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Compliance Monitoring and Long-term Water Quality and Biological Indicator Trends in Hillsborough Bay Initial Report

City of Tampa Department of Sanitary Sewers

COMPLIANCE MONITORING AND LONG-TERM WATER QUALITY AND BIOLOGICAL INDICATOR TRENDS IN HILLSBOROUGH BAY
INITIAL REPORT

submitted to

the Florida Department of Environmental Regulation
Tampa Office

May 1, 1990

by

City of Tampa
Department of Sanitary Sewers
Bay Study Group

INTRODUCTION

This is the second 1990 report to FDER to satisfy the requirements set forth in specific condition #6 of FDER construction permit DC29-152790. This report includes trend analyses of water quality parameters and biological indicators of water quality collected by us, and the Hillsborough County Environmental Protection Commission (HCEPC). Trend results are grouped into two major sections: 1) compliance monitoring, and 2) long-term trends of water quality and biological indicator data collected by the City of Tampa (COT).

Compliance monitoring results cover data we collect monthly at three northern Hillsborough Bay sampling stations initially sampled in January 1990. Samples collected at these stations are analyzed at the HCEPC laboratory for carbonaceous biological oxygen demand (5 day), total phosphorus, ortho-phosphate, total nitrogen, total Kjeldahl nitrogen, nitrite+nitrate-nitrogen, and ammonia-nitrogen. In addition, we measure chlorophyll-a and dissolved oxygen from these three stations. Compliance monitoring results also include trend analyses of annually averaged Hillsborough Bay water quality data collected at 14 stations by the HCEPC.

Our long-term water quality and biological indicator monitoring study reflects a multidisciplinary approach to water quality assessment of Hillsborough Bay. Assessed trends encompass water clarity (Secchi disk depths), dissolved oxygen, phytoplankton growth rates, phytoplankton cell concentrations, drift macroalgae biomass, and the growth of seagrasses and the attached benthic alga Caulerpa prolifera. Seagrasses and Caulerpa prolifera were reported on previously in our first 1990 report submitted to FDER March 1, 1990.

METHODS

Field and laboratory methods are described in the monitoring plan report submitted to the FDER Tampa office on November 16, 1989 entitled "City of Tampa Surface Monitoring Plan of Hillsborough Bay."

RESULTS-TREND ANALYSES

Compliance Monitoring

Hillsborough Bay data collected by the COT (stations 15, 16 and 17):

Three months of data (Tables 1 and 2) from our compliance monitoring stations (Figure 1) have been tabulated. No graphical trends were evident with only three months of information.

Hillsborough Bay data collected by the HCEPC:

Annual averages for all 14 HCEPC stations and for the group of stations close to the COT AWT outfall (2, 6, 52 and 70; see Figure 1) are plotted on each of the following graphs (Figures 2-10).

Total Nitrogen (TN; Figure 2):
Excluding 1987, TN has declined since 1983. Nitrogen data generated by the HCEPC prior to 1980 has been deemed questionable by HCEPC.

Total Kjeldahl Nitrogen (TKN; Figure 3):
Excluding 1987, TKN also has been decreasing since 1983.

Total Phosphorus (TP; Figure 4):
The highest TP levels (~2ppm) occurred in 1974, but concentration have now declined to values of 0.6-0.7ppm during the last several years.

Ortho-Phosphate (OP; Figure 5):
OP trends are similar to the TP trends described above.

Biological Oxygen Demand (BOD_5; Figure 6):
BOD_5 peaked during 1976-77 (4.5-5mg/l). Values have gradually declined until leveling off in 1984 when the present average of about 2.0mg/l was reached.

Dissolved Oxygen (DO; Figures 7-9):
Surface, mid-depth, and bottom DO's (Figures 6, 7 and 8, respectively) show slightly declining trends in concentrations since 1980.

Chlorophyll-a (chl-a; Figure 10):
Chl-a concentrations were greatest between 1975 and 1983 when values ranged from about 23 to 32ug/l. Chl-a decreased considerably after 1983 and has leveled off at about 15ug/l since 1987.

Long-Term Trends of Annually Averaged Water Quality and Biological Indicator Data collected by the COT

COT water quality station locations are shown on Figure 11.

Phytoplankton Production (Figure 12):
Integrated production has shown a steady decline since 1985 at all three stations. In general, the Middle Tampa Bay station (13) has lower production relative to the Hillsborough Bay stations (4 and 12).

Chlorophyll-a (Chl-a; Figure 13):
Surface chl-a dropped off sharply between 1982 and 1984. A gradual decline to the average 1989 concentrations of 15.0, 9.9, and 5.5ug/l for stations 4, 12 and 13, respectively, has occurred.

Total Phytoplankton (Figure 14):
No long-term trends of total phytoplankton cell concentrations are apparent. The Hillsborough Bay stations have higher cell concentrations compared to the Middle Tampa Bay station.

Schizothrix calcicola sensu Drouet (Figure 15):
This blue-green alga has shown a marked reduction in numbers after 1983 and has maintained concentrations of less than one-third of the pre-1984 levels during the last six years.

Dissolved Oxygen (DO; Figure 16):
Annually averaged surface and bottom DO's have declined gradually since 1986 at all three stations. DO prior to 1986 is considered questionable, and was not reported, due to possible interferences encountered using the Winkler titration method. All DO has been measured using a probe since 1986.

Secchi Disk Depths (Figure 17):
Secchi disk depths have gradually increased at all three stations since 1982.

COT macroalgae transect locations are shown on Figure 18.

Macroalgae Catch (Figure 19):
Long term temporal trends are not apparent from the first four years of data. Spatial trends show that two areas, Transect B in northeastern Hillsborough Bay, and Transect E in northwestern Hillsborough Bay, have much higher average drift macroalgae accumulations compared to the other areas surveyed.

DISCUSSION

Trends from both HCEPC and our data have shown improvements during the last 10-15 years. Most of these trends are in accord with our knowledge of the nutrient loading history of Hillsborough Bay. A few of these trends, however, warrant further explanation.

The TN and TKN concentration were extremely high in 1987, thereby breaking the declining trend initiated in 1983 (Figures 2 and 3). Further scrutiny revealed unusually high 1987 Delaney Creek TN loads. In addition, HCEPC data show high TN ambient concentration for most of Tampa Bay during 1987. In the perspective of TN loadings to Hillsborough Bay within the last 5 years, these 1987 TN concentrations suggest that some major, presently unknown, source (or sources) of nitrogen was released into Hillsborough Bay and/or Tampa Bay. We believe all possible resources should be utilized to investigate the 1987 TN pulse in order to preclude another similar occurrence.

The TP and OP concentrations (Figures 4 and 5) reveal that the northern Hillsborough Bay stations 2, 6, 52, and 70, had consistently lower values than the average of all Hillsborough Bay stations. The northern Hillsborough Bay stations had lower values since they are not directly influenced by the Alafia River, which was the dominant phosphorus source to Hillsborough Bay.

We cannot explain the declining DO's illustrated by the HCEPC and our data (Figures 7-9, and 16). However, we feel that wet season and dry season DO averages, rather than calender year averages, may be a more relevant way to assess water quality trends.

Although HCEPC and our chl-a trends in Hillsborough Bay are very similar, our concentrations (Figure 13) are higher than those measured by the HCEPC (Figure 10) before 1984 due to methodology differences. We grind our filters and the HCEPC do not grind filters as part of the pigment extraction process. The blue-green algae, Schizothrix calicola sensu Drouet, periodically dominated the phytoplankton community prior to 1984. Unless blue-green cells are ground, a complete pigment extraction does not occur. Consequently, we believe HCEPC chl-a values are lower, prior to 1984, due to the incomplete extraction of these blue-green algae pigments.

Increases in Secchi disk depths (Figure 17), or apparent water clarity, appear to be related to decreases in chl-a (Figure 13). These inversely related trends suggest that the phytoplankton biomass is an important determinant of water clarity.

Our data, averaged form 1979 to 1989, indicate that the phytoplankton biomass per unit volume (ug/l chl-a) in Middle Tampa Bay is about one-half the average biomass found in Hillsborough Bay. In Hillsborough Bay, relative to Middle Tampa Bay, the greater chl-a values are also reflected in higher phytoplankton production, higher total phytoplankton and blue-green algae concentrations, and lower Secchi disk depths.

Table 1. Results of water quality parameters collected at compliance monitoring stations 15, 16 and 17. STA= station; DEP=sample depth (m); DEP.B=bottom DEP (m); SD=Secchi depth (m); SAL=salinity (ppt); DO=dissolved oxygen (mg/l); DO.B=bottom DO (mg/l); TEMP=temperature (°C); CHL-a=chlorophyll-a (ug/l)

DATE	STA	EST TIME	DEP	DEP.B	SD	SAL	DO	DO.B	TEMP	CHL-a
01/10/90	15	07:11	0.0	3.4	2.7	25.5	8.1	6.5	16.5	7.52
01/10/90	15	07:11	1.0				7.9		16.5	
01/10/90	15	07:11	2.0			26.0	6.9		17.2	
01/10/90	15	07:11	3.0				6.6		17.2	
01/10/90	15	07:11	4.0			26.0	6.5		17.2	
01/10/90	16	07:22	0.0	3.0	2.3	25.0	7.1	6.3	17.8	9.33
01/10/90	16	07:22	1.0			25.0	6.8		17.8	
01/10/90	16	07:22	2.0				6.6		17.8	
01/10/90	16	07:22	3.0			26.0	6.3		17.5	
01/10/90	17	07:32	0.0	2.0	BOT	24.0	6.9	6.8	18.0	8.99
01/10/90	17	07:32	1.0			24.0	6.8		18.0	
01/10/90	17	07:32	2.0			24.0	6.8		18.0	
02/14/90	15	07:25	0.0	4.0	1.4	23.5	6.6	5.4	20.5	7.43
02/14/90	15	07:25	1.0			23.8	6.5		21.0	
02/14/90	15	07:25	2.0			24.0	6.2		21.0	
02/14/90	15	07:25	3.0			24.5	6.1		21.0	
02/14/90	15	07:25	4.0			24.5	5.4		21.0	
02/14/90	16	07:35	0.0	3.3	1.4	23.5	6.8	6.1	20.5	6.34
02/14/90	16	07:35	1.0			23.5	6.8		20.5	
02/14/90	16	07:35	2.0			23.5	6.7		20.5	
02/14/90	16	07:35	3.0			24.5	6.4		21.0	
02/14/90	16	07:35	4.0			24.5	6.1		21.0	
02/14/90	17	07:45	0.0	2.5	1.1	24.0	6.7	6.4	20.5	7.05
02/14/90	17	07:45	1.0			24.0	6.5		20.5	
02/14/90	17	07:45	2.0			24.0	6.4		20.5	
02/14/90	17	07:45	2.5			24.0	6.4		20.5	
03/14/90	15	07:12	0.0	3.9	1.4	24.5	7.2	4.8	22.0	13.78
03/14/90	15	07:12	1.0			25.0	7.2		22.0	
03/14/90	15	07:12	2.0			25.0	6.8		22.0	
03/14/90	15	07:12	3.0			25.0	5.4		22.0	
03/14/90	15	07:12	4.0			25.0	4.8		22.0	
03/14/90	16	07:31	0.0	3.5	1.4	24.5	7.3	6.4	21.5	11.8
03/14/90	16	07:31	1.0			24.5	7.3		21.5	
03/14/90	16	07:31	2.0			25.0	7.1		22.0	
03/14/90	16	07:31	3.0			25.0	6.7		22.0	
03/14/90	16	07:31	3.5			25.0	6.4		22.0	
03/14/90	17	07:47	0.0	2.5	1.7	25.0	7.0	6.8	22.0	7.92
03/14/90	17	07:47	1.0			25.0	7.0		22.0	
03/14/90	17	07:47	2.0			25.0	6.9		22.0	
03/14/90	17	07:47	2.5			25.0	6.8		22.0	

Table 2. Results of nutrient samples analyzed by the Environmental Protection Commission of Hillsborough County at compliance monitoring stations 15, 16 and 17.

DATE	STA	EST TIME	mg/l NO2 +NO3	TP	OP	TKN	NH3-N	TN	CBOD5
01/10/90	15	07:11	0.03	0.42	0.46	0.86	0.08	0.89	0.43
01/10/90	16	07:22	0.03	0.45	0.47	0.73	0.05	0.76	0.47
01/10/90	17	07:32	0.01	0.44	0.46	0.71	0.06	0.72	0.90
02/14/90	15	07:25	0.04	0.68	0.60	0.94	0.12	0.98	0.95
02/14/90	16	07:35	0.04	0.75	0.68	0.91	0.12	0.95	0.80
02/14/90	17	07:45	0.05	0.62	0.56	0.98	0.17	1.03	1.20
03/14/90	15	07:12	0.05	0.57	0.46	0.92	0.09	0.97	1.19
03/14/90	16	07:31	0.02	0.48	0.56	0.77	0.82	0.79	1.08
03/14/90	17	07:47	0.02	0.44	0.84	0.70	0.06	0.72	0.61

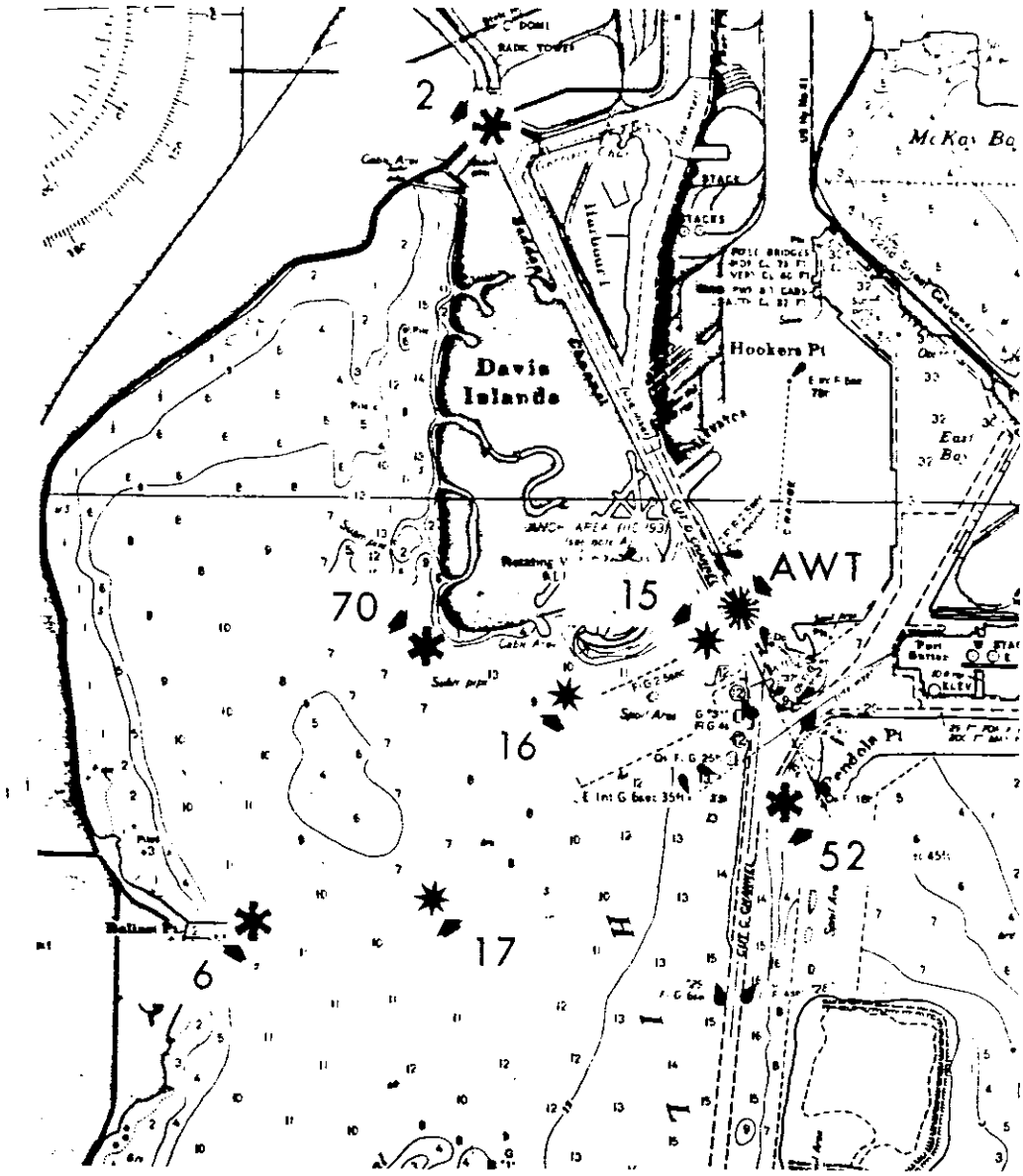

Figure 1. The Hookers Point outfall (AWT; ✸), COT compliance monitoring stations (✱), and nearby EPC stations (✱) in Hillsborough Bay.

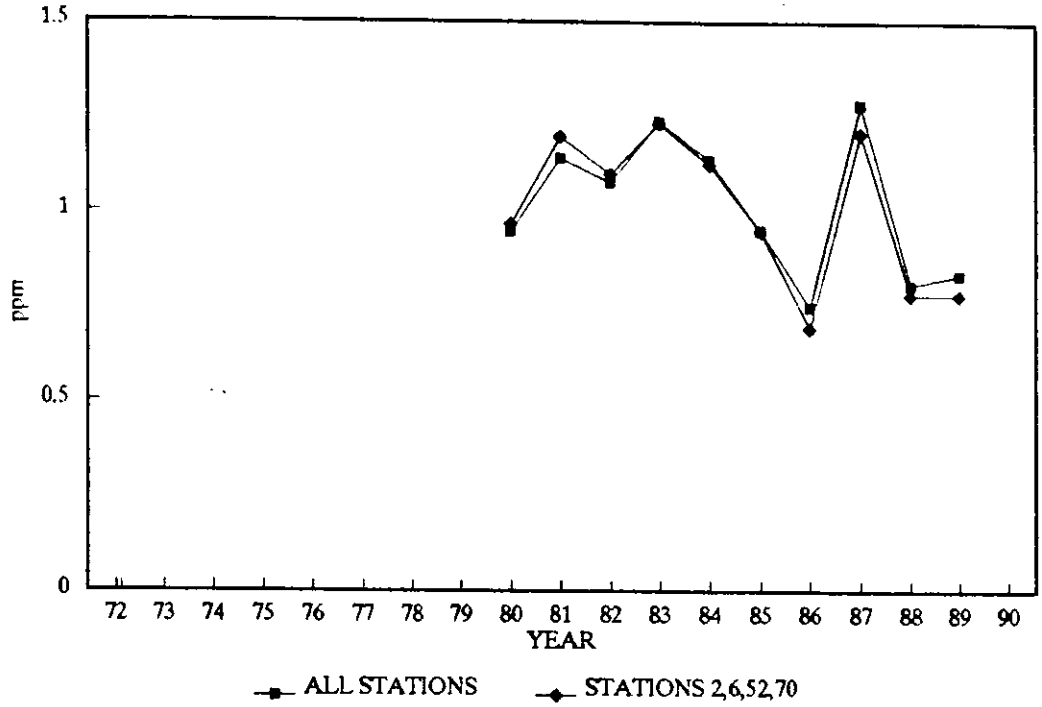

Figure 2. Annual average concentrations of total nitrogen for stations sampled in Hillsborough Bay by HCEPC.

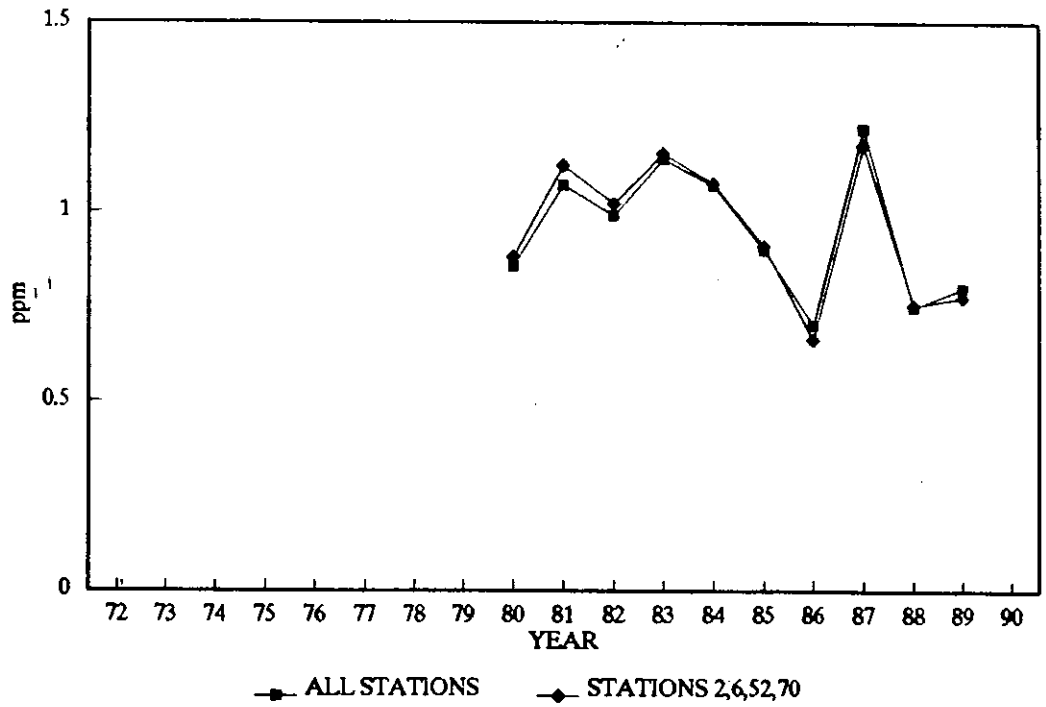

Figure 3. Annual average concentrations of Kjeldahl nitrogen for stations sampled in Hillsborough Bay by HCEPC.

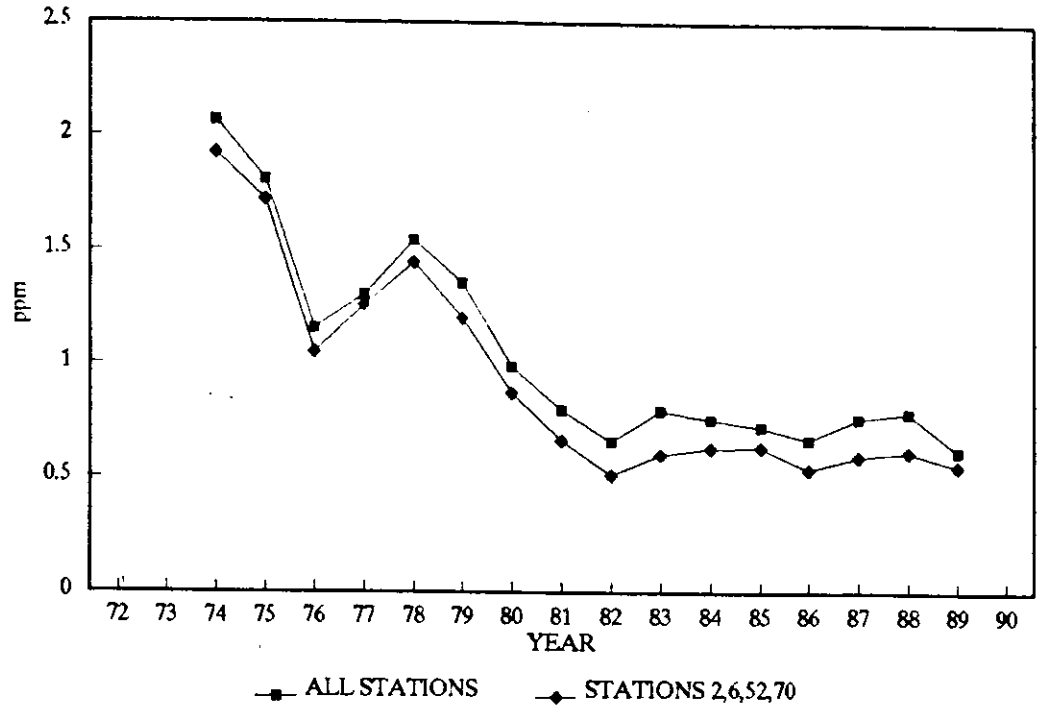

Figure 4. Annual average concentrations of total phosphorus for stations sampled in Hillsborough Bay by HCEPC.

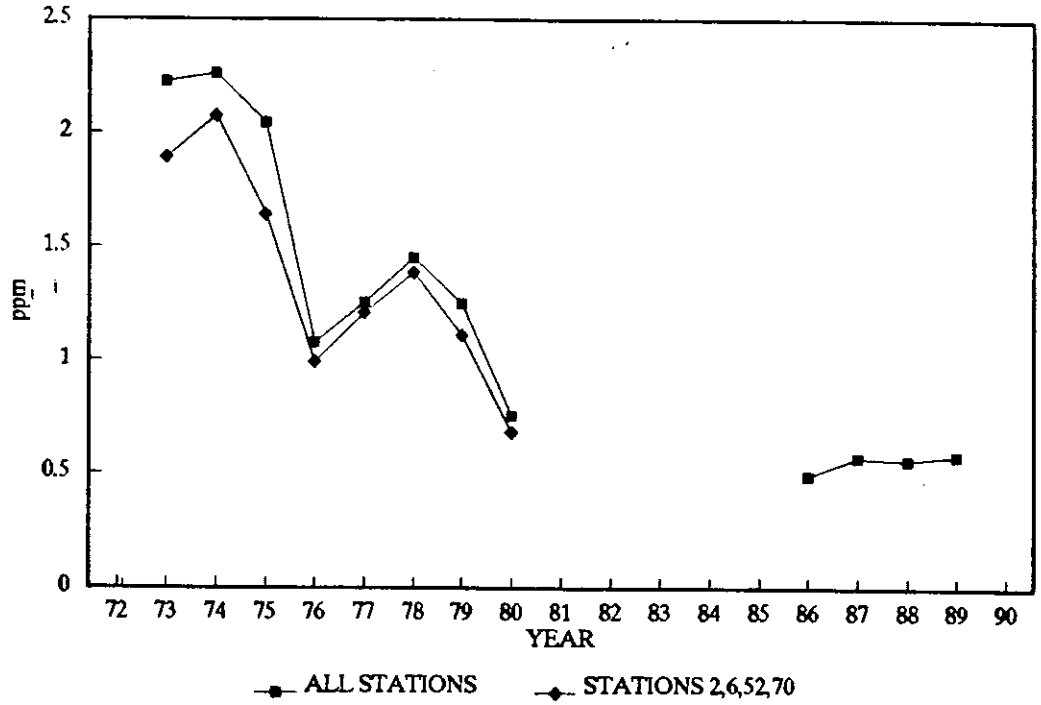

Figure 5. Annual average concentrations of ortho-phosphate for stations sampled in Hillsborough Bay by HCEPC.

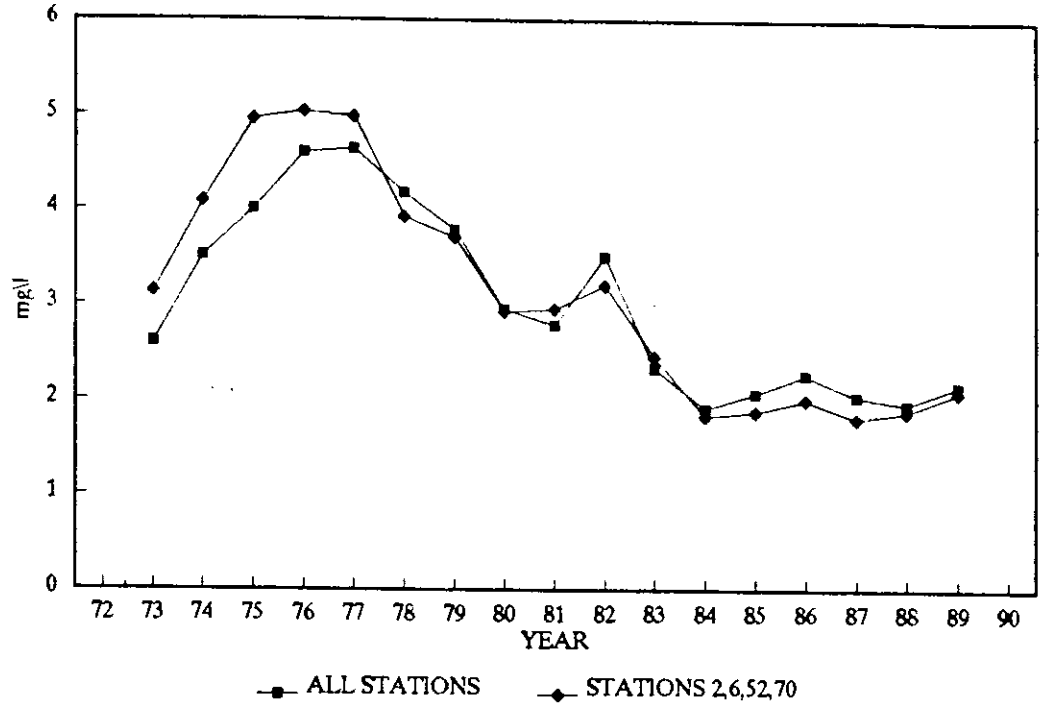

Figure 6. Annual average concentrations of BOD_5 for stations sampled in Hillsborough Bay by HCEPC.

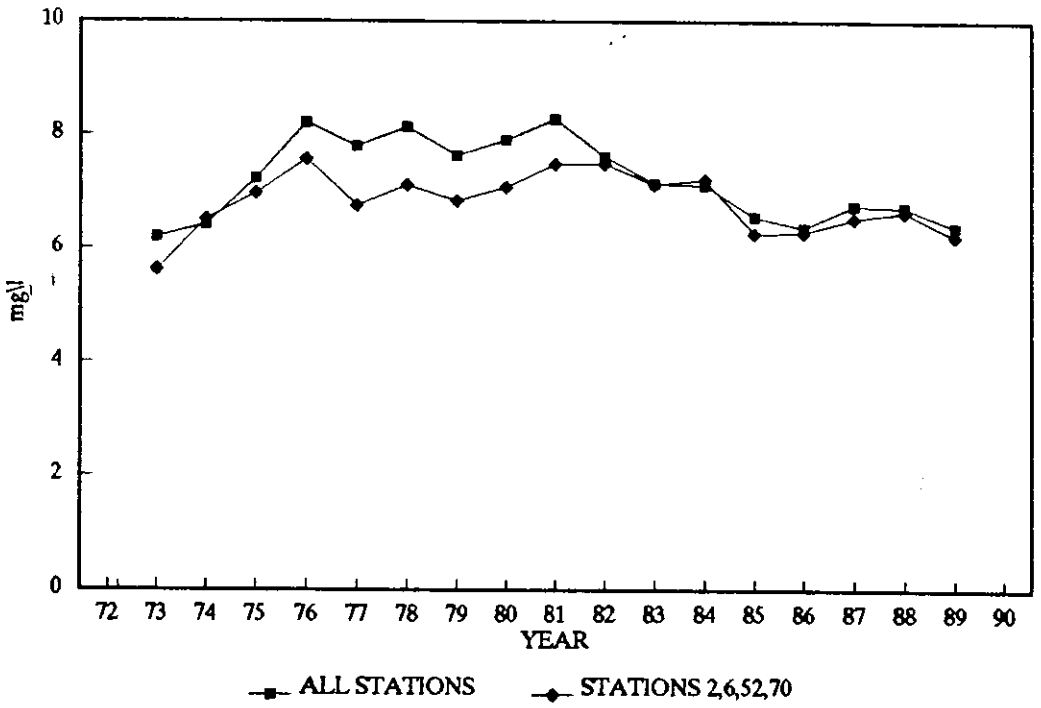

Figure 7. Annual average concentrations of surface dissolved oxygen for stations sampled in Hillsborough Bay by HCEPC.

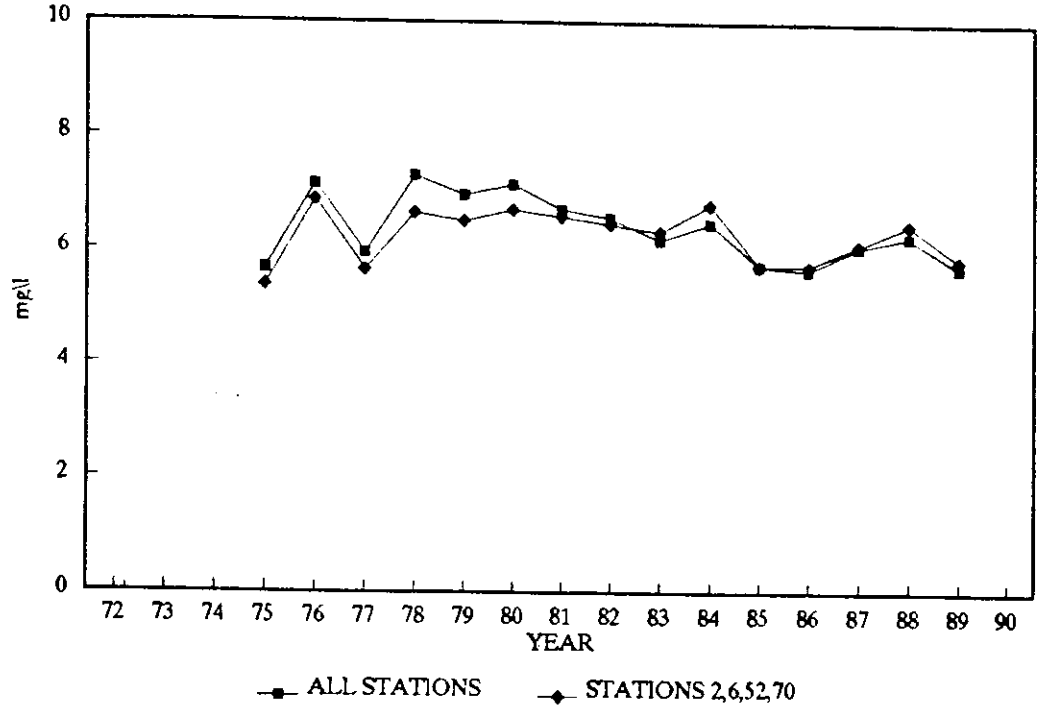

Figure 8. Annual average concentrations of mid-depth dissolved oxygen for stations sampled in Hillsborough Bay by HCEPC.

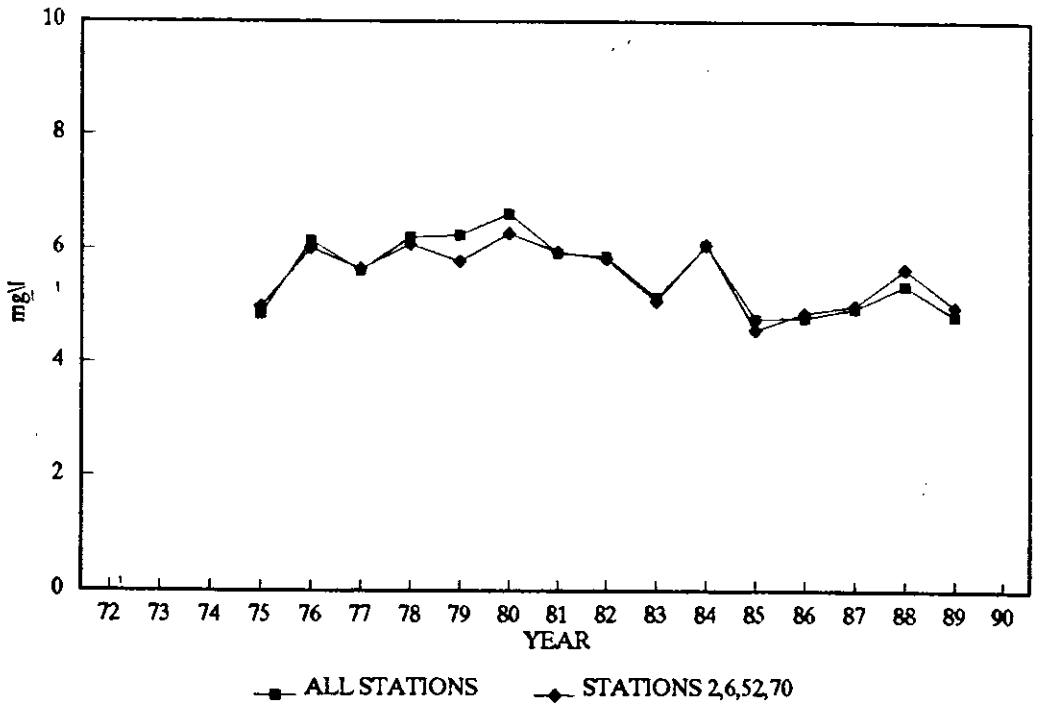

Figure 9. Annual average concentrations of bottom dissolved oxygen for stations sampled in Hillsborough Bay by HCEPC.

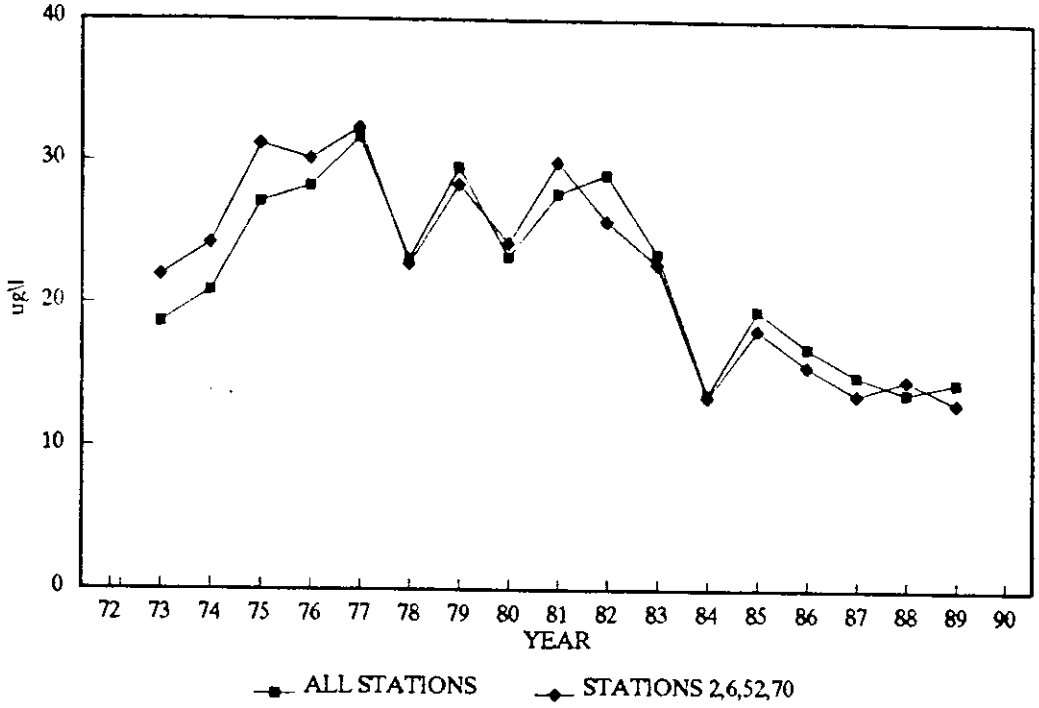

Figure 10. Annual average concentrations of chlorophyll-a for stations sampled in Hillsborough Bay by HCEPC.

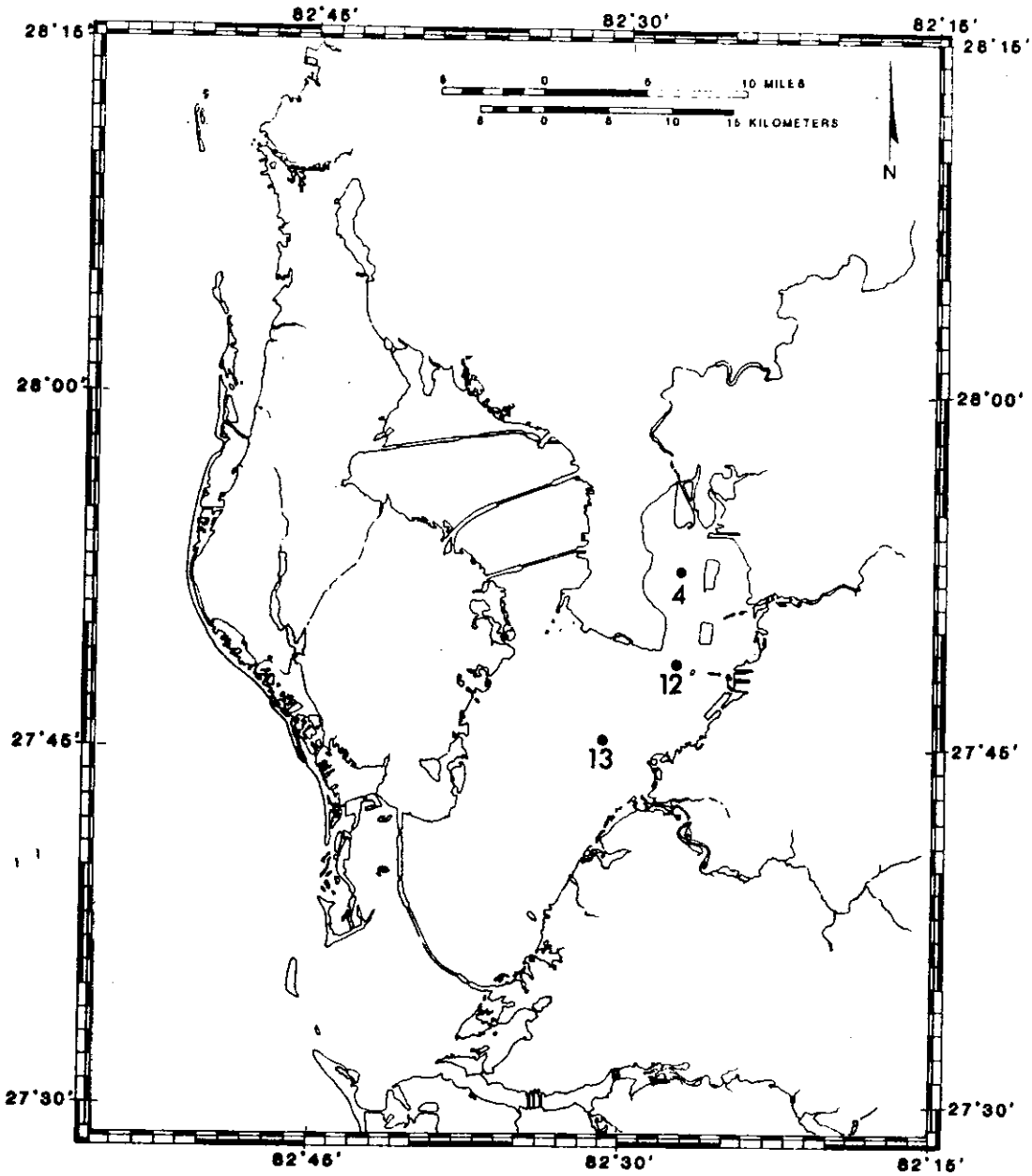

Figure 11. Locations of water quality stations in the Tampa Bay system sampled by the COT.

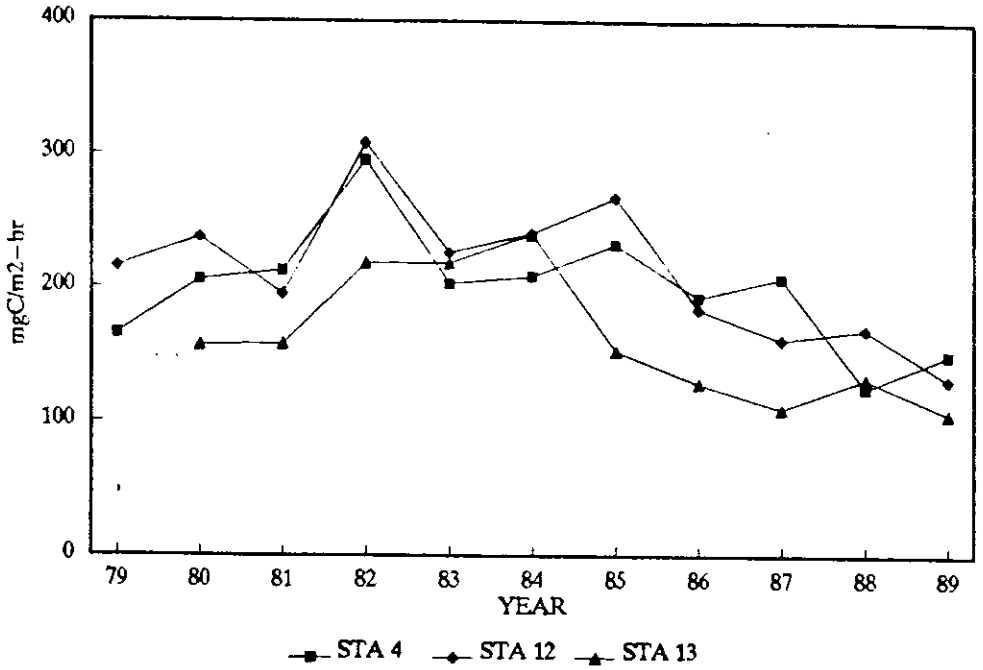

Figure 12. Annual average depth integrated phytoplankton production sampled by the COT at stations 4 and 12 in Hillsborough Bay and at station 13 in Middle Tampa Bay.

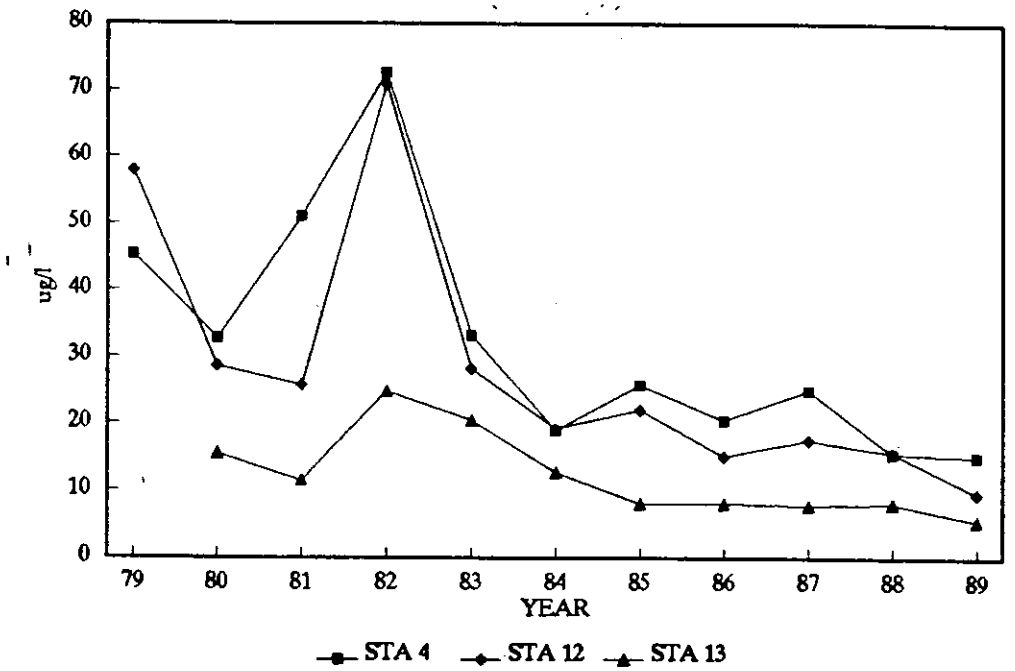

Figure 13. Annual average concentrations of chlorophyll-a sampled by the COT at stations 4 and 12 in Hillsborough Bay and at station 13 in Middle Tampa Bay.

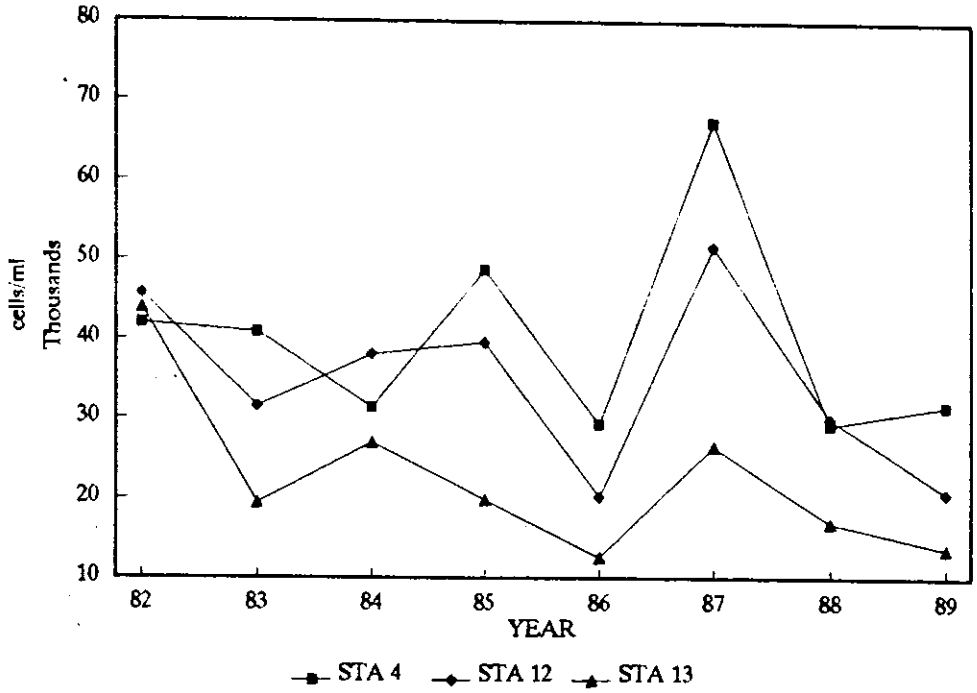

Figure 14. Annual average densities of total phytoplankton sampled by the COT at stations 4 and 12 in Hillsborough Bay and at station 13 in Middle Tampa Bay.

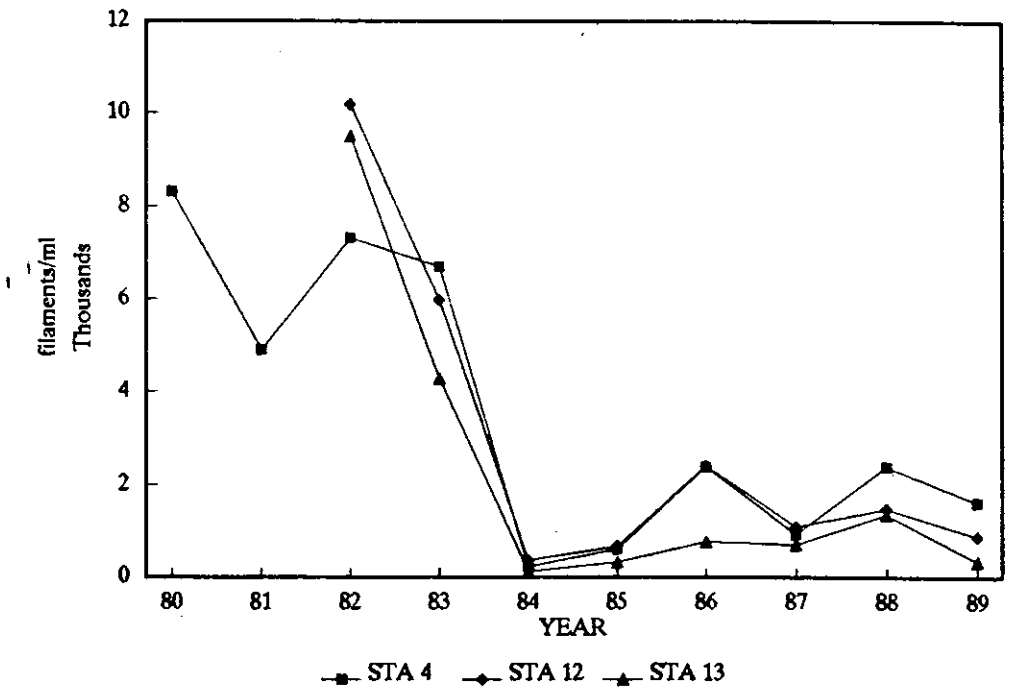

Figure 15. Annual average densities of Schizothrix calcicola sensu Drouet sampled by the COT at stations 4 and 12 in Hillsborough Bay and at station 13 in Middle Tampa Bay.

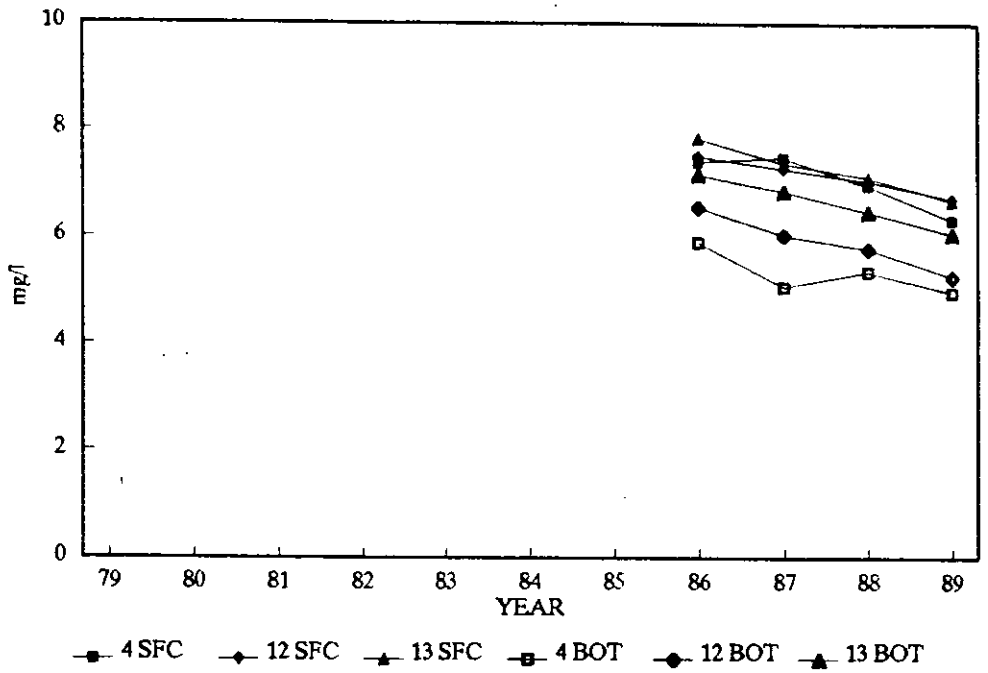

Figure 16. Annual average concentrations of surface and bottom dissolved oxygen sampled by the COT at stations 4 and 12 in Hillsborough Bay and at station 13 in Middle Tampa Bay.

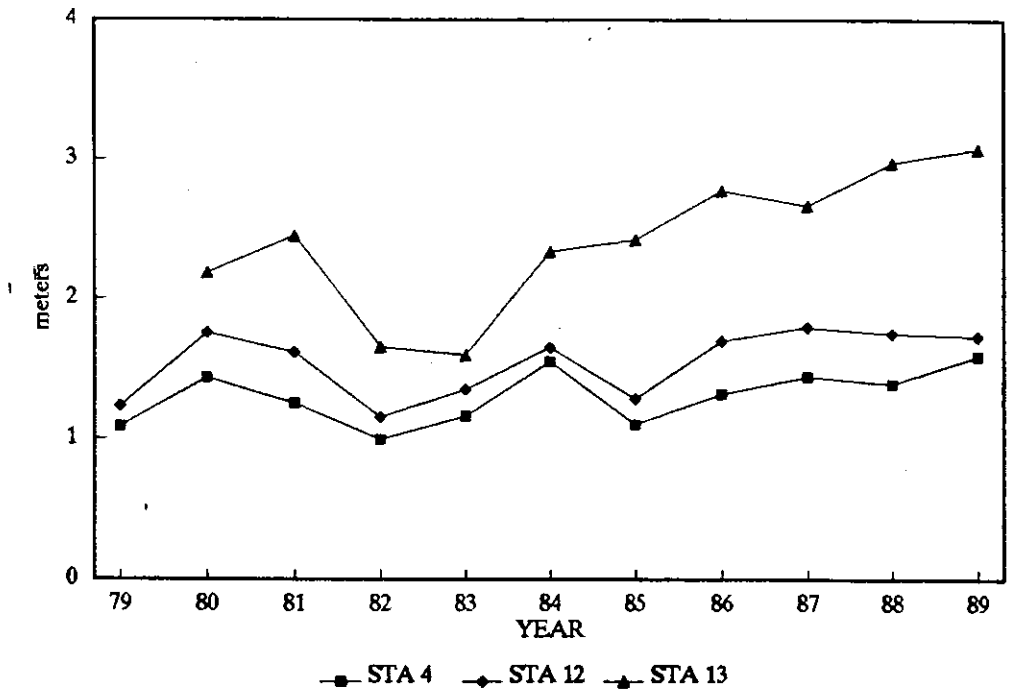

Figure 17. Annual average Secchi disk depth measured by the COT at stations 4 and 12 in Hillsborough Bay and at station 13 in Middle Tampa Bay.

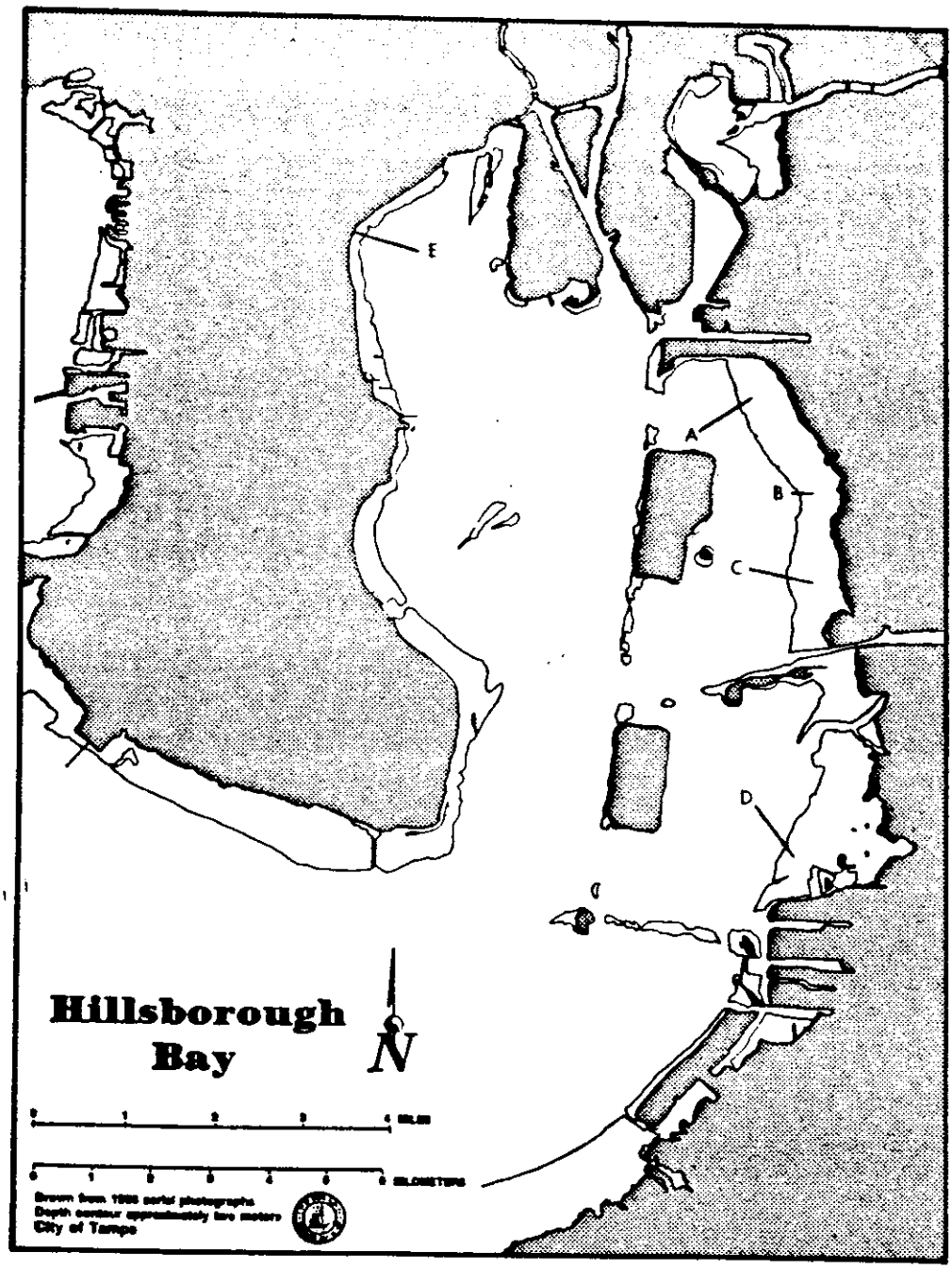

Figure 18. Locations of macroalgae transects A-E in Hillsborough Bay sampled by the COT.

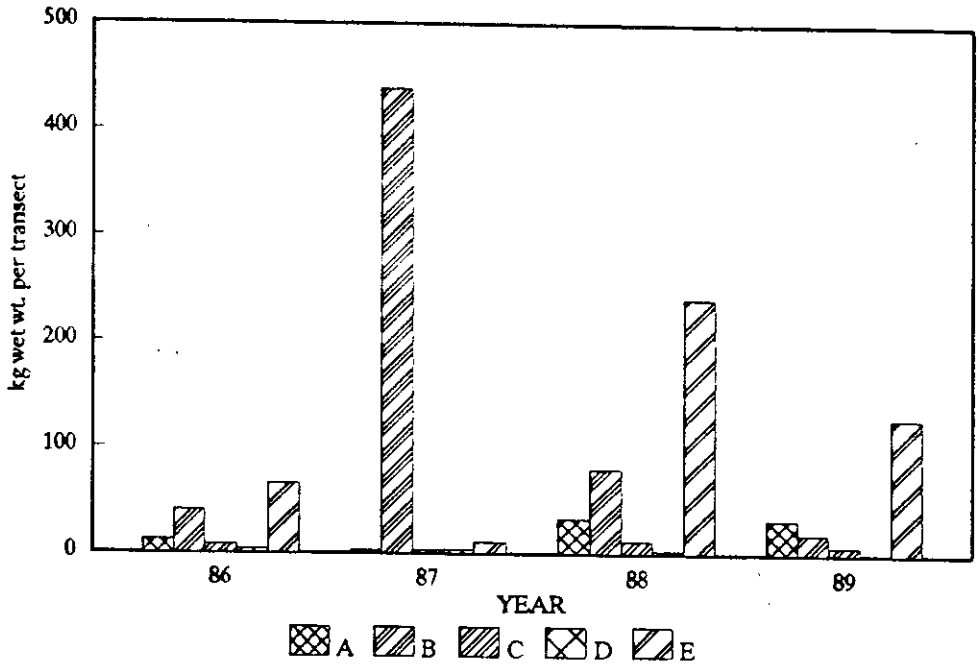

Figure 19. Annual average catch of macroalgae for transects A-E sampled by the COT in Hillsborough Bay .