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PHYSICAL AND CHEMICAL VARIABLES OF SAGINAW BAY, LAKE HURON IN 1994-1996

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Abstract. Physical and chemical data were collected in Saginaw Bay, Lake Huron over the period 1991–1996 as part of a monitoring program to assess the ecological impact of the zebra mussel, *Dreissena polymorpha*. This report presents monitoring results for the years 1994–1996 and builds upon the previous technical memorandum GLERL-91 (ftp://ftp.glerl.noaa.gov/publications/tech_reports/glerl-091/) that described results for the years 1991–1993. Detailed accounts of sampling times, locations, and methods, and analytical procedures are included in each of the reports.

INTRODUCTION

This technical memorandum presents physical and chemical data collected in Saginaw Bay from 1994 to 1996 and is a follow-up to a previous report (ERL-GLERL-91) that described data collected on Saginaw Bay during 1991–1993 (Nalepa et al., 1996). All of these data were collected as part of a larger effort to monitor and assess impacts of the zebra mussel, *Dreissena polymorpha*, on the Saginaw Bay ecosystem. The first large recruitment of mussels into the bay did not occur until summer 1991, therefore, the data presented herein reflect physical and chemical conditions of Saginaw Bay from 3 to 6 years after the initial invasion. Information on the selection of the study site and its description are repeated here from the original report for convenience. A detailed account of sampling sites and dates, and of collection methods and analytical procedures used throughout the entire 6-year monitoring study are also presented.

While all physical and chemical data collected over the period 1994–1996 are presented, no attempt is made at interpretation. Data summaries and interpretations for the 1991–1993 results are contained in a series of papers published in a special issue of the *Journal of Great Lakes Research* (Volume 21, Number 4). The following papers specifically summarize and interpret these physical and chemical data: Fahnenstiel et al. (1995a, 1995b) and Johengen et al. (1995). Additional manuscripts are being prepared that will interpret the 1994–1996 water quality monitoring data and integrate these results with additional results on collections of the phytoplankton, zooplankton, and benthic communities. The complete 1991–1996 data set for the Saginaw Bay Ecosystem Monitoring Study is archived on the NOAA GLERL web site and can be viewed at the address: ftp://ftp.glerl.noaa.gov/publications/tech_reports/glerl-115. This site will also house a record of all CTD profiles taken during sample collections. In the original report, all CTD profiles taken in 1991-93 were presented in graphical form, however, CTD profiles for 1994–96 are only given on the web site.

JUSTIFICATION OF STUDY SITE

Soon after the zebra mussel was discovered in the Great Lakes in 1988, we identified Saginaw Bay as an ideal location to assess ecological changes that might result from the filtering activities of this organism. Specific considerations that led to the decision to initiate a monitoring program in the bay were (1) at the time, the zebra mussel was not yet established in the bay, thus baseline conditions immediately prior to the mussel's invasion could be documented; further, previous surveys of water quality parameters in 1974-80 (Smith et al., 1977; Bierman et al., 1984) could provide a longer term perspective to assess potential changes; (2) the bay had extensive areas of hard bottom, along with ideal temperature and food regimes, and thus large populations of mussels were expected to develop; (3) there existed an important commercial and sport fishery that could be affected; (4) with a natural gradient between the eutrophic inner bay and the more oligotrophic outer bay, the bay provided an opportunity to assess impacts over a wide range of trophic conditions, and; (5) the bay is an Area of Concern as designated by the International Joint Commission and the subject of remedial action by the State of Michigan. After a decade of little or no monitoring in the bay, surveys of selected physical and chemical variables not only provide information to assess changes induced by the zebra mussel, but also provide information to assess the bay's response to continued efforts to improve water quality.

DESCRIPTION OF STUDY SITE

Saginaw Bay is a shallow, well-mixed extension of the western shoreline of Lake Huron (Figure 1). The bay is 21-42 km wide, about 82 km long , and has a drainage basin of about 21,000 km^2. Total area of the bay is 2.77 x 10^9 m^2, and total water volume is 24.54 x 10^9 m^3 (Table 1). The bay can be functionally divided into an inner and outer region by a line extending along its narrowest width (21 km) from Sand Point to Point Lookout (Figure 1). A broad shoal and several islands (Charity Islands) along this line provide a natural demarcation between the two regions. The outer bay can be defined from Lake Huron by a line from Pointe aux Barques to Au Sable point. Differences in physical and chemical features of the inner and outer bay regions are distinct (Beeton et al., 1967; Smith et al., 1977). The inner bay has a mean depth of 5.1 m, is nutrient-rich, and is heavily influenced by input from the Saginaw River, which accounts for over 70% of the total tributary flow into the bay. The outer bay has a mean depth of 13.7 m and is more influenced by the colder, nutrient-poor waters of Lake Huron.

Circulation within the inner and outer bay is generally weak; currents average about 7 cm s^{-1} in the inner bay and about 11 cm s^{-1} in the outer bay (Danek and Saylor, 1977). Exchange and flushing of water in the inner bay occurs when winds blow along the long axis of the bay (southwest/northeast). Dominant winds in the summer are from the southwest. Little exchange occurs when winds are perpendicular to the long axis (west/east). Most water exchange/flushing between the inner and outer bay occurs on the northern side of the bay within the deep channel that occurs between Point Lookout and Charity Island and which continues into the inner bay. Although some water may exit the inner bay along the southern shoreline, it is of minor significance because of the shallowness of the region (Danek and Saylor, 1977). Furthermore, preliminary results of Lagrangian current measurements in the outer bay during the summers of 1992 and 1993 suggest that the flushing of inner bay waters into Lake Huron is episodic in nature (McCormick, unpublished).

Bottom substrates in Saginaw Bay range from silt to mostly cobble and rock. The inner bay has a wide sand-gravel bar that extends along the eastern side of the bay from the Saginaw River to the Charity Islands. Another sand-gravel bar extends along the western shoreline to Point Au Gres. Both sand bars

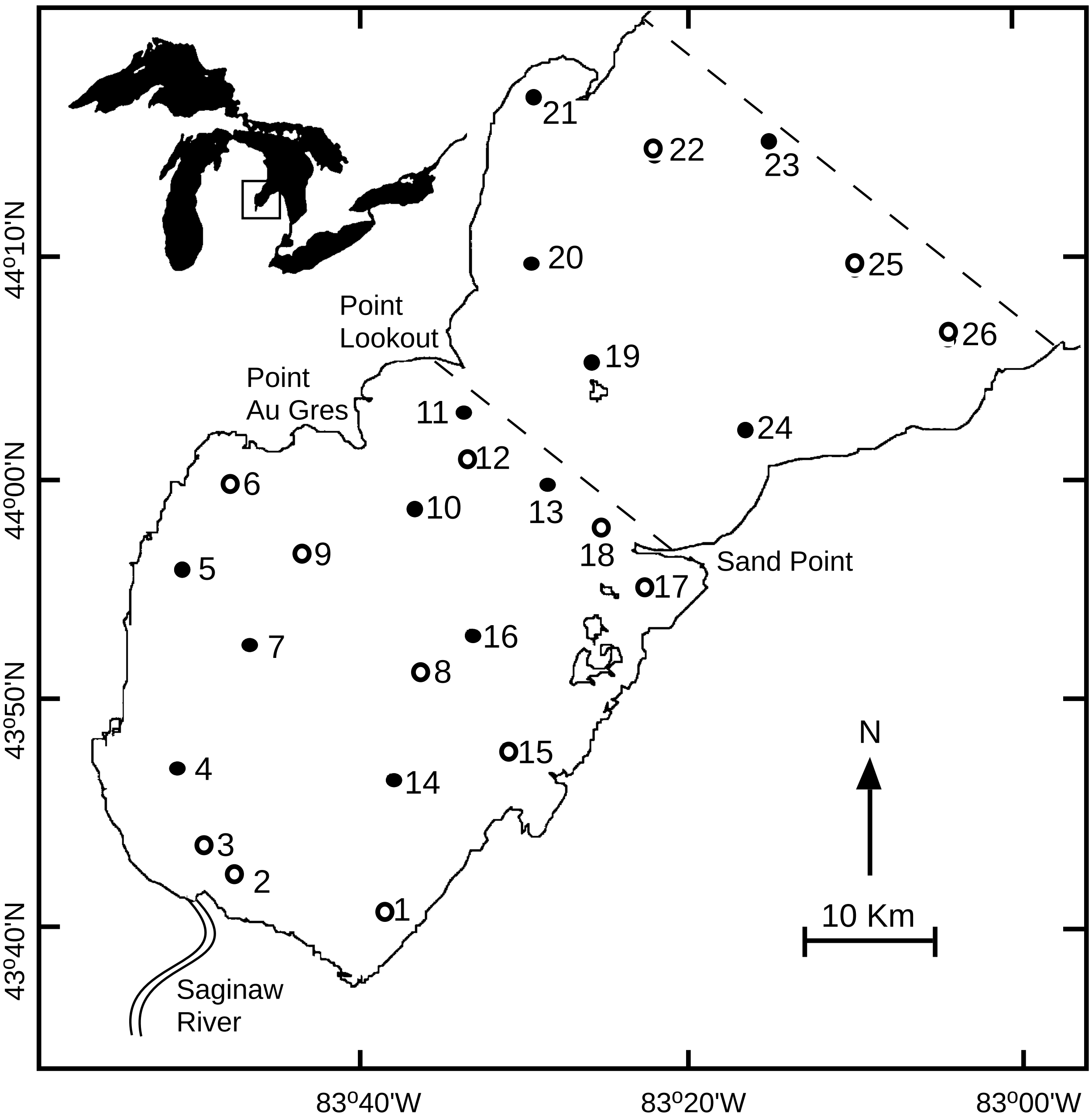

Figure 1. Location of sampling sites in Saginaw Bay, 1991-96. Sites with open circles were sampled only in 1991 and 1992, while sites with closed circles were sampled every year. Dashed lines differentiate the inner bay form the outer bay and the outer bay from Lake Huron.

Table 1. Mean depth, surface area, and water volume of the inner bay, the outer bay, and the bay as a whole. Values were computed from digitized NOAA chart No. 14863. A 0.66 m offset was used to account for low water datum.

	Mean Depth (m)	Surface Area (m^2)	Volume (m^3)
Inner Bay	5.09	1.55×10^9	7.91×10^9
Outer Bay	13.66	1.22×10^9	16.63×10^9
Whole Bay	8.86	2.77×10^9	24.54×10^9

have irregular areas of cobble along with patches of sand, gravel, and pebbles. The bars extend into the shorelines as extensive flats grade into marshes. Between the two sand bars is an area of maximum depth where the substrate consists of fine-grained sediments (silt/mud). Based on areal estimates of substrate type by Wood (1964) and extensive benthic sampling in the late 1980s (Nalepa unpublished), we estimated that 70% of the bottom in the inner bay consists of sand, gravel, and cobble, and 30% consists of silt/mud. In the outer bay, the east shore is rocky, as is the area around the Charity Islands. The western shore has extensive sandy areas, with rock and clay found near Point Lookout. Most of the offshore region of the outer bay has a bottom consisting of silty sand (Nalepa unpublished).

SAMPLING SITES AND DATES

At the inception of the monitoring program, 26 sites were selected to provide thorough coverage of both the inner and outer bay (Figure 1). The exact location and water depth of these sites, designated as Stations 1-26, are given in Table 2. Thirteen of the sites (Stations 1, 2, 3, 6, 8, 9,12, 15, 17, 18, 22, 25, 26) were the same sites sampled by the Environmental Protection Agency (EPA) in 1974-75 (Smith et al., 1977), while the other 13 sites (Stations 4, 5, 7, 10, 11, 13, 14, 16, 19, 20, 21, 23, 24) were established as monitoring sites by this laboratory (NOAA). The EPA sites were sampled only in 1991 and 1992, while the NOAA sites were sampled all 6 years. Samples were generally collected once a month from April to October, except in May when occasionally two sampling periods occurred within the month. The presence of ice and bad weather delayed the first sampling trip until May in 1995 and 1996. In addition, such logistical constraints occasionally resulted in not all sampling sites being visited on all

Table 2. Location and water depth of sampling sites in Saginaw Bay in 1991-93. The sites were designated as Stations 1 through 26. Thirteen of the sites were established by the Environmental Protection Agency (EPA) in 1974-75 while the other 13 sites were established by NOAA.

Station	Latitude	Longitude	Depth (m)
SB1 (EPA-12)	43 38’ 25”	83 39’ 40”	4.0
SB2 (EPA-8)	43 40’ 00”	83 48’ 25”	4.0
SB3 (EPA-7)	43 41’ 05”	83 50’ 35”	3.0
SB4 (NOAA)	43 44’ 39”	83 52’ 04”	7.0
SB5 (NOAA)	43 53’ 43”	83 51’ 38”	3.0
SB6 (EPA-30)	43 58’ 05”	83 49’ 15”	4.0
SB7 (NOAA)	43 50’ 17”	83 47’ 34”	7.0
SB8 (EPA-27)	43 49’ 10”	83 37’ 10”	5.0
SB9 ((EPA-29)	43 54’ 50”	83 44’ 50”	7.0
SB10 (NOAA)	43 56’ 30”	83 37’ 26”	11.0
SB11 (NOAA)	44 01’ 14”	83 34’ 25”	9.0
SB12 (EPA-35)	43 58’ 45”	83 34’ 40”	13.0
SB13 (NOAA)	43 57’ 34”	83 29’ 19”	3.0
SB14 (NOAA)	43 44’ 18”	83 38’ 27”	3.0
SB15 (EPA-26)	43 45’ 40”	83 31’ 35”	5.0
SB16 (NOAA)	43 50’ 49”	83 33’ 45”	3.0
SB17 (EPA-34)	43 53’ 00”	83 23’ 35”	3.0
SB18 (EPA-61)	43 55’ 40”	83 26’ 25”	2.0
SB19 (NOAA)	44 03’ 10”	83 26’ 31”	4.0
SB20 (NOAA)	44 07’ 34”	83 30’ 00”	16.0
SB21 (NOAA)	44 15’ 10”	83 30’ 23”	4.0
SB22 (EPA-49)	44 12’ 40”	83 22’ 40”	20.5
SB23 (NOAA)	44 13’ 15”	83 15’ 45”	28.5
SB24 (NOAA)	44 00’ 05”	83 17’ 00”	12.5
SB25 (EPA-51)	44 07’ 25”	83 10’ 15”	28.5
SB26 (EPA-52)	44 04’ 10”	83 04’ 50”	13.5

sampling dates. All sites were located using Loran C during the study period. A listing of all sampling dates for every cruise during the entire 1991-96 period is given in Table 3. Also included in this table is the mean temperature for all sampling sites in the inner bay on each sampling date.

FIELD PROCEDURES

Water samples for nutrients, carbon, chlorophyll, and total suspended solids were collected with a 5-L Niskin bottle at a depth of 1 m at every site and at the mid-water column depth for sites deeper than 10 m. Samples were placed into acid-rinsed 4-L polyethylene containers and immediately stored in coolers. Water temperature was obtained by placing a thermometer in a portion of water collected in the Niskin bottle immediately after it was brought to the surface. At each of the NOAA sites, a Sea-Bird CTD with fluorometer and transmissometer (25-cm beam path) was slowly lowered from the surface to 1 m above the bottom. All data points were logged twice each second. Secchi-disk transparency was measured by lowering a white disk 25-cm in diameter. In 1996, photosynthetically active irradiation (PAR) was measured at a number of depths in the water column with a LI-COR 193SB spherical (4 p) light sensor and LI-COR 1000 data logger, from which the underwater light extinction coefficient (kPAR) was calculated. These measurements were not taken during 1994–1995.

For quality control, duplicate water samples were collected at each sampling depth at Stations 5 and 20 on each sampling date during 1994-1996. Nutrient analysis was performed separately on the two samples.

LABORATORY PROCEDURES

All water samples were processed within 24 h of collection. The following are detailed analytical procedures for each of the variables measured.

Table 3. Sampling dates for all cruises of the Saginaw Bay monitoring study during 1991 – 1996, and the corresponding inner bay mean temperature recorded for those dates.

Year	Cruise Number	Sampling Dates	Mean Inner Bay Temp (^{o}C)
1991	911	April 11-18	8.2
	912	May 1-3	10.4
	913	May 20-21	16.0
	914	June 15-18	22.9
	915	July 22-26	23.6
	916	August 19-23	22.8
	917	September 9-12	22.1
	918	October 7-22	12.2
	919	November 8-12	3.5
1992	921	April 14-15	3.8
	922	May 4-6	10.1
	923	May 27 – June 3	15.1
	924	June 15-23	19.0
	925	July 20-23	20.2
	926	August 10-12	21.9
	927	September 9-15	19.0
	928	October 4-7	14.6
1993	931	April 29-30	7.8
	932	May 17	13.7
	933	June 21	19.5
	934	July 12	23.6
	935	August 10	21.0
	936	September 8	19.9
	937	October 5 &14	11.9
1994	941	April 20	7.0
	942	June 6-10	17.9
	943	July 11-13	22.3
	944	August 8-10	20.6
	945	September 8-9	19.3
	946	October 17-19	14.1
1995	951	May 2-3	8.1
	952	May 17-18	14.2
	953	June 12-13	18.9
	954	July 17 & 19	23.4
	955	August 21-22	24.1
	956	September 12	19.7
	957	October 25 & 30	10.1
1996	961	May 4 & 7	7.4
	962	May 28 & 30	14.3
	963	June 11-12	16.4
	964	June 27	21.7
	965	July 15 & 17	22.4
	966	August 21	23.8
	967	September 20	18.5

Chlorophyll

Chlorophyll (Chl) was measured in triplicate using the method of Strickland and Parsons (1972). Fifty or 100 mL of water was filtered through a 47-mm GF/F Whatman Glass Fiber filter. The filters were placed individually into amber vials containing 5 mL of cold acetone (90 %) and then stored in the freezer. Within 30 days, the filters were ground in cold acetone and then steeped for 24 h in the freezer. Samples were centrifuged, the extract poured into a 1-cm curvette, and readings taken with a Turner Design Fluorometer. After an initial reading, 2 drops of 1N HCL were added to the curvette and another reading taken.

Nutrients

Nutrient concentrations were determined using standard automated colorimetric techniques (APHA, 1990) on a Technicon Auto Analyzer II, as detailed in Davis and Simmons (1979). Dissolved nutrients were determined on sample aliquots which were filtered through a pre-rinsed 0.2-um HA Millipore filter or a 0.2-um Nucleopore filter. Nitrate + nitrite was determined using the cadmium reduction method and hereafter is simply referred to as NO_3. Ammonia concentrations (NH_4) were determined by the Bertholet reaction. Phosphorus concentrations were determined by the molybdate/ascorbic acid method. Soluble reactive phosphorus (SRP) was determined on a filtered portion of the water sample, while total phosphorus (TP) and total dissolved phosphorus (TDP) were determined after digesting 50 mL of unfiltered and filtered sample, respectively, with potassium persulfate in an autoclave for 30 min (Menzel and Corwin, 1965). Values of nitrate and soluble reactive phosphorus were occasionally below detection. For these occasions, concentrations were reported to be at our operationally defined detection limit of 0.01 mg/L for nitrate and 0.1 µg/L for soluble reactive phosphorus. Particulate silica (PSi) was determined on 100 mL aliquots of water filtered through a 0.45-µm Nucleopore filter and then extracted with 0.2N NaOH at 95 ^{o}C for 30 minutes (Krausse et al., 1983). The extract was neutralized with 1N H_2SO_4 and silica (SiO_2) concentrations determined by the heteropoly blue method. Chloride (Cl) concentrations were determined by the mercuric thiocyanide/ferric ammonium sulfate method. For the 1991–93 data set, particulate phosphorus was calculated from the difference between TP and TDP. This calculation was not conducted for the current data set. Nutrient concentrations are reported for mass units of N, P, SiO2, and Cl for the respective nutrient ions.

Alkalinity

Alkalinity was not determined for samples collected during 1994–96. For samples from 1991–93, alkalinity (Akl) was determined from the milli-equivalents of acid needed to bring the pH of the water sample below 4.0 (Davis and Simmons, 1979). Twenty mL of sample was pipetted with a volumetric buret into a chemically clean polyethylene bottle that contained 5 mL of 0.01 N HCL. Additional 1 mL aliquots of acid were added if the pH was above 4.0.

Carbon

Samples for particulate organic carbon (POC) and dissolved organic carbon (DOC) were processed in triplicate by filtering 50 or 100 mL of sample through pre-combusted GFF filters. For POC, filters were frozen until analysis, then thawed, acidified with 10 % v/v HCL, and dried at 70^{o}C for 24 h. POC measurements were made with a Perkin Elmer (model 2400) CHN elemental analyzer. The filtrate was frozen for later determination of DOC. Prior to analysis, the filtrate was acidified with HCL and sparged with air for 6 min to remove CO_2. DOC was determined using a Shimadzu total organic carbon analyzer (model TOC-5000) fitted with an auto sampler. DOC concentrations were not determined in 1996.

Total Suspended Solids
Total Suspended Solids (TSS) were determined gravimetrically by filtering between 500 and 2,000 mL of sample through a pre-dried, pre-weighed Whatman GFC 47-mm filter. The filters were then dried at 60°C for at least 48 h and then reweighed.

RESULTS

Data
Values of all measured physical and chemical variables on each sampling date in 1994-96 are given in Appendix I and are also contained in both ASCII and MS Excel files at ftp://ftp.glerl.noaa.gov/publications/tech_reports/glerl-115. As was done in the first data report, values for temperature, chlorophyll, and total suspended solids from discrete samples were compared to values obtained from CTD profiles throughout the water column. That is, shipboard temperature was compared to CTD temperature, extracted chlorophyll was compared to CTD fluorescence, and total suspended solids was compared to CTD transmissivity for all sampling dates, stations, and depths for which a comparison was possible. This procedure was used to identify discrete values that should be checked for errors, as well as to provide a means for empirically calibrating the CTD instrumentation. Statistical models describing the relationship between the three variables and their CTD counterparts were all significant, indicating good agreement between the two independent measures for each of the three variables. Outliers were identified as values where the studentized residual was greater than a t-value corresponding to $P = 0.01$. Before inclusion in Appendix I, the outliers were examined and corrections made if deemed necessary. Several factors were considered in deciding whether or not to correct an outlier, including variation among analytical replicates, values at nearby sites or depths, the value derived from the model, and values derived from additional models using co-determined parameters such as total phosphorus and particulate organic carbon.

The relationship between discretely measured water temperature and CTD water temperature was fit to the linear model: Temp = 0.99 + 0.974 (CTDtemp) ($P < 0.001$; $r^2 = 0.969$; n = 260), and three outliers were identified by the model (Figure 2; Table 4). For case 1, the outlier for the 1 m sample was replaced with the discrete temperature determined for the 14 m sample at that site because their was no thermal stratification and this value was in better agreement with the CTD measured temperature. For case 2, the final temperature was obtained from the average of the shipboard and CTD because there was no evidence to disprove either. For case 3, the CTD value was used because a well pronounced thermocline existed and the shipboard determination appeared to be in error.

The relationship between chlorophyll and CTD fluorescence was fit to the linear model: CHL = -0.519 + 1.344 (CTDfluor) ($P < 0.001$; r^2=0.691; n=331), and 7 outliers were identified by the model (Figure 3; Table 5). For all of the outliers we kept the original discrete value based on excellent agreement among analytical replicates, as well as, good agreement between the discrete chlorophyll value and a predicted value based on a relationship between discrete values of CHL and particulate organic carbon value ($P < 0.001$; r^2=0.783; n=352).

The relationship between total suspended solids (TSS) and CTD transmissivity fit a linear model after transmissivity was log transformed: TSS = 29.733 * -6.706 (ln Trans) ($P < 0.001$, $r^2 = 0.892$, n=330) and ten outliers were identified by the model (Figure 4; Table 6). A second relationship between TSS and Secchi-disk transparency was also examined to provide an independent evaluation of the TSS outliers. For this relationship only TSS values obtained from the 1 m samples were included in the model. The

Figure 2. Relationship between temperatures taken shipboard and temperatures from similar depths taken in situ with a CTD. Each point represents a sampling date, site, and depth where temperature was taken by both methods. Circled points are considered outliers at $P < 0.01$. Individual outliers are numbered and can be identified by the corresponding case number in Table 4.

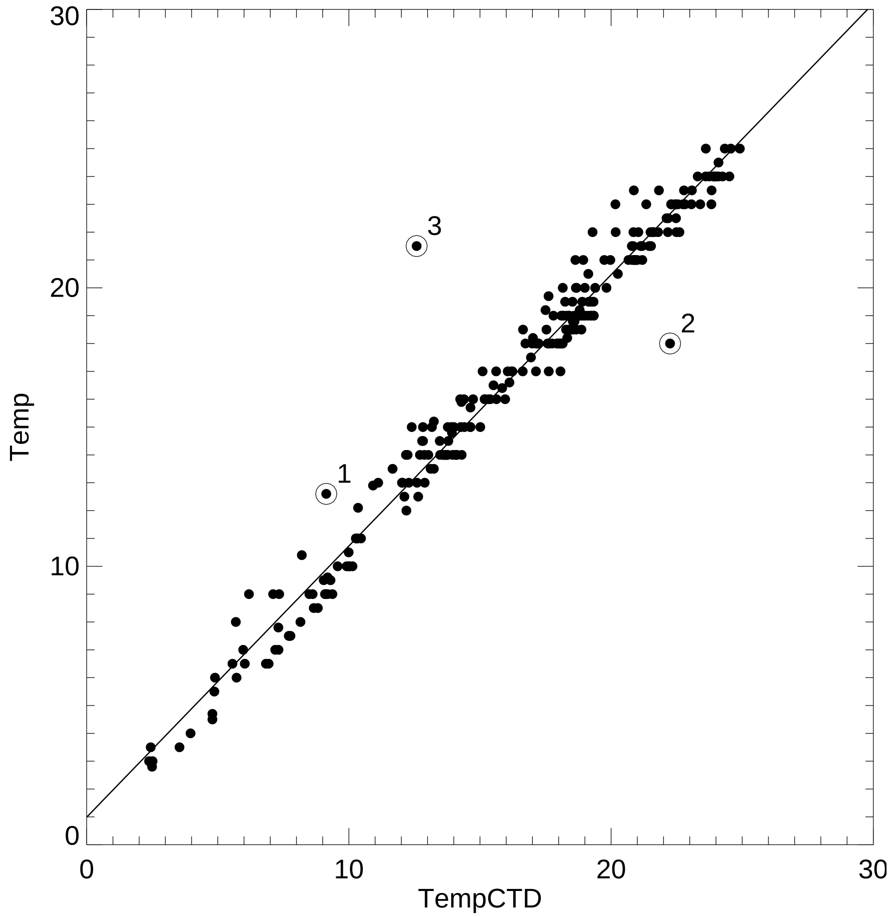

Figure 3. Relationship between chlorophyll (ug/L) and fluorescence as measured in situ with the CTD. Each point represents a sampling date, site, and depth where the two variables were measured. Circled points are considered outliers at $P < 0.01$. Individual outliers are numbered and can be identified by the corresponding case number in Table 5.

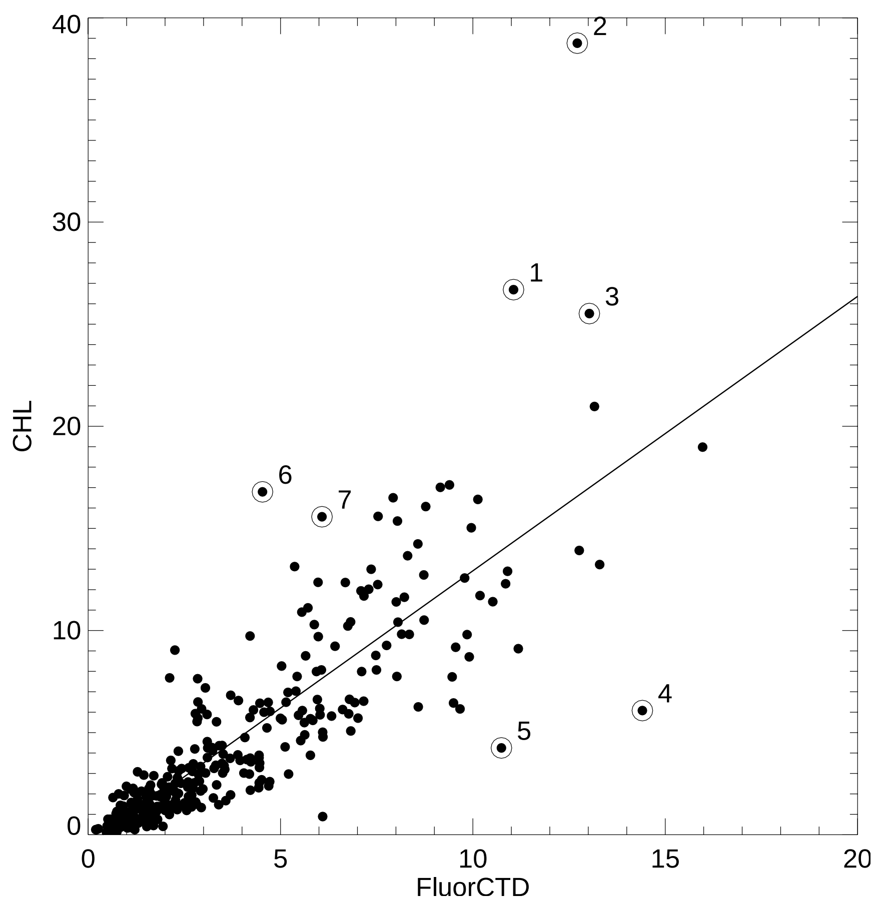

Table 4. A list of outliers for water temperature as determined from the functional relationship between shipboard temperature and CTD temperature as determined for all values in 1994-1996. Final values in Appendix I were corrected as defined in the text. The case number corresponds to numbers given in Figure 2.

Case	Year	Cruise	Station	Sampling Depth (m)	Shipboard Temp. (C)	CTD Temp. (C)	Appendix I Temp. (C)
1	1994	942	23	1	12.6	9.1	10.4
2	1994	943	24	1	18.0	22.2	20.1
3	1996	966	23	14	21.5	12.6	12.6

Table 5. A list of outliers for chlorophyll as determined from the functional relationship between chlorophyll and CTD fluorescence as determined for all values in 1994-1996. Chl_1 is the value derived from this relationship. Final values in Appendix I were corrected as given in the text. The case number corresponds to numbers given in Figure 3.

Case	Year	Cruise	Station	Sampling Depth (m)	Chl (mg/L)	Chl_1 (mg/L)	Appendix I Chl (mg/L)
1	1994	944	4	1	26.7	14.3	26.7
2	1994	944	14	1	38.8	16.2	38.8
3	1994	945	14	1	25.5	17.0	25.5
4	1995	956	7	1	6.1	19.0	6.1
5	1996	964	4	1	4.3	13.9	4.3
6	1996	966	5	1	16.8	5.6	16.8
7	1996	966	14	1	15.6	0.7	15.6

Table 6. List of outliers for total suspended solids (TSS) as determined from the functional relationship between TSS and CTD transmissivity. TSS_1 is the value derived from the functional relationship between TSS and CTD transmissivity. Final values were corrected as defined in the text and included in Appendix I. Case numbers correspond to numbers given in Figure 4.

Case	Year	Cruise	Station	Sampling Depth (m)	TSS (mg/L)	TSS_1 (mg/L)	Appendix I TSS (mg/L)
1	1994	944	14	1	15.7	8.7	15.7
2	1995	951	14	1	11.1	6.3	11.1
3	1995	954	13	1	14.0	9.3	14.0
4	1995	954	16	1	12.4	8.4	12.4
5	1995	956	7	1	8.4	12.8	8.4
6	1995	957	13	1	16.3	12.6	16.3
7	1995	957	14	1	15.5	9.7	15.5
8	1996	962	10	6	18.6	11.1	18.6
9	1996	966	5	1	10.5	6.9	10.5
10	1996	967	4	1	16.6	25.6-	16.6

Figure 4. Relationship between total suspended solids (mg/L) and transmissivity as measured in situ with the CTD. Each point represents a sampling date, site, and depth where the two variables were measured. Circled points are considered outliers at P < 0.01. Individual outliers are numbered and can be identified by the corresponding case number in Table 6.

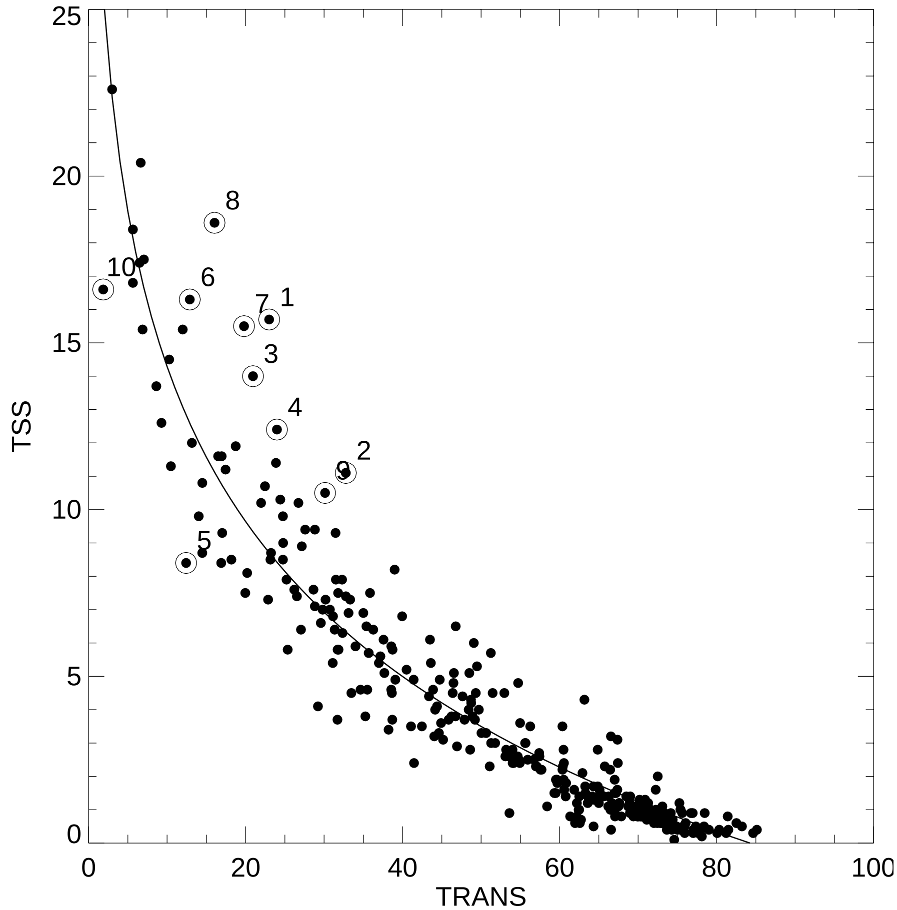

Figure 5. Relationship between total suspended solids (mg/L) and Secchi-disk transparency (m). Values natural-log transformed. Each point represents a sampling date, site, and depth where the two variables were measured.

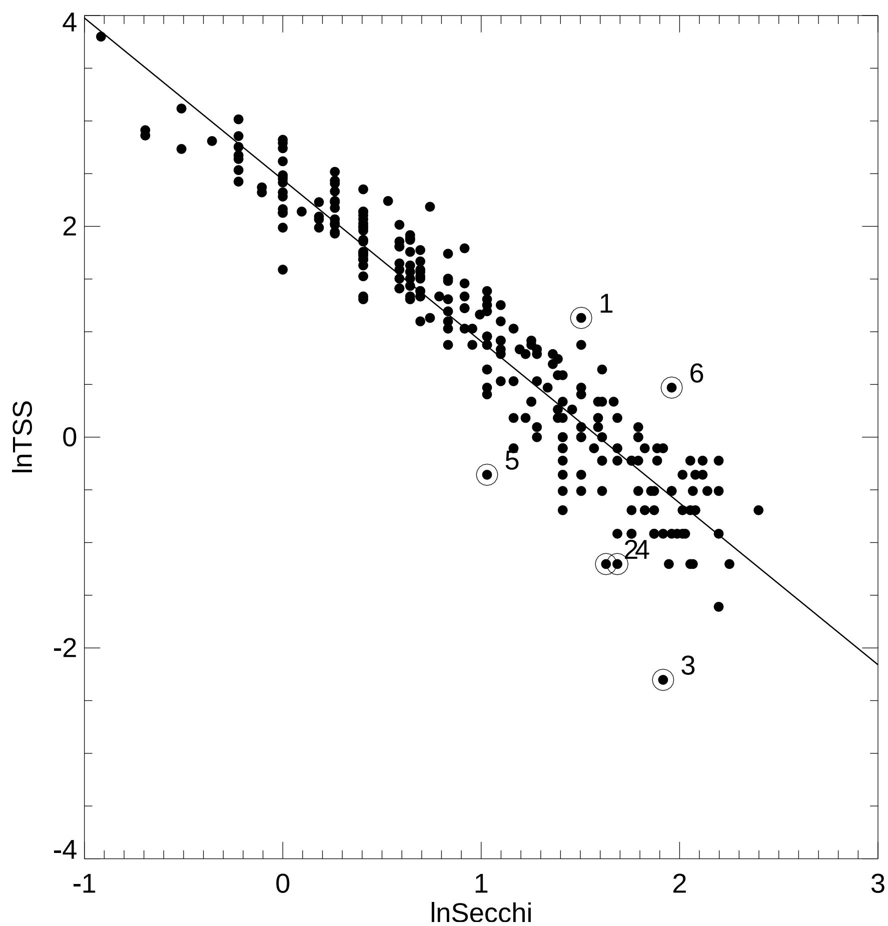

Table 7. List of outliers for total suspended solids (TSS) as determined from the functional relationship between TSS and Secchi depth transparency. TSS_1 is the value derived from the functional relationship between TSS and Secchi depth. Final values were corrected as defined in the text and included in Appendix I. Case numbers correspond to numbers given in Figure 5.

Case	Year	Cruise	Station	Sampling Depth (m)	TSS (mg/L)	TSS_1 (mg/L)	Appendix I TSS (mg/L)
1	1994	941	11	1	3.1	1.1	3.1
2	1994	942	21	1	0.3	0.9	0.3
3	1994	942	24	1	0.1	0.6	0.7
4	1996	961	21	1	0.3	0.9	0.3
5	1996	964	5	1	0.7	2.4	0.7
6	1996	964	21	1	1.6	0.6	1.6

relationship was described by the power function: ln TSS = 2.443 * -1.534 (ln Secchi depth) ($P < 0.001$, $r^2 = 0.890$, n=250) and six new outliers for TSS were identified beyond those previously identified by the transmissivity relationship (Figure 5; Table 7). For each of the 10 values identified as outliers by the transmissivity relationship, the original discrete value was selected based on agreement with the values of the nearest neighbor and the values predicted from the relationship with Secchi depth (Table 6). For each of the 6 values identified as outliers by the TSS and Secchi depth relationship, except for case 3, we kept the original discrete value. For case 3, we replaced the original value with the value observed for the 6 m sample at this site because it agreed closely with a predicted value based on transmissivity, and there was no stratification within the water column at the time of sampling (Table 7).

The introduction of zebra mussels into Saginaw Bay resulted in a general increase in water clarity during at least certain portions of the year. Consequently, during the later monitoring years, secchi depths were frequently greater than the depth of the water column at some of the sampling stations. Specifically, there were 33 cases where the secchi depth was recorded as “to bottom” during 1994-96 (Table 8). In order to fill in these missing values, we compared the predicted secchi depth value using the functional relationship with known TSS values, as well as, the secchi depth of the nearest neighbor where it was readable. In all cases the “to bottom” readings were replaced with the value of the nearest neighbor because it was generally the more conservative estimate, although the two estimates were in good general agreement and substantiated that the secchi depth was indeed greater than the water column depth.

Analytical Precision

As noted, water samples were collected in duplicate at two sites (three total duplicate samples since one site was sampled at two depths) on each date. The coefficient of variation was determined for each duplicate for the following variables: total suspended solids, soluble reactive phosphorus, nitrate, ammonia, silica, particulate silica, particulate organic carbon, dissolved organic carbon, and chlorophyll. The yearly mean coefficient of variation and the pooled mean for each of these variables is given in Table 9.

Vertical CTD Profiles

Vertical profiles of temperature (C), fluorescence (ug/L), and transmissivity (percent) from the CTD casts are not presented in this data report but are available electronically from GLERL’s web site at the address:ftp://ftp.glerl.noaa.gov/publications/tech_reports/glerl-115. Data file units are listed in volts; for fluorescence the scale is 0-5 volts with 5 volts=30 ug/L, for transmissivity the scale is 0-5 volts with 5

Table 8. List of secchi depth transparencies that were reported as “to bottom” and the corresponding value of the nearest station and the values predicted from the functional relationship between Secchi depth and total suspended solids. Final values in Appendix I were selected as defined in the text.

Case	Year	Cruise	Station	To Bottom Depth(m)	Predicted Secchi Depth(m)	Neighboring Secchi Depth(M)	Appendix I Secchi Depth (m)
1	1994	941	21	5.0	7.8	6.8	6.8
2	1994	943	21	5.3	8.4	6.5	6.5
3	1995	951	13	3.9	11.1	9.0	9.0
4	1995	951	16	3.8	3.1	3.9	3.9
5	1995	951	19	6.2	7.4	7.8	7.8
6	1995	951	21	5.0	10.7	7.8	7.8
7	1995	952	5	3.2	3.2	5.0	5.0
8	1995	952	19	4.0	6.8	7.5	7.5
9	1995	952	21	5.0	7.9	7.5	7.5
10	1995	953	5	3.4	4.5	4.5	4.5
11	1995	953	13	3.9	6.6	4.5	4.5
12	1995	953	16	3.8	3.0	4.0	4.0
13	1995	953	21	5.0	8.2	6.5	6.5
14	1995	954	21	4.8	5.3	8.3	8.3
15	1995	955	21	4.8	4.4	6.0	6.0
16	1995	957	19	3.4	2.8	4.5	4.5
17	1995	957	21	5.3	6.5	6.0	6.0
18	1996	961	13	3.8	5.4	5.4	5.4
19	1996	961	19	3.2	7.9	5.4	5.4
20	1996	961	21	5.2	9.7	5.4	5.4
21	1996	962	19	3.2	8.1	5.8	5.8
22	1996	962	21	4.1	7.1	5.8	5.8
23	1996	963	13	3.6	5.1	4.1	4.1
24	1996	963	14	3.5	6.8	4.1	4.1
25	1996	963	21	4.8	6.6	7.1	7.1
26	1996	964	14	3.5	4.3	4.1	4.1
27	1996	964	16	3.5	4.8	4.1	4.1
28	1996	964	21	4.5	3.6	7.1	7.1
29	1996	965	5	3.5	4.7	3.6	3.6
30	1996	965	19	3.5	4.4	4.9	4.9
31	1996	965	21	6.0	9.2	7.9	7.9
32	1996	967	13	3.8	5.0	4.1	4.1
33	1996	967	19	3.5	6.4	4.1	4.1

Table 9. Yearly and pooled mean coefficients of variation for field replicates collected during 1994 – 1996 for each of the listed variables. Individual values (each n) were derived from duplicate water samples collected at station 5-1m, station 20-1m, and station 20-8m during each sampling date for that year. In 1996, TDP, SRP, NO3, NH4, SiO2, were only determined on samples collected from station 5-1m, and DOC measurements were not conducted on any samples. The number of samples used in the computation (N) denote these difference among parameters.

Year	N	TSS	TP	TDP	SRP	NO_3	NH_4	SiO_2	PSi	Cl	POC	DOC	Chl
1994	18	7.9	3.9	12.7	16.3	0.9	10.3	0.6	17.1	0.3	6.2	2.7	4.4
1995	21	5.1	5.3	7.8	6.5	1.8	7.9	1.5	4.1	0.7	7.2	1.9	6.1
1996	21/7	4.4	5.9	4.6	16.9	7.7	15.7	2.1	4.3	0.6	5.1		3.0
1994-96	5.7	5.1	9.2	11.9	2.3	10.0	1.2	9.2	0.5	6.2	2.3	4.5	
	(N)	*(60)*	*(60)*	*(46)*	*(46)*	*(46)*	*(46)*	*(46)*	*(46)*	*(46)*	*(60)*	*(39)*	*(60)*

volts=100%. The CTD casts are stored as ascii files and are defined by unique filenames denoted as SBYY_C_ST.txt where YY=year, C= cruise number, and ST=station number. The files are divided into two directories corresponding to the sampling periods 1991-93 and 1994-96.

Inner Bay Means

Figures 6 gives inner bay and outer bay mean values of selected variables for each cruise in 1994-96. No interpretations of these data are given in this report.

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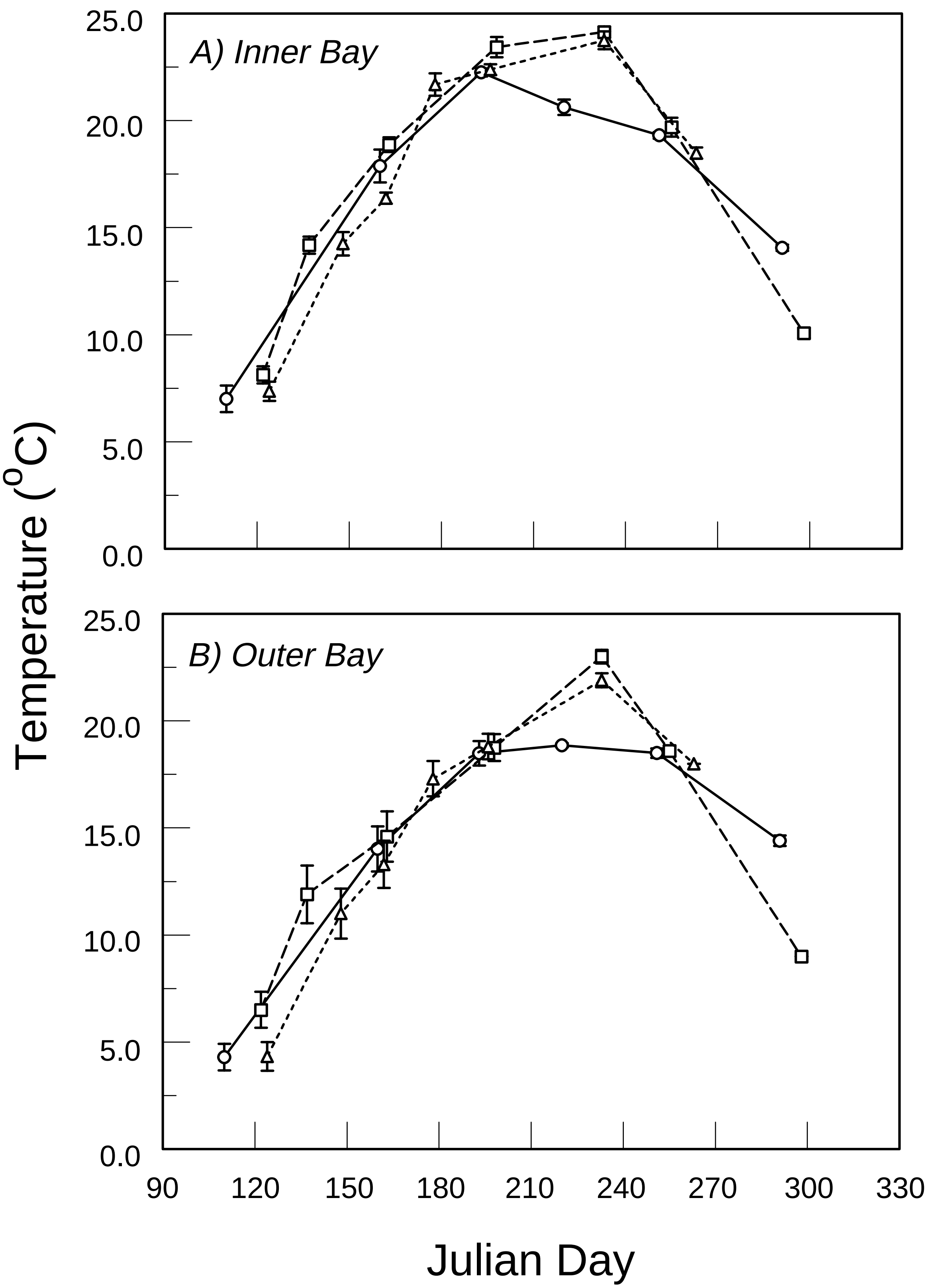
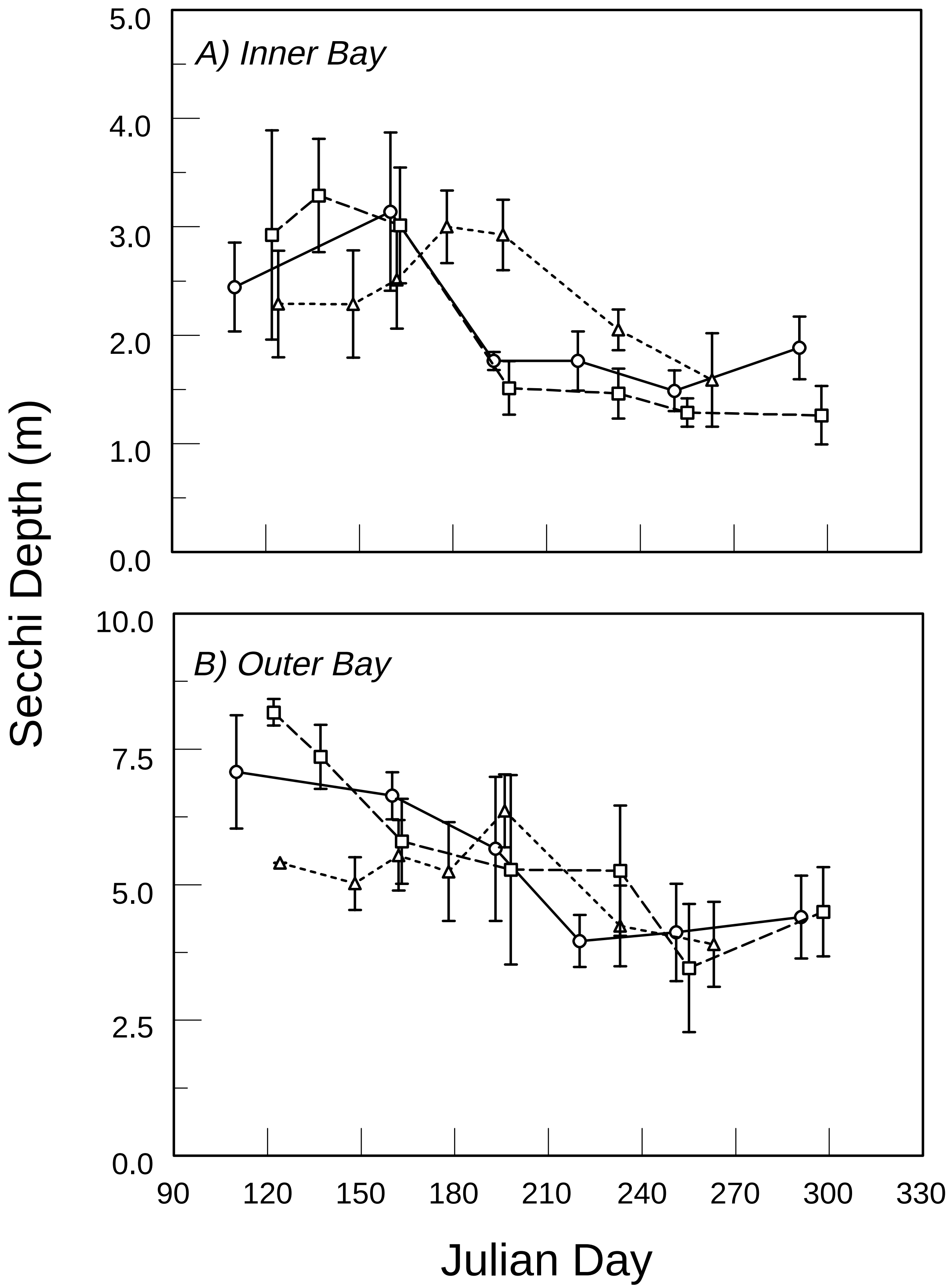
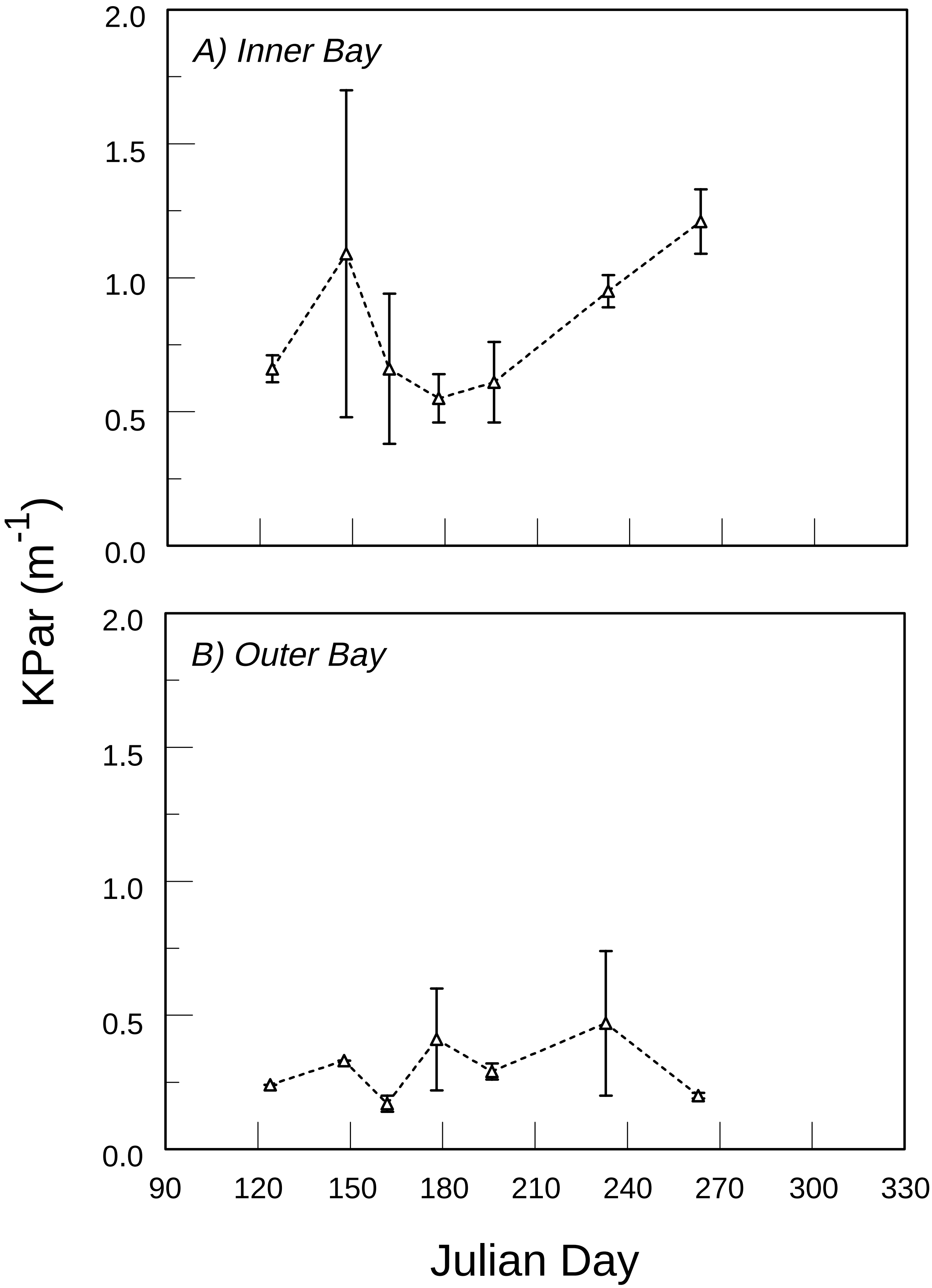


Figure 6. Mean (+ SE) values of selected physical and chemical variables at sites in the inner bay (A) and outer bay (B) for all sampling dates in 1994-96.

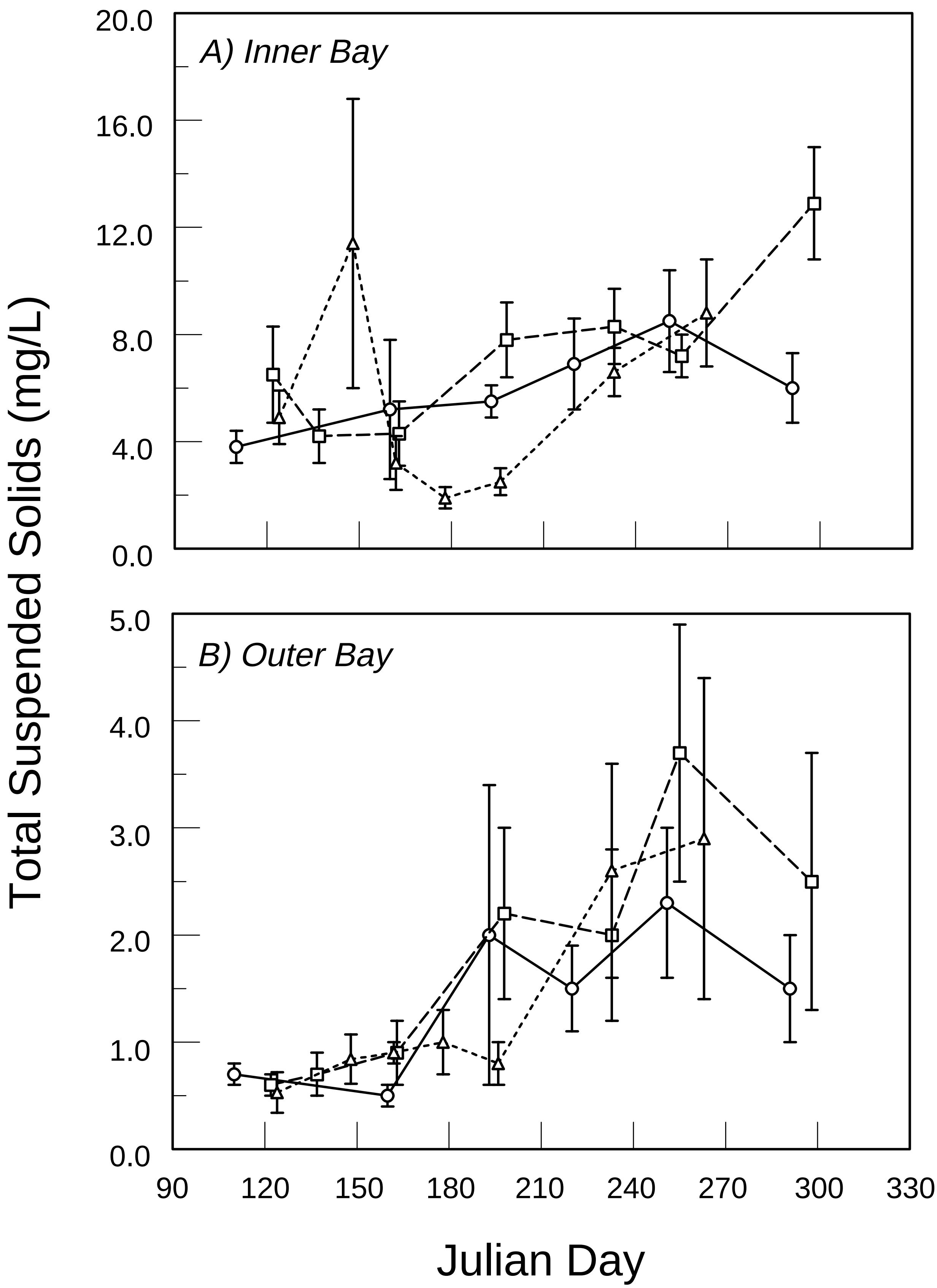
○—○ =1994 □—□ =1995 △—△ =1996

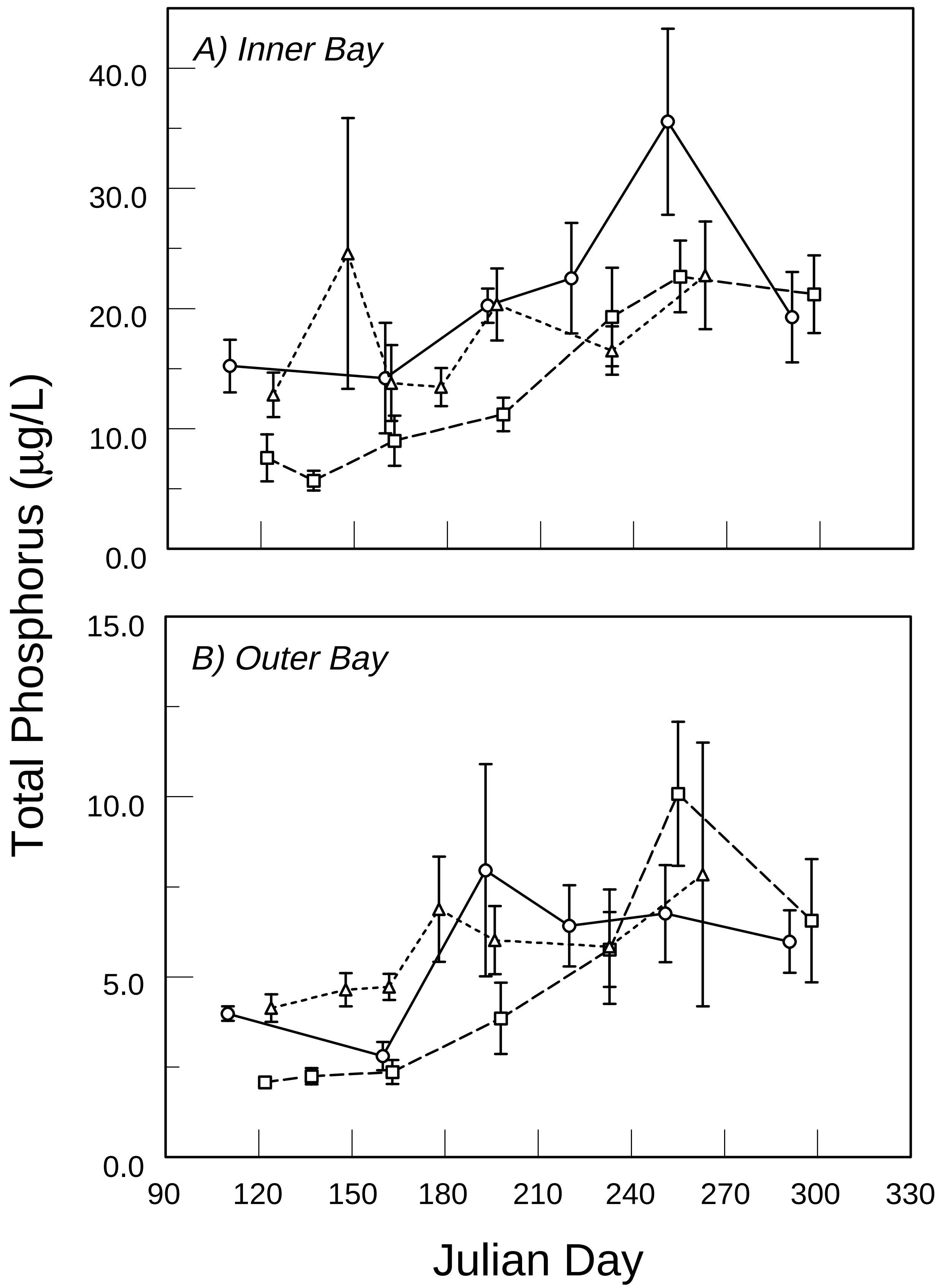


A) Inner Bay
B) Outer Bay
Secchi Depth (m)
Julian Day
5.0
4.0
3.0
2.0
1.0
0.0
10.0
7.5
5.0
2.5
0.0
90
120
150
180
210
240
270
300
330

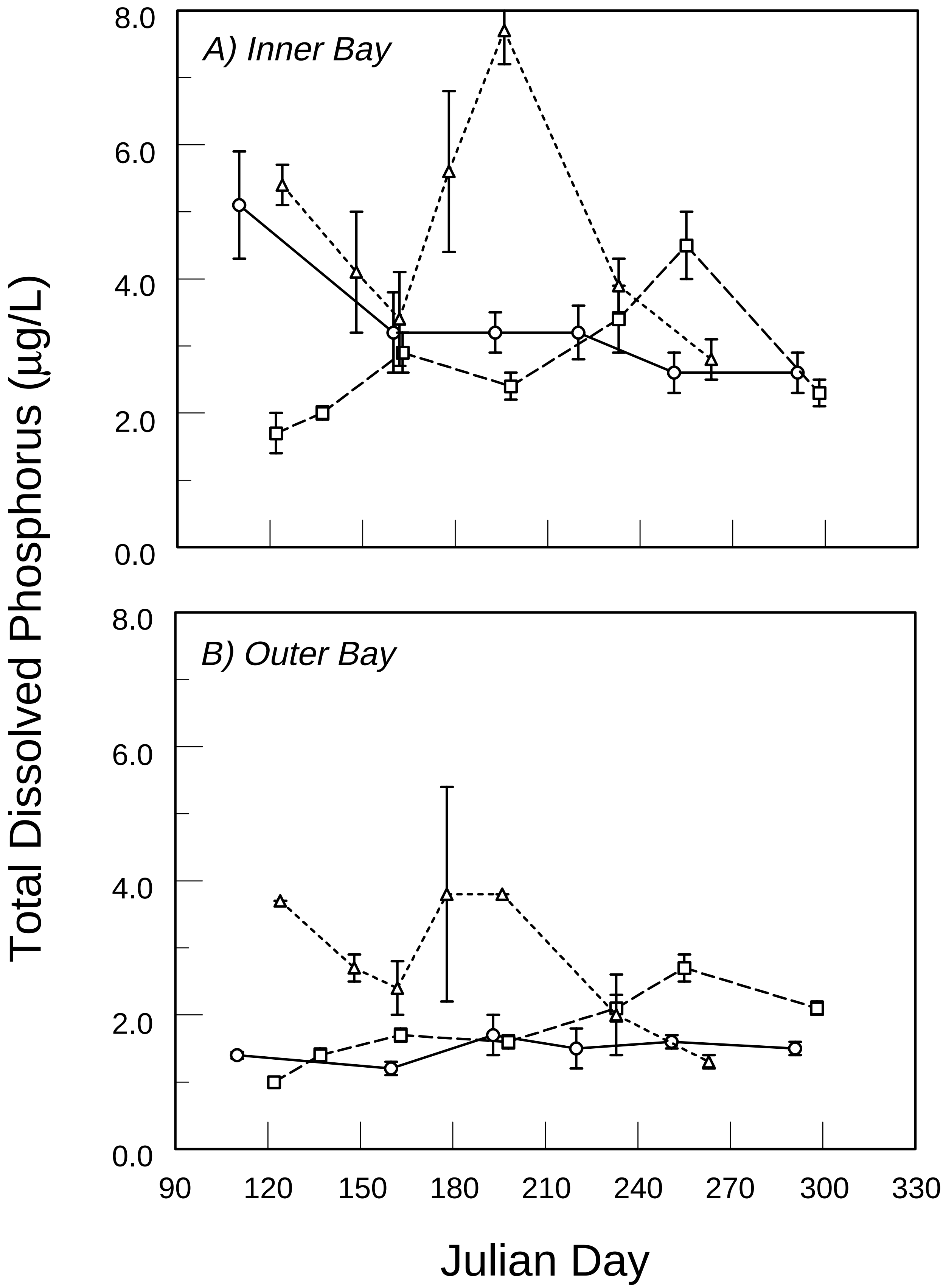


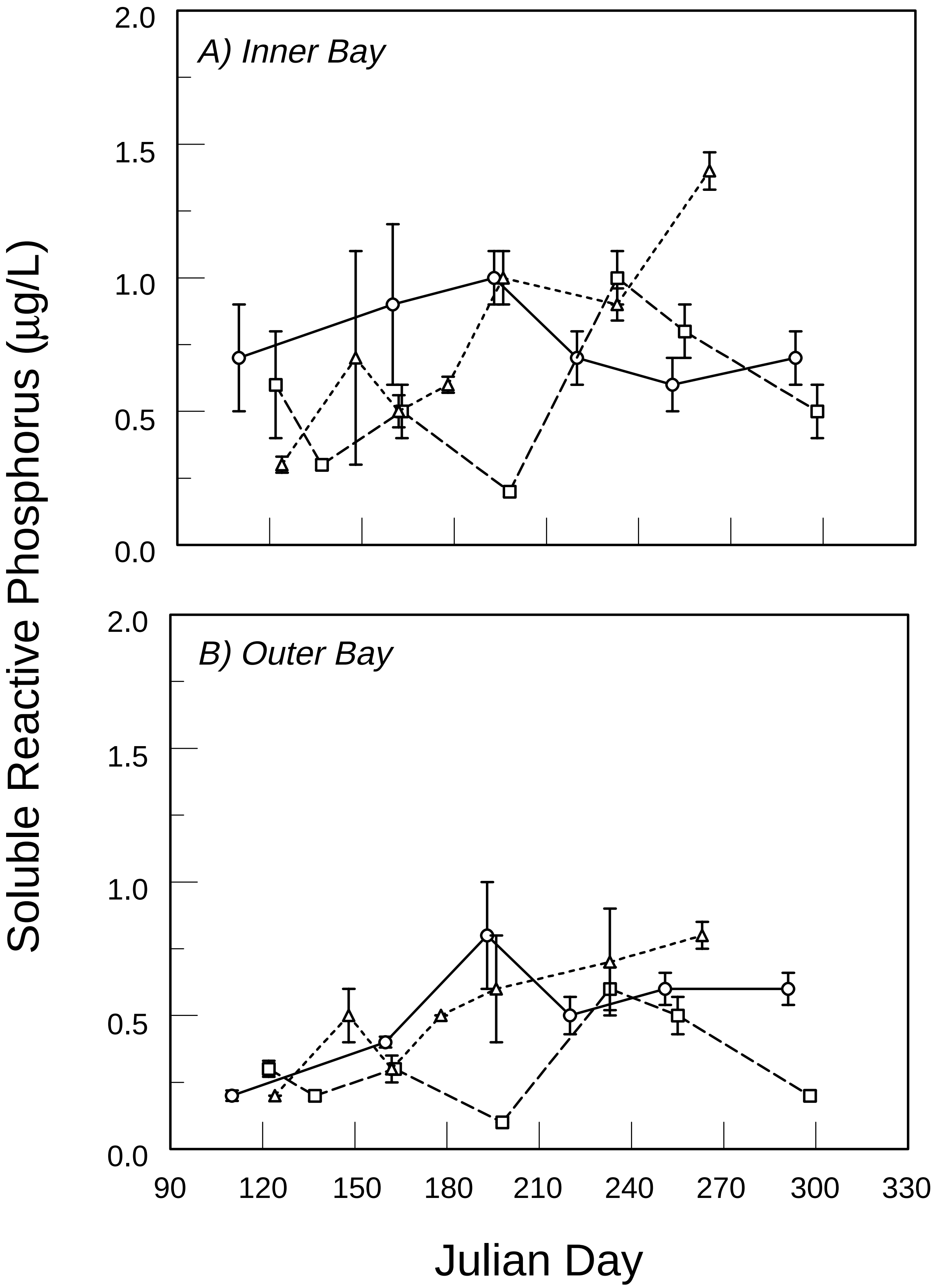
A) Inner Bay
B) Outer Bay
KPar (m^{-1})
Julian Day
2.0
1.5
1.0
0.5
0.0
90
120
150
180
210
240
270
300
330

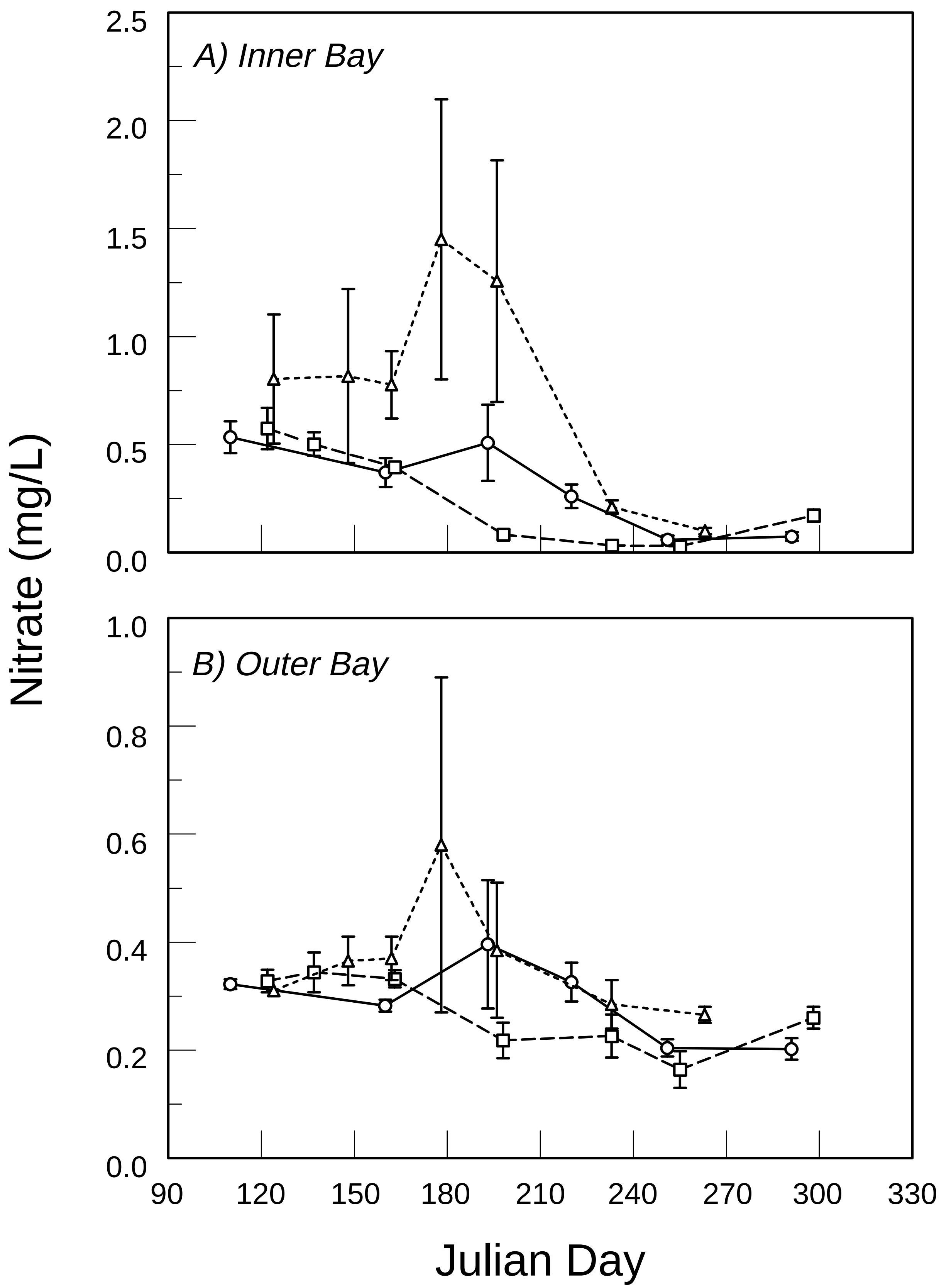

A) Inner Bay
B) Outer Bay
Total Suspended Solids (mg/L)
20.0
16.0
12.0
8.0
4.0
0.0
5.0
4.0
3.0
2.0
1.0
0.0
90
120
150
180
210
240
270
300
330
Julian Day

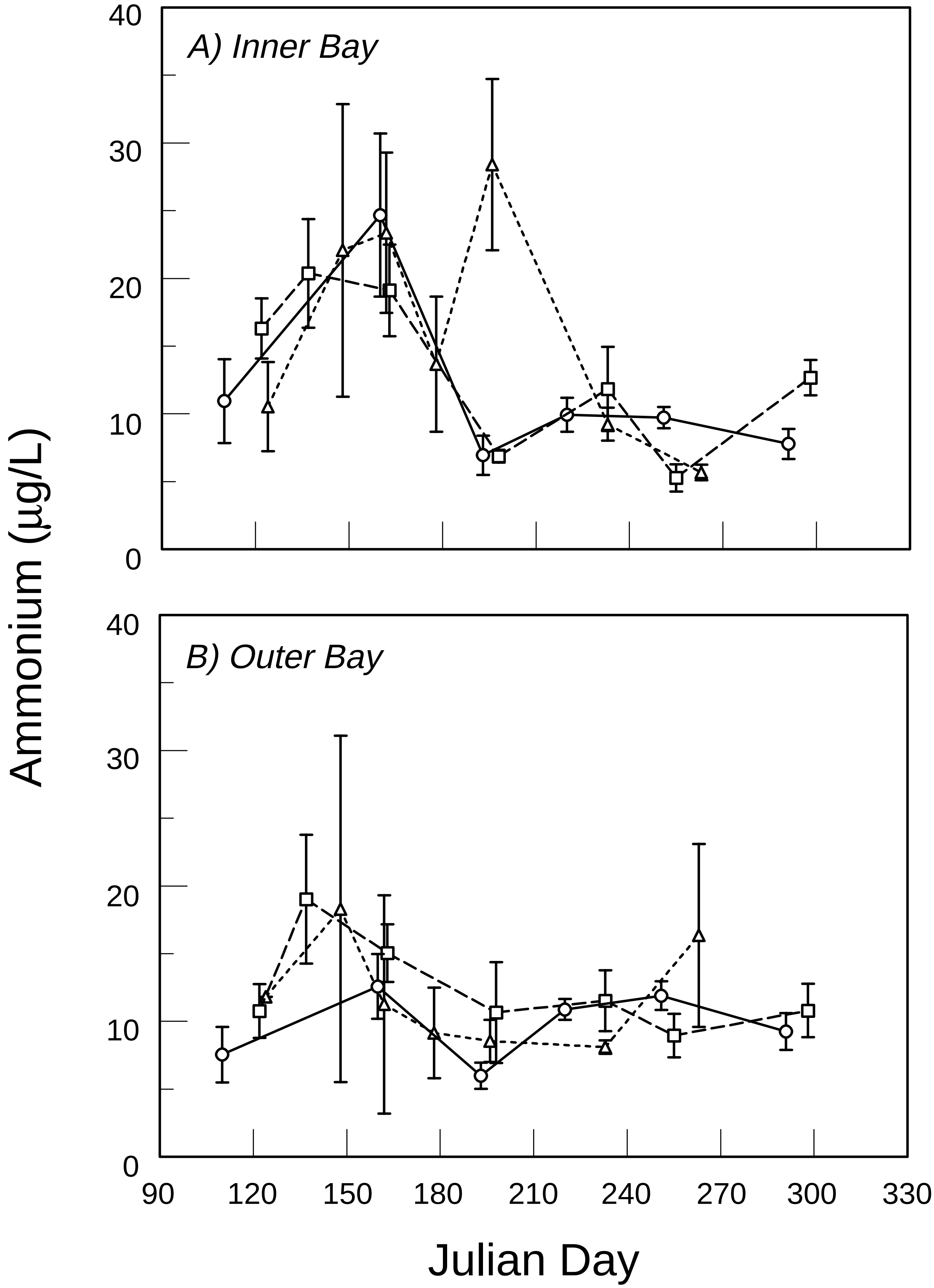


Total Phosphorus (µg/L)
A) Inner Bay
40.0
30.0
20.0
10.0
0.0
B) Outer Bay
15.0
10.0
5.0
0.0
90
120
150
180
210
240
270
300
330
Julian Day

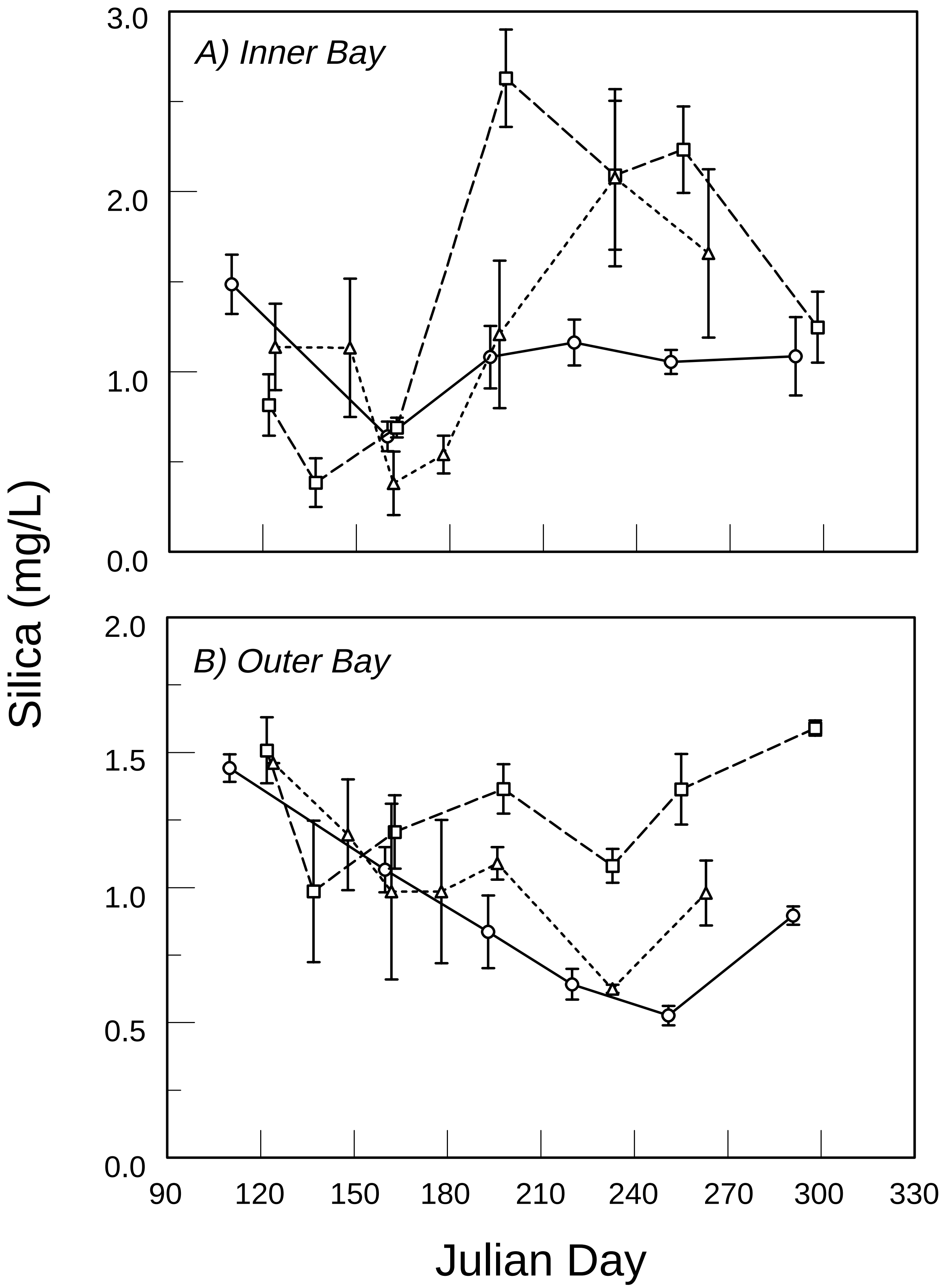

A) Inner Bay
B) Outer Bay
Total Dissolved Phosphorus (µg/L)
Julian Day
0.0
2.0
4.0
6.0
8.0
90
120
150
180
210
240
270
300
330

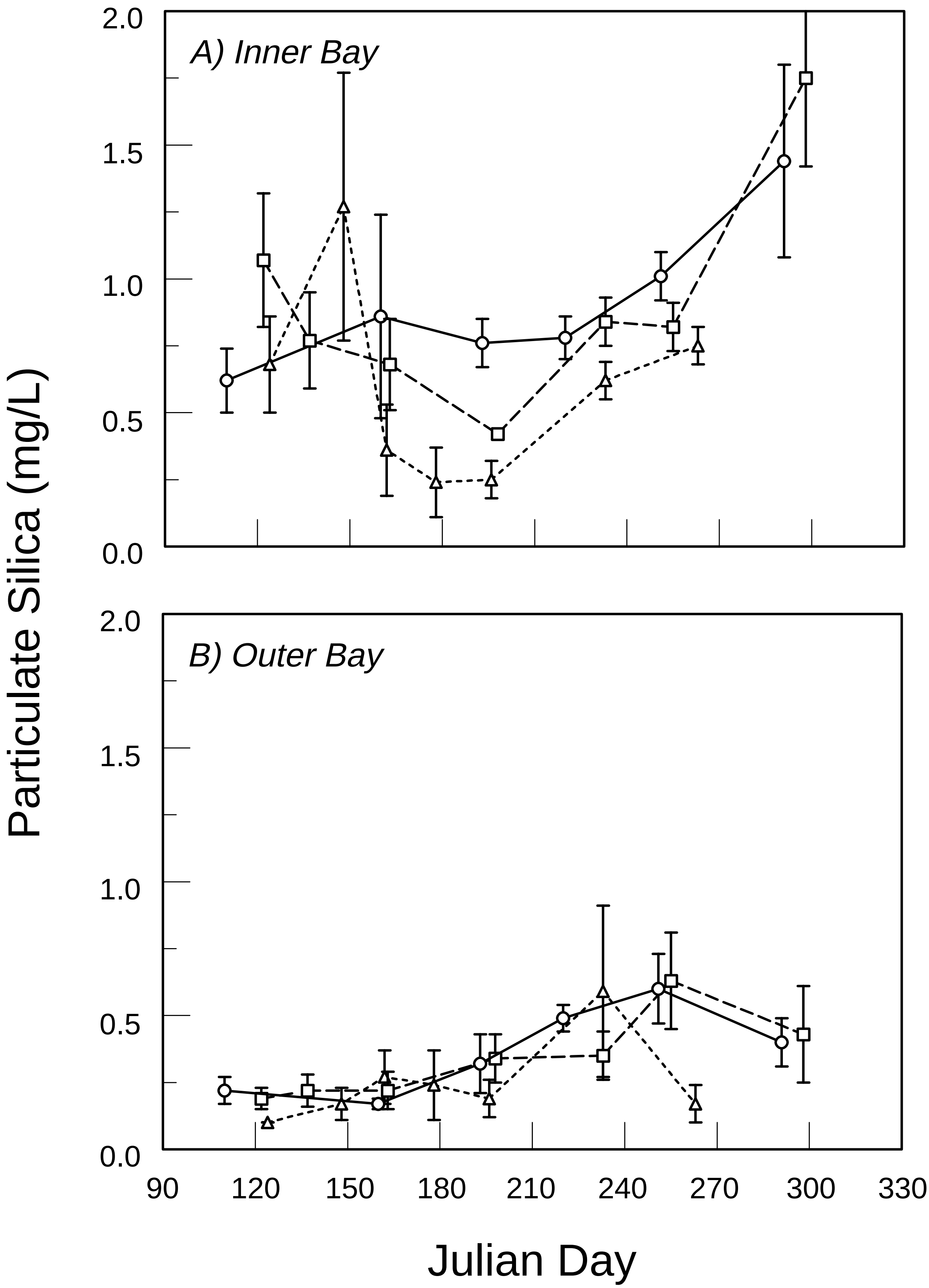

A) Inner Bay
B) Outer Bay
Soluble Reactive Phosphorus (µg/L)
Julian Day
2.0
1.5
1.0
0.5
0.0
90
120
150
180
210
240
270
300
330

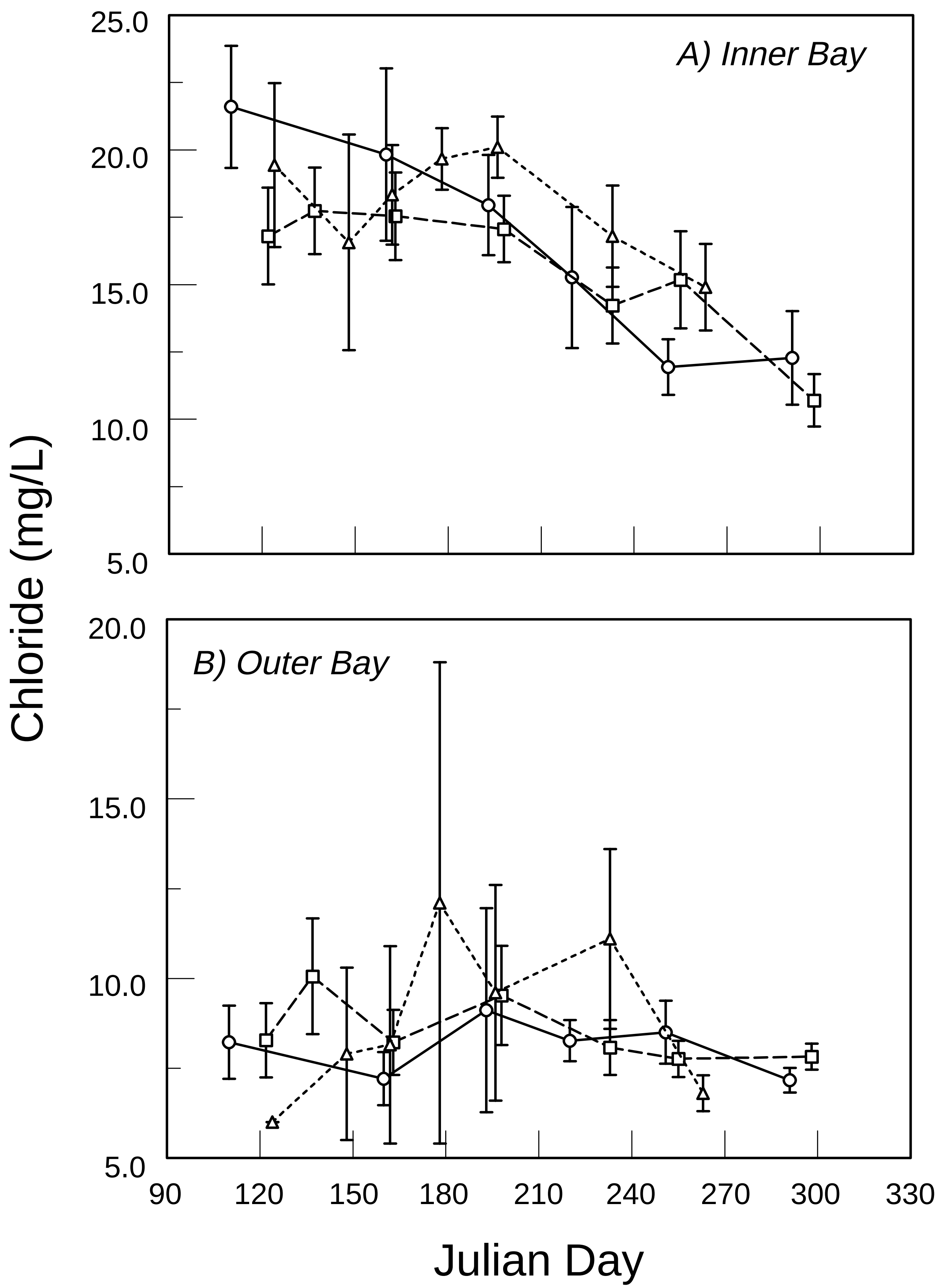

A) Inner Bay
B) Outer Bay
Nitrate (mg/L)
Julian Day
2.5
2.0
1.5
1.0
0.5
0.0
1.0
0.8
0.6
0.4
0.2
0.0
90
120
150
180
210
240
270
300
330



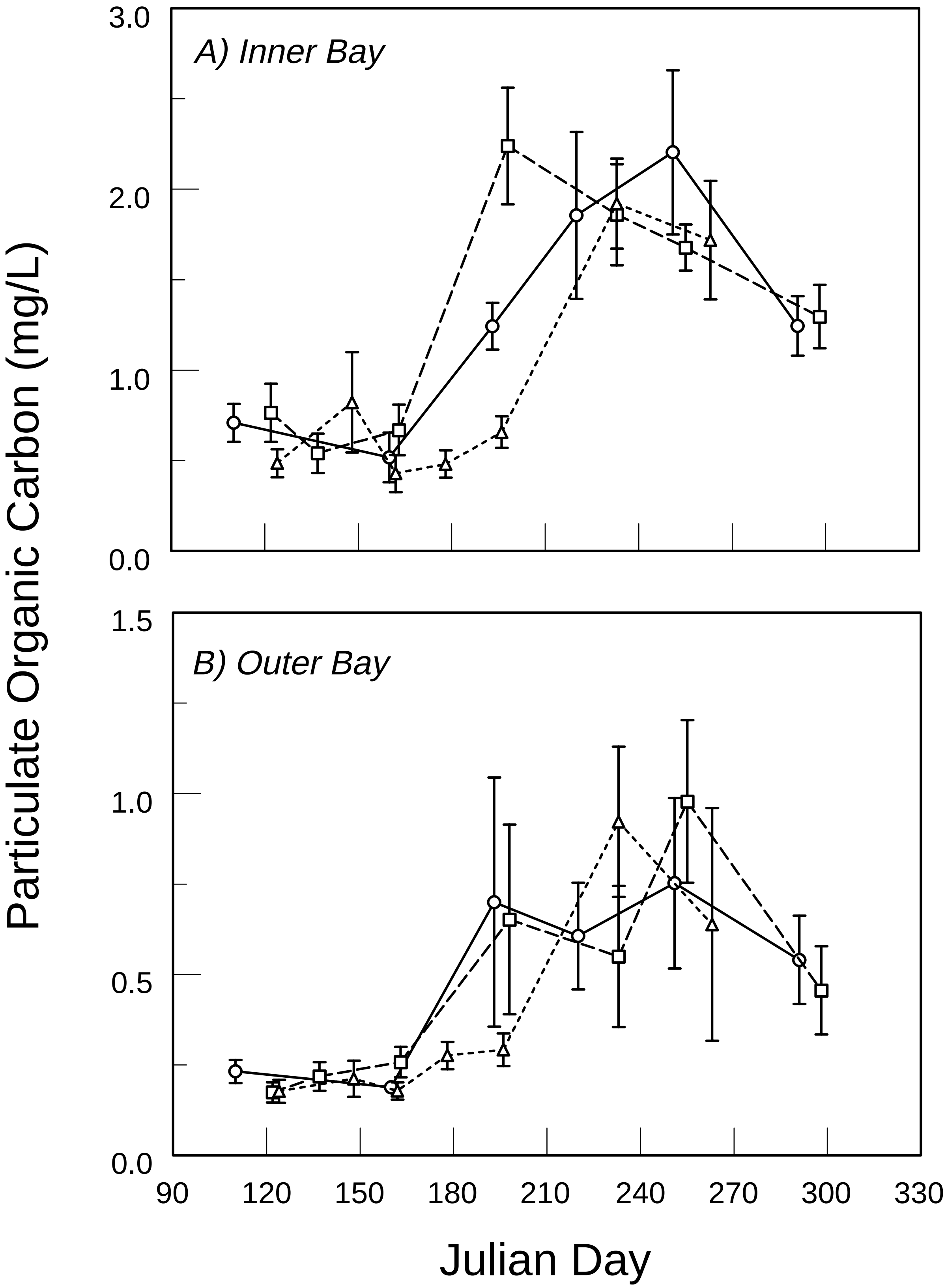
A) Inner Bay
B) Outer Bay
Ammonium (µg/L)
Julian Day
0
10
20
30
40
90
120
150
180
210
240
270
300
330


A) Inner Bay
B) Outer Bay
3.0
2.0
1.0
0.0
2.0
1.5
1.0
0.5
0.0
90
120
150
180
210
240
270
300
330
Silica (mg/L)
Julian Day

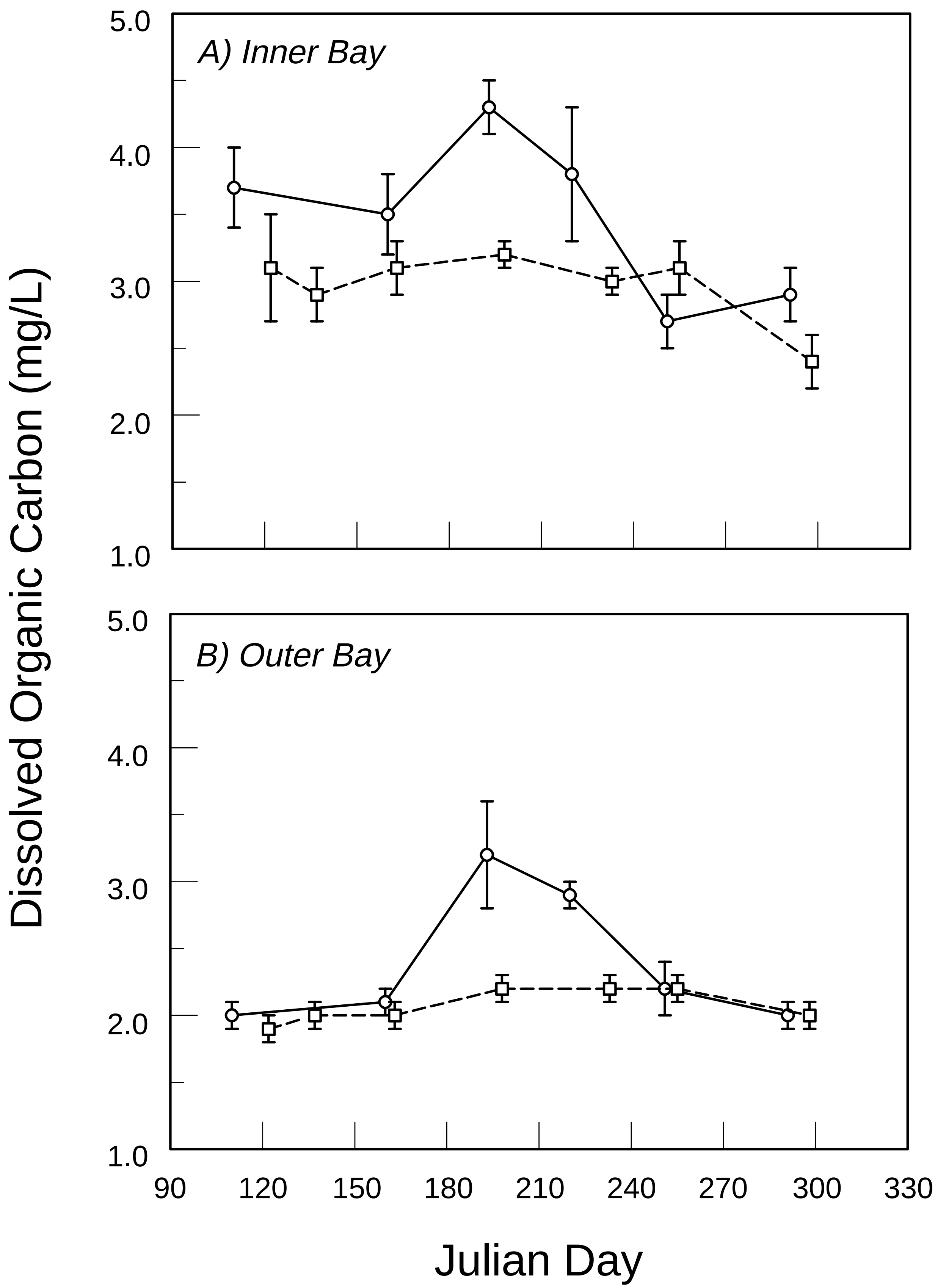

A) Inner Bay
B) Outer Bay
Particulate Silica (mg/L)
0.0
0.5
1.0
1.5
2.0
90
120
150
180
210
240
270
300
330
Julian Day

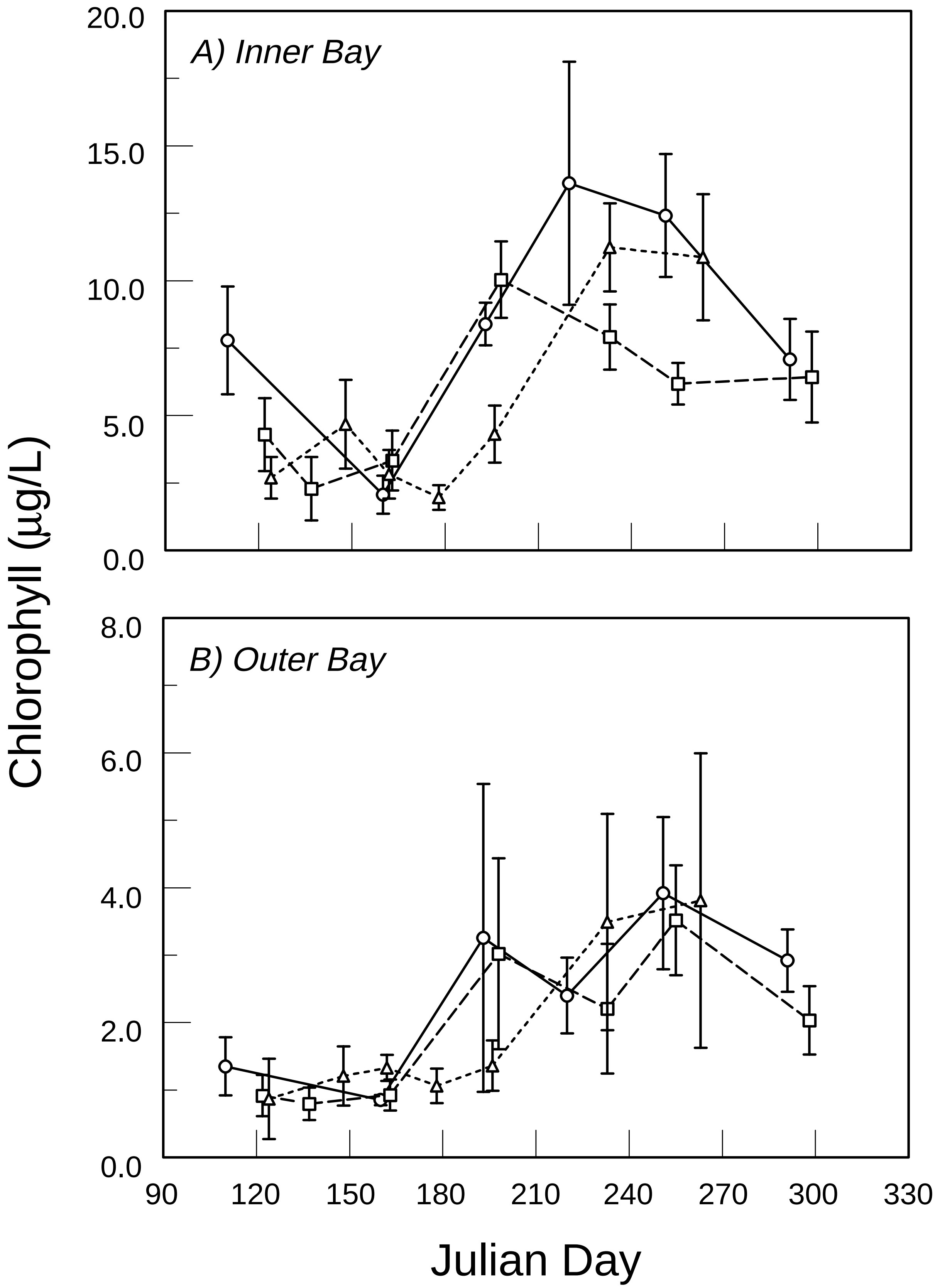


25.0
20.0
15.0
10.0
5.0
A) Inner Bay
20.0
15.0
10.0
5.0
B) Outer Bay
90
120
150
180
210
240
270
300
330
Chloride (mg/L)
Julian Day



A) Inner Bay
B) Outer Bay
3.0
2.0
1.0
0.0
1.5
1.0
0.5
0.0
90
120
150
180
210
240
270
300
330
Particulate Organic Carbon (mg/L)
Julian Day


A) Inner Bay
B) Outer Bay
Dissolved Organic Carbon (mg/L)
5.0
4.0
3.0
2.0
1.0
90
120
150
180
210
240
270
300
330
Julian Day



A) Inner Bay
B) Outer Bay
20.0
15.0
10.0
5.0
0.0
8.0
6.0
4.0
2.0
0.0
Chlorophyll (µg/L)
90
120
150
180
210
240
270
300
330
Julian Day

Appendix 1
Values of all physical and chemical variables collected in Saginaw Bay during 1994–1996.

Missing data are represented by "."

Data are also contained in both ASCII and MS Excel files at:
ftp://ftp.glerl.noaa.gov/publications/tech_reports/glerl-115.

Cruise	Sampling Dates Year	Month	Day	Station ID	Depth (m)	Temp (oC)	Secchi (m)	KPAR (/m)	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	SRP (ug/L)	NIT (mg/L)	AMM (ug/L)	SILICA (mg/L)	PSI (mg/L)	CL (mg/L)	POC (mg/L)	DOC (mg/L)	CHL (ug/L)
941	1994	Apr	20	4	1	6.5	1.5	.	6.5	26.4	6.0	1.8	0.56	5.3	1.41	1.12	22.8	1.28	3.64	18.98
941	1994	Apr	20	5	1	7.5	1.8	.	4.6	19.8	8.9	0.7	0.80	9.8	1.60	0.70	26.5	0.70	4.90	8.32
941	1994	Apr	20	7	1	6.0	2.0	.	3.8	14.4	3.8	0.5	0.43	3.3	1.80	0.61	21.1	0.92	3.61	10.93
941	1994	Apr	20	10	1	5.0	.	.	3.8	12.2	2.8	0.3	0.37	2.9	1.56	0.69	17.7	0.71	3.05	8.06
941	1994	Apr	20	10	6	.	.	.	4.0	12.1	2.9	0.3	0.37	2.5	1.56	0.69	17.7	0.64	2.91	8.05
941	1994	Apr	20	11	1	4.7	4.5	.	3.1	7.7	2.3	0.3	0.37	17.8	1.75	0.31	12.5	0.47	2.49	1.69
941	1994	Apr	20	11	5	4.5	.	.	3.2	7.6	1.9	0.3	0.37	17.0	1.63	0.40	12.9	0.40	2.44	1.87
941	1994	Apr	20	13	1	7.8	2.8	.	1.5	9.4	7.6	0.3	0.58	5.7	0.91	0.15	24.1	0.40	3.82	2.52
941	1994	Apr	20	14	1	9.0	3.0	.	2.3	12.4	4.3	1.2	0.30	28.0	0.72	0.40	15.5	0.41	3.14	3.02
941	1994	Apr	20	16	1	9.5	1.5	.	5.1	19.4	4.8	0.5	0.86	14.7	2.13	0.96	32.6	0.78	5.26	8.78
941	1994	Apr	20	19	1	4.0	4.8	.	0.9	4.1	1.6	0.2	0.30	6.5	1.41	0.35	7.3	0.24	2.03	1.40
941	1994	Apr	20	20	1	3.0	6.8	.	0.9	4.4	1.4	0.2	0.30	3.7	1.50	0.30	6.3	0.30	1.80	2.37
941	1994	Apr	20	20	8	2.8	.	.	1.0	4.2	1.4	0.3	0.30	3.7	1.50	0.30	6.2	0.30	2.00	2.47
941	1994	Apr	20	21	1	6.0	6.8	.	0.4	3.5	1.4	0.2	0.34	11.5	1.43	0.09	11.8	0.15	2.33	0.37
941	1994	Apr	20	23	1	3.0	6.0	.	1.0	4.4	1.3	0.2	0.33	2.9	1.59	0.26	6.6	0.30	1.88	2.23
941	1994	Apr	20	23	14	3.5	.	.	1.2	4.6	1.4	0.2	0.33	3.7	1.75	0.29	6.6	0.27	1.78	2.44
941	1994	Apr	20	24	1	5.5	11.0	.	0.5	3.5	1.4	0.1	0.34	13.1	1.28	0.10	9.1	0.17	2.04	0.38
941	1994	Apr	20	24	6	.	.	.	0.6	4.4	1.6	0.3	0.37	13.9	1.26	0.10	9.2	0.14	2.02	0.43
942	1994	Jun	9	4	1	19.2	.	.	15.4	36.6	6.5	3.1	0.45	57.8	0.82	1.81	30.7	0.91	4.43	2.97
942	1994	Jun	9	5	1	18.8	3.5	.	1.4	9.5	3.7	0.6	0.30	23.4	0.60	0.30	20.3	0.30	3.90	0.41
942	1994	Jun	9	7	1	.	0.5	.	18.4	33.4	3.2	0.7	0.31	13.5	0.47	3.19	20.8	1.32	3.84	6.45
942	1994	Jun	6	10	1	16.6	3.5	.	1.4	6.0	1.9	0.5	0.23	9.1	0.72	0.35	10.8	0.34	2.67	2.39
942	1994	Jun	6	10	6	16.4	.	.	1.5	5.7	1.9	0.3	0.23	11.3	0.72	0.37	10.8	0.38	2.75	2.18
942	1994	Jun	6	11	1	14.8	5.0	.	0.6	4.8	1.3	0.4	0.24	14.2	0.93	0.31	8.2	0.27	2.34	1.36
942	1994	Jun	6	11	5	14.5	.	.	1.0	4.0	1.3	0.4	0.25	14.2	0.93	0.29	8.2	0.26	2.21	1.60
942	1994	Jun	6	13	1	.	3.2	.	2.8	7.3	2.6	0.5	0.31	26.0	0.33	0.51	16.3	0.35	3.08	0.75
942	1994	Jun	9	14	1	19.7	.	.	1.1	10.6	4.1	0.6	0.81	11.9	0.89	0.16	34.6	0.41	4.98	1.80
942	1994	Jun	9	16	1	18.2	.	.	0.5	5.4	2.3	0.6	0.32	41.5	0.37	0.25	16.7	0.24	3.13	0.40
942	1994	Jun	10	19	1	15.7	6.4	.	0.6	3.7	1.2	0.3	0.27	20.9	0.82	0.24	9.4	0.18	2.38	0.75
942	1994	Jun	10	20	1	12.9	7.6	.	0.4	2.3	0.8	0.4	0.28	8.2	1.17	0.17	5.9	0.19	1.89	1.05
942	1994	Jun	10	20	8	12.1	.	.	0.7	2.7	0.8	0.4	0.28	6.3	1.17	0.23	5.9	0.25	1.93	1.67
942	1994	Jun	10	21	1	15.9	5.1	.	0.3	3.8	1.6	0.4	0.25	14.5	1.03	0.11	6.0	0.19	2.13	0.61
942	1994	Jun	10	23	1	10.4	7.3	.	0.4	2.1	1.2	0.4	0.30	8.2	1.31	0.14	6.0	0.19	1.89	0.92
942	1994	Jun	10	23	14	10.4	.	.	0.8	2.9	2.1	0.4	0.31	7.9	1.31	0.27	6.0	0.31	1.88	3.20
942	1994	Jun	10	24	1	15.2	6.8	.	0.7	2.1	1.2	0.4	0.31	11.1	1.00	0.20	8.4	0.19	2.34	0.92
942	1994	Jun	10	24	6	14.5	.	.	0.7	2.3	1.2	0.4	0.31	12.4	1.00	0.26	8.3	0.22	2.34	1.14
943	1994	Jul	13	4	1	22.5	1.5	.	5.8	26.0	3.0	1.4	0.23	10.0	1.33	0.70	18.7	1.14	4.22	10.42
943	1994	Jul	13	5	1	23.0	2.0	.	4.0	21.4	4.7	1.1	1.50	4.5	2.00	0.30	28.2	1.30	5.50	8.26
943	1994	Jul	13	7	1	22.0	2.0	.	4.0	15.4	2.4	0.9	0.18	6.5	1.06	0.63	13.0	0.77	3.66	5.74
943	1994	Jul	11	10	1	22.0	1.5	.	3.7	15.0	3.0	1.1	0.21	4.5	0.92	0.73	13.5	0.97	4.10	6.57
943	1994	Jul	11	10	6	22.0	.	.	3.6	16.0	2.4	1.0	0.22	5.2	0.87	0.69	12.7	0.93	3.85	6.04
943	1994	Jul	11	11	1	21.5	1.8	.	5.2	16.6	2.0	1.0	0.25	4.9	0.96	0.74	12.7	1.30	3.90	7.75
943	1994	Jul	11	11	5	.	.	.	4.5	17.0	1.8	0.9	0.23	6.2	0.96	0.76	12.2	1.16	3.88	6.97
943	1994	Jul	13	13	1	22.0	1.8	.	7.5	22.3	2.8	0.9	0.15	4.6	0.45	1.10	16.5	1.87	3.89	12.25
943	1994	Jul	13	14	1	23.0	2.0	.	5.3	22.6	4.0	1.0	1.03	15.9	1.37	0.83	21.7	0.97	4.86	6.44
943	1994	Jul	13	16	1	22.0	1.5	.	8.2	22.6	3.6	0.9	0.51	4.6	0.56	1.04	19.0	1.62	4.46	9.70
943	1994	Jul	12	19	1	19.5	4.3	.	1.3	8.0	1.8	0.6	0.28	4.3	0.81	0.37	7.4	0.52	3.13	1.71
943	1994	Jul	12	20	1	17.8	6.5	.	0.6	3.6	2.4	0.5	0.30	4.5	0.90	0.20	6.0	0.40	2.70	0.91
943	1994	Jul	12	20	8	18.0	.	.	0.5	4.1	1.3	0.5	0.30	3.7	1.00	0.20	6.0	0.30	2.80	0.91
943	1994	Jul	12	21	1	18.0	6.5	.	0.4	5.0	1.1	0.7	0.25	7.0	1.11	0.14	6.0	0.30	3.00	0.62
943	1994	Jul	13	23	1	17.0	9.5	.	0.3	3.9	1.1	0.6	0.28	4.8	1.02	0.13	5.6	0.22	2.66	0.69
943	1994	Jul	13	23	14	.	.	.	0.4	3.9	1.1	0.5	0.28	4.2	1.02	0.15	5.6	0.21	2.67	0.69
943	1994	Jul	13	24	1	20.1	1.5	.	7.4	19.3	2.0	1.4	0.87	9.3	0.34	0.74	20.4	2.06	4.75	12.35
943	1994	Jul	13	24	6	.	.	.	6.3	19.9	2.4	0.7	0.89	8.8	0.34	0.73	20.6	2.08	4.31	11.63
944	1994	Aug	8	4	1	21.5	0.9	.	10.7	43.2	4.0	1.2	0.23	9.2	1.66	1.14	17.5	2.48	4.39	26.69
944	1994	Aug	8	5	1	21.0	1.2	.	9.3	25.7	2.7	0.7	0.10	6.9	1.60	0.80	15.1	2.60	3.80	15.59
944	1994	Aug	8	7	1	21.0	1.8	.	4.1	16.3	5.7	0.7	0.19	11.1	1.02	0.51	12.1	0.97	3.16	5.92
944	1994	Aug	10	10	1	19.0	2.8	.	2.6	11.7	3.0	0.7	0.21	17.2	1.05	0.65	11.4	0.86	3.08	5.23
944	1994	Aug	10	10	6	19.0	.	.	2.7	12.0	2.1	1.0	0.22	18.0	1.07	0.65	10.9	0.86	3.10	5.63
944	1994	Aug	8	11	1	19.0	2.8	.	1.9	11.3	2.4	0.7	0.30	12.6	0.82	0.59	8.9	0.63	2.67	3.77
944	1994	Aug	8	11	5	19.5	.	.	1.9	10.6	1.9	0.6	0.30	10.7	0.80	0.62	8.9	0.90	2.66	3.51
944	1994	Aug	8	13	1	21.0	1.9	.	6.5	13.6	1.9	0.5	0.21	7.6	0.75	1.07	12.1	1.44	3.25	5.87
944	1994	Aug	8	14	1	21.5	0.8	.	15.8	41.4	3.5	0.8	0.62	7.2	1.46	0.82	32.4	4.55	6.74	38.76
944	1994	Aug	8	16	1	21.0	1.9	.	4.5	17.0	2.1	0.5	0.22	7.6	0.94	0.69	12.1	1.31	3.10	7.03
944	1994	Aug	10	19	1	19.0	3.5	.	2.4	9.4	1.9	0.5	0.31	13.4	0.58	0.60	8.9	0.78	2.97	3.02
944	1994	Aug	10	20	1	18.8	4.5	.	1.0	4.2	1.1	0.3	0.30	9.7	0.50	0.50	7.7	0.40	2.70	1.38
944	1994	Aug	10	20	8	.	.	.	0.9	4.5	1.2	0.5	0.30	12.4	0.60	0.50	7.7	0.30	2.60	1.50
944	1994	Aug	10	21	1	18.5	5.0	.	0.8	6.9	1.1	0.7	0.24	10.3	0.68	0.34	7.1	0.45	2.88	2.04
944	1994	Aug	10	23	1	19	4.5	.	0.7	3.5	1.1	0.5	0.32	9.2	0.61	0.43	7.3	0.30	.	1.29
944	1994	Aug	10	23	14	18	.	.	0.7	3.7	1.0	0.5	0.31	11.1	0.57	0.48	7.1	0.27	.	1.22
944	1994	Aug	10	24	1	19.0	2.3	.	2.8	8.1	2.4	0.6	0.46	11.8	0.84	0.60	10.1	1.10	3.14	4.27
944	1994	Aug	10	24	6	.	.	.	2.6	9.0	1.3	0.6	0.45	11.1	0.84	0.69	10.0	1.01	3.02	4.30
945	1994	Sep	8	4	1	19.5	1.2	.	7.9	65.1	3.4	0.9	0.01	9.8	1.25	0.87	12.4	2.09	2.79	17.01
945	1994	Sep	8	5	1	19.0	0.9	.	10.2	58.1	2.8	0.6	0.01	10.4	0.90	1.00	11.7	2.80	2.60	10.90
945	1994	Sep	8	7	1	20.0	1.5	.	5.6	56.0	3.0	0.7	0.01	7.3	1.21	0.85	11.3	1.82	2.69	13.66
945	1994	Sep	8	10	1	19.0	2.0	.	4.9	16.0	2.2	0.7	0.13	11.9	1.10	0.87	9.8	1.08	2.45	7.19
945	1994	Sep	8	10	6	.	.	.	5.3	16.9	2.1	0.7	0.15	15.0	1.03	1.00	9.8	1.25	2.37	6.60
945	1994	Sep	9	11	1	19.0	2.2	.	3.8	13.5	1.6	0.6	0.13	6.3	1.07	0.79	9.7	1.20	2.24	6.50

Cruise	Sampling Dates Year	Month	Day	Station ID	Depth (m)	Temp (oC)	Secchi (m)	KPAR (/m)	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	SRP (ug/L)	NIT (mg/L)	AMM (ug/L)	SILICA (mg/L)	PSI (mg/L)	CL (mg/L)	POC (mg/L)	DOC (mg/L)	CHL (ug/L)
945	1994	Sep	9	11	5	.	.	.	4.2	13.6	1.8	0.6	0.13	7.8	0.92	0.87	9.9	1.18	2.27	6.71
945	1994	Sep	8	13	1	19.0	2.0	.	4.8	14.0	1.8	0.3	0.10	8.3	0.89	0.87	10.1	1.34	2.65	6.83
945	1994	Sep	8	14	1	20.0	0.8	.	20.5	40.5	4.0	0.7	0.01	11.4	1.25	1.51	18.7	5.03	3.71	25.52
945	1994	Sep	8	16	1	19.0	1.3	.	10.3	21.3	2.1	0.6	0.07	12.4	0.76	1.28	11.4	2.27	2.74	11.69
945	1994	Sep	9	19	1	19.0	3.4	.	2.2	6.7	1.7	0.7	0.23	10.9	0.52	0.64	8.4	0.69	2.27	3.24
945	1994	Sep	9	20	1	18.0	5.8	.	0.8	4.0	1.4	0.5	0.20	11.4	0.60	0.30	6.9	0.30	1.9	1.36
945	1994	Sep	9	20	8	.	.	.	1.0	3.9	1.5	0.4	0.20	13.4	0.60	0.30	6.9	0.40	1.9	1.61
945	1994	Sep	9	21	1	18.5	3.0	.	2.5	6.7	1.4	0.6	0.15	9.8	0.56	0.68	7.9	0.67	2.25	4.09
945	1994	Sep	9	23	1	18.0	6.6	.	0.9	4.7	1.4	0.4	0.24	11.4	0.56	0.39	7.3	0.45	1.90	2.84
945	1994	Sep	9	23	14	.	.	.	0.8	4.1	1.4	0.9	0.22	14.5	0.56	0.38	7.1	0.37	1.93	2.05
945	1994	Sep	9	24	1	19.0	1.8	.	4.9	11.7	1.9	0.7	0.20	16.0	0.39	1.01	11.8	1.65	2.82	8.07
945	1994	Sep	9	24	6	.	.	.	5.5	11.3	1.8	0.7	0.20	15.0	0.39	1.04	12.0	1.60	2.83	7.67
946	1994	Oct	17	4	1	14.0	1.0	.	13.7	40.7	3.7	1.2	0.17	8.6	1.72	3.28	23.5	1.88	4.14	15.03
946	1994	Oct	17	5	1	13.5	.	.	6.4	18.8	2.7	0.7	0.01	8.9	1.50	1.40	13.5	1.40	3.10	3.34
946	1994	Oct	17	7	1	14.0	.	.	7.4	26.3	3.3	0.8	0.04	7.1	1.08	2.63	13.0	1.35	2.97	9.82
946	1994	Oct	17	10	1	15.0	1.5	.	5.7	23.1	3.7	1.0	0.04	7.1	1.53	0.87	11.4	1.29	2.87	9.27
946	1994	Oct	17	10	6	.	.	.	6.9	25.2	3.5	0.8	0.04	7.6	1.58	1.22	11.4	1.56	2.84	12.72
946	1994	Oct	19	11	1	14.0	2.0	.	3.0	12.3	2.0	0.7	0.14	12.7	1.46	0.52	8.7	0.69	2.37	4.36
946	1994	Oct	19	11	5	.	.	.	3.0	10.8	1.9	0.5	0.14	12.2	1.46	0.53	8.7	0.74	2.29	4.37
946	1994	Oct	19	13	1	14.0	1.5	.	6.5	14.3	1.5	0.4	0.07	9.2	0.19	1.49	9.0	1.77	2.37	7.99
946	1994	Oct	17	14	1	14.0	3.0	.	1.7	8.5	2.3	0.5	0.09	7.1	1.08	0.53	9.4	0.59	2.61	2.58
946	1994	Oct	17	16	1	14.0	2.3	.	3.3	10.3	1.6	0.1	0.04	1.5	0.13	0.80	9.3	0.98	2.47	4.25
946	1994	Oct	19	19	1	14.0	2.5	.	2.8	8.7	1.7	0.5	0.15	6.6	0.92	0.60	7.9	0.92	2.18	4.56
946	1994	Oct	19	20	1	14.0	5.0	.	0.8	4.9	1.5	0.7	0.20	6.6	1.00	0.30	6.6	0.40	2.0	2.54
946	1994	Oct	19	20	8	.	.	.	1.0	5.5	1.5	0.7	0.20	6.9	1.00	0.30	6.7	0.30	1.9	2.66
946	1994	Oct	19	21	1	15.0	3.5	.	2.5	7.3	1.3	0.5	0.17	11.7	0.90	0.64	7.7	0.72	2.25	3.28
946	1994	Oct	19	23	1	15.0	7.0	.	0.3	4.1	1.3	0.4	0.26	8.1	0.79	0.18	6.1	0.25	1.83	2.13
946	1994	Oct	19	23	14	.	.	.	0.4	3.9	1.3	0.3	0.26	8.1	0.83	0.19	6.3	0.35	1.84	1.98
946	1994	Oct	19	24	1	14.0	4.0	.	1.3	4.9	1.5	0.7	0.23	13.2	0.87	0.27	7.3	0.41	1.95	2.10
946	1994	Oct	19	24	6	.	.	.	1.2	5.1	1.3	0.5	0.23	14.2	0.87	0.27	7.3	0.44	2.04	2.02
951	1995	May	2	4	1	10.0	0.8	.	12.6	18.4	4.0	2.1	1.21	25.0	1.07	1.74	25.8	1.20	5.54	5.08
951	1995	May	2	5	1	8.5	1.8	.	6.1	5.8	1.6	0.3	0.50	14.6	0.29	1.28	17.9	0.75	2.95	3.68
951	1995	May	2	7	1	7.5	1.0	.	11.9	12.5	1.5	0.3	0.41	8.9	0.57	2.07	18.2	1.45	3.09	11.41
951	1995	May	2	10	1	7.0	1.8	.	6.1	7.7	1.7	0.5	0.57	7.4	0.61	1.30	19.0	0.90	3.23	7.75
951	1995	May	2	10	6	.	.	.	5.9	7.2	1.7	0.5	0.58	7.4	0.61	1.20	19.0	0.92	3.22	7.73
951	1995	May	2	11	1	7.0	3.8	.	1.6	3.5	1.3	0.3	0.47	19.8	1.26	0.40	14.6	0.33	2.57	1.50
951	1995	May	2	11	5	.	.	.	1.5	3.4	1.3	0.3	0.48	20.3	1.31	0.37	14.6	0.31	2.66	1.56
951	1995	May	2	13	1	8.0	9.0	.	0.2	1.8	1.0	0.3	0.38	20.3	1.31	0.08	10.2	0.18	2.87	0.36
951	1995	May	2	14	1	9.5	1.3	.	11.1	7.9	1.5	0.3	0.63	13.1	0.10	1.34	18.3	0.98	2.16	4.12
951	1995	May	2	16	1	7.5	3.9	.	2.0	3.0	1.3	0.5	0.42	21.4	1.31	0.33	10.4	0.32	2.16	0.44
951	1995	May	3	19	1	6.5	7.8	.	0.5	1.9	1.0	0.4	0.33	11.0	1.44	0.20	10.5	0.16	1.90	0.78
951	1995	May	3	20	1	6.5	7.8	.	0.8	2.1	0.9	0.3	0.32	6.4	1.58	0.18	6.6	0.22	1.82	1.02
951	1995	May	3	20	8	.	.	.	0.8	2.1	1.0	0.3	0.33	6.5	1.58	0.17	6.7	0.24	1.86	1.17
951	1995	May	3	21	1	8.5	7.8	.	0.3	1.8	1.0	0.3	0.27	12.8	1.77	0.05	6.8	0.08	2.13	0.14
951	1995	May	3	23	1	3.5	8.5	.	0.6	2.2	1.0	0.2	0.32	6.6	1.68	0.19	6.4	0.24	1.69	2.00
951	1995	May	3	23	14	.	.	.	0.8	3.2	1.0	0.2	0.34	4.3	1.72	0.22	6.4	0.23	1.58	2.31
951	1995	May	3	24	1	7.5	9.0	.	0.8	2.4	1.1	0.3	0.40	17.0	1.07	0.31	11.1	0.17	2.08	0.64
951	1995	May	3	24	6	.	.	.	0.9	2.4	1.0	0.3	0.42	17.5	1.07	0.31	10.8	0.19	2.11	0.56
952	1995	May	17	4	1	14.5	1.5	.	8.5	10.2	2.2	0.3	0.54	8.9	0.27	1.61	20.5	1.09	3.21	10.51
952	1995	May	17	5	1	16.0	5.0	.	1.9	5.1	2.1	0.3	0.48	33.4	0.22	0.33	19.3	0.32	3.27	0.57
952	1995	May	17	7	1	13.0	2.0	.	5.9	7.9	2.2	0.3	0.43	7.2	0.22	1.24	19.8	0.93	3.12	0.89
952	1995	May	17	10	1	13.0	5.0	.	1.4	4.4	1.8	0.2	0.41	12.8	0.85	0.34	13.3	0.28	2.49	1.59
952	1995	May	17	10	6	.	.	.	1.5	3.5	1.7	0.4	0.40	13.9	0.94	0.34	13.0	0.36	2.45	1.54
952	1995	May	17	11	1	13.0	5.0	.	1.0	2.7	1.5	0.2	0.36	15.3	1.13	0.24	11.1	0.29	2.22	1.08
952	1995	May	17	11	5	.	.	.	1.2	2.5	1.5	0.3	0.35	14.2	1.23	0.24	10.4	0.27	2.11	1.15
952	1995	May	17	13	1	15.0	2.3	.	5.7	4.5	1.7	0.3	0.35	19.8	0.08	1.07	13.9	0.45	2.27	1.19
952	1995	May	17	14	1	14.0	2.5	.	6.0	5.9	2.4	0.3	0.79	36.9	0.17	0.76	24.7	0.52	3.82	1.47
952	1995	May	17	16	1	15.0	3.0	.	3.5	4.7	2.3	0.3	0.66	28.7	0.13	0.56	19.3	0.44	3.00	0.99
952	1995	May	18	19	1	13.5	7.5	.	0.5	2.7	1.8	0.3	0.41	33.2	0.51	0.20	13.6	0.15	2.36	0.33
952	1995	May	18	20	1	11.0	7.5	.	0.7	2.2	1.5	0.2	0.35	14.9	1.06	0.22	10.8	0.24	2.07	0.98
952	1995	May	18	20	8	.	.	.	0.7	2.2	1.5	0.2	0.34	12.1	1.13	0.24	10.2	0.24	1.99	1.12
952	1995	May	18	21	1	14.0	7.5	.	0.4	1.7	1.2	0.2	0.23	17.3	1.52	0.08	6.4	0.11	1.90	0.15
952	1995	May	18	23	1	7.0	9.0	.	0.6	1.8	1.2	0.2	0.30	4.9	1.57	0.17	6.2	0.25	1.51	1.44
952	1995	May	18	23	14	.	.	.	0.8	2.0	1.1	0.3	0.30	3.8	1.57	0.22	6.2	0.32	1.47	1.86
952	1995	May	18	24	1	14.0	5.3	.	1.4	2.8	1.5	0.3	0.43	24.8	0.27	0.45	13.3	0.34	2.16	1.07
952	1995	May	18	24	6	.	.	.	1.6	2.9	1.5	0.3	0.41	24.3	0.41	0.48	12.3	0.39	2.11	1.12
953	1995	Jun	12	4	1	19.5	1.3	.	7.9	17.4	4.0	0.5	0.37	7.3	0.80	0.88	24.4	1.30	3.81	9.81
953	1995	Jun	12	5	1	19.0	4.5	.	1.1	5.7	2.9	0.3	0.34	20.8	0.46	0.13	19.3	0.35	3.57	0.84
953	1995	Jun	12	7	1	20.0	1.3	.	9.3	17.6	4.2	1.0	0.36	28.0	0.75	1.42	20.5	1.16	3.43	5.71
953	1995	Jun	12	10	1	18.0	1.5	.	7.6	12.0	3.0	0.9	0.42	29.8	0.75	1.31	18.3	0.73	3.11	3.75
953	1995	Jun	12	10	6	.	.	.	9.0	12.4	2.9	1.0	0.43	34.3	0.70	1.32	18.7	0.83	3.25	3.29
953	1995	Jun	12	11	1	18.0	4.5	.	1.6	4.2	2.2	0.3	0.37	11.8	0.84	0.37	12.6	0.34	2.57	1.22
953	1995	Jun	12	11	5	.	.	.	2.9	5.9	2.2	0.3	0.39	10.9	0.70	0.62	14.3	0.56	2.73	2.30
953	1995	Jun	12	13	1	17.5	4.5	.	0.6	3.1	1.9	0.4	0.36	29.8	0.84	0.19	11.6	0.24	2.39	0.48
953	1995	Jun	12	14	1	20.0	2.5	.	3.8	6.8	2.6	0.4	0.56	7.3	0.51	0.51	20.5	0.78	3.17	3.10
953	1995	Jun	12	16	1	19.0	4.0	.	2.1	5.1	2.2	0.3	0.38	18.1	0.56	0.63	13.1	0.45	2.43	1.74
953	1995	Jun	13	19	1	16.0	4.0	.	1.2	3.3	2.0	0.3	0.35	16.3	0.94	0.28	11.0	0.30	2.34	1.59
953	1995	Jun	13	20	1	15.0	6.5	.	0.5	2.0	1.7	0.2	0.30	14.5	1.37	0.13	7.1	0.26	1.94	0.46

Cruise	Sampling Dates Year	Month	Day	Station ID	Depth (m)	Temp (oC)	Secchi (m)	KPAR (/m)	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	SRP (ug/L)	NIT (mg/L)	AMM (ug/L)	SILICA (mg/L)	PSI (mg/L)	CL (mg/L)	POC (mg/L)	DOC (mg/L)	CHL (ug/L)
953	1995	Jun	13	20	8	.	.	.	0.8	2.2	1.9	0.2	0.31	11.4	1.34	0.24	6.8	0.27	1.84	0.85
953	1995	Jun	13	21	1	16.0	6.5	.	0.4	1.8	1.6	0.3	0.29	17.2	1.32	0.10	7.0	0.18	2.00	0.43
953	1995	Jun	13	23	1	10.0	8.0	.	0.5	1.7	1.5	0.3	0.35	7.3	1.56	0.13	6.3	0.16	1.69	0.83
953	1995	Jun	13	23	14	.	.	.	0.8	2.1	1.7	0.3	0.35	9.1	1.56	0.23	6.3	0.27	1.64	1.84
953	1995	Jun	13	24	1	16.0	4.0	.	1.8	3.0	1.6	0.3	0.37	19.9	0.84	0.45	9.7	0.39	2.09	1.31
953	1995	Jun	13	24	6	.	.	.	1.8	3.0	1.9	0.2	0.38	19.9	0.84	0.45	9.7	0.32	2.07	1.23
954	1995	Jul	17	4	1	23.0	1.2	.	7.3	15.8	2.5	0.3	0.07	6.1	3.63	0.45	17.9	2.16	3.11	11.11
954	1995	Jul	19	5	1	24.0	1.3	.	8.8	11.2	1.6	0.2	0.03	5.7	3.21	0.38	19.4	2.82	3.44	13.01
954	1995	Jul	17	7	1	23.5	1.0	.	4.9	10.7	2.9	0.2	0.09	6.8	3.22	0.31	16.9	1.78	3.00	7.99
954	1995	Jul	17	10	1	21.0	2.0	.	4.5	7.0	2.4	0.2	0.11	7.6	2.10	0.40	14.6	1.48	3.08	6.11
954	1995	Jul	17	10	6	.	.	.	4.5	7.0	2.5	0.2	0.13	6.8	2.00	0.41	14.3	1.67	2.80	5.70
954	1995	Jul	19	11	1	.	3.0	.	2.2	4.1	1.8	0.1	0.22	9.1	1.42	0.44	9.7	0.70	2.28	2.83
954	1995	Jul	19	11	5	.	.	.	2.2	4.4	1.5	0.1	0.21	11.3	1.39	0.41	9.6	0.65	2.42	2.72
954	1995	Jul	17	13	1	23.5	0.8	.	14.0	13.2	2.4	0.2	0.02	5.3	2.07	0.51	20.5	3.56	3.66	14.24
954	1995	Jul	17	14	1	25.0	1.5	.	7.9	14.9	3.1	0.2	0.08	6.1	3.12	0.42	17.9	2.43	3.28	13.00
954	1995	Jul	17	16	1	24.0	1.3	.	12.4	12.6	2.5	0.2	0.04	8.3	2.27	0.45	19.6	2.98	3.43	12.02
954	1995	Jul	19	19	1	20.0	2.0	.	3.8	5.9	2.0	0.1	0.16	8.3	1.56	0.44	12.2	1.14	2.55	5.50
954	1995	Jul	19	20	1	19.0	8.3	.	0.7	2.2	1.4	0.1	0.28	6.5	1.15	0.28	7.4	0.25	2.00	0.89
954	1995	Jul	19	20	8	.	.	.	0.8	2.6	1.4	0.1	0.29	6.8	1.18	0.32	7.2	0.27	1.93	1.03
954	1995	Jul	19	21	1	17.0	8.3	.	0.8	2.1	1.5	0.1	0.27	21.7	1.29	0.13	6.9	0.15	1.99	0.26
954	1995	Jul	19	23	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
954	1995	Jul	19	23	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
954	1995	Jul	19	24	1	19.0	2.5	.	3.4	5.2	1.6	0.1	0.16	6.1	1.46	0.51	11.6	1.07	2.38	5.43
954	1995	Jul	19	24	6	.	.	.	3.2	6.3	1.6	0.1	0.16	6.1	1.49	0.53	11.6	0.99	2.62	5.19
955	1995	Aug	22	4	1	25.0	0.8	.	14.5	43.6	5.1	1.5	0.03	9.7	3.11	1.03	23.8	2.34	3.79	15.36
955	1995	Aug	22	5	1	24.0	1.0	.	11.6	22.4	3.1	0.9	0.04	7.0	2.78	0.74	15.1	2.91	3.36	7.64
955	1995	Aug	22	7	1	.	1.0	.	7.3	27.1	6.2	1.5	0.03	33.3	4.30	0.65	12.9	1.15	2.78	6.62
955	1995	Aug	21	10	1	24.0	2.3	.	3.7	9.8	2.7	0.6	0.03	9.7	1.12	0.62	12.5	1.14	2.80	6.00
955	1995	Aug	21	10	6	.	.	.	3.5	9.8	2.7	0.5	0.03	8.1	1.12	0.63	12.5	1.12	2.85	5.85
955	1995	Aug	22	11	1	23.0	2.5	.	3.4	9.4	2.7	0.9	0.03	11.3	1.45	0.55	12.2	0.92	2.85	4.76
955	1995	Aug	22	11	5	.	.	.	3.5	9.6	2.7	0.7	0.03	12.9	1.45	0.56	12.2	0.88	2.80	5.49
955	1995	Aug	21	13	1	24.0	1.8	.	6.4	11.2	2.7	0.9	0.04	9.7	1.39	0.76	12.3	1.61	2.72	6.48
955	1995	Aug	21	14	1	25.0	1.3	.	9.4	14.9	2.1	0.7	0.03	7.4	1.16	1.21	12.5	1.91	2.87	6.16
955	1995	Aug	21	16	1	24.0	1.0	.	10.2	16.0	2.7	0.7	0.03	6.6	1.42	1.16	12.5	2.89	2.83	10.29
955	1995	Aug	22	19	1	23.0	3.0	.	3.0	7.3	1.8	0.5	0.26	18.4	1.02	0.47	7.7	0.62	2.16	2.25
955	1995	Aug	22	20	1	23.0	6.0	.	0.8	4.8	2.0	0.5	0.27	9.3	0.97	0.22	7.4	0.34	2.06	1.15
955	1995	Aug	22	20	8	.	.	.	0.8	3.9	1.8	0.5	0.27	8.9	0.94	0.22	7.4	0.33	2.07	1.19
955	1995	Aug	22	21	1	22.0	6.0	.	1.1	4.8	2.7	0.7	0.21	15.2	1.29	0.27	7.8	0.37	2.16	1.21
955	1995	Aug	22	23	1	23.0	9.0	.	0.4	3.0	1.6	0.5	0.31	8.1	0.96	0.15	6.5	0.15	1.97	0.53
955	1995	Aug	22	23	14	.	.	.	0.5	3.2	1.8	0.3	0.31	8.1	0.92	0.16	6.5	0.22	2.10	0.74
955	1995	Aug	22	24	1	24.0	2.3	.	4.5	8.9	2.4	0.9	0.08	6.6	1.16	0.65	11.0	1.27	2.50	5.89
955	1995	Aug	22	24	6	.	.	.	4.6	9.4	2.4	0.5	0.09	5.0	1.19	0.70	10.8	1.24	2.48	5.60
956	1995	Sep	12	4	1	.	0.8	.	11.3	37.4	6.4	1.1	0.03	7.6	2.34	1.01	23.6	1.97	3.86	9.11
956	1995	Sep	12	5	1	.	1.3	.	7.5	19.9	3.9	1.0	0.03	5.1	3.45	0.50	16.4	2.07	3.48	3.74
956	1995	Sep	12	7	1	21.0	1.0	.	8.4	33.3	6.4	1.1	0.03	4.7	2.49	1.04	22.1	1.68	3.64	6.08
956	1995	Sep	12	10	1	20.5	.	.	4.5	21.4	5.3	0.7	0.02	3.2	2.05	0.58	12.9	1.19	2.90	5.12
956	1995	Sep	12	10	6	.	.	.	7.4	25.7	7.0	0.7	0.02	2.8	2.09	1.57	12.8	1.70	2.89	10.57
956	1995	Sep	12	11	1	19.0	1.5	.	7.3	22.1	4.4	0.5	0.05	11.3	2.38	1.24	10.9	1.48	2.83	9.80
956	1995	Sep	12	11	5	.	.	.	7.0	21.1	4.7	0.7	0.04	9.1	2.31	1.27	10.9	1.38	2.64	9.18
956	1995	Sep	12	13	1	19.0	1.5	.	5.8	13.0	2.7	0.5	0.03	3.2	1.55	0.83	10.6	1.49	2.65	6.08
956	1995	Sep	12	14	1	.	1.1	.	8.5	16.8	3.3	0.9	0.02	3.2	1.18	0.69	13.4	2.19	2.99	4.89
956	1995	Sep	12	16	1	19.0	1.8	.	4.1	17.5	3.3	0.7	0.02	3.9	2.42	0.69	11.5	1.35	2.61	4.61
956	1995	Sep	12	19	1	18.5	1.3	.	7.6	17.0	2.4	0.7	0.08	9.1	1.47	1.27	9.2	1.70	2.43	6.18
956	1995	Sep	12	20	1	18.5	2.7	.	3.2	11.2	3.4	0.6	0.16	10.6	1.55	0.65	8.2	0.87	2.23	3.57
956	1995	Sep	12	20	8	.	.	.	3.3	11.4	3.6	0.6	0.17	10.2	1.53	0.61	8.2	0.78	2.17	3.64
956	1995	Sep	12	21	1	18.0	3.3	.	2.3	7.7	2.7	0.4	0.11	3.9	1.62	0.24	8.0	0.82	2.45	2.79
956	1995	Sep	12	23	1	18.5	8.0	.	0.7	5.1	2.4	0.4	0.27	7.6	0.89	0.30	6.2	0.33	2.00	1.15
956	1995	Sep	12	23	14	.	.	.	0.6	4.1	2.4	0.5	0.27	7.6	0.89	0.30	6.2	0.36	1.97	1.35
956	1995	Sep	12	24	1	19.5	2.0	.	4.6	9.4	2.7	0.3	0.20	13.6	1.29	0.71	7.2	1.17	2.09	3.89
956	1995	Sep	12	24	6	.	.	.	4.5	11.1	2.7	0.3	0.20	15.8	1.29	0.78	7.2	1.16	2.08	3.89
957	1995	Oct	25	4	1	11.0	1.0	.	16.8	29.9	2.8	0.5	0.08	8.0	0.64	2.57	13.3	1.78	2.87	13.23
957	1995	Oct	25	5	1	10.0	0.8	.	17.4	31.4	3.6	1.1	0.04	16.8	0.27	3.11	15.0	1.96	3.16	13.92
957	1995	Oct	25	7	1	10.0	0.5	.	17.5	28.5	2.2	0.7	0.16	8.4	1.56	2.52	11.6	1.52	2.53	8.07
957	1995	Oct	25	10	1	9.6	3.0	.	2.5	5.6	1.9	0.3	0.29	9.2	1.70	0.44	7.6	0.49	1.89	1.87
957	1995	Oct	25	10	6	.	.	.	2.6	5.6	1.6	0.4	0.30	14.5	1.82	0.41	7.4	0.46	1.96	1.90
957	1995	Oct	30	11	1	9.0	1.5	.	5.4	11.5	2.2	0.5	0.14	14.9	0.93	0.89	12.5	0.77	2.80	4.20
957	1995	Oct	30	11	5	.	.	.	5.1	11.5	2.5	0.5	0.14	12.2	0.96	0.85	12.3	0.71	2.55	3.95
957	1995	Oct	25	13	1	10.0	1.0	.	16.3	22.4	1.6	0.3	0.21	17.2	1.65	1.78	8.6	1.37	2.12	3.78
957	1995	Oct	25	14	1	11.0	1.0	.	15.5	22.2	1.9	0.3	0.24	13.4	1.56	1.48	8.1	1.41	2.03	3.40
957	1995	Oct	25	16	1	10.0	1.3	.	11.4	18.0	2.2	0.4	0.21	13.4	1.67	1.24	8.9	1.07	2.10	2.96
957	1995	Oct	30	19	1	9.0	4.5	.	2.4	7.6	1.9	0.3	0.23	11.1	1.56	0.37	8.3	0.52	2.23	1.91
957	1995	Oct	30	20	1	9.0	4.5	.	1.5	5.4	2.4	0.3	0.30	9.6	1.65	0.28	7.2	0.37	1.94	2.15
957	1995	Oct	30	20	8	.	.	.	1.5	5.4	1.9	0.3	0.31	8.8	1.66	0.27	7.2	0.34	1.82	2.33
957	1995	Oct	30	21	1	9.0	6.0	.	0.6	3.4	1.9	0.2	0.27	18.0	1.65	0.12	7.8	0.21	1.92	0.31
957	1995	Oct	30	23	1	9.0	6.0	.	1.0	3.7	1.9	0.2	0.30	6.1	1.59	0.22	6.9	0.28	1.81	2.33
957	1995	Oct	30	23	14	.	.	.	1.0	3.7	1.9	0.2	0.31	6.5	1.65	0.22	7.0	0.33	1.68	2.28
957	1995	Oct	30	24	1	9.0	1.5	.	7.1	12.7	2.2	0.2	0.20	9.2	1.50	1.14	8.9	0.90	2.10	3.47
957	1995	Oct	30	24	6	.	.	.	7.5	13.4	2.2	0.2	0.20	9.2	1.50	1.17	8.9	0.93	2.09	3.49

Cruise	Sampling Dates Year	Month	Day	Station ID	Depth (m)	Temp (oC)	Secchi (m)	KPAR (/m)	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	SRP (ug/L)	NIT (mg/L)	AMM (ug/L)	SILICA (mg/L)	PSI (mg/L)	CL (mg/L)	POC (mg/L)	DOC (mg/L)	CHL (ug/L)
961	1996	May	7	4	1	8.0	1.0	.	9.8	21.1	.	.	.	.	.	.	.	0.82	.	2.89
961	1996	May	7	5	1	.	2.8	0.69	2.4	10.2	5.5	0.3	0.54	15.5	1.21	0.33	17.9	0.32	.	0.76
961	1996	May	7	7	1	8.0	1.3	.	6.9	15.5	.	.	.	.	.	.	.	0.59	.	2.92
961	1996	May	7	10	1	7.0	1.9	0.57	4.2	15.0	4.9	0.3	0.47	4.3	1.51	0.78	15.1	0.65	.	5.93
961	1996	May	7	10	6	.	.	.	4.3	14.0	4.3	0.3	0.47	5.5	1.51	0.80	15.3	0.63	.	5.54
961	1996	May	4	11	1	5.0	1.9	.	5.1	10.4	.	.	.	.	.	.	.	0.35	.	2.27
961	1996	May	4	11	5	.	.	.	4.4	10.4	.	.	.	.	.	.	.	0.46	.	2.24
961	1996	May	7	13	1	7.0	5.4	.	0.8	4.9	.	.	.	.	.	.	.	0.17	.	0.25
961	1996	May	7	14	1	8.5	1.5	0.73	5.4	17.0	5.8	0.4	1.40	11.8	0.69	0.93	25.3	0.64	.	5.71
961	1996	May	7	16	1	8.0	2.5	.	4.3	8.4	.	.	.	.	.	.	.	0.34	.	0.76
961	1996	May	4	19	1	5.0	5.4	0.24	0.4	4.3	3.7	0.2	0.31	11.8	1.46	0.10	6.0	0.14	.	0.29
961	1996	May	4	20	1	3.0	5.4	.	0.9	4.7	.	.	.	.	.	.	.	0.24	.	2.06
961	1996	May	4	20	8	.	.	.	0.9	4.6	.	.	.	.	.	.	.	0.25	.	2.08
961	1996	May	4	21	1	5.0	5.4	.	0.3	3.4	.	.	.	.	.	.	.	0.15	.	0.25
961	1996	May	.	23	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
961	1996	May	.	23	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
961	1996	May	.	24	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
961	1996	May	.	24	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
962	1996	May	30	4	1	17.0	0.4	.	44.7	92.2	.	.	.	.	.	.	.	2.21	.	8.71
962	1996	May	30	5	1	14.0	3.2	0.30	1.7	6.1	3.8	0.4	0.39	12.7	0.52	0.40	14.5	0.23	.	0.80
962	1996	May	30	7	1	14.0	1.0	.	12.0	19.6	.	.	.	.	.	.	.	1.13	.	6.16
962	1996	May	30	10	1	16.0	0.6	2.28	22.6	53.4	5.8	1.4	1.62	43.6	1.84	2.71	24.3	1.70	.	12.90
962	1996	May	30	10	6	15.0	.	.	18.6	45.3	5.2	1.1	1.17	27.4	1.13	2.45	23.7	1.52	.	12.29
962	1996	May	28	11	1	13.0	2.8	.	3.3	9.4	.	.	.	.	.	.	.	0.67	.	6.49
962	1996	May	28	11	5	.	.	.	3.7	12.7	.	.	.	.	.	.	.	0.81	.	6.26
962	1996	May	30	13	1	13.0	3.6	.	1.1	4.3	.	.	.	.	.	.	.	0.14	.	0.22
962	1996	May	30	14	1	14.5	2.8	0.69	3.5	6.3	2.8	0.3	0.44	9.9	1.04	0.69	10.9	0.31	.	1.58
962	1996	May	30	16	1	12.5	3.9	.	2.2	5.3	.	.	.	.	.	.	.	0.19	.	0.55
962	1996	May	28	19	1	13.0	5.8	0.33	0.4	4.3	2.8	0.6	0.41	31.1	0.99	0.11	10.3	0.10	.	0.12
962	1996	May	28	20	1	12.0	3.6	.	1.7	6.3	.	.	.	.	.	.	.	0.39	.	2.51
962	1996	May	28	20	8	.	.	.	1.4	5.8	.	.	.	.	.	.	.	0.34	.	2.14
962	1996	May	28	21	1	12.5	5.8	.	0.5	3.7	.	.	.	.	.	.	.	0.14	.	0.44
962	1996	May	28	23	1	6.5	5.8	.	0.8	4.0	2.5	0.4	0.32	5.5	1.40	0.23	5.5	0.24	.	1.82
962	1996	May	28	23	14	6.0	.	.	1.0	3.7	2.5	0.6	0.31	5.5	1.43	0.26	5.4	0.26	.	2.16
962	1996	May	28	24	1	11.0	4.1	.	0.8	4.9	.	.	.	.	.	.	.	0.19	.	1.14
962	1996	May	28	24	6	10.5	.	.	0.7	3.7	.	.	.	.	.	.	.	0.20	.	1.11
963	1996	Jun	12	4	1	17.0	1.5	.	3.8	15.7	.	.	.	.	.	.	.	0.42	.	2.69
963	1996	Jun	12	5	1	17.0	3.2	0.51	1.2	9.6	2.7	0.5	0.52	26.5	0.29	0.27	17.4	0.28	.	0.85
963	1996	Jun	12	7	1	17.0	1.5	.	4.6	14.8	.	.	.	.	.	.	.	0.66	.	5.81
963	1996	Jun	12	10	1	16.0	1.0	1.21	8.4	30.2	4.8	0.6	1.06	11.9	0.72	0.69	21.9	0.87	.	6.54
963	1996	Jun	12	10	6	16.0	.	.	8.7	27.6	4.2	0.5	1.05	11.9	0.72	1.18	21.7	0.89	.	6.13
963	1996	Jun	11	11	1	16.0	1.5	.	5.4	22.3	.	.	.	.	.	.	.	0.74	.	4.79
963	1996	Jun	11	11	5	.	.	.	5.8	18.6	.	.	.	.	.	.	.	0.68	.	5.02
963	1996	Jun	11	13	1	15.0	4.1	.	0.9	3.8	.	.	.	.	.	.	.	0.17	.	0.67
963	1996	Jun	12	14	1	17.0	4.1	0.27	0.5	5.8	2.6	0.4	0.75	31.7	0.13	0.13	15.7	0.12	.	0.35
963	1996	Jun	12	16	1	16.0	3.2	.	0.9	8.1	.	.	.	.	.	.	.	0.17	.	0.88
963	1996	Jun	11	19	1	15.0	4.1	0.20	1.0	5.0	2.8	0.3	0.41	19.3	0.66	0.36	10.9	0.16	.	1.03
963	1996	Jun	11	20	1	14.0	4.5	.	1.1	6.0	.	.	.	.	.	.	.	0.22	.	1.43
963	1996	Jun	11	20	8	14.0	.	.	1.2	6.2	.	.	.	.	.	.	.	0.25	.	1.49
963	1996	Jun	11	21	1	13.5	7.1	.	0.6	4.2	.	.	.	.	.	.	.	0.13	.	0.79
963	1996	Jun	11	23	1	9.0	7.1	0.14	0.6	4.0	2.0	0.2	0.33	3.2	1.31	0.17	5.4	0.13	.	1.92
963	1996	Jun	11	23	14	8.0	.	.	0.9	4.0	2.4	0.2	0.34	3.2	1.40	0.29	5.1	0.19	.	1.94
963	1996	Jun	11	24	1	15.0	4.9	.	1.2	4.4	.	.	.	.	.	.	.	0.25	.	1.46
963	1996	Jun	11	24	6	.	.	.	1.3	4.0	.	.	.	.	.	.	.	0.26	.	1.54
964	1996	Jun	27	4	1	23.5	2.6	.	2.4	18.6	.	.	.	.	.	.	.	0.75	.	4.25
964	1996	Jun	27	5	1	23.0	2.8	0.44	0.7	9.3	4.5	0.5	0.59	23.2	0.44	0.10	17.4	0.25	.	0.45
964	1996	Jun	27	7	1	23.0	2.1	.	3.1	19.1	.	.	.	.	.	.	.	0.75	.	2.54
964	1996	Jun	27	10	1	21.0	1.9	0.73	3.8	16.9	4.2	0.6	1.04	11.5	0.75	0.50	21.1	0.60	.	2.97
964	1996	Jun	27	10	6	20.0	.	.	2.8	14.6	4.2	0.5	1.04	15.0	0.78	0.45	20.6	0.57	.	3.02
964	1996	Jun	27	11	1	19.5	2.3	.	2.4	13.9	.	.	.	.	.	.	.	0.57	.	1.67
964	1996	Jun	27	11	5	.	.	.	2.2	15.2	.	.	.	.	.	.	.	0.54	.	2.60
964	1996	Jun	27	13	1	20.0	4.1	.	0.7	9.0	.	.	.	.	.	.	.	0.29	.	0.73
964	1996	Jun	27	14	1	22.0	4.1	0.49	1.2	13.1	8.0	0.6	2.72	6.3	0.43	0.13	20.5	0.40	.	2.24
964	1996	Jun	27	16	1	21.5	4.1	.	1.0	7.7	.	.	.	.	.	.	.	0.24	.	0.87
964	1996	Jun	27	19	1	18.5	2.8	0.60	1.6	11.6	5.4	0.5	0.89	12.5	0.72	0.36	18.8	0.41	.	1.95
964	1996	Jun	27	20	1	18.0	3.4	.	1.2	8.3	.	.	.	.	.	.	.	0.28	.	1.33
964	1996	Jun	27	20	8	.	.	.	1.1	6.8	.	.	.	.	.	.	.	0.28	.	1.33
964	1996	Jun	27	21	1	18.0	7.1	.	1.6	6.6	.	.	.	.	.	.	.	0.28	.	0.62
964	1996	Jun	27	23	1	14.0	7.1	0.22	0.4	3.2	2.2	0.5	0.27	5.8	1.25	0.11	5.4	0.19	.	0.64
964	1996	Jun	27	23	14	9.0	.	.	1.1	3.8	2.8	0.4	0.27	4.8	1.19	0.40	5.1	0.41	.	2.43
964	1996	Jun	27	24	1	18.0	5.8	.	0.4	4.7	.	.	.	.	.	.	.	0.22	.	0.76
964	1996	Jun	27	24	6	17.0	.	.	0.8	6.9	.	.	.	.	.	.	.	0.20	.	0.99
965	1996	Jul	17	4	1	22.5	1.9	.	3.7	26.5	.	.	.	.	.	.	.	0.83	.	5.68
965	1996	Jul	17	5	1	22.5	3.6	0.45	1.0	13.4	7.8	1.0	0.79	26.4	0.59	0.10	20.7	0.44	.	1.85
965	1996	Jul	17	7	1	22.0	2.8	.	2.4	15.7	.	.	.	.	.	.	.	0.56	.	2.62
965	1996	Jul	17	10	1	22.0	3.6	0.46	2.2	15.6	6.8	0.8	0.61	18.6	1.05	0.32	17.9	0.59	.	3.13
965	1996	Jul	17	10	6	21.0	.	.	2.3	12.6	4.8	0.8	0.38	10.6	1.08	0.36	12.5	0.57	.	2.44
965	1996	Jul	15	11	1	21.0	4.5	.	1.0	10.3	.	.	.	.	.	.	.	0.36	.	1.13

	Sampling Dates			Station	Depth	Temp	Secchi	KPAR	TSS	TP	TDP	SRP	NIT	AMM	SILICA	PSI	CL	POC	DOC	CHL
Cruise	Year	Month	Day	ID	(m)	(oC)	(m)	(/m)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(mg/L)	(ug/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ug/L)
965	1996	Jul	15	11	5	18.5	.	.	0.8	9.2	.	.	.	.	.	.	.	0.30	.	1.20
965	1996	Jul	17	13	1	23.0	2.3	.	3.0	23.6	.	.	.	.	.	.	.	0.97	.	6.47
965	1996	Jul	17	14	1	23.0	2.8	0.91	1.9	21.0	8.4	1.3	2.37	40.2	1.98	0.32	21.7	0.50	.	3.38
965	1996	Jul	17	16	1	23.0	1.9	.	4.8	36.6	.	.	.	.	.	.	.	1.01	.	10.22
965	1996	Jul	15	19	1	19.5	4.9	0.32	1.1	9.2	3.8	0.7	0.51	10.1	1.03	0.25	12.6	0.35	.	2.26
965	1996	Jul	15	20	1	17.0	7.9	.	0.6	6.1	.	.	.	.	.	.	.	0.27	.	0.88
965	1996	Jul	15	20	8	16.5	.	.	0.7	5.5	.	.	.	.	.	.	.	0.32	.	0.99
965	1996	Jul	15	21	1	19.0	7.9	.	0.3	4.3	.	.	.	.	.	.	.	0.17	.	0.53
965	1996	Jul	15	23	1	18.0	6.2	0.26	0.5	3.9	3.8	0.4	0.26	7.0	1.15	0.12	6.6	0.24	.	0.87
965	1996	Jul	15	23	14	15.0	.	.	0.8	4.1	2.6	0.4	0.26	5.0	1.18	0.22	6.6	0.30	.	1.45
965	1996	Jul	15	24	1	20.5	4.9	.	1.4	6.6	.	.	.	.	.	.	.	0.43	.	2.26
965	1996	Jul	15	24	6	20.5	.	.	1.3	8.6	.	.	.	.	.	.	.	0.43	.	2.54
966	1996	Aug	21	4	1	24.5	1.5	.	8.5	24.8	.	.	.	.	.	.	.	2.16	.	17.13
966	1996	Aug	21	5	1	25.0	1.5	1.03	10.5	23.8	4.6	0.9	0.17	10.7	2.91	0.57	20.2	2.78	.	16.79
966	1996	Aug	21	7	1	24.0	2.8	.	3.7	13.2	.	.	.	.	.	.	.	1.04	.	5.53
966	1996	Aug	21	10	1	23.5	2.8	0.82	4.0	13.4	4.1	1.0	0.27	10.2	2.11	0.54	13.7	1.21	.	6.63
966	1996	Aug	21	10	6	23.5	.	.	6.8	17.9	3.7	1.0	0.26	7.6	2.37	0.63	14.5	1.85	.	11.40
966	1996	Aug	21	11	1	21.0	2.3	.	4.4	11.7	.	.	.	.	.	.	.	.	.	8.76
966	1996	Aug	21	11	5	.	.	.	4.6	11.7	.	.	.	.	.	.	.	.	.	9.23
966	1996	Aug	21	13	1	24.0	1.9	.	6.8	11.1	.	.	.	.	.	.	.	1.95	.	10.41
966	1996	Aug	21	14	1	24.0	1.7	0.99	9.4	21.1	3.1	0.8	0.19	6.8	1.21	0.76	16.5	2.61	.	15.57
966	1996	Aug	21	16	1	24.0	1.9	.	5.8	12.9	.	.	.	.	.	.	.	1.69	.	9.04
966	1996	Aug	21	19	1	23.0	1.9	0.74	6.6	11.9	2.5	0.8	0.24	7.6	0.61	0.91	13.6	1.73	.	9.73
966	1996	Aug	21	20	1	22.0	3.6	.	2.3	5.7	.	.	.	.	.	.	.	0.71	.	3.24
966	1996	Aug	21	20	8	22.0	.	.	2.3	5.9	.	.	.	.	.	.	.	0.73	.	3.25
966	1996	Aug	21	21	1	21.0	4.1	.	1.8	5.0	.	.	.	.	.	.	.	0.87	.	1.96
966	1996	Aug	21	23	1	21.5	6.2	0.20	0.9	3.3	1.4	0.5	0.33	8.6	0.64	0.27	8.6	0.56	.	1.04
966	1996	Aug	21	23	14	12.6	.	.	0.8	2.5	1.9	0.5	0.33	7.4	0.64	0.26	8.5	0.55	.	1.01
966	1996	Aug	21	24	1	22.0	5.4	.	1.2	3.3	.	.	.	.	.	.	.	0.74	.	1.48
966	1996	Aug	21	24	6	21.5	.	.	1.4	4.4	.	.	.	.	.	.	.	0.87	.	1.58
967	1996	Sep	20	4	1	19.0	0.7	.	16.6	42.4	.	.	.	.	.	.	.	2.58	.	20.97
967	1996	Sep	20	5	1	18.2	1.3	0.97	7.0	15.8	3.0	1.3	0.08	4.9	1.71	0.62	14.1	1.77	.	7.68
967	1996	Sep	20	7	1	19.2	1.0	.	8.7	25.5	.	.	.	.	.	.	.	1.84	.	12.57
967	1996	Sep	20	10	1	19.0	1.2	1.33	8.1	25.3	3.1	1.5	0.13	5.3	2.44	0.76	12.6	1.47	.	11.71
967	1996	Sep	20	10	6	.	.	.	10.8	32.5	2.7	1.5	0.13	9.6	2.42	1.24	12.7	1.72	.	16.42
967	1996	Sep	20	11	1	17.0	1.0	.	11.2	31.1	.	.	.	.	.	.	.	1.97	.	16.50
967	1996	Sep	20	11	5	.	.	.	11.6	30.5	.	.	.	.	.	.	.	1.98	.	16.07
967	1996	Sep	20	13	1	18.0	4.1	.	0.9	3.8	.	.	.	.	.	.	.	0.21	.	0.77
967	1996	Sep	20	14	1	18.5	0.6	1.32	15.4	29.6	2.3	1.5	0.09	6.8	0.82	0.86	18.0	3.12	.	13.13
967	1996	Sep	20	16	1	19.0	2.8	.	2.6	8.6	.	.	.	.	.	.	.	0.79	.	3.64
967	1996	Sep	20	19	1	18.0	4.1	0.20	0.6	3.5	1.4	0.8	0.28	23.1	0.86	0.10	7.3	0.16	.	0.25
967	1996	Sep	20	20	1	18.0	2.1	.	8.9	22.3	.	.	.	.	.	.	.	1.89	.	12.36
967	1996	Sep	20	20	8	18.0	.	.	9.8	23.5	.	.	.	.	.	.	.	1.82	.	11.94
967	1996	Sep	20	21	1	18.0	4.1	.	1.4	4.6	.	.	.	.	.	.	.	0.43	.	1.98
967	1996	Sep	20	23	1	18.0	6.6	0.19	0.8	2.7	1.2	0.7	0.25	9.6	1.10	0.23	6.3	0.16	.	1.38
967	1996	Sep	20	23	14	.	.	.	0.8	2.9	1.4	0.6	0.25	8.8	1.13	0.24	6.5	0.17	.	1.40
967	1996	Sep	20	24	1	18.0	2.6	.	2.8	6.1	.	.	.	.	.	.	.	0.55	.	3.08
967	1996	Sep	20	24	6	.	.	.	3.6	7.5	.	.	.	.	.	.	.	0.69	.	3.91