FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT

UNITS 3 & 4

FLORIDA POWER & LIGHT COMPANY

ENVIRONMENTAL MONITORING REPORT NO. 11

JANUARY 1, 1978

THROUGH

JUNE 30, 1978

Rec w/ltr dtd 8-31-78
ENVIRO.

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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. It covers the period January 1, 1978 through June 30, 1978.

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, 3, and 4 of this report. Page 5 contains the amounts of chemicals added from Units 3 and 4 to the circulating water system. These data are discussed in Section III.A. 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 1978

MO.	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
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	8.0	4.9	37.5	8.00	5.8	36.5	7.95	4.7	35.5	8.0	5.6	37.0	8.08	5.1	35.5	8.06	4.5	39.0
2	8.0	4.7	37.5	8.00	5.4	36.5	7.95	4.7	35.5	8.0	5.4	37.5	8.03	4.4	36.0	8.06	4.4	39.5
3	8.0	4.5	36.0	8.00	5.1	36.0	7.99	4.8	36.0	8.1	5.1	37.5	8.05	4.0	36.0	8.06	4.7	39.5
4	8.0	5.1	35.0	8.05	5.1	36.5	7.99	4.9	34.5	8.0	4.8	37.5	8.00	4.5	36.5	8.03	4.6	40.0
5	8.0	5.4	37.5	8.05	5.2	36.5	7.99	5.2	34	8.1	4.8	37.5	7.98	4.4	36.5	8.03	4.4	40.0
6	8.05	5.2	37.5	7.95	5.4	35.5	7.99	5.2	34.5	7.99	4.6	38.0	7.98	4.1	37.0	8.05	4.4	40.5
7	8.0	4.9	37.5	7.95	6.1	36.0	7.99	5.4	34.5	7.99	4.4	38.0	7.99	4.5	37.0	8.04	4.5	41.0
8	8.0	4.8	37.5	7.95	5.9	36.0	7.99	5.3	35.0	8.0	4.2	38.0	7.97	4.4	38.0	8.06	4.4	41.0
9	8.025	5.1	36.0	7.95	5.0	36.0	7.99	5.1	35.0	8.0	4.2	38.0	7.99	4.2	38.0	8.06	4.5	41.0
10	8.10	6.0	37.0	8.00	5.0	35.5	7.99	5.1	34.0	7.99	4.0	38.5	7.98	4.5	38.0	8.06	4.2	41.0
11	8.00	6.2	37.0	7.95	5.0	36.0	7.99	5.1	34.5	7.99	4.4	38.5	7.94	4.0	38.0	8.05	4.4	41.0
12	8.00	6.5	37.0	7.95	5.2	36.0	7.99	5.2	34.5	7.99	4.6	38.5	7.96	4.2	37.0	8.05	4.3	41.5
13	8.00	5.9	37.5	8.00	5.8	36.0	7.99	5.1	35.0	7.99	4.5	39.0	8.0	4.5	38.0	8.06	3.8	40.5
14	8.00	5.7	37.0	8.00	5.6	36.5	7.99	4.8	35.5	7.99	4.4	39.5	8.0	4.2	38.5	8.06	4.5	40.5
15	8.00	5.4	36.5	8.00	5.6	36.5	7.99	4.7	35.5	7.99	4.6	37.5	8.03	4.2	39.0	8.05	4.4	39.5
16	8.05	6.4	37.0	7.95	5.6	36.5	7.99	4.7	35.5	7.99	4.7	37.0	9.03	4.2	39.0	8.07	4.8	40.5
17	8.05	6.4	37.5	7.95	5.3	36.0	8.0	4.4	35.5	7.99	4.6	37.5	8.0	4.2	39.5	8.05	4.6	40.0
18	8.0	5.4	37.5	7.95	4.8	35.5	8.0	4.8	35.5	7.99	4.6	37.5	8.02	4.3	40.0	8.05	4.7	40.0
19	8.0	5.0	37.5	7.95	4.9	35.5	8.00	5.6	36.0	7.95	4.3	38.5	8.02	4.0	38.5	8.04	4.8	39.0
20	8.00	4.8	36.0	8.0	4.6	34.5	7.99	5.6	36.5	7.99	4.2	38.0	8.03	4.4	38.5	8.04	4.6	39.5
21	8.00	5.2	35.0	7.95	5.6	34.5	7.99	5.3	37.0	7.99	4.3	38.5	8.01	4.6	39.0	8.03	4.6	39.0
22	8.00	5.4	36.0	7.95	6.0	34.5	7.99	5.4	37.0	7.99	4.2	38.0	8.0	4.3	39.5	8.04	4.6	39.5
23	8.00	5.6	33.5	8.0	6.5	34.5	7.99	5.1	37.0	7.98	4.2	38.5	8.04	4.5	40.0	8.04	4.6	36.5
24	8.00	5.2	35.5	7.95	6.5	35.0	7.99	4.9	37.0	7.95	4.5	37.5	8.06	4.4	40.0	8.03	4.6	38.5
25	8.05	5.3	36.0	8.0	6.2	35.0	7.99	4.5	37.0	8.0	4.5	34.0	8.06	4.3	40.0	8.03	4.7	38.0
26	8.05	4.8	36.0	7.95	6.1	35.0	7.99	4.5	37.5	7.95	4.4	34.5	8.06	4.0	39.5	8.07	4.6	38.5
27	8.00	4.8	36.0	7.98	5.7	35.0	7.99	4.7	37.5	8.05	5.1	35.0	8.06	4.3	39.5	8.08	4.4	39.0
28	8.05	6.2	36.0	7.99	5.2	35.5	7.99	4.7	37.5	8.06	5.0	35.0	8.06	4.4	39.5	8.08	4.4	40.0
29	8.05	5.2	36.0				7.99	5.2	37	8.10	5.4	35.5	8.05	4.4	39.5	8.08	4.6	39.5
30	8.00	6.7	36.0				7.99	5.5	35	8.08	5.1	35.5	8.06	4.4	38.5	8.06	4.2	39.5
31	8.00	6.1	36.5				8.0	5.3	37.5				8.06	4.4	38.5			

pH = standard units

D.O = mg/l

Salinity = parts per thousand(ppt)

TABLE II.A.1

TABLE II.A.2
FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANTS UNITS 3 & 4
LAKE WARREN DISCHARGE

NOTE: All Results in mg/L YEAR 1978

DATE	T. RES. CHLOR.	AMMONIA	B.O.D.	C.O.D.	Cu	Zn	Co	As	Hg	OIL	Cr	Pb
1-6-78		<0.2	<1	227	<0.02	0.04	<0.02	<0.002	<0.0002	1	<0.02	<0.05
1-13-78		<0.2	<1	259					<0.0002	1		
1-20-78		<0.2	<1	332					<0.0002	<1		
1-27-78		<0.2	<1	277					<0.0002	2		
2-3-78		<0.02	<1	243	<0.02	0.04	<0.02	<0.01	<0.0002	1	<0.02	<0.05
2-10-78		<0.2	<1	218					<0.0002	<1		
2-17-78		<0.2	<1	349					<0.0002	2		
2-21-78		<0.2	<1	284					<0.0002	1		
3-3-78		<0.2	<1	292	<0.02	0.04	<0.02	0.007	<0.0002	1	<0.02	<0.05
3-10-78		<0.2	<1	343					<0.0002	2		
3-17-78		<0.02	<1	318					<0.0002	<1		
3-24-78		<0.2	<1	430					<0.0002	1		
3-31-78		<0.2	<1	330					<0.0002	2		
4-7-78		<0.2	<1	469	<0.02	0.03	<0.02	<0.002	<0.0002	2	<0.02	<0.05
4-14-78		<0.2	<1	592					<0.0002	1		
4-21-78			<1	444					<0.0002	<1		
4-28-78			<1	389					0.0002	2		
5-5-78			<1	288	<.02	0.04	<.02	<0.002	<0.0002	1	<.02	<.05
5-12-78			<1	233					<0.0002	<1		
5-19-78			<1	182					<0.0002	2		
5-26-78			<1	165					<0.0002	1		

TABLE II.A.2 (con't)
FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANTS UNITS 3 & 4
LAKE WARREN DISCHARGE

NOTE: All Results in mg/L YEAR 1978

DATE	T. RES. CHLOR.	AMMONIA	B.O.D.	C.O.D.	Cu	Zn	Co	As*	Hg	OIL	Cr	Pb
6-2-78			<1	244	<.02	.06	<.02		<.0002	1	<.02	<.05
6-9-78			<1	218					<.0002	2		
6-16-78			<1	198					<0.0002	1		
6-23-78			<1	233					<.0002	1		
6-30-78			<1	261					<.0002	2		

*As analysis for June not available from laboratory. Value will be included in next Semi-Annual Report.

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

TABLE II.A.3

NOTE: ALL RESULTS IN POUNDS

YEAR 1978

CHEMICAL \ MONTH	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
BENTONITE CLAY	1516	1,352	1,784	1776	1,751	1,711
POTASSIUM DICHROMATE	145	12	0	.5	12	0
POTASSIUM CHROMATE	0	30	9	16	0	56
SODIUM HEXAMETA-PHOSPHATE	20.4	5	13.0	3	5	0
BORIC ACID	1652	2,178	4,235	9276	0	5,870
HYDRATED LIME	22738	19,505	26,495	26941	27,065	25,698
POLYELECTROLYTE	32	0	30	30	32	730
CONCENTRATED (50%) SODIUM HYDROXIDE	81804	63,277	81,281	15042	86,806	78,819
CONCENTRATED SULFURIC ACID	81909	64,853	91,309	100127	105,180	107,660
HTH - CALCIUM HYPOCHLORITE	0	0	0	0	0	0
LIQUID CHLORINE	0	0	0	0	0	0
SALT	0	0	0	0	0	0

III. ANALYSIS OF ENVIRONMENTAL DATA

III.A Chemical

The monitoring of pH for the first six months of 1978 shows the same trends which have been previously observed. The range of pH was from a low of 7.94 to a high of 8.10. This very narrow range is as expected since the canal water is highly buffered.

Dissolved Oxygen (D.O) ranges from a low of 4.0 mg/l during May to a high of 6.5 mg/l in January. These variations are of the same magnitude as has been observed in the past.

Salinity concentrations ranged from 33.5 ppt to a high of 41.0 ppt which displays a trend characteristic of past years. Data showing Salinity, Dissolved Oxygen, and pH were given by Table II.A.1.

No chlorination of the circulating water system was performed during this six-month period and, therefore, no residual chlorine tests were performed.

Biological Oxygen Demand (BOD) was measured to be below the detection limit for this six-month period. This is as expected based on previous monitoring.

Ammonia levels were consistently below the detection limit for the months from January through April. No ammonia analysis was performed for the last week in April and during May or June because the analyzer was out of service. The device was sent to the manufacturer for repair. Although this data is lost, we have no reason to believe that the ammonia concentration in the plant discharge was different during May and June than during the previous four months. Also, the measurement over past years and recent months has shown ammonia to be consistently below the detection level.

Chemical Oxygen Demand (COD) levels averaged 301 mg/l for this six months, with a min/max of 592/165. Monitoring results for COD, BOD, and Ammonia were shown in Table II.A.2.

Table II.A.3 summarized the chemicals added from Units 3 and 4 to the circulating water system. The quantities added are reasonably consistent from month to month and are not appreciably changed from amounts added in past years. These chemicals are considered in the biological analysis given in Section III.D.2.

III.B Thermal

As required by Environmental Technical Specification 3.1, the temperatures at the inlet and outlet to the plant were monitored hourly. This data is summarized into temperature - time duration tables by month in Tables III.B.1-1 through III.B.1-6. The temperatures ranges are similar to those observed during previous years and display a pattern which is expected. Warmer inlet and outlet temperatures are seen during the warm months of May and June while January through April displays cooler temperatures.

Listed below are the maximum inlet & outlet temperatures for the same six month period during the past four years.

	MAX. INLET TEMP				MAX. OUTLET TEMP			
	1975	1976	1977	1978	1975	1976	1977	1978
January	86	80	75	78	99	96	90	91
February	89	83	82	77	101	98	99	90
March	92	86	85	86	102	102	103	101
April	90	86	84	87	101	102	100	101
May	92	87	91	92	105	105	105	108
June	96	90	94	95	110	106	109	111

TABLE III.B.1-1

TIME DURATION CURVES - TEMPERATURE

JANUARY - 1978

UNITS 3 & 4 INTAKE

Number Of Hours	Temperature °F	Accumulated Time - %
3	78	0.4
41	77	6.2
39	76	11.7
45	75	18.0
54	74	25.6
44	73	31.8
66	72	41.1
49	71	48.0
66	70	57.2
43	69	63.3
35	68	68.2
28	67	72.2
35	66	77.1
27	65	80.9
24	64	84.2
32	63	88.7
26	62	92.4
23	61	95.6
11	60	97.2
20	59	100.0

LAKE WARREN OUTLET

Number Of Hours	Temperature °F	Accumulated Time - %
5	91	0.7
20	90	3.4
38	89	8.5
74	88	18.4
34	87	23.0
40	86	28.4
45	85	34.4
63	84	42.9
47	83	49.2
87	82	60.9
57	81	68.5
29	80	72.4
51	79	79.3
32	78	83.6
35	77	88.3
15	76	90.3
19	75	92.9
8	74	94.0
7	73	94.9
23	72	98.0
4	71	98.5
4	70	99.1
2	69	99.3
5	68	100.0

TABLE III.B.1-2

TIME DURATION CURVES - TEMPERATURE

FEBRUARY - 1978

UNITS 3 & 4 INTAKE

Number Of Hours	Temperature °F	Accumulated Time - %
7	77	1.1
21	76	4.2
60	75	13.3
99	74	28.2
51	73	35.8
56	72	44.3
16	71	46.7
38	70	52.4
61	69	61.6
66	68	71.5
50	67	79.1
33	66	84.0
17	65	86.6
29	64	91.0
20	63	94.0
17	62	96.5
14	61	98.6
7	60	99.7
2	59	100.0

LAKE WARREN OUTLET

Number Of Hours	Temperature °F	Accumulated Time - %
8	90	1.2
11	89	2.8
17	88	5.4
18	87	8.0
22	86	11.3
22	85	14.6
18	84	17.3
19	83	20.1
79	82	31.8
59	81	40.6
55	80	48.8
89	79	62.1
60	78	71.0
97	77	85.4
33	76	90.3
36	75	95.7
8	74	96.9
13	73	98.8
7	72	99.9
1	71	100.0

TABLE III.B.1-3

TIME DURATION CURVES - TEMPERATURE

MARCH - 1978

UNITS 3 & 4 INTAKE

Number Of Hours	Temperature °F	Accumulated Time - %
5	86	0.7
18	85	3.1
17	84	5.4
58	83	13.2
44	82	19.1
52	81	26.1
41	80	31.6
35	79	36.3
57	78	44.0
70	77	53.4
54	76	60.6
69	75	69.9
50	74	76.6
30	73	80.6
78	72	91.1
30	71	95.2
23	70	98.3
7	69	99.2
6	68	100.0

LAKE WARREN OUTLET

Number Of Hours	Temperature °F	Accumulated Time - %
8	101	1.1
14	100	3.0
14	99	4.8
19	98	7.4
51	97	14.2
17	96	16.5
39	95	21.8
25	94	25.1
42	93	30.8
45	92	36.8
52	91	43.8
112	90	58.9
48	89	65.3
81	88	76.2
37	87	81.2
56	86	88.7
28	85	92.5
36	84	97.3
15	83	99.3
5	82	100.0

TABLE III.B.1-4

TIME DURATION CURVES - TEMPERATURE

APRIL - 1978

UNITS 3 & 4 INTAKE

Number Of Hours	Temperature °F	Accumulated Time - %
6	87	0.8
35	86	5.7
72	85	15.7
143	84	35.6
113	83	51.3
76	82	61.9
56	81	69.7
77	80	80.4
62	79	89.0
42	78	94.9
11	77	96.4
14	76	98.3
11	75	99.9
0	74	99.9
1	73	100.0

LAKE WARREN OUTLET

Number Of Hours	Temperature °F	Accumulated Time - %
14	101	1.9
100	100	15.9
127	99	33.5
88	98	45.8
95	97	59.0
44	96	65.1
54	95	72.6
54	94	80.1
74	93	90.4
18	92	92.9
20	91	95.7
29	90	99.7
2	89	100.0

TABLE III.B.1-5

TIME DURATION CURVES - TEMPERATURE

MAY - 1978

UNITS 3 & 4 INTAKE

Number Of Hours	Temperature °F	Accumulated Time - %
5	92	0.7
20	91	3.4
70	90	12.8
113	89	28.0
136	88	46.2
94	87	58.9
122	86	75.3
45	85	81.3
89	84	93.3
26	83	96.8
19	82	99.3
3	81	99.7
2	80	100.0

LAKE WARREN OUTLET

Number Of Hours	Temperature °F	Accumulated Time - %
5	108	0.7
23	107	3.8
45	106	9.8
32	105	14.1
93	104	26.6
99	103	39.9
181	102	64.2
42	101	69.9
108	100	84.4
25	99	87.8
32	98	92.1
31	97	96.2
12	96	97.8
5	95	98.5
3	94	98.9
8	93	100.0

TABLE III.B.1-6

TIME DURATION CURVES - TEMPERATURE

JUNE - 1978

UNITS 3 & 4 INTAKE

Number Of Hours	Temperature °F	Accumulated Time - %
8	95	1.1
49	94	7.9
84	93	19.6
131	92	37.8
127	91	55.4
93	90	68.3
59	89	76.5
46	88	82.9
21	87	85.8
18	86	88.3
8	85	89.4
41	84	95.1
17	83	97.5
18	82	100.0

LAKE WARREN OUTLETS

Number Of Hours	Temperature °F	Accumulated Time - %
9	111	1.2
22	110	4.3
59	109	12.5
177	108	37.1
45	107	43.3
82	106	54.7
66	105	63.9
68	104	73.3
20	103	76.1
46	102	82.5
36	101	87.5
56	100	95.3
16	99	97.5
16	98	99.7
2	97	100.0

III.C FISH AND SHELLFISH

III.D BENTHOS

These two sections are covered by the report entitled "Ecological Monitoring of Selected Parameters at the Turkey Point Plant -- January - June, 1978." This report was prepared for Florida Power & Light Company by its consultant, Applied Biology, Inc., and is appended to this Environmental Monitoring Report.

III.E. ASSESSMENT OF RECOVERY IN THE TURKEY POINT PLANT DISCHARGE AREAS

GRAND CANAL DISCHARGE AREA

Purpose

This section 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 1978 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. Reference points were used to determine the scale of the photo. A tracing of specific areas of dominant grasses and macroalgae was made from the photograph. 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, one square meter each, 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.

RESULTS

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 old discharge (Figure 1).

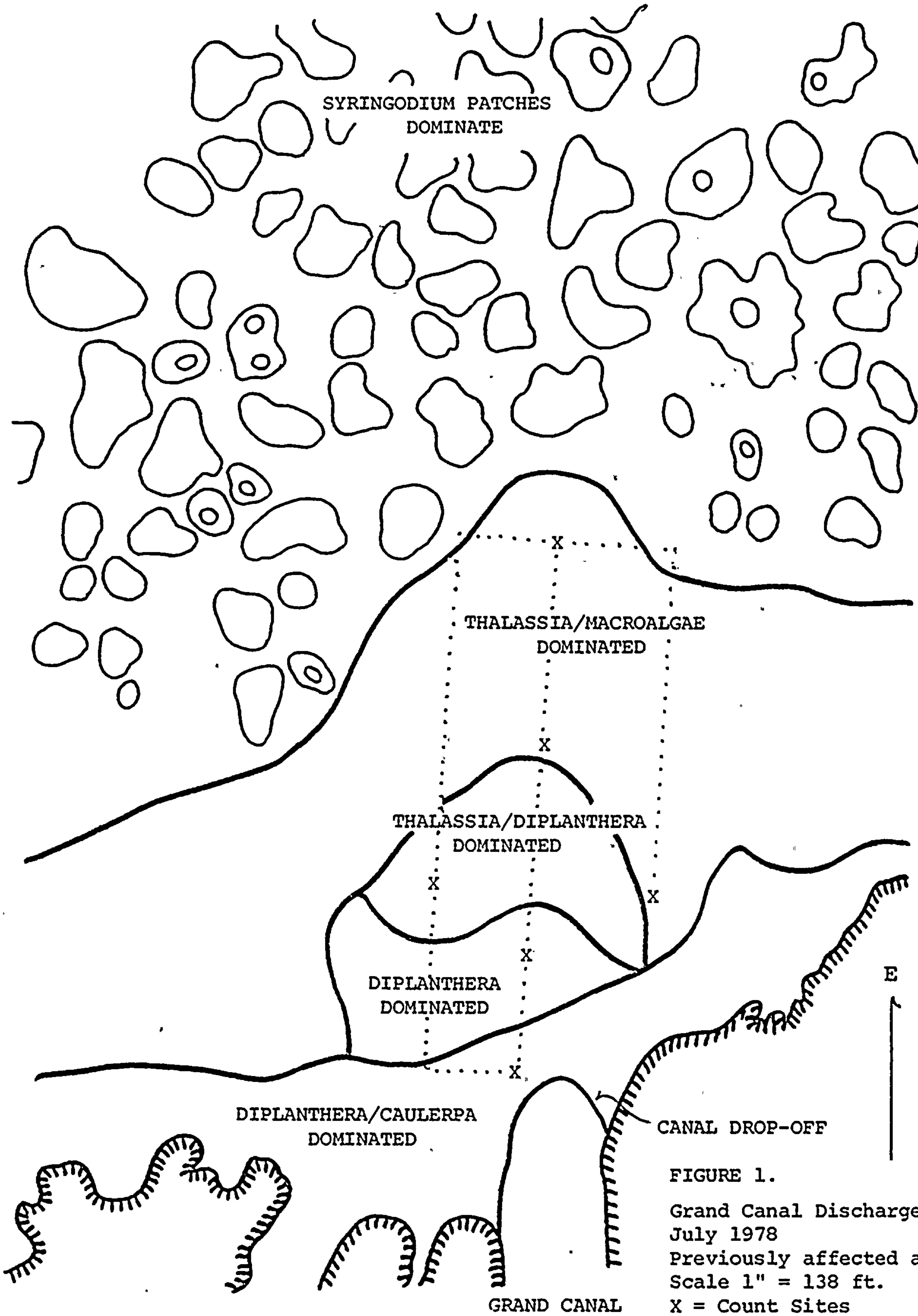

FIGURE 1.

Grand Canal Discharge
July 1978
Previously affected area.
Scale 1" = 138 ft.
X = Count Sites
..... = Transect Swim

SQUARE METER SURVEY

Table I represents 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 are based on the fasicles (sheaths of leaves).

TABLE 1

GRAND CANAL DISCHARGE REVEGETATION

		X-1	X-2	X-3	X-4	X-2N	X-2S
GRASSES:	*Diplanthera wrightii*	>60	>1900	>2400	>2000	>500[1]	>800
	Thalassia testudinum	39	28	193	76	79	62
CHLOROPHYTA:	*Acetabularia crenulata*	**	**	**	**	**	**
	Avrainvillea nigricans	0	0	0	0	0	0
	Batophora oerstedii	0	0	0	0	0	0
	Caulerpa sp.	**	**	*	*	0	**
	Halimeda sp.	*	**	**	**	**	**
	Penicillus sp.	0	10	24	8	3	22
	Anadyomene stellata	0	0	*	0	0	0
PHAEOPHYTA:	*Laurencia poitei*	0	**	**	0	*	**
	Dictoyota sp.	0	0	0	0	*	0
OTHERS:	*Rhizophora mangle*	0	0	1	0	0	0

Sampling Date: July 1978

[1] This number represents atypical data (much lower than previous reports) as it is in a *Diplanthera* - dominated area. This station will be watched closely and commented on again in the year-end report.

* Present

** Common

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 2 - 4" deep and composed mostly of dead Diplanthera with some Thalassia fascicles.

Between stations X-2 and X-3 the vegetation became more diverse with much more Thalassia and Penicillus present. Large patches of Caulerpa were still evident. The Thalassia was shorter in this area. The Penicillus population was composed mostly of young shoots or mature plants. By X-3 Thalassia, Diplanthera, and Penicillus shared the dominance, although there were many patches composed almost exclusively of Thalassia. The detrital layer was 1" deep and composed almost equally of Thalassia and Diplanthera.

The transect between X-3 and X-4 continued to be Thalassia dominated while there were patches comprised solely of Penicillus, Avrainvillea, and Halimeda. 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. A detrital layer 1-2" thick was found in this area. It was composed almost exclusively of an unidentified green algae, which was reported in Semi-Annual Report 10.

Moving east of X-4 there continued to be diverse stands of the calcareous green alga dominated by Halimeda, Avrainvillea, and Penicillus. After about one hundred feet, there was a point at which it suddenly changed to a Syringodium dominance, with interspersed Thalassia.

North of X-1, Diplanthera was the dominant grass with large patches of Caulerpa also present. Thalassia was patchy and exhibited very long fascicles.

Moving east of 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. Some scattered Laurencia was present here. The detrital layer was 1 - 2" thick.

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 a patch of short Syringodium was observed. There was some Caulerpa scattered throughout this area. In general, there was little silt in this area. The detrital layer was about 1" deep and composed mainly of dead *Thalassia* fascicles.

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 scattered throughout and again large patches were present closer to shore. The detrital layer for the South quadrant, West of X-3 is about 1" deep and composed of a diverse mixture of grasses and algae. There was no measurable sedimentation at any of the sampling sites.

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 area.

It is interesting to note that the _Laurencia_, which was reported covering large areas in previous 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.

III.F. PHYSICAL AND NUTRIENT DATA

1. PHYSICAL DATA

Purpose

The purpose of this section is to provide basic physical data to help in the interpretation of the plankton reports. This section deals with data collected on a monthly basis during plankton sampling. More detailed temperature, salinity, and dissolved oxygen data can be found in another section of this report.

Methods and Procedures

1. Temperature was measured by a Y.S.I. Telethermometer; accuracies were $\pm$ 0.1°C.
2. Salinities were measured with an American Optical Refractometer; accuracies were $\pm$ 0.5 PPT.
3. Dissolved oxygen was measured with a Y.S.I. Probe type oxygen meter; accuracies were $\pm$ 0.2 PPM.

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

Discussion and Conclusions

The maximum temperature measured in the cooling canal system (Figure 1) was 42.0°C with 31.9°C being the maximum temperature in Biscayne Bay and Card Sound (Figures 2 & 3). The maximum temperatures both within the cooling system and within the Bay were higher than the maximum temperatures in the same period last year.

The minimum temperature measured in the canal system was 18.0°C and was recorded in February. The minimum temperature of 15.5°C in the Bay was recorded the same month. Both of these values were lower than the minimums recorded in the same period last year.

The average temperature in the Bay continued to be lower by approximately 2.0°C than the average temperature at the power plant intake.

There was a range of 26.0°C between the maximum and minimum temperatures in the cooling canal system for this period.

The maximum salinity in the cooling canals (Figure 4) was 40.0 ppt or 3.0 ppt higher than the maximum in the Bay (Figures 5 & 6). Most of this period of the year is considered the dry season, thus accounting for the high salinities in the cooling canals. The lowest salinities in the system, reported in the westernmost canal, were due to the operation of the interceptor ditch pump for salt water intrusion control.

The range of salinities in the system was 6.0 ppt, excluding the station in the westernmost canal, and 13.0 ppt in the Bay. Salinities in the cooling canal system, as in the Bay, are within the tolerable limits of the marine organisms of the area.

Due to the elevated temperatures and salinity of the cooling canal system, the average dissolved oxygen (Figure 7) was 1.1 ppm lower than in Biscayne Bay (Figures 8 & 9). The lowest value for the canal system was 4.4 ppm. This is a sufficient oxygen supply for the organisms therein.

2. NUTRIENT DATA

Methods and Procedures

Samples were collected monthly from 12 sample points within the canal system, and 3 control points in the Bay and Card Sound.

Acid washed, ground glass stoppered, clear glass containers were used for the ammonia samples and phenol-alcohol was added as the preservative. Dark glass 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 Auto-analyzer. Data was recorded in parts per million.

Discussion and Conclusions

Canal system NH_3 levels (Figure 10) were down slightly from this period last year. Canal system NH_3 levels were approximately 4X the Bay for this period. Bay NH_3 levels (Figure 11) were consistent with this period last year.

Canal system NO_2 levels (Figure 12) tended to be similiar to last year this period, except during the May and June wet periods of 1977, which were higher than this year's compar-

able period. Canal system NO_2 levels were 10X the levels in the Bay for this period. Bay NO_2 levels (Figure 13) were equal to or slightly higher than for this period last year.

Canal system NO_3 levels (Figure 14) were dissimiliar in pattern to this period last year. Canal system NO_3 levels were approximately 10X the Bay for this period. Bay NO_3 levels (Figure 15) were consistent with this period last year.

Canal system I-PO_4 levels (Figure 16) were similiar to last year this period. Canal system I-PO_4 levels were approximately 3X the levels in the Bay. Bay I-PO_4 levels (Figure 17) (as above) were slightly lower than last year for this period.

Canal system T-PO_4 levels (Figure 18) were similiar to last year this period. Canal system T-PO_4 levels were approximately 4X the Bay levels. Bay T-PO_4 levels (Figure 19) were slightly lower than this period last year.

The apparent cycling of the ammonia, nitrite, and nitrates seen in the canal system in previous years appeared to have been repeated this period.

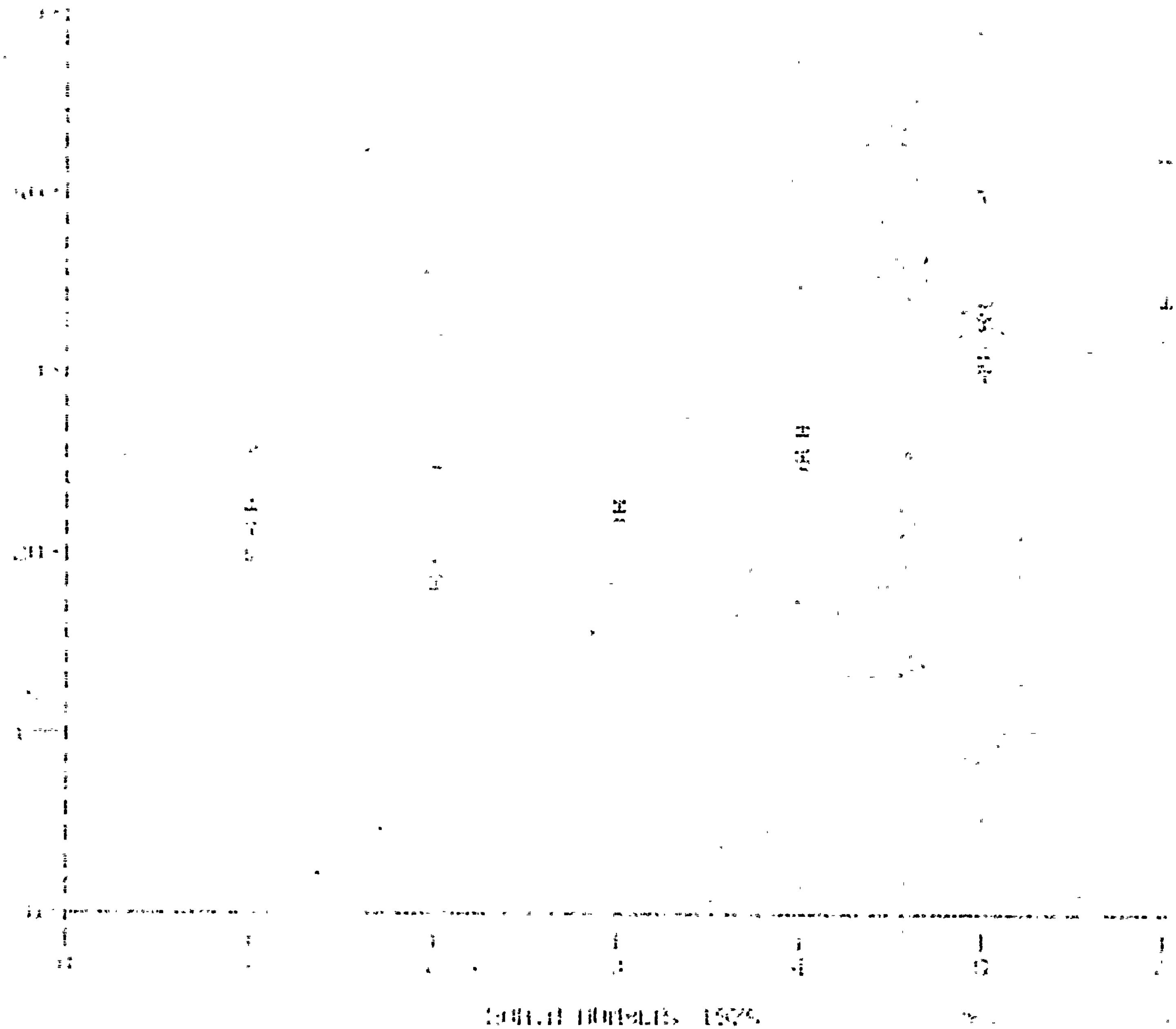

Figure 1. Temperature in the Canal System in Degrees Centigrade.

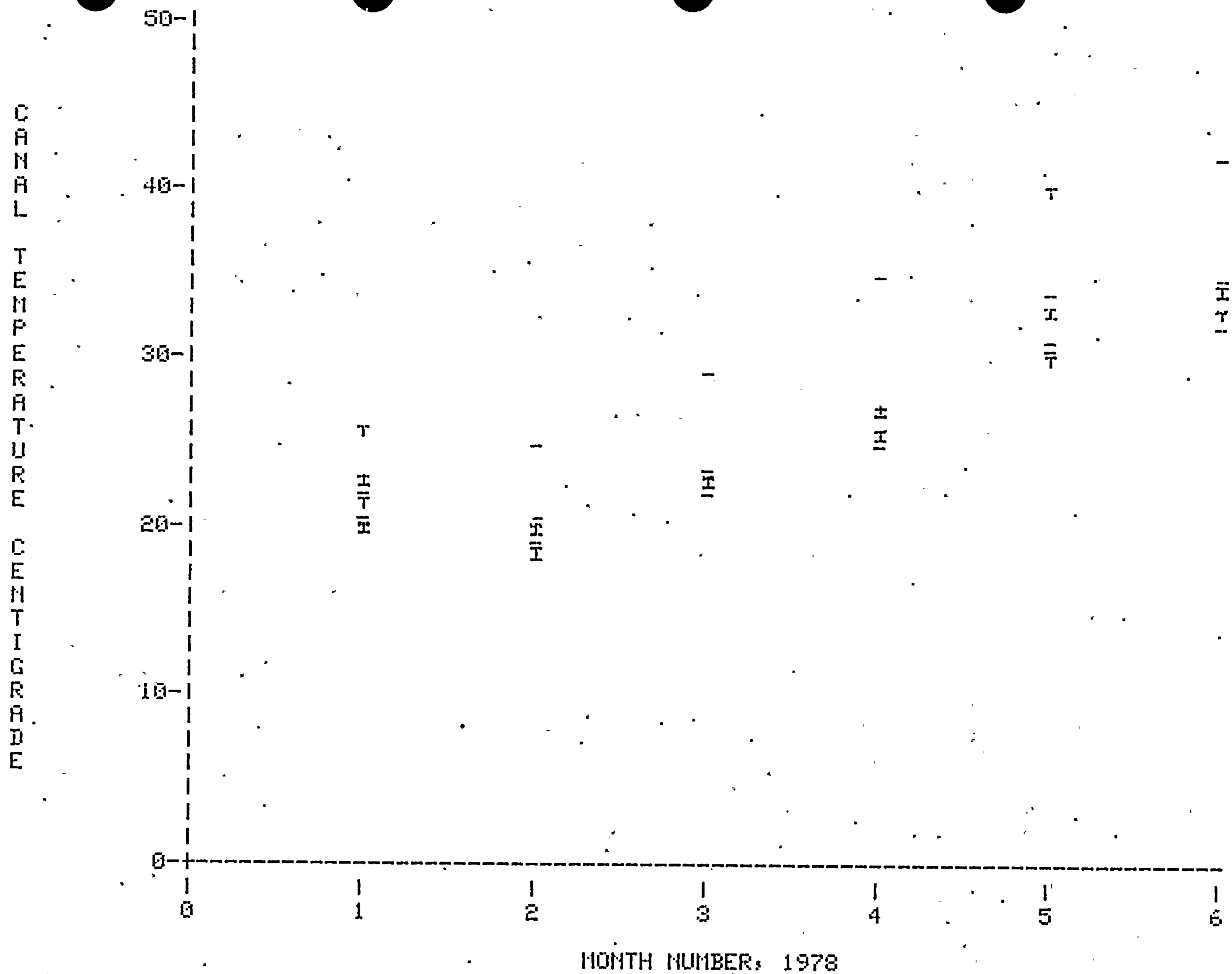

Figure 1. Temperature in the Canal System in Degrees Centigrade.

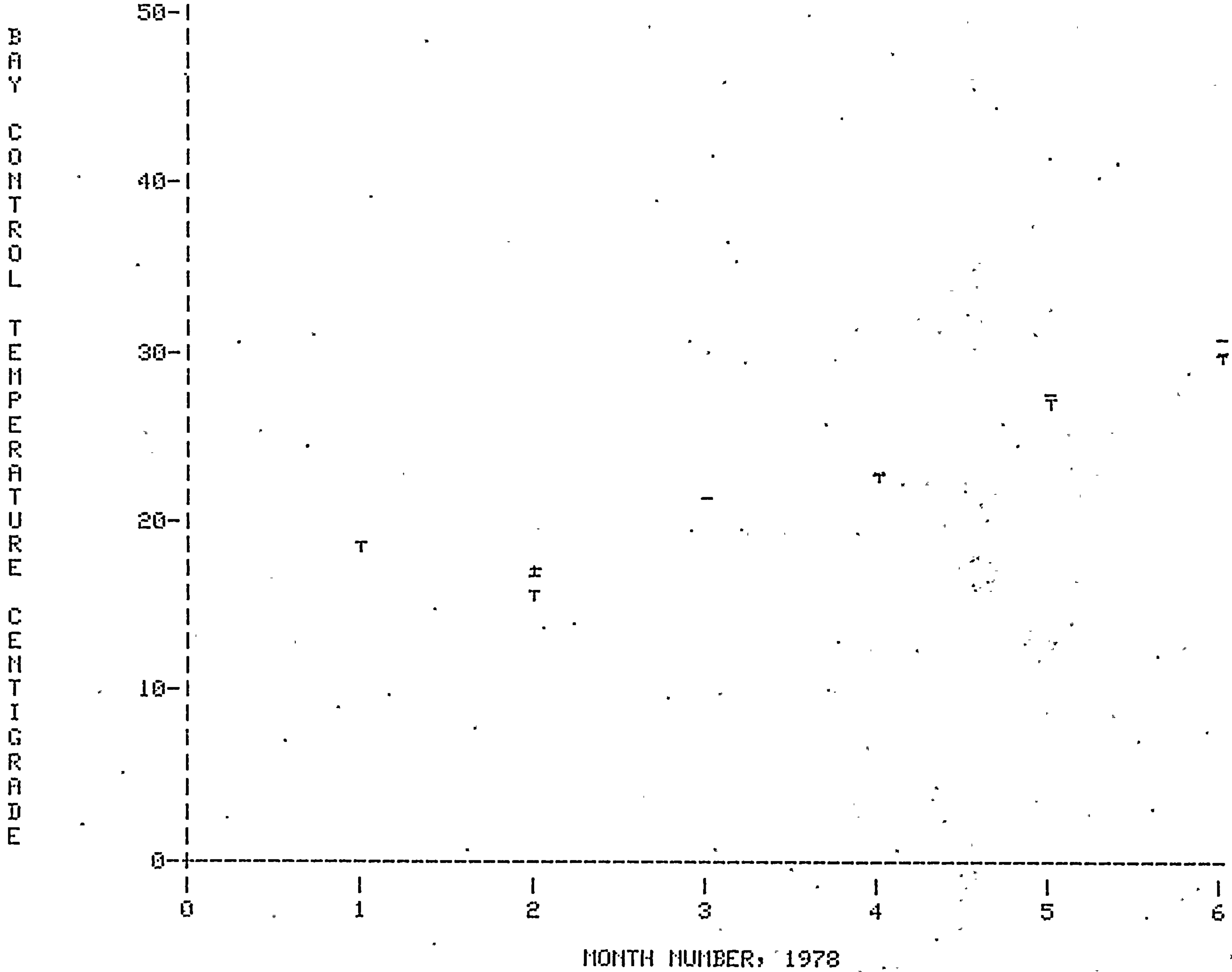

Figure 2. Temperature at the Bay Control Stations in Degrees Centigrade.

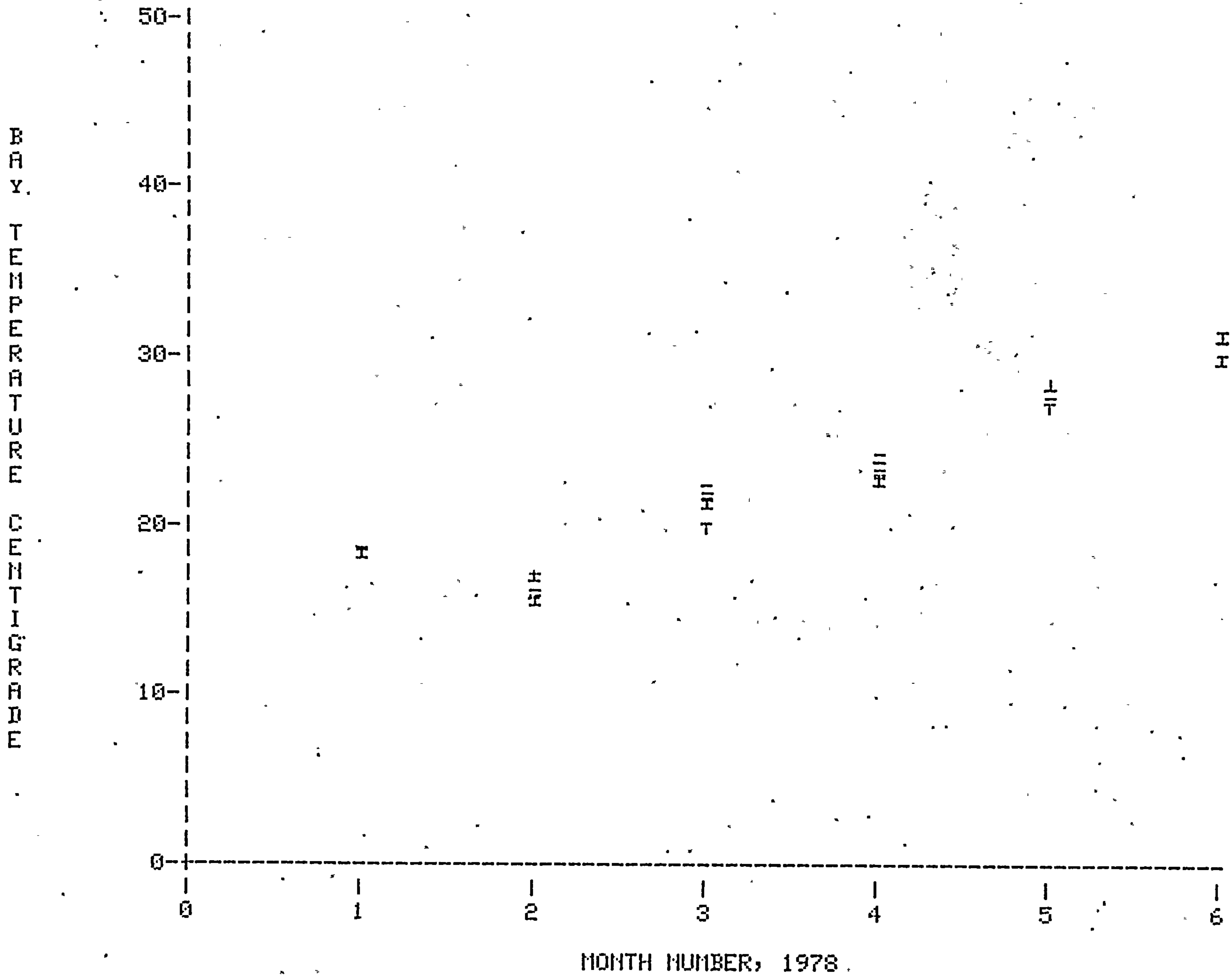

Figure 3. Temperature at the Bay Plankton Stations in Degrees Centigrade.

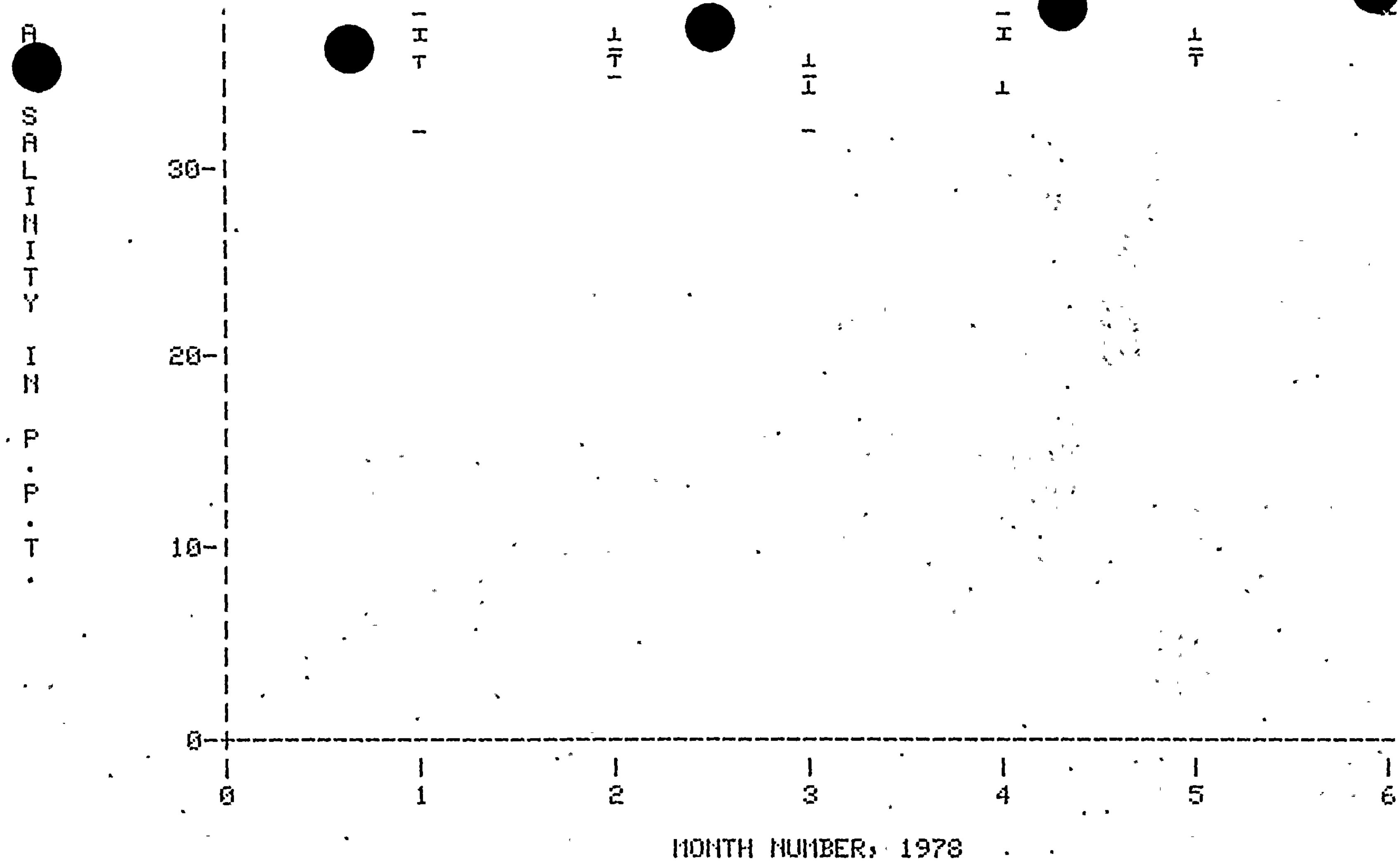

Figure 4. Salinity in the Canal System in PPT.

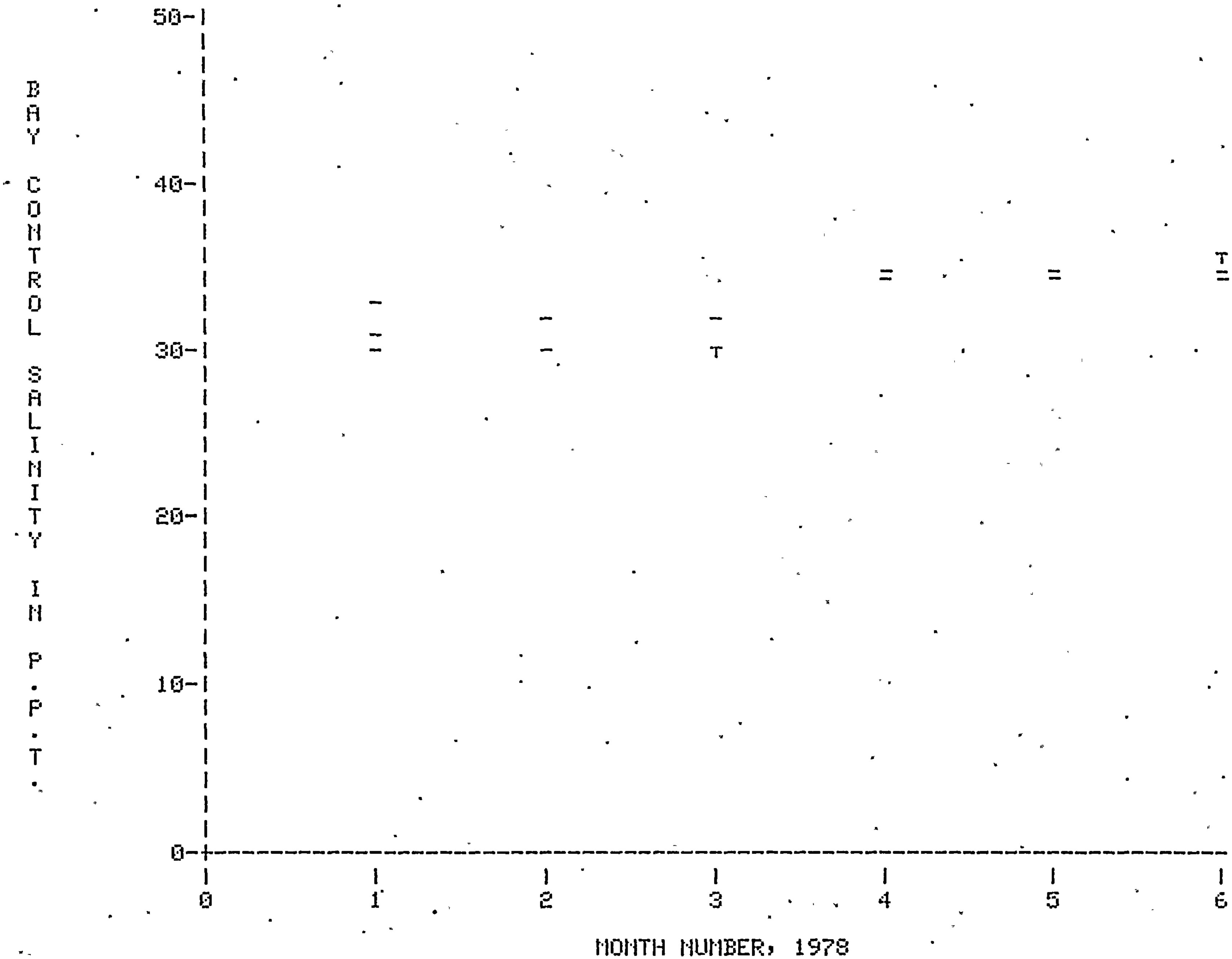

Figure 5. Salinity at the Bay Control Stations in PPT.

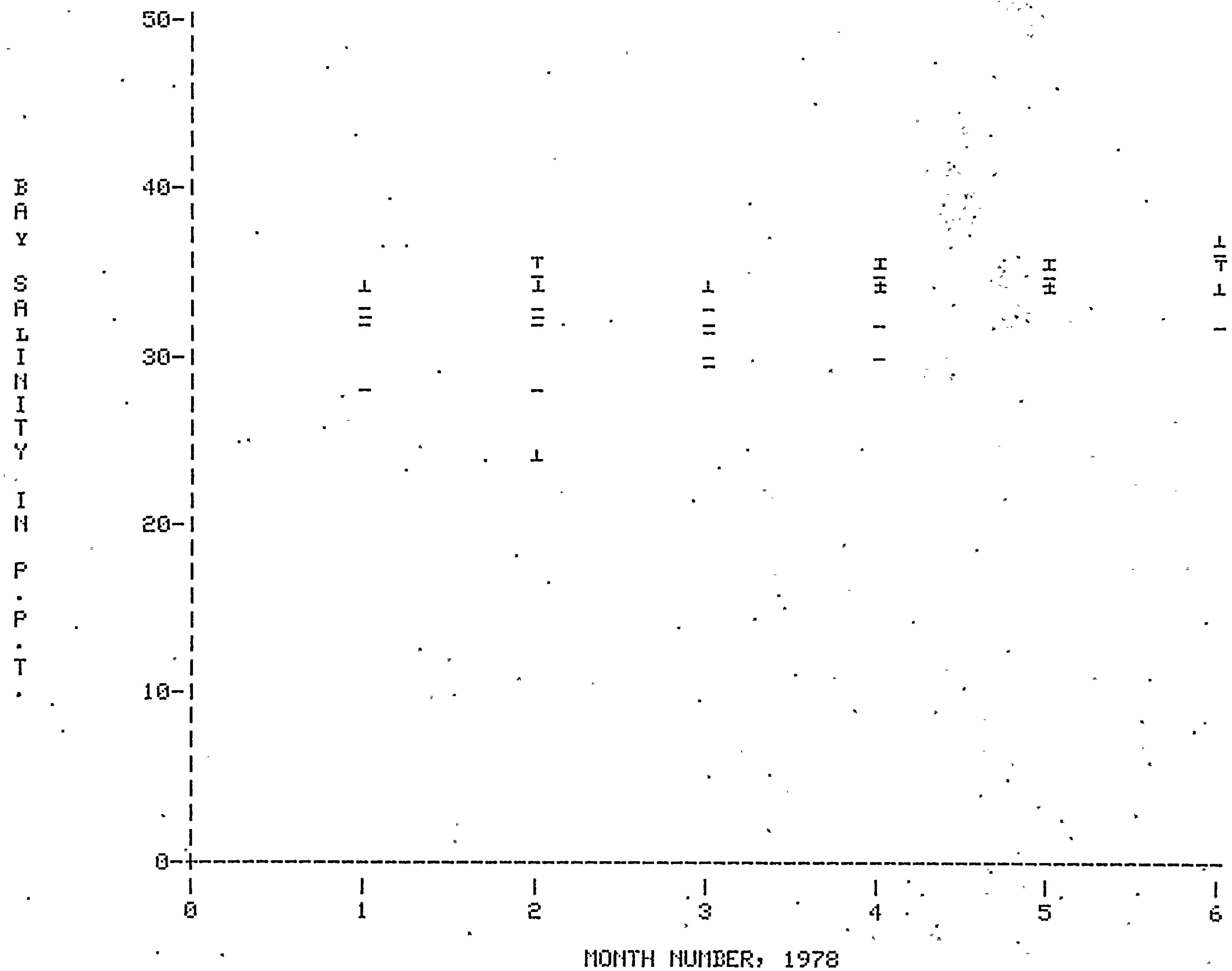

Figure 6. Salinity at the Bay Plankton Stations in PPT.

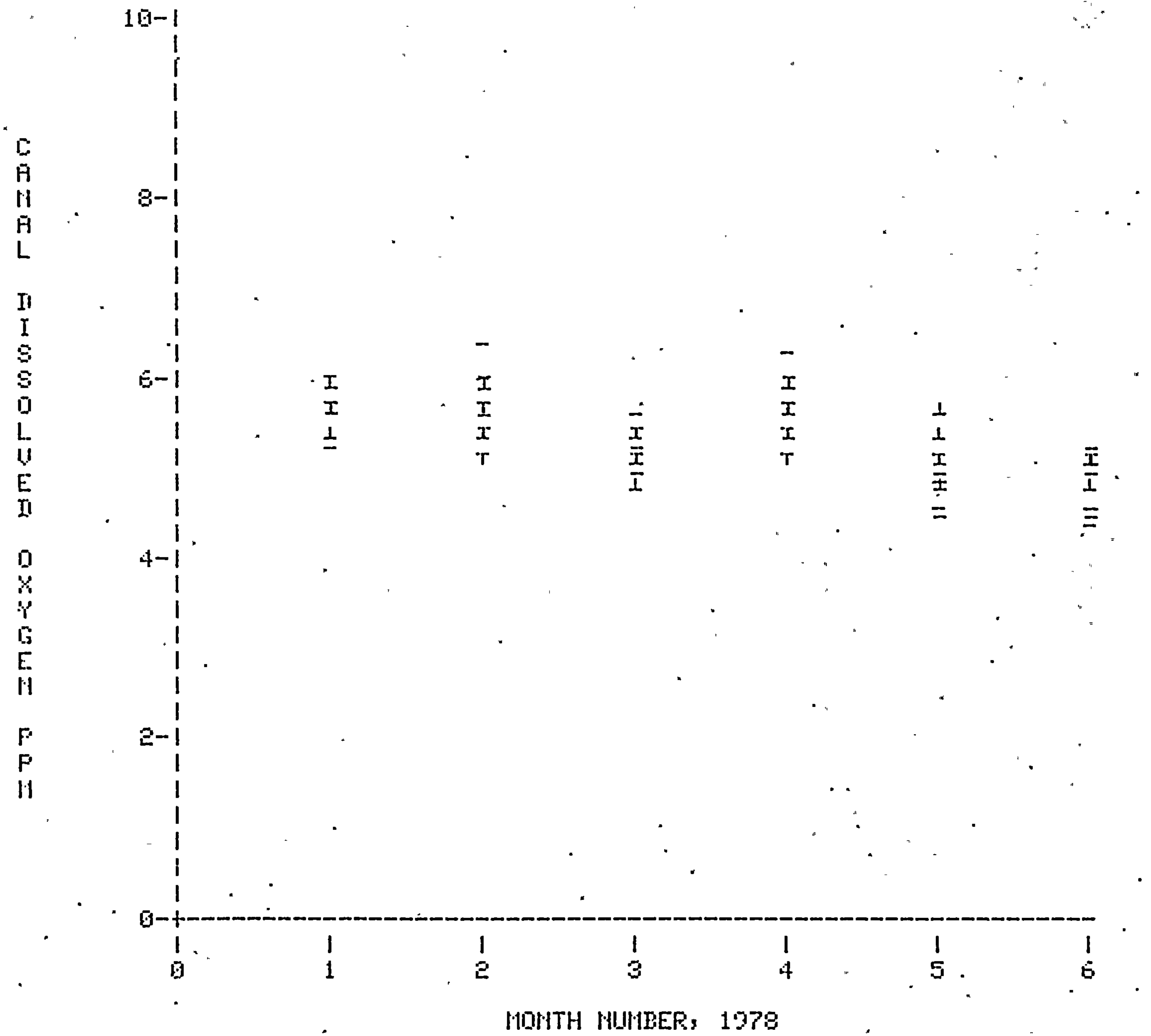

Figure 7. Dissolved Oxygen in the Canal System in PPM.

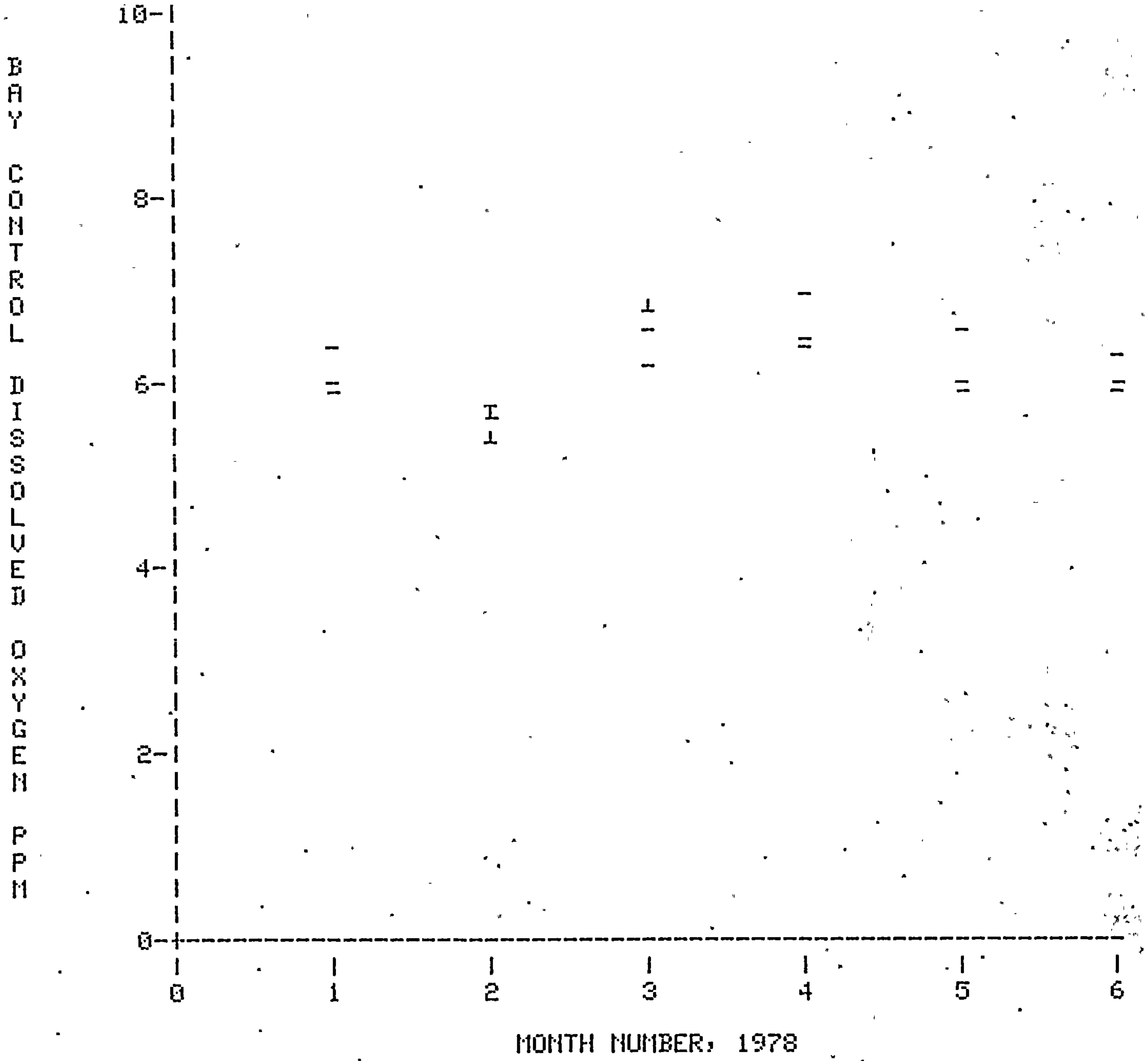

Figure 8. Dissolved Oxygen at the Bay Control Stations in PPM.

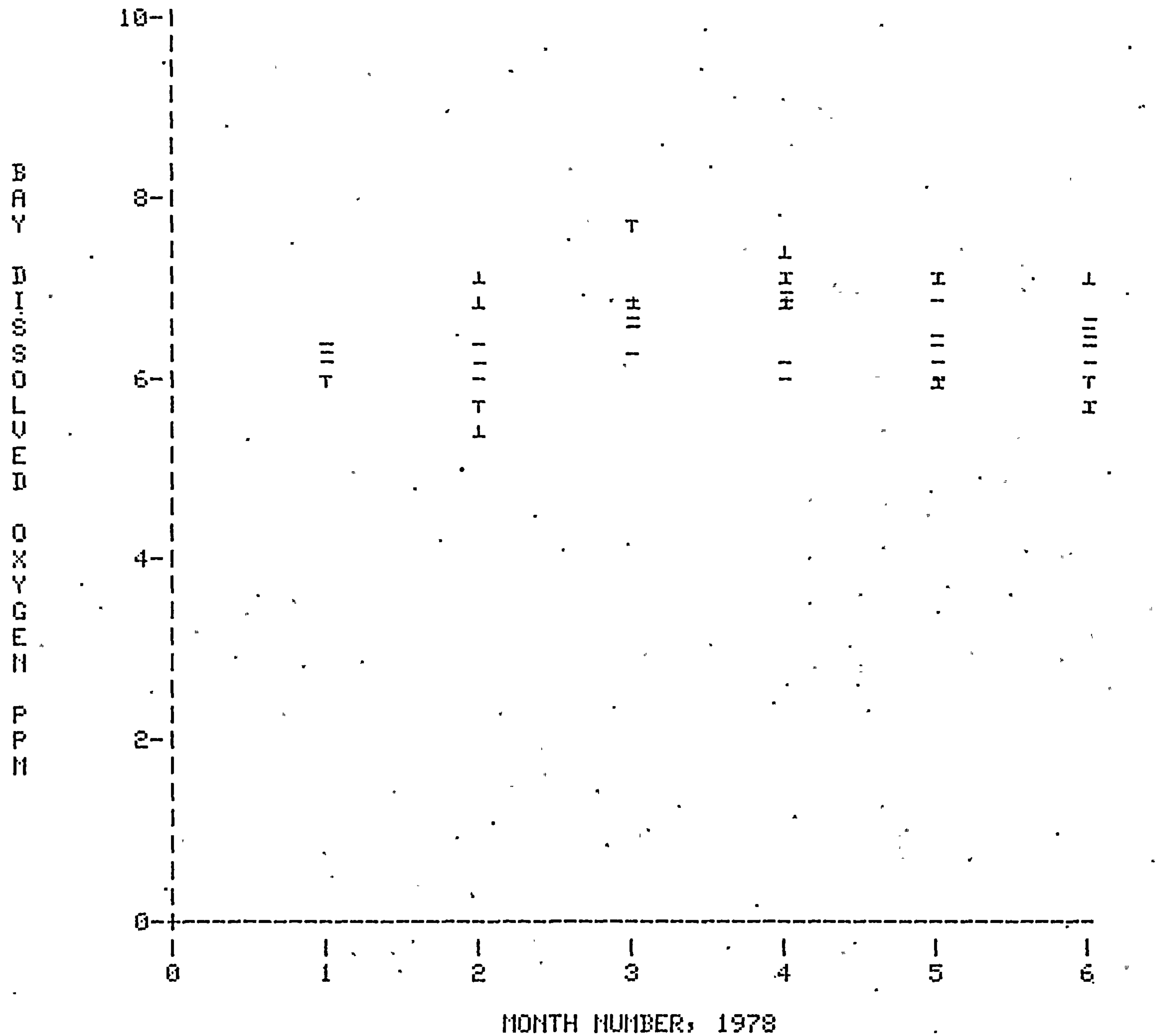

Figure 9. Dissolved Oxygen at the Bay Plankton Stations in PPM.

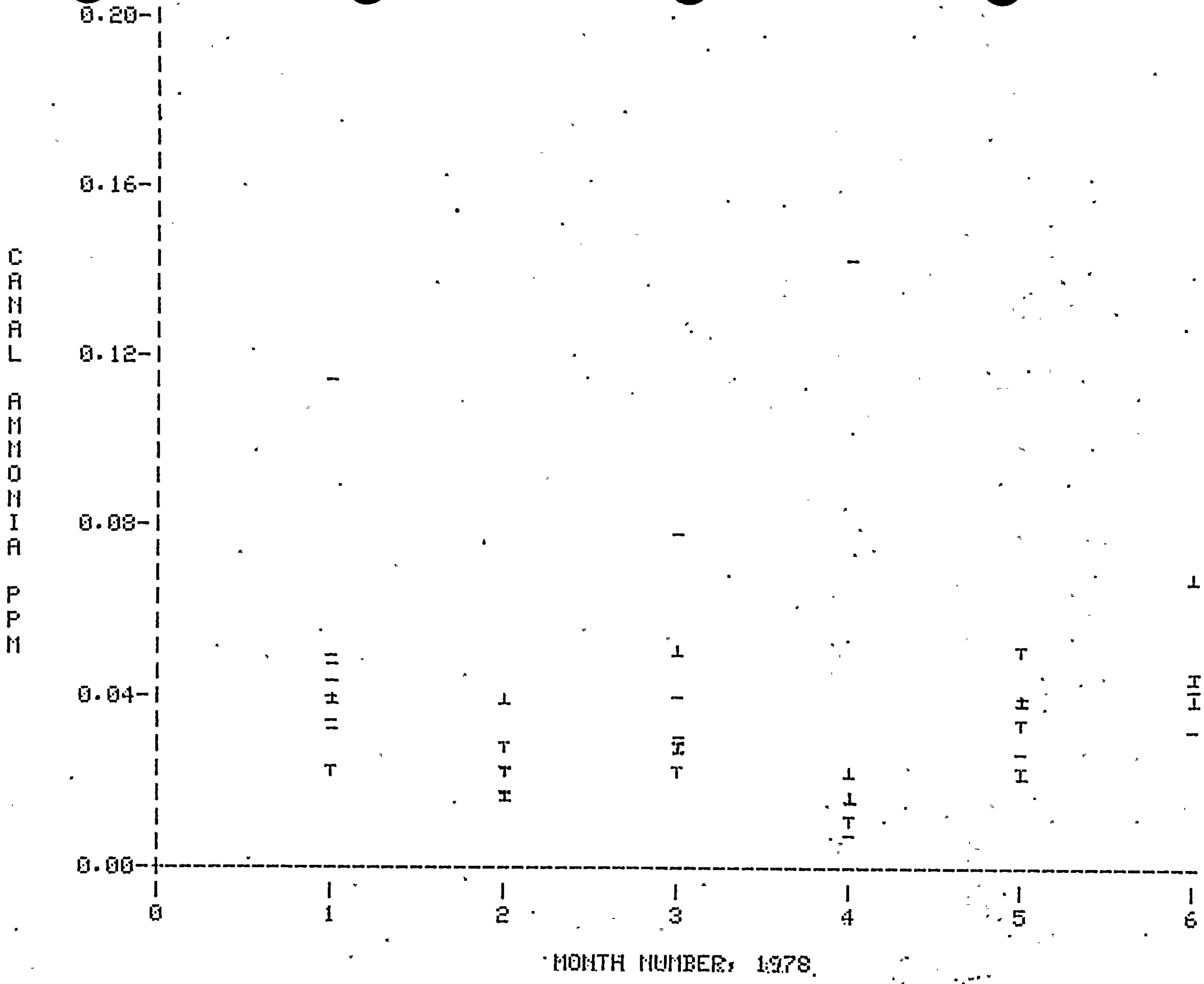

Figure 10. Ammonia in the Canal System in PPM.

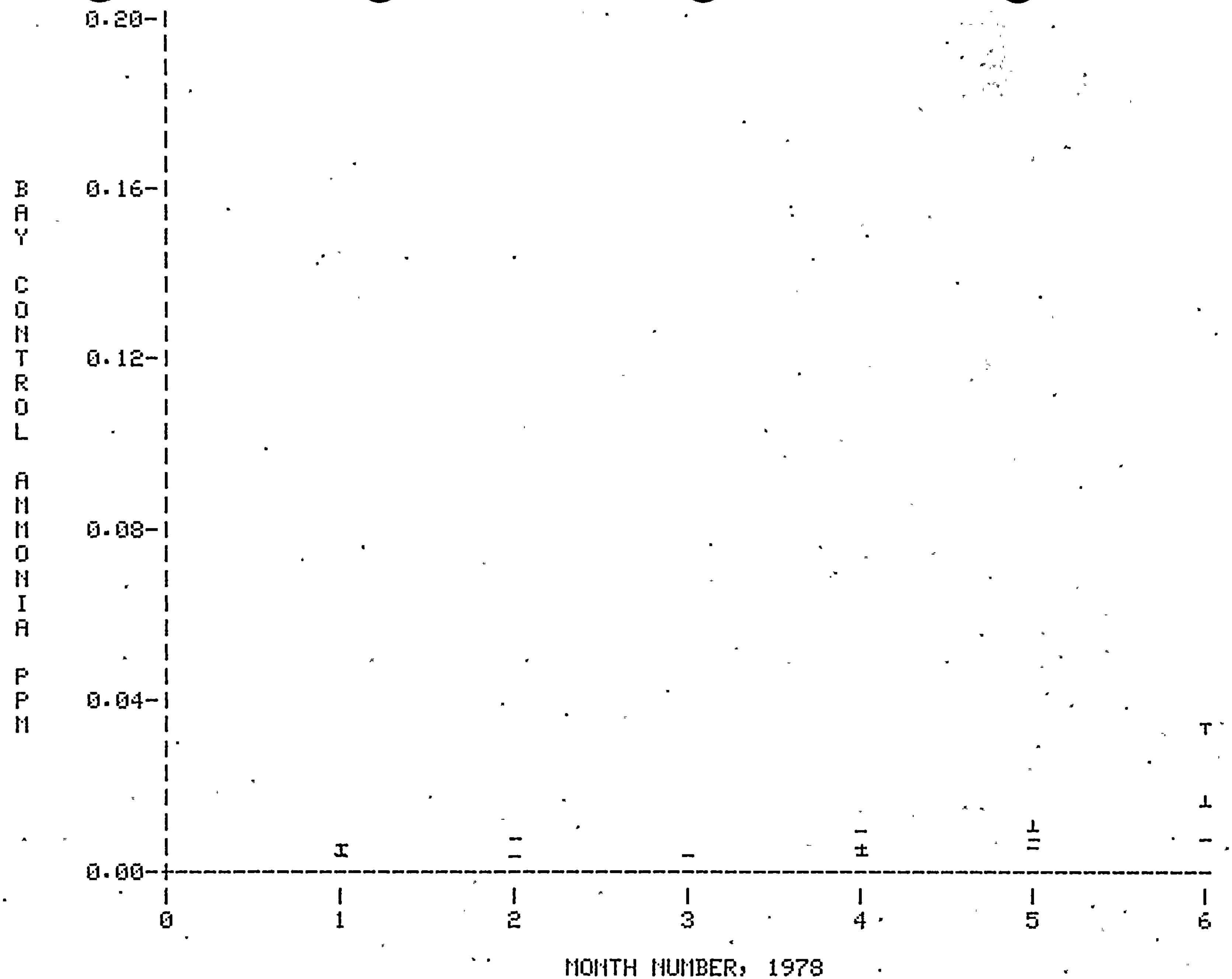

Figure 11. Ammonia concentrations of the Bay Control Stations in PPM.

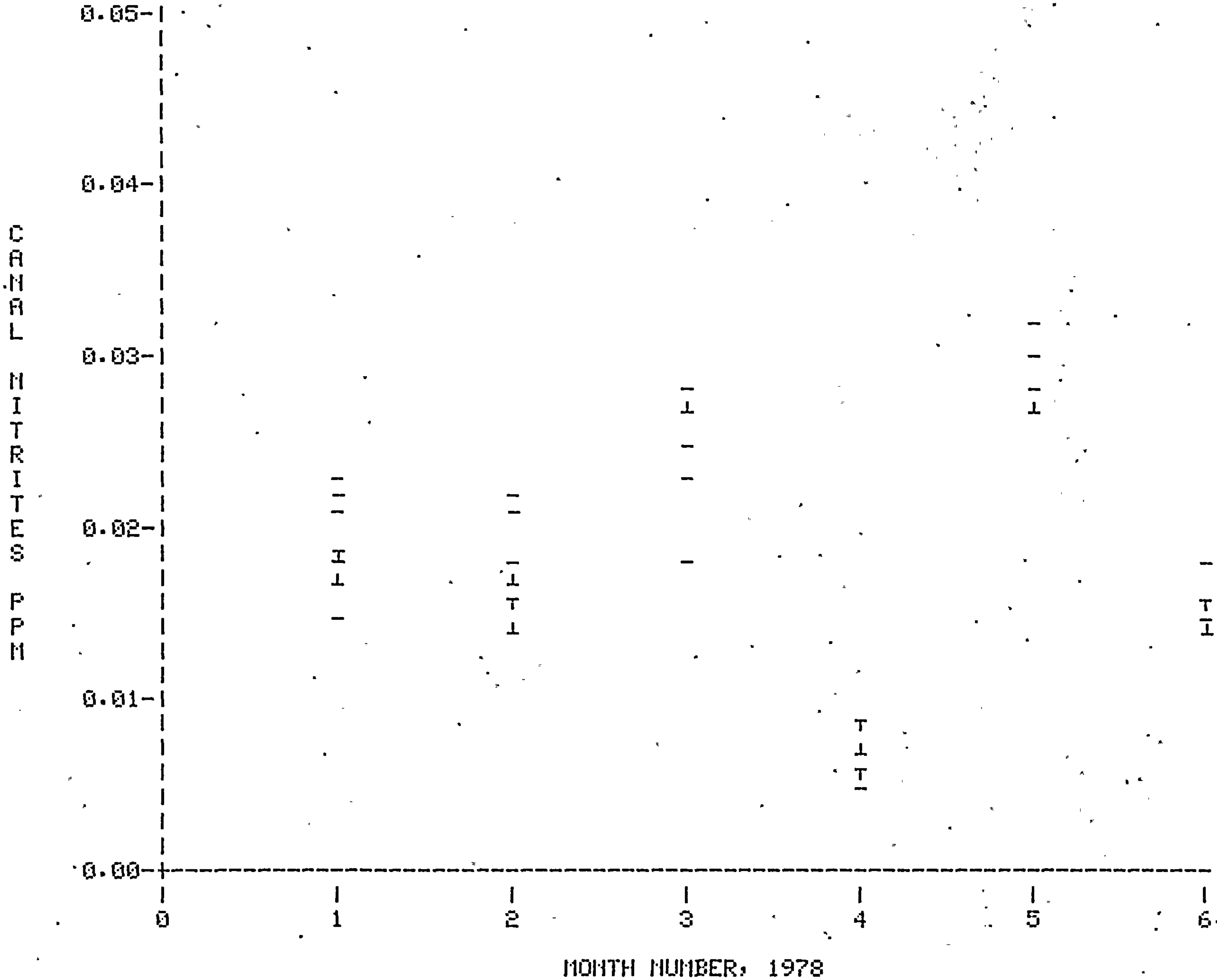

Figure 12. Nitrite concentration in the Canal System in PPM.

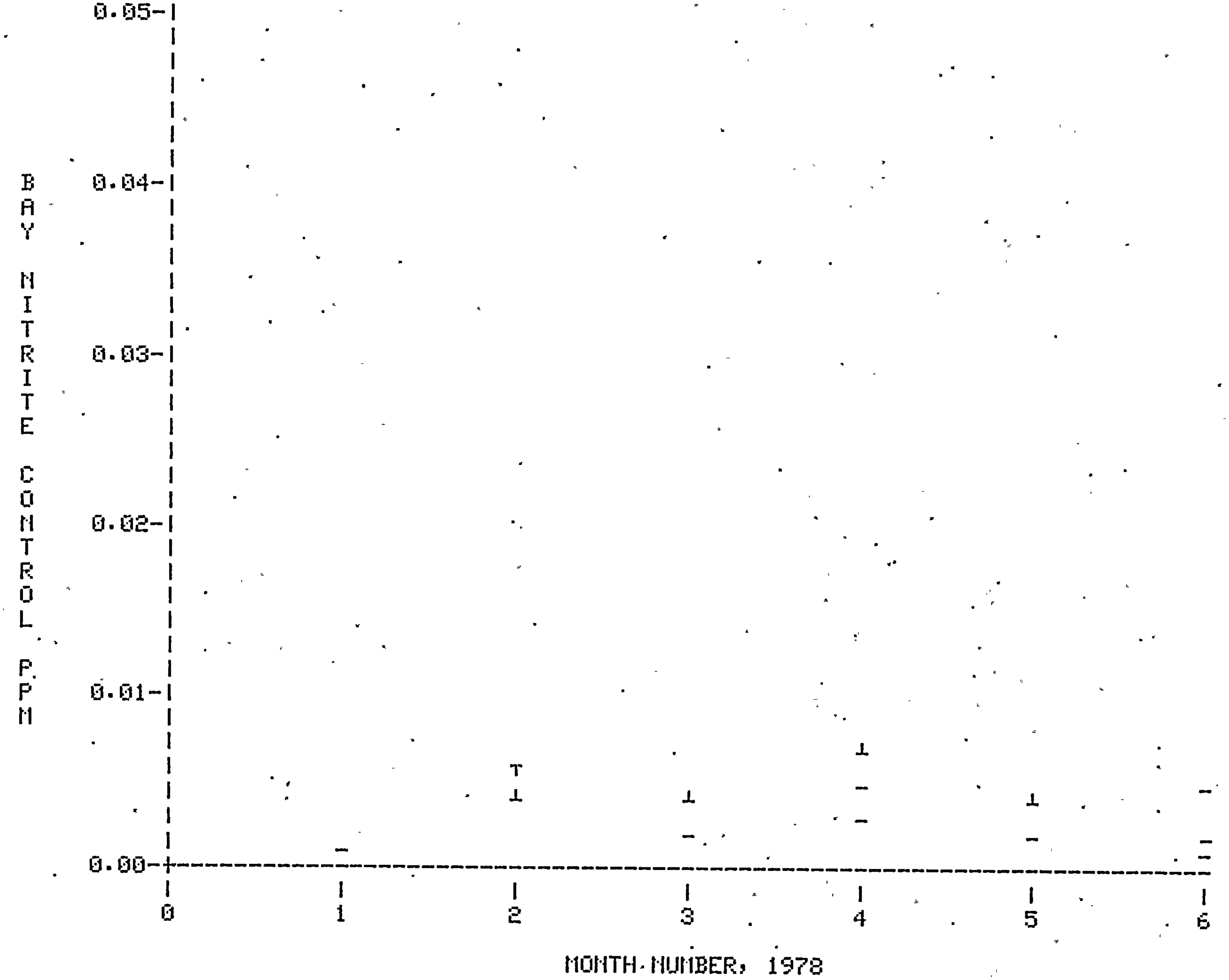

Figure 13. Nitrite concentrations of the Bay Control Stations in PPM.

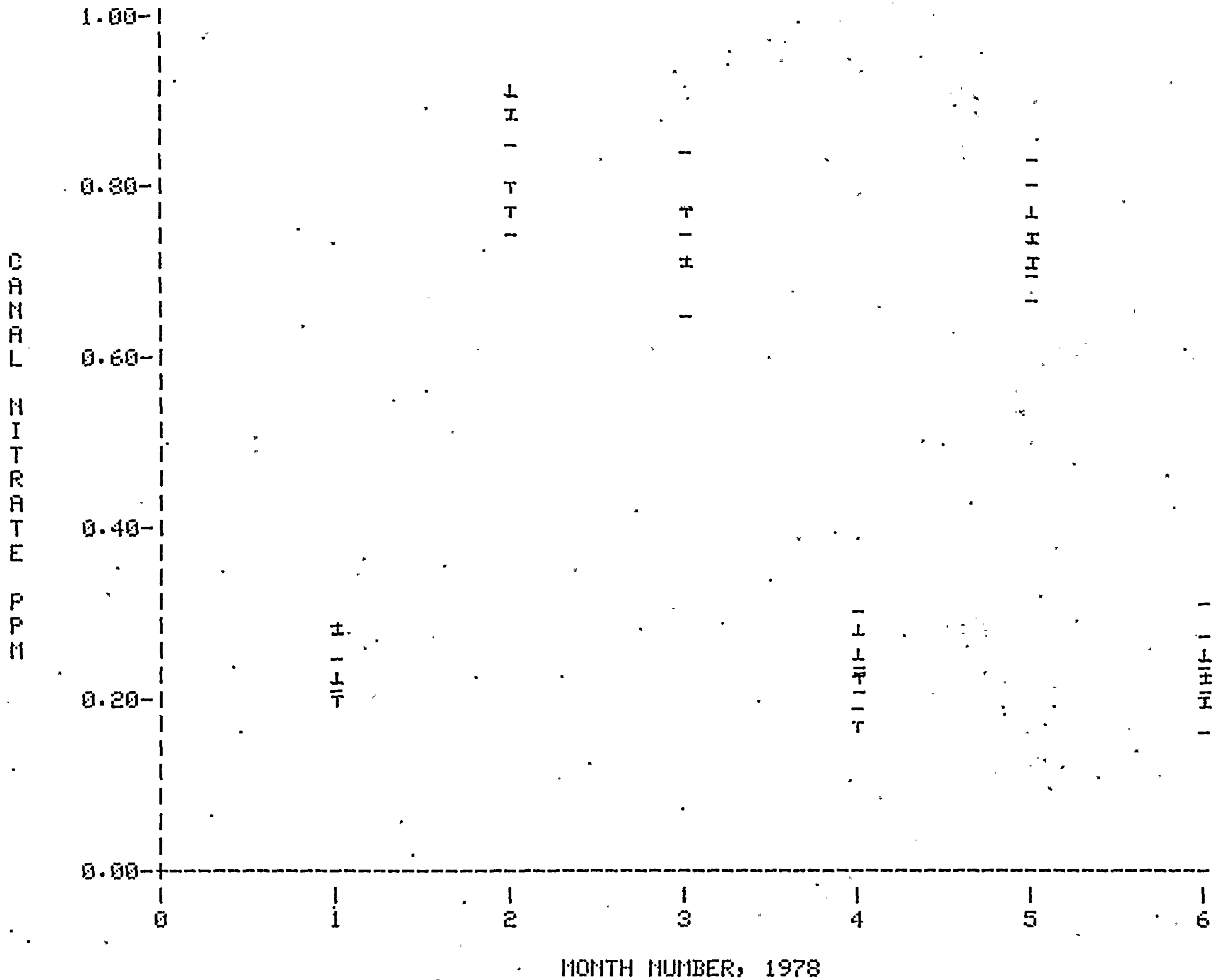

Figure 14. Nitrate concentrations in the Canal System in PPM.

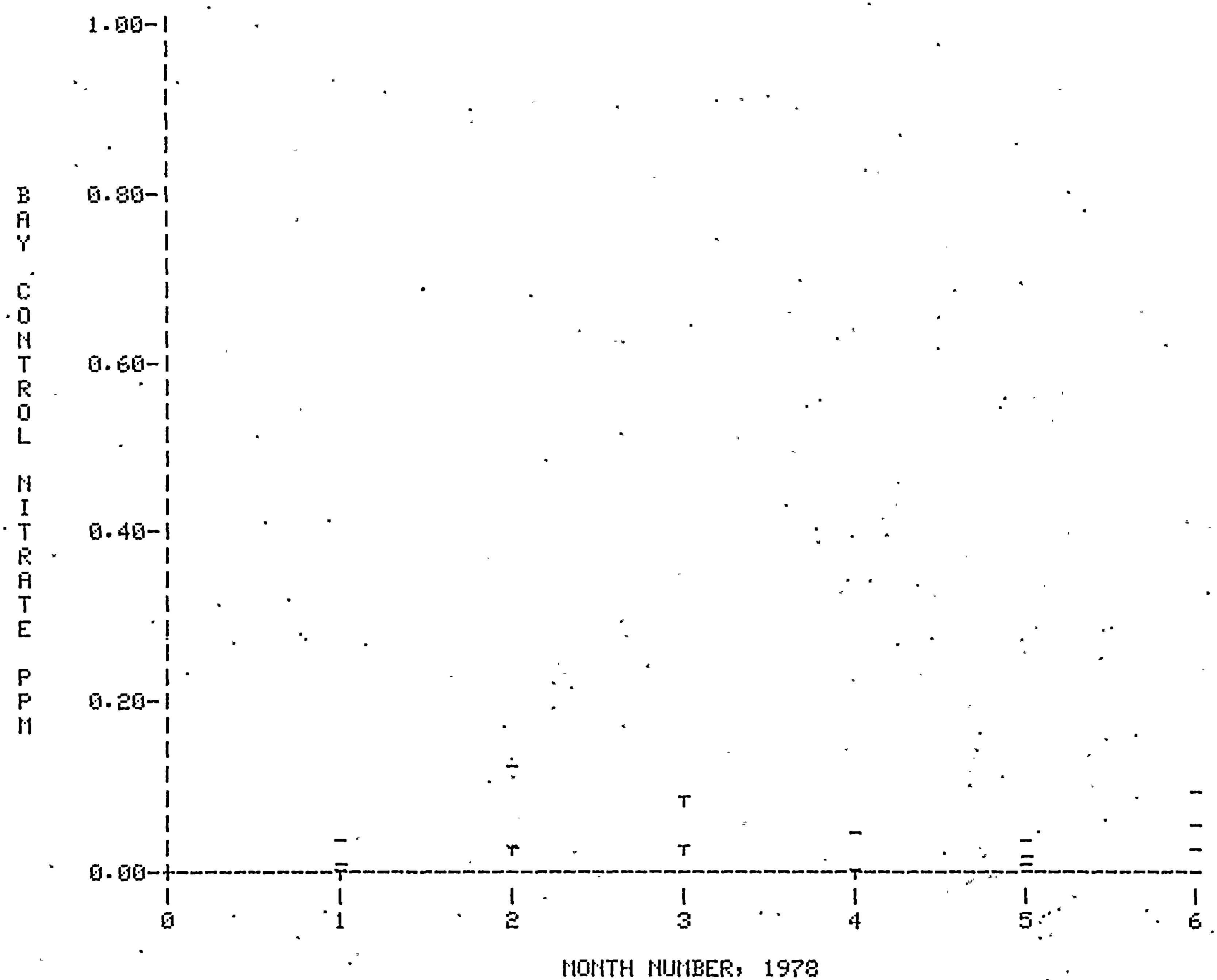

Figure 15. Nitrate concentrations of the Bay Control Stations in PPM.

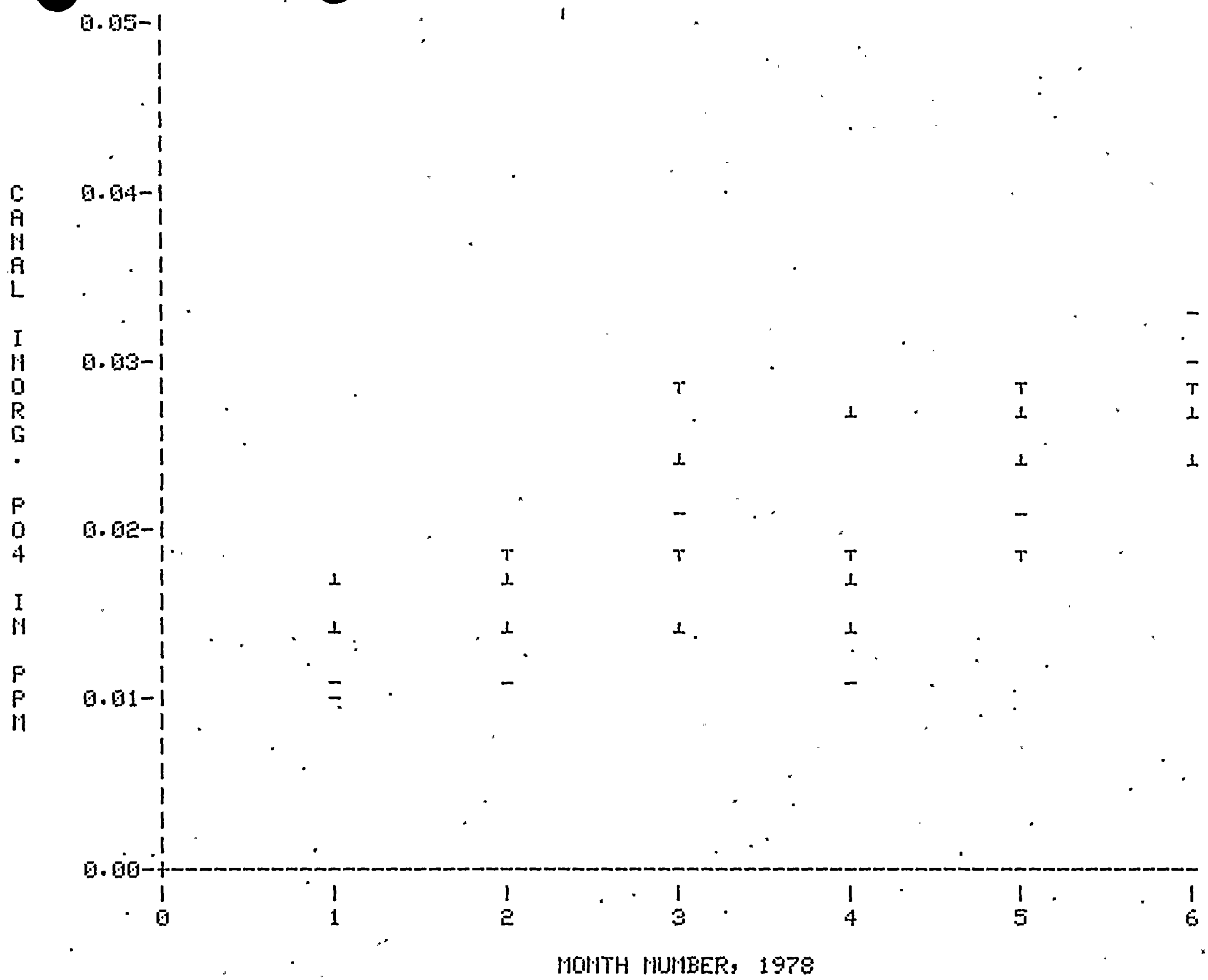

Figure 16. Inorganic Phosphate in the Canal System in PPM.

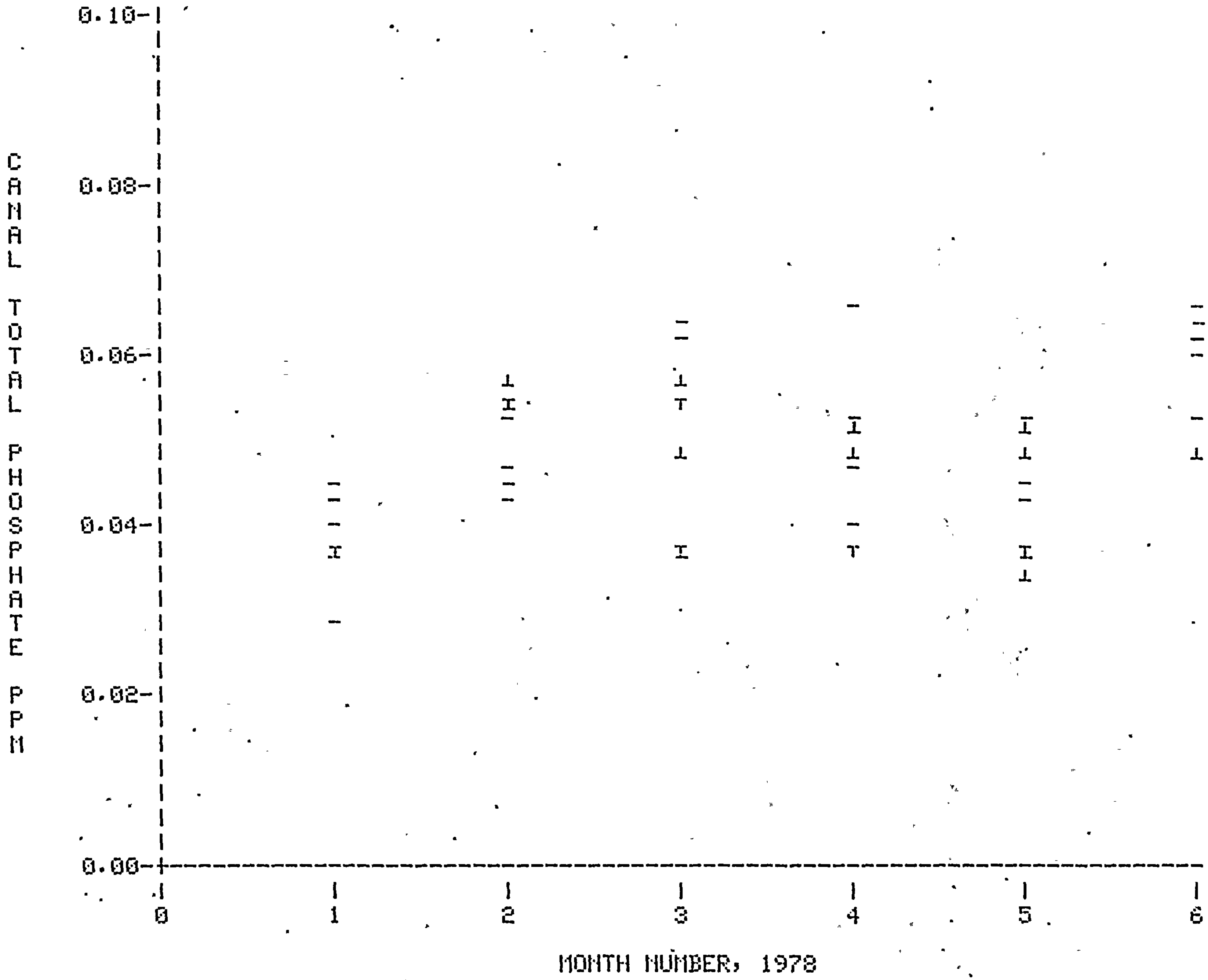

Figure 18. Total Phosphate concentrations in the Canal System in PPM.

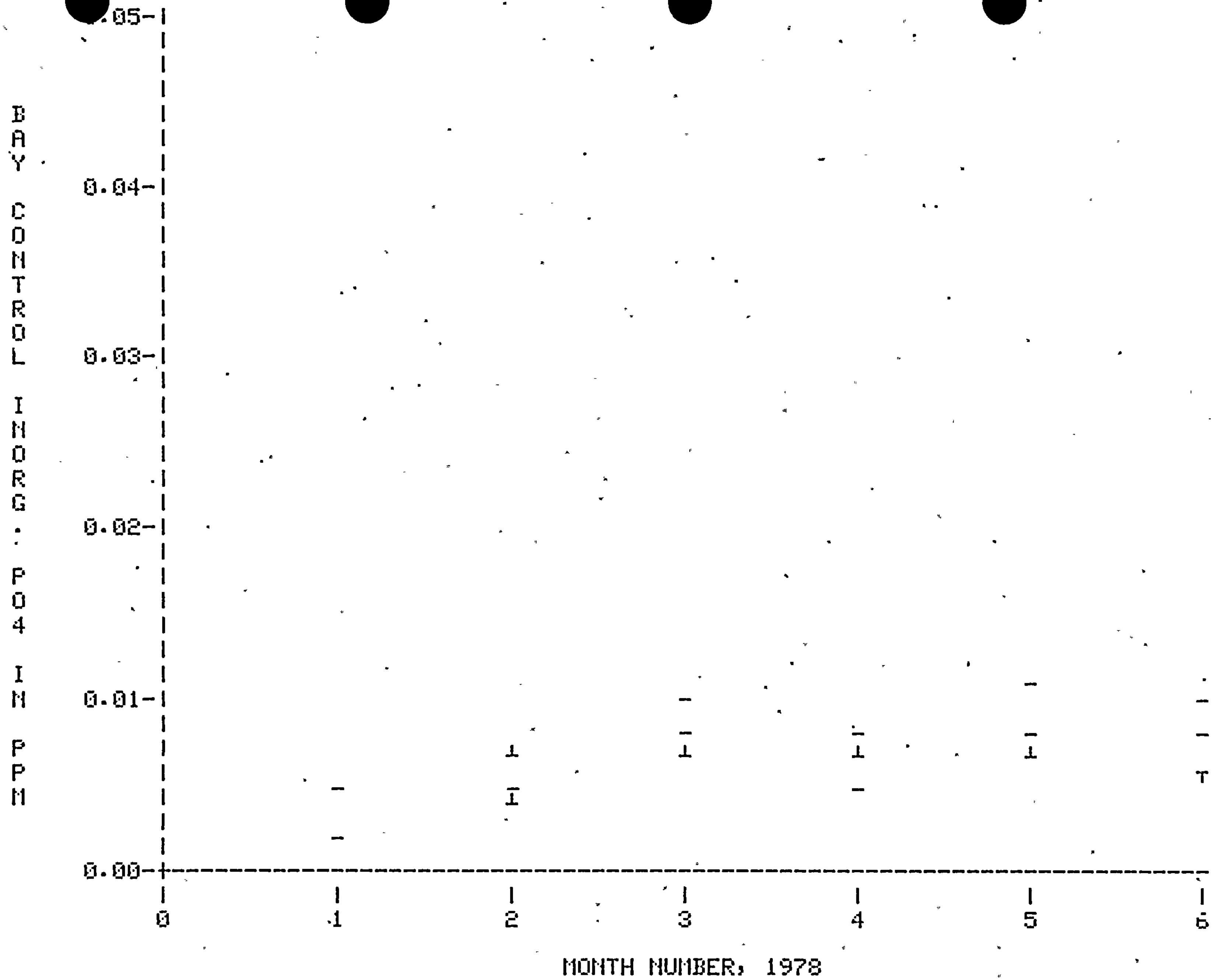

Figure 17. Inorganic Phosphate of the Bay Control Stations in PPM.

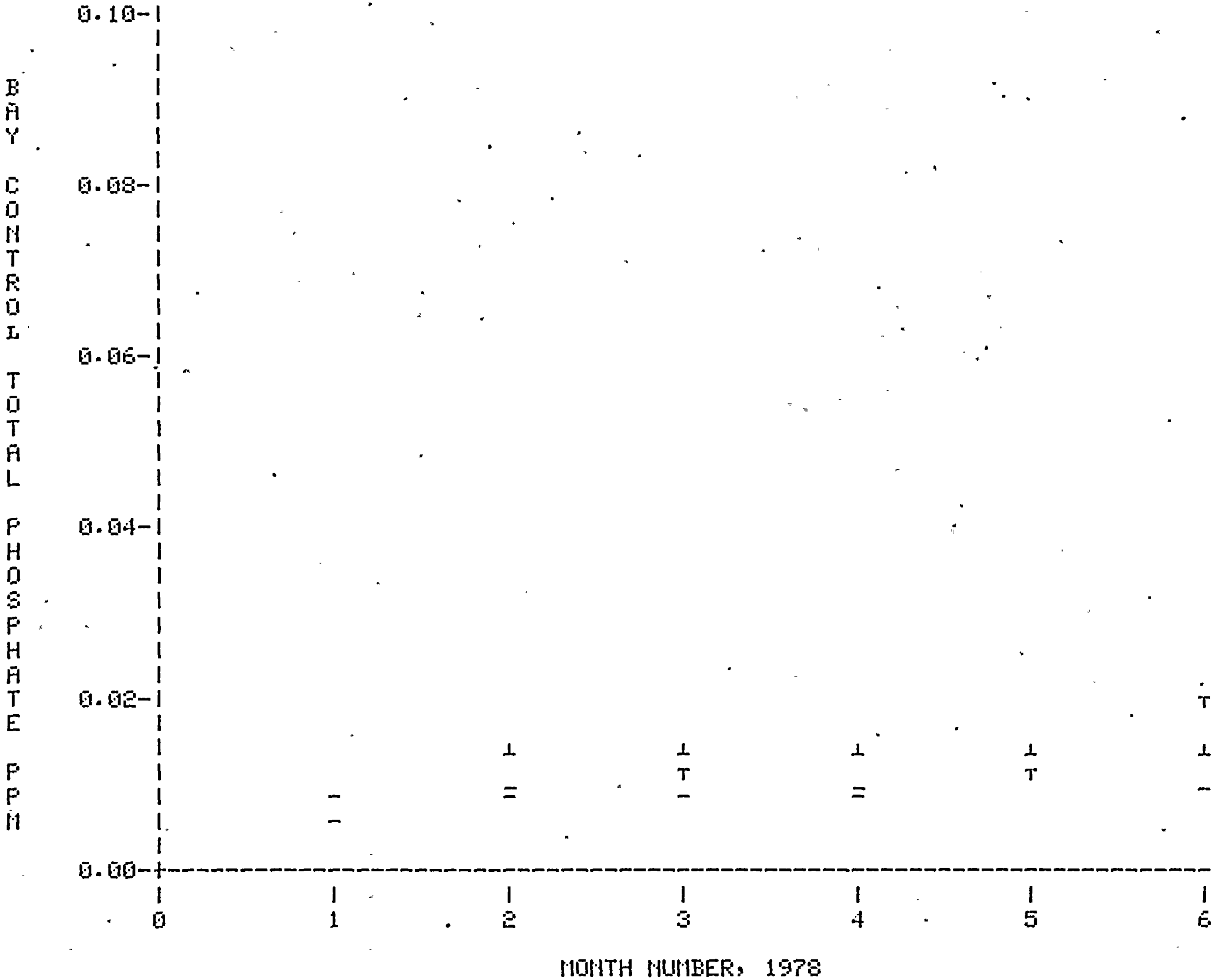

Figure 19. Total phosphate concentrations of the Bay Control Stations in PPM.

III.G PLANKTON

1. ZOOPLANKTON

Methods and Procedures

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

Sampling was made in the top meter of the water column at a 1-3 mph speed. Tows were approximately 5 minutes long in the canals and 3 minutes long in the Bay.

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

Zooplankton organisms were divided into six categories as follows:

1. COPEPODS including all cyclopoid, harpacticoid and monstrilloid copepods.
2. GASTROPODS including all gastropod veligers.
3. BIVALVES LARVAE including all bivalve veligers.
4. COPEPOD NAUPLII including all crustacea similar in appearance to copepod nauplii (with the exception of cirripeds).
5. CIRRIPED NAUPLII as distinguished from other nauplii.
6. OTHER ORGANISMS including all other zooplankton not included in the first five categories.

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

Discussion and Conclusions

A lower level population of zooplankton continues to exist in the cooling canal system. However, the level for this period showed higher concentrations than those that were recorded for the same period last year.

In Biscayne Bay and Card Sound the zooplankton concentrations remained approximately 8-10X the levels as those found in the canal system. A more indepth analysis on zooplankton will be made in the annual report.

COPEPODS

The low levels of copepods of last year have continued through the first half of 1978 in the cooling canal system (Figure 1). The highest concentration was .43 per liter while the average was .16 per liter. This was 0.11 per liter higher than the first half of 1977.

In the Bay, (Figure 2), the average recorded for this period was 5.6 per liter which was higher than 1977.

In both the Bay and the cooling system copepods constituted a majority of the organisms counted for the zooplankton analysis.

GASTROPOD AND BIVALVE LARVAE

Both gastropod and bivalve larvae continued to be almost totally absent in the cooling canal system (Figures 3 & 5). However, for the gastropods, mean levels of .04 and .09 per liter were recorded in the months of May and June respectively. This is similar to 1977 data.

In Biscayne Bay and Card Sound gastropods (Figure 4) were second only to copepods in total number.

The highest levels for gastropods, both for the canals and the Bay, occurred in May and June. These high levels were apparently due to "blooms". The maximum average concentration occurred in May.

Bivalves were always at a low level (Figure 6). In the Bay the highest concentrations were reported in May and June. In the cooling canals, June was the only sampling month in which bivalve larvae were found.

COPEPOD AND CIRRIPED NAUPLII

Nauplii of copepods and cirripeds are too small to be adequately sampled by a #10 mesh net.

In the cooling canals (Figure 7 & 9), the levels of both nauplii were essentially zero. The highest concentration for cirriped nauplii in the canal system was .01 per liter with .05 per liter being the highest level for copepod nauplii. In general both nauplii are at very low levels in the system. The highest level for copepod nauplii was recorded in March for both the canal system and the Bay (Figures 8 & 10). Cirriped nauplii were found in the canal system in February only, while in the Bay, their highest level occurred in June.

OTHER ZOOPLANKTON

The average levels in both Bay and Card Sound continue to show the yearly cycling as seen in 1977.

The highest concentration of other plankton was 1.8 per liter in the Bay (Figure 12) and .12 per liter in the cooling system (Figure 11). The average level was 0.4 per liter in the Bay and .04 per liter in the cooling system.

Other zooplankton found in the cooling canals were fish eggs, fish larvae, shrimp larvae, zoea larvae, chaetognaths, polychaete larvae, tunicate larvae, and medusae.

In Biscayne Bay and Card Sound in addition to the previous groups, nematodes, amphipods, cladocerans, and ostracods were found.

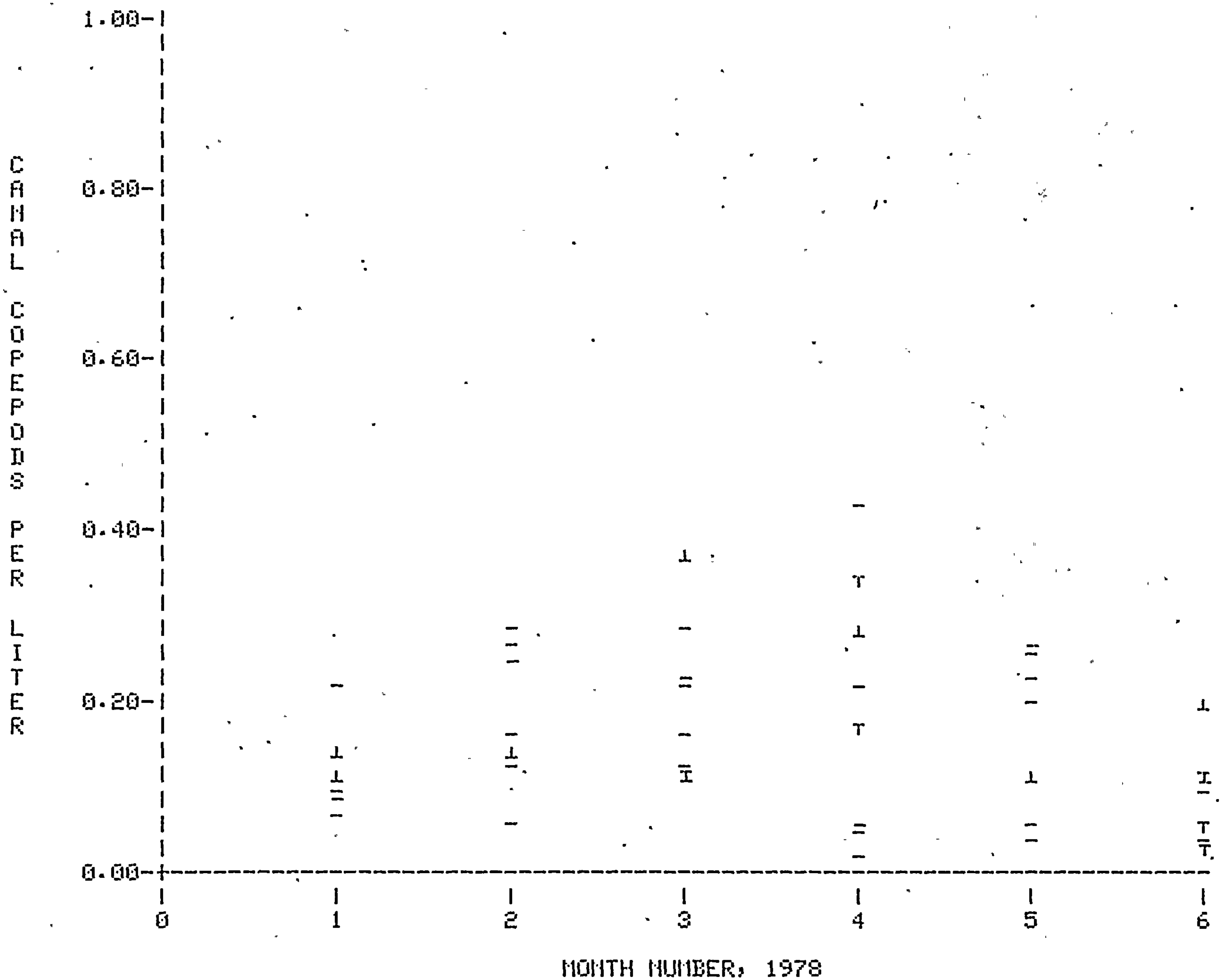

Figure 1. Copepods per liter in the Canal System.

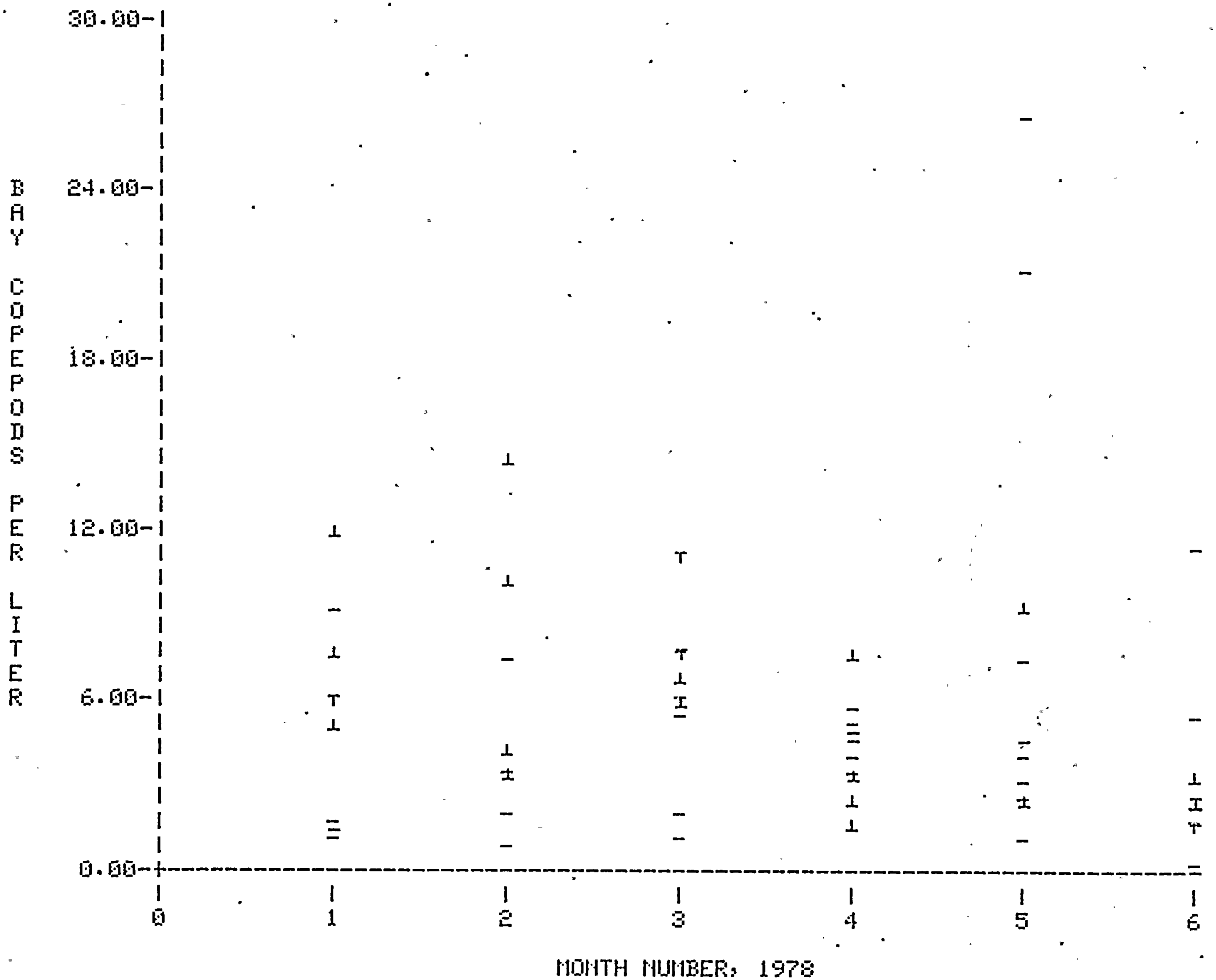

Figure 2. Copepods per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Copepods scale is 1/30th this scale.

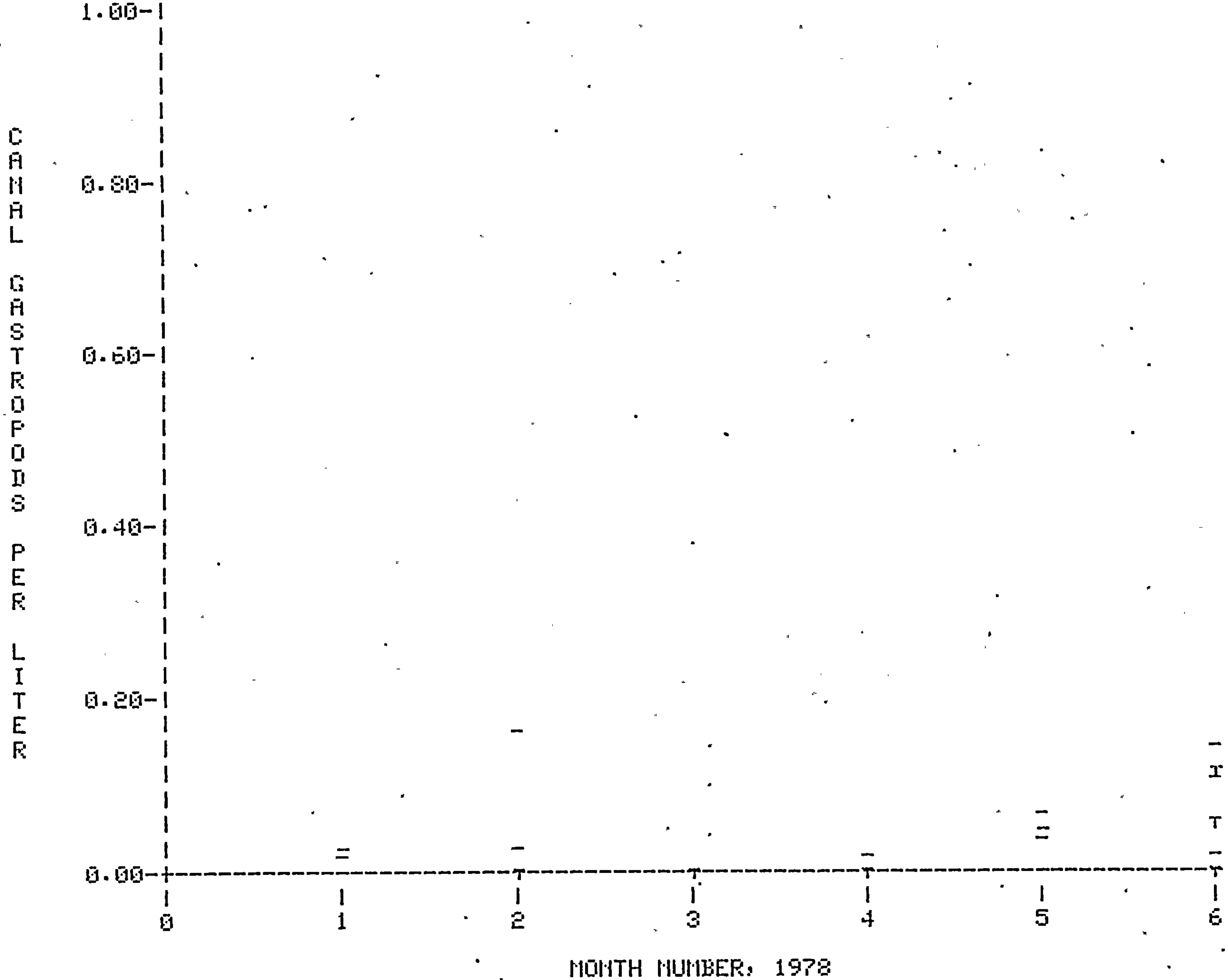

Figure 3. Gastropods per liter in the Canal System.

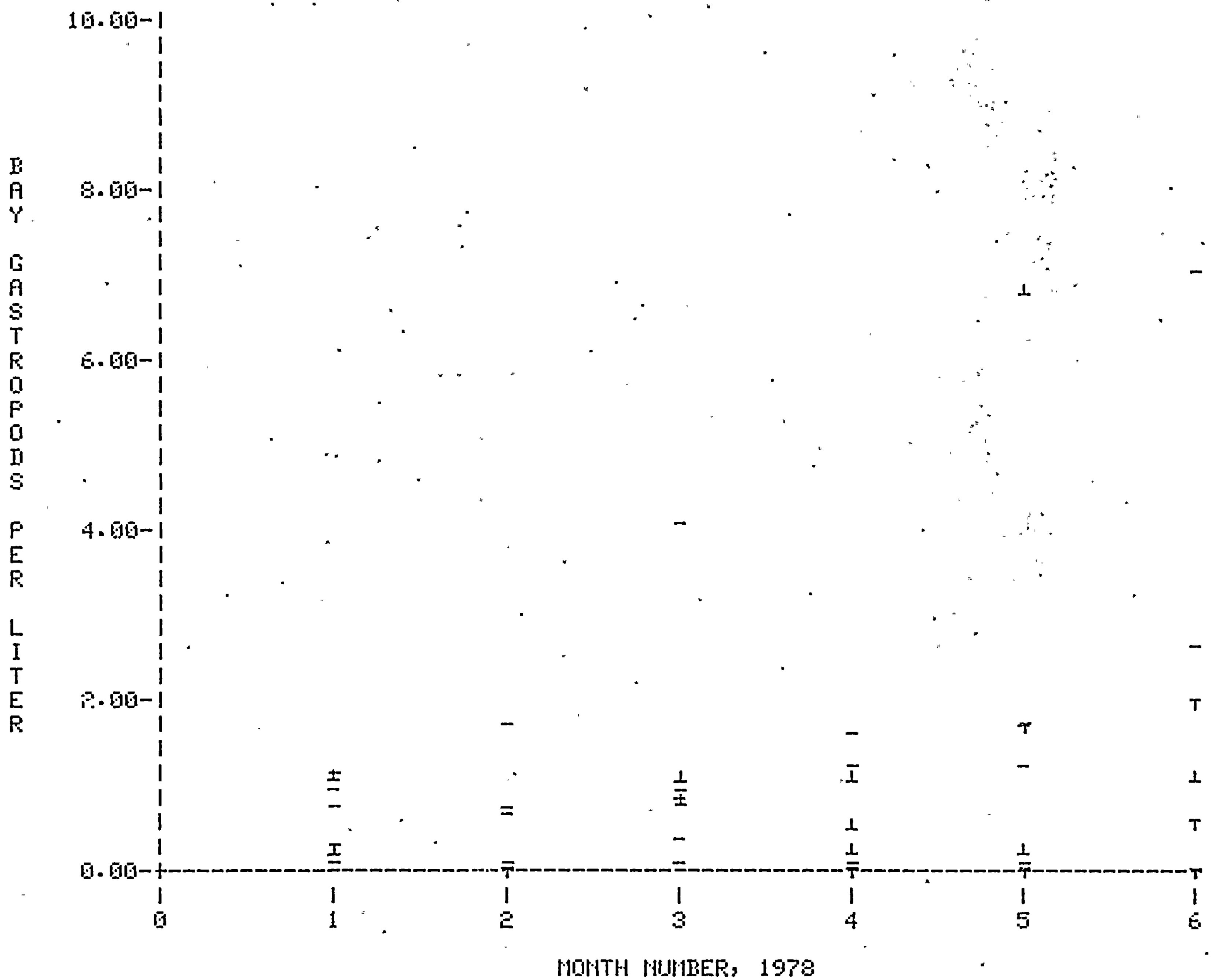

Figure 4. Gastropods per liter in Biscayne Bay and Card Sound area. NOTE: Canal Gastropods scale is 1/10th this scale.

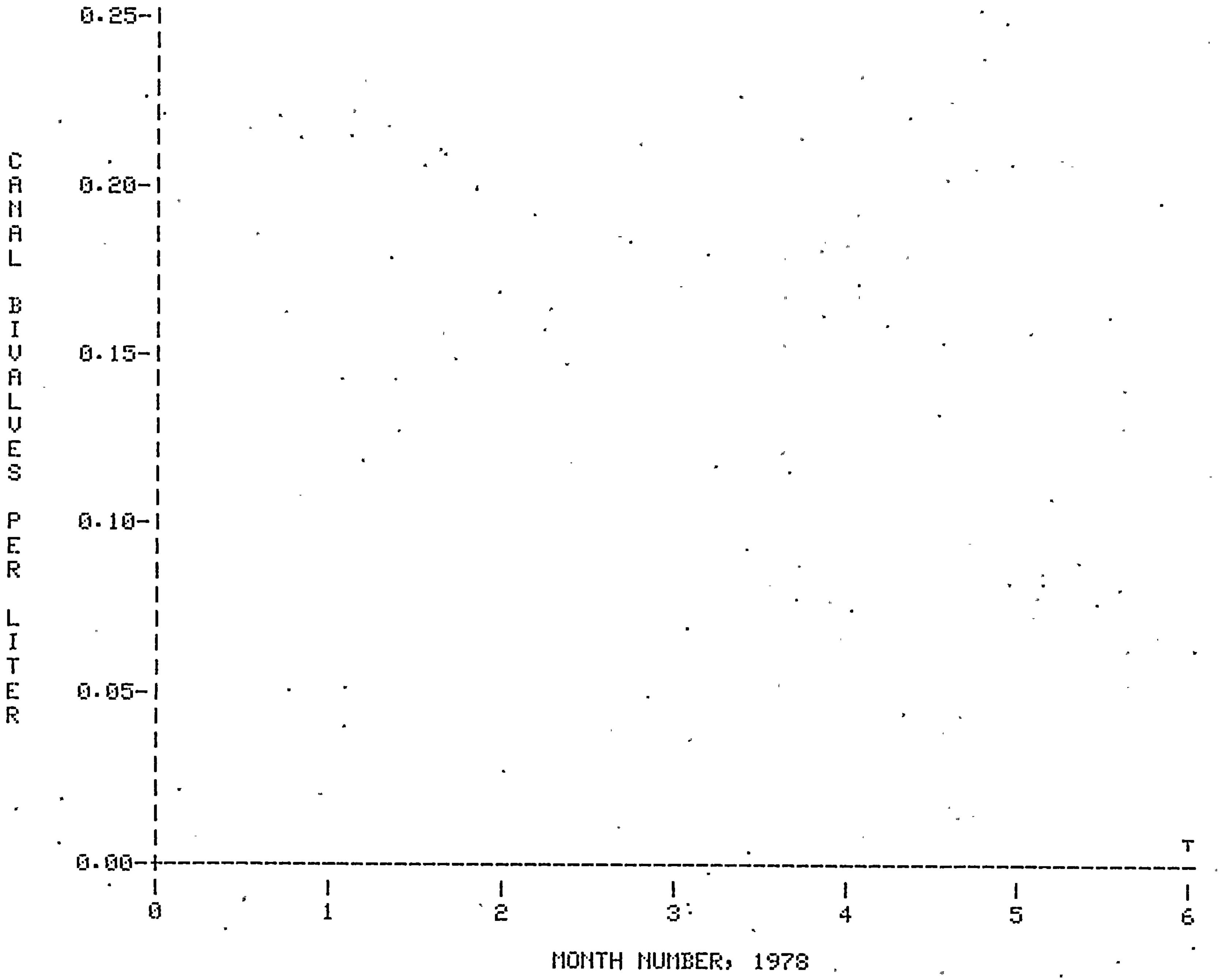

Figure 5. Bivalves per liter in the Canal System.

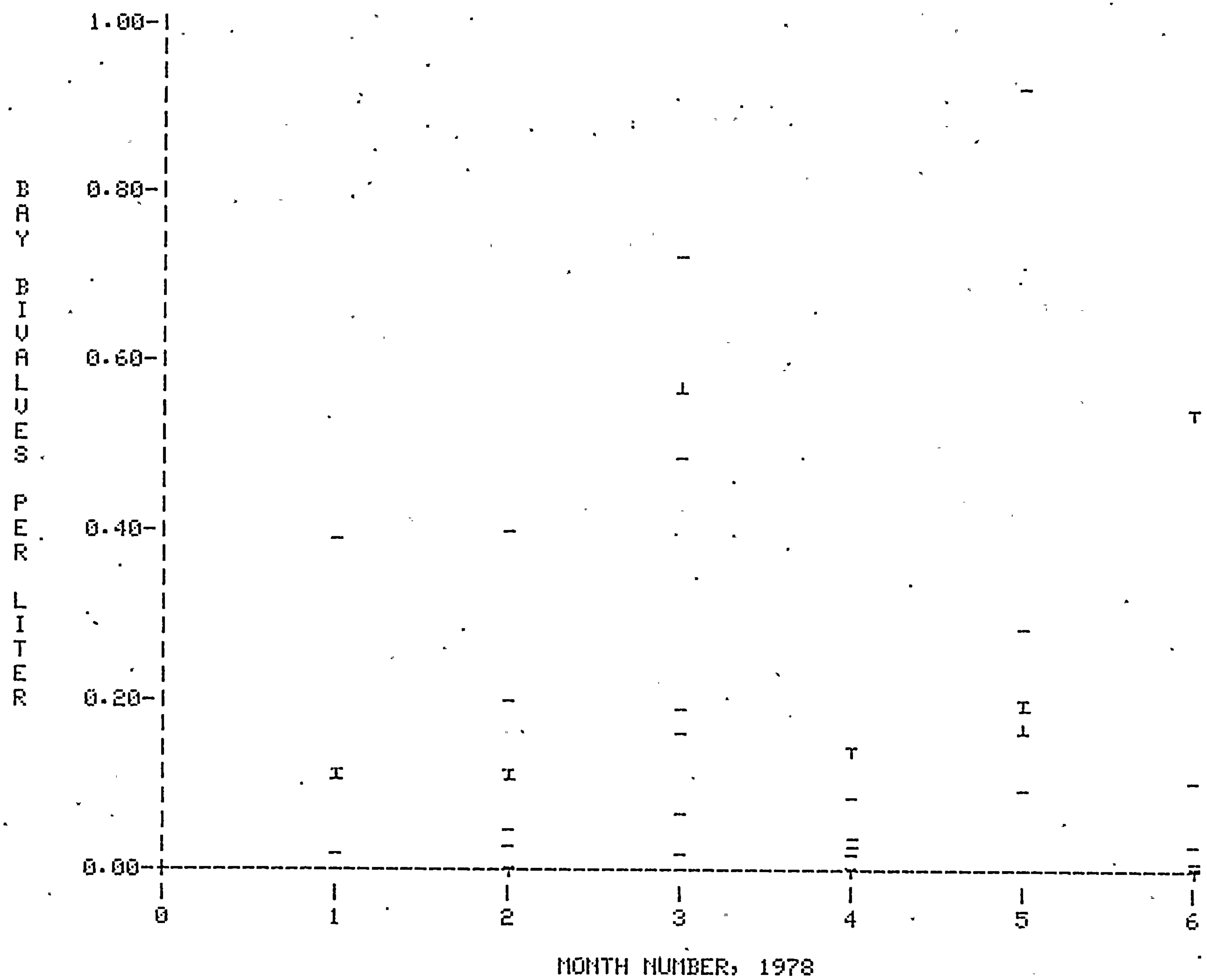

Figure 6. Bivalves per liter in Biscayne Bay and Card Sound area.
NOTE: Canal Bivalve scale is 1/4th this scale.

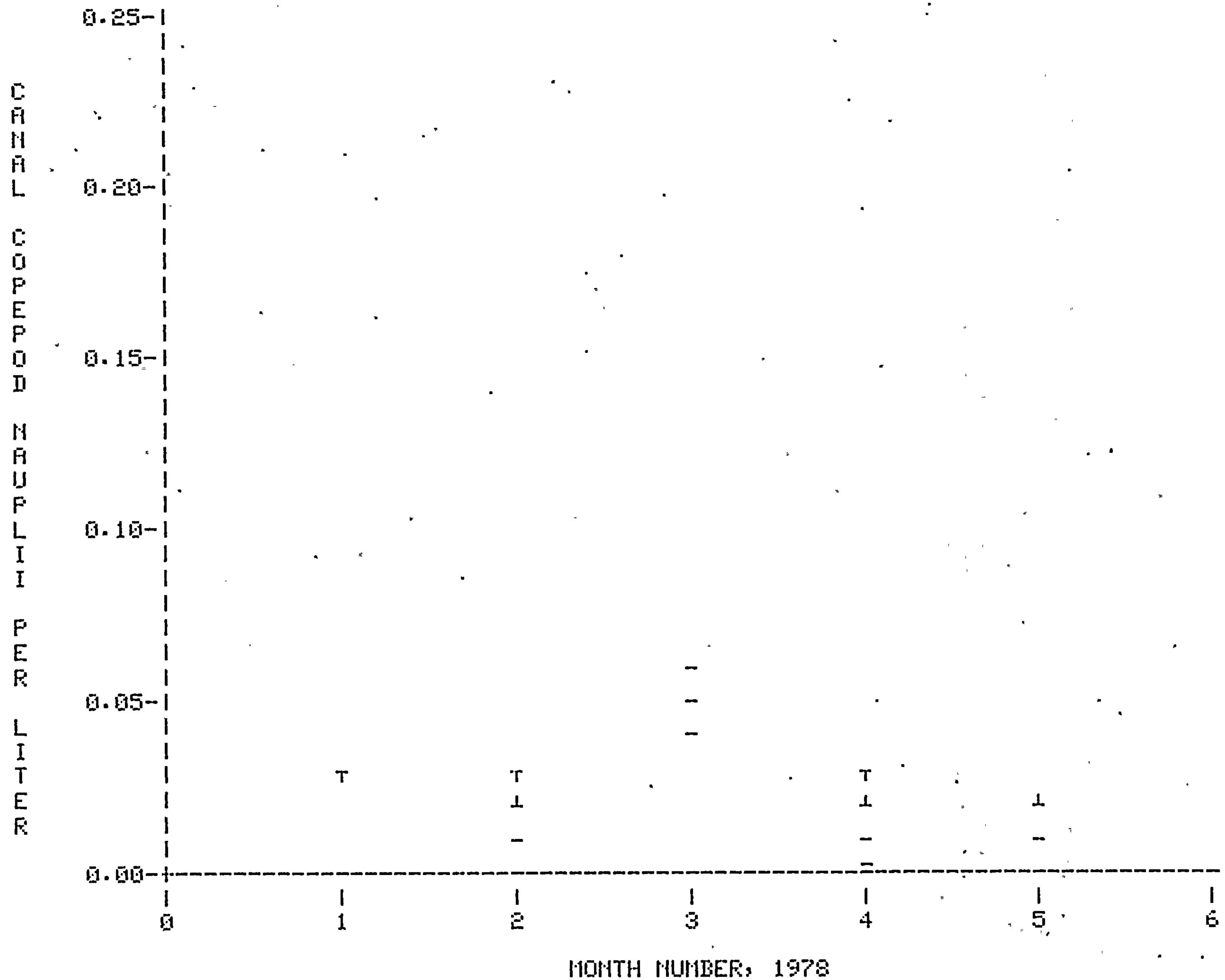

Figure 7. Copepod Nauplii per liter in the Canal System.

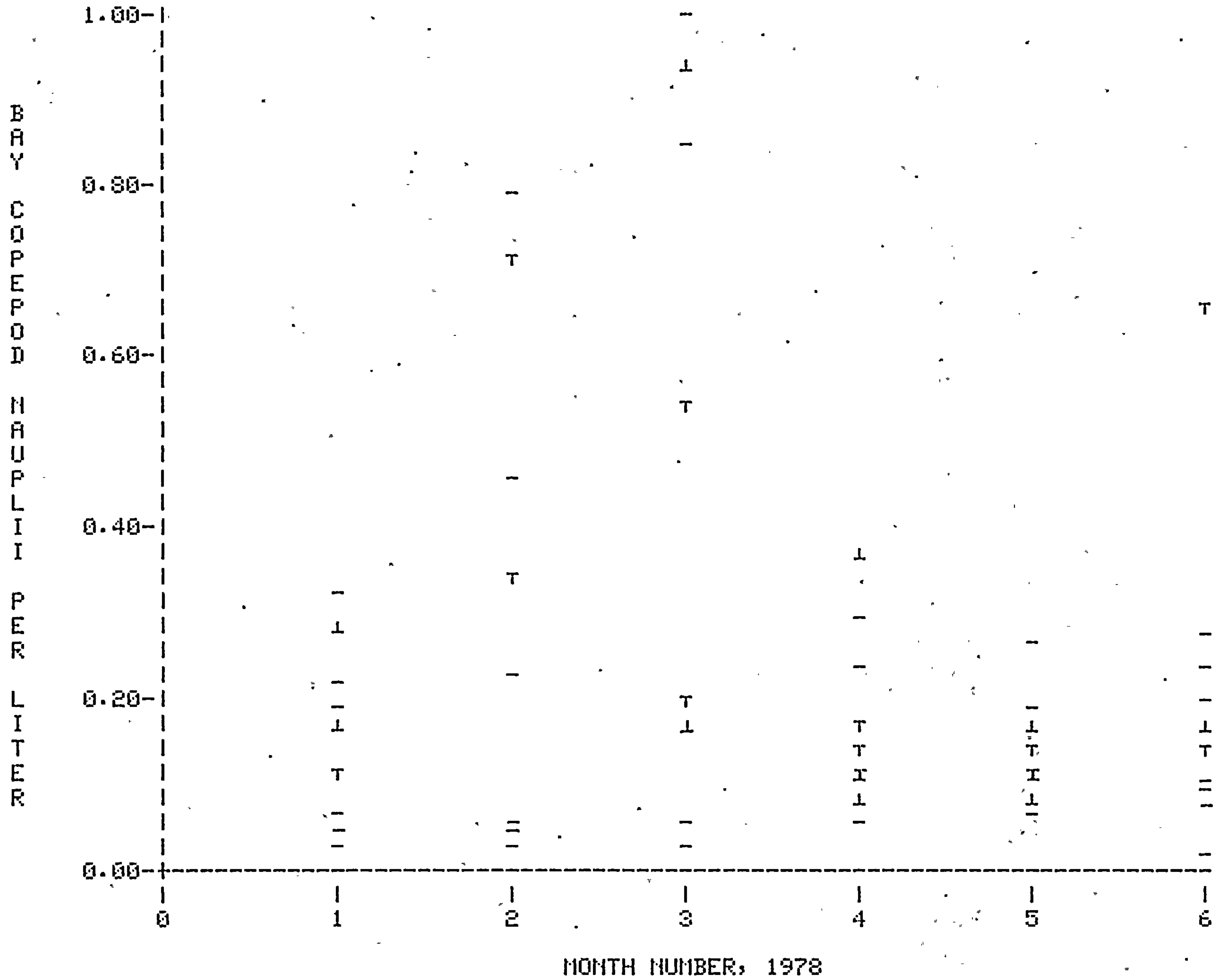

Figure 8. Copepod Nauplii per liter in Biscayne Bay and Card Sound area. NOTE: Canal Copepod Nauplii scale is 1/4th this scale.

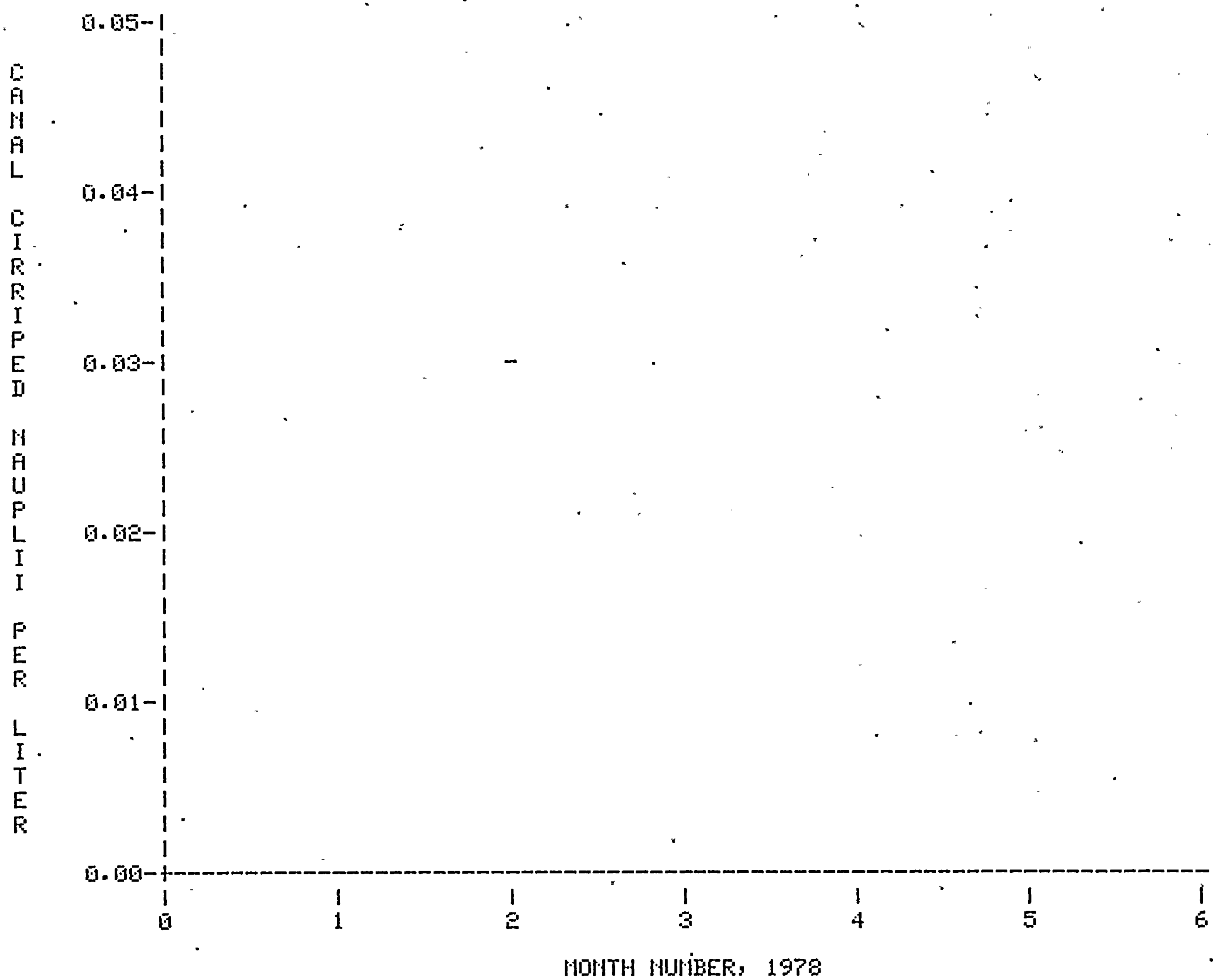

Figure 9. Cirriped Nauplii per liter in the Canal System.

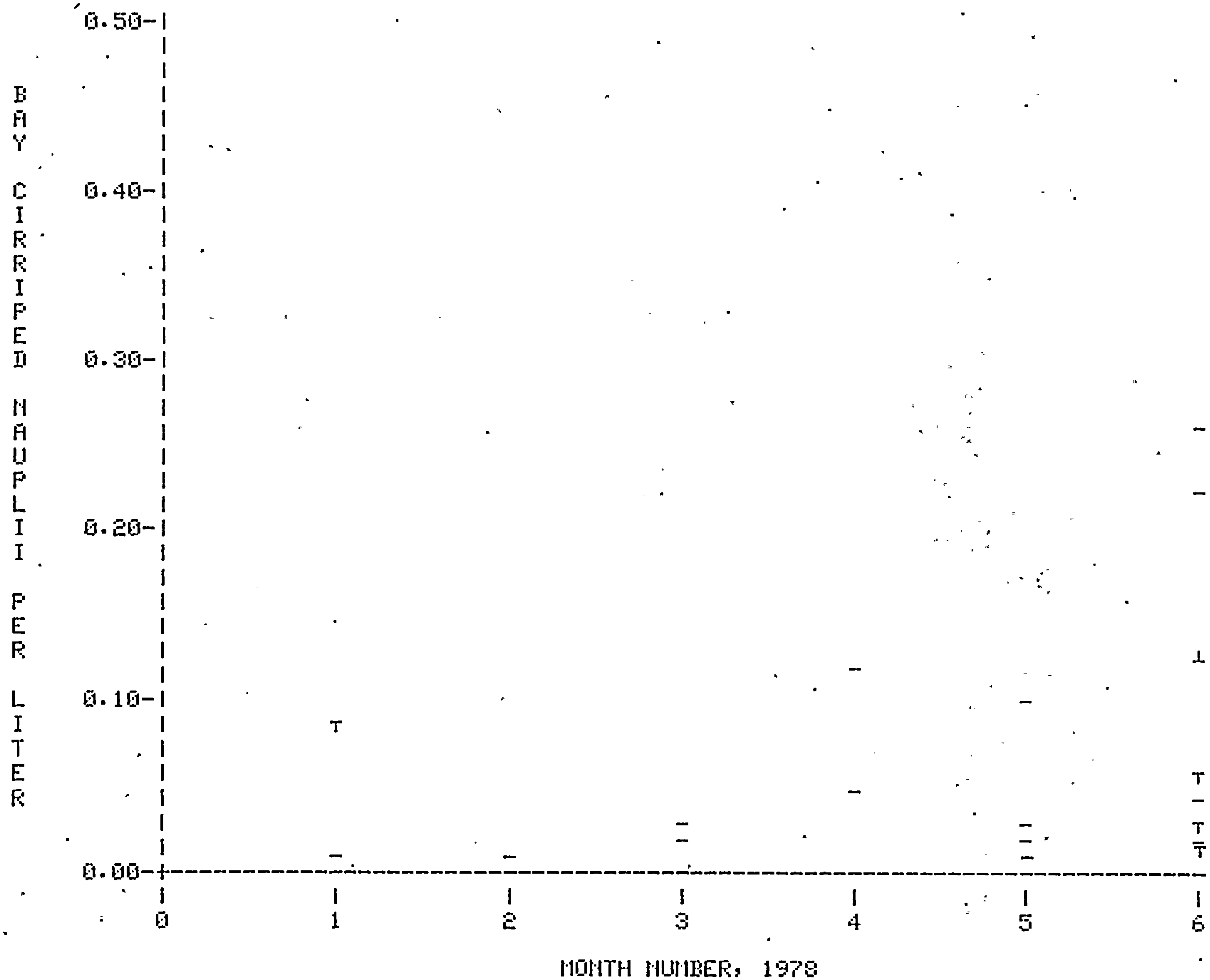

Figure 10. Cirriped Nauplii per liter in Biscayne Bay and Card Sound area. NOTE: Canal Cirriped Nauplii scale is 1/10th this scale.

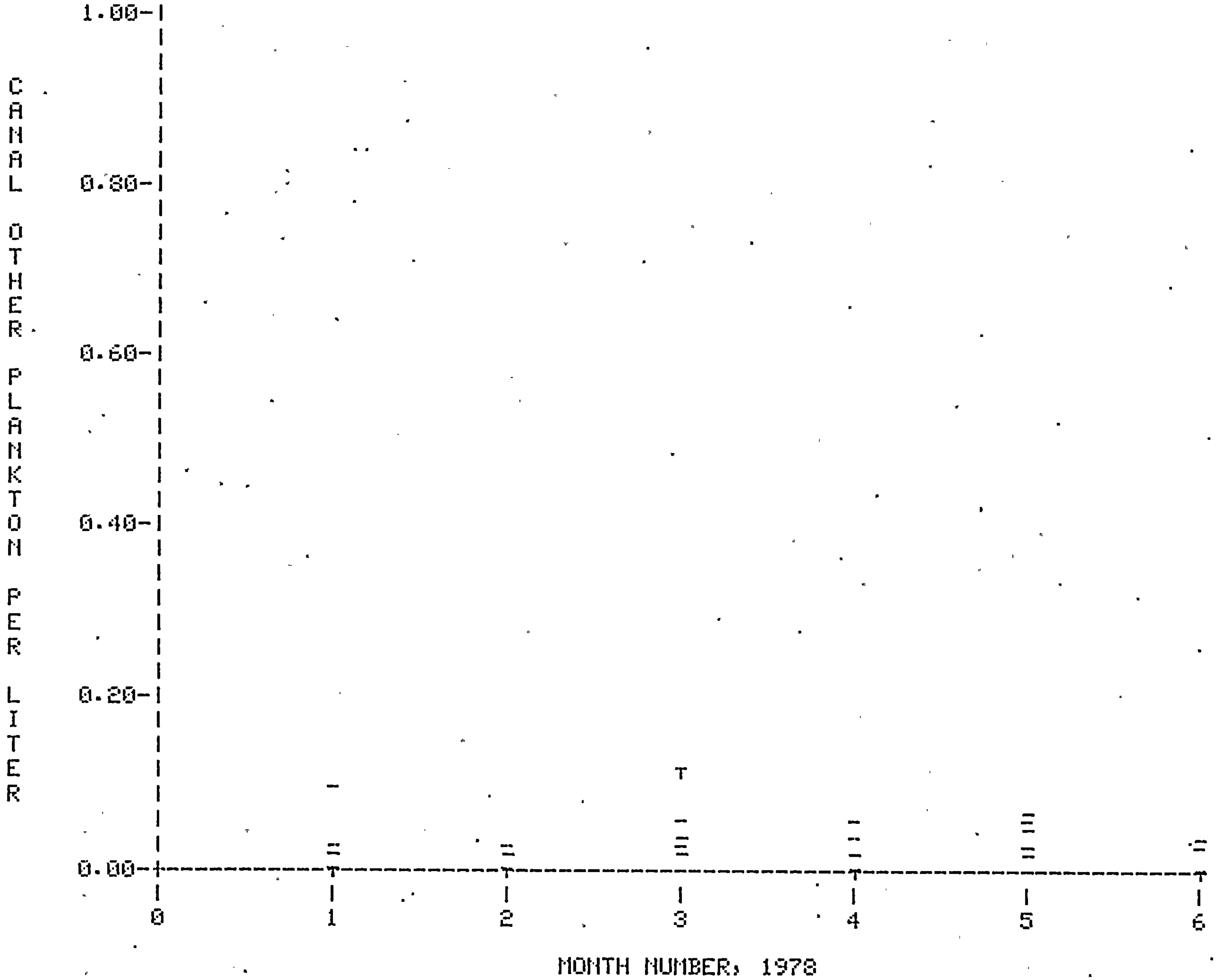

Figure 11. Other plankton found in the Canal System, but not included in any of the major category.

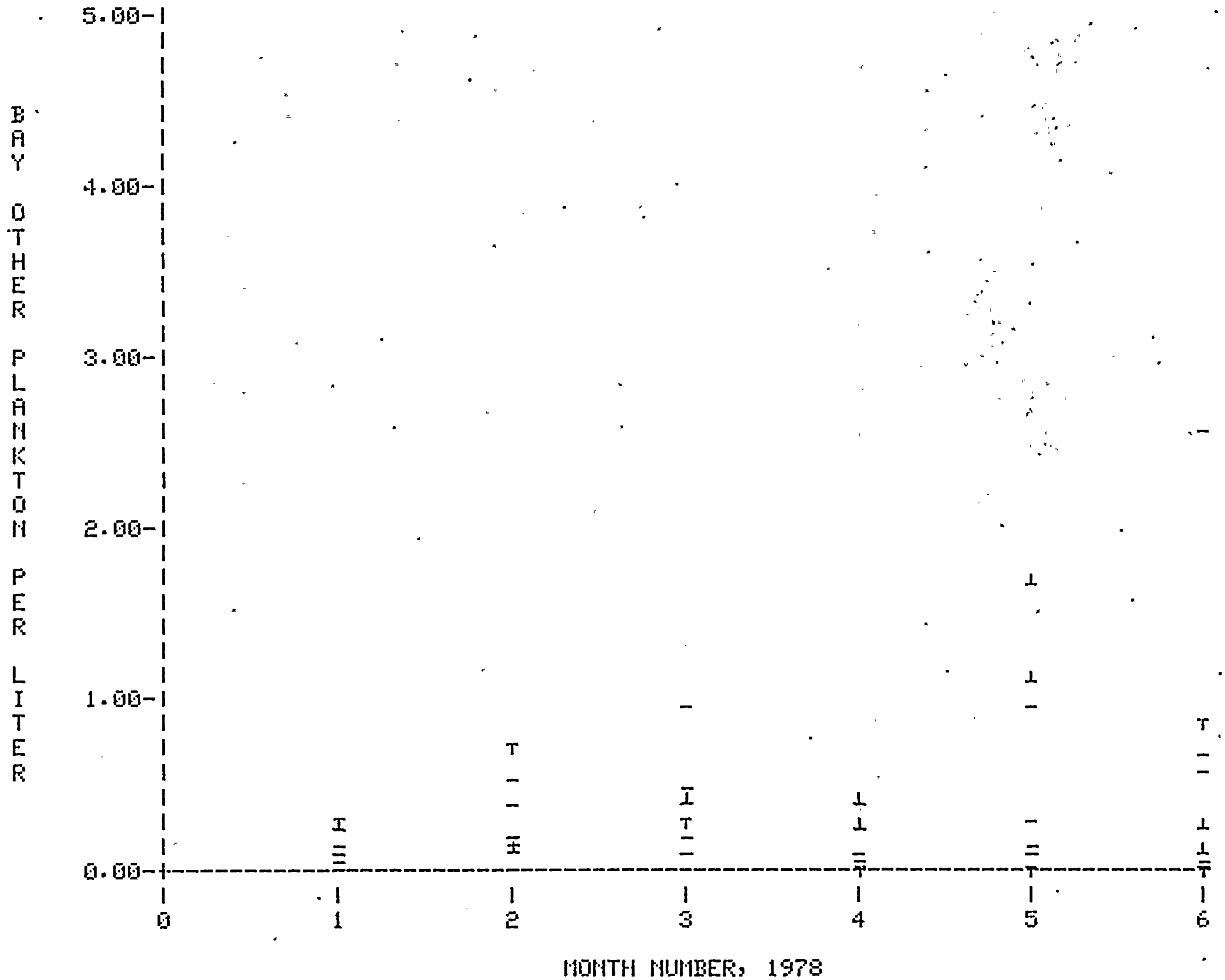

Figure 12. Other plankton found in the Bay and Card Sound area, but not included in any of the major categories. NOTE: Canal Other Plankton scale is 1/5th this scale.

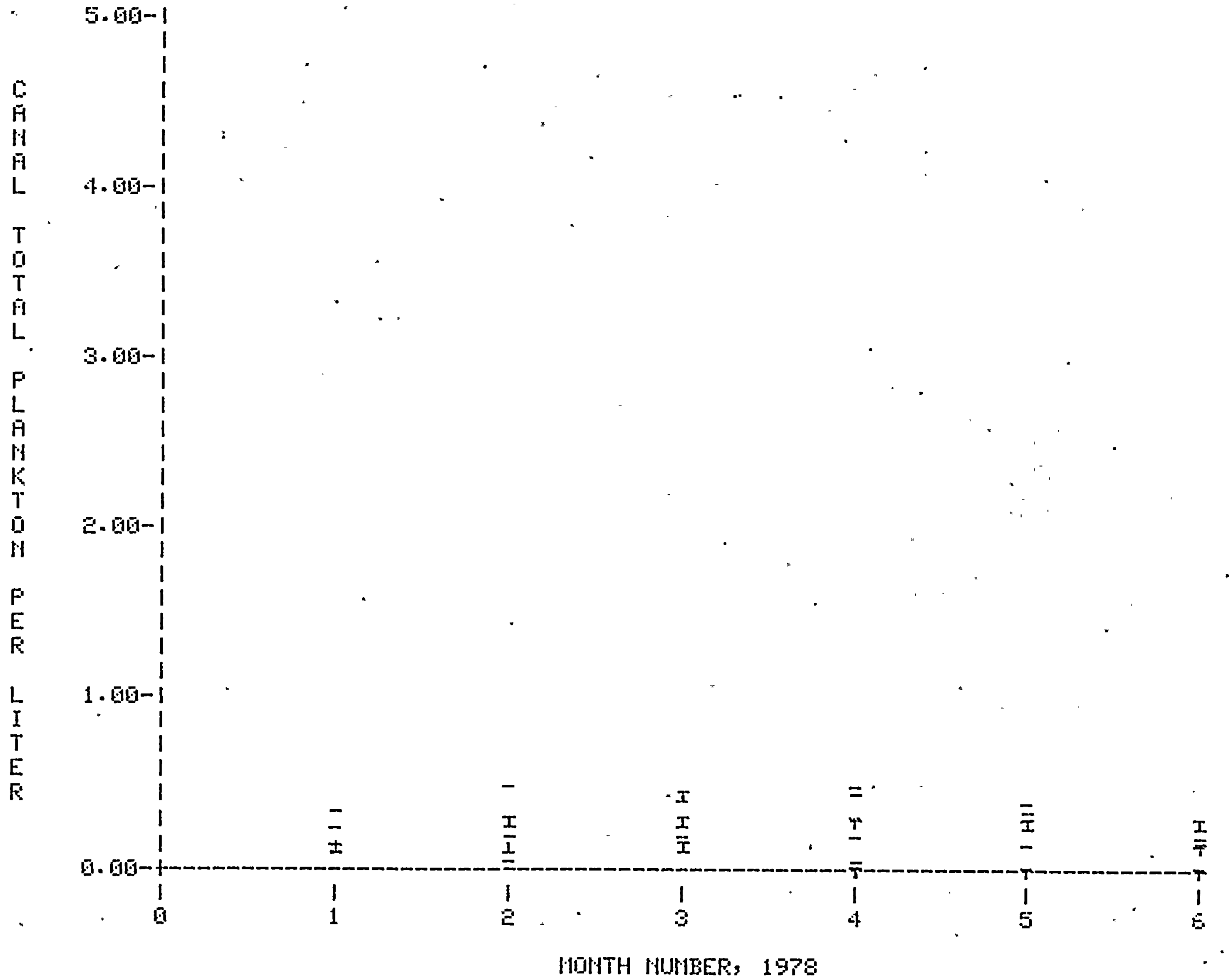

Figure 13. Total Plankton per liter in the Canal System.

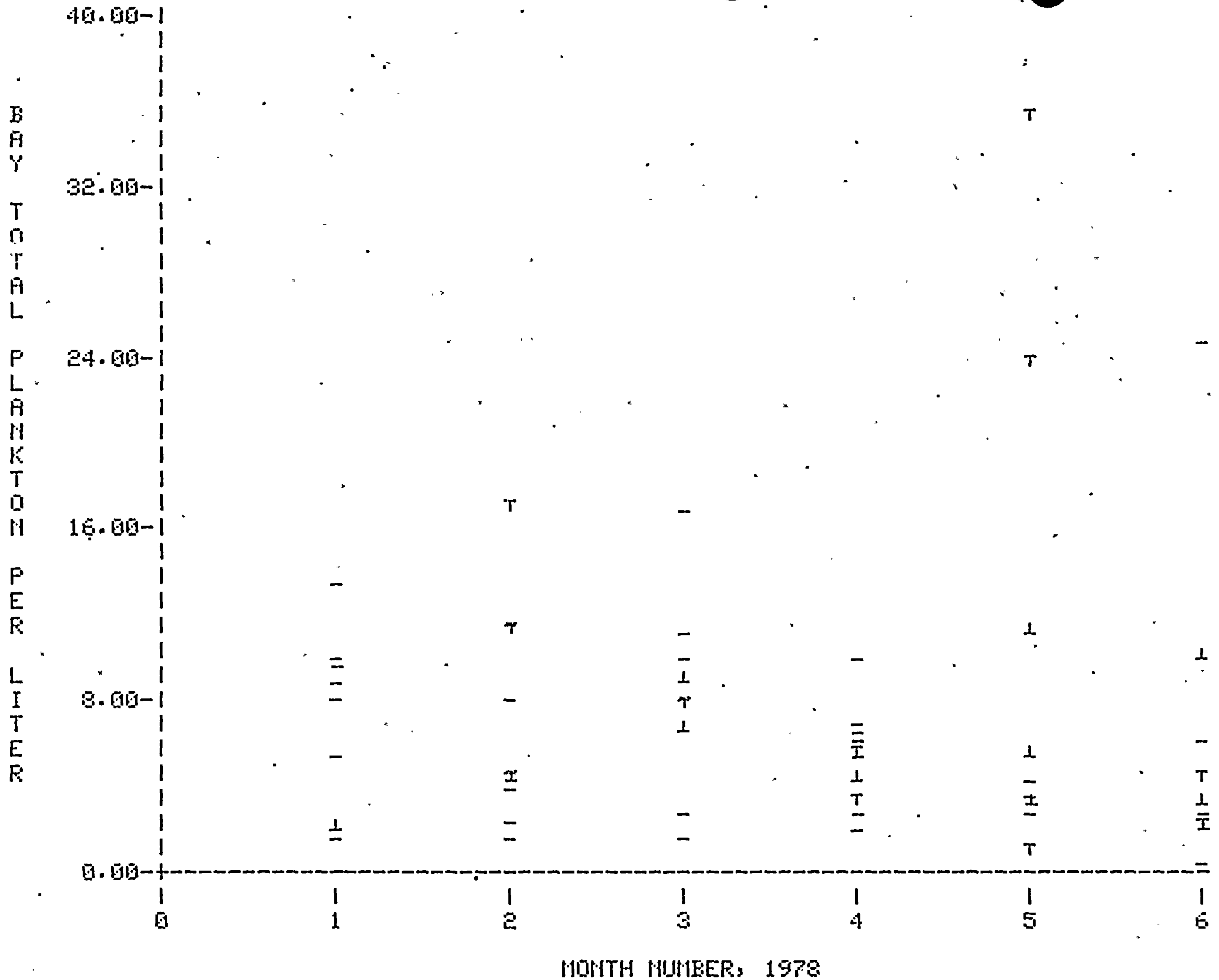

Figure 14. Total Plankton per liter in Biscayne Bay and Card Sound area. NOTE: Canal Total Plankton scale is 1/8th this scale.

2. PHYTOPLANKTON

The microbiota of Biscayne Bay at Turkey Point and the Canals of the Turkey Point Cooling System. January through June, 1978.

The six months' study included in this report has verified several established facts or need for further investigation. These include:

1. A list of endemic species in lower Biscayne Bay.
2. Endemic species in the cooling canals.
3. Seasonal succession.
4. Species replacement.
5. Biomass differences.
6. Blooms.
7. Organisms of special interest.
8. Nutritive environment.
9. Physical environment.
10. Summary.

1. Endemic species in lower Biscayne Bay-Card Sound are those which normally are found there, whether rare or abundant, year after year. Presumably, a 500 ml sample catches all but the very rare species and certainly all the more common ones. Settling and centrifuging concentrates them so there is little chance of missing a given species under the microscope. In the latter months of the study, debris decreased markedly, especially in the canal samples, permitting much better recognition.

All the species in Table 1 have not been noted in other South Florida waters, but only one species in this list is believed to be hitherto undescribed. It is a small elongate biflagellated cell, presumed to be a zooflagellate which has occurred repeatedly, and which is tentatively called <u>Bodo</u>

elongata.

All major groups of algae and protozoa are represented in the plankton. Chlorophyceae have only one species-*Chlorella vulgaris*, which was noted sparingly. However, only three Volvocidae have been found and very few Euglenida and Cryptomonadida. If the sediment interface had been examined, additional colorless euglenids would have been noted. Chloromonadida and Coccolithophorida were lacking, although they are fairly common in other semi-tropical areas. The dominant groups are diatoms and dinoflagellates.

Protozoa are sparse, with rhizopods and zooflagellates being very scarce. Most of the marine species of these are sediment-water interface dwellers. It is hard to explain why *Monas* spp. and *Oicomonas* spp. do not appear in the plankton. Radiolaria, Actimaria, and Globerinids are pelagic forms, totally lacking here although common in the Gulf Stream. Their absence indicates that the plankton studied here are truly an inshore microbiota.

This list of endemic species is not a complete one. From time to time additional species will appear, and while they may be rare they are truly endemic. This year *Podocysits adriatica* (diatom) and *Tintinnopsis bermudensis* (ciliate) appeared for the first time, and several species recorded in previous years were not noted. But Biscayne Bay is a stable environment, while subject to seasonal and diurnal changes and storms, so its plankton should be stable. Those species which find it favorable should show frequent occurrence there, often in large numbers. Some organisms such as Rhizosolenia and Chroomonas are absent, however. These missing organisms may cytolize so badly as not to be recognizable in preserved samples.

2. The canal system is relatively new and cannot be considered stable in comparison to the Bay. From the beginning of this project until June, 1978, the water contained much debris, which interfered with plankton determinations. But in the June samples the debris was greatly reduced.

Temperatures in the Canals are consistently higher than in the Bay and may at times exceed 35°C. Salinity, because of evaporation, gradually climbs and exceeds Bay values. The only source of nutrient O-PO_4 and T-PO_4 is internal biological action on bottom sediments and for NO_3-N, rainfall. With a large diatom population these nutrients tend to gradually drop. But now the Canals are being colonized by some 10-20 species of microscopic algae, which also derive their nutrition from the surrounding water and compete with the plankton.

In the beginning the canals had the same plankton as the Bay. Now the similarities are largely in the diatoms, some blue-greens and a few species of small dinoflagellates, notably Gymnodinium spp. Ciliates and large dinoflagellates are largely gone. Some of the large diatoms have persisted, as well as the smaller naviculoid forms.

The endemic species for this reporting period are recorded in Table 1.

3. No seasonal succession has been evident in the Canals. In the Bay about the only seasonal succession seen

is the flux of dinoflagellates and it is not pronounced. Atlantic cold water species such as the ciliate Favella and some Ceratia occur very sparingly only in the colder months. No diatom seasonal succession has been noted.

4. Some species originally present seem to have dropped out and been replaced by others. Metacylis angulata is an example. It was the only species of the genus in earlier reports, although never very abundant. It has now practically disappeared and has been replaced by Metacylis jurgensi. In most cases such replacement is hard to justify, but frequently an organism suddenly appears for a short period of time, (see Dictyocha fibula in Table 1) or a species may appear and seem to establish itself. Thus in the beginning of these studies Pyrodinium bahamiensis was not found, but by June, 1978, it had become well established.

5. Biomass differences refers to the biomass of a small population of a large organism as compared to a large population of a much smaller species. Thus a few Copepod nauplii are as important or more so than small diatoms or small Gymnodinia which far exceed it. It is hardly possible to make a list showing the relative size of the organisms in Table 1, but it should be apparent that organisms such as Copepod nauplii, Pyrodinium, Synedra bipes, and many others, while present in small numbers, share importance with small Naviculoid diatoms or Gymnodinia which are present in large numbers.

6. Blooms have been arbitrarily set at 500 organisms per ml. The largest number recorded in this period was 10500 *Coccochloris* spp., which would be 21000 in a liter or 21 per ml. This does not constitute a bloom.

Blooms are caused by various dinoflagellates or *Eutreptia* or blue-green algae, in marine waters and generally discolor the water brown, red or green. Marine blooms, unlike those of fresh water, do not necessarily occur in grossly polluted water.

7. The varied organisms in Table 1 may be of special interest as a group, or individually. There will be found in Table 1 many names with the designation "p.n." behind the name. This is a way of indicating the organism is a distinctive entity either because of well defined morphology, or because of recurrence, or because more than one has been found. Organisms so designated have not been indentified from the available literature. Thus in the blue-greens, *Anabaena microscopica* p.n. is a straight chain of round cells, 1-3 microns in diameter, bright blue-green, without heterocysts or akinetes. It is quite distinctive. The five species of sulfur bacteria are not normally found in the plankton, though evidently characteristic of the bottom sediments. They are important in the metabolism of sulfur compounds.

There are three blue-green algae which occur rather frequently in the Bay, always in limited numbers. They are *Gomphosphaeria*, *Johannesbaptista*, and *Trichodesmium*.

Schizothrix calcicola is frequent in both Bay and Canals. None of the blue-green algae are ecologically abundant, except to serve as seeding stock.

The Volvocida are poorly represented in oceanic waters and the only one of importance here is Pyramidomonas grossi which might be a seeding organism if conditions became suitable.

The only euglenoid of interest is *Eutreptia* referred to above. Some of these could be *Eutreptiella*, the only difference between the two is equal or dissimilar flagella lengths. The colorless euglendis are usually found in the sediment-water interface where they are common. *Cylindromonas* is a large hitherto undescribed genus and species.

Cryptomonadida are a small group, several of which are marine. In this study, only the small *Rhodomonas baltica* occurs frequently, but in Escambia Bay it causes blooms. *Cryptomonas marina* is a large dark-red species, and is rare in the Bay.

The status of the organism listed as Glenodinium in Table 1, Dinoflagellates, is unclear. It is probably a Peridinium, although its plate structure could not be determined. It is perfectly spherical, with a median, thin, but sharply defined list. Two were in catena, the other solitary. Several being present, it is a valid species, and is termed *Peridinium sphaericum p.n.*

The dinoflagellates are sufficiently diverse to be of interest. Thus, the "small Gymnodinia" and. "large Gymnodinia" comprise several species which cannot be separated

because they stain intensely black. They probably contain G. simplex, G. marinum, G. veneficum, G. vitiligo, G. variable, and others. Their abundance in the Canals is noteworthy since there are very few other dinoflagellates there. Peridinium trochoideum seems to be uboquitous. In the Bay, two bloom forming species, Pyrodinium bahamiensis and Gymnodinium breve, were noted; the former has not thus far produced fish kills in South Florida waters, but seems to be increasing, while the first Atlantic fish kill due to G. breve occurred at Port Everglades in 1978. Neither species has occurred in the Canals.

Gymnodinium splendens frequently cytolizes badly on preservation, but is still easily recognized.

Dinoflagellates probably show greater diversity of form and structure than any other group discussed in this report deals.

Diatoms are greatest in number per liter and number of species. Generally, the larger ones (Synedra biceps, S. undulata, etc.) occur sparingly in both Bay and Canals; while small naviculoid species, as well as Cyclotella, occur most frequently and in greater numbers in the Canals. Colonial diatoms are nowhere abundant. Aside from being a food source for small animals--protozoa and nauplii--and attesting to an abundance of silicon, there appears to be no further ecologic significance to the diatom population. It is quite apparent that the dominant species are temporary, and no stable population exists aside from perhaps a dozen which are hardly present as dominants. Examples are Cyclotella and Navicula ostrea.

In June Navicula became dominant in the Canals, whereas it had not been seen previously.

Some of these diatoms are of academic interest. Many of them occur in both salt and fresh water. Amphiprora or Amphora pellucida p.n. has a frustule so thin and transparent it cannot be seen, except occasionally on edge. The only detection is by its cytolized cytoplasm, much as in the fresh water species Attheya zachariasi.

The diatoms are the best indication that the canals are non-toxic. While other groups are sparsely represented there, diatoms are not, and so far any diatom found in the Bay has also been noted in Canal samples. In the early work on the microbiota, slides were hung in the Canals, and quickly became colonized with huge colonies of diatoms. Among them was a species of Actinella not described in the literature. It is still present in canal samples but in reduced numbers, indicating a tolerance of whatever changes have occurred in the Canal environment.

Diatoms are the most abundant and important group in the Canals with regard to reoxygenation, uptake of o-PO_4, NO_3-N, and Silicon and probably some organic compounds. There are no signs that they are restricted by any conditions in the Canals.

8. In the Bay, there is probably some sort of balance between animal and plant life--animal adding inorganic minute amounts of CO_2 while taking up O_2. This is also generally true for bacteria. In the Canals, there are so few animals that an inbalance exists that is compensated for in part by the bacteria in the sediment-water interface. It seems that water being recirculated must gradually use up its o-PO_4 and NO_3N if there is a plankton/algae population, which demands more than can be absorbed from the atmosphere and from rainfall. Now that the Canals are being colonized by macroscopic algae, the situation becomes more competitive. So far there has been no indication that it is becoming restrictive.

9. Stability of the environment has already been discussed to a considerable extent. It is concluded that the Bay is stable within the limits of seasonal change, tidal flow, diurnal variation, and weather changes (storms, rainfall, etc.). There is currently absolutely no effect of the Turkey Point Plant on the plankton in the Bay.

The Canals on the contrary are still "settling down". There is still much debris in the bottom, most of it from mangroves, and subject to slow decomposition. Tidal changes are non-existent, and seasonal temperature changes are limited. There is new crop of mangroves growing along the edges of the Canals and there is an invasion of macroscopic algae. The plankton must develop within the limits imposed by these and possibly other factors. It appears that restrictive influences are at work, and it cannot be determined which ones. They do not seem to be total, and are probably non-restrictive for diatoms.

10. This report contains a list of endemic protozoa and algae for Lower Biscayne Bay-Card Sound for January through June, 1978, and identifies species in the Canal Cooling System. All 215 genera and species either known or provisionally named organisms. The Bay is deemed stable, largely because of its diversity of species and the large number, as well as recurrence. The Canals are still stabilizing. The species list is conservative because in some genera more species were present than actually identified. A few groups of algae were not found. Bottom dwellers were largely absent, as in Zoomastigophorea and Rhizopodea. Dominant groups, i.e., the most species, were blue-green algae, Dinoflagellida, Bacillariophyceae (diatoms), and Ciliophorea. A sufficient number of Metazoan larvae were found in Canal samples to indicate the adults live there.

No effect on the microbiota could be traced to the Turkey Point Plant.

TABLE 1

THE PLANKTON ORGANISMS AT TURKEY POINT IN BISCAYNE BAY AND THE COOLING CANAL SYSTEM, JANUARY THRU JUNE 1978
(In each month Column 1 represents the number of occurrence of each species, and Column 2 the maximum number per 500 mls for that month.)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Sulfur Bacteria																								
Achromatium oxaliferum			2	4																				
Beggiatoa alba															1	4			1	32			3	8
Beggiatoa arachnoidea		1	5	96											7	64			4	8			1	4
Beggiatoa mirabilis			3	12			2	32							1	8							3	4
Thiothrix sp.	1	8																						
Blue Green Algae																								
Anabaena microscopica, p.n.	1	32	2	32	2	32					2	32			1	64			1	64			1	32
Aphanocapsa planctonica					1	32															4	64		
Aphanocapsa pulcher									2	32			2	32										
Chroococcus gigantea																			1	4				
Chroococcus Kuetzingianum																	1	32						
Chroococcus planctonica					1	32	1	256					2	96							2	32		
Coelosphaerium Kuetzingianum																	1	64						
Gleothece linearis	1	32							1	12														
Gomphosphaeria aponina	1	4					1	32	7	64			2	32							1	32		
Johannesbaptistia minor, p.n.													5	32										
Johannesbaptistia pellucida	3	8			3	4	1	4	6	96			3	96			3	32			4	32		
Lyngbya aestuarii			4	96	2	32	5	32															3	32
Lyngbya majuscula			1	4																				
Lyngbya minuta, p.n.									2	4					3	12							5	80
Lyngbya sp.			6	16																	2	4		
Merismopedia elegans					1	32																		
Merismopedia glauca									5	64			1	32										
Merismopedia punctata	2	32			1	32	1	32	7	32							1	32						
Microcystis incerta	1	32											2	160										
Oscillatoria rilyi									1	32														
Oscillatoria sp.															1	4								

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Blue Green Algae (cont.)																								
Schizothrix calcicola			1	64	1	32	2	64					2	32	2	384			1	32	2	384	7	640
Spirulina major					2	32																		
Spirulina minor			1	32					4	32	1	32	2	32					1	32				
Trichodesmium erythraeum	4	4	6	28			2	8	3	4											3	316		
Chlorophyceae																								
Chlorella vulgaris*																								
Coccochloris sp.									1	4096														
Volvacadeas																								
Chlamydomonas spp.	7	608							2	64														
Dunaliella sp.	1	32					1	32																
Pyramidomonas grossi	4	64			1	32			1	256			2	64							2	32		
Euglenophyceae																								
Anisonema ovale					1	4																		
Eutreptia hirudoidea															1	32			3	32			2	12
Eutreptia viridis	1	32	2	32			1	32	1	32	5	32												
Peranema trichophorum					2	4																		
Petalomonas elongata, p.n.									1	32					1	32								
Petalomonas sp.	1	4							1	32			1	32										
Euglena unid. colorless									1	32			2	32									1	4
Cryptomonadida																								
Cryptomonas marina													1	8										
Rhodomonas baltica	7	160	10	288	8	3840	13	2112	9	288	6	192	11	320	3	32					2	32		
Silicoflagellida																								
Dictyocha fibula					1	64							2	32							1	4		

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Dinoflagellida																								
Amphidinium crassa											3	64	2	64					1	32	4	32		
Amphidinium operculatum							1	32																
Amphidinium phaeocystola																			1	32				
Amphidinium sp.									4	128														
Dinophysis tripos																					2	8		
Dyslopsalis lenticularis	4	8			3	4			6	4											4	64	2	4
Exiuvella apora	2	4			3	12			7	4			1	4			3	8			3	4		
Exiuvella marina	7	32	8	32	11	132	6	32	11	44	2	24	8	96	4	32	2	32	2	4	5	64	1	4
Exiuvella minor, p.n.	3	32			6	96	2	32	10	64	4	192	2	32	4	48	2	32	3	32			5	96
Glenodinium foliaceum															2	8								
Gonyaulax diegenesis																					3	4		
Gonyaulax polygramma									2	324														
Gonyaulax scrippsae	1	8																						
Gonyaulax triacantha					4	4																		
Gymnodinium albulum	4	64							6	192	9	160	7	128	7	160	2	32			9	64	1	32
Gymnodinium breve																	2	32						
Gymnodinium catenata, p.n.																					3	64		
Gymnodinium splendens	9	12			8	40	1	8	9	16							2	4			4	96		
Gymnodinium large	10	256	12	512	10	512	1	1280	12	526	13	480	10	96	12	512	5	256			11	160	7	160
Gymnodinium small	9	416	12	388	13	576	13	2432	13	768	13	1024	13	896	12	384	3	32	1	32	12	572	7	256
Gymnodinium sp.																			7	160				
Gyrodinium lachryma	1	4							1	4											4	4		
Gyrodinium pingue	1	32			2	32															5	64		
Peridinium conicum																					1	4		
Peridinium divergens									1	4			1	4							3	16		
Peridinium longum																					3	12		
Peridinium obtusum					2	32			4	64			1	32							1	4		
Peridinium pentagonum									3	64											1	4		
Peridinium quadridens									1	32														
Peridinium trochoideum	1	6	8	224	7	192	7	160	1	96	13	768	2	32	6	128					2	32		
Peridinium tuba	1	132	3	32	2	32	2	32	5	32							1	12			2	64		
Peridinium sp.	2	.16					4	4			1	32	1	32	2	32	3	32	1	4	8	64	4	4
Peridenopsis rotundata					2	8			2	32	1	8												

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Dinoflagellida (cont.)																								
Prorocentrum gracile	2	4			5	8															1	32		
Prorocentrum micans	8	8			9	12			7	12			3	32			1	8			9	36		
Prorocentrum triangulatum	3	160	1	32	1	32			6	64														
Protoceratium reticulatum	4	8			6	12			10	64			8	24	4	8	5	32	1	8	5	24		
Pyrodinium bahamiensis	1	8			4	8			3	8							1	32			13	444		
Torodinium robustum													2	32										
Dinoflagellata unid.	8	96	9	96	12	256	6	96	7	32	7	288	3	32	4	64	3	32			13	128		
Bacillariophyceae (diatoms)																								
Achnanthes longipes					1	32																		
Actinella sp.					2	8	1	4					1	32	2	320			1	4			10	96
Amphiprora abata									4	4							1	4			1	32	2	4
Amphiprora marina							8	192									1	32			3	32	3	32
Amphiprora pellucida, p.n.			2	32																			8	128
Amphora biscayensis, p.n.													1	416	2	32			1	32				
Amphora marina	1	64							4	32			2	32										
Amphora ovalis	4	16	4	160			7	48	11	64	4	128	6	96	5	84	1	4	9	32	1	20	10	288
Biddulphia sp.									1	4									2	32			1	4
Campylodiscus sp.	1	4							3	4							2	4						
Campylosira cymbelliformis													1	96					1	64				
Campylosira sp.	1	64																						
Chaetoceras sp.							1	32									1	72			8	12400		
Cocconeis diminuenda	3	64	7	64	5	32	3	32	3	32	1	32												
Cocconeis hustedti	7	64	7	2560	8	64	2	32	1	32	5	32	4	96	1	64	4	64	2	64	10	384	5	64
Cocconeis placentula	7	160	2	64	2	64	3	256	6	32	1	64	4	32	1	32	5	32	3	64	6	64	2	20
Cocconeis sp.	1	8																	1	32			1	4
Coscinodiscus concinnus	1	4											1	4							4	4		
Cyclotella catenata, p.n.			1	128	1	96	5	256			3	224			1	128	1	64	6	384				
Cyclotella meneghianiana	1	96	7	288			13	7562	2	32	3	64	6	96					12	1664	5	96		
Cyclotella nana	5	160	2	32	2	92	2	512	1	96			2	64					7	128	4	64		
Cyclotella sp., colony unid. (Cylinedropyxis?)									1	32														

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bacillariophyceae (diatoms) (cont.)																								
Cymatopleura solea	8	96	8	128	2	32	4	32	11	256	5	32	4	192	2	64			1	32				
Cymatopleura sp.			7	96			4	128	2	4											7	96	9	240
Cymbella sp.			1	32					7	32			4	64							2	128	8	96
Diploneis bombus							2	32	1	4			2	8							1	4		
Eunotia sp.	1	64													3	32								
Fragilaria sp.							1	96																
Gramatophora serpentisa															1	64								
Gyrosigma baltica	1	4	4	12																			1	8
Gyrosigma formosa							4	8																
Gyrosigma hippocampus			2	4			4	8																
Gyrosigma longum v. inflatum																			1	4				
Gyrosigma scalipoides							1	256			1	32			3	64			1	32	1	4	8	672
Gyrosigma strigosum													1	12										
Gyrosigma tenuissima	3	3	3	32	2	8	4	64	4	96			6	96	2	4	3	4	1	32	2	64	2	32
Gyrosigma Vanheareki																							1	4
Leptocylindrus danicus					1	576																		
Licmophora abbreviata	5	160			12	1664	6	256	13	192			1	256							3	64		
Licmophora flabellula	6	64	6	36	7	32	4	48	6	16			4	32			5	32	1	32	3	4	5	8
Licmophora ramulus	7	12	4	8	9	32	1	8	10	24	3	32	5	64			4	64			4	4	4	64
Licmophora splendens							1	40																
Melosira granulata							1	40			1	64												
Melosira monilata													1	4										
Navicula amphbola	3	32	3	128			2	32	6	64			4	92	1	32	2	32					3	4
Navicula ostrea																							7	2944
Navicula (Stauroneis?) membranaceae									1	224														
Navicula spp.	13	640	12	1344	13	736	13	3768	13	1920	13	2368	13	3264	12	4096	9	768	11	3200	13	832	11	3752
Nitzschia acicularis	5	96	3	128	6	64	9	1216	12	128	4	64	3	96	3	64	2	48			5	64	1	64
Nitzschia closterium	3	64	6	96	2	264	6	512	9	224	7	128	4	32	5	96			3	64			5	160
Nitzschia delicatissima									1	16														
Nitzschia longa					1	264	1	32	7	32	3	64			3	64							2	4

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bacillariophyceae (diatoms) (cont.)																								
Nitzschia paradoxa			1	8	1	4																		
Nitzschia pungens					1	64	2	32									1	64						
Nitzschia seriata					1	32																		
Nitzschia sigmoidea	1	4			1	4	1	64	3	4					4	4					2	4		
Nitzschiella acutissimus	3	4	6	12			8	64																
Oekedemea inflexa									4	64			4	96										
Opephora marina	1	32																						
Pleurosigma balticum	4	4															1	8						
Pleurosigma fasciola v. clostroides			3	64	2	32	13	192	6	64	8	128	1	32	7	64	2	64	2	128	2	32		
Pleurosigma formosa																	4	8	3	16				
Pleurosigma nicobarium	1	4							9	8	3	32	3	12	5	12					4	4	1	12
Pleurosigma tenuissmuna															2	128								
Pleurosigma sp.			1	8																				
Podocystis adriatica							3	32			1	4			1	4								
Rhizosolenia fragilissima					1	576																		
Skeletonema costatum					2	608																		
Striatella interrupta									2	64			3	32			1	32			3	160		
Striatella minuta, p.n.											2	32												
Striatella unipunctata									1	12					1	4	1	4						
Striatella sp.																					1	4		
Sururella festuosus	1	4	4	8	1	4	4	16	8	32	5	8	2	8	5	12			4	8			4	64
Synedra actinastroides			1	52																				
Synedra biceps	3	4	4	4			2	4	4	8			1	12	2	4	5	8			5	12	1	3
Synedra biceps v. minor, p.n.																					1	8		
Synedra crystallina	3	4	1	4							3	4	1	4							1	8	1	12
Synedra longa							2	32																
Synedra superba	2	8	6	12	1	4	10	96			2	64			4	128	1	32	1	4			9	640
Synedra ulna	6	192	2	32	8	96	1	8	9	96			4	96			1	32			6	64	2	64
Synedra undulata	3	8	9	36	1	20	6	64	3	4	1	4	2	12	3	144	3	12	2	4	5	8	5	16
Synedra sp.																	1	12						

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TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bacillariophyceae (diatoms) (cont.)																								
Tabellaria sp.	1	12					2	64	1	64					1	12			1	28	1	64		
Thalassiosira condensa									1	4														
Thalassiosira rotula	1	64			3	256															4	96		
Tropidoneis lepidoptera					1	4			4	4	1	4	3	4			4	192			2	4		
Diatoms unid.	6	64	2	96	3	8	7	64	6	32	2	64	4	24	7	24	2	32	2	8	8	32	4	32
Zooflagellida																								
Bioeca mediterranea									2	120			6	192										
Bodo elongata, p.n.									2	32							1	32	1	64	3	32		
Spirochaeta sp.													1	32										
Zooflagellates unid.													2	160										
Rhizopoda																								
Amoeba radiosa			1	32							1	32												
Rhizopoda shelled near Pseudo difflugia			1	32																				
Rhizopoda shelled unid.									1	4			1	4										
Rhizopoda shelled near Pyxidicula							1	32																
Rhizopoda radiata																	2	32						
Rhizopoda unid.																							1	4
Ciliophorea																								
Askenasia volvox					4	4																		
Cyclidium glaucoma	1	32									1	32												
Favella panamensis									1	4	6	20												
Lohmaniella oviformis									5	96			3	96	1	4			1	64	7	64		
Mesodinium rubrum													1	32							3	64		
Metacylis angulata	2	16							2	8			2	4										
Metacylis jurgensi					2	4											2	4			6	16		

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Ciliophorea (cont.)																								
Steenstrupiella near intremescens									2	128														
Steenstrupiella robusta					1	4																		
Strobilidium humile					6	576	2	32	9	64	2	64	9	160							4	64		
Strombidium acuminatum																					1	32		
Strombidium claparides											1	96									5	96		
Strombidium conicum	13	384	6	288	13	160	2	64	13	128			11	160			3	32			13	128		
Strombidium coronatum											5	1184												
Strombidium strobilius	2	4			7	92							1	4			4	32						
Strombidium strobilius v. minor, p.n.													6	96										
Strombidium sp.																	1	64						
Tintinnopsis bermudonsis	1	4					1	4	2	4							1	4			2	4		
Tintinnopsis beroidea	3	8			2	4			5	16			1	4							2	4		
Tintinnopsis brasiliensis	1	4																						
Tintinnopsis gracilis									1	4														
Tintinnopsis minutus	1	12			4	192	6	32	2	32	2	32	6	32	3	32	1	32			1	4		
Tintinnopsis nana									2	64														
Tintinnopsis platenses									2	16							1	4						
Tintinnus apertus							1	4					2	16										
Tintinnus turgescens									2	4														
Vorticellids sp.																	1	160						
Ciliata unid.	3	96					1	32	5	96	1	4	1	4			2	4			4	28		
Metazoa																								
Bivalve larvae									2	4			1	4			1	4	2	4	3	4		
Crab larvae	1	4			1	4			3	8			2	4					1	4				
Coelenterata hydrozoa																					1	4		
Copepod nauplii calanoid	8	12	9	20	9	12	3	48	11	28	5	8	8	28	5	8	10	32	4	4	12	24	2	40
Copepod nauplii harpacticoid			1	4																				
Egg, not identified	1	8	5	224	5	12			6	8			6	8			4	8			6	12		
Gastropod larvae	1	4							4	8			3	4			5	16	1	216	4	12	1	8

TABLE 1 (continued)

	January				February				March				April				May				June			
	Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal		Bay		Canal	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Metazoa (cont.)																								
Larvae, unid.	1	4	3	4	2	4															3	8		
Nematoda, adults			1	4					4	4			3	32					2	4	1	4	1	4
Planaria larvae																	1	4						
Plutei, Echinodium larvae					1	4															1	4		
Polychaeta larvae			2	4							1	16			1	4								
Rotifera			1	4	1	4																		
Tunicate larvae	1	4			2	4			1	4			1	4			2	12			1	4		
Dinoflagellida																								
Ceratum farca	9	24	1	4	9	28	1	4			1	4	5	20			5	12			10	44		
Ceratum fusus									9	40			2	16			2	12			2	96		

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 acetone extraction of the plankton. The optical density of the extract was then determined by spectrohpotometric 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. Note that the Secchi disk readings in the Bay are measured, but the water is not deep enough to get a true reading. Therefore, the measurement is made to the bottom and the additional depth needed is estimated.

Discussion and Conclusions

The highest values for all three parameters studied in the cooling canals occurred in May (Figure 1). The chlorophyll "a" concentration was 0.73 mg/m^3, the biomass concentration was 48.90 mg/m^3 and primary productivity was 0.07 $gC/m^2/day$. The lowest values occurred in March when the chlorophyll "a" concentration was 0.30 mg/m^3, the biomass concentration was 20.10 mg/m^3 and primary productivity estimate was 0.03 $gC/m^2/day$.

In Biscayne Bay and Card Sound (Figure 2), the highest values for the three parameters studied occurred in June. The chlorophyll "a" concentration was 0.60 mg/m^3, the biomass concentration was 40.20 mg/m^3 and the primary productivity estimate was 0.35 $gC/m^2/day$. The lowest values occurred in February, when the chlorophyll "a" concentration was 0.10 mg/m^3, biomass concentration was 6.70 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 for the entire period. 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 lignin which produce color, and organic debris which produces turbidity. This color and turbidity should be expected in a mangrove environment.

Quite a large increase in primary productivity estimates occurred in June. This phenomenon was probably due to higher nutrient levels caused by increased rainfall in the latter half of May and early June. 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).

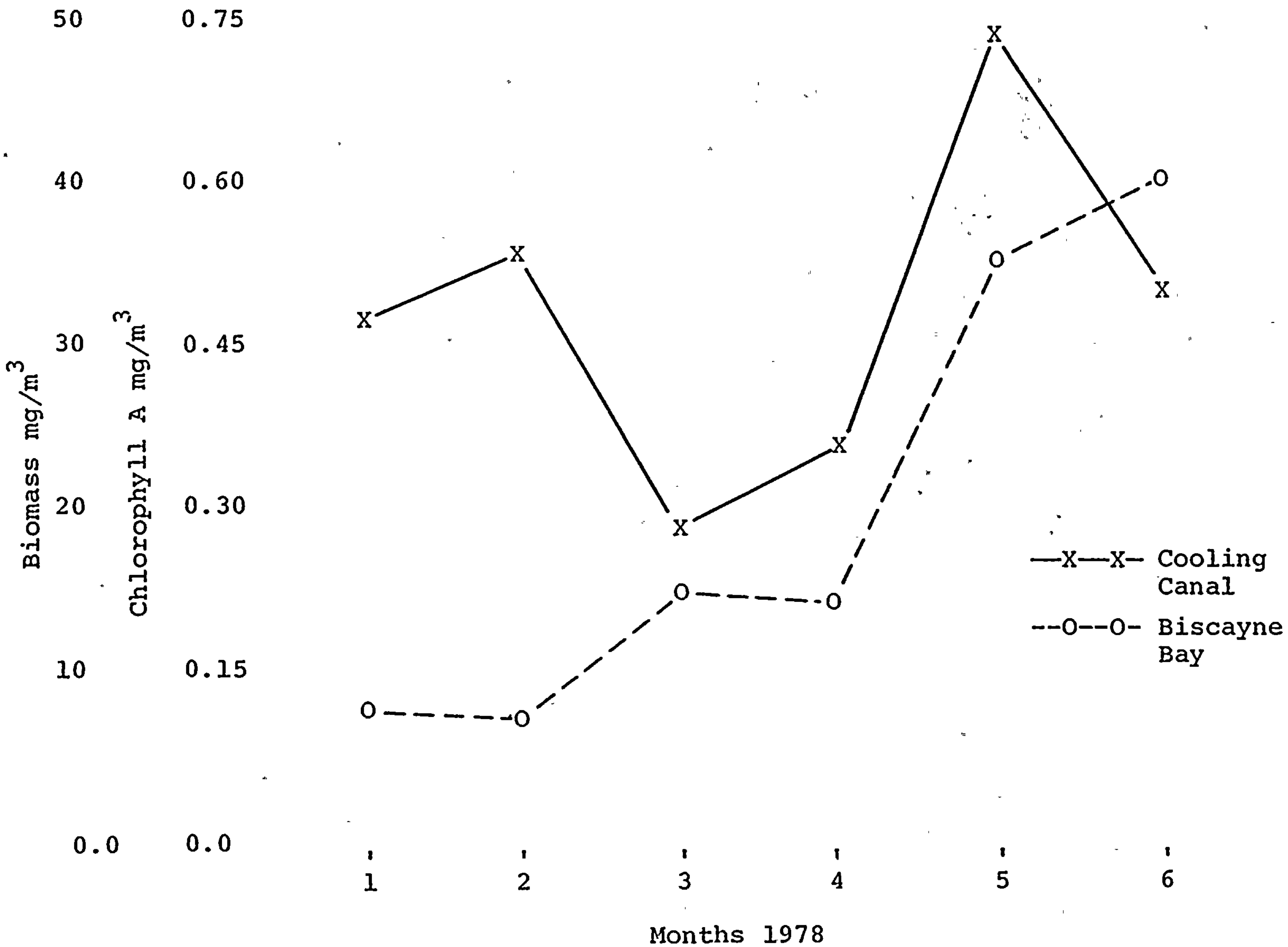


Figure 1. Chlorophyll A and Biomass in the Cooling Canal System and Biscayne Bay. Mean values for all stations.

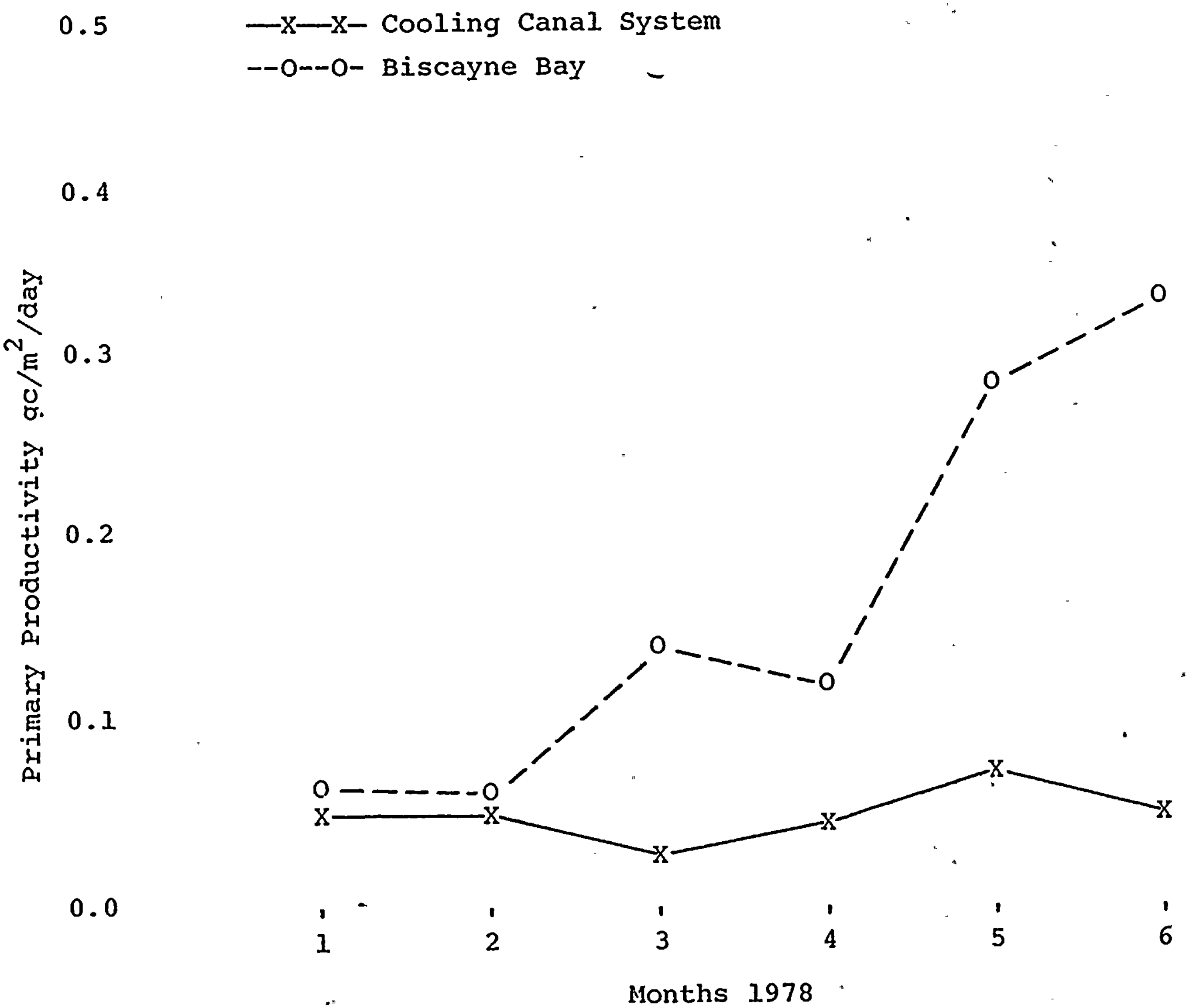


Figure 2. Primary Productivity in the Cooling Canal System and Biscayne Bay. Mean values for all stations.

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 Oceanographic Institute, Woods Hole, Mass.

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

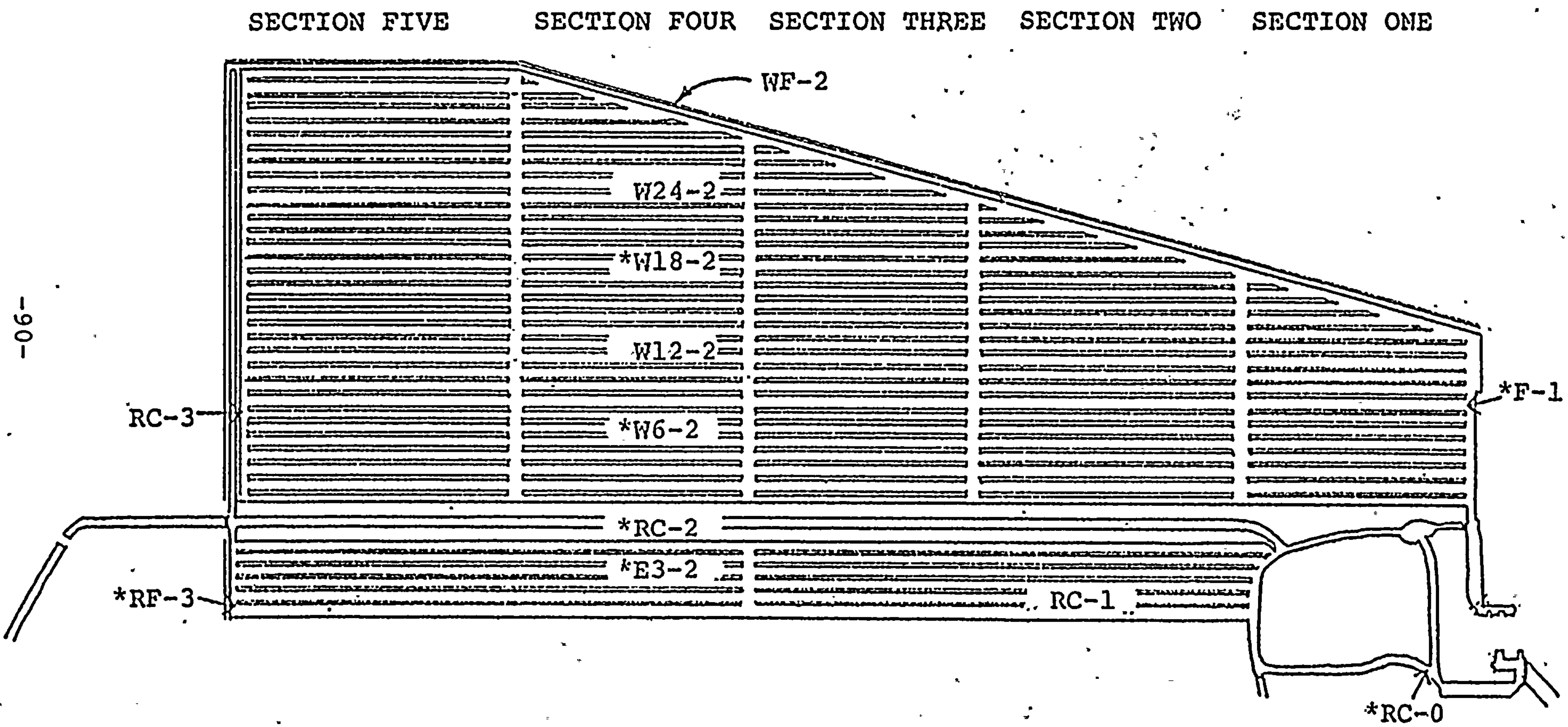


Figure 4 Turkey Point Plant Site & Cooling Canal System
*Zooplankton Tow and Chlorophyll "a" sample stations
Phytoplankton sample at each station

III.G Chlorine Usage

The 3Bs condenser and water box were inspected on May 21, 1978. Unit 4's 4As condenser and water box were inspected on May 31, 1978. On June 5, 1978, the intake wells were inspected for organic growth. Units 3 and 4 intake wells, condensers, and water boxes were found to be in a satisfactory state of cleanliness, therefore, not requiring chlorination at this time.

IV. RECORDS OF CHANGES IN SURVEY PROCEDURES

None

V. SPECIAL ENVIRONMENTAL STUDIES NOT REQUIRED BY THE ETS

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

VI. VIOLATIONS OF THE ETS

None

VII. UNUSUAL EVENTS, CHANGES TO THE PLANT, ETS, PERMITS, OR CERTIFICATES

Amendment Nos. 29 and 26 to Facility Operating License Nos. DPR-31 and DPR-41 deleted the requirements in the Environmental Technical Specifications (ETS) for monthly and quarterly monitoring of the E-series wells in the groundwater monitoring program. These amendments were issued by NRC by letter dated October 7, 1977. Reporting of this change to the ETS was not included in Semi-Annual Environmental Monitoring Report No. 10.

VIII. STUDIES REQUIRED BY THE ETS NOT INCLUDED IN THIS REPORT

The reports entitled "Baseline Ecological Study of a Subtropical Terrestrial Biome in Southern Dade County, Florida" and "Evaluation of Ecological Studies Conducted at Turkey Point and South Dade Study Area" were forwarded to the NRC on June 1, 1978. These reports met the requirements of ETS 4.B.1.a, b, and c and ETS 4.B.2 respectively.

APPENDIX

AB-119

ECOLOGICAL MONITORING OF SELECTED PARAMETERS AT THE FLORIDA POWER & LIGHT CO. TURKEY POINT PLANT

SEMIANNUAL REPORT

JANUARY-JUNE 1978

AUGUST 1978

APPLIED BIOLOGY, INC.

ATLANTA, GEORGIA

CONTENTS[a]

[a]This report will be incorporated into a larger report to be submitted to the Nuclear Regulatory Commission by Florida Power & Light. This outline is therefore incomplete, comprising only the sections for which Applied Biology, Inc., is responsible.

C. FISH AND SHELLFISH

INTRODUCTION

The Turkey Point cooling canal system was closed off in February 1973, effectively isolating populations of fish and shellfish within the canals from Biscayne Bay and adjacent offshore habitats.

Sampling of the fish and shellfish populations was initiated in December 1974. The purpose of the sampling was to determine which species were present and their relative abundance and size. Within the confines of the canal system, reproduction would be limited to species which spawn inshore and lack any prolonged planktonic larval stages. Species which demonstrated a variety of life history stages could be considered to be reproductive and established in the canals.

These continuing studies are documenting the changes that are occurring in the fish and shellfish fauna in the canal system. To place changes in perspective, this fauna is compared to that of inshore Biscayne Bay.

MATERIALS AND METHODS

Fishes were collected monthly from January through June 1978, the period covered by this report, at the ten stations which were surveyed in 1974 and 1975 (Florida Power & Light Co., 1976). Stations 1 and 8 were relatively deepwater (6 m) localities near the plant intake and discharge, respectively (Figure III.C-1). Stations 2 and 4 were situated between deep (6 m) and shallow (1 m) water areas. Stations 3, 5, 6, and 7 averaged less than 1 m in water depth. Canal width at Stations 1 through 8 was approximately 61 m. Stations 9 and 10 were in a backwater area and small pond, respectively, off the canal system proper. Water depth at these two stations was less than 0.6 m.

Collections were made by gill net and minnow trap. Each monofilament net was 30.5 m in length by 1.8 m in depth and consisted of three 10-m panels of 25-, 38-, and 51-mm^2 mesh sewn end to end. The minnow traps were of the funnel type and measured 406 mm long by 229 mm in diameter. These traps were constructed of 6.4-mm^2 galvanized mesh.

The sampling method at each station was determined primarily by the water depth at the sampling site. Gill nets were fished at Stations 1, 2, 4, and 8; minnow traps at Stations 2 through 10. Preliminary sampling at Station 1 had shown an absence of the small fishes which could be collected by minnow traps. One gill net and/or two minnow traps were fished for one 24-hr period per station per month.

All specimens collected were identified to species, counted, measured to the nearest millimeter, and weighed to the nearest gram. Fishes were measured from the tip of the snout to the base of the tail (standard length). Crabs were measured across the shell (carapace width) and shrimp along the carapace and tail. Fish nomenclature was in accordance with Bailey et al. (1970).

RESULTS AND DISCUSSION

Two species of shellfishes and 21 species of fishes were collected during this 6-month sampling period. Collections by month and station number are presented in Tables III.C-1 through III.C-6. The number of individuals of each species collected, range of standard lengths, total weight, and the range of water temperatures recorded at each station during sampling are included. The data presented in Tables III.C-1 through III.C-6 are summarized in Table III.C-7, which also includes the percentage composition by number and weight of the fishes collected.

The killifish family (Cyprinodontidae) comprised 93.5% of the 2730 total fishes collected. The goldspotted killifish and sheepshead minnow were the predominant species collected with 1499 and 1038 individuals, respectively. Other members of this family collected were the rainwater, marsh and gulf killifishes (Table III.C-7). These are all small (<60 mm) fishes and, although abundant, comprised only 12.7% of the total weight of the fishes collected.

The livebearer family (Poeciliidae) comprised 3.1% of the total fishes collected but, also being small forage fishes, accounted for only 0.7% of the total biomass. The sailfin molly and pike killifish were the two poeciliids found (Table III.C-7).

The balance of the fishes collected, although comprising only 3.4% of the total number, accounted for over 86.6% of the total biomass. The majority of this biomass resulted from the collection of a few (12) individuals of relatively large species: bonefish, snook, gray snapper and crevalle jack (Table III.C-7).

The goldspotted killifish, sheepshead minnow, and sailfin molly were the only species collected in large enough numbers for meaningful comparison between stations. The goldspotted killifish was the dominant species at Stations 2, 3, 4, 6, 7, and 9; while the sheepshead minnow was the dominant species at Stations 8 and 10 (Figure III.C-2). Similar numbers of goldspotted killifish and sheepshead minnow were collected at Station 5. The sailfin molly was the most abundant at Station 10 but was nowhere dominant. Habitat differences, physiological tolerances and/or competitive abilities have been previously discussed to account for differences in species dominance (Applied Biology, 1977). These differences will be further elucidated in the annual report for 1978, when four years of data on these species will have been analyzed.

The killifishes and livebearers are maintaining reproducing populations within the canal system, based on the continuing abundance of these fishes found in our collections and the occurrence of juveniles as well as adults. Although not as abundant as the killifishes, the crested goby and gulf toadfish were also collected as juveniles and adults and are considered established in the system. Redfin needlefish (*Strongylura notata*) were not collected by the methods employed, but were frequently observed in the system and are also considered established. Although no juvenile silver jenny or spotfin mojarra were found, small individuals are not generally taken by the methods employed (small individuals were found in April 1977 when gill nets of fine mesh were employed in miscellaneous collections). These two species of mojarra are probably reproducing and established in the system.

The reproductive status of the tidewater silverside in the canals is less certain. Although probably capable of reproducing in the system, a decreasing number of individuals has been found over each of the years sampled. Numbers of this schooling species are probably not high enough to maintain a viable population over time.

The remainder of the species collected, with the exception of two individuals, were represented only by adults (Table III.C-7). These include the blue crab, shrimp, bonefish, yellowfin mojarra, snook, snapper, grunt, jack, barracuda and sea catfish. The two exceptions were a juvenile blue crab at 53 mm and juvenile pinfish at 27 mm. These two juveniles were members of species not considered to be reproducing in the canals, and their occurrence has not been explained.

The number of fishes collected by each gill net per 24-hr sample period (catch per unit effort) has decreased over the 43 months sampled to date (Figure III.C-3). Fishes and shellfishes represented only by adult forms which mature and die may be expected to disappear from the canal system unless recruitment occurs from outside. Several species which were observed or collected prior to January 1978 and not found thereafter may have already disappeared (Table III.C-8).

Concurrent with the decrease in the number of larger fishes has been an increase in populations of the small forage fishes as indicated by the number of fishes collected by each minnow trap per 24-hour sample period (Figure III.C-3). This increase in forage fish populations is attributed to filling the new habitat created by the construction of the system, as well as by the continuing decrease in predation pressure as the larger forms are lost to natural attrition. Whether or not populations of forage species will stabilize on a yearly basis, and at what levels, is still unknown. Seasonal variations in population levels will continue to be great within each year.

COMPARATIVE STUDIES

Voss et al. (1969) list almost 500 species of fishes which could potentially occur in Biscayne National Monument. However, only 80 species of fishes were collected by trawling in south Biscayne Bay and Card Sound during the baseline survey for the Turkey Point Plant (Bader and Roessler, 1971). Additional work was conducted by Nugent

(1970) in the immediate vicinity of the plant. This work was done primarily with gill nets and traps in tidal creeks, and resulted in the collection of 51 species of fishes. Pinfish, mojarras, snappers, and mullet were the fishes most commonly found. Blue crabs and shrimp were the common shellfishes. Applied Biology has collected or observed 41 species of fishes within the canal system since studies were initiated after the closing of the system to Biscayne Bay.

The previous studies conducted in the vicinity of Turkey Point indicate that the species of fishes and shellfishes which became trapped within the canal system were primarily the common, and often abundant, species found outside the canal system in the bay. However, with the natural attrition of most of the predatory species within the canal system, the killifishes and livebearers have reached levels of abundance probably not found outside the system. Continuing studies are documenting the changes which are occurring in the fish and shellfish fauna within the canal system.

SUMMARY

The Turkey Point cooling canals are a closed system containing a decreasingly diverse assemblage of fishes and shellfishes. Species reproducing in the system, as evidenced by the occurrence of both juveniles and adults, are primarily in the killifish and livebearer families of fishes. The goldspotted killifish and the sheepshead minnow are the predominant fishes, based on the number of individuals

collected. The majority of fish and shellfish species are disappearing from the canal system as natural attrition occurs.

LITERATURE CITED

Applied Biology, Inc. 1977. Ecological monitoring of selected parameters at the Turkey Point Plant. Annual Report 1976. Florida Power & Light Co., Miami, FL.

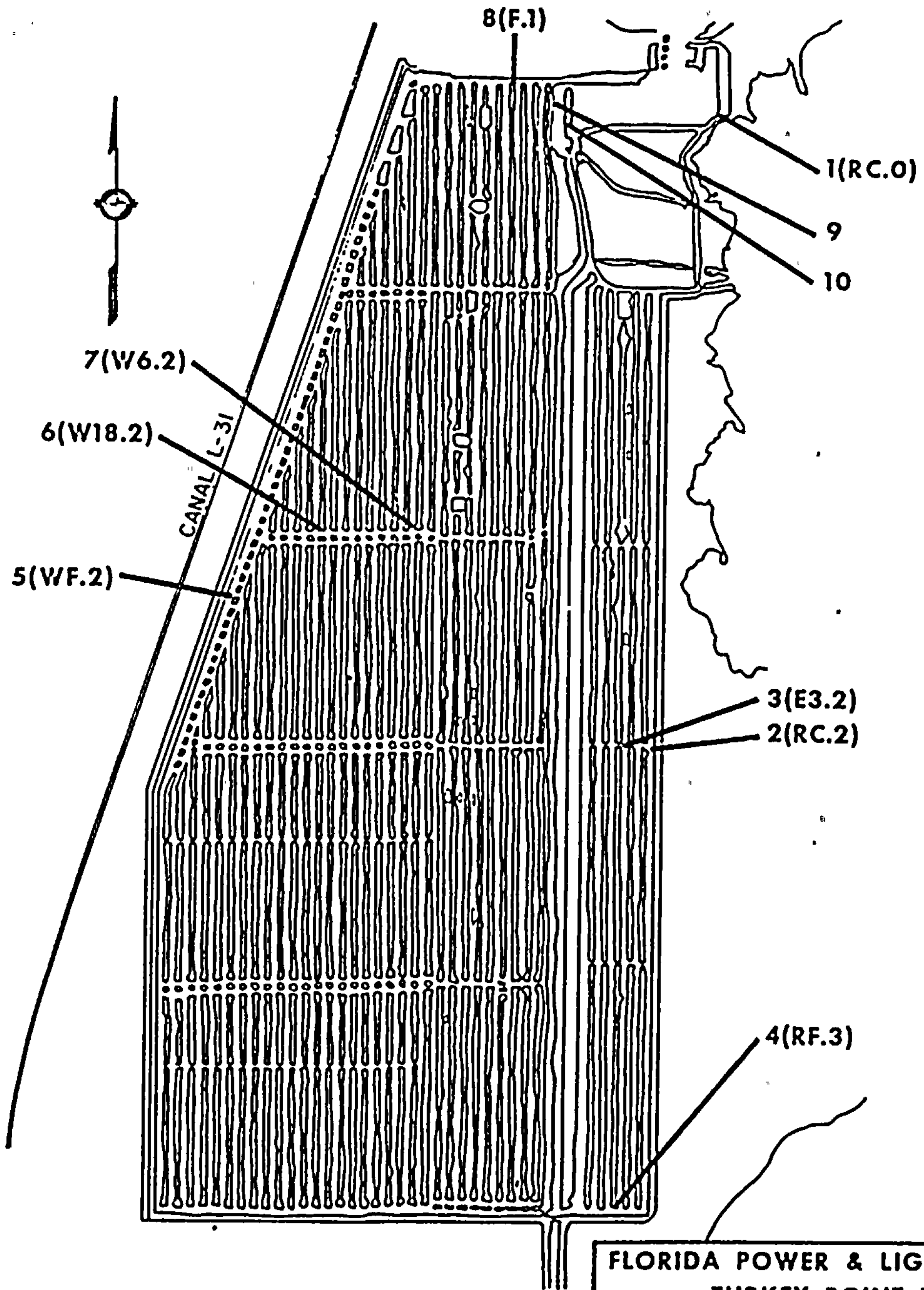
Bader, R.B., and M.A. Roessler, principal investigators. 1971. An ecological study of south Biscayne Bay and Card Sound. Prog. Rept. to U.S. AEC [AT (40-1) - 3801-3] and Fla. Power & Light Co. Rosenstiel School of Mar. and Atmos. Sci., Univ. of Miami, FL.

Bailey, R.M., J.E. Fitch, E.S. Herald, E.A. Lachner, C.C. Lindsey, C.R. Robins, and W.B. Scott. 1970. A list of common and scientific names of fishes from the United States and Canada, 3rd ed. Amer. Fish. Soc., Spec. Publ. 6. 150 pp.

Florida Power & Light Co. 1976. Turkey Point Units 3 and 4: semi-annual environmental monitoring report no. 6, July 1 to December 31, 1975. Miami, FL. 248 pp.

Nugent, R.S., Jr. 1970. The effects of thermal effluent on some of the macrofauna of a subtropical estuary. Sea Grant Tech. Bull. No. 1., Univ. of Miami, FL. 198 pp.

Voss, G.L., F.M. Bayer, C.R. Robins, M. Gomon, and E.T. LaRoe. 1969. The marine ecology of the Biscayne National Monument. Rept. to the National Park Service Dept. of the Interior. Inst. Mar. and Atmos. Sci., Univ. of Miami, FL. 128 pp.



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

FISH AND SHELLFISH
SAMPLING STATIONS

(FP&L Station Numbers)

APPLIED BIOLOGY, INC.
Figure III.C-1

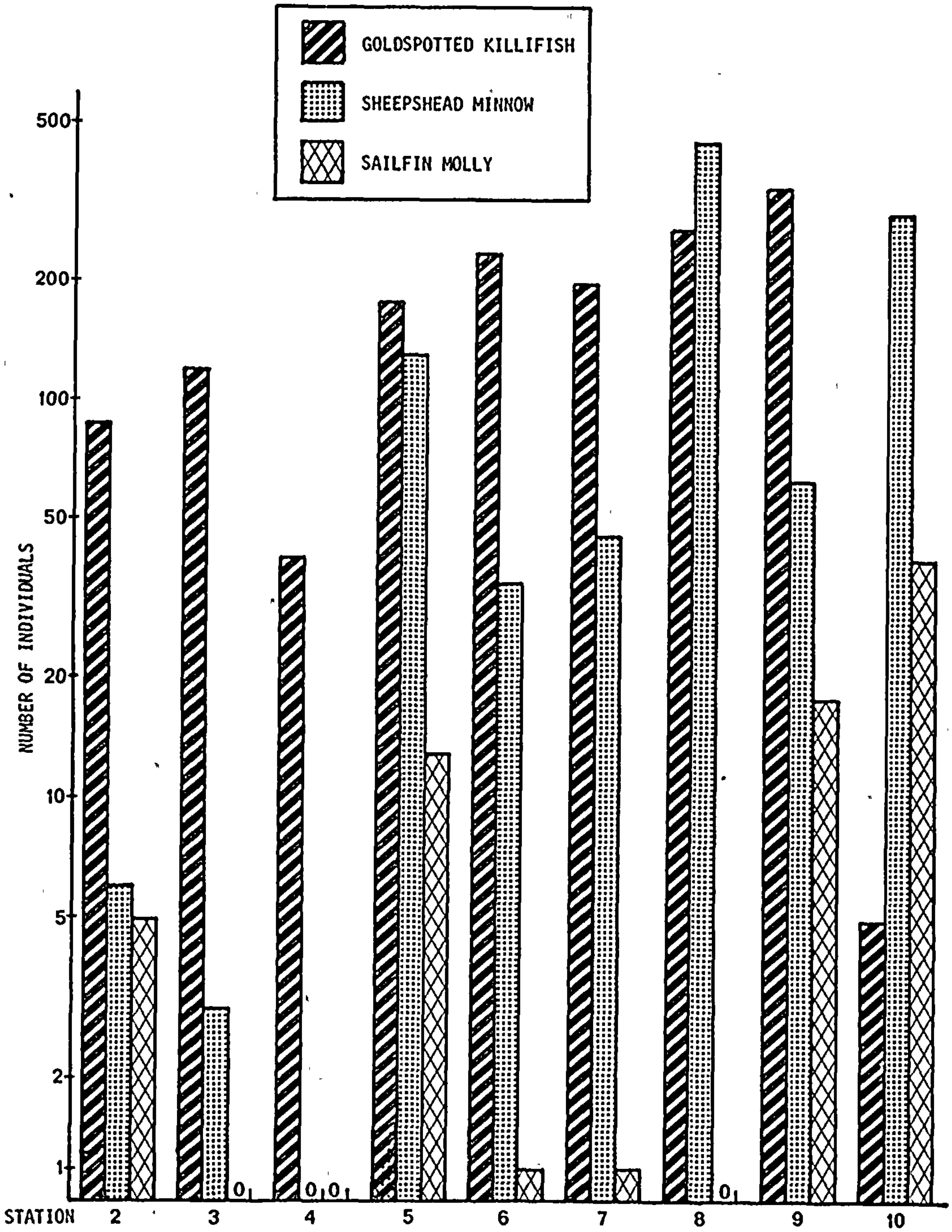


Figure III.C-2. Total number of goldspotted killifish, sheepshead minnow, and sailfin molly collected within the Turkey Point cooling canal system, January-June 1978.

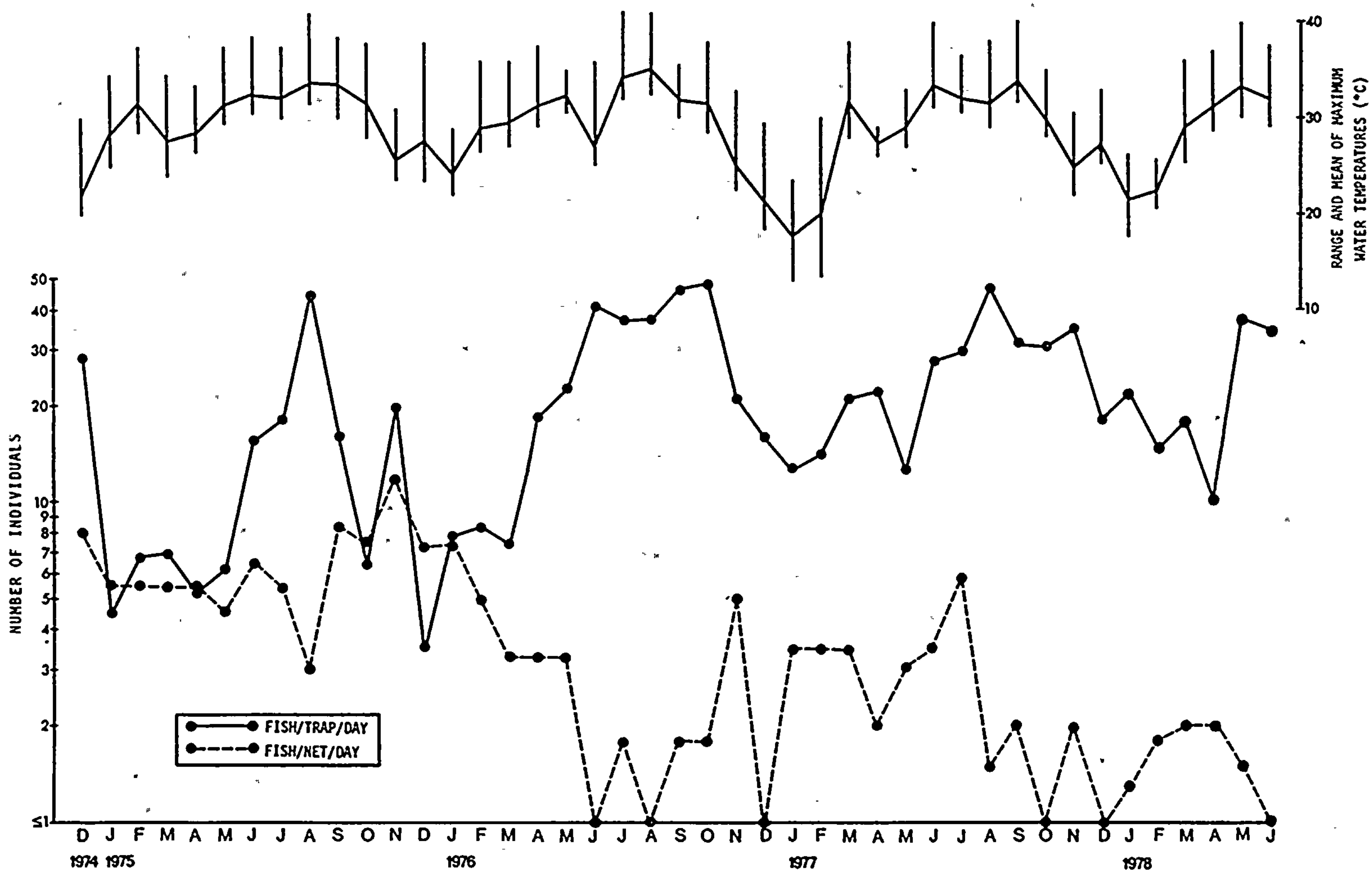


Figure III.C-3: Fish per gill net per day, fish per minnow trap per day, and range and mean of maximum water temperatures recorded at Stations 1 through 8, Turkey Point cooling canal system, December 1974-June 1978.

TABLE III.C-1

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
16-17 JANUARY 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	nothing collected	-	-	-	17.0-18.0
2	great barracuda	1	320	266	18.5-19.0
	bonefish	1	372	696	
	silver jenny	1	119	48	
	goldspotted killifish	41	22-43	67	
	sailfin molly	6	25-33	5	
	sheepshead minnow	5	22-28	3	
3	goldspotted killifish	8	25-35	9	16.0-18.0
4	blue crab	3	153-167	927	16.5-20.0
	bonefish	1	376	759	
	yellowfin mojarra	1	172	155	
	goldspotted killifish	4	23-31	3	
	tidewater silverside	1	44	fragment	
5	sheepshead minnow	83	20-32	57	19.5-23.0
	sailfin molly	13	25-41	14	
	goldspotted killifish	11	27-32	10	
6	goldspotted killifish	25	23-35	25	20.5-24.0
	sheepshead minnow	21	18-27	9	
7	goldspotted killifish	20	25-36	18	20.5-24.0
	sheepshead minnow	15	20-28	7	
	sailfin molly	1	28	1	
8	blue crab	1	165	292	25.5-26.0
	goldspotted killifish	50	23-46	67	
	sheepshead minnow	3	23-25	1	

TABLE III.C-1
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
16-17 JANUARY 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
9	sailfin molly	8	37-52	21	16.0-23.5
	sheepshead minnow	7	33-41	16	
	goldspotted killifish	1	42	3	
	pike killifish	1	86	7	
10	sheepshead minnow	128	30-41	308	20.0
	sailfin molly	3	45-53	15	

TABLE III.C-2

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
9-10 FEBRUARY 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	bluestripped grunt	1	187	251	17.5-21.0
2	sea catfish	1	391	1062	19.0-22.0
	spotfin mojarra	1	102	29	
	silver jenny	1	105	35	
	goldspotted killifish	26	26-50	56	
	gulf toadfish	1	90	25	
3	goldspotted killifish	3	28-32	4	18.0-20.5
4	blue crab	1	139	288	19.0-21.0
	yellowfin mojarra	1	180	196	
	bonefish	1	345	719	
	gray snapper	1	371	1434	
	goldspotted killifish	31	22-44	46	
5	goldspotted killifish	39	24-40	52	21.5-23.0
	sheepshead minnow	15	20-28	8	
6	goldspotted killifish	33	25-38	34	22.0-22.5
	sheepshead minnow	1	22	1	
	sailfin molly	1	31	1	
7	sheepshead minnow	18	18-25	8	22.0-23.5
	goldspotted killifish	17	22-38	16	
8	shrimp	3	69-111	20	24.5-25.5
	goldspotted killifish	19	23-35	20	
	sheepshead minnow	1	23	1	
9	goldspotted killifish	44	24-44	66	24.5-25.0
	sheepshead minnow	9	29-42	17	
	crested goby	2	39-53	7	
	marsh killifish	1	42	2	

TABLE III.C-2
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
9-10 FEBRUARY 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10	sheepshead minnow	75	27-42	247	20.0-21.5
	sailfin molly	11	38-50	39	
	goldspotted killifish	1	46	6	
	rainwater killifish	1	28	1	

TABLE III.C-3

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
27-28 MARCH 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	nothing collected	-	-	-	25.5-28.0
2[a]	bonefish	1	210	174	26.0-28.0
		2	409-420	2311	
	crevalle jack	1	672	6810	
3	goldspotted killifish	43	21-45	54	22.5-25.5
	sheepshead minnow	3	24-25	2	
4	blue crab	1	172	350	25.5-26.5
	shrimp	1	148	30	
	bonefish	2	376-391	1828	
	gray snapper	1	298	714	
	yellowfin mojarra	1	206	276	
	crested goby	3	38-54	10	
5	blue crab	1	53	7	28.5-29.0
	goldspotted killifish	31	24-44	37	
	sheepshead minnow	4	20-28	3	
6	goldspotted killifish	25	23-36	26	28.5-30.0
	sheepshead minnow	1	23	1	
7	goldspotted killifish	21	23-37	22	28.0-29.0
	sheepshead minnow	2	21-25	1	
8	goldspotted killifish	64	25-40	80	35.0-36.0
	sheepshead minnow	18	23-28	12	
	marsh killifish	1	35	2	
9	goldspotted killifish	63	26-40	102	28.5-30.0
	sailfin molly	6	31-47	12	
	sheepshead minnow	4	22-32	4	

TABLE III.C-3
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
27-28 MARCH 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
9 (cont.)	crested goby	1	48	4	
	pinfish	1	27	1	
10	sailfin molly	20	27-42	34	24.0-26.5
	sheepshead minnow	6	28-37	13	
	rainwater killifish	2	28-29	2	
	marsh killifish	2	44-47	7	

[a]Minnow traps destroyed; no catch.

TABLE III.C-4

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 APRIL 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	snook	2	402-414	2294	26.0-30.0
2	silver jenny	2	91-92	48	27.0-29.0
	spotfin mojarra	1	107	33	
	yellowfin mojarra	1	182	197	
	goldspotted killifish	2	29-32	3	
3	goldspotted killifish	12	19-34	10	24.0-28.5
4	spotfin mojarra	1	120	46	26.5-29.0
	yellowfin mojarra	1	200	230	
	crested goby	4	43-55	13	
	gulf toadfish	1	55	4	
5	goldspotted killifish	10	28-35	13	30.0-31.5
	sheepshead minnow	5	22-25	3	
6	goldspotted killifish	8	23-38	9	32.0-32.5
7	goldspotted killifish	26	22-40	28	30.5-31.5
	sheepshead minnow	5	20-23	3	
8	shrimp	1	89	8	37.0
	sheepshead minnow	41	21-28	28	
	goldspotted killifish	26	23-33	24	
9	goldspotted killifish	85	22-37	71	30.0-30.5
	sheepshead minnow	32	20-29	19	
	sailfin molly	4	27-34	4	
	pike killifish	2	67-79	11	
	gulf killifish	1	51	4	

TABLE III.C-4
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 APRIL 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10	crested goby	20	27-63	50	26.0-28.0
	sailfin molly	4	28-40	7	
	sheepshead minnow	1	37	3	
	gulf killifish	1	48	5	

TABLE III.C-5

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
22-23 MAY 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	snook	1	359	781	30.0-31.0
2	goldspotted killifish	11	27-45	21	31.0-32.0
3	goldspotted killifish	7	25-38	13	29.0-30.0
	rainwater killifish	3	27-40	4	
	crested goby	1	59	6	
4	silver jenny	3	102-107	111	31.0
	spotfin mojarra	2	103-122	75	
	goldspotted killifish	7	25-38	9	
	crested goby	1	53	6	
	gulf toadfish	1	101	29	
5	goldspotted killifish	33	19-47	46	33.5-35.0
	sheepshead minnow	8	20-26	5	
	crested goby	2	42-52	6	
6	goldspotted killifish	11	22-35	10	32.5-34.0
	sheepshead minnow	2	19-21	1	
7	goldspotted killifish	38	24-40	44	32.0-34.0
	sheepshead minnow	1	22	1	
8	sheepshead minnow	377	23-36	367	37.5-40.0
	goldspotted killifish	17	22-35	14	
9	goldspotted killifish	90	24-56	148	28.0-31.5
	sheepshead minnow	9	22-35	9	
	rainwater killifish	1	36	1	

TABLE III.C-5
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
22-23 MAY 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10	crested goby	8	31-60	29	28.5-29.5
	sheepshead minnow	1	35	2	
	sailfin molly	1	48	4	
	rainwater killifish	1	36	1	

TABLE III.C-6

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
19-20 JUNE 1978

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	nothing collected	-	-	-	30.0-30.5
2	yellowfin mojarra	1	239	386	29.0-31.0
	goldspotted killifish	7	26-39	12	
	gulf toadfish	1	108	40	
3	goldspotted killifish	49	23-44	81	29.0
4	yellowfin mojarra	3	178-207	692	25.5-29.0
	crested goby	3	45-52	13	
	goldspotted killifish	2	23-27	2	
5	goldspotted killifish	54	25-52	101	30.0-33.0
	sheepshead minnow	17	21-29	12	
	crested goby	1	56	6	
6	goldspotted killifish	139	22-39	146	30.0-33.5
	sheepshead minnow	11	22-30	8	
7	goldspotted killifish	78	22-40	89	27.5-33.0
	sheepshead minnow	5	21-24	3	
8	goldspotted killifish	98	23-42	121	36.0-37.5
	sheepshead minnow	15	22-37	13	
9	goldspotted killifish	65	25-59	176	25.0-30.0
	sheepshead minnow	2	28-47	5	
	pike killifish	1	75	8	
10	sheepshead minnow	87	30-46	162	25.5-29.0
	crested goby	6	58-63	40	
	goldspotted killifish	4	41-57	21	
	sailfin molly	1	40	2	

TABLE III.C-7

SHELLFISHES AND FISHES COLLECTED WITHIN THE
TURKEY POINT COOLING CANAL SYSTEM
JANUARY - JUNE 1978

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition of fishes by	
				Number	Weight
Blue crab (*Callinectes sapidus*)	7	53-172	1864	-	-
Shrimp (*Penaeus* sp.)	5	69-148	58	-	-
Goldspotted killifish (*Floridichthys carpio*)	1499	19-59	2035	54.9	7.6
Sheepshead minnow (*Cyprinodon variegatus*)	1038	18-42	1363	38.0	5.1
Rainwater killifish (*Lucania parva*)	8	27-40	9	0.3	0.0
Marsh killifish (*Fundulus confluentus*)	4	35-47	11	0.2	0.0
Gulf killifish (*Fundulus grandis*)	2	48-51	9	0.1	0.0
Sailfin molly (*Poecilia latippinna*)	79	25-53	159	2.9	0.6
Pike killifish (*Belonesox belizanus*)	4	67-86	26	0.2	0.1
Crested goby (*Lophogobius cyprinoides*)	52	27-63	190	1.9	0.7
Bonefish (*Albula vulpes*)	8	210-420	6487	0.3	24.4
Yellowfin mojarra (*Gerres cinereus*)	9	172-239	2132	0.3	8.0
Silver jenny (*Eucinostomus gula*)	7	91-119	313	0.3	1.2
Spotfin mojarra (*Eucinostomus argenteus*)	5	102-122	183	0.2	0.7
Gulf toadfish (*Opsanus beta*)	4	55-108	98	0.2	0.4
Snook (*Centropomus undecimalis*)	3	359-414	3075	0.1	11.6
Gray snapper (*Lutjanus griseus*)	2	298-371	2148	0.1	8.1
Pinfish (*Lagodon rhombiodes*)	1	27	1	0.0	0.0
Bluestriped grunt (*Haemulon sciurus*)	1	187	251	0.0	0.9
Crevalle jack (*Caranx hippos*)	1	672	6810	0.0	25.6
Great barracuda (*Sphyraena barracuda*)	1	320	266	0.0	1.0
Sea catfish (*Arius felis*)	1	391	1062	0.0	4.0
Tidewater silverside (*Menidia beryllina*)	1	44	fragment	0.0	0.0

TABLE III.C-8

SHELLFISHES AND FISHES OBSERVED OR COLLECTED PRIOR TO JANUARY 1978
AND NOT FOUND AFTER THIS DATE
TURKEY POINT COOLING CANAL SYSTEM

Scientific name	Common name
Limulus polyphemus	horseshoe crab
Menippe mercenaria	stone crab
Panulirus argus	spiny lobster
Archosargus probatocephalus	sheepshead
Atherinomorus stipes	hardhead silverside
Caranx crysos	blue runner
Chaetodipterus faber	Atlantic spadefish
Diapterus plumieri	striped mojarra
Dormitator maculatus	fat sleeper
Echeneis naucrates	sharksucker
Elops saurus	ladyfish
Gobionellus sp.	goby
Haemulon parrai	sailors choice
Hippocampus erectus	lined seahorse
Lutjanus apodus	schoolmaster
Menticirrhus littoralis	gulf kingfish
Microgobius microlepis	banner goby
Mugil curema	white mullet
Scarus guacamaia	rainbow parrotfish
Selene vomer	lookdown
Sphoeroides testudineus	checkered puffer
Syngnathus sp.	pipefish
Synodus foetens	inshore lizardfish
Trachinotus falcatus	permit

D. BENTHOS

1. MACROINVERTEBRATES

Introduction

The Turkey Point cooling canal system is a unique habitat in that it is a closed marine ecosystem. This study documents changes which have occurred in the benthic macroinvertebrate populations since they were cut off from outside recruitment nearly six years ago. The species present and their relative abundance were analyzed so that projections of future community trends might then be made.

Benthic macroinvertebrates are animals large enough to be seen by the unaided eye and can be retained by a U.S. Standard No. 30 sieve (0.595 mm mesh) (EPA, 1973). They live at least part of their life cycles within or upon any available substrate. Their sensitivity to external stress due to relatively limited mobility, diverse trophic structure, varied habitat preferences, and relatively long life span enables benthic communities to exhibit characteristics which are a function of environmental conditions in the recent past. These communities have been shown to reflect the effects of temperature, salinity, depth, current, substrate, and chemical and organic pollutants. In addition, benthic macroinvertebrates are also important members of the food web as prey to many species that live in the upper water column (EPA, 1973).

Materials and Methods

Benthic macroinvertebrates were collected and analyzed using methods and materials recommended by the U.S. Environmental Protection Agency (EPA, 1973), Holme and McIntyre (1971), APHA (1971), and NESP (1975).

The substrate of the Turkey Point cooling canal system was sampled with an Ekman grab. The device used was a 6" x 6" metal box equipped with spring-loaded jaws which closed when tripped with a messenger weight. The enclosed material was then raised to the surface and washed through a No. 30 mesh sieve to remove fine sediment and detritus particles. All material retained on the sieve was preserved in a 1:1 mixture of Eosin B and Biebrich Scarlet stains in a 1:1000 concentration of 5% formalin (Williams, 1974). These stains color animal tissue red and enable faster, more accurate hand sorting of benthic samples. Preserved samples were placed in labelled containers and taken to the laboratory where they were hand-sorted and the macroinvertebrates identified to the lowest practical taxon.

Three replicate grab samples were taken in April 1978 at each of eight sampling stations (Figure III.D.1-1). Replication is necessary for valid statistical analysis because of variation in distribution patterns of benthic fauna (EPA, 1973). Sampling at Station RC.0 was hindered by the fact that the substrate is very rocky, thus allowing

the grab to shut without enclosing a sample. No reliable data could be obtained at this station.

Biomass analyses of the samples were made on a dry weight basis, exclusive of molluscan shells. Whole samples were dried at 105°C for 4 hours, then weighed on a Mettler H32 analytical balance (EPA, 1973). Biomass per square meter and density per square meter were calculated by taking the mean of results of three replicate samples and multiplying by the appropriate factor.

The Shannon-Weaver index of diversity and the equitability component were also computed from the data. Diversity indices are an additional tool for measuring the quality of the environment and the effect of induced stress on the structure of a community of macroinvertebrates. Their use is based on the generally observed phenomenon that relatively undisturbed environments support communities having large numbers of species with no individual species present in overwhelming abundance. Many forms of stress tend to reduce diversity by making the environment unsuitable for some species or by giving other species a competitive advantage.

Species diversity has two components: the number of species (species richness) and the distribution of individuals among the species (species evenness). The inclusion of this latter component renders the diversity index relatively independent of sample size.

The Shannon-Weaver index of diversity (H') (Lloyd, Zar, and Karr, 1968) calculates mean diversity and is recommended by the EPA (1973):

$$H' = \frac{C}{N} (N \log_{10} N - \Sigma n_i \log_{10} n_i)$$

where: C = 3.321928 (converts base 10 log to base 2)

N = total number of individuals

n_i = total number of individuals of the i^{th} species

Mean diversity as calculated above is affected by both species richness and evenness, and may range from 0 to 3.321928 log N.

Equitability, the distribution of individuals among the species present, is computed by

$$e = \frac{s'}{s}$$

where: s = number of taxa in the sample

s' = hypothetical maximum number of taxa in the sample based on a table devised by Lloyd and Ghelardi (1964).

Data from EPA biologists have shown that diversity indices in unpolluted waters generally range from 3 to 4 and are usually below 1 in polluted waters. Equitability levels below 0.5 have not been encountered in waters known to be free of oxygen-demanding wastes. In such waters, equitability usually ranges from 0.6 to 0.8, while equitability in polluted waters is generally 0.0 to 0.3.

Results and Discussion

Benthic macroinvertebrates at Turkey Point were of four main groups: polychaete marine worms, molluscs (snails and bivalves), crustaceans, and a miscellaneous group of diverse animals which were present irregularly and in small numbers (Tables III.D.1-1 through III.D.1-7). Salinity, temperature, and dissolved oxygen measurements were made during each biotic sampling (Table III.D.1-8). Additional invertebrates were collected during fish surveys (see Section C). These included small numbers of commercially important decapod crustaceans, namely blue crabs and penaeid shrimp.

Density of benthic macroinvertebrates was dependent on station location, and ranged from 6839 individuals/m^2 at Station E3.2 to 1250/m^2 at Station F.1. The mean density of all stations combined was 3594 individuals/m^2. The April mean density figure was moderate when compared to those of previous samplings (Figure III.D.1-2). Populations were dominated by polychaete worms at all stations except F.1, which was dominated by the snail *Batillaria minima*. Except for April 1977, polychaetes have always dominated the Turkey Point Canal fauna.

In April, a mean biomass of 4.537 g/m^2 was recorded (Figure III.D.1-3). As with density, the mean biomass value was intermediate when compared to samples collected since May 1975. Biomass values ranged from 13.405 g/m^2 at Station RC.2 to 0.819 g/m^2 at Station WF.2. Most of the wide variation in biomass between stations was caused by *Batillaria* (found at

Station W18.2 and F.1) and a large, unidentified Leptomedusa jellyfish (found at Station RC.2). *Batillaria* comprised 64 percent of the molluscs found in April, a considerable reduction from the 95.5 percent of all molluscs collected during 1977.

Data from the canals show a pattern of density and biomass fluctuation in which values tend to increase in spring and decrease in fall. As collections are only made twice per year, efforts have been made to sample at times of peak and lowest abundances.

Mean diversity at the Turkey Point sampling stations was the highest since November 1976 (Figure III.D.1-4), but was also a moderate value when compared to all previously collected data. Primarily responsible for the increased diversity was the number of crustacean species encountered (12). Crustacean species have always been more numerous in the canals in spring, but, in 1978, there were more species with more equitable distribution of individuals among the species. Such conditions contribute to higher diversity indices.

A total of 30 species were collected in April 1978, two more than in October 1977. Of the 1738 individuals collected, 13 species had eight individuals or less; and nine species had from 12 to 41 individuals. The ostracod *Cylindroleberis* and the snail *Batillaria* were moderately abundant (79 and 144 individuals, respectively). Combined, these 24 species comprised only 26.7 percent of all macroinvertebrates collected. Therefore, the bulk of the benthic fauna (73.3 percent) was

distributed among only six species, all polychaete worms. All of these polychaete species are among the 10 most abundant benthic species collected in the canals since 1974. These species are:

rank	name	type
1.	*Autolytus brevicirrata*	polychaete
2.	*Batillaria minima*	snail
3.	*Platynereis dumerilii*	polychaete
4.	*Nereis succinea*	polychaete
5.	*Odontosyllis enopla*	polychaete
6.	*Amphicteis gunneri floridus*	polychaete
7.	*Cylindroleberis mariae*	ostracod
8.	*Podarke obscura*	polychaete
9.	*Dorvillea sociabilis*	polychaete
10.	*Cirriformia filigera*	polychaete

In comparison with neighboring ecosystems, the Turkey Point canal system macroinvertebrate fauna appears depauperate. Bader and Roessler (1972) reported 266 species of molluscs, larger crustaceans, sponges, and echinoderms from Biscayne Bay and Card Sound. This larger number of species does not include polychaete worms and smaller crustacean species which comprised the bulk of the species in the canal system. If polychaete and small crustacean species were included in the total, it is estimated that as many as 500 different species of benthic macroinvertebrates could be found in Biscayne Bay and Card Sound. The low number of species in the Turkey Point canal system is probably due to the lack of means of recruitment of new species from neighboring ecosystems.

While several species were present in the canal system, the numerically important species (all polychaete worms) were very limited. All are burrowing, sedentary species which are detritus or filter feeders.

The bottom substrate is composed of fibrous peat and mud mixed with shell debris, a type of substrate to which these worms are well adapted.

Polychaete worms are known to tolerate wider variances in environmental conditions than most other animals. Several studies have shown polychaetes to be among the only animals capable of surviving the effects of thermal outfalls (Markowski, 1960; Warinner and Brehmer, 1965, 1966). Studies in southern California have reported polychaetes surviving in heavily polluted areas with restricted circulation (Reish, 1956, 1959).

Bandy (1965) reported that polychaetes outnumbered other groups eight to one at an ocean sewage outfall. Polychaetes thus appear best suited for life in an area of elevated temperature, restricted circulation, and highly organic substrate like the Turkey Point canal system.

Conclusion

When compared to the data collected in October 1977, the general trends exhibited by the Turkey Point benthic macroinvertebrate community in April 1978 were of increased density and biomass coupled with a significant increase in diversity. Over a longer period of time, however, these parameters were intermediate to the range of values encountered. It appears that a fairly regular pattern of higher density and biomass in spring alternating with lower density and biomass in fall has emerged.

The benthic macroinvertebrate community has several species which occur in small numbers, but only those burrowing, sedentary, detritus or filter-feeding species better adapted to living in the thick, fibrous peat substrate may be expected to occur in significant number. The low number of species in the Turkey Point canal system is probably due to the lack of means of new species recruitment from neighboring ecosystems.

LITERATURE CITED

APHA. 1971. Standard methods for the examination of water and wastewater, 13th ed. American Public Health Assoc., New York. 874 pp.

Bader, R.G., and M.A. Roessler. 1972. An ecological study of south Biscayne Bay and Card Sound. Prog. Rpt. to AEC and FPL.

Bandy, O.L., J.C. Ingle, and J.M. Resig. 1965. Modification of foraminiferal distribution by the Orange County outfall, California. Ocean Sci. Ocean Engr. 1:54-76.

EPA. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. C.I. Weber, ed. EPA-670/4-73-001. Environmental Protection Agency, National Environmental Research Center, Cincinnati.

Holme, N.A., and A.D. McIntyre. 1971. Methods for the study of marine benthos. IBP Handbook No. 16. Blackwell's Oxford. 396 pp.

Lloyd, M., and R.J. Ghelardi. 1964. A table for calculating the "equitability" component of species diversity. J. Anim. Ecol. 33:217-225.

Lloyd, M., J.H. Zar, and J.R. Karr. 1968. On the calculation of information - theoretical measures of diversity. Amer. Mid. Natur. 79(2):257-272.

Markowski, S. 1960. Observations on the response of some benthonic organisms to power station cooling water. J. Anim. Ecol. 29(2):249-357.

NESP. 1975. National environmental studies project. Environmental impact monitoring of nuclear power plants: source book of monitoring methods. Battelle Laboratories, Columbus, Ohio. 918 pp.

Reish, D.J. 1956. An ecological study of lower San Gabriel River, California, with special reference to pollution. Calif. Fish Game 42:53-61.

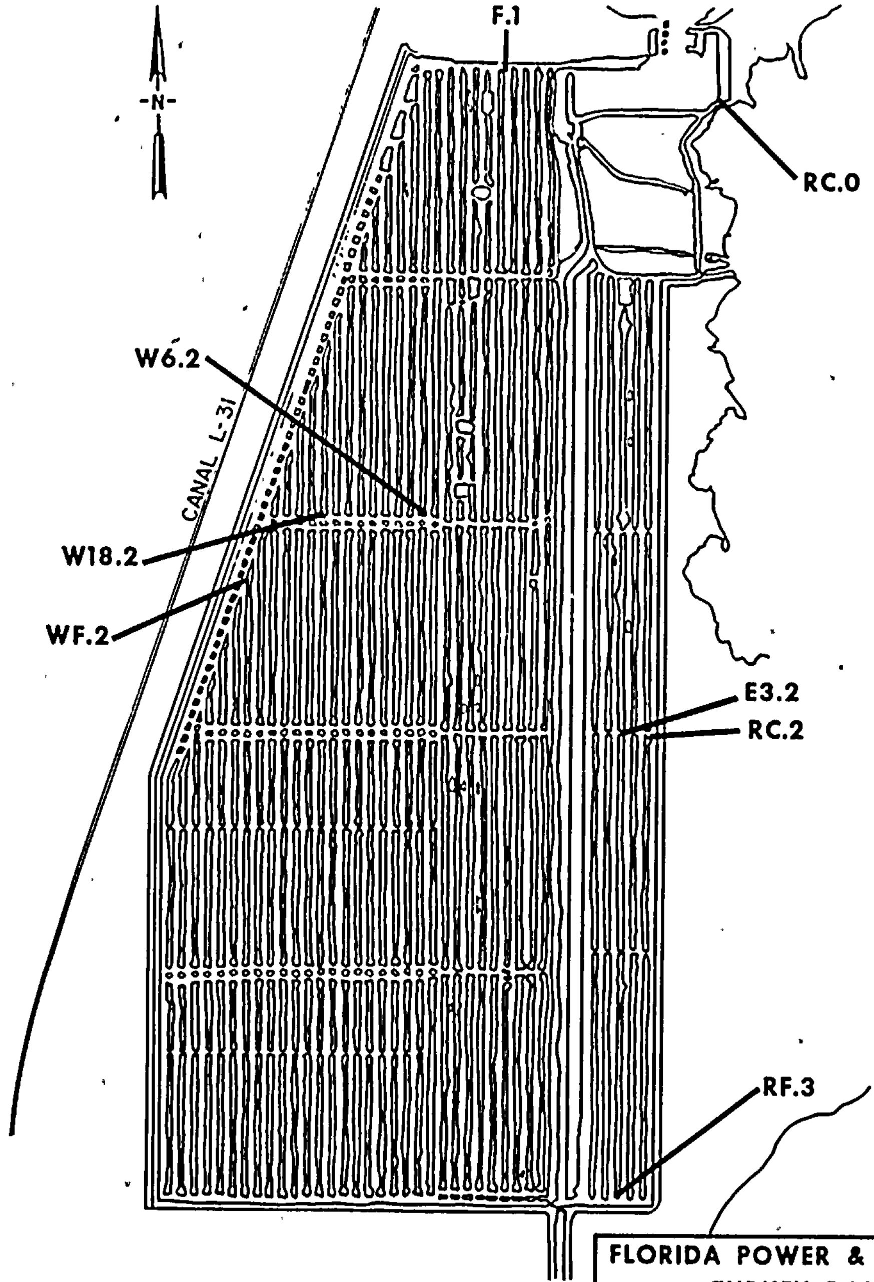
_________. An ecological study of pollution in Los Angeles - Long Beach Harbors, California. Alan Hancock Occ. Paper 22. 119 pp.

Warinner, J.E., and M.L. Brehmer. 1965. The effects of thermal effluents on marine organisms. Proc. 19th Industrial Waste Conf. Purdue Univ. Eng. Ext. Ser. 117:479-492.

_________. 1966. The effects of thermal effluents on marine organisms. Air Water Poll. Int. J. 10:277-289.

LITERATURE CITED (continued)

Williams, G.E., III. 1974. New techniques to facilitate handpicking macrobenthos. Trans. Amer. Micros. Soc. 93(2):220-226.



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

MACROBENTHOS SAMPLING
STATION LOCATIONS

APPLIED BIOLOGY, INC.
Figure III.D.1-1

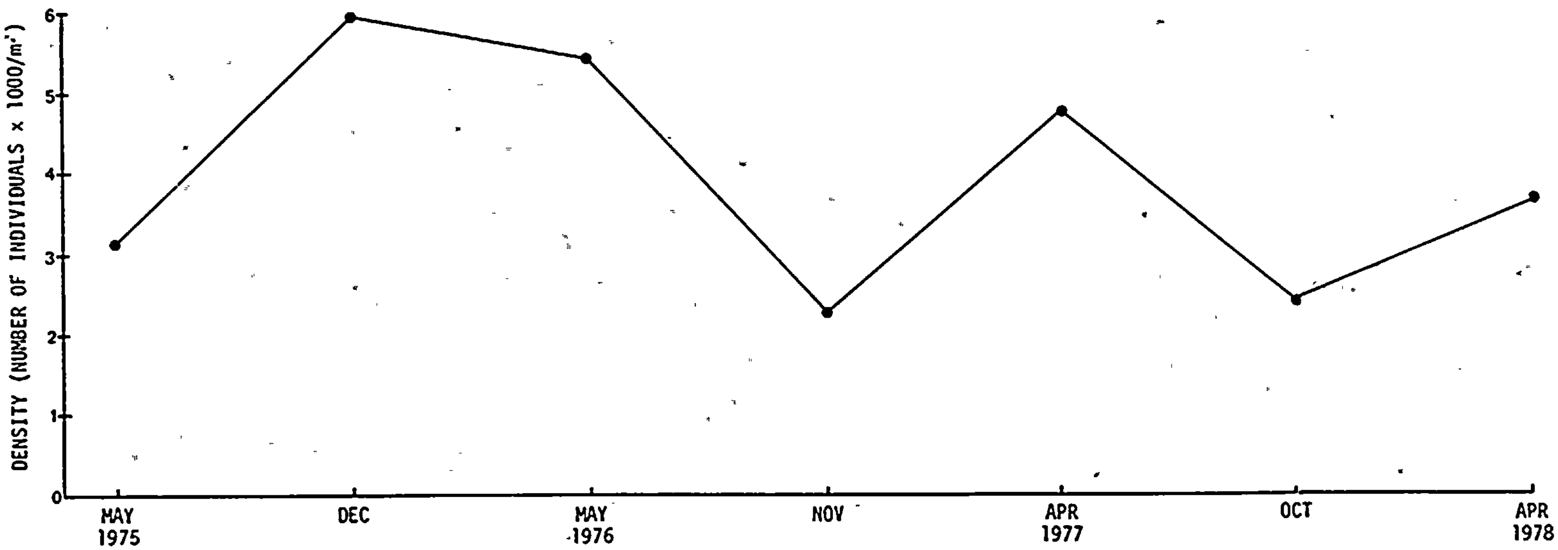


Figure III.D.1-2. Mean number of individuals per square meter, Turkey Point Plant, May 1975-April 1978.

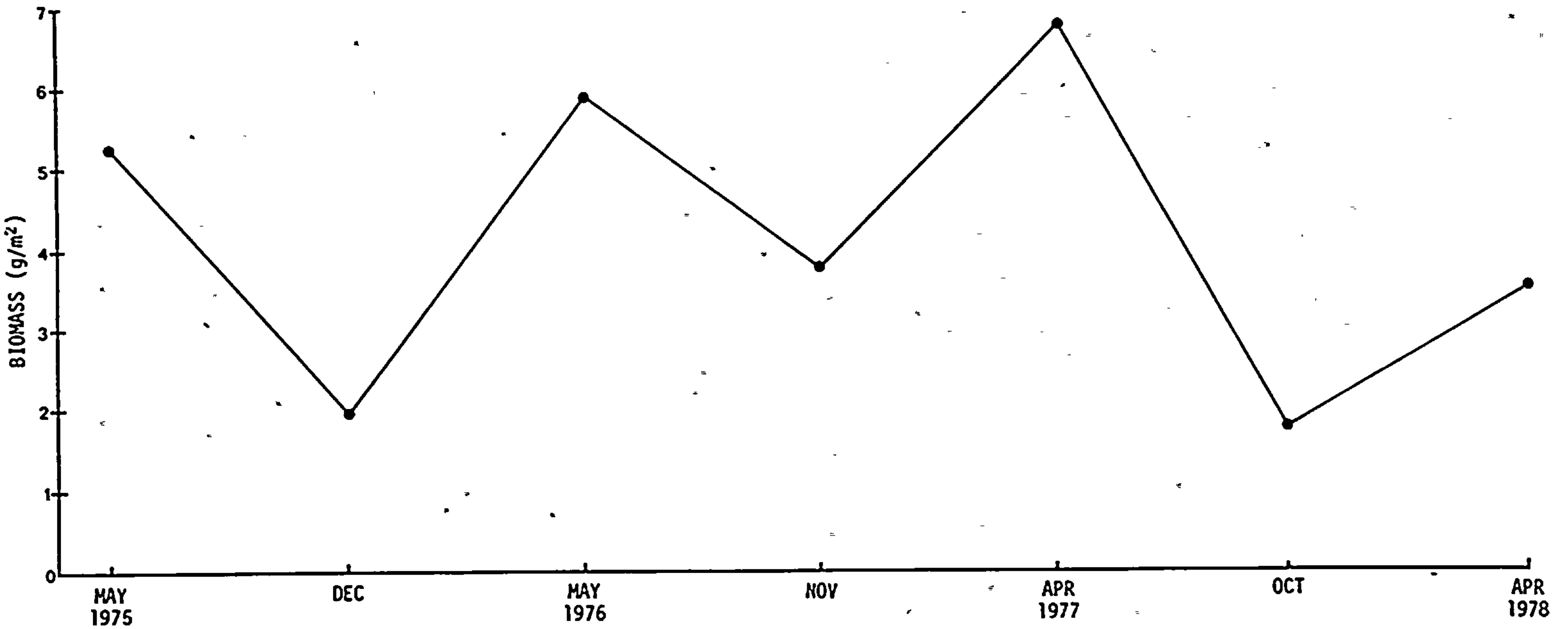


Figure III.D.1-3. Mean Biomass per square meter, Turkey Point Plant, May 1975-April 1978.

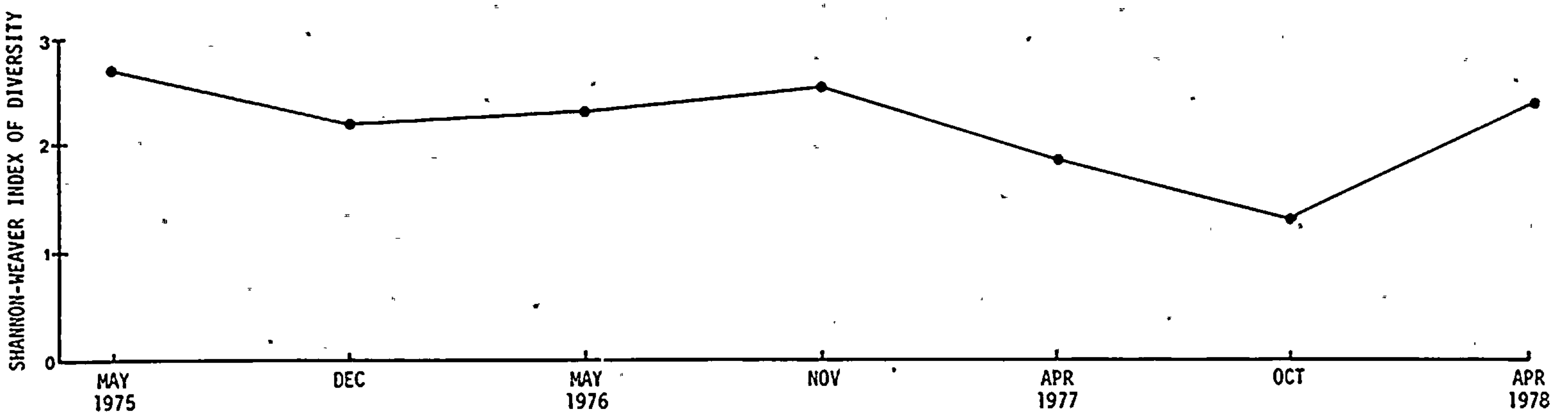


Figure III.D.1-4. Mean diversity of macrobenthos at the Turkey Point Plant, May 1975-April 1978

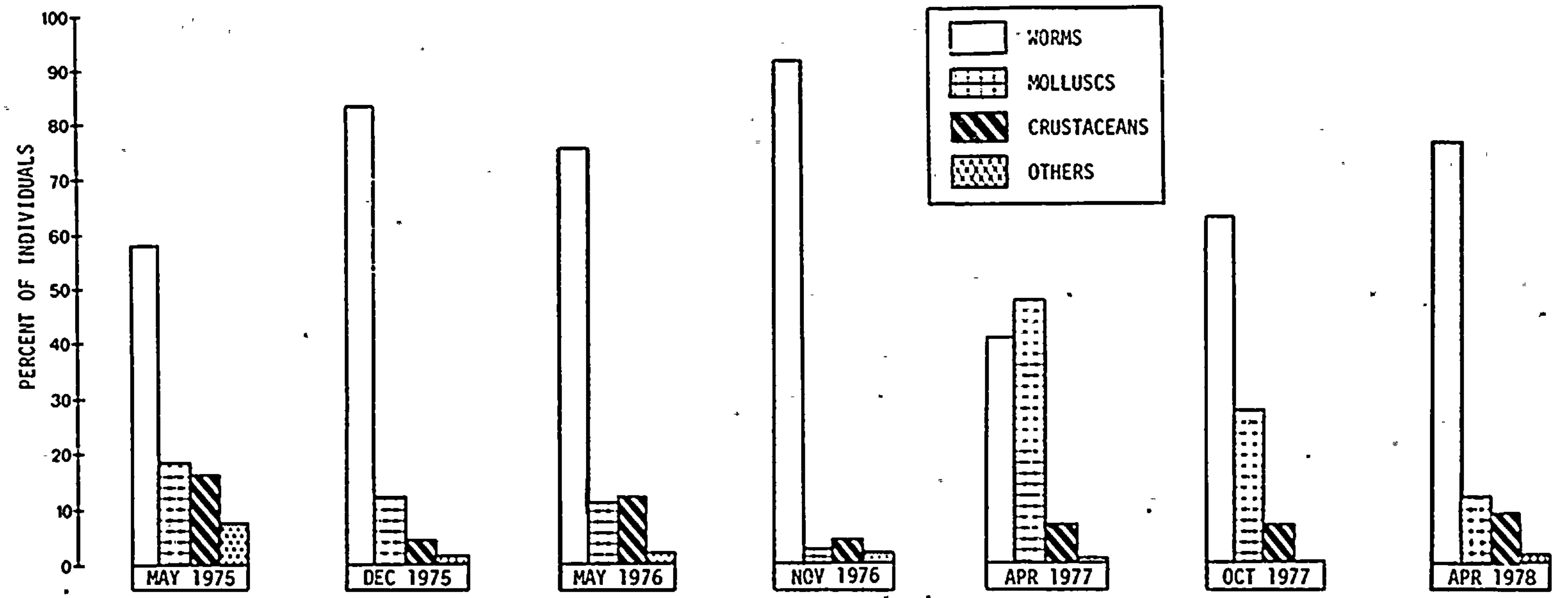


Figure III.D.1-5. Structure of benthic macroinvertebrate community at the Turkey Point Plant, May 1975-April 1978.

TABLE III.D.1-1

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION RC.2
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Class Hydrozoa				
unidentified Leptomedusa		-	2	-
Class Polychaeta				
worms	*Amphicteis gunneri floridus*	11	16	14
	Autolytus brevicirrata	3	-	6
	Dorvillea sociabilis	8	12	8
	Nereis succinea	8	4	-
	Pista cristata	3	4	-
	Platynereis dumerilii	10	8	36
	Sabellaria sp.	-	4	-
Class Gastropoda				
snails	*Prunum apicinum*	3	-	-
Class Crustacea				
isopods	*Ericsoniella filiformis*	2	-	-
amphipods	*Grandidierella bonnieroides*	1	-	2
	Lysianopsis alba	1	-	-
shrimp	*Alpheus heterochaelis*	1	-	2
Individuals/replicate		51	50	68
Biomass/replicate (g)		0.121	0.661	0.151
Density (no./m^2)			2428	
Biomass (g/m^2)			13.405	
Index of diversity			2.77	
Equitability			0.73	

TABLE III.D.1-2

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION E3.2
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Phylum Echiurida				
echiurid worms	*Thalassema* sp.	-	2	-
Class Polychaeta				
worms	*Amphicteis gunneri floridus*	-	20	16
	Autolytus brevicirrata	12	2	42
	Dorvillea sociabilis	8	14	-
	Nereis succinea	12	14	34
	Pista cristata	-	-	6
	Platynereis dumerilii	88	32	62
	Sabellaria sp.	-	2	-
Class Pelecypoda				
bivalves	*Gouldia cerina*	4	4	4
	Lyonsia floridana	8	2	-
Class Crustacea				
ostracods	*Cylindroleberis mariae*	16	4	4
	Sarsiella americana	8	6	2
copepods	*Harpacticus* sp.	-	2	-
isopods	*Cymodoce faxoni*	4	-	-
	Idotea baltica	4	6	4
amphipods	*Elasmopus rapax*	-	6	4
	Grandidierella bonnieroides	4	2	4
	Lysianopsis alba	-	-	2
shrimp	*Thor floridana*	-	2	-
Individuals/replicate		168	120	188
Biomass/replicate (g)		0.124	0.185	0.096
Density (no./m^2)			6839	
Biomass (g/m^2)			5.819	
Index of diversity			3.09	
Equitability			0.63	

TABLE III.D.1-3

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION RF.3
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Class Polychaeta				
worms	*Amphicteis gunneri floridus*	4	4	16
	Autolytus brevicirrata	10	-	32
	Cirriformia filigera	-	6	24
	Dorvillea sociabilis	2	-	-
	Nereis succinea	2	-	-
	Odontosyllis enopla	14	2	60
	Platynereis dumerilii	6	-	8
	Sabellaria sp.	-	-	4
Class Gastropoda				
snails	*Cylichna bidentata*	-	-	8
Class Pelecypoda				
bivalves	*Gouldia cerina*	-	-	24
Class Crustacea				
copepods	*Harpacticus* sp.	-	-	4
ostracods	*Cylindroleberis mariae*	2	-	40
tanaids	*Leptochelia savigny*	-	-	4
Individuals/replicate		40	12	224
Biomass/replicate (g)		0.044	0.013	0.062
Density (no./m^2)			3966	
Biomass (g/m^2)			1.720	
Index of diversity			3.03	
Equitability			0.89	

TABLE III.D.1-4

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION WF.2
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Phylum Echiurida				
echiurid worms	*Thalassema* sp.	-	8	-
Class Polychaeta				
worms	*Autolytus brevicirrata*	28	176	56
	Nereis succinea	6	24	4
	Odontosyllis enopla	-	12	-
	Platynereis dumerilii	-	36	4
Class Pelecypoda				
bivalves	*Gouldia cerina*	-	-	4
	Lyonsia floridana	-	8	4
Class Crustacea				
ostracods	*Cylindroleberis mariae*	-	4	4
tanaids	*Leptochelia savigny*	-	4	-
amphipods	*Grandidierella bonnieroides*	-	4	-
Individuals/replicate		34	276	78
Biomass/replicate (g)		0.001	0.041	0.015
Density (no./m^2)			5575	
Biomass (g/m^2)			0.819	
Index of diversity			1.78	
Equitability			0.44	

TABLE III:D.1-5

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION W18.2
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Class Polychaeta				
worms	*Autolytus brevicirrata*	6	36	48
	Nereis succinea	2	16	8
	Odontosyllis enopla	-	4	8
	Platynereis dumerilii	-	8	36
Class Gastropoda				
snails	*Batillaria minima*	4	44	8
Class Crustacea				
ostracods	*Cylindroleberis mariae*	-	-	4
amphipods	*Elasmopus rapax*	2	4	-
	Grandidierella bonnieroides	4	-	-
Individuals/replicate		18	112	112
Biomass/replicate (g)		0.036	0.174	0.101
Density (no./m^2)			3477	
Biomass (g/m^2)			4.468	
Index of diversity			2.36	
Equitability			0.86	

TABLE III.D.1-6

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION W6.2
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Phylum Echiurida				
echiurid worms	*Thalassema* sp.	-	-	2
Class Polychaeta				
worms	*Autolytus brevicirrata*	14	12	19
	Glycera americana	2	-	-
	Nereis succinea	2	4	-
	Pista cristata	-	4	-
	Platynereis dumerilii	-	12	6
Class Pelecypoda				
bivalves	*Astarte nana*	2	-	-
	Gouldia cerina	-	-	1
	Lyonsia floridana	-	4	2
Class Crustacea				
ostracods	*Cylindroleberis mariae*	-	-	1
Individuals/replicate		20	36	31
Biomass/replicate (g)		0.028	0.043	0.047
Density (no./m^2)			1250	
Biomass (g/m^2)			1.695	
Index of diversity			2.22	
Equitability			0.63	

TABLE III.D.1-7

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION F.1
TURKEY POINT PLANT
APRIL 1978

Species		Number/replicate A	B	C
Class Polychaeta				
worms	*Amphicteis gunneri floridus*	-	4	-
	Autolytus brevicirrata	1	4	-
	Platynereis dumerilii	2	12	2
Class Gastropoda				
snails	*Batillaria minima*	38	32	18
Individuals/replicate		41	52	20
Biomass/replicate (g)		0.115	0.097	0.055
Density (no./m^2)			1624	
Biomass (g/m^2)			3.836	
Index of diversity			1.05	
Equitability			0.62	

TABLE III.D.1-8

PHYSICAL PARAMETERS OF SEDIMENTS MEASURED
DURING BENTHIC MACROINVERTEBRATE SAMPLING
TURKEY POINT PLANT
APRIL 1978

Station	Temperature (°C)	Salinity (‰)	Dissolved oxygen (ppm)
RC.0	29.8	28.9	7.8
RC.2	29.0	28.8	7.8
E3.2	28.7	28.7	7.9
RF.3	28.8	26.1	7.9
WF.2	31.4	24.7	7.5
W18.2	32.3	28.8	7.3
W6.2	31.6	28.0	7.5
F.1	36.8	28.2	6.9

2. MICROBIOLOGY

Introduction

The bacteriological study of the Turkey Point canal system was conducted to provide information concerning the bacterial population of the canal sediments. Because the majority of all bacteria are heterotrophic organisms, they are primarily responsible for the breakdown of organic material rather than its production. The main function performed by bacteria in water and sediment is therefore the mineralization of organic material, which in turn provides the nutrients necessary for the primary producers to survive and generate more organic material. This continual cycle of dissimilatory and assimilatory process is the mechanism by which nutrients remain balanced in an intact system.

This study had three primary objectives. The first was to estimate the total number of heterotrophic bacteria present in the semiments of the canal system. Secondly, a representative sample of the bacterial isolates was characterized and grouped taxonomically to determine the diversity of the bacterial population present. The third objective involved testing isolates for their ability to utilize various substrates. These substrates include representative members from the three major classes of organic macromolecules (protein, carbohydrate, lipid) which are probably present in the canal system due to the death and lysis of larger

organisms. Other smaller organic substrates as well as inorganic molecules involved in the nitrogen cycle were also tested for substrate utilization.

It should be noted that microbiological and sediment data for June, 1978, have been excluded from this semi-annual report. These analyses had not been completed as of this writing. Upon completion of the June analyses, these values will be included in the Turkey Point annual report for 1978. To submit the microbiological and sediment data as a supplementary report was not considered as a reasonable course of action because these data would not readily lend themselves to interpretation without the entire accompanying text.

Materials and Methods

Sample collection for bacterial analysis -- Sediment samples were collected monthly with a gravity-type core sampler (Wildco Supply Company) at eight stations within the canal system and three stations in Biscayne Bay (Figure III.D.2-1). A sample of the top 2 cm of sediment from each station was placed in a sterile container, cooled to 4°C in an ice chest, and shipped to the laboratory for analysis.

Estimation of total number of heterotrophic bacteria -- Immediately after arriving in the laboratory, a known weight of each sediment sample was added to 99 ml of 3% NaCl, the mixture was shaken, and a serial dilution was made. From appropriate dilutions, a most-probable-number (MPN) analysis (APHA, 1976) was performed by using 0.1-ml inoculations into triplicate tubes of broth containing 3% trypticase-soy-broth plus 0.1% yeast extract in artificial seawater (TSB/YE/SW). The inoculated tubes were incubated at 25°C and checked for growth at intervals for 10 days. The results are reported as the most probable number of bacteria per gram of wet weight sediment.

Estimation of the number of sulfate-reducing bacteria -- A known weight of each sediment sample was placed in a dilution bottle containing 99 ml of 3% NaCl and shaken. A 1.0-ml aliquot was withdrawn and added to 9.0 ml of API sulfate-reducing agar which was kept in a liquid state at 45°C. Appropriate serial dilutions were then made with liquid API sulfate-reducing agar. After rapid solidification of the agar, the tubes were incubated at 25° C for 2 weeks and checked at intervals for the formation of black colonies which indicate sulfate-reducing bacteria. The results are reported as the number of sulfate-reducing bacteria per gram of wet weight sediment.

Characterization of bacterial isolates -- A 0.1-ml inoculum was taken from an appropriate dilution of a sample from each station and streaked onto an agar plate (TSB/YE/SW). The plates were incubated at 25° C for 3 to 5 days and observed for growth of bacterial colonies. Three colonies (isolates) were randomly selected from each plate to be characterized.

The isolates were grouped taxonomically according to the results of the following observations and procedures as described by Shewan (1963):

1. gram stain
2. cell morphology
3. oxidase test
4. motility test
5. colony appearance
6. dissimilation of carbohydrate (Hugh and Leifson, 1953)
7. sensitivity to penicillin
8. sensitivity to 0/129 (Collier et al., 1950)

Except where noted, these procedures were performed as described by the Society of American Bacteriologist (1957). All growth media were prepared with artificial seawater (SW) which contained the following components per 1000 ml of distilled water:

NaCl	-	24.0 g
$MgCl_2 \cdot 6H_2O$	-	5.3 g
$MgSO_4 \cdot 7H_2O$	-	7.0 g
KCl	-	0.7 g

Utilization of various substrates -- Each isolate was tested as outlined in Table III.D.2-1 to ascertain the potential of the isolate to utilize various groups of substrates. The methodology used was that provided by the manufacturer of the product (BBL, 1968) or that found in the *Manual of Microbiological Methods* (Society of American Bacteriologists, 1957). All media were prepared with artificial seawater.

Chemical analysis -- Samples containing a combination of water and sediment were taken monthly at the same canal and bay stations as the bacteriological samples. These samples were collected in 1-liter screwcap polypropylene bottles, placed in an ice chest and kept at 4°C until analyzed. Samples collected by this procedure were homogenized and filtered and then analyzed for soluble ammonia, nitrate, nitrite, orthophosphate, and sulfate.

Water samples to be analyzed for the presence of sulfite and sulfide were collected in 250-ml screwcap polyethylene bottles containing 0.5 ml of zinc acetate (2N). Because these chemicals are susceptible to oxidation, the bottles were filled to overflowing when collected to avoid excessive exposure to oxygen contained in an airspace. These samples were also kept at 4°C and analyzed without filtration to minimize the deleterious effects of oxygenation.

Sediment samples were also collected at the same canal and bay stations for analysis of total sulfide contact. These smples were placed in 50-ml sterile polypropylene tubes, tightly capped, and kept at 4°C until analyzed. A portion of each of these samples was acidified to convert insoluble sulfides to H_2S, which was then distilled into a trapping solution of zinc acetate and analyzed by spectrophotometric methods.

The preceding chemical analyses were performed using the standard analytical methods listed in Table III.D.2-2.

The pH of sediment samples diluted 1:3 with distilled water was measured with a standard Corning pH meter (Model 10). Samples for salinity determinations were transported to the laboratory and measured with a refractometer. Values of conductivity for each station were measured with a YSI Model 33 salinity-conductivity-temperature meter as well as calculated from salinity and temperature measurements according to tables published in *Marine Chemistry* (Horne, 1969).

Results and Discussion

Table III.D.2-3 shows the distribution of heterotrophic bacteria per gram of wet weight soil at the 11 sampling stations as estimated by the MPN analysis using TSB/YE/SW as a growth medium. Mean values are given for the three stations in the bay as well as for the eight stations within the canal system on a monthly and 5-month basis.[a] The 5-month average bacterial count for the canal stations was approximately twofold greater than the mean value for Biscayne Bay. Table III.D.2-4 shows a similar distribution of heterotrophic bacteria when estimated by the MPN method using distilled water instead of artificial seawater to prepare the growth medium (TSB/YE/DW). A comparison of the 5-month averages between bay and canal stations indicates that differences in the number of heterotrophic bacteria between the two locations are similar with either medium. Figure III.D.2-2 graphically illustrates these relationships. With growth media prepared with either artificial seawater or distilled water, bacterial counts are generally higher in the canal sediments than in the Biscayne Bay sediments. Bacterial counts are also significantly higher when estimated using artificial seawater rather than distilled water in the growth medium. This indicates that marine bacteria are the predominate type of organism present in both the canal and Biscayne Bay sediments.

The reduction of sulfate is a key reaction in the sulfur cycle and can be accomplished by two general processes. The first is assimilatory sulfate reduction which can be performed by many bacteria and

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

other larger organisms. The purpose of this assimilatory process is to reduce sulfate to sulfite or sulfide in order to incorporate it into a molecule used as a building block, such as a sulfo-lipid or a sulfur-containing amino acid. This process produces very little excess sulfide. The second type of reduction is termed dissimilatory sulfate reduction and is common only to a very limited group of bacteria. These bacteria are called sulfate-reducing bacteria and are limited to two genera, *Desulfovibrio* and *Desulfotomaculum*. They are strict anaerobes and use sulfate ($SO_4=$) as the terminal electron acceptor in respiration. Sulfate is reduced to the level of sulfide ($S^=$) which is released in copious amounts as hydrogen sulfide gas.

Table III.D.2-5 shows the distribution of sulfate-reducing bacteria per gram of wet weight soil at the 11 sampling stations. The overall average number of sulfate-reducing bacteria for the canal stations was twice that of the Biscayne Bay stations. This difference in the 5-month averages is due to an abnormally high bacterial count in February for the canal stations. Other than this variation in February, the 5-month averages would be very similar between the canal and Biscayne Bay stations.

The bacterial isolates selected for taxonomic identifications were characterized according to the procedures listed in the Materials and Methods section. Table III.D.2-6 shows a distribution of the isolates divided into four groups. Organisms which were found to be

gram negative rods were grouped according to a scheme put forth by Shewan (1963). Group I, which contains species of *Pseudomonas*, *Aeromonas*, *Vibrio*, and *Xanthomonas*, are characterized as oxidase positive, gram negative motile rods. Group II are gram negative, non-motile rods that are non-pigmented; these are either *Achromobacter* or *Alcaligens*. Group III contains *Flavobacter* and *Cytophaga* which are gram negative, non-motile rods that are pigmented, and Group IV are gram positive rods.

Group I, which contains the motile gram negative rods, is the predominate group in both the canal and Biscayne Bay sediments. Based on the preceding taxonomic groupings, the distribution of bacterial types in the canal sediments is similar to that in the Biscayne Bay sediments.

The substrate utilization tests indicated that the bacterial isolates were capable of degrading a wide range of organic substrates. The monthly and 5-month average percentages of bacterial isolates from the canal and Biscayne Bay stations capable of utilizing the substrates tested are presented in Tables III.D.2-7 through III.C.2-11.

Table III.D.2-7 lists the monthly percentage of bacterial isolates capable of hydrolyzing casein, a common milk protein. Proteins are hydrolyzed to polypeptides and then further degraded to amino acids, which then can be deaminated to produce ammonia and various organic acids. The organic acids can be used as substrates for other bacteria as either building blocks for growth or as energy sources in oxidation or fermentation reactions. The ammonia can enter the nitrogen cycle and be oxidized to produce nitrites and nitrates by the nitrifying bacteria *Nitrobacter* and *Nitrosomonas.* These two genera are strict aerobes and chemoautotrophic, so they cannot be isolated on the heterotrophic media used in this study. The results of the test which measured the ammonification of peptone (Table III.D.2-7) indicated that approximately 60 to 80% of the bacterial isolates were capable of producing ammonia from peptone and hence could start the process by which protein nitrogen becomes mineralized to nitrates.

Carbohydrates are a complex group of compounds which include such diverse macromolecules as cellulose, starch, and chitin. Table III.D.2-8 lists the percentages of bacterial isolates capable of hydrolyzing chitin, which is a polymer of N-acetyl-glucosamine. The breakdown of chitin also shunts ammonia into the nitrogen cycle and provides simple sugars as substrates for a number of reaction possibilities. Starch, which is a macromolecule used almost universally as an energy storage product, was degraded by 55.5% of the canal isolates and 56.7% of the bay isolates (Table III.D.2-8).

Cellobiose is the repeating disaccharide unit of cellulose. Like cellulose it contains the B(1-4) glycosidic linkage which makes cellulose

resistant to digestion by most organisms. Table III.D.2-8 lists the percentages of canal and bay isolates capable of fermenting cellobiose.

The breakdown products of the complex carbohydrates are simple sugars such as the monosaccharides, glucose and mannitol, and the disaccharides, saccharose and lactose. These simple carbohydrates can be further degraded to provide energy and smaller molecules used as building blocks by many bacteria. Table III.D.2-9 shows the percentage of both the canal and bay isolates capable of metabolizing four simple sugars. Glucose is utilized most frequently, with mannitol and saccharose metabolized less frequently and lactose metabolized most infrequently.

Lipids are a varied group of macromolecules which are more resistant to degradation than proteins and carbohydrates. As shown in Table III.D.2-10, however, bacteria isolates from both the canal and bay sediments are capable of lipid hydrolysis.

During bacterial metabolism, nitrate can sometimes serve as a terminal electron acceptor and hence be reduced to nitrite or ammonia. Therefore, bacteria either can serve to oxidize ammonia to nitrate, as previously discussed, or can use different metabolic reactions to reduce nitrate to ammonia. Table III.D.2-11 lists the percentages of bacterial isolates capable of reducing nitrates to nitrites.

When sulfuric acid dissolves in water, the soluble anionic species liberated is the sulfate ion. A calculation was made to determine if the amount of sulfuric acid discharged into Lake Warren was responsible for an elevation in sulfate concentration in the canal system waters. The results indicated that the effect of the added sulfuric acid on the sulfate ion concentration in the overall canal system would be negligible when compared to the concentration normally found in seawater.

A similar calculation was made concerning the effect of all discharged chemicals on the salinity of the canal water. Again, the effect was found to be very small.

Chemical analyses performed by Applied Biology, Inc., from January through May 1978 indicated that the soluble sulfate ion concentration of the cooling canal system was approximately 10-15 percent higher than at adjacent Biscayne Bay sampling stations. This differential is probably due in part to freshwater runoff into Biscayne Bay which reduces sulfate concentrations to values below those of the cooling canal system. The 5-month average soluble sulfate concentration of both the Biscayne Bay and cooling canal sampling stations were well below values that would be expected for normal seawater.

As with the distribution of taxonomic groups, the bacterial isolates from the Turkey Point canal sediments are very similar, with respect to their capability of substrate utilization, to the isolates from the Biscayne Bay sediments.

The results of the chemical analyses of the Turkey Point canal system from January 1978 through May 1978 are given in Tables III.D.2-12 through III.D.2-19. These values were not found to vary significantly from values reported from other years.

The pH's of the canal and Biscayne Bay sediments for the first five months of 1978 appear in Table III.D.2-20. As expected, they are in the narrow range usually encountered in the strongly buffered seawater environment.

The results of sediment salinity and temperature measurements are given in Tables III.D.2-21 and III.D.2-22, respectively. Conductivity values are presented in Table III.D.2-23. Because conductivity is a function of both ionic concentration and temperature, the highest conductivity values are found at the warmest stations in the canal system.

<u>Conclusions</u>

Sediment samples from stations in the Turkey Point canal system and Biscayne Bay were analyzed for the presence of bacteria responsible for nutrient turnover of organic materials. Heterotrophic bacteria counts were higher in the Turkey Point canals than in the Biscayne Bay sediments; however, samples from both locations contained similar taxonomically grouped populations that could degrade a variety of common organic substrates. The number of heterotrophic microorganisms estimated by Bader and Roessler (1971) in sediments of Card Sound is of the same order of magnitude as the number of heterotrophic bacteria measured in the present study from sediments in Biscayne Bay. A more comprehensive comparison of the University of Miami study with the present studies is not possible because the bacteriological work presented in the Miami report is quite limited and methodologies are different from those employed by Applied Biology.

During the January through May 1978 time period, concentrated sulfuric acid and concentrated sodium hydroxide were added to Lake Warren at a rate approaching 100,000 pounds per month (Table II. A.1.). Hydrated lime was also added at an average rate of 25,000 pounds per month. Although those chemicals are either very alkaline or acidic in pH, when added in a balanced fashion, as described above, the overall pH of Lake Warren was not affected; it remained in the normal range expected of seawater. This is documented both by pH data on the water column taken daily in Lake Warren and the sediment pH data collected monthly by Applied Biology at eight stations within the cooling canal system. The pH in both instances remained very close to 8.0, which is considered normal for seawater.

LITERATURE CITED

APHA. 1976. Standard methods for the examination of water and wastewater, 14th ed. American Public Health Association, Washington, D. C. 1193 pp.

Bader, R.B., and M.A. Roessler, principal investigators. 1971. An ecological study of south Biscayne Bay and Card Sound. Prog. Rept. to U.S. AEC [AT (40-1) - 3801-3] and Fla. Power & Light Co. Rosenstiel School of Mar. and Atmos. Sci., Univ. of Miami, FL.

BBL. 1968. BBL manual of products and laboratory procedures, 5th ed. BBL, Division of Becton, Dickinson and Company, Cockeysville, Md. 211 pp.

Campbell, L. L., Jr. and O. B. Williams. 1951. A study of chitin-decomposing microorganisms of marine origin. J. Gen. Microbiol. 5:894-905.

Collier, H. O. J., N. R. Campbell and M. E. H. Fitzgerald. 1950. Vibriostatic activity in certain series of pteridines. Nature 165(4208):1004-1005.

Horne, R. A. 1969. Marine chemistry. John Wiley and Sons, Inc., New York. p. 487.

Hugh, R. and E. Leifson. 1953. The taxonomic significance of fermentative versus oxidative metabolism of carbohydrates by various gram-negative bacteria. J. Bacteriol. 66:24-26.

Shewan, J. M. 1963. The differentiation of certain genera of gram negative bacteria frequently encountered in marine environments. Pages 449-521 *in* Symposium on marine microbiology. C. D. Thomas, Springfield, Ill.

Society of American Bacteriologists. 1957. Manual of microbiological methods. McGraw-Hill, New York.

Strickland, J. D., and T. R. Parsons. 1972. A practical handbook of seawater analysis. Fish Res. Bd. Canad. Ottawa, Bulletin No. 167. 310 pp.

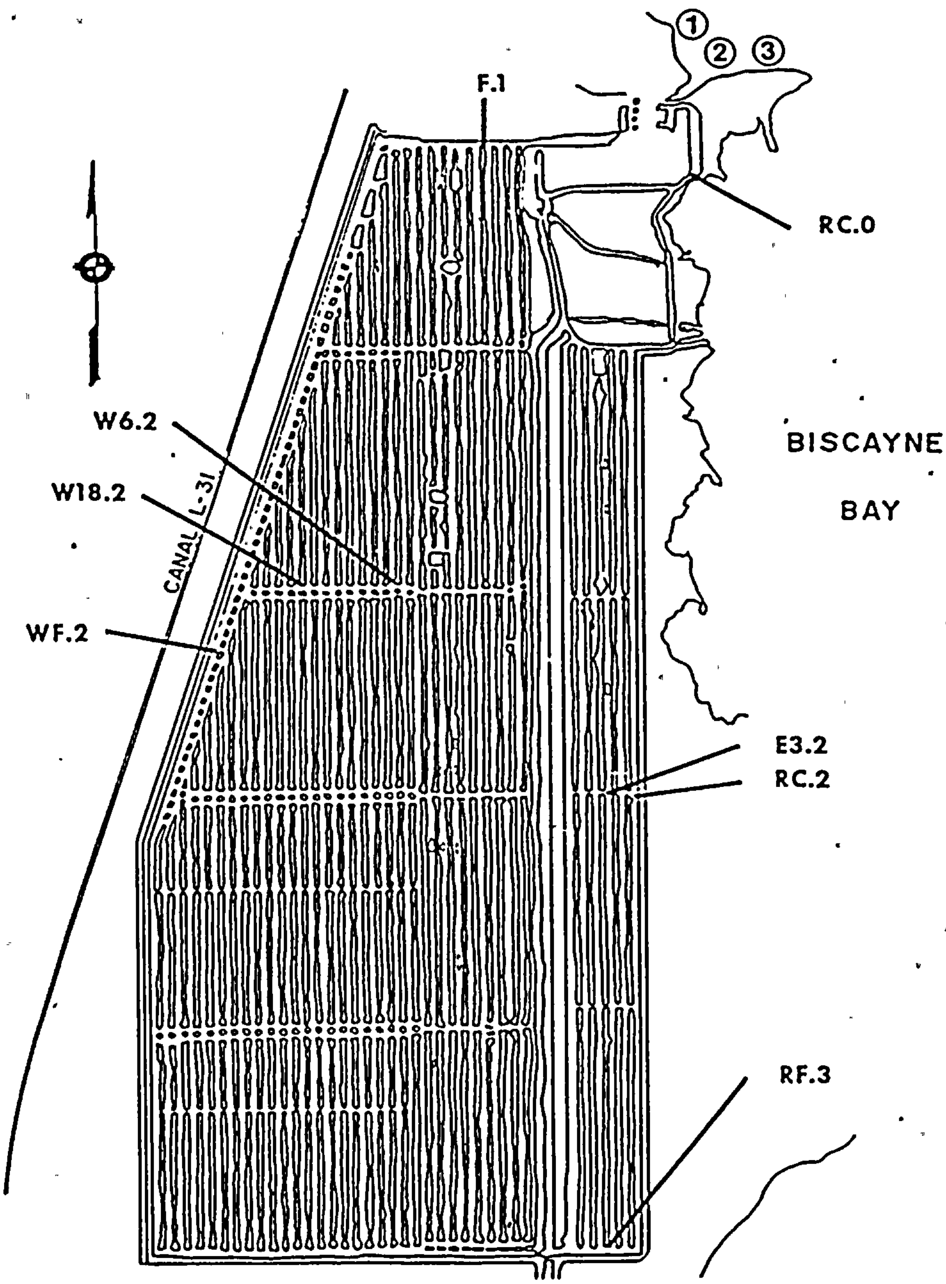
LITERATURE CITED (continued)

ADDITIONAL SOURCES

Fincher, E. L. 1975. Ecological studies of a subtropical terrestrial biome: microbial ecology. Annual report to Florida Power & Light Company. Ga. Inst. of Technology, Atlanta, GA.

Rheinheimer, G. 1974. Aquatic microbiology. John Wiley & Sons, London.

Stevenson, L. H., and R. R. Colwell. 1973. Estuarine microbial ecology. Univ. of South Carolina Press, Columbia, S. C.



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

MICROBIOLOGY
SAMPLING STATIONS

APPLIED BIOLOGY, INC.
Figure III.D.2-1

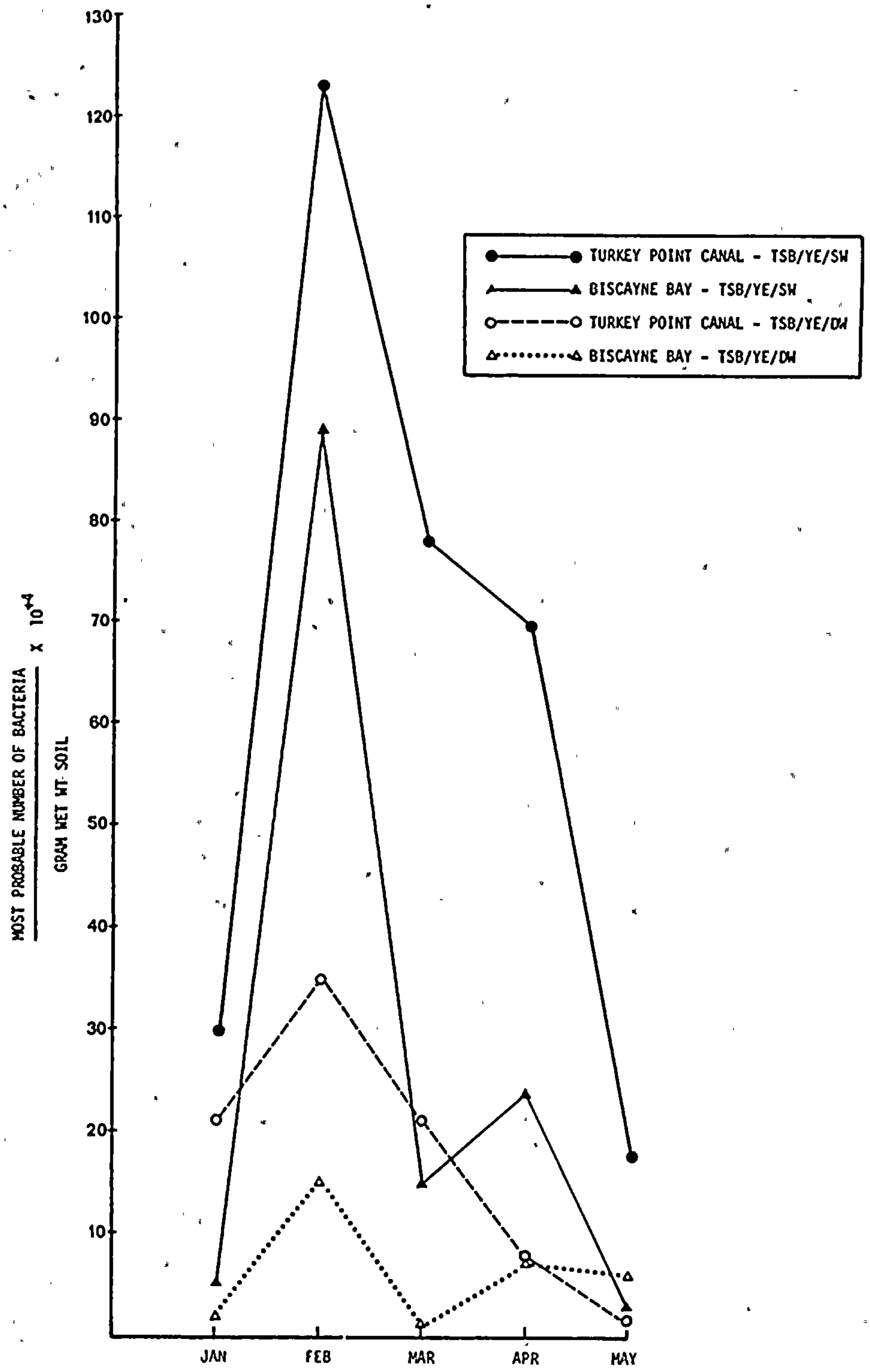


Figure III.D.2-2. Comparison of 1978 bacteria counts between Turkey Point canal and Biscayne Bay sediments with two types of growth media.

TABLE III.D.2-1

TESTS FOR DETERMINATION OF SUBSTRATE UTILIZATION
TURKEY POINT PLANT

Test	Medium
Casein Hydrolysis	(1) Prepare TSA/YE/SW plates containing 1% instant nonfat dry milk (2) Streak plates with inoculum and incubate for 5 days (3) Observe for clearing of the medium around the bacterial growth which is indicative of casein hydrolysis
Chitin Hydrolysis (Campbell et al., 1951)	(1) Prepare medium by adding several flakes of purified chitin to 5 ml of artificial seawater (2) Inoculate and incubate at 25°C for 2 weeks (3) Test for ammonia produced from the hydrolysis of chitin by adding Nesslers reagent to the culture
Starch Hydrolysis	(1) Prepare TSA/YE/SW plates containing 0.5% soluble starch (2) Streak plates with the inoculum and incubate for 5 days at 25°C (3) Test for starch hydrolysis by flooding with an iodine solution (Iodine, 3 g; KI, 6 g; H_2O, 400 ml). A deep blue color indicates the presence of starch and therefore starch hydrolysis is indicated by a clear zone around the bacterial growth
Lipid Hydrolysis	(1) Prepare Difco spirit blue agar plates with artificial seawater and Difco lipase reagent (2) Streak plates with the inoculum and incubate for 5 days at 25°C (3) Observe for a dark blue color beneath the bacterial growth as well as clearing of the lipid emulsion. Both changes indicate lipid hydrolysis

TABLE III.D.2-1
(continued)
TESTS FOR DETERMINATION OF SUBSTRATE UTILIZATION
TURKEY POINT PLANT

Test	Medium
Ammonification of Peptone	(1) Prepare 1% Bacto-peptone (Difco) with artificial seawater and dispense into tubes (2) Inoculate tubes and incubate at 25°C for 5 days (3) Test for ammonia production by addition of Nessler's reagent to the culture
Nitrate Reduction	(1) Prepare Indole-nitrite medium (Difco) with artificial seawater and dispense into tubes (2) Inoculate tubes and incubate at 25°C for 5 days (3) Test for nitrate reduction by adding one ml of sulfanilic acid solution followed by one ml of alpha-naphylamine solution. A red color within 1-2 min indicates the presence of nitrite and therefore positive for nitrate reduction. If no red color appears, add zinc metal to check for the presence of nitrate. Zinc will chemically reduce nitrate and hence a red color will appear.
Carbohydrate Fermentation	(1) Prepare phenol red broth (Difco) with artificial seawater and 0.5% of the carbohydrate to be tested (2) Inoculate tubes and incubate for 2 days at 25°C and observe for fermentation denoted by a change in color from red to yellow

TABLE III.D.2-2

METHODS FOR CHEMICAL ANALYSIS OF SOIL AND WATER
TURKEY POINT PLANT

Parameter	Method	Reference
Ammonia-nitrogen	spectrophotometric (phenol-hypochlorite)	Strickland and Parsons, 1972, p. 87
Nitrate-nitrogen	(1) cadmium reduction	APHA, 1976, p. 423
Nitrite-nitrogen	spectrophotometric (diazotization)	APHA, 1976, p. 434
Orthophosphate	spectrophotometric (ascorbic acid)	APHA, 1976, p. 481
Sulfate	turbidimetric (barium sulfate)	APHA, 1976, p. 493
Sulfite	titrimetric (iodide-iodate)	APHA, 1976, p. 509
sulfide	spectrophotometric (p-phenylenediamine)	Strickland and Parsons, 1972, p. 41

TABLE III.D.2-3

MOST PROBABLE NUMBER OF BACTERIA ($x10^4$) PER GRAM OF WET WEIGHT SOIL
GROWTH MEDIUM-TSB/YE/SW
TURKEY POINT PLANT
JANUARY-MAY 1978 [a]

	Station location and number												
	Biscayne Bay				Turkey Point Canal System								
Month	1	2	3	Mean	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0	Mean
JAN	7.1	6.8	2.3	5.4	43.6	22.4	80.0	3.2	8.1	17.9	85.1	8.1	29.8
FEB	139.0	161.0	68.1	123.0	16.7	45.9	28.2	17.6	45.5	448.0	17.2	200.0	102.4
MAR	22.8	21.1	1.8	15.2	131.0	12.7	30.8	116.0	216.0	139.0	22.1	31.3	77.6
APR	8.4	21.4	42.0	23.9	88.5	26.8	51.1	44.4	16.3	86.8	92.0	220.0	69.5
MAY	2.4	3.7	3.4	3.2	4.5	4.2	28.7	31.0	39.0	27.3	8.7	4.3	18.4
5-month average	35.9	42.8	23.5	27.4	56.8	22.4	43.8	42.4	64.9	144.0	45.0	453.0	59.5

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-4

MOST PROBABLE NUMBER OF BACTERIA ($x10^4$) PER GRAM OF WET WEIGHT SOIL
GROWTH MEDIUM-TSB/YE/DW
TURKEY POINT PLANT
JANUARY-MAY 1978[a]

	Station location and number												
	Biscayne Bay				Turkey Point Canal System								
Month	1	2	3	Mean	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0	Mean
JAN	1.4	2.2	1.3	1.6	43.6	18.9	48.0	3.2	17.5	1.7	1.7	8.1	21.4
FEB	13.9	16.2	14.7	14.9	2.7	17.8	8.1	8.2	17.6	140.0	42.6	41.8	34.8
MAR	0.1	4.0	0.7	1.6	1.8	35.6	13.7	7.9	90.2	1.5	16.2	1.1	21.0
APR	3.4	0.8	18.6	7.92	8.3	7.7	4.9	3.9	13.2	22.6	1.9	4.60	8.4
MAY	7.2	8.2	3.9	6.4	2.8	1.5	1.8	0.9	0.7	4.4	1.7	0.7	1.8
5-month average	5.2	6.3	7.8	6.5	11.8	16.3	15.3	4.8	27.8	34.0	12.8	11.2	17.5

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-5

NUMBER OF SULFATE-REDUCING BACTERIA PER GRAM
OF WET WEIGHT SOIL
TURKEY POINT PLANT
JANUARY- MAY 1978[a]

	Station location and number												
	Biscayne Bay				Turkey Point Canal System								
	1	2	3	Mean	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0	Mean
JAN	9091	8772	833	6232	100	114	111	119	2083	10638	1020	10417	3075
FEB	75	86	79	80	36364	19230	18868	18868	18868	18518	18518	36364	23199
MAR	5000	100	8333	4478	62	833	71	55	100	<12	710	71	239
APR	83	<17	<20	40	<20	83	1000	100	83	<20	100	1000	298
MAY	83	83	83	83	1000	100	100	1000	83	10000	10000	1667	2994
5-month average	2866	1812	1870	2813	7509	4072	4030	4028	4243	7838	6070	9904	5961

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-6

TAXONOMIC GROUPING OF BACTERIAL ISOLATES
TURKEY POINT PLANT
JANUARY- MAY 1978[a]

	JAN		FEB		MAR		APR		MAY		5-month average	
	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay
Group I pseudomonas aeromonas vibrio xanthomonas	29.2	66.7	66.7	66.7	12.5	55.5	66.7	22.2	58.3	55.6	46.7	53.4
Group II achromobacter alcaligenes	8.3	22.2	12.5	33.3	25.0	44.4	20.8	44.4	12.5	0	15.8	28.9
Group III flavobacter cytophaga	33.3	11.1	4.2	0	29.2	0	0	22.2	16.7	11.1	16.7	8.9
Group IV gram positive rods	29.2	0	16.7	0	33.3	0	12.5	11.1	12.5	33.3	20.8	8.9

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-7

PROTEIN UTILIZATION
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Ammonification of peptone		Hydrolysis of casein	
	Bay	Canal	Bay	Canal
JAN	54.2	77.8	54.2	88.9
FEB	62.5	77.8	83.3	33.3
MAR	50.0	77.8	37.5	33.3
APR	87.5	100.0	33.3	66.7
MAY	50.0	66.7	54.2	44.4
5-month average	60.8	80.0	52.5	53.3

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-8

CARBOHYDRATE UTILIZATION
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Starch hydrolysis		Chitin Hydrolysis		Cellobiose fermentation	
	Bay	Canal	Bay	Canal	Bay	Canal
JAN	25.0	44.4	25.0	88.9	12.5	55.5
FEB	79.2	44.4	37.5	77.8	45.8	55.5
MAR	50.0	44.4	33.3	22.2	33.3	55.5
APR	62.5	66.7	95.8	100.0	25.0	66.7
MAY	66.7	77.8	87.5	100.0	70.8	66.7
5-month average	56.7	55.5	55.8	77.8	37.5	60.0

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-9

CARBOHYDRATE FERMENTATION
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Glucose		Saccharose		Mannitol		Lactose	
	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal
JAN	70.8	88.9	50.0	77.8	41.7	77.8	8.3	0
FEB	83.3	88.9	79.2	66.7	83.3	55.5	70.8	77.8
MAR	50.0	55.5	33.3	66.7	41.7	66.7	37.5	55.5
APR	66.7	100.0	58.3	77.8	50.0	100.0	33.3	44.4
MAY	75.0	88.9	79.2	88.9	83.3	77.8	87.5	77.8
5-month average	69.2	84.4	60.0	75.6	60.0	75.6	47.5	51.1

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-10

LIPID UTILIZATION
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Lipid hydrolysis	
	Bay	Canal
JAN	45.8	55.5
FEB	41.7	55.5
MAR	29.2	33.3
APR	54.2	33.3
MAY	54.2	66.7
5-month average	45.0	48.9

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-11

NITRATE METABOLISM
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Reduction of nitrates Bay	Canal
JAN	29.2	22.2
FEB	62.5	55.5
MAR	33.3	44.4
APR	62.5	88.9
MAY	29.2	88.9
5-month average	43.3	60.0

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-12

ANALYSIS OF SOLUBLE AMMONIA (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	0.29	0.29	0.52	0.82	0.76	0.70	0.24	1.45	0.76
FEB	0.27	0.25	0.35	0.44	0.52	0.21	0.33	0.56	1.91
MAR	0.40	0.63	0.49	0.43	0.60	0.49	0.32	0.56	0.63
APR	0.42	0.47	0.27	0.70	0.64	0.53	0.23	0.81	0.53
MAY	0.46	0.27	0.19	0.20	0.40	0.36	0.18	<0.01	0.66

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-13

ANALYSIS OF SOLUBLE NITRATE (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	0.012	0.136	0.143	0.074	0.074	0.043	0.049	0.011	0.083
FEB	0.018	0.081	0.071	0.054	0.064	0.095	0.085	0.042	0.064
MAR	0.027	0.060	0.028	0.367	0.028	0.113	0.051	0.035	0.039
APR	0.011	0.024	0.057	0.005	0.040	0.317	0.010	0.012	0.012
MAY	0.009	0.065	0.053	0.089	0.049	0.277	0.017	0.054	0.002

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-14

ANALYSIS OF SOLUBLE NITRITE (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.001	0.006	0.005	0.003	0.003	0.001	0.009	<0.001	0.005
FEB	<0.001	0.003	0.002	0.002	0.004	<0.001	0.006	0.003	0.007
MAR	0.003	0.005	0.006	0.013	0.005	0.005	0.005	0.004	0.005
APR	0.002	0.002	0.004	0.001	0.003	0.002	0.001	0.002	0.001
MAY	0.002	0.003	0.002	0.004	0.024	0.012	0.001	0.011	0.001

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-15

ANALYSIS OF SOLUBLE ORTHOPHOSPHATE (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	0.01	0.01	0.01	0.03	0.03	0.06	0.05	0.07	0.03
FEB	<0.01	0.03	0.02	0.01	0.03	0.01	0.04	0.02	0.04
MAR	<0.01	0.06	0.03	0.03	0.03	0.03	0.02	1.33	0.03
APR	<0.01	0.05	0.02	0.04	0.01	0.05	0.03	0.24	0.04
MAY	<0.01	0.01	0.04	<0.01	0.11	0.12	0.01	0.02	0.03

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-16

ANALYSIS OF SOLUBLE SULFATE (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978 [a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	2273	2970	2870	2970	2950	2950	3100	2270	3000
FEB	1900	2850	2750	2750	2600	2850	2750	2750	3050
MAR	2250	2850	2800	2850	2250	2800	2850	2750	2800
APR	2666	1900	2850	1650	2600	2050	1225	1525	1750
MAY	2883	3100	3100	3100	3950	2900	3100	3100	2050

[a] Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-17

ANALYSIS OF SOLUBLE SULFITE (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
FEB	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MAR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
APR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MAY	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

[a] Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-18

ANALYSIS OF SOLUBLE SULFIDE (ppm)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
FEB	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
MAR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
APR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
MAY	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-19

ANALYSIS OF INSOLUBLE SULFIDES (μg/g wet wt. soil)
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

Month	Mean of 3 controls	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.05	<0.05	<0.05	<0.05	0.44	<0.05	<0.05	<0.05	5.94
FEB	1.07	2.98	5.56	12.0	6.43	2.98	0.45	<0.05	1.44
MAR	1.84	1.26	<0.05	<0.05	0.73	3.19	0.46	<0.05	<0.05
APR	0.14	2.97	0.51	0.55	0.16	<0.05	0.07	12.2	0.18
MAY	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.19

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-20

pH OF TURKEY POINT CANAL AND BISCAYNE BAY SEDIMENTS
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

	Station location and number										
	Biscayne Bay			Turkey Point Canal System							
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	8.2	8.2	8.2	8.2	8.3	7.6	7.9	7.9	8.7	7.8	7.6
FEB	8.1	8.1	8.1	8.2	8.2	8.1	8.0	8.2	8.2	8.1	7.8
MAR	7.7	7.6	8.3	7.9	7.9	7.9	8.0	7.9	8.0	7.7	7.6
APR	7.7	7.7	8.0	7.9	7.9	7.7	7.9	7.7	7.7	7.7	7.3
MAY	8.1	8.0	7.8	8.0	8.2	8.2	8.0	7.6	7.7	8.2	7.4

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-21

SALINITY ($^{0}/_{00}$) OF SEDIMENTS AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

	Station location and number										
	Biscayne Bay			Turkey Point Canal System							
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	27.5	27.5	27.2	28.5	31.0	29.4	30.1	28.1	30.1	32.2	31.4
FEB	14.3	15.1	20.5	31.0	28.7	26.9	27.1	27.0	27.6	29.2	26.6
MAR	22.5	22.0	22.2	27.9	24.2	25.6	23.2	29.6	27.8	24.9	29.1
APR	27.1	27.0	27.1	28.2	28.0	28.8	24.7	26.1	28.7	28.8	28.9
MAY	24.6	29.5	30.1	24.4	24.1	25.5	26.2	25.4	25.8	25.5	26.2

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-22

TEMPERATURE (^{o}C) OF SEDIMENTS AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

	Station location and number										
	Biscayne Bay			Turkey Point Canal System							
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	18.5	18.5	19.1	25.6	20.4	20.6	19.7	16.7	15.8	18.9	18.0
FEB	19.4	19.5	20.0	24.6	22.2	22.1	22.8	20.9	20.6	21.8	20.8
MAR	28.5	28.5	28.9	35.8	29.1	30.0	28.8	26.7	25.4	27.8	28.0
APR	32.0	32.0	32.1	36.8	31.6	32.3	31.4	28.8	28.7	29.0	29.8
MAY	33.5	33.9	33.9	37.4	32.0	32.3	33.3	31.1	30.2	32.0	30.9

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.

TABLE III.D.2-23

SPECIFIC CONDUCTIVITY ($ohm^{-1}cm^{-1}$ x 1000) OF SEDIMENTS AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - MAY 1978[a]

	Station location and number										
	Biscayne Bay			Turkey Point Canal System							
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	36.0	35.5	34.7	39.4	40.2	37.0	38.9	36.1	38.8	41.2	40.2
FEB	28.0	28.0	28.0	50.0	39.0	36.2	37.9	35.5	37.2	39.8	35.2
MAR	40.1	38.9	39.4	50.0	41.2	44.1	40.2	47.2	45.1	40.9	48.6
APR	49.3	49.1	49.4	50.0	50.0	50.0	44.3	45.2	49.0	49.8	50.0
MAY	46.0	46.9	48.0	48.2	45.3	47.1	49.0	47.0	45.9	48.4	47.9

[a]Samples taken in June 1978 were not completely analyzed at the time of this writing and will be included in the annual report for 1978.