FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT

UNITS 3 & 4

FLORIDA POWER & LIGHT COMPANY

ENVIRONMENTAL MONITORING REPORT NO. 10

JULY 1, 1977

THROUGH

DECEMBER 31, 1977

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I. INTRODUCTION

This report is submitted in accordance with Turkey Point Plant Environmental Technical Specifications, Appendix B, Section 5.4.9. This report covers the period July 1, 1977 through December 31, 1977.

II. RECORDS OF MONITORING REQUIREMENT SURVEYS AND SAMPLES

The results of the chemical analyses conducted at the outlet of Lake Warren are shown on pages 2 and 3 of this report. Page 4 contains the amounts of chemicals added from Units 3 and 4 to the circulating water system. A summary of thermal data is given in Section III.B of this report.

TURKEY POINT PLANT UNITS 3 & 4
pH, DISSOLVED OXYGEN AND SALINITY
LAKE WARREN DISCHARGE

YEAR 1977

MO.	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
DAY	pH	D.O.	Sal.	pH	D.O.	Sal.	pH	D.O.	Sal.	pH	D.O.	Sal.	pH	D.O.	Sal.	pH	D.O.	Sal.
1	8.00	3.6	40.0	8.00	3.3	38.5	8.00	4.6	39.0	8.00	3.8	36.5	8.0	4.6	40	8.0	4.6	36
2	8.00	2.8	40.5	8.00	3.2	39.0	8.00	4.6	38.5	8.00	3.8	38	8.0	4.3	40	8.0	4.5	36
3	8.00	3.2	40.5	8.05	3.5	40.0	8.00	4.5	36.5	8.00	4.0	38	8.0	4.1	40	8.0	4.6	35
4	8.00	3.4	41.0	8.05	3.3	40.0	8.00	4.5	36.0	8.00	4.0	38	8.0	4.0	40	8.0	4.2	35.0
5	8.00	3.0	41.0	8.05	3.0	40.0	8.00	4.5	34.0	8.00	4.2	39	8.0	3.9	40	8.0	4.3	36.5
6	8.05	3.0	40.5	8.00	3.2	40.0	8.00	4.1	35.0	8.00	4.5	39	8.0	4.1	40	8.0	4.4	36.5
7	8.00	2.8	40.5	8.00	3.1	40.0	8.00	3.8	36.5	8.00	4.6	39	8.0	4.1	41	8.0	4.6	36.5
8	8.00	2.8	41.0	8.00	3.2	39.5	8.00	3.9	36.5	8.00	4.2	39.5	8.0	4.1	41	7.95	5.5	37
9	8.00	2.8	41.0	8.00	3.6	39.0	8.00	4.1	35.5	8.00	4.2	39.5	8.0	4.1	40	7.98	5.1	38.
10	8.00	2.8	40.5	8.00	4.4	39.5	8.00	3.9	35.5	8.00	4.0	39.5	8.0	4.1	41	7.98	5.1	40
11	8.00	2.9	40.0	8.00	4.1	40.5	8.00	3.8	36.0	8.00	3.9	40.0	8.0	4.3	40	7.98	4.9	37.5
12	8.00	2.8	40.0	8.00	3.8	40.0	8.00	3.4	37.0	8.00	4.0	40.0	8.0	4.5	40	8.02	4.8	36.5
13	8.05	3.0	40.0	8.00	3.8	39.5	8.00	3.8	37.0	8.00	3.9	40.0	8.0	4.9	40	8.05	4.9	38
14	8.05	3.1	38.0	8.00	3.6	39.0	8.00	3.95	37.0	8.00	4.6	40.0	8.0	4.7	40	8.05	4.8	38
15	8.05	3.0	38.0	8.00	4.4	40.0	8.00	4.6	37.5	8.05	4.7	40.0	8.0	4.5	40	8.00	4.7	39
16	8.00	3.1	37.5	8.00	4.4	39.0	8.00	4.3	36.0	8.00	4.6	41	8.0	4.5	40	8.00	4.5	39
17	8.00	3.2	38.0	8.00	4.2	39.0	8.00	4.4	36.5	8.00	4.6	41	8.0	4.4	40.5	8.00	4.5	37.5
18	8.01	3.1	37.0	8.00	4.2	39.0	8.00	4.2	36.5	8.00	4.8	41	8.0	4.3	40	8.05	4.9	37.5
19	8.00	3.0	36.5	8.00	4.2	39.0	8.00	4.1	37.0	8.00	4.7	41	8.0	4.2	40	8.05	5.1	38.0
20	8.01	3.2	36.0	8.00	4.0	39.5	8.00	4.4	37.0	8.00	4.4	41	8.0	4.4	39.5	8.00	5.2	38.0
21	8.00	3.0	36.5	8.00	4.0	39.5	8.05	4.4	37.0	8.00	4.5	41	8.0	4.5	40.5	8.00	5.3	37.0
22	8.00	3.0	36.0	8.00	3.8	40.0	8.00	4.5	37.5	8.00	4.8	40	8.0	4.3	40.5	8.05	5.5	38.0
23	8.01	3.1	36.0	8.00	3.7	39.5	8.00	4.3	37.0	8.00	4.7	37.5	8.0	4.4	40.5	8.05	5.5	37.0
24	8.05	2.7	38.0	8.00	4.1	39.5	8.00	4.2	37.5	8.00	4.2	38.0	8.0	5.0	39.0	8.00	5.4	37.0
25	8.01	2.6	38.0	8.00	4.0	39.5	8.05	4.4	38.0	8.00	4.4	38.0	8.0	5.1	34.5	8.00	5.6	37.0
26	8.05	2.5	37.5	8.00	4.2	39.5	8.00	4.0	38.0	8.00	4.0	39.5	8.0	5.1	35.0	8.00	5.3	36.5
27	8.05	2.6	38.0	8.00	4.1	39.5	8.00	4.1	37.5	8.00	3.8	39	8.0	5.2	36.0	8.05	5.6	36.5
28	8.00	2.5	38.0	8.00	4.2	40.0	8.00	4.0	38.0	8.00	4.1	39	8.0	5.0	36.0	8.00	6.3	36.5
29	8.00	2.7	38.0	8.00	4.3	40.0	8.00	3.9	37.5	8.00	3.8	39.5	8.0	4.8	36.0	8.10	6.4	36.0
30	8.00	3.0	38.0	8.00	4.3	39.5	8.00	3.9	38.0	8.00	3.8	40	8.0	4.7	36.0	8.10	6.4	37.5
31	8.00	3.3	38.5	8.00	4.1	40.0	-	-	-	8.00	4.1	40	-	-	-	8.00	6.5	37.0

FIG. 1

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANTS UNITS 3 & 4
LAKE WARREN DISCHARGE

NOTE: All Results in mg/L YEAR 1977

DATE	T. RES. CHLOR.	AMMONIA	B.O.D.	C.O.D.	Cu	Zn	Co	As	Hg	OIL	Cr	Pb	Cd
7/1/77		< 0.2	< 1	364	< 0.02	0.02	< 0.02	<0.001	<0.0002	<1	< 0.02	< 0.05	<0.02
7/8/77		< 0.2	< 1	333					<0.0002	<1			
7/15/77		< 0.2	< 1	360					<0.0002	<1			
7/22/77		< 0.2	< 1	414					<0.0002	<1			
8/5/77		< 0.2	< 1	314	< 0.02	0.03	< 0.02	<0.001	<0.0002	<1	< 0.02	< 0.05	<0.02
8/12/77		< 0.2	< 1	326					<0.0002	<1			
8/19/77		< 0.2	< 1	437					<0.0002	<1			
8/26/77		< 0.2	< 1	384					<0.0002	2			
9/2/77		< 0.2	< 1	300	< 0.02	0.05	< 0.02	<0.001	<0.0002	<1	<0.02	< 0.05	<0.02
9/9/77		< 0.2	< 1	411					<0.0002	<1			
9/16/77		< 0.2	< 1	267					<0.0002	2			
9/23/77		< 0.2	< 1	352					<0.0002	1			
9/30/77		< 0.2	< 1	311					<0.0002	1			
10/7/77		< 0.2	< 1	256	< 0.02	0.04	< 0.02	<0.001	<0.0002	2	<0.02	<0.05	<0.02
10/14/77		< 0.2	< 1	321					<0.0002	2			
10/21/77		< 0.2	< 1	334					<0.0002	1			
10/28/77		< 0.2	< 1	276					<0.0002	2			
11/4/77		< 0.2	< 1	308	< 0.02	0.03	< 0.02	<0.001	<0.0002	1	<0.02	<0.05	<0.02
11/11/77		< 0.2	< 1	200					<0.0002	1			
1/18/77		< 0.2	< 1	234					<0.0002	<1			
1/25/77		< 0.2	< 1	299					<0.0002	2			
2/2/77		< 0.2	< 1	219	< 0.02	0.04	< 0.02	<0.001	<0.0002	1	<0.02	<0.05	<0.02
2/9/77		< 0.2	< 1	307					<0.0002	2			
12/16/77		< 0.2	< 1	234					<0.0002	1			
12/23/77		< 0.2	< 1	259					<0.0002	<1			
12/30/77		< 0.2	< 1	211					<0.0002	2			

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4
CHEMICAL DISCHARGES TO LAKE WARREN

NOTE: ALL RESULTS IN POUNDS

YEAR 1977

CHEMICAL \ MONTH	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
BENTONITE CLAY	2,040	1,429	1,843	1,650	1,471	1,339
POTASSIUM DICHROMATE	29	10	4	5.5	23	11
POTASSIUM CHROMATE	0	0	20	0	0	0
SODIUM HEXAMETA-PHOSPHATE	13	21	0	17	5	8
BORIC ACID	2,158	1,723	1,849	858	1,979	1,265
HYDRATED LIME	30,589	28,883	28,981	25,141	23,008	21,601
POLYELECTROLYTE	50	52	50	55	54	40
CONCENTRATED (50%) SODIUM HYDROXIDE	85,824	129,029	102,029	79,610	61,963	80,886
CONCENTRATED SULFURIC ACID	88,936	106,068	102,562	79,597	73,411	86,165
HTH - CALCIUM HYPOCHLORITE	0	0	0	0	0	0
LIQUID CHLORINE	0	0	0	0	0	0
SALT	0	0	0	0	0	0

* COAGULANT AID

III. ANALYSIS OF ENVIRONMENTAL DATA

A. Chemical

Analysis of pH monitoring results shows, once again, the same trends that have been observed for the last four years and reported in previous semiannual reports. pH ranged from a low of 7.95 to a high of 8.10. Dissolved Oxygen ranged from a low of 2.5 mg/L during July to a high of 6.5 mg/L in December, again, as expected. Salinity concentrations ranged from a low of 34.0 ppt during the rainy season, to a high of 41.0 ppt during the dry season.

No chlorination of the Circulating Water System was performed during this six-month period and therefore, no residual chlorine tests were performed. Once again, ammonia and Biological Oxygen Demand (BOD) levels remained at or below the respective detection limits. Chemical Oxygen Demand (COD) levels averaged 309 mg/L for the period, with a min/max of 200/439.

No appreciable change can be seen in the amounts of chemicals discharged to the cooling system. After processing in the plant's waste treatment facilities and mixing with the circulating water system waters, these chemicals are undetectable.

Heavy metals concentrations remained at their previous levels.

III.B THERMAL

Thermal data collected have been summarized into temperature time duration curves by month, for both inlet and outlet. These are shown on pages 6 and through 11.

TABLE III.B.1

TIME DURATION CURBES - TEMPERATURE

JULY 1977

UNITS 3 & 4 INTAKE

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
12	93	1.6
78	92	12.2
148	91	32.3
134	90	50.5
139	89	69.3
85	88	80.9
52	87	87.9
39	86	93.2
18	85	95.7
16	84	97.8
12	83	99.5
4	82	100.0

LAKE WARREN OUTLET

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
8	110	1.1
13	109	2.8
95	108	15.7
87	107	27.5
128	106	44.9
47	105	51.3
65	104	60.1
33	103	64.6
56	102	72.2
36	101	77.1
77	100	87.5
19	99	90.1
6	98	90.9
12	97	92.5
13	96	94.3
26	95	97.8
9	94	99.1
7	93	100.0

TABLE III.B.2

TIME DURATION CURVES - TEMPERATURE

AUGUST 1977

UNITS 3 & 4 INTAKE

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
8	94	1.1
19	93	3.6
49	92	10.2
62	91	18.5
83	90	29.7
134	89	47.7
118	88	63.6
146	87	83.2
79	86	93.8
23	85	96.9
9	84	98.1
14	83	100.0

LAKE WARREN OUTLET

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
5	111	0.7
3	110	1.1
17	109	3.4
62	108	11.7
31	107	15.9
73	106	25.7
38	105	30.8
73	104	40.6
53	103	47.7
136	102	66.0
53	101	73.1
144	100	92.5
36	99	97.3
16	98	99.5
2	97	99.7
0	96	99.7
1	95	99.9
1	94	100.0

TABLE III.B.3

TIME DURATION CURVES - TEMPERATURE

SEPTEMBER 1977

UNITS 3 & 4 INTAKE

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
10	95	1.4
40	94	6.9
56	93	14.7
72	92	24.7
73	91	34.9
168	90	58.2
92	89	71.0
49	88	77.8
60	87	86.1
22	86	89.2
10	85	90.6
17	84	92.9
21	83	95.8
11	82	97.4
19	81	100.0

LAKE WARREN OUTLET

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
4	110	0.6
36	109	5.6
67	108	14.9
55	107	22.5
95	106	35.7
53	105	43.1
94	104	56.1
69	103	65.7
86	102	77.6
40	101	83.2
30	100	87.4
12	99	89.0
10	98	90.4
25	97	93.9
13	96	95.7
13	95	97.5
9	94	98.7
6	93	99.6
2	92	99.9
1	91	100.0

TABLE III.B.4

TIME DURATION CURVES - TEMPERATURE

OCTOBER 1977

UNITS 3 & 4 INTAKE

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
20	92	2.7
14	91	4.6
44	90	10.5
58	89	18.3
43	88	24.1
44	87	30.0
34	86	34.5
48	85	41.0
33	84	45.4
77	83	55.8
86	82	67.3
80	81	78.1
55	80	85.5
20	79	88.2
51	78	95.0
33	77	99.5
4	76	100.0

LAKE WARREN OUTLET

NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
3	108	0.4
11	107	1.9
39	106	7.1
30	105	11.2
48	104	17.6
35	103	22.3
43	102	28.1
25	101	31.5
41	100	37.0
88	99	48.8
31	98	53.0
75	97	63.0
57	96	70.7
62	95	79.0
25	94	82.4
61	93	90.6
23	92	93.7
39	91	98.9
8	90	100.0

TABLE III.B.5

TIME DURATION CURVES - TEMPERATURE

NOVEMBER 1977

UNITS 3 & 4 INTAKE			LAKE WARREN OUTLET		
NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %	NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
17	84	2.4	2	100	0.3
97	83	15.8	17	99	2.6
120	82	32.5	40	98	8.2
67	81	41.8	90	97	20.7
69	80	51.4	52	96	27.9
59	79	59.6	60	95	36.2
35	78	64.4	46	94	42.6
44	77	70.6	68	93	52.1
44	76	76.7	43	92	58.1
23	75	79.9	49	91	64.9
28	74	83.7	65	90	73.9
20	73	86.5	26	89	77.5
21	72	89.4	36	88	82.5
18	71	91.9	21	87	85.4
19	70	94.6	25	86	88.9
4	69	95.1	8	85	90.0
4	68	95.7	19	84	92.6
17	67	98.1	6	83	93.5
14	66	100.0	27	82	97.2
			20	81	100.0

TABLE III.B.6

TIME DURATION CURVES - TEMPERATURE

DECEMBER 1977

UNITS 3 & 4 INTAKE			LAKE WARREN OUTLET		
NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %	NUMBER OF HOURS	TEMPERATURE	ACCUMULATED TIME - %
8	84	1.2	2	97	0.3
16	83	3.4	31	96	4.4
11	82	4.8	57	95	12.1
41	81	10.4	29	94	16.0
74	80	20.3	41	93	21.5
62	79	28.7	13	92	23.3
19	78	31.2	50	91	30.0
20	77	33.9	64	90	38.6
37	76	38.9	13	89	40.4
30	75	42.9	57	88	48.0
40	74	48.3	31	87	52.2
41	73	53.8	56	86	59.8
53	72	61.0	16	85	61.9
49	71	67.6	45	84	68.0
43	70	73.4	15	83	70.0
27	69	77.0	48	82	76.4
21	68	79.8	18	81	78.9
17	67	82.1	14	80	80.8
35	66	86.8	28	79	84.5
16	65	89.0	8	78	85.6
12	64	90.6	22	77	88.6
13	63	92.3	8	76	89.6
14	62	94.2	13	75	91.4
12	61	95.8	8	74	92.5
15	60	97.8	21	73	95.3
7	59	98.8	28	72	99.1
7	58	99.7	2	71	99.3
2	57	100.0	5	70	100.0

III.B THERMAL (Continued)

No major differences were observed between this six-month period and the same periods in 1974, 1975 and 1976. Listed below are the maximum inlet and outlet temperatures in degrees Farenheit.

	Max. Inlet Temp.				Max. Outlet Temp.			
	1974	1975	1976	1977	1974	1975	1976	1977
July	94	94	94	93	110	109	111	110
August	95	93	94	94	112	109	110	111
September	94	93	92	95	110	108	108	110
October	92	89	89	92	109	104	104	108
November	83	82	83	84	98	97	96	100
December	82	80	83	84	97	97	97	97

III.C FISH & SHELLFISH

III.D BENTHOS

III.E TERRESTRIAL ENVIRONMENT

These three sections are fully covered in the report entitled "Ecological Monitoring of Selected Parameters at the Turkey Point Plant" for 1977. This report was prepared for Florida Power & Light Company by its consultant, Applied Biology, Inc., and the report is appended to this Environmental Monitoring Report.

III.F. ASSESSMENT OF RECOVERY IN THE TURKEY POINT PLANT DISCHARGE AREA

1. GRAND CANAL DISCHARGE AREA

Purpose

This report assesses the revegetation of grasses and benthic macrophytes in areas affected by the Turkey Point Plant discharge prior to the conversion of the cooling system to a closed mode. The recovery studies prior to July 1977 are recorded in previous semi-annual environmental monitoring reports.

Methods and Procedures

Method 1

To measure the overall revegetation quantitatively, aerial photographs were taken from 2000 feet. Using reference points in the photographs to determine the scale of the photo, sizes of areas were measured by tracing specific areas onto a grid. The tracing is included in this report.

Method 2

Qualitative and quantitative measurements of the algae were made by counting and identifying the vegetation in six each one meter square areas permanently located on the bottom.

Method 3

To identify and quantify the less abundant species not represented in the square meter areas, a survey was made by transect across the previously affected areas. Species identifications, quantities present, and general conditions were noted.

AERIAL SURVEY

It can be seen from the aerial photograph that the entire discharge area has revegetated. There are only a few patches of Syringodium in the immediate discharge area. This grass is still quite prevalent approximately 800 feet from the mouth of the old discharge (Figure 1).

The tracing of the photograph (Figure 1) shows the five major vegetative communities.

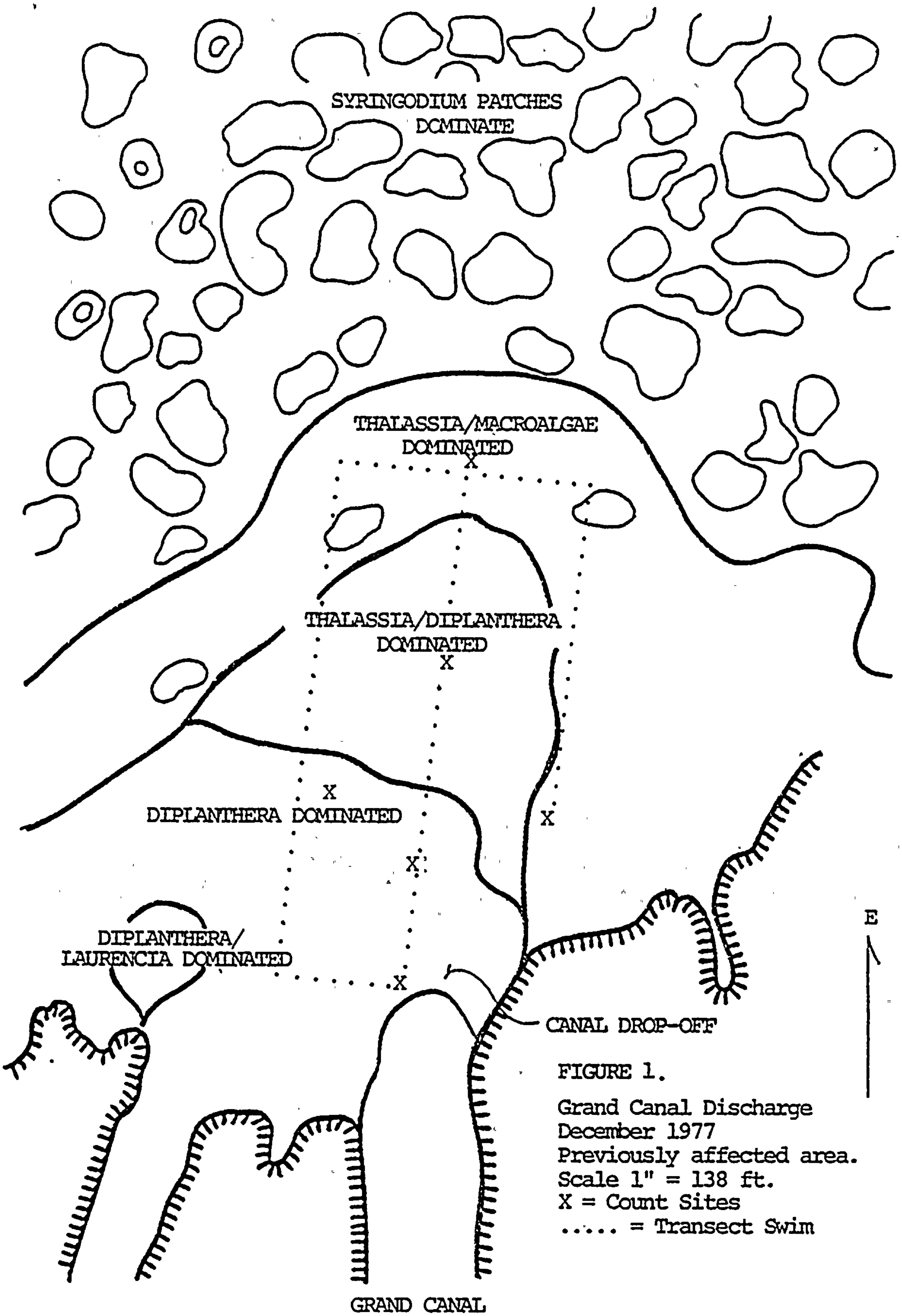


FIGURE 1.

Grand Canal Discharge
December 1977
Previously affected area.
Scale 1" = 138 ft.
X = Count Sites
..... = Transect Swim

SQUARE METER SURVEY

The following table is data from square meter areas permanently staked out on the bottom. The counts and identifications were made in situ. The sample points X-1, X-2, X-3, and X-4 are located approximately 100, 200, 400, and 600 feet east of the mouth of the canal respectively. Station X-2N is approximately 200 feet NNE of X-2. Station X-2S is approximately 200 feet SSE of X-2. The data reported as greater than (>) is based on extrapolation of counts of plants in 1/16 of a square meter. The counts on the grasses are counts of the fasicles (sheaths of leaves).

TABLE 1
Grand Canal discharge revegetation
for period July - December 1977

	GENUS/SPECIES	STATIONS					
		X-1[1]	X-2	X-3	X-4	X-2N	X-2S
GRASSES:	Diplanthera wrightii		>500	>1800	>1400	>1400	>400
	Thalassia testudinum		33	195	80	62	56
CHLOROPHYTA:	Acetabularia crenulata		0	*	*	*	*
	Avrainvillea nigricans		0	0	36	0	32
	Batophora oerstedii		0	0	0	0	0
	Caulerpa sp.		**	0	0	0	**
	Halimeda sp.		*	0	**	**	**
	Penicillus sp.		48	154	32	96	208
	Anadyomene stellata		0	0	*	0	0
PHAEOPHYTA:	Laurencia poitei		0	0	0	0	0
	Dictyota sp.		0	0	0	*	0

Sampling Date: January 1978

* Present
** Common
1 Poor visability - could not be conducted

TRANSECTS

Between stations X-1 and X-2 there were high concentrations of Diplanthera which decreased greatly in length and slightly in number toward X-2. There were patches of very long Thalassia - often two or three times the length found in most other areas. Large areas were covered by patches of Caulerpa, growing over the other grasses. All of the plants in this area were encased by a layer of silt. The detrital layer was very deep and composed mostly of dead Diplanthera and Thalassia fascicles.

From X-2 to X-3 the vegetation became more diverse with much more Thalassia and Penicillus present. The Thalassia was shorter in this area. The Penicillus population was composed mostly of mature or dying plants, however many new shoots were in evidence. By X-3 Thalassia, Diplanthera, and Penicillus shared the dominance, although there were many patches composed almost exclusively of Thalassia.

The transect between X-3 and X-4 continued to be Thalassia dominated while there were patches comprised solely of Penicillus, Avrainvillea, and Halimeda. This entire area had patches of an unidentified green algae covering it and floating through it. About 60 feet from X-4 there was a large patch of short Syringodium. Diplanthera was present here although it was very short and not as easily noticed among the more dominant Thalassia. Several completely submerged mangrove

shoots were present in this area.

Moving east of X-4 there continued to be diverse stands of the calcareous green alga - Halimeda, Avrainvillea, and Penicillus in particular, for about one hundred feet at which point it suddenly changed almost completely to Syringodium, with interspersed Thalassia.

North of X-1 Diplanthera was the dominant species. As at station X-1, it was long and encased by silt. There were patches of long Thalassia and also some patchy Penicillus. This was the only area where a sizable amount of Laurencia was found as opposed to the large Laurencia covered areas observed in the last two semi-annual reports.

Moving east to X-2N the Diplanthera grew shorter and more and more Thalassia and Penicillus were found until at X-2N Thalassia and Diplanthera shared the dominance. In this area there was not as much silt as there was closer to shore.

East of X-2N Thalassia became the dominant grass. It was short and often almost covered by a large amount of dead Diplanthera blades. A few patches were almost barren of Thalassia and these were dominated by short Diplanthera and Penicillus. North of station X-3 there was the first observed patch of short Syringodium. In general, there was little silt in this area.

North of X-4 Thalassia and Syringodium shared dominance.

South of X-4 and west to the level of X-3 Thalassia was the dominant species with quite a bit of Penicillus present. Moving west again, the amount of silt present increases.

Further west this transect took on the low, shrubby , "park-like" appearance which was described in previous semi-annual reports. Here Penicillus became more dominant and as tall as the surrounding Diplanthera and Thalassia. There was a diverse mixture of Penicillus, Avrainvillea, and Halimeda. Caulerpa was present closer to shore.

Discussions and Conclusions

The entire area previously affected remained revegetated.

The Syringodium continued to move east away from the discharge and is being replaced by Thalassia as had been observed in previous semi-annual reports. This trend is expected to continue.

Thalassia continued to encroach upon previously Diplanthera dominated areas, moving closer toward the canal drop-off, while maintaining a constant concentration in those areas which it had previously revegetated. Eventually Thalassia will dominate all but the extreme inshore areas.

It is interesting to note that the Laurencia, which was reported covering large areas in the last two semi-annual reports,

was almost absent from the study area.

The red mangroves (Rhizophora mangle) which were reported probably will not become an important factor in this area as they were submerged by at least 18" of water at low tide and will probably run out of stored energy sources and die before they can break the surface.

Penicillus, Avrainvillea, and Halimeda remained the dominant macroalgae with the Penicillus showing particularly large increases at all stations.

III.G GRASSES AND MACROPHYTON WITHIN THE TURKEY POINT COOLING CANAL SYSTEM

Methods

Most observations as well as identification and quantification were made while carrying out other monitoring requirements in the cooling canals.

Discussion and Conclusions

Ruppia maritima (Widgeon grass) continues to be a grass of primary importance in the cooling system. It is still confined to the southwest canals but is spreading north and east. This grass, considered a submergant form, obtains lengths of 10 - 15 feet. The length of the strands allows it to reach the surface and form large mats, thereby restricting water flow. Several biological and chemical methods of control are being examined to determine their potential usefulness in controlling this grass.

Other marine grasses, Diplanthera wrightii, Thalassia testudinum, and Syringodium filiforms are also found in the cooling canal system. The northernmost sections of the return canals continue to represent the most dense growth of these grasses in the cooling canals. Diplanthera is particularly well represented. Diplanthera runners are normally attached to the substrate by hold fasts, and because of the finite growth habit of its fascicles, would be no problem. However, in dense stands of this species the long runners are

over lapping each other in such a way that the hold fast doesn't reach the substrate, thus developing into long floating strands which have the potential of obstructing water flow.

The amount of Syringodium present has increased as predicted in Semi-Annual Report Number 6.

There is substantial growth of various red and brown alga found along the rocky shoreline of most of the canals, particularly the deeper ones. The red algae Dasya reaches lengths of 6 feet during the winter. It grows predominantly along the canal banks and on rocks in the more shallow canals.

There is also substantial green algae growth on solid substrates throughout the system. Halimeda is found on small rocks in the southern end of the western canals. Penicillus is common in the northeastern canals. Caulerpa paspaloides, mentioned as three circular patches in Report Number 6 has now spread to the point that it practically covers large sections of the bottoms in the northeast canals. Batophora oerstedii and Acetabularia crenulata are epiphytes on any stable substrate in shallow water.

III.H PHYSICAL AND NUTRIENT DATA

1. PHYSICAL

Purpose

The purpose of this report is to provide basic physical data which will aid in the interpretation of the reports that follow. This report deals with data collected on a monthly basis during plankton sampling at various stations in southern Biscayne Bay, Card Sound, and the Turkey Point Cooling Canal System. (Fig.1).

Methods and Procedures

a. Temperature was measured by a Y.S.I. Thermistemp Telethermometer. Accuracy is $\pm$ 0.5^{o} C.

b. Salinities were determined using an American Optical Refractometer. Accuracy is $\pm$ 0.10 PPT

c. Dissolved oxygen was measured with a Y.S.I. probe type oxygen meter. Accuracy is $\pm$ 0.20 PPM

All instruments were calibrated before each sampling date. All measurements were made in the top meter of the water column.

Discussions and Conclusion

a. Temperature (^{o}C)

In 1977, the maximum temperature that was measured in the cooling canal system was 40.0^{o}C. and occurred in Sept. In Biscayne Bay and Card Sound the maximum temperature recorded was 32.1^{o} C and occurred in August. Those maximum temperatures were lower than those in 1976.

A minimum temperature in the canal system of 19.2°C was recorded during January. The minimum temperature in the Bay, 18.7°C was recorded in February.

b. Salinity (PPT)

The maximum salinity in the cooling canals was 41.5 PPT and in the Bay was 38.0 PPT. Fluctuation of salinity levels continues from a peak in the dry season to a low level in the rainy season. There was an average increase of 0.7 PPT salinity in the Turkey Point Cooling Canals from 1976 to 1977. The lowest salinity in the system, reported at the westernmost canal, was due to the operation of the interceptor ditch pump for salt water intrusion control.

Salinities in the cooling canal system, as in the Bay, were within the tolerance limits of the marine organisms found in each area.

c. Dissolved Oxygen (PPM)

The dissolved oxygen levels, in the Bay, for 1977 (3.3 - 8.3 PPM), were consistently higher than those in the cooling canals (3.0 - 7.4 PPM).

The elevated temperature in the canals along with a resultant lower saturation value, and high organic levels, may account for the lower levels of dissolved oxygen.

The lowest level of dissolved oxygen in the cooling canals was 3.0 PPM, 1.10 PPM lower than that recorded in 1976. This

reading was taken at the station nearest the discharge. This is sufficient for organisms living in the canals.

Physical data by month is plotted in Figures 1-6.

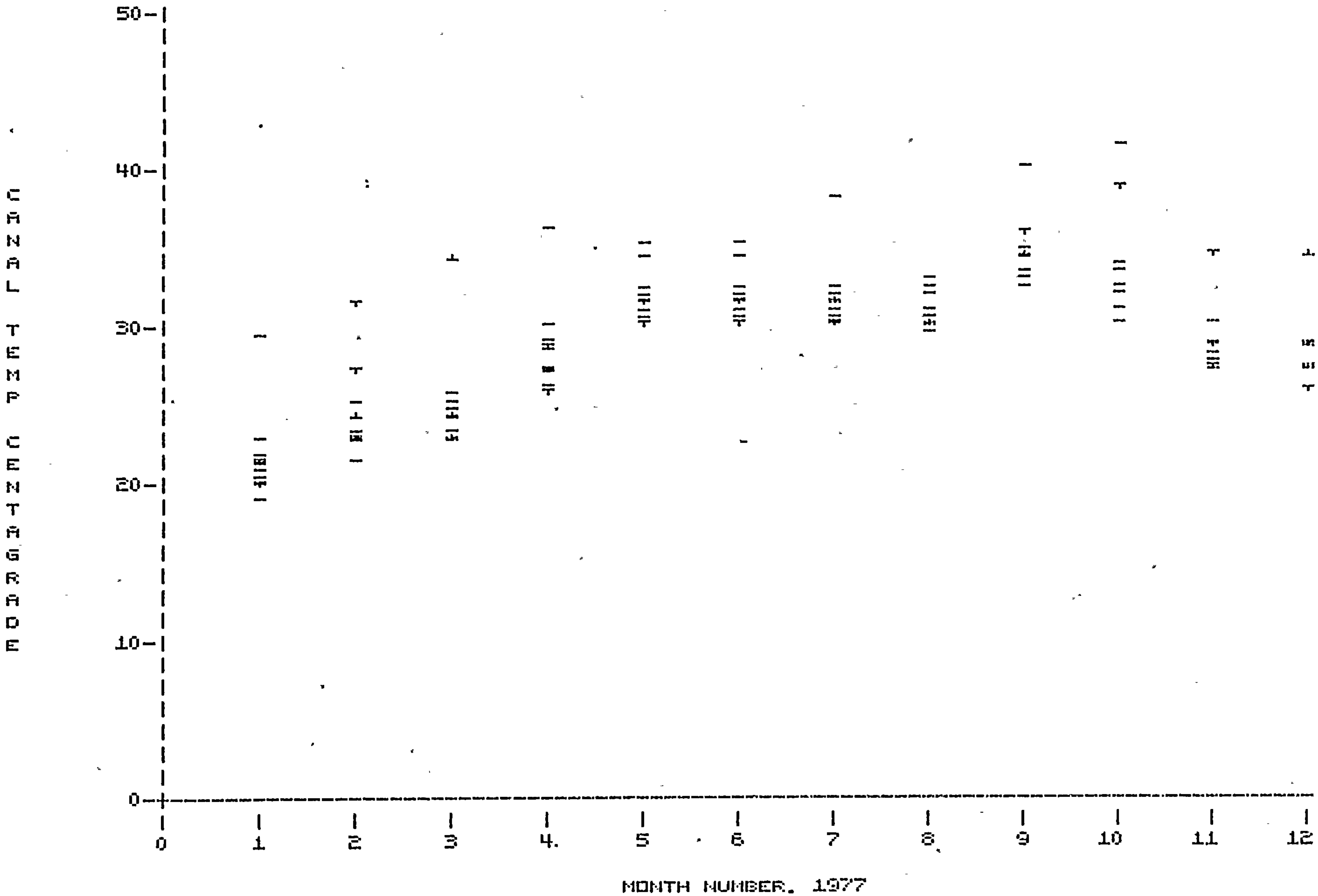


Figure 1. Temperature in the Canal System in degrees centagrade

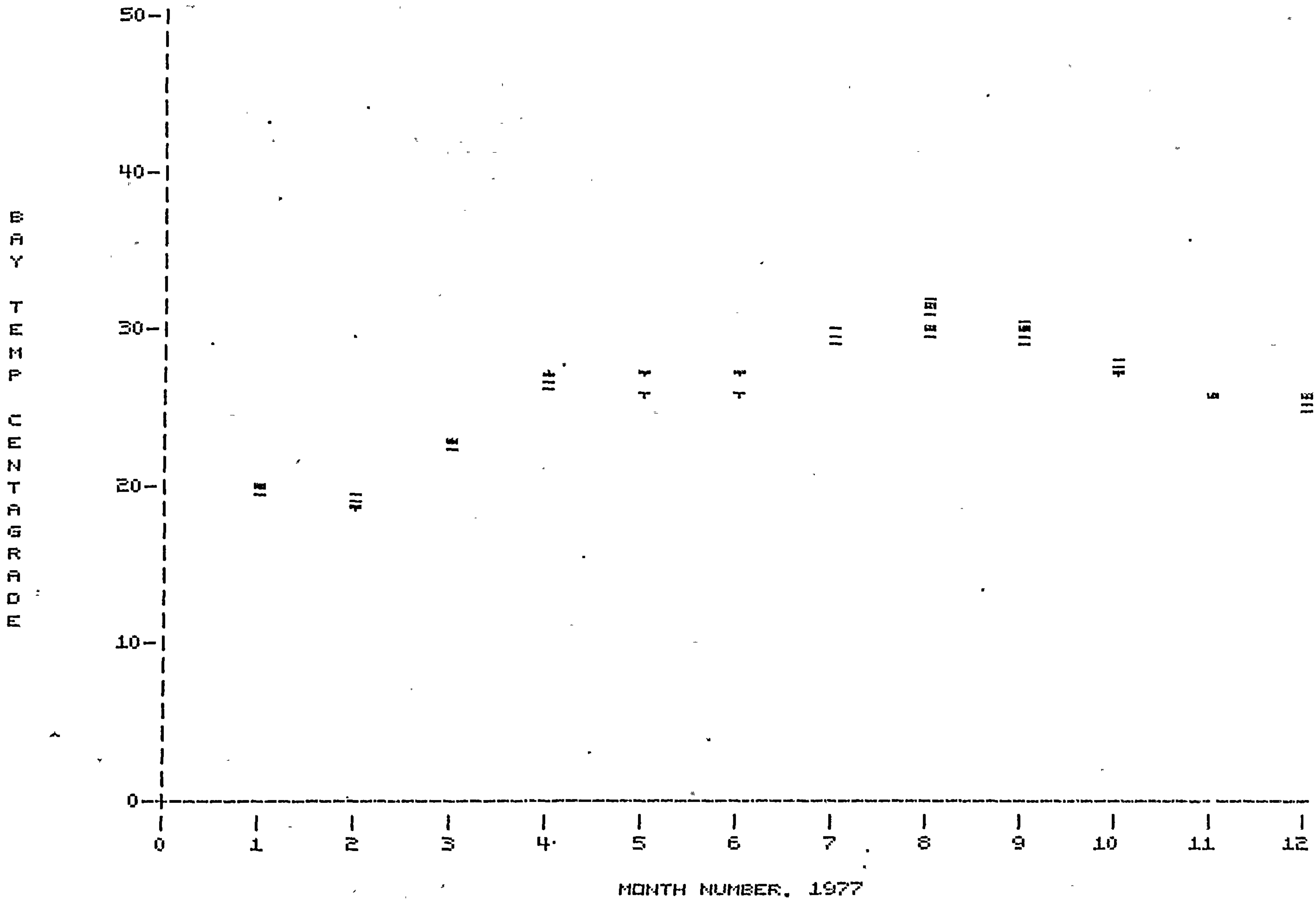


Figure 2. Temperature in the Bay in degrees centagrade

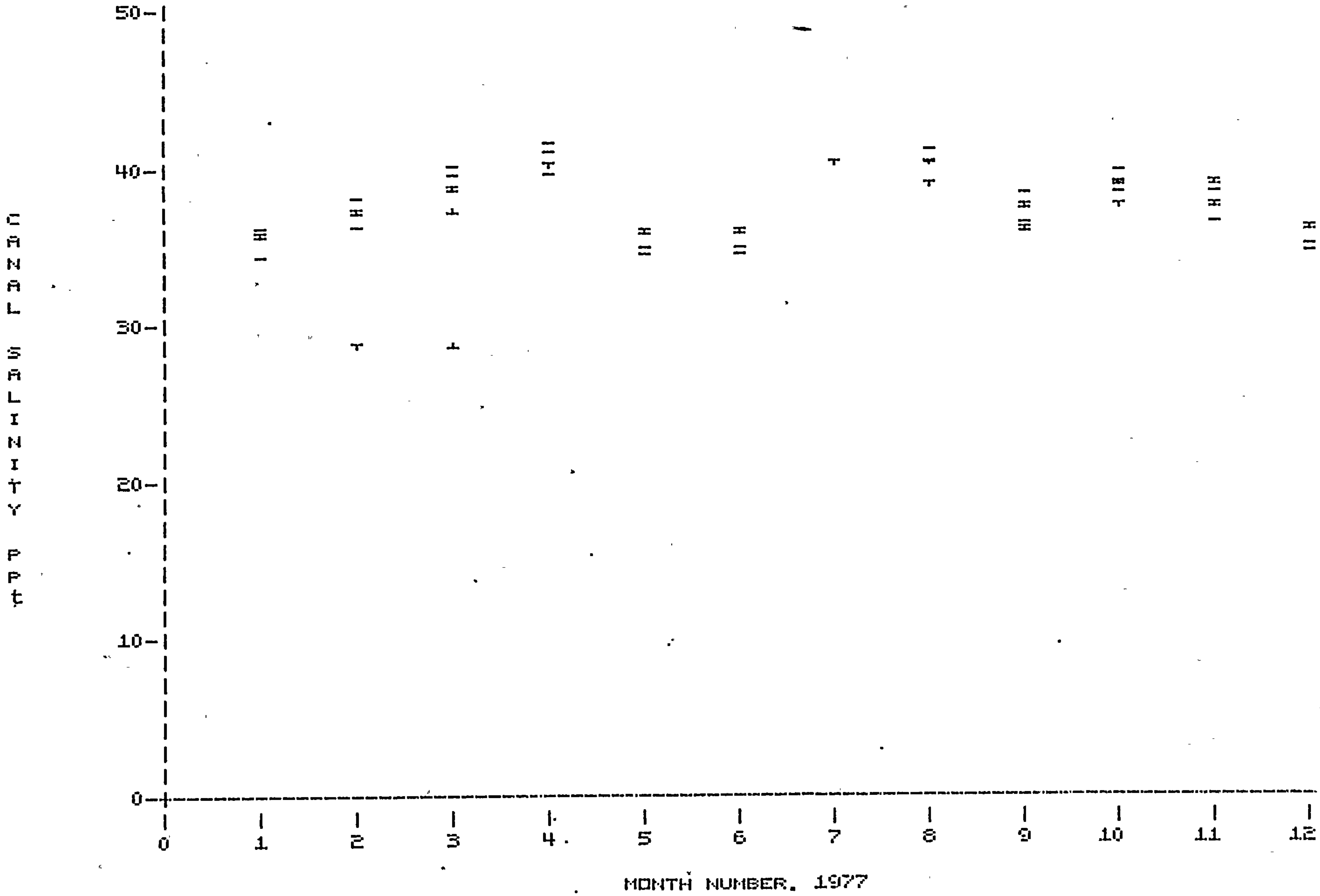


Figure 3. Salinity in the Canal System in PPT.

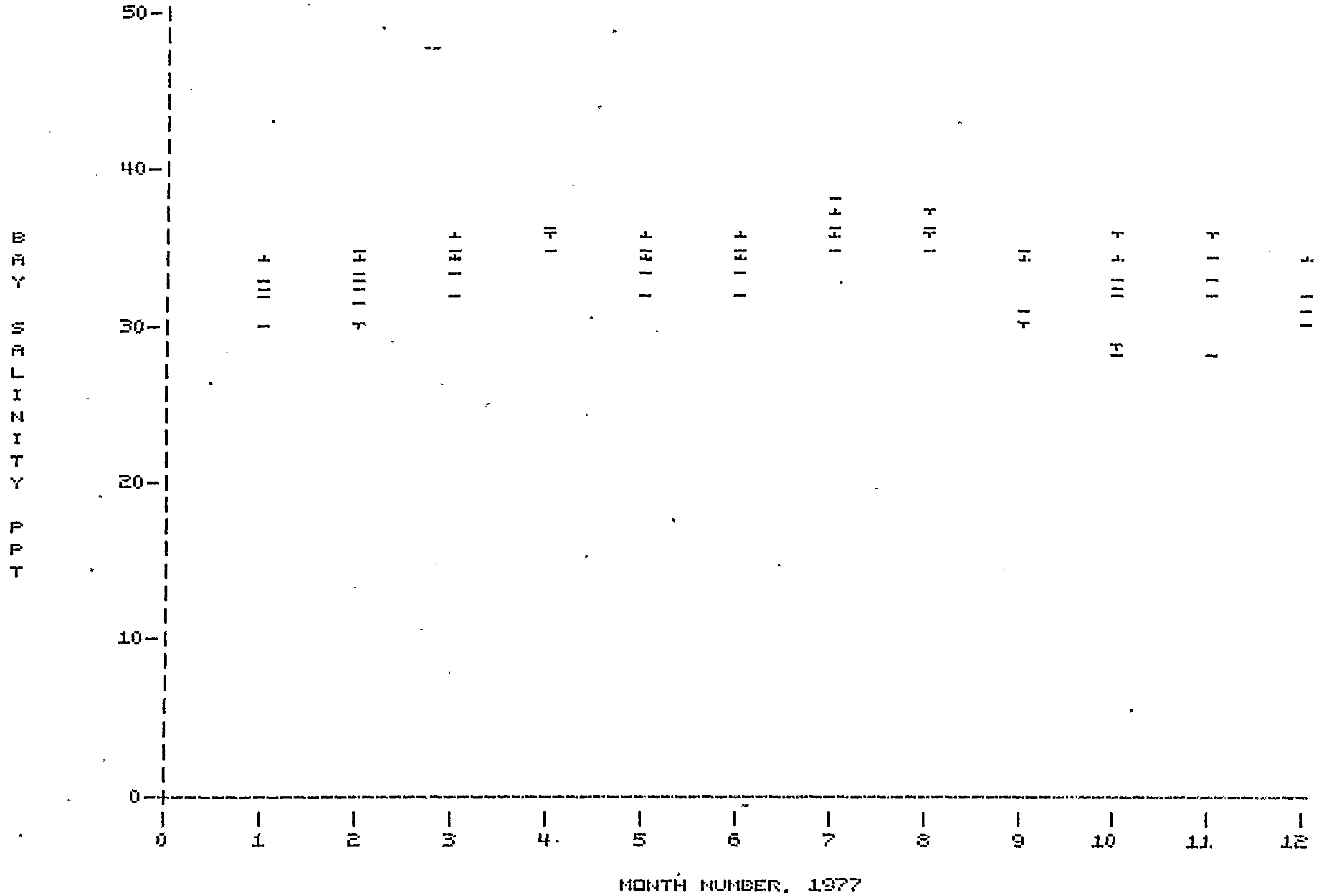


Figure 4. Salinity in the Bay in PPT

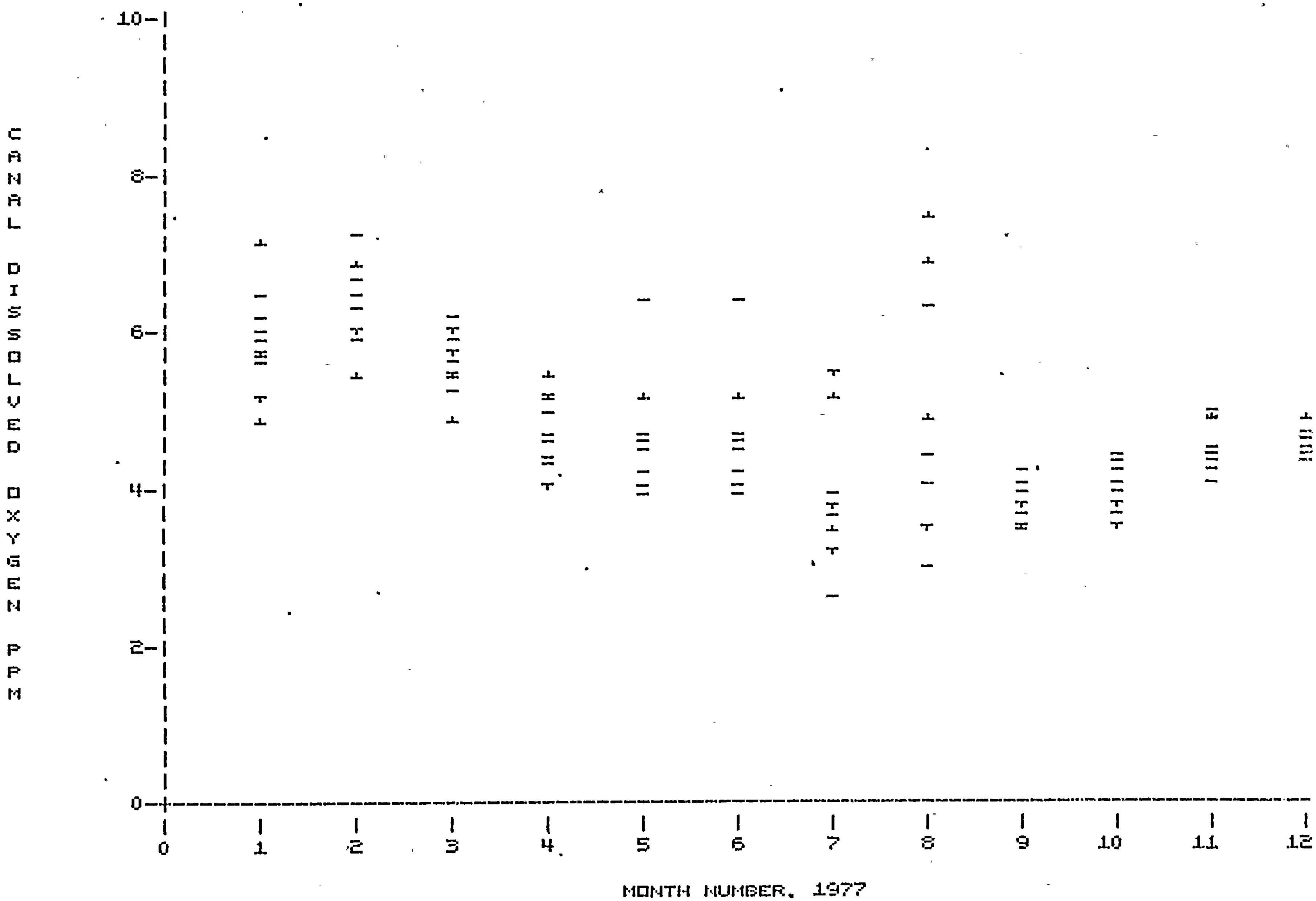


Figure 5. Dissolved oxygen in the Canal System in PPM.

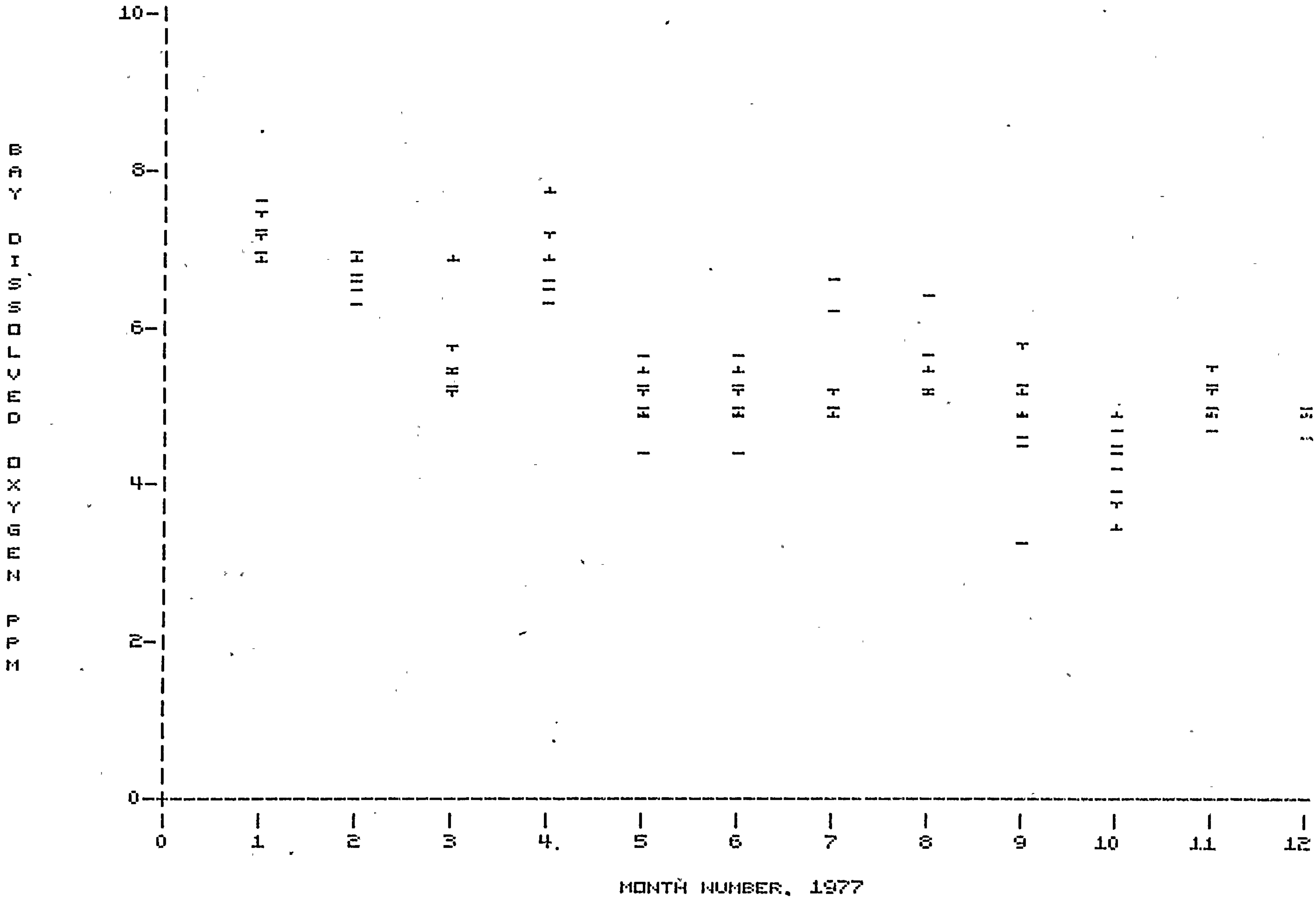


Figure 6. Dissolved oxygen in the Bay in PPM.

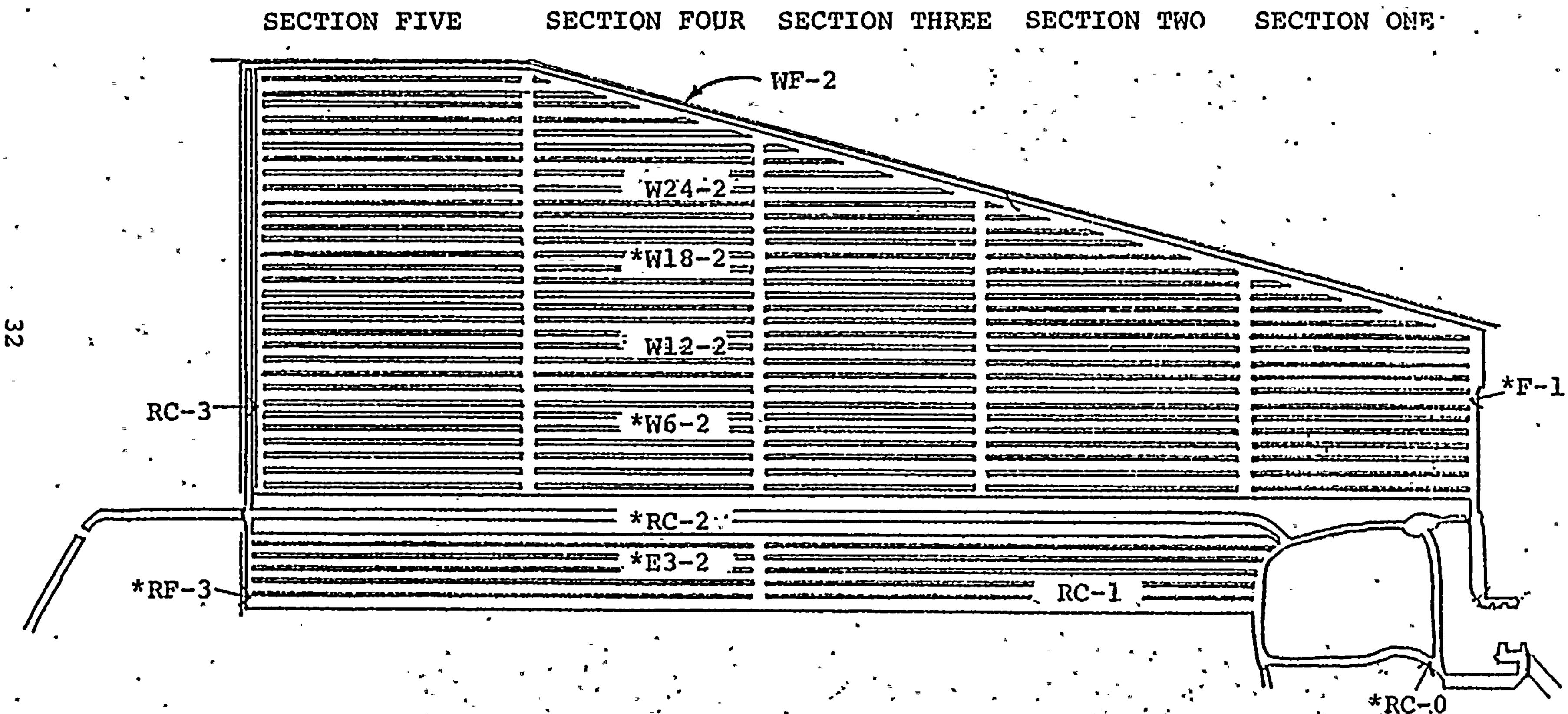


Figure 7. Turkey Point Plant Site & Cooling Canal System
*Zooplankton Tow and Chlorophyll "a" sample stations
Phytoplankton sample at each station

2. NUTRIENT DATA

Methods & Procedures

Samples were collected monthly from 12 sample points within the canal system, and three control sample points in Biscayne Bay and Card Sound.

Acid washed, ground glass stoppered, clear containers were used for the ammonia samples. Phenol alcohol was added as the preservative. Acid washed, ground glass, stoppered, dark containers were used for the other nutrient samples with mercuric chloride added as the preservative.

All analyses were performed on a Technicon (CS M 6) Autoanalyzer. Data was recorded in PPM.

Discussion & Conclusions

The purpose of these analyses is to provide a more complete picture of the various parameters related with the plankton in the system (Figures 1-10).

The nutrient levels in the cooling canal system were consistently higher than those levels in the Bay and Card Sound.

The apparent cycling of the ammonia, nitrite, and nitrate seen in the cooling canal system in previous years was repeated in 1977.

The nutrient levels at all sampling points remain below any level that could be considered eutrophic.

The absence of July nutrient data, was due to contamination of the sample.

In 1977 ammonia levels in the cooling canals were between .065 PPM (average minimum) and .11 PPM (average maximum). At the control station average minimum levels of ammonia were 0.020 PPM and the average maximum levels were 0.038 PPM.

Due to the operation of the interceptor ditch pump during the period January through June, the ammonia levels at Station WF-2 were above the maximum levels seen in the rest of the Canal System. The brackish water in the interceptor ditch contains relatively high levels of ammonia, and the levels at WF - 2 correlate with the rate and volume of water which was pumped from the interceptor ditch. Ammonia levels at the other stations in the system are directly proportional to the amount of rainfall recorded.

Nitrite levels, in the cooling canal, ranged between .025 PPM (average minimum) and 0.040 PPM (average maximum). The levels in the control stations were between .003 PPM (average minimum) and 0.007 PPM (average maximum).

Nitrite levels for 1977 were approximately the same as 1976, both within the cooling canals and at control points in the bay.

Nitrate levels in the cooling canal ranged between .21 PPM (average minimum) and 0.43 PPM (average maximum). The levels in the control stations were between 0.028 PPM (average minimum) and 0.055 PPM (average maximum).

Average inorganic phosphate levels for 1976 in the cooling canal system were 0.030 PPM. This is .003 PPM higher than 1976. At the control stations in 1977 the inorganic phosphate levels remained the same as the levels of 1976.

The average minimum in the canals was 0.014 and the average maximum was 0.028.

The average minimum at the control stations was 0.005. The average maximum was 0.010.

Total phosphate level in 1977 was higher than 1975 both in the canals and at the control stations.

The average minimum levels in the canals were 0.037 PPM. The average maximum levels were 0.057 PPM. At the control stations the average minimum levels were 0.011 PPM and the average maximum levels were 0.018 PPM.

Nutrient data can be seen by month for both the bay and the canals in Fig. 1-10.

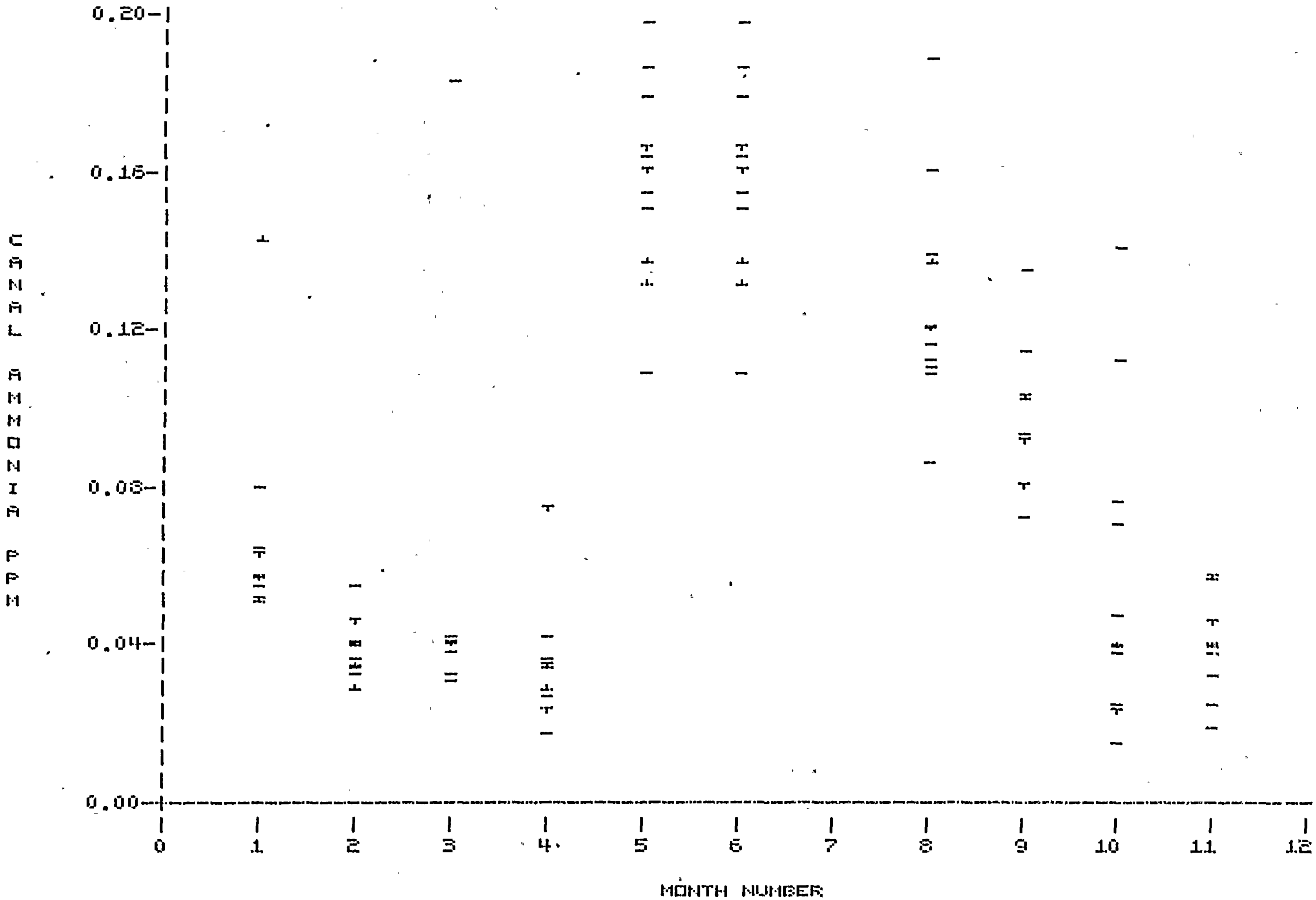


Figure 1. Ammonia in the Canal System in PPM

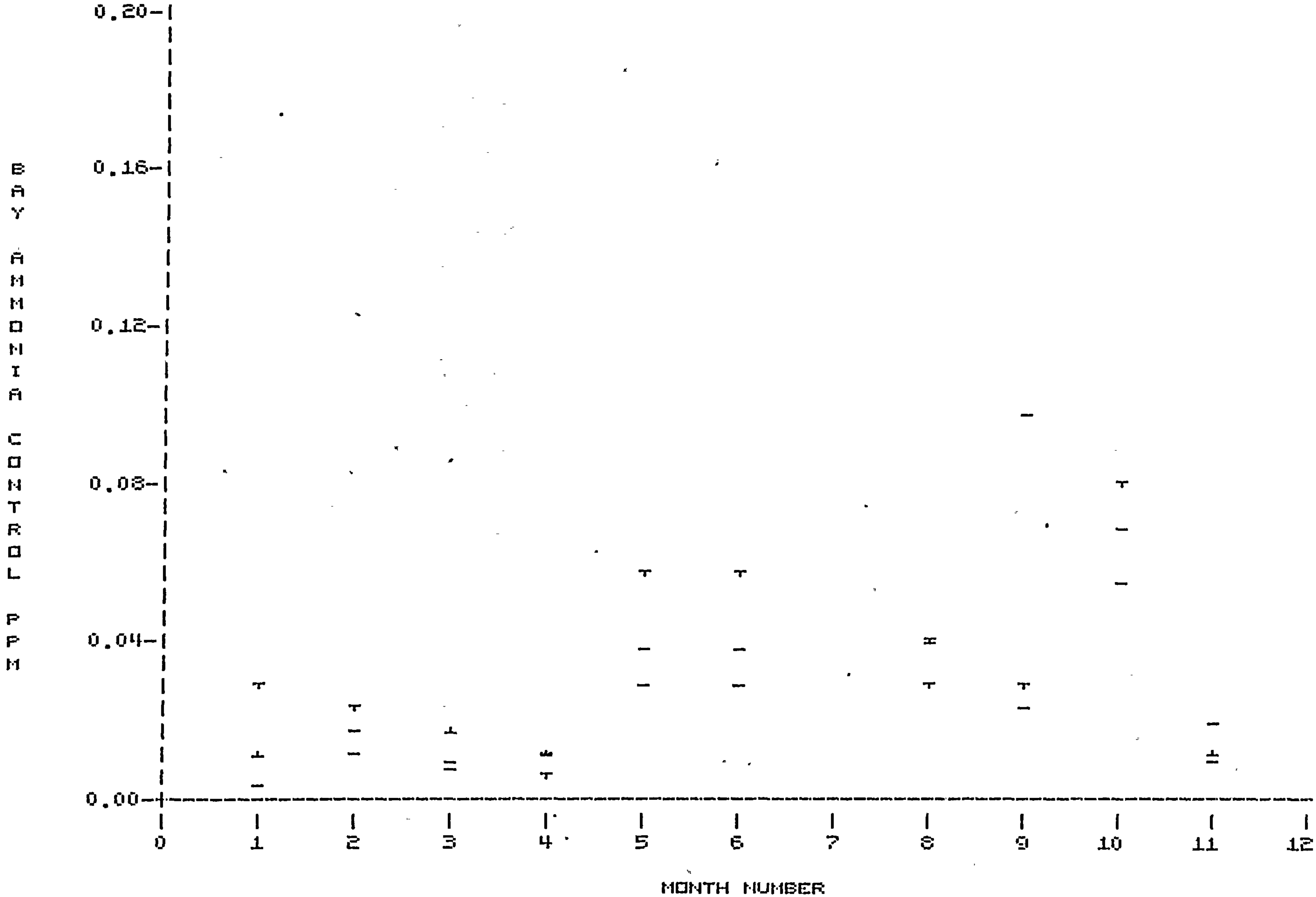


Figure 2. Ammonia concentrations of the Bay Control Stations in PPM

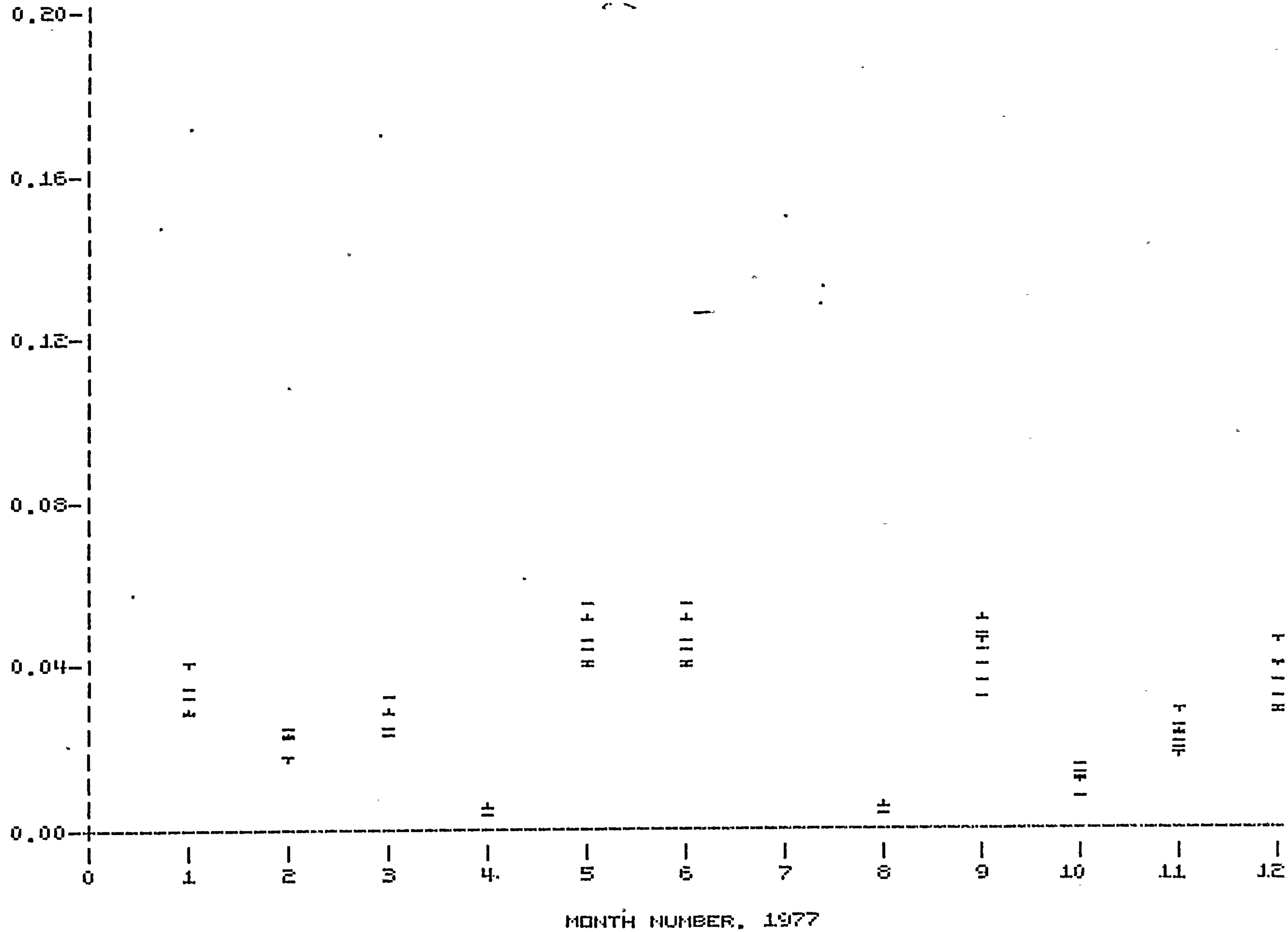


Figure 3. Nitrite concentration in the Canal System in PPM

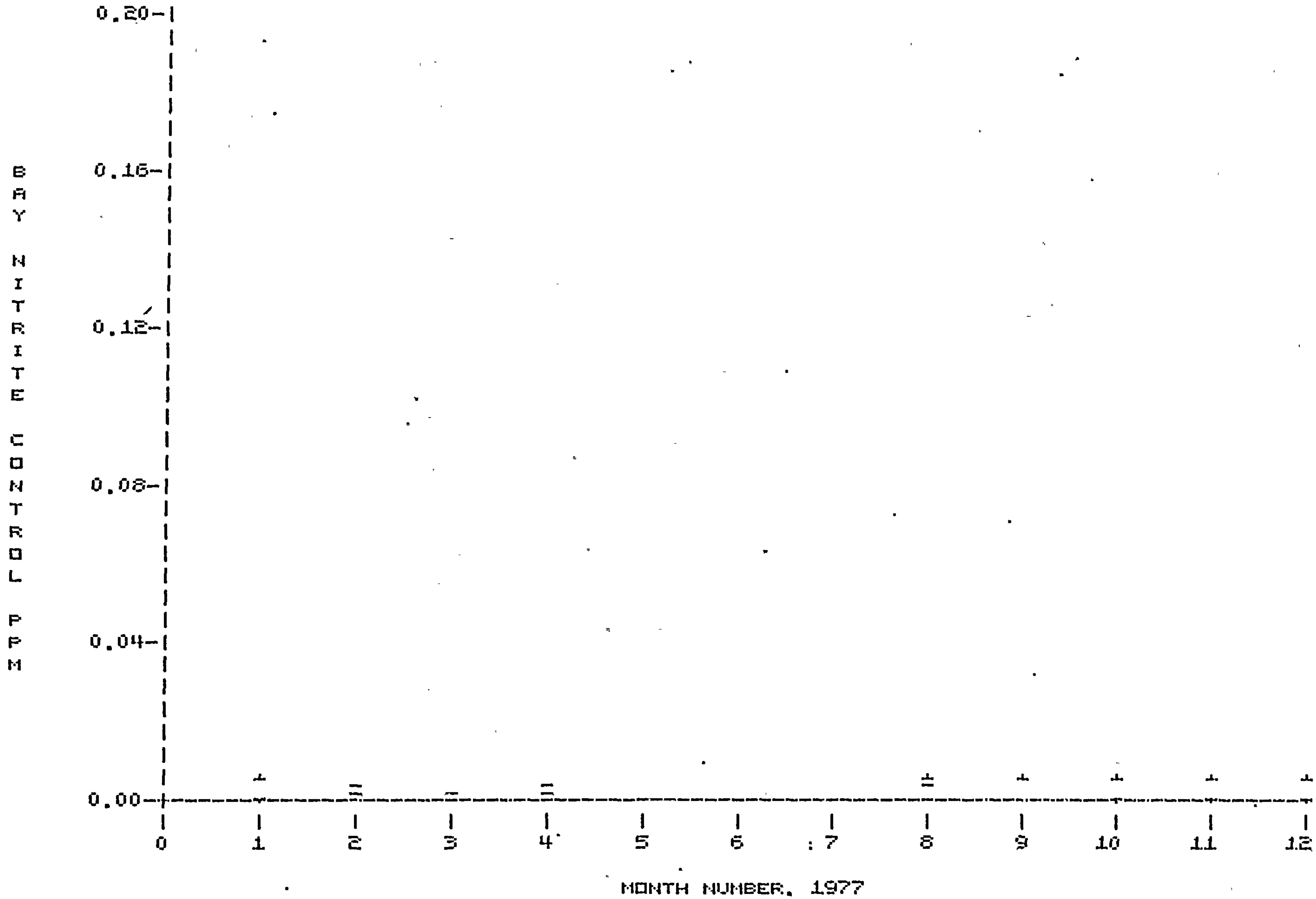


Figure 4. Nitrite concentrations of the Bay Control Stations in PPM

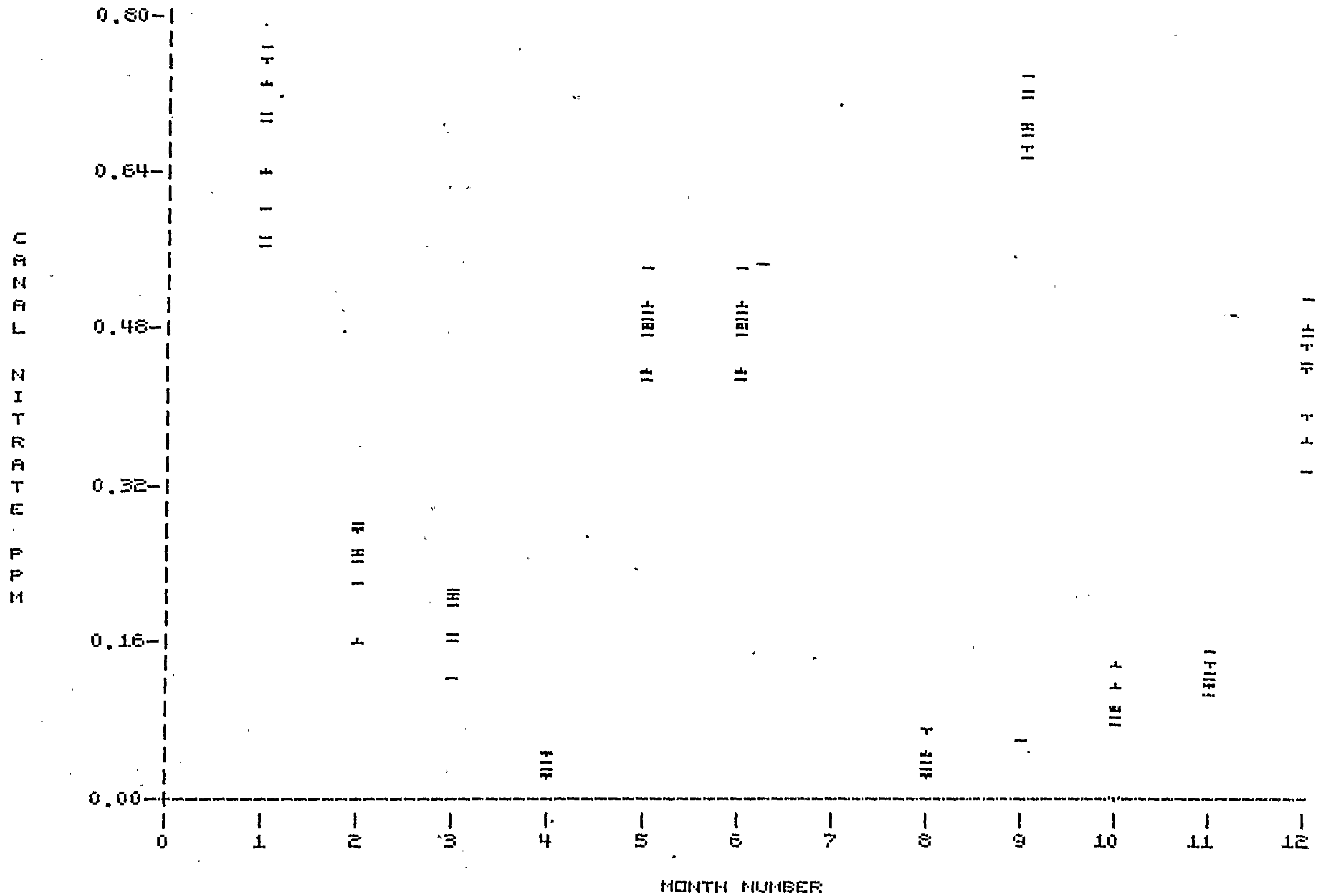


Figure 5. Nitrate concentrations in the Canal System in PPM

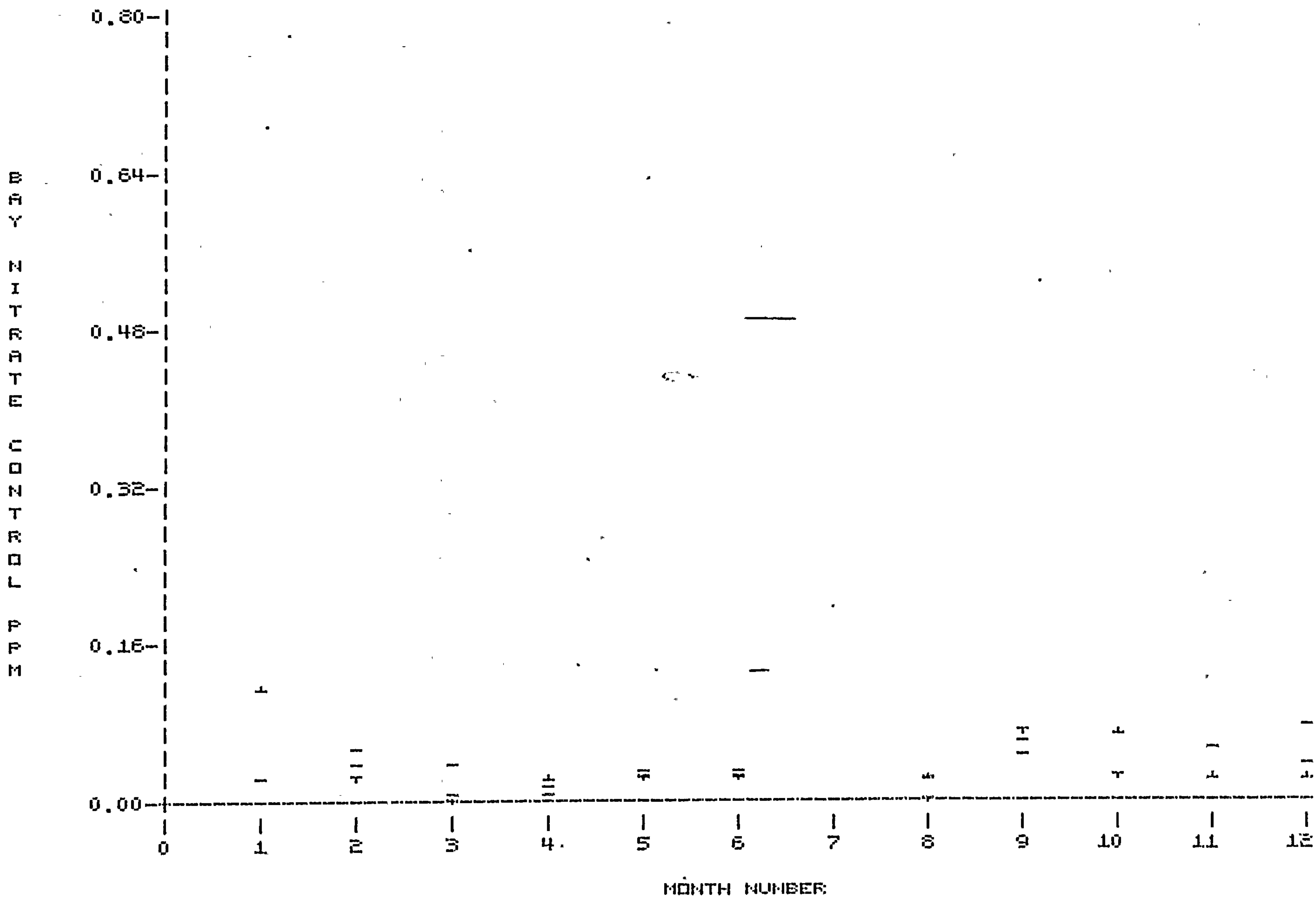


Figure 6. Nitrate concentrations of the Bay Control Stations in PPM

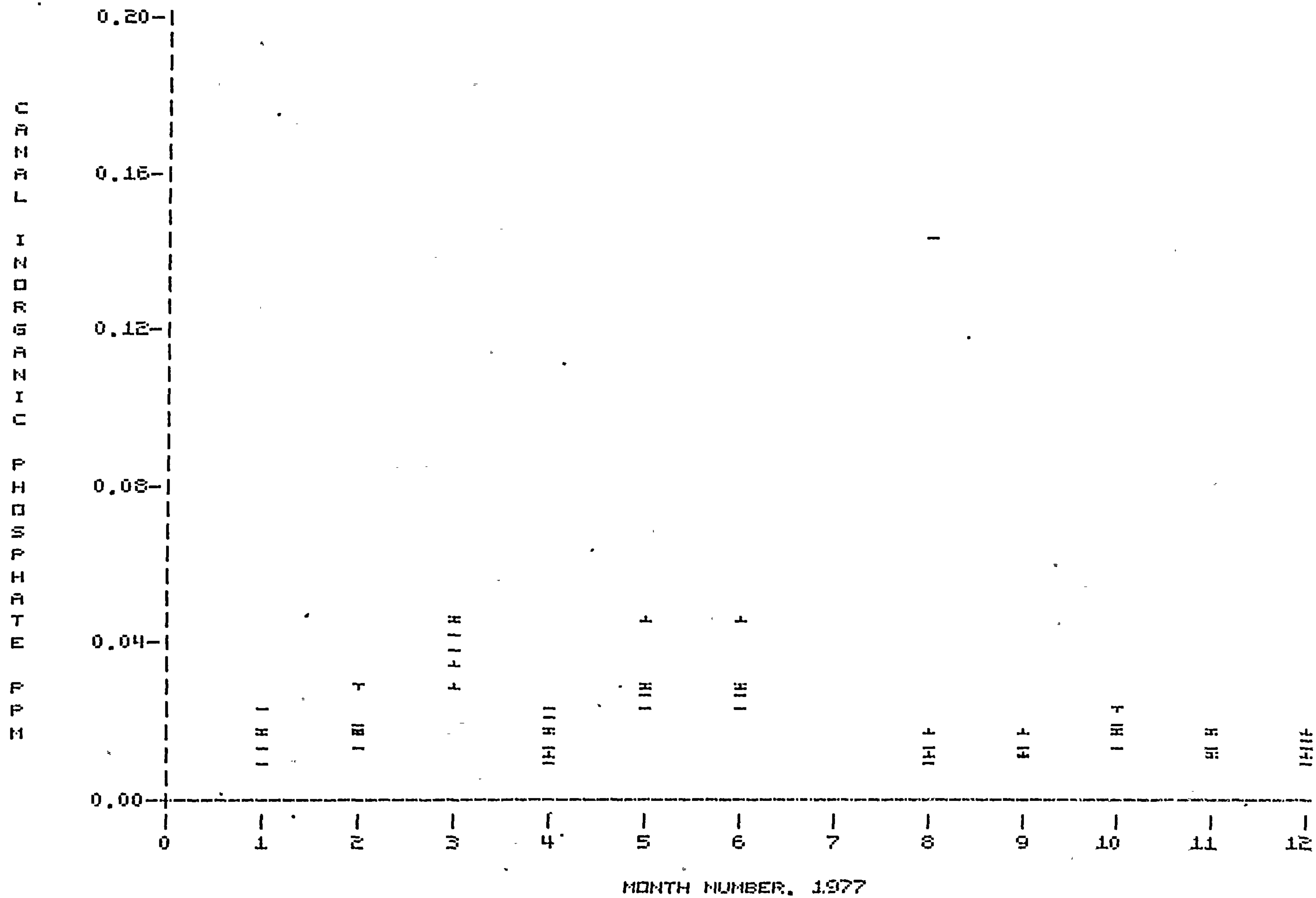


Figure 7. Inorganic Phosphate in the Canal System in PPM

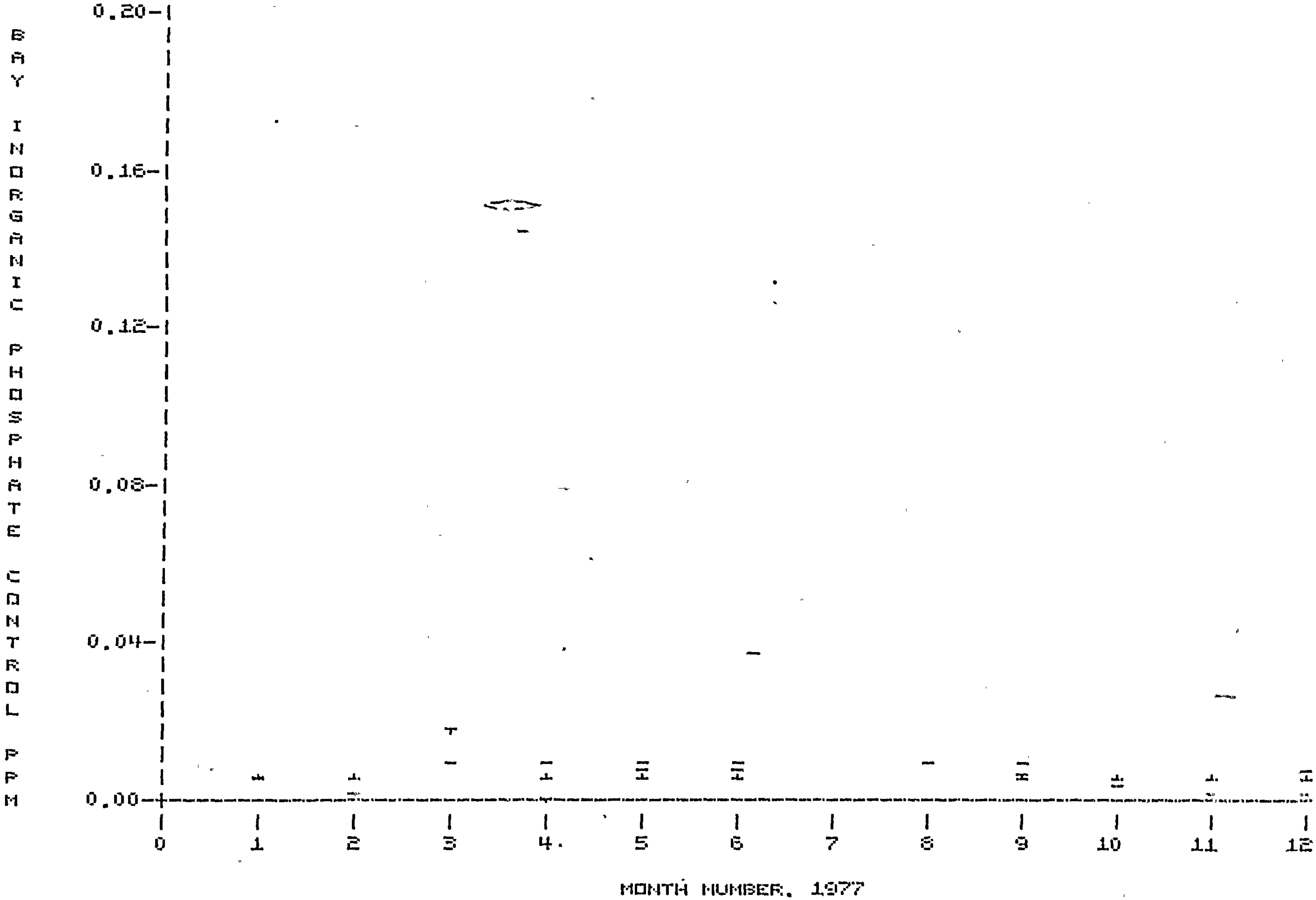


Figure 8. Inorganic Phosphate of the Bay Control Stations in PPM.

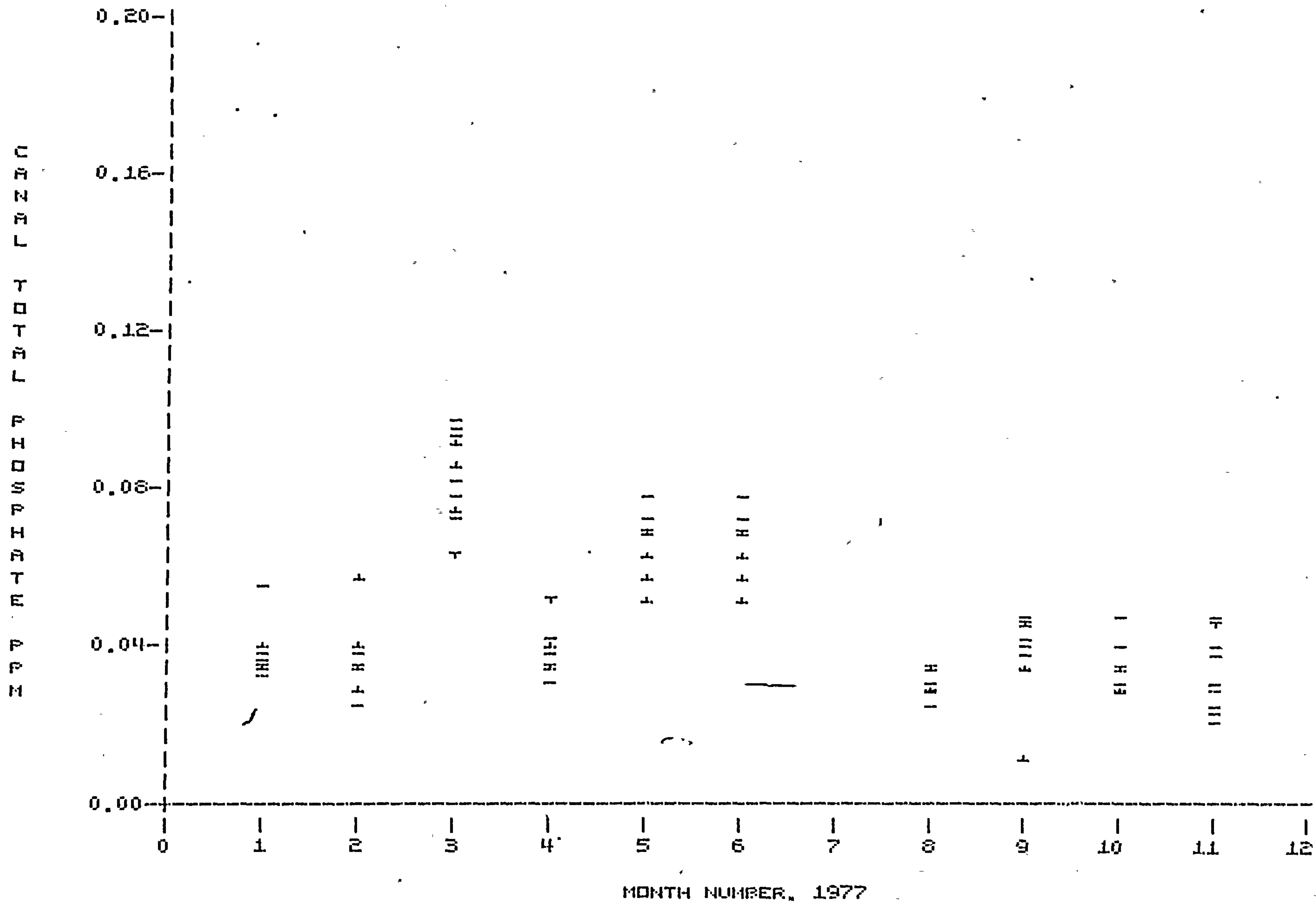


Figure 9. Total Phosphate concentrations in the Canal System in PPM.

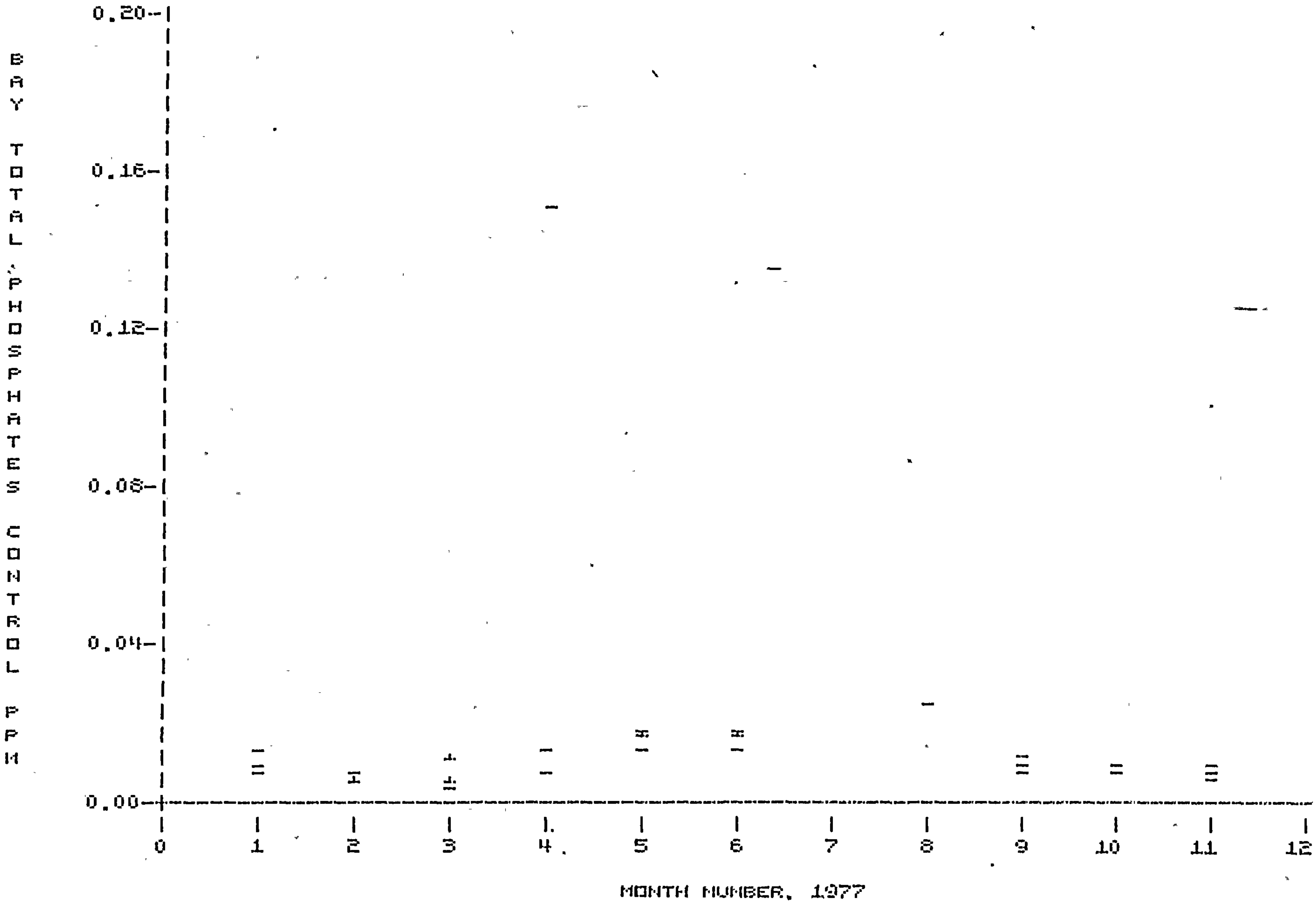


Figure 10. Total phosphate concentrations of the Bay Control Stations in PPM.

III.I PLANKTON

1. ZOOPLANKTON

Methods & Procedures

Methods and procedures were as previously reported using a standard 5" Clark-Bumpus Sampler with a #10 mesh net and bucket.

Sampling was done in the top meter of the water at a speed of 1 to 3 m.p.h. Tows were approximately 3 minutes long in the Bay and 5 minutes in the Canals.

The methods of counting zooplankton in the laboratory were the same as previously reported.

Zooplankton organisms are divided into six categories as following:

a. Copepods includes cyclopoid, harpacticoid, and monstrilloid copepods.

b. Gastropods includes all gastropod veligers.

c. Bivalve larvae includes all bivalve veligers.

d. Copepod nauplii includes all crustacean nauplii similar in appearance to copepod nauplii (with the exception of cirripeds).

e. Cirriped nauplii are distinguished from all other nauplii.

f. Other organisms include all other zooplankton not included in the first five categories.

The date is given as number per liter for each of the groups of zooplankton.

a. Copepods

Mean copepod population levels for the canal system remained the same in 1977 as in 1976. There were 0.01 organisms per liter.

The mean level of copepods in the Bay increased from 3.08 organisms per liter in 1976 to 3.80 in 1977. This 1977 mean concentration for the Bay was 38 times as great as the concentration in the canal system..

In general, the number of copepods has increased in both the cooling canals and the bay from 1975 to 1977, but it remains below 1974 levels.

b. Gastropods

Gastropod veligers again showed a large increase in concentration in the cooling canals. Their mean concentrations have increased from <0.1 organisms per liter in 1974 and 1975, to 0.06 in 1976, and 0.15 in 1977. They have now become the most common group in the canal system. The highest numbers of gastroped veligers were found at stations F-1 and WF-2 (Fig. 15). There was a bloom in August in which the F-1 gastropod concentration reached 2.7 organisms per liter and WF-2 reached 3.5. Almost all of the gastropods were collected between April and December.

In Biscayne and Card Sound, the mean gastropod con-

centration increased from 0.40 organisms per liter in 1976 to 0.58 in 1977. Their concentrations remained fairly level throughout the year, although several blooms with concentrations of 3.0 organisms per liter to 10.5 organisms per liter occurred at various times throughout the year. In general, the mean concentration of gastropods in the Bay is 4 times greater than the gastropod level in the canal system.

c. Bivalve Larvae

Bivalve larvae continue to be almost totally absent from the cooling canals. This is probably due to an inadequate food supply.

The mean concentration for bivalve larvae in the bay was o.07 organisms per liter, as compared to 0.03 in 1976 and 0.02 in 1975. Most of the bivalve larvae were found in July through December.

d. e. Copepod and Cirriped Nauplii

Both nauplii are too small to be adequately sampled by a #10 mesh net. In the cooling canals, copepod nauplii were present in all of the months except March, May, and June. However, in all but one case there were less than 0.05 organisms per liter. The mean concentration for the year was 0.007. This was an increase from 0.002 in 1975 and 0.001 in 1976.

The cirriped nauplii were present in the canal samples from seven

months, but they were never present at a concentration greater than 0.02 per liter.

In Biscayne Bay and Card Sound, copepod and cirriped nauplii continue to be present at low levels. The copepod nauplii concentration was 0.11 organisms per liter in 1977 while the cirriped concentration was 0.05 organisms per liter.

f. Other Plankton

In the cooling canals, the mean concentration of the other plankton decreased slightly from 0.05 organisms per liter in 1976 to 0.04 in 1977. This 1977 value was higher than the 1975 concentration of 0.03 organisms per liter.

In Biscayne Bay and Card Sound the mean concentration of other plankton increased from 0.20 organisms per liter to 0.41 in 1977.

Other plankton found in the canal system included fish eggs, fish larvae, shrimp larvae, zoea larvae, rotifers, water mites, and polychaete larvae. In Biscayne Bay, fish eggs, fish larvae, shrimp larvae, zoea larvae, echinoderm pleuti, medusae, amphipods, cladocerans, ostrocods, tunicate larvae and chaetognaths were found.

Total Plankton

Zooplankton concentrations in the cooling canals were consistently lower than those seen in Biscayne Bay and Card Sound. In 1977, the total plankton concentration in the Bay and the Canals were higher than those in 1976. In 1977 the

mean for total plankton in the cooling canals was 0.29 organisms per liter as compared to 0.21 in 1976 and 0.11 in 1975. This in trend was mainly due to a large increase in the gastropod population.

In Biscayne Bay and Card Sound, the mean for total plankton was 5.03 organisms per liter or almost 18 times the mean in the Canals. This concentration was also 1.5 times greater than those in 1975.

Monthly data for all groups of zooplankton can be found in Figures 1-14.

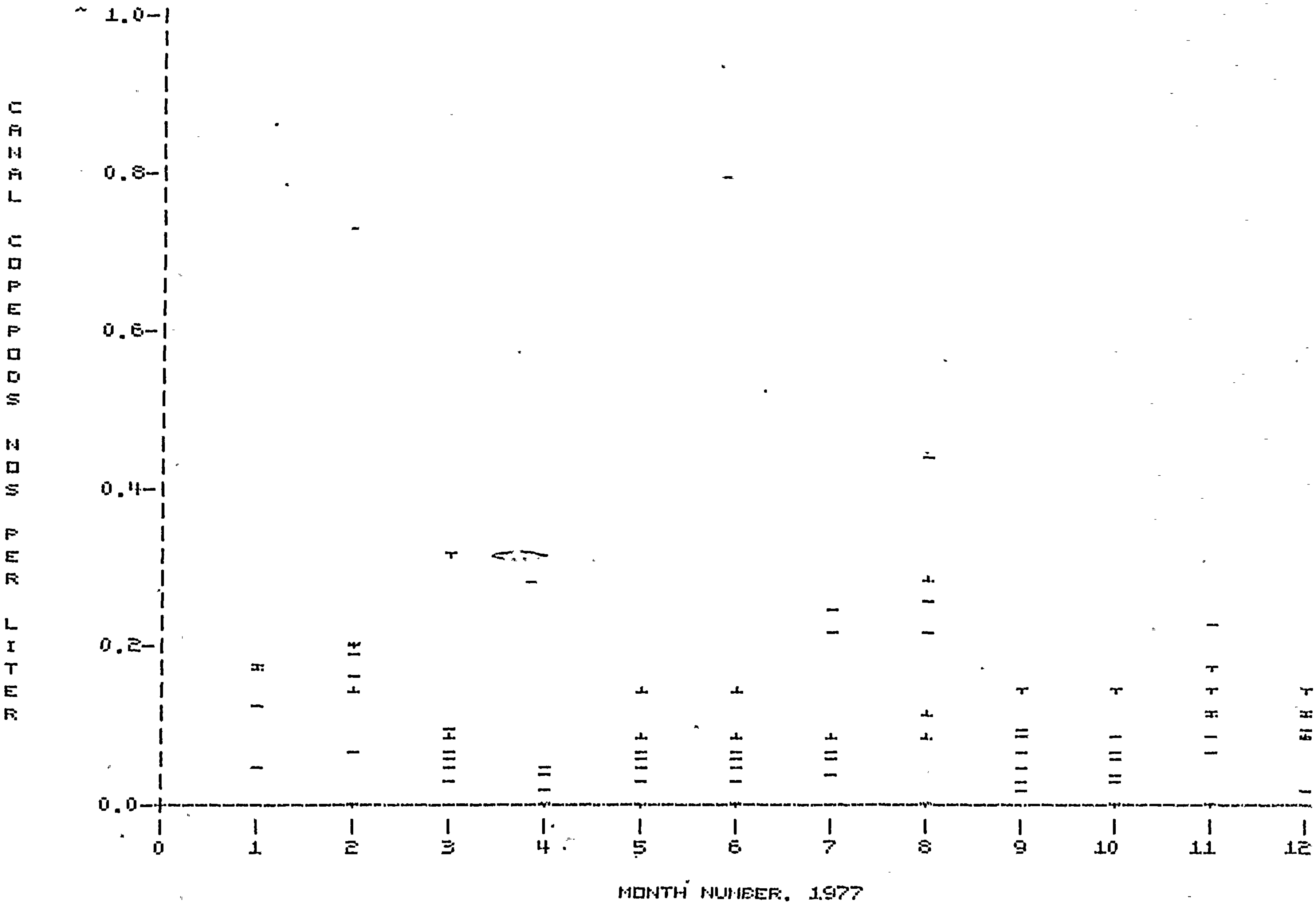


Figure 1. Copepods per liter in the Canal System.

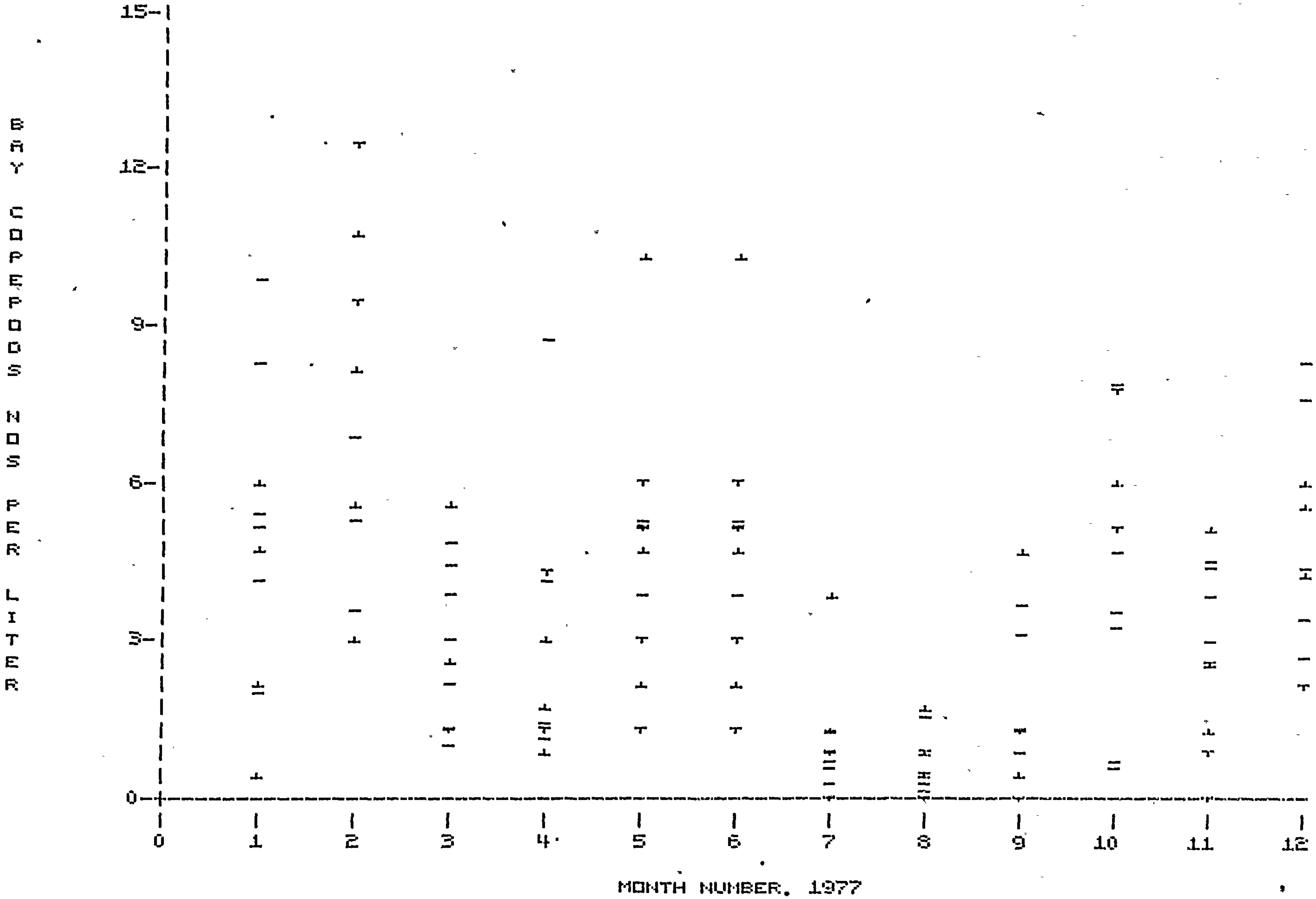


Figure 2. Copepods per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Copepods scale is 1/15 th this scale.

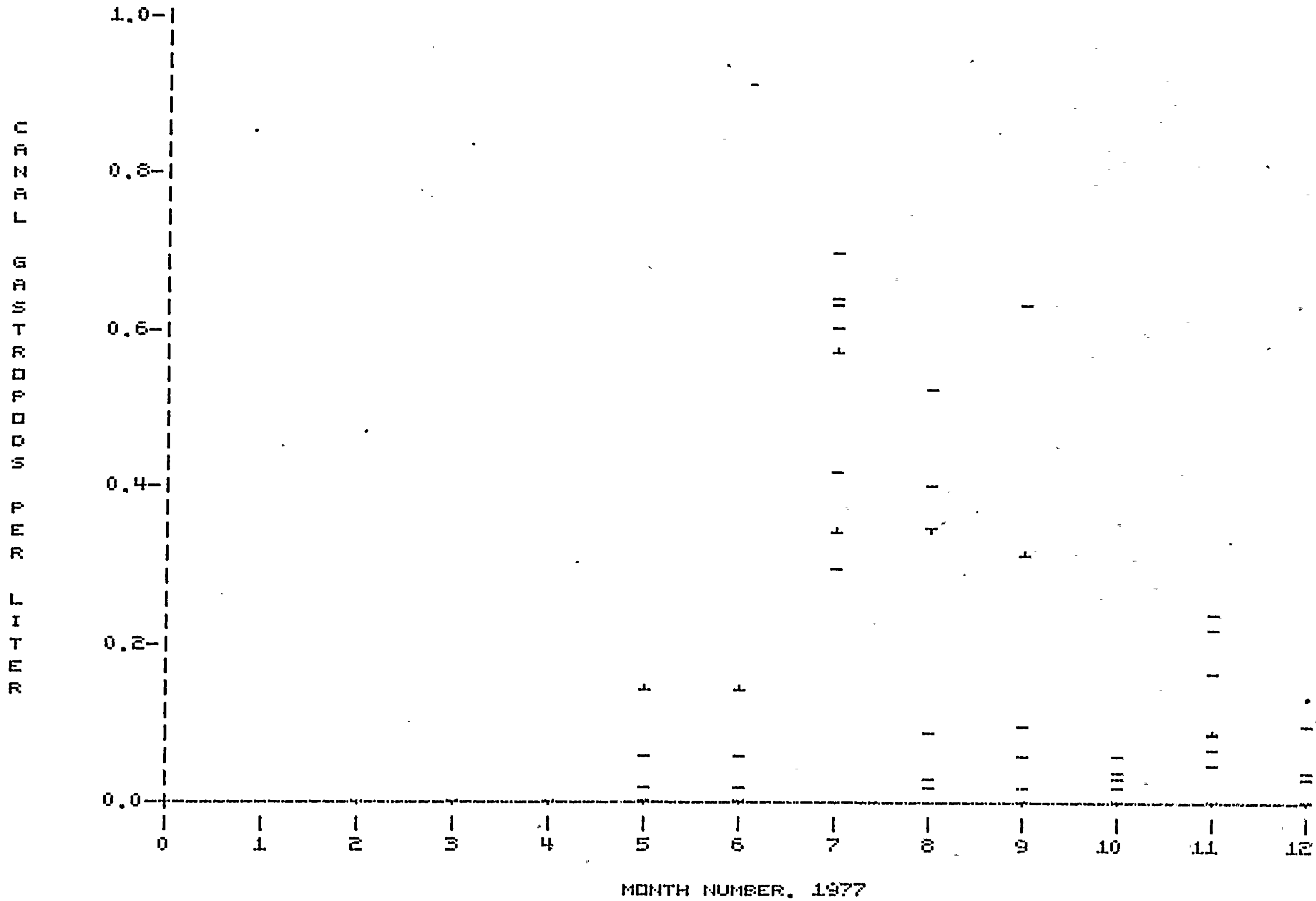


Figure 3. Gastropods per liter in the Canal System.

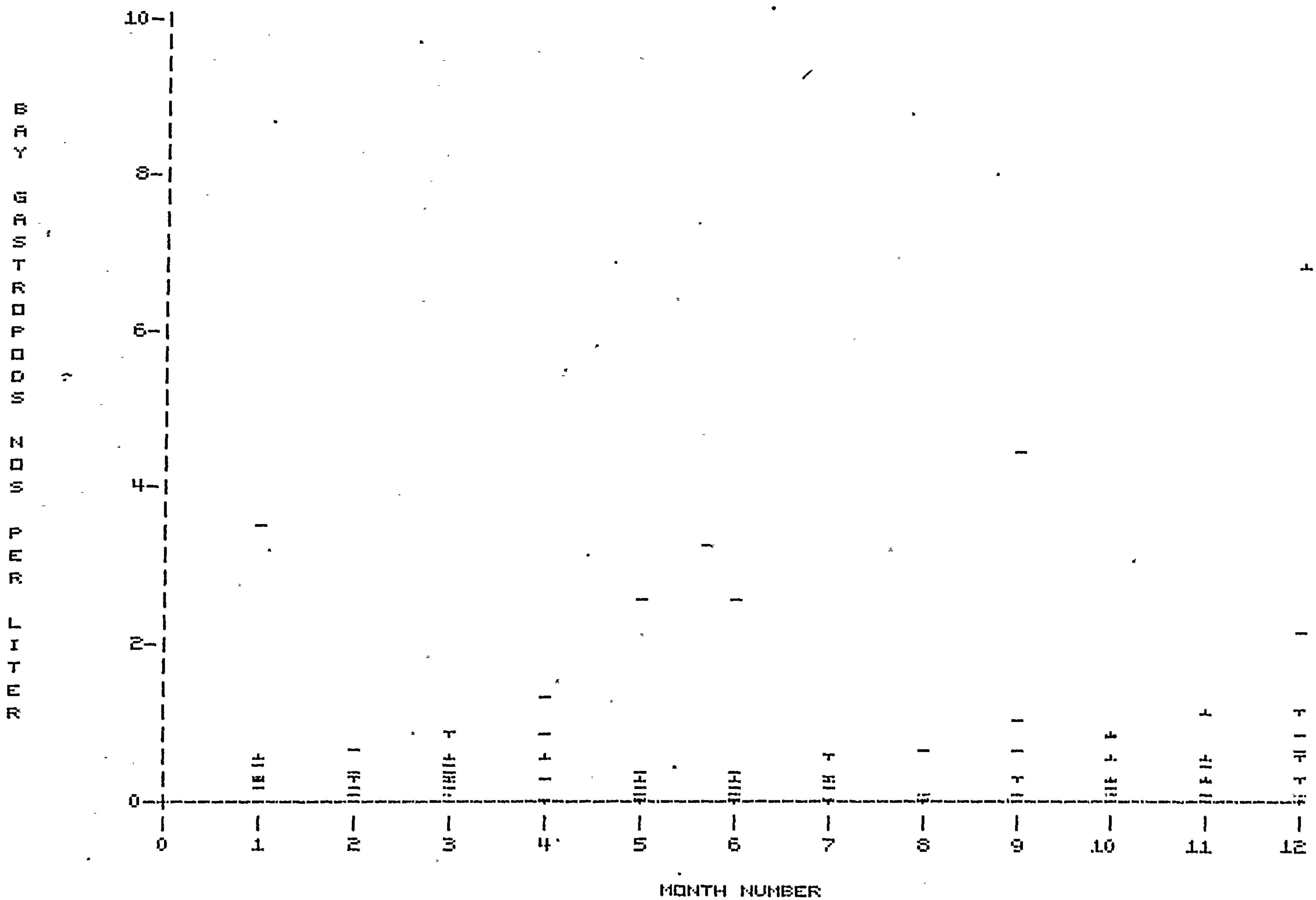


Figure 4. Gastropods per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Gastropods scale is 1/10 th this scale.

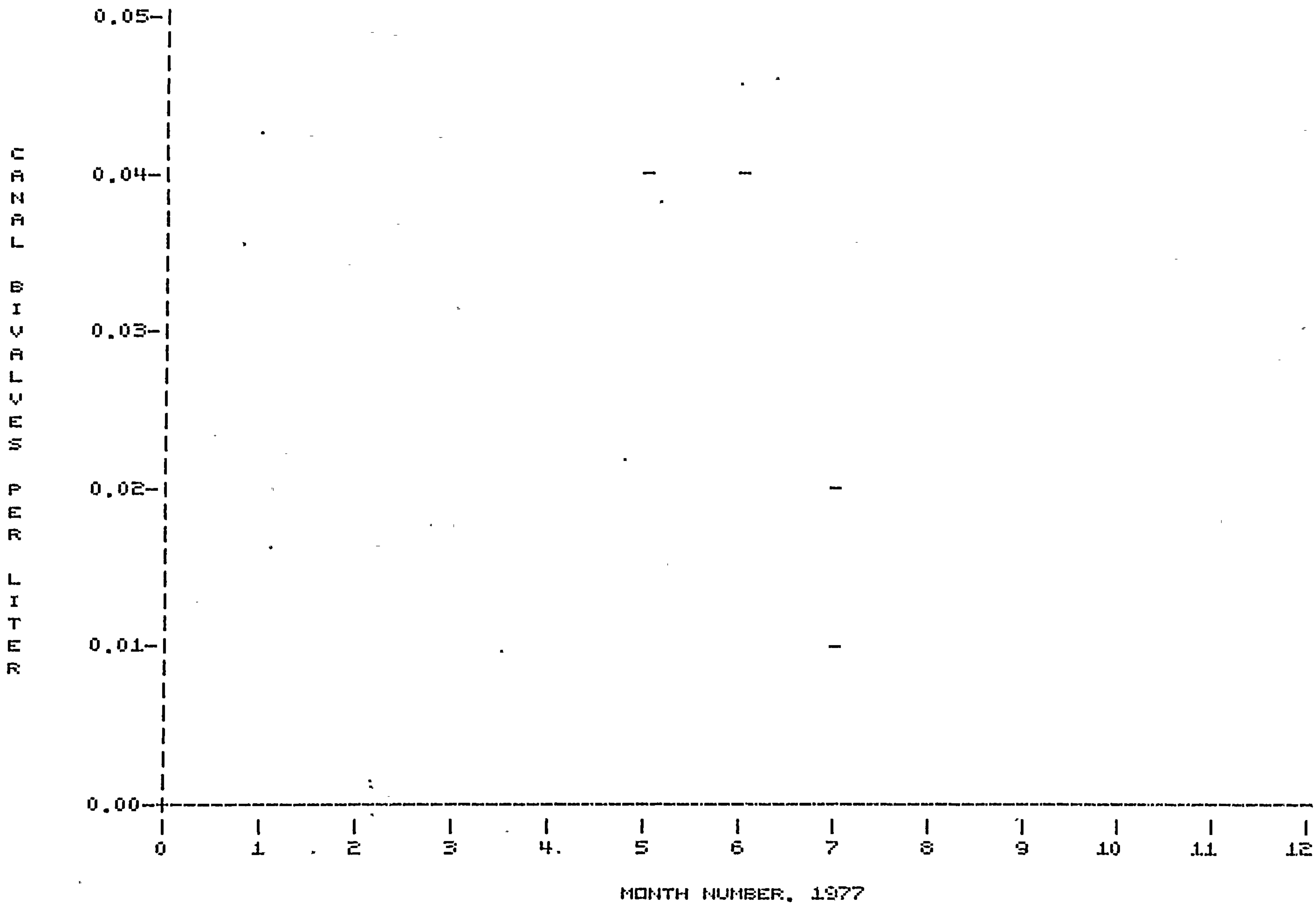


Figure 5. Bivalves per liter in the Canal System.

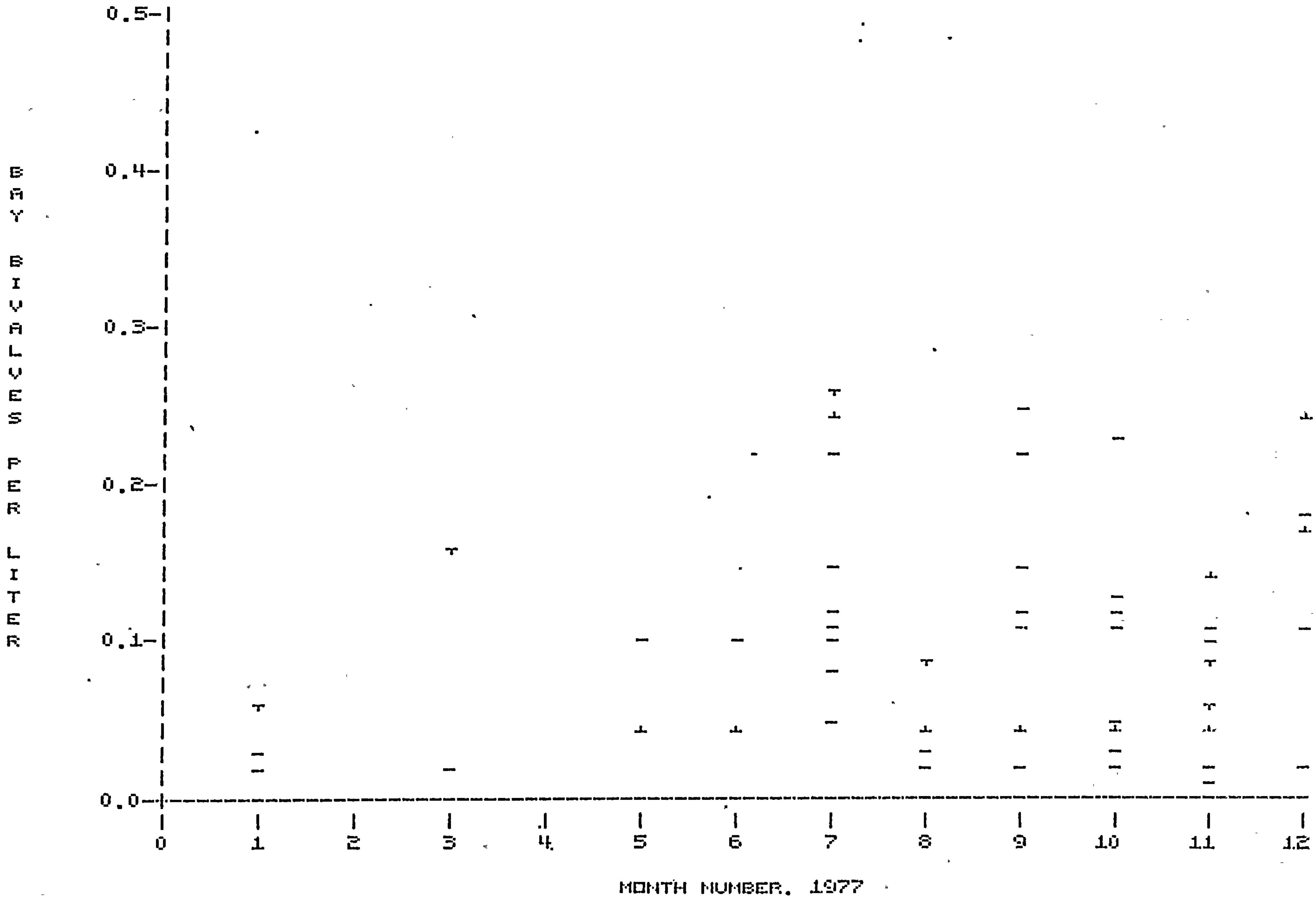


Figure 6. Bivalves per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Bivalve scale is 1/10 th this scale.

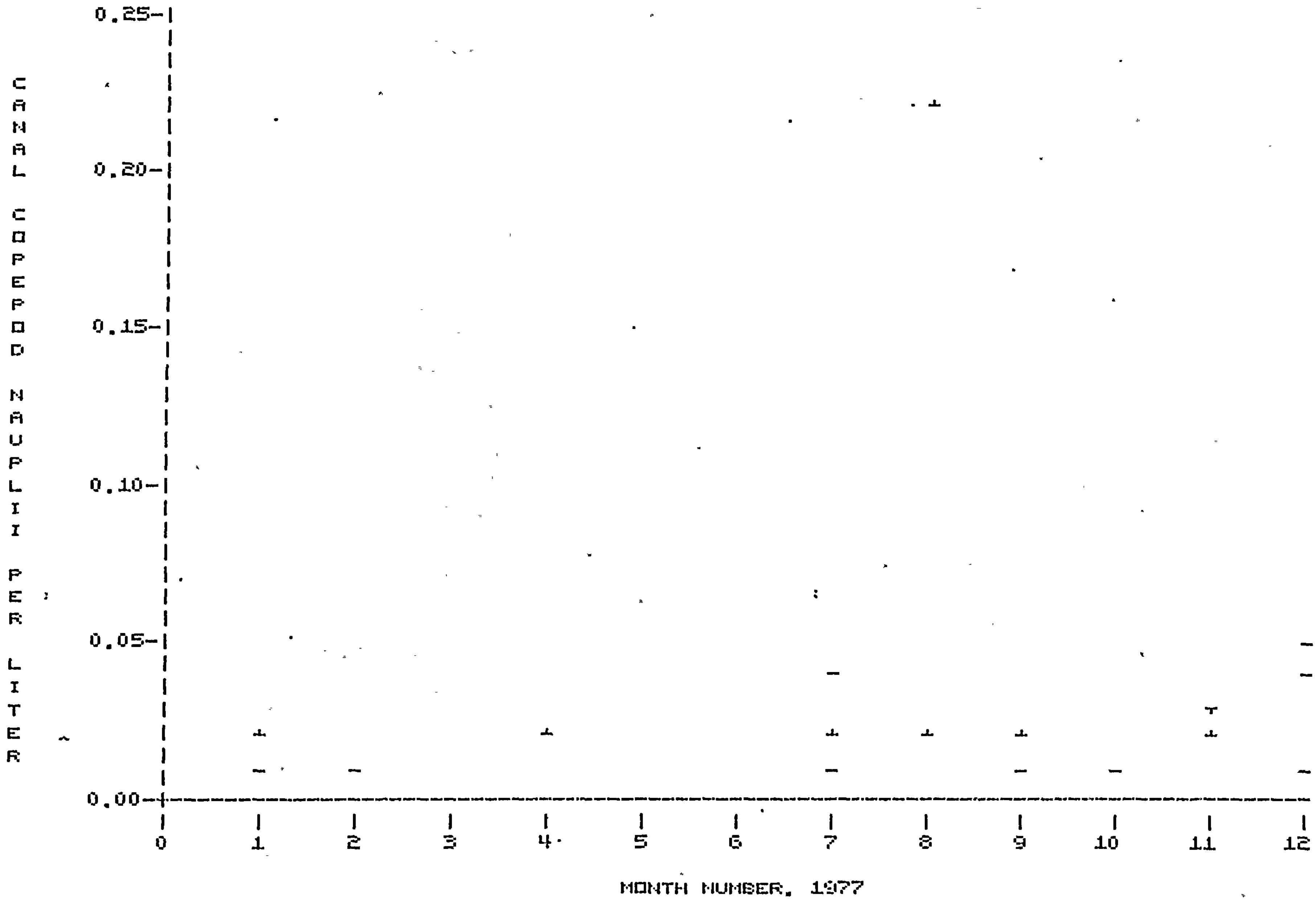


Figure 7. Copepod Nauplii per liter in the Canal System.

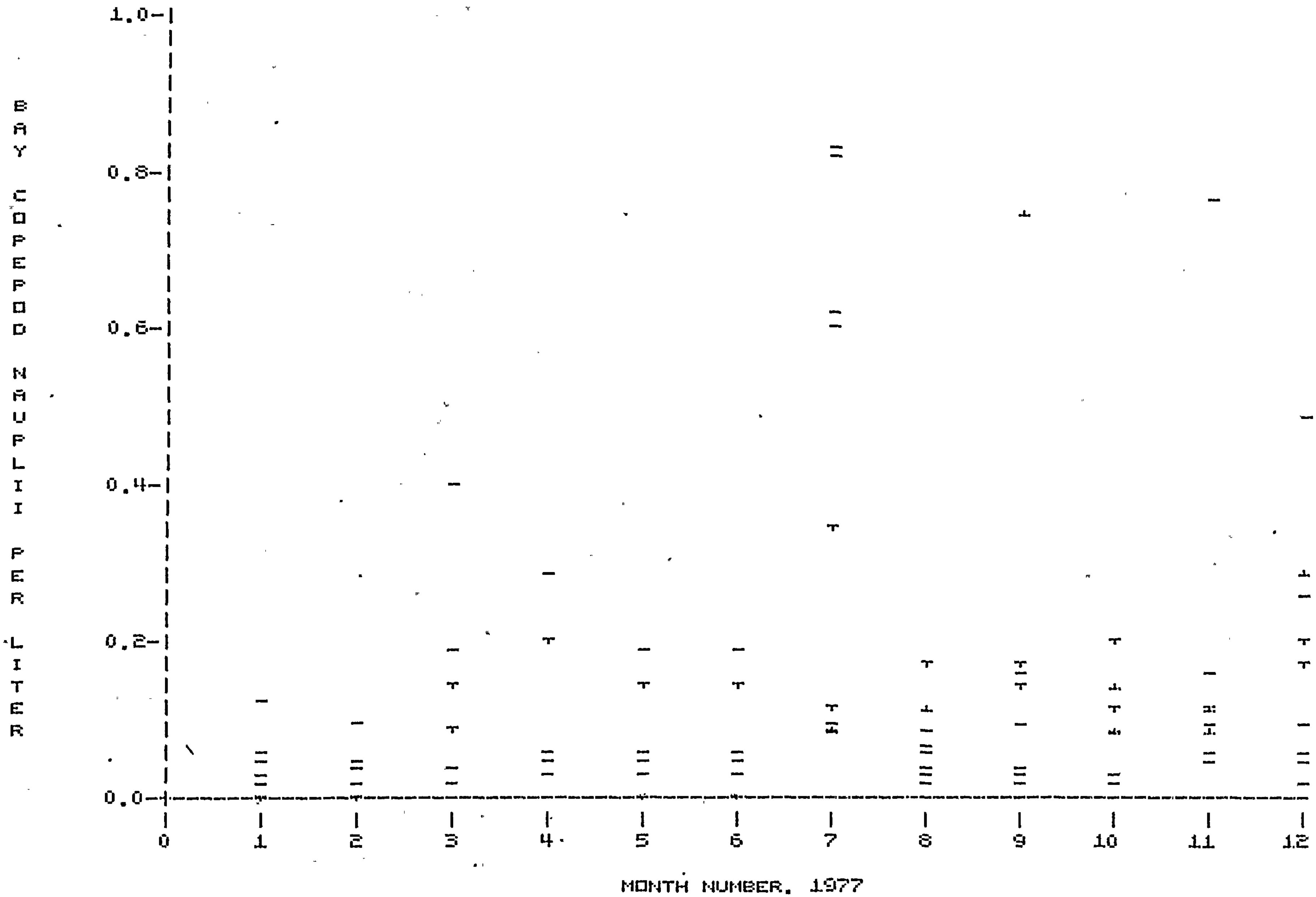


Figure 8. Copepod Nauplii per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Copepod Nauplii scale is 1/4 th this scale.

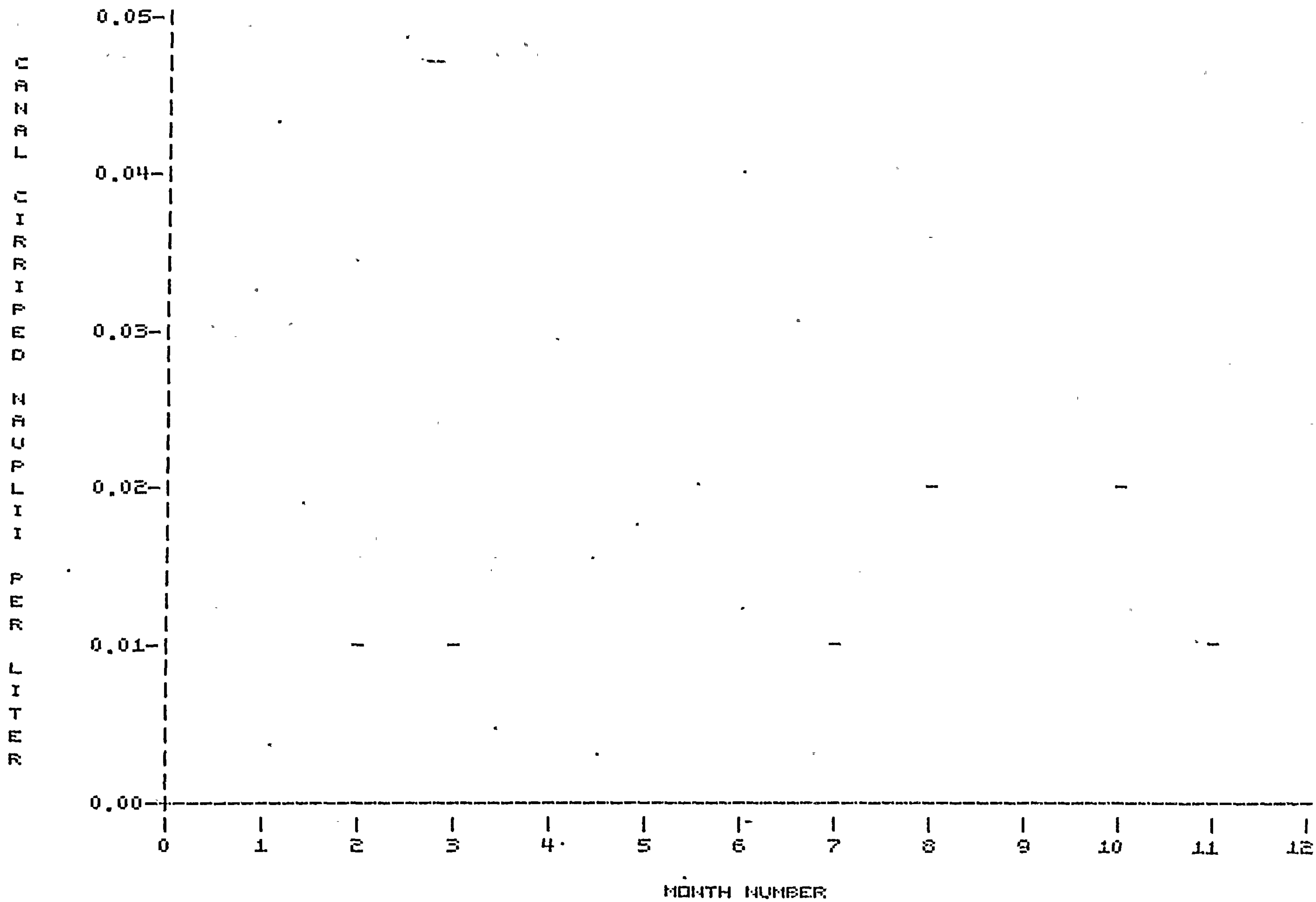


Figure 9. Cirriped Nauplii per liter in the Canal System.

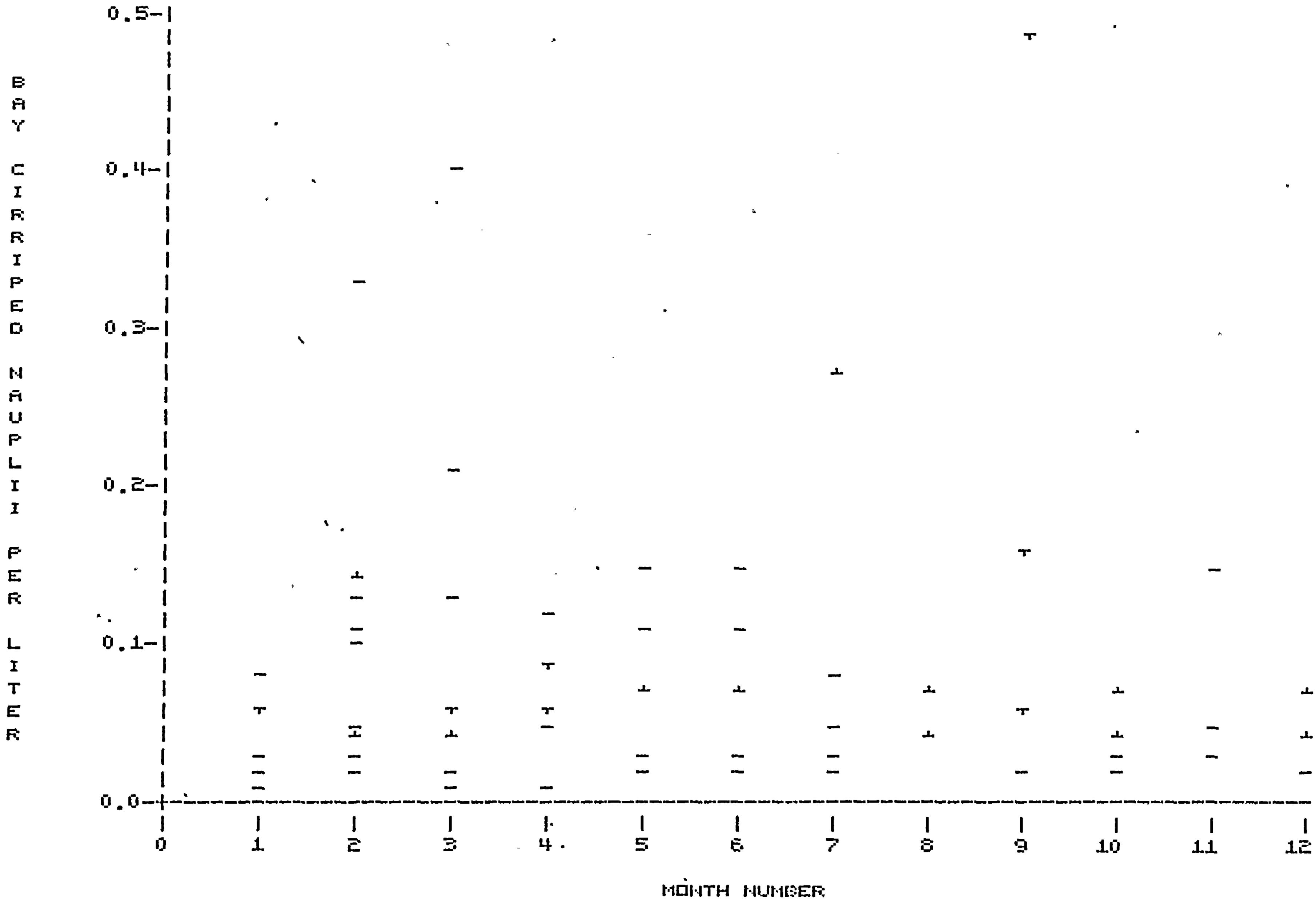


Figure 10. Cirriped Nauplii per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Cirriped Nauplii scale is 1/10 th this scale.

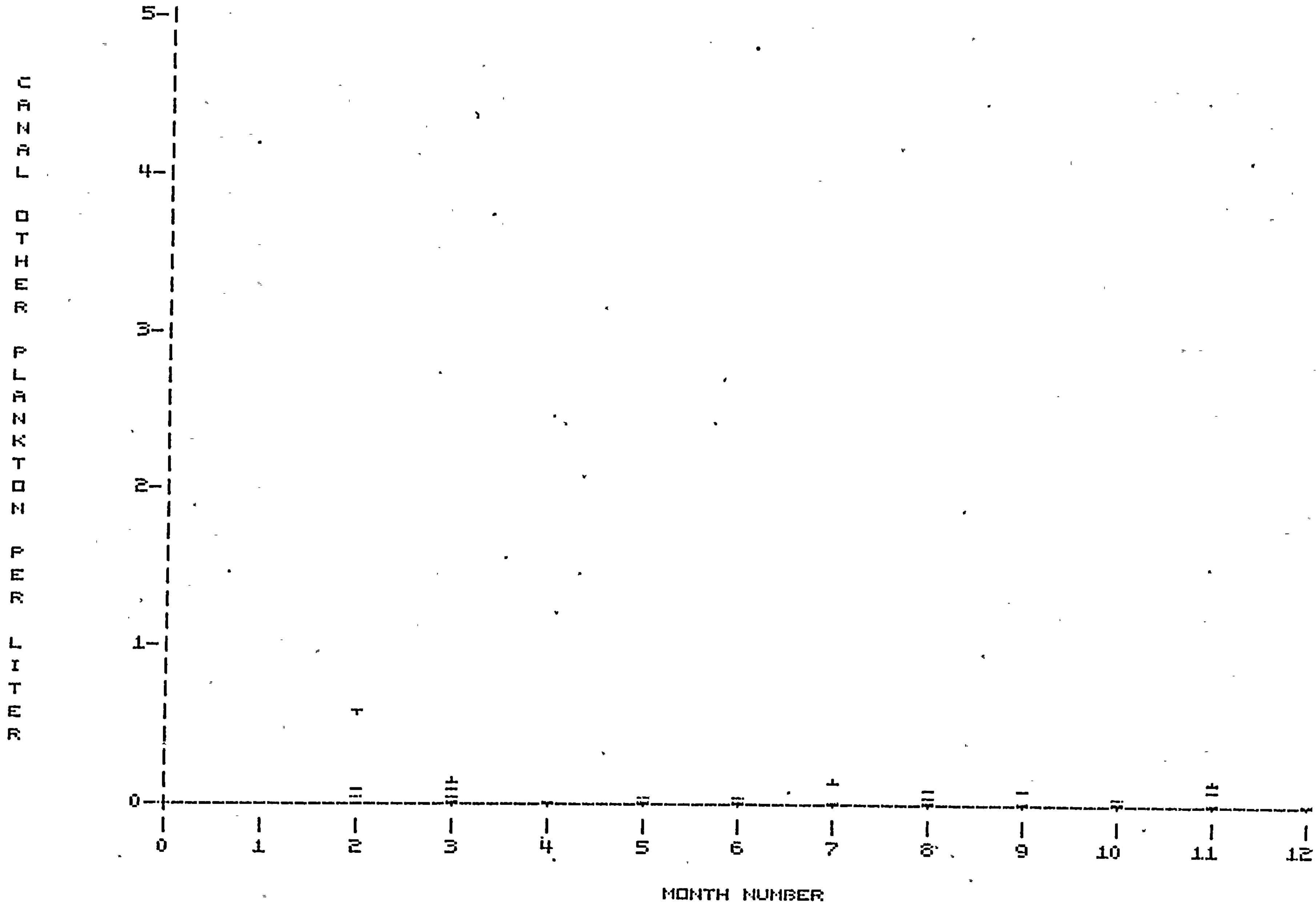


Figure 11. Other plankton found in the Canal System, but not included in any of the major category.

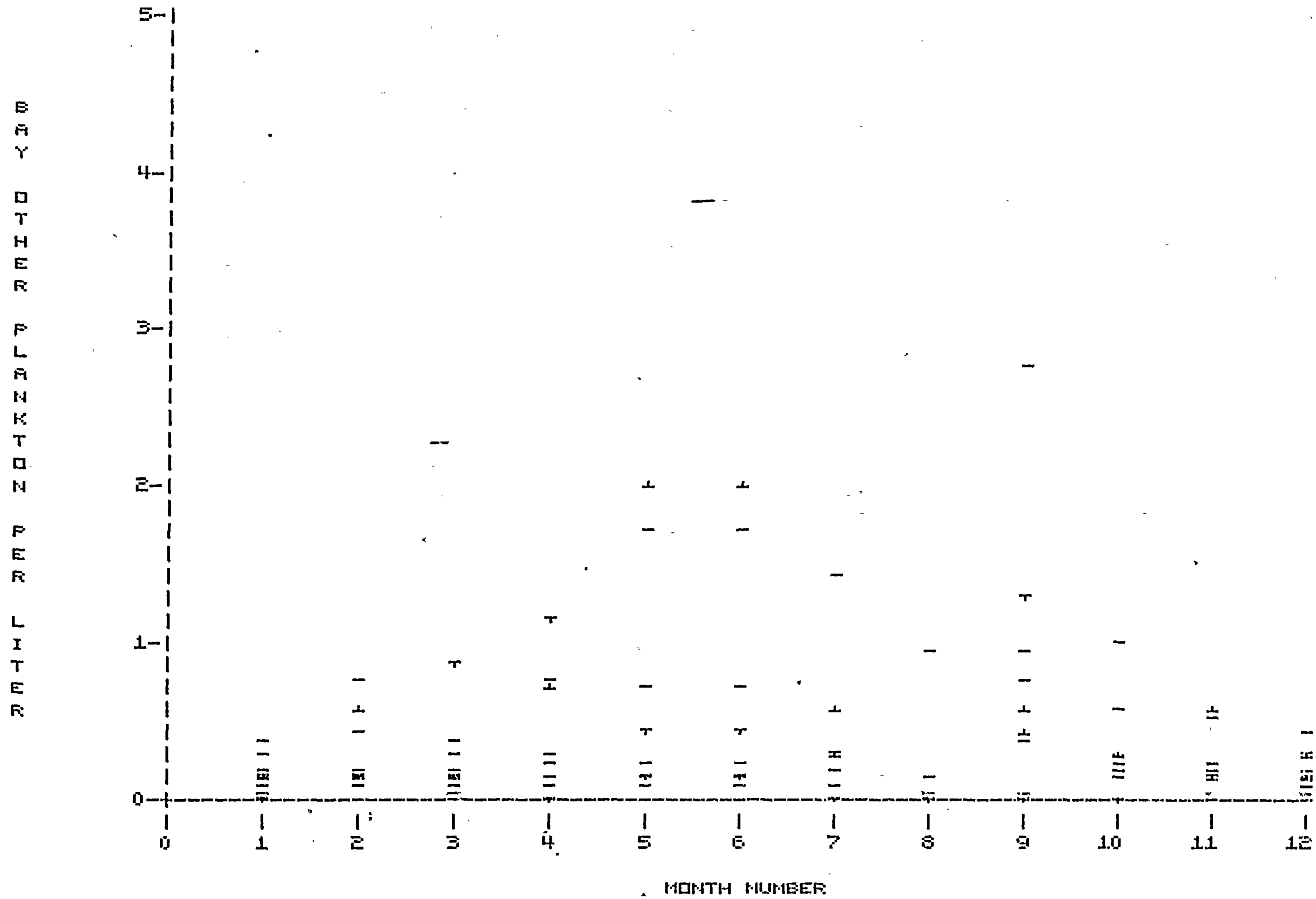


Figure 12. Other plankton found in the Bay and Card Sound area, but not included in any of the major categories.

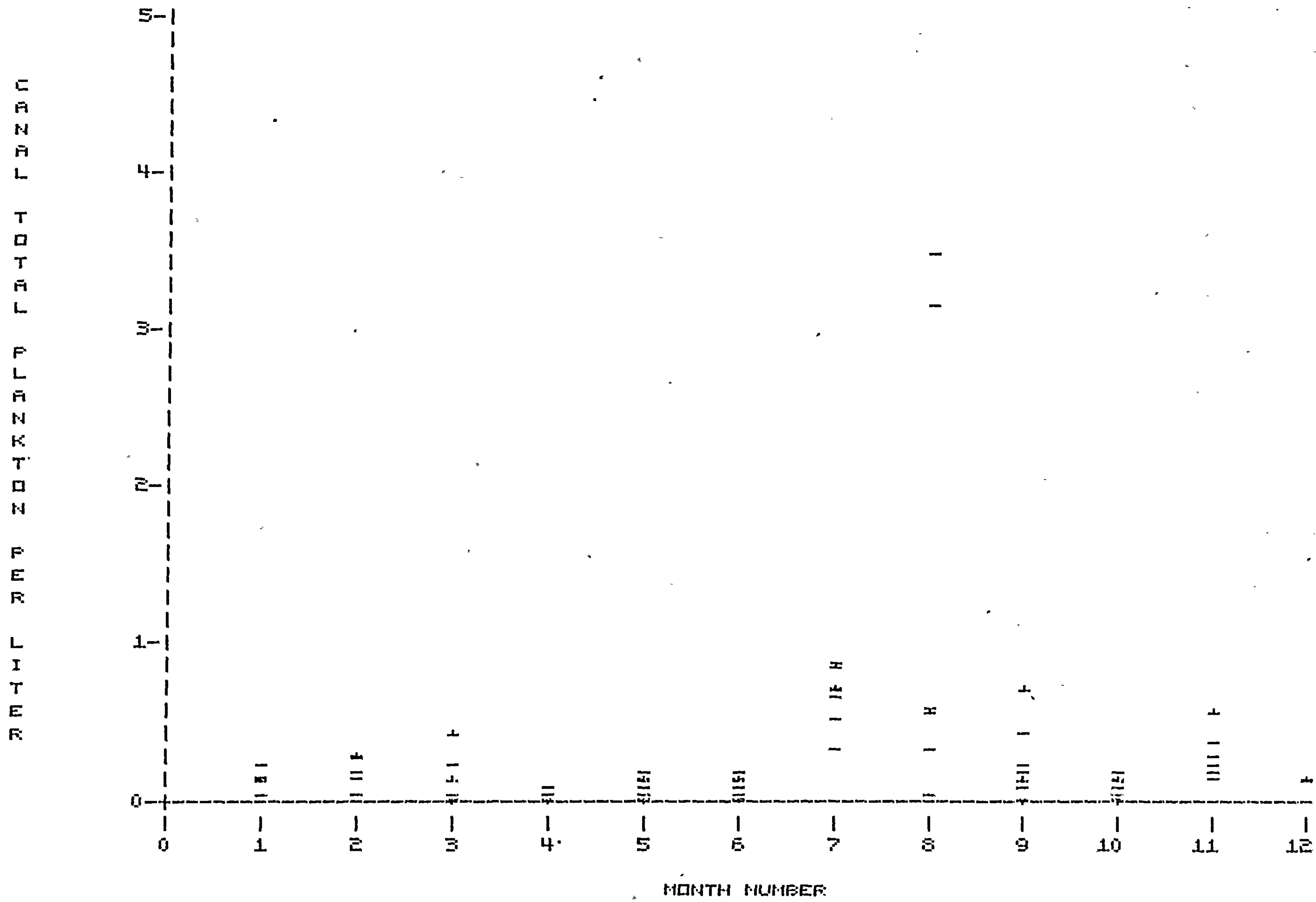


Figure 13. Total Plankton per liter in the Canal System.

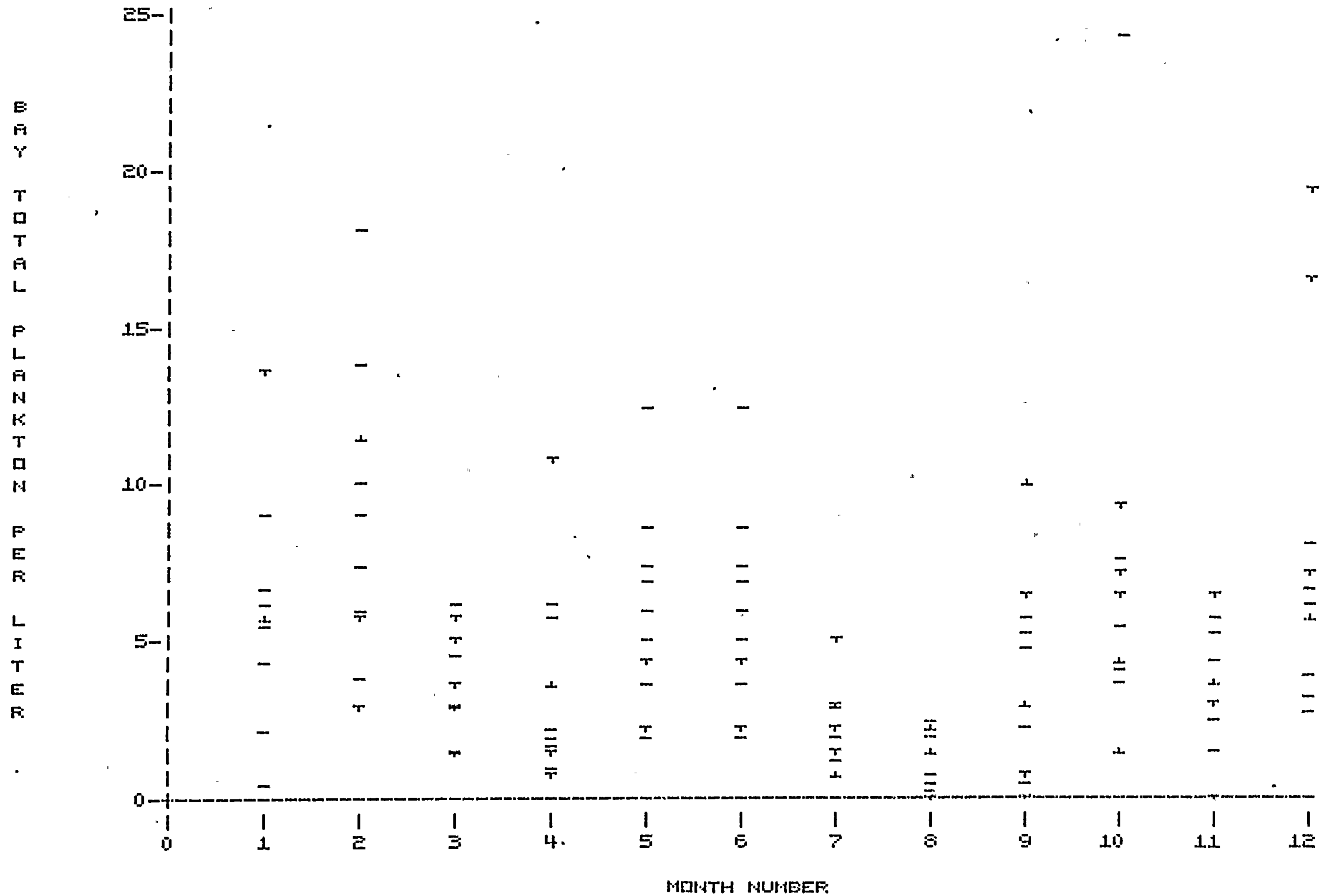


Figure 14. Total Plankton per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Total Plankton scale is1/5 th this scale.

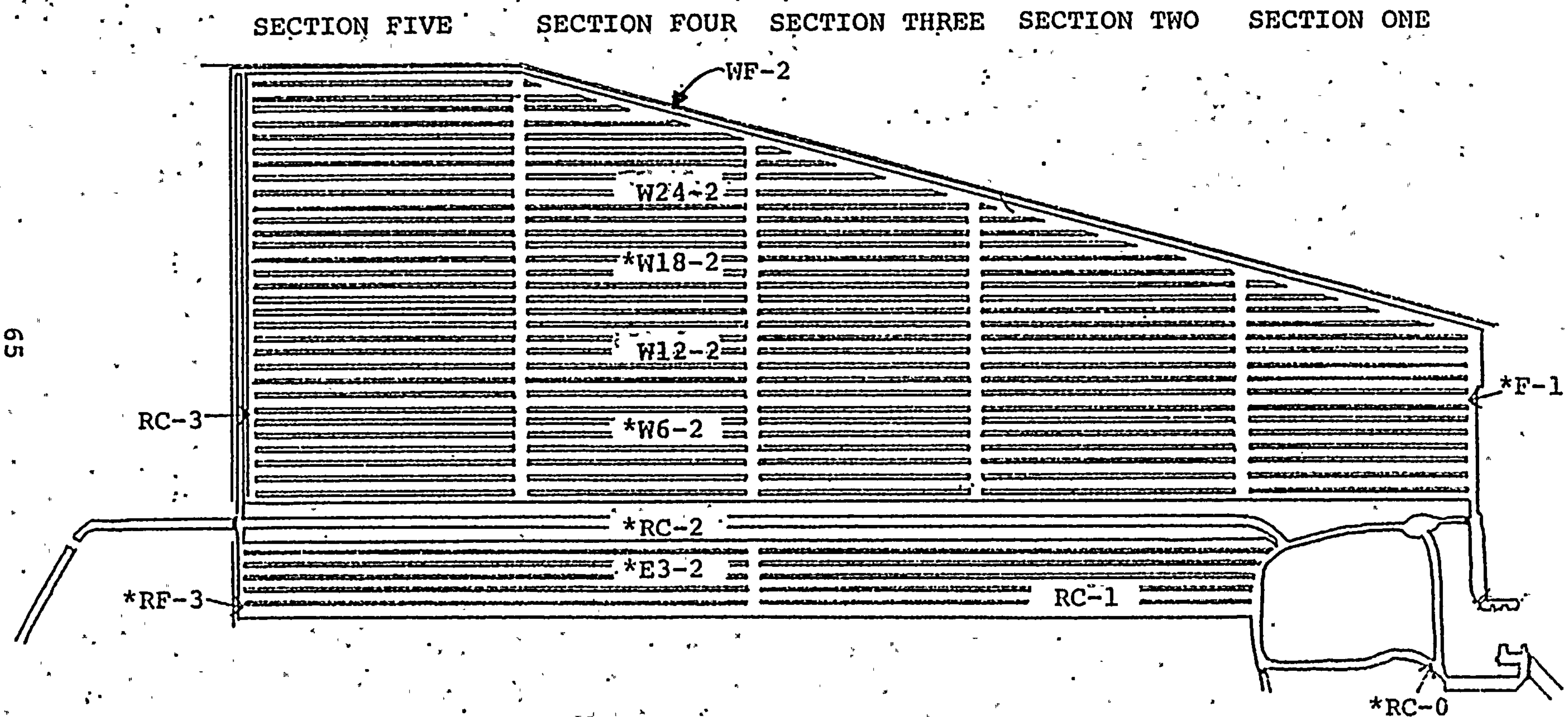


Figure 15. Turkey Point Plant Site & Cooling Canal System

*Zooplankton Tow and Chlorophyll "a" sample stations

Phytoplankton sample at each station

2. PHYTOPLANKTON

Report on the Microbiota
of the Turkey Point Area
July through December, 1977

Introduction

This report, which covers the period July through December 1977, presents the microbiota noted in lower Biscayne Bay, Card Sound and the Turkey Point Cooling Canal System. It shows the number of species and/or genera found, the number of occurrences of each, and the number found per 500 ml of raw water. It also discusses the relationships between certain organisms, those which have appeared for the first time in this six month period, and the possible significance of the various organisms.

Table 2 is a list of all the identified species and genera which were noted in the approximately 150 samples taken from July through December. The 500 ml samples taken at the same locations once a month were preserved in a 3-5% Formalin solution. Each sample was allowed to settle, decanted to about 30 ml, fixed in Lugols' Iodine, and further concentrated by centrifuging for 5 minutes at 2200 r.p.m. in conical ended tubes. Identification was performed on 1 drop of the concentrate which constituted a volume of approximately 1/16 ml. This drop usually contained debris, particularly in the canal samples, so that not all organisms were seen upon examination. Identification and

counting was made at 100 and 400 diameters, using 4 paths across a No. 125 mm square cover glass. At the low power the number of organisms in 4 paths equalled the number which could be found in 125 mls of raw sample. At the high power, the number of organisms in 4 paths equalled the number which could be found in 31.25 mls. of raw sample. Organisms 30 microns or less were counted at 400X.

This method yielded conservative results. Most debris either had a diameter of less than 30 microns or was transparent enough that larger organisms were easily seen. Organisms under 30 microns may have been hidden by debris and missed. The preservative sometimes blackened small dinoflagellates to a degree that plate and overall structure could not be distinguished, but cilia and flagella were still well defined. Thus Mesodinium rubrum, which tends to cytolize on preservation, was easily identified by its blackened symbiotic cryptomonads and cilia.

Table 1 shows the groups observed and the numbers of species, genera or other classification in each. Actually, the species list is greater than shown, because in several groups a small number of unidentified species were present, and several genera could be broken down to more than a single species. Also, the 14 groups of Metazoa (Table 3) were not separated into genera.

The 12 groups of algae and protozoa (Table 1) include all the free-living genera except Chloromonas and

Coccolithophora. Chloromonads are rare in marine waters except in some organically polluted conditions. Coccolithophora are common along the Atlantic Coast, and there is no accounting for their absence in this area. Marine flagellates are not abundant in the plankton, but they are predominately associated with salt water of good quality. Planktonic forms were 25 times as frequent in occurrence in the Bay samples as in the Canal samples. The planktonic forms were in small numbers and were of no particular significance in either bay or canal samples.

Table 1 shows three major groups of algae: 28 species of Blue Green Algae, 50 species of dinoflagellates, and 90 species of diatoms. All three groups occurred more frequently in the Bay than in the Canal. Ciliate protozoa were the only common animal form, and were most abundant in the Bay. Copepods, mostly nauplii, were the most common Metazoa. All seemed to be of the calanoid types with none of the harpacticoid types observed. Apparently, the Metazoa larval forms, with the possible exception of Gastropods, Nematoda and Rotifers, develop best in the Bay. Eggs of an unidentified plankton form were noted in the November and December Bay samples.

Identification was based on Dr. J. B. Lacky's 50 years of work with marine plankton, at Woods Hole, various locations in Florida, Plymouth, England, Newfoundland, Rio de Janeiro, San Deigo and Hawaii. There were still some

organisms which could not be identified, either because they were new, or because the light microscope used was not adequate for the task.

GROUPS PRESENT
(Bacteria)

Sulfur Bacteria

The sulfur bacteria, four in number, are not primarily plankton forms. Their normal habitat is the sediment-water interface. It was somewhat difficult to say which ones were alive when fixed, because the sulfur droplets do not retain their identity in the preserved material. It is probable that along with the four species listed *Beggiatoa minima* and *B. leptomitiformis* were also present. These organisms would most likely not be identified because of their small size, and absence of sulfur droplets. The six species were taken from Bergey's Eleventh Edition (2). The last report did not list sulfur bacteria, but the 1976 Report, July through December, listed two species. This genus is apparently abundant in the bottom of the canals where it metabolizes the sulfur in the bottom mud.

Sulfur purple bacteria and *Thiothrix* were not found in the Bay. The same is true of *Achromatium exaliferum*, a form often found in the Cutler Ridge portion of the Bay.

GROUPS PRESENT
(Algae)

Blue green Algae

This group tends to be associated with organic pollution and was well represented by low density populations averaging less than 1 organism per ml. However, most of them were colonial filaments or multi-cellular colonies in jelly so that the number of cells per liter should be materially larger. Only two species of Blue Greens were found in the Canals that were not found in the Bay, and 11 species were found in the Bay that were not found in the Canal. Coccochloris is not regarded as a valid genus by Bourelly (3), but in many of the samples there were small single cells blackened by the iodine which could have been this genus. They could have also been Holopedium irregulars, or the green algae Nannochloris or Chlorella. Coccochloris (Aphanocapsa) was certainly present in the area, but no counts were given in Table 2.

Anabaena microscopica p.n. is of dubious status. It is filamentous with vivid blue green cells about 2 microns in diameter. No heterocysts or akinetes were seen, but the algae occurred with sufficient frequency to be given further consideration. Most of these species have been recorded in fresh water, with the exceptions of Anabaena microscopica sp. The ability to thrive under saline conditions is in striking contrast to that of the planktonic green algae which

are poorly represented in salt water.

Species identification of the genus Lyngbya and Oscillatoria was somewhat tenuous, especially when large numbers were not present. This was also true of Trichodesmium, which Bourelly regards as an Oscillatoria with red coloring.

Green Algae, Chlorophyceae

These algae vary from 2 to 10 microns in size. Counts and identification of preserved members of the planktonic green algae are therefore of questionable value. Halosphera, a large green algae was not noted in these waters, and Nannochloris was practically absent. At 400X small cells could be found, but they could not be easily counted in most of the Bay and in a few of the Canal samples. Some of these cells could have been Nannochloris, Coccochloris or Chlorella. The only counts were in the May Bay samples. In no case were these small cells sufficiently abundant to exert an ecological effect on the area other than to have a possible seeding effect if the environment were to reach an optimum for their development.

Volvocidae

Chlamydomonas sp. and Dunaliella salina were recorded in a single sample and, like Chlorella, were considered of no importance.

Pyramidomonas grossi is common in estuarine waters but is less frequent in more open waters. This was reflected

in samples containing 10 organisms per ml from the bay, and in a total absence in samples from the canals. The somewhat lowered salinities in estuaries may explain the higher numbers there. The earlier mentioned small Volvocidae are extremely difficult to count, and may represent a conservative figure.

Euglenophyceae

Cylindromonas sp. p.n. and Petalomonas sp. are typical sediment-water interface species, and both were recorded in the previous report. Euglena acus and E. deses are adventitious forms, and there is no ready explanation for their occurrence in the Bay. Eutreptia hirudoidea and E. viridis are common inshore marine forms which in abundance, are indicative of recent organic pollution. Dense blooms have been found below outfalls from sewage treatment plants in Peconic Bay, Long Island and Plymouth, England, where the sewage was untreated. Occurrence in both Bay and Canals was too sparse to be of importance.

Cryptophysidae

Cryptomonas sp. and C. marina are both sparse in open water. C. marina is a very large, dark red species. It has been found in deep water at Deerfield Beach. Cryptomonas sp. is identifiable only in the living condition. The Rhodomonas found probably includes only R. baltica. Rhodomonas seems to prefer only water of high quality, as

indicated by its occurrence only in Bay samples.

Silicoflagellida

Dictocysta fibula contains no chlorophyll and is holozoic in nutrition. It is usually common in open inshore waters, but high densities have never been noted in this area. It occurred in the Bay only in August, 876 per liter; September, 2736 per liter; November, 32 per liter; and December, 256 per liter. This appears to be a good example of a seasonal fluctuation in Bay water since it occurred in three stations in August, 10 stations in September and then dropped out of all but single occurrences in November and December.

Dinoflagellida

Dinoflagellates were second in numbers of species in the area. More than 49 species were recognized in the Bay and 22 species in the Canals. The larger species were almost lacking in the Canals, whereas they tended to recur in the Bay. The only dinoflagellates which occur consistently in both Canal and Bay were small and large Gymnodinium. These are distinguishable by gross outline alone, and probably include such species as G. agile and G. aeruginosum. Some good specimens of G. aeruginosum, G. granmaticum, G. hamulus, G. incertum, G. simplex and others were also seen.

Most of the identified species have been noted in

previous reports. Gyrodinium pingue and Torodinium robusta cytolize badly upon fixation, and counts of these two may be far too small. Gymnodinium breve was recorded for the first time in October. Gymnodinium breve is a notorious killer of fish and other animal life along the West Coast of Florida and elsewhere. There is as yet no evidence that it has become endemic along the Atlantic Coast. Recently, Dr. Beatrice Sweeny of Yale has reported that Pyrodinium bahamiense is a cause of fish mortality in Indonesian waters. This dinoflagellate is endemic here, and should be watched carefully.

When the Canals were first put into operation, they contained a population similar to that of the Bay. During the ensuing years some canal populations steadily declined in species and density as compared to the Bay. Gymnodinium and some species of diatoms appear to be the exception to this decline. There are several possible reasons for the decline. The Canals are a closed system and therefore lack the normal input of nutrients. Salinity is gradually increasing and the temperature, instead of fluctuating seasonally, tends to remain at moderately high levels throughout the year. These temperatures are at or near the critical levels for plankton. The canal system with its roughly two-day recycling, must represent a hostile environment for most of the endemic species, particularly at the discharge. Table 2 reflects this trend.

The only new dinoflagellates found this period were Gymnodinium breve, and Amphidinium latum. Peridinium umbonatum is normally a fresh water species. It may have been incorrectly identified here, or it may have been introduced into the west side canals via Interceptor Ditch pumping. Pouchetia sp., an easily recognized genus, was not found during this 6 month period, but it was present in the preceding 6 month's report.

Cells incertae sedis

This final group in Algae consists of those cells which because of their morphology, apparent organization, and distribution among the debris on the slides, are manifestly living organisms, but which could not be placed with certainty in any particular group. Some were probably protozoa, and some may have been spores or even artifacts or debris. However, because the criteria of self movement, color due to chromatophores, and cytoplasmic color were not met, they could only be lumped into a category of small cells. Their principal importance here is that they either consume nutrients, saprozoically or holozoically, or they become food for other predators.

GROUPS PRESENT
(Protozoa)

Mastigophorea. (Flagellated protozoa)

Very few of these were present in the plankton, although they are abundant in the sediment-water interface. It seems

incredible that no Monas or Oicomonas showed up in these inshore waters, although Norris (4), in a careful study of "Phytoplankton" in Wellington Harbor, New Zealand, found only a limited number of colorless species.

The minute elongated organism, tentatively called *Bodo elongata*, occurred consistently in small numbers. Four species of unidentified zooflagellates were seen occasionally in the Bay and are of no particular significance.

Rhizopodea

A single amoeboid species seen in two samples and an unidentified shelled rhizopod seen once merit no further comment.

Ciliophorea

This is the third largest group of microorganisms. It is also the group whose species seem to recur most frequently. The more than 28 species in this report period did not include 8 of the species in the previous period. More than 13 of the present list did not occur in the previous list.

Most of the ciliates are large and varied enough that identification is easy. *Coxiella* and *Dictocepta lipida* were extremely difficult to identify. Probably, the most difficult to identify was *Tintinnopsis bermudensis*. The shell of this ciliate has a tall collar which spreads at a small angle. The body of the shell is round, yellow in

color and has a posterior spine which is about ½ as long as the body. This ciliate was very unlike a tintinnid.

Perhaps too much dependence was placed on the shape and markings of the empty frustules. Hendey (5) once stated that he could only identify diatom species when he had cleaned frustules. But, there are species such as Nitzschia sigmoidea or Asterionella formosa which are recognizable at once when seen, either as cleaned frustules or alive.

A number of diatoms were recorded for the first time in this study. In some cases they were present before, but were not correctly identified. Others were simply included under "unidentified species". Amphiprora alata and A. paludosa could fit into either of the above categories. Both are listed in Hustedt (7) and Bourelly as fresh water species, but Hustedt says that they also occur in salt water. Navicula amphibola was also a first record, but Hustedt lists it as fresh water, and it may really be N. pusilla. Perhaps the most striking first occurrence is Podocystis adriatica. The several occurrences of this diatom were quite unlike those in the figure in Hendey (5). All were alike and closely resemble Figure E in Plate One, by Hargraves.

There were two diatoms which may be new species. One was given the temporary name Licmophora incurvum and the other was called Amphora pellucida. L. incurvum has long

been common at Turkey Point, where it grew in great numbers attached to glass slides suspended in the Canals. There is nothing like it in Hendey (loc. cit.), while Bourelly (loc. cit.) does show and describe Actinella as a curved, transversely striated, heteropolar, colonial genus with a short raphe and pseudoraphe. More careful study may show the diatoms to be Actinella, although there were no visible transverse striae. Bourelly terms it a heteropolar Eunotia.

The other possible new specie was termed Amphora pellucida because of the clarity of the actual frustule. No more than a hint of its outline was visible which is much less than in the case of the frustule of Aptheya. Like that diatom, its chromatophore(s) were in a small, somewhat irregular mass. In counting, only these masses could be seen. Therefore, the counts, as well as the description, were not extremely accurate. It was not noticed until November and, while fairly abundant, was confined to the Canal.

Diatoms were the most abundant of all the organisms. While forms like Cyclotella and Navicula were abundant in the Canals, no blooms were seen. However, it appears unlikely that there will be blooms, such as sometimes occur for Rhizosclenia or Chaetoceras, in either the Bay or the Canals.

The 13 metazoan groups illustrate, very well, that a

varied environment is more conducive to a more varied biota than the somewhat restricted one found in the Canals. Six of the 13 types did not occur in the Canals, and the water mite was the only detritus feeder. The nematodes which were most abundant in the Canals were typically bottom dwellers. This holds true also for the gastropods, unless the particular gastropods noted here were a species which is epizoic. Copepod nauplii were present in somewhat larger numbers in the Canals than was expected, but many probably represented some sort of a relic population.

Discussion

All of the groups shown in Table 2 vary in numbers of species and densities of population except the Sulfur Bacteria and the diatoms in the Bay. The Bay populations have been increasing, whereas there has been a gradual decrease in the Canal biota. The exception to this trend is the diatoms. This says very plainly that the Canal is a restrictive environment and that its biota will decrease, slowly, until it reaches some sort of plateau. This plateau could be sterility, but will apparently stop short of sterility. For one thing, bottom dwelling species will continually find the sediment-water interface a suitable habitat. They can then be swept into suspension in large numbers and show up as plankton. This seems particularly true of sulfur bacteria and various diatoms, as well as ciliates Strombidium

spp. and Stromilidium spp. It is also probably true of large and small Gymnodinium which live near the bottom and feed on bacteria.

It seems that some of the diatoms remain in the Canals long enough to reproduce, so that there is a constant replenishment of the population, exceeding or equal to the numbers lost due to the adverse Canal environment. This would be true of the smaller diatoms, the ciliates Strombidium and Strobilidium, and the smaller Gymnodinium. The browsing habits of these two ciliates would keep them near the bottom where the bacteria are the most numerous. Delany (8) has shown that a small dinoflagellate Amphidinium avoideum absorbs its nutrients autotrophically. Two small dinoflagellates recently described by Ballentine (9) undoubtedly live autotrophically since the Canals are shallow and fully exposed to the sunlight. They are probable members of the groups for which species cannot be determined.

Nutrients are not necessarily limiting. The rocky bottom of the Canals is overlain by a thin layer of debris and sediment which is presumably still providing soluble nutrients. Rainfall should provide some nutrients vai run-off from the berms, however O-PO_4 is probably still in limiting quanities.

Temperature in the Canals is uniformly higher and with less seasonal fluctuation than that in the Bay. This relatively stable higher temperature will surely cause species shift, and/or exert a general inhibitory effect.

Presumably, the decline in the Canals is a multiple factor effect.

TABLE 1

Groups of Microbiota present in
150 samples from the Turkey Point area.

	No. Species	Occurance In Bay Samples	Occurance In Canal Samples
Sulfur Bacteria-Beggiatoales	4	12	4
Blue Green algae	28	168	152
Green Algae and Volvocales	4	36	7
Euglenophyceae	6	20	13
Cryptophyceae	2	43	4
Silicoflagellata	1	14	0
Dinoflagellata	50	920	238
Diatoms	90	794	823
Amoeboid Protozoa	2	2	0
Flagellated Protozoa	4	25	1
Ciliate Protozoa	28	271	31
Metazoa	13		
Copepoda		59	33
Crab larvae		3	0
Bivalve larvae		12	1
Gastropod larvae		9	9
Unidentified larvae		11	3
Tunicate larvae		8	0
Polychaete larvae		3	3
Plutei		2	0
Coelenterata		1	0
Nematoda		0	8
Rotifera		6	5
Water mite (Hydracarina?)		0	1

TABLE 2

A list of planktonic microorganisms, and numbers per 500 ml, from 13 stations in the lower Biscayne Bay - Card Sound area, and 12 stations from the Cooling Canal System at Florida Power & Light Company's Turkey Point Power Plant, July through December, 1977. (p.n. indicates a provisional name.)

GENERA/SPECIES	NOS. PER 500 ml BAY	CANAL
Sulfur Bacteria		
Beggiatoa alba	140	124
Beggiatoa arachnoidea	24	20
Beggiatoa gigantea	68	4
Beggiatoa mirablis	22	4
Blue green algae		
Anabaena microscopica p.n.	0	484
Anabaena bornetiana (red)	76	0
Anabaena sp.	32	0
Aphanocapsa grevillei	104	0
Arthrospira jenneri	32	0
Chroococus gigantea	292	16
Chroococus planctonica	264	152
Coelosphaerium kuntzingianum	0	92
Coelosphaerium nagelianum	32	0
Coccochoris sp.		
Gleocapsa sp.	64	0
Gleotheca linearis	8	0
Gomphosphaeria aponina	746	0
Johannesbaptsia pellasida	358	68
Lynbya limnetica	470	928
Merismopedia glauca	416	64
Merismopedia punctata	3214	64
Merismopedia sp.	64	0
Microcystis incerta	2884	0
Oscillatoria minor p.n.	1918	152
Oscillatoria sp. red, 10 u	60	0
Oscillatoria sp. red, 7-8 u	464	16
Oscillatoria sp. 10-12 u	32	16
Oscillatoria sp. 20 u	32	0
Schizothrix calcicola	568	1608
Spirulina major	288	64
Spriulina minor	1232	196
Trichodesmium sp.	320	300

TABLE 2 (CONTINUED)

GENERA/SPECIES	NOS. PER 500 ml BAY	CANAL
Chlorophyceae, Green Algae		
Chlorella spp.	10700	0
Volvocidae		
Chlamydomonas sp.	36	32
Dunaliella (salina?)	64	0
Pyramidomonas grossi	10544	0
Euglenophyceae		
Cylindromonas sp. p.n.	32	0
Euglena acus	0	0
Euglena deses	0	0
Eutreptia hirudoides	26	64
Eutreptia viridis	1090	832
Petalomonas sp.	128	16
Cryptophysidae		
Cryptomonas marina	32	0
Cryptomonas sp.	254	32
Phodomonas baltica	8856	32
Silicoflagellata		
Dictyocysta fibula	1962	0
Dinophyceae		
Amphidinium latrum	100	0
Amphidinium crassa	160	0
Amphidinium operculatum	64	64
Amphidinium sp.	672	128
Ceratium furca	1284	104
Ceratium fusus	162	36
Dinophysis tripos	16	0
Diplopsalis lenticularis	336	0
Exuvialla (apora?)	104	0
Exuvialla marina	660	792
Exuvialla minor	420	5174
Goniodama polyedricum	16	0
Gonyaulax diegenesis	4	0
Gonyaulax digitale	0	4
Gonyaulax (cateneta) (not monilata)	40	0
Gonyaulax triacantha	76	0
Gonyaulax sp.	100	64
Gymnodinium aeruginosium	0	8
Gymnodinium albulum	3856	1344
Gymnodinium breve	188	0
Gymnodinium sp. (large)	17427	34432
Gymnodinium sp. (small)	31602	12936

TABLE 2 (CONTINUED)

GENERA/SPECIES	NOS. PER 500 ml BAY	CANAL
Gymnodinium splendens	1724	552
Gyrodinium lachryma	312	0
Gyrodinium pingue	5692	960
Peridinium conicum	12	0
Peridinium depressum	80	0
Peridinium divergens	356	0
Peridinium globulus	392	0
Peridinium latum	1109	0
Peridinium longum	12	0
Peridinium obtussum	708	0
Peridinium pentagonum	4	0
Peridinium triangulatum	32	0
Peridinium trochoideum	6064	480
Peridinium tuba	368	128
Peridinium imbonatum	160	0
Peridinium sp.	2188	476
Peridiniopsis rotumdata	982	36
Polykrikos schwartzi	8	0
Prorocentrum gracilis	288	0
Prorocentrum micans	548	0
Prorocentrum triangulatum	720	0
Protocuratium reticulatum	8892	12
Protodinium sp.	1156	36
Pyrodinium bahamiensis	1064	4
Pyrophacus horologicum	24	8
Torodinium robusta	96	0
Unidentified	9244	0
Diatoms		
Achnanthes calas	0	4
Amphiprora alata	12	0
Amphiprora biscayensis	0	21632
Amphiprora minuta	192	284
Amphiprora paludosa	0	796
Amphiprora small	0	355
Amphiprora sp.	104	1320
Amphora alata	104	468
Amphora ovalis	1500	20036
Amphora paludosa	0	72
Amphora small	48	392
Bacteriastum	216	0
Biddulphia	4	8
Caloneis ladogensis marine?	148	0
Campylodiscus fustuosus (samoensis green)	64	0
Campylosira cymbelliformis	64	0
Campylosira sp.	64	0
Chaetoceras sp.	190852	0

TABLE 2 (CONTINUED)

GENERA/SPECIES	NOS. PER 500 ml BAY	CANAL
DIATOMS (CONTINUED)		
Cocconeis diminuta	384	160
Cocconeis hustedti	1904	864
Cocconeis plancentula	760	0
Caloneis sp.	0	36
Cossinodiscus concinnus	40	4
Cossinodiscus sp.	113	0
Cyclotella cantenata	864	0
Cyclotella glomerata	0	640
Cyclotella meneghiniana	1120	3520
Cyclotella nana	832	2320
Cyclotella sp.	32	0
Cymatopleura solea	4908	4288
Cymbella sp.	260	804
Diploneis interrupta	28	40
Diploneis n. puella	32	0
Diploneis ovalis	32	0
Diploneis sp.	8	0
Fragilaria sp.	32	0
Gramatophora sp.	112	0
Gyrosigma attennatum	36	0
Gyrosigma augusta	392	28
Gyrosigma balticum	0	8
Gyrosigma major p.n.	0	4
Gyrosigma minor	32	3796
Gyrosigma spenceri	0	12
Gyrosigma (pleur) tonuissima	0	176
Syrosigma sp.	0	8
Licmophora abbreivata	644	128
Licmophora ehrenbergii	520	60
Licmophora flabellata	140	252
Licmophora incurvum	88	1496
Meolsira granulata	0	64
Meolsira monilata	12	0
Navicula amphibola	564	384
Navicula pandura	148	0
Navicula spp.	50316	125234
Nitzschia acicularis	1468	228
Nitzschia actinastrodes	108	0
Nitzschia closterium	2328	2888
Nitzschia longa	404	108
Nitzschia paradoxa colony	4	0
Nitzschia sigmoidea	12	108
Nitzschiaiella acutissimus	40	132
Opephora martyi	160	0
Peridinium longum	12	0
Pinnularia sp.	8	16

TABLE 2 (CONTINUED)

GENERA/SPECIES	NOS. PER 500 ml BAY	CANAL
DIATOMS (CONTINUED)		
Pleurosigma elongtum	0	8
Pleurosigma fasula v. closterides	268	456
Pleurosigma gigas	0	4
Pleurosigma nicobarium	92	148
Podocystis ardriatica	0	32
Rhabdonima minutum	32	60
Rhapododia sp.	32	0
Skellotonema costatum	96	0
Striatella delicatula (?)	236	0
Striatella interrupta	2084	52
Striatella unipunctata	88	52
Surirella striatula	0	120
Synedra actinatroides	16	0
Synedra acus	704	44
Synedra biceps	200	20
Synedra capitata	8	0
Synedra crystallina	60	36
Synedra crystallina (biceps?)	272	0
Synedra longa	384	16
Synedra longa (gaillone?)	0	56
Synedra superba	284	4360
Synedra ulna	2204	1156
Syndrea undulata	176	220
Tabellaria	152	0
Thalassionema	32	0
Thalassiosira sp.	7556	0
Thalassiothrix sp.	12	0
Tropidoneis	16	44
Diatoms Unidentified	1334	12132
Cells incertae sedis	57456	29212
Cilophorea--Ciliated Protozoa		
Askenasia volvox	136	0
Aspidisca costata	4	0
Coxliella sp.	8	0
Cyclidium glaucoma	32	64
Dictyocysta lipida	4	0
Dysteria sp.	4	0
Favella panamensis	88	0
Mesodinium pulux	64	0
Mesodinium rubrum	332	0
Metacylis angusta	132	0
Metacylis jurgensis	526	4
Metacylis lucasensis	20	0
Strobilidium spp.	6288	4

TABLE 2 (CONTINUED)

GENERA/SPECIES	NOS. PER 500 ml BAY	CANAL
CILOPHOREA--CILIATED PROTOZOA (CONTINUED)		
Strombidium conicum	24	0
Strombidium strobilius	140	16
Strombidium spp.	6052	1006
Tintinnopsis bermudensis	24	0
Tintinnopsis beroidea	44	4
Tintinnopsis corona	4	0
Tintinnopsis lindeni	4	0
Tintinnopsis minuta	700	64
Tintinnopsis platensis	104	0
Tintinnopsis prowazeki	12	0
Tintinnopsis rotundata	264	0
Tintinnus apertus	68	0
Tintinnus sp.	12	0
Tontonia ppendiculata	12	0
Unidentified	744	252
Zoomastigophorea. Colorless Flagellates		
Bodo elongata p.n.	4	36
Chilomonas marina	12	0
Spirochaeta (plicatilis?)	4	0
Unidentified species	24	0
Rhizopodea. Amoeboid Protozoa		
Amoeba sp.	0	0
Shelled rhizopod. Unidentified	4	16

TABLE 3

Groups of Metazoa present in
150 samples from the Turkey Point area.

	NO. KINDS		NO. PER 500 ml	
	BAY	CANAL	BAY	CANAL
Copepoda, mostly nauplii	47	26	188	104
Gastropoda	9	9	36	36
Bivalve	12	1	48	4
Plutei	2	0	8	0
Larvae, unidentified	11	3	48	12
Tunicate larvae	8	0	32	0
Crab larvae	3	0	12	0
Medusae	1	0	4	0
Polychaeta	3	3	12	0
Nematoda	1	7	4	28
Rotifera	7	2	28	8
Water mite	0	1	0	4
Eggs	11	0	44	0

REFERENCES

1. Thomsen, H.A. 1976. Studies on Marine Choanoflagellates. II Five structural observations on some silicified choanoflagellates from the Isefjord (Denmark), including the description of two new species. Norwegian Journal of Botany, Vol. 23, No. 1.

2. Bergey's Manual of Determinative Bacteriology. Seventh Edition. 1957 Breed, Robert S., E. G. D. Murray and Nathan R. Smith. Williams and Wilkins Co. Baltimore.

3. Bourelly, Pierre. 1970. Les Algues d'eau douce. Initation a la Systematique. III Les Algues bleues et rouge. Editions N. Boubee et Cie. Paris.

4. Norris, Richard E. 1964. Studies on Phytoplankton in Wellington Harbour. New Zealand Journal of Botany, Vol. 2, No. 3.

5. Hendey, N. Ingram. 1964. An Introductory Account of the Smaller Algae of British Coastal Waters. Part V Bacillariophyceae (Diatoms). H. M. S. Stationery Office.

6. Gran, H. H. and E. C. Anyst. 1931. Plankton Diatoms of Puget Sound. Pub. Puget Sound Biological Station, Vol. 7, pp. 417-519.

7. Hustedt, Friedrich. 1976 (reprint from 1930). III Bacillariophyta (Diatomeae). In Die Susswassecflora Misteleuropas. Gustav Fischer Jena.

8. Delany, M. H. 1956. The Mass Culture of a Presumably Autotrophic Dinoflagellate. Am. Midland Naturalist, pp. 56-7, 128-132.

9. Ballantine, Dorothy. 1956. Two new marine species of Gymnodinium isolated from the Plymouth area. Journal, March Biol. Assn., Vol. 35, pp. 67-474.

NOTE: Lugols' Iodine has not been used for the past 2-3 years. A solution of potassium iodide, iodine and sea water has been used as a substitute.

3. CHLOROPHYLL "a", BIOMASS, AND PRIMARY PRODUCTION

Introduction

Chlorophyll "a", biomass, and primary production were determined monthly at eleven stations. Eight of these stations are located in the cooling canal system, and three are located in the Biscayne Bay/Card Sound area (Figure 1).

Methods

Chlorophyll "a" determinations were made by extracting the pigment from plankton concentrate with aqueous acetone. The optical density of the extract was then determined by spectrophotometric analysis using the trichromatic method.

Chlorophyll "a" is an algal biomass indicator (Creitz and Richards, 1955). By assuming that chlorophyll "a" constitutes 1.5 percent of the dry weight organic matter of the algae, algal biomass can be estimated by multiplying the chlorophyll "a" content by a factor of 67 (Std. Methods, 14th Ed.).

Knowing the mass of chlorophyll is very close to knowing primary production (Cole, 1975). This is especially true for chlorophyll "a". Estimates of primary production were calculated from chlorophyll "a" data using equations derived from Ryther and Yentsch, 1957. Surface radiation values were also taken from Ryther and Yentsch, 1957. Water transparency was determined by Secchi disk readings.

Discussion and Conclusions

The highest values for all three parameters studied in the cooling canals occurred in March (See Figures 1 & 2). The chlorophyll "a" concentration was 1.60 mg/m^3, the biomass concentration was 107.1 mg/m^3 and primary productivity was 0.16 $gc/m^2/day$. The lowest values occurred in November when the chlorophyll "a" concentration was 0.28 mg/m^3, the biomass concentration was 18.63 mg/m^3 and primary productivity estimate was 0.03 $gc/m^2/day$.

In Biscayne Bay and Card Sound, the highest values for the three parameters studied occurred in June. The chlorophyll "a" concentrations was 0.54 mg/m^3, the biomass concentration was 36.18 mg/m^3 and the primary productivity estimate was 0.32 $gc/m^2/day$. The lowest values occurred in February, when the chlorophyll "a" concentration was 0.11 mg/m^3, biomass concentration was 7.17 mg/m^3, and primary productivity was 0.06 $gc/m^2/day$.

In general, lower chlorophyll "a" and biomass concentrations were derived from the Bay samples. This is probably due to the lower nutrient levels found in the Bay. There is extreme competition for available nutrients in the Bay, with most of them being tied up by macrophytes.

The lowest primary productivity estimates were exhibited in the cooling canals at stations where water velocities were relatively high.

The primary productivity estimates were greater in the Bay than in the cooling canals in every month except February.

The higher estimates were probably due to greater light penetration and the corresponding higher extinction coefficients. The primary reasons for less light penetration in the canals are thought to be the high concentrations of tannin and lignins which produce color, and organic debris which produces turbidity. This color and turbidity should be expected from a disrupted mangrove situation.

Quite a large increase in primary productivity estimates occurred in June and July. This phenomenon was probably due to higher nutrient levels caused by increased rainfall in the latter half of May. Rain causes nutrients and land runoff to enter the Bay which in turn leads to build-ups of phytoplankton and benthic flora during the summer (Bader and Roessler, 1972).

Figure 1. Chlorophyll A and Biomass in the Cooling Canal System and Biscayne Bay. Mean values for all stations.

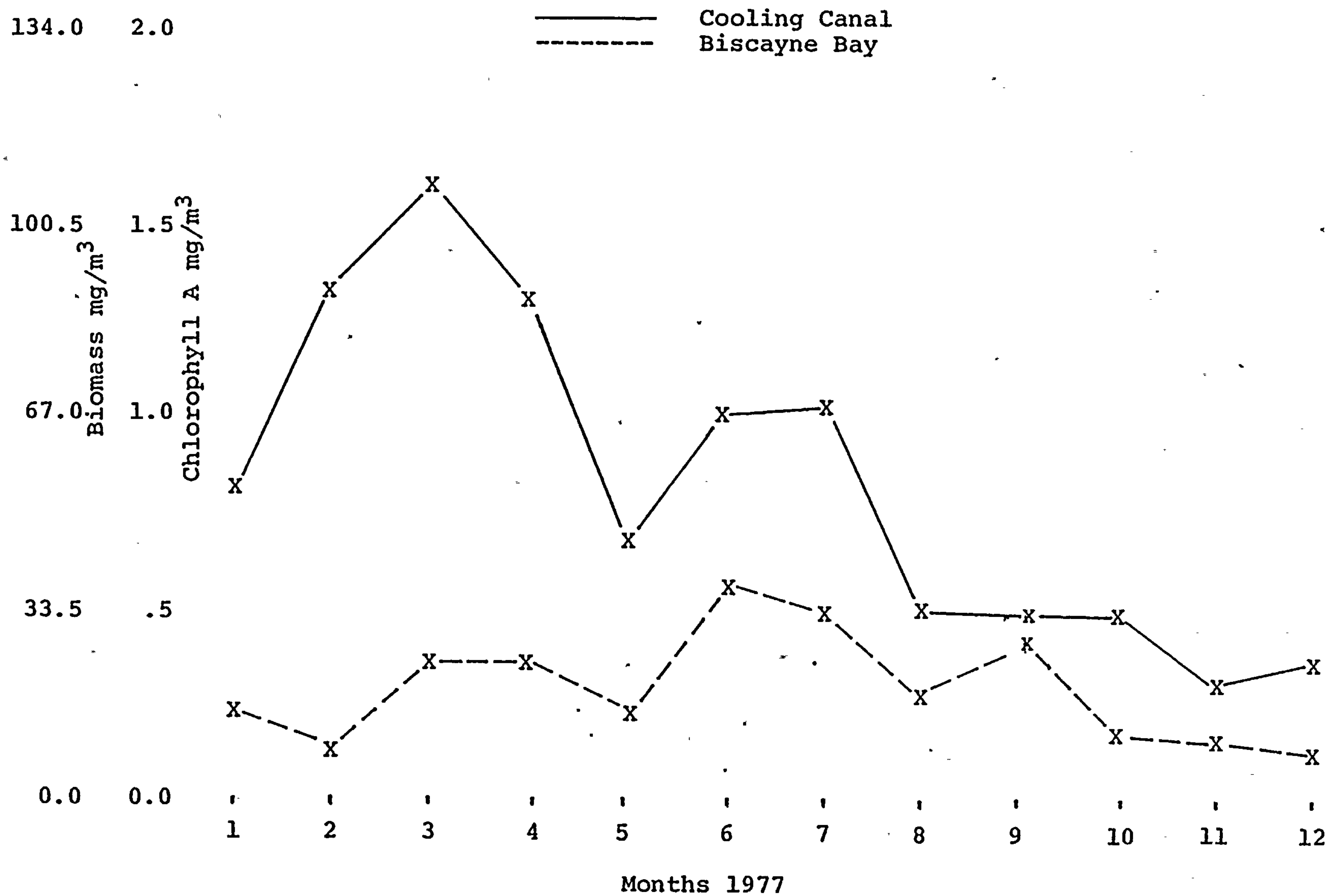
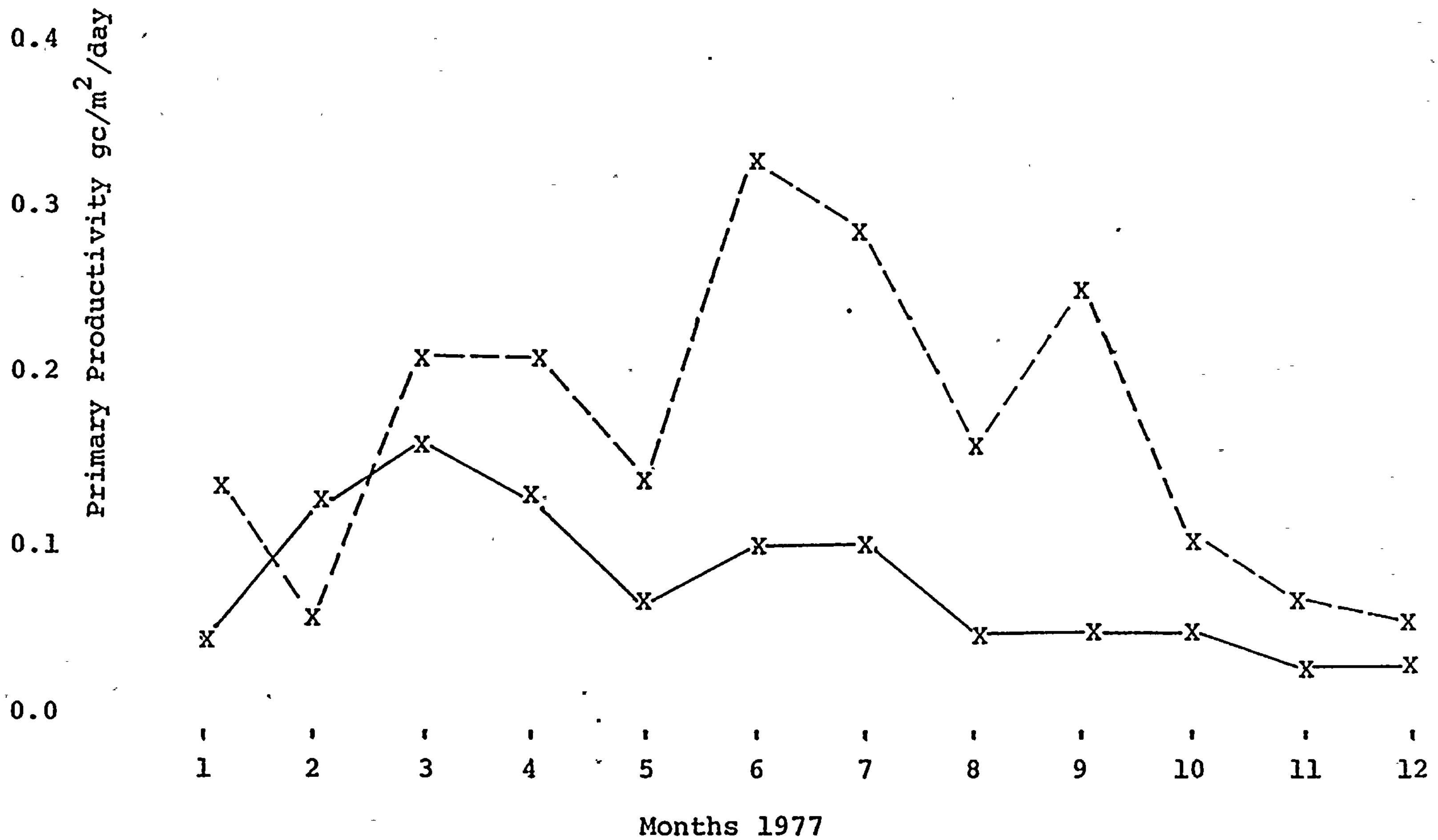


Figure 2. Primary Productivity in the Cooling Canal System and Biscayne Bay. Mean values for all stations.

——— Cooling Canal System
- - - - - Biscayne Bay



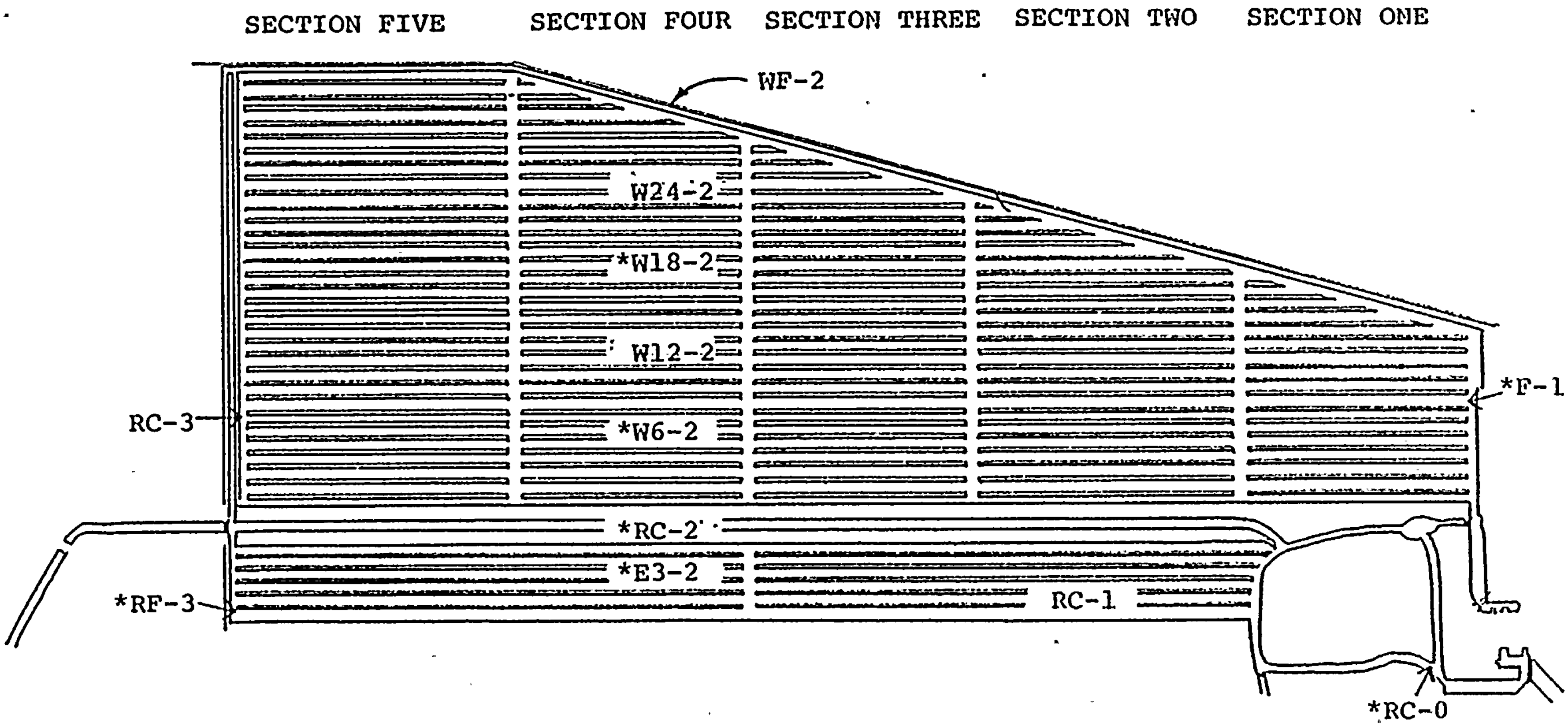


Figure . Turkey Point Plant Site & Cooling Canal System
*Zooplankton Tow and Chlorophyll "a" sample stations
Phytoplankton sample at each station

Literature Cited

1. Bader, R. and Roessler, M. 1972. An Ecological study of South Biscayne Bay and Card Sound. Univ. Miami RSMAS-72060

2. Cole, G. 1975. Textbook of Limnology. The C. V. Mosby Company.

3. Creitz, G., and Richards, F., 1955. The estimation and characterization of plankton populations by pigment analysis. J. Mar. Res. 14:211.

4. Ryther, J. and Yentsch C. 1957. The Estimation of Phytoplankton Production in the ocean from Chlorophyll and Light Data. Woods Hale Oceanographic Institute, Woods Hole, Mass.

5. Standard Methods for the Examination of water and waste water, 14th Edition, 1976.

III.J VEGETATION AND SOIL

1. Revegetation of the Turkey Point Canal Cooling System Berms

a. INDUCED VEGETATION

1) INITIAL STUDY

Method

The 30 species of grasses, shrubs, and trees planted during the 1973-74 season were checked quarterly for survival and vitality (Table 1). The parameter of vitality is an attempt to isolate those plants which could survive but are in some manner being inhibited in growth.

Discussion and Conclusions

Growth rates and vitality continued to be higher in the more organic areas and lower in the mucky clays. These trends were best observed in the species with excellent survival rates. For example, the Coccoloba uvifera (sea grapes), planted in organic soils, were as high as 10 feet and covered areas of $9m^2$ or more. Those sea grapes planted in the mucky clays, although seemingly healthy, remained small and exhibited little new growth. No induced vegetation of the initial study remained in the areas of extreme clay. Several of the sites have been overgrown by native plant species, particularly Conocarpus erectus (buttonwoods), with a resulting loss of vigor and increase in mortality to the test species.

Plants in the "Excellent" and "Good" survival categories generally exhibited "Good" vitality thus indicating a tolerance

to wind exposure and salty conditions on the berms. An exception to this was Cocculus larifolius which showed only "fair" survival but "excellent" vitality. It survived only in organic soils in areas that were protected by native vegetation from extreme sun and wind.

Generally, the patterns of mortality and vigor are unchanged since 1975.

Table 1. Average survival rates and vitality of the 1973-74 Initial Study Plantings on the Spoil Berms at Turkey Point Cooling Canal System. Data taken January 1978.

Vitality		
	Excellent (90% survival)	
Good	*Coccoloba uvifera*	Sea Grape
Good	*Conocarpus erecta*	Silver Button Bush
Good	*Scaevola friutescens*	Scaeval Shrub
Good	*Zoysia japonica*	Zoysia Grass
	Good (60-89% survival)	
Fair	*Pittosporum tobira*	Green Pittosporum
Good	*Rhaeo discolor*	Oyster Plant
Good	*Crinum asiaticum*	Crinum Lily
	Fair (30-59% survival)	
Fair	*Cocos nucifera*	Coconut Palm
Fair	*Pittosporum sp.*	Variegated Pittosporum
Good	*Zamia intergrifolia*	Coontee Evergreen
Fair	*Stenotathrum secundatum*	Bitter Blue Grass
Excellent	*Cocculus larifolius*	Snail Seed
	Poor (30% survival)	
Fair	*Eugenia uniflora*	Florida Cherry
Poor	*Cortaderia selloana*	Pampas Grass
Poor	*Hymenocallis palmeri*	Spider Lily

2) PROJECT SERENDIPITY

Method

Twenty-one species of trees and shrubs (Table 1) were planted at six stations (Figure 1), which cover the three major soil types found within the cooling canal system. This was done to assess not only their saline tolerances but also edaphic limitations relative to berm conditions. Plants were measured primarily for vitality and the ability to survive. This long term project is being supported in part by the U.S.D.A. Plant Introduction Station at Chapman Field.

Discussions and Conclusions

The initial concept of this project was to discover plants which could survive the severe edaphic and saline conditions of the berms. Two factors that were not adequately considered, wind and lack of edaphic consistency (similar to "marble cake effect" in the Soil Temp. Section) have proved to be major stumbling blocks in short term analysis.

Species planted in the clay and mucky clay areas were either dead or in such poor condition as to make their survival unlikely. The survival rate was much better in the organic areas, with Tabebuia, Thespesia populnea, Swietenia mahogoni, Acacia confusa, Mimusops, and Picrodendron macrocarpum doing well. A variety of other species are still surviving (Table 1).

Table 1. Project Serendipity species list, survival as a function of soil type as of January 1978.

	Clay	Mucky Clay	Organic
Acacia confusa		D	+
Acacia cornigera	-	D	D
Acacia farnesiana	-	-	+
Calophyllum calaba	D	D	
Cassia fistula	D	-	-
Cochlosperma vitifolium	D	D	
Cordia glabra	D	D	
Crinum sp.	-	-	-
Jacaranda acutiflolia	D	D	-
Jacquinia pungens		+	
Leucaena leucocephala	D	D	D
Mimusops commersonii	-	-	+
Moringa oleifera		-	
Pachira aquatica	D		
Parkinsonia aculeata	-	-	+
Picrodendron macrocarpum	D	-	+
Psidium guajava		D	-
Sapindus saponaria		-	
Swietenia mahagoni	D	+	+
Tabebuia avellenedae	D	D	
Tabebuia pentaphylla	D	-	+
Terminalia catappa		-	D
Thespesia populnea	-	-	+

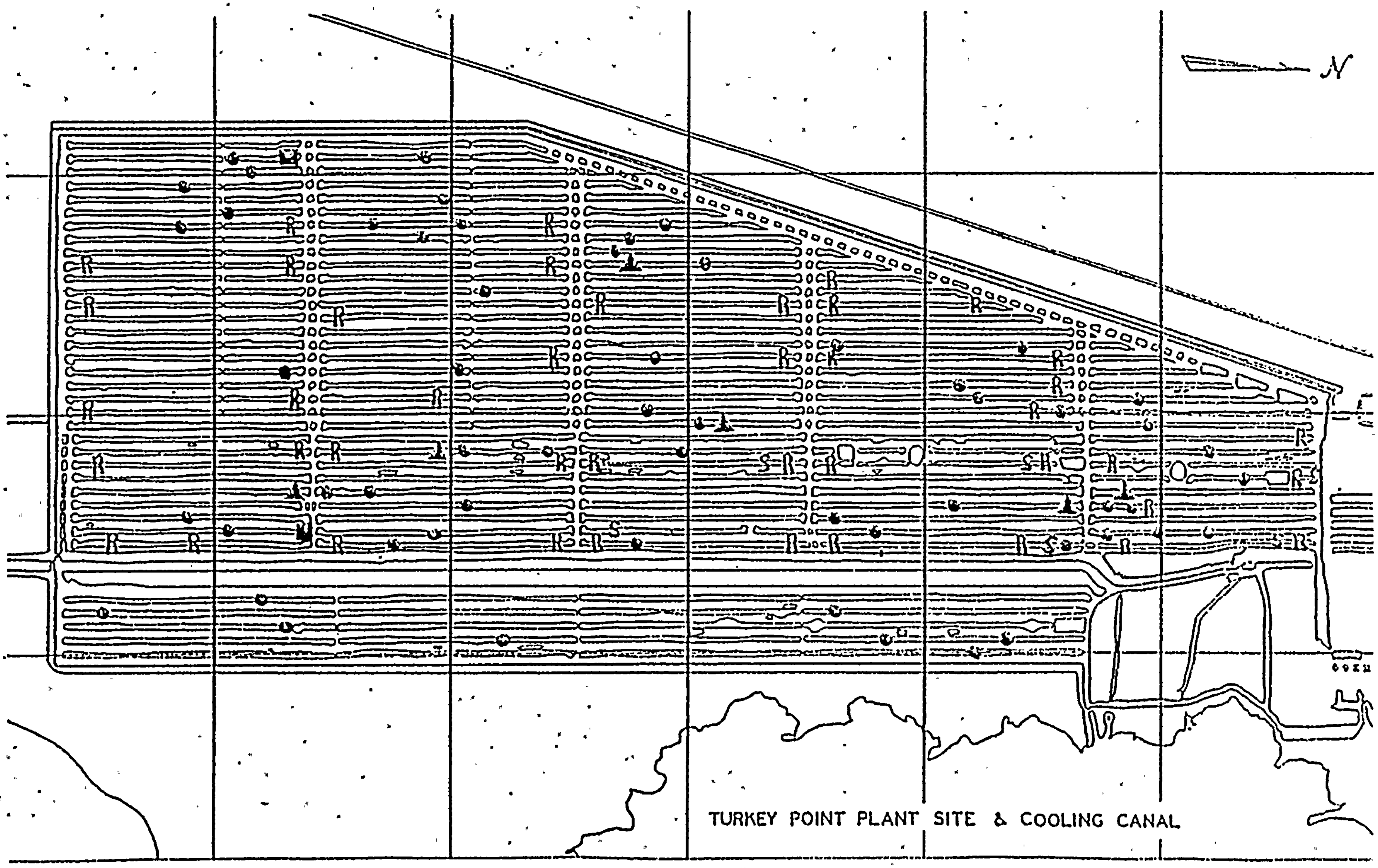
+ = fair to good growth and/or vitality

\- = poor growth and/or vitality

D = dead

Figure 1. Turkey Point Plant Site & Cooling Canal System

- ▲ Natural Revegetation and Soil Temperatures
- ● Soil Chemistry
- ■ Soil Erosion Test Sites
- R Revegetation - Induced "Initial Study"
- S Revegetation - Induced "Serendipity"



B. NATURAL REVEGETATION

Method

Six 100 square meter stations have been permanently staked out on the cooling systems spoil berms (Figure 1). A study of the most common species in the quadrats has continued (Tables 1-3).

Discussion and Conclusions

As no selective removal of Australian Pine (Causarina) occured in 1977, this noxious exotic increased by between 20 to 200 percent (Tables 1-3) at the four stations where it was found. The canopy of the trees present also increased markedly.

Salt grass, Distichlis spicata, is the major ground cover over much of the older berms and is rapidly invading the newer ones. This grass has rhizomes and roots spreading several feet deep, grows well even on clay soils and survives inundation in salt water. It will serve as excellent hurricane protection for the berms. Salt grass showed increases of 122 to 414 percent (Tables 1-3) at the four stations where it was found. These increases were as large on the clay soils as they were on the organic soils. A program of salt grass propagation through seed collection and planting might be beneficial in the attempt to control soil erosion on the berms.

Saw grass, Cladium jamaicensis, is another important specie which serves as ground cover and prevents soil erosion. It was found on three of the sample sites and showed large increases

to the point that it now covers one-third of the area of site 323S.

The buttonwood, Conocarpus erecta, was found on all of the sample sites. Although it did not increase in number at four of the sites (Tables 1-3), it can be seen as a major species on most of the berms.

The red mangrove, Rhizophora mangle, was found in only two of the stations, however it can be seen in abundance along the banks of all the berms. Most of the stations are centered on the berms, thus, with only two exceptions the canal banks are not sampled. These red mangroves help to hold berm banks in place.

Soil type continues to be the overt factor determining vegetative density. Heavy vegetation, Casuarina and Conocarpus being dominant, tends to occupy the old tidal creeks and hammock areas, while salt grass is dominant on the clay barrens.

The higher elevation caused by berm building has allowed sufficient edaphic changes to permit non-mangrove community species such as Baccharis halimifolia, Passiflora suberosa, and several Solanum species, among others, to progressively invade from the western side of the canal system. Schinus terebinthifolius, the exotic Brazilian Pepper tree, which is known for its aggressiveness is rapidly invading much of the cooling systems fringe areas.

The predicted rates of revegetation for the three species of major interest are: +25% for the Buttonwoods (Conocarpus erectus); +150% for the Salt Grass (Distichlis spicata); +100% for Saw Grass (Cladium jamaicensis).

Figure 1. Turkey Point Plant Site & Cooling Canal System

▲ Natural Revegetation and Soil Temperatures
● Soil Chemistry
■ Soil Erosion Test Sites

R Revegetation - Induced "Initial Study"
S Revegetation - Induced "Serendipity"

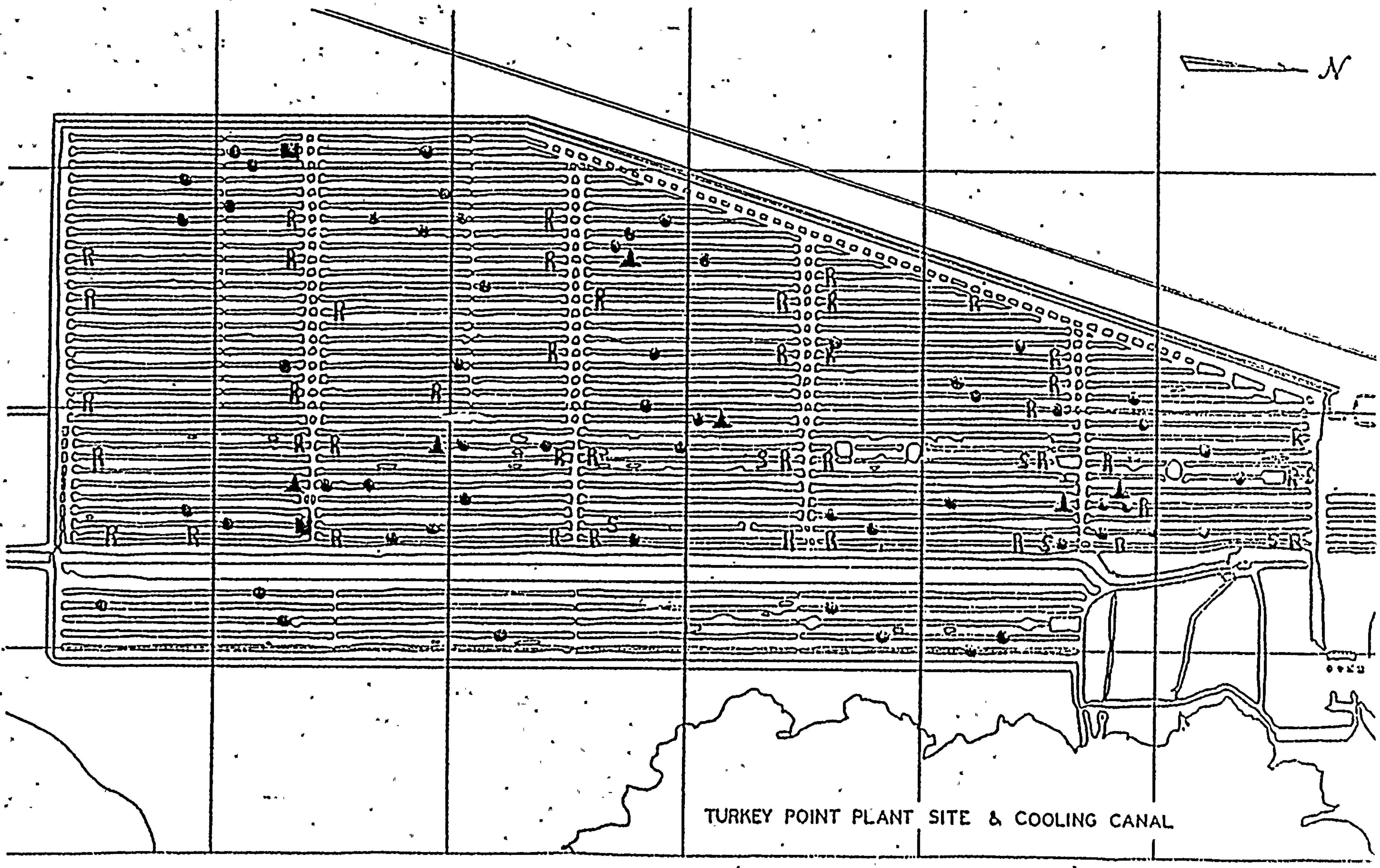


Table 1. Species counts in two medium density vegetation stations, 323S and 408M.

Station 323S

Species	Percent Change
Conocarpus erecta	+22
Causuarina sp.	+58
Cladium jamaicensis	1/3 Area
Baccharis halimifolia	+20
Juncus roemerianus	-61
Solanum donianum	+82
Ipomoea sagittata	+100
Pluchea rosea	Seasonal
Morrenia odorata	Present
Passiflora sp.	No Change
Eupatorium capillifolium	+33
Acrostichum sp.	+200
Schinus (Brazilian Pepper)	+100
Florida trema	New Species
Andropogon	+100
Astera	-37.5

Table 1. (CONTINUED) Species counts in two medium density vegetation stations, 323S and 408M.

Station 408M

Species	Percent Change
Sonchus oleraceas	No Change
Solanum sp.	-50
Conocarpus erecta	-140
Causuarina sp.	+60
Cladium jamaicensis	+366
Distichlis spicata	+414
Baccharis	No Change
Sabatia	+100
Pteris bitta	+52
Pylysteris sp.	-11
Aerostichum	-66
Eupatorium capillifolium	New Species
Pluchea	Seasonal
Andropogan	New Species
Morrenia odorata	New Species

Table 2. Species counts in two heavy density vegetation stations, 204N and 310N.

Station 204N

Species	Percent Change
Conocarpus erecta	No Change
Causuarina sp.	+220
Borrichia sp.	+215
Acrostichum sp.	+250
Solanum nigrans	+50
Solanum donianum	No Change
Chamaesyce mesembryanthemifolia	+300
Baccharis halimifolia	New Species
Pluchea sp.	New Species
Eupatorium capillifolium	New Species
Morrenia odorata	New Species
Physalis subglabrata	Seasonal New Species
Thelypteris normalis	New Species
Astera temifolia	New Species
Phytolacca americana	New Species
Thistle (Unidentified)	New Species

Table 2. (CONTINUED) Species counts in two heavy density vegetation stations, 204N and 310N.

Station 310N

Species	Percent Change
Rhizophora mangle	+33
Laguncularia racemosa	No Change
Conocarpus erecta	+100
Causuarina sp.	+25
Cladium jamaicensis	+100
Distichlis spicata	+200
Mangrove Rubber Vine	No Change
Acrostichum	No Change
Thelypteris normalis	-100
Baccharis halimifolia	+100
Astera tenufolia	New Species

Table 3. Species counts at two light density vegetation stations, 105S and 505N.

Station 105S

Species	Percent Change
Rhizophora mangle	+40
Laguncularia racemosa	+40
Conocarpus erecta	No Change
Distichlis spicata	+122
Juncus roemerianus	+73

Station 505N

Conocarpus erecta	No Change
Borrichia frutescens	+40
Distichlis spicata	+300

c. FAUNAL STUDY

Introduction

The purpose of this section is to report on the birds, mammals, reptiles, and amphibians found within the cooling canal system and compare it with the fauna of the surrounding area. The study area encompasses 6,800 acres of land needed for the cooling canal network and 28 acres of the plant site.

Methods

All faunal observations were recorded from diurnal observations while doing routine monitoring. Since many species, especially mammals, are nocturnal, it is very likely that some species that inhabit the study area were not observed.

Bird populations were estimated by counting and identified with the aid of binoculars. Small reptiles and mammals were brought back to the laboratory for identification and then released. Larger mammals were observed and recorded from diurnal observation, natural deaths and road kills.

Discussion

Table 1 is a list of 66 birds sighted in the study area since July 1, 1977. These birds have occurred either as permanent residents, regular visitors, migrants that appear

only in migration, or casual visitors in small numbers. To the right of the bird names in the table are three columns containing information on the relative abundance, season(s) of occurrence, and any comments of interest.

Table 2 is a list of eight reptiles and three amphibians that frequent the study area. To the right of the scientific names are two columns giving the preferred habitat and any comments of interest.

With the exception of the Atlantic Loggerhead sea turtle, all other reptiles and amphibians are permanent residents of the study area. The Loggerhead (weighing 60 pounds) was caught in the cooling canal system on August 26, 1977 and released into its natural habitat.

Four adult crocodiles ranging from five to approximately twelve feet are permanent residents in the south end of the Interceptor Ditch. Following the 1976 nesting season, a single baby crocodile (Crocodylus acutus) was found. The presence of this juvenile indicates that they are nesting successfully. It has been estimated that less than 200 crocodiles remain scattered throughout remote corners of the Everglades and the Upper Keys.

The Florida soft shell turtle is also common in the brackish Interceptor Ditch and fresh water of the Levee-31 canal. They have not been observed in the salt water cooling system.

Table 3 is a list of four mammals known to occur in the study area. The marsh rabbit is chiefly nocturnal and

rarely observed in the cooling canal system. However, based on the frequency of droppings they are considered to be quite common on the canal berms.

Data from the South Dade Preliminary report was in part used to compare fauna of the study area to that of the surrounding area. The South Dade area was selected because of its habitat similarity. A total of 78 birds, 19 reptiles and amphibians, and 10 mammals were observed in the surrounding area. The study area had a total of 66 birds, 11 reptiles and amphibians, and 4 mammals. The greater number of species in the surrounding area can be attributed mainly to different methods of data collection. The South Dade report used intensive diurnal monitoring, nocturnal monitoring, and traps. Data for the study area was collected using diurnal observation only.

Tables 4, 5, and 6 compare the fauna of the study area to that of the surrounding area. Thirty five species of birds, were common to both areas. Only two species of mammals were common to both areas while five species of reptiles and amphibians were common to both areas.

Conclusions

The Turkey Point cooling canal network has modified the preconstruction habitat. The main modification effecting the terrestrial animal distribution has been the disruption of uniform terrain and floral patterns. These changes in topography have altered the large shallow tidal areas once

open to large numbers of small fish, shellfish and their associated preditors.

The partial removal of the mangrove scrub, wet prairie, and tidal creeks necessary for construction of the cooling canals has resulted in a decrease in natural cover for many animal species. The mangrove was the dominant vegetation type and via its long range stability, primary nutrient source and cover, represented the key to faunal population dynamics and species diversity. As the cooling canal berms revegetate with different plant species, it is probable that different animal populations, better adapted to life in this new environment will move into the area.

TABLE 1

List of birds observed in the Study Area from July 1, 1977 to December 31, 1977

Common Name	Scientific Name	Relative Abundance	Season Of Occurrence	Comments
Great White Heron	Ardea occidentalis	Fairly Common	Permanent	
Great Blue Heron	Ardea herodias	Common	Permanent	Feeding in Lake Warren
Common Egret	Cosmerodius albus	Common	Permanent	
Snowy Egret	Leucophoyx thula	Common	Permanent	
Cattle Egret	Bublcus ibis	Common	Permanent	
Reddish Egret	Dichromanassa rufescens	Rare	Summer	
Louisiana Heron	Hydranassa tricolor	Common	Permanent	
Little Blue Heron	Florida caerulea	Common	Permanent	
Green Heron	Butorides virescens	Common	Permanent	
Yellow-crowned Night Heron	Nyctanassa violacea	Rare	Permanent	Mangrove Areas
Wood Ibis	Mycteria americana	Rare	Winter	
White Ibis	Eudocimus albus	Uncommon	Permanent	Fresh Water
Roseate Spoonbill	Ajaia ajaja	Rare	Winter	
Magnificent Frigatebird	Fregata magnificens	Very Rare	Permanent	
Anhinga	Anhinga anhinga	Fairly Common	Permanent	
Double-crested Cormorant	Phalacrocorax auritis	Common	Permanent	
Red-breasted Merganser	Mergus serrator	Common	Winter	

TABLE 1 (CONTINUED)

List of birds observed in the Study
Area from July 1, 1977 to December 31, 1977

Common Name	Scientific Name	Relative Abundance	Season Of Occurrence	Comments
Hooded Merganser	Lophodytes cucullatus	Uncommon	Winter	20 sighted 11/25/77
American Coot	Fulica americana	Common	Winter	
Lesser Scaup	Aythya affinis	Fairly Common	Winter	
Mottled Duck	Anas fulvigula	Uncommon	Permanent	
Pied-billed Grebe	Podilymbus podiceps	Common	Permanent	
Herring Gull	Larus argentatus	Fairly Common	Winter	
Ring-billed Gull	Larus delaware nsis	Fairly Common	Winter	
Laughing Gull	Larus atricilla	Common	Permanent	
Least Tern	Sterna albifrons	Common	Summer	Diving in Lake Warren
Belted Kingfisher	Megaceryle alcyon	Common	Permanent	
Killdeer	Charadrius vociferus	Fairly Common	Winter	
Yellow-shafted Flicker	Colaptes auratus	Uncommon	Permanent	
Red-bellied Woodpecker	Centurus carolinus	Uncommon	Permanent	
Mangrove Cuckoo	Coccyzus minor	Rare	Permanent	
Yellow-billed Cuckoo	Coccyzus americanus	Rare	Summer	
Smooth-billed Ani	Crotophaga ani	Uncommon	Permanent	

TABLE 1 (CONTINUED)

List of birds observed in the Study
Area from July 1, 1977 to December 31, 1977

Common Name	Scientific Name	Relative Abundance	Season Of Occurrence	Comments
Bald Eagle	Haliaeetus leucocephalus	Fairly Common	Permanent	
Osprey	Pandion haliaetus	Common	Permanent	
Red-tailed Hawk	Buteo jamaicensis	Uncommon	Permanent	
Broad-winged Hawk	Buteo platypterus	Rare	Transient	
Marsh Hawk	Circus cyaneus	Common	Winter	
Sparrow Hawk	Falco sparverius	Common	Winter	Seen on power lines
Common Night Hawk	Chordeiles minor	Common	Permanent	Berms and road sides
Barn Owl	Tyto alba	Uncommon	Winter	
Barred Owl	Strix varia	Uncommon	Permanent	
Turkey Vulture	Cathartes aura	Common	Permanent	
Black Vulture	Coragyps atratus	Common	Permanent	
Boat-tailed Grackle	Cassidix mexicanus	Common	Permanent	
Red-winged Blackbird	Agelaius phoeniceus	Common	Permanent	
House Sparrow	Passer domesticus	Common	Permanent	
Savannah Sparrow	Passerculus sandwichensis	Common	Winter	
Tree Swallow	Iridoprocne bicolor	Uncommon	Winter	50 sighted 12/22/77

TABLE 1 (CONTINUED)

List of birds observed in the Study Area from July 1, 1977 to December 31, 1977

Common Name	Scientific Name	Relative Abundance	Season Of Occurrence	Comments
Purple Martin	Progne subis	Fairly Common	Transient	75 sighted 11/25/77
Barn Swallow	Hirundo rustica	Common	Fall	
Bobwhite	Colinus virginjanus	Fairly Common	Permanent	
White-crowned Pigeon	Columba leucocephala	Uncommon	Summer	
Rock Dove	Columba livia	Common	Permanent	
Mourning Dove	Zenaidura macroura	Common	Permanent	
Ground Dove	Columbigullina passerina	Common	Permanent	
Yellow Throat	Geothlypis trichas	Fairly Common	Permanent	
Palm Warbler	Dendroica palmarum	Common	Winter	
Cape May Warbler	Dendroica tigrina	Uncommon	Spring & Fall	
House Wren	Troglodytes aedon	Common	Winter	
Bobolink	Dolichonyx oryzivorus	Fairly Common	Spring & Fall	
Indigo Bunting	Passerina cyanea	Uncommon	Spring & Fall	
Mockingbird	Mimus polyglottos	Common	Permanent	
Catbird	Dumetella carolinensis	Common	Permanent	
Blue Jay	Cyanocitta cristata	Uncommon	Permanent	

TABLE 2

List of Reptiles and Amphibians observed
in the Study Area from July 1, 1977 to December 31, 1977

Common Name	Scientific Name	Preferred Habitat	Comments
American Crocodile	Crocodylus acutus	Salt or brackish water	Endangered species
Florida Softshell	Trionyx ferox	Lakes, ponds, canals, roadside ditches	
Atlantic Loggerhead	Caretta caretta caretta	Warm waters of the Atlantic Ocean	See data discussion
Eastern Indigo Snake	Drymarchon corais couperi	Near thickets of dense natural vegetation	
Mangrove Water Snake	Natrix fasciata compressicauda	Salt or brackish water	
Reef Gecko	Sphaerodactylus notatus notatus	around buildings	
Brown Anole	Anolis sagrei		
Green Anole	Anolis carolinensis carolinensis	Scrub and vines	
Oak Toad	Bufo quercicus	Southern pine woods, hides under objects	Found in Raingauge
Spadefoot Toad	Scaphiopus holbrooki holbrooki	Sandy soils	
Cuban Treefrog	Hyla septentrionalis	Near moisture	

TABLE 3

List of Mammals observed in
the Study Area from July 1, 1977
to December 31, 1977

Common Name	Scientific Name	Preferred Habitat	Comments
Cat	Felis domestica	Associated with man	
Marsh Rabbit	Sylvilagus palustris	Berms, swamps, hammocks	Droppings on berms
Raccoon	Procyon lotor	Along streams, berms	
Roof Rat	Rattus rattus	buildings & occasionally in fields	

TABLE 4

Comparison of Turkey Point
Avian Species to Surrounding Area

	TURKEY POINT	SURROUNDING AREA
American Bittern		X
American Coot	X	
American Goldfinch		X
American Kestrel		X
American Redstart		X
Anhinga	X	X
Bald Eagle	X	X
Barn Owl	X	
Barn Swallow	X	X
Barred Owl	X	
Belted Kingfisher	X	X
Balck-bellied Plover		X
Black-crowned Night Heron		X
Black Skimmer		X
Black Vulture	X	
Blackpoll Warbler		X
Black-whiskered Vireo		X
Blue-gray Gnatcatcher		X
Blue Jay	X	X
Boat-tailed Grackle	X	X
Bobolink	X	X
Bobwhite	X	
Broadwinged Hawk	X	
Brown Pelican		X
Cape May Warbler	X	
Cardinal		X
Caspida Tern		X
Catbird	X	
Cattle Egret	X	X
Cedar Waxwing		X
Chuck-Will's Widow		X
Clapper Rail		X
Common Egret	X	X
Common Flicker		X
Common Grackle		X
Common Nighthawk	X	X
Common Snipe		X
Double-Crested Cormorant	X	X
Downy Woodpecker		X
Eastern Meadowlark		X
Eastern Phoebe		X
Glossy Ibis		X
Gray Kingbird		X
Great Blue Heron	X	X

TABLE 4 (CONTINUED)

	TURKEY POINT	SURROUNDING AREA
Great White Heron	X	
Green Heron	X	X
Ground Dove	X	
Herring Gull	X	X
Hooded Merganser	X	
House Sparrow	X	
House Wren	X	X
Indigo Bunting	X	
Killdeer	X	X
Laughing Gull	X	X
Least Tern	X	X
Lesser Scaup	X	
Little Blue Heron	X	X
Louisiana Heron	X	X
Magnificent Frigatebird	X	X
Mangrove Cuckoo	X	
Marsh Hawk	X	
Merlin		X
Mockingbird	X	X
Mottled Duck	X	
Mourning Dove	X	
Northern Waterthrush		X
Osprey	X	X
Palm Warbler	X	X
Peregrine Falcon		X
Pie-billed Grebe	X	X
Prairie Warbler		X
Purple Martin	X	
Red-bellied Woodpecker	X	X
Red-brested Merganser	X	X
Reddish Egret	X	X
Red-shouldered Hawk		X
Red-tailed Hawk	X	
Red-winged Blackbird	X	X
Ring-billed Gull	X	X
Roseate Spoonbill	X	X
Rock Dove	X	
Royal Tern		X
Sanderling		X
Savannah Sparrow	X	
Screech Owl		X
Sharp-shinned Hawk		X
Smooth-billed Ani	X	
Snowy Egret	X	X
Sparrow Hawk	X	X
Tree Swallow	X	X
Turkey Vulture	X	X
White-Crowned Pigeon	X	

TABLE 4 (CONTINUED)

	TURKEY POINT	SURROUNDING AREA
White-eyed Vireo		X
White Ibis	X	
White Pelican		X
Willet		X
Wood Duck		X
Wood Ibis	X	
Yellowlegs		X
Yellowthroat	X	X
Yellow-bellied Sapsucker		X
Yellow-billed Cuckoo	X	
Yellow-crowned Night Heron	X	X
Yellow-rumped Warbler		X
Yellow-shafted Flicker	X	
Yellow Warbler		X

TABLE 5

Comparison of Turkey Point Reptiles and Amphibians to Surrounding Area

	TURKEY POINT	SURROUNDING AREA
American Alligator		X
American Crocodile	X	X
Bahaman Bark Anole		X
Brown Anole	X	
Corn Snake		X
Cuban Treefrog	X	X
Eastern Diamondback Rattlesnake		X
Eastern Indigo Snake	X	X
Everglades Racer		X
Florida Cricket Frog		X
Florida Softshell	X	X
Florida Water Snake		X
Green Anole	X	X
Green House Frog		X
Green Treefrog		X
Key West Anole		X
Mangrove Water Snake	X	X
Oak Toad	X	
Pig Frog		X
Reef Gecko	X	
Southern Leopard Frog		X
Spadefoot Toad	X	

TABLE 6

Comparison of Turkey Point Mammals to Surrounding Area

	TURKEY POINT	SURROUNDING AREA
Black Rat		X
Bob Cat		X
Cottom Rat		X
Dolphin		X
Domestic Cat	X	
House Mouse		X
Manatee		X
Marsh Rabbit	X	X
Raccoon	X	X
Rice Rat	X	X
Roof Rat	X	
White Tailed Deer		X

LITERATURE CITED

Burt, W.H., and R. P. Grossenheider. 1976. A Field Guide to the Mammals. Houghton Mifflin Company Boston.

Corant, R. 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Company.

Peterson, R. T. 1947. A Field Guide to the Birds. Houghton Mifflin Company.

Robbins, C. S., B. Bruun, and H. S. Zim. 1966. Birds of North America. Western Publishing Company, Inc. Rocaine, Wisconsin.

Florida Power and Light Company. 1976. Turkey Point Units 3 & 4 Semmiannual Environmental Monitoring Report No. 9.

Florida Power and Light Company. 19 . Environmental Report, South Dade Plant Units 1 & 2. Vol. 1,2.

2. SOIL OF TURKEY POINT COOLING CANAL SYSTEM BERMS

a. SOIL CHEMISTRY

Methods

One hundred and forty seven samples were collected at 49 sample sites covering the entire cooling canal system (Figure 1) and all major soil types. Sample sites are classified as follows:

Sites based on soils

1. dark black
2. organic
3. mucky - clay
4. clay

Sites based on vegetative density

5. none
6. heavy
7. medium
8. light
9. area (initially) covered by grass

Levels

T top of berm

M mid level of berm

L 1 foot above water level

Samples were analyzed for pH, salinity, conductivity and nutrients (Tables 1-4).

Discussion and Conclusions

Edaphic conditions on the Turkey Point Cooling Canal spoil berms depend heavily on the amount of rainfall received in a particular year. During the dry season, levels of nitrogen, phosphorus, potassium, calcium, and chlorides build up only to be leached out or washed off during the rainy season. The extent to which the levels of these nutrients drop seems to be proportional to the amount of rainfall in the area. The soil also tends to be slightly more alkaline during the wet season.

According to Dr. Dalton of the Dade County Agricultural Extention Service, nutrient levels in the berms undergo a cyclic fluctuation, and long term trends, particularly in chloride levels, are highly unlikely. This fact is mainly due to the extreme low elevation of the berms. The highest chloride levels (Table 1-2) are observed during the dry season when salt water is drawn up through the berms by capillary action and concentrated along the surface by evaporation. Low levels (Table 3-4) are recorded during the wet season when precipitation either leaches the nutrients back through the soils or causes them to be carried away by surface runoff. The lowest levels also seem to occur in the organic soils and heavy vegitation categories.

According to Dalton, phosphorus is the limiting nutrient for plant growth in the system. The high chloride content of the soils also serves as a major growth retardant for many species.

Figure 1. Turkey Point Plant Site & Cooling Canal System

▲ Natural Revegetation and Soil Temperatures
● Soil Chemistry
▣ Soil Erosion Test Sites
R Revegetation - Induced "Initial Study"
S Revegetation - Induced "Serendipity"

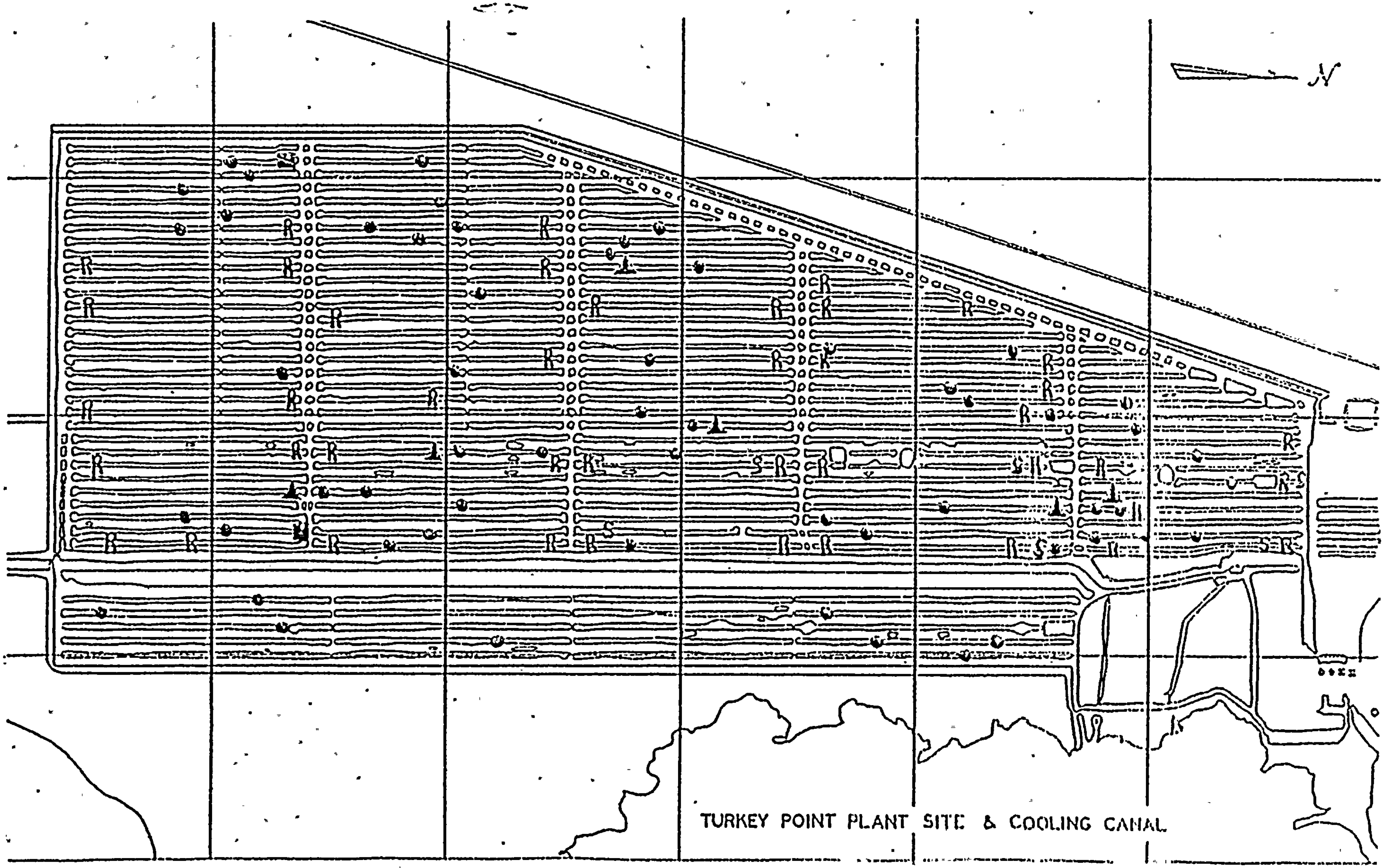


Table 1 . Soil test report from Turkey Point Cooling Canal System Berms for April 1977 covering the period January through March.

Sample	pH	NO_3*	P*	K*	Ca*	Cl*	Cond MHOSx10-5
1 WT	6.0	41	0.8	10	500	260	132
WM	6.2	55	0.5	14	200	1,500	276
WL	7.1	47	0.1	790	1950	38,500	3200
2 WT	6.4	107	1.0	18	550	1,550	260
WM	6.5	220	0.1	130	450	10,100	1250
WL	7.3	60	0.1	840	2400	35,000	4000
3 WT	7.5	61	1.0	45	550	2,575	330
WM	7.7	20	0.1	65	2500	4,525	550
WL	7.7	10	0.1	700	900	22,000	2800
4 WT	7.6	52	1.0	86	1350	4,400	495
WM	7.7	49	0.1	225	450	13,750	1050
WL	8.0	20	0.1	610	750	20,375	2075
5 WT	7.8	65	0.8	110	400	5,450	760
WM	7.7	105	0.1	148	1000	7,000	675
WL	7.9	15	1.0	270	700	14,500	1560
6 WT	7.7	150	1.0	110	1300	5,800	900
WM	7.2	160	0.12	71	1500	3,750	410
WL	7.7	45	0.12	500	1000	16,750	1900
7 WT	6.4	11	0.1	2	2000	255	244
WM	7.0	36	0.8	10	900	300	120
WL	7.6	26	0.1	580	1250	25,500	3200
8 WT	7.3	70	0.8	35	1400	2,550	520
WM	7.4	108	0.1	45	500	2,000	330
WL	7.8	18	0.1	95	400	6,450	950
9 WT	7.6	85	0.12	35	550	4,000	480
WM	7.6	168	2.0	35	550	2,950	404
WL	7.8	10	2.0	450	800	18,000	2100
WET	7.4	50	0.1	130	900	5,950	640
WEM	7.3	48	2.0	71	800	2,800	238
WEL	7.1	65	0.12	610	1500	20,000	2050

*all these numbers in PPM

Table 2 . Soil test report from Turkey Point Cooling Canal System Berms for July 1977 covering the period April through June.

Sample	pH	NO_3*	P*	K*	Ca*	Cl*	Cond MHOSx10-5
1 WT	6.8	94	0.1	45	2000	2,250	238
WM	6.8	98	0.1	35	2100	1,400	380
WL	7.2	44	0.1	30	645	21,000	2255
2 WT	6.8	105	0.1	30	1050	1,050	198
WM	6.9	86	1.0	40	1250	4,860	332
WL	7.25	56	0.1	460	2450	24,000	2250
3 WT	7.7	65	0.1	71	500	4,500	382
WM	7.7	34	0.1	40	500	3,400	357
WL	7.6	20	0.1	173	800	16,750	1000
4 WT	7.9	67	3.0	86	500	5,100	422
WM	7.8	41	0.1	103	550	6,125	627
WL	7.8	17	0.2	260	850	18,500	1100
5 WT	7.8	44	0.1	45	450	3,450	360
WM	7.6	47	0.1	45	750	3,650	380
WL	7.6	17	0.1	340	850	14,000	1050
6 WT	7.3	58	0.1	25	450	1,200	139
WM	7.0	138	0.1	95	2500	5,950	788
WL	7.6	54	0.4	430	1500	21,000	2000
7 WT	7.5	37	0.1	30	500	3,400	275
WM	7.4	90	0.12	25	2250	2,160	342
WL	7.6	44	0.1	340	1050	18,500	1400
8 WT	7.7	46	0.1	30	550	2,375	279
WM	7.6	47	0.1	65	1250	4,150	448
WL	7.6	36	0.1	300	900	17,250	1250
9 WT	7.8	46	0.1	35	300	2,200	260
WM	7.7	75	0.5	59	850	3,750	406
WL	7.7	39	0.2	205	1000	9,375	1050
WET	7.5	91	0.1	215	2350	12,750	1500
WEM	7.7	56	0.1	79	700	5,500	600
WEL	7.7	49	0.1	215	1200	17,000	1250

*all these numbers in PPM

Table 3 . Soil test report from Turkey Point Cooling Canal System Berms for October 1977 covering the period July through September.

Sample	pH	NO_3*	P*	K*	Ca*	Cl*	Cond MHOSx10-5
1 WT	6.7	75	0.1	40	750	3,000	245
WM	6.5	140	0.1	6	800	1,900	160
WL	7.5	90	3.0	270	4000	10,000	1075
2 WT	6.1	305	0.1	35	800	500	210
WM	6.6	110	3.0	25	1350	2,400	235
WL	7.2	48	0.1	340	4000	20,500	1100
3 WT	7.6	60	0.1	35	700	1,750	270
WM	7.7	48	3.0	40	750	5,375	440
WL	7.8	40	0.1	164	1000	13,000	810
4 WT	7.8	70	2.0	86	650	5,000	210
WM	7.8	34	0.1	95	650	7,500	590
WL	7.9	10	0.5	260	4400	25,000	1050
5 WT	7.6	60	0.1	59	3000	2,250	360
WM	7.8	44	0.1	95	1100	3,400	305
WL	7.4	40	2.0	400	1200	25,000	1500
6 WT	7.6	49	0.1	25	600	2,100	185
WM	6.8	135	0.1	71	1500	3,100	340
WL	7.4	24	0.1	325	1200	25,000	1500
7 WT	7.7	49	0.5	20	550	400	158
WM	7.6	75	0.1	45	800	3,500	300
WL	7.9	30	0.4	238	600	13,500	1300
8 WT	7.8	47	0.1	40	3400	2,600	305
WM	7.6	60	0.1	59	700	3,550	315
WL	7.9	16	2.0	238	650	13,500	1050
9 WT	7.9	44	0.1	25	3500	1,450	450
WM	7.6	49	0.1	65	650	3,550	315
WL	7.6	24	4.0	260	750	13,500	1050
WET	7.4	60	0.5	86	800	4,000	325
WEM	7.6	47	0.5	65	800	4,500	300
WEL	7.6	48	0.1	40	700	5,450	475

*all these numbers in PPM

Table 4. Soil test report from Turkey Point Cooling Canal System Berms for January 1978.

Sample	pH	NO_3*	P*	K*	Ca*	Cl*	Cond MHOSx10-5
1 WT	6.5?	150	0.1	30	1500	1,100	448
WM	6.9	125	1.0	20	750	1,750	380
WL	7.3	85	2.0	600	2350	37,500	4,000
2 WT	7.1	180	0.1	25	1450	1,050	444
WM	7.3	170	1.0	20	750	1,440	300
WL	7.3	50	1.0	355	2000	22,000	2,400
3 WT	7.8	75	0.1	65	600	2,500	518
WM	8.0	65	1.0	95	400	4,000	520
WL	7.9	34	0.1	195	1000	11,000	1,200
4 WT	8.0	148	5.0	175	800	9,500	1,080
WM	8.1	50	1.0	103	800	4,950	800
WL	7.9	26	1.0	225	650	18,000	1,600
5 WT	7.9	148	0.1	103	650	4,000	720
WM	8.0	47	1.0	45	1,150	2,700	440
WL	8.0	24	1.0	35	750	9,500	1,040
6 WT	7.4	36	1.0	20	1,600	450	90
WM	7.2	105	3.0	120	1,900	5,250	1,000
WL	7.7	55	1.0	270	1,350	18,000	2,050
7 WT	7.7	39	0.1	14	300	400	80
WM	7.8	80	2.0	40	550	1,450	480
WL	7.9	24	1.0	205	1,250	11,000	1,275
8 WT	7.8	48	0.1	30	1,250	1,350	438
WM	7.9	50	1.0	40	400	1,450	390
WL	7.9	16	1.0	185	850	10,750	1,080
9 WT	8.0	47	3.0	18	325	975	204
WM	7.9	28	0.5	10	250	850	220
WL	8.0	20	1.0	225	800	11,000	1,400
WET	7.9	58	1.0	53	600	3,200	405
WEM	7.8	55	1.0	45	650	2,600	370
WEL	8.0	48	1.0	225	800	13,500	1,300

*all these numbers in PPM

b. SOIL EROSION TEST SITES

Methods

Two soil erosion test sites were set up in the cooling canal system , one on berm 2 at the north end of section 5, and the other on berm 30, also at the north end of section 5. At each site, four pipes were driven through the berms and into the underlying rock. Each pipe was marked with a reference point and the distance to the berm soil measured. Also, an averaging cross was then placed on the pipe at each station and the distance from the tips of the cross to the berm soil measured. Comparison of these measurements from period to period will allow the determination of changes in the height of the berms. In addition, a 12 to 18 inch deep trough was dug on the slope of the berm, perpendicular to the flow in the canals. The depth of the trough was measured to determine possible erosion due to rainfall.

Rainfall data used was collected by the MRI rain gauge at the South Dade Meterological Site.

If the soil is oxidized, blown off of the berms by wind, or washed away by the rain, the effect should be measurable. This will provide the information needed to assess the rate at which erosion occurs.

Discussion and Conclusions

Of the three methods tried, the averaging cross gave the most consistent data (Table 1). The "vertical reference point" was discontinued due to three factors. First, the pipes tended to corrode and the outer metal flaked off so previous marks were impossible to find. Second, the act of pounding the pipe into the ground disrupted the soil directly adjacent to the pipe, leaving results obtained questionable. Third, rain water running down the pipe caused additional erosion around the pipe which introduced error into the results.

Analysis of the data shows that the net change on berm 2, section 5 was 0.0 for both methods, seeming to indicate that no erosion took place. However, this is misleading since in the "run-through trough" method the upper station decreased by 0.7 inches while the lower station increased by the same amount. This indicated that dirt was washed from the upper station to the lower one.

The results from the average cross for berm 30, section 5, show an average decrease of 0.13, indicating that erosion has occurred at a rate of 0.0023 inches per inch of rainfall. The run-through trough data of this site shows an increase which is due to the sides of the trough eroding and settling in the bottom.

The most dramatic effects of erosion are still found in simple qualitative observations. Wave action has caused 1 to 2 foot deep caves to be out into shore lines. Stakes, used to tie up airboats at various stations are seemingly getting closer to the shoreline. Rocks and shells can be seen sitting atop one and two inch pedestals of substrate material. Mud-slides can be seen at various areas along the canal banks.

All of the above are clear indications of water (rain and waves) and/or, to a lesser extent wind erosion.

Table 1. The averaging cross and run-through trough methods of determining soil erosion for 1977 on the Turkey Point Cooling Canal Berms.

AVERAGE CROSS METHOD

Berm	Section	Station	Average Decrease/ Station (in.)	Average Decrease/ Site (in.)
2	5	NORTH	-.01	0.00
		EAST	----*	
		SOUTH	-.01	
		WEST	+.02	
30	5	NORTH	-0.19	-0.13
		EAST	----*	
		SOUTH	-0.08	
		WEST	-0.13	

RUN-THROUGH TROUGH METHOD

Berm	Section	Station	Decrease	Average Decrease for Site
2	5	Upper	-0.07	0.00
		Lower	+0.07	
30	5	Upper	+0.02	+0.04
		Lower	+0.06	

Rainfall = 55.59 inches

* Station overgrown by vegetation

\+ Plus denotes gain rather than decrease

c. SOIL TEMPERATURES

Method

Soil temperatures were monitored at the Natural Vegetation Study Sites. Temperatures at the sites were checked at one inch and one foot below the soils surface at each of three levels; high, middle, and low. "High" indicates the top or highest part of the berm. "Low" indicates an area approximately one foot above the water line. "Middle" indicates an area approximately equidistant between the "high" and "low" levels. Ambient air temperatures were taken chest high in shadow at the top of the berm at each site. Ambient water temperatures were taken near the shore line of each site at a depth of approximately one foot. The soil temperature program data for the four quarters beginning January, 1977 are shown in Tables 1-4.

Discussion and Conclusions

The heterogenous character of the soil masks any tendencies or correlations between temperature and soil type. The heat retention and conduction properties of highly organic substrates is different from that of the clays. Yet in a majority of sample sites, the different layers (peat, muck, clay) and thus the soil types have been mechanically disturbed so as to produce a "marbled-

cake" effect. For example, there are pockets and layers of muck covered by clay, and swirls of mucky-clay in black organic soil areas. Soil temperatures under these conditions can fluctuate as much as 4° F per horizontal foot at a soil depth of one foot.

There is evidence of some correlation between low level soil temperature and the ambient water temperatures (Fig. 1-4). There is still no correlation between temperatures at different levels. Surface temperatures still tend to relate to short term environmental factors such as cloud cover or cool nights, etc.

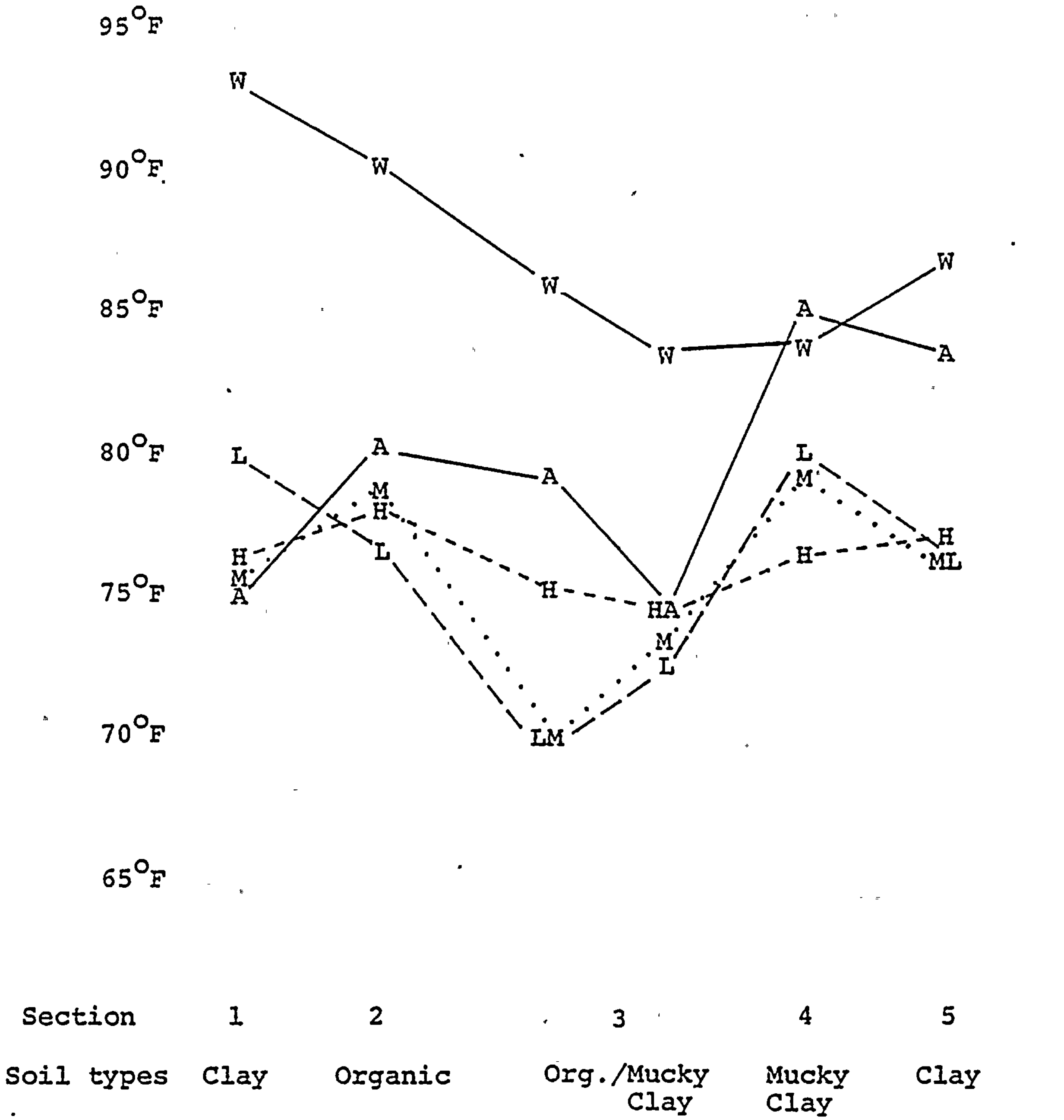


Figure 1. Air, water and soil temperatures as a function of section and soil type on April 6, 1977.

W = ambient water temperatures
A = ambient air temperatures
H = high level soil temp. at 1ft. depth
M = middle level soil temp. at 1ft. depth
L = low level soil temp. at 1ft. depth

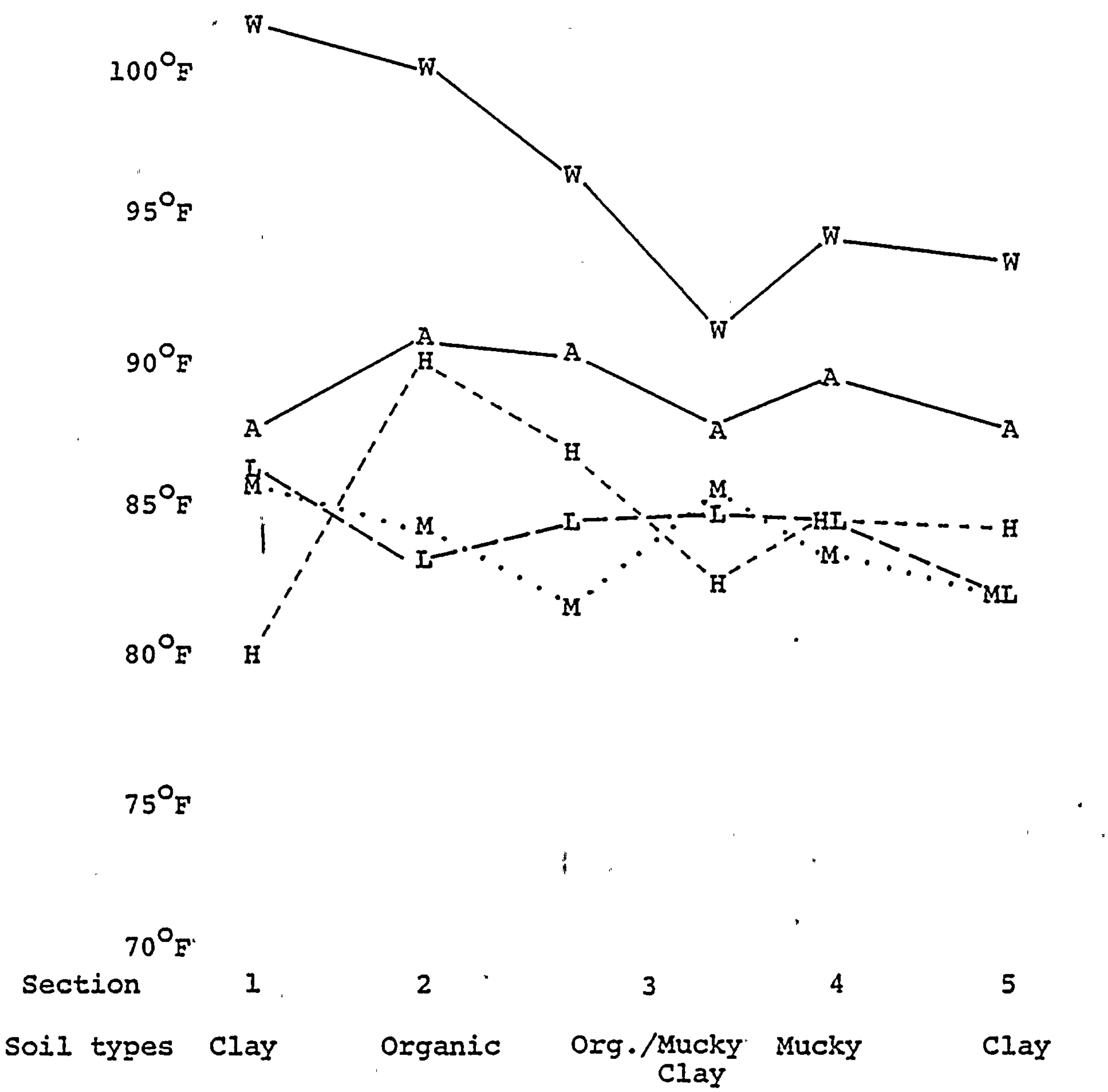


Figure 2. Air, water, and soil temperatures as a function of section and soil type on July 20, 1977.

W = ambient water temperatures
A = ambient air temperatures
H = high level soil temp. at 1ft. depth
M = middle level soil temp. at 1ft. depth
L = low level soil temp. at 1ft. depth

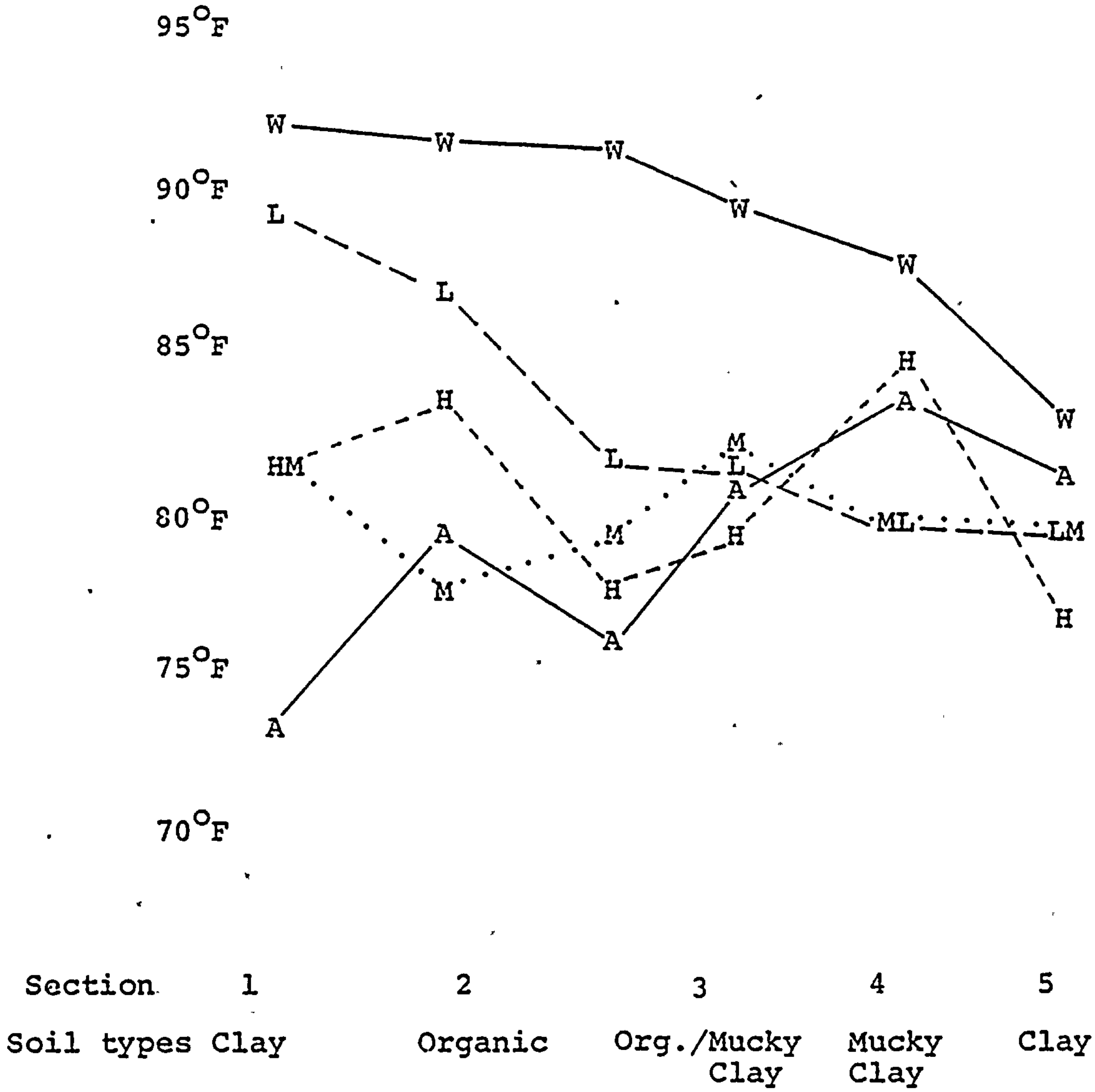


Figure 3. Air, water, and soil temperatures as a function of section and soil type on October 15, 1977.

W = ambient water temperatures
A = ambient air temperatures
H = high level soil temp. at 1ft. depth
M = middle level soil temp. at 1ft. depth
L = low level soil temp. at 1ft. depth

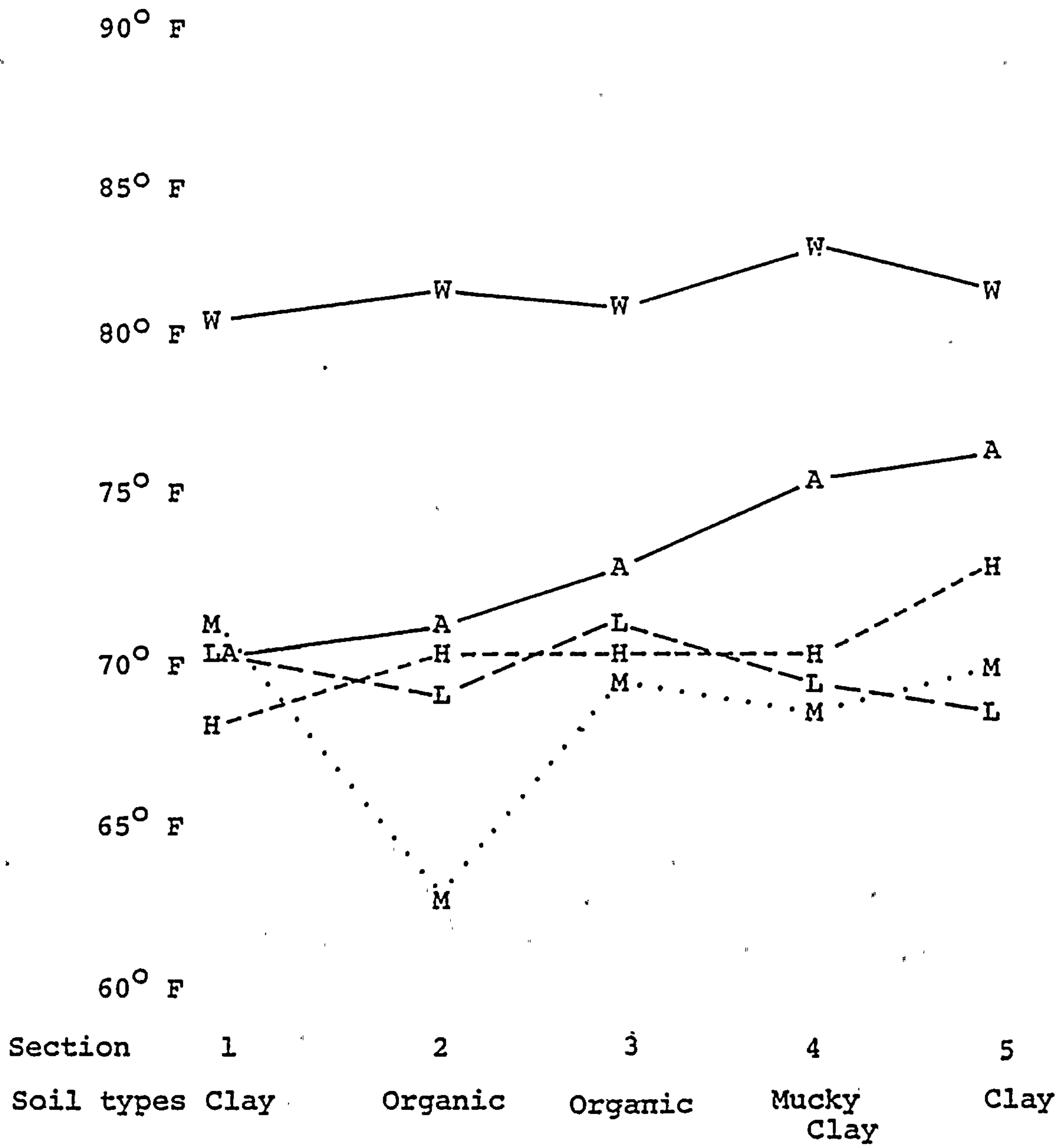


Figure 4. Air, water and soil temperatures as a function of section and soil type on January 18, 1978.

W = ambient water temperatures
A = ambient air temperatures
H = high level soil temp. at 1 ft. depth
M = middle level soil temp. at 1 ft. depth
L = low level soil temp. at 1 ft. depth

Table 1. A comparison of soil temperatures taken on April 6, 1977 as a function of soil type and elevation.

	Soil Types					
	Organic		Mucky - Clay		Clay	
Site	*2-04-00	3-10-80	3-23-100	4-08-124	1-05-00	5-05-171
Levels						
High	**78.2/78.7	71.5/75.0	74.0/74.5	74.3/76.4	78.0/75.9	75.4/76.0
Middle	77.8/78.1	69.4/69.8	80.0/73.3	76.9/79.0	77.8/75.6	76.4/76.1
Low	76.2/76.8	68.4/69.8	80.0/72.8	77.2/80.0	77.4/80.0	80.1/76.1
Means	77.4/77.9	69.7/71.5	78.0/73.5	76.1/78.4	77.7/77.2	77.3/76.1
Range	02.0/01.9	03.1/05.2	06.0/01.7	02.9/03.6	00.6/04.4	04.7/00.1

* 2-04-00 = Section 2, Berm 4, Station 00.

** Temperatures in ^{o}F at depths of 1 inch/1 foot below soil surface.

Table 2. A comparison of soil temperatures taken on July 20, 1977 as a function of soil type and elevation.

	Soil Types					
	Organic		Mucky - Clay		Clay	
Site	*2-04-00	3-10-80	3-23-100	4-08-124	1-05-00	5-05-171
Levels						
High	**98.2/90.3	89.0/87.0	90.9/82.9	81.9/84.9	86.5/80.1	93.1/84.8
Middle	89.0/84.8	84.5/81.9	89.9/85.8	88.5/83.9	91.0/86.1	92.0/82.3
Low	91.5/83.9	87.1/84.8	95.0/85.8	92.0/84.9	88.9/86.5	84.1/82.2
Means	92.9/86.3	86.9/84.6	91.9/84.8	89.9/84.5	88.8/84.2	89.7/83.1
Range	06.7/06.4	04.5/05.1	04.1/02.9	02.9/01.0	04.5/06.4	09.0/02.6

* 2-04-00 = Section 2, Berm 4, Station 00.

** Temperatures in ^{o}F at depths of 1 inch/1 foot below soil surface.

Table 3. A comparison of soil temperatures taken on October 15, 1977 as a function of soil type and elevation.

	Soil Types					
	Organic		Mucky - Clay		Clay	
Site	*2-04-00	3-10-80	3-23-100	4-08-124	1-05-00	5-05-171
Levels						
High	**75.7/83.1	77.3/77.5	83.2/79.2	81.7/84.5	75.5/81.3	77.3/76.8
Middle	72.0/77.4	78.5/79.0	80.1/81.5	80.5/79.5	71.0/81.2	85.2/79.3
Low	79.8/86.5	78.8/81.1	76.1/81.3	77.0/79.6	71.5/89.2	75.8/79.3
Means	75.8/82.4	78.2/79.2	79.8/80.7	79.8/81.2	72.7/83.9	79.5/78.5
Range	07.8/09.1	01.5/03.6	07.1/02.1	04.7/05.0	04.5/07.9	09.4/02.5

* 2-04-00 = Section 2, Berm 4, Station 00.

** Temperatures in ^{O}F at depaths of 1 inch/1 foot below soil surface.

Table 4. A comparison of soil temperatures taken on January 1978 as a function of soil type and elevation.

	Soil Types					
	Organic		Mucky - Clay		Clay	
Site	*2-04-00	3-10-80	3-23-100	4-08-124	1-05-00	5-05-171
Levels						
High	70.3/70.9	72.5/70.3	73.5/69.4	75.7/70.8	69.8/68.0	80.4/73.5
Middle	71.5/63.8	71.6/69.8	75.5/72.3	76.5/68.0	71.5/70.3	77.2/69.5
Low	70.5/69.1	70.2/70.8	78.5/70.6	74.8/69.1	70.7/71.2	77.6/68.5
Means	70.8/67.9	71.4/70.3	75.8/70.77	75.7/69.3	70.7/69.8	78.4/70.5
Range	1.2/7.1	2.3/1.0	5.0/2.9	1.7/2.8	1.7/3.2	3.2/5.0

* 2-04-00 = Section 2, Berm 4, Station 00.

** Temperatures in °F at depths of 1 inch/ 1 foot below soil surface.

III.K AERIAL PHOTOGRAPHS

Due to consistently overcast skies, the color and color infrared photographs were not taken over the Turkey Point site until late January, 1978. The actual photographs were not printed by the contractor until late February and therefore, the assessment could not be done on time for this report. However, this assessment will be sent to the NRC by March 31, 1978.

III.L CHLORINE USAGE

The condenser and water boxes of Unit 3 were inspected December 1, 1977. Unit 4's condenser and water boxes were inspected on October 21, 1977. On December 1, 1977, the intake wells were inspected for organic growth. Units 3 and 4 intake wells, condenser and water boxes were found to be in a satisfactory state of cleanliness, therefore, not requiring chlorination at this time.

IV. RECORDS AND CHANGES IN SURVEY PROCEDURES

None

V. SPECIAL ENVIRONMENTAL STUDIES NOT REQUIRED BY THE E.T.S

Section III.H of this report analyzes data collected which was not required by the E.T.S.

VI. VIOLATION OF THE E.T.S.

None

VII. UNUSUAL EVENTS, CHANGES TO THE PLANT, E.T.S. PERMITS OR CERTIFICATES

None

VIII. STUDIES REQUIRED BY THE E.T.S. NOT INCLUDED IN THIS REPORT

See Section III.K