure 10) at all sites were near the detection limit of our laboratory

(1.0 ppb as P). Unlike open water areas of Lake George, mean concentrations of OP were above 1.0 ppb at most sites with the exception of Bolton Landing, 1.0 meter and Clay Island, 1.0 meter. The 0.5 meter sites exhibited greater concentrations of OP than their associated 1.0 m sites, although differences were not large. Inshore sites contained more OP than comparable offshore sites. The need to analyse OP immediately after collection and its contamination prone nature lead to a limited amount of OP data being available.

Concentrations of soluble reactive silica ranged from 0.52 to 1.20 ppm through the period of sampling, and were similar in the 0.5 and 1.0 m stations at each site (Appendix 3). Highest average silica concentrations were observed at the West Huddle Bay 0.5 and 1.0 meter stations, 0.85 and 0.80 ppm respectively (Figure 11). Silica concentrations in inshore samples were generally less than in adjacent offshore sampling sites.

Calcium concentrations were variable between sites (Appendix 3). The highest mean calcium concentrations were found at the 0.5 and 1.0 meter stations at Sweetbriar Bay (12.9 and 12.4 ppm, respectively). The 0.5 meter stations generally had higher calcium concentrations than their related 1.0 m stations (Figure 12). Resuspension of calcium from the sediments by wave action, or runoff from adjacent terrestial areas may be the source.

Concentrations of chlorophyll a were highly variable both between and within sites (Appendix 3). The low levels of chlorophyll a present in the samples (range 0.4 to 1.9 ppb) coupled with the variability of the data, makes any discussion of trends highly speculative.

DISCUSSION

Results from the first year (1986) of the Inshore Chemical Monitoring Program provided data necessary to evaluate site selection and sampling frequency. Sites in the north basin were found to be different, chemically, than comparable sites in the south basin. Basin effects were identified as an important aspect of the nutrient dynamics of inshore waters. Differences in the concentrations of various chemical constituents, notably phosphorus and nitrogen compounds, in the surface waters of the two basins of Lake George have been reported extensively (FWI; 1981-1988). These between-basin differences were found to make interpretation of results from various shoreline land uses difficult during the 1986 Inshore Monitoring Program. In order to reduce between-basin effects, the sampling program was moved to a geographically restricted area (Bolton Bay) in 1987.

Sampling frequency appears to be adequate however; a comparison of event based versus fixed interval sampling may be considered in future studies. Event based sampling is timed to precipitation or rapid snow melt episodes, when large amounts of runoff occur. Precipitation and runoff are major sources of nutrients to Lake George. Rapid changes in water chemistry of streams tributary to Lake George following precipitation events were observed in the NURP Program (Sutherland et al. 1983). These changes were generally of a short duration, indicating that they may not have been observed if a fixed interval sampling program was used. The same situation may occur in inshore waters of Lake George, perhaps dictating the need for event based sampling.

Inshore sampling sites were found to have higher levels of orthophosphorus and total phosphorus than found at offshore sites. Early summer (July) concentrations of nitrate at inshore sites were higher than at adjacent offshore sites. Measureable nitrate concentrations are characteristic of Spring (pre-summer stratification) conditions observed in the surface waters farther removed from the shoreline (FWI; 1986; 1987; 1988). Soluble silica concentrations were lower at inshore sites while other nutrient levels (nitrogeneous compounds) were comparable to offshore levels as the summer progressed. Whether differences in nutrient levels are due to resuspension from the sediments in the shallow water areas where these sampling sites were located or to increased impact from terrestrial runoff is not known at the present time.

Silica is derived principally from erosion in the terrestial portion of the basin or resuspension from sediments on the lake bottom, thus higher levels would be expected nearshore. Soluble reactive silica concentrations at the inshore sampling sites however, were less than at nearby deeper water (0-2 m) locations. The principle mechanism for soluble silica removal from the water column is through incorporation into the frustules of diatoms. Whether the diatom populations of inshore waters, depths of 1 meter or less, are substantially greater than those of adjacent deeper waters, depths of 2 meters or greater, was not a part of this study.

Total phosphorus (TP), total filterable phosphorus (TFP) and orthophosphorus (OP) concentrations in the nearshore samples were higher than in similar deeper water samples. This phenomena is not unexpected when it is realized than surface runoff and precipitation are two of the major sources of phosphorus to the lake.

Differences were observed between sites characterized as marinas and sites with other land uses. The principle differences were in pH, specific conductance and the concentrations of nitrate and phosphorus compounds. Marina sites displayed lower pH and higher specific conductance than other sites. Concentrations of nitrate and phosphorus were also higher at the marina sites than other inshore sites with the exception of the West Huddle Bay site. Nutrients found at marina sites may be derived through resuspension from sediments as a result of increased boating activity and/or accelerated runoff and reduced percolation as a result of a greater proportion of impermeable surface (pavement and roof) extending to near the waters edge. The site at West Huddle Bay also produced high levels of nutrients. The West Huddle Bay site is in a protected area, with water circulation limited by a number of docks. In addition, this site possesses an abundant growth of aquatic plants. Lack of circulation coupled with cycling of nutrients up from the sediments by the vegetation may account for elevated nutrient levels observed at this site. The presence of Huddle Bay Brook's outlet a nominal distance away may also impact on this site however the flow appears to be diverted away from this site by a number of docks seperating the sampling site from the outflow of the brook.

A greater range in concentration of each of the ions tested was observed at the inshore sampling sites relative to adjacent deeper water locations. This phenomena was expected since previous investigators have reported large shifts in concentration of a number of ions in streams and other shoreline drainage systems in relation to precipitation and surface runoff.

ACKNOWLEDGMENTS

We wish to again thank the Lake George Association Fund for its financial support which makes the continuing study of the chemical water quality of Lake George possible. Thanks also go to the Lake George Association, its office staff, members and leadership for their moral and financial support of our efforts to monitor and study Lake George. Many thanks to all of you.

All samples obtained as part of this program were collected and analyzed by the Fresh Water Institute staff. Lawrence W. Eichler had responsibility for day to day on site operations of the program. He was aided in the data collection, analysis and report preparation by John Madsen, Reginald Soracco, Jan Witting, Kathleen Regan and Elizabeth Lawrence. David Smith, Anne Erb, Chris Loft and John Miller did much of the sampling and chemical analyses. Dr. Charles W. Boylen, Director of the FWI does, of course, have ultimate responsibility for the monitoring program and this report.

REFERENCES

Aulenbach, D.B. 1979. Nutrient budgets and the effects of development on trophic conditions in lakes. Fresh Water Institute Report No. 79-2, Rensselaer Fresh Water Institute, Rensselaer Polytechnic Institute, Troy, NY

Dillon, P.J. 1983. Nutrient budgets for Lake George, New York. In: C.D. Collins (ed.) The Lake George Ecosystem, Volume III. The Lake George Association, Lake George, NY pp 157-167.

Ferris, J.J. and N.L. Clesceri. 1977. A description of the trophic status and nutrient loading for Lake George, New York. In: North American Project - A Study of U.S. Water Bodies. EPA-600/3-77-086, USEPA, Corvallis, OR

FWI. 1987. Report on the Lake George chemical monitoring program, March 1986 - November 1986. Fresh Water Institute Technical Report No. 87-1, Rensselaer Fresh Water Institute, Rensselaer Polytechnic Institute, Troy, NY

Gibble, E.B. 1974. Phosphorus and nitrogen loading and nutrient budget on Lake George, New York. Masters Thesis, Rensselaer Polytechnic Institute, Troy, NY

Sutherland, J.W., J.A. Bloomfield and J.M. Swart. 1983. Final report for the Lake George urban runoff study, nationwide urban runoff program. Bureau of Water Research, New York State Department of Environmental Conservation, Albany, NY

Wood, L.W. and G.W. Fuhs. 1979. An evaluation of the eutrophication process in Lake George based on historical and 1978 limnological data. Environmental Health Report No. 5, Environmental Health Center, Division of Laboratories and Research, New York State Department of Health, Albany, NY. 73 pp.

APPENDIX 1

Analysis	Method	Instrument
pH	Electrometric (EPA Method 150.1)	Orion, Model 811
Specific Conductance	Wheatstone Bridge type meter (EPA Method 120.1)	YSI, Model 31
Dissolved Oxygen	Membrane Electrode (EPA Method 360.1)	YSI, Model 54
Chloride	Automated Ferricyanide (EPA Method 325.2)[1]	Technicon Autoanalyzer II
Nitrate	Automated Cadmium Reduction (EPA Method 353.2)[1]	Technicon Autoanalyzer II
Ammonia	Automated Phenate (EPA Method 350.1)	Technicon Autoanalyzer II
Total Phosphorus	Colorimetric (EPA Method 365.2)	Bausch & Lomb Spec 710
Total Filterable Phosphorus	Colorimetric (EPA Method 365.2)	Bausch & Lomb Spec 710
Ortho Phosphorus	Colorimetric (EPA Method 365.2)	Bausch & Lomb Spec 710
Calcium	Direct Aspiration (EPA Method 215.1)	Perkin-Elmer Model 403
Soluble Reactive Silica	Automated Molybdate (Technicon Method)	Technicon Autoanalyser II
Chlorophyll a	Methanol Extraction	Bausch & Lomb Spec 710

EPA Methods listed in this table are derived from: USEPA, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Cincinnati, Ohio.

APPENDIX 2

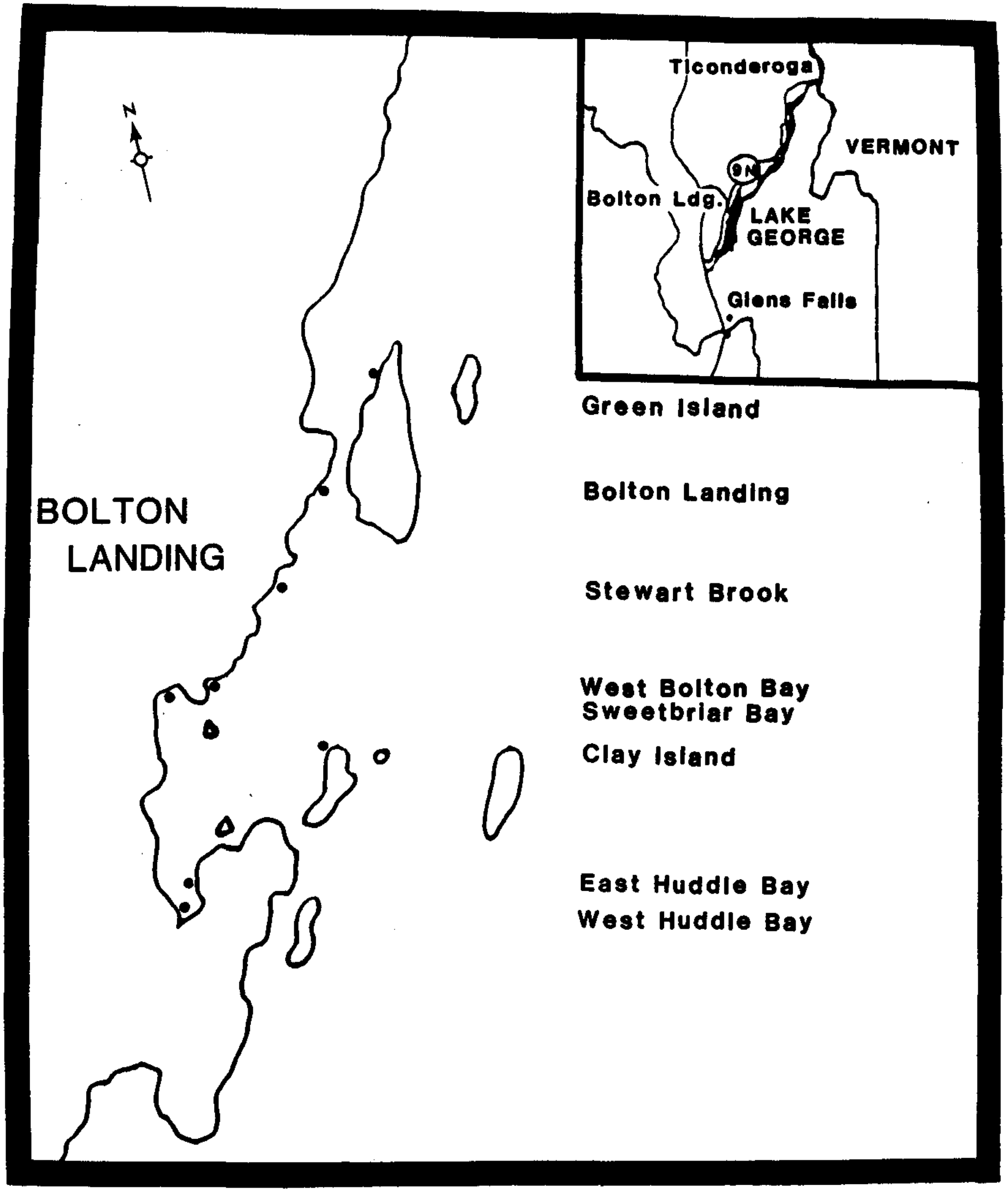

Figure 1. Map of Inshore Sampling sites. Sites are designated by filled circles.

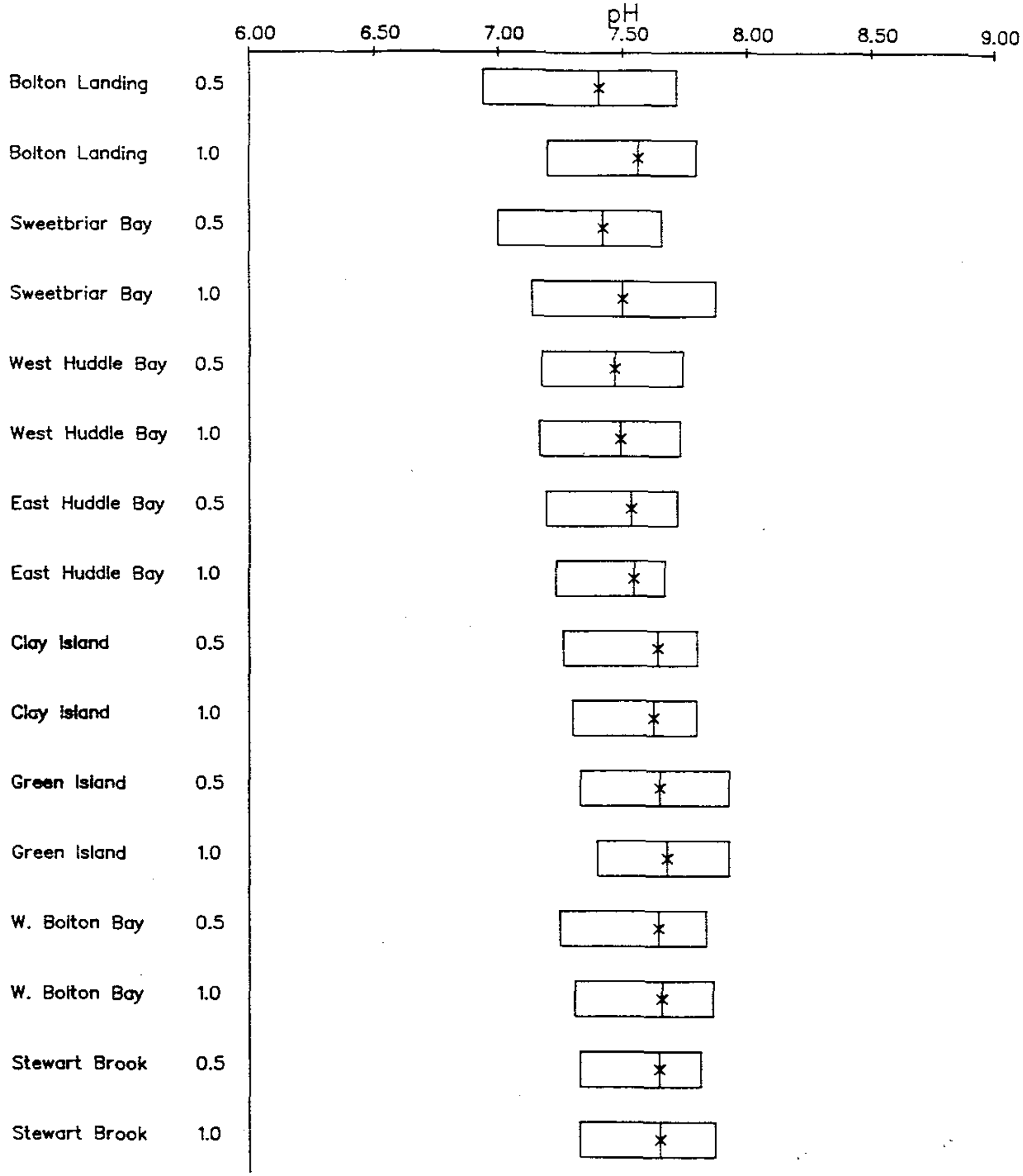

Figure 3. Minimum, maximum and average pH at inshore sampling sites.

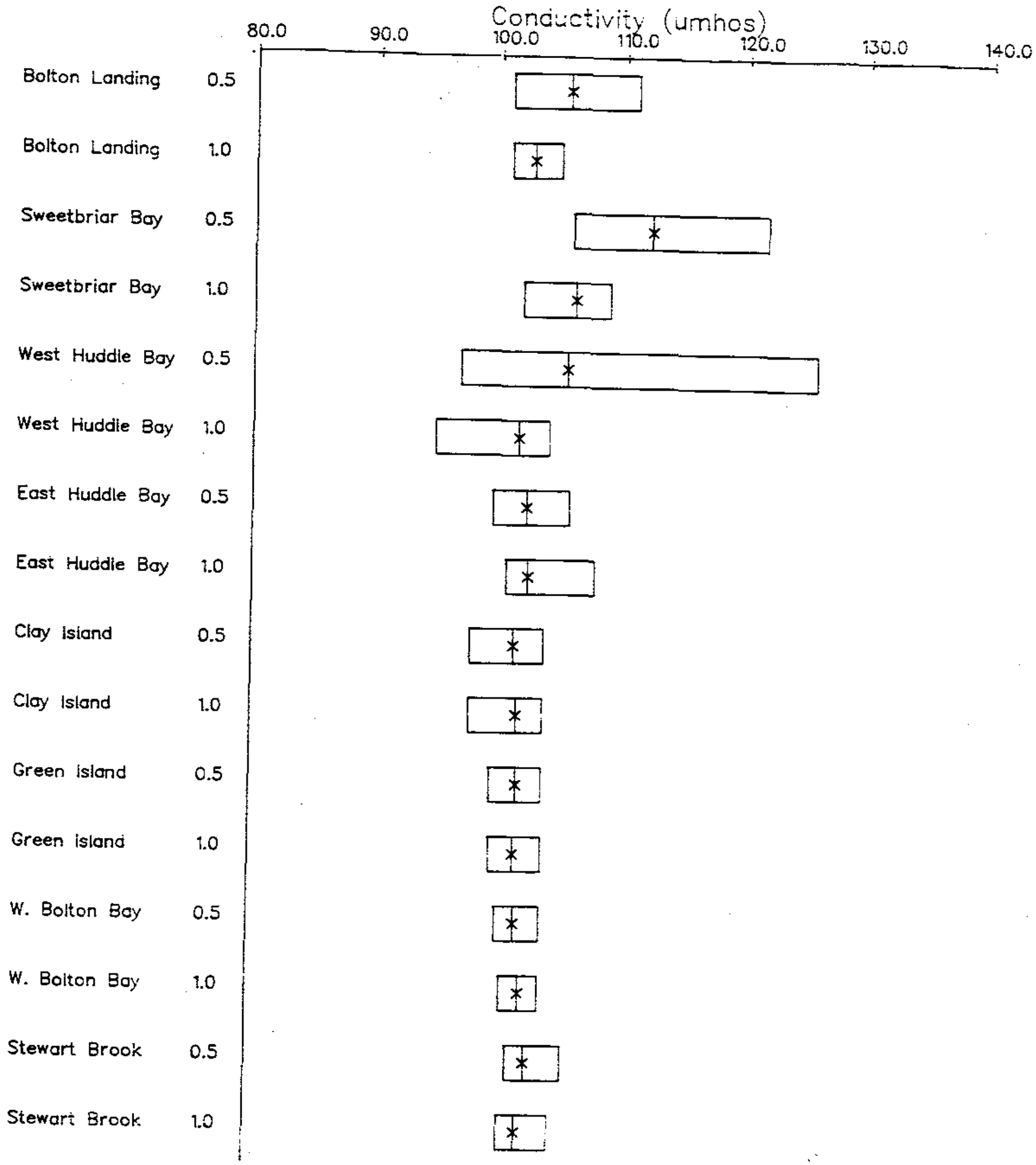

Figure 4. Minimum, maximum and average conductivity at all inshore sites.

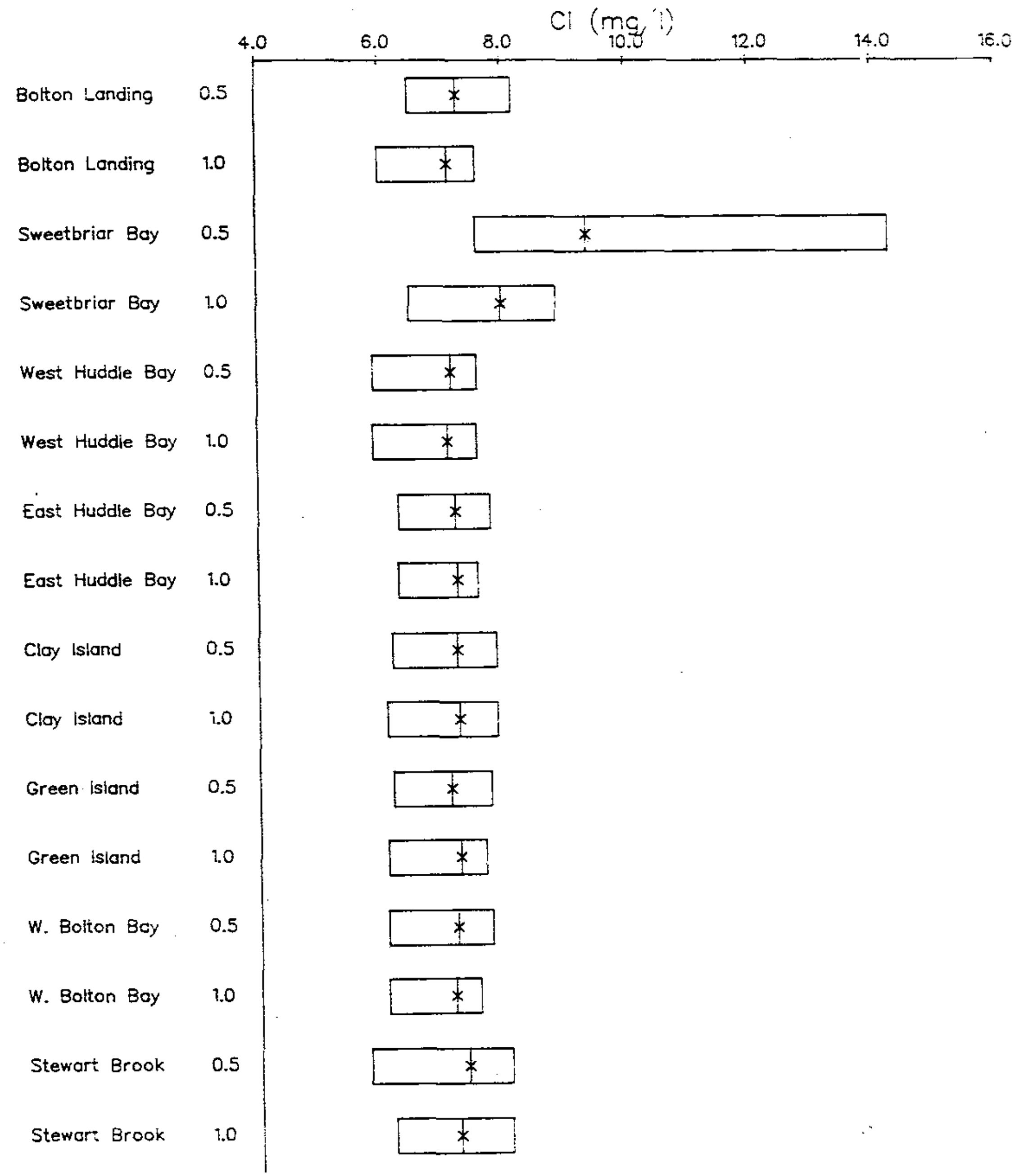

Figure 5. Minimum, maximum and average chloride concentrations at each inshore site.

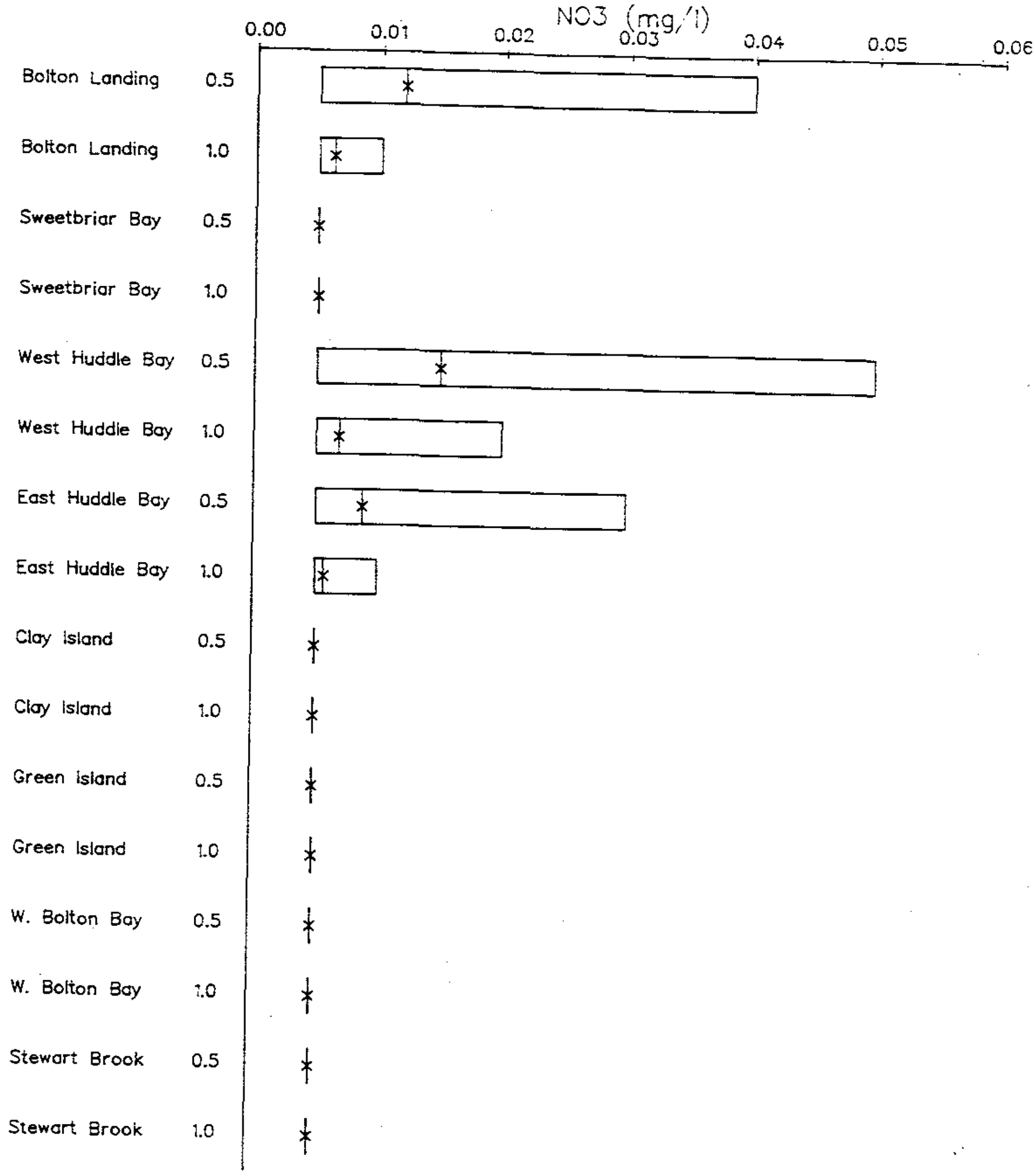

Figure 6. Minimum, maximum and average nitrate concentrations at each inshore site.

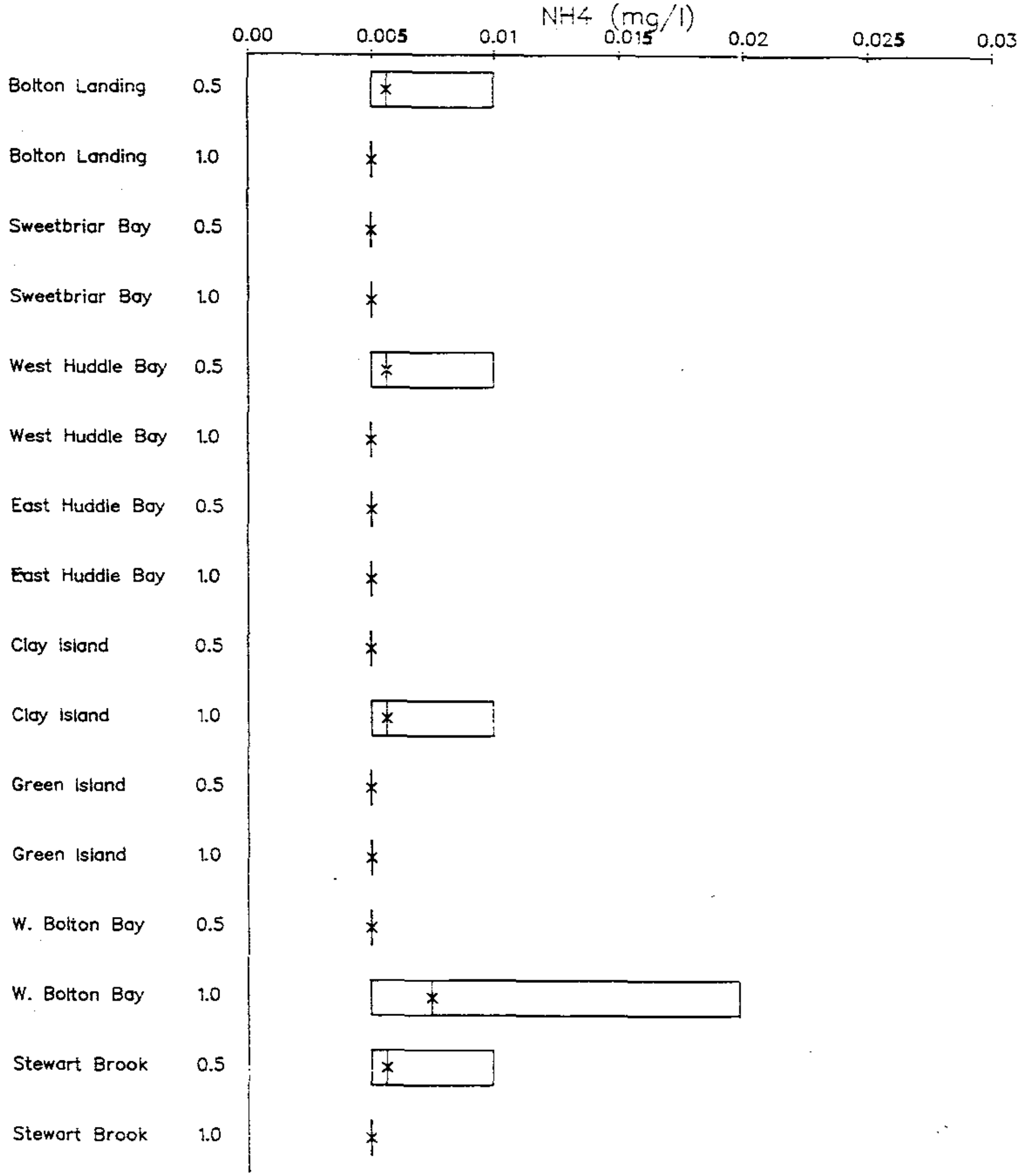

Figure 7. Minimum, maximum and average ammonia concentrations at each inshore site.

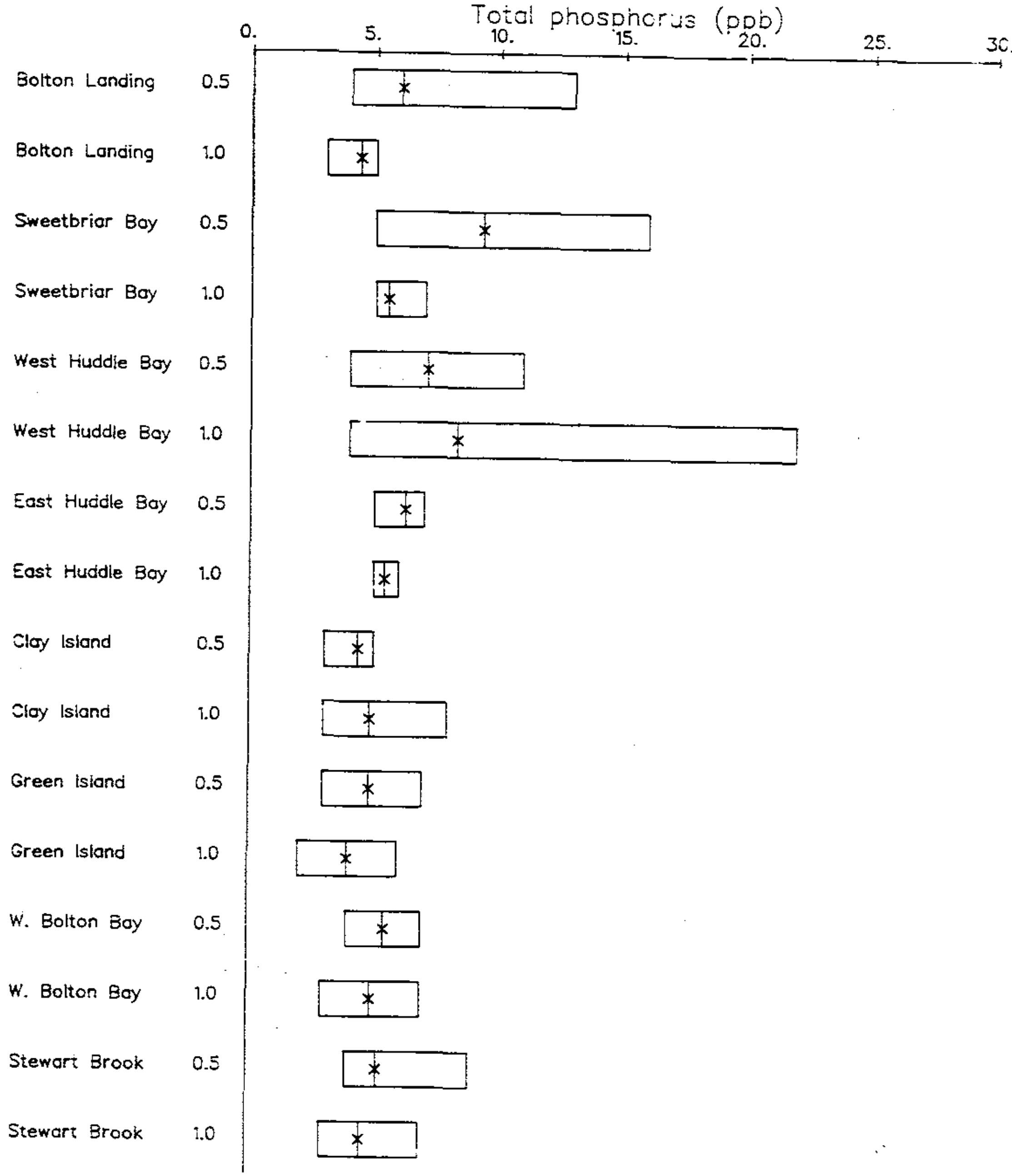

Figure 8. Minimum, maximum and average total phosphorus concentrations at each inshore site.

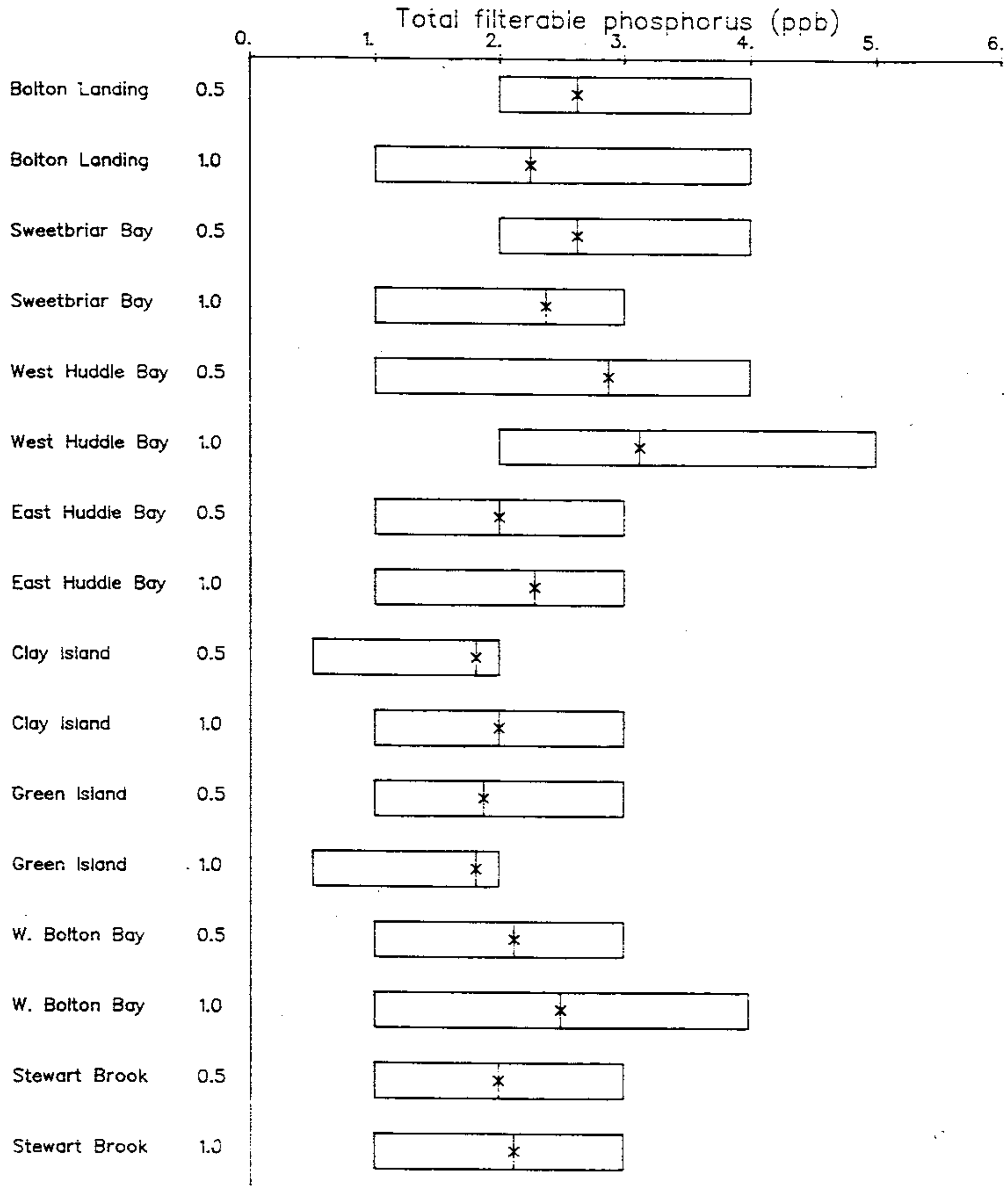

Figure 9. Minimum, maximum and average total filterable phosphorus concentrations at each inshore site.

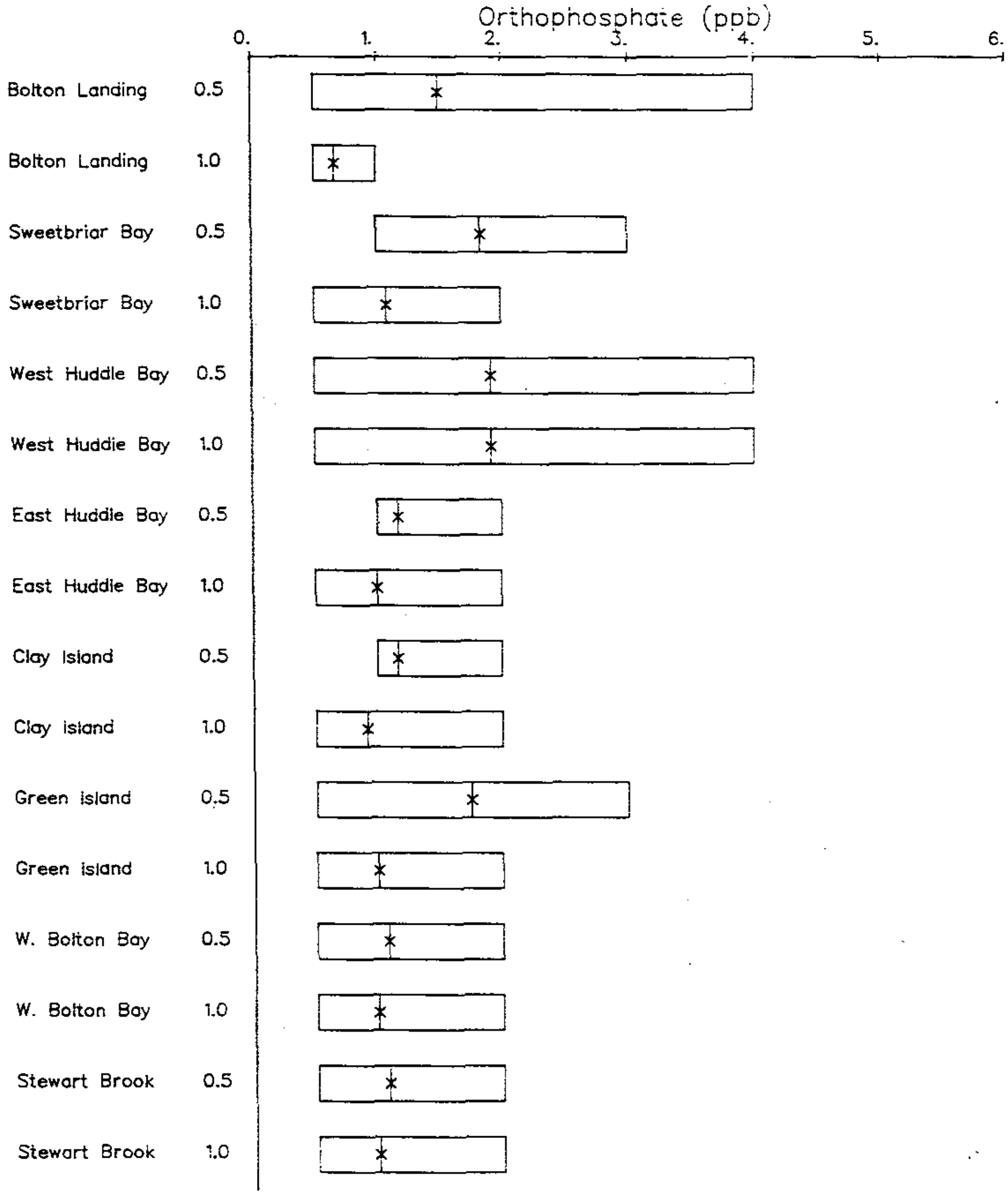

Figure 10. Minimum, maximum and average orthophosphorus concentrations at each inshore site.

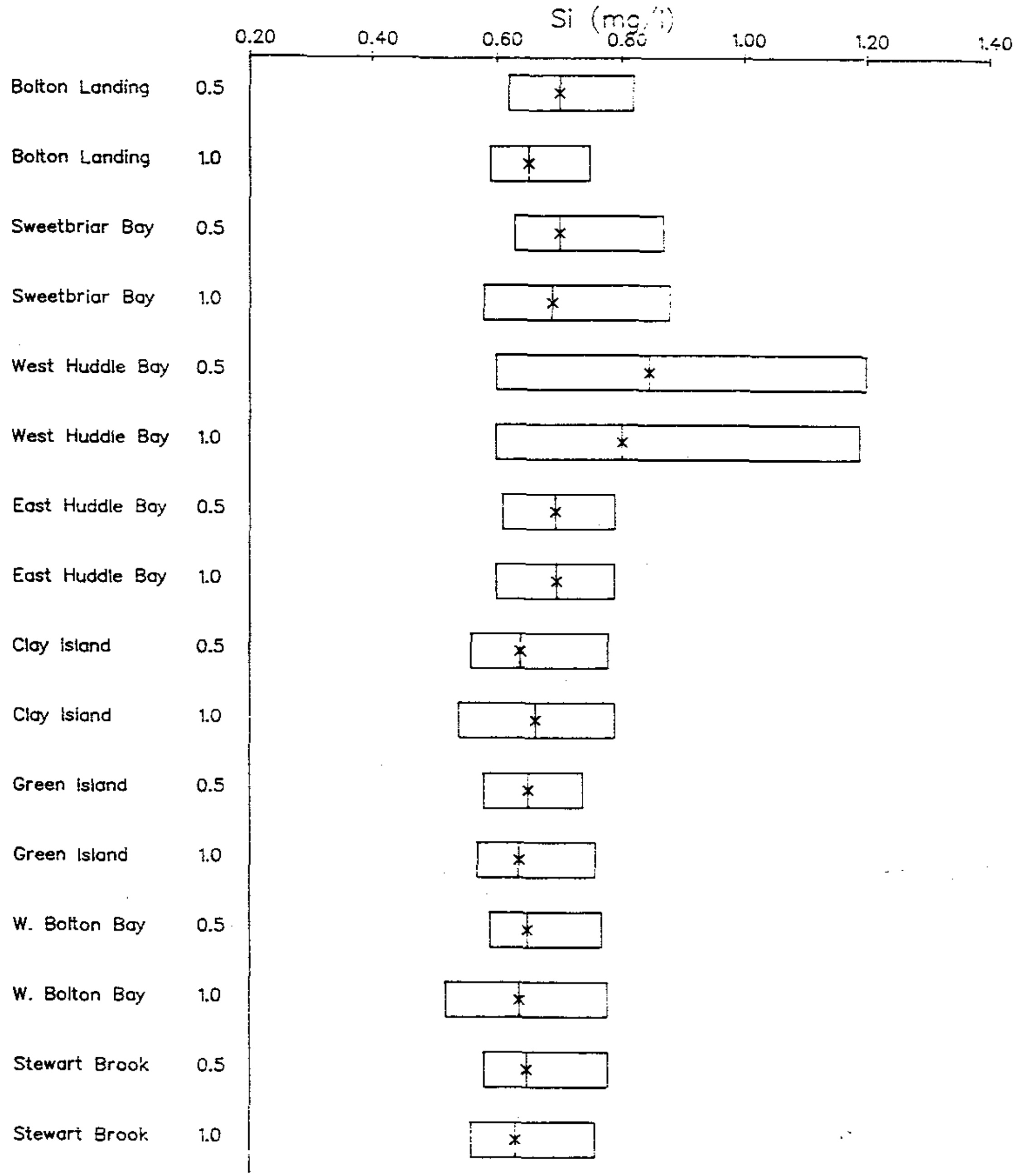

Figure 11. Minimum, maximum and average silica concentrations at each inshore site.

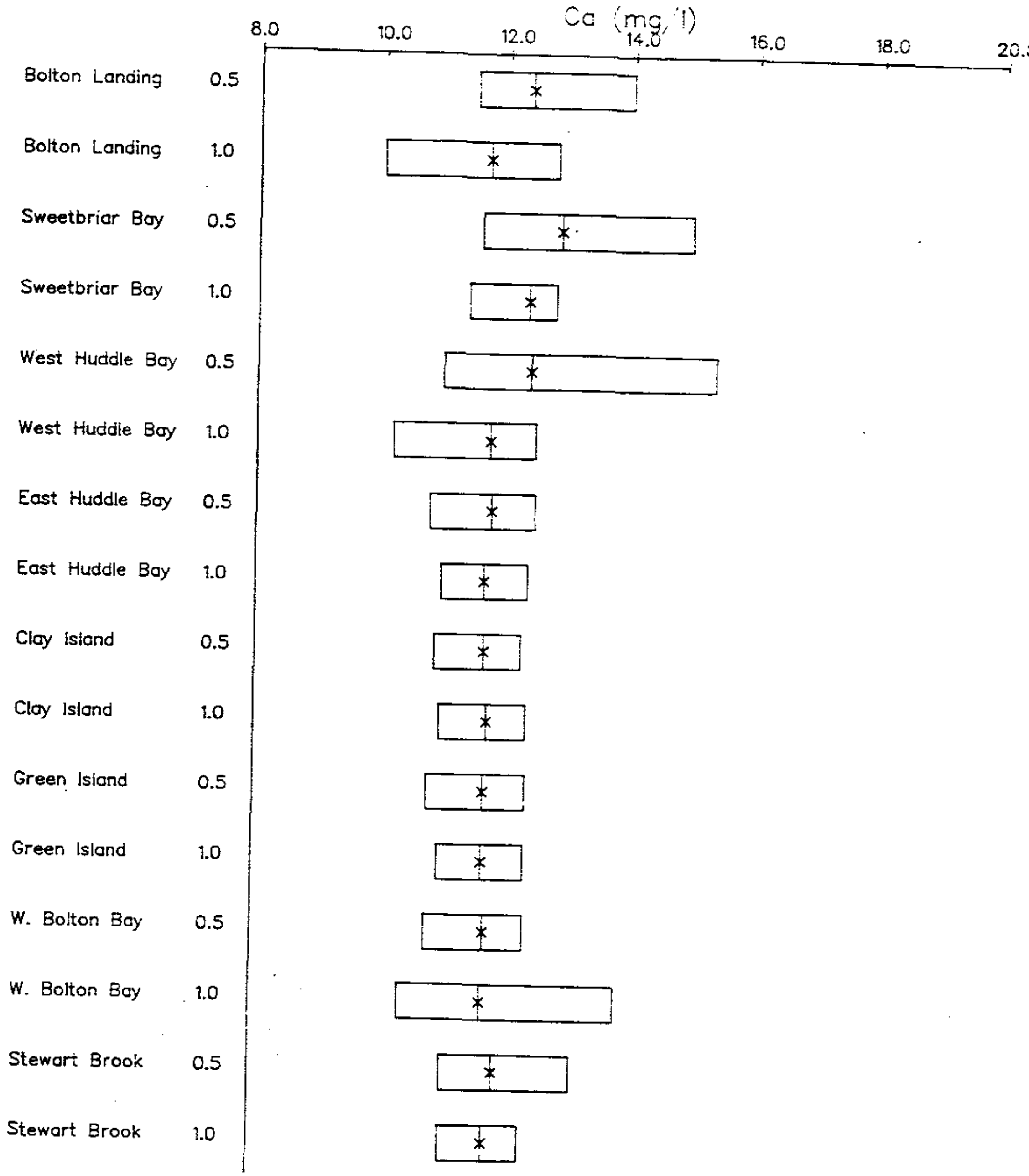

Figure 12. Minimum, maximum and average calcium concentrations at each inshore site.

APPENDIX 3

1987 Chl-a (ppb)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	1.04	0.98	0.73	0.60	0.95	0.73	1.30	1.11
	1.0	1.14	0.85	1.01	0.73	1.07	0.57	1.20	1.01
Sweetbriar Bay	0.5	1.77	1.66	1.26	0.72	1.36	1.55	0.82	0.85
	1.0	1.39	1.42	1.20	0.54	*****	0.60	0.82	0.89
West Huddle Bay	0.5	1.23	1.07	*****	0.79	1.30	0.66	0.85	1.62
	1.0	*****	0.92	1.23	0.73	1.30	0.95	1.39	1.17
East Huddle Bay	0.5	0.82	1.48	1.36	0.70	1.23	0.79	0.60	1.26
	1.0	0.92	1.93	1.17	0.70	*****	0.66	0.98	0.98
Clay Island	0.5	1.11	1.17	0.98	0.76	1.07	0.51	1.23	1.30
	1.0	0.70	0.89	1.07	0.76	0.85	0.60	1.26	1.33
Green Island	0.5	1.17	0.41	1.37	0.66	1.36	0.38	1.04	1.01
	1.0	0.85	0.92	0.82	0.57	1.10	0.89	0.82	0.79
W. Bolton Bay	0.5	1.14	0.98	1.04	0.89	1.42	1.14	1.20	0.95
	1.0	0.95	1.33	1.23	0.63	1.45	0.70	1.07	*****
Stewart Brook	0.5	0.89	1.39	0.95	0.98	1.80	0.80	0.95	1.17
	1.0	0.92	0.82	1.11	0.73	1.11	0.76	1.07	1.04

***** : indicates no data available

1987 Total filterable phosphorus (ppb)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	3.	2.	2.	3.	3.	2.	4.	2.
	1.0	2.	1.	2.	3.	4.	2.	2.	2.
Sweetbriar Bay	0.5	2.	3.	2.	3.	4.	3.	2.	2.
	1.0	2.	1.	2.	3.	3.	3.	3.	2.
West Huddle Bay	0.5	4.	1.	2.	3.	3.	3.	4.	3.
	1.0	3.	3.	2.	3.	3.	3.	5.	3.
East Huddle Bay	0.5	2.	1.	2.	3.	2.	2.	2.	2.
	1.0	3.	1.	3.	3.	*****	2.	2.	2.
Clay Island	0.5	2.	-1.	2.	2.	2.	2.	2.	2.
	1.0	3.	1.	2.	2.	2.	2.	2,	2.
Green Island	0.5	2.	1.	1.	3.	2.	2.	2.	2.
	1.0	2.	-1.	2.	2.	2.	2.	2.	2.
W. Bolton Bay	0.5	2.	1.	2.	3.	2.	2.	3.	2.
	1.0	4.	1.	2.	3.	2.	4.	2.	2.
Stewart Brook	0.5	2.	1.	2.	3.	2.	2.	2.	2.
	1.0	3.	2.	3.	2.	2.	1.	2.	2.

***** : indicates no data available

1987 Orthophosphate (ppb)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	2.	4.	1.	*****	1.	-1.	-1.	*****
	1.0	1.	-1.	-1.	*****	1.	-1.	-1.	*****
Sweetbriar Bay	0.5	2.	1.	2.	*****	2.	3.	1.	*****
	1.0	2.	1.	1.	*****	1.	-1.	1.	*****
West Huddle Bay	0.5	4.	-1.	1.	*****	1.	2.	3.	*****
	1.0	4.	-1.	1.	*****	1.	1.	4.	*****
East Huddle Bay	0.5	2.	1.	1.	*****	1.	1.	1.	*****
	1.0	2.	-1.	1.	*****	*****	1.	-1.	*****
Clay Island	0.5	2.	1.	1.	*****	1.	1.	1.	*****
	1.0	2.	-1.	-1.	*****	1.	-1.	1.	*****
Green Island	0.5	2.	2.	3.	*****	2.	-1.	1.	*****
	1.0	2.	-1.	1.	*****	1.	1.	-1.	*****
W. Bolton Bay	0.5	2.	-1.	1.	*****	1.	1.	1.	*****
	1.0	2.	-1.	-1.	*****	1.	1.	1.	*****
Stewart Brook	0.5	2.	-1.	-1.	*****	2.	1.	-1.	*****
	1.0	2.	-1.	-1.	*****	2.	-1.	-1.	*****

***** : indicates no data available

1987 Cl (mg/l)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	8.2	8.0	7.7	6.5	6.6	6.7	*****	7.4
	1.0	7.5	7.4	7.6	6.0	6.4	7.5	7.2	7.5
Sweetbriar Bay	0.5	8.6	14.3	9.4	7.6	8.6	8.8	8.3	9.5
	1.0	8.8	8.9	7.8	6.5	7.4	8.2	7.9	8.5
West Huddle Bay	0.5	7.4	7.2	7.5	5.9	7.8	7.5	7.3	7.0
	1.0	7.5	7.3	7.4	5.9	7.3	7.6	7.0	7.0
East Huddle Bay	0.5	7.4	7.2	7.5	6.3	7.8	6.7	7.8	7.2
	1.0	7.5	7.3	7.5	6.3	*****	7.6	7.4	7.3
Clay Island	0.5	7.4	7.1	7.4	6.2	7.4	7.1	7.6	7.9
	1.0	7.1	7.4	7.3	6.1	7.9	7.7	7.6	7.2
Green Island	0.5	7.3	7.2	7.4	6.2	7.1	7.1	7.8	7.1
	1.0	7.3	7.3	7.6	6.1	7.7	7.5	7.6	7.2
W. Bolton Bay	0.5	7.5	7.3	7.5	6.1	6.9	7.0	7.8	7.8
	1.0	7.5	7.4	6.5	6.1	7.6	7.6	7.5	7.4
Stewart Brook	0.5	7.4	8.1	7.7	5.8	7.7	7.9	7.4	7.2
	1.0	7.5	7.4	6.5	6.2	7.8	7.3	8.1	7.3

***** : indicates no data available

1987 NO3 (mg/l)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	0.01	0.04	0.02	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	0.01	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sweetbriar Bay	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
West Huddle Bay	0.5	0.05	0.04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
East Huddle Bay	0.5	-0.01	0.03	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
	1.0	-0.01	0.01	-0.01	-0.01	*****	-0.01	-0.01	-0.01
Clay Island	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Green Island	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
W. Bolton Bay	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Stewart Brook	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01

***** : indicates no data available

1987 pH

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	7.03	6.84	7.43	7.72	7.72	7.49	7.45	7.46
	1.0	7.32	7.20	7.71	7.76	7.80	7.67	7.49	7.57
Sweetbriar Bay	0.5	7.24	7.00	7.51	7.61	7.66	7.40	7.42	7.54
	1.0	7.26	7.14	7.71	7.64	7.88	7.46	7.41	7.54
West Huddle Bay	0.5	7.35	7.18	7.70	7.65	7.75	7.61	7.18	7.48
	1.0	7.33	7.17	7.72	7.86	7.74	7.52	7.36	7.48
East Huddle Bay	0.5	7.38	7.20	7.73	7.83	7.89	7.85	7.47	7.59
	1.0	7.40	7.24	7.68	7.67	*****	7.84	7.61	7.64
Clay Island	0.5	7.45	7.27	7.81	7.73	7.75	7.80	7.72	7.68
	1.0	7.46	7.31	7.78	7.71	7.76	7.81	7.61	7.85
Green Island	0.5	7.50	7.34	7.94	7.73	7.72	7.75	7.82	7.71
	1.0	7.54	7.41	7.94	7.72	7.76	7.79	7.68	7.70
W. Bolton Bay	0.5	7.45	7.26	7.85	7.78	7.82	7.85	7.59	7.68
	1.0	7.47	7.32	7.75	7.79	7.82	7.88	7.65	7.72
Stewart Brook	0.5	7.53	7.34	7.79	7.76	7.83	7.76	7.62	7.88
	1.0	7.50	7.34	7.80	7.80	7.89	7.75	7.65	7.82

***** : indicates no data available

1987 Conductivity (umhos)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	107.1	111.1	105.0	103.0	104.0	106.0	101.0	108.0
	1.0	102.0	102.4	102.0	101.0	105.0	104.0	101.0	105.0
Sweetbriar Bay	0.5	108.8	121.8	110.0	113.0	110.0	117.0	106.0	112.0
	1.0	108.8	107.1	102.0	106.0	106.0	108.0	103.0	109.0
West Huddle Bay	0.5	107.7	101.7	101.0	102.0	105.0	105.0	126.0	97.0
	1.0	104.3	102.2	101.0	102.0	104.0	104.0	102.0	95.0
East Huddle Bay	0.5	99.8	101.4	102.0	106.0	105.0	103.0	100.0	103.0
	1.0	100.9	101.5	101.0	108.0	*****	104.0	101.0	102.0
Clay Island	0.5	101.5	102.0	101.0	102.0	104.0	103.0	101.0	98.0
	1.0	102.0	102.0	98.0	102.0	104.0	104.0	101.0	102.0
Green Island	0.5	99.8	101.9	101.0	101.0	104.0	104.0	104.0	100.0
	1.0	99.8	102.3	101.0	102.0	104.0	103.0	102.0	100.0
W. Bolton Bay	0.5	102.0	100.4	101.0	102.0	104.0	102.0	102.0	102.0
	1.0	100.9	101.5	102.0	104.0	103.0	103.0	101.0	104.0
Stewart Brook	0.5	101.5	101.5	102.0	103.0	105.0	106.0	102.0	103.0
	1.0	100.8	101.5	102.0	101.0	105.0	104.0	102.0	102.0

***** : indicates no data available

1987 NH4 (mg/l)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sweetbriar Bay	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
West Huddle Bay	0.5	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
East Huddle Bay	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	*****	-0.01	-0.01	-0.01
Clay Island	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Green Island	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
W. Bolton Bay	0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	0.02	-0.01	-0.01	0.01
Stewart Brook	0.5	-0.01	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	-0.01
	1.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01

***** : indicates no data available

1987 Total phosphorus (ppb)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	6.	13.	7.	5.	5.	4.	4.	4.
	1.0	4.	3.	4.	5.	4.	5.	5.	5.
Sweetbriar Bay	0.5	8.	6.	11.	15.	11.	16.	5.	5.
	1.0	5.	5.	8.	7.	5.	6.	5.	5.
West Huddle Bay	0.5	7.	4.	9.	6.	6.	7.	11.	7.
	1.0	7.	4.	7.	7.	5.	9.	22.	8.
East Huddle Bay	0.5	7.	6.	7.	6.	7.	6.	5.	6.
	1.0	5.	6.	6.	5.	*****	6.	5.	5.
Clay Island	0.5	3.	5.	5.	5.	4.	5.	4.	4.
	1.0	5.	3.	6.	5.	4.	8.	4.	4.
Green Island	0.5	4.	3.	5.	7.	7.	4.	4.	5.
	1.0	3.	2.	4.	5.	4.	6.	4.	4.
W. Bolton Bay	0.5	5.	4.	6.	7.	6.	6.	5.	5.
	1.0	5.	3.	5.	6.	5.	7.	5.	4.
Stewart Brook	0.5	4.	4.	5.	7.	9.	5.	4.	4.
	1.0	3.	4.	5.	6.	7.	4.	4.	4.

***** : indicates no data available

1987

Si (mg/l)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	0.82	0.78	0.64	0.62	0.68	0.63	0.69	0.76
	1.0	0.72	0.66	0.59	0.59	0.63	0.59	0.68	0.75
Sweetbriar Bay	0.5	0.72	0.76	0.64	0.63	0.64	0.64	0.72	0.87
	1.0	0.72	0.68	0.58	0.60	*****	0.65	0.72	0.88
West Huddle Bay	0.5	0.70	0.66	0.73	0.60	0.65	1.12	1.11	1.20
	1.0	0.68	0.66	0.88	0.60	0.71	0.93	0.97	1.19
East Huddle Bay	0.5	0.74	0.68	0.70	0.61	0.68	0.65	0.71	0.79
	1.0	0.74	0.70	0.70	0.60	*****	0.65	0.70	0.79
Clay Island	0.5	0.68	0.64	0.69	0.56	0.62	0.59	0.65	0.78
	1.0	0.68	0.66	0.68	0.64	0.63	0.66	0.66	0.79
Green Island	0.5	0.72	0.66	0.58	0.59	0.62	0.69	0.71	0.74
	1.0	0.70	0.66	0.60	0.57	0.61	0.59	0.60	0.76
W. Bolton Bay	0.5	0.68	0.66	0.60	0.60	0.63	0.59	0.67	0.77
	1.0	0.68	0.66	0.62	0.58	0.62	0.58	0.68	0.78
Stewart Brook	0.5	0.68	0.66	0.62	0.58	0.62	0.58	0.67	0.78
	1.0	0.68	0.64	0.59	0.58	0.56	0.58	0.67	0.76

***** : indicates no data available

1987

Ca (mg/l)

Site	Depth	7/1	7/14	7/30	8/12	8/25	9/10	9/22	10/1
Bolton Landing	0.5	13.0	14.0	11.6	12.2	12.5	12.4	11.5	11.9
	1.0	12.6	12.8	11.2	10.0	12.3	*****	11.5	11.6
Sweetbriar Bay	0.5	13.2	15.0	11.6	13.2	12.8	13.0	11.6	12.6
	1.0	12.8	12.8	11.4	12.6	12.5	12.6	12.0	12.2
West Huddle Bay	0.5	12.8	12.6	11.2	12.4	12.3	11.6	15.4	11.0
	1.0	12.4	12.4	11.0	12.4	12.5	*****	11.5	10.2
East Huddle Bay	0.5	12.2	12.2	10.8	12.5	12.2	11.7	11.6	11.2
	1.0	12.0	12.2	11.0	12.4	*****	11.8	11.4	11.1
Clay Island	0.5	11.9	12.2	11.0	12.3	12.1	11.8	11.4	10.9
	1.0	12.2	12.4	11.0	12.3	12.2	*****	11.3	11.0
Green Island	0.5	12.2	12.2	10.8	12.4	12.1	11.8	11.3	11.0
	1.0	12.4	12.2	11.0	12.3	12.0	11.7	11.2	11.0
W. Bolton Bay	0.5	12.4	12.4	10.8	12.2	12.0	11.9	11.4	11.0
	1.0	11.7	12.4	11.0	10.4	12.1	13.9	11.4	11.0
Stewart Brook	0.5	11.8	12.4	11.2	12.3	12.3	13.2	11.3	11.1
	1.0	11.8	12.4	11.4	12.1	12.4	12.0	11.3	11.1

***** : indicates no data available