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Chesapeake Bay Citizen Monitoring Program Report

Chesapeake Bay Program

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CHESAPEAKE BAY CITIZEN MONITORING PROGRAM REPORT

July 1985 - October 1988

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SUMMARY

The Alliance for the Chesapeake Bay, Inc. (ACB) began a pilot water quality testing project for volunteers in July 1985 as one of the activities funded under its Chesapeake Bay Program public participation grant from USEPA. The project was designed to answer four questions and this report addresses them:

1. Can citizens collect water quality data that meet rigorous quality control standards? We believe the project has demonstrated that citizen volunteers can, indeed, collect water quality data that meet rigorous quality control standards. A complete summary of the data collected from the beginning of the project through October 1988 is included in Appendix I and a listing of the data is included in Appendix II of this report.

2. Does data collected at nearshore locations reflect water qualtiy in the river generally? The major data interpretation section of the report addresses this question. Such shallow, nearshore waters are increasingly recognized for their importance as living resources habitat. We have compared data collected nearshore and in some of the tributaries to the James and Patuxent Rivers with data collected from boats in the middle of the same rivers by the Virginia Water Control Board and Maryland Department of the Environment respectively at nearby stations.

3. What are the most reliable sampling procedures, reporting formats, and data management systems for a volunteer program? Sampling procedures and reporting formats developed here can be and are being used for other volunteer monitoring programs in the Bay region and throughout the U.S. because of their reliability.

4. Is it feasible to include a permanent, Bay-wide citizen monitoring network among the long-term Bay management strategies of the state and federal governments? The Implementation Committee of the Chesapeake Bay Program has endorsed the incremental expansion of the Citizen Monitoring Program to meet other data needs of Bay managers and Scientists and instructed its relevant subcommittees to report on ways citizen monitoring data can be used to provide a better understanding of the status of the quality of the nearshore habitat.

Two tributaries to the Chespeake Bay were included in this project, the Patuxent River in Maryland and the James River in Virginia. The volunteers sample on a weekly basis from a pier, dock or shoreline. Sites are located between the mouth of the river and the head-of-tide. Five surface water quality factors are measured: water temperature; pH (using a color comparator kit); limit of water visibility using a Secchi disk; disolved oxygen (using a micro-Winkler titration kit); and salinity (using a hydrometer). In addition, monitors record weather and general ecological observations about the site. Data Collection Forms are sent to the

Chesapeake Bay Liaison Office in Annapolis, MD where the information is stored on-line at the Chesapeake Bay Computer Center.

A comparison was made between water quality data collected by the states and by the citizen monitors. Citizen monitoring sites and state monitoring stations were grouped for comparison based on their proximity and similarity in classified hydrography, i.e. tidal freshwater, riverine-estuarine transition zone or lower estuary.

Because sampling dates differed for state and citizen monitoring sites, a sampling time period was defined in order to compare data sets. We selected a weekly time period since citizen monitors usually sample at weekly intervals.

Six variables were chosen for analysis: dissolved oxygen, percent saturation of dissolved oxygen, salinity, pH, water temperature, and water clarity. Because citizen monitors sampled more frequently than the state, we also examined the number of instances that low dissolved oxygen events were recorded at state stations and citizen monitoring sites.

Several patterns of differences between the citizen monitoring sites and state monitoring stations occurred frequently enough to suggest that they may be real. Presumably most of the differences result from the sampling locations of the citizen monitoring sites. We confined our analysis strictly to differences in parameter measurements taken within the same week. We have, therefore, taken a conservative approach in attempting to answer the question: "Do the data taken by citizen monitors enhance our knowledge of the Bay's tributaries?" We looked only for consistent differences. However, we can point with some confidence to having identified spatial heterogeneities in dissolved oxygen, percent saturation of dissolved oxyten, salinity, turbidity, water temperature and pH that often consistently occurred between state stations located in the middle of the rivers and locations along the river banks or in the tributaries of the river itself.

In the future we plan to test the utility of citizen monitoring data in characterizing nearshore habitats by spatially integrating the citizen monitoring data and state water quality data. We also hope to look at correlations between certain measured variables, such as low dissolved oxygen, and the frequency of observed events, such as fish kills and algae blooms. It should be possible to identify which sites provide for particular living resources habitats and attempt to link their character with water quality indicators.

We think it would be useful to evaluate the feasibility of using the citizen monitoring data set to determine data collection frequency optima for time series of water quality indicators.

INTRODUCTION

The Alliance for the Chesapeake Bay, Inc. (ACB) began a pilot water quality testing project for volunteers in July 1985 as one of the activities funded under its Chesapeake Bay Program public participation grant from EPA. The project was designed to answer four questions:

1. Can citizens collect water quality data that meet rigorous quality control standards?

2. Does data collected at nearshore locations reflect water quality in the river generally?

3. What are the most reliable sampling procedures, reporting formats and data management systems for a volunteer program?

4. Is it feasible to include a permanent, Bay-wide citizen monitoring network among the long term Bay management strategies of the state and the federal governments?

The establishment of such a program was suggested in "Volunteer Monitoring Program, Chesapeake Bay: A Framework for Action, Appendix F, Attachment 5" (8). In response to a request from the Chesapeake Bay Program Monitoring Subcommittee, ACB established an ad-hoc committee to analyze and report on the desirability and feasibility of citizen monitoring efforts and to provide specific recommendations. The committee's proposal was presented to and accepted by the Chesapeake Bay Program Implementation Committee in February 1985 (4).

It was anticipated that data collected by volunteers would augment information gathered in the Chesapeake Bay Monitoring Program begun in 1984. This program now collects data at over 165 stations Bay-wide. Its major objectives are to determine long-term trends and the driving forces behind them, and to establish the link between water quality and the health of the Bay's living resources. The monitoring program should help to distinguish the effects on the Bay from natural events (e.g., flows and salinities) and from man-induced pollutants (such as excessive nuitrients) (5). It is well documented that several years (5-20 years in some cases) are necessary to separate trends from natural variability in complex ecological systems like the Bay. This program is making monitoring information widely available so that it can be used to help managers make decisions on the Bay's future.

Volunteer monitoring that delivers data of known quality can augment the Baywide program and help to determine seasonal and temporal changes in Bay waters and to evaluate the water quality status of selected tributaries. Specifically, volunteers can contribute by:

* providing long-term water quality data in areas which are not routinely monitored (e.g. nearshore habitats, small tidal creeks);

* providing more frequent sampling to yield time-series data with the large number of points required to establish response and lag times in changes;

* capturing data on short-lived phenomena of interest (e.g., storms);

* providing observational information on weather, living resources, and site conditions, and

* answering short-term research questions.

A well-coordinated, long- term volunteer monitoring program also can promote active stewardship of natural resources by local residents; provide an early warning of problems in stormwater management, sediment control, and sewage contamination; and further the education of the general public and concerned public officials regarding the Bay.

USEPA believes citizen monitoring programs can help fill the data gaps identified in a recently completed Agency study on surface water monitoring. The role of citizen monitoring may be further defined in guidance for model state water monitoring programs now being developed by EPA (7).

PURPOSE

This report addresses the four questions posed at the outset of the project.

1. Can citizens collect water quality data that meet rigorous quality control standards? We believe the project has demonstrated that citizen volunteers can, indeed, collect water quality data that meet rigorous quality control standards. A complete summary of the data collected from the beginning of the project through October 1988 is included in Appendix I of this report.

2. The major data interpretation section of the report addresses the second question - does data collected at nearshore locations reflect water quality in the river generally? Such shallow, nearshore waters are increasingly recognized for their importance as living resources habitat. We have compared data collected nearshore and in some of the tributaries to the James and Patuxent Rivers with data collected from boats in the middle of the same rivers by the Virginia Water Control Board and Maryland Department of the Environment respectively at nearby stations.

3. What are the most reliable sampling procedures, reporting formats, and data management systems for a volunteer program? Sampling procedures and reporting formats developed here can be and are being used for other

volunteer monitoring programs in the Bay region and throughout the U.S. because of their reliability. We have received enquiries about our program from as far afield as Czechoslovakia and Mexico. Because we have access to the Chesapeake Bay Program Computer Center, our data management system is more sophisticated than those in other areas. Perhaps other programs will develop data storage and management approaches that can be used in less extensive projects and that these techniques can be shared in the near future.

4. Is it feasible to include a permanent, Bay-wide citizen monitoring network among the long-term Bay management strategies of the state and the federal governments? Because we were able to demonstrate that the volunteers can provide data of known quality and, based on the findings of the Members of the Advisory Committee to the Citizen Monitoring Project, the Implementation Committee of the CBP approved a Resolution that:

* Endorses incremental expansion of the Citizen Monitoring Program to meet other data needs of Bay managers and scientists;

* Tasks the Monitoring Subcommittee (utilizing, as appropriate, the Living Resources Subcommittee and the Scientific and Technical Advisory Committee) to report on ways citizen monitoring data can be used to provide a better understanding of the status of the quality of the inshore habitat; and

* Tasks the Chesapeake Bay Liaison Office to distribute and encourage the use of computer software developed to facilitate the entry, storage, interpretation and verification of Citizen Monitoring data (4).

PROJECT ORGANIZATION AND IMPLEMENTATION

Rivers Studied

Two tributaries to the Chesapeake Bay were chosen, the Patuxent River in Maryland and the James River in Virginia because each has an extensive estuarine gradient, a cadre of identifiable volunteers, and identified environmental problems related to water quality degradation. In addition, the water quality of each river is monitored regularly by the states, permitting the quantitative assessment of the techniques, sampling frequencies and results of the volunteer program.

Patuxent River

The Patuxent River is the longest river in Maryland whose watershed lies completely within the state boundaries. The Patuxent originates in the Piedmont plateau and flows 110 miles through seven counties enroute to the Chesapeake Bay. The area of the Patuxent watershed is approximately 900 square miles.

This river has experienced marked declines in water quality, a concomitant loss of submerged aquatic vegetation, and declines in native estuarine-dependent commercial and recreational finfish and shellfish. This decline is generally attributed to increases in nutrient loadings which have led to excessive algal (microscopic plant) growth. These nutrients come from sewage treatment plant discharges and land run-off, both urban and agricultural in origin.

In 1982 the State of Maryland developed and adopted the Patuxent Nutrient Control Strategy which outlined specific nitrogen and phosphorus reduction goals for point and non-point sources. Presently, the Maryland Department of the Environment reports: "that the goal for phosphorus removal has been met. When nitrogen removal at the Western Branch wastewater treatment plant becomes operative, the goals of the Patuxent Strategy for nitrogen removal will be met as well. However, management of nutrient discharges to the Patuxent estuary will not be complete at that time. If the Patuxent watershed continues to experience the growth that it has in the past, sewage flows can be expected to increase even further. With a greater volume of treated waters entering the estuary, it will be necessary to reduce nitrogen and phosphorus effluent concentrations even further in order to maintain the goals of the Patuxent strategy and to realize the desired improvements to water quality in the Patuxent" (6).

James River

The James River drains roughly one quarter of Virginia's total land area, making it the largest river basin (10,195 miles) in the state and the third largest in the Bay region.

The James River system has long been stressed by a combination of pollutants, including nutrients, toxics and bacteria. Landings of freshwater spawners, such as shad and striped bass and commercial harvests of market oysters from the tidal James River have declined over the years. Over 53,000 acres of productive shellfish beds are now closed (2).

The James receives the highest nutrient inputs of any river in Virginia, mostly from sewage treatment plants and industrial discharges but also in lesser amounts from agricultural and urban runoff. Ammonia, a form of nitrogen which can be toxic to marine life and can also deplete the water of oxygen through nitrification, sometimes reaches levels in the waters below Richmond that violate state standards. The ammonia levels in the river between Richmond and Tar Bay below Hopewell are being monitored concurrently by the state and citizen volunteers. The staff of the Virginia Water Control Board has proposed a water quality plan for the upper James River and part of the Appomattox that would prevent increased discharge of several effluent constituents from 13 municipal and industrial sewage treatment plants after 1990. A decrease in ammonia levels in the upper James estuary is anticipated as the state plan is implemented (2).

Overflows from combined sewers are another serious problem on the James River. Normally, sewage is carried to treatment plants by one system of pipes, while another carries stormwater directly to the river. However, about 11,000 acres of Richmond's land area are served by combined sewer pipes, which use one pipe to convey both sewer and stormwater to wastewater treatment plants (WWTP's). When wet weather hits, the stormwater creates high flows that are too great in volume for the WWTP and excess flows go straight, untreated, into the river, carrying large quantities of fecal bacteria, nutrients and suspended solids. The City of Richmond is currently studying alternative methods for correcting the combined sewer overflow problem, including expansion of Richmond's wastewater treatment plant, new conduits and structures along the river, and new treatment facilities in other areas of the City (2).

Toxic chemical pollution represents another threat to the James. In 1975 large quantities of kepone, an extremely potent pesticide, were discharged into the river at Hopewell. The James River has recently been re-opened to recreational and commercial fishing for the first time since the kepone disaster but the industrialized section of the James, such as in the Norfolk and Hampton Road areas, are still among the most contaminated sections of the Bay. Virginia will be implementing a toxic reduction program as part of the 1987 Chesapeake Bay Agreement (2).

Administration

A committee of eight Bay managers and scientists worked with the Citizen Monitoring Coordinator in setting up the pilot program. This technical advisory committee reviewed the project plans and the protocol manual, provided technical guidance to the project coordinator as needed, and reviewed and evaluated results for inclusion in interim reports.

At the outset, volunteers were asked to commit to taking weekly samples for six months. At the end of that time a few people dropped out. A few others had found it necessary to stop monitoring due to moving away, changed jobs, or they just did not wish to continue. However, 81% of the original volunteers were still in the program at the end of the first year.

To date, data have been collected at 20 sites on the Patuxent and at 16 sites on the James. Thirteen sites on the Patuxent River and twelve sites on the James River are still being monitored. These two rivers have been and still are intensely monitored by the states and researchers. As volunteers drop out of the program we will seek replacements only in locations where a particular environmental problem has been identified.

Recruitment letters were sent to individuals and organizations who had an interest in water quality or in monitoring. This included Sierra Club, Audubon Society, League of Women Voters, Soil Conservation District Committees, Lower James River Association, Patuxent River Association, maritime businesses, watermen's associations, etc. Extensive followup by telephone was necessary to find people who were willing to participate. Once the program was underway, people volunteered who had heard about the project from friends and neighbors.

Volunteers were sought who live on the water so that obtaining samples would be convenient and take a minimum of time. It was not practical to pre-select precise sites in this voluntary program. However, state monitoring program coordinators in Maryland and Virginia suggested we try to locate sites using the following criteria:

1. equally divided in the lower estuarine, riverine-estuarine transition and tidal fresh zones of each river;

2. above and below the mouth of any significant tributary running into the river;

3. above and below major construction sites and wastewater treatment plants;

4. near a farm or animal holding facility that is instituting best management practices;

5. on shore opposite a state water quality monitoring station to allow for more direct comparison of data sets.

In addition, an effort was made to involve different user groups, such as high school science classes, marina owners, boating clubs, community organizations and river basin groups.

Sampling Methods

The key to carrying out a successful monitoring program is to have clearly established data quality objectives (DQO's) identified at the outset of the data collection effort. One of the major purposes of this pilot project was to determine the potential data quality that could be delivered by volunteers using simple, low-cost methods.

A Quality Assurance Project Plan (QAPjP) was prepared and accepted by the Chesapeake Bay Program Quality Assurance Officer (QAO) (9). The initial testing of methods for use in this program was conducted at the EPA Central Regional Laboratory, Annapolis, MD under the supervision of the CBP QAO and various other chemists and technicians. Instruments and methods used in this project were chosen based on simplicity of use, cost, and accuracy. Every possible effort has been made to use methods that are comparable to those employed by the CBP Monitoring Program. Where methods are necessarily different, methods comparison tests have been performed and degree of comparability has been determined. The units reported are the same as those in the CBP Monitoring Program.

The standard deviations (SD) for the values are reported in Table 1. The precision and accuracy SD's were arrived at by determining the differences between individual monitors' results and those obtained with the standard CBP method. These measurements were made at the first round of quality control (QC) sessions. At subsequent QC sessions we have used the results obtained by the coordinator as the reference standard. The

TABLE 1. PRECISION AND ACCURACY OBJECTIVES

Parameter	Method/Range	Units	Sensitivity*	Precision	Accuracy	Calibration
Temperature	Thermometer -5.0° to +45°	°C	0.5°C	± 1.0	± 0.5	with NBS Certified Thermometers
pH	Color Comparator Wide-Range Narrow-Range	Standard pH units	0.5 units 0.1	± 0.6 ?**	± 0.4 ± 0.2	Orion Field pH Meter Beckman pH Meter
Salinity	Hydrometer	parts per thousand (o/oo)	0.1 o/oo	± 1.0	± 0.82	Certified Salinity Hydrometer Set
Dissolved Oxygen	Micro Winkler Titration	mg/l	0.1 mg/l	± 0.9	± 0.3***	Standard Winkler & Y.S.I. DO Meter
Limit of Visibility	Secchi Disk Depth	meters	0.05 m	NA	NA	NA

NOTE: The criteria used to judge completeness of data are addressed in Section 5.

* Determined by the increments measurable with the stated method reflecting estimation where allowed.

** Lack of sufficient data at present

***Paired t analysis (α=0.05, 3 d.f.) of the standard deviation of the mean difference between 4 paired determinations.

precision reported in Table 1 reflects the overall results of differences observed between individual monitors compared to the reference standard. The reported accuracy reflects results of comparing the citizen monitoring program method with the stated calibration method.

The volunteers initially attend a 3-hour training session. These sessions include the viewing of an introductory slide show followed by a demonstration and carrying out of the test procedures. Volunteers who are unable to attend a session are trained by the coordinator individually. Two quality control sessions per year are conducted by the monitoring coordinator.

Various ways to actually test the monitors have been worked out. QC sessions can include different combinations of approaches. Essentially, there are two basic approaches: 1) have them all test the same water with their equipment in the way they do it at home; 2) have them read/record already set up laboratory tests. Their results then provide a measure of how well they perform as a group or how precisely they measure the characteristics and constituents required.

Volunteer monitors are asked to collect data and samples once a week year round---a potential of 52 observations per site per year. However, it is assumed that some weeks will be missed for vacations, illness, and severe weather (i.e. wind, flooding, ice.) Therefore, 48 observations per year are considered to constitute a complete data set for a given site.

Five water quality parameters are measured weekly at each site: water and air temperature; pH; Secchi depth/water transparency; salinity; and dissolved oxygen(DO). Monitors report weekly accumulated rainfall if they have a sufficiently clear space to install a rain gage near the site. Rain gages are not installed at sites that are not on private property because they might be vandalized.

The thermometers, Secchi disks, pH kits and DO titration kits are manufactured by LaMotte Chemical Products, Inc., Chestertown, MD. The hydrometers are made by Greers Ferry Glass Works, Inc., Quitman, AR with 500 ml graduated cylinders used as hydrometer jars. Each volunteer monitor is supplied with a "Citizen Monitoring Manual" which was prepared specially for this program (1). The Manual gives step by step instructions for all sampling and analysis procedures as well as brief background material on what the test results mean.

In addition, information on weather and general observations about the site (live or dead organisms, debris, oil slicks, ice, odor, water color, anything unusual) is recorded on a Data Collection Form (see Figure 1) and sent to the project coordinator. Data are entered into a computer file stored in the Chesapeake Bay Program Computer Data Base. SAS software is used to generate plots and graphics of the various parameters versus time.

Surface water samples were obtained in a bucket from the water's edge, a dock or pier and, in a few instances, from a boat depending on the individual monitor's site. Armored thermometers reading from -5.0 to

+45.0°C were used to determine air and water temperature. They were calibrated against NBS certified thermometers and found sufficiently accurate to make it unnecessary to carry out corrections for these values.

Salinity was determined by the hydrometric method as described in Standard Methods for the Examination of Water and Wastewater (3). The specific gravity value is corrected for temperature of the water in the hydrometer jar and converted to salinity by equations stored in a computer program.

An effort was made to compare the hydrometric method for measuring salinity to results obtained with a refractometer, a salinometer and a titration kit. These results indicated that the hydrometer or titration kits produce similar results, excluding human error. The refractometer and salinometer appear to produce consistently lower readings than the other two methods (9).

Secchi disks with black and white quadrants and measuring 8 inches in diameter were used to determine the limit of visibility. These disks provide a convenient method for measuring light penetration below the water surface. Water transparency is directly related to the amount of materials suspended in the water. Particulate matter, such as algae or silt, limit light penetration and reduce the water's clarity. In shallow areas, wind-generated waves and boat wakes interact with the bottom to stir up sediments.

Color comparator kits were used to measure pH. In the beginning of the program pH comparators that test for a wide range of values (3-10 pH units) were used. After a year's worth of data had been collected and a general range of pH values was known for each site, narrow range kits were supplied. These kits measure a range of 1.4 standard pH units in increments of 0.2 units.

The test for dissolved oxygen is made using a water analysis kit which employs a modified Winkler method. The bias in DO values determined with the LaMotte kit is reported as n mg/l $\pm$ 0.3 mg/l. This was arrived at by carrying out a paired t analysis of the standard deviation of the mean difference between results of four paired measurements with the Kit and a Standard Winkler titration.

Monitors titrate two samples at each sampling time. If the difference between the first two is greater that 0.6 mg/l, they do a third titration. The average of the two closer values is recorded. If values greater than 0.9 mg/l are reported with no third test done, the results are not entered in the file. Less than 25 (of the over 4000) DO measurements have been determined to be above the upper control limit of 0.9 mg/l.

COMPARISON OF WATER QUALITY DATA COLLECTED BY THE STATES AND CITIZEN MONITORS

Methods

Citizen Monitoring sites and state monitoring stations were grouped for comparison based on their proximity and similarity in classified hydrography, i.e. tidal freshwater, riverine-estuarine transition zone or lower estuary (Tables 2 and 3, Figures 2 and 3).

Upriver distances of Citizen Monitoring sites and state monitoring stations were estimated using ARC/INFO mapping software interactively. The rivers were displayed on the screen of a Tektronix graphics terminal via the ARC/INFO subsystem ARCPLOT. Incremental distances in meters were measured using the 'Measure Length' command applied visually to the displayed river maps.

Because sampling dates differed for state and Citizen Monitoring sites, a sampling time period was defined in order to compare data sets. We selected a weekly time period since Citizen Monitors usually sample at weekly intervals. We assigned a week index to each sampling date, defining weeks from Wednesday through the following Tuesday in order to cast observations taken over a weekend into the same week period. Table 4 lists the inclusive dates for each week period.

Because Citizen Monitoring sites are primarily in shallow water, we selected water quality parameters measured at a depth of one meter at state monitoring stations for comparison.

Dissolved oxygen saturation was estimated from a complete quadratic response surface fit to tabled values developed by Whipple and Whipple (10), which is a standard reference for dissolved oxygen solubility. We fit the surface in order to avoid interpolating tabled values. The equation we obtained using the SAS (Vers. 5) RSREG program was:

$$Y\,est = 14.37478 - 0.32886\,X1 - 0.15353\,X2 + 0.003452\,X1*X1 + 0.002941\,X1*X2 + .000075\,X2*X2$$

where,

Y est = Estimated saturation concentration of dissolved oxygen (mg/l)

X1 = Water temperature in °C

X2 = Chloride concentration of water (g/l)

An R-square value of 0.9988 was obtained indicating the correlation between observed and estimated values was 0.99. Examination of residuals indicated that the deviation between observed and estimated values was similar over the entire surface and within the likely error associated with the measurement of temperature and salinity.

Table 2. Citizen Monitoring sites and state monitoring stations selected for comparison in the Patuxent River. RD refers to distances (km) up river of State Station LE1.4 close to the mouth of the river; CD (km) refers to the additional distance of sites up creeks on the river.

State Station		Citizen Monitoring site		
RD	Name	RD	CD	Name
0.0	LE1.4	2.56	2.98	Spring Cove-Mill Creek
		3.32		Green Holly Pond
8.75	LE1.3	7.01		Kingston
		8.48	1.71	Cuckold Creek
13.75	LE1.2	12.19		St. Cuthbert Wharf
		14.96		Sotterley
13.75	LE1.2	13.48	1.53	St. Leonard
		13.48	2.23	Osborn Cove
23.03	LE1.1	22.74		Cape St. Mary's
		24.00	2.20	Battle Creek
		28.42		Cremona
32.19	RET1.1	30.24		Trent Hall
		34.38		Benedict
43.11	TF1.7	42.18		Pott's Point
		45.14		Holland Cliff
52.45	TF1.6	51.96		Lower Marlboro
60.38	TF1.5			
68.21	TF1.4	69.18		Jug Bay
72.69	TF1.3			
78.28	TF1.1			
73.56	TF1.2	69.18		Jug Bay
		71.43		Rt. 4 Bridge

Table 3. Citizen Monitoring sites and state monitoring stations selected for comparison in the James River. RD refers to distances (km) up river of the mouth of the river; CD (km) refers to the additional distance of sites up creeks on the river.

State Station			Citizen Monitoring site		
RD	CD	Name	RD	CD	Name
8.29	7.86	LE5.6	13.80		Pig Point
8.29		LE5.4			
18.94		LE5.3	25.32		Hilton Pier
			25.32	9.23	Town Farm Creek
			25.32	12.80	Smithfield
31.42		LE5.2	25.32		Hilton Pier
			25.32	9.23	Town Farm Creek
			25.32	12.80	Smithfield
49.73		LE5.1	49.55		Carter's Grove
			52.16		Kings Mill
65.44		RET5.2	77.36		Dancing Point
			68.52		First Colony
115.71		TF5.5	112.77		West Bank-Tar Bay
120.02		TF5.4	116.40		Jordan Point
137.71		TF5.3	132.78		Deep Bottom
			138.72		Dutch Gap
155.03		TF5.2	159.45		James River Park
			169.21		Huguenot Bridge

Table 4. Weekdates, Wednesday through Tuesday, corresponding to week codes.

1985		1986			
Week	Dates	Week	Dates	Week	Dates
4	Jun 26- 2 Jul	31	Jan 1- 7		
5	Jul 3- 9	32	8-14	57	Jul 2- 8
6	10-16	33	15-21	58	9-15
7	17-23	34	22-28	59	16-22
8	24-30	35	29- 4 Feb	60	23-29
9	31- 6 Aug	36	5-11	61	30- 5 Aug
10	7-13	37	12-18	62	6-12
11	14-20	38	19-25	63	13-19
12	21-27	39	26- 4 Mar	64	20-26
13	28- 3 Sep	40	5-11	65	27- 2 Sep
14	4-10	41	12-18	66	3- 9
15	11-17	42	19-25	67	10-16
16	18-24	43	26- 1 Apr	68	17-23
17	25- 1 Oct	44	2- 8	69	24-30
18	2- 8	45	9-15	70	Oct 1- 7
19	9-15	46	16-22	71	8-14
20	16-22	47	23-29	72	15-21
21	23-29	48	30- 6 May	73	22-28
22	30- 5 Nov	49	7-13	74	29- 4 Nov
23	6-12	50	14-20	75	5-11
24	13-19	51	21-27	76	12-18
25	20-26	52	28- 3 Jun	77	19-25
26	27- 3 Dec	53	4-10	78	26- 2 Dec
27	4-10	54	11-17	79	3- 9
28	11-17	55	18-24	80	10-16
29	18-24	56	25- 1 Jul	81	17-23
30	25-31			82	24-30

Table 4. Continued

1987				1988	
Week	Dates	Week	Dates	Week	Dates
83	Dec 31- 6 Jan	109	Jul 1- 7	135	Dec 30- 5 Jan
84	7-13	110	8-14	136	6-12
85	14-20	111	15-21	137	13-19
86	21-27	112	22-28	138	20-26
87	28- 3 Feb	113	29- 4 Aug	139	27- 2 Feb
88	4-10	114	5-11	140	3- 9
89	11-17	115	12-18	141	10-16
90	18-24	116	19-25	142	17-23
91	25- 3 Mar	117	26- 1 Sep	143	24- 1 Mar
92	4-10	118	2- 8	144	2- 8
93	11-17	119	9-15	145	9-15
94	18-24	120	16-22	146	16-22
95	25-31	121	23-29	147	23-29
96	Apr 1- 7	122	30- 6 Oct	148	30- 5 Apr
97	8-14	123	7-13	149	6-12
98	15-21	124	14-20	158	13-19
99	22-28	125	21-27	159	20-26
100	29- 5 May	126	28- 3 Nov	160	27- 3 May
101	6-12	127	4-10		
102	13-19	128	11-17		
103	20-26	129	18-24		
104	27- 2 Jun	130	25- 1 Dec		
105	3-9	131	2- 8		
106	10-16	132	9-15		
107	17-23	133	16-22		
108	24-30	134	23-29		

Thus in estimating dissolved oxygen saturation, given observed temperature and salinity values, we first converted observed salinity values (o/oo) to chloride concentration through the well-known relationship:

Chlorinity = (salinity - 0.03)/ 1.805

Percent dissolved oxygen (DO) saturation was calculated as the ratio:

$$\% \text{ DO saturation} = \frac{\text{measured DO concentration}}{\text{estimated DO saturation}} \times 100$$

In order to determine the feasibility of using time series analysis to investigate patterns in the data, we inspected the data to determine how many missing time periods, based on our weekly interval, existed in the Citizen Monitoring series of observations and the states' monitoring series. This inspection revealed several missing weeks occurred in many of the data series. Due to this limitation, we chose to compare data sets by examining the temporal series of signed (+,-) differences between parameters measured within the same week. This approach reduces the effect of spurious contrasts between data set parameters due to sampling at different stages of diurnal or tidal cycles. Thus, it emphasizes identifying consistent differences, seasonal differences, or trends in differences between surface water quality parameters measured at monitored sites.

Six variables were selected for analysis: dissolved oxygen, percent saturation of dissolved oxygen, salinity, pH, water temperature, and water clarity or turbidity. The previously described differences in the method used to measure salinity by the state and the citizens (see above) probably inflated observed differences in salinity between Citizen Monitoring and state sites by up to 2 o/oo. Thus, differences in salinity less than this amount were not considered significant. Also, it should be noted that this magnitude of difference in salinity imparted a negligible effect on percent dissolved oxygen saturation differences.

Because Citizen Monitors sampled more frequently than the state stations, we also examined the number of instances that low dissolved oxygen events were recorded at state stations and Citizen Monitoring sites.

Results

Patuxent River

Lower estuarine segment

State Station LE1.4 and CM sites Spring Cove-Mill Creek and Green Holly Pond. Length of series: August 1985 to November 1987.

Dissolved oxygen values were generally higher at the CM sites from May to December, when values in mid-river were lowest, and were lower than those measured in mid-river from January to March (Figures 4a and 4b). Percent oxygen saturation showed a similar seasonal pattern of differences.

The creeks were usually 1 o/oo to 3 o/oo more saline than the river.

The pH was almost always higher at Green Holly Pond than in the river; the pH in Spring Cove-Mill Creek was about the same as that of the river.

Water temperatures in the creeks were usually higher than those in the river with the differences most marked at the onset of spring each year, suggesting the shallower areas warmed faster in the spring. Thereafter, temperature differences between the creeks and river appeared to decline and then reverse, with temperatures in the creeks becoming colder than in the river.

Each creek was more turbid than the river except for brief periods in March and April when the river was more turbid.

State Station LE1.3 and CM sites Kingston and Cuckold Creek. Length of series: July 1985 to November 1987 (Cuckold Creek), July 1985 to May 1986 (Kingston).

The series from Kingston was too short to use in comparisons, but the few data obtained were similar to those from Cuckold Creek.

The magnitudes of differences in dissolved oxygen levels between Cuckold Creek and the river were greatest in the spring, but there was no consistent pattern in the direction of the differences. A similar pattern occurred in percent oxygen saturation.

Salinity was usually higher in the creeks than in the river (up to 6 o/oo), though there was evidence of freshets lowering the salinity below that of the river.

The magnitude of the pH differences was largest in the spring, when both positive and negative differences occurred. The creek was usually more alkaline than the river during the rest of the year.

Cuckold Creek was usually warmer than the river, especially in the spring.

Cuckold Creek was usually clearer than the river from March to July, and more turbid than the river in the rest of the year.

State Station LE1.2 and CM sites St. Cuthbert and Sotterley. Length of series: July 1985 to November 1987.

There was a slight tendency for dissolved oxygen at the nearshore sites to be lower than that in the river during November 1985 to April 1986, but this pattern was not repeated the following winter. Patterns for percent oxygen saturation were similar.

The nearshore sites were almost always more saline than the river. The difference was usually greatest during April to July.

Differences in pH appeared to be within the range of measurement error.

Water temperatures tended to be higher at the nearshore sites than in the river during the spring and summer, with variable differences in the winter.

The CM sites were usually clearer than the river from March to September, and more turbid than the river from October to February. However, the pattern was less evident than that observed in Cuckold Creek.

State Station LE1.2 and CM sites Osborn Cove and St. Leonard. Length of series: July 1985 to December 1987.

Dissolved oxygen and percent saturation of dissolved oxygen values in the creek varied most from those measured at the state station from May through August, when levels of both parameters were seasonally lowest (Figures 6a and 6b).

Salinity was usually higher in the creek, although this difference tended to decline as salinity levels increased seasonally. Salinities measured at Osborn Cove were usually higher than those measured at St. Leonard.

The pH of the water measured in the creek was usually more alkaline than that in the river between April and September.

The temperature of the water in the creek was higher in the spring than in the river and this differential decreased during the year, until temperatures in the creek were usually lower from June to December (Figures 7a and 7b).

The water in the creek was usually clearer than the river from November or January to April. The creek tended to be more turbid than the river from May to December.

State Station LE1.1 and CM sites Cape St. Mary's, Cremona, and Battle Creek. Length of series: August 1985 to November 1987.

There was a slight tendency for dissolved oxygen and percent oxygen saturation levels at the CM sites to vary most from the state station in the spring, when water temperatures rose and oxygen levels fell.

The salinities at the CM sites tended to be higher than those in mid-river, especially at Cape St. Mary's.

Differences in pH were within the range of measurement error.

There was a slight tendency for water at the nearshore sites to be warmer than water in mid-river in the spring, with more similar temperatures occurring during the rest of the year.

Seasonal patterns of turbidity varied among the three CM sites. Cape St. Mary's was almost always more turbid than the state station, except for a few measurements in the spring. Cremona was also more turbid than the state station through much of the year, except during December and January, when it was similar to the state station. Battle Creek was clearer than the river in April and May (more so in 1986 than in 1987), and more turbid than the river the rest of the year.

Riverine-estuarine transition segment

State Station RET1.1 and CM sites Trent Hall and Benedict. Length of series: September 1985 to November 1987.

Both CM sites, and especially Trent Hall, had higher dissolved oxygen (Figs. 8a and 8b) and percent oxygen saturation than the river in the late spring and summer, roughly April to August. Differences in oxygen levels were variable during the rest of the year at both CM sites.

The CM sites were usually 1-4 o/oo more saline than the river, while each was less saline than the river on a few scattered occasions.

The CM sites were up to 1.7 units more alkaline than the river during May to August. Differences in pH were smaller and more variable during the rest of the year.

Water temperature differences showed no clear seasonal trend at either CM site.

The water clarity at both CM sites tended to be greater than in mid-river. However, there were scattered observations at both CM sites that were more turbid than the river.

Tidal fresh segment

We have omitted salinity comparisons in this river segment, since all methods of determining salinity become unreliable below 5-7 o/oo.

State Station TF1.7 and CM sites Pott's Point and Holland Cliff. Length of series: August 1985 to November 1987 (fragmentary from Holland Cliff).

The data from Holland Cliff were too incomplete for analysis.

Dissolved oxygen was higher at Pott's Point than in the river during the summer (April to November) and lower than the river during the rest of the year (Figures 9a and 9b). The pattern for percent saturation of dissolved oxygen was similar.

Pott's Point was usually more alkaline than the river (up to 1.5 units), except during the fall and early winter of 1985-86 and at a few times in 1987, when it was up to 1.7 units more acid than the river.

Pott's Point was up to 4°C warmer than the river during March to August, but the difference was more pronounced in 1986 than in 1987.

There were differences in turbidity, but the magnitudes were small (0.1 - 0.2 m).

State Stations TF1.6 and TF1.5 and CM site Lower Marlboro. Length of series: July 1985 to September 1986.

Both dissolved oxygen and percent saturation of dissolved oxygen were usually lower at Lower Marlboro than at either state station. The differences were most pronounced in the summer, when dissolved oxygen levels were lowest.

The CM site appeared to be more acid than the river in the winter and more alkaline in the summer (varying by 0.8 units), but a longer series would be necessary to substantiate this conclusion.

Lower Marlboro tended to be cooler than the river in the summer and warmer than the river in the winter, but more data are needed to substantiate this conclusion also.

There were too few turbidity data to make comparisons.

State Stations TF1.4, TF1.3, and TF1.1 and CM site Jug Bay. Length of series: July 1985 to November 1987.

Measurements at Jug Bay differed from those at the state stations by up to 7.1 mg/l in dissolved oxygen, and by up to 83% in saturation of dissolved oxygen, but there was no clear seasonal pattern. There was a slight tendency for greater oxygen concentrations to occur at Jug Bay.

Jug Bay tended to be more alkaline than the river (by up to 1.5 units) in the summer and fall, but periods of greater acidity at Jug Bay were scattered throughout the year.

The water at Jug Bay was usually warmer than water in the river, except for July through October 1987, when Jug Bay was colder.

There were too few turbidity data for comparison.

State Station TF1.2 and CM sites Jug Bay and Rt. 4 Bridge. Length of series: July 1985 to November 1987 (several gaps at both sites).

Rt. 4 Bridge had lower dissolved oxygen concentrations than the state station during all but two weeks. The pattern at Jug Bay was similar, except that dissolved oxygen concentrations there were higher than those at the state station several times during the winter. Percent saturation of dissolved oxygen data were not available for Rt. 4 Bridge due to the lack of salinity readings; at Jug Bay the differences varied without seasonal pattern.

Both CM sites had pH differences from the state station that were outside the range of measurement error (up to 1.8 units at Rt. 4 Bridge and 1.5 units at Jug Bay). However, there were no seasonal patterns.

Water temperatures at Rt. 4 Bridge were usually slightly higher than those taken by the state in mid-river and showed no seasonal pattern in their differences. Jug Bay was consistently warmer than the river, except during July to October 1987, when it was consistently cooler (by up to 11°C).

No state observations of turbidity were available for comparison with those from the CM sites.

Number of low dissolved oxygen events in the river

More low dissolved oxygen events were detected at the CitizenMonitoring sites than at the state stations due to the more frequent water quality sampling at the Citizen Monitor sites (Table 5). The occurance of low dissolved oxygen was most notable at Pott's Point, St. Cuthbert, Sotterley and Cremona.

James River

Lower estuarine segment

State Stations LE5.6 and LE5.4 and CM site Pig Point. Length of series: September 1985 to October 1987.

Dissolved oxygen levels and percent saturation of dissolved oxygen at Pig Point were usually higher than at both state stations.

Salinity at Pig Point was lower that at the state stations during both winters monitored, and it was higher than at the state stations in summer 1986 but not in summer 1987.

pH values did not consistently differ between the sites.

There was a tendency for water at Pig Point to be warmer than at the two state sites in the winter, especially during 1987-88. Water temperatures were about the same in the summer.

Water at Pig Point was usually more turbid than at the state stations.

Table 5. Instances of dissolved oxygen levels in the Patuxent River near ($\leq$ 5.50 mg/l), at or below the Maryland minimum standard of 5 mg/l measured at state monitoring stations and Citizen Monitoring sites during matched observation periods.

	1985	1986	1987
LE1.4	0	3	4
Mill Creek	0	0	1
Green Holly Pond	0	1	1
LE1.3	0	3	2
Kingston	1	0	no obs
Cuckold Creek	1	2	2
LE1.2	1	2	3
St. Cuthbert	3	3	2
Sotterley	2	2	2
LE1.2	1	2	3
Osborn Cove	1	1	0
St. Leonard	2	1	7
LE1.1	0	3	3
Cape St. Mary	2	1	no obs
Cremona	3	8	2
Battle Creek	no obs	3	2
RET1.1	1	6	6
Trent Hall	no obs	0	0
Benedict	0	2	4
TF1.7	0	1	5
Pott's Point	11	2	1
TF1.6	1	1	1
TF1.5	0	0	1
Lower Marlboro	4	2	no obs
TF1.4	0	1	4
TF1.3	0	3	1
TF1.1	2	9	6
Jug Bay	2	4	6
TF1.2	0	0	0
Rt. 4 Bridge	no obs	3	7

State Station LE5.3 and CM site Hilton Pier. Length of series: November 1985 to December 1987.

Dissolved oxygen levels and percent saturation of dissolved oxygen were usually higher than those measured at the state station during the summer when state values are lowest. In addition, both parameters measured at Hilton Pier appeared to trend upward during the period of comparison, which was evident in the data taken at the state station.

Salinity at Hilton Pier was usually higher than that measured at the state station.

No consistently remarkable differences in pH or water temperature were apparent between the state station and Hilton Pier.

The turbidity of the water at Hilton Pier compared to the state station showed increased turbidity beginning in January to March, becoming greater through November/December as river water at the state station became clearer in the annual cycle exhibited by both sites of clearer water in late fall and winter and more turbid water in the spring and summer.

State Station LE5.3 and CM sites Town Farm Creek and Smithfield. Length of series: November 1985 to December 1987.

Dissolved oxygen differences, both positive and negative, occurred between sites throughout the year, but there were no consistent seasonal differences among sites. Dissolved oxygen at both CM sites varied most from that at the state site in the winter, when DO was higher at all sites, and the magnitudes of the differences were less in the summer. Percent oxygen saturation levels tended to be lower and more variable at the CM sites than in the river, especially in the summer (Figures 10a and 10b).

Salinities at the two CM sites, located on the Pagan River, were consistently lower than at the state site.

Measurements of pH were not begun until April 1986, and were not done for a complete winter. There were no clear trends, based on these limited data.

Water temperatures at the CM sites generally exceeded those at the state site. This difference was most pronounced from January to April.

During the winter low of turbidity, the two CM sites had generally lower turbidity than the state site during 1985-86, but the state site was less turbid during 1986-87 and 1987-88. As a rule, the creeks were more turbid than the state station.

Riverine-estuarine transition segment

State Station RET5.2 and CM sites Dancing Point and First Colony. Length of series: August 1985 to November 1986.

There were not enough data from Dancing Point to use for comparisons.

Dissolved oxygen and percent oxygen saturation were consistently higher at First Colony than at the state site.

Salinity at First Colony varied from 2.4 o/oo above to 3.6 o/oo below the salinity at the state site, but there was no clear seasonal pattern.

There was a slight tendency for the pH at First Colony to exceed that at the state site, but a longer series would be needed to confirm this.

Water temperatures at First Colony were generally higher than at the state site. There may be seasonal differences in the magnitude of the difference, but the series is incomplete.

The seasonal variation in turbidity was not pronounced at either site, and there were no clear seasonal differences between the sites.

Tidal fresh segment

As in the Patuxent River, salinity comparisons are omitted in this hydrological segment due to methodological constraints.

State Stations TF5.4 and TF5.5 and CM sites Jordan Point and Tar Bay. Length of series: November 1985 to December 1987 (Jordan Point).

The series at Tar Bay was too short to use for comparisons.

Dissolved oxygen (Figures 11a and 11b) and percent oxygen saturation were usually lower at Jordan Point than at either state station.

The pH at Jordan Point was usually lower than the pH at either state station.

The water at Jordan Point was warmer than at the state stations during December to March, and the differences decreased with time until the state stations were usually warmer from May to November.

The water at Jordan Point was slightly but consistently more turbid than that at the state stations. The magnitude of the difference was from 0.1 to 0.5 m.

State Station TF5.3 and CM sites Deep Bottom and Dutch Gap. Length of series: August 1985 to May 1988 (Dutch Gap), May 1987 to May 1988 (Deep Bottom).

There was a slight tendency for dissolved oxygen to be lower at Dutch Gap than at the state station, but there were no seasonal trends. There were too few data from Deep Bottom for a comparison. Few percent oxygen saturation estimates were available for comparison due to the lack of salinity measures.

The pH was usually lower at Dutch Gap than at the state station (up to 1.2 units), especially during 1986 and early 1987.

Water temperatures at Dutch Gap usually exceeded those at the state station, without any seasonal trends.

Both CM sites were more turbid than the state station, except for brief periods in the winter when the clarity of the water at the CM sites was greater.

State Station TF5.2 and CM sites James River Park and Huguenot Bridge. Length of series: October 1985 to March 1988, except at Deep Water (October 1986 to August 1987).

Dissolved oxygen during the spring was higher at Huguenot Bridge than at the state station (Figures 12a and 12b). The difference declined through the year until dissolved oxygen was lower at Huguenot Bridge in the winter. Dissolved oxygen at James River Bridge was generally higher than at the state station (Figures 12a and 12b). Percent oxygen saturation was not calculated because salinity measurements were not made at the CM sites.

There was a slight tendency for the pH to be lower at the CM sites in the summer (by up to 1.7 units) and higher at the CM sites in the winter (by up to 1.6 units), compared to the state station. However, the CM readings are less precise than the state readings, so the actual differences may be less.

There were no consistent or seasonal trends in differences in water temperature between sites. Turbidity data were not collected at the state station.

Number of low dissolved oxygen events in the river

More low dissolved oxygen events were observed at the Citizen Monitor sites at Town Farm Creek, Smithfield and at Jordan Point in all years sampled than at the closest state monitoring stations (Table 6).

Table 6. Instances of dissolved oxygen levels in the James River near (≤ 4.50 mg/l), at or below the Virginia minimum standard of 4 mg/l measured at state monitoring stations and Citizen Monitoring sites during matched observation periods.

	1985	1986	1987	1988
LE5.6	0	1	0	no obs
LE5.4	0	0	0	no obs
Pig Point	0	1	0	1
LE5.3	no obs	0	0	0
Hilton Pier	no obs	1	0	0
LE5.3	no obs	0	0	0
Town Farm Creek	no obs	3	14	0
Smithfield	no obs	5	2	5
RET5.2	0	0	no obs	no obs
Dancing Point	0	no obs	no obs	no obs
First Colony	0	0	no obs	no obs
TF5.4	0	0	0	no obs
TF5.5	0	0	0	no obs
Jordan Point	no obs	7	7	7
Tar Bay	0	no obs	no obs	0
TF5.3	0	0	1	0
Deep Bottom	no obs	no obs	1	0
Dutch Gap	0	0	0	0
TF5.2	0	0	0	0
James River Park	0	0	0	0
Huguenot Bridge	no obs	0	0	0

Discussion

Several patterns of differences between the Citizen Monitoring sites and state monitoring station occurred frequently enough to suggest that they may be real. Only the most common pattern for each water quality variable will be mentioned. Presumably most of the differences result from the sampling locations of the Citizen Monitoring sites, which were in the shallows along the river margins and in tributaries of the rivers, in contrast to the state monitoring stations which were situated mid-river.

Oxygen levels showed a variety of patterns. In the most common pattern, both dissolved oxygen and percent oxygen saturation at the Citizen Monitoring sites were higher compared to surface river concentrations during the summer, when oxygen levels were low, than during the rest of the year. This occurred in five of 17 comparisons, including both rivers.

Citizen Monitoring sites tended to be more saline than the mid-river locations. This was true in all comparisons made in the Patuxent River and in one of five comparisons on the James River. Some of these differences were likely due to the method differences described earlier, which tended to produce slightly higher readings in water samples measured by the citizens. Two of the James River Citizen Monitoring sites, Town Farm Creek and Smithfield, were less saline than the river, probably due to fresh water flow of the Pagan River.

The Citizen Monitoring sites on the Patuxent River tended to be more alkaline than the state stations, especially in the summer (seven of 10 comparisons). There was no clear pattern in pH differences observed in the James River data.

The CM sites on the Patuxent River were usually warmer than the river, especially during the spring warming period of March to June (eight of 10 comparisons). The seasonal pattern was less pronounced in the tidal fresh segment. This pattern was less common in the James River data (two of seven comparisons), where fewer of the CM sites were on creeks.

Turbidity tended to be higher in the creeks and along the river edges than at the mid-river state stations, in both the Patuxent and James Rivers (eight of 12 comparisons). This difference was most often reversed in the spring, when the water in the river was more turbid.

CONCLUSIONS

In considering the utility of data collected by Citizen Monitors in comparison to that collected by the states for water quality monitoring, we confined our analysis strictly to differences in parameter measurements taken within the same week. Thus we have taken a conservative approach in attempting to answer the question: "Do the data taken by citizen monitors enhance our knowledge of the Bay's tributaries?", as we have only looked for consistent differences. We therefore excluded much of the information collected by citizen monitors that relates to the interpretation of the data and to characterization of the weekly ecological variation at the sites that are the real value of this program.

Having taken a conservative approach, however, we can point with some confidence to having identified spatial heterogeneities in dissolved oxygen, percent saturation of dissolved oxygen, salinity, turbidity, water temperature and pH that often consistently occurred between state stations located in the middle of the rivers and locations along the river banks or in the tributaries of the river itself. The value to the Bay restorative program of monitoring these differences will depend on questions that are asked about habitats, living resources, and water quality, and the importance in answering these questions of characterizing the small-scale variability that is the hallmark of estuarine systems. The similarities we observed between the citizen monitoring data and state data, conversely, are useful in characterizing spatially homogeneous water quality aspects that are also of interest.

In the future we plan to test the utility of citizen monitoring data in characterizing nearshore habitats by spatially integrating the citizen monitoring data and state water quality data. We also hope to look at correlations between certain measured variables, such as low dissolved oxygen, and the frequency of observed events, such as fish kills and algae blooms. It should be possible to identify which sites provide for particular living resources habitats and attempt to link their character with water quality indicators.

We think it would be useful to evaluate the feasibility of using the citizen monitoring data set to determine data collection frequency optima for time series of water quality indicators.

The key to meeting our goal of restoring the Bay to its more nearly natural life cycle, thereby slowing down the sedimentation and eutrophication process which leads to living resource population changes, lies in man's activities in the watershed, particularly on the land adjacent to the water. The Citizen Monitoring Program sponsored by the Alliance for the Chesapeake Bay, Inc. for the Chesapeake Bay Program has demonstrated that having the region's citizens involved directly in collecting information that meets the needs of the overall Monitoring Program not only creates a clearer understanding of the Bay ecosystem and man's role in complex ecological processes, but also establishes advocates for the life style changes that must occur if the Bay is to be "saved".

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LIST OF FIGURES

Figure 8a. Comparison of dissolved oxygen levels (mg/l) at CM sites Trent Hall ('N') and Benedict ('O') with State station RET1.1 ('*'). The state minimum standard (5 mg/l) is shown by the dashed line.

Figure 8b. Signed differences in dissolved oxygen levels (mg/l) between CM sites Trent Hall ('N') and Benedict ('O') and State station RET1.1. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM site was higher that at the state station.

Figure 9a. Comparison of dissolved oxygen levels (mg/l) at CM sites Pott's Point ('P') and Holland Cliff ('Q') with State station TF1.7 ('*'). The state minimum standard (5 mg/l) is shown by the dashed line.

Figure 9b. Signed differences in dissolved oxygen levels (mg/l) between CM sites Pott's Point ('P') and Holland Cliff ('Q') and State station TF1.7. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level measured at the CM site was higher that at the state station.

Figure 10a. Comparison of percent oxygen saturation levels at CM sites Town Farm Creek ('D') and Smithfield ('E') with State station LE5.3 ('*'). The dashed line in the middle of the plot shows 100% saturation.

Figure 10b. Signed differences in percent oxygen saturation between CM sites Town Farm Creek ('D') and Smithfield ('E') and State station LE5.2. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM sites was higher that at the state station.

Figure 11a. Comparison of dissolved oxygen levels at CM site Jordan Point ('L') with State station TF5.5 ('*'). The state minimum standard (4 mg/l) is shown by the dashed line.

Figure 11b. Signed differences in dissolved oxygen levels (mg/l) between CM site Jordan Point ('L') and State station TF5.5. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM site was higher than at the state station.

Figure 12a. Comparison of dissolved oxygen levels at CM sites James River Park ('P') and Huguenot Bridge ('Q') with State station TF5.2 ('*'). The state minimum standard (4 mg/l) is shown by the dashed line.

Figure 12b. Signed differences in dissolved oxygen levels (mg/l) between CM sites James River Park ('P') and Huguenot Bridge ('Q') and State station TF5.2. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM site was higher than at the state station.

Figure 1. Sample data sheet.

RETURN TO: Kathleen Ellett
c/o Chesapeake Bay Program
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Annapolis, Md 21403

ALLIANCE PROGRAM FOR THE CHESAPEAKE BAY
CITIZEN MONITORING PROGRAM
DATA COLLECTION FORM

JAMES RIVER

Collection Date: ____________

Time of Day: ____________

Monitor Name: ____________ Monitor Number : ______

Site Name: ____________ Site Number: ______

Air Temperature: ____________ C

Secchi Depth: ____________ m

Water Depth: ____________ m

Water Temperature: ____________ C
(In bucket)

Hydrometer Reading: ____________ Salinity: ______ 0/00

Water Temperature: ____________ C
(In hydrometer jar)

pH: ____________ SU (Standard Units)

Dissolved Oxygen: Test 1: _____ Test 2: _____ Average: _____mg/l (ppm)

Ammonia: ________ppm

Water Surface: (Circle one)
1 Calm 2 Ripple 3 Waves 4 White Caps

Weather: (Circle one)
1 Cloudless 2 Partly Cloudy 3 Overcast 4 Fog/Haze
5 Drizzle 6 Intermittent Rain 7 Rain 8 Snow

Rainfall: ________ mm (Weekly accumulation, enter '0' if no rainfall)

Other: (Circle ones that apply)
1 Sea Nettles 2 Dead Fish 3 Dead Crabs 4 SAV
5 Oil Slick 6 Ice 7 Debris 8 Erosion
9 Foam 10 Bubbles 11 Odors

Water Color: (Circle one and describe) Normal Abnormal

Comments: (Observations about your site)

Signature ______________________________ Date ______________

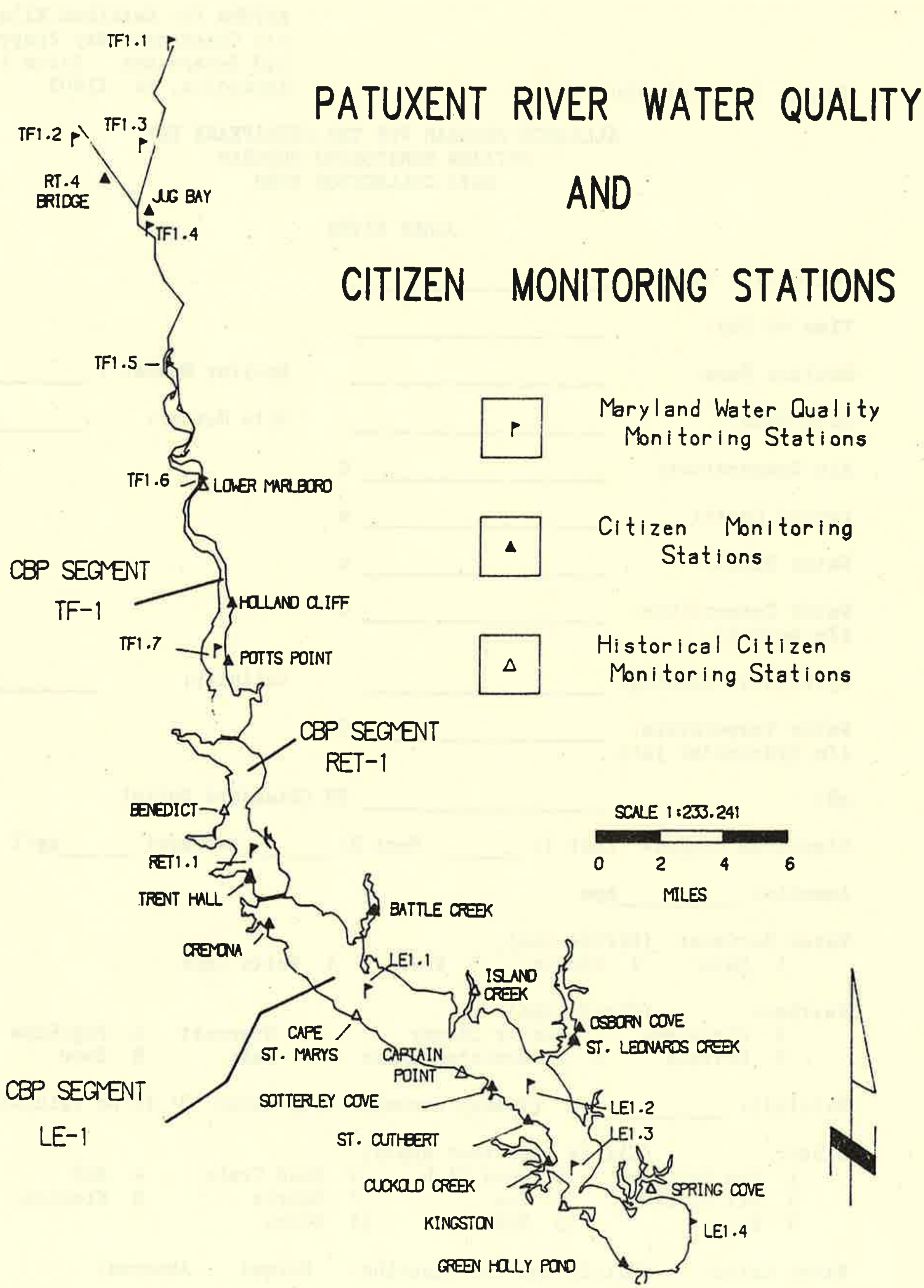


Figure 2. Map of the Patuxent River showing state monitoring stations and Citizen Monitoring sites.

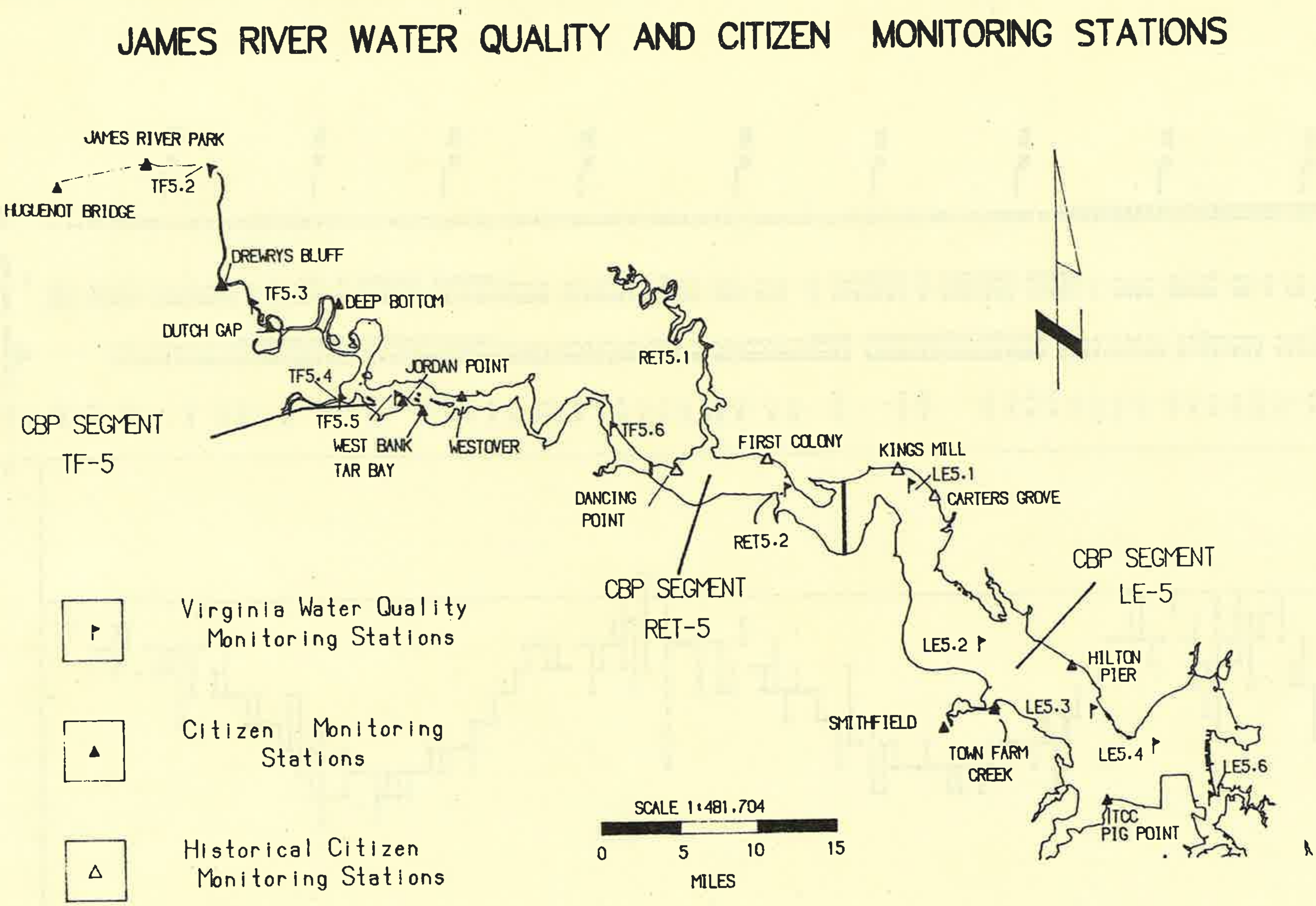


Figure 3. Map of the James River showing state monitoring stations and Citizen Monitoring sites.

	WEEK	MILL CREEK (A)	GREEN HOLLY POND (B)	LE1.4 (*)
	6	9.00	.	.
	7	6.50	.	6.10
	8	6.50	.	.
	9	.	.	.
	10	6.75	.	8.10
	11	7.50	.	.
	12	6.50	7.80	.
	13	6.50	6.70	5.60
	14	8.20	7.70	.
	15	.	7.10	.
	16	7.00	8.30	.
OCT 85	17	7.50	8.40	.
	18	7.50	9.90	.
	19	8.50	8.80	6.80
	20	7.50	7.20	.
	21	9.00	8.50	.
	22	7.50	8.60	7.90
	23	9.50	9.20	.
	24	.	10.00	8.70
	25	9.25	10.10	.
	26	.	10.30	.
	27	10.00	10.60	.
	28	9.50	11.50	10.90
	29	9.50	12.50	.
	30	10.60	13.00	.
JAN 86	31	10.50	13.90	.
	32	.	12.80	13.40
	33	11.00	13.10	.
	34	.	12.50	.
	35	12.50	.	.
	36	12.50	12.70	13.70
	37	12.30	13.10	.
	38	13.00	12.20	.
	39	12.00	12.90	.
	40	12.00	12.20	.
	41	.	11.50	12.20
	42	11.50	12.00	.
APR 86	43	11.50	11.50	12.00
	44	11.50	11.30	.
	45	10.00	10.60	12.00
	46	10.00	10.50	.
	47	10.00	10.00	9.50
	48	9.50	8.70	.
	49	8.50	8.50	9.20
	50	8.00	7.25	.
	51	7.50	7.50	7.00
	52	8.00	7.80	6.70
	53	.	7.90	7.10
	54	8.00	8.20	.
	55	7.00	7.50	6.90
JUL 86	56	7.50	8.90	.
	57	7.00	8.00	7.90
	58	6.50	7.50	.
	59	8.00	7.20	5.40
	60	9.00	6.00	.
	61	7.50	7.70	4.40
	62	.	5.20	.
	63	12.50	6.70	5.40
	64	6.50	6.90	.
	65	7.50	.	7.90
	66	6.50	9.20	.
	67	.	.	7.50
	68	7.50	9.30	7.50
	69	8.50	9.40	.
OCT 86	70	6.50	7.30	5.80
	71	.	8.10	.
	72	8.50	9.20	.
	73	7.50	8.90	7.90
	74	9.00	9.80	.
	75	.	8.60	8.00
	76	.	9.40	.
	77	9.00	10.20	.
	78	.	10.00	.
	79	11.00	11.60	10.40
	80	8.50	11.00	.
	81	11.50	.	.
	82	10.00	12.70	.
JAN 87	83	11.50	13.10	.
	84	11.50	12.10	.
	85	11.70	11.80	12.20
	86	.	11.70	.
	87	11.50	12.20	12.40
	88	.	12.20	.
	89	12.70	11.80	.
	90	12.50	12.80	.
	91	12.00	12.10	.
	92	11.70	13.20	.
	93	12.00	12.00	11.50
	94	11.00	11.00	.
	95	11.00	11.20	11.80
APR 87	96	.	11.20	.
	97	11.50	12.00	11.30
	98	11.50	10.40	.
	99	13.50	.	11.30
	100	11.00	10.40	.
	101	10.20	9.00	9.50
	102	.	7.80	.
	103	7.75	9.50	8.70
	104	.	7.10	.
	105	7.50	7.30	7.00
	106	7.00	5.10	.
	107	7.25	6.80	5.20
	108	7.25	8.30	.
	109	.	7.50	.
JUL 87	110	5.00	.	6.00
	111	7.50	7.50	.
	112	6.75	8.80	5.80
	113	8.50	10.00	.
	114	10.70	6.40	5.50
	115	.	7.20	.
	116	6.00	7.60	5.00
	117	6.50	9.20	.
	118	.	7.20	5.80
	119	6.00	.	.
	120	.	6.80	5.20
	121	7.75	8.80	.
	122	7.00	9.20	.
OCT 87	123	.	11.20	8.70
	124	9.00	12.50	.
	125	.	9.70	8.50
	126	.	10.40	.
	127	.	.	8.60
	128	.	10.40	.
	129	.	11.20	.
	130	.	.	.
	131	.	.	.
	132	.	11.00	10.30

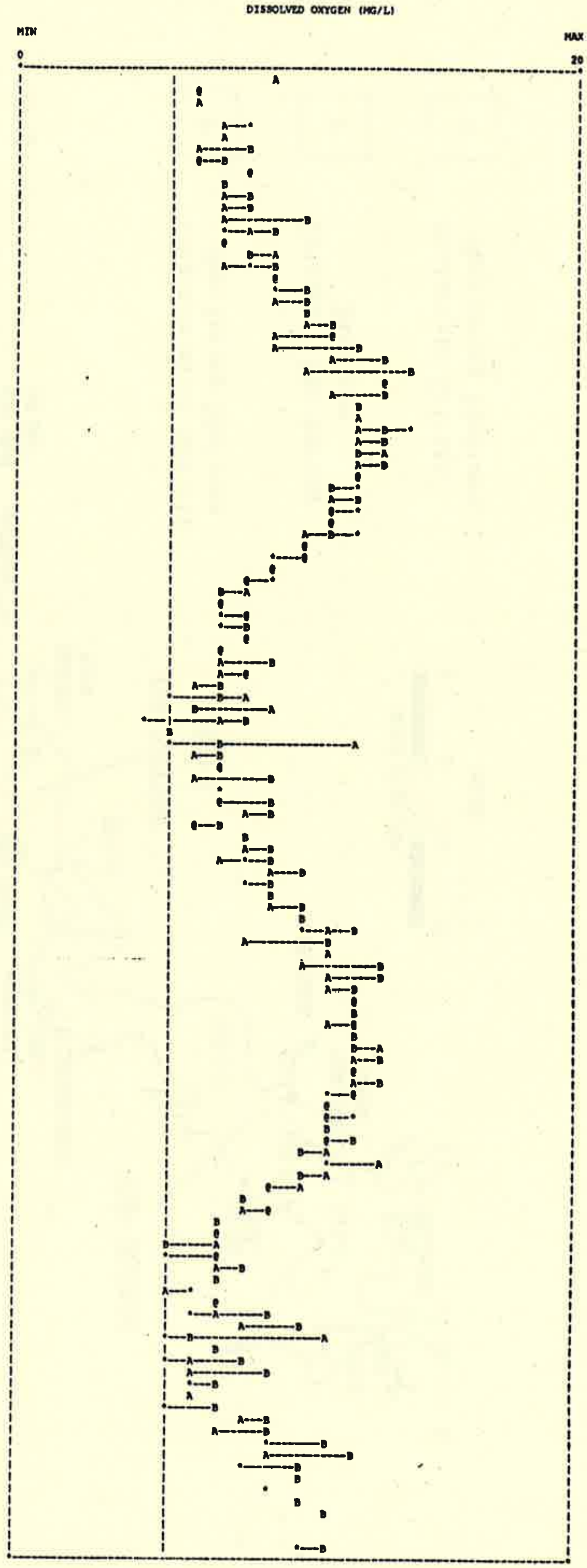


Figure 4a. Comparison of dissolved oxygen levels (mg/l) at CM sites Spring Cove-Mill Creek ('A') and Green Holly Pond ('B') with State station LE1.4 ('*'). The dashed line in the middle of the plot represents the state minimum standard (5 mg/l).

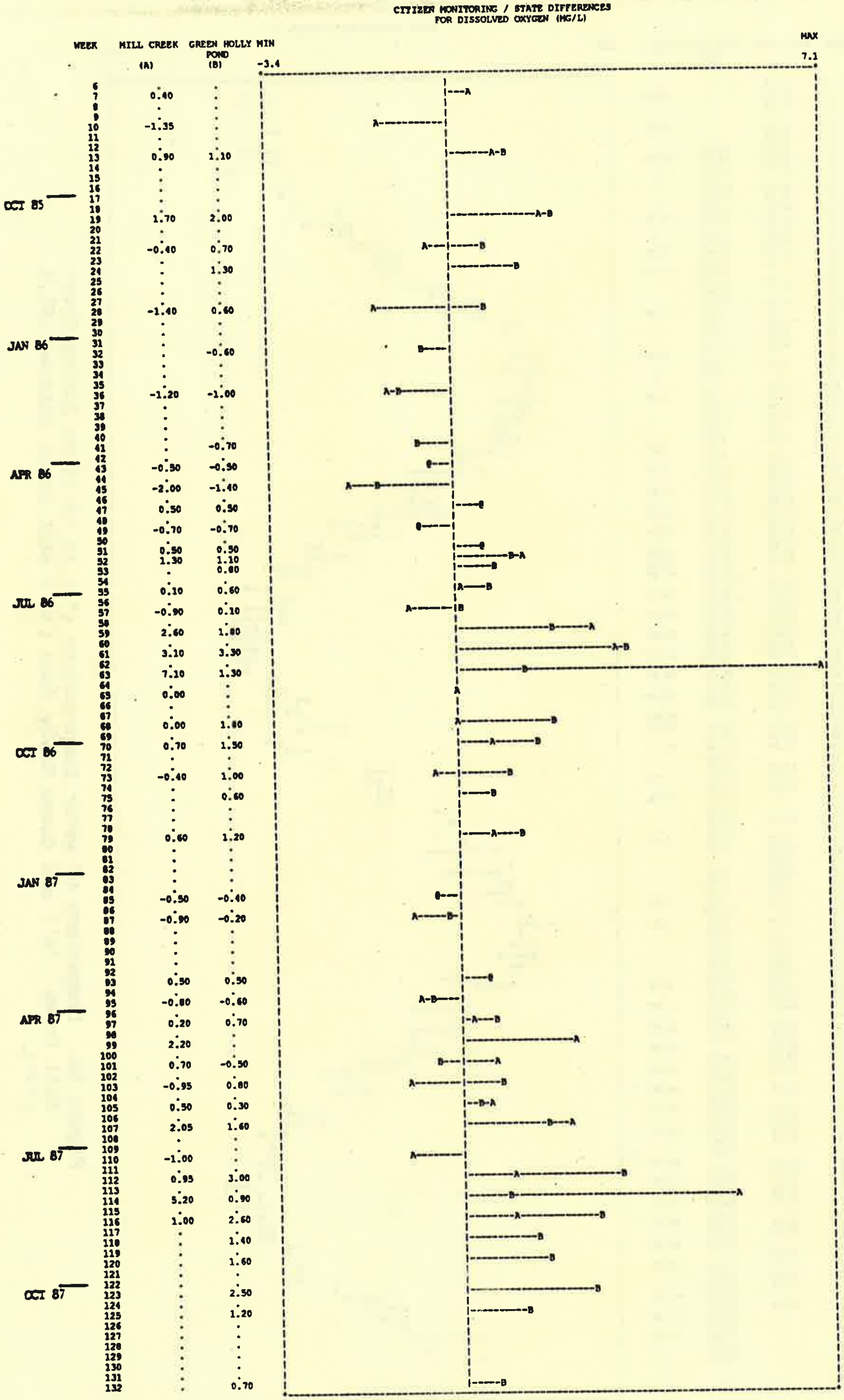


Figure 4b. Signed differences in dissolved oxygen levels (mg/l) between CM sites Spring Cove-Mill Creek ('A') and Green Holly Pond ('B') and State station LE1.4. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level measured at the CM site was higher than at the state station.

	WEEK	MILL CREEK (A)	GREEN HOLLY POND (B)	LE1.4 (*)
	6	27.00	.	.
	7	29.00	.	25.80
	8	27.50	.	.
	9	.	.	.
	10	25.00	.	26.90
	11	35.00	.	.
	12	29.00	26.50	.
	13	27.00	26.00	25.30
	14	31.50	30.00	.
	15	.	24.00	.
	16	25.00	25.00	.
OCT 85	17	24.00	24.00	.
	18	20.50	20.50	.
	19	23.00	19.00	20.30
	20	20.00	19.00	.
	21	16.50	19.00	.
	22	15.50	16.00	16.80
	23	17.00	15.50	.
	24	.	16.00	15.00
	25	11.50	14.00	.
	26	.	12.00	.
	27	7.00	9.50	.
	28	7.50	7.50	7.70
	29	5.50	4.50	.
	30	5.00	5.00	.
JAN 86	31	4.00	4.00	.
	32	.	4.00	2.50
	33	2.00	5.00	.
	34	.	3.50	.
	35	3.00	.	.
	36	6.50	4.50	2.30
	37	4.00	3.00	.
	38	6.00	4.50	.
	39	6.00	5.00	.
	40	4.00	6.50	.
	41	.	9.50	4.20
APR 86	42	11.00	9.50	.
	43	14.00	14.50	7.50
	44	16.00	12.00	.
	45	14.00	14.00	12.00
	46	12.50	14.00	.
	47	14.50	17.00	11.20
	48	21.50	17.00	.
	49	18.00	19.50	15.00
	50	22.00	23.50	.
	51	22.50	23.00	17.60
	52	23.50	26.50	22.10
	53	.	25.00	23.00
	54	29.00	27.00	.
JUL 86	55	26.00	26.00	23.90
	56	25.50	29.00	.
	57	25.50	30.50	25.70
	58	29.00	28.50	.
	59	30.50	29.00	27.10
	60	30.50	28.50	.
	61	30.00	29.00	27.60
	62	.	29.00	.
	63	27.50	27.50	26.60
	64	27.50	25.00	.
	65	23.50	24.00	23.50
	66	24.50	25.00	.
	67	.	.	23.00
	68	20.50	24.50	22.30
	69	27.00	26.00	.
OCT 86	70	25.50	25.00	23.30
	71	.	21.00	.
	72	16.50	18.50	.
	73	18.00	17.00	17.30
	74	16.00	17.00	.
	75	.	17.00	15.70
	76	.	12.00	.
	77	10.00	11.00	.
	78	.	12.50	.
	79	9.00	9.50	9.00
	80	13.00	6.00	.
	81	5.50	.	.
JAN 87	82	11.50	6.00	.
	83	6.00	5.50	.
	84	7.00	5.00	.
	85	6.50	4.50	4.50
	86	.	-4.00	.
	87	4.00	3.00	1.50
	88	.	4.00	.
	89	5.00	3.00	.
	90	6.00	3.50	.
	91	5.00	4.50	.
	92	9.50	10.00	.
	93	8.50	6.00	4.70
	94	11.50	10.00	.
	95	14.00	11.50	9.20
APR 87	96	.	9.00	.
	97	13.50	14.00	11.10
	98	14.00	14.50	.
	99	16.50	.	12.20
	100	15.50	19.00	.
	101	22.00	20.00	16.50
	102	.	19.50	.
	103	18.50	21.50	19.20
	104	.	25.50	.
	105	25.00	25.50	22.10
	106	25.00	22.00	.
	107	28.00	26.50	24.70
	108	27.50	27.00	.
JUL 87	109	.	27.00	.
	110	27.00	.	28.10
	111	28.00	28.50	.
	112	31.00	30.00	28.60
	113	31.00	28.50	.
	114	30.00	29.50	27.90
	115	.	28.00	.
	116	28.50	27.50	26.60
	117	28.00	27.50	.
	118	.	25.50	24.30
	119	25.00	.	.
	120	.	24.00	24.50
	121	24.00	25.00	.
OCT 87	122	21.00	21.50	.
	123	.	20.00	17.00
	124	15.50	18.50	.
	125	.	17.00	15.10
	126	.	15.50	.
	127	.	8.00	13.70
	128	.	13.00	.
	129	.	8.50	.
	130	.	.	.
	131	.	.	.
	132	.	8.00	7.50

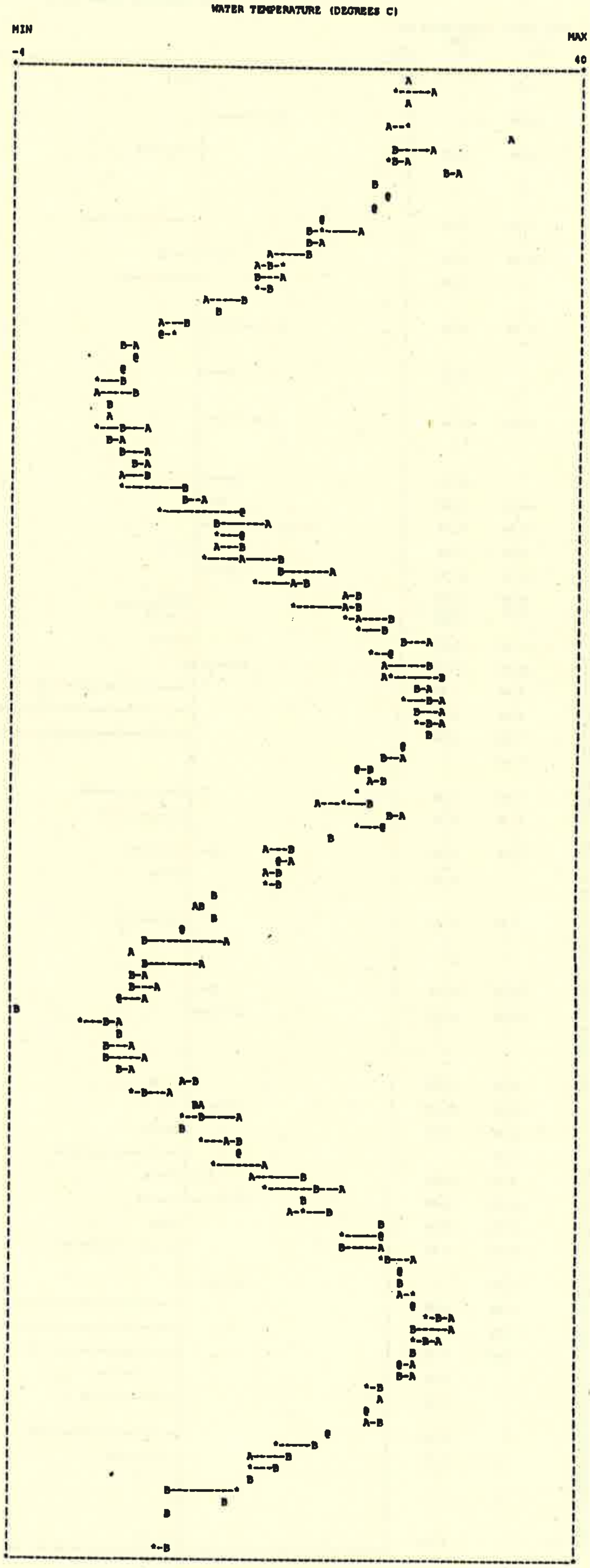
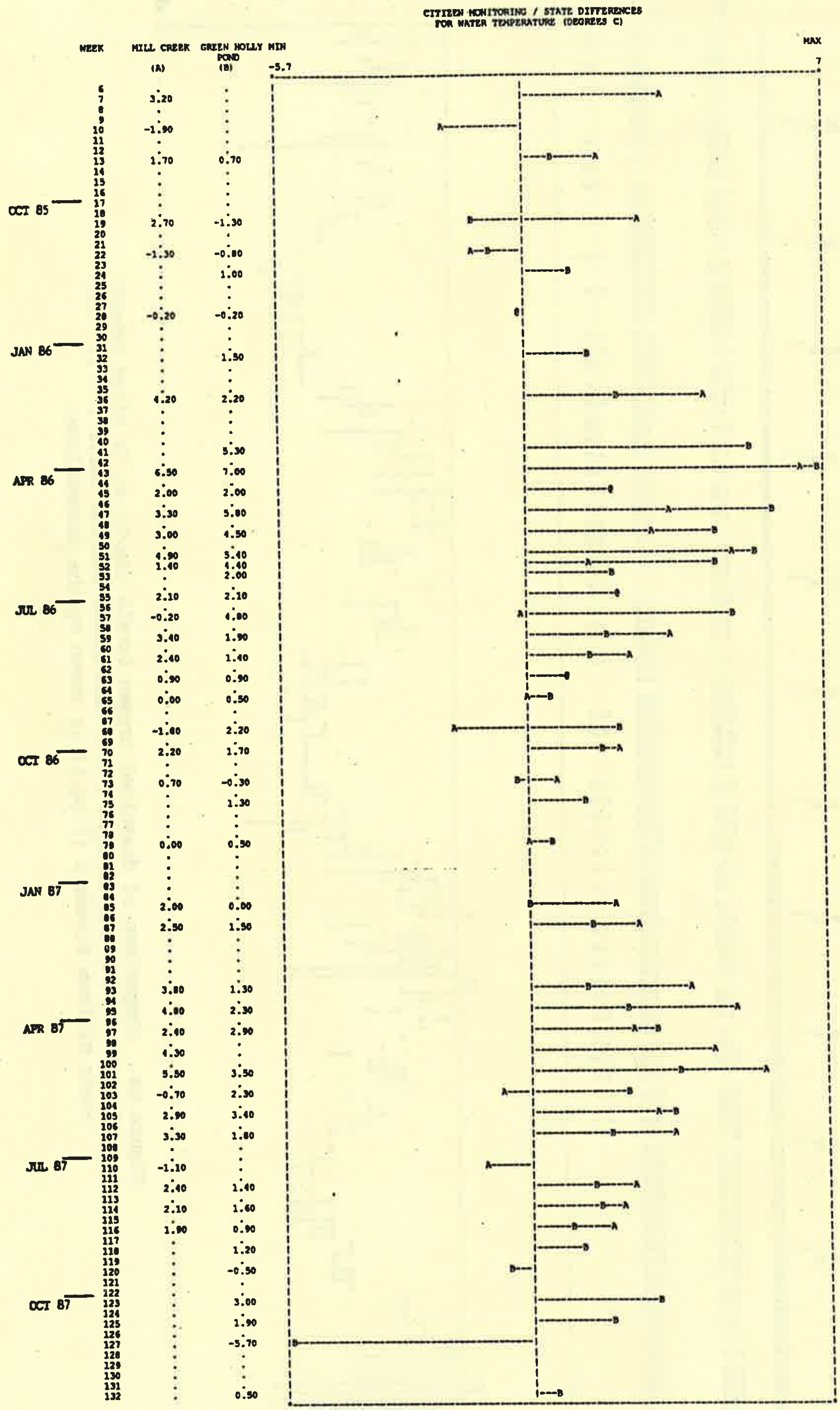


Figure 5a. Comparison of water temperatures (°C) at CM sites Spring Cove-Mill Creek ('A') and Green Holly Pond ('B') with State station LE1.4 ('*').



WEEK	MILL CREEK (A)	GREEN HOLLY MIN POND (B)
7	3.20	.
10	-1.90	.
13	1.70	0.70
19	2.70	-1.30
22	-1.30	-0.80
24	.	1.00
28	-0.20	-0.20
32	.	1.50
36	4.20	2.20
41	.	5.30
43	6.50	7.00
45	2.00	2.00
47	3.30	5.80
49	3.00	4.50
51	4.90	5.40
52	1.40	4.40
53	.	2.00
55	2.10	2.10
57	-0.20	4.80
59	3.40	1.90
61	2.40	1.40
63	0.90	0.90
65	0.00	0.50
68	-1.80	2.20
70	2.20	1.70
73	0.70	-0.30
75	.	1.30
79	0.00	0.50
85	2.00	0.00
87	2.50	1.50
93	3.80	1.30
95	4.80	2.30
97	2.40	2.90
99	4.30	.
101	5.50	3.50
103	-0.70	2.30
105	2.90	3.40
107	3.30	1.80
110	-1.10	.
112	2.40	1.40
114	2.10	1.60
116	1.90	0.90
118	.	1.20
120	.	-0.50
123	.	3.00
125	.	1.90
127	.	-5.70
132	.	0.50

Figure 5b. Signed differences in water temperatures (°C) between CM sites Spring Cove-Mill Creek ('A') and Green Holly Pond ('B') and State Station LE1.4. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the water temperature measured at the CM site was higher than at the state station.

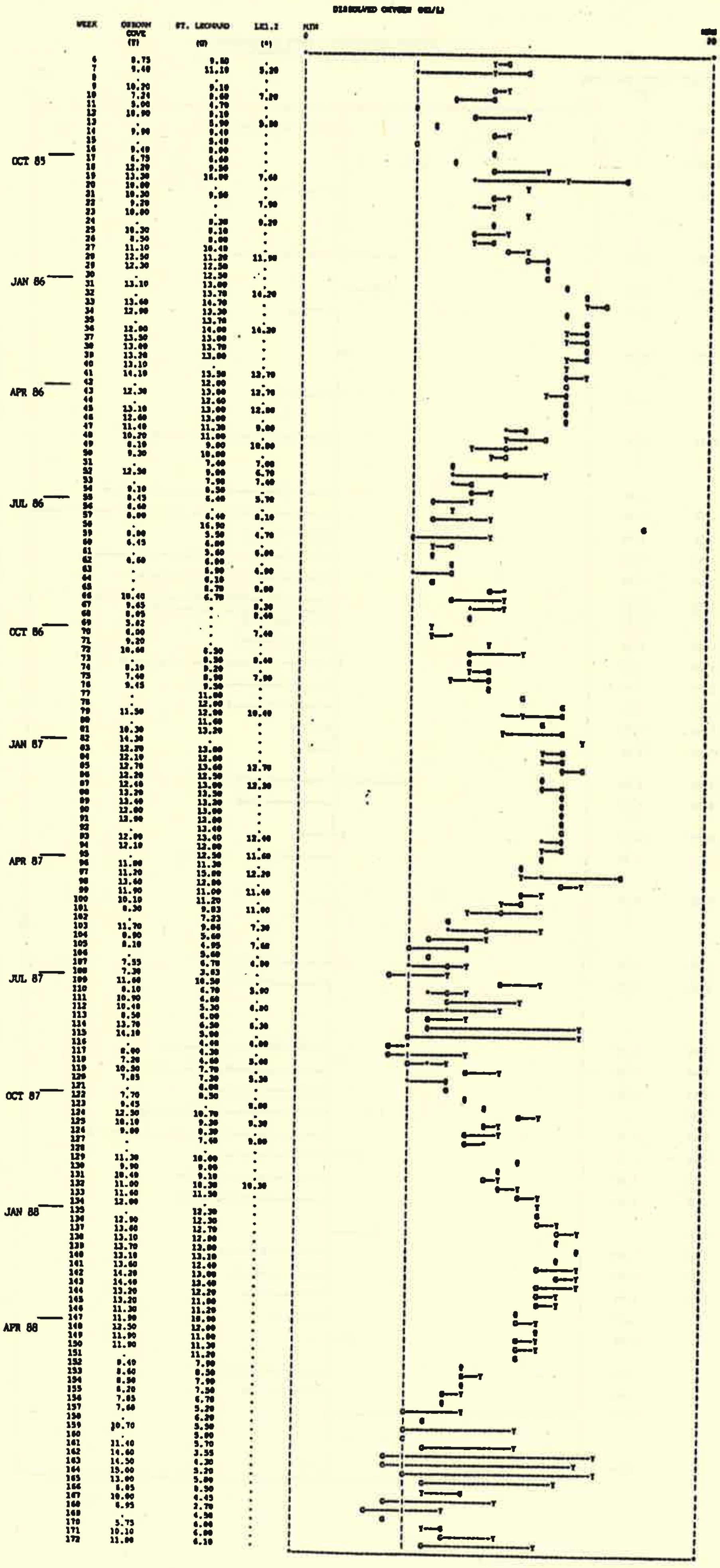


Figure 6a. Comparison of dissolved oxygen levels (mg/l) at CM sites Osborn Cove ('F') and St. Leonard ('G') with State station LE1.2 ('*'). The state minimum standard (5 mg/l) is shown by the dashed line.

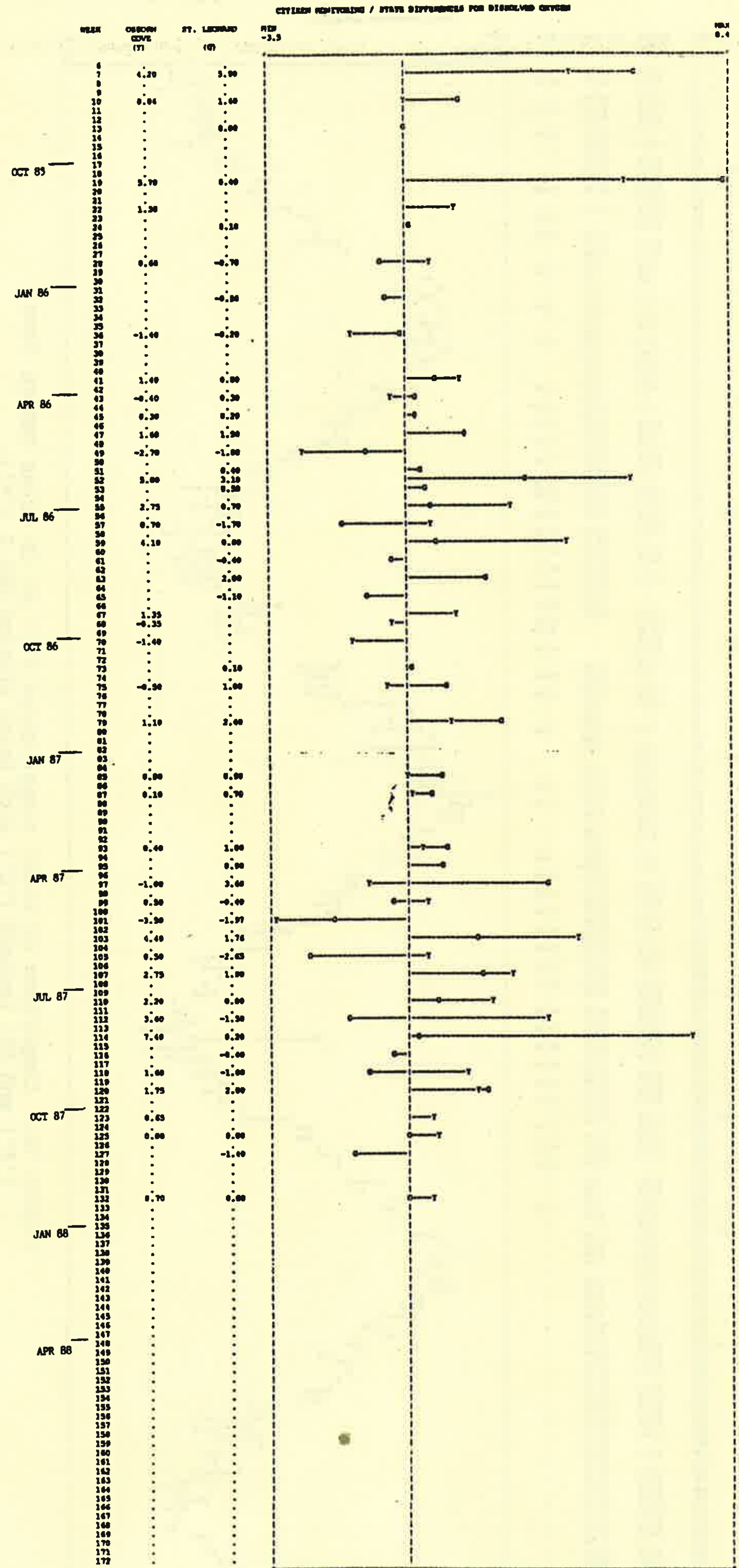


Figure 6b. Signed differences in dissolved oxygen levels (mg/l) between CM sites Osborn Cove ('F') and St. Leonard ('G') and State station LE1.2. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level measured at the CM site was higher than at the state station.

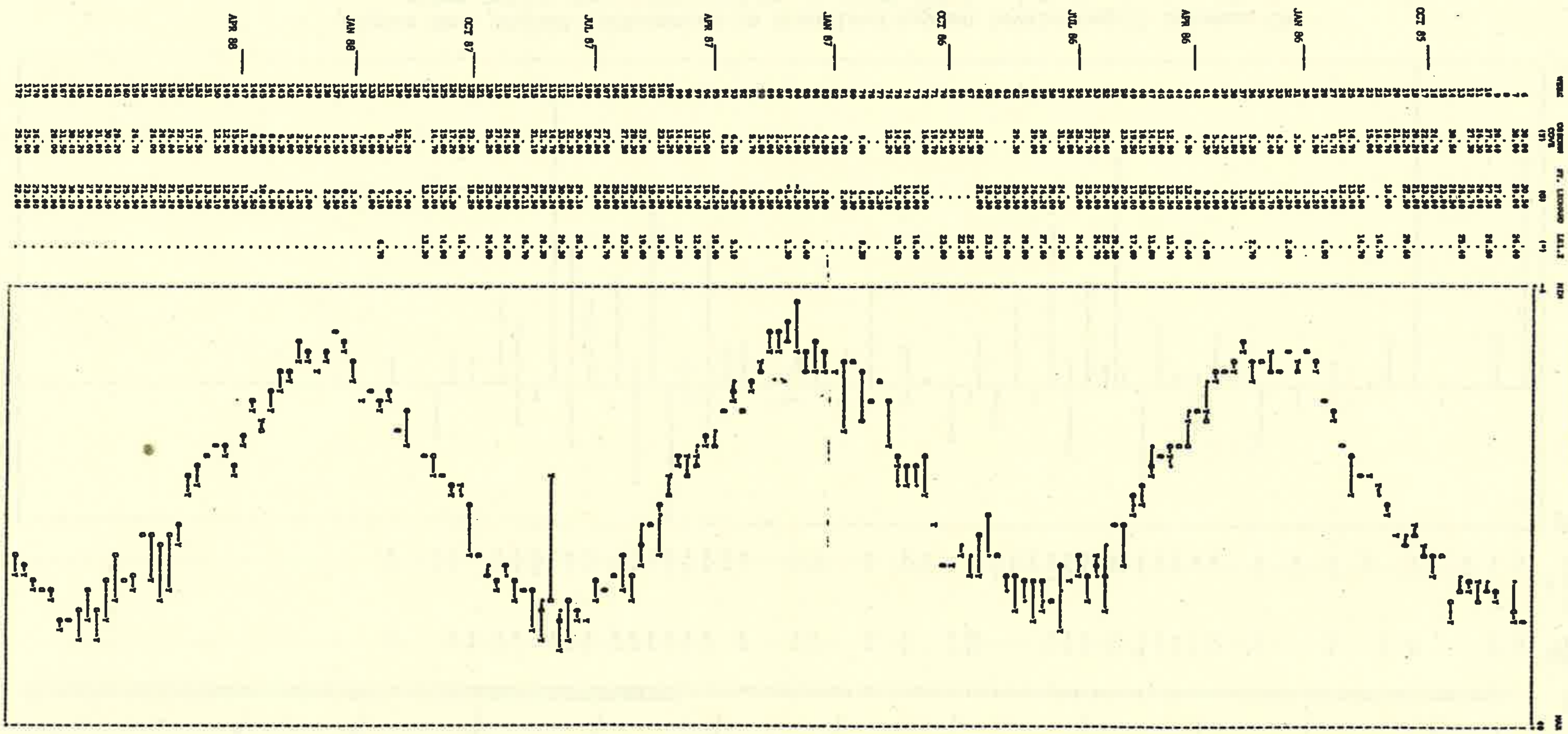


Figure 7a. Comparison of water temperatures (°C) at CM sites Osborn Cove ('F') and St. Leonard ('G') with State station LE1.2 ('*').

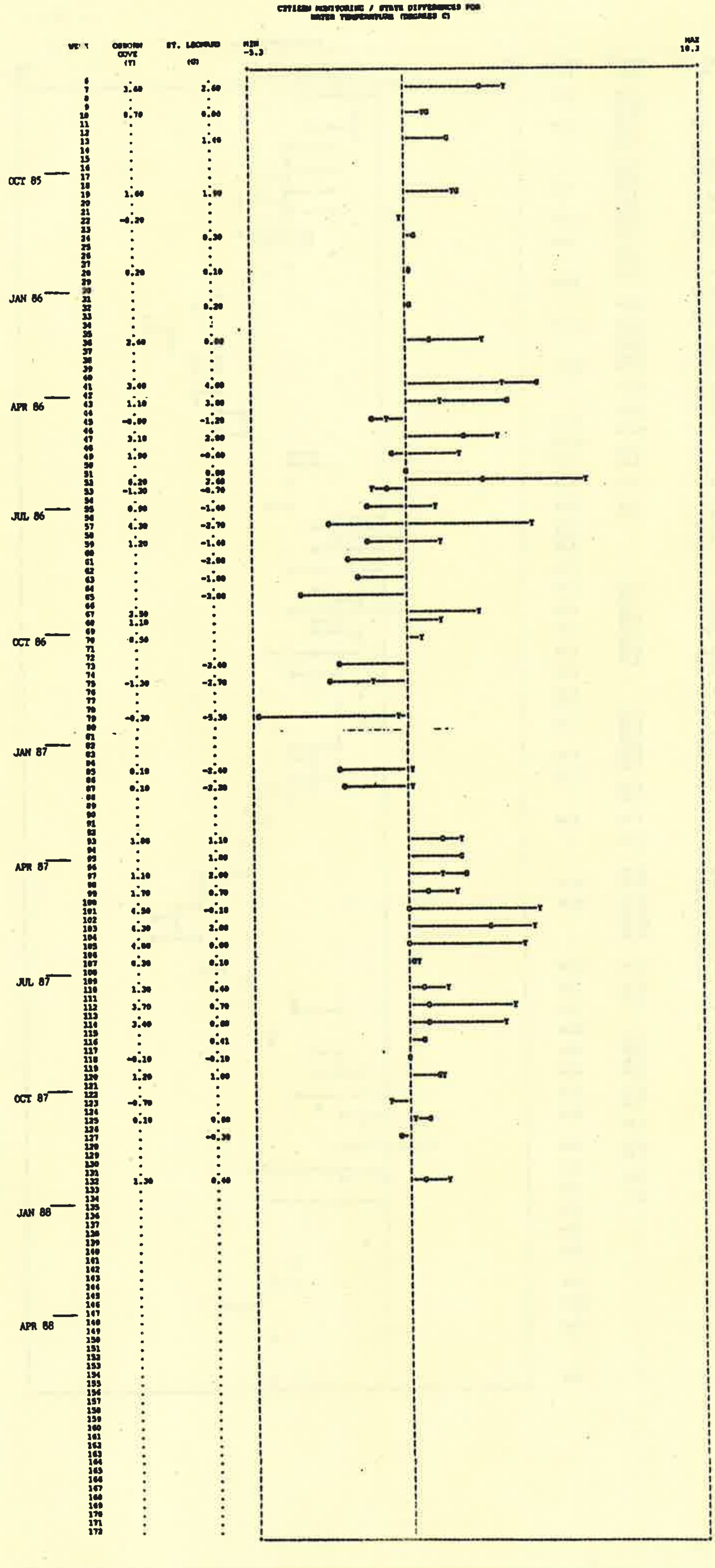


Figure 7b. Signed differences in water temperatures (°C) between CM sites Osborn Cove ('F') and St. Leonard ('G') and State station LE1.2. The dashed line in the middle of the plot represents zero difference; positive differences indicate that the water temperature measured at the CM sites was higher than at the state station.

	WEEK	TRENT HALL (N)	BENEDICT (O)	RET1.1 (*)
	10	.	7.80	5.00
	11	.	10.10	.
	12	.	6.00	.
	13	7.85	7.30	5.90
	14	.	6.10	.
	15	9.30	7.30	.
	16	9.30	.	.
OCT 85	17	9.30	6.90	.
	18	10.20	9.50	.
	19	.	9.00	7.30
	20	10.90	9.35	.
	21	8.70	6.70	.
	22	.	9.10	10.20
	23	10.70	8.50	.
	24	10.20	.	8.20
	25	.	7.50	.
	26	.	8.70	.
	27	10.10	10.00	.
	28	.	.	10.60
	29	12.00	.	.
JAN 86	30	.	12.60	.
	31	14.60	.	.
	32	14.90	14.10	14.20
	33	.	13.70	.
	34	13.60	13.60	.
	35	13.50	12.40	.
	36	13.00	11.80	12.30
	37	.	.	.
	38	13.20	12.10	.
	39	13.10	.	.
	40	11.20	11.90	.
	41	.	.	11.10
	42	12.10	10.80	.
APR 86	43	.	.	10.10
	44	8.40	8.70	.
	45	7.90	8.60	7.30
	46	.	.	.
	47	9.30	9.40	8.80
	48	.	.	.
	49	9.60	8.65	9.50
	50	6.90	5.45	.
	51	8.30	.	5.20
	52	6.80	.	4.40
	53	7.80	.	5.50
	54	.	.	.
JUL 86	55	9.30	.	5.20
	56	.	.	.
	57	.	8.15	5.80
	58	6.00	6.90	.
	59	8.80	4.20	5.20
	60	7.60	6.80	.
	61	8.00	5.70	5.90
	62	.	6.30	.
	63	7.80	9.80	6.00
	64	6.70	6.90	.
	65	9.30	.	6.90
	66	.	.	.
	67	6.10	.	6.00
	68	.	.	6.60
	69	6.00	6.80	.
OCT 86	70	.	6.40	5.50
	71	6.80	6.80	.
	72	9.20	6.90	.
	73	8.90	8.00	8.10
	74	.	8.40	.
	75	9.10	.	7.20
	76	8.40	9.75	.
	77	.	9.10	.
	78	11.30	.	.
	79	.	9.95	9.60
	80	11.60	.	.
	81	.	10.60	.
JAN 87	82	11.40	.	.
	83	.	.	.
	84	13.00	11.50	.
	85	12.60	13.30	11.90
	86	12.80	.	.
	87	14.00	13.10	13.60
	88	13.80	15.50	.
	89	.	13.60	.
	90	13.40	14.80	.
	91	12.00	.	.
	92	12.20	.	.
	93	12.40	12.70	12.00
	94	10.90	.	.
	95	.	7.90	7.50
APR 87	96	9.00	8.70	.
	97	8.80	.	7.10
	98	.	.	.
	99	9.90	.	10.20
	100	.	9.60	.
	101	.	7.90	7.40
	102	.	7.35	.
	103	.	7.85	6.10
	104	.	.	.
	105	9.00	5.10	6.50
	106	.	7.60	.
	107	7.20	.	5.40
	108	.	5.95	.
JUL 87	109	.	.	.
	110	.	6.90	3.50
	111	.	4.80	.
	112	11.50	.	5.20
	113	7.00	5.20	.
	114	.	.	4.70
	115	10.30	5.40	.
	116	.	.	5.70
	117	.	.	.
	118	.	.	5.00
	119	6.00	.	.
	120	.	.	4.20
	121	8.60	.	.
OCT 87	122	.	.	.
	123	9.70	.	8.80
	124	.	.	.
	125	11.90	.	10.70
	126	.	.	.
	127	.	.	8.40
	128	9.80	.	.
	129	.	.	.
	130	.	.	.
	131	.	.	.
	132	10.40	.	9.60

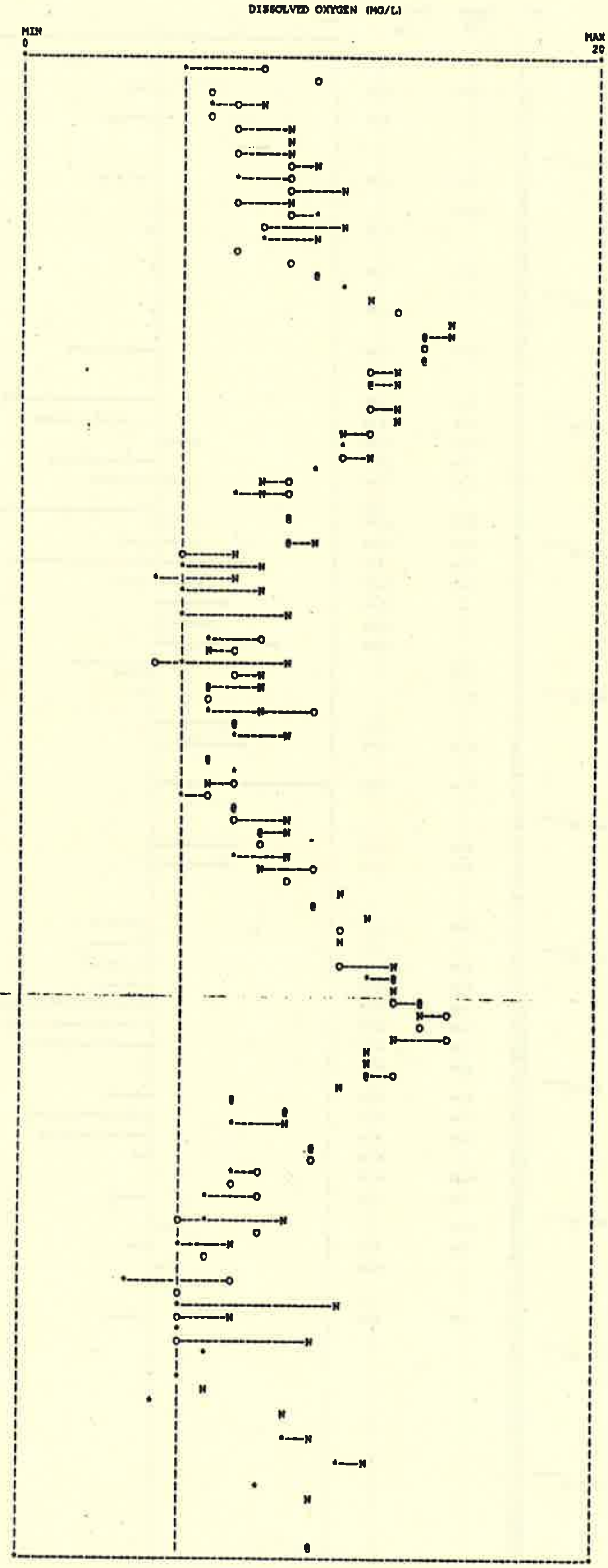


Figure 8a. Comparison of dissolved oxygen levels (mg/l) at CM sites Trent Hall ('N') and Benedict ('O') with State station RET1.1 ('*'). The state minimum standard (5 mg/l) is shown by the dashed line.

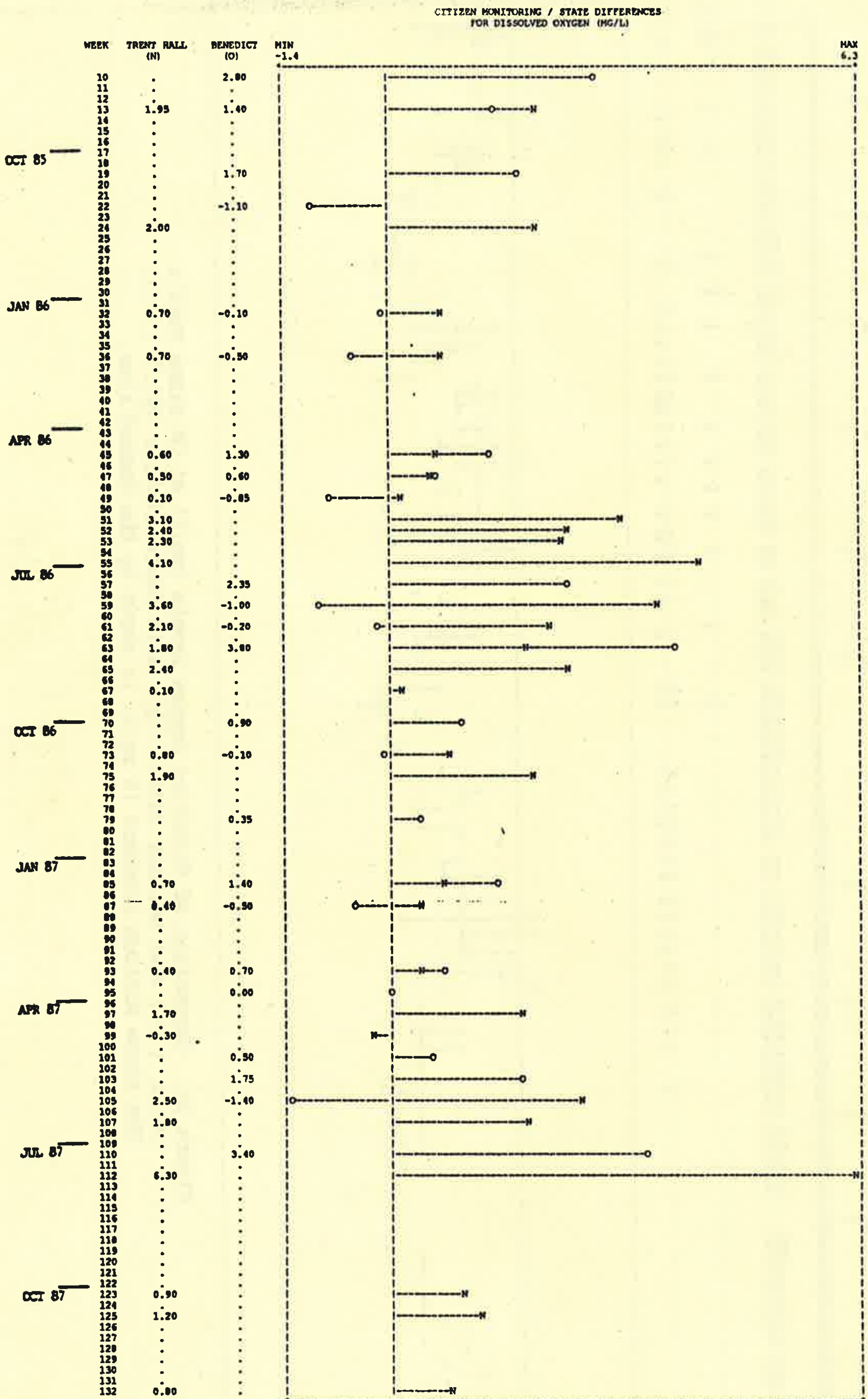


Figure 8b. Signed differences in dissolved oxygen levels (mg/l) between CM sites Trent Hall ('N') and Benedict ('O') and State station RET1.1. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM site was higher that at the state station.

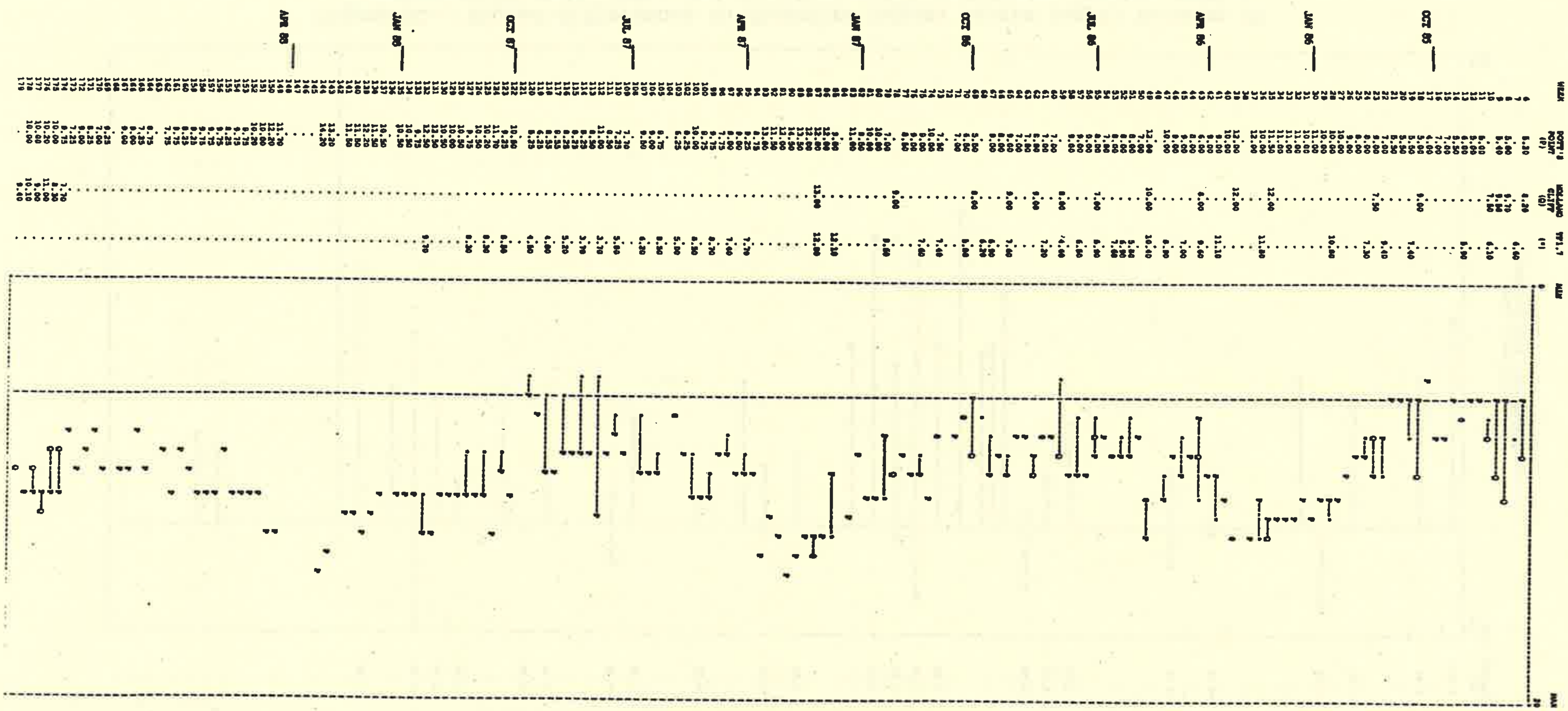


Figure 9a. Comparison of dissolved oxygen levels (mg/l) at CM sites Pott's Point ('P') and Holland Cliff ('Q') with State station TF1.7 ('*'). The state minimum standard (5 mg/l) is shown by the dashed line.

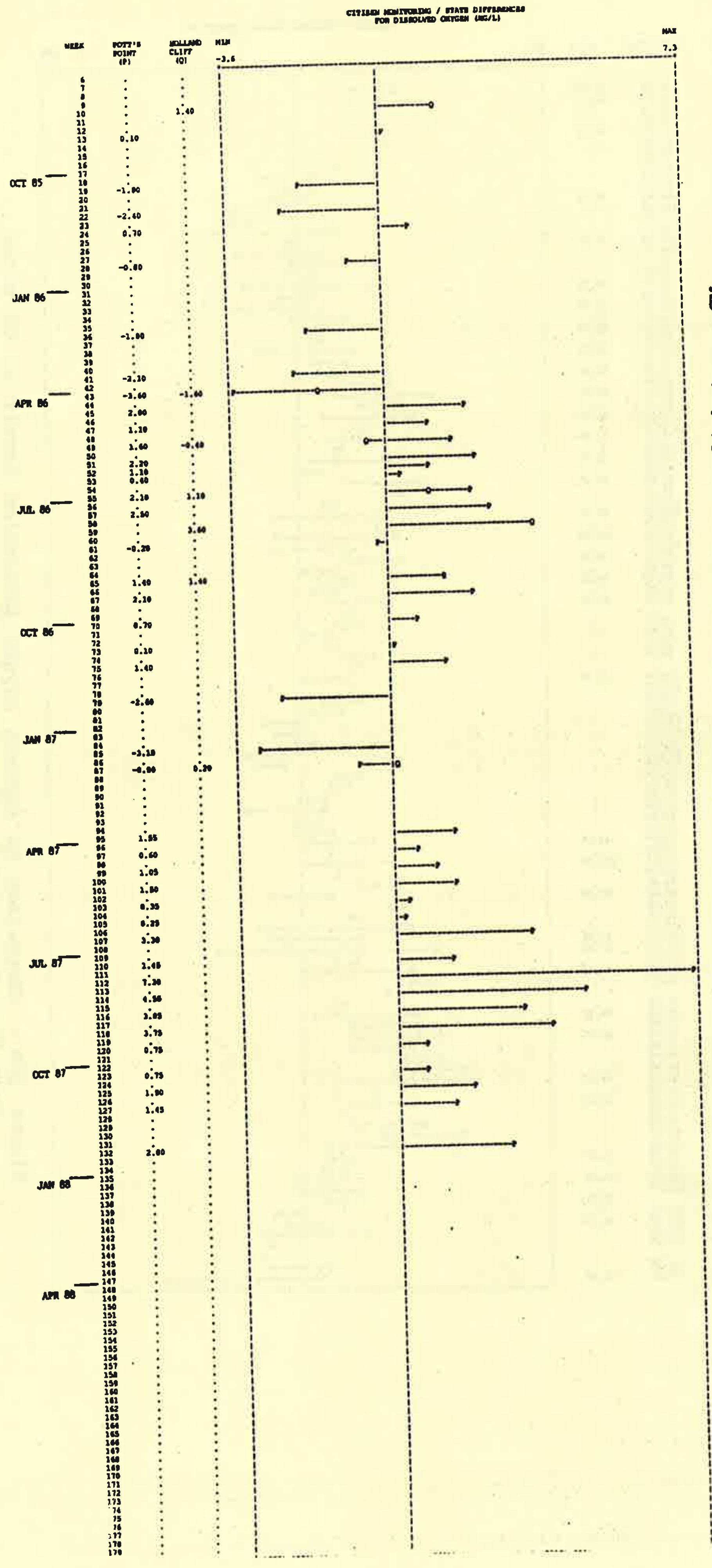


Figure 9b. Signed differences in dissolved oxygen levels (mg/l) between CM sites Pott's Point ('P') and Holland Cliff ('Q') and State station TF1.7. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level measured at the CM site was higher that at the state station.

	WEEK	TOWN FARM (D)	SMITHFIELD (E)	LE5.3 (*)
	22	.	69.41	.
	23	.	62.18	78.83
	24	.	49.61	78.71
	25	.	69.19	.
	26	.	48.45	.
	27	.	70.27	81.12
	28	.	64.85	.
	29	.	76.22	.
	30	.	82.53	.
JAN 86	31	115.32	93.25	.
	32	106.01	93.33	.
	33	100.68	110.43	98.56
	34	127.79	103.35	.
	35	128.11	119.73	.
	36	135.37	86.60	.
	37	104.78	101.56	98.24
	38	124.64	89.66	.
	39	101.58	82.13	.
	40	128.54	93.70	.
	41	124.24	70.74	98.26
	42	109.30	97.24	.
	43	128.75	121.32	90.86
APR 86	44	103.17	80.10	.
	45	77.69	93.24	91.95
	46	95.14	90.40	.
	47	78.51	118.36	99.25
	48	95.51	79.78	.
	49	88.78	64.28	96.72
	50	63.77	84.06	.
	51	68.17	46.13	86.05
	52	77.34	60.60	.
	53	68.55	54.06	91.89
	54	75.45	73.74	.
	55	83.15	76.88	89.28
JUL 86	56	86.90	83.24	.
	57	63.07	86.25	95.74
	58	91.82	98.60	.
	59	73.53	52.06	82.15
	60	60.79	60.15	.
	61	84.58	89.88	.
	62	68.59	110.30	83.77
	63	51.68	69.12	.
	64	62.25	91.66	110.18
	65	80.19	112.10	.
	66	77.12	59.25	80.08
	67	84.75	99.12	.
	68	83.97	80.75	93.30
	69	94.74	87.27	.
OCT 86	70	65.10	73.97	87.80
	71	81.33	.	.
	72	84.63	75.74	.
	73	98.91	87.98	.
	74	90.56	85.82	.
	75	80.22	70.74	.
	76	77.07	.	.
	77	89.46	98.00	86.84
	78	113.26	113.74	.
	79	77.49	89.88	.
	80	84.00	95.60	.
	81	101.60	114.88	.
	82	109.74	102.09	.
JAN 87	83	94.62	102.95	.
	84	123.31	108.62	.
	85	118.84	108.02	.
	86	76.22	86.63	.
	87	87.81	81.15	.
	88	98.11	89.99	.
	89	122.22	90.08	.
	90	101.63	92.63	.
	91	104.13	87.79	.
	92	97.20	70.58	99.05
	93	.	89.09	.
	94	92.45	75.27	100.14
	95	.	84.79	.
APR 87	96	64.57	76.38	.
	97	111.99	89.00	95.10
	98	58.79	63.00	.
	99	77.93	81.70	.
	100	55.85	117.41	.
	101	75.51	114.90	87.12
	102	46.16	134.06	84.38
	103	78.00	87.68	.
	104	56.09	100.28	96.92
	105	48.54	56.51	.
	106	66.23	.	.
	107	83.11	88.74	.
	108	54.03	96.52	94.40
	109	53.78	79.80	.
JUL 87	110	45.02	54.48	80.67
	111	56.91	81.89	.
	112	45.12	57.70	.
	113	33.87	62.89	.
	114	28.74	57.41	85.47
	115	.	71.15	.
	116	55.59	81.95	82.11
	117	.	87.13	.
	118	52.31	79.89	.
	119	36.09	67.77	.
	120	36.92	89.72	.
	121	.	91.35	81.29
	122	84.07	93.44	.
OCT 87	123	85.04	105.20	94.00
	124	79.41	103.79	.
	125	86.80	.	94.41
	126	104.34	113.07	.
	127	.	107.73	91.85
	128	75.93	119.10	.
	129	.	116.23	.
	130	116.93	.	.
	131	91.81	116.32	.
	132	109.89	157.32	93.86

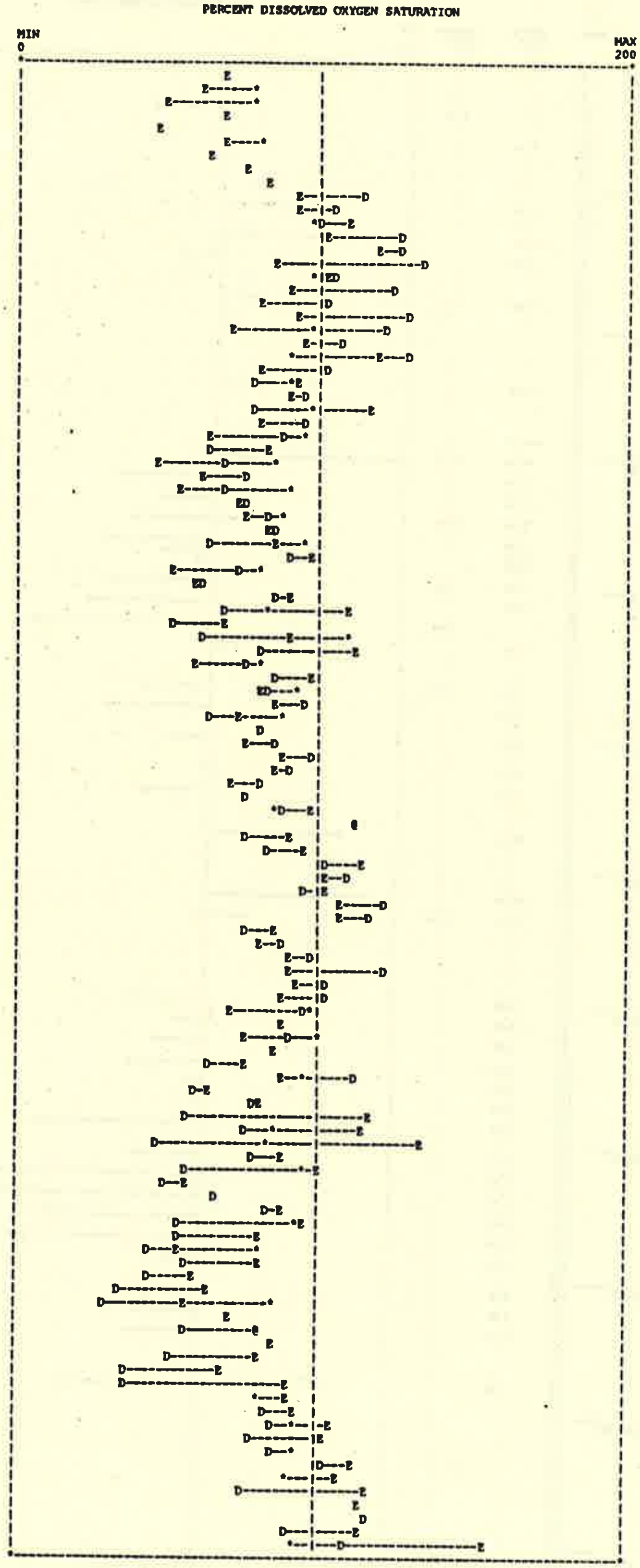


Figure 10a. Comparison of percent oxygen saturation levels at CM sites Town Farm Creek ('D') and Smithfield ('E') with State station LE5.3 ('*'). The dashed line in the middle of the plot shows 100% saturation.

CITIZEN MONITORING / STATE DIFFERENCES
FOR DISSOLVED SATURATION

	WEEK	TOWN FARM (D)	SMITHFIELD (E)
	22	.	.
	23	.	-16.65
	24	.	-29.11
	25	.	.
	26	.	.
	27	.	-10.85
	28	.	.
	29	.	.
	30	.	.
JAN 86	31	.	.
	32	.	.
	33	2.12	11.86
	34	.	.
	35	.	.
	36	.	.
	37	6.54	3.32
	38	.	.
	39	.	.
	40	.	.
	41	25.98	-27.52
	42	.	.
APR 86	43	37.90	30.46
	44	.	.
	45	-14.26	1.29
	46	.	.
	47	-20.74	19.11
	48	.	.
	49	-7.94	-32.44
	50	.	.
	51	-17.08	-39.91
	52	.	.
	53	-23.34	-37.03
	54	.	.
	55	-6.12	-12.40
JUL 86	56	.	.
	57	-32.67	-9.49
	58	.	.
	59	-8.62	-30.09
	60	.	.
	61	.	.
	62	-15.18	26.52
	63	.	.
	64	-47.93	-18.53
	65	.	.
	66	-2.96	-20.83
	67	.	.
	68	-9.33	-12.55
	69	.	.
OCT 86	70	-22.70	-13.83
	71	.	.
	72	.	.
	73	.	.
	74	.	.
	75	.	.
	76	.	.
	77	2.82	11.36
	78	.	.
	79	.	.
	80	.	.
	81	.	.
JAN 87	82	.	.
	83	.	.
	84	.	.
	85	.	.
	86	.	.
	87	.	.
	88	.	.
	89	.	.
	90	.	.
	91	.	.
	92	-1.85	-28.47
	93	.	.
	94	-7.68	-24.86
	95	.	.
APR 87	96	.	.
	97	16.90	-6.09
	98	.	.
	99	.	.
	100	.	.
	101	-11.61	27.78
	102	-38.22	49.68
	103	.	.
	104	-40.83	3.35
	105	.	.
	106	.	.
	107	.	.
	108	-40.38	2.12
JUL 87	109	.	.
	110	-35.64	-26.18
	111	.	.
	112	.	.
	113	.	.
	114	-56.73	-28.07
	115	.	.
	116	-26.52	-0.16
	117	.	.
	118	.	.
	119	.	.
	120	.	.
	121	.	10.06
OCT 87	122	.	.
	123	-8.97	11.19
	124	.	.
	125	-7.62	.
	126	.	.
	127	.	15.89
	128	.	.
	129	.	.
	130	.	.
	131	.	.
	132	16.04	63.47

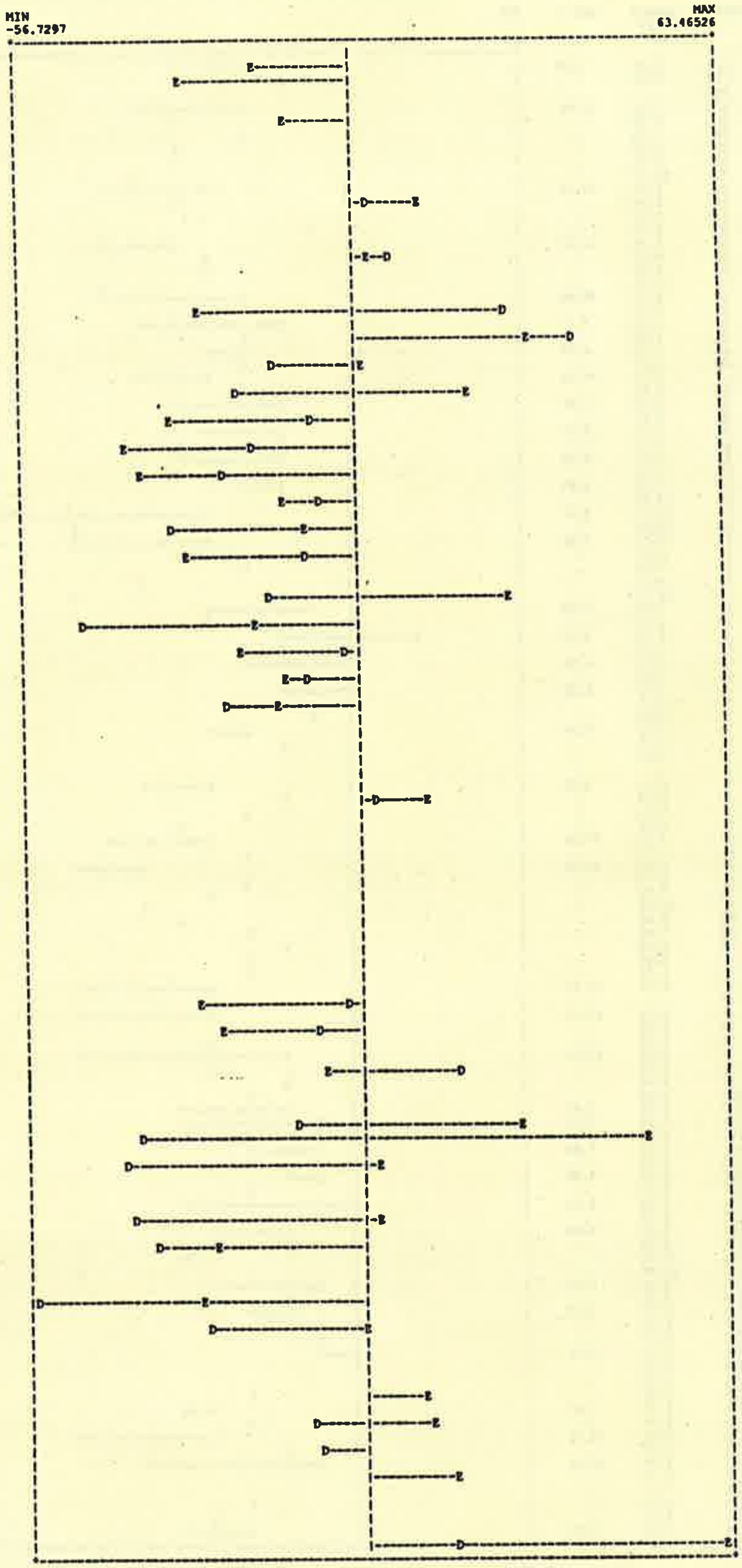


Figure 10b. Signed differences in percent oxygen saturation between CM sites Town Farm Creek ('D') and Smithfield ('E') and State station LE5.2. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM sites was higher that at the state station.

	WEEK	JORDON POINT (L)	TF5.5 (*)
	24	5.20	7.80
	25	5.80	.
	26	.	.
	27	7.50	10.00
	28	8.85	.
	29	7.35	.
	30	8.95	.
	31	9.45	.
JAN 86	32	10.30	.
	33	7.55	11.40
	34	9.00	.
	35	8.20	.
	36	5.05	.
	37	9.30	11.00
	38	8.00	.
	39	8.40	.
	40	11.20	.
	41	6.60	10.80
	42	9.00	.
	43	6.45	9.90
APR 86	44	7.40	.
	45	7.40	8.40
	46	6.60	.
	47	8.35	10.40
	48	6.40	.
	49	5.90	9.20
	50	5.10	.
	51	5.70	8.00
	52	5.70	.
	53	6.10	8.60
	54	9.10	.
	55	6.00	6.80
	56	15.30	.
JUL 86	57	14.70	8.07
	58	12.50	.
	59	12.40	7.90
	60	8.85	.
	61	6.80	.
	62	9.60	.
	63	12.30	.
	64	7.80	5.00
	65	3.60	.
	66	2.00	6.10
	67	5.90	.
	68	4.50	7.00
	69	4.10	.
	70	3.70	6.90
OCT 86	71	5.70	.
	72	5.35	.
	73	7.33	7.60
	74	5.70	.
	75	3.80	.
	76	.	.
	77	8.10	9.80
	78	5.90	.
	79	6.80	.
	80	9.00	.
	81	7.80	10.80
	82	6.90	.
	83	9.80	11.90
JAN 87	84	6.70	.
	85	7.90	.
	86	10.40	.
	87	9.50	.
	88	7.00	.
	89	6.00	.
	90	7.20	.
	91	7.30	.
	92	8.30	11.80
	93	.	.
	94	8.00	11.60
	95	7.20	.
	96	8.20	.
APR 87	97	6.10	11.60
	98	8.00	.
	99	6.50	.
	100	7.20	.
	101	6.00	8.60
	102	4.70	9.10
	103	4.90	.
	104	5.00	7.03
	105	4.10	.
	106	5.20	5.90
	107	6.90	.
	108	4.50	8.90
	109	5.10	.
JUL 87	110	6.30	7.80
	111	6.15	.
	112	8.90	.
	113	12.20	.
	114	4.60	7.97
	115	6.00	.
	116	5.70	6.90
	117	4.60	.
	118	5.00	.
	119	4.20	5.15
	120	4.20	.
	121	3.90	.
	122	7.00	.
OCT 87	123	9.40	7.90
	124	6.90	.
	125	7.60	11.60
	126	6.00	.
	127	5.50	10.40
	128	3.90	.
	129	.	.
	130	6.80	.
	131	8.40	.
	132	7.40	9.20

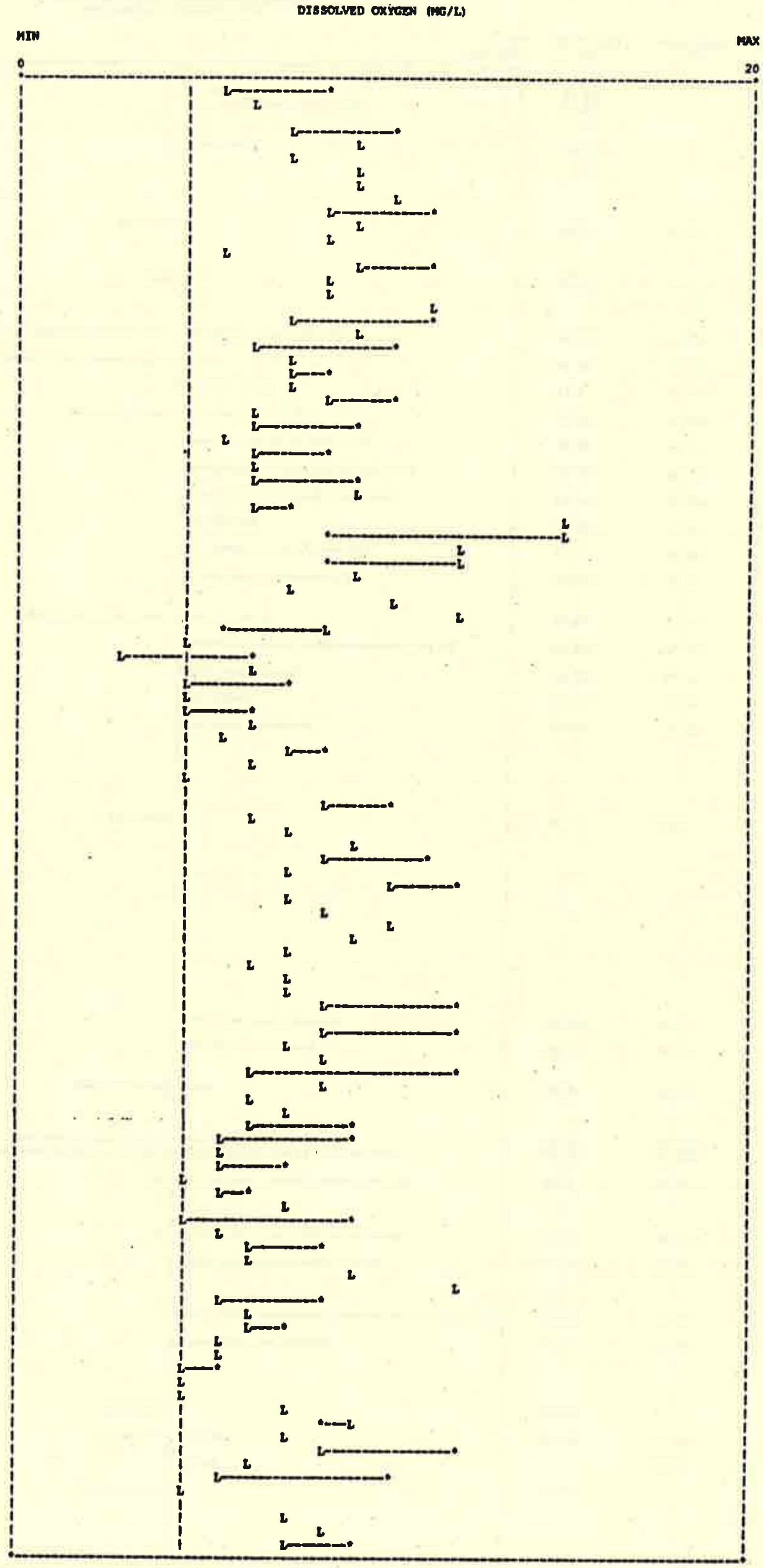


Figure 11a. Comparison of dissolved oxygen levels at CM site Jordan Point ('L') with State station TF5.5 ('*'). The state minimum standard (4 mg/l) is shown by the dashed line.

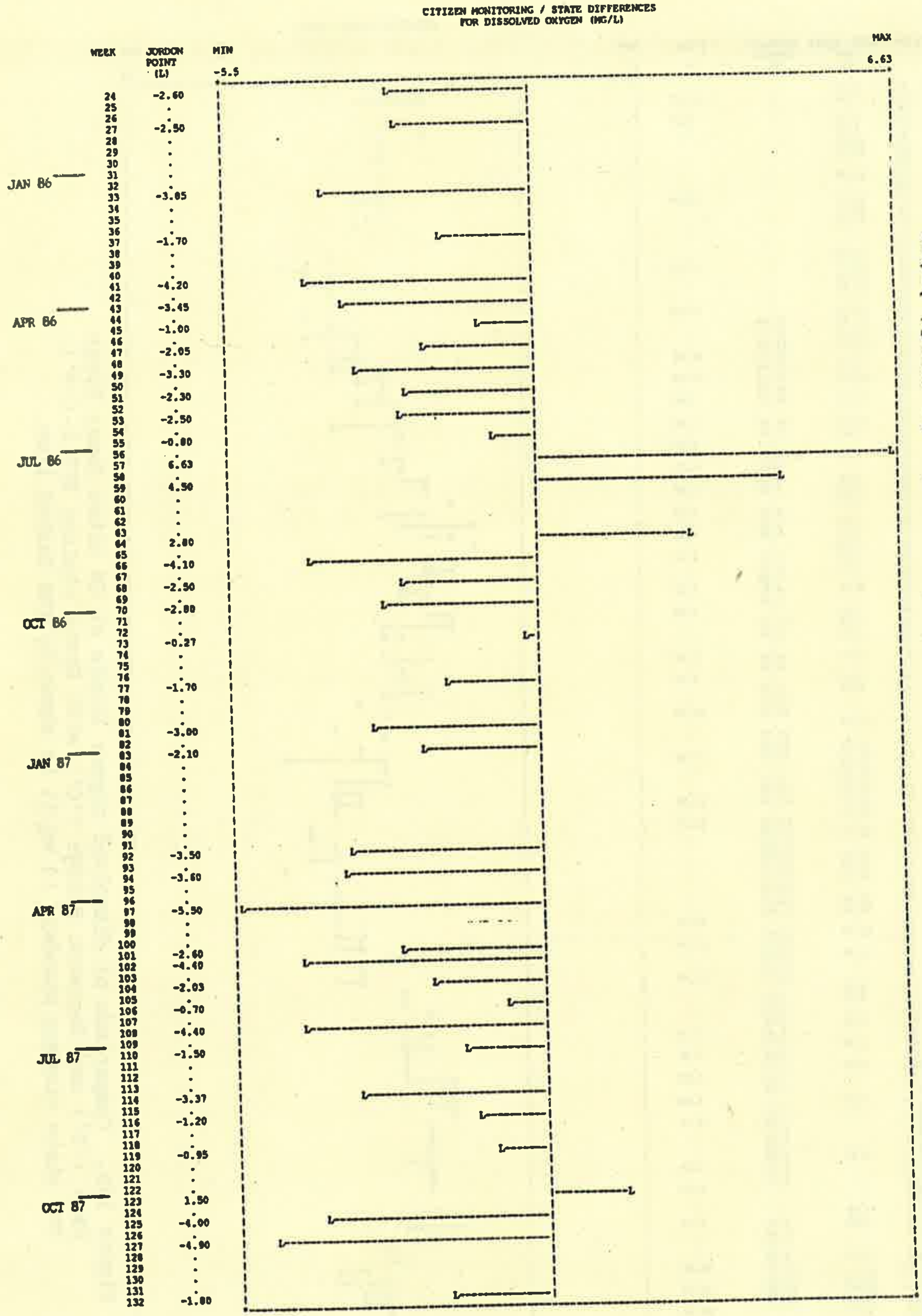


Figure 11b. Signed differences in dissolved oxygen levels (mg/l) between CM site Jordan Point ('L') and State station TF5.5. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM site was higher than at the state station.

	WEEK	JAMES RIVER PARK (P)	HUGUENOT BRIDGE (Q)	TF5.2 (*)
OCT 85	17	7.10	.	.
	18	7.90	.	11.10
	19	.	.	.
	20	9.10	.	9.80
	21	8.40	.	.
	22	10.00	.	.
	23	10.00	.	.
	24	.	.	.
	25	10.00	.	.
	26	.	.	.
	27	10.00	.	10.60
	28	10.00	.	.
	29	11.20	.	.
	30	.	.	.
JAN 86	31	.	.	.
	32	12.20	.	.
	33	13.30	.	14.00
	34	11.60	.	.
	35	12.40	.	.
	36	.	.	.
	37	12.70	.	12.80
	38	11.60	12.00	.
	39	11.50	12.70	.
	40	11.40	11.20	.
	41	.	10.70	12.00
	42	9.70	12.30	.
APR 86	43	10.00	11.10	10.60
	44	.	10.20	.
	45	10.40	10.70	9.00
	46	.	.	.
	47	10.70	11.60	8.00
	48	9.00	8.70	.
	49	.	.	8.60
	50	9.40	10.40	.
	51	.	9.00	8.70
	52	9.20	8.20	.
	53	8.10	8.40	8.50
	54	6.60	.	.
	55	.	9.80	8.50
JUL 86	56	6.50	9.30	.
	57	7.30	8.30	8.10
	58	5.65	.	.
	59	7.70	7.70	8.10
	60	7.30	8.30	.
	61	.	7.90	.
	62	8.20	8.80	8.42
	63	.	8.80	.
	64	7.40	.	7.90
	65	7.20	10.20	.
	66	8.80	9.60	.
	67	.	.	.
	68	9.90	9.80	8.40
	69	.	9.20	.
OCT 86	70	9.20	.	9.40
	71	8.10	9.60	.
	72	.	11.00	.
	73	.	10.00	10.20
	74	11.70	.	.
	75	.	10.00	.
	76	11.20	11.40	.
	77	11.00	10.50	14.50
	78	10.10	.	.
	79	11.60	9.60	.
	80	10.70	11.70	.
	81	10.80	12.40	11.80
	82	12.50	.	.
JAN 87	83	.	13.10	12.60
	84	12.70	13.00	.
	85	.	11.80	.
	86	12.30	13.00	.
	87	14.20	13.90	.
	88	12.00	12.30	.
	89	.	12.30	.
	90	12.80	12.10	.
	91	12.10	12.20	.
	92	.	.	12.00
	93	11.90	11.40	.
	94	.	11.40	11.60
	95	8.60	10.50	.
APR 87	96	.	11.10	.
	97	.	10.90	11.80
	98	9.00	.	.
	99	9.50	9.50	.
	100	.	8.10	.
	101	9.00	9.60	.
	102	.	9.50	8.10
	103	8.50	8.70	.
	104	.	9.30	8.60
	105	8.80	8.70	.
	106	.	7.20	8.53
	107	.	7.10	.
	108	7.50	.	7.80
JUL 87	109	.	7.50	.
	110	.	7.80	8.40
	111	.	8.10	.
	112	.	7.70	.
	113	9.30	7.90	.
	114	.	8.00	7.60
	115	.	8.30	.
	116	.	.	8.20
	117	.	.	.
	118	7.50	.	.
	119	6.80	9.00	8.30
	120	.	8.30	.
	121	.	9.70	.
	122	9.50	9.80	.
OCT 87	123	.	11.80	11.00
	124	10.00	11.60	.
	125	10.40	11.00	10.60
	126	10.40	11.10	.
	127	9.70	.	10.40
	128	.	.	.
	129	11.40	13.20	.
	130	10.50	11.40	.
	131	.	12.10	.
	132	11.60	12.80	13.20
	133	12.70	13.70	.
	134	.	.	.
	135	12.80	.	.
JAN 88	136	.	.	.
	137	13.80	12.80	.
	138	11.70	.	.
	139	.	13.30	.
	140	10.80	13.10	.
	141	12.50	13.30	.
	142	.	11.60	.
	143	12.50	.	.
	144	.	12.20	12.25
	145	9.90	10.60	.
	146	12.30	11.60	13.50
	147	.	9.90	.
	148	9.50	9.30	.
APR 88	149	9.50	10.10	.
	150	11.20	.	.

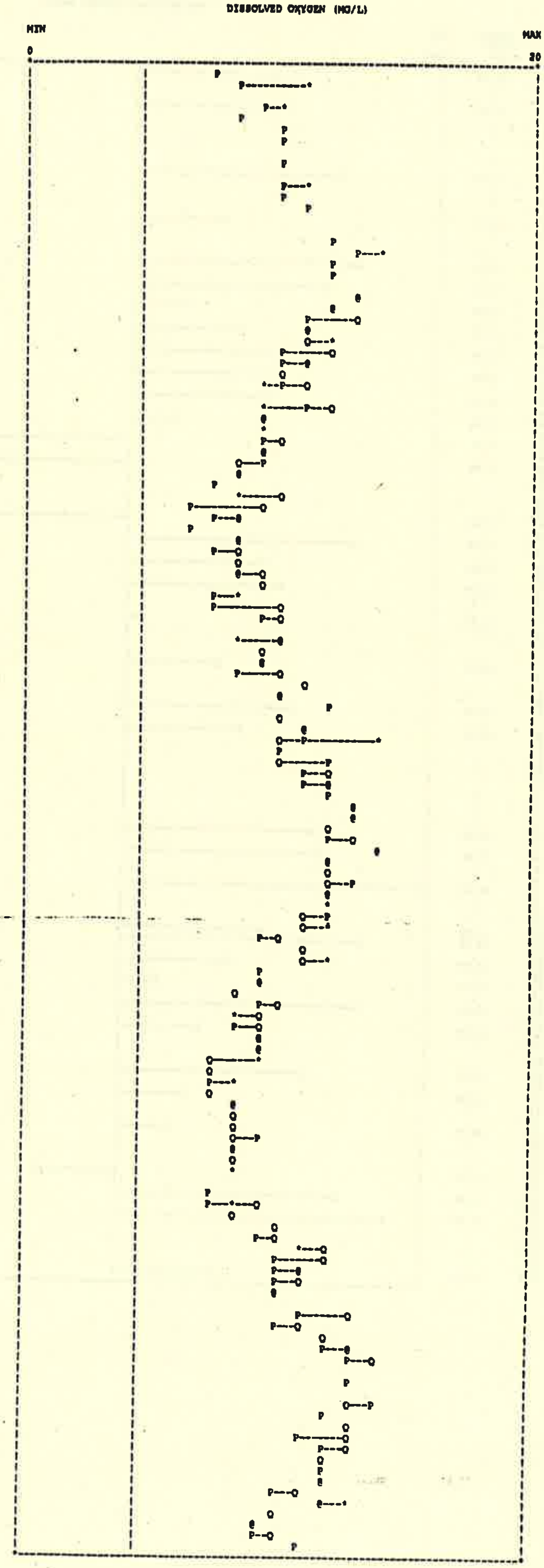


Figure 12a. Comparison of dissolved oxygen levels at CM sites James River Park ('P') and Huguenot Bridge ('Q') with State station TF5.2 ('*'). The state minimum standard (4 mg/l) is shown by the dashed line.

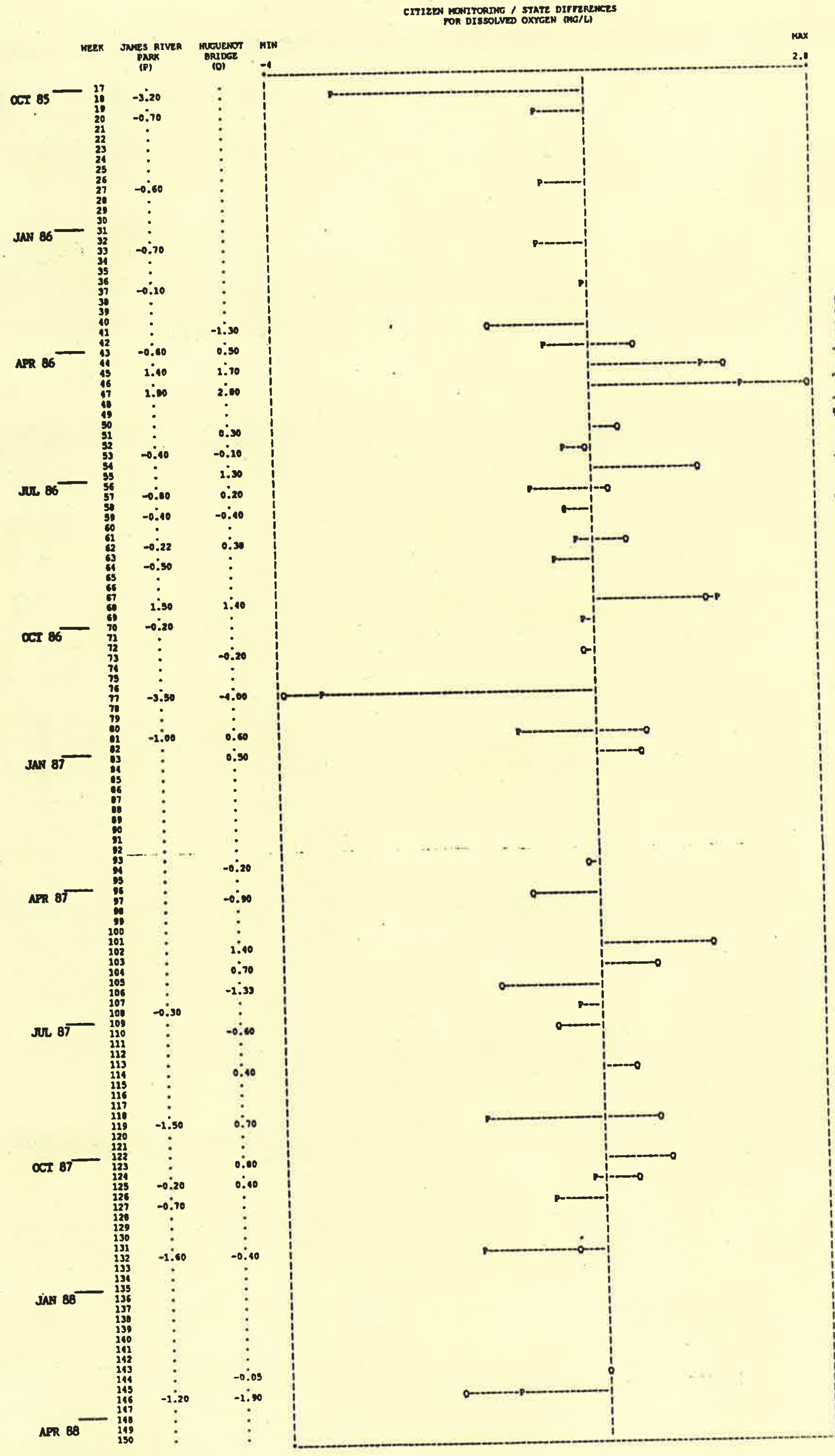


Figure 12b. Signed differences in dissolved oxygen levels (mg/l) between CM sites James River Park ('P') and Huguenot Bridge ('Q') and State station TF5.2. The dashed line in the middle of the plot represents zero difference; a positive difference indicates that the level at the CM site was higher than at the state station.

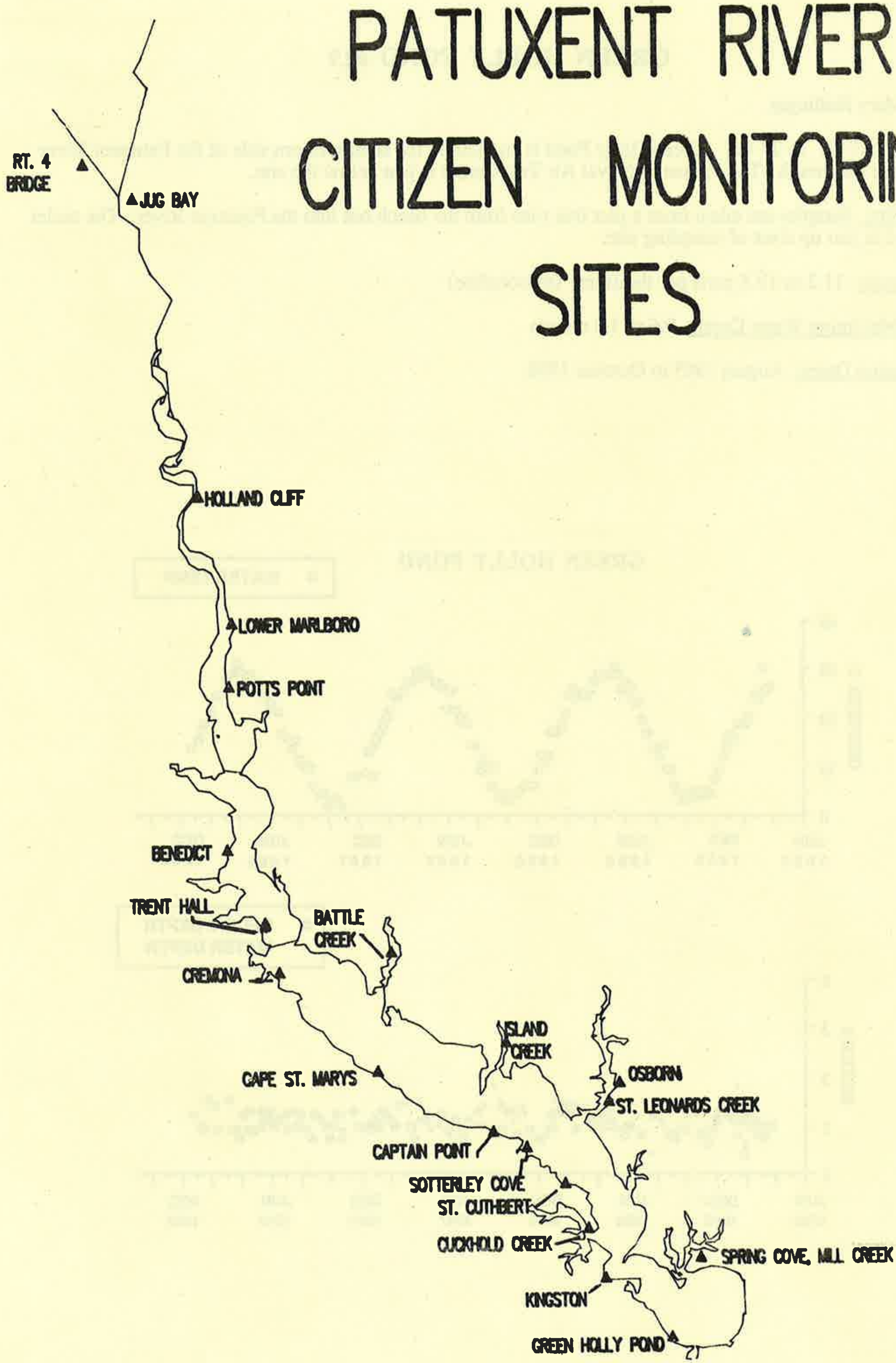
APPENDIX I: DATA SUMMARY

The following section presents a site by site data summary of all verified data in the Citizen Monitoring Program Data File. The sites are in order progressing from the mouth of each river. A site map precedes the data for each river. The sites are identified by name and number followed by the location and a description of the site. We have then listed the range in salinity (where applicable), the minimum\maximum water depth and the dates that data were collected at the site.

The above information is followed by plots of each parameter value versus date of collection. Not all parameters were measured at every site. The sites in the tidal fresh zone did not measure salinity consistently and were, therefore, excluded. Bottom as well as surface dissolved oxygen concentrations were measured at only four sites on the Patuxent River and are plotted accordingly. Rainfall was not measured at sites that were located in areas with public access. Rainfall values measuring over 100 mm are indicated by a circle and the actual value. In the beginning of the program, pH comparators that test for a wide range of values were used. After data had been collected for a year and a general range of pH values was known for each site, narrow range kits were supplied.

A complete listing of all the data is available on request as Appendix II.

PATUXENT RIVER CITIZEN MONITORING SITES



GREEN HOLLY POND #19

Monitor: Mary Hollinger

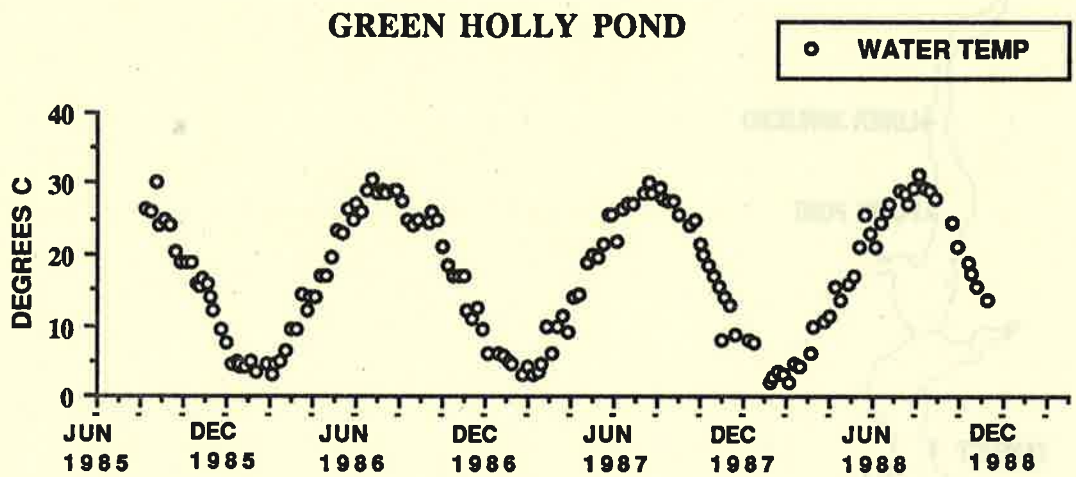
Location: 38 17 48 76 27 40 Green Holly Pond is an inlet on the southwestern side of the Patuxent River 3.32 km from the mouth. The Patuxent Naval Air Test Center is just below the site.

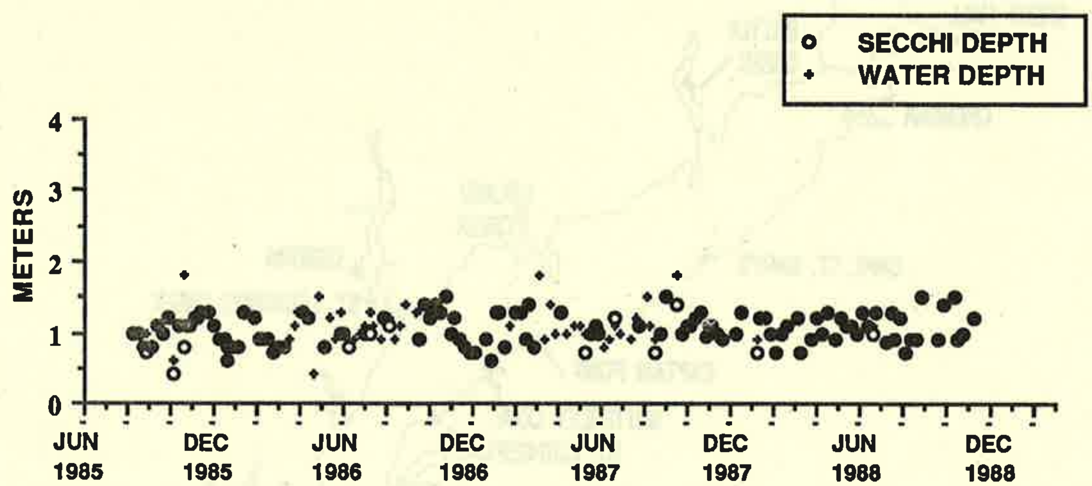
Sampling Site: Samples are taken from a pier that runs from the beach out into the Patuxent River. The outlet for the pond is just up river of sampling site.

Salinity Range: 11.2 to 19.5 parts per thousand (mesohaline)

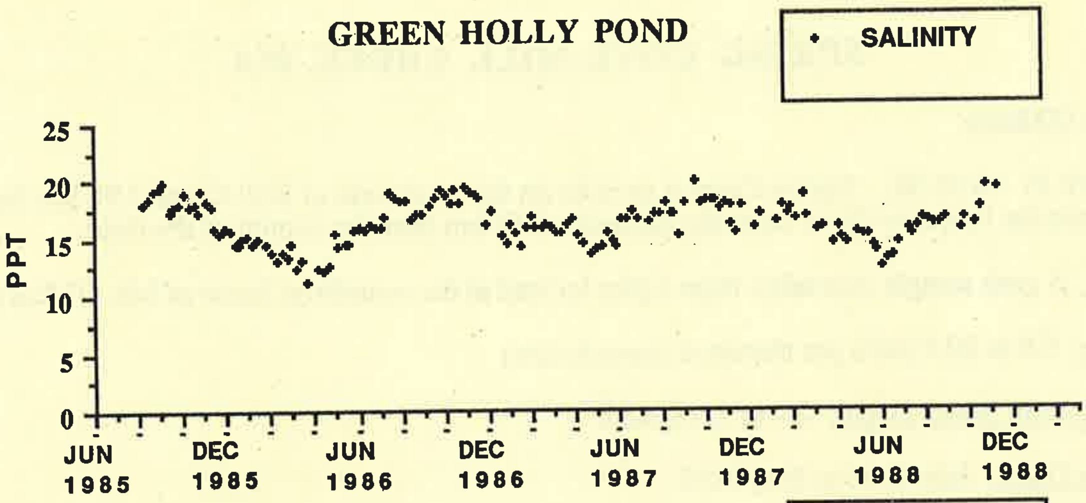
Minimum/Maximum Water Depth: 0.6 to 1.8 meters

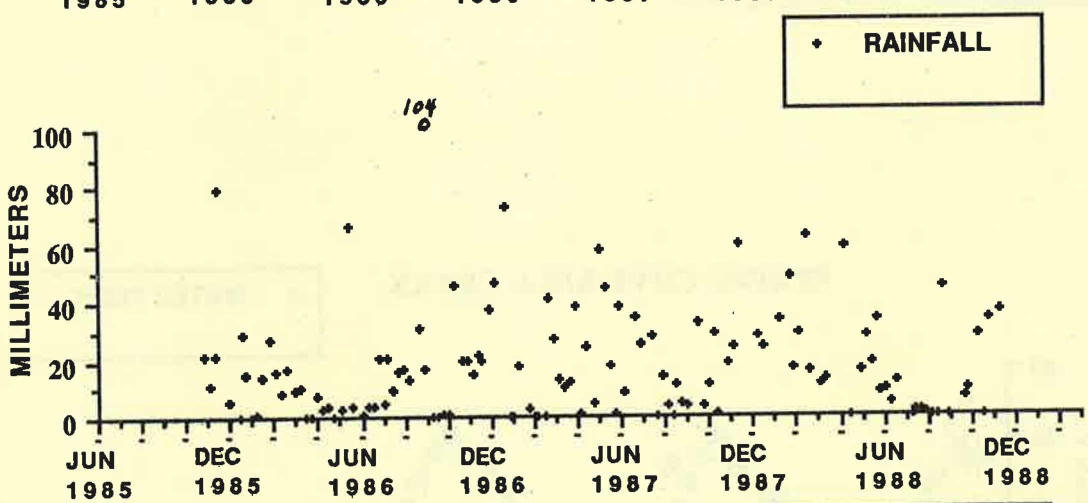
Data Collection Dates: August 1985 to October 1988.

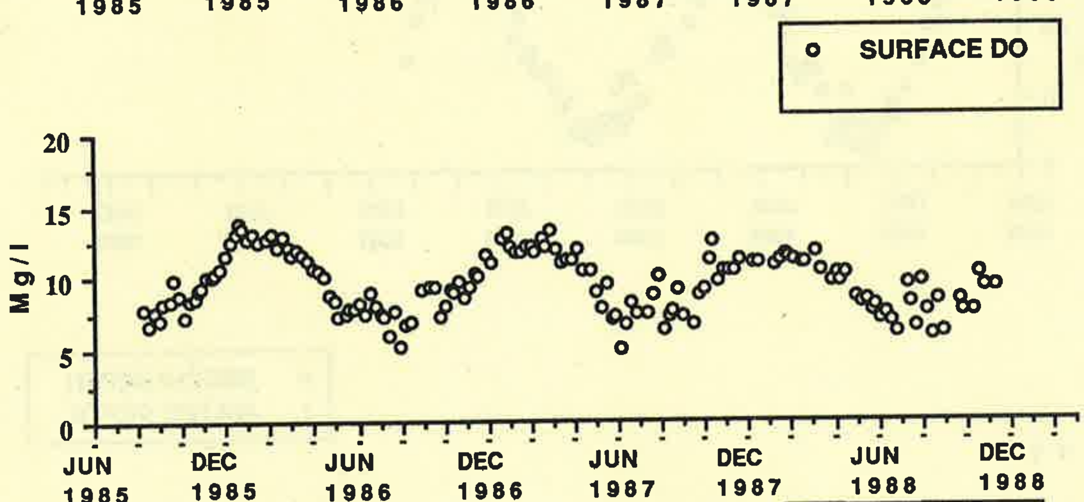


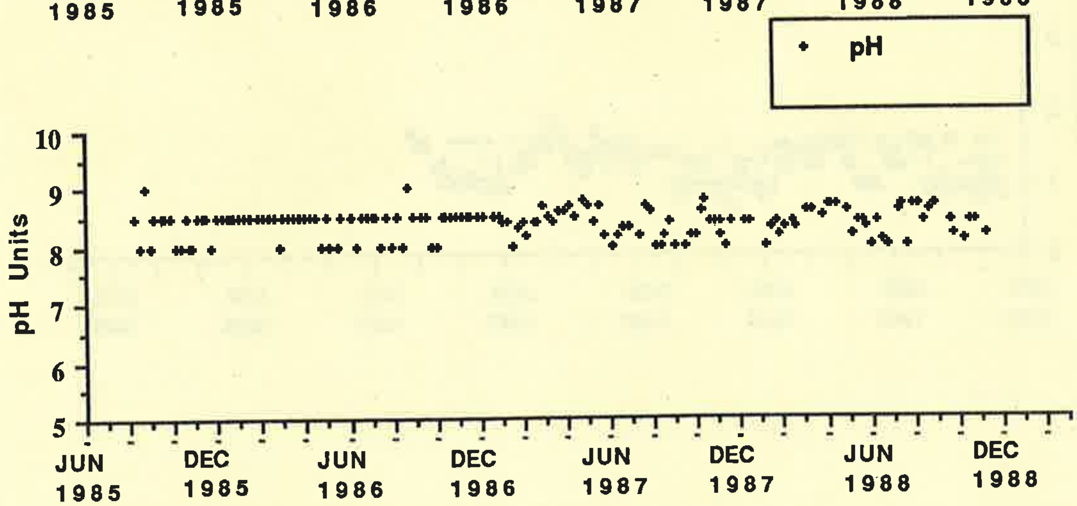


GREEN HOLLY POND









SPRING COVE-MILL CREEK #14

Monitor: John O'Meara

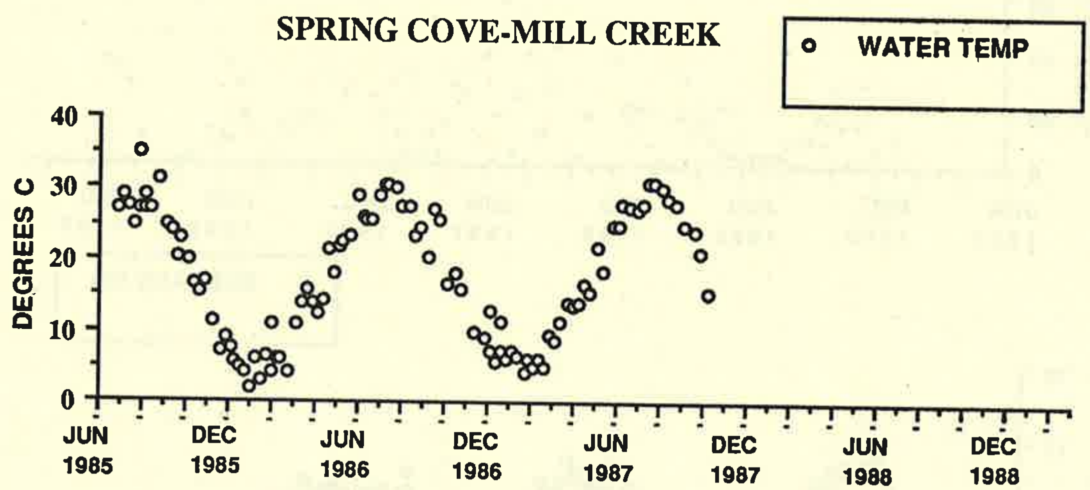
Location: 38 19 45 76 26 36 Spring Cove is an inlet on the south side of Mill Creek 2.98 km from the mouth where it runs into the Patuxent River from the northeast 2.56 km from the mouth of the river.

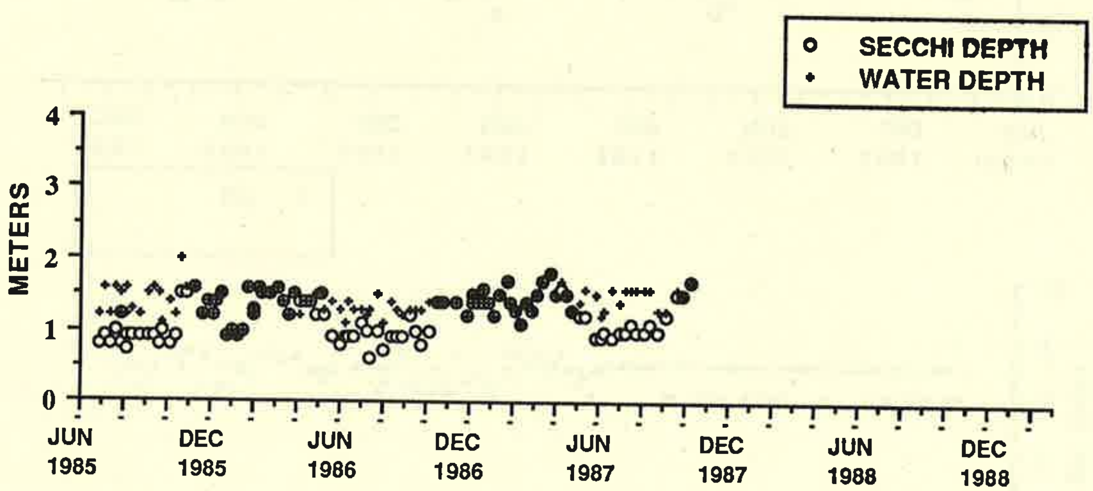
Sampling Site: A grab sample was taken from a pier located at the waterfront home of Mr. O'Meara.

Salinity Range: 5.8 to 20.9 parts per thousand (mesohaline)

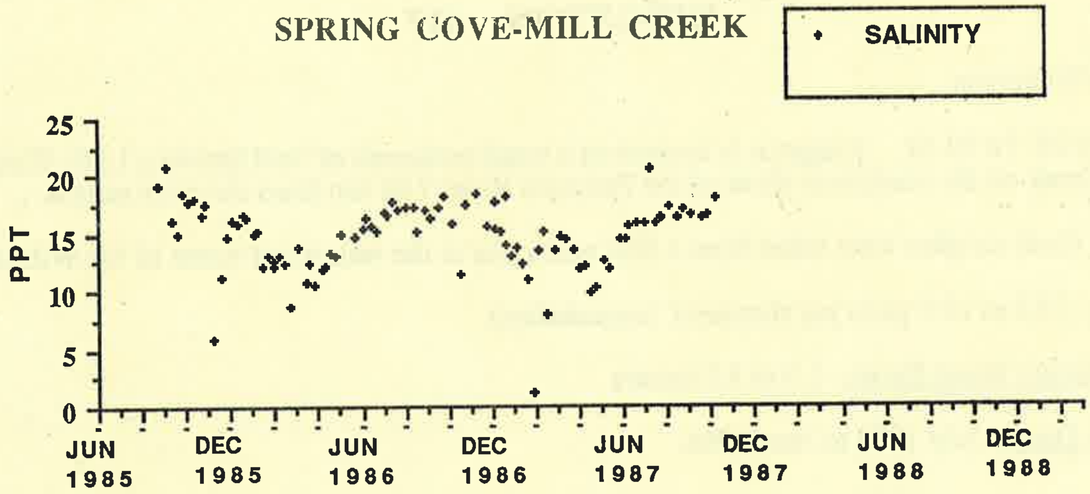
Minimum/Maximum Water Depth: 0.9 to 2.0 meters

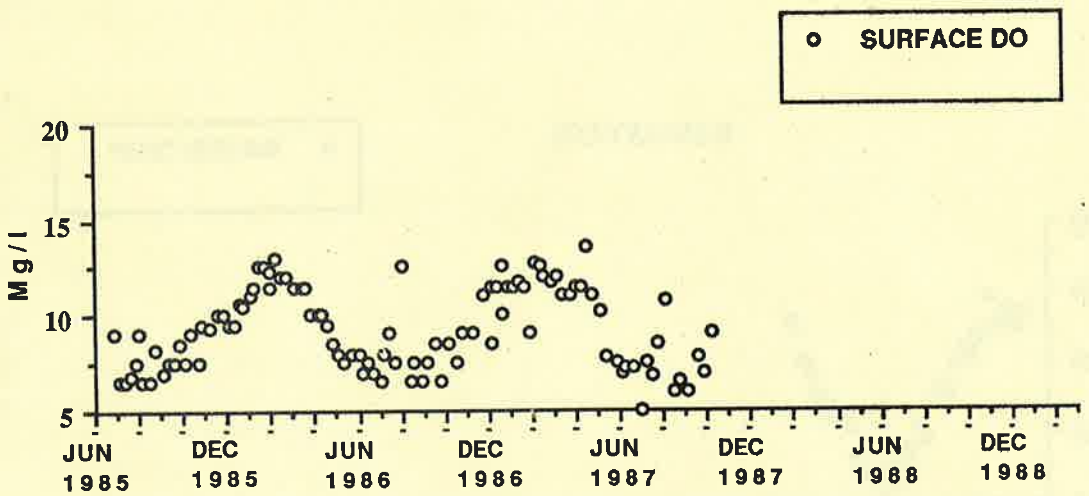
Data Collection Dates: July 1985 to May 1987.

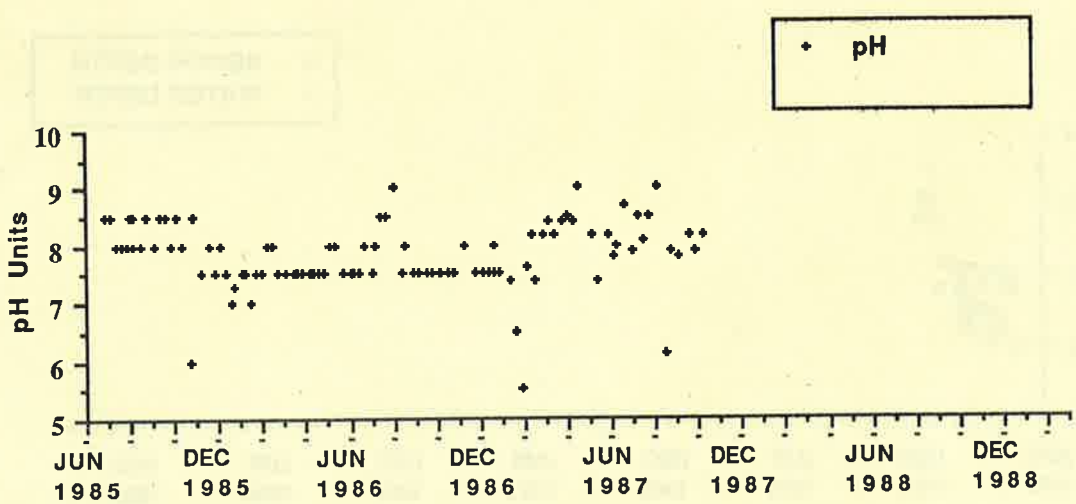




SPRING COVE-MILL CREEK







KINGSTON #17

Monitor: Oran Wilkerson

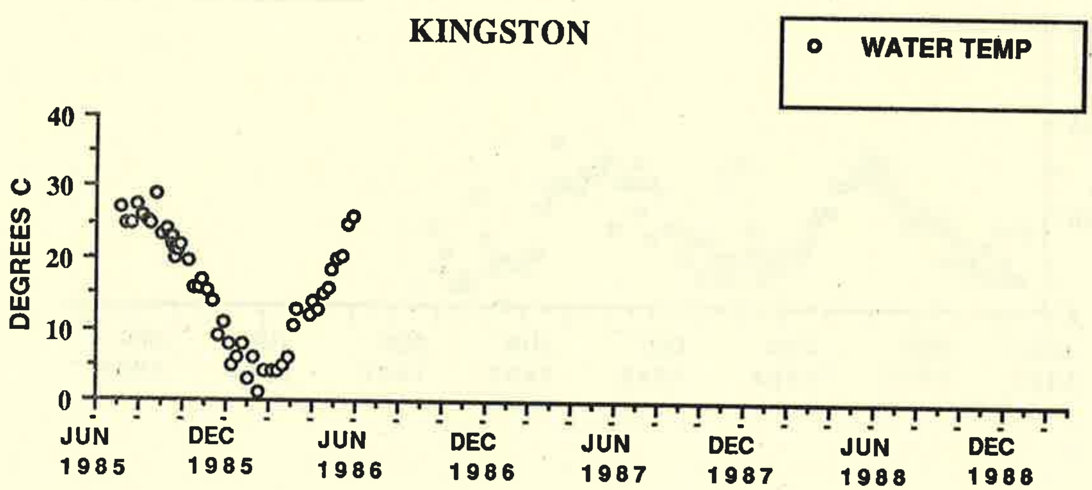
Location: 38 19 23 76 29 38 Kingston is located on a small peninsula of land between Little Kingston Creek and Kingston Creek on the southwest shore of the Patuxent River 7.01 km from the river mouth.

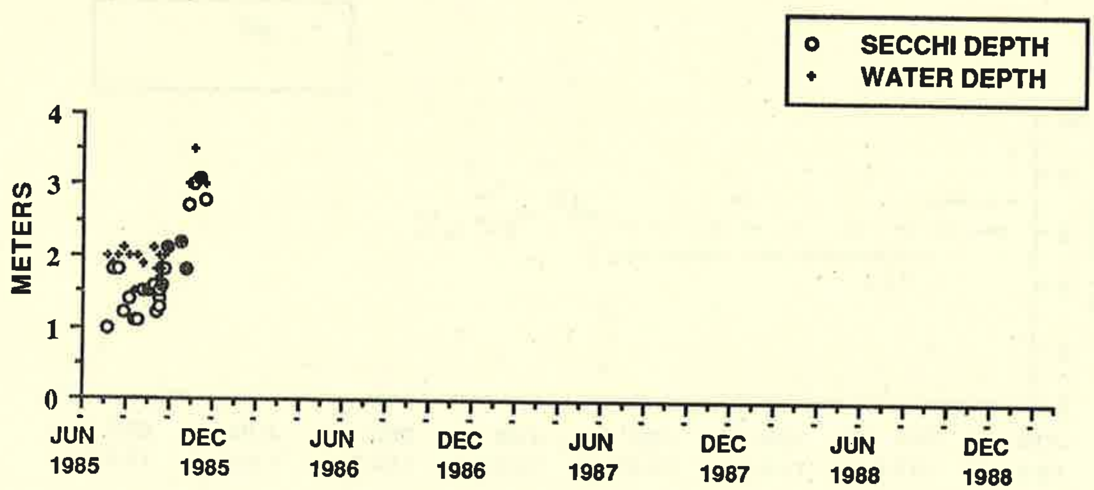
Sampling Site: Grab samples were taken from a boat and a pier at the waterfront home of Mr.Wilkerson.

Salinity Range: 10.8 to 19.5 parts per thousand (mesohaline)

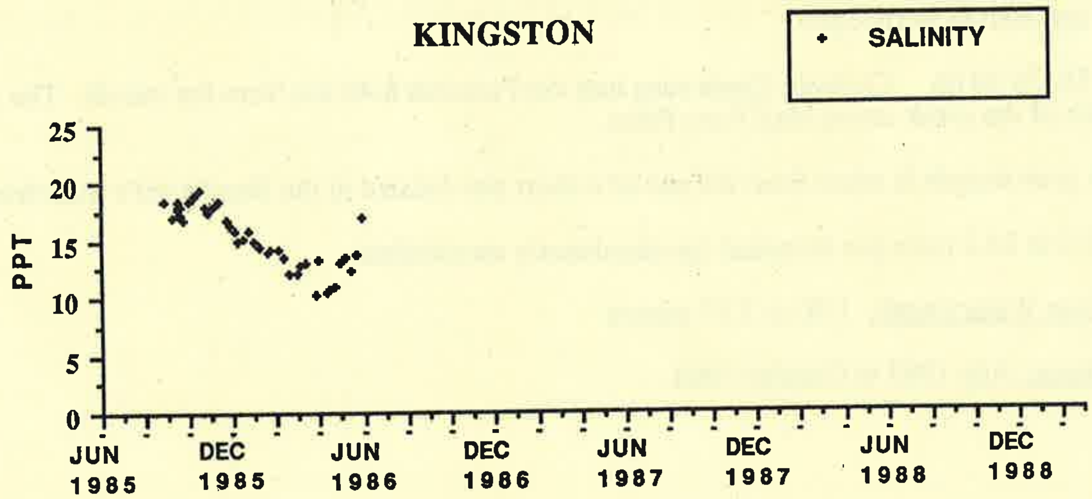
Minimum/Maximum Water Depth: 1.5 to 3.5 meters

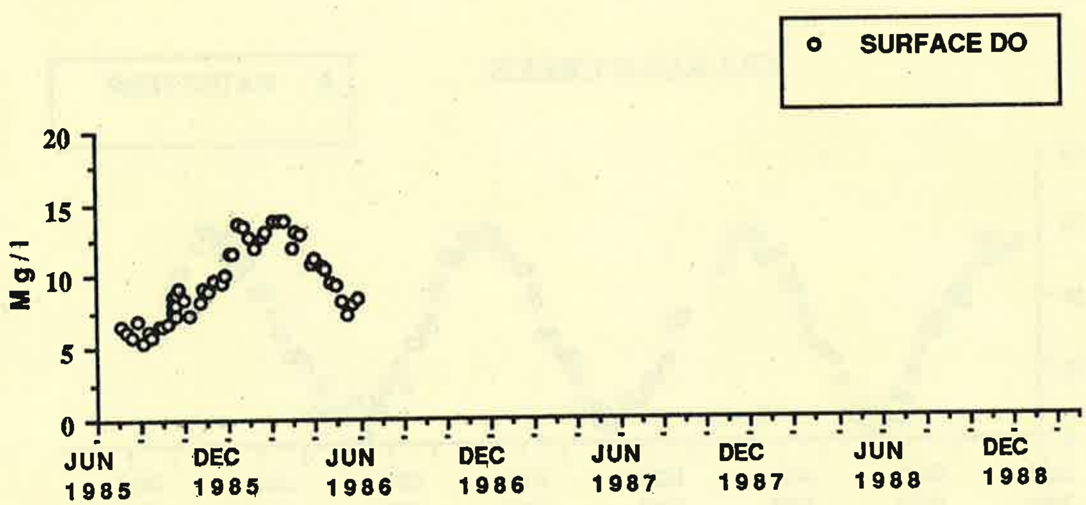
Data Collection Dates: July 1985 to June 1986.

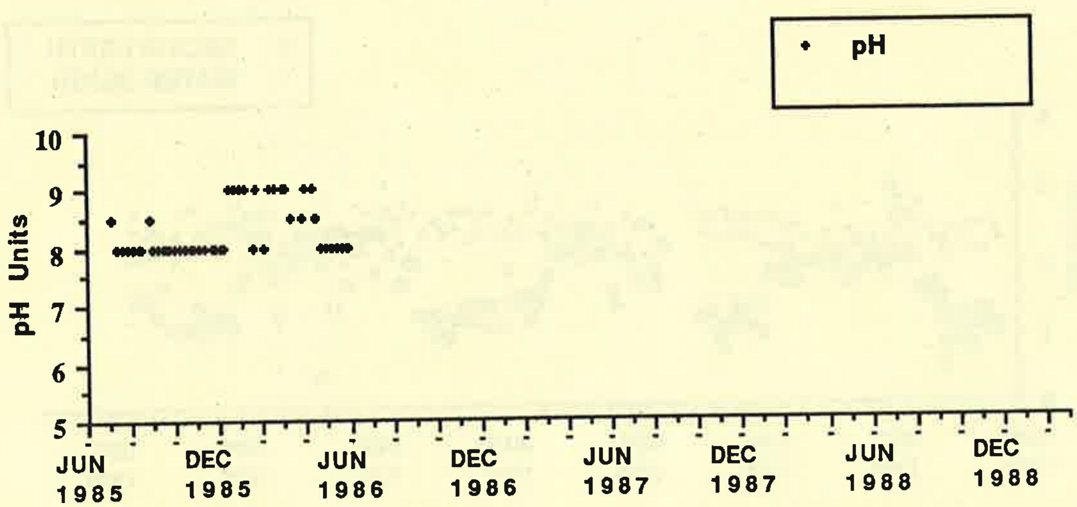




KINGSTON


SALINITY
PPT
25
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


SURFACE DO
Mg/l
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


pH
pH Units
10
9
8
7
6
5
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

Cuckold Creek #2

Monitors: Frank and Bertha Bernheisel

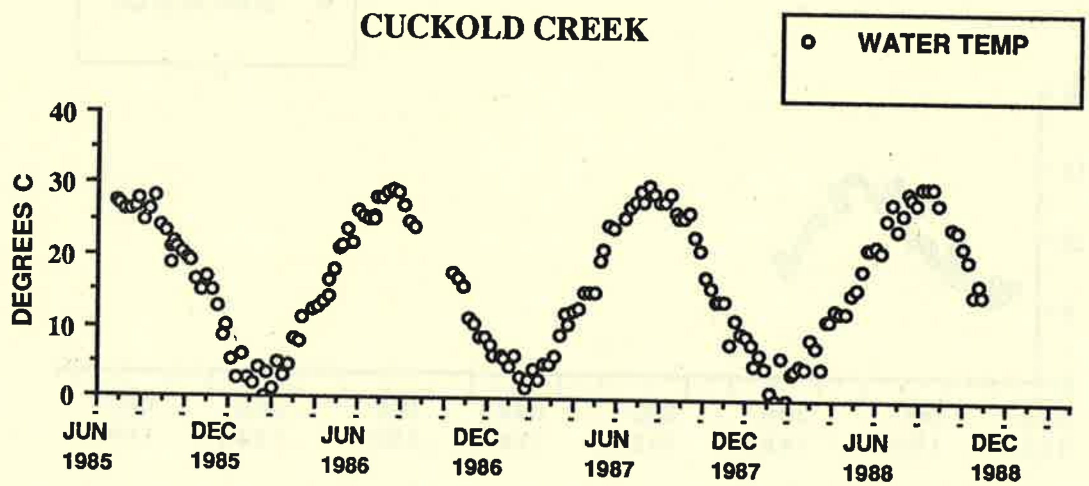
Location: 38 20 38 76 30 05 Cuckold Creek runs into the Patuxent 8.48 km from the mouth. The site is 1.71 km from the mouth of the creek inside Half Pone Point.

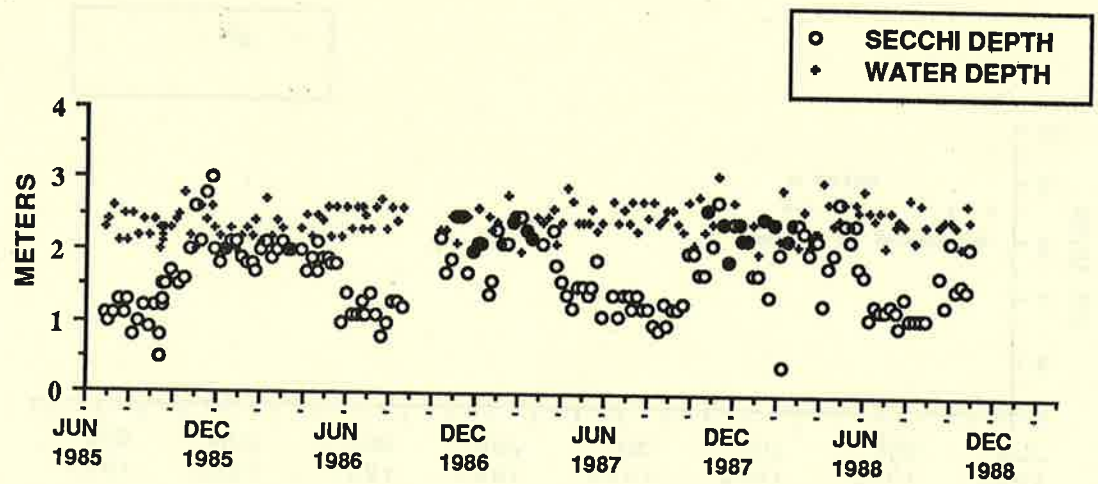
Sampling Site: A grab sample is taken from the end of a short pier located at the Bernheisel's waterfront home.

Salinity Range: 8.9 to 24.2 parts per thousand (predominantly mesohaline)

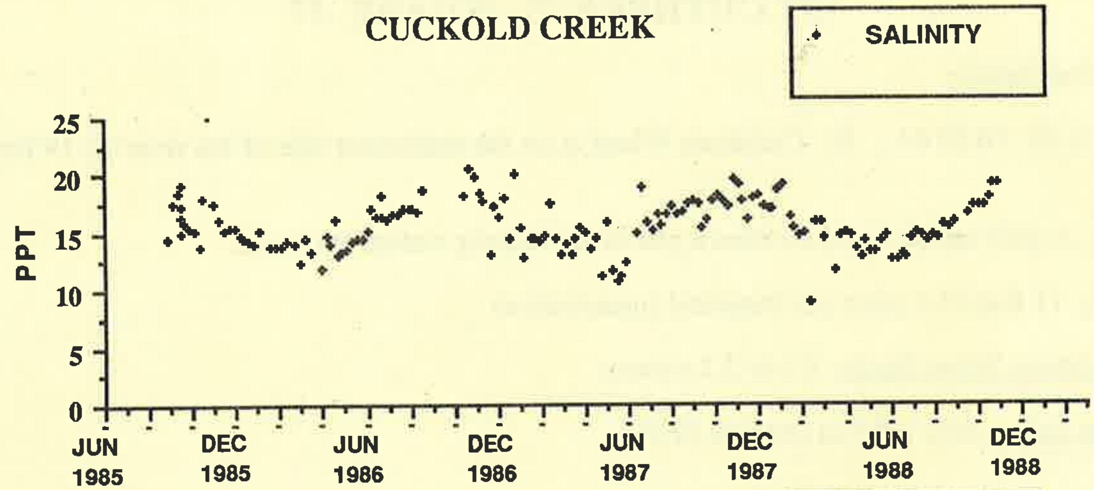
Minimum/Maximum Water Depth: 1.90 to 2.97 meters

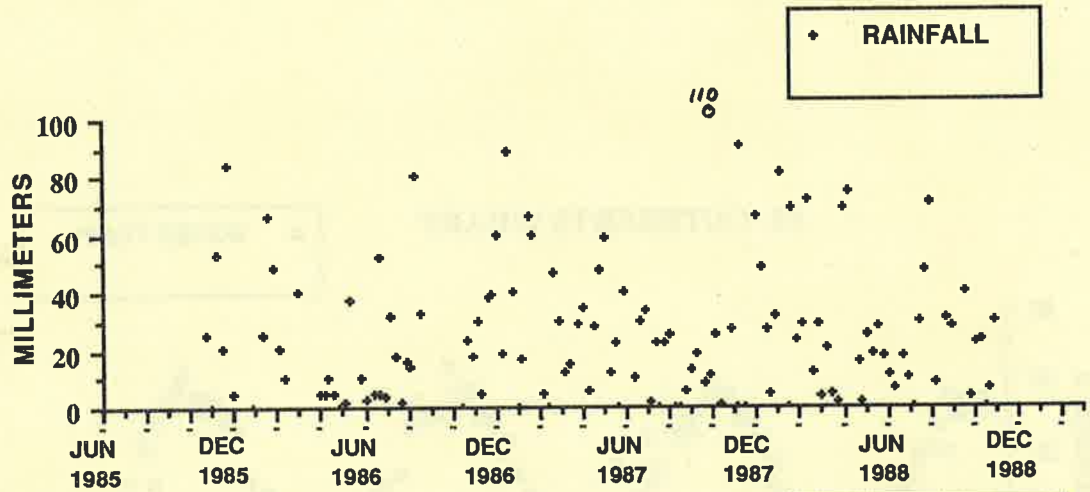
Data Collection Dates: July 1985 to October 1988.

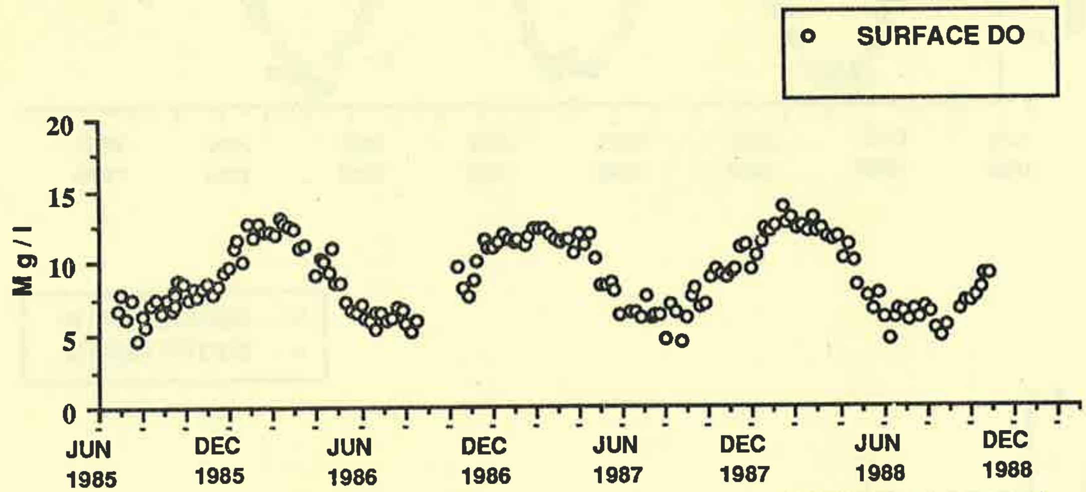


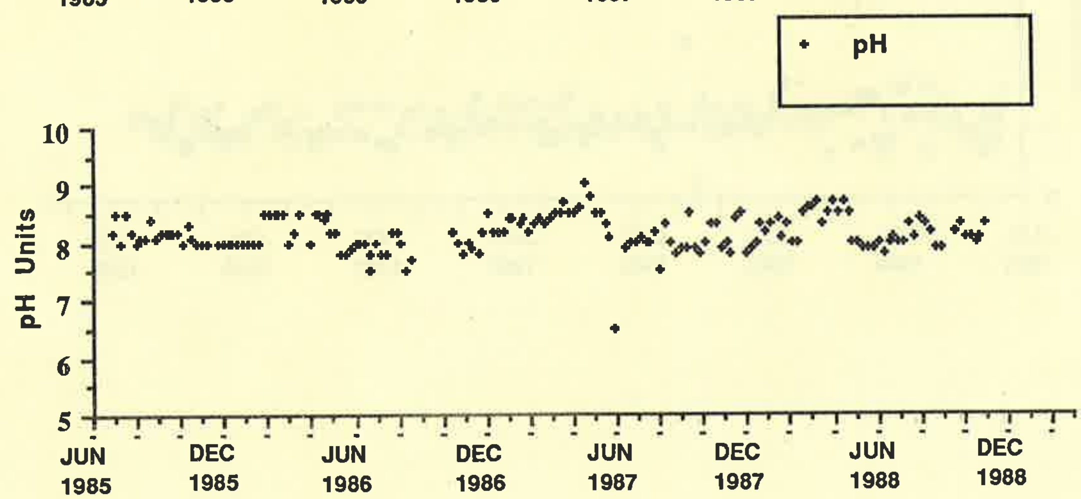


CUCKOLD CREEK









ST.CUTHBERTS WHARF #7

Monitor: Charles Helwig

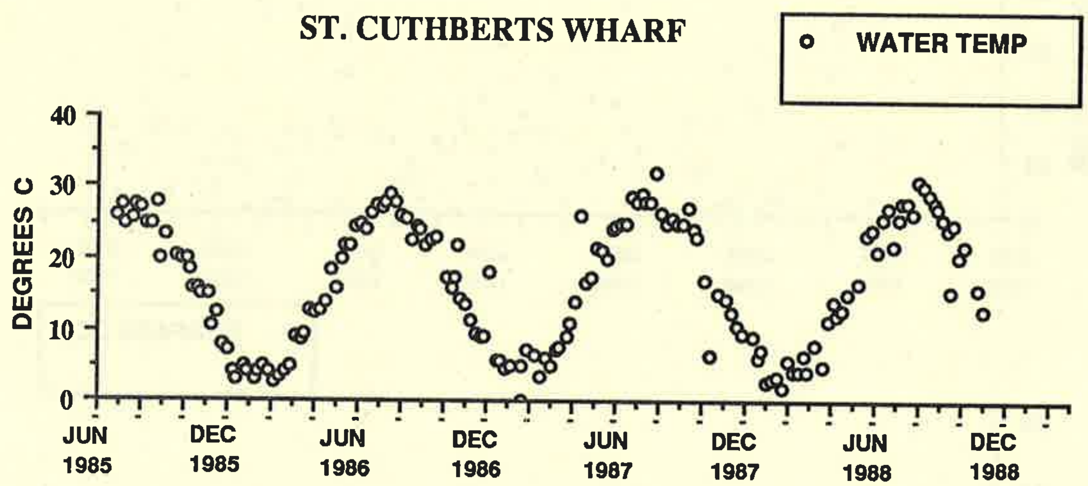
Location: 38 21 47 76 30 44 St. Cuthberts Wharf is on the southwest side of the river 12.19 km from the mouth.

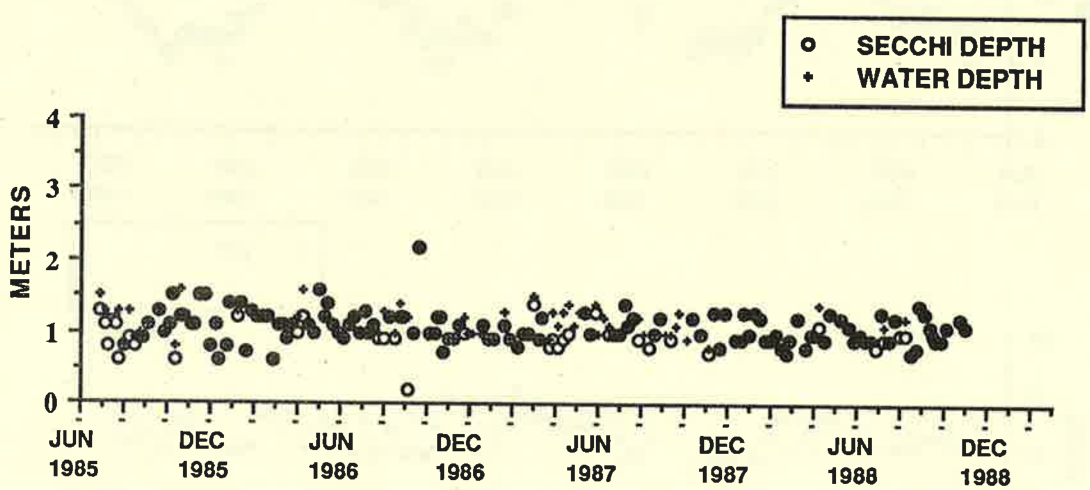
Sampling Site: A grab sample is taken from a pier at the Helwig waterfront home.

Salinity Range: 11.8 to 21.4 parts per thousand (mesohaline)

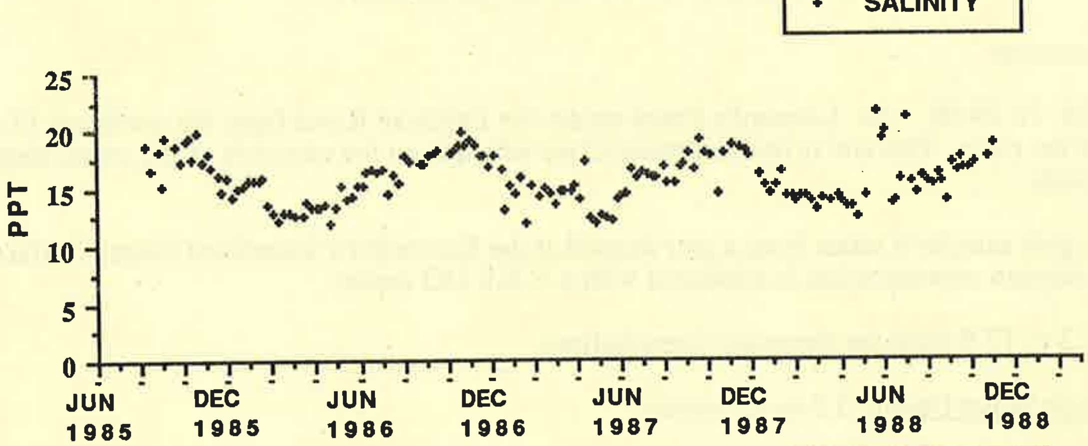
Minimum/Maximum Water Depth: 0.6 to 2.2 meters

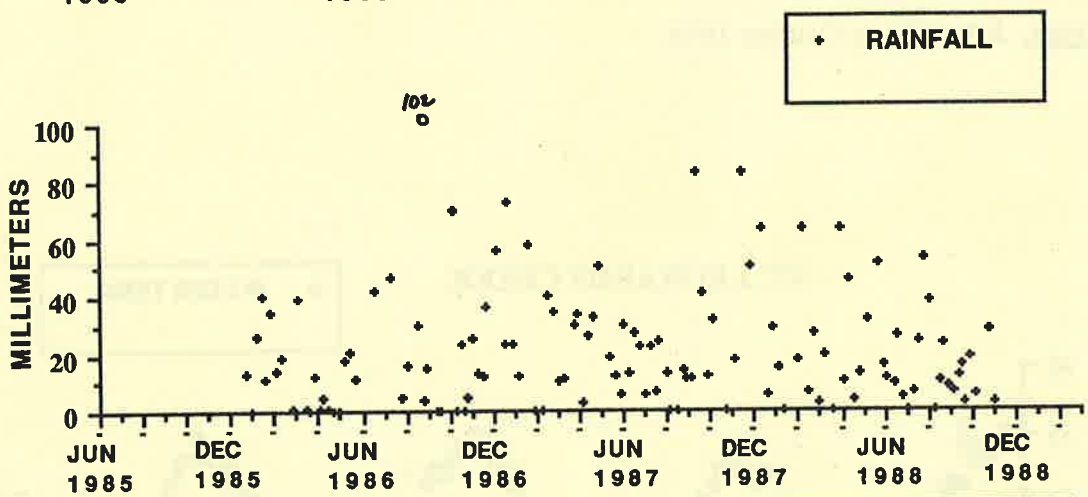
Data Collection Dates: July 1985 to October 1988.

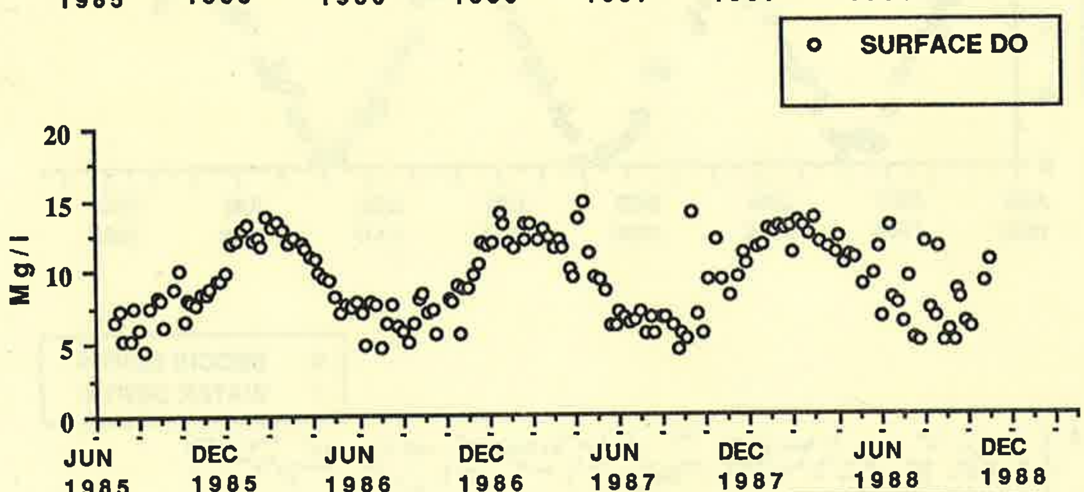


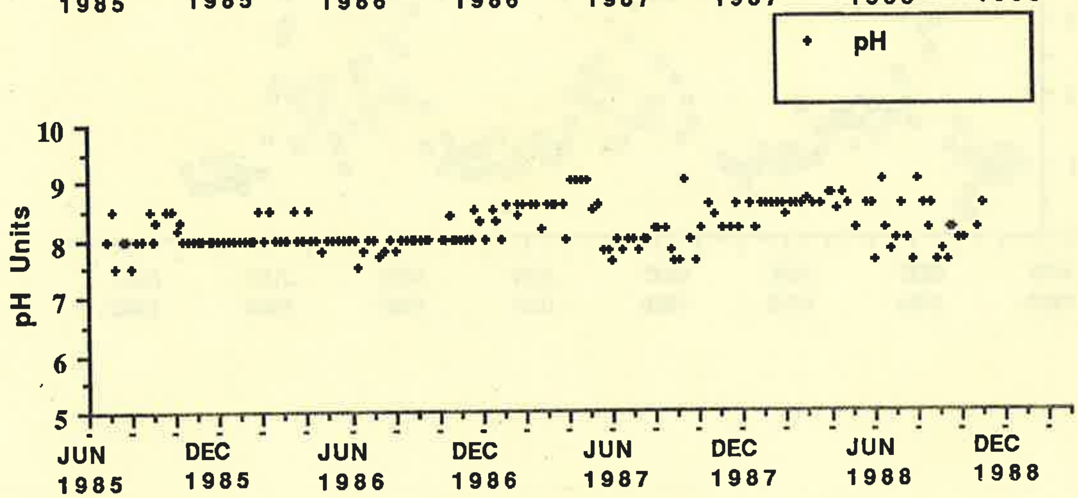


ST. CUTHBERTS WHARF









ST. LEONARDS CREEK #11

Monitor: Ken Kaumeyer

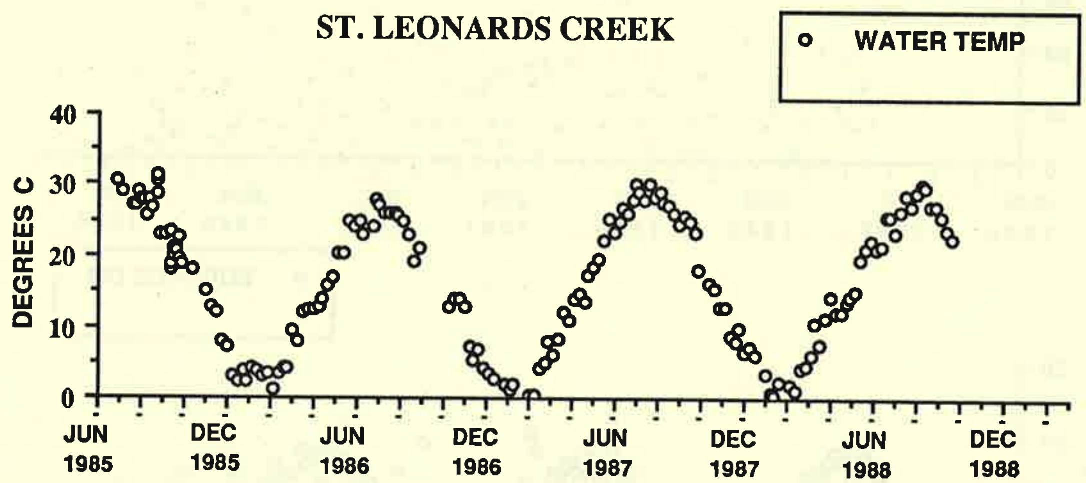
Location: 38 23 08 76 29 00 St. Leonard's Creek enters the Patuxent River from the northeast 13.48 km from the mouth of the river. This site is on Grapevine Cove which is on the east side of the creek about 1.53 km from the creek mouth.

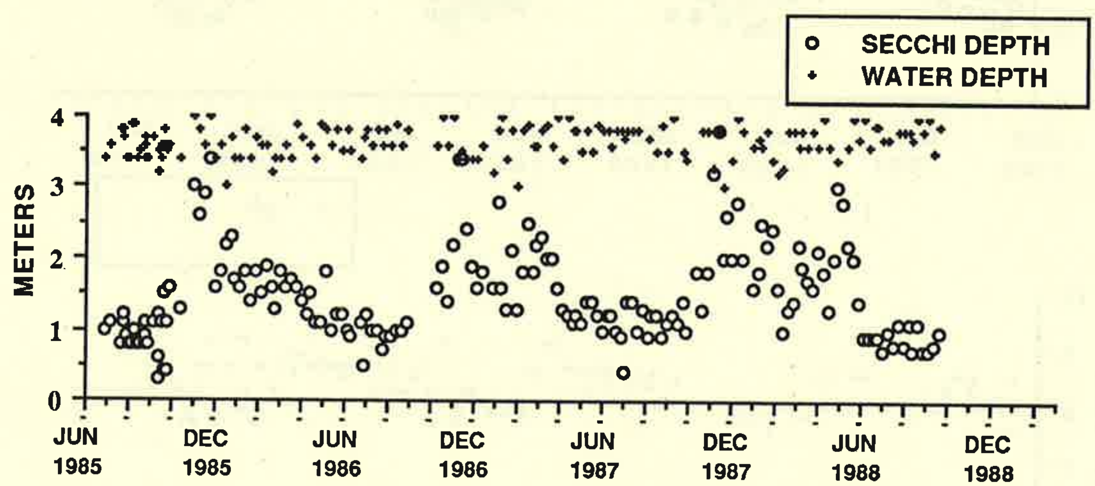
Sampling Site: A grab sample is taken from a pier located at the Kaumeyer's waterfront home. Surface and bottom dissolved oxygen concentration is measured with a Y.S.I. DO meter.

Salinity Range: 7.3 to 17.9 parts per thousand (mesohaline)

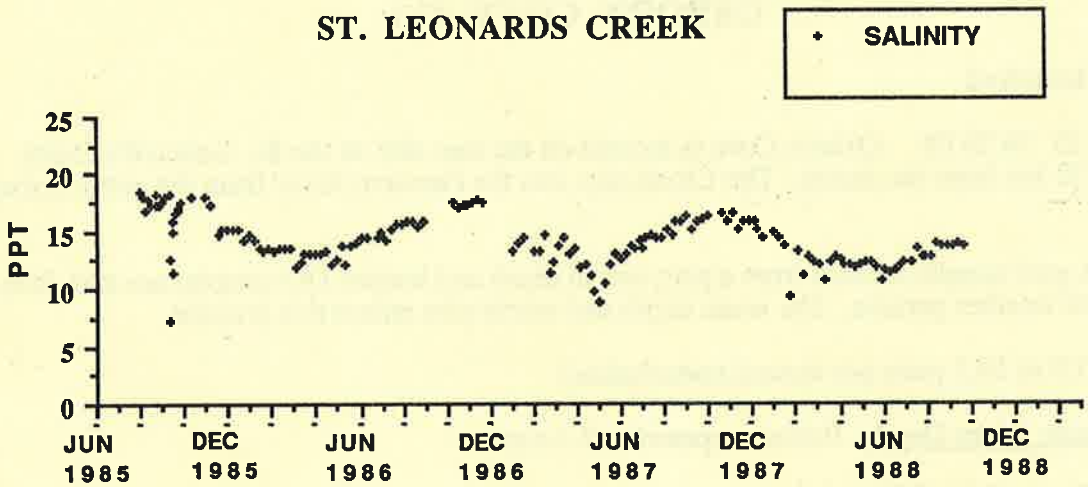
Minimum/Maximum Water Depth: 3.2 to 4.3 meters

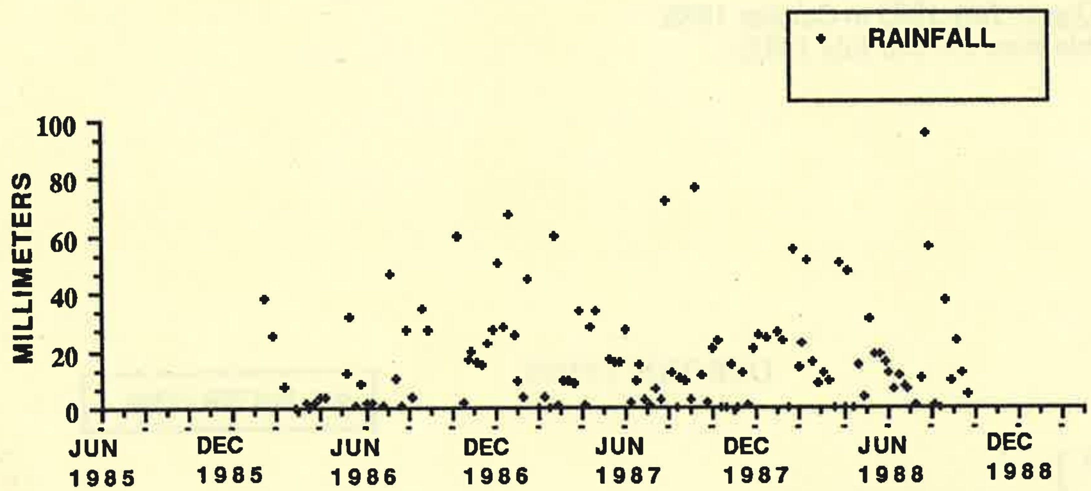
Data Collection Dates: July 1985 to October 1988.

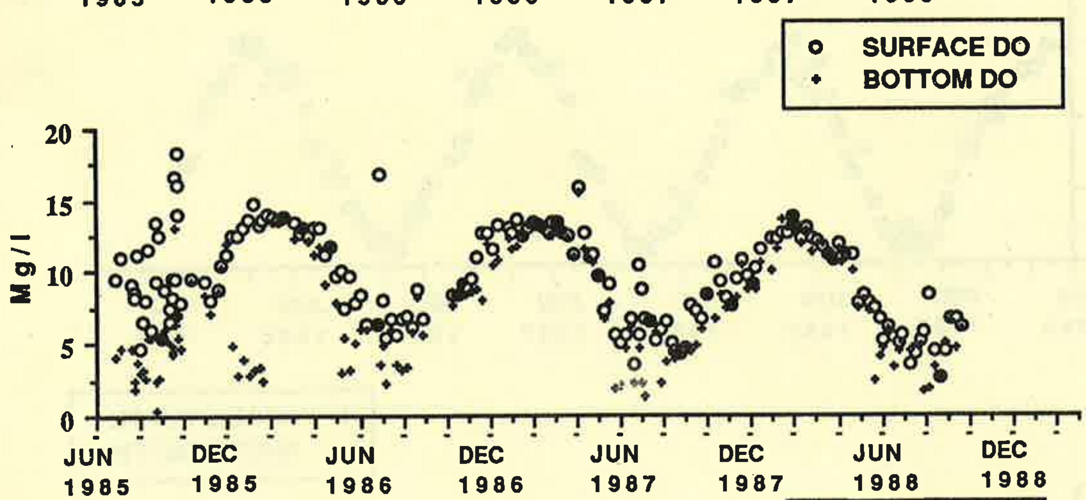


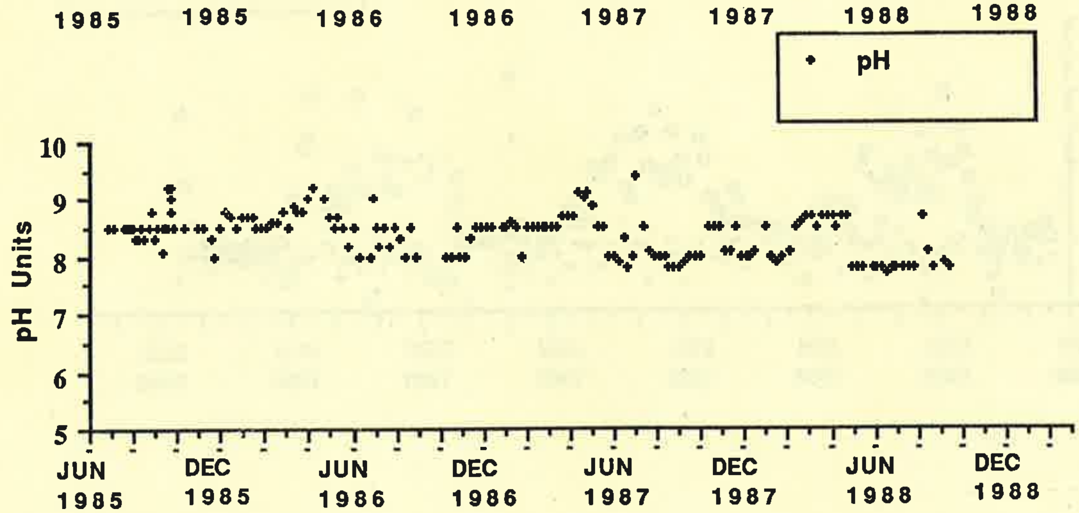


ST. LEONARDS CREEK









OSBORN COVE #13

Monitor: Kent Mountford

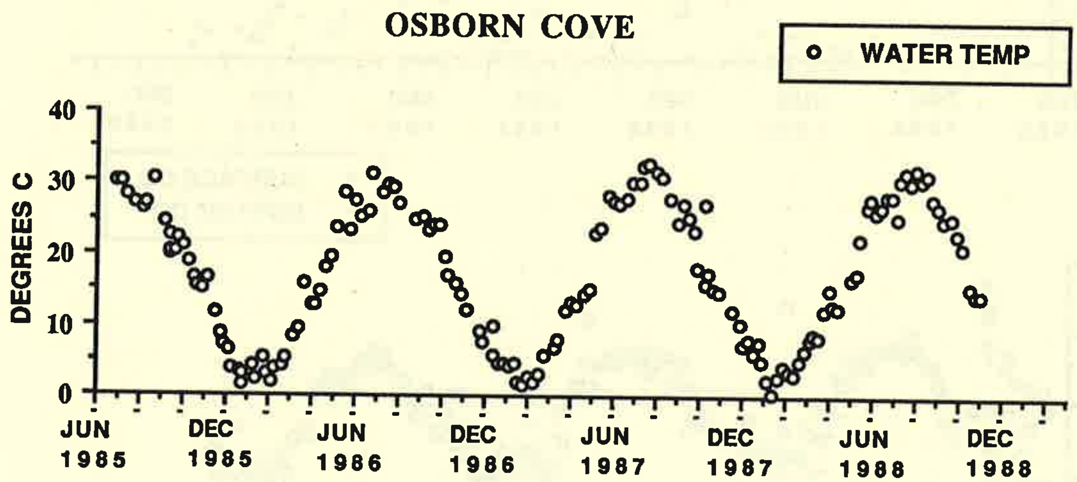
Location: 38 24 15 76 28 08 Osborn Cove is located on the east side of the St. Leonard's Creek approximately 2.23 km from the mouth. The Creek runs into the Patuxent River from the north at river km 13.48.

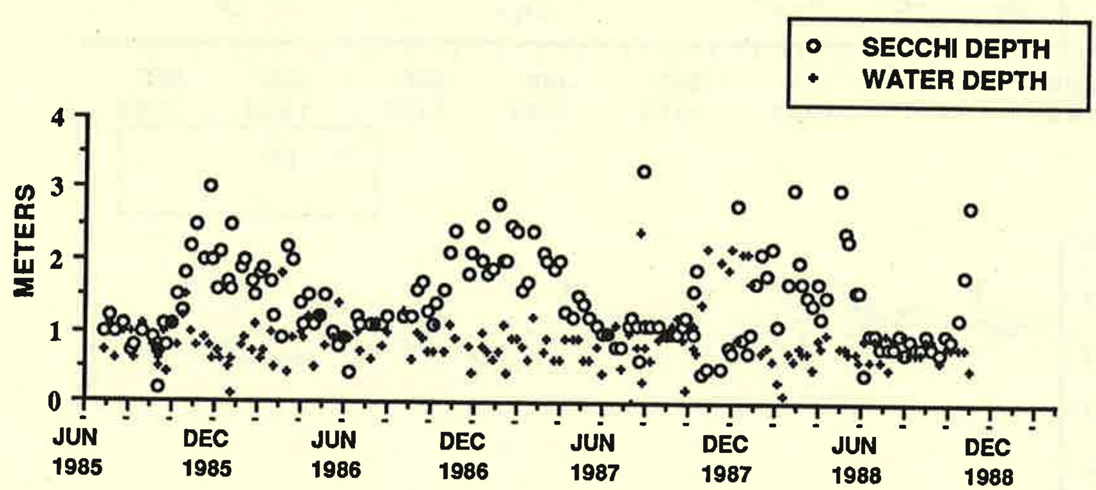
Sampling Site: A grab sample is taken from a pier; secchi depth and bottom DO samples are take from a boat in deeper water when weather permits. The water depth and secchi plot reflect this practice.

Salinity Range: 7.9 to 19.3 parts per thound (mesohaline)

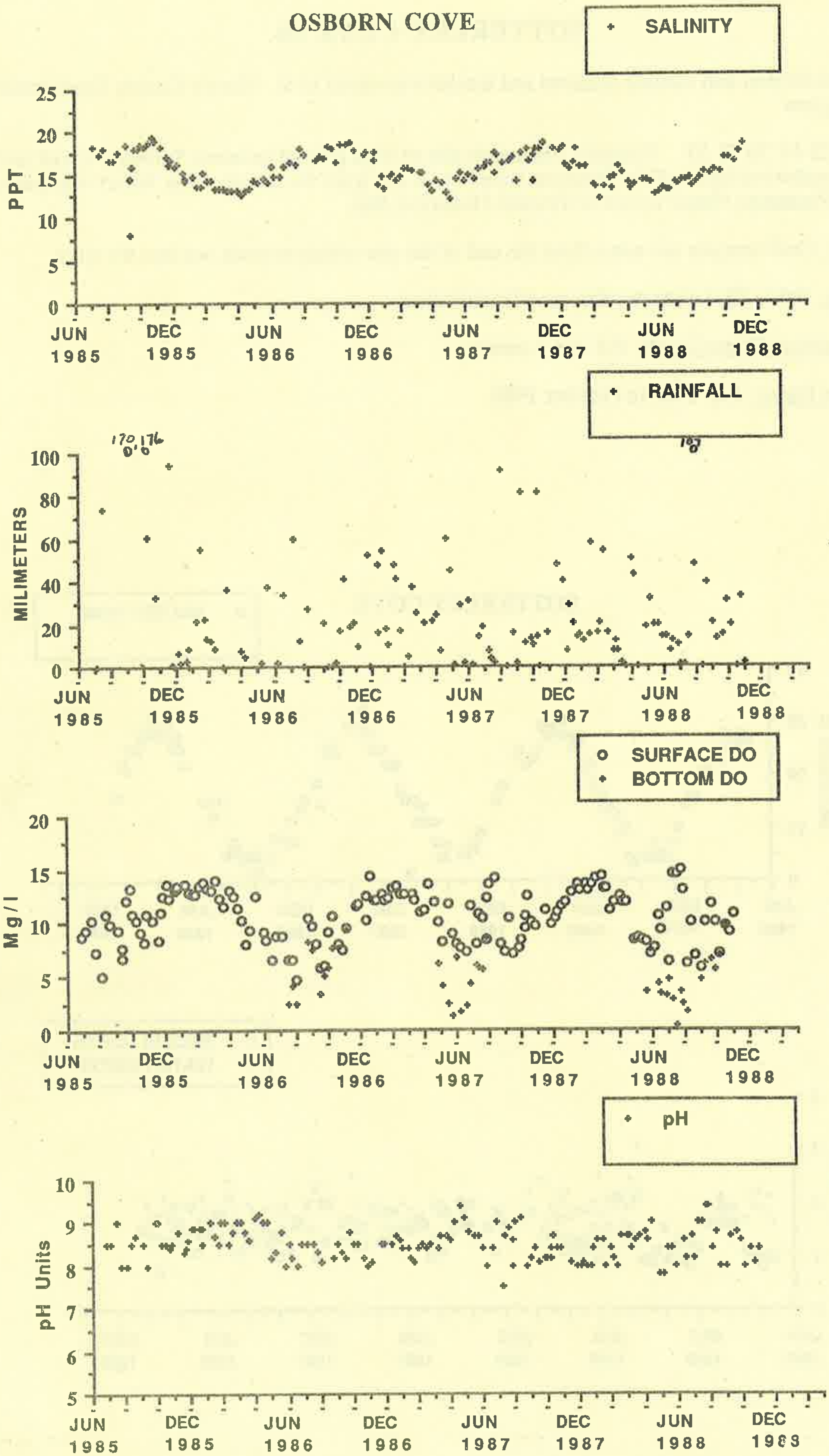
Minimum/Maximum Water Depth: Bottom exposed to 2.4 meters

Data Collection Dates: July 1985 to October 1988.
(Data also available from 1976 to July 1985)





OSBORN COVE


SALINITY
PPT
RAINFALL
MILIMETERS
170 176
183
SURFACE DO
BOTTOM DO
Mg/l
pH
pH Units
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

SOTTERLEY COVE #8

Monitors: John Horton and various students and teachers involved in St. Mary's County Environmental Education Program

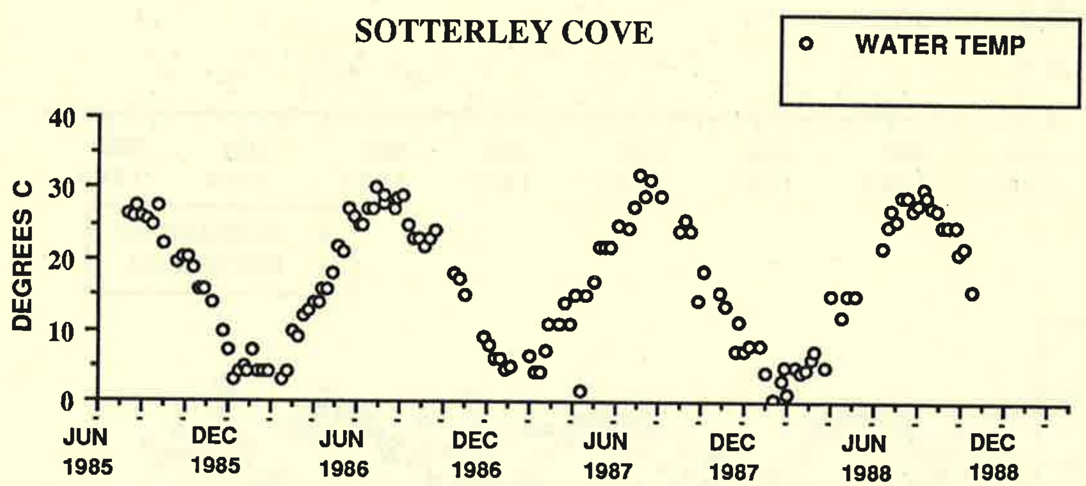
Location: 38 22 44 76 31 53 Sotterley Plantation sits on high ground between Sotterley Creek and Hog Neck Creek on the southwest banks of the Patuxent River 14.96 km from the mouth. The Wharf was used to loade tobacco. The Plantation House is now a National Historical Site.

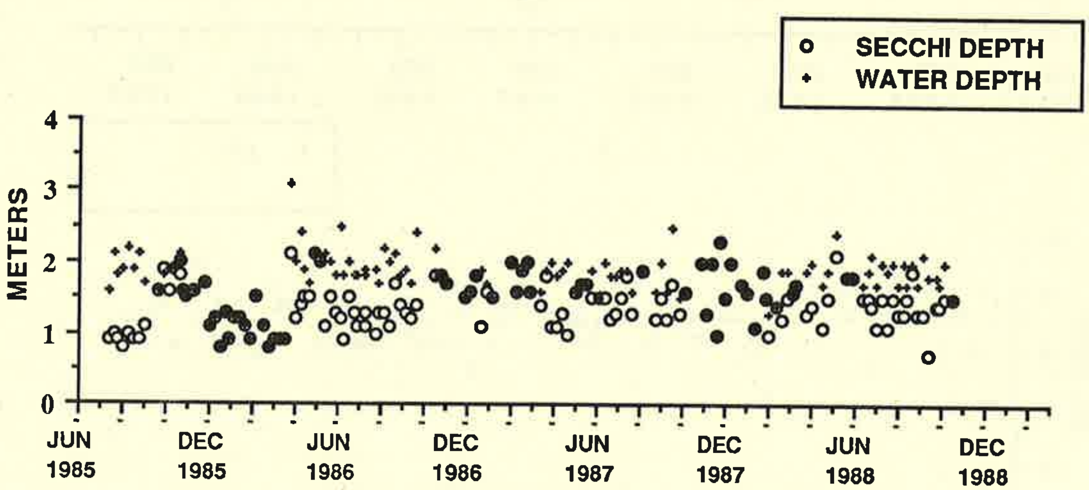
Sampling Site: Grab samples are taken from the end of the pier which extends out into the river.

Salinity Range: 8.9 to 22.4 parts per thousand (mesohaline)

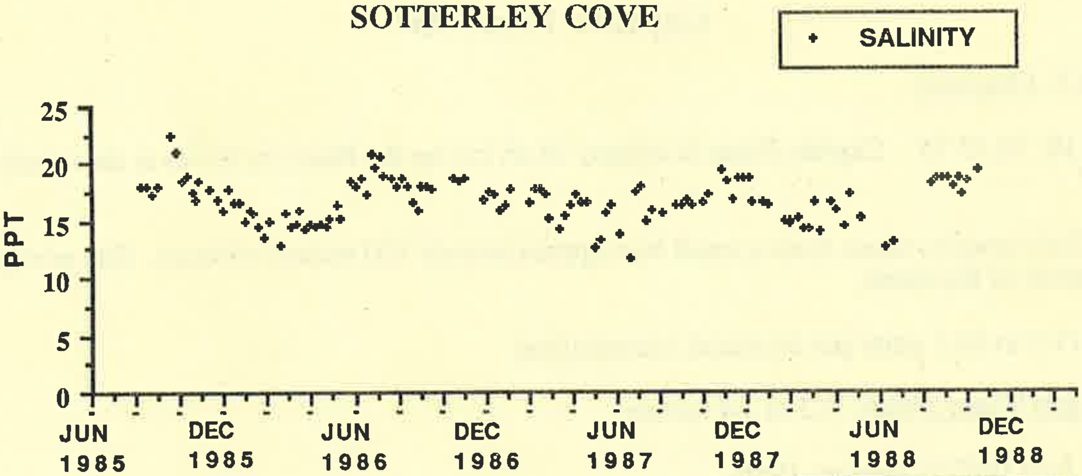
Minimum/Maximum Water Depth: 0.8 to 3.1 meters

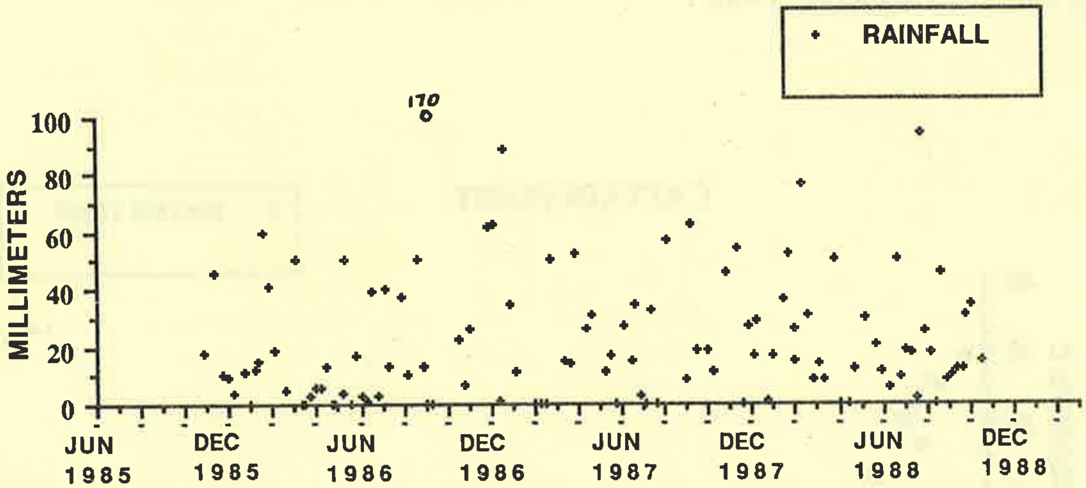
Data Collection Dates: July 1985 to October 1988.

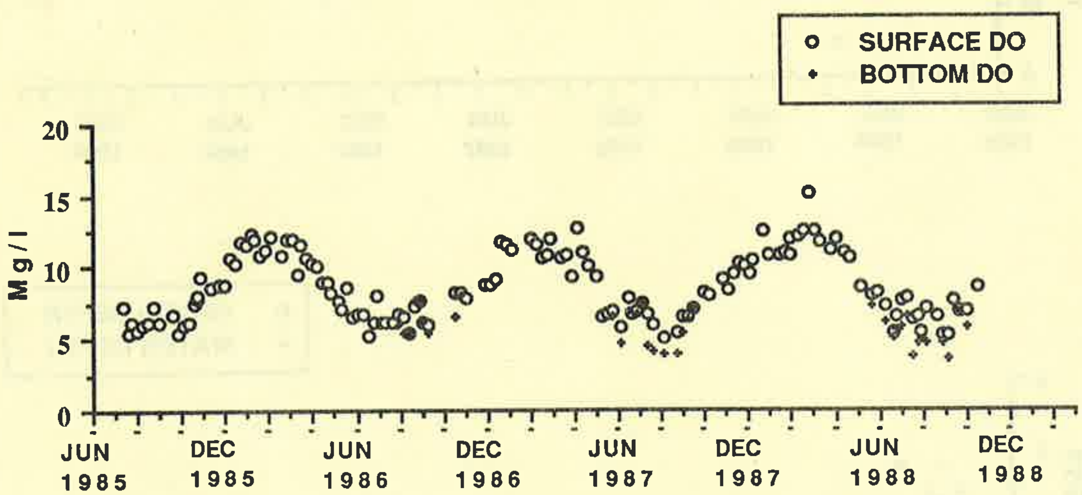


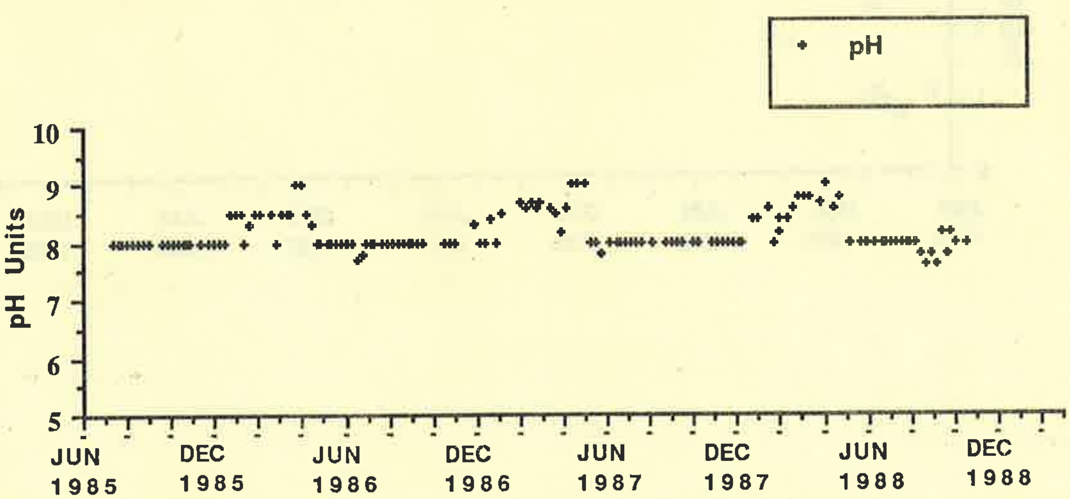


SOTTERLEY COVE









Captain Point #3

Monitor: Robert F. Chapman

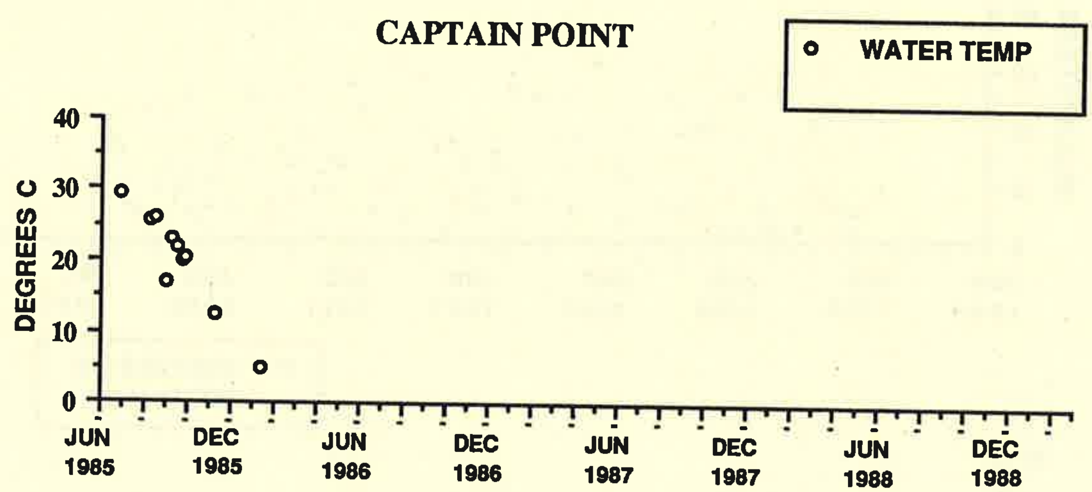
Location: 38 23 10 76 32 55 Captain Point is located 16.45 km up the Patuxent River at the mouth of St. Thomas Creek.

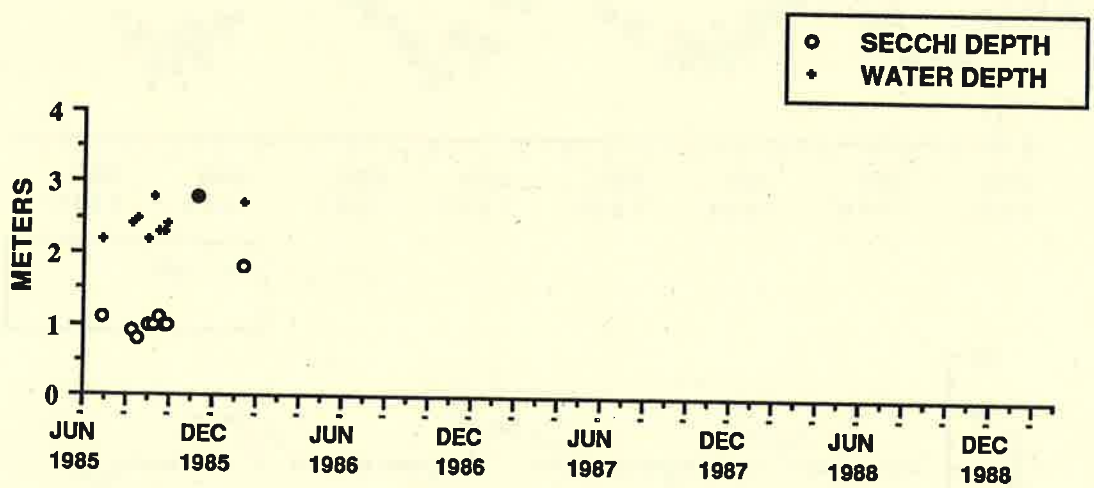
Sampling Site: Grab samples taken from a small boat approximately 100 meters offshore. Site protected by a sand bar at the mouth of the creek.

Salinity Range: 11.5 to 19.1 parts per thousand (mesohaline)

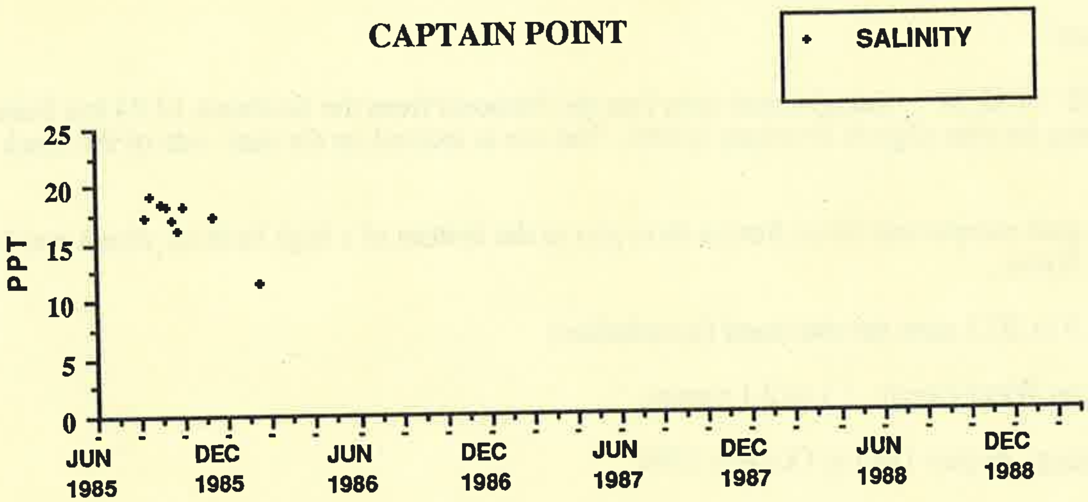
Minimum/Maximum Water Depth: 2.2 to 3.4 meters

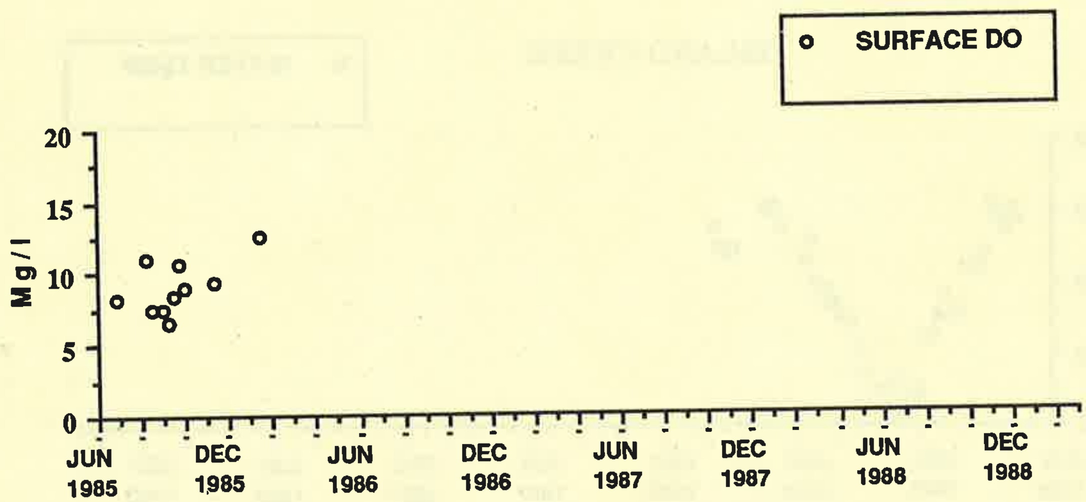
Data Collection: July 1985 to January 1986.

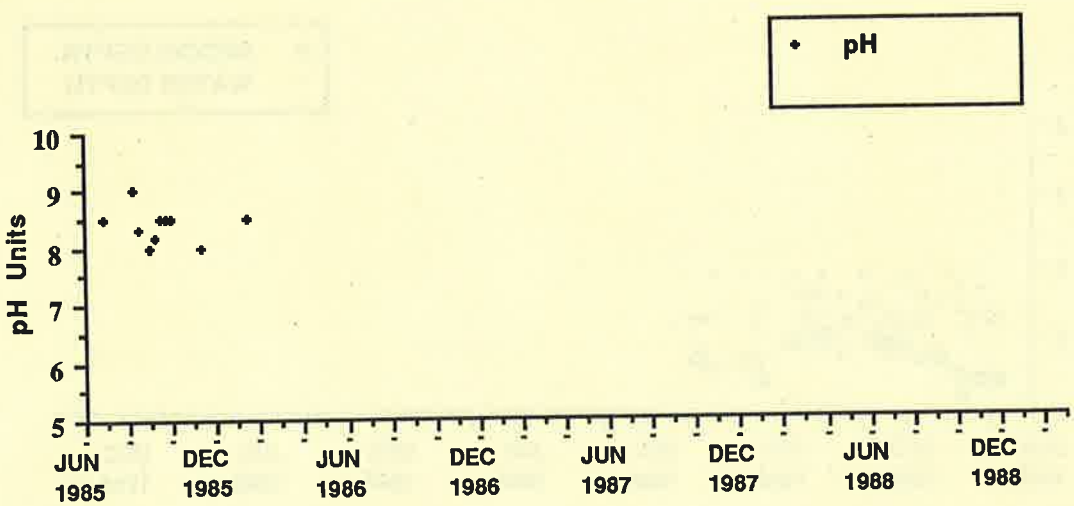




CAPTAIN POINT







ISLAND CREEK #9

Monitor: Ruth Wolf

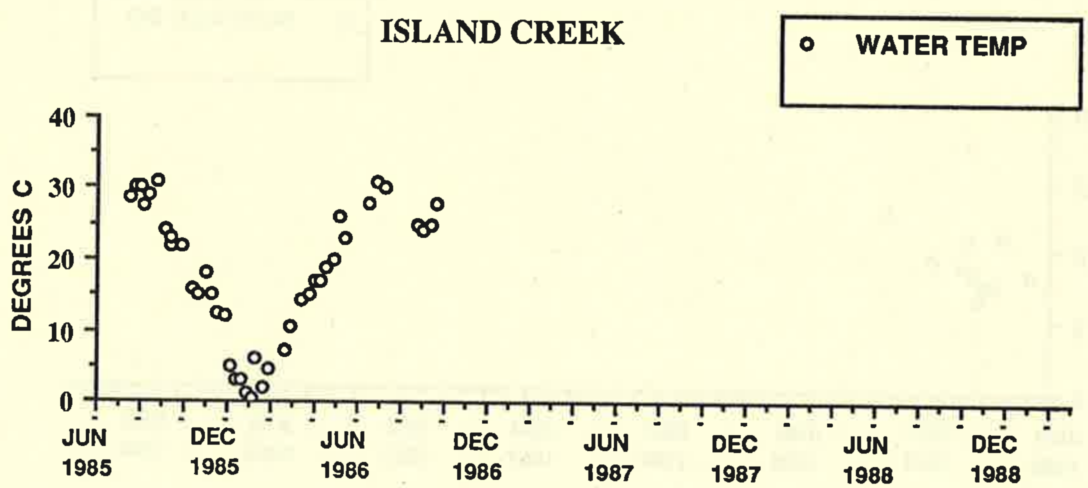
Location: 38 25 22 76 32 20 Island Creek runs into the Patuxent from the northeast 17.28 km from the mouth. It runs along the east edge of Broomes Island. The site is located on the east side of the creek 2.92 km from the mouth.

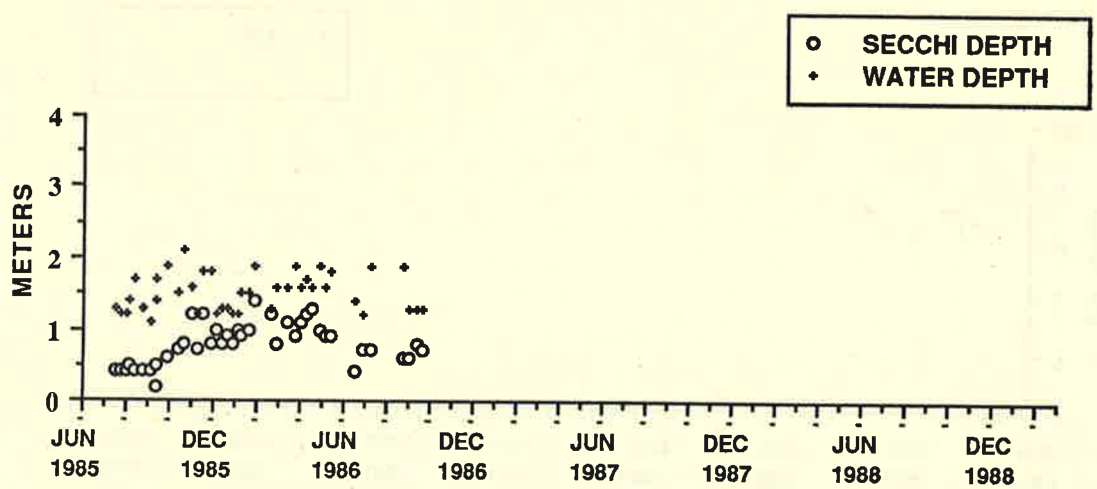
Sampling Site: A grab sample was taken from a short pier at the bottom of a high bank on which was built the Wolf's waterfront home.

Salinity Range: 7.9 to 20.2 parts per thousand (mesohaline)

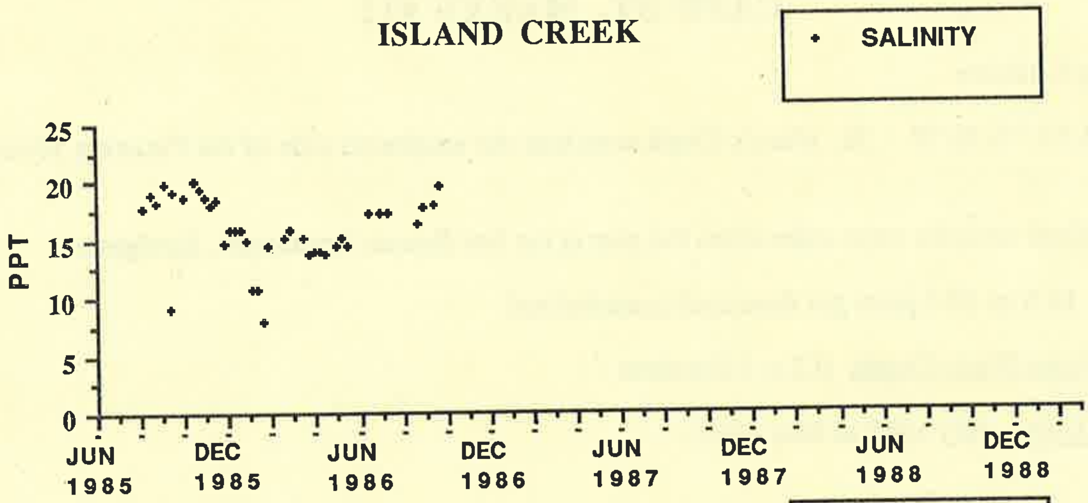
Minimum/Maximum Water Depth: 1.1 to 2.1 meters

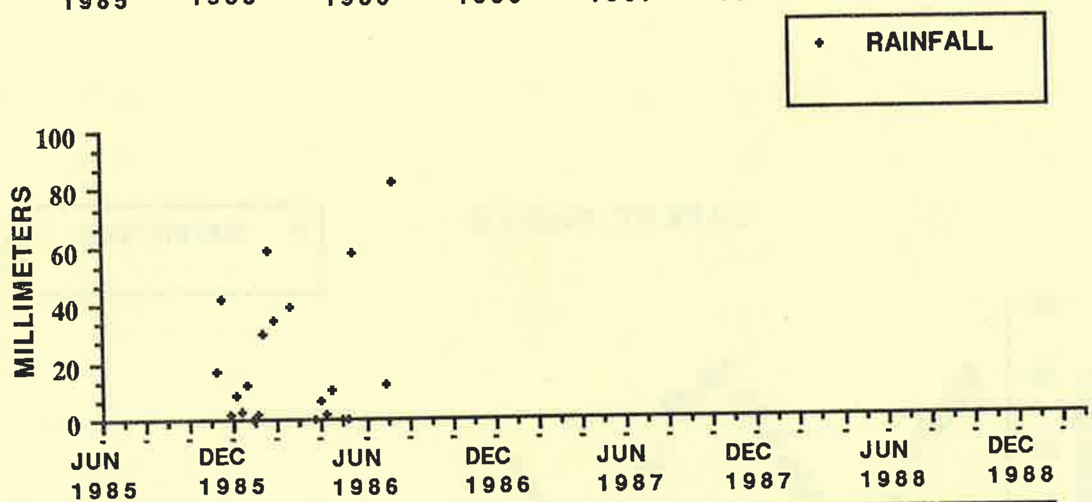
Data Collection Dates: August 1985 to October 1986.

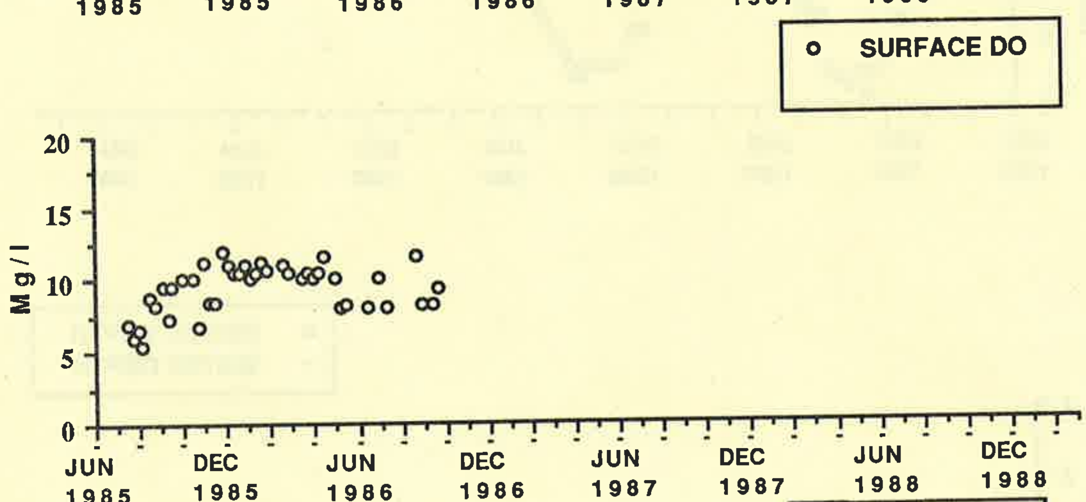


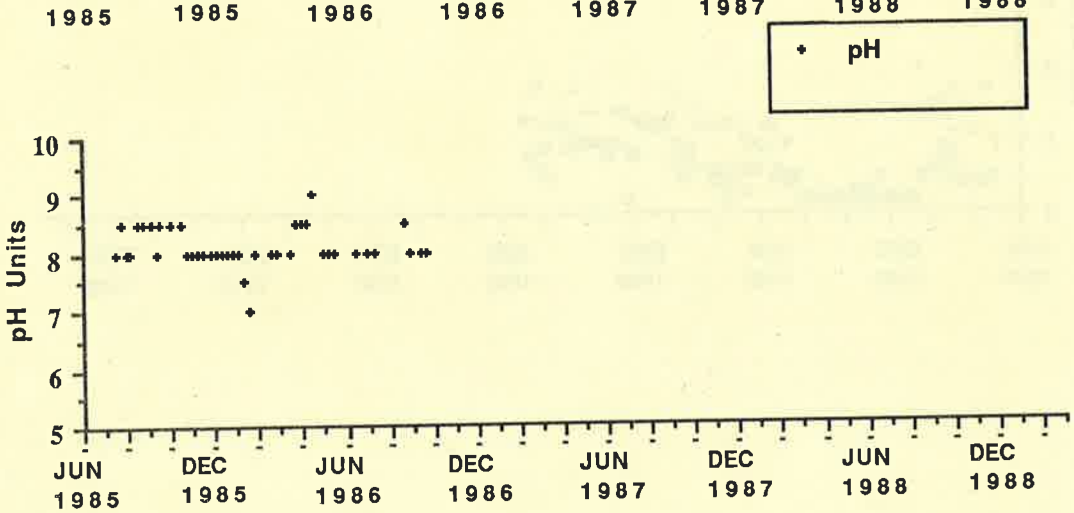


ISLAND CREEK









CAPE ST. MARYS #12

Monitor: Dudley Lindsley

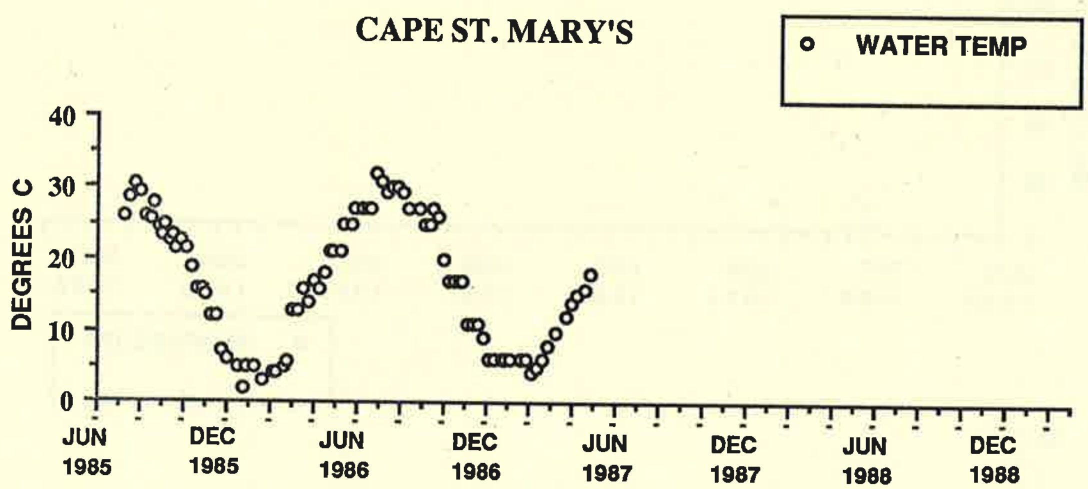
Location: 38 24 50 76 36 27 St. Mary's Creek runs into the southwest side of the Patuxent River 22.74 km from the mouth .

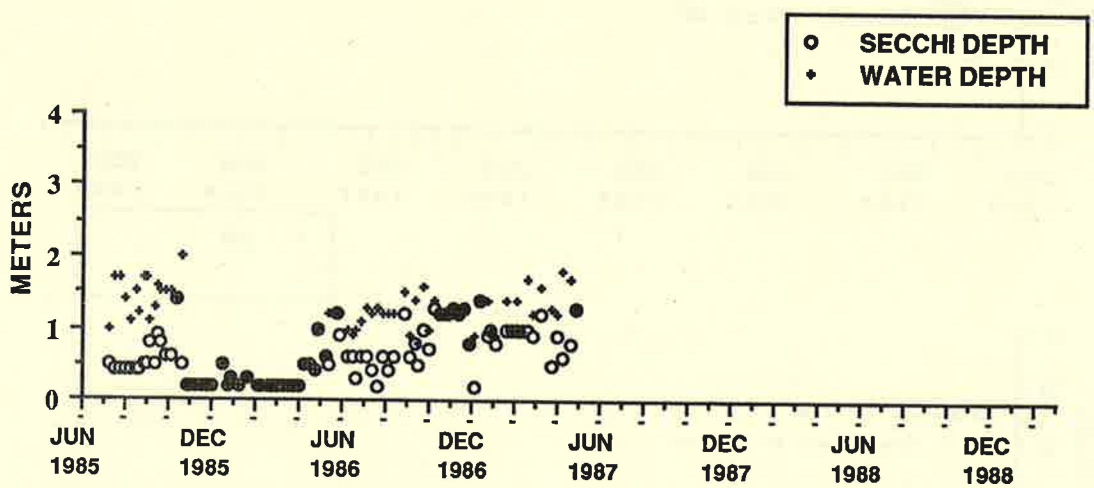
Sampling Site: Grab samples were taken from the pier at the Sea Breeze Restaurant, Sandgates.

Salinity Range: 10.5 to 19.6 parts per thousand (mesohaline)

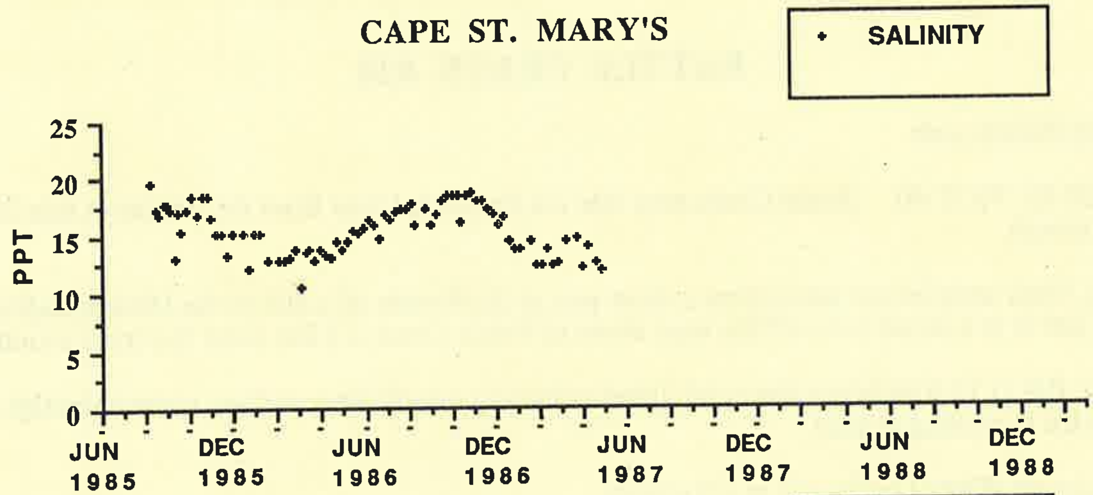
Minimum/Maximum Water Depth: 0.2 to 2.0 meters

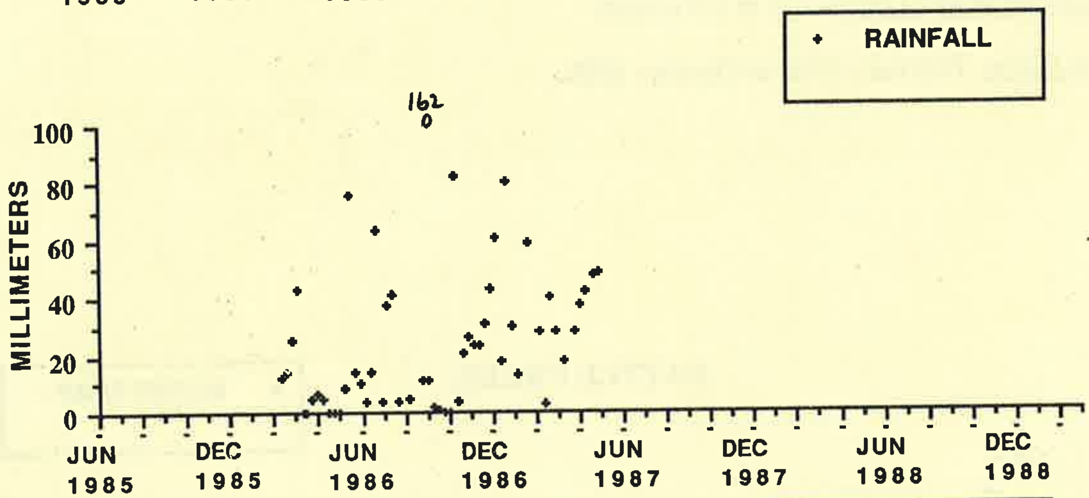
Data Collection Dates: July 1985 to May 1987.

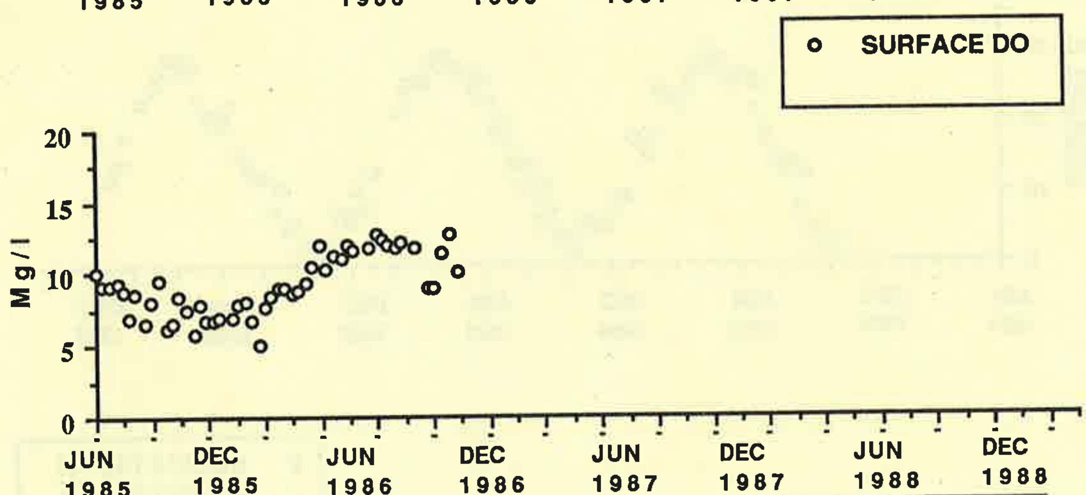


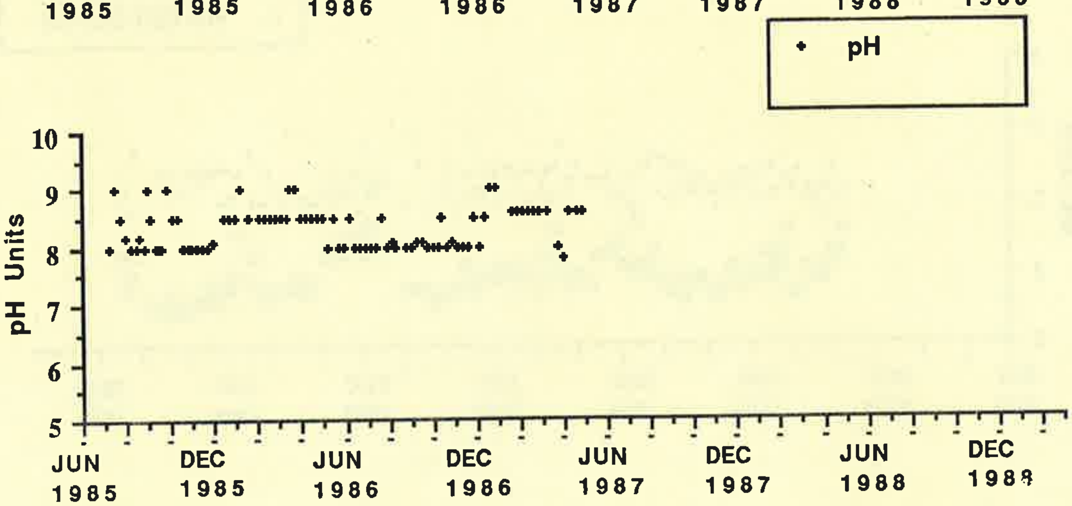


CAPE ST. MARY'S









BATTLE CREEK #20

Monitor: Philip Hildebrandt

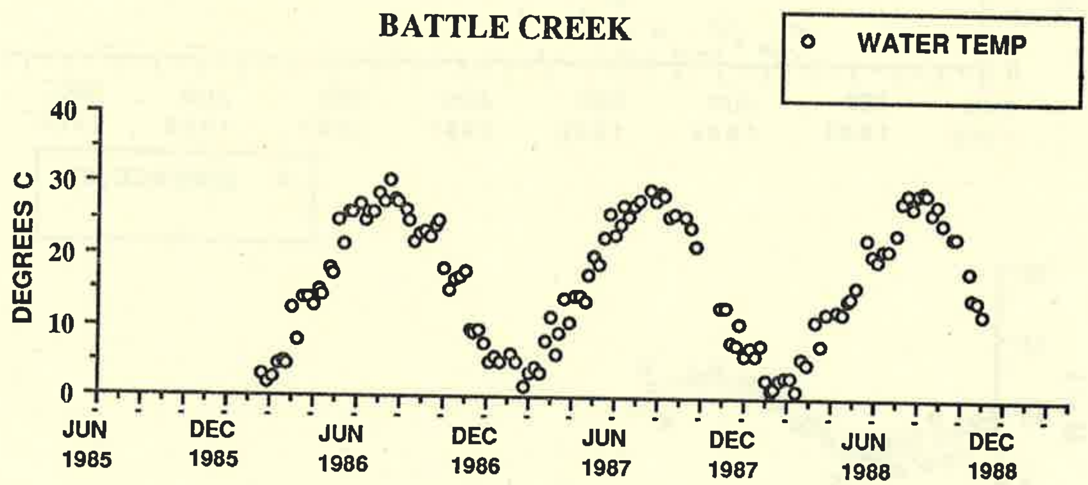
Location: 38 26 40 76 37 40 Battle Creek runs into the Patuxent River from the northeast side 24.00 km from the river mouth.

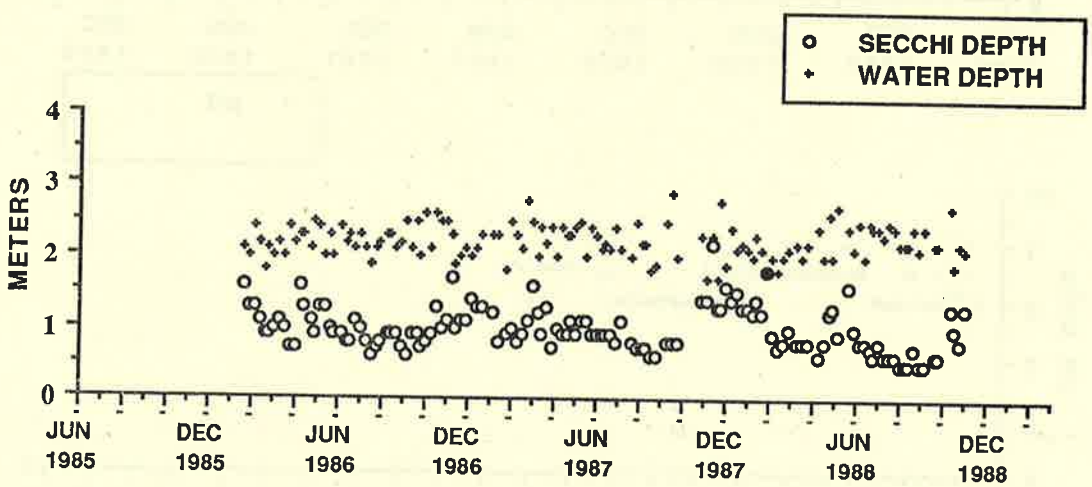
Sampling Site: Grab samples are taken from a short pier at the bottom of a hill on the Hildebrandt's waterfront property. The site is in a small cove off the west shore of Battle Creek 2.2 km from the creek mouth.

Salinity Range: 0.0 to 17.9 parts per thousand (predominately mesohaline; surface water salinities of 0.0 observed when ice is melting at site)

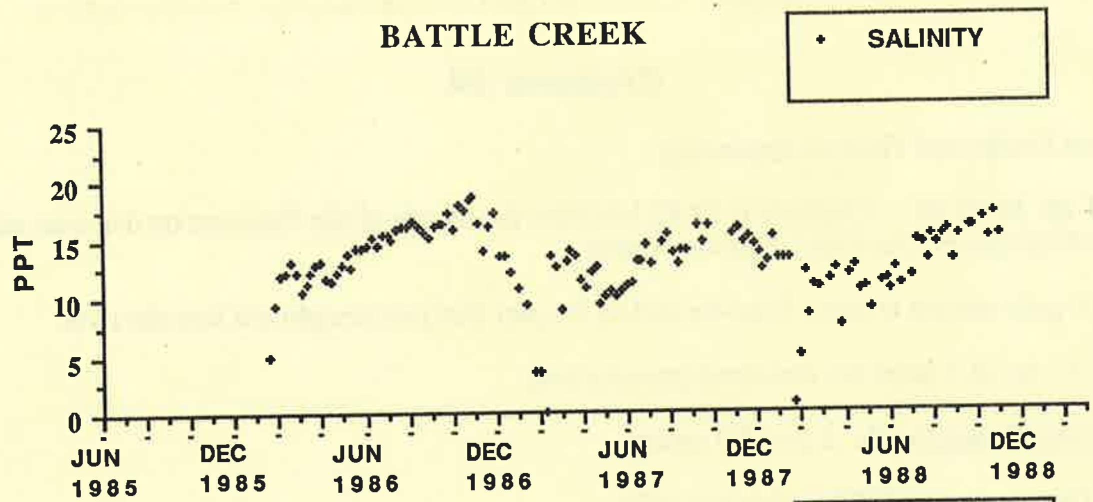
Minimum/Maximum Water Depth: 1.7 to 2.9 meters

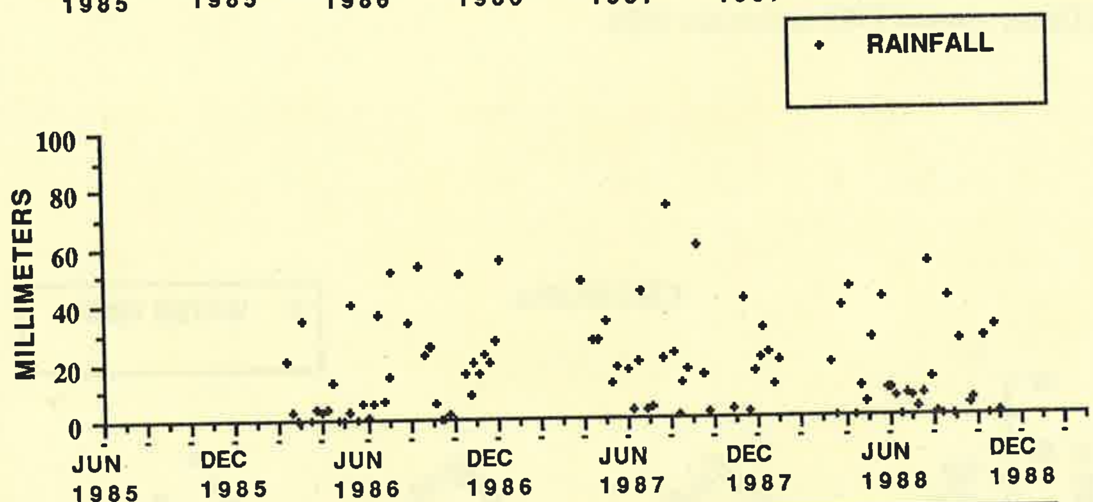
Data Collection Dates: February 1986 to October 1988.

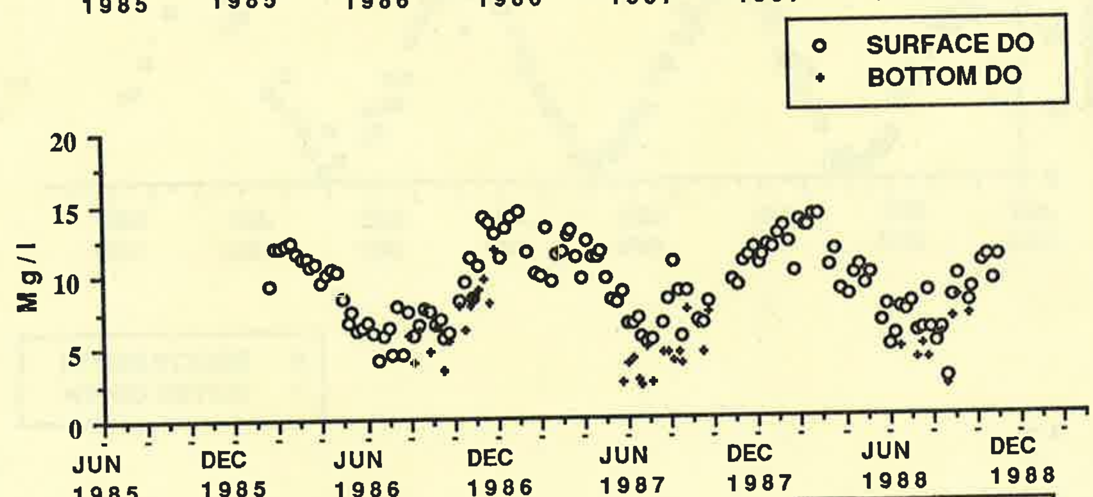


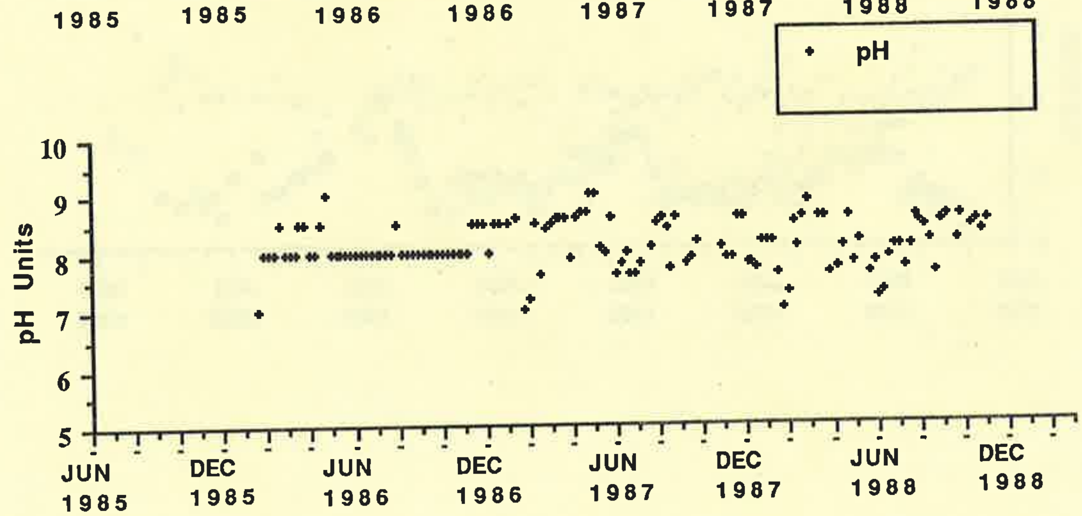


BATTLE CREEK









Cremona #4

Monitors: Norton Dodge and Thomas Repenning

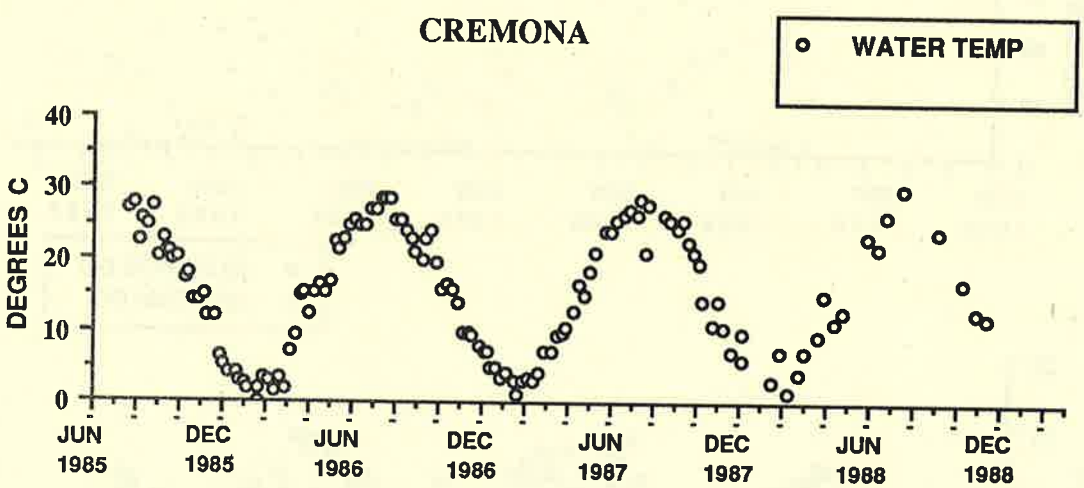
Location: 38 27 25 76 39 20 Cremona is 28.42 km from the mouth of the Patuxent on the west side of the river and bordered by Persimmon Creek and Cremona Creek.

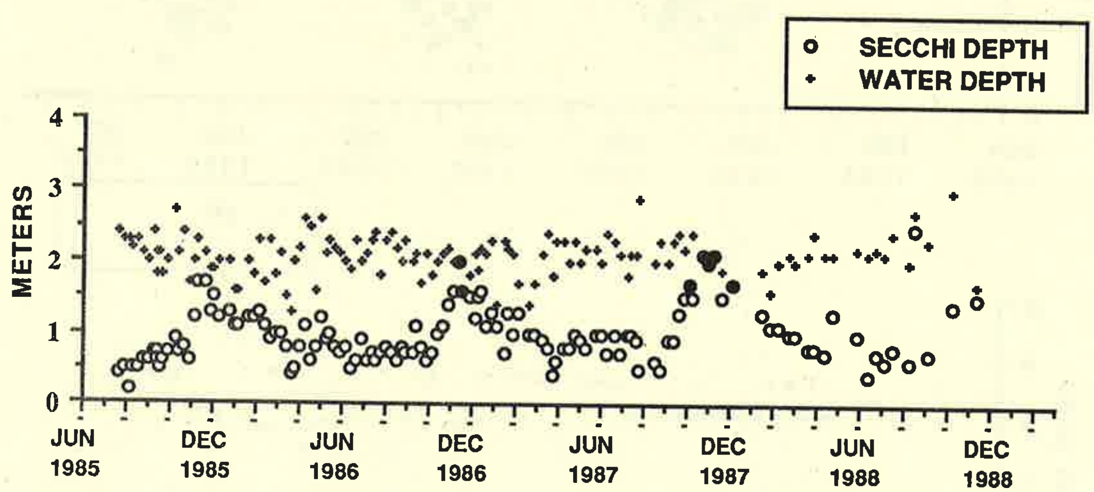
Sampling Site: A grab sample is taken from the end of the pier that juts straight out into the river.

Salinity Range: 5.1 to 19.9 parts per thousand (mesohaline)

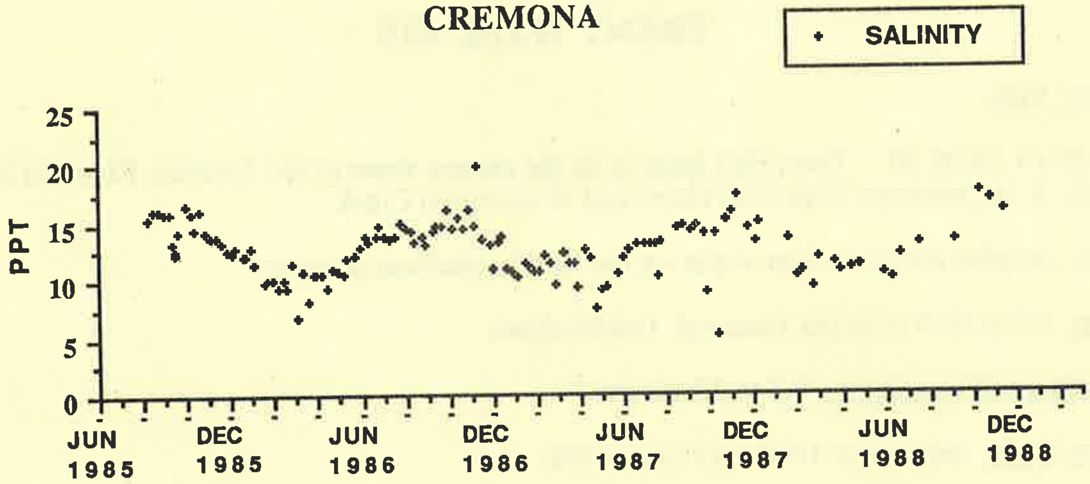
Minimum/Maximum Water Depth: 1.3 to 3.0 meters

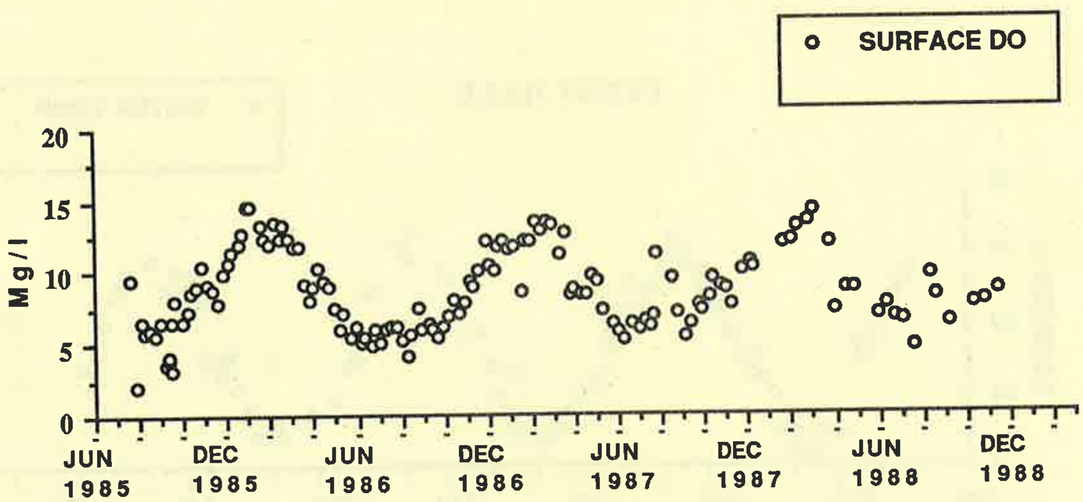
Data Collection Dates: August 1985 to October 1988.

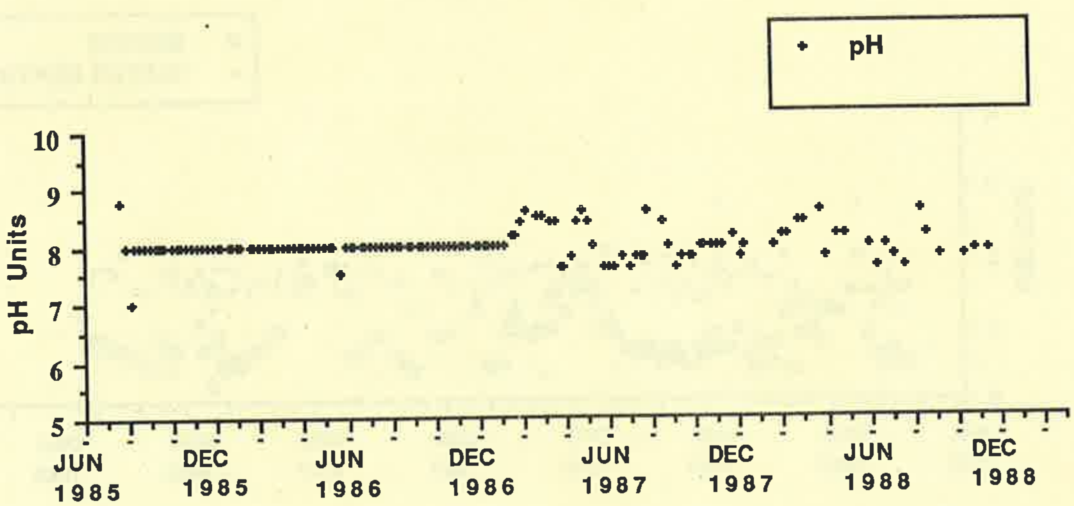




CREMONA


SALINITY
PPT
25
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


SURFACE DO
Mg/l
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


pH
pH Units
10
9
8
7
6
5
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

TRENT HALL #18

Monitor: Henry Virts

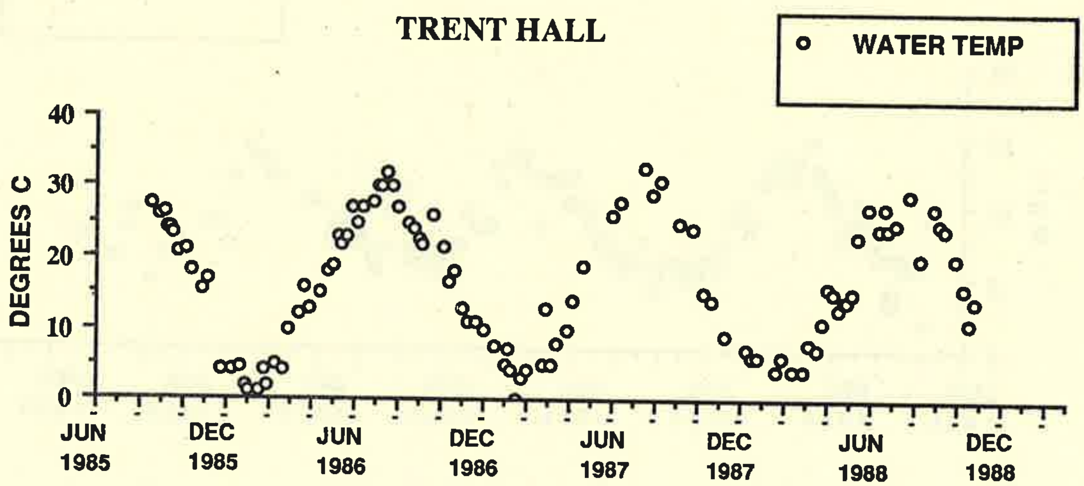
Location: 38 28 14 76 39 50 Trent Hall Point is on the eastern shore of the Patuxent River 30.24 km from the river mouth. It lies between Trent Hall Creek and Washington Creek.

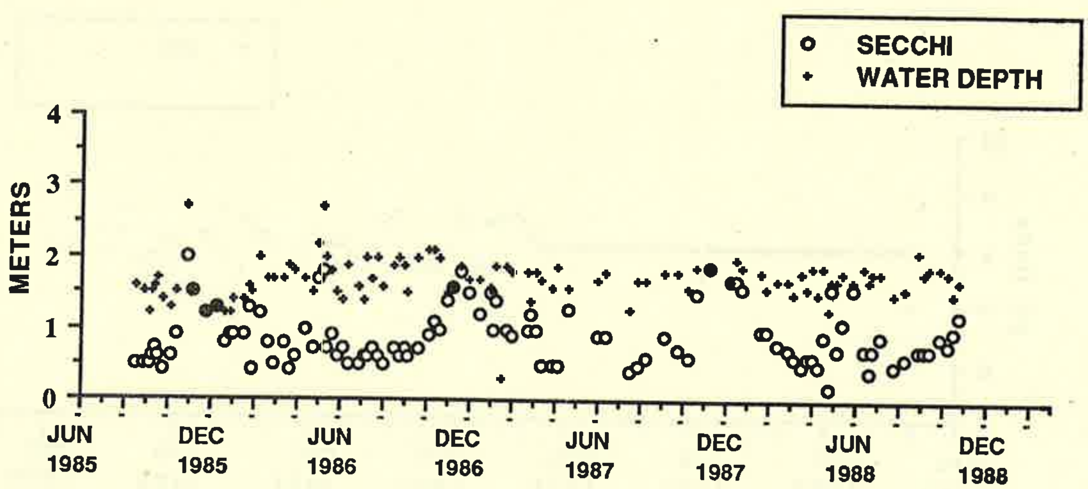
Sampling Site: Samples are taken from a pier on the Virts' waterfront property.

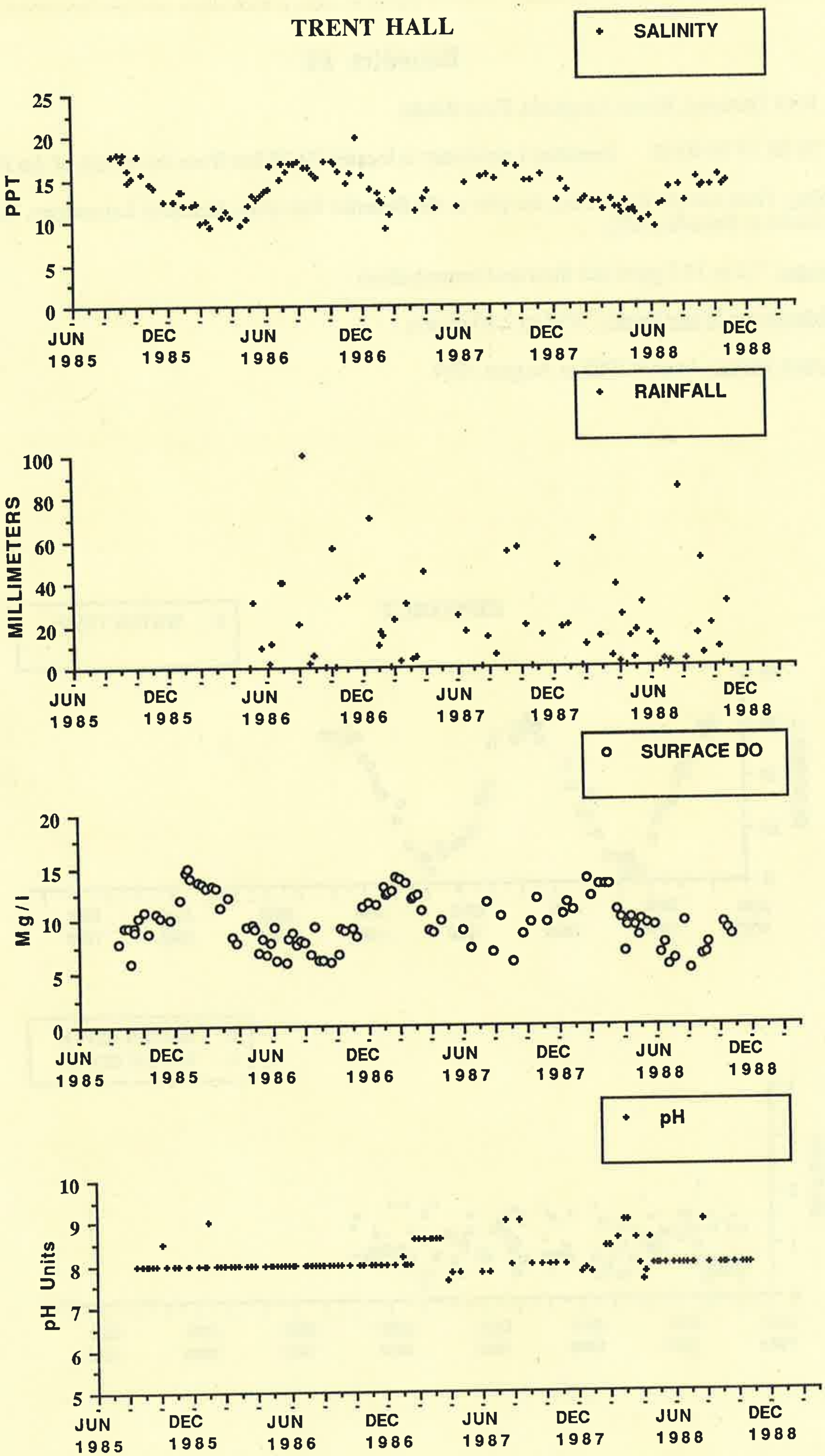
Salinity Range: 9.2 to 20.0 parts per thousand (mesohaline)

Minimum/Maximum Water Depth: 0.3 to 2.7 meters

Data Collection Dates: September 1985 to October 1988.







TRENT HALL
SALINITY
PPT
25
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988
RAINFALL
MILLIMETERS
100
80
60
40
20
0
SURFACE DO
Mg/l
pH
pH Units
10
9
8
7
6

Benedict #1

Monitors: Rick Osmond, Kevin Junghaus, Fritz Riedel

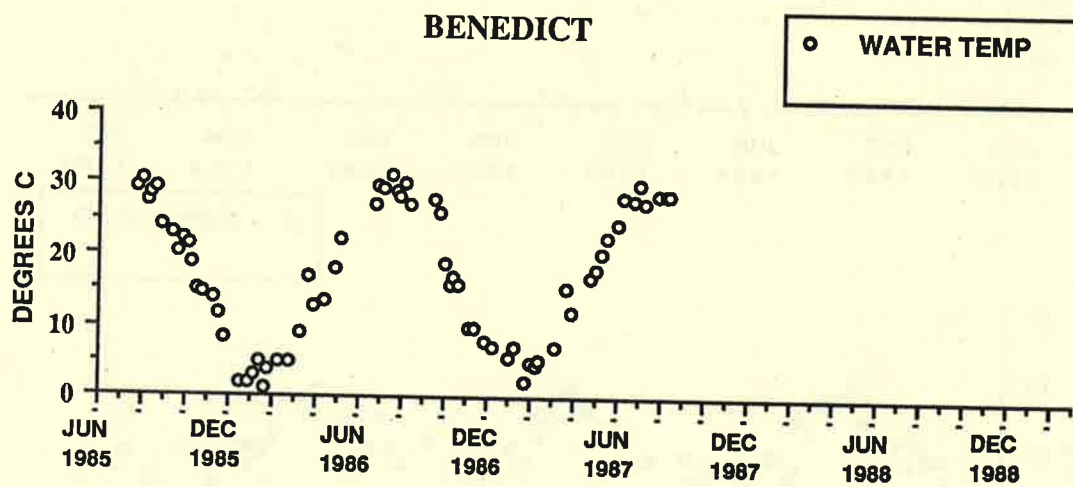
Location: 38 30 33 76 40 45 Benedict Laboratory is located 34.38 km from the mouth of the Patuxent River.

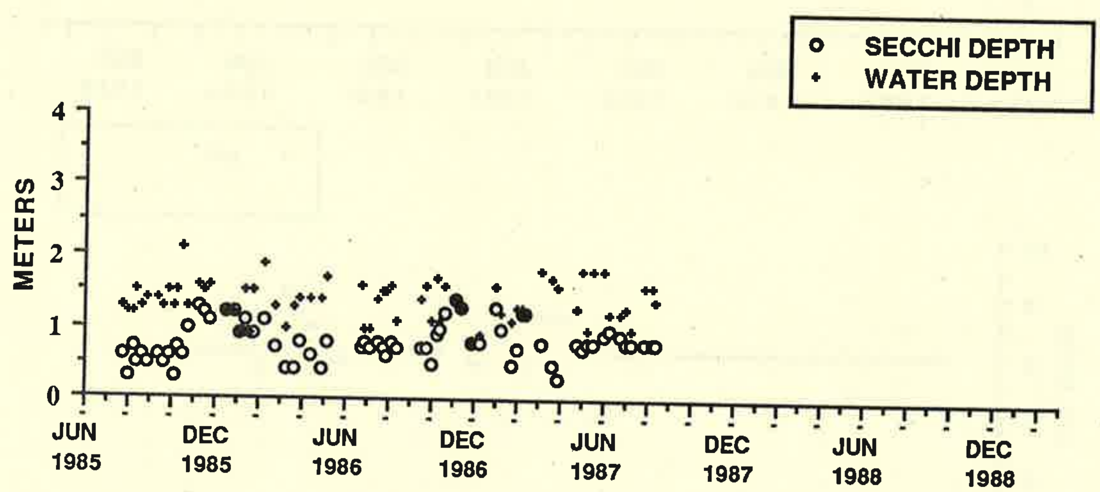
Sampling Site: Grab sample taken from the pier at the Benedict Estuarine Research Laboratory, The Academy of Natural Sciences at Benedict, MD.

Salinity Range: 7.2 to 19.2 parts per thousand (mesohaline)

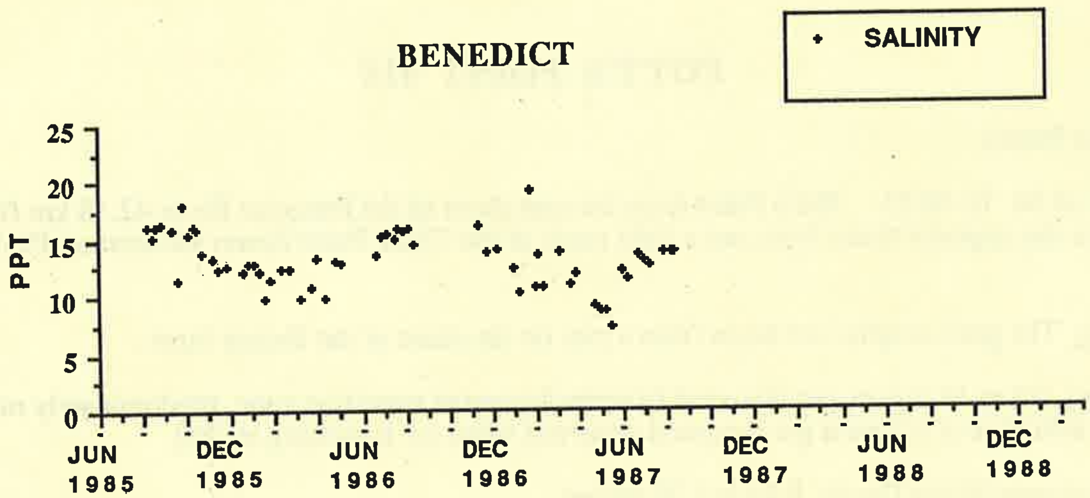
Minimum/Maximum Water Depth: 0.95 to 2.10 meters

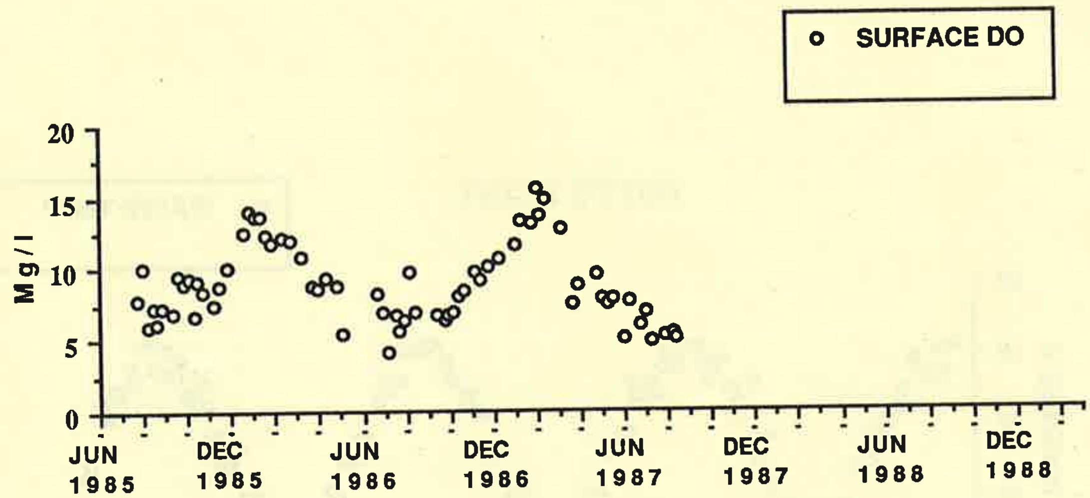
Data Collection Dates: August 1985 to August 1987.

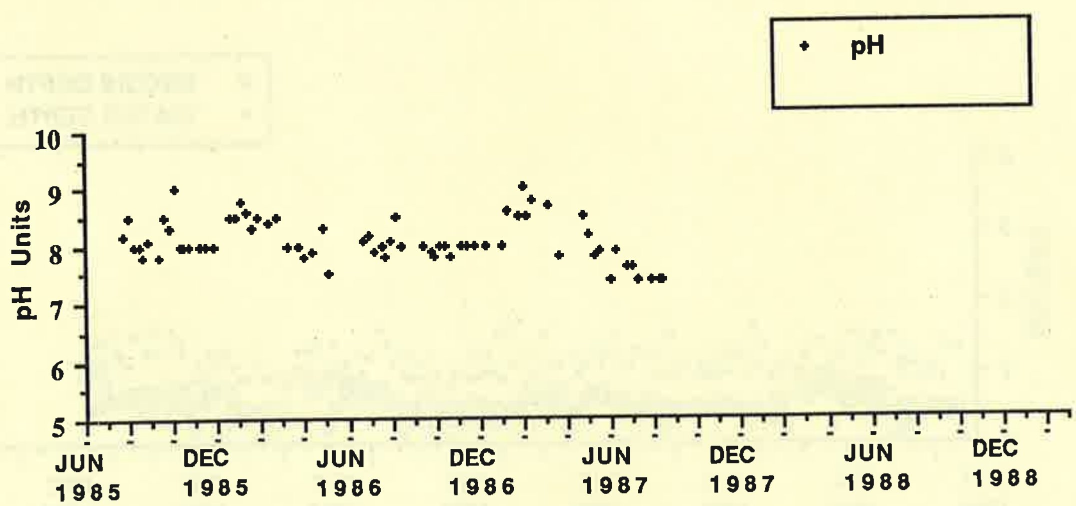




BENEDICT


SALINITY
PPT
25
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


SURFACE DO
Mg/l
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


pH
pH Units
10
9
8
7
6
5
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

POTT'S POINT #15

Monitor: John Prouty

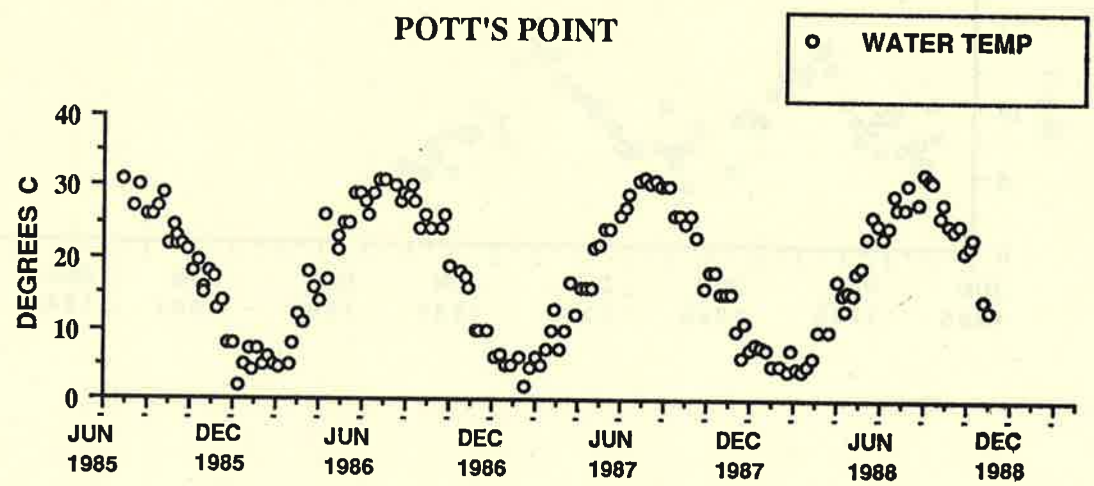
Location: 38 34 36 76 40 23 Pott's Point is on the east shore of the Patuxent River 42.18 km from the mouth. It is on the opposite shore from and a little north of the Chalk Point Power Generating Plant cooling water outlet.

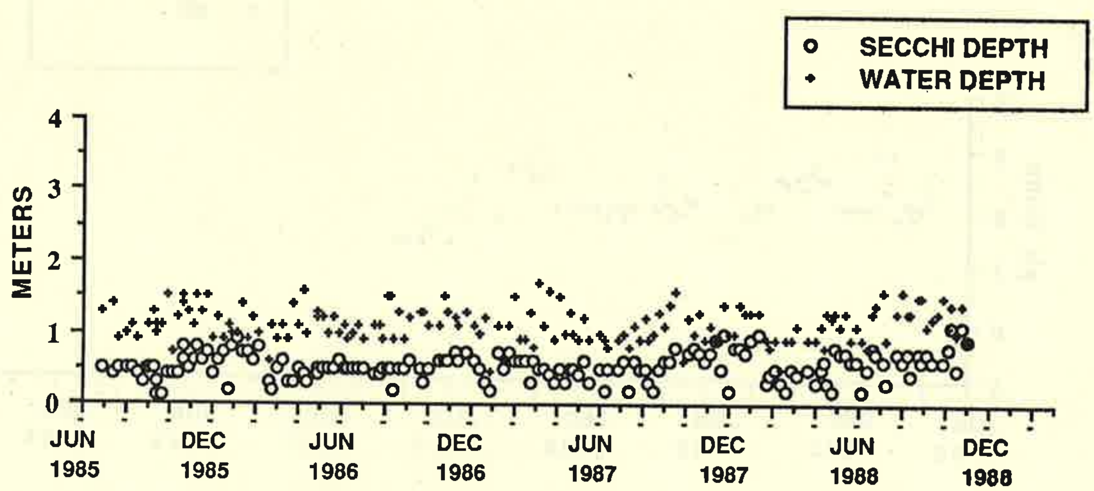
Sampling Site: The grab samples are taken from a pier on the shore of the Prouty farm .

Salinity Range: 0.0 to 17.3 parts per thousand (riverine/estuarine transition zone, predominately mesohline; surface water salinities of 0.0 parts per thousand observed when ice is melting at site)

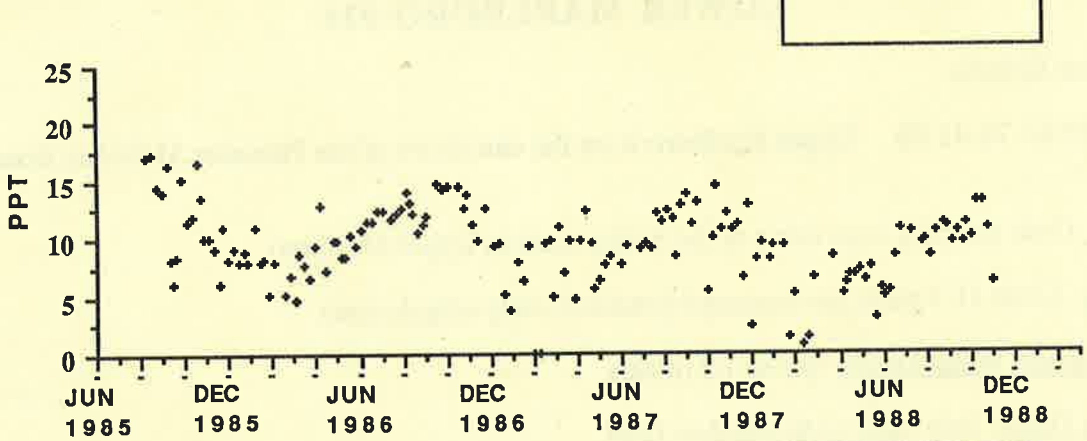
Minimum/Maximum Water Depth: 0.45 to 1.70 meters

Data Collection Dates: July 1985 to October 1988.

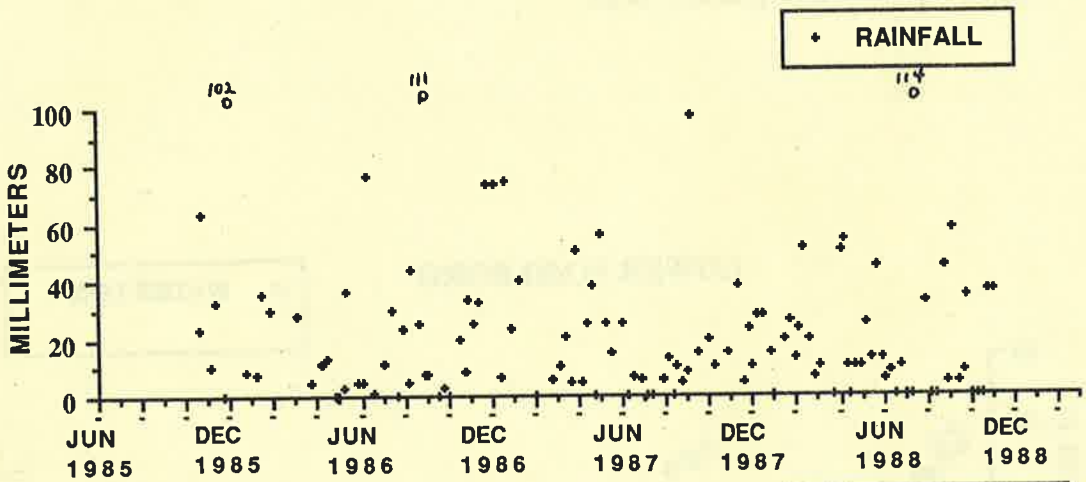




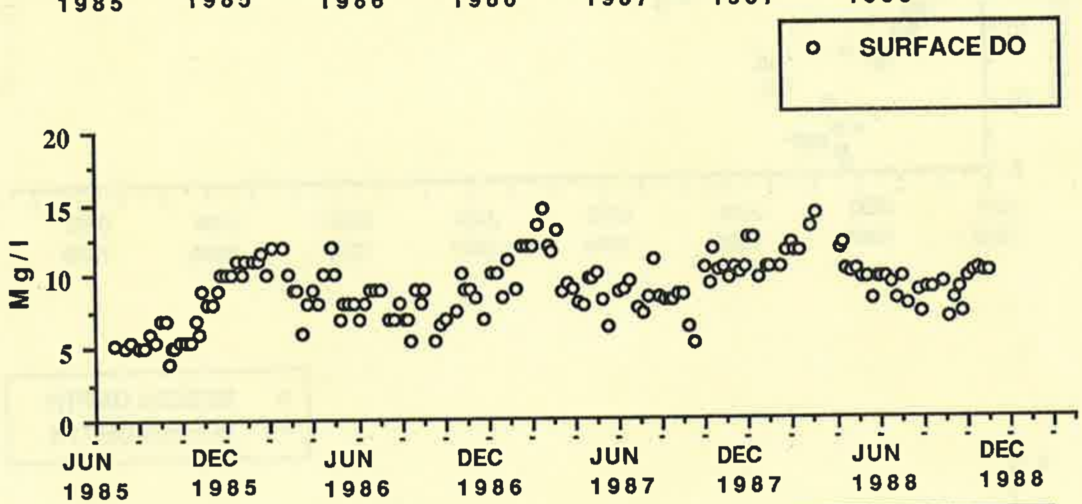
POTT'S POINT



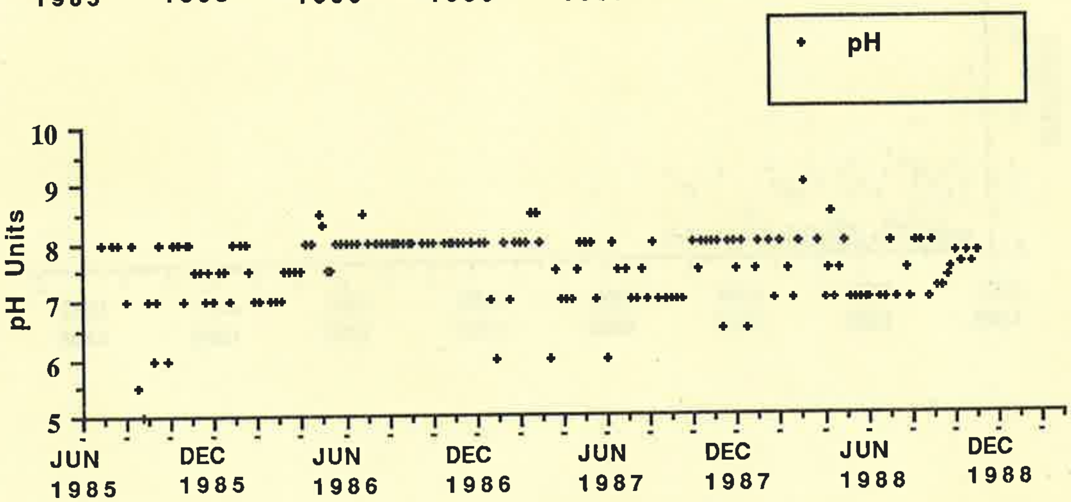
SALINITY
PPT
25
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988



RAINFALL
MILLIMETERS
100
80
60
40
20
0
102
111
114
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988



SURFACE DO
Mg/l
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988



pH
pH Units
10
9
8
7
6
5
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

LOWER MARLBORO #16

Monitor: Joanne Roberts

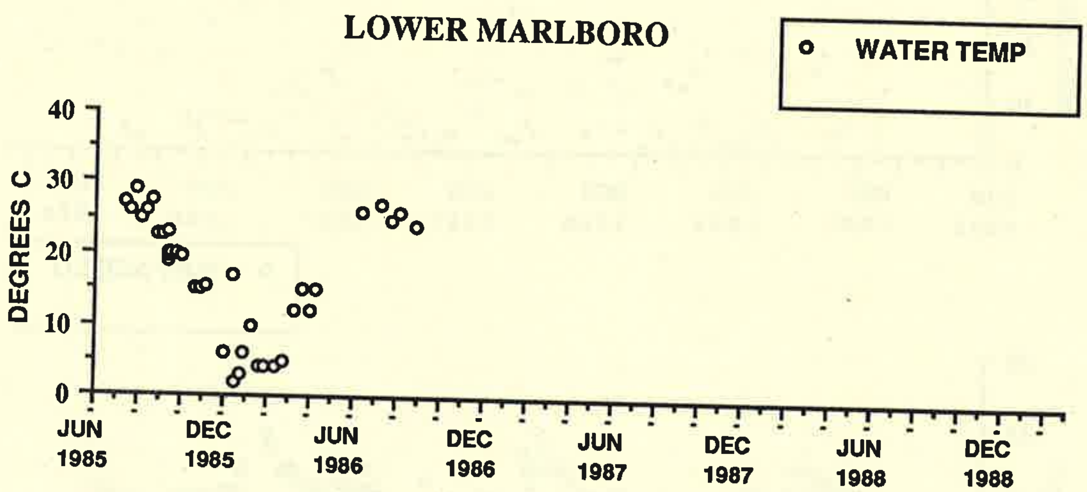
Location: 38 39 22 76 41 00 Upper Marlboro is on the east shore of the Patuxent 51.96 km from the mouth of the river.

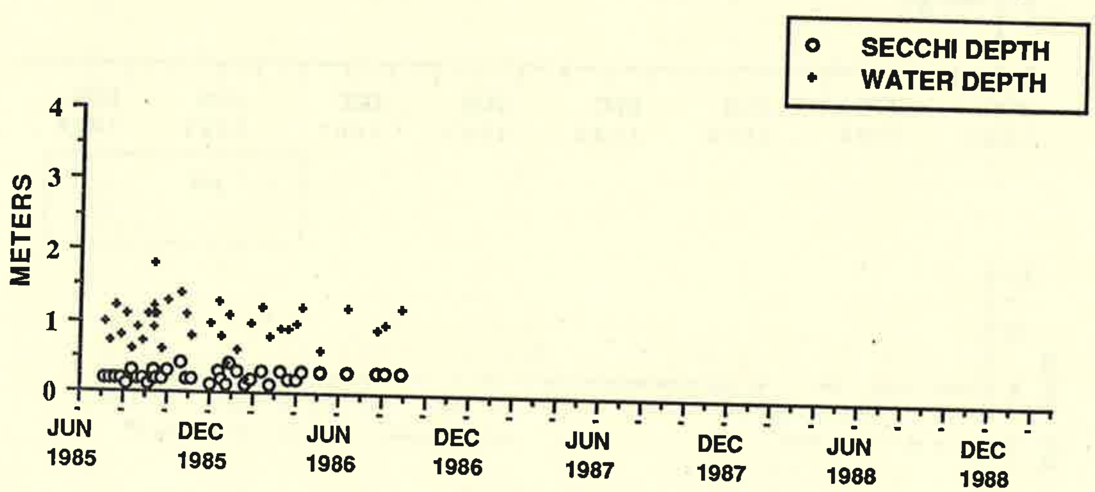
Sampling Site: Grab samples were taken at the public dock in Upper Marlboro.

Salinity Range: 1.3 to 11.7 parts per thousand (predominately oligohaline)

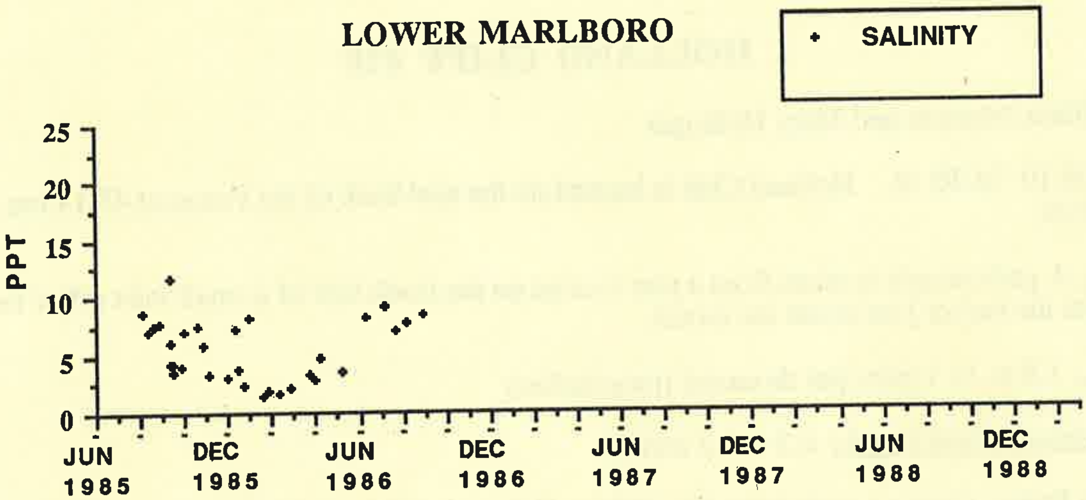
Minimum/Maximum Water Depth: 0.2 to 1.8 meters

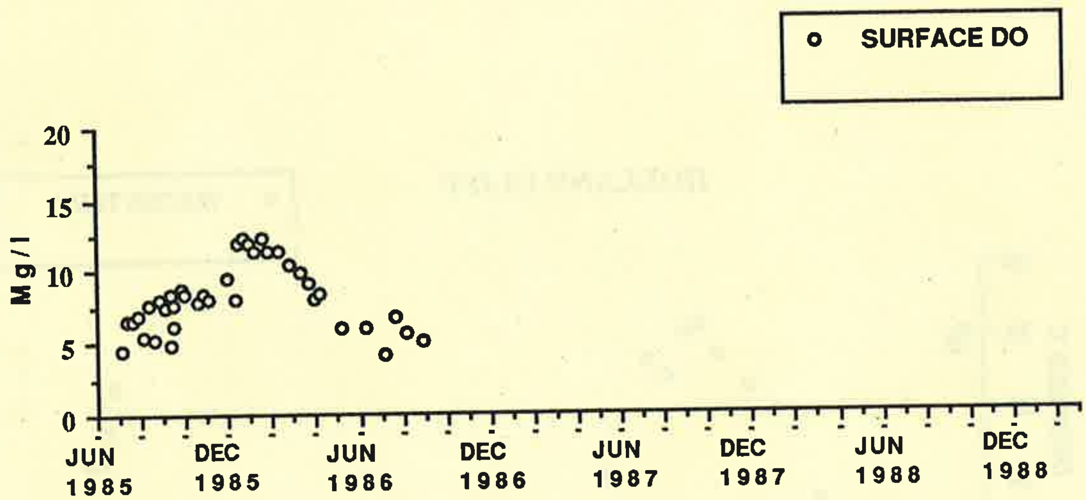
Data Collection Dates: July 1985 to September 1986.

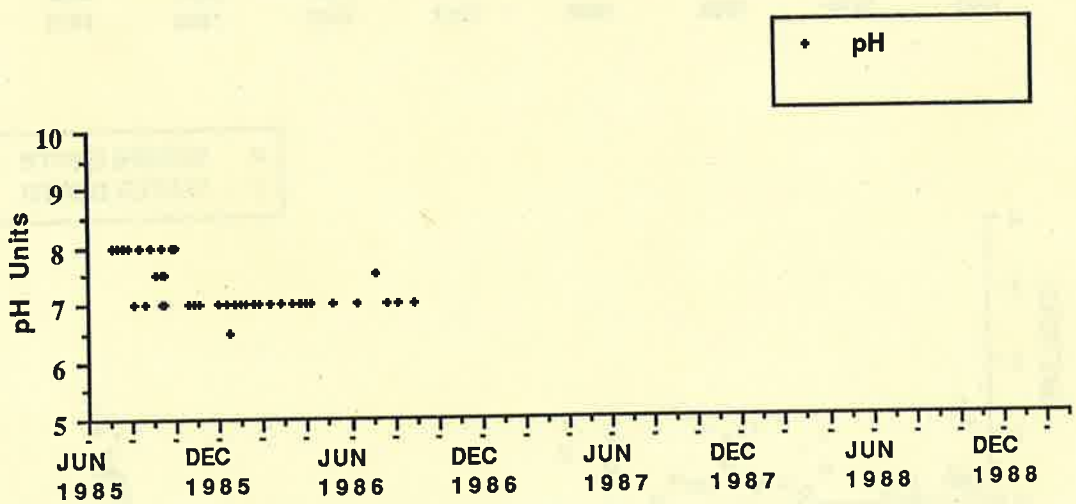




LOWER MARLBORO







HOLLAND CLIFF #10

Monitors: William Johnston and Mary Hollinger

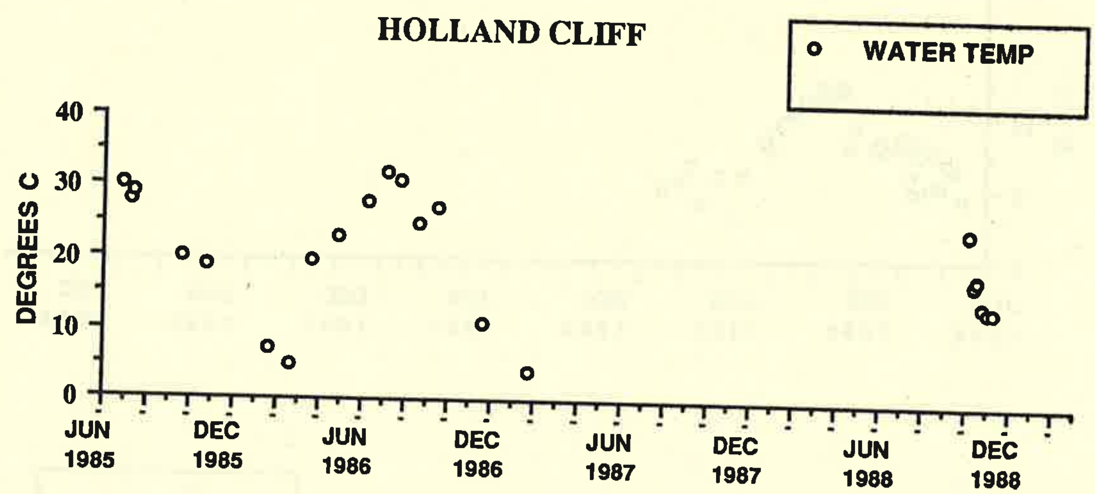
Location: 38 36 10 76 40 10 Holland Cliff is located on the east bank of the Patuxent 45.14 km from the mouth of the river.

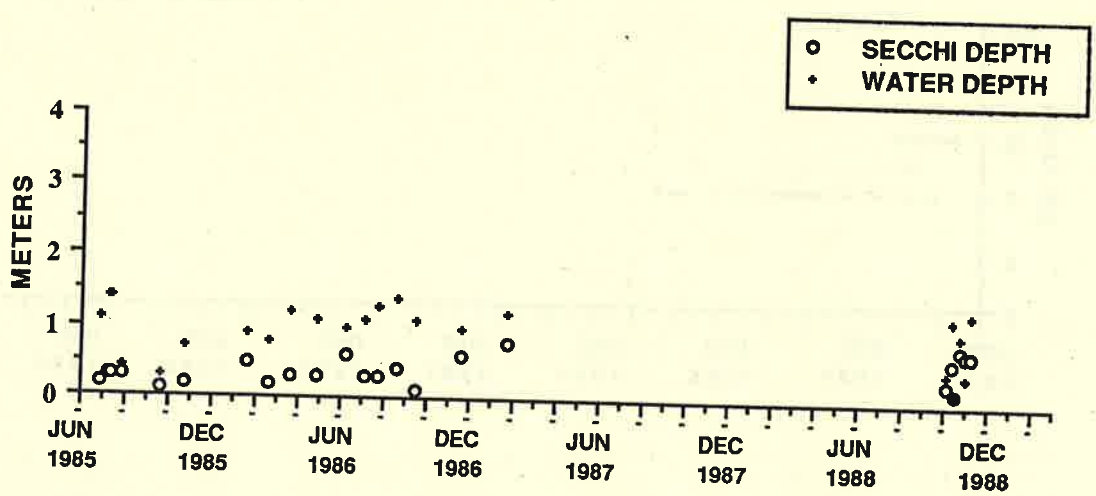
Sampling Site: A grab sample is taken from a pier located on the north side of a small inlet off of the river. The pier extends into the harbor just inside the mouth.

Salinity Range: 1.8 to 11.7 parts per thousand (mesohaline)

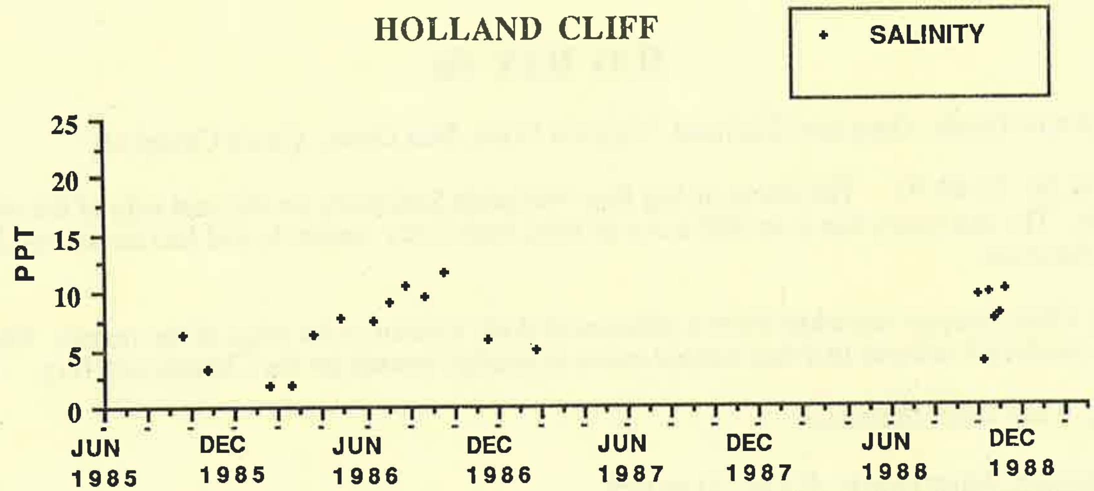
Minimum/Maximum Water Depth: 0.2 to 1.3 meters

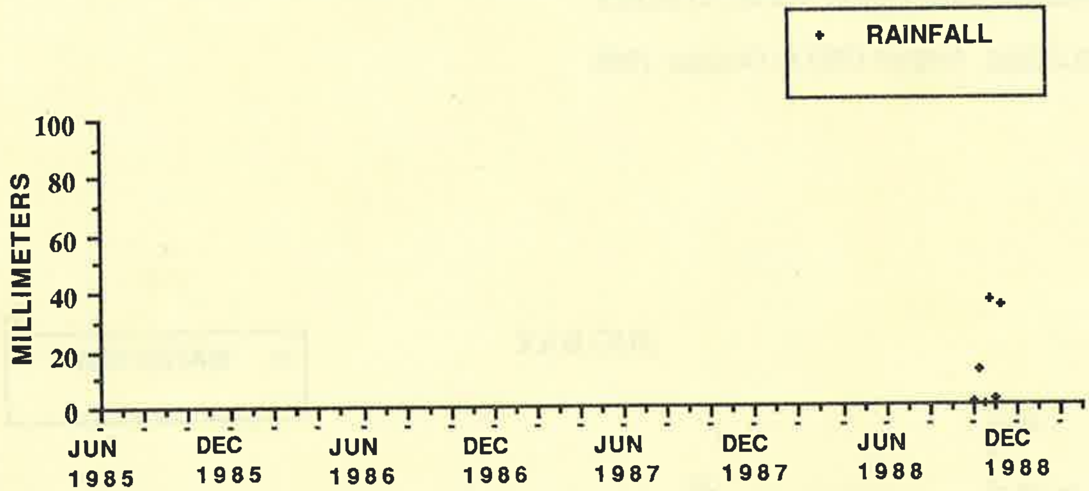
Data Collection Dates: Once a month from July 1985 to February 1987, weekly from October 1988 to December 1988.

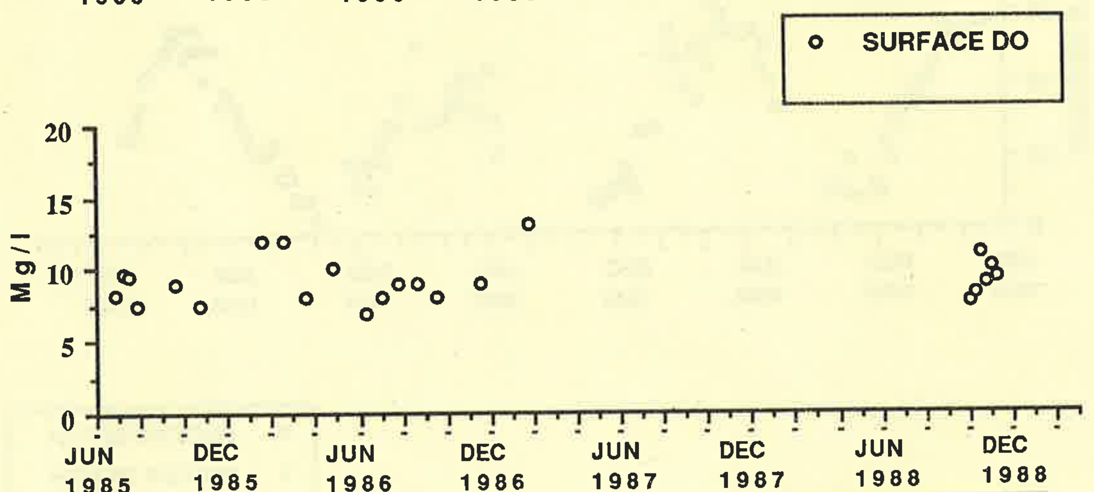


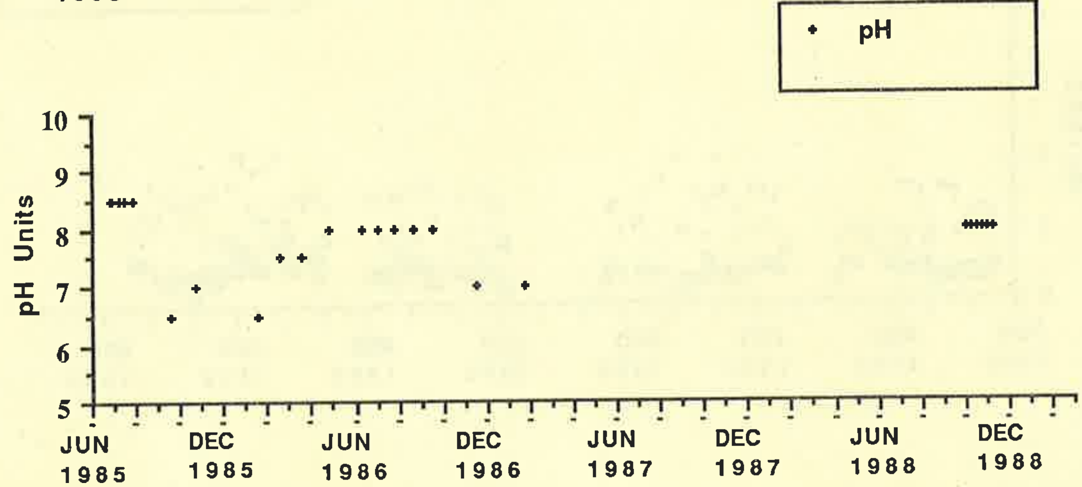


HOLLAND CLIFF









JUG BAY #6

Monitors: Christine Gault, Gretchen Seielstad, Virginia Dove, Ben Dove, Gayla Campbell

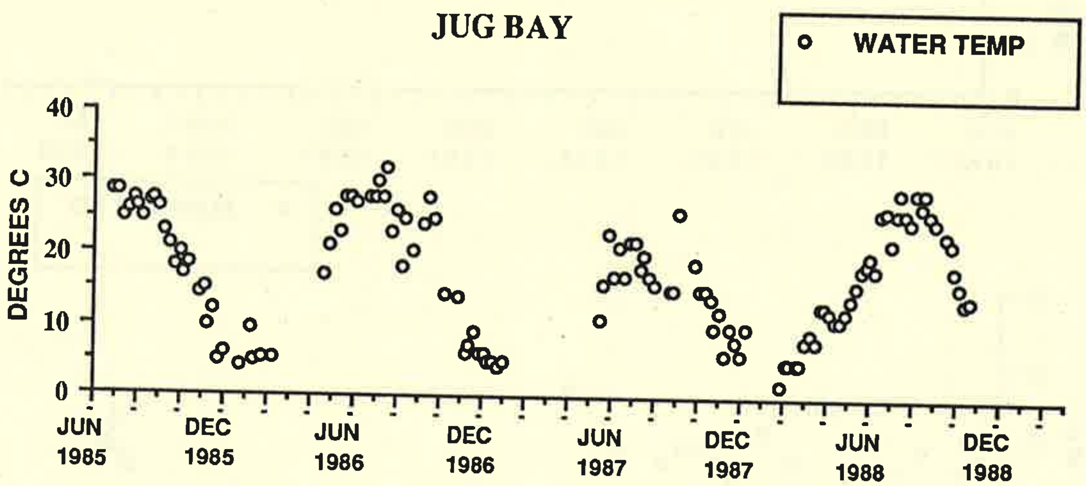
Location: 38 46 50 76 42 30 The site is at Jug Bay Wetlands Sanctuary on the east side of the river 69.18 km from the mouth. The sanctuary has over 200 acres of tidal freshwater wetlands and focuses on wetlands research and education.

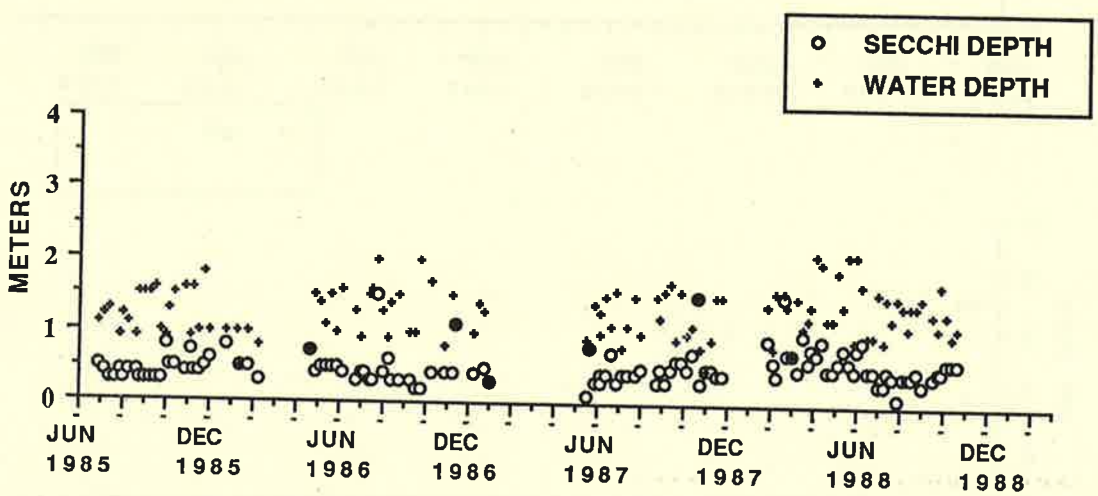
Sampling Site: Grab samples are taken from a permanent dock located at the edge of the marsh. The site is at the end of an abandoned railroad bed that carried trains to seaside resorts on the Chesapeake Bay.

Salinity Range: Tidal fresh (limnetic)

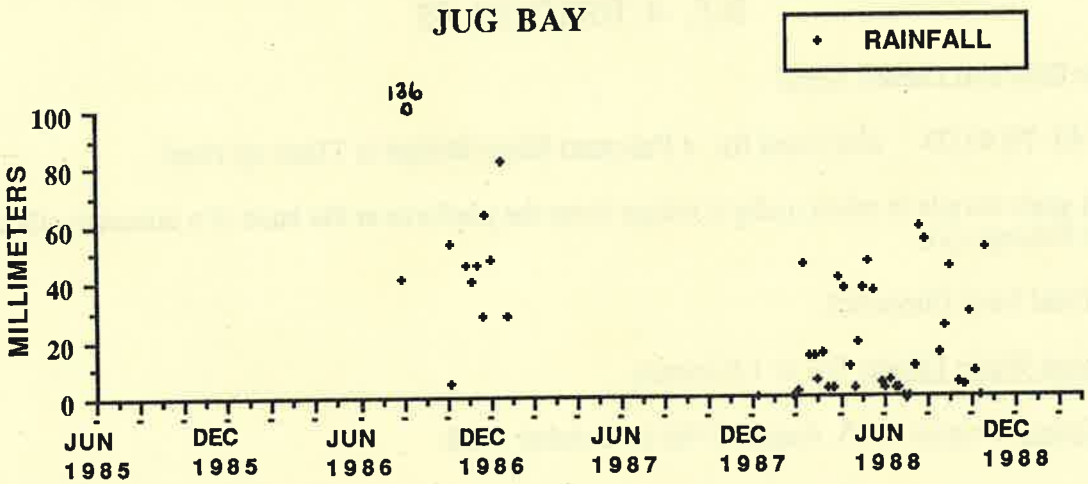
Minimum/Maximum Water Depth: 0.3 to 2.0 meters

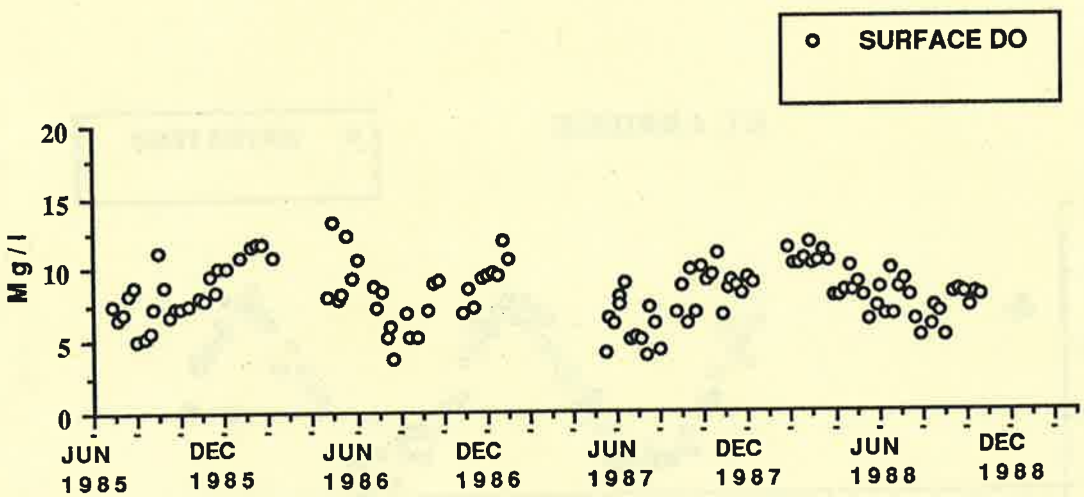
Data Collection Dates: August 1985 to October 1988.

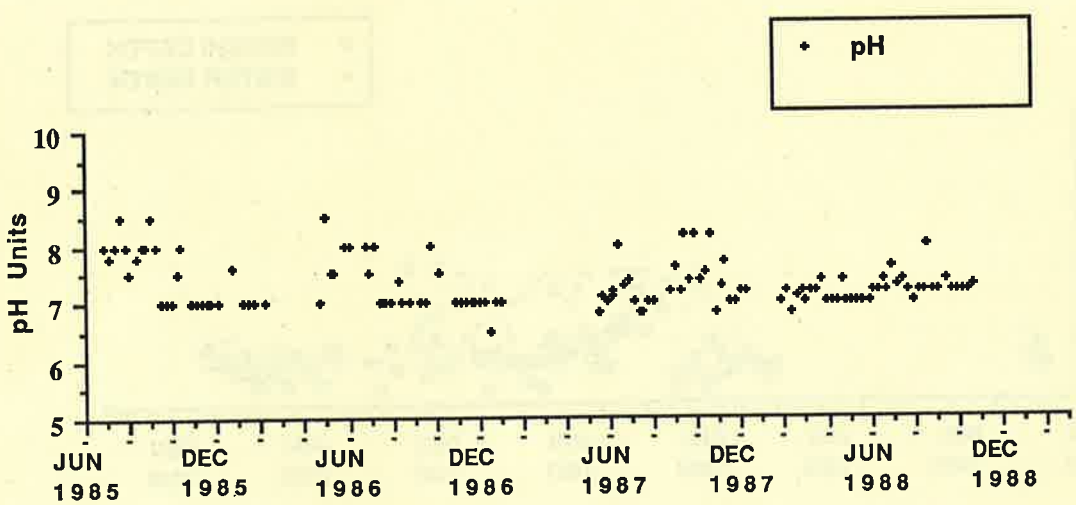




JUG BAY


RAINFALL
MILLIMETERS
100
80
60
40
20
0
136
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


SURFACE DO
Mg/l
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988


pH
pH Units
10
9
8
7
6
5
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

RT. 4 BRIDGE #5

Monitors: Ginger Ellis and Darrell Knoll

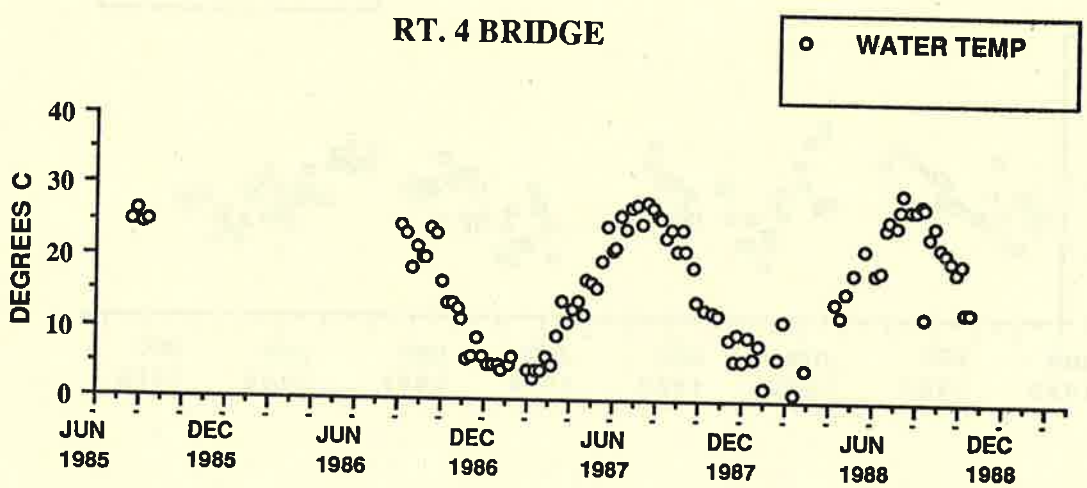
Location: 38 47 45 76 44 00 Maryland Rt. 4 Patuxent River Bridge is 71km up river.

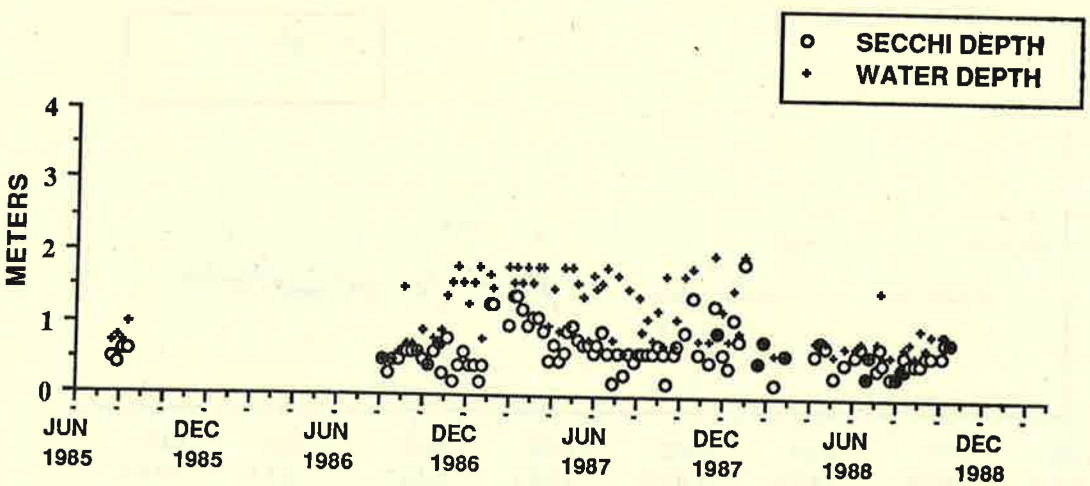
Sampling Site: A grab sample is taken under a bridge from the platform at the base of a concrete pillar. The site is a popular sport fishing spot.

Salinity Range: Tidal fresh (limnetic)

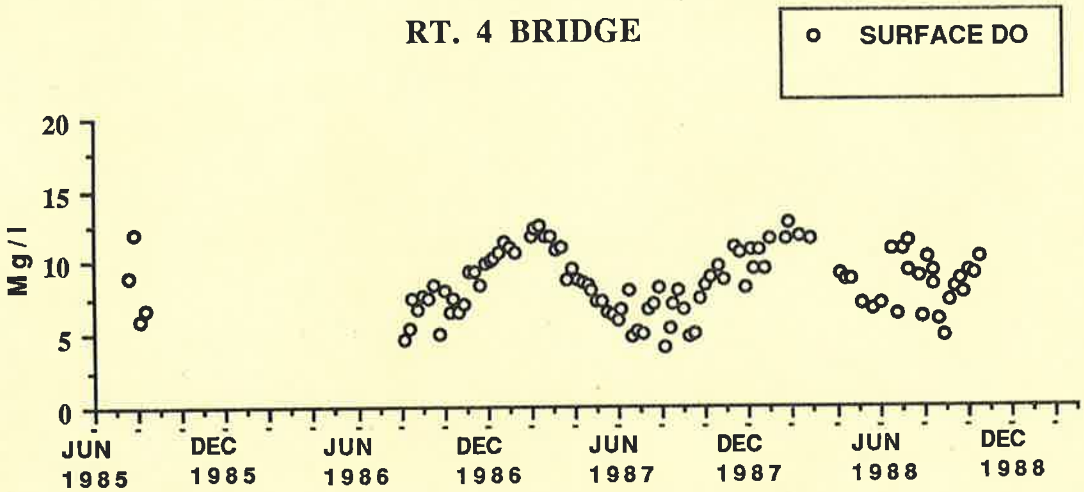
Minimum/Maximum Water Depth: 0.3 to 1.8 meters

Data Collection Dates: August 1985, August 1986 to October 1988.

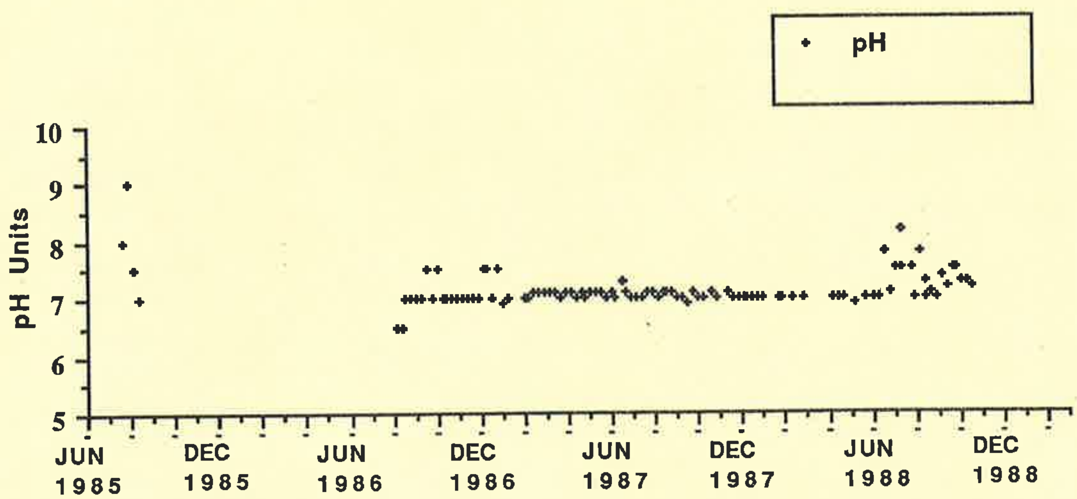




RT. 4 BRIDGE

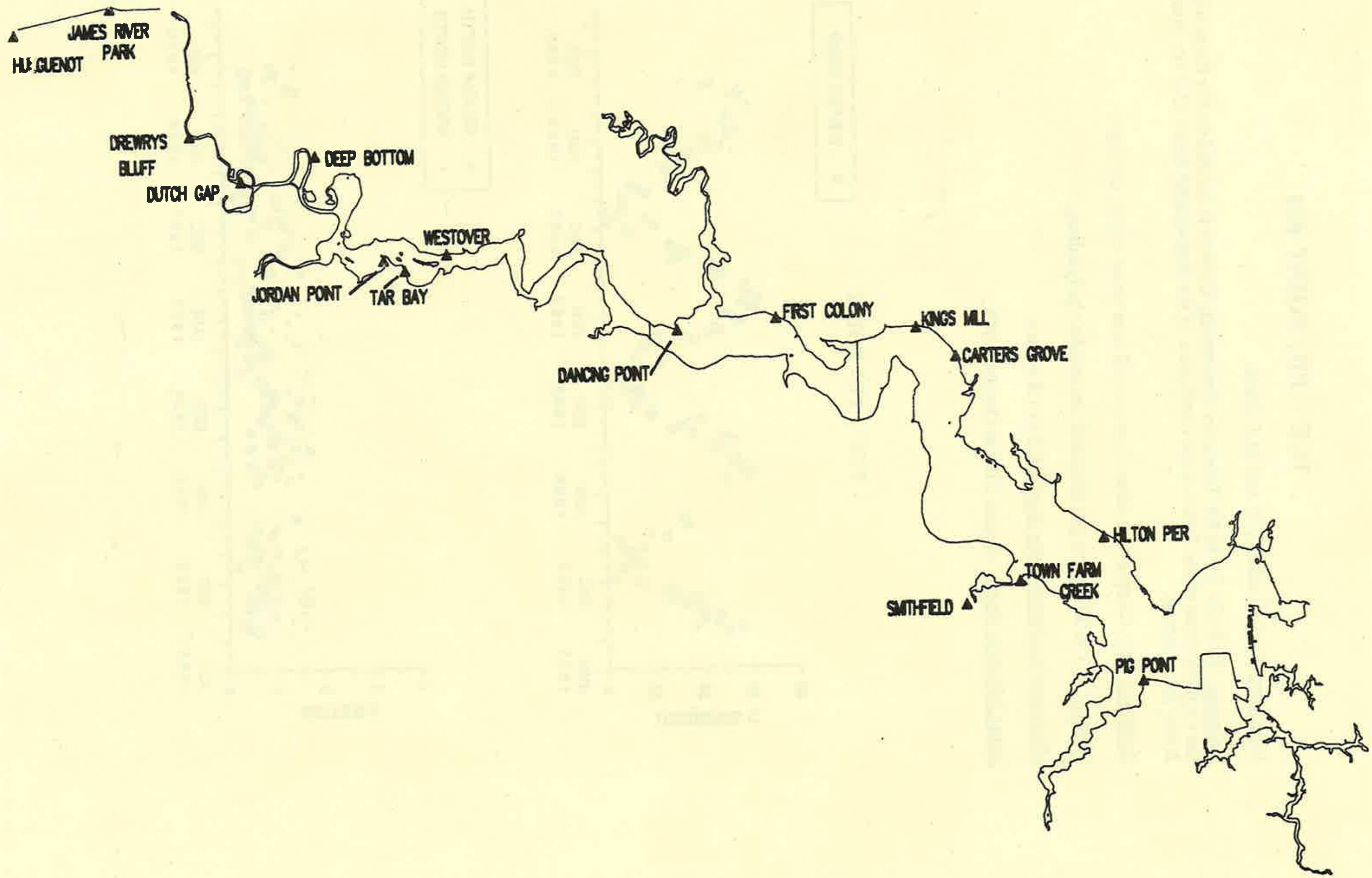


SURFACE DO
Mg/l
20
15
10
5
0
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988



pH
pH Units
10
9
8
7
6
5
JUN 1985
DEC 1985
JUN 1986
DEC 1986
JUN 1987
DEC 1987
JUN 1988
DEC 1988

JAMES RIVER CITIZEN MONITORING SITES



TCC - PIG POINT #34

Monitors: Kerby Latham, Jr. and M.J. Stairs.

Location: 36 54 25 76 26 53 Tidewater Community College is located on Pig Point which is on the southern shore of the James at the confluence of the Nansemond River 13.8 km from the James River mouth.

Sampling Site: Samples are taken from a small boat about 200 ft. offshore.

Salinity: 4.7 to 29.3 parts per thousand (mesohaline/polyhaline).

Minimum/maximum water depth: 0.2 to 1.8 meters.

Data Collection Dates: August 1985 to October 1988.