FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT ANNUAL NON-RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT
1979

FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT

UNITS 3 & 4

FLORIDA POWER & LIGHT COMPANY

ENVIRONMENTAL MONITORING REPORT NO.13

JANUARY 1, 1979

THROUGH

DECEMBER 31, 1979

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I. INTRODUCTION

This report is submitted in accordance with Section 5.4.1 of Appendix B to Operating Licenses DPR-31 and DPR-41. It constitutes the Annual Non-Radiological Environmental Monitoring Report for the period from January 1, 1979 through December 31, 1979.

II. ABIOTIC MONITORING

A. Thermal (ETS 3.1.1)

Tables II.A-1 through II.A-12 present a summary of the plant inlet and Lake Warren outlet temperatures for the period from January 1, 1979 through December 31, 1979. These temperatures were recorded hourly and provide the mean canal temperatures.

The temperature trends observed during 1979 show no unusual occurrences and did not differ dramatically from previous years. This is illustrated by Table II.A-13, which gives maximum inlet and outlet temperatures from January through December for the years 1975 through 1979.

TABLE II.A-1

TIME DURATION CURVES - TEMPERATURE

JANUARY 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	79	0.0
26	78	3.5
52	77	10.5
93	76	23.0
84	75	34.3
72	74	44.0
45	73	50.0
112	72	65.1
46	71	71.2
60	70	79.3
39	69	84.5
35	68	89.2
29	67	93.1
13	66	94.9
4	65	95.4
5	64	96.1
16	63	98.3
8	62	99.3
5	61	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	91	0.0
4	90	0.5
10	89	1.9
38	88	7.0
31	87	11.2
71	86	20.7
58	85	28.5
115	84	44.0
57	83	51.6
130	82	69.1
73	81	78.9
35	80	83.6
53	79	90.7
14	78	92.6
16	77	94.8
6	76	95.6
13	75	97.3
9	74	98.5
6	73	99.3
5	72	100.0

TABLE II.A-2

TIME DURATION CURVES - TEMPERATURE

FEBRUARY 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	83	0.0
2	82	0.3
34	81	5.4
57	80	13.8
75	79	25.0
80	78	36.9
50	77	44.3
26	76	48.2
33	75	53.1
39	74	58.9
49	73	66.2
47	72	73.2
26	71	77.1
31	70	81.7
37	69	87.2
16	68	89.6
15	67	91.8
12	66	93.6
8	65	94.8
9	64	96.1
14	63	98.2
8	62	99.4
4	61	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	94	0.0
15	93	2.2
47	92	9.2
61	91	18.3
107	90	34.2
20	89	37.2
51	88	44.8
27	87	48.8
70	86	59.2
39	85	65.0
46	84	71.9
17	83	74.4
65	82	84.1
30	81	88.5
13	80	90.5
13	79	92.4
8	78	93.6
13	77	95.5
12	76	97.3
12	75	99.1
1	74	99.3
5	73	100.0

TABLE II.A-3

TIME DURATION CURVES - TEMPERATURE

MARCH 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	82	0.0
19	81	2.6
63	80	11.0
94	79	23.7
109	78	38.3
119	77	54.3
104	76	68.3
84	75	79.6
68	74	88.7
38	73	93.8
33	72	98.3
13	71	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	95	0.0
2	94	0.3
18	93	2.7
34	92	7.3
87	91	19.0
138	90	37.5
50	89	44.2
71	88	53.8
82	87	64.8
72	86	74.5
47	85	80.8
49	84	87.4
31	83	91.5
34	82	96.1
15	81	98.1
5	80	98.8
6	79	99.6
3	78	100.0

TABLE II.A-4

TIME DURATION CURVES - TEMPERATURE

APRIL 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	88	0.0
3	87	0.4
26	86	4.1
44	85	10.2
73	84	20.5
104	83	35.1
96	82	48.5
90	81	61.2
65	80	70.3
56	79	78.1
41	78	83.9
40	77	89.5
34	76	94.2
29	75	98.3
12	74	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	103	0.0
2	102	0.3
10	101	1.7
28	100	5.6
14	99	7.5
9	98	8.8
13	97	10.6
36	96	15.6
25	95	19.1
18	94	21.6
28	93	25.5
31	92	29.8
84	91	41.5
161	90	63.9
43	89	69.9
87	88	82.0
34	87	86.8
35	86	91.6
11	85	93.2
16	84	95.4
7	83	96.4
13	82	98.2
3	81	98.6
8	80	99.7
2	79	100.0

TABLE II.A-5

TIME DURATION CURVES - TEMPERATURE

MAY 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	90	0.0
6	89	0.8
41	88	6.3
95	87	19.1
130	86	36.6
161	85	58.2
128	84	75.4
69	83	84.7
58	82	92.5
37	81	97.4
19	80	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	104	0.0
2	103	0.3
47	102	6.6
57	101	14.2
141	100	33.2
99	99	46.5
49	98	53.1
82	97	64.1
34	96	68.7
51	95	75.5
31	94	79.7
56	93	87.2
30	92	91.3
35	91	96.0
18	90	98.4
4	89	98.9
3	88	99.3
3	87	99.7
2	86	100.0

TABLE II.A-6

TIME DURATION CURVES - TEMPERATURE

JUNE 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	93	0.0
39	92	5.4
138	91	24.6
161	90	46.9
116	89	63.1
105	88	77.6
66	87	86.8
64	86	95.7
20	85	98.5
11	84	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	109	0.0
5	108	0.7
10	107	2.1
60	106	10.4
32	105	14.9
91	104	27.5
47	103	34.0
92	102	46.8
46	101	53.2
102	100	67.4
77	99	78.1
33	98	82.6
45	97	88.9
16	96	91.1
28	95	95.0
20	94	97.8
16	93	100.0

TABLE II.A-7

TIME DURATION CURVES - TEMPERATURE

JULY 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	97	0.0
11	96	1.5
79	95	12.1
148	94	32.0
162	93	53.8
109	92	68.4
54	91	75.7
34	90	80.2
30	89	84.3
51	88	91.1
43	87	96.9
14	86	98.8
9	85	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	113	0.0
24	112	3.2
50	111	9.9
109	110	24.6
154	109	45.3
180	108	69.5
34	107	74.1
36	106	78.9
21	105	81.7
41	104	87.2
22	103	90.2
24	102	93.4
25	101	96.8
20	100	99.5
2	99	99.7
2	98	100.0

TABLE II.A-8

TIME DURATION CURVES - TEMPERATURE

AUGUST 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	96	0.0
26	95	3.5
41	94	9.0
115	93	24.6
159	92	46.0
220	91	75.7
73	90	85.6
42	89	91.2
50	88	98.0
10	87	99.3
5	86	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	113	0.0
15	112	2.0
54	111	9.3
39	110	14.6
84	109	25.9
99	108	39.3
36	107	44.1
68	106	53.3
37	105	58.3
48	104	64.8
33	103	69.2
15	102	71.3
36	101	76.1
95	100	88.9
38	99	94.1
16	98	96.2
21	97	99.1
4	96	99.6
3	95	100.0

TABLE II.A-9

TIME DURATION CURVES - TEMPERATURE

SEPTEMBER 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	92	0.0
8	91	1.4
69	90	13.9
79	89	28.3
167	88	58.5
100	87	76.6
72	86	89.7
29	85	94.9
12	84	97.1
8	83	98.6
8	82	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	108	0.0
7	107	1.3
46	106	10.1
43	105	18.3
96	104	36.5
106	103	56.7
103	102	76.2
36	101	83.1
48	100	92.2
5	99	93.2
1	98	93.3
7	97	94.7
2	96	95.1
0	95	95.1
2	94	95.4
2	93	95.8
2	92	96.2
11	91	98.3
8	90	99.8
1	89	100.0

TABLE II.A-10

TIME DURATION CURVES - TEMPERATURE

OCTOBER 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	92	0.0
45	91	6.1
80	90	16.8
76	89	27.1
108	88	41.6
94	87	54.2
93	86	66.8
59	85	74.7
64	84	83.3
35	83	88.0
60	82	96.1
23	81	99.2
6	80	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	109	0.0
3	108	0.4
2	107	0.7
38	106	5.8
26	105	9.3
52	104	16.3
60	103	24.4
69	102	33.6
81	101	44.5
166	100	66.9
94	99	79.5
56	98	87.1
45	97	93.1
28	96	96.9
18	95	99.3
5	94	100.0

TABLE II.A-11

TIME DURATION CURVES - TEMPERATURE

NOVEMBER 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	95	0.0
1	94	0.1
0	93	0.1
0	92	0.1
0	91	0.1
0	90	0.1
0	89	0.1
25	88	3.6
48	87	10.3
38	86	15.6
22	85	18.6
64	84	27.5
66	83	36.7
95	82	49.9
111	81	65.3
84	80	76.9
40	79	82.5
15	78	84.6
23	77	87.8
20	76	90.6
35	75	95.4
16	74	97.6
15	73	99.7
2	72	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	104	0.0
6	103	0.8
23	102	4.0
29	101	8.1
57	100	16.0
45	99	22.2
47	98	28.7
76	97	39.3
58	96	47.4
107	95	62.2
41	94	67.9
47	93	74.4
24	92	77.8
44	91	83.9
67	90	93.2
12	89	94.9
31	88	99.2
4	87	99.7
0	86	99.7
1	85	99.9
1	84	100.0

TABLE II.A-12

TIME DURATION CURVES - TEMPERATURE

DECEMBER 1979

UNITS 3 & 4 INTAKE

Number Hours	Inlet Temperature °F	Accumulated Time - %
0	84	0.0
9	83	1.2
28	82	5.0
50	81	11.7
38	80	16.8
55	79	24.2
34	78	28.8
55	77	36.2
26	76	39.7
54	75	47.0
59	74	54.9
82	73	65.9
79	72	76.6
103	71	90.4
55	70	97.8
16	69	100.0

LAKE WARREN OUTLET

Number Hours	Outlet Temperature °F	Accumulated Time - %
0	96	0.0
20	95	2.7
5	94	3.4
40	93	8.7
29	92	12.7
44	91	18.6
96	90	31.5
35	89	36.2
76	88	46.4
46	87	52.6
66	86	61.5
29	85	65.4
57	84	73.1
23	83	76.2
16	82	78.3
15	81	80.3
11	80	81.8
32	79	86.1
36	78	91.0
38	77	96.1
19	76	98.7
10	75	100.0

TABLE II.A-13

INLET & OUTLET WATER TEMPERATURES

1975 - 1979

	MAX. INTAKE TEMPERATURE					MAX. OUTLET TEMPERATURE				
	1975	1976	1977	1978	1979	1975	1976	1977	1978	1979
JANUARY	86	80	75	78	78	99	96	90	91	90
FEBRUARY	89	83	82	77	82	101	98	99	90	93
MARCH	92	86	85	86	81	102	102	103	101	94
APRIL	90	86	84	87	87	101	102	100	101	102
MAY	92	87	91	92	89	105	105	105	108	103
JUNE	96	90	94	95	92	110	106	109	111	108
JULY	94	94	93	96	96	109	111	110	111	112
AUGUST	93	94	94	94	95	109	110	111	108	112
SEPTEMBER	93	92	95	92	91	108	108	110	106	107
OCTOBER	89	89	92	91	91	104	104	108	104	108
NOVEMBER	82	83	84	87	88	97	96	100	100	103
DECEMBER	80	83	84	86	83	97	97	97	99	95

B. Chemical Concentrations (ETS 3.1.2)

The results of the 1979 chemical monitoring program for copper, zinc and chemical oxygen demand are given in Table II.B-1. Copper and zinc are further compared with data from 1976 through 1979 in Figures II.B-1 and II.B-2. Chemical Oxygen Demand (COD) data for 1976-1979 are presented in Figures II.B-3 through II.B-6.

These comparisons demonstrate that no unusual levels of copper and zinc were observed during 1979. However, COD values for 1979 were generally lower than those reported for 1976, but were within the ranges reported for 1977 and 1978. COD data for 1979 are presented in a different format from data gathered for 1976-1978 due to the revised monitoring frequency as specified in Amendments 41 and 43 to License Nos. DPR-31 and DPR-41. However, for comparative purposes, 1976-1978 COD data are included. Future Annual Reports will continue with the format shown in Figure II.B-6.

Table II.B-2 reports the quantities of chemicals used in the operation of Units 3 and 4, which ultimately were added in some form to the circulating water system. Most of the chemicals were utilized in plant water treatment processes necessary to produce high quality water for steam production. The quantities of chemicals listed were

considered to be conservative since they were transported in aqueous solution through a neutralizing/settling pond, where processes of combination, neutralization and precipitation were carried out before discharge to Lake Warren.

Two adjacent fossil units also discharged similar water treatment-related chemicals to the canal system, although in much lesser quantities than from Units 3 and 4. If at some later date chemical stress is noted in the cooling canal system, this additional chemical discharge should be taken into account.

TABLE II.B-1

Chemical parameters found in Florida Power & Light Company's Turkey Point Plant Units 3 & 4 Lake Warren Discharge for 1979.

Monthly				Weekly			
DATE	C.O.D. mg/l	Cu mg/l	Zn mg/l	DATE	pH std. units	D.O. ppm	Salinity ppt
Jan.	292	<0.02	0.03	1/04/79	8.0	5.5	36.0
Feb.	315	<0.02	0.04	1/11/79	8.0	5.8	37.0
March	262	<0.02	0.03	1/18/79	7.9	5.2	38.0
April	222*	<0.02	0.03	1/25/79	8.0	5.1	37.0
May	233*	<0.02	0.02	2/01/79	8.0	5.2	38.0
June	252	<0.02	0.02	2/08/79	8.0	4.9	38.0
July	334	<0.02	<0.02	2/15/79	8.0	5.1	40.0
Aug.	271	<0.02	0.03	2/22/79	8.0	4.9	40.0
Sept.	342	<0.02	0.02	3/01/79	8.0	5.0	41.0
Oct.	133*	<0.02	<0.02	3/08/79	8.0	4.9	39.0
Nov.	202*	<0.02	<0.02	3/15/79	8.0	4.9	40.0
Dec.	338	<0.02	<0.02	3/22/79	8.0	4.9	42.0
				3/29/79	8.0	4.9	42.0
				4/05/79	7.9	4.9	42.0
				4/12/79	8.0	4.9	42.0
				4/19/79	8.0	4.4	42.0
				4/26/79	8.0	4.8	36.0
				5/03/79	7.9	4.2	36.0
				5/10/79	8.0	5.3	38.0
				5/17/79	8.0	5.2	39.0
				5/24/79	8.0	4.6	40.0
				5/31/79	8.0	4.6	39.0
				6/07/79	8.0	4.0	39.0
				6/14/79	8.0	4.3	40.0
				6/20/79	7.9	4.4	40.0
				6/28/79	7.9	4.2	41.0
				7/05/79	8.0	4.2	41.0
				7/12/79	8.0	4.7	44.0
				7/19/79	8.0	4.2	44.0
				7/21/79	8.0	4.2	44.0
				8/02/79	8.0	3.8	45.0
				8/09/79	8.0	4.2	44.0
				8/16/79	8.0	3.7	45.0
				8/23/79	8.0	4.1	45.0
				8/30/79	8.0	3.6	45.0
				9/06/79	8.0	4.1	42.0

* Values of less than 250 mg/l C.O.D. should be discounted due to the large chloride correction factor used (EPA, 1979) for salt water samples.

TABLE II.B-1 (Cont.)

Chemical parameters found in Florida Power & Light Company's Turkey Point Plant Units 3 & 4 Lake Warren Discharge for 1979.

	Monthly				Weekly		
DATE	C.O.D. mg/l	Cu mg/l	Zn mg/l	DATE	pH std. units	D.O. ppm	Salinity ppt
				9/13/79	8.0	4.2	43.0
				9/20/79	8.0	4.3	42.0
				9/27/79	8.0	4.0	41.0
				10/04/79	8.0	3.9	40.0
				10/11/79	8.0	4.6	41.0
				10/18/79	8.0	4.3	39.0
				10/25/79	8.0	4.8	41.0
				11/01/79	8.0	4.9	41.0
				11/08/79	8.0	4.9	41.0
				11/14/79	8.1	5.0	41.0
				11/22/79	8.1	4.2	43.0
				11/29/79	8.1	2.6	42.0
				12/06/79	8.0	3.4	41.0
				12/13/79	8.0	3.6	39.0
				12/20/79	8.0	4.2	40.0
				12/27/79	8.0	4.4	41.0

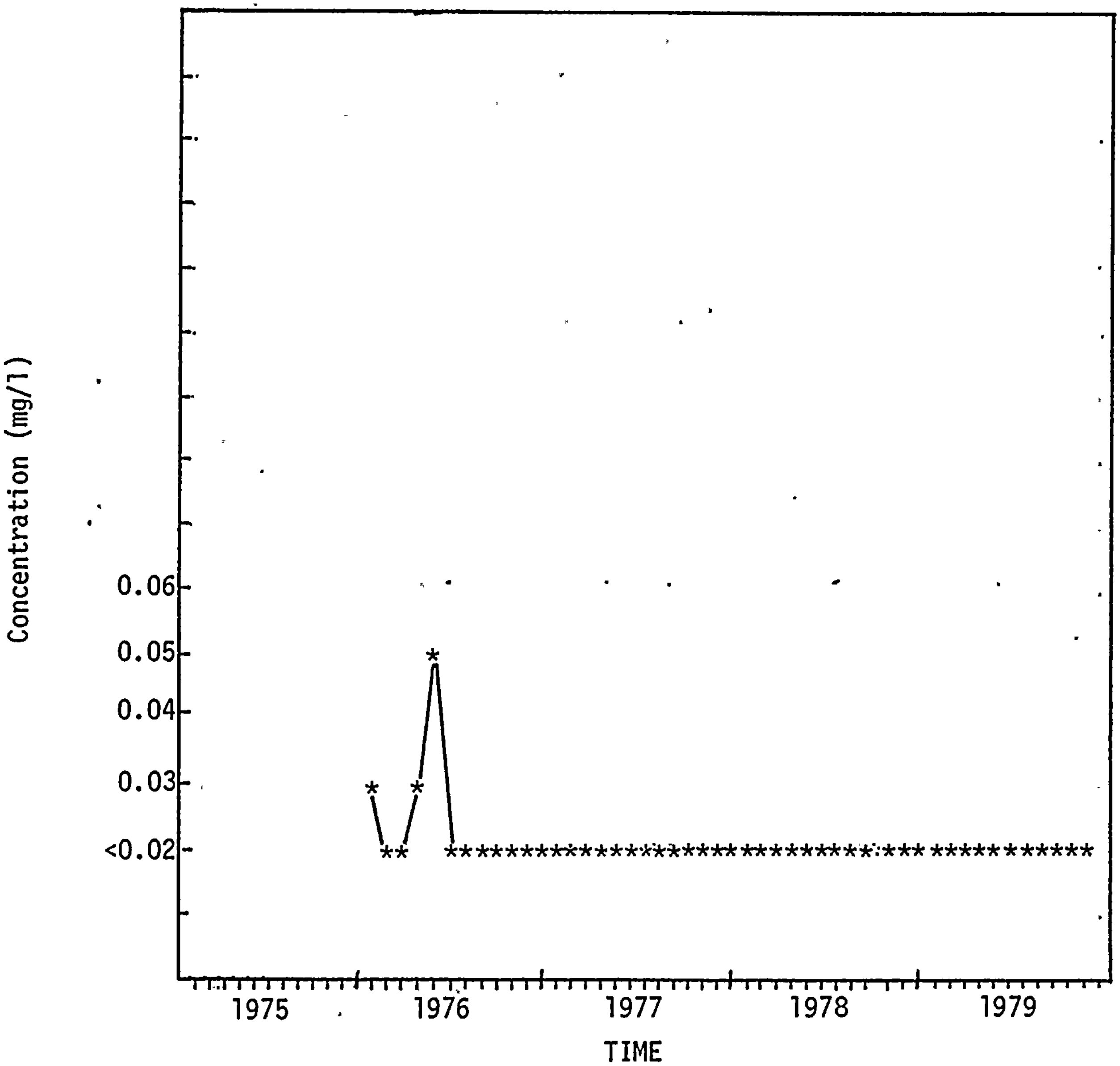

Figure II.B-1 Monthly copper in mg/l at outlet from Lake Warren, i.e. Discharge.

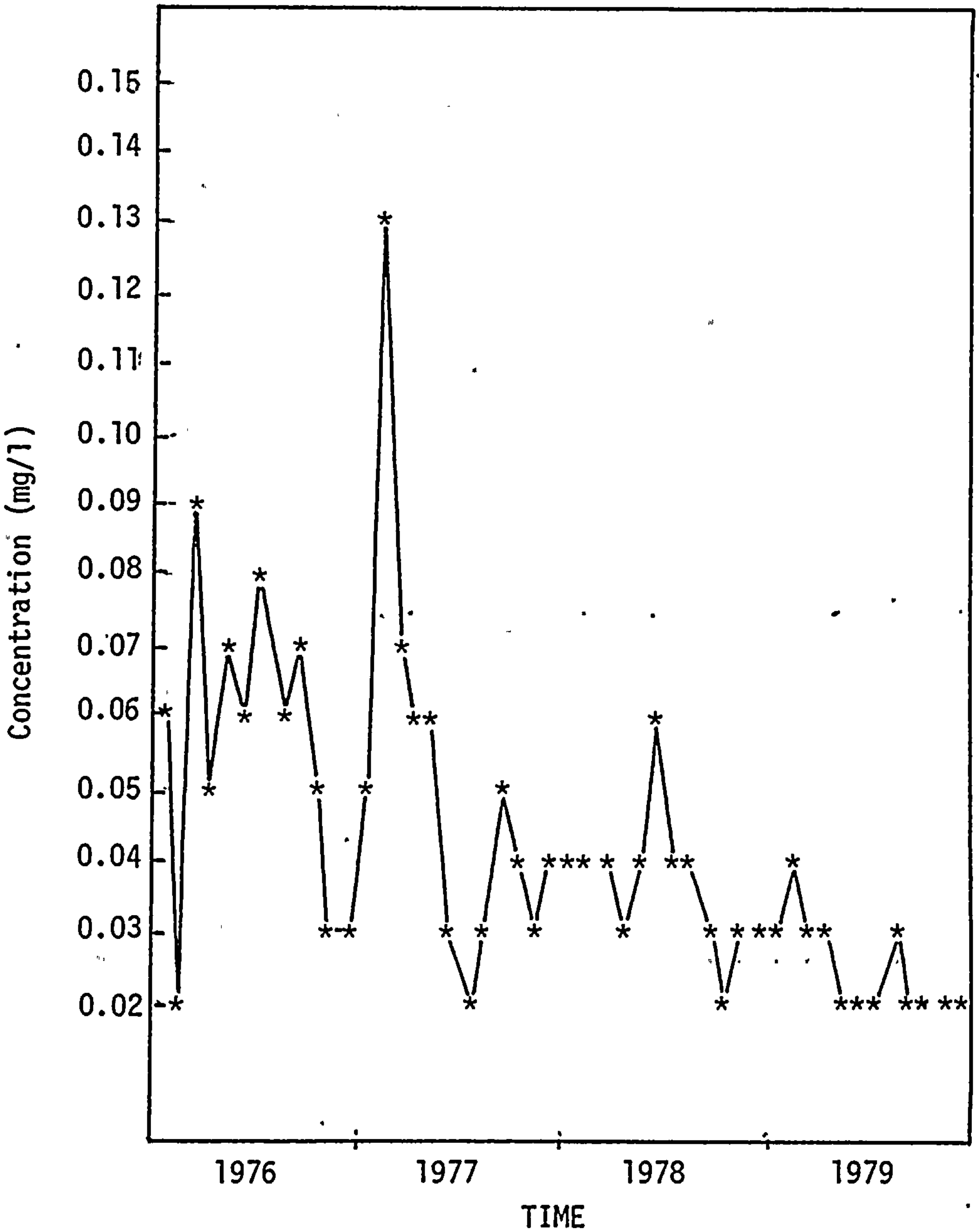

Figure II.B-2 Monthly zinc in mg/l at the outlet from Lake Warren i.e. Discharge.

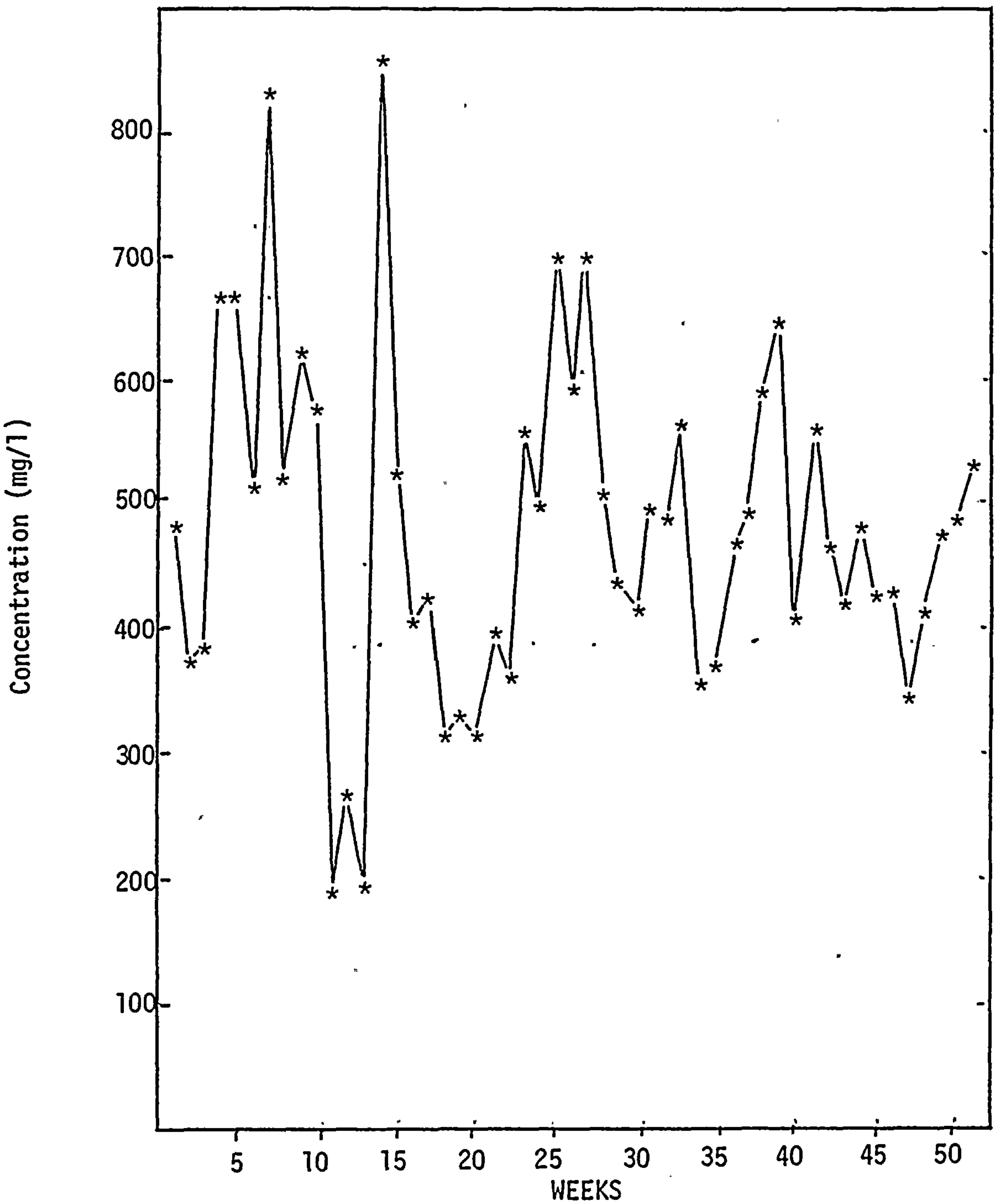

Figure II.B-3 C.O.D. concentration at the outlet from Lake Warren i.e. discharge during 1976.

NOTE: Values of less than 250 mg/l C.O.D. should be discounted due to the large chloride correction factor used (EPA, 1979) for salt water samples.

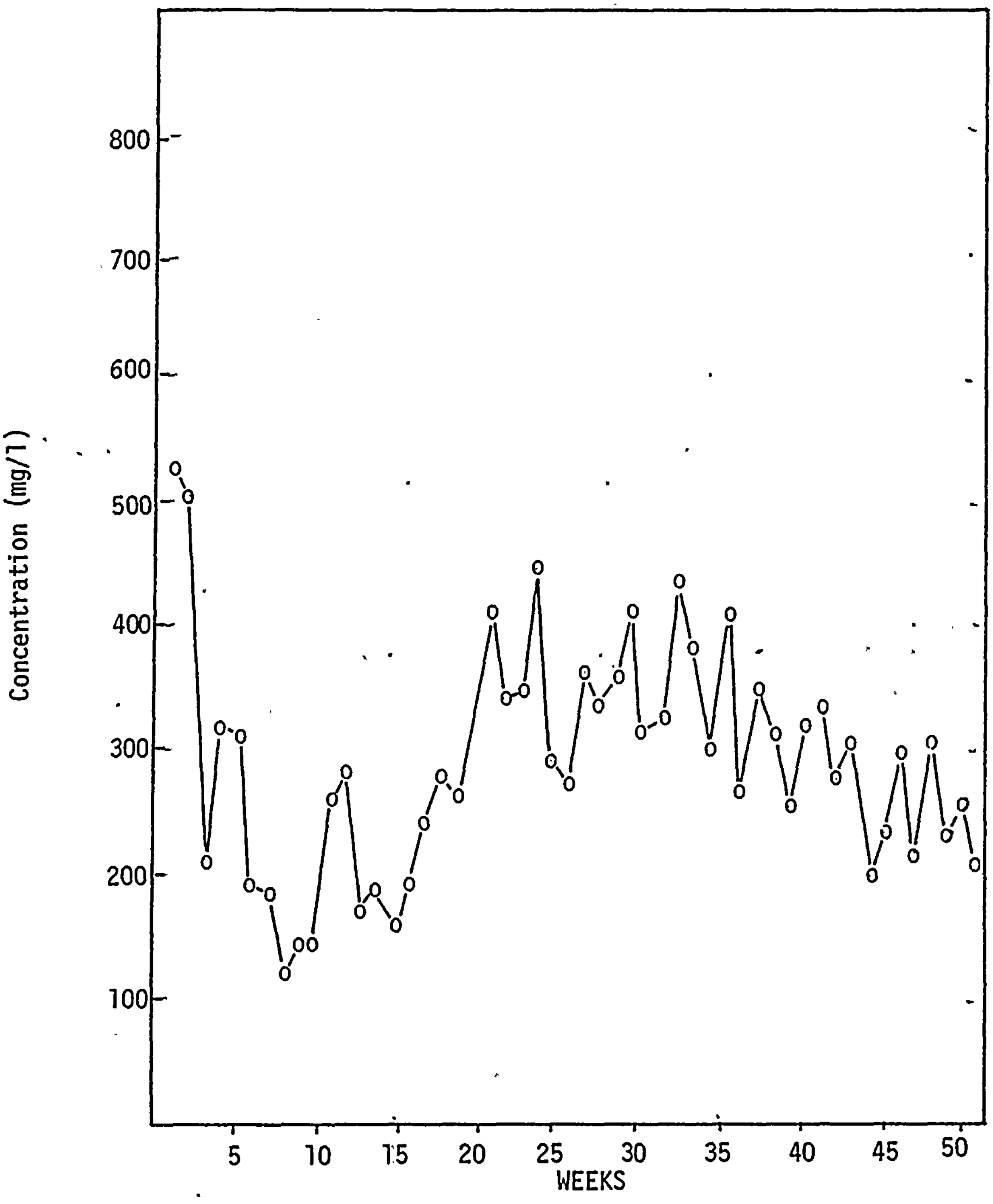

Figure II.B-4 C.O.D. concentration at the outlet from Lake Warren i.e. discharge during 1977.

NOTE: Values of less than 250 mg/l C.O.D. should be discounted due to the large chloride correction factor used (EPA, 1979) for salt water samples.

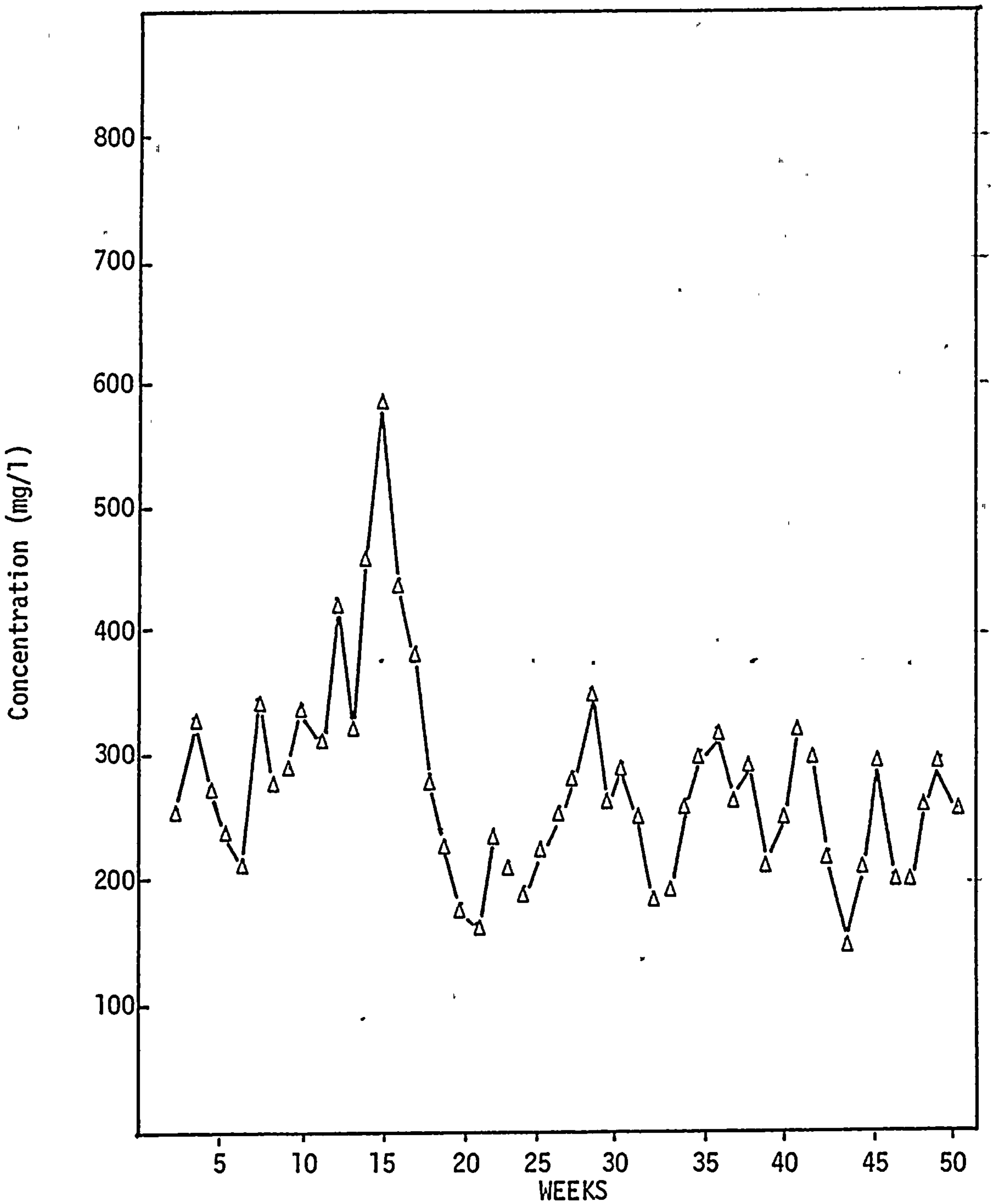

Figure II.B-5 C.O.D. concentration at the outlet from Lake Warren i.e. discharge during 1978.

NOTE: Values of less than 250 mg/l C.O.D. should be discounted due to the large chloride correction factor used (EPA, 1979) for salt water samples.

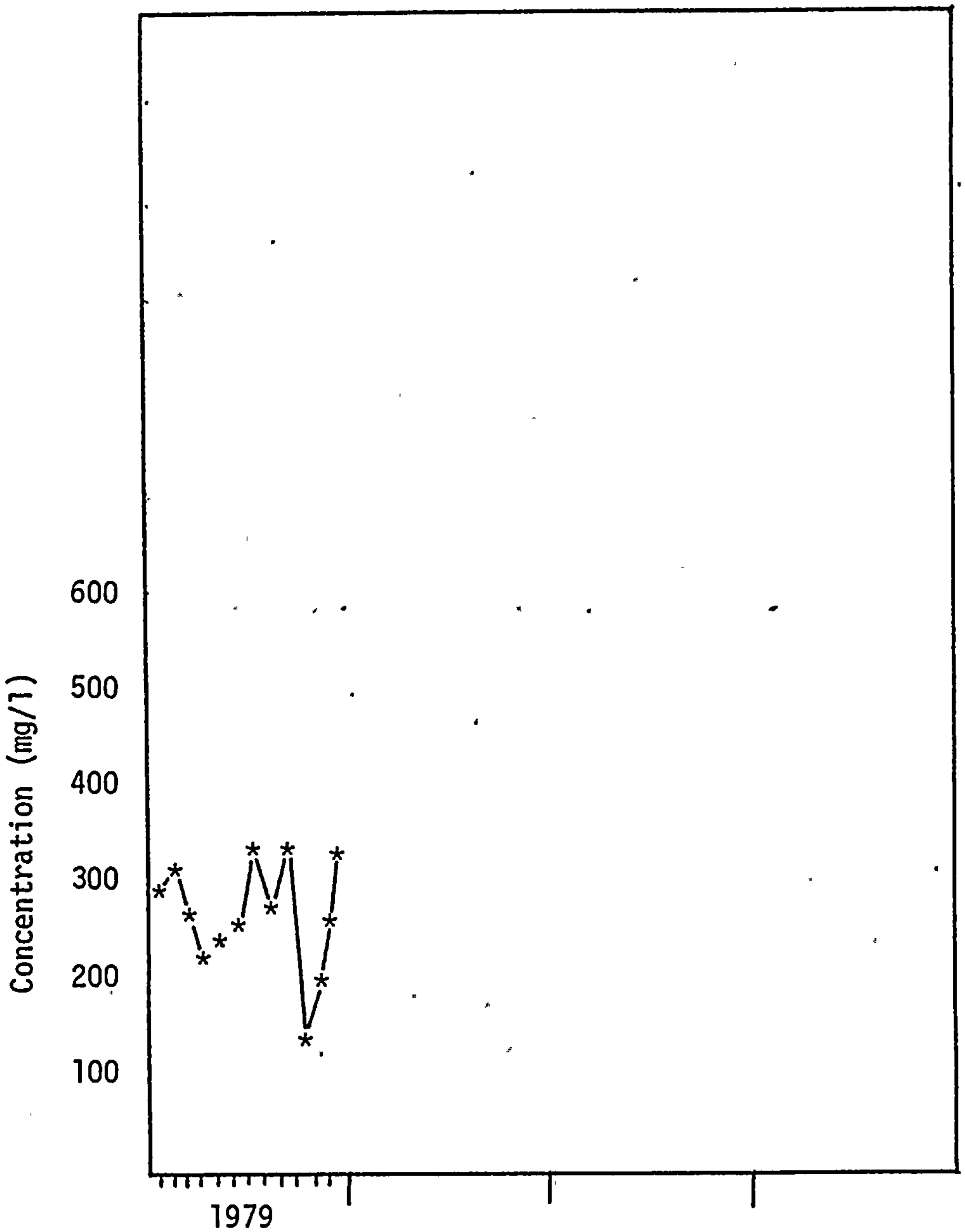

Figure II.B-6 Monthly C.O.D. in mg/l at the outlet from Lake Warren i.e. Discharge.

TABLE II.B-2

Chemical discharges to Lake Warren at Florida Power & Light Company's Turkey Point Plant Units 3 & 4 during January through June 1979.

CHEMICALS	January	February	March	April	May	June
Bentonite Clay	1,587	1,262	1,431	1,354	1,532	1,213
Potassium Dichromate	11	19	45	0	12	15
Potassium Chromate	0	0	0	0	92.5	0
Sodium Hexametaphosphate	10	7	32	5	6	14
Boric Acid	2,210	2,316	5,959	7,317	2,598	9,025
Hydrated Lime	26,764	18,542	21,330	20,796	23,646	19,949
Polyelectrolyte	33	27	0	30	0	30
Concentrated (50%) Sodium Hydroxide	90,685	84,905	92,995	80,082	85,237	71,839
Concentrated Sulfuric Acid	157,693	119,525	136,626	115,499	134,988	113,401
HTH - Calcium Hypochlorite, Chlorine	0	0	0	0	0	0
Amerfloc* 275	0	0	38	0	30	0
Salt	0	0	0	0	0	0

NOTE: All results in pounds
* Coagulant Aid

TABLE II.B-2 (Cont.)

Chemical discharges to Lake Warren at Florida Power & Light Company's Turkey Point Plant Units 3 & 4 during July through December 1979.

CHEMICALS	July	August	September	October	November	December
Bentonite Clay	1,862	2,258	1,938	1,660	1,740	1,030
Potassium Dichromate	10	12	10	10	0	9
Potassium Chromate	0	40	0	50	25	100
Sodium Hexametaphosphate	0	4	0	5	0	0
Boric Acid	6,245	6,507	2,925	2,109	0	1,258
Hydrated Lime	28,430	28,839	28,928	26,031	26,916	18,217
Polyelectrolyte	0	0	0	0	0	0
Concentrated (50%) Sodium Hydroxide	132,092	135,690	116,818	103,496	97,946	77,594
Concentrated Sulfuric Acid	177,519	195,891	186,660	168,441	148,170	111,242
HTH - Calcium Hypochlorite, chlorine	0	0	0	0	0	0
Amerfloc* 275	27	0	23	26	29	22
Salt	0	0	0	0	0	0

NOTE: All results in pounds
* Coagulant Aid

III. BIOTIC MONITORING

A. AQUATIC ENVIRONMENT

1. Plankton (ETS 4.1.1.1.1)

Zooplankton - physical data

Introduction

The purpose of this section is to provide basic physical data which will aid in the interpretation of the reports that follow. This report deals with data collected on a quarterly basis during plankton sampling at various stations in southern Biscayne Bay, Card Sound, and the Turkey Point Cooling Canal System (Figures 1 and 2).

Methods and Procedures

a. Temperature was measured using a Y.S.I. Telethermometer. Its accuracy was $\pm$ 0.15°C with a meter readability of 0.2°C.

b. Salinities were determined using an American Optical Refractometer. This instrument's accuracy was $\pm$ 0.10 o/oo with a readability of 0.5 o/oo.

c. Dissolved oxygen was measured using a Y.S.I. Polarographic probe type oxygen meter. The accuracy of this method was $\pm$ 0.20 ppm with an instrument readability of 0.1 ppm.

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

Comparisons to previous years data, refer to F.P.& L. Annual and Semi Annual Environmental Reports #1 - 12 (1973-1978). Comparisons to baseline data are handled in standard fashion i.e. Reeve &

Cosper (FPL 1972).

Results, Discussion, and Conclusions

a. Temperature

The temperatures in the canal system for 1979 ranged from a maximum of 44.0°C to a minimum of 24.0°C with a mean of 29.8°C (Table 1). The maximum reading was recorded at Station F-1, nearest the power plant discharge.

The temperature in the bay for 1979 ranged from a maximum of 32.7°C to a minimum of 19.9°C with a mean of 25.7°C (Table 3). The maximum bay temperature was typical of the deeper waters of the bay and Card Sound area at various times, but did not reflect the very high temperatures that are known to occur on the tidal flats due to solar heating.

The mean temperature for the canal system was 4.1°C higher than the bay temperature. The canal and bay temperatures had similar trends with little deviation (Figures 3 and 4).

These parallel temperature trends between the canal system and bay seem to indicate that seasonal fluctuations in temperature were more important in determining the mean temperature of the canal system than general power plant loading. The exception to this generalization was Station F-1, located near the plant discharge.

b. Salinity

The salinity in the canal system for 1979 ranged from a maximum of 46.0 o/oo to a minimum of 36.5 o/oo, with a mean of 40.8 o/oo. There was an average increase of 3.5 o/oo in salinity in the canal system from 1978 to 1979. This increase was consistent with the continuous slow rise in average canal salinities since 1976 (Table 1). The lowest salinity in the canal system was 36.5 o/oo and occurred at several unrelated stations during the second quarter. Low salinity values were due to heavy rains that occurred just prior to sampling.

The salinity in the bay for 1979 ranged from a maximum of 41.5 o/oo to a minimum of 21.5 o/oo, with a mean of 34.3 o/oo. Salinity levels fluctuated with increases occurring in the dry season and decreases occurring in the wet season. The exception to this generalization was a peak during the third quarter (August) that reflected a previous month of unusually dry weather.

Salinities generally ran parallel for canal compared with bay by quarter, with the canal an average of 3.6 o/oo higher than the bay (Figures 5 and 6).

c. Dissolved oxygen

The range of dissolved oxygen levels (4.4 - 9.2 ppm) in the bay for 1979 was consistently higher than that in the canal system of 3.2 - 7.9 ppm (Figures 7 and 8). The elevated temperature in

the canals along with a resultant lower saturation value, and high organic levels accounted for the lower levels of dissolved oxygen.

The lowest level of dissolved oxygen in the canal system was 3.2 ppm and occurred once at Station F-1 (Power Plant Discharge Canal). This value illustrated the inverse relationship between temperature and oxygen solubility. Even the lowest D.O. reported was sufficient for the organisms living in the canal system.

Physical data for 1978 vs. 1979 was as shown in Figures 3 - 8.

Zooplankton - nutrient data

Introduction

The purpose of these analyses was to monitor nutrient levels in relation to the plankton community dynamics for the canal system and Card Sound/Biscayne Bay.

Methods

Samples were collected quarterly from 12 sample points within the canal system, and three control sample points in Biscayne Bay and Card Sound (Figures 1 and 2).

Acid washed, ground glass stoppered, clear containers were used for the ammonia samples. Five milliliters of Phenol/Ethanol solution were added as the preservative. Acid washed, ground glass, stoppered, dark containers were used for the other nutrient samples with 0.5 milliliters of 0.2N Mercuric Chloride added as the preservative.

All analyses were performed either on a Beckman DU-2 Spectrophotometer or a Technicon (CS-M-6) Autoanalyzer. Nitrite, nitrate and inorganic phosphate were determined by Technicon methodology modified by Klaus Grasshoff. Ammonia was determined using the Phenol-Hypochlorite method and total phosphate was measured using EPA method, 1979. Data were reported in ppm.

Comparisons to previous years data, refer to FP&L Annual and

Semi Annual Environmental Monitoring Reports #1 - 12 (1973-1978).

Results, Discussion and Conclusions

Generally, nutrient levels in the canal system were consistently higher than those levels in the bay and Card Sound (Figures 9 - 18).. The apparent cycling of the ammonia, nitrite, and nitrate, seen in the canal system in previous years was repeated in 1979. The nutrient levels at all sampling points in the canal system remained below any level that could be considered eutrophic. Pre-operational nutrient results (Bader & Roessler, 1972) are not comparable with current data due to differences in analytical procedure.

Ammonia

Ammonia levels in the canal system were between 0.011 ppm and 0.169 ppm. At the bay control stations the maximum level was 0.059 ppm and the minimum level was 0.007 ppm. The average canal values were roughly twice the average bay control values (Tables 1 and 3). Trend data for 1978 and 1979 appear in Figures 9 and 10.

Due to the operation of the Interceptor Ditch pumps during the second quarter, the ammonia levels at Station WF-2 were above the levels found in the rest of the canal system.

Nitrite

Nitrite levels in the canal system were between 0.029 ppm and

0.002 ppm. Canal nitrites for 1979 showed trends similar to 1978. At the bay control stations the maximum level was 0.018 ppm and the minimum level was 0.002 ppm. The average canal value was approximately twice the average bay control value. There was no significant change in this nutrient level in either canal or bay from the 1978 values (Figures 11 and 12). The canal nitrite levels showed a mean decline which was characteristic of the apparent long term trend, while the bay nitrite levels remain relatively stable (Tables 1 and 3).

Nitrate

Nitrate levels in the canal system were between 0.649 ppm and 0.009 ppm. At the bay control stations the maximum level was 0.237 ppm and the minimum level was 0.022 ppm. The average canal value was approximately five times the average bay control value. There was a notable increase in average values of the canal system and bay over 1978 values (Figures 13 and 14). This was indicative of the long term trend of increasing nitrate levels (Tables 1 and 3) in both bay and canal.

Inorganic Phosphate

Inorganic phosphate levels in the canal system were between 0.019 ppm and 0.000 ppm. At the bay control stations the maximum level was 0.025 ppm and the minimum level was 0.000 ppm. The mean value for the canal system was equal to the bay mean value. Mean values of the canal system were 1/2 those of 1978. There were no

significant changes in the bay during the 1978 to 1979 time period (Figures 15 and 16). The average canal values continued a slow decline while the bay values remain relatively stable (Tables 1 and 3).

Total Phosphate

Total phosphate levels in the canal system were between 0.064 ppm and 0.009 ppm. At the bay control stations the maximum level was 0.066 ppm and the minimum level was 0.009 ppm. Between 1978 and 1979 the average total phosphate levels in the bay doubled while the canal system's dropped slightly. The 1979 average canal value was approximately one third higher than the bay control value (Figures 17 and 18). Average yearly total phosphate levels continued a slow decline in the canals, but appeared to be increasing in the bay (Tables 1 and 3). Phosphate was still thought to be the limiting nutrient in the Card Sound Basin; it was speculated that macroalgae kept the levels low and diuturnal flushing characteristics of the basin inhibited replenishment.

Zooplankton - organisms

Introduction

The purpose of this section was to analyze qualitatively and quantitatively the standing crop of the planktonic primary consumers in the canal system and bay.

Methods

A 5 inch diameter Clark-Bumpus sampler with a number 10 mesh (158 micron) net and bucket were used to entrain zooplankters. Plankton tows were performed in the top meter of the water column at speeds of 1 to 3 mph. Each tow lasted 3 minutes in the bay and 5 minutes in the canal system (Figures 1 and 2). Zooplankton organismal densities were obtained using the Lackey Drop Method (APHA, 1975).

Zooplankton organisms were divided into six categories as following:

a. Copepods included cyclopoid, harpactidoid, and calanoid copepods.

b. Gastropods included all gastropod veligers.

c. Bivalve larvae included all bivalve veligers.

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

e. Cirriped nauplii were separated from all other nauplii.

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

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

Comparisons to previous years data, refer to FP&L Annual and Semi Annual Environmental Reports #1 - 12 (1973-1978).

Results, Discussion and Conclusions

Copepods

The mean copepod levels for the canal system decreased slightly from 0.15 organisms per liter in 1978 to 0.14 organisms per liter in 1979. The means still appeared to be fluctuating around 0.10 per liter. The percent of total plankton population represented by copepods decreased from 70% in 1978 to 29% in 1979.

The mean level of copepods in the bay steadily increased from 3.08 organisms per liter in 1976, 3.80 in 1977, 5.34 in 1978 to 7.20 in 1979. The mean concentration for the bay was 51 times greater than the concentration in the canal system (Figures 19 and 20). Copepods represented 73.4% of the plankton population. This is a decrease of almost 6% from 1978. The change in both bay and canal copepods was due more to the increase of other plankton populations than it was to a decrease in copepods.

Gastropods

The gastropod veligers increased in the canal system from an

average of 0.036 organisms per liter or 17% of-the total plankton population in 1978 to 0.302 or 64% of the total plankton population in 1979. Gastropods are highly adventitious organisms capable of thriving in a broad range of habitats and changing conditions. High gastropod veliger densities occurred at several stations this year. F-1 and WF-2 still represented the stations with greatest densities. Both these stations were atypical and unstable relative to the rest of the system. The stations F-1, nearest the discharge, had high thermal fluctuations, and WF-2 in the southwest corner had the greatest variation in chemical characteristics. Seasonal trends were difficult to discern due to change in monitoring frequency (Figure 21).

In Biscayne Bay and Card Sound, the mean gastropod concentration increased from 0.85 organisms per liter or 13% of the total plankton in 1978 to 1.57 organisms per liter or 16% of the total plankton populations in 1979. Although several "blooms" occurred, their concentrations remained fairly uniform throughout the year. Most notable among the "blooms" was one that occurred at Station 5 in the fourth quarter of this year (Figure 22), in which a density of 17.89 organisms per liter was recorded. In general, the 1979 mean density of gastropods in the bay was 5 times greater than the gastropod density level in the canal system (Tables 2 and 4). In comparison, last year there was only a 4-fold difference in mean density levels between bay and canal system.

Bivalve Larvae

Thermal exclusion of the larvae during initial open mode operation and subsequent inadequate adult base populations (e.g. 1968-1972) continued to be the apparent reasons for bivalve larvae being almost totally absent from the canal system (Figure 23).

The mean concentration for bivalve larvae in the bay has dropped by 20% this year (Table 4). The trend of the last four years may be reversing itself (Figure 24).

Copepod and Cirriped Nauplii

Both nauplii were too small to be adequately sampled by a #10 mesh (158 micron) net. Copepod nauplii were noted in the canal system in the first quarter only. Densities of this organism were very low with a maximum of 0.011 organisms per liter (Figure 25). The mean concentration for 1978 was 0.006 organisms per liter, or 3% of the total plankton population, relative to 0.001 or 2% in 1979.

The cirriped nauplii were noted in the canal samples for the first and third quarters only (Figure 27); they were never present at a concentration greater than 0.01 per liter or 0.2% of the total plankton population.

In Biscayne Bay and Card Sound, copepod and cirriped nauplii continued to be present at low levels (Figures 26 and 28). The mean

copepod nauplii concentration was 0.14 organisms per liter or 2% of total plankton populations in 1978 and 0.067 or 0.06% in 1979, while the cirriped nauplii concentration was 0.016 organisms per liter or 0.2% in 1978 and only 0.027 or 0.3% in 1979.

Other Plankton

The mean density of the other plankton in the canal system increased slightly from 0.02 organisms per liter or 8% of the total plankton population in 1978 to 0.03 or 6% of the total population in 1979.

In Biscayne Bay and Card Sound the mean concentration of other plankton increased from 0.31 organisms per liter or 5% of total plankton in 1978 to 0.85 or 8.7% in 1979.

The "n^{th}-fold" difference factor in density levels between the bay and canal system appeared to be increasing i.e., 11-fold in 1977, 18-fold in 1978, and 31-fold in 1979 (Tables 2 and 4). Seasonal and quarterly trends for 1978 and 1979 respectively can be found in Figures 29 and 30.

The "Other Plankton" category includes the fish eggs, fish larvae, zoea and megalops of various crustaceans, cladocerans, ostracods, chaetagnaths, tunicate larvae, polychaete larvae, echinopluteii, bipinnaria, and medusae.

Total Plankton

Zooplankton concentrations in the canal system were consistently lower than those found in Biscayne Bay and Card Sound (Figures 31 and 32). The bay total plankton density was 19-fold higher in 1975 and 1976, 17-fold higher in 1977, 32-fold higher in 1978, and 21-fold higher than the canal system density in 1979. The fluctuations in the "n^{th}-fold" density trend was due to the extreme variability of bay plankton populations and not due to a large increase or decrease in canal plankton populations. In other words, the canal system showed little variability in population density with time.

Data for all groups of zooplankton can be found in Figures 19-32 for year 1978 vs. 1979 and Tables 1-4 for 1974 through 1979.

Present data are not comparable to the pre-operational data because of the different methods of collection and quantification that were employed i.e. different plankton net size, style, and taxonomic categories.

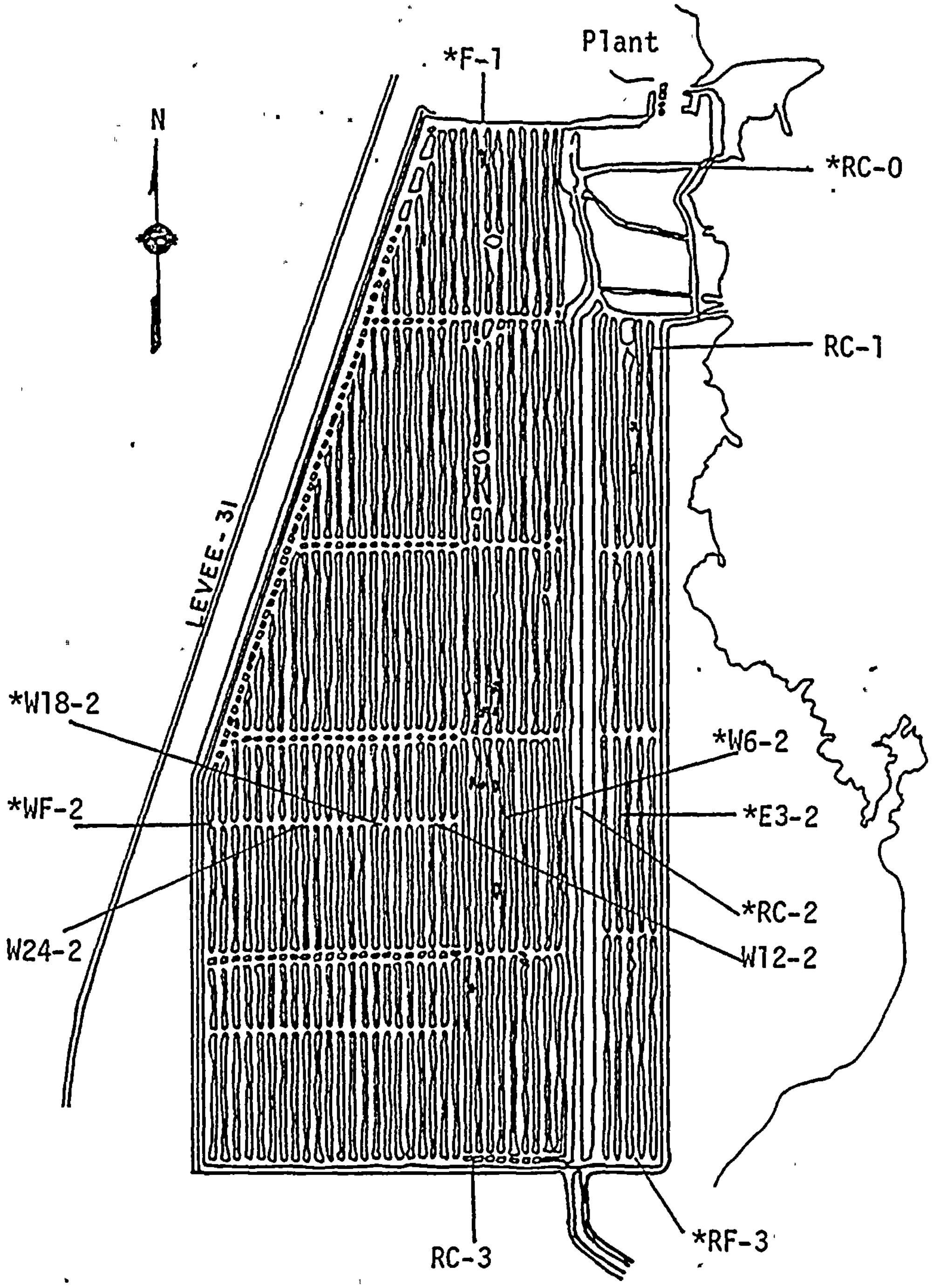

Figure 1. Physical, nutrient, and zooplankton sample sites at the Turkey Point Cooling Canal System. Zooplankton sites are indicated by (*).

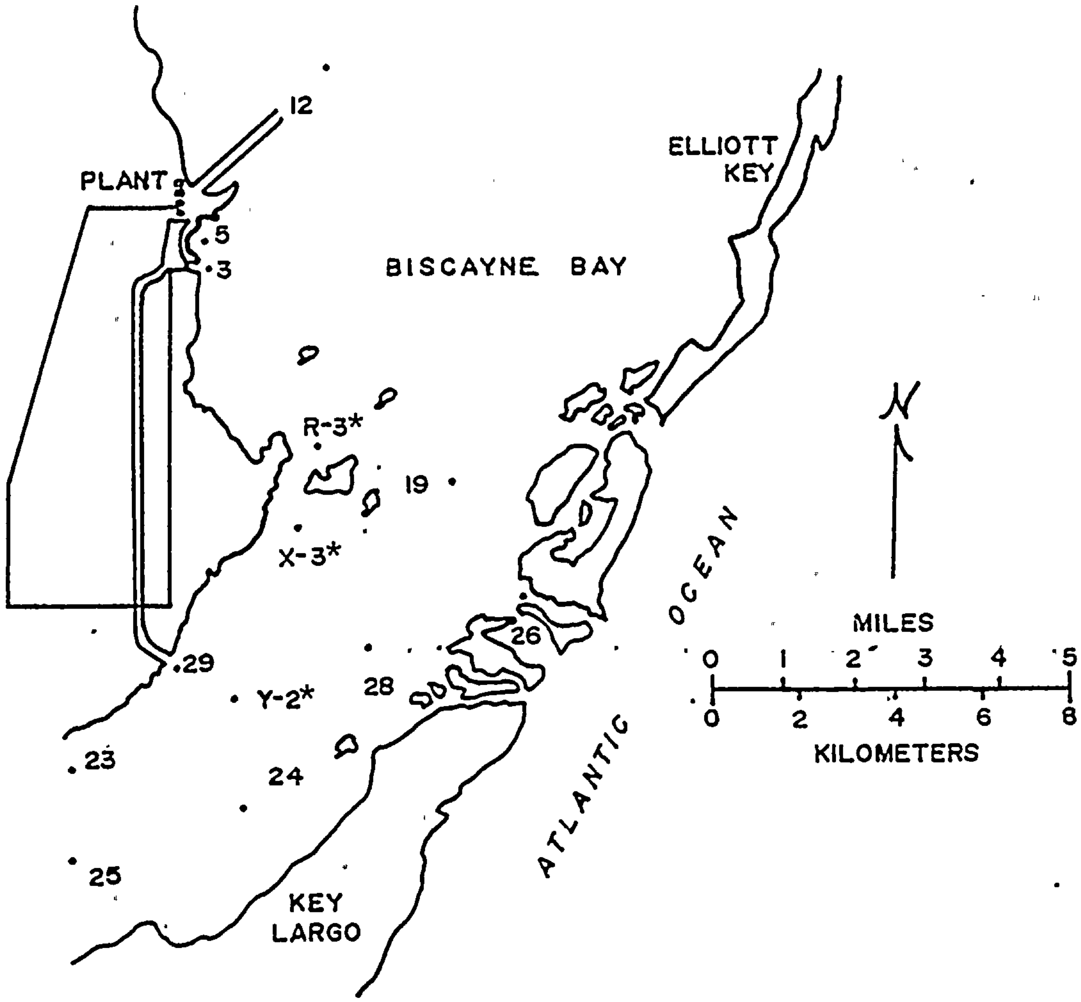

Figure 2. Physical, nutrient, and zooplankton sample sites in Biscayne Bay and Card Sound associated with the Turkey Point Cooling Canal System. Nutrient sites are indicated by (*).

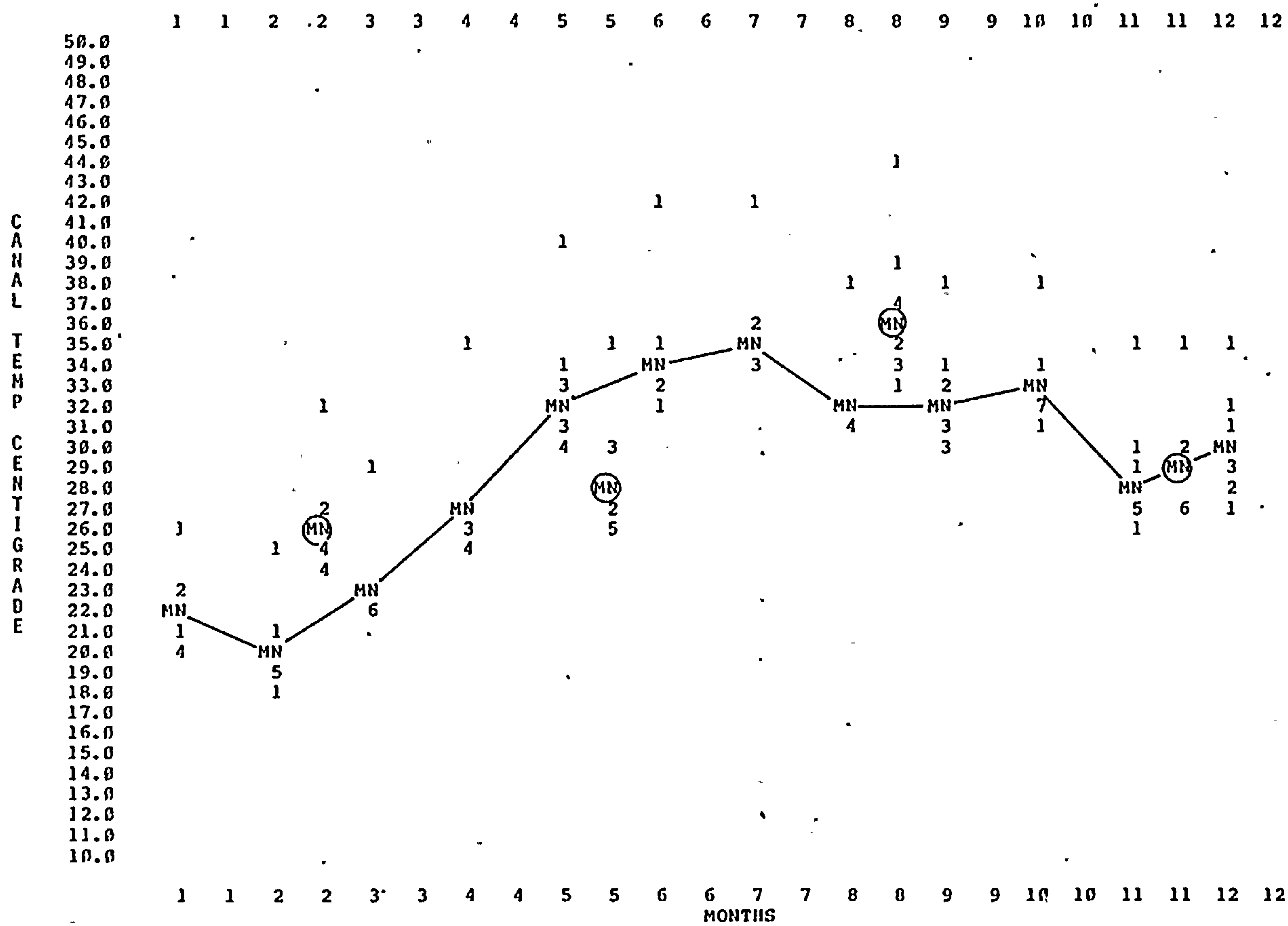

Figure 3. A comparison of temperature in the Canals for years 1978 (1st Column) and 1979 (2nd Column, circled) in degrees centigrade.

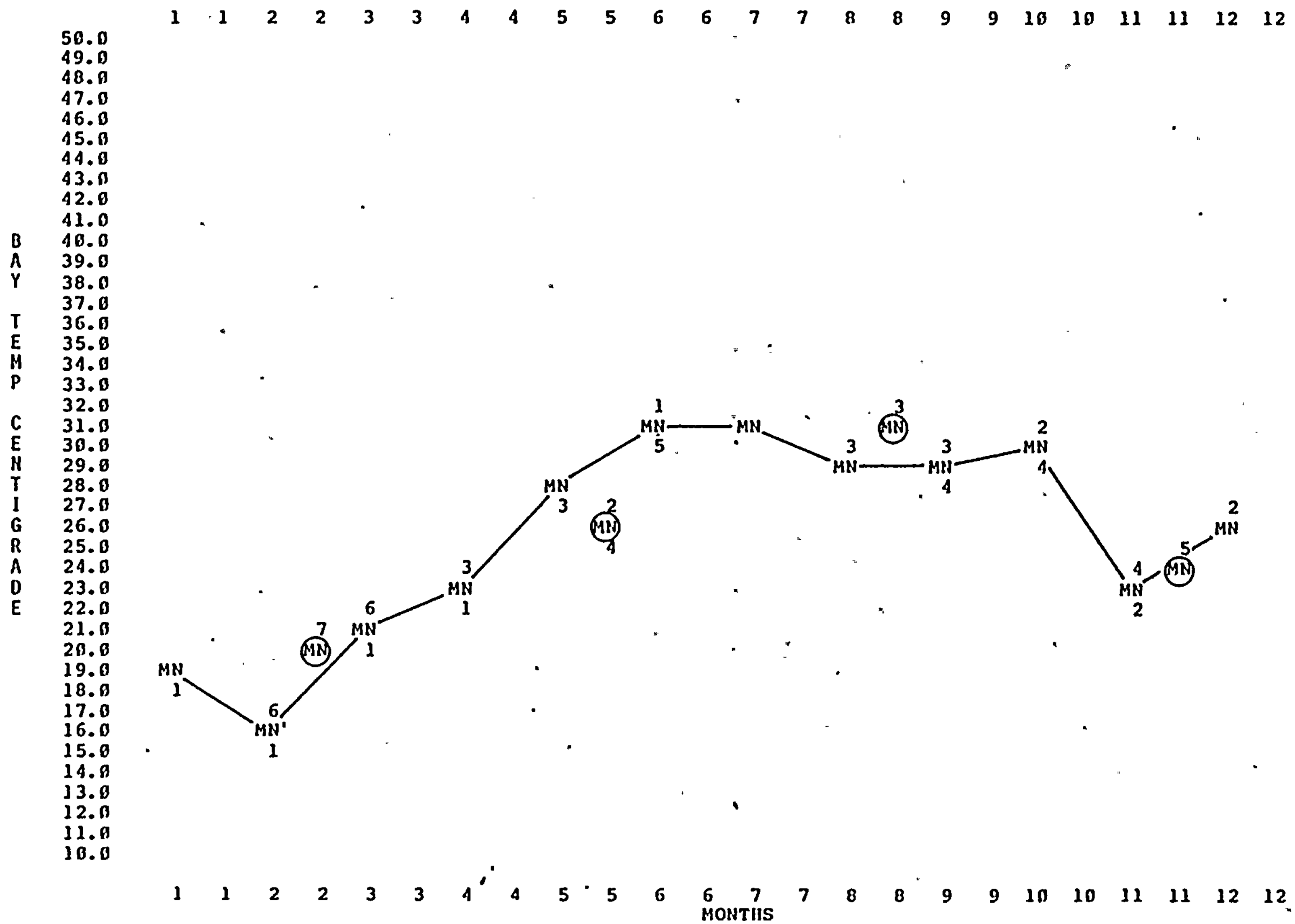

Figure 4. A comparison of temperature in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in degrees centigrade.

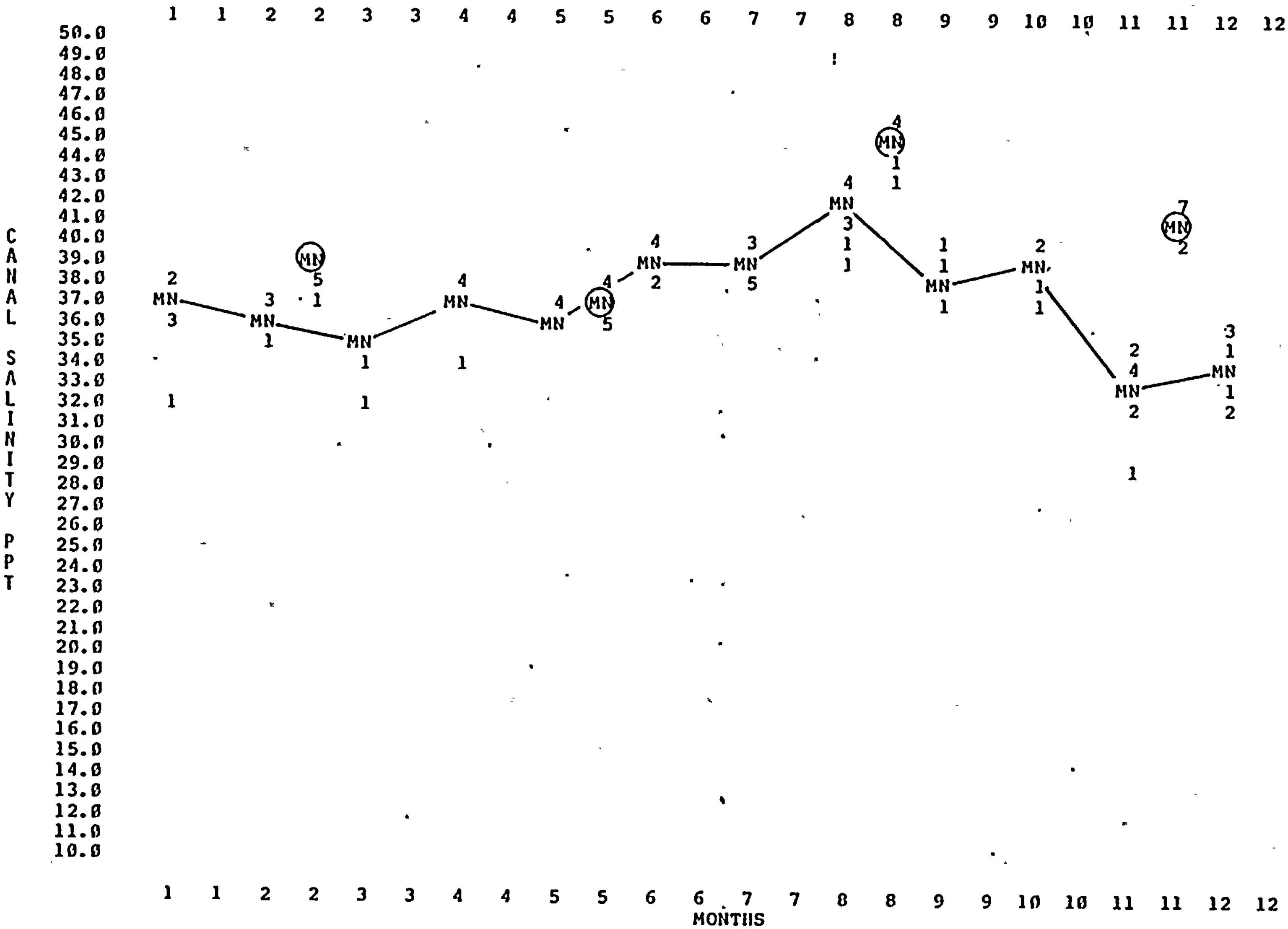

Figure 5. A comparison of salinity in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPT.

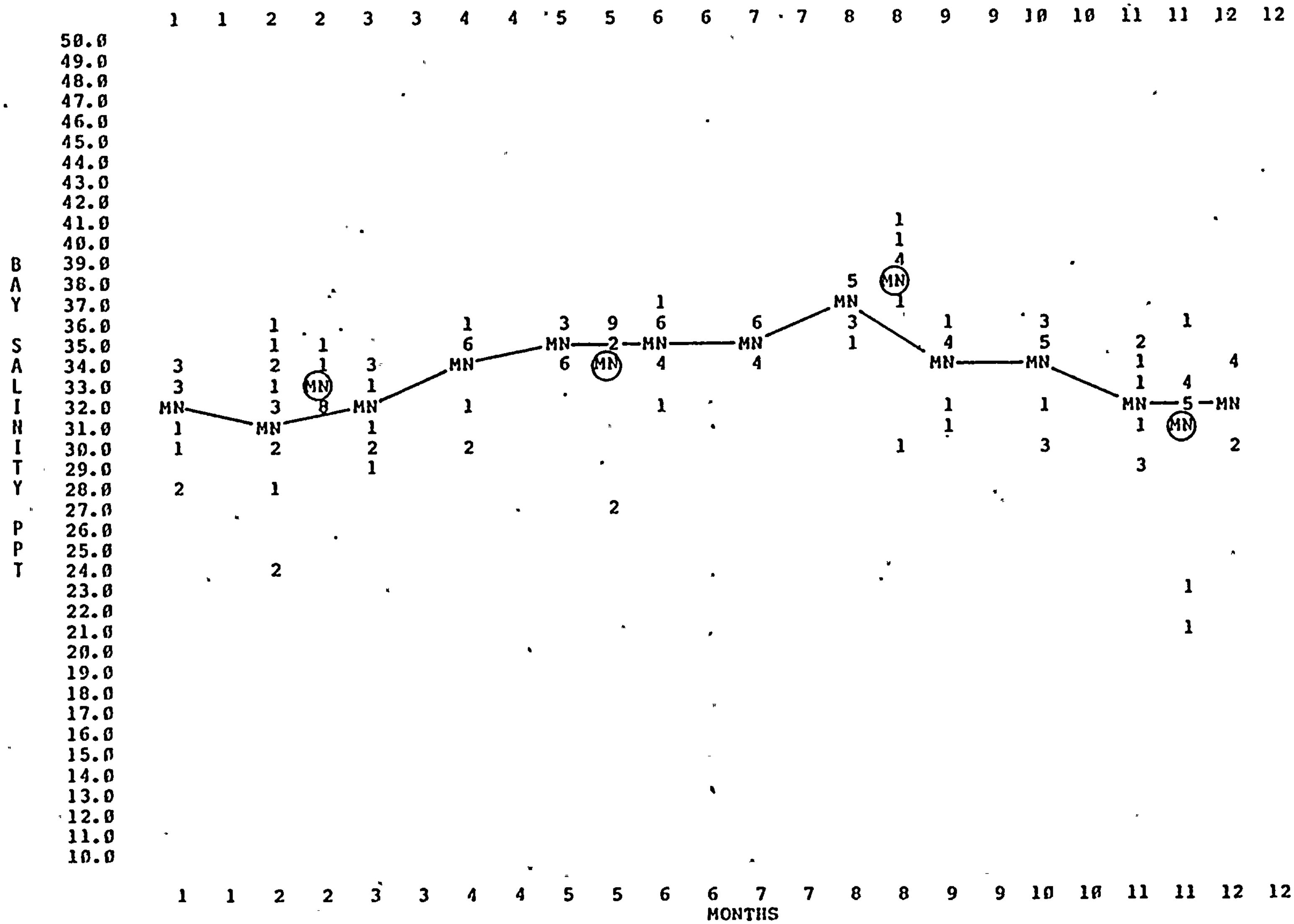

Figure 6. A comparison of salinity in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPT.

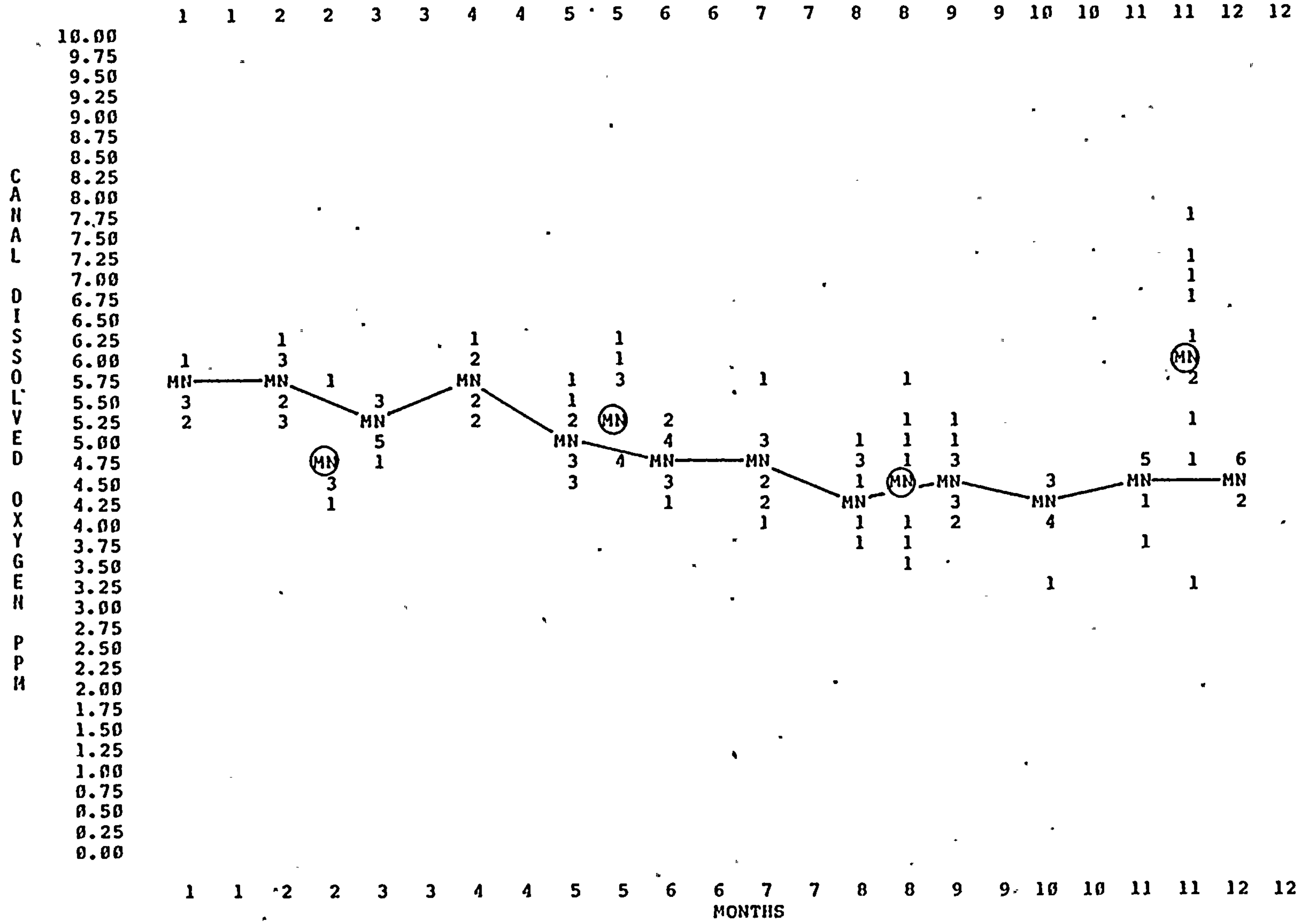

Figure 7. A comparison of dissolved oxygen in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM

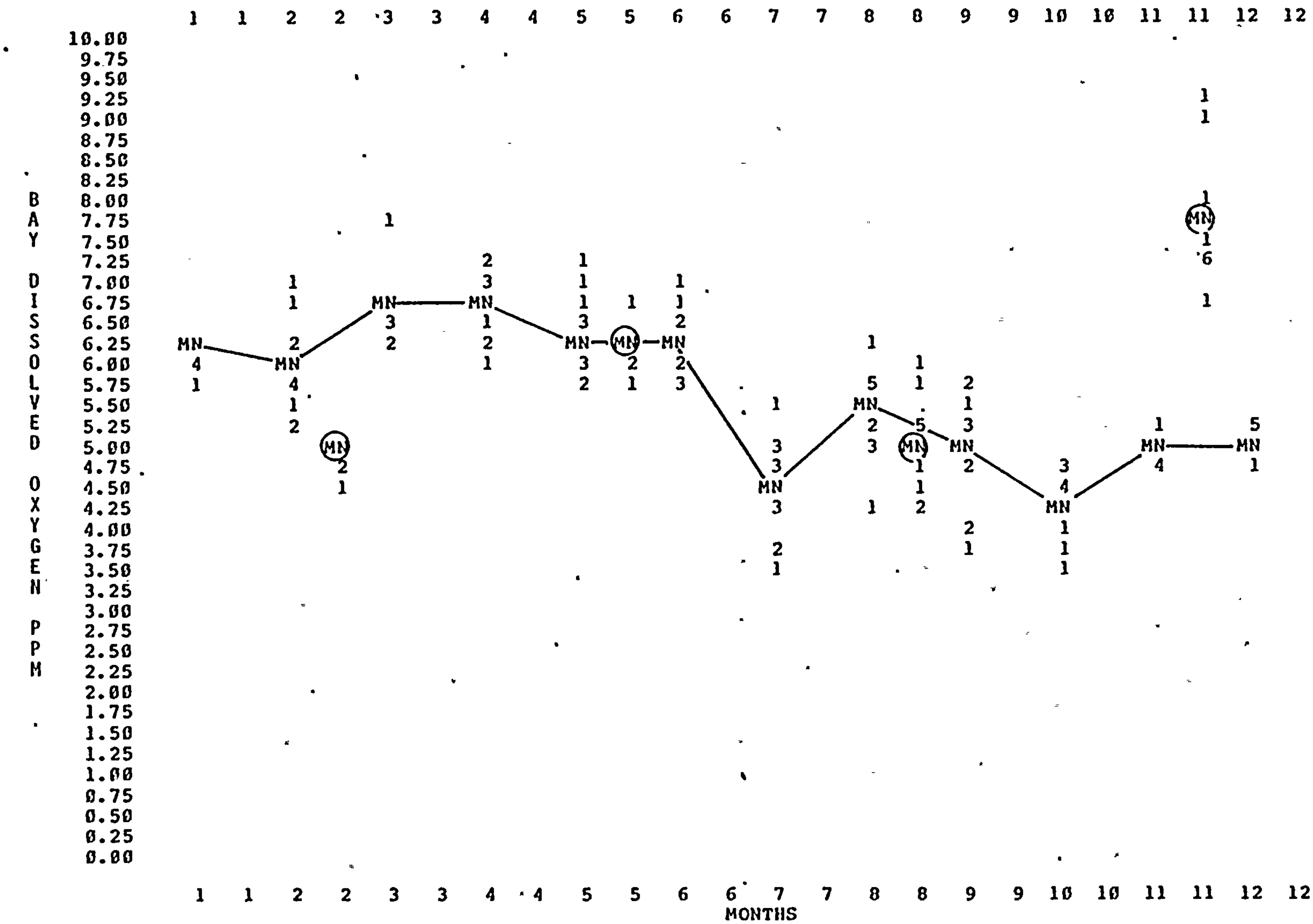

Figure 8. A comparison of dissolved oxygen in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM.

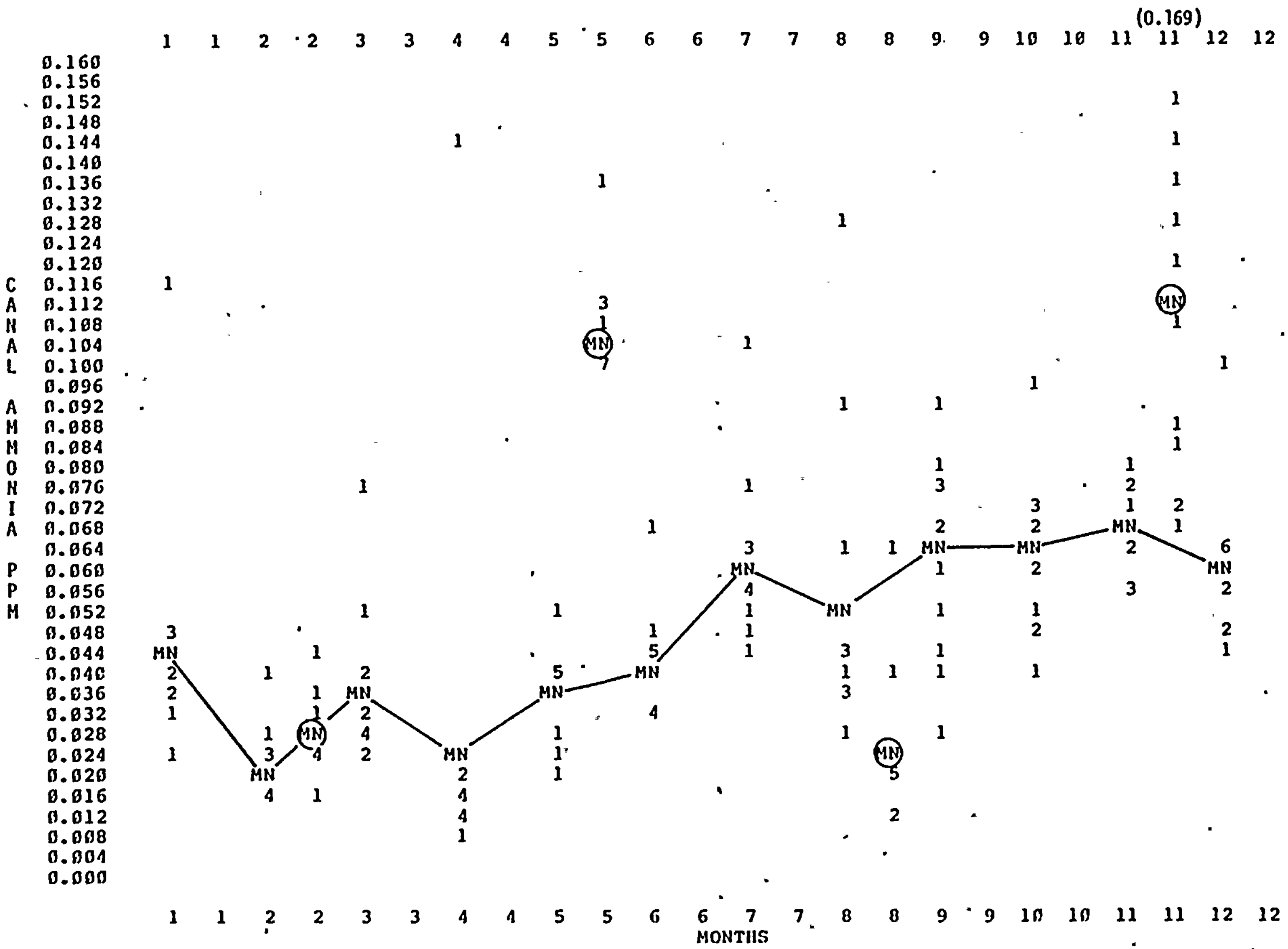

Figure 9. A comparison of ammonia in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM. Scaled 2X the Bay.

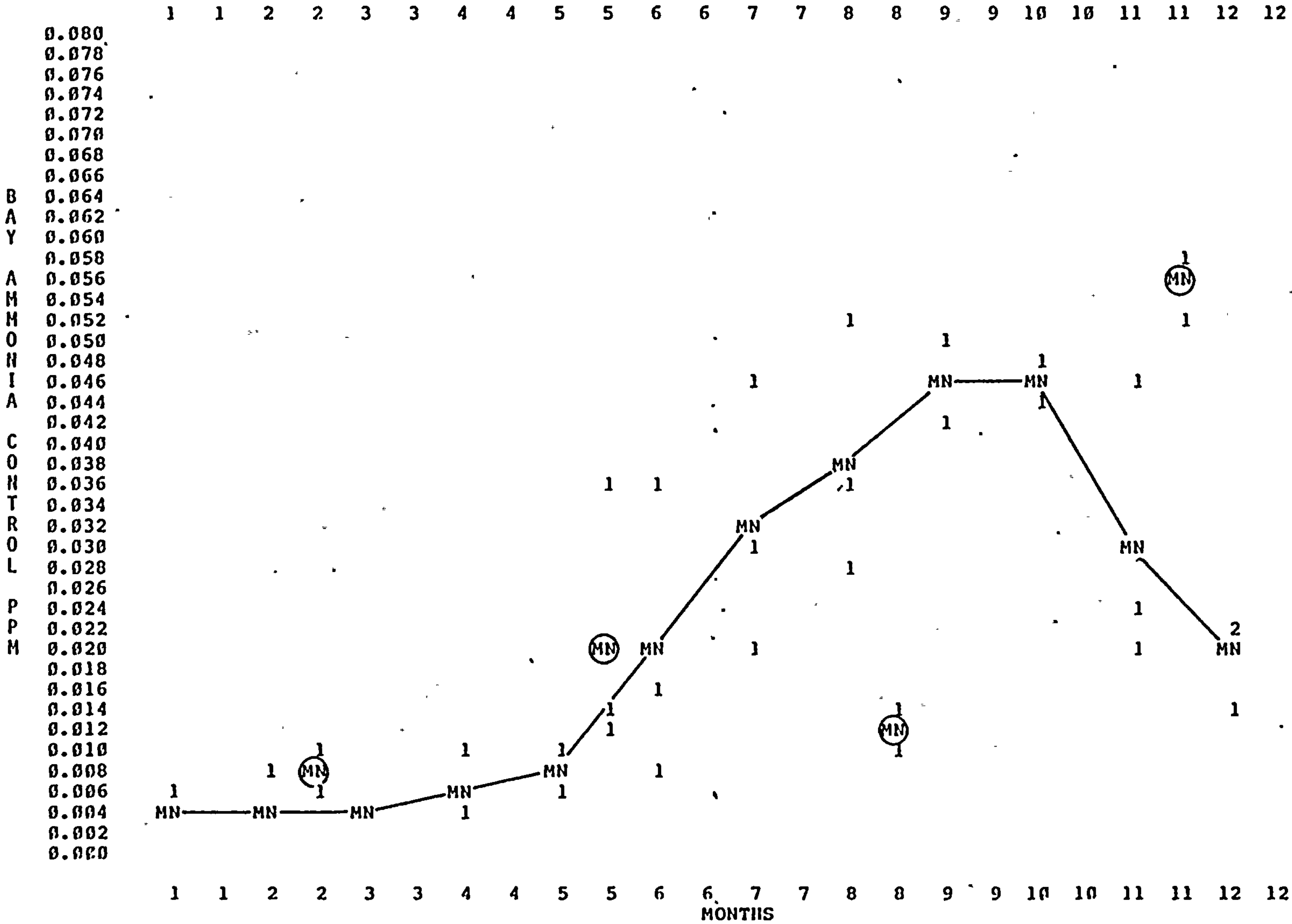

Figure 10. A comparison of ammonia in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM. Scaled 1/2X the Canals.

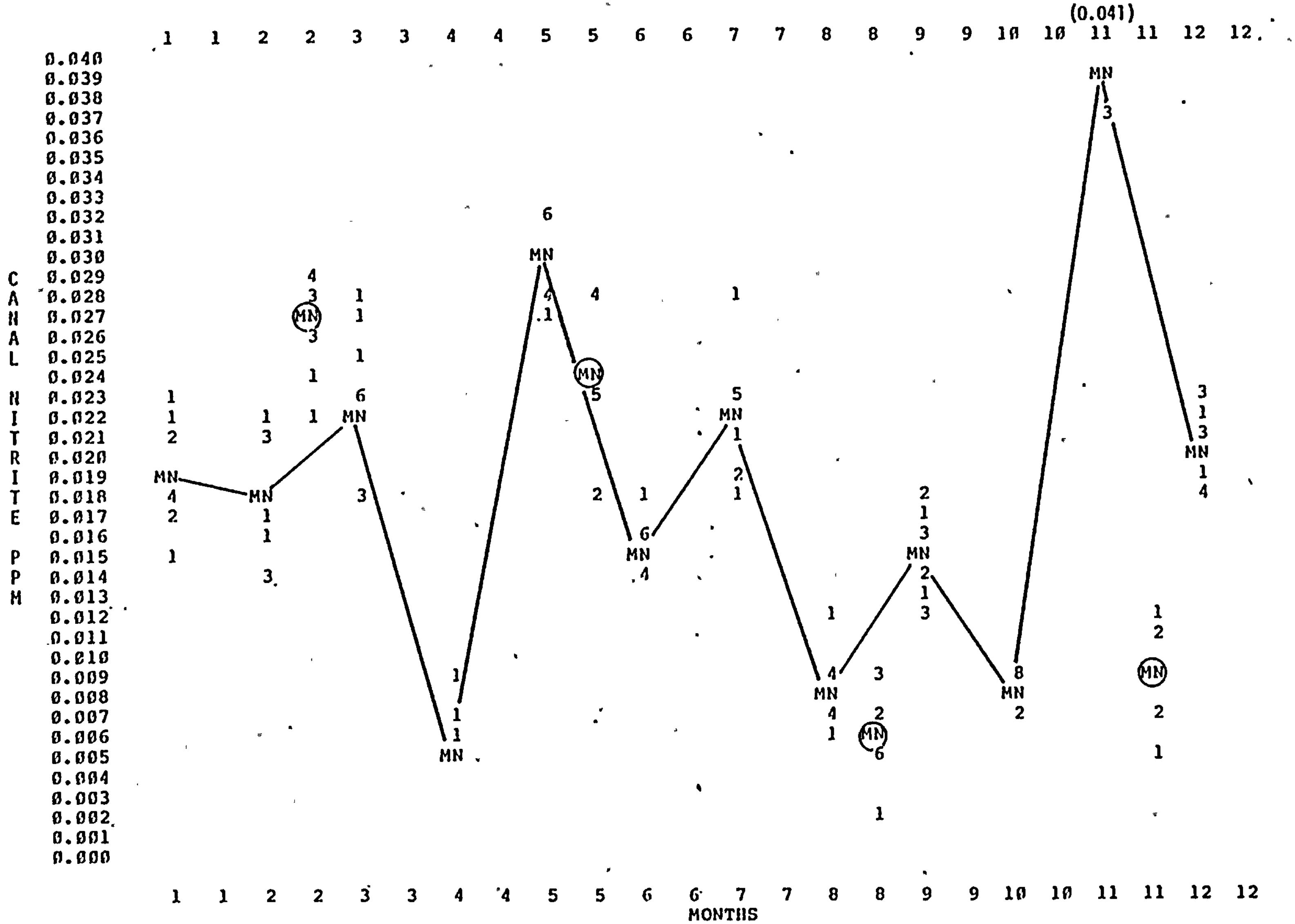

Figure 11. A comparison of nitrite in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM. Scaled 2X the Bay.

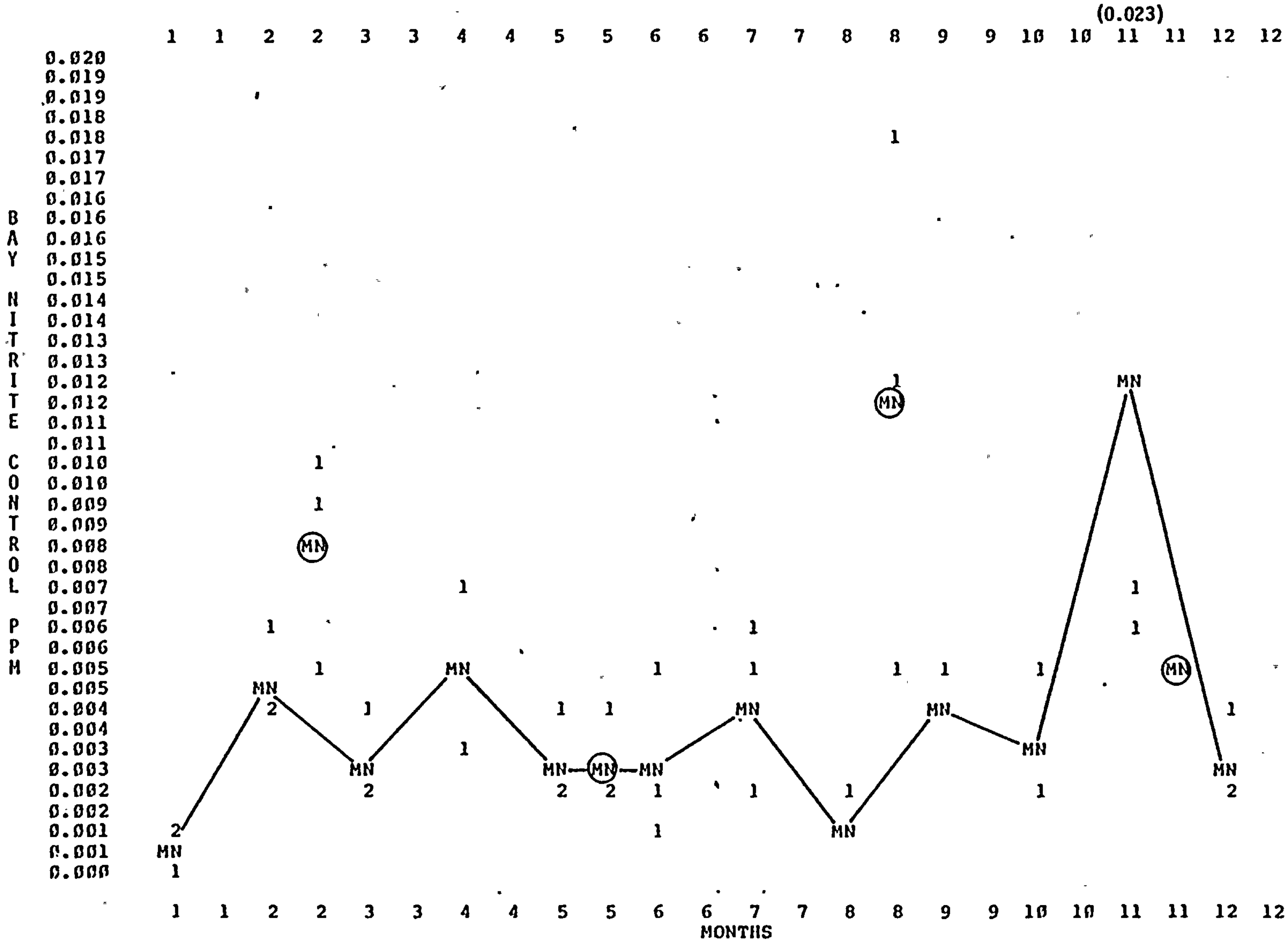

Figure 12. A comparison of nitrite in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM. Scaled 1/2X Canals.

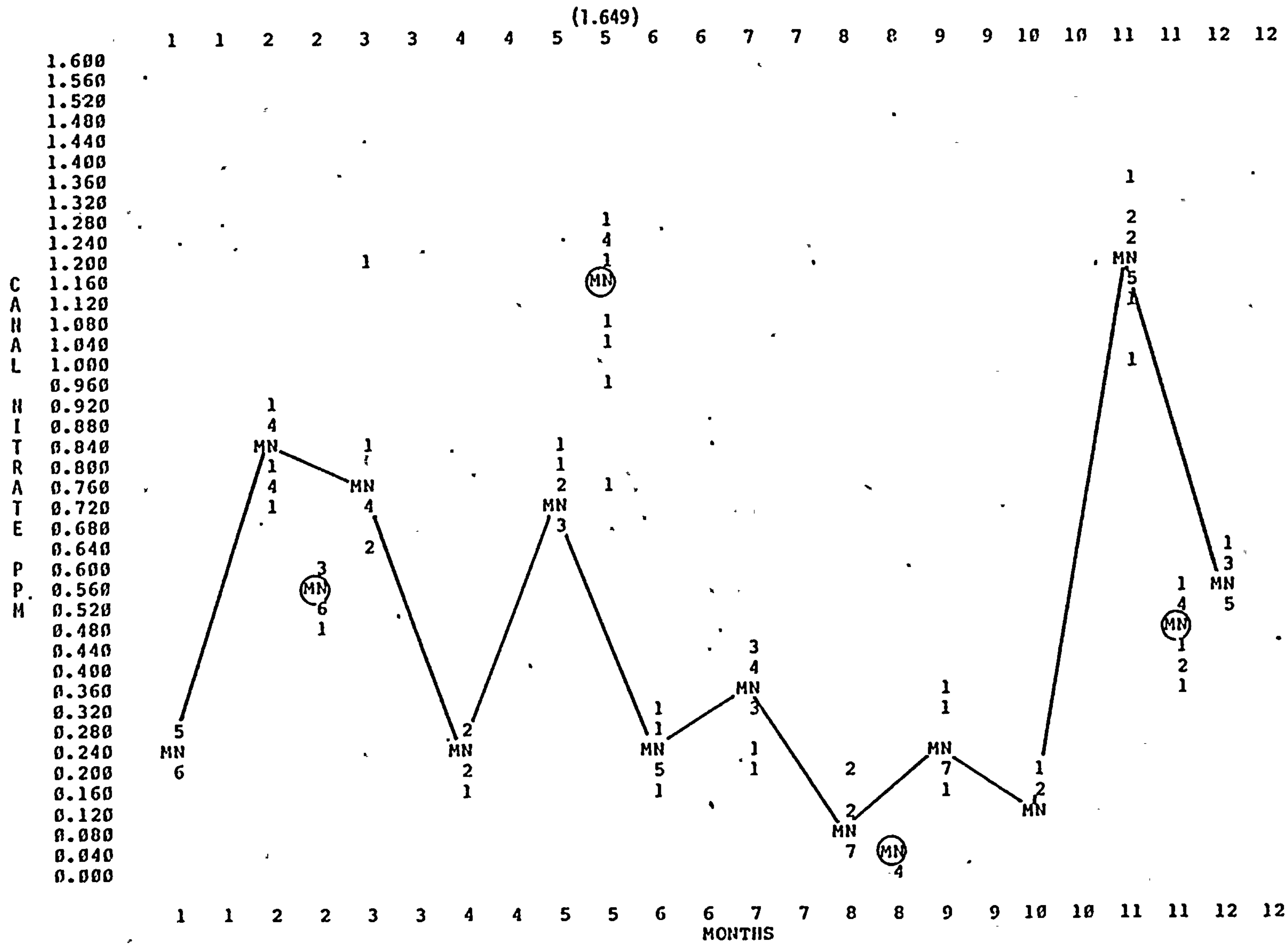

Figure 13. A comparison of nitrate in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM. Scaled 4X Bay.

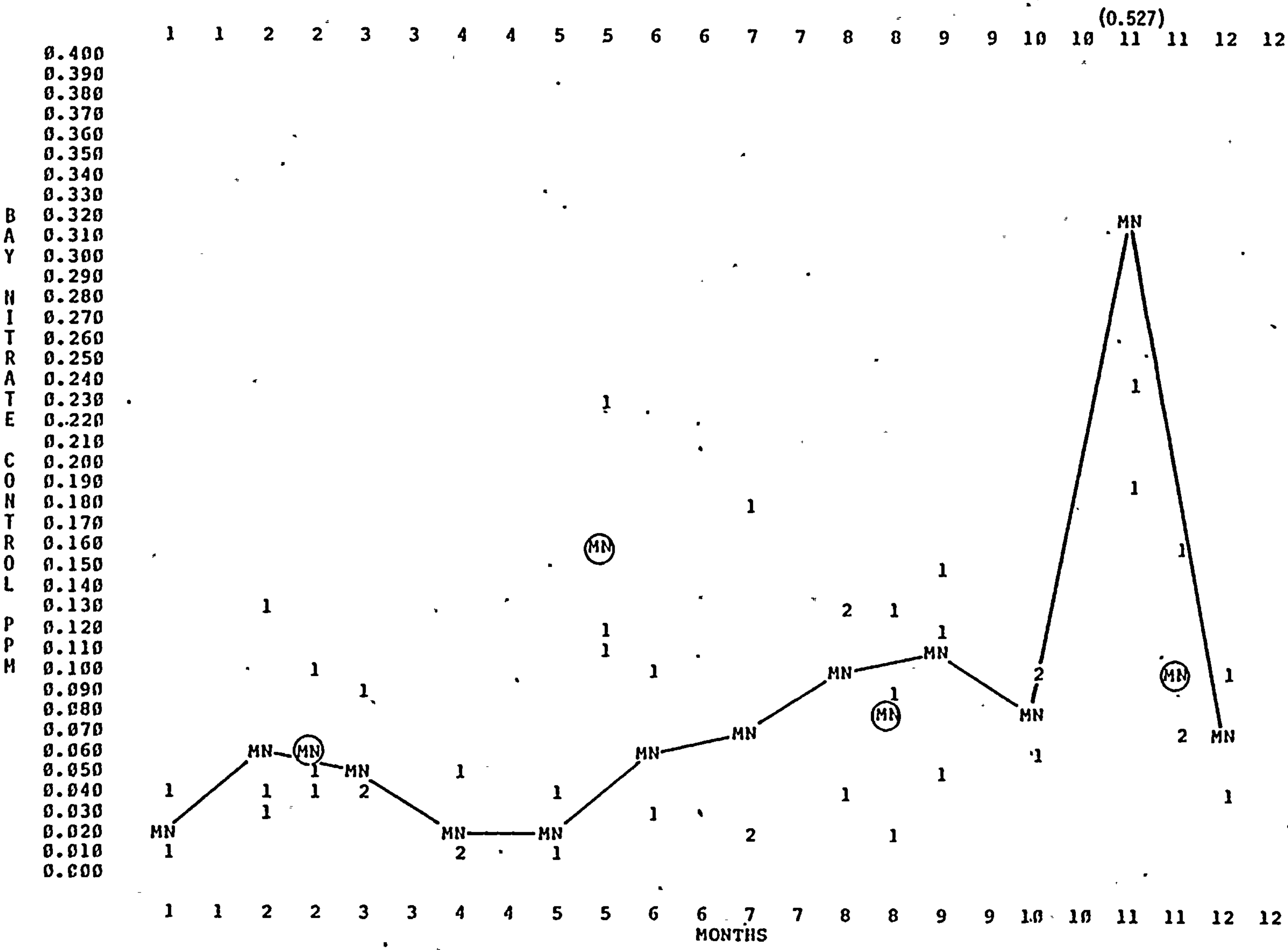

Figure 14. A comparison of nitrate in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM. Scaled 1/4th X Canals.

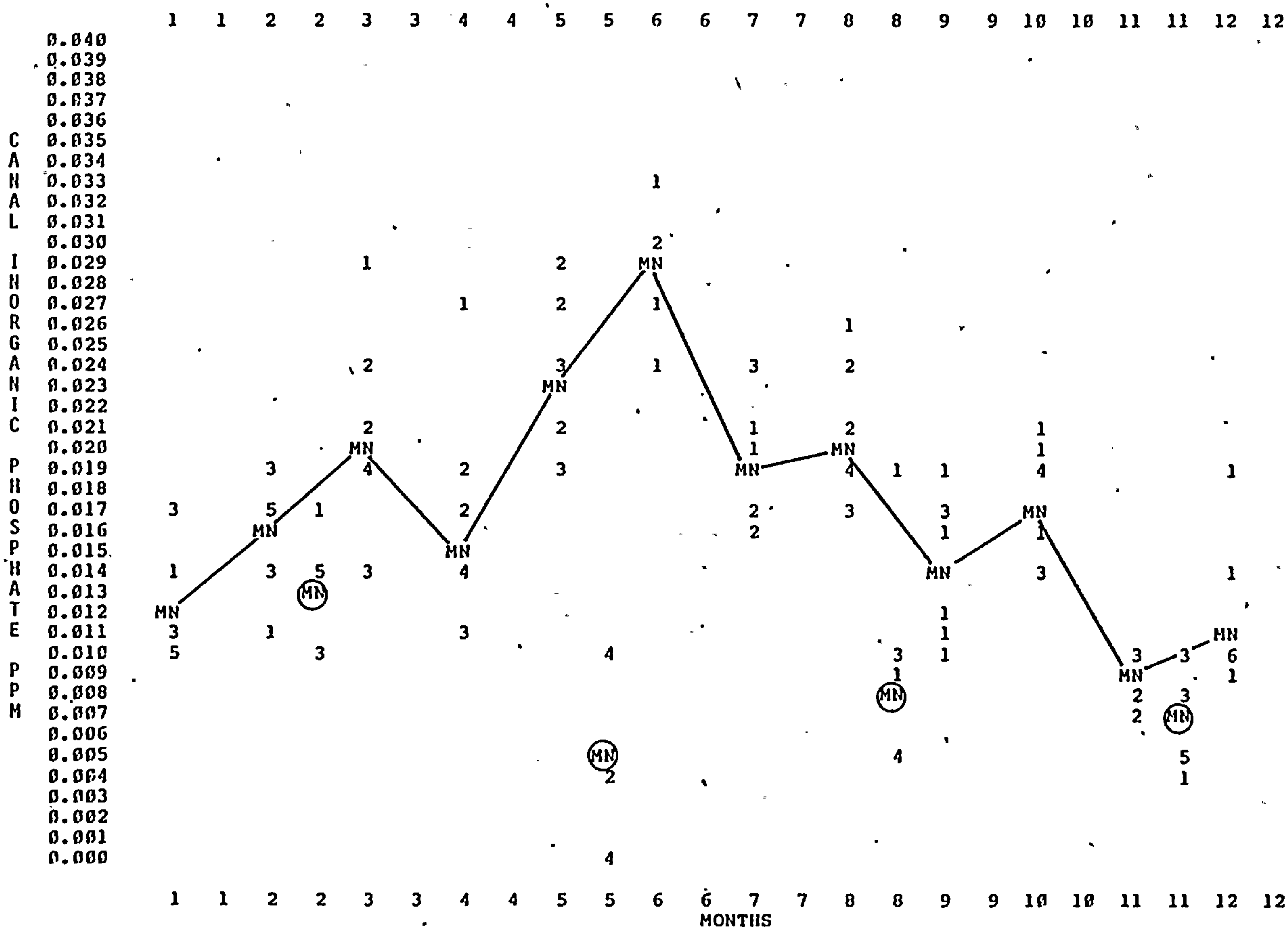

Figure 15. A comparison of inorganic phosphate in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM.

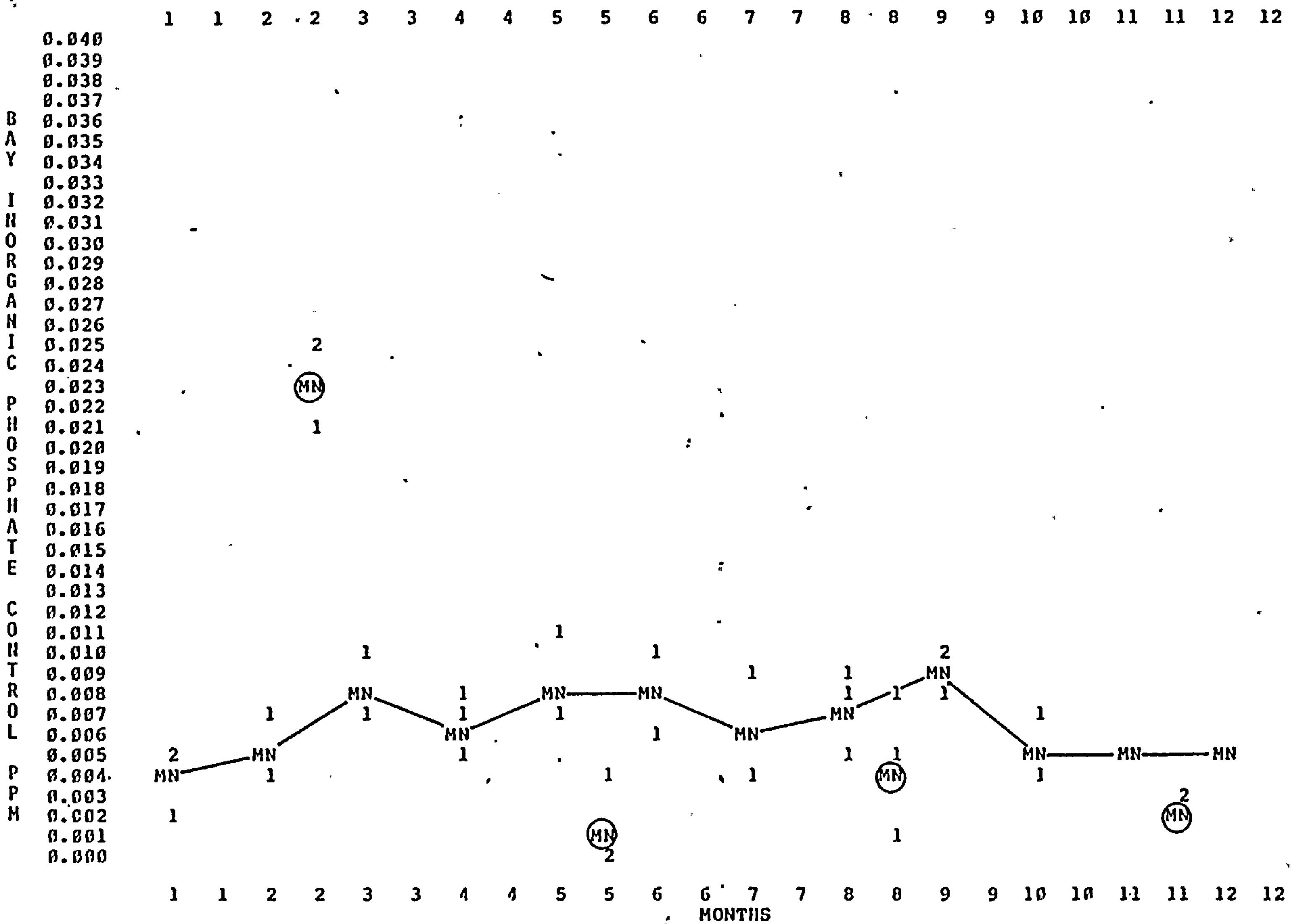

Figure 16. A comparison of inorganic phosphate in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM.

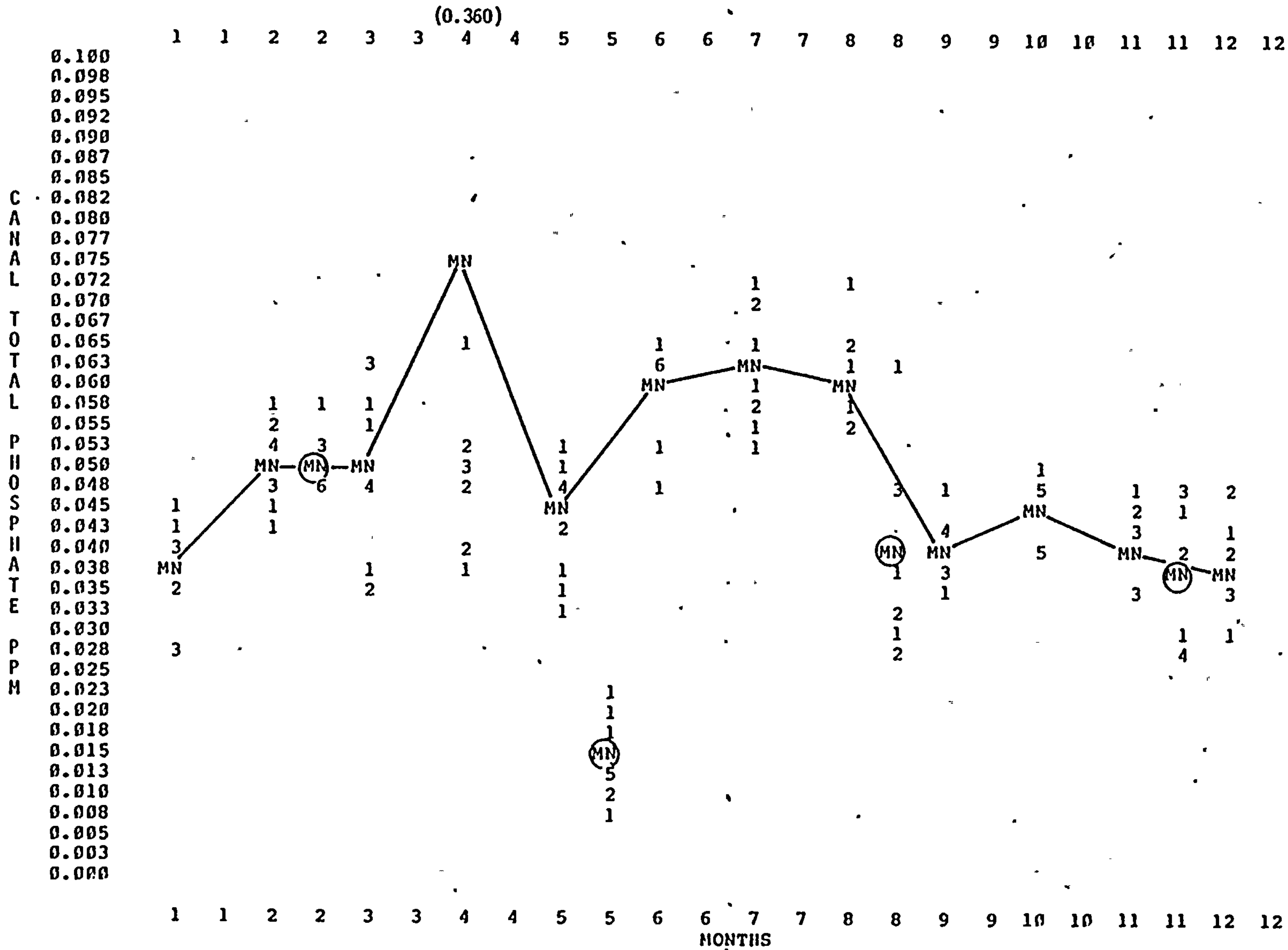

Figure 17. A comparison of total phosphate in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM.

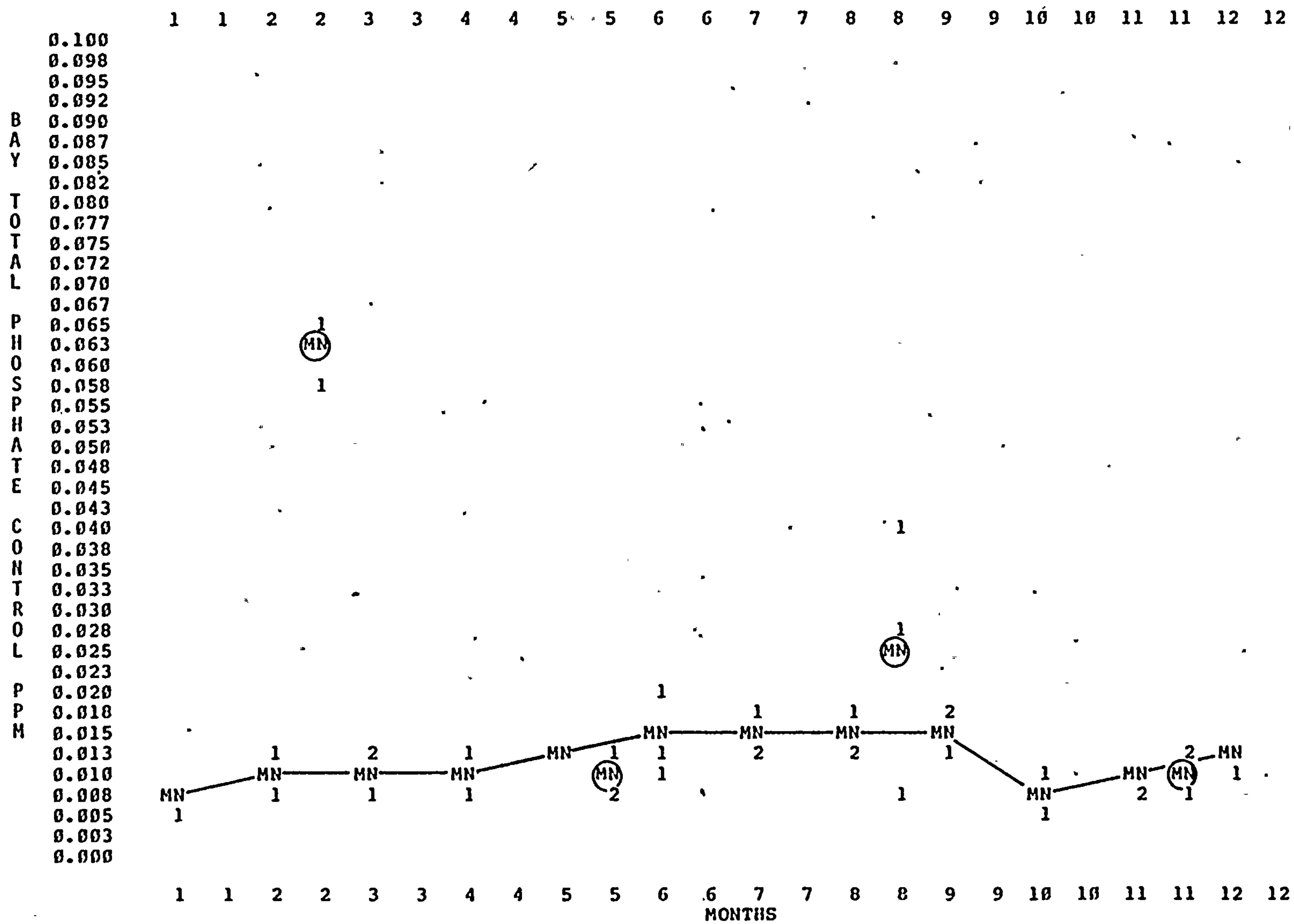

Figure 18. A comparison of total phosphate in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) in PPM.

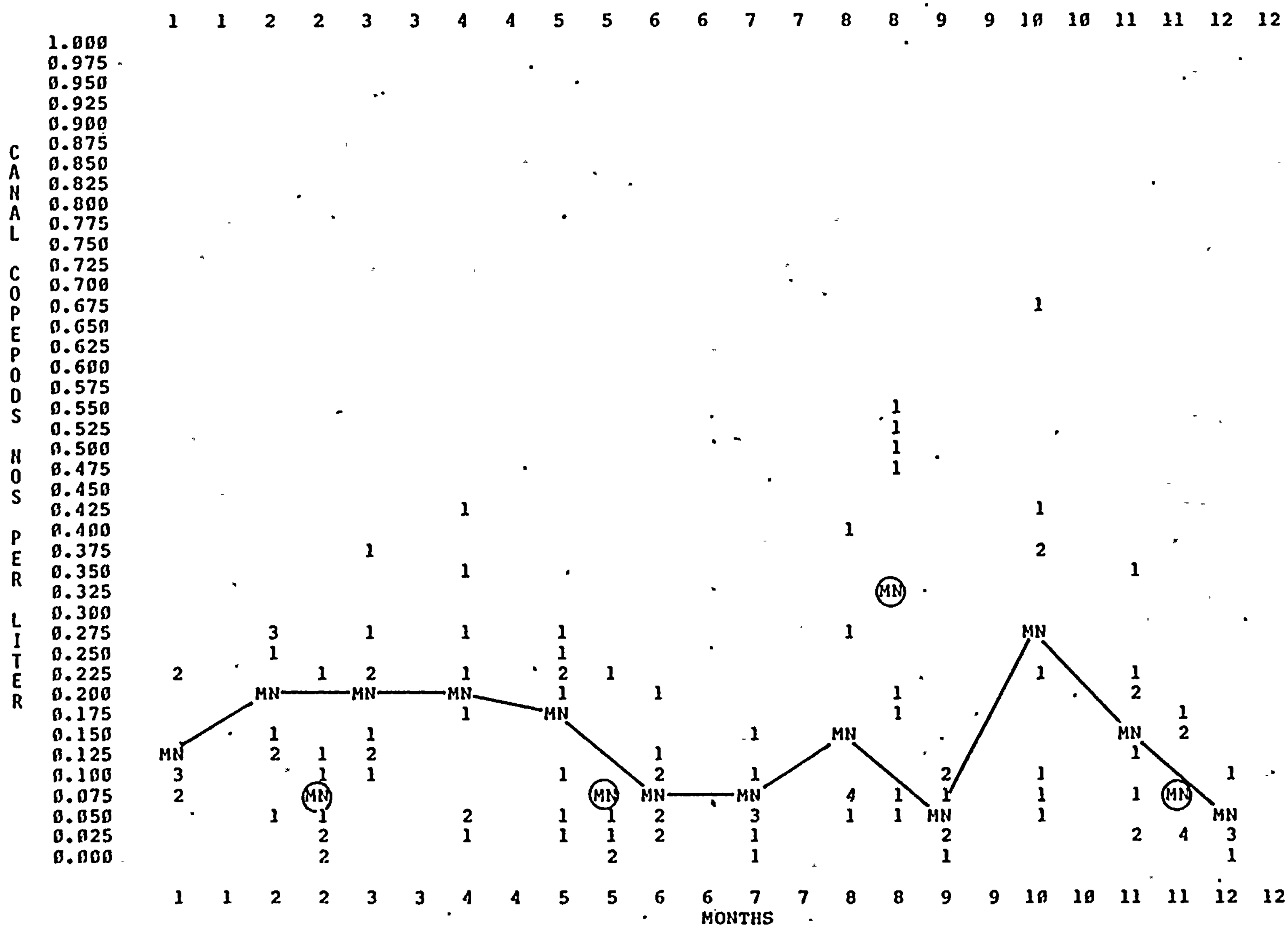

Figure 19. A comparison of Copepods in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/20th the Bay.

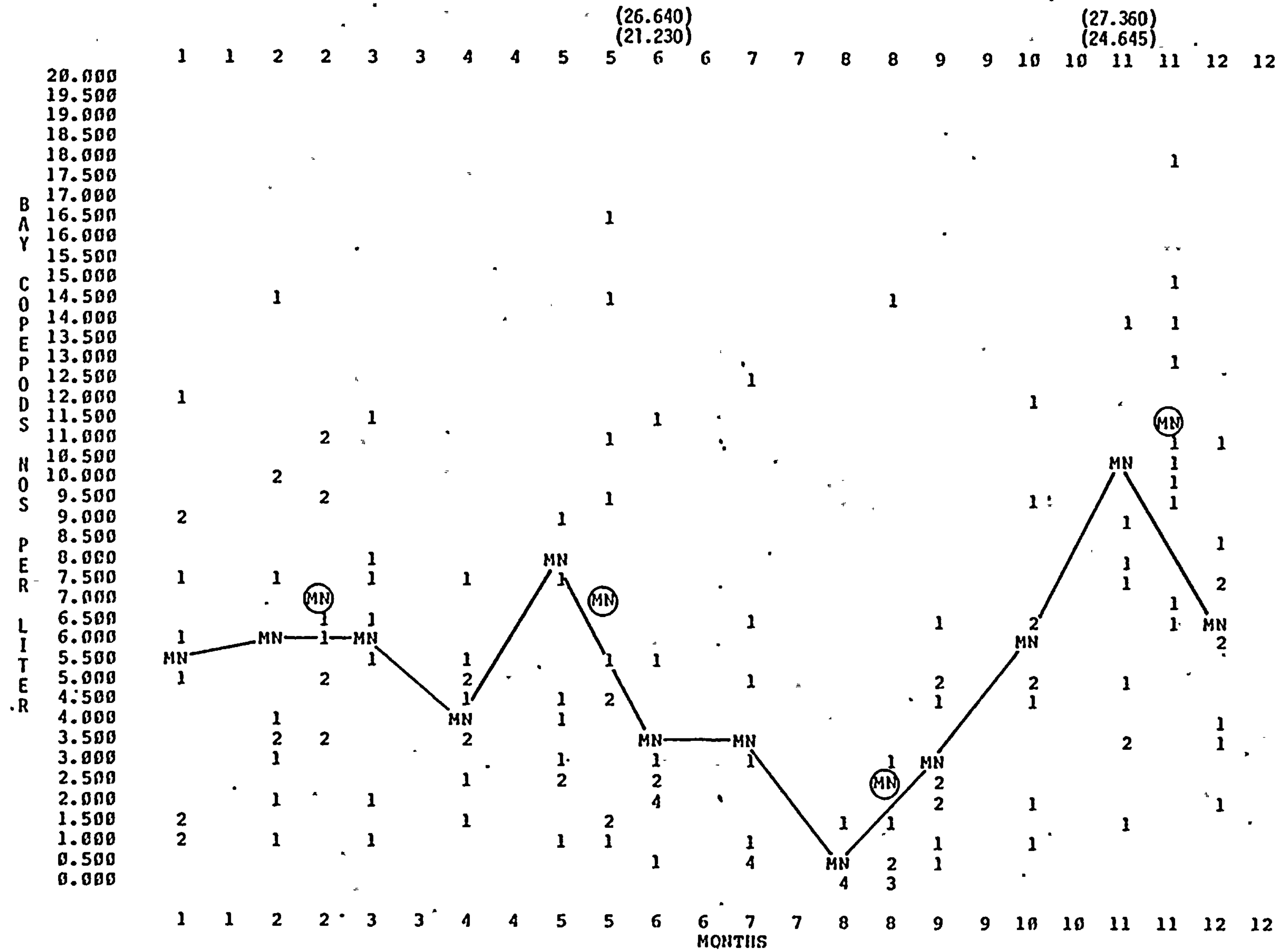

Figure 20. A comparison of Copepods in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 20 times the Canals.

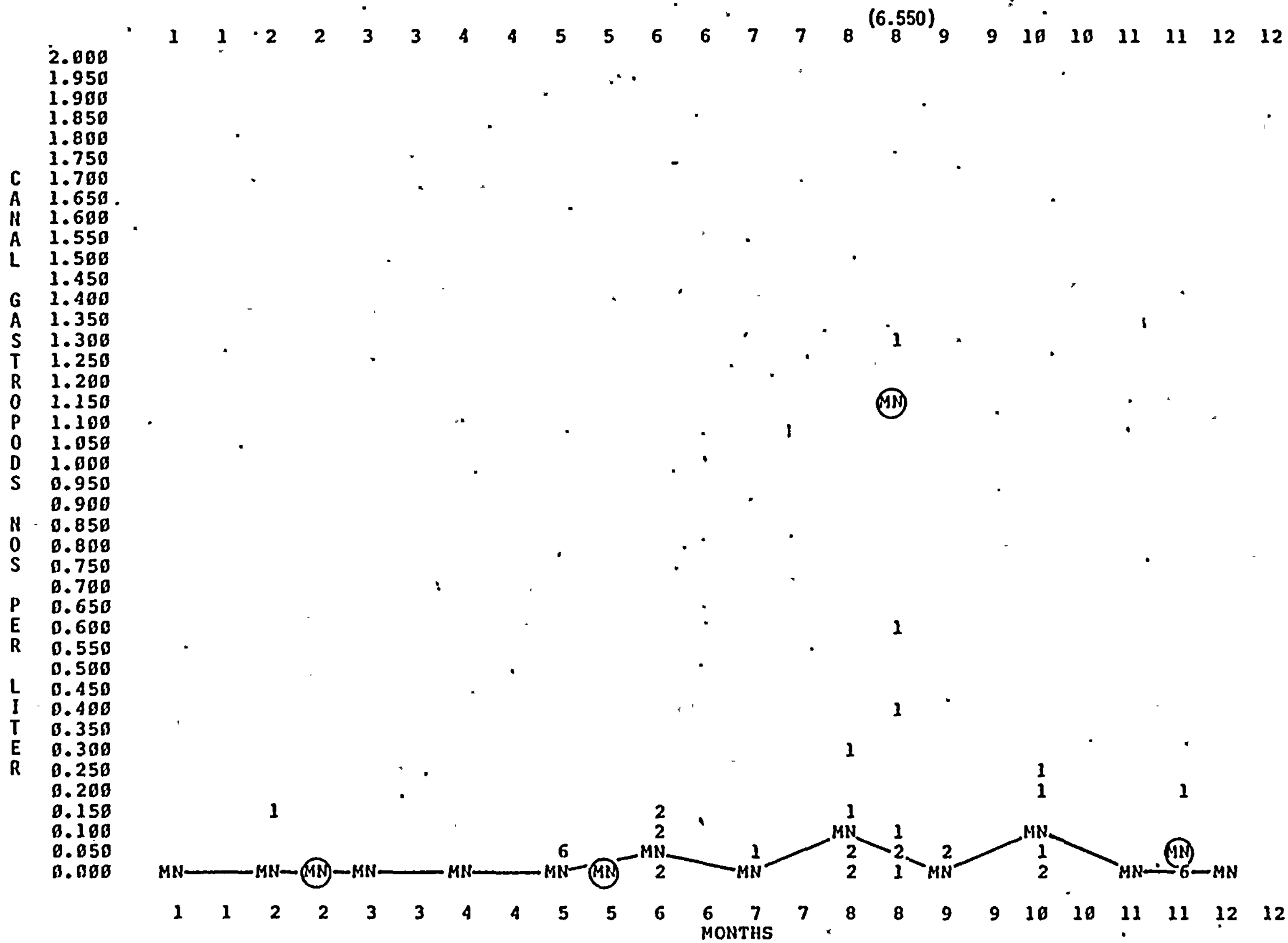

Figure 21. A comparison of Gastropods in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/4th the Bay.

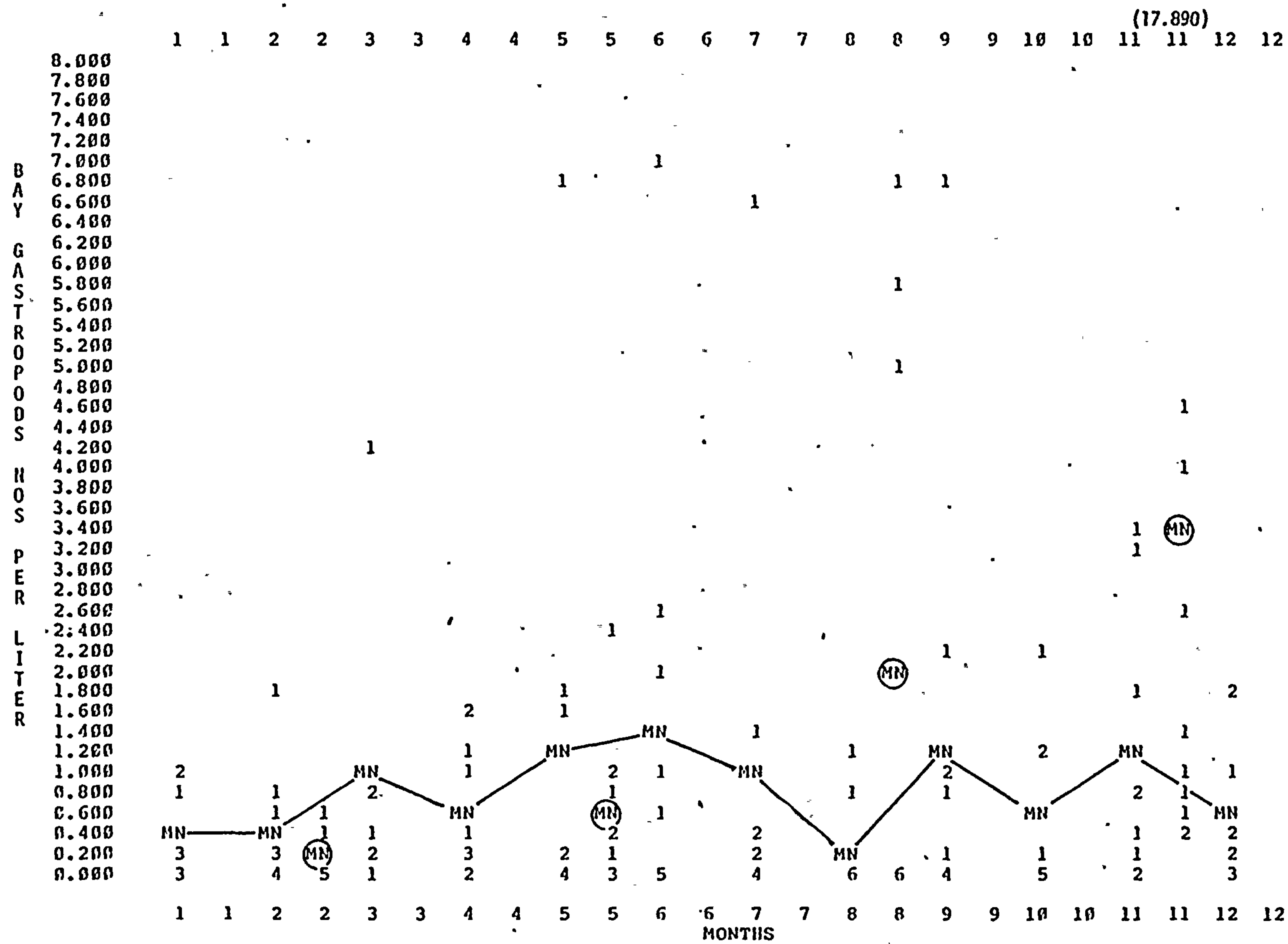

Figure 22. A comparison of Gastropods in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 4 times the Canals.

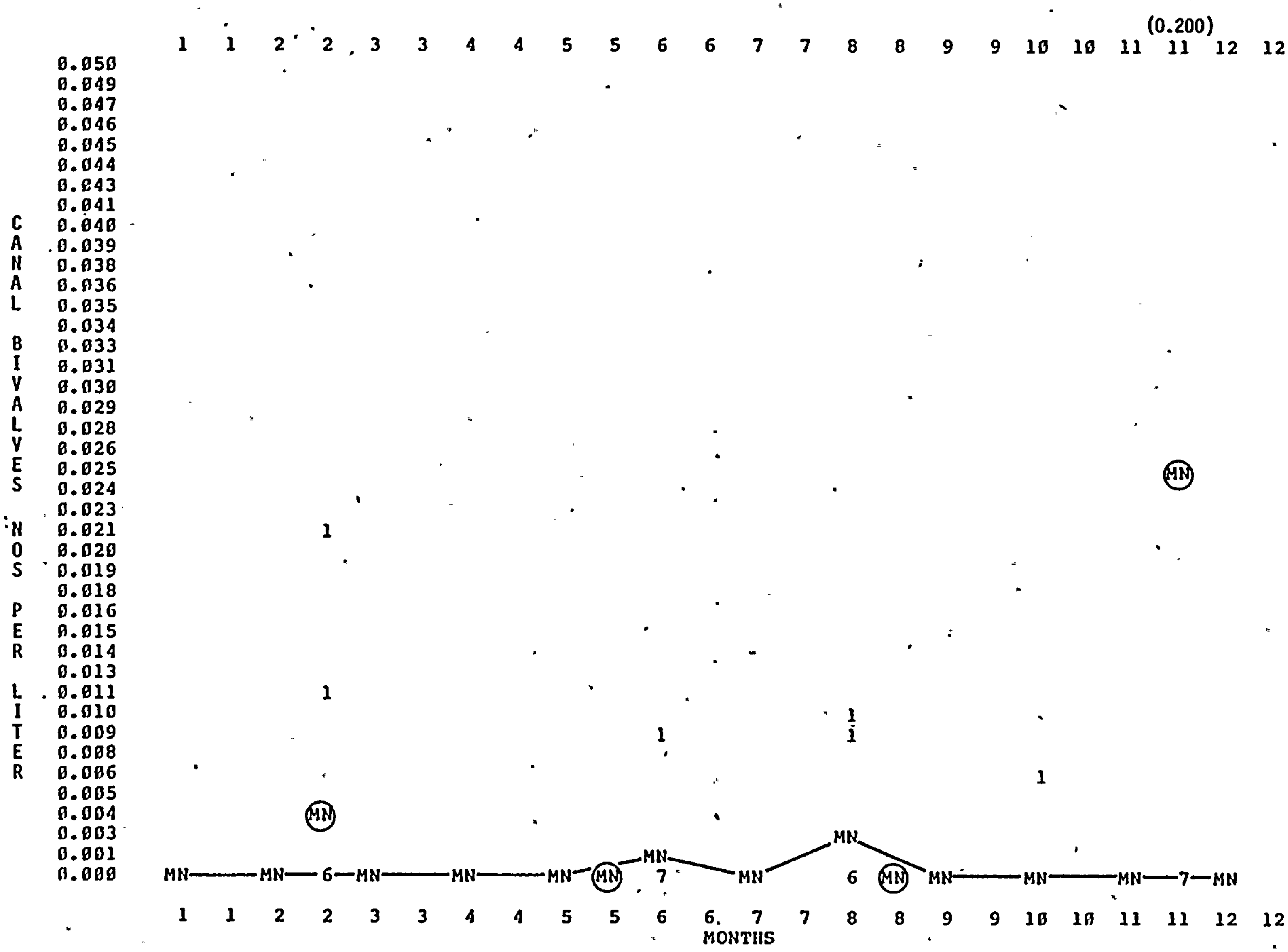

Figure 23. A comparison of Bivalves in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/20th the Bay.

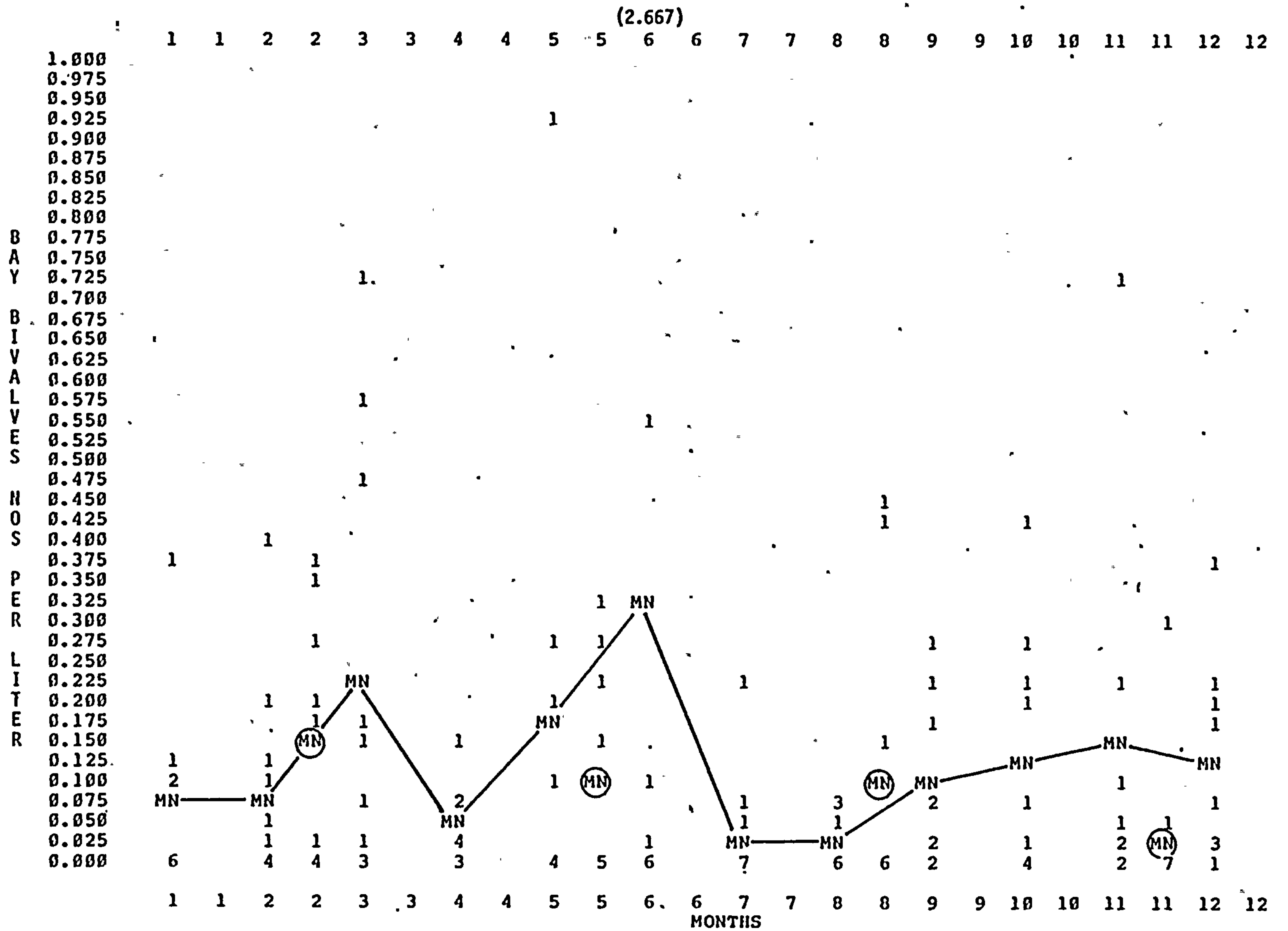

Figure 24. A comparison of Bivalves in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 20 times the Canals.

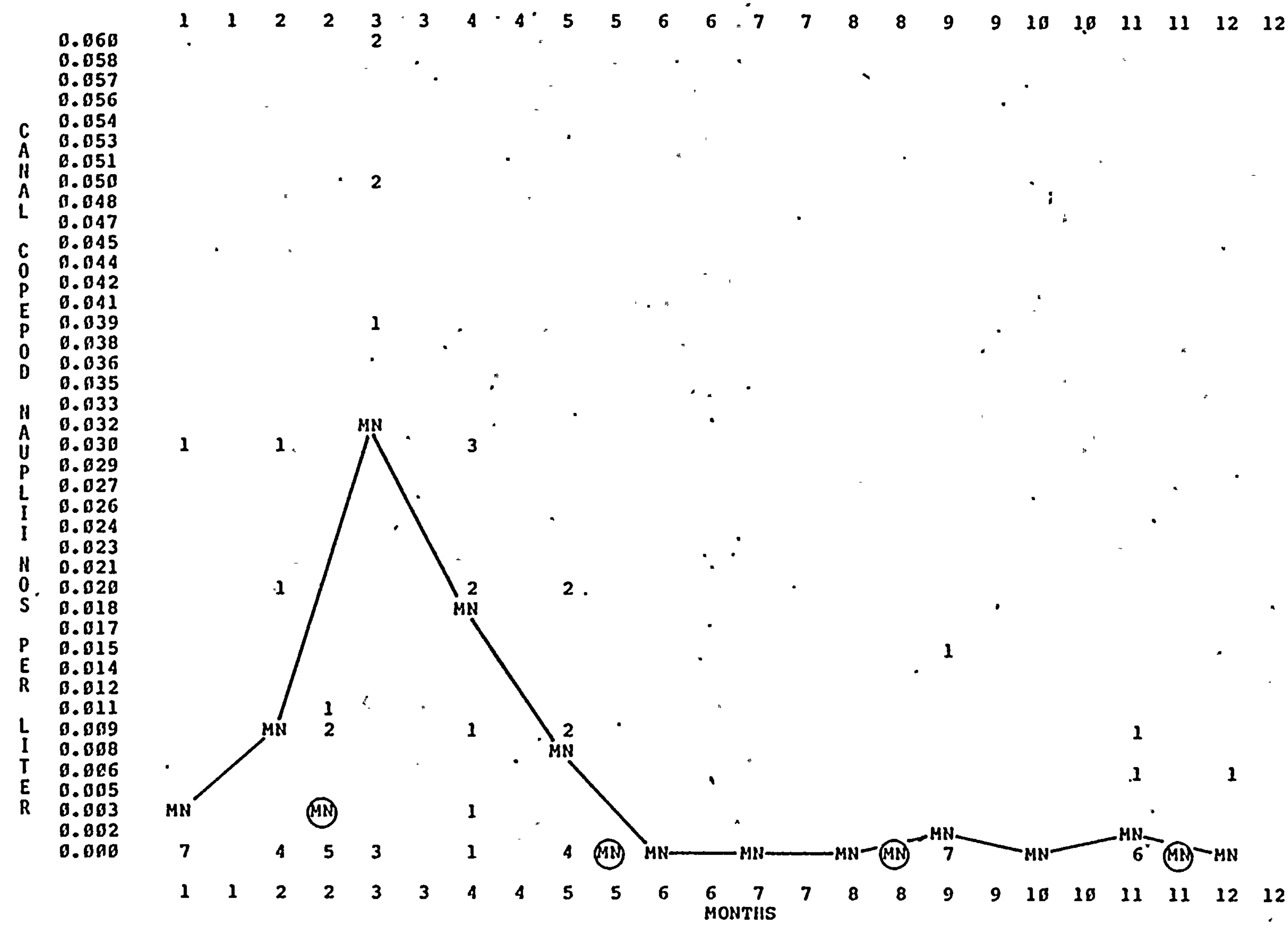

Figure 25. A comparison of Copepod Nauplii in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/20th the Bay.

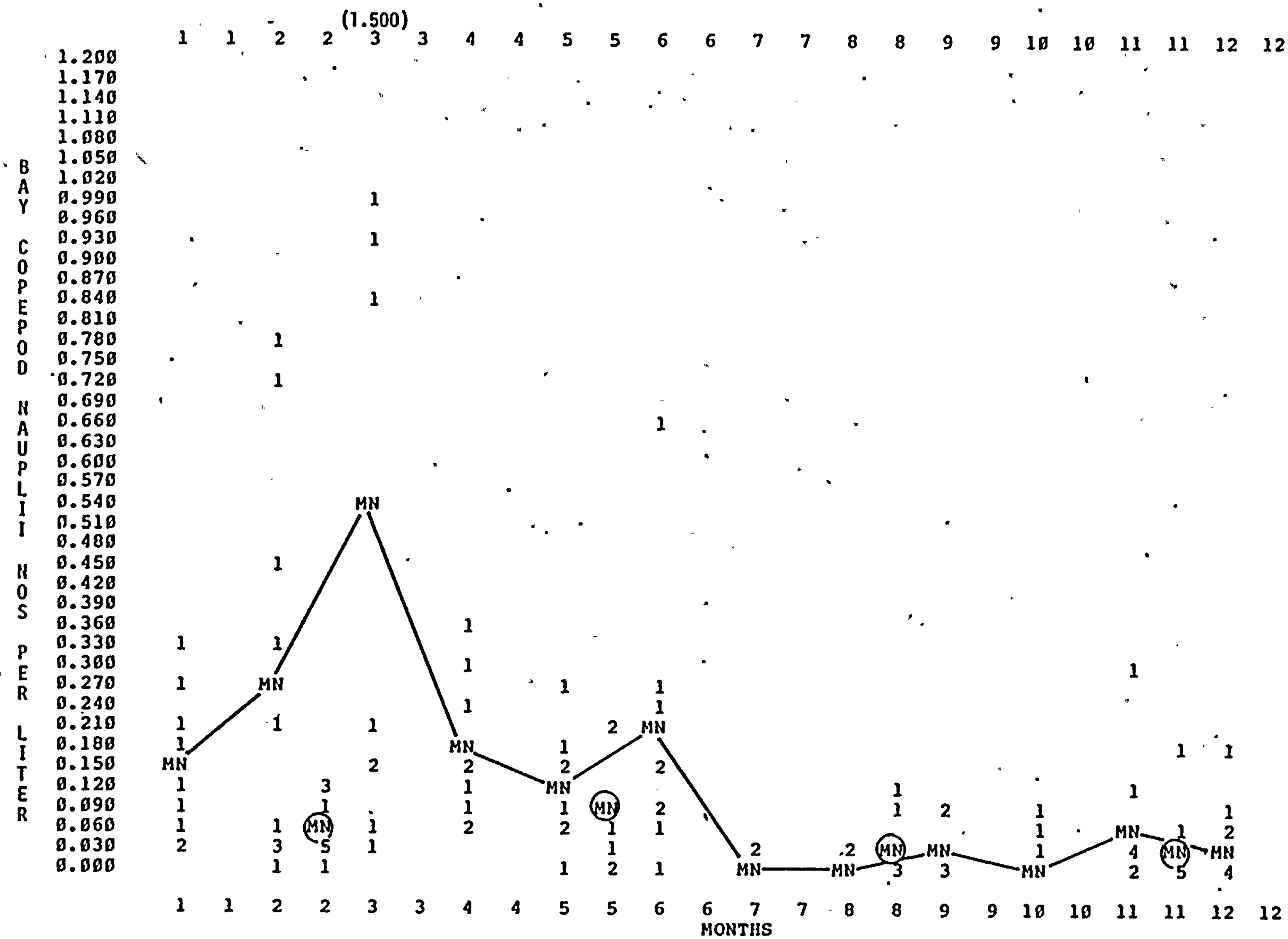

Figure 26. A comparison of Copepod Nauplii in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 20 times the Canals.

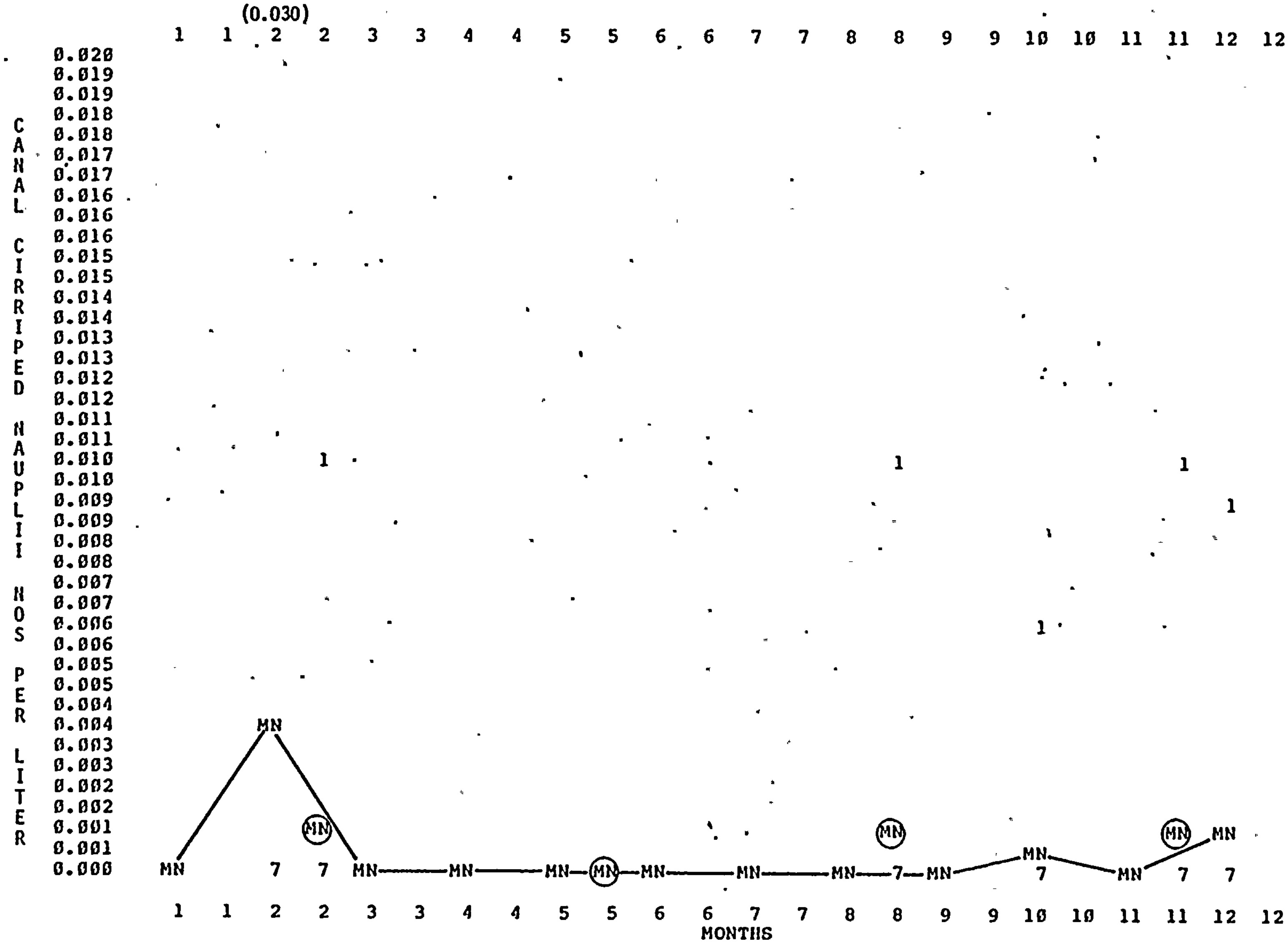

Figure 27. A comparison of Cirriped Nauplii in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/10th the Bay.

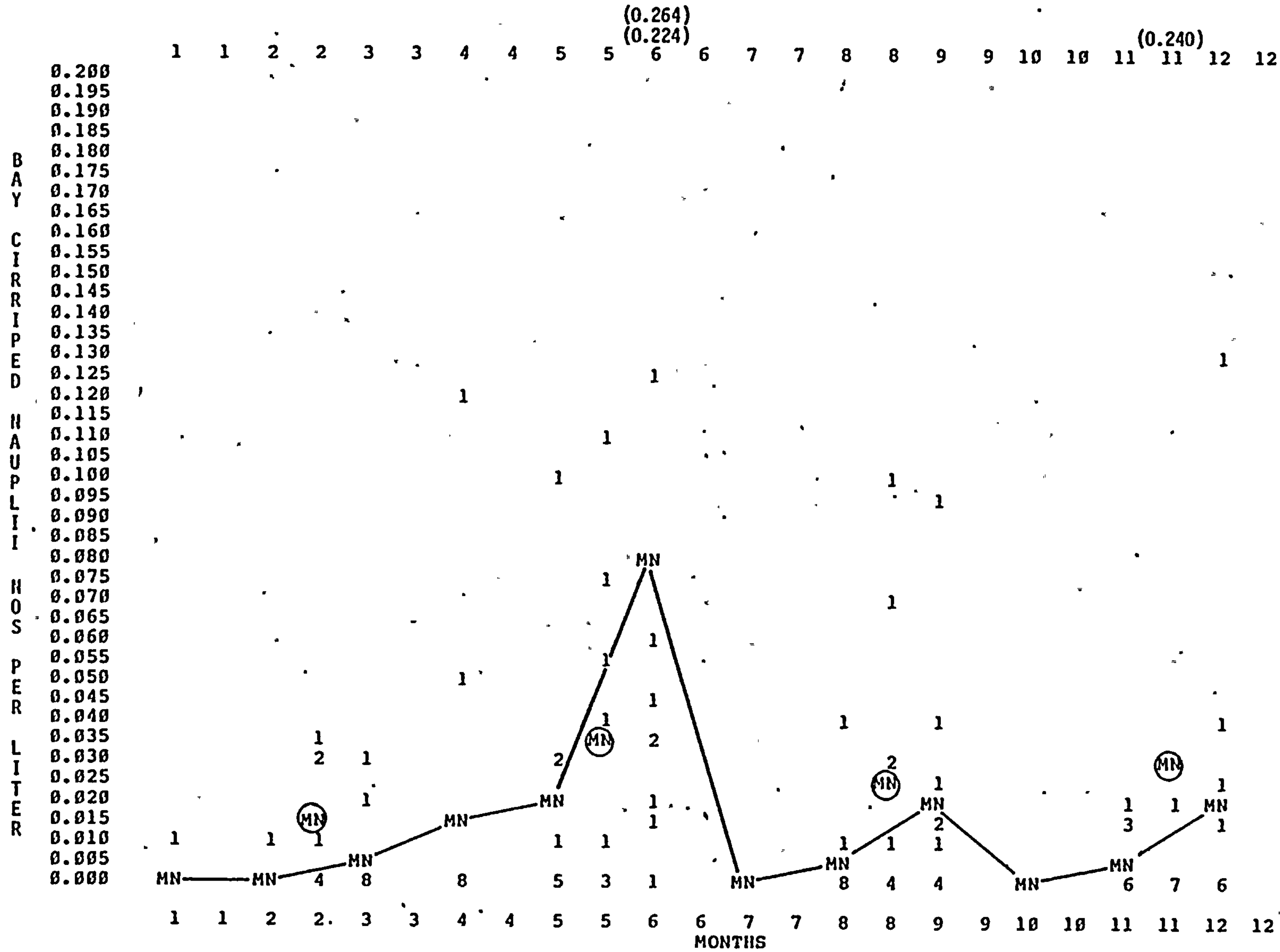

Figure 28. A comparison of Cirriped Nauplii in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 10 times the Canals.

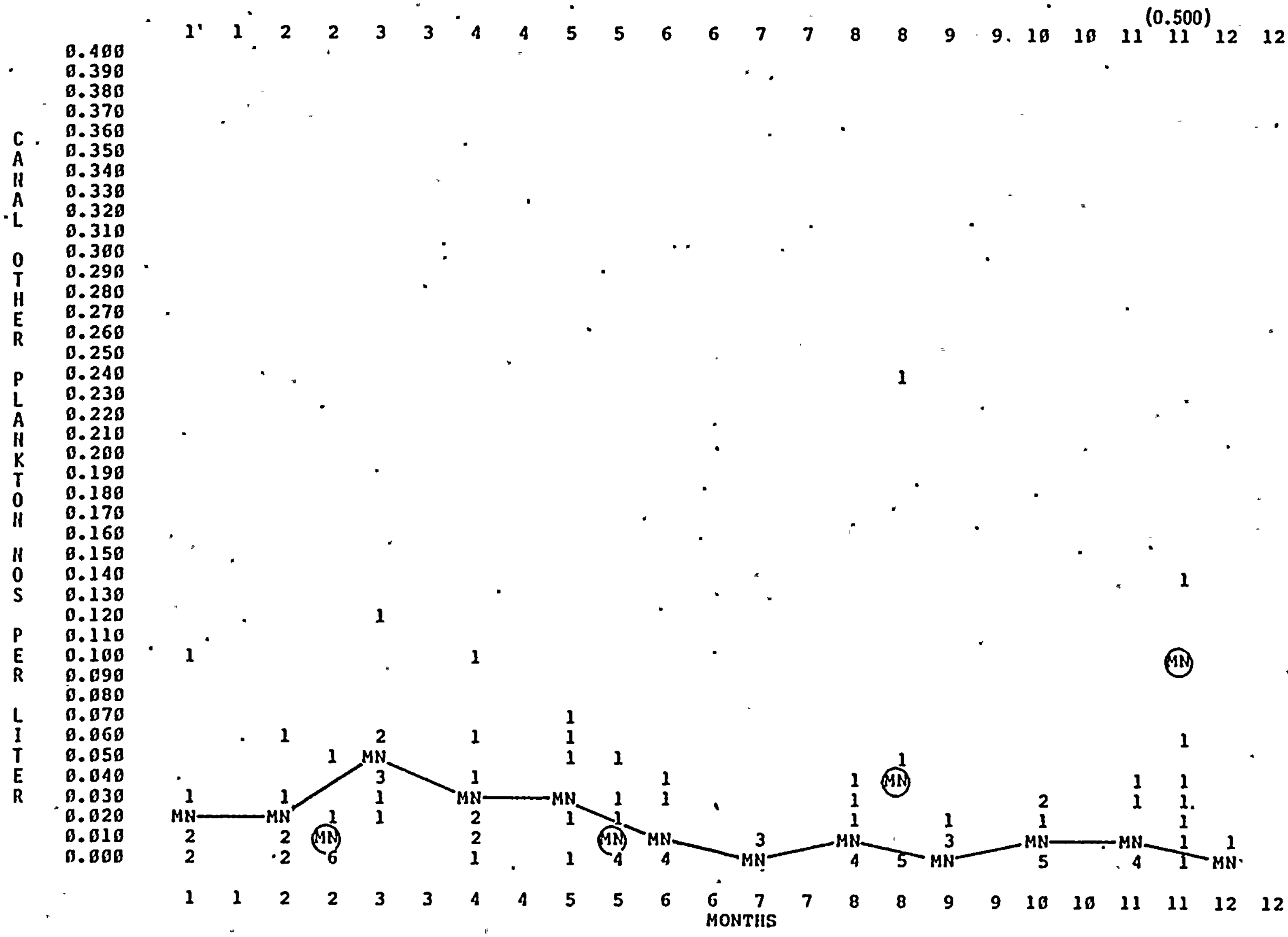

Figure 29. A comparison of other plankton in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/10th the Bay.

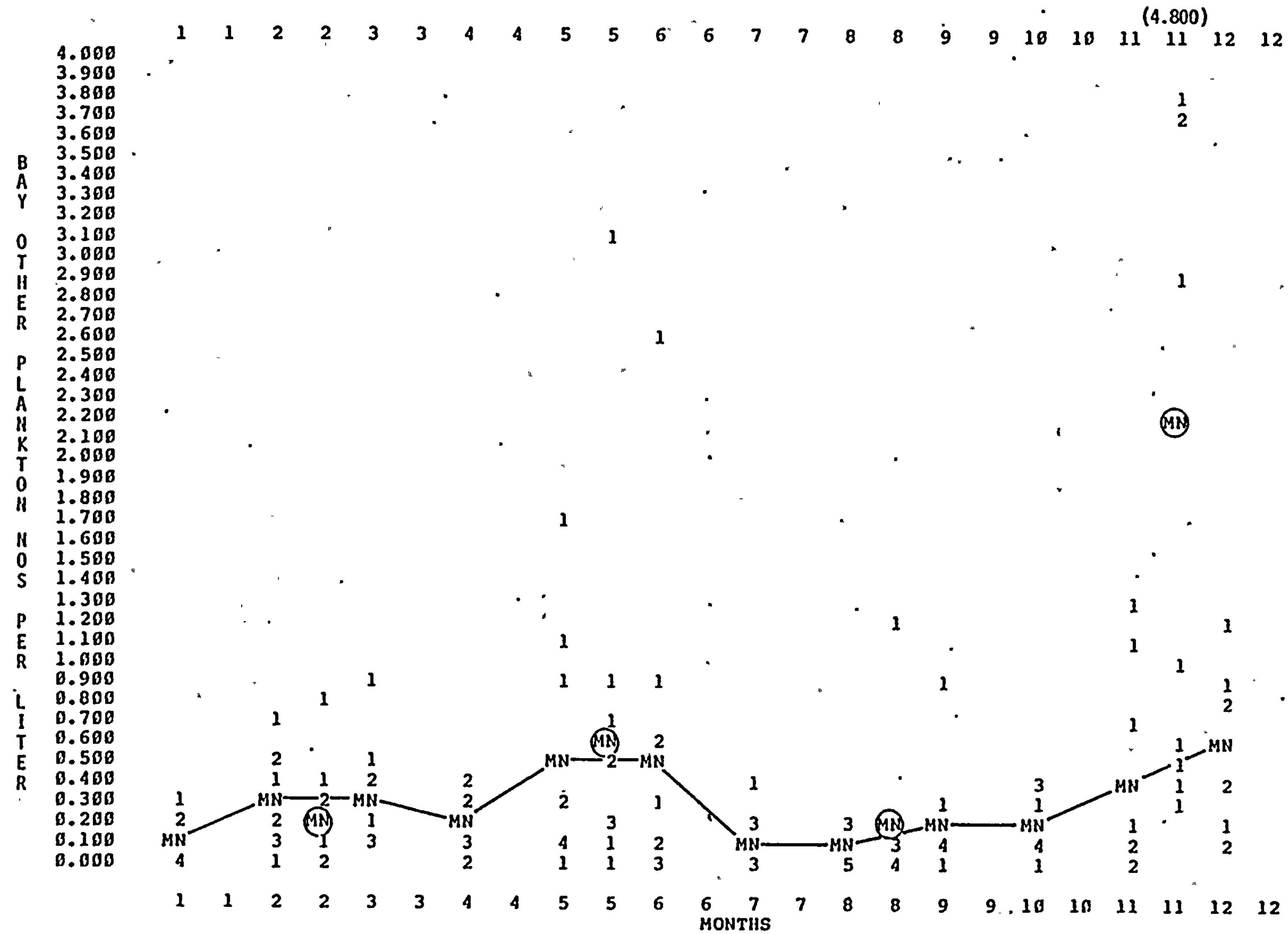

Figure 30. A comparison of other plankton in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 10 times the Canals.

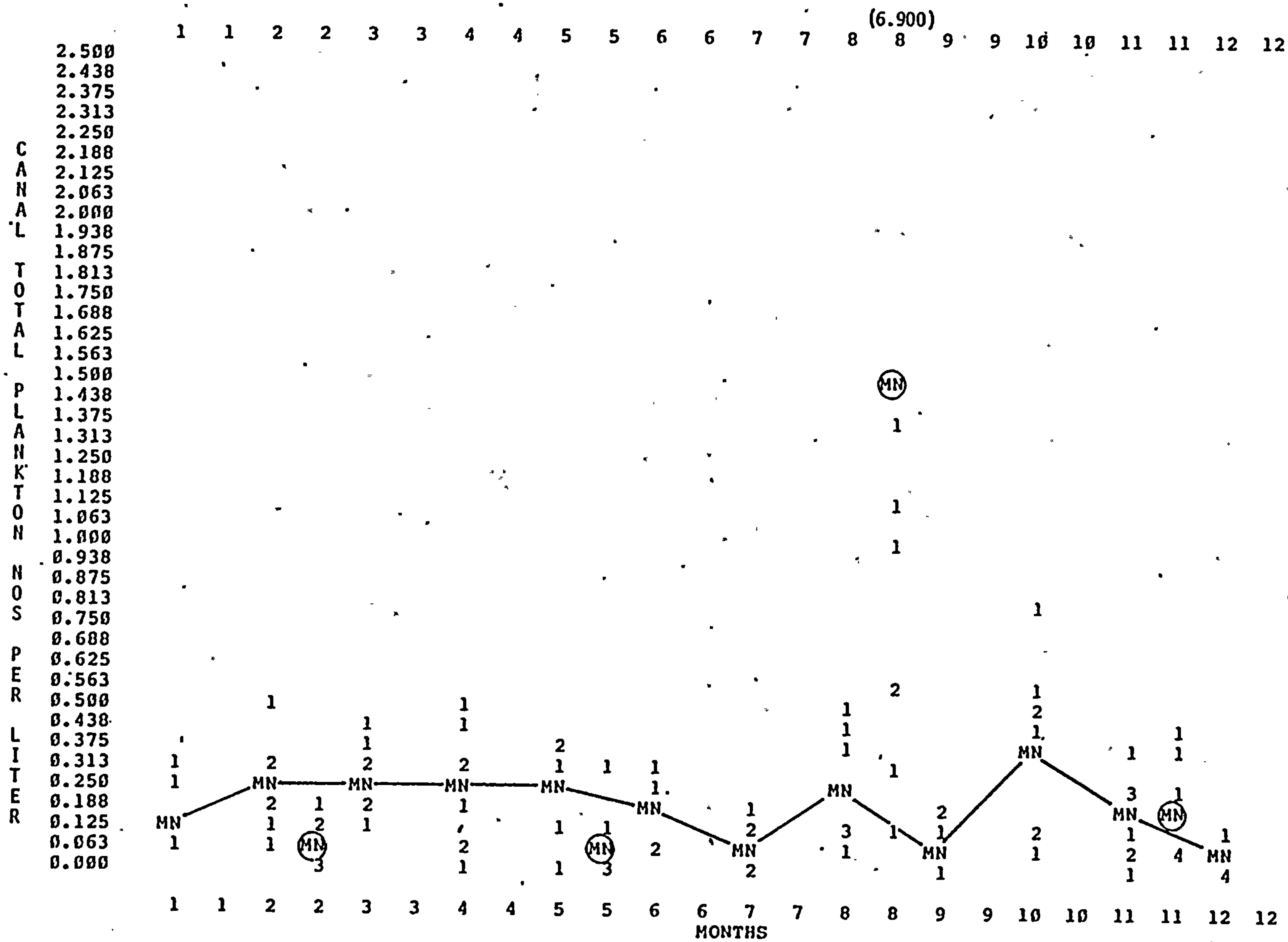

Figure 31. A comparison of total plankton in the Canals for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 1/10th the Bay.

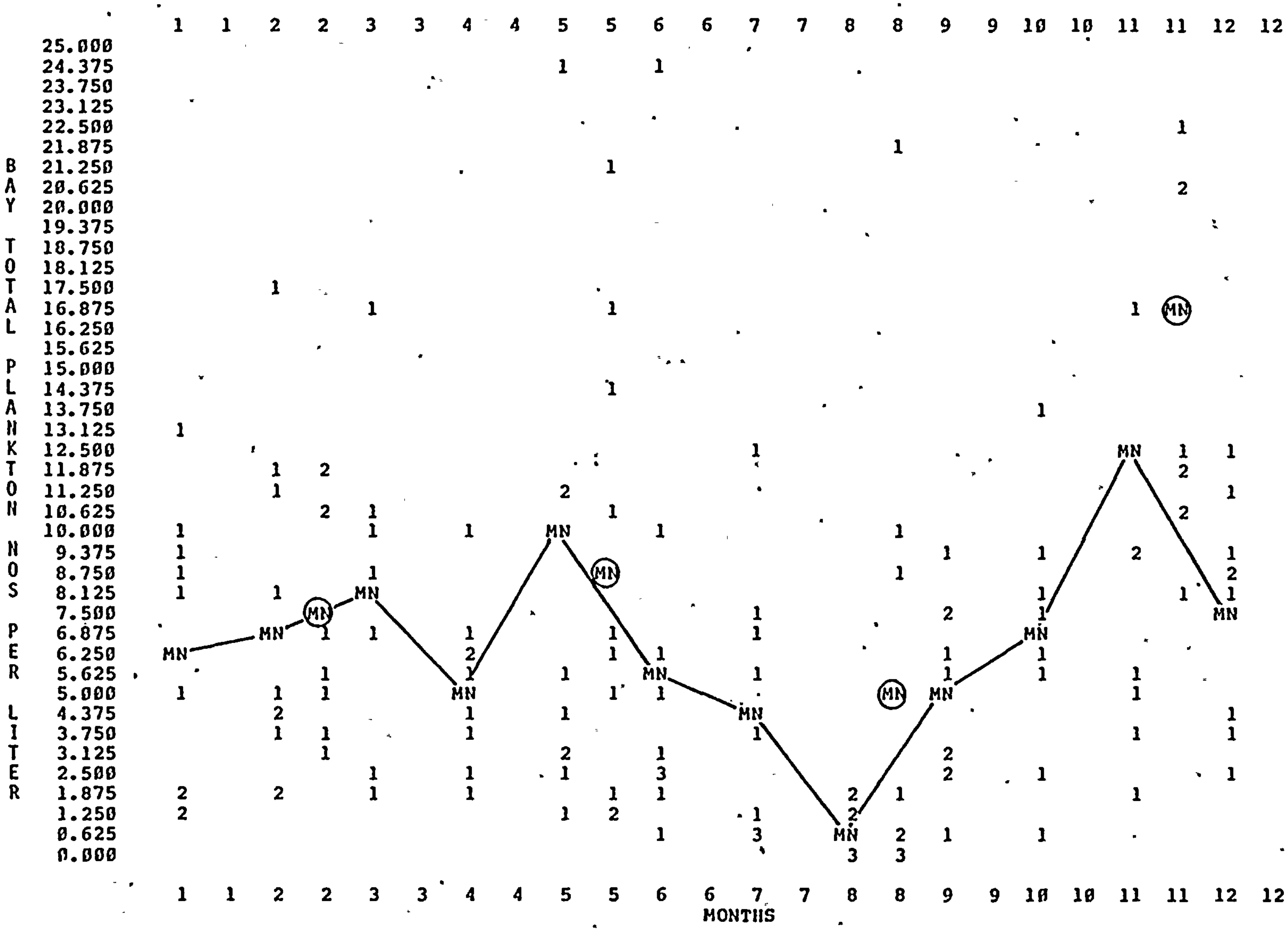

Figure 32. A comparison of total plankton in the Bay for the years 1978 (1st Column) and 1979 (2nd Column, circled) per liter. Scaled 10 times the Canals.

Table 1. Composite physical and nutrient data for years 1974 through 1979 showing the maximum, minimum and mean for all plankton stations in the Turkey Point Cooling Canals.

		1974	1975	1976	1977	1978	1979
Temperature ^oC	Max.	41.3	42.0	41.6	40.0	42.5	44.0
	Mean	29.1	29.2	28.3	29.2	29.2	29.8
	Min.	20.0	22.0	18.5	19.2	18.0	24.0
Salinity o/oo	Max.	38.7	42.0	40.0	41.5	43.5	46.0
	Mean	33.6	36.7	36.6	37.7	37.3	40.8
	Min.	25.0	30.0	26.0	28.5	29.5	36.5
Dissolved Oxygen ppt	Max.	7.2	6.2	8.4	7.4	6.4	7.9
	Mean	5.4	5.2	5.4	4.8	5.0	5.3
	Min.	3.0	4.0	4.1	2.6	3.3	3.2
NH_3 ppm	Max.	0.980	0.270	0.463	0.284	0.208	0.169
	Mean	0.196	0.095	0.072	0.093	0.049	0.068
	Min.	0.014	0.034	0.012	0.015	0.008	0.011
NO_2 ppm	Max.	0.138	0.078	0.060	0.055	0.041	0.029
	Mean	0.042	0.031	0.028	0.025	0.019	0.016
	Min.	0.006	0.008	0.010	0.004	0.005	0.002
NO_3 ppm	Max.	0.620	0.666	0.960	0.769	1.373	1.649
	Mean	0.135	0.249	0.474	0.287	0.476	0.553
	Min.	0.008	0.021	0.042	0.007	0.040	0.009
IPO_4 ppm	Max.	0.123	0.090	0.048	0.143	0.033	0.019
	Mean	0.034	0.024	0.026	0.021	0.017	0.008
	Min.	0.002	0.005	0.008	0.010	0.007	0.000
TPO_4 ppm	Max.	0.580	0.086	0.098	0.098	0.072	0.064
	Mean	0.077	0.054	0.058	0.049	0.048	0.036
	Min.	0.009	0.021	0.019	0.011	0.029	0.009

Table 2. Composite zooplankton data for years 1974 through 1979 showing the maximum, minimum and mean for all stations in the Turkey Point Cooling Canals.

		1974	1975	1976	1977	1978	1979
Copepods	Max.	3.840	0.430	0.630	0.440	0.682	0.560
	Mean	0.375	0.072	0.100	0.096	0.148	0.136
	Min.	0.010	0.000	0.000	0.000	0.008	0.000
Gastropods	Max.	0.060	0.060	2.530	3.380	0.325	6.550
	Mean	0.006	0.006	0.064	0.153	0.036	0.302
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Bivalves	Max.	0.020	0.000	0.000	0.040	0.010	0.022
	Mean	0.001	0.000	0.000	0.001	0.000	0.001
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Copepod Nauplii	Max.	0.200	0.030	0.010	0.220	0.060	0.011
	Mean	0.015	0.002	0.001	0.007	0.006	0.001
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Cirriped Nauplii	Max.	0.150	0.000	0.240	0.020	0.030	0.010
	Mean	0.008	0.000	0.004	0.002	0.005	0.001
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Other Plankton	Max.	0.680	0.510	0.680	0.620	0.120	0.240
	Mean	0.074	0.030	0.049	0.036	0.017	0.027
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Total Plankton	Max.	4.020	0.620	2.610	3.490	0.844	6.990
	Mean	0.483	0.110	0.210	0.291	0.210	0.472
	Min.	0.030	0.000	0.000	0.010	0.008	0.000

NOTE: All values in organisms per liter.

Table 3. Composite physical and nutrient Biscayne Bay/Card Sound data for years 1974 through 1979 showing the maximum, minimum and mean for all plankton stations.

		1974	1975	1976	1977	1978	1979
Temperature °C	Max.	30.7	32.0	32.4	32.1	31.9	32.7
	Mean	26.5	27.7	26.0	26.2	25.7	25.7
	Min.	19.1	21.4	17.5	18.7	15.5	19.9
Salinity o/oo	Max.	42.0	42.5	40.0	38.0	38.5	41.5
	Mean	36.6	37.5	35.2	33.5	33.7	34.3
	Min.	25.0	28.0	21.0	28.0	24.0	21.5
Dissolved Oxygen ppt	Max.	9.2	10.6	8.8	8.3	7.8	9.2
	Mean	7.0	6.7	6.8	5.6	5.6	6.0
	Min.	5.2	4.4	5.0	3.3	3.6	4.4
NH_3 ppm	Max.	0.228	0.060	0.044	0.098	0.134	0.059
	Mean	0.048	0.022	0.022	0.032	0.028	0.025
	Min.	0.000	0.006	0.007	0.004	0.004	0.007
NO_2 ppm	Max.	0.034	0.012	0.028	0.009	0.023	0.018
	Mean	0.006	0.006	0.005	0.003	0.004	0.007
	Min.	0.000	0.002	0.001	0.000	0.000	0.002
NO_3 ppm	Max.	0.140	0.061	0.164	0.112	0.527	0.237
	Mean	0.013	0.022	0.052	0.034	0.085	0.103
	Min.	0.000	0.002	0.002	0.001	0.009	0.022
IPO_4 ppm	Max.	0.100	0.011	0.019	0.019	0.011	0.025
	Mean	0.013	0.007	0.007	0.007	0.007	0.008
	Min.	0.001	0.002	0.002	0.002	0.002	0.000
TPO_4 ppm	Max.	0.161	0.028	0.055	0.151	0.021	0.066
	Mean	0.034	0.017	0.016	0.017	0.012	0.027
	Min.	0.001	0.012	0.006	0.004	0.006	0.009

Table 4. Composite zooplankton Biscayne Bay/Card Sound data for years 1974 through 1979 showing the maximum, minimum and mean for all stations.

		1974	1975	1976	1977	1978	1979
Copepods	Max.	27.100	9.570	15.050	17.090	27.360	18.320
	Mean	5.233	1.696	3.075	3.799	5.341	7.200
	Min.	0.000	0.030	0.030	0.050	0.026	0.060
Gastropods	Max.	5.400	0.980	6.290	10.540	7.029	17.890
	Mean	0.621	0.104	0.396	0.576	0.849	1.569
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Bivalves	Max.	1.780	0.550	0.370	1.670	2.667	0.450
	Mean	0.129	0.019	0.027	0.074	0.129	0.102
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Copepod Nauplii	Max.	5.200	0.500	0.280	0.083	1.500	0.217
	Mean	0.280	0.032	0.030	0.111	0.139	0.067
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Cirriped Nauplii	Max.	1.100	0.130	1.000	0.490	0.264	0.240
	Mean	0.038	0.011	0.652	0.046	0.016	0.027
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Other Plankton	Max.	46.090	3.260	1.330	5.190	2.584	4.800
	Mean	1.372	0.263	0.204	0.409	0.309	0.849
	Min.	0.000	0.010	0.000	0.000	0.000	0.012
Total Plankton	Max.	66.520	11.500	18.980	24.350	35.820	41.630
	Mean	7.484	2.124	3.790	5.030	6.727	9.808
	Min.	0.010	0.030	0.040	0.150	0.039	0.080

NOTE: All values in organisms per liter.

Phytoplankton - chlorophyll a, biomass, and primary productivity

Introduction

Chlorophyll *a*, biomass, and primary productivity were determined quarterly at 13 stations. Eight of these stations were located in the Turkey Point Cooling Canal System (Figure 1), and five were located in the Biscayne Bay/Card Sound area (Figure 2).

Chlorophyll is a green pigment contained in the chloroplasts of plants, Its primary function is that of absorbing radiant energy which is then used by the plant to manufacture food. The chlorophyll discussed in this report was extracted from the microscopic plants in seawater. These organisms, called phytoplankton, occur in enormous numbers and are the primary producers on which most ocean life depends.

Methods - Chlorophyll *a*

Chlorophyll *a* determinations were made using the Trichromatic Method (Standard Methods, 14th Edition). Two samples of one liter each were taken at each of the 13 stations and concentrated using glass fiber filters. Pigments were extracted from the concentrated samples, by homogenizing the impinged sample with a tissue grinder, steeping with an aqueous acetone solution and decanting the supernatant. Optical density of the extracts were determined using a Beckman 25 UV-Visible Light Spectrophometer and a 5 centimeter path length.

Methods - Biomass

Chlorophyll *a* constitutes approximately one to two percent of the dry weight of organic material in all planktonic algae and is therefore, the preferred indicator for algal biomass estimates. By assuming that chlorophyll *a* constitutes, on the average, 1.5 percent of the dry weight organic matter (ashfree weight) of the algae, one can estimate the algal biomass by multiplying the chlorophyll *a* content by a factor of 67 (Standard Methods, 14th Edition).

Methods - Primary Productivity

By knowing the abundance of chlorophyll *a* and using equations derived by Ryther and Yentsch (1957), it was possible to establish empirically the relationship of chlorophyll *a* to photosynthetic production. To determine production data, surface radiation values and extinction coefficients were needed. Surface radiation values were taken from the South Dade Meterological Tower. A table by Ryther & Yentsch, (1957) showed the relationship between total daily surface radiation and daily relative photosynthesis beneath a unit of sea surface. Extinction coefficients were calculated in the canal system using Secchi Disc measurements. However, due to the shallowness and water clarity, it was not possible to obtain Secchi Disc readings at sample stations in Biscayne Bay. Consequently an estimated extinction coefficient (0.15/m for the bay) was ascertained by observations in deeper parts of the bay.

Results, Discussion and Conclusions

The chlorophyll in the euphotic zone of a community, within the course of a year, is subject to changes by specific environmental factors such as nutrients, temperature, turbulence, and grazing by herbivores. Annual patterns of chlorophyll also differ with different annual factor sequences in different areas. The chlorophyll of a whole euphotic zone fluctuates as a function of available nutrients, predation, and conditions favoring high turnover rates (Odum, 1963).

Table 1 shows the mean chlorophyll a values for the canal system and Biscayne Bay for the quarters of 1979. The highest values for chlorophyll a in the canal system and Biscayne Bay occurred during quarters with long photoperiods and/or high nutrient values. The 1977 average chlorophyll a value in the canal system was 0.44 mg/m^3. The 1978 mean value was 0.33 mg/m^3, while this year's (1979) mean value was 0.40 mg/m^3. Chlorophyll a values in Biscayne Bay decreased from a mean value of 0.27 mg/m^3 in 1977 to 0.21 mg/m^3 in 1978 and to 0.19 mg/m^3 in 1979 (Figure 3).

The higher chlorophyll a values in the canal system were attributed primarily to its high phytoplankton levels as a result of the higher nutrient levels. Nutrient levels, in general, were three to four times greater in the canal system than in Biscayne Bay/Card Sound.

There appeared to be a limited amount of nutrients in Biscayne Bay and Card Sound, with most of them being utilized by the macrophytes or otherwise tied-up in relatively long turnaround cycles i.e. biogeochemical cycles, etc.

1979 chlorophyll a values for both the bay and the canal system fall within baseline value ranges for Biscayne Bay as determined by Reeve & Cosper (FPL 1972).

Mean biomass values for all stations appear in Table 1. Since biomass values were a function of the chlorophyll a, they followed the same trends as chlorophyll a The average biomass value in the canal system was 30.60 mg/m^3 in 1977, 20.90 mg/m^3 in 1978, and 26.50 mg/m^3 in 1979. Biscayne Bay values were 18.30 mg/m^3 in 1977, 13.0 mg/m^3 in 1978, and 12.96 mg/m^3 in 1979 (Figure 4). These data can not be validly compared with the Reeve & Cosper (FPL 1972) baseline biomass data since different analytical methods were employed.

The mean primary production estimate for the canal system for 1979 was 0.056 $gC/m^2/day$. This reflects an increase over the previous two years. Conversely, the bay mean estimate showed a slight decrease when compared to the two previous years. The 1979 bay value was 0.100 $gC/m^2/day$. Figure 5 shows that primary productivity estimates have remained consistently greater in the bay than in the canal system. Higher productivity estimates in the bay were attributed to greater light penetration. The primary reasons for

light attenuation in the canal system were thought to be the result of high concentrations of tannin and lignins which produced color and organic debris which produced turbidity. The color and turbidity were expected byproducts of the impoundment of the once tidally flushed area. The lowest primary production estimates were exhibited in the canal system at stations where water velocities were relatively high. Again, no comparisons between the baseline and present primary productivity estimates can be made owing to the differences in the methodologies employed.

Rain causes nutrients from land runoff to enter the bay, which in turn leads to a buildup of phytoplankton and benthic flora during the early summer (Bader and Roessler, 1972). In 1979 the highest primary productivity estimates in Biscayne Bay occurred in the third quarter. This increase was correlated to the generally higher nutrient levels caused by heavy rainfall in July and August, and the longer photoperiod mentioned earlier. In 1978 the highest primary productivity estimates occurred in April, July, and October.

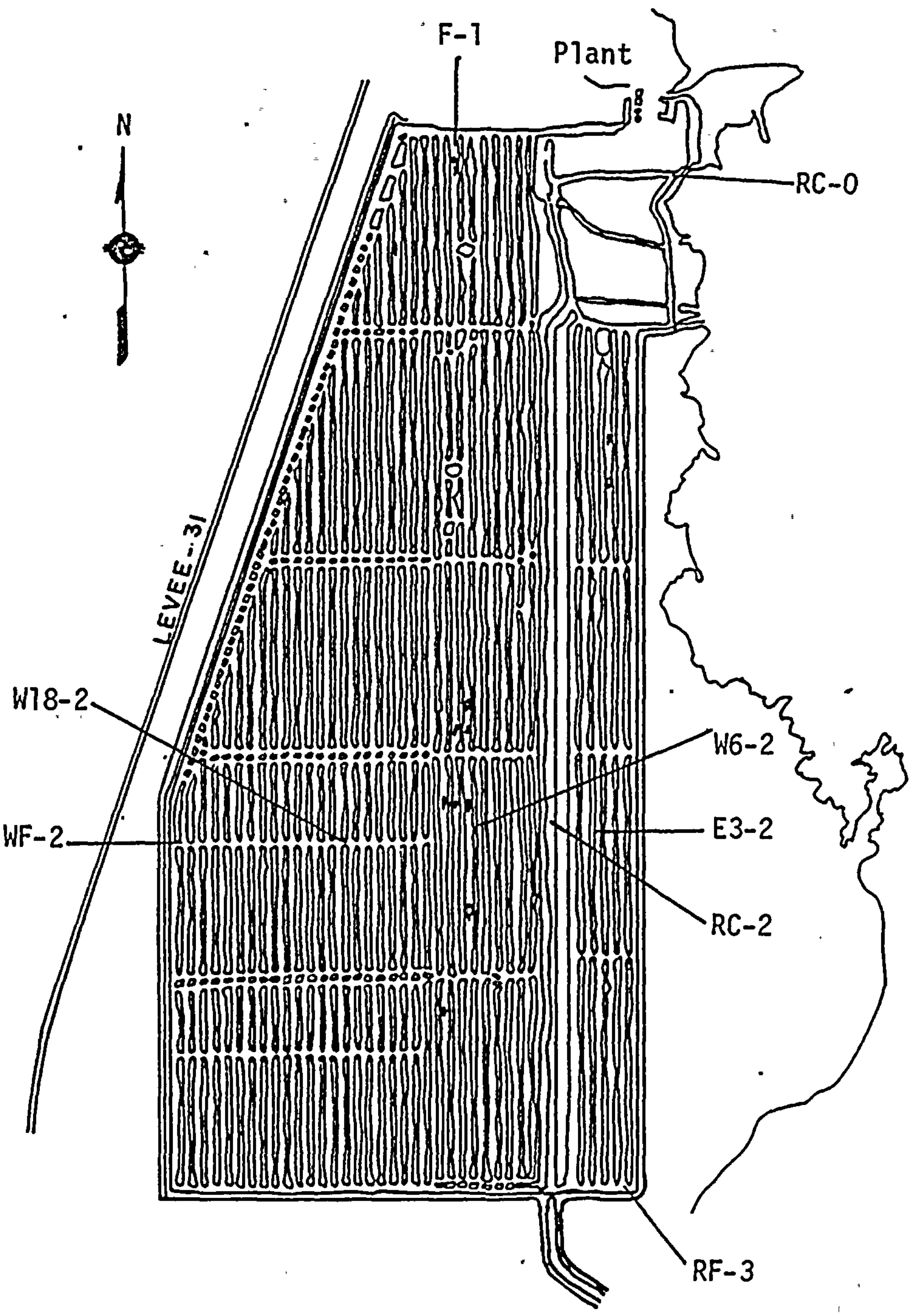

Figure 1. Chlorophyll a sample sites in the Turkey Point Cooling Canal System.

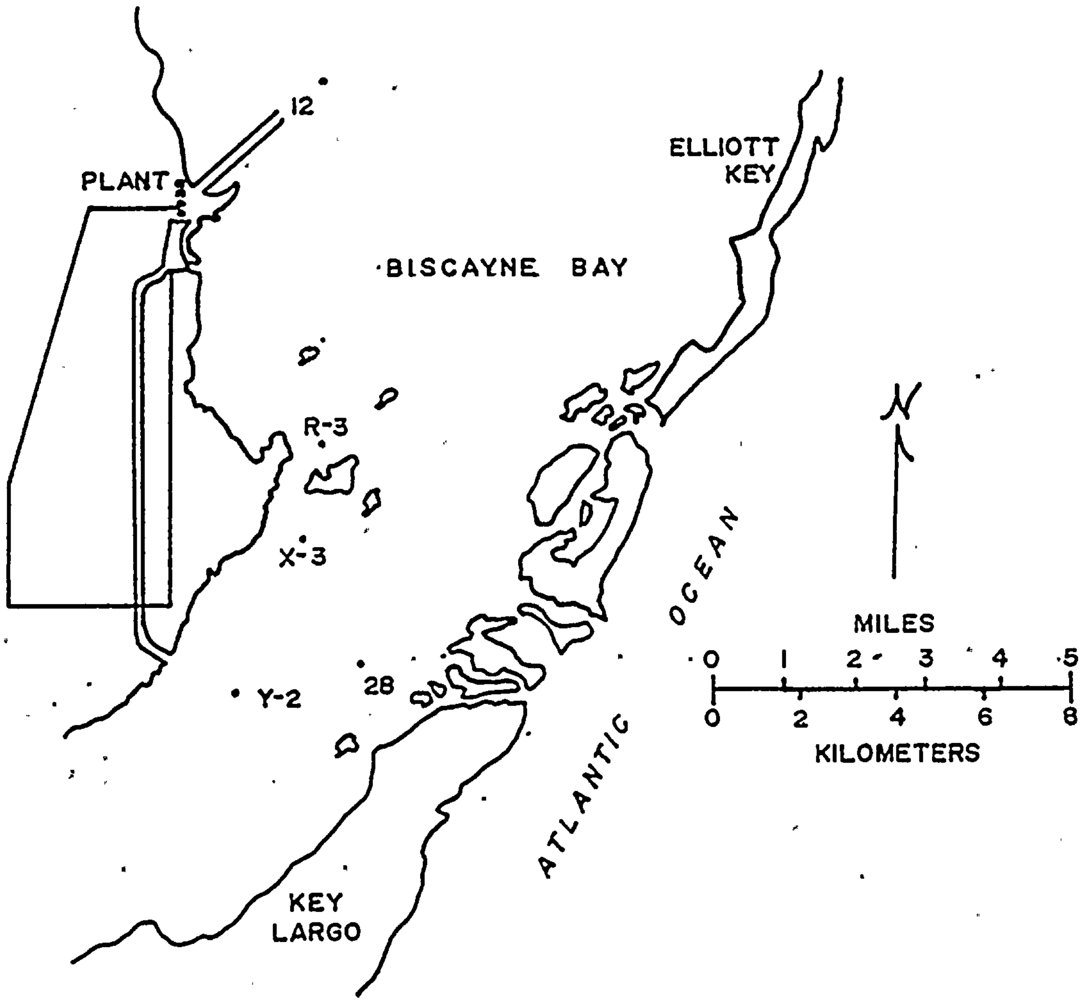

Figure 2. Chlorophyll a sample sites in Biscayne Bay and Card Sound associated with the Turkey Point Cooling Canal System.

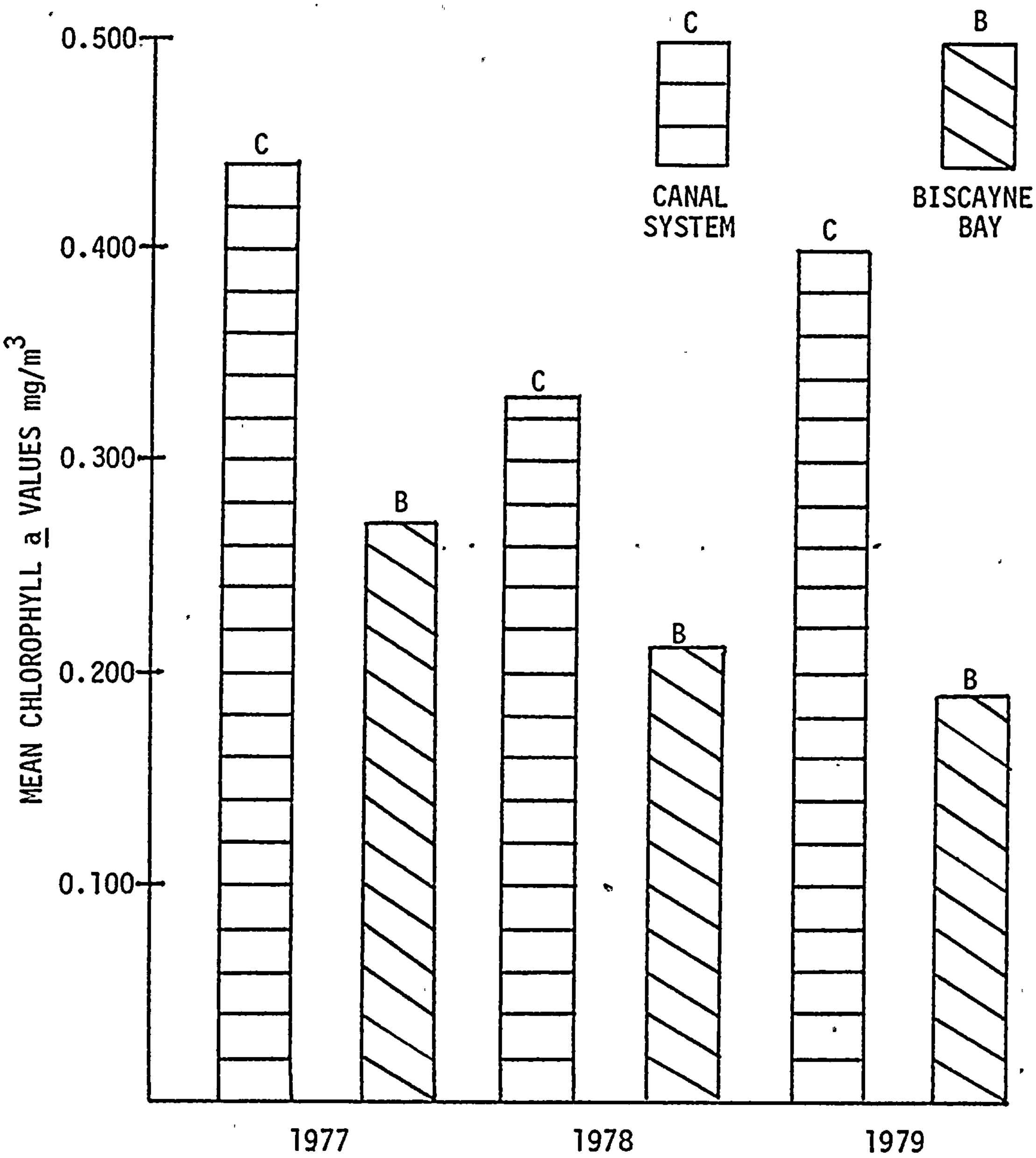

Figure 3. A comparison of 1977 through 1979 mean Chlorophyll a values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound.

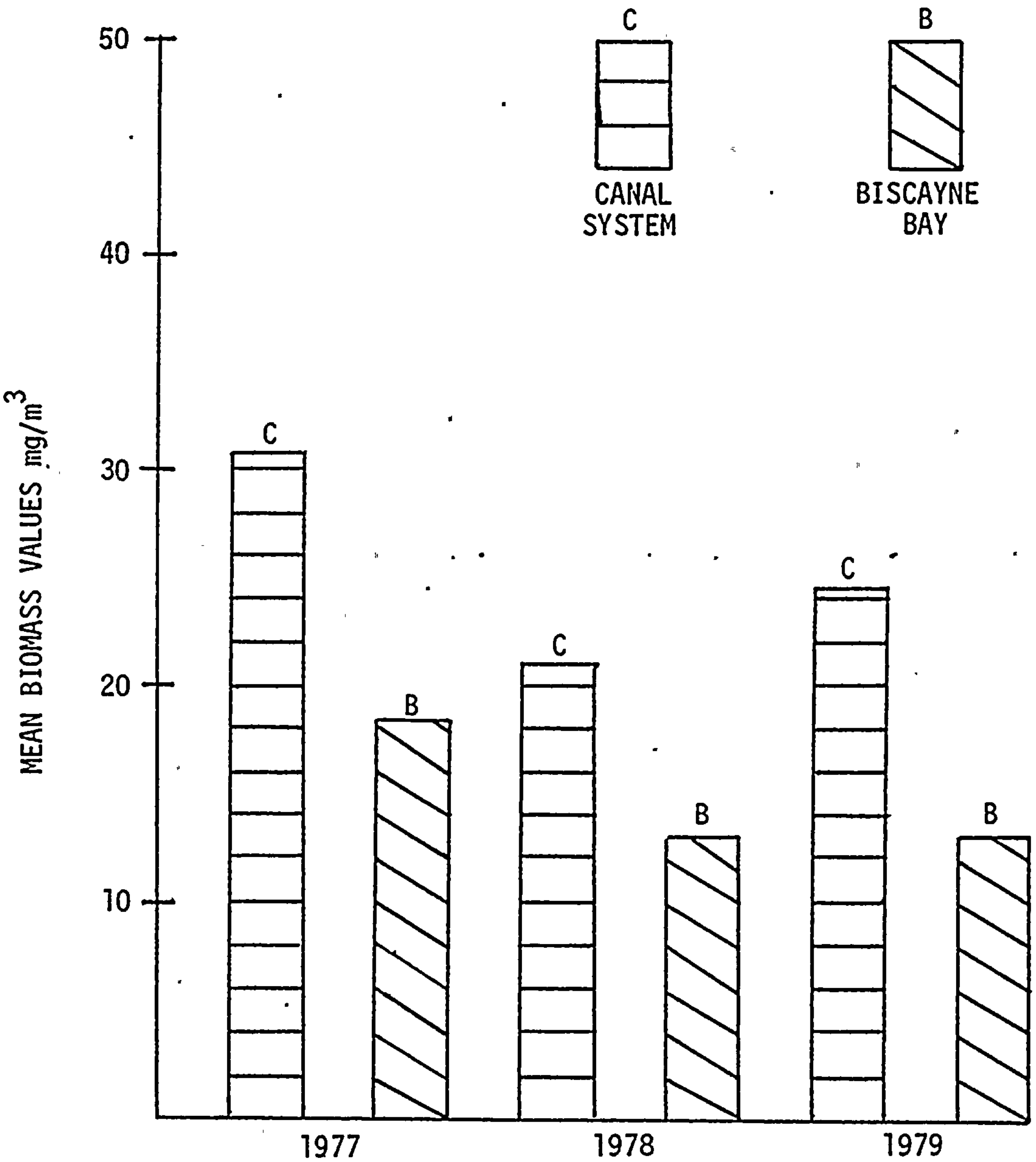

Figure 4. A comparison of 1977 through 1979 mean Biomass values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound.

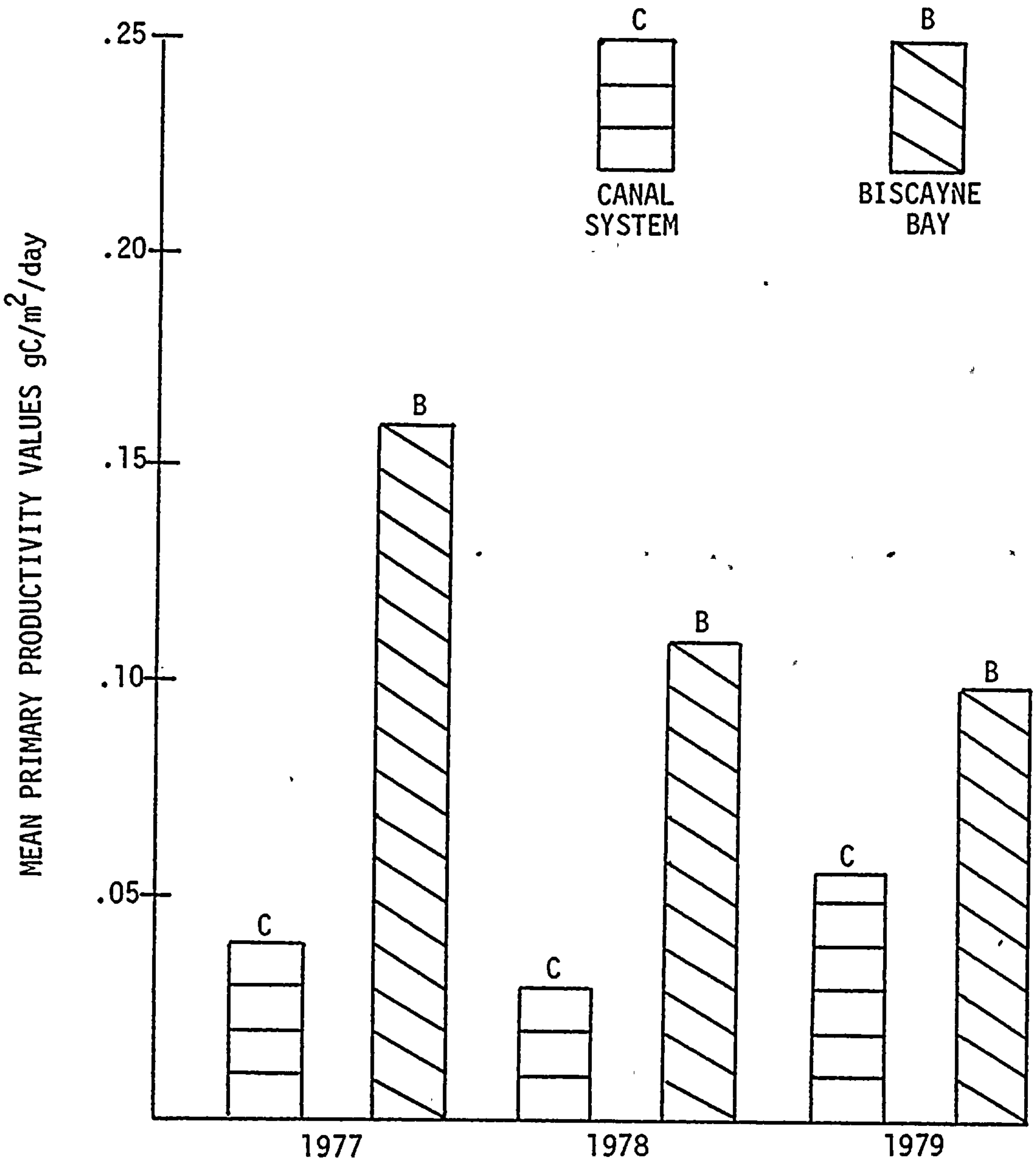

Figure 5: A comparison of 1977 through 1979 mean Primary Productivity values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound.

Table 1. Mean Chlorophyll a, Biomass and Primary Productivity Values for the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound for 1979.

	Chlorophyll a (mg/m^3)		Biomass (mg/m^3)		Primary Productivity ($gC/m^2/day$)	
	Canals	Bay	Canals	Bay	Canals	Bay
First Quarter (February)	0.40	0.19	26.55	12.95	0.047	0.0100
Second Quarter (May)	0.30	0.17	20.43	11.39	0.043	0.088
Third Quarter (August)	0.58	0.15	38.52	10.22	0.082	0.079
Fourth Quarter (November)	0.30	0.26	20.47	17.26	0.050	0.133
Yearly Mean	0.40	0.19	26.49	12.96	0.056	0.100

Phytoplankton - organisms

Introduction

Phytoplankton of lower Biscayne Bay/Card Sound and the Turkey Point Cooling Canal System (Figures 1 and 2) was sampled at quarterly intervals in 1979 (February, May, August, and November). The samples were examined for kinds and abundance of organisms. This report is based on the same specific study area as the previous semi-annual reports. Its purpose is to compare phytoplankton populations occurring in the study area with those described in the data of previous reports in order to follow biological succession and population changes.

Methods

Subsurface water samples were collected early each designated month by personnel operating from surface craft. The samples were reduced in volume, sedimented and preserved in preparation for enumeration and identification. Procedures were as in the previous reports (July-December 1977). A new American Optical binocular microscope with wide field oculars was utilized. Factors employed for population counts were modified accordingly. It was felt that the traditional method used to preserve samples occasionally permitted erroneous determination of diatoms at the species level, however for the purpose of this report identification to genus was acceptable. Comparisons to previous years data, refer to F.P.L. Annual and Semi Annual Environmental Monitoring Reports #1 - 12 (1973 - 1978).

Results

A total of 160 species were identified in bay waters, including 121 common and relatively abundant species, and 25 others of sporadic occurrence. A total of 126 species were identified in the canals, including 92 which were considered common and relatively abundant, and 11 others which were of sporadic occurrence. These species were nearly all recorded in previous studies of these waters, in similar or comparable numbers.

Counts of the principal organisms are shown in Tables 1 and 2 for the bay and canal system respectively. Organisms which appeared only sporadically are shown in Table 3.

The diversity of the phytoplankton populations is expressed by giving the number of species identified in the different groups (Table 4). Table 5 lists, for the principal taxonomic groups, counts of organisms by month and group for bay stations collectively and for canal system stations collectively. It also gives total counts for the year by group and total counts by month.

Bay populations seldom coincided with those of the canals. Commonly the canals showed larger populations of certain groups than the bay. Most populations appeared to build up to an August maximum.

As in previous surveys, diatoms represented the largest component of the phytoplankton.

Discussions

Populations of specific groups and specific organisms showed wide fluctuations from season to season, sometimes of an order of magnitude (i.e., *Chaetoceros sp.* and *Nitzschia closterium* in the bay stations, *Rhodomonas baltica, Amphiprora paludosa* and *Synedra superba* in the canals).

Numbers of certain organisms in both the canals and the bay appeared greater than for 1978; however, the variation was well within what might be expected on chance alone.

No changes were noted which could suggest the development of abnormal or unhealthy conditions in the bay.

The populations of the canal system remained much as in previous data reported. Peak populations were attained by *Rhodomonas baltica* in February in all twelve canal stations. Other flagellates maintained high populations in both February and May. The naviculoid diatoms reached their highest populations in August and November.

As in previous reports, diversity of blue-green algae was greater in the canals than in the bay, while the dinoflagellates showed greater diversity in the bay. The latter observation was emphasized by the apparent absence from the canal system of *Ceratium furca, Exuviaella marina, Gonyaulax* (all species), *Peridinium depressum,* and *divergens, Peridiniopsis rotundata, Prorocentrum* (all

species), *Protoceratium reticulatum* and *Pyrodinium bahamense*. In the previous report, these species were found, only sparingly, in the canals. Many of these species are relatively large cells and may have temperature or other requirements which are not usually met in the warmer canal waters. The 1979 diversities (Table 4) compared well with those of 1978. Totals in the bay and the canals were slightly smaller than 1978 totals. This difference was slight and was accounted for by the fewer diatom species recorded in 1979 samples from the bay. There was no evidence of a trend developing. More ciliates and dinoflagellate species were observed for the bay in 1979 than in 1978. Conversely the canal system had more species of blue-green algae in 1979 than in 1978.

Water chemistry data for 1979 were generally similar to comparable data available from previous studies (see Zooplankton Nutrient section). The canals remain relatively warmer and richer in principal nutrients than the bay, and their productivity was apparently higher.

Conclusions

Counts in the canals expressing the relative abundance of phytoplankton organisms and taxonomic groups showed expected levels of fluctuation from period to period. Such fluctuations have been observed since the beginning of operations and were not indicative of instability. Several species, i.e. *Schizothrix calcicola, Gyrodinium*

pingue, Peridinium trochoideum, Prorocentrum micans, Cymatopleura solea, and *Nitzachia closterium* were commonly present in moderate numbers and were considered indicative of a stable system. Shifts in populations were to be expected in a linear system which is shallow, productive and held at a relatively high temperature. The canals collectively function as a group of microhabitats. Isolated populations can be expected to build up rapidly at times without causing much more than local influence.

The canal populations were characterized by a lower species diversity and greater numbers of organisms than found in the bay. This was especially noted in the populations of the larger dinoflagellates. There was no indication that this lowered diversity or population fluctuations were indicative of any major change in the habitat as compared with previous assessments.

The proportion existing between the different taxonomic groupings of the populations of bay and canal were likewise comparable to previous studies.

The picture presented for the bay phytoplankton was of a well-balanced generally healthy population of microorganisms with higher species diversity and a smaller number of organisms than was found in the canals.

No marked trends over this period, as compared to previous

reporting periods, could be identified.

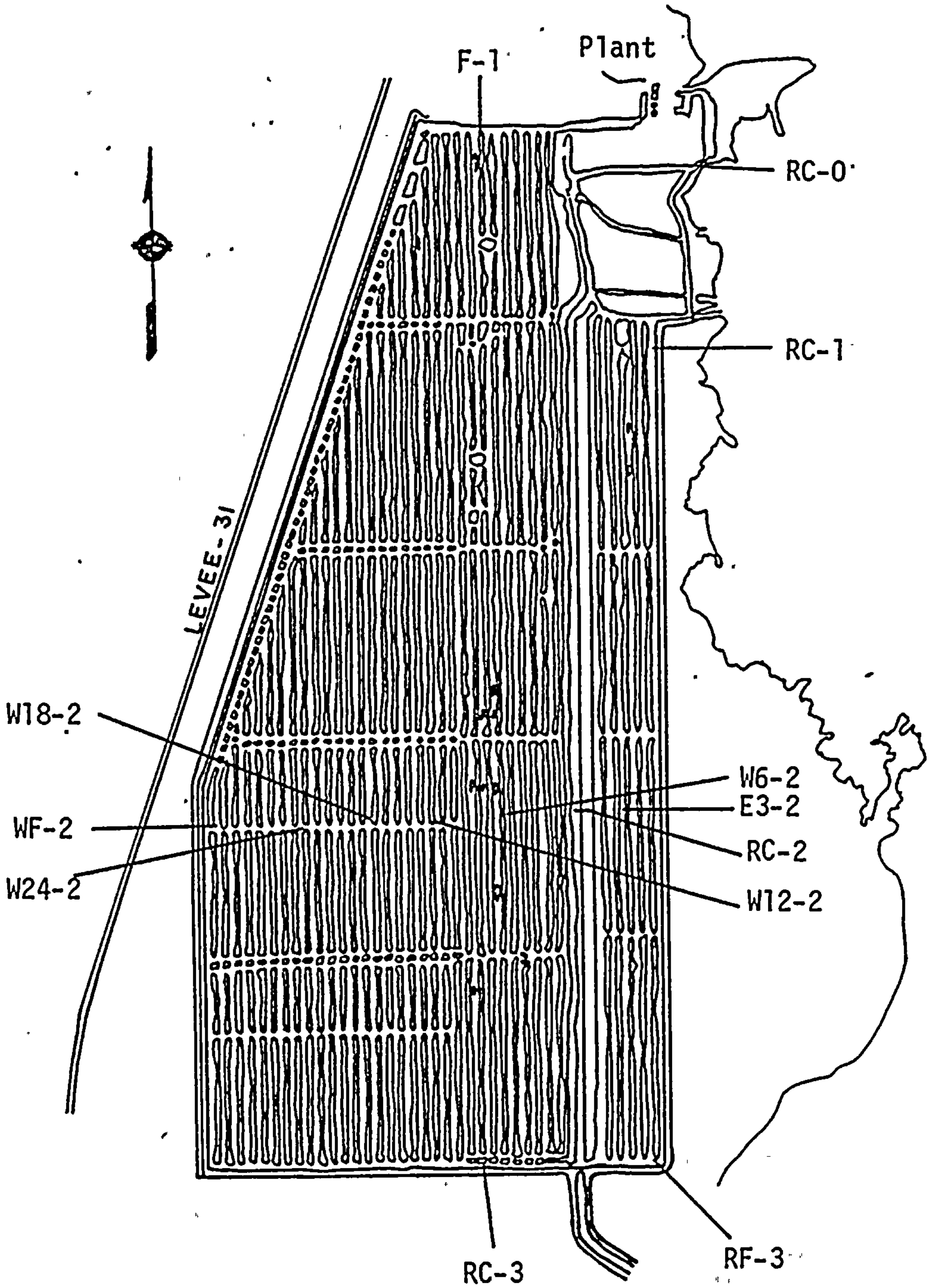

Figure 1. Phytoplankton sample sites at the Turkey Point Cooling Canal System.

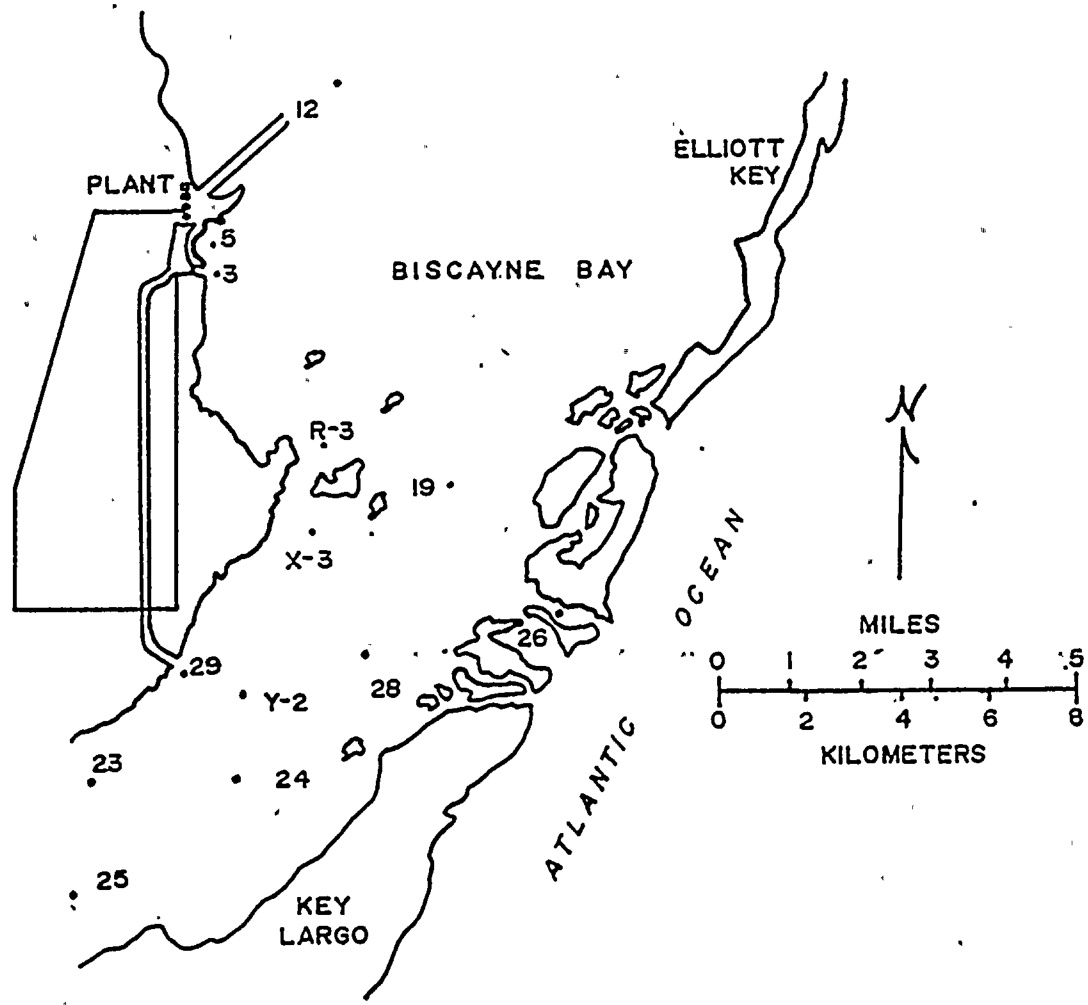

Figure 2. Phytoplankton sample sites in Biscayne Bay and Card Sound associated with the Turkey Point Cooling Canal System.

Table 1. Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1979. Column A indicates number of stations at which it occurred; Column B indicates total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Sulfur organisms								
Beggiatoa gigantea								
Beggiatoa sp.					3	119	6	153
Blue-green algae								
Anabaena bornetiana					1	55		
Anabaena sp.	5	590	2	145	5	592	2	125
Aphanocapsa sp.					6	475	5	255
Arthrospira jenneri					1	55	4	191
Chroococcus gigantea					1	43		
Chroococcus planktonica			2	169	4	180	3	145
Coelosphaerium sp.								
Gloeocapsa sp.					1	55	2	125
Gomphosphaeria aponina	3	144	3	149	4	28	5	259
Johannesbaptistia pellucida	4	450	6	410	6	456	10	525
Lyngbya sp.								
Merismopedia sp.	1	35	2	90	1	55	2	70
Microcystis sp.	1	55	3	2450	1	55		
Oscillatoria sp. 7μ diam.			1	70	3	193	5	377
O. sp. (red, 7-8μ)			2	187	3	24	4	20
O. sp. (red, 10μ)			1	4	2	169		
O. sp. (10-12μ)			1	220	3	71		
O. sp. (20μ)								
Schizothrix calcicola	4	248	3	220	9	1910	1	35

Table 1. (CONT'D) Counts of the principal phytoplankton organisms found in the 13 Biscayne/Card Sound samples in 1979. Column A indicates number of stations at which it occurred; Column B indicates total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Blue-green algae (cont'd)								
Spirulina major	1	35					1	55
Spirulina minor	1	19			2	63	1	90
Chlorophyceae								
Chlorella sp.	1	55	1	70				
Chlamydomonas sp.	4	255	8	410	1	35	1	110
Pyramidomonas sp.	5	495	7	720	6	1265	1	55
Euglenoids								
Euglena deses							3	138
Euglena sp.			1	55			3	94
Eutreptia sp.	3	105					2	59
Undet. euglenoids	2	74	7	695	9	1055	3	495
Silicoflagellates								
Dictyocha fibula	5	635			2	39	2	180
Cryptophysidae								
Cryptomonas marina								
Cryptomonas sp.	1	55	3	145	9	955	6	355
Rhodomonas baltica	9	1075	10	1851	9	1681	9	1000
Flagellates								
Incertae sedia	13	7465	13	13640	13	16775	13	12105

Table 1. (CONT'D) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1979. Column A indicates number of stations at which it occurred; Column B indicates total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Dinophyceae								
Amphidinium sp.	4	410	6	625	13	2437	13	2180
Ceratium furca	8	271	9	371	11	464	13	764
Ceratium fusus					1	4	1	8
Cochlodinium sp.							2	173
Dinophysis tripos					1	4		
Exuviaella marina	1	19	4	55			5	58
Exuviaella minor					1	55		
Exuviaella oblonga	3	338	7	431	3	268	6	173
Gonyaulax diegensis			1	55				
Gonyaulax digitale	3	105			1	110		
Gonyaulax triacantha					1	55		
Gymnodinium albulum					6	990	5	819
Gymnodinium aeruginosum								
Gymnodinium sp. (large)			1	55				
Gymnodinium sp. (small)	12	2341	13	3570	13	7990	6	930
Gymnodinium splendens					6	288	1	8
Gyrodinium pingue	2	89	2	39	7	585	1	4
Peridinium depressum	1	35	1	35	2	8	2	59
Peridinium divergens	3	146	2	59	2	118	1	4
Peridinium grani					4	126		
Peridinium hirobis					2	126	2	90
Peridinium triqueta					5	1506	5	325
Peridinium trochoideum			1	35	8	1585	3	180
Peridinium sp.	11	3296	13	2000	13	6415	12	2535

Table 1. (CONT'D) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1979. Column A indicates number of stations at which it occurred; Column B indicates total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Dinophyceae (cont'd)								
Peridiniopsis rotundata			1	70	2	165	3	106
Prorocentrum gracile	3	67	4	223	4	32	4	24
Prorocentrum micans	5	209	6	135	8	369	8	99
Protoceratium reticulatum	2	31	4	110	4	276	6	1463
Pyrodinium bahamense	5	456	5	354	11	2382	11	703
Pyrocystis sp.					13	3022	8	114
Undet. dinoflagellates	13	3307	13	4560	8	2750	11	2809
Diatoms								
Amphiprora alata	3	90	3	125	4	180	3	78
Amphiprora minuta	1	70	4	145	4	330	6	379
Amphiprora paludosa					2	110	1	55
Amphiprora sp.	2	70			2	110	1	4
Amphora sp.	7	719	5	399	6	520	4	168
Biddulphia sp.								
Bacteriastrum sp.	3	345						
Campylosira cymbelliformis	1	55						
Chaetoceros sp.	6	8607	2	249	2	195	3	114
Cocconeis sp.	5	291	9	1125	8	1230	12	1383
Coscinodiscus sp.	1	55	1	35	1	4	2	8
Cyclotella sp.	12	2313	12	4555	8	980	6	670
Cymatopleura solea	6	934	11	2760	10	2165	11	1260
Cymbella sp.	2	385	2	220	4	295		
Diploneis interrupta			1	35	1	55		

Table 1. (CONT'D) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1979. Column A indicates number of stations at which it occurred; Column B indicates total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Diatoms (cont'd)								
Fragilaria sp.			1	35	1	75	1	55
Grammatophora marina	1	23						
Gyrosigma sp.	4	113	4	98	3	87		
Licmophora sp.	11	2298	7	347	12	2145	10	710
Navicula amphibola	1	55	2	110	7	471	4	161
Navicula pandura	1	35						
Naviculoid diatoms	13	4287	13	5670	12	7791	13	14465
Nitzschia closterium	3	545	5	855	1	55	2	70
Nitzschia sigmoidea			1	8	2	8	2	12
Nitzschia spp.	6	410	5	204	11	2941	8	663
Pleurosigma sp.	1	27	5	294	1	59	1	8
Striatella sp.	3	16	3	310	3	660	6	223
Synedra crystallina	5	101	6	232	9	115	9	52
Synedra superba	2	114			6	660	2	39
Synedra undulata			2	110	1	4	2	39
Synedra sp.	5	215	4	160	8	845	9	843
Surirella sp.			2	94	4	134	3	74
Thallassiosira sp.	3	195			7	710		
Tropidoneis sp.	1	19	1	35				
Undet. diatoms	12	2513	11	849	5	530		
Rhizopoda								
Amoeba sp.	2	90						

Table 1. (CONT'D) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1979. Column A indicates number of stations at which it occurred; Column B indicates total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Ciliates								
Canthariella brevis			1	4				
Coxliella sp.					6	226		
Dictyocysta lepida								
Favella sp.			2	59				
Metacylis juergensenii	1	4	3	47	5	115	5	52
Parafavella sp.	2	195	1	110				
Strombidium sp.	3	74	5	195	5	448		
Strobilidium sp.	1	94						
Tintinnopsis sp.			7	1077	4	122	11	641
Tintinnus sp.	3	62			1	4	5	2544
Undet. ciliates	10	1091	10	1117	11	2828	12	1648
Metazoa								
Copepoda (incl. larvae)	9	430	9	467	10	312	13	974
Gastropoda	2	66	1	4	1	4	3	20
Undet. larvae	3	67	5	106			8	296
Polychaetes	2	8			3	16		
Nematodes	2	8	1	4	3	83	2	8
Rotifers							1	4
Animal eggs	4	98	1	16	6	87	9	103
Undet. cells.	13	68141	13	20420	13	38255	13	19385

Table 2. Counts of the principal phytoplankton organisms found in the Canal System in 1979. Column A indicates number of occurrences; Column B indicates organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Sulfur organisms								
Beggiatoa gigantea							4	71
Beggiatoa sp.					6	505	11	396
Blue-green algae								
Anabaena bornetiana					6	990		
Anabaena sp.	3	165	3	165	8	5697	7	1434
Aphanocapsa sp.					1	825		
Arthrospira jenneri					1	55		
Chroococcus gigantea	1	35	1	35	8	691	9	355
Chroococcus planktonica	2	110	1	55	7	1285	2	63
Coelosphaerium sp.					1	55	1	55
Gloeocapsa sp.					2	165	1	55
Gomphosphaeria aponina			3	114	7	637	5	71
Johannesbaptistia pellucida	2	110	3	228	8	398	5	79
Lyngbya sp.			1	4	4	83	1	4
Merismopedia sp.					2	130	1	114
Microcystis sp.	1	55			1	55		
Oscillatoria sp. 7μ diam.	2	220	2	220	10	1463	9	762
O. sp. (red, 7-8μ)	1	456	1	12	8	246	9	534
O. sp. (red, 10μ)	2	79			3	20	1	4
O. sp. (10-12μ)	7	292	4	193	1	4	1	55
O. sp. (20μ)			1	8			1	55
Schizothrix calcicola	4	715	5	1060	11	7140	6	1155

Table 2. (CONT'D) Counts of the principal phytoplankton organisms found in the Canal System in 1979. Column A indicates number of occurrences; Column B indicates organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Blue-green algae (cont'd)								
Spirulina major			2	165	9	2754	1	605
Spirulina minor	2	165	2	110			10	1654
Chlorophyceae								
Chlorella sp.	1	55						
Chlamydomonas sp.	7	1430	12	1855				
Pyramidomonas sp.	5	330	8	1610			1	55
Euglenoids								
Euglena deses							1	55
Euglena sp.	1	55						
Eutreptia sp.	1	55	2	110			5	193
Undet. euglenoids			3	165	7	267	5	181
Silicoflagellates								
Dictyocha fibula								
Cryptophysidae								
Cryptomonas marina			2	145				
Cryptomonas sp.	2	285	12	3790	6	660	7	660
Rhodomonas baltica	12	17710	11	6555	4	855	3	220
Flagellates								
Incertae sedis	12	14850	12	14935	12	8220	12	4455

Table 2. (CONT'D) Counts of the principal phytoplankton organisms found in the Canal System in 1979. Column A indicates number of occurrences; Column B indicates organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Dinophyceae								
Amphidinium sp.	4	440	8	1385	1	55	7	770
Ceratium furca								
Ceratium fusus								
Cochlodinium sp.							2	220
Dinophysis tripos								
Exuviaella marina			1	35				
Exuviaella minor								
Exuviaella oblonga	3	2310	8	676	5	385	9	1035
Gonyaulax diegensis								
Gonyaulax digitale								
Gonyaulax triacantha								
Gymnodinium albulum					1	55	2	110
Gymnodinium aeruginosum					2	8375		
Gymnodinium sp. (large)unk.								
Gymnodinium sp. (small)unk.	12	2754	11	5750	7	665	2	165
Gymnodinium splendens								
Gyrodinium pingue			2	175				
Peridinium depressum								
Peridinium divergens								
Peridinium grani								
Peridinium hirobis								
Peridinium triqueta								
Peridinium trochoideum	6	615	3	160				
Peridinium sp.	9	1100	11	4100	8	2090	9	990
Peridiniopsis rotundata								

Table 2. (CONT'D) Counts of the principal phytoplankton organisms found in the Canal System in 1979. Column A indicates number of occurrences; Column B indicates organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Dinophyceae (cont'd)								
Prorocentrum gracile								
Prorocentrum micans								
Protoceratium reticulatum								
Pyrodinium bahamense								
Pyrocystis sp.					1	4		
Undet. dinoflagellates	10	3465	11	1755	5	825	6	994
Diatoms								
Amphiprora alata	1	55	4	330	10	1180	9	1346
Amphiprora minuta	3	385	5	440	1	220	8	625
Amphiprora paludosa	1	55	2	165	10	10235	3	220
Amphiprora sp.	2	220					3	169
Amphora sp.	7	995	8	695	12	4022	9	913
Biddulphia sp.	1	8						
Bacteriastrum sp.								
Campylosira cymbelliformis	4	275			9	1590	4	240
Chaetoceros sp.	1	110						
Cocconeis sp.	3	165	7	455	1	165	9	1045
Coscinodiscus sp.								
Cyclotella sp.	4	4015	10	1000	1	55		
Cymatopleura solea	3	330	10	2375	9	1760	12	5005
Cymbella sp.	2	110	4	200	5	680	5	440
Diploneis interrupta	2	59	1	35				
Fragilaria sp.			4	5565	5	1230	7	1100
Grammatophora marina							2	385

Table 2. (CONT'D) Counts of the principal phytoplankton organisms found in the Canal System in 1979. Column A indicates number of occurrences; Column B indicates organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Diatoms (cont'd)								
Gyrosigma sp.	1	63	3	75	4	115	2	8
Licmophora sp.	3	1292	10	457	12	3558	12	1485
Navicula amphibola			1	55	10	1446	7	2158
Navicula pandura							2	130
Naviculoid diatoms	12	25135	12	13605	12	69090	12	59895
Nitzschia closterium	6	990	4	180	10	939	2	228
Nitzschia sigmoidea					2	63	3	16
Nitzschia spp.	7	770	8	1057	7	1167	12	2587
Pleurosigma sp.	2	765	3	145	11	9280	5	299
Striatella sp.	1	4	3	224			1	4
Synedra crystallina	2	24	1	4			12	1004
Synedra superba	7	1265	4	235	12	29729	8	3136
Synedra undulata	1	4						
Synedra sp.	6	888	5	530	4	1599	5	888
Surirella sp.	4	228	5	236	3	173	1	55
Thallassiosira sp.								
Tropidoneis sp.			1	55				
Undet. diatoms	9	2090	9	1085	6	562	4	177
Rhizopoda								
Amoeba sp.							1	55
Ciliates								
Canthariella brevis								
Coxliella sp.	1	20	3	16	1	4		

Table 2. (CONT'D) Counts of the principal phytoplankton organisms found in the Canal System in 1979. Column A indicates number of occurrences; Column B indicates organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Ciliates								
Dictyocysta lepida								
Favella sp.								
Metacylis juergensenii					2	8		
Parafavella sp.								
Strombidium sp.	1	55	1	55				
Strobilidium sp.								
Tintinnopsis sp.	9	994	7	772			8	600
Tintinnus sp.							1	4
Undet. ciliates	4	605	8	955	4	354	4	660
Metazoa								
Copepoda (incl. larvae)	8	288	6	87	2	8	10	230
Gastropoda	2	8			3	16		
Undet. Larvae	2	59	2	59	2	59	3	20
Polychaetes	2	8	2	59			2	8
Nematodes	3	12	3	12	9	269	4	130
Rotifers					3	83		
Animal eggs	1	4	4	200	2	59	5	24
Undet. cells	12	143935	12	18575	12	8965	12	13365

Table 3. Organisms of sporadic occurrence in both Card Sound/Biscayne Bay and the canal system, in addition to Tables 1 and 2.

Blue-green algae	
Coelosphaerium kuetzingianum	C
Oscillatoria sp.	C
Pelodictyon sp.	C
Raphidiopsis sp.	C
Chlorophyceae	
Bryopsis sp. (fragment)	B
Carteria sp.	C
Pediastrum sp.	B
Euglenoids	
Euglena acus	C
Unknown euglenoid	B
Rhodophyta	
Unknown red algal cells	B
Chrysophyceae	
Unknown spherical colony	B
Dinoflagellates	
Amphidinium sp. "A"	B,C
Dinophysis sacculus	B
Exuviaella baltica	C
Unknown *Exuviaella*	C
Gonyaulax sphaeroidea	C
Peridinium achromaticum	B
Protoceratium aerolatum	B
Unknown *Prorocentrum*	B
Unknown *Pyrocystis*	B
Ciliates	
Epiplocylis deflexa	B
Helicostomella sp.	B
Metacylis angusta	B
Parafavella inflata	B
Parafavella groenlandica	B
Tintinnopsis bermudensis	B
Tintinnopsis everta	B
Tintinnopsis minuta	B
Tintinnopsis platensis	B
Tintinnopsis strigosa	B
Tintinnopsis tribulosoides	B
Tintinnopsis wailesi	B
Tintinnus procura	B
Metazoa	
Bivalve larva	B
Crab larva	C

NOTE: B=Biscayne Bay/Card Sound C=Canal System

Table 4. Species diversity of the respective groups of phytoplankton organisms found in the Canal System and in Biscayne Bay/ Card Sound in 1978 (July-December) and in 1979 (from Tables 1-3 of this and the preceding report).

	1978		1979	
Groups	Canals	Bay	Canals	Bay
Bacteria	1	1	2	1
Green Algae	5	6	4	5
Blue-Greens	22	20	25	18
Euglenids	5	6	5	4
Silico-flagellates	1	1	0	1
Cryptomonads	3	3	3	2
Dinoflagellates	22	31	16	35
Diatoms	56	70	55	61
Rhizopoda	1	1	1	1
Flagellates Inc. Sedis	1	1	1	1
Ciliates	10	21	6	23
Metazoa	11	9	8	8
Total	138	170	126	160

Table 5. Counts by taxonomic group of organisms found in the Bay and Canal System in 1979. Population totals are in each case for the 500 ml. Canal and Bay samples.

Groups	Feb.		May		Aug.		Nov.		Sub-totals		Total
	Bay	Canals	Bay	Canals	Bay	Canals	Bay	Canals	Bay	Canals	By Group
Blue-greens	3522	2402	4474	2369	4479	22693	2425	7521	14900	34985	49885
Dinoflagellates	11210	10794	12782	14036	32130	12454	13574	4284	69696	41568	111264
Diatoms	24900	40300	19059	29203	23464	138858	21533	83558	88956	291919	380875
Ciliates	1520	1674	2609	1748	3743	366	4885	1264	12757	5052	17809
Flagellates Inc. Sedis	7465	14850	13640	14935	16775	8220	12105	4455	49985	42460	92445
Subtotals	48617	70020	52564	62291	80591	182591	54522	101082	236294	415984	652278
Totals by month - Bay and Canals together	118637		114855		263182		155604		652278 (Grand Total)		

2. Fish and Shellfish (ETS 4.1.1.1.2)

Introduction

Populations of fish and shellfish within the Turkey Point Cooling Canal System were isolated from Biscayne Bay and adjacent offshore habitats when the system was closed in February 1973. Sampling of these populations within the canals was conducted from December 1974 through December 1979 to determine the species present and their relative abundance and size. Species that demonstrated a variety of life history stages were considered to be reproducing and established in the canals, while those represented only by adults were not reproducing and could be expected to be lost through natural attrition.

The studies documented population changes that occurred in the fish and shellfish fauna within the canals. To place these changes in perspective, the canal fauna was compared to that of Biscayne Bay, Card Sound, and pre-operational data.

Methods

Fishes were collected monthly from January through December 1979 at the ten stations established in 1974 and 1975 (FPL, 1976).

Stations 1 and 8 were relatively deepwater (6 m) areas located near the plant intake and discharge, respectively (Figure 1). Water depth at Stations 2 and 4 ranged from 1 to 6 m deep. Water depth at Stations 3, 5, 6, and 7 averaged less than 1 m. Canal width at

Stations 1 through 8 was approximately 60 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 nylon gill nets and minnow traps. Each gill net was 30 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 gill nets were fished perpendicular to shore in water depth of 1 to 2.5 m. The minnow traps were of the double funnel type and measured 406 mm long by 229 mm in diameter. These traps were constructed of 6.4 mm^2 galvanized mesh. The traps were set near the edges of the canals at water depths of from 30 to 50 cm.

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 1 through 10. One gill net and/or two minnow traps were fished for one 24-hour 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 caudal peduncle (standard length). Crabs were measured across the carapace. Total body length was measured for shrimp. Fish nomenclature was in accordance with Bohlke and Chaplin (1968). Comparisons to previous years

data, refer to F.P.&L. Annual and Semi Annual Environmental Monitoring Reports #1 - 12 (1973-1978).

Results

Shellfish

Blue crabs and shrimp were the only shellfishes collected in the canals during 1979. A total of 3 species represented by 143 individuals was collected (Table 1).

Fish

A total of 21 species represented by 3443 individuals was collected in the canals during 1979 (Table 1). The vast majority of these individuals were small forage fishes collected by minnow traps.

The killifish family (Cyprinodontidae) comprised 89.9% of the total number of fishes collected in 1979. The goldspotted killifish and sheepshead minnow were the predominant species found with 1984 and 1091 individuals, respectively (Table 1). Other members of this family collected were the rainwater and marsh killifishes. Killifish are generally less than 65mm in length and, because of their small size, they comprised only about 7.7% of the total weight of the fishes collected.

The livebearer family (Poecilidae) was represented by the sailfin mollies. Live bearers comprised 1.4% of the total number

of fishes collected during 1979 and, due to their small size, only 0.3% of the total fish biomass (Table 1).

The balance of the fishes collected in 1979 comprised only 8.7% of the total number but accounted for almost 92.0% of the total biomass. The collection of a relatively few large individuals such as bonefish, barracuda, snapper, and crevalle jack accounted for most of this biomass (Table 1).

Discussion

Shellfish

During the four years (1975-1978) in which fish and shellfish studies were conducted at Turkey Point, the number of shellfishes collected decreased from 146 in 1975 to 23 in 1978 (Table 2). Apparently, the shellfishes were unable to reproduce in the canals and populations were being reduced through natural attrition of the adults. The blue crabs found during the fall of 1978 and glass shrimp found early in 1979 were probably carried as larvae or juveniles into the canals with water pumped from Card Sound during a special test program (see Annual Report #12, Section V.A.). It is unlikely that these shellfish were spawned within the canals.

Fish

Actively reproducing populations of killifishes and livebearers within the canals were evidenced by the occurrence of juveniles as well as adults (Table 1) and the continued abundance of these

fishes over the five years sampled (Table 2). Although not as abundant as the killifishes, crested gobies, and gulf toadfish were also collected as juveniles and adults and were considered established in the system. No juvenile silver jennys or spotfin mojarras were collected during 1979.

Redfin needlefish were frequently observed in the system and are considered established. However, they were generally not collected because of the sampling methods employed. Needlefish are becoming a prominent predator in the canals as populations of non-reproducing predatory species are reduced by natural attrition.

The remainder of the species found did not appear to be reproducing in the canals as indicated by an absence of juveniles and a decline in number collected (Table 2). The species that were not reproducing within the canals generally spawn at sea and have pelagic eggs and larvae which develop offshore. Confinement to the inshore canals was not conducive to spawning and development of eggs and larvae.

Changes which occurred in fish populations in the canals were reflected in the data when plotted as catch per unit effort (CPUE). The minnow trap CPUE, indicative of populations of the small forage species, increased after the first year of the study and decreased slowly over subsequent years (Figure 2). The large expanse of generally shallow water provided an ideal situation for forage

fishes and may be a cause for the slower decline in their populations relative to the larger predators. The gill net CPUE, indicative of populations of larger fishes, decreased after the first year of the study and has decreased substantially over subsequent years.

Whether populations of forage species will stabilize on a yearly basis, and at what levels, is still unknown. The collection of fewer forage fishes in 1979 than during 1977 or 1978 (Table 2) may indicate population stabilization, natural year class variation, or other factors. Regardless of annual population levels, seasonal variations will continue to be great within each year, as shown in Figure 2.

Study comparisons

Eighty 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) compared to 42 species collected by Applied Biology, Inc. in the canal system from 1974 to 1978. Although the different collecting methods used during the two studies may have accounted for some of the difference in the number of species, it appears that many species found in the bay and sound simply did not enter the canal system during the brief period it was open.

The surveys conducted by Nugent (1970) with gill nets and fish

traps in the immediate vicinity of the plant resulted in the collection of 51 species of fishes. These baseline studies were conducted in tidal creeks and other nearshore areas so that the species found were more representative of those collected in the cooling canals (Table 3). Nevertheless, Nugent (1970) also found more species than were found in the canals. This is a further indication that certain fish species in the area may not have entered the canals.

The studies conducted by Florida Power & Light show that the fishes and shellfishes which became isolated in the canals were primarily the common, and often abundant, species found by Nugent (1970) outside the canal system. The few species collected by Applied Biology which were not found by Nugent (Table 3) were mainly small fishes collected by minnow traps, a collection method which Nugent did not use.

Conclusions

Populations of fish and shellfish within the Turkey Point Cooling Canal System became isolated from Biscayne Bay, Card Sound, and adjacent offshore habitats when the system was closed off in February 1973. Certain species, particularly forage fishes in the killifish and livebearer families, have done relatively well in the canals. Other fishes, such as snappers, grunts and barracuda, were not able to reproduce within the canals and their numbers have been reduced through natural attrition. Many of the species lost through natural attrition were predators which may, at least

in part, account for the abundance of the forage fishes.

Study comparisons indicated that several species found in the bay and sound adjacent to the canal system did not enter when the system was open, or become entrapped in the canals. All fishes found within the canals were members of species which were common or abundant outside the system in adjacent waters.

In keeping with the intent of the Technical Specifications to associate all aquatic monitoring stations with plankton stations, effective January 1980 the following station labeling and location change is being affected: Fish and Shellfish Station RC.2 (2), Benthos Sediments Chemistry Station RC.2, and Benthic Organism Station RC.2 are being moved north 1 1/2 miles to sample the same key cut canal as previously sampled, but they will now be labeled and associated with a long standing plankton station (RC-1).

RC-2 is the label for a long established plankton station (Plankton Figure 1) in the deep "square cut" return canal designated as Card Sound Canal and should not be confused with the RC.2 label in the return key cut canal (Fish & Shellfish Figure 1).

During 1980 sampling stations W6.2, W18.2 and WF.2 sampling points have been relocated several hundred feet to reassociate with long standing plankton stations.

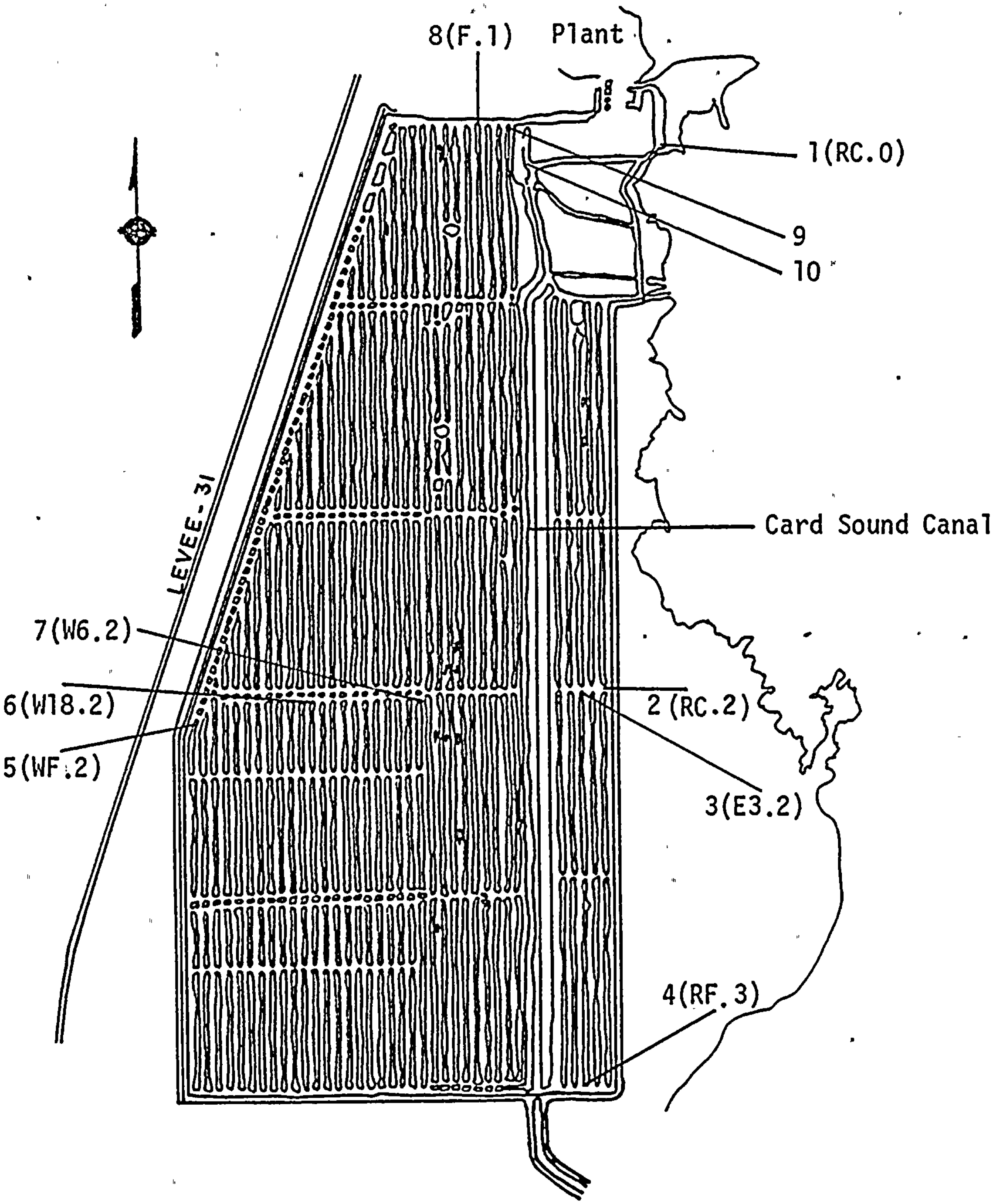

Figure 1. Fish and shellfish sampling station locations, Turkey Point Cooling Canal System

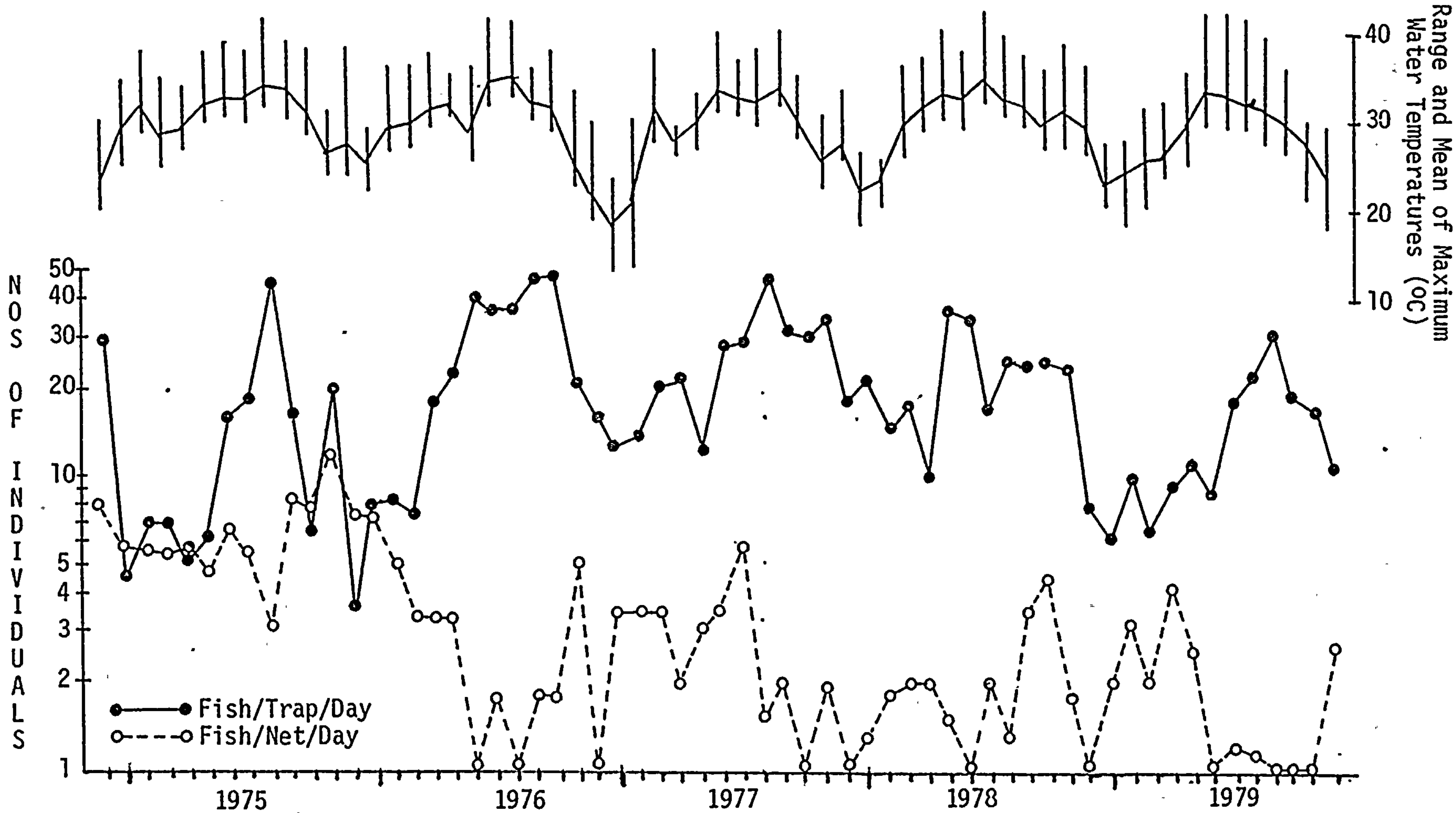

Figure 2. Minnow trap and gill net catch per unit effort, and maximum temperatures recorded in the Turkey Point Cooling Canal for December 1974 through December 1979.

Table 1. Fish and shellfish collected within the Turkey Point Cooling Canal System during January through December 1979.

Species	Number of individuals	Range of stardard lengths (mm)	Total weight (g)	Percentage composition of fishes by	
				Number	Weight
blue crab (*Callinectes sapidus*)	56	72-162	8278	39.2	99.4
glass shrimp (*Tozeuma carolinensis*)	86	3-24	31	60.1	0.4
shrimp (*Penaeus* spp.)	1	44	18	0.7	0.2
goldspotted killifish (*Floridichthys carpio*)[a]	1984	17-61	2447	55.6	4.9
sheepshead minnow (*Cyprinodon variegatus*)[a]	1091	17-45	781	30.4	1.6
rainwater killifish (*Lucania parva*)[a]	10	26-36	5	0.3	<0.1
marsh killifish (*Fundulus confluentus*)[a]	1	48	1	<0.1	<0.1
sailfin molly (*Poecilia latipinna*)[a]	48	22-55	116	1.3	0.2
crested goby (*Lophogobius cyprinoides*)[a]	154	25-79	503	4.29	1.0
yellowfin mojarra (*Gerres cinereus*)	58	120-238	7140	1.6	14.2
silver jenny (*Eucinostomus gula*)[a]	44	104-150	2358	1.2	4.7
spotfin mojarra (*Eucinostomus argenteus*)[a]	3	127-140	178	<0.1	0.4
stripped mojarra (*Diapterus plumieri*)	3	125-140	818	<0.1	1.7
bonefish (*Albula vulpes*)	6	120-238	9768	0.2	19.4
great barracuda (*Sphyraena barracuda*)	8	326-620	5902	0.2	11.9
gulf toadfish (*Opsanus beta*)[a]	13	67-170	615	0.4	1.2
gray snapper (*Lutjanus griseus*)	9	128-390	6798	0.3	13.5
schoolmaster (*Lutjanus apodus*)	2	140-274	888	<0.1	1.8
bluestriped grunt (*Haemulon sciurus*)	1	348	216	<0.1	0.7
crevalle jack (*Caranx hippos*)	1	272	610	<0.1	1.2
tidewater silverside (*Menidia beryllina*)	3	38-39	2	<0.1	0.1

Table 1. (cont'd) Fish and shellfish collected within the Turkey Point Cooling Canal System during January through December 1979.

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition of fishes by	
				Number	Weight
Atlantic spadefish (*Chaetedipterus faber*)	1	333	1132	<0.1	2.3
sailor's choice (*Harmulon parrae*)	1	265	554	<0.1	1.1
sharksucker (*Echeneis naucrates*)	2	410-412	952	<0.1	1.9

[a]species which are reproducing in the Canal System.

Table 2. Fish and shellfish collected within the Turkey Point Cooling Canal System for 1975 through 1979.

Species	Number of individuals per year				
	1975[b]	1976[b]	1977[b]	1978[b]	1979[b]
SHELLFISHES[a]					
glass shrimp (*Tozeuma carolinensis*)	0	0	0	0	86
blue crab (*Callinectes sapidus*)	57	3	47	15	56
shrimp (*Penaeus* spp.)	2	3	3	8	1
stone crab (*Menippe mercenaria*)[obs]	70	18	0	0	0
spiny lobster (*Panulirus argus*)[obs]	16	5	2	0	0
horseshoe crab (*Limulus polyphemus*)[obs]	1	1	0	0	0
Total shellfishes	146	30	52	23	143
FISHES[a]					
goldspotted killifish (*Floridichthys carpio*)[c]	1949	3351	3392	3233	1984
sheepshead minnow (*Cyprinodon variegatus*)[c]	358	2181	2207	1212	1091
crested goby (*Lophogobius cyprinoides*)[c]	15	27	53	73	154
yellowfin mojarra (*Gerres cinereus*)	68	55	59	29	58
sailfin molly (*Poecilia latipinna*)[c]	111	341	762	173	48
silver jenny (*Eucinostomus gula*)[c]	4	1	14	21	44
gulf toadfish (*Opsanus beta*)[c]	0	1	8	6	13
rainwater killifish (*Lucania parva*)[c]	18	2	7	13	10
gray snapper (*Lutjanus griseus*)	28	16	9	4	9
great barracuda (*Sphyraena barracuda*)	12	3	4	6	8
bonefish (*Albula vulpes*)	9	8	11	8	6

Table 2. Fish and shellfish collected within the
(cont'd) Turkey Point Cooling Canal System
for 1975 through 1979.

Species	Number of individuals per year				
	1975[b]	1976[b]	1977[b]	1978[b]	1979[b]
FISHES[a] (continued)					
spotfin mojarra (*Eucinostomus argenteus*)[c]	8	3	2	13	3
tidewater silverside (*Menidia beryllina*)	15	3	8	1	3
striped mojarra (*Diapterus plumieri*)	3	3	2	1	3
schoolmaster (*Lutjanus apodus*)	9	8	10	4	2
sharksucker (*Echeneis naucrates*)	0	1	0	0	2
marsh killifish (*Fundulus confluentus*)[c]	0	5	12	4	1
bluestriped grunt (*Haemulon sciurus*)	31	9	4	2	1
crevalle jack (*Caranx hippos*)	1	0	1	1	1
sailors choice (*Haemulon parrai*)	17	11	1	0	1
Atlantic spadefish (*Chaetodipterus faber*)	3	3	0	0	1
pike killifish (*Belonesox belizanus*)[c, obs]	2	2	3	15	0
snook (*Centropomus undecimalis*)	0	0	1	4	0
gulf killifish (*Fundulus grandis*)[c]	0	10	13	2	0
sea catfish (*Arius felis*)	18	0	2	2	0
redfin needlefish (*Strongylura notata*)[c, obs]	0	0	0	1	0
pinfish (*Lagodon rhomboides*)	0	1	4	1	0
hardhead silverside (*Atherinomorus stipes*)	17	0	20	0	0
striped mullet (*Mugil cephalus*)[obs]	7	13	0	0	0
ladyfish (*Elops saurus*)	4	2	1	0	0
Atlantic needlefish (*Strongylura marina*)	0	1	0	0	0
lined seahorse (*Hippocampus erectus*)	0	1	0	0	0

Table 2. (cont'd) Fish and shellfish collected within the Turkey Point Cooling Canal System for 1975 through 1979.

Species	Number of individuals per year				
	1975[b]	1976[b]	1977[b]	1978[b]	1979[b]
FISHES[a] (continued)					
permit (*Trachinotus falcatus*)	0	1	0	0	0
sheepshead (*Archosargus probatocephalus*)	0	0	1	0	0
fat sleeper (*Dormitator maculatus*)	0	0	1	0	0
blue runner (*Caranx crysos*)	1	0	0	0	0
gulf kingfish (*Monticirrhus littoralis*)	1	0	0	0	0
banner goby (*Microgobius microlepis*)	1	0	0	0	0
checkered puffer (*Sphoecroides testudineus*)	1	0	0	0	0
pipefish (*Syngnathus*)	2	0	0	0	0
goby (*Gobionellus*)	2	0	0	0	0
lookdown (*Selene vomer*)	2	0	0	0	0
Total fishes	2723	6063	6595	4829	3443

[a]Ranked from most abundant to least abundant as they were found in collections taken during 1979.

[b]Reference Annual Reports for N.R.C. Appendix B Technical Specifications.

[c]Species which are reproducing in the canals.

[obs]Observed, but not collected during 1979 program.

Table 3. Species of fish and shellfish collected in the Turkey Point Cooling Canal System, tidal creeks, and near shore areas around the Turkey Point Plant.

Species	Nugent Aug 1968-Jan 1970	Applied Biology Dec 1974-Dec 1978	LU/TP Jan 1978-Dec 1979
blue crab (*Callinectes sapidus*)	X	X	X
glass shrimp (*Tozeuma carolinensis*)[a]	X	X	X
horseshoe crab (*Limulus polyphemus*)	X	X	X
shrimp (*Penaeus* spp.)	X	X	X
spiny lobster (*Panulirus argus*)		X	X
stone crab (*Menippe mercenaria*)	X	X	X
Atlantic needlefish (*Strongylura marina*)	X	X	X
Atlantic spadefish (*Chaetodipterus faber*)	X	X	X
bandtail puffer (*Sphoeroides spengleri*)	X		
banner goby (*Microgobius microlepis*)		X	X
barbfish (*Scorpaena brasiliensis*)	X		
black drum (*Pogonias cromis*)	X		
bonefish (*Albula vulpes*)		X	X
blue runner (*Caranx crysos*)	X	X	X
blue striped grunt (*Haemulon sciurus*)	X	X	X
bull shark (*Carcharhinus leucas*)	X		
checkered puffer (*Sphoeroides testudineus*)	X	X	X
crested goby (*Lophogobius cyprinoides*)	X	X	X
crevalle jack (*Caranx hippos*)	X	X	X
fantail mullet (*Mugil trichodon*)	X		
fat sleeper (*Dormitator maculatus*)		X	
fat snook (*Centropomus parallelus*)	X		
goby (*Gobionellus* sp.)		X	X

Table 3. (cont'd) Species of fish and shellfish collected in the Turkey Point Cooling Canal System, tidal creeks, and near shore areas around the Turkey Point Plant.

Species	Nugent Aug 1968-Jan 1970	Applied Biology Dec 1974-Dec 1978	LU/TP Jan 1978-Dec 1979
goldspotted killifish (*Floridichthys carpio*)		X	X
gray (Mangrove) snapper (*Lutjanus griseus*)	X	X	X
gray triggerfish (*Balistes capriscus*)	X		
great barracuda (*Sphyraena barracuda*)	X	X	X
gulf flounder (*Paralichthys albigutta*)	X		
gulf killifish (*Fundulus grandis*)		X	X
gulf kingfish (*Menticirrhus littoralis*)		X	X
gulf toadfish (*Opsanus beta*)	X	X	X
hardhead silverside (*Atherinomorus stipes*)		X	X
jewfish (*Epinaphelus itajara*)	X		
ladyfish (*Elops saurus*)	X	X	X
lane snapper (*Lutjanus synagris*)	X		
lemon shark (*Negaprion brevirostris*)	X		
lined seahorse (*Hippocampus erectus*)		X	X
lookdown (*Selene vomer*)	X	X	X
margate (*Haemulon album*)	X		
marsh killifish (*Fundulus confluentus*)		X	X
mosquitofish (*Gambusia affinis*)	X		
mummichog (*Fundulus heteroclitus*)	X		
nurse shark (*Ginglymostoma cirratum*)	X		
permit (*Trachinotus falcatus*)	X	X	X
pike killifish (*Belonesox belizanus*)		X	X
pinfish (*Lagodon rhomboides*)	X	X	X
pipefish (*Syngnathus* sp.)		X	X

Table 3. (cont'd) Species of fish and shellfish collected in the Turkey Point Cooling Canal System, tidal creeks, and near shore areas around the Turkey Point Plant.

Species	Nugent Aug 1968-Jan 1970	Applied Biology Dec 1974-Dec 1978	LU/TP Jan 1978-Dec 1979
rainwater killifish (*Lucania parva*)		X	X
redfin needlefish (*Strongylura notata*)		X	X
remora (*Remora remora*)	X		X
sailfin molly (*Poecilia latipinna*)	X	X	X
sailor's choice (*Haemulon parrai*)	X	X	X
sargassum fish (*Histrio histrio*)	X		
scrawled cowfish (*Lactophys quadricornis*)	X		
schoolmaster (*Lutjanus apodus*)	X	X	X
sea catfish (*Arius felis*)	X	X	X
sharksucker (*Echenesis naucrates*)		X	X
sheepshead (*Archosargus probatocephalus*)	X	X	X
sheepshead minnow (*Cyprinodon variegatus*)	X	X	X
shortnose gar (*Lapisosteus platyrhineus*)	X		
silver jenny (*Eucinostomus gula*)	X	X	X
snook (*Centropomus undecimalis*)	X	X	X
southern stingray (*Dasyatis americana*)	X		
spot (*Leiostomus xanthurus*)	X		
spotfin mojarra (*Eucinostomus argenteus*)	X	X	X
spotted seatrout (*Cynoscion nebulosus*)	X		
striped mojarra (*Diapterus plumieri*)	X	X	X
striped mullet (*Mugil cephalus*)	X	X	X
tarpon (*Megalops atlantica*)	X		X
tarpon snook (*Centropomus pectinatus*)	X		
tidewater silverside (*Menidia beryllina*)		X	X

Table 3. (cont'd) Species of fish and shellfish collected in the Turkey Point Cooling Canal System, tidal creeks, and near shore areas around the Turkey Point Plant.

Species	Nugent Aug 1968-Jan 1970	Applied Biology Dec 1974-Dec 1978	LU/TP Jan 1978-Dec 1979
tripletail (*Lobotes surinamensis*)	X		
white mullet (*Mugil curema*)	X		
yellowfin mojarra (*Gerres cinereus*)	X	X	X

3. BENTHOS (ETS 4.1.1.1.3)
a. CHARACTERISTICS OF THE SEDIMENTS

INTRODUCTION

The sediment characteristics study was designed to determine the pH, salinity and temperature and to monitor selected nutrients in the interstitial (pore) water and sediments of the Turkey Point canal system. A comparison of these results with data from samples collected at three control areas outside of the cooling canals provided a basis for assessing biological changes resulting from operation of the Turkey Point Plant.

From September 1970 through May 1971, preoperational chemical data were collected in Biscayne Bay and Card Sound (RSMAS, 1971, 1972). This study differed from the existing operational monitoring program in most aspects (Characteristics of the Sediments Table 1). However, monitoring data can be compared with relevant preoperational data to evaluate the long term impact of the Turkey Point Plant on the water and sediments in the area surrounding the plant.

Most of the world's oceans are well mixed, at low temperatures, and contain some dissolved oxygen. Anoxic conditions in which no oxygen is present however, can occur if waters are exposed to high temperatures, poor circulation and high oxygen consumption caused by factors such as an excess of organic matter. These conditions are first observed in the interstitial water of the sediment-water

interface. The Turkey Point canal system is potentially an oxygen poor system because of high temperatures resulting from the heated discharge from the power plant and restricted exchange with adjacent waters. Additionally, the canal system is located in the subtropics which are characterized by high production of organic material.

During 1979, several chemicals were discharged into the circulating water system at the rates shown in Table II.B-2, Section II.B. These chemicals were used in the Turkey Point Plant's water treatment program. The effects of selected chemicals from this tabulation were considered in evaluating the results of the chemistry program (Characteristics of the Sediments Tables 2 through 12).

MATERIALS AND METHODS

Samples containing a combination of water and sediment were collected monthly at eight canal stations and three bay stations (Characteristics of the Sediments Figure 1). Samples were collected in 1-liter screwcap polypropylene bottles, placed in an ice chest and kept at 4°C until analyzed. Samples were then homogenized, filtered and analyzed for the following soluble nutrients: sulfate, sulfite, sulfide, nitrate, nitrite, ammonia and orthophosphate. Standard analytical methods (Characteristics of the Sediments Table 13) were used to perform all chemical analyses.

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 ions are susceptible to oxidation, the bottles were filled to overflowing to avoid excessive exposure to oxygen that would be contained in an airspace. To prevent deleterious effects of oxygenation, these samples were kept at 4°C and analyzed without filtration.

Sediment samples were also collected at canal and bay stations for analysis of insoluble sulfide content. These samples 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 sulfide to H_2S, which was then distilled into a trapping solution of zinc acetate and analyzed spectrophotometrically.

The pH of sediment samples was measured with a standard Corning pH meter (Model 10). Salinity was measured with a YSI Model 33 meter. Temperature was measured in the field using a YSI Model 42 dissolved oxygen/temperature meter.

RESULTS AND DISCUSSION

pH

The pH of marine and estuarine waters is a measure of the acid-base equilibrium of dissolved components. pH is an important factor in aquatic chemical and biological systems because 1) dissociation

of weak acids and bases is affected by changes in pH, 2) the toxicity of many compounds is affected by the degree of dissociation, and 3) the solubility of metals from suspended solids and bottom sediments is affected by pH.

The pH values of the cooling canal system sediments ranged from 7.6 to 8.9. Measurements for Biscayne Bay stations ranged from 7.8 to 8.9 pH (Characteristics of the Sediments Tables 2 and 15). These values are close to the narrow range of 6.8 to 8.2 pH found for most marine porewaters (Goldberg, 1974). Comparison of the yearly average values (Characteristics of the Sediments Table 16) shows very small variations between canal stations (8.0 to 8.4 pH units) and Biscayne Bay stations (8.4 to 8.6 pH units). The canal's pH range was apparently not affected by the additions of sulfuric acid, sodium hydroxide and hydrated lime to the circulating water system.

Salinity

Salinity is a measure of the salt content of water. Marine organisms vary in their ability to tolerate salinity changes. Animals which are sensitive to relatively small salinity changes are particularly characteristic of deep water and open sea, where salinity ranges vary only from 34 to 36 ppt. Those which have a higher degree of tolerance are characteristic of the coastal regions and estuaries, where wide salinity variations may occur.

During 1979, the salinity of the sediments ranged from 14.0 to 31.5 ppt at Biscayne Bay stations and from 18.3 to 48.0 ppt in the Turkey Point canal system (Characteristics of the Sediments Tables 3 and 15). In 1978, these ranges were from 11.6 to 37.7 ppt for Biscayne Bay stations and from 22.0 to 43.1 ppt for the Turkey Point canal system (ABI, 1979). The average yearly sediment salinity in the adjacent Biscayne Bay sampling stations was 29.6 ppt in 1977, 22.2 ppt in 1978, and 22.5 ppt in 1979. Sediment salinity in the canal system was 38.4 ppt in 1977, 30.4 ppt in 1978, and 29.3 ppt in 1979.

In a closed marine system like the Turkey Point Plant cooling canals, evaporation can increase sediment salinity to a level that the life forms present in the system cannot tolerate. Data show that there was no increase in sediment salinity from 1978 to 1979 in the canal system, although values were higher in the canals than at control stations in Biscayne Bay. Seasonal variations in salinity were also noted during the study. These variations were influenced by rainfall in the Turkey Point area.

Temperature

Temperatures in the Turkey Point canal system reflected the thermal discharge from the power plant. Temperature is important to biological systems because high temperatures decrease dissolved oxygen levels, increase the rates of chemical reactions, and give false temperature cues to aquatic life. If temperatures are high enough, lethal temperature limits may be exceeded. These factors

affect the infauna and sedimentary bacterial populations and may also affect the benthic flora and the sessile or semi-sessile bottom fauna.

Temperatures ranged from 10.0° to 37.0°C at control stations in Biscayne Bay and from 17.5° to 44.0°C in the cooling canals (Characteristics of the Sediments Tables 4 and 15). In 1978, temperatures ranged from 18.5° to 33.9°C at the Biscayne Bay stations and 15.8° to 39.5°C in the canal system (ABI, 1979). There was a definite difference in the yearly average temperature values between sampling stations (Characteristics of the Sediments Table 16). Biscayne Bay stations had lower temperatures than canal stations. The highest average temperature (34.6°C) was recorded at canal Station 8, lower temperatures were found at Stations 5, 6, and 7 (29.7° to 29.9°C), and the lowest readings were at Stations 1, 2, 3 and 4 (26.6° to 28.3°C). This gradient followed the path of the water in the canal system. Warm water discharged from the plant enters the canal system close to Station 8, moves through the canal system in a circular fashion, and enters the plant at Station 1. Temperatures observed at Station 8 are in a range considered to exclude some biota occurring in the other parts of Turkey Point canal system (Roessler and Tabb, 1974).

Selected Nutrients

Sulfur

Sulfur occurs in a number of forms in marine water, but only

two are of major importance--sulfate and sulfide. Both forms are present in the waters of anoxic sediments, with sulfate usually the most abundant. Bacteria can reduce sulfate to sulfide. This reduction can take place in the water column if oxygen is not available, but more frequently, sulfate reduction occurs in the underlying sediment. Dissolved sulfides are to a large extent precipitated to form sulfide minerals. Sulfite can also be present in the marine environment where the oxido-reduction process (sulfate-sulfide conversion) is active.

The Turkey Point canal system, being a closed system, is a potentially anoxic environment in which sulfide could build up within the sediment through depletion of available sulfate.

During 1979, the sulfate concentration ranged from 2399 to 3450 ppm in the cooling canals (Characteristics of the Sediments Tables 5 and 15) and from 1521 to 3120 ppm at Biscayne Bay stations. In 1978, these values ranged from 360 to 3950 ppm in the cooling canals (ABI, 1978) and from 180 to 3100 ppm at Biscayne Bay stations. The 1979 data showed that the average yearly sulfate concentration in the canal waters (2998 ppm) was about 22 percent higher than in Biscayne Bay samples (2467 ppm). The average yearly sulfate concentration in the canal waters increased from the 1978 value of 2528 ppm, but in Biscayne Bay the increase was even greater (1898 ppm in 1978). It is evident that changes in sulfate concentrations in the canal system paralleled those in Biscayne Bay. There was no difference in the average yearly concentration of sulfate for the different stations in the canal system.

Soluble sulfite and sulfide (Characteristics of the Sediments Tables 6 and 7) were below the detection limits of the method employed --<0.1 and <0.05 ppm, respectively.

Insoluble sulfide values in the cooling canals ranged from <0.05 to 8.37 μg/g wet weight of soil (Characteristics of the Sediments Table 8) and in Biscayne Bay from <0.05 to 2.83 μg/g wet weight of soil. These were in the same general ranges as in 1978 when they were <0.05 to 12.20 μg/g wet weight of soil for the cooling canals (ABI, 1979) and <0.05 to 3.16 μg/g wet weight of soil for the Biscayne Bay stations. No build-up of insoluble sulfide was found during this time. These findings also indicated that sediments in the Turkey Point canal system were not anoxic.

Nitrogen

Nitrogen occurs in a number of different forms in marine waters. The principal ones are NO_3 (nitrate), NO_2 (nitrite), N_2 (dissolved nitrogen gas) and NH_4^+ (ammonia). Under the conditions existing in the porewaters of anoxic marine sediments, the principal species are N_2 and NH_4^+ (Thorstenson, 1970). A lack of nitrate and nitrite is caused by rapid bacterial reduction to N_2 and NH_4^+. Nitrate, nitrite and ammonia were analyzed in the interstitial water of Turkey Point cooling canal samples.

During 1979, nitrate concentrations ranged from <0.001 to 2.712 ppm in the cooling canals (Characteristics of the Sediments Tables 9

and 15) and from <0.001 to 0.341 ppm at Biscayne Bay control stations. In 1978, these ranges were very similar[a]; 0.002 to 0.346 ppm in the cooling canals and <0.005-0.253 ppm for the Biscayne Bay stations. If the extreme value of 2.712 ppm observed during March 1979 is disregarded, then yearly average values observed in the canal system are very close for all stations but higher than for Biscayne Bay stations (Characteristics of the Sediments Table 16). Comparison with Biscayne Bay stations and 1978 values indicates that during 1979 there was no depletion of nitrate in the cooling canals from anoxic conditions.

During 1979, nitrite concentrations ranged from <0.001 to 0.028 ppm in the cooling canals (Characteristics of the Sediments Tables 10 and 15) and from <0.001 to 0.014 ppm for the Biscayne Bay stations. In 1978, these ranges were almost the same, <0.001 to 0.024 in the cooling canals and <0.001 to 0.012 ppm for the Biscayne Bay stations. Yearly average values were similar for canal and Biscayne Bay stations. This constancy in nitrite concentrations indicates that during 1979 there was no depletion of nitrite in the cooling canals due to anoxic conditions.

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[a]The exception was a single observation of 2.712 ppm in March 1979 at Station 8.

Ammonia values found in the Turkey Point canal system during 1979 ranged from 0.02 to 0.97 ppm (Characteristics of the Sediments Tables 11 and 15) and were similar to the control stations values, which ranged from 0.09 to 1.00 ppm. In 1978, these ranges were similar in the cooling canals (<0.01 to 1.91 ppm) and in the Biscayne Bay stations (0.24 to 1.78 ppm). Yearly average values were similar for canal and Biscayne Bay stations (Characteristics of the Sediments Table 16). This constancy in ammonia concentrations indicates that conditions were not anoxic at the sediment/water interface in the cooling canals.

Phosphorus

The most stable and dominant form of dissolved phosphorus in marine sediments is orthophosphate (Kester and Pytkowicz, 1967). Dissolved orthophosphate levels in oxygen-containing sediments are similar to values for the overlying water. By contrast, phosphate levels increase in anoxic sediments (Brooks et al., 1968) along with ammonia, and to a lesser extent, sulfide.

During 1979, orthophosphate values in interstitial waters ranged from <0.01 to 0.90 ppm in the cooling canals (Characteristics of the Sediments Tables 12 and 15) and from <0.01 to 0.24 ppm at the control stations in Biscayne Bay. In 1978, orthophosphate values were <0.01 to 0.24 ppm in the cooling canals and <0.01 to 0.17 ppm for the Biscayne Bay stations. Yearly average values were similar for canal and Biscayne Bay stations (Characteristics of the Sediments Table 15) except for Stations 2 and 3 which had unusually

high orthophosphate concentrations during the January sampling. Except for these unusual values, there was no increase in orthophosphate concentrations in the interstitial waters of the cooling canals. This trend indicated that the sediments are not anoxic.

Comparison With Preoperational Data

Parameters monitored, analytical methods and sampling locations differed between the preoperational and operational studies (Characteristics of the Sediments Table 1). However, the data for the same parameters were in similar ranges. The pH range of 7.0 to 7.8 found in Card Sound sediments in 1970-71 is slightly lower than the pH ranges found during 1977-79 (Characteristics of the Sediments Table 15). The salinity of Biscayne Bay/Card Sound water during the 1970-71 sampling was higher (27.3 to 44.4 ppt) than that of sediments in Biscayne Bay control stations in 1979 (14.0 to 31.5 ppt). This difference was probably caused by the rainfall pattern during this time. The range of nitrate values (<0.001 to 0.023 ppm) found during the preoperational study was lower than that found in 1979 (<0.001 to 0.341 ppm). Differences in preservation and analysis methods used in these studies probably caused this discrepancy. Nitrite and orthophosphate values were in the same range during the 1970-71 and 1979 monitoring.

SUMMARY AND CONCLUSIONS

Monthly sediment and interstitial water samples from the Turkey Point Plant cooling canals and control stations in Biscayne Bay were analyzed for pH, salinity, temperature, and the presence of selected nutrients.

Temperature, salinity, and sulfate values in the Turkey Point Plant cooling canal sediments were higher than in Biscayne Bay. Temperatures in the cooling canal sediments were influenced by plant operations as shown by the decrease in temperature at stations farther from the plant discharge. Salinity and sulfate values were influenced by outside factors such as water evaporation and rainfall. All other parameters were in the same range as values from control stations.

Comparisons with preoperational study data showed that there was no measurable impact on physical or chemical parameters as a result of plant operation.

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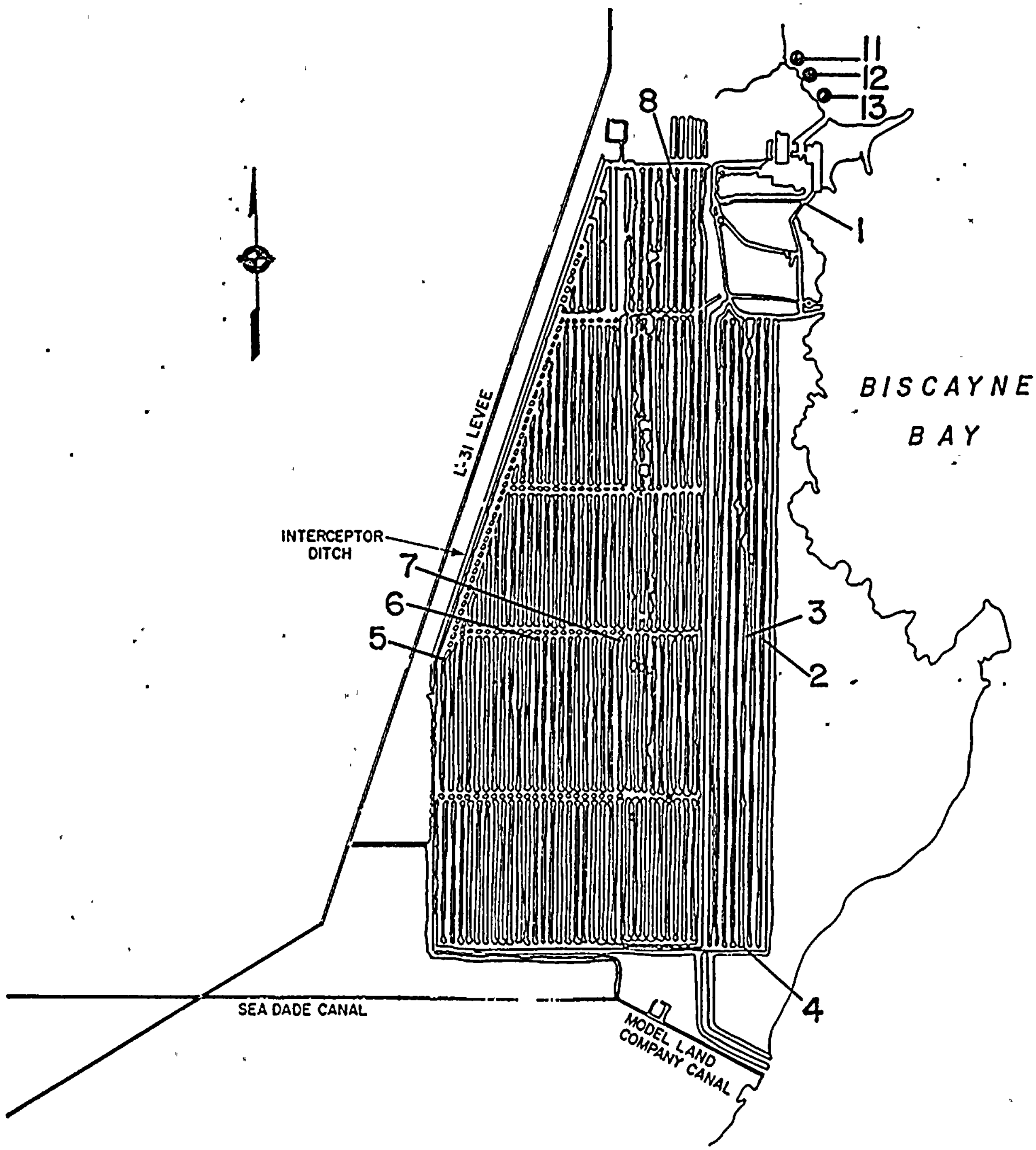

Characteristics of the Sediments Figure 1. Chemistry sampling locations, Turkey Point Plant, 1979.

CHARACTERISTICS OF THE SEDIMENTS TABLE 1

PARAMETERS MEASURED DURING PREOPERATIONAL AND OPERATIONAL STUDIES
TURKEY POINT PLANT
1970, 1971 AND 1979

	Preoperational study 1970-1971		Operational study 1979		
Parameter	Water	Sediment	Interstitial water	Water	Sediment
Alkalinity	X				
Ammonia			X		
Dissolved inorganic carbon	X				
Dissolved organic carbon	X	X			
Dissolved oxygen	X				
Nitrate	X		X		
Nitrite	X		X		
pH		X			X
Phosphate	X		X		
Radioactivity	X	X			
Salinity	X				X
Silica	X				
Sulfate			X		
Sulfide				X	X
Sulfite					X
Temperature	X	X			X
Trace metals	X	X			

CHARACTERISTICS OF THE SEDIMENTS TABLE 2

pH OF SEDIMENTS AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	ND[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FEB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAR	7.9	8.2	8.2	8.1	8.2	8.3	8.2	8.3	8.7	8.5	8.4
APR	7.9	8.1	8.0	8.0	8.2	8.2	8.2	8.4	8.4	8.4	8.4
MAY	8.0	8.2	8.5	8.2	8.3	8.3	8.2	8.4	8.5	8.6	8.8
JUN	7.6	7.9	8.4	8.2	8.4	8.1	8.3	8.4	8.5	8.4	8.6
JUL	7.9	8.0	8.8	8.9	8.9	8.6	8.8	8.9	8.9	8.9	8.8
AUG	8.0	8.3	8.4	8.4	8.4	8.3	8.4	8.3	8.5	8.4	8.6
SEP	8.2	8.1	8.2	7.9	8.1	8.0	8.1	7.9	8.6	8.2	8.0
OCT	8.2	7.9	8.7	8.3	8.1	8.5	8.5	8.2	8.5	8.4	8.3
NOV	7.9	8.2	7.9	8.3	8.7	8.2	8.4	8.4	8.2	7.8	8.2
DEC	8.4	8.7	8.4	8.5	8.7	8.7	8.5	8.7	8.7	8.8	8.7

aND = No data. pH of sediments was not measured during January and February.

CHARACTERISTICS OF THE SEDIMENTS TABLE 3

SALINITY (ppt) OF SEDIMENTS AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	54.2	35.4	34.9	36.1	35.9	33.5	33.1	34.9	27.8	28.0	27.5
FEB	37.2	38.6	39.5	18.3	36.8	38.4	38.0	33.5	29.8	29.9	29.9
MAR	24.9	23.9	24.9	25.6	21.9	25.1	25.5	20.0	22.1	22.6	20.7
APR	25.0	24.5	26.0	24.8	19.9	24.1	26.0	24.0	22.1	22.1	21.8
MAY	26.0	25.8	26.5	26.2	26.5	27.2	26.8	25.8	18.5	21.8	20.8
JUN	25.0	23.0	25.0	25.0	25.1	25.2	25.4	20.3	20.3	20.2	20.6
JUL	33.8	33.3	32.9	33.8	33.0	33.5	33.3	33.8	31.5	31.0	30.3
AUG	25.8	25.5	24.8	24.4	23.0	24.3	25.1	23.9	21.1	20.2	19.2
SEP	20.1	20.5	20.9	20.9	20.8	21.4	20.9	20.0	18.0	17.8	18.0
OCT	29.9	29.8	30.3	29.9	28.9	28.7	28.6	29.2	21.8	21.8	22.1
NOV	34.0	42.0	44.0	48.0	40.0	38.0	42.0	44.0	24.0	14.0	24.0
DEC	31.2	25.3	29.0	31.8	29.0	28.8	32.1	30.6	16.5	14.8	16.8

CHARACTERISTICS OF THE SEDIMENTS TABLE 4

TEMPERATURE (°C) OF SEDIMENT SURFACE AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	21.2	21.1	17.5	19.0	23.1	21.8	20.4	29.0	10.1	10.0	11.0
FEB	25.5	25.1	23.3	23.5	27.8	27.6	27.2	32.8	22.5	22.7	23.0
MAR	23.8	24.2	22.0	22.8	27.0	27.0	26.8	32.0	18.8	19.5	19.9
APR	28.1	27.9	27.0	26.0	28.0	28.4	29.1	32.2	23.9	23.8	23.8
MAY	28.1	28.3	27.8	28.1	30.3	31.0	31.5	34.2	23.2	24.0	24.8
JUN	30.4	30.8	25.0	28.5	31.0	30.5	31.3	37.0	37.0	27.1	27.0
JUL	34.4	33.7	32.5	34.2	36.5	35.5	36.0	44.0	28.0	29.0	29.0
AUG	33.8	31.5	32.5	32.5	34.2	34.5	34.9	40.2	28.0	28.8	29.5
SEP	30.3	29.0	29.8	29.8	32.2	31.8	32.0	34.5	27.3	27.1	27.5
OCT	32.2	32.5	32.0	33.0	34.7	34.9	34.5	38.2	26.5	27.2	26.9
NOV	28.2	26.4	26.4	27.2	29.6	27.5	27.3	33.6	23.9	23.9	23.9
DEC	23.0	22.0	23.2	22.0	25.8	25.8	26.0	27.9	19.9	20.1	20.1

CHARACTERISTICS OF THE SEDIMENTS TABLE 5

ANALYSIS OF SOLUBLE SULFATE (ppm) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	2750	2950	2950	3450	2600	2950	3200	3000	2000	2300	2200
FEB	2850	2950	2950	3250	3000	3050	3100	2950	2250	2500	2300
MAR	2850	2830	3090	2865	3040	2815	2900	3040	2780	2640	2850
APR	2999	2983	3103	2948	2448	3069	3086	3138	2896	3120	3086
MAY	3008	2887	2904	2869	3078	2922	2956	2904	2539	2469	2435
JUN	2939	2956	3026	3008	2939	2939	2956	3113	2452	2469	2365
JUL	3095	3008	3026	3113	3095	3130	3148	3200	2939	3026	3043
AUG	3165	3374	3339	3217	2991	3356	3165	3113	2939	3026	3095
SEP	2922	2991	3043	2956	3061	3078	2991	3026	2661	2574	2574
OCT	2869	2869	3107	3107	2904	2939	3078	3061	2469	2410	2365
NOV	2869	3235	2817	2922	2765	2539	2782	2626	1687	1530	1965
DEC	3304	3078	2399	3043	3112	3095	3234	3078	1756	1521	1592

CHARACTERISTICS OF THE SEDIMENTS TABLE 6

ANALYSIS OF SOLUBLE SULFITE (ppm) AT STATIONS IN TURKEY POINT CANALS AND BISCAYNE BAY TURKEY POINT PLANT JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
FEB	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
APR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAY	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
JUN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
JUL	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
AUG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SEP	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
OCT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NOV	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DEC	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

CHARACTERISTICS OF THE SEDIMENTS TABLE 7

ANALYSIS OF SOLUBLE SULFIDE (ppm) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	<0.05	<0.05	<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	<0.05	<0.05
MAR	<0.05	<0.05	<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	<0.05	<0.05
MAY	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
JUN	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
JUL	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
AUG	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SEP	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
OCT	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
NOV	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
DEC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

CHARACTERISTICS OF THE SEDIMENTS TABLE 8

ANALYSIS OF INSOLUBLE SULFIDE (μg/g wet weight sediment) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	1.90	0.39	0.29	0.50	0.42	1.63	<0.05	<0.05	0.39	2.83	2.70
FEB	0.35	0.27	0.28	0.24	<0.05	0.26	0.25	<0.05	0.18	0.22	0.26
MAR	1.35	<0.05	8.37	0.55	0.60	0.84	0.25	0.05	<0.05	0.28	0.33
APR	0.91	0.35	0.32	0.41	<0.05	0.13	<0.05	0.15	0.48	<0.05	0.35
MAY	1.05	0.56	0.29	0.29	<0.05	0.57	0.23	0.29	0.20	<0.05	<0.05
JUN	0.19	1.04	0.27	1.02	1.63	1.39	0.34	2.68	0.81	0.34	0.44
JUL	0.31	0.96	2.84	0.51	1.50	0.81	1.01	0.06	1.89	0.19	2.02
AUG	2.46	1.38	2.79	5.89	0.19	5.69	2.01	3.47	0.49	0.93	1.74
SEP	<0.05	0.51	<0.05	<0.05	0.45	0.93	0.39	1.24	0.12	<0.05	1.02
OCT	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.12	1.55	0.16
NOV	<0.05	0.06	<0.05	<0.05	0.10	<0.05	<0.05	0.15	0.26	0.14	<0.05
DEC	0.08	0.33	4.93	1.26	<0.05	0.48	3.87	2.46	1.26	1.79	0.10

CHARACTERISTICS OF THE SEDIMENTS TABLE 9

ANALYSIS OF SOLUBLE NITRATE (ppm) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.074	0.442	2.712	0.093	0.029	0.060	0.127	0.102	ND[a]	0.013	0.012
FEB	0.015	0.010	0.013	0.017	0.031	0.046	0.037	0.060	0.009	0.008	0.007
MAR	0.028	0.020	0.015	0.013	0.019	0.017	0.017	0.032	0.006	0.013	0.013
APR	0.005	0.004	0.007	0.016	0.010	0.089	0.007	0.015	0.005	0.006	0.022
MAY	0.100	<0.001	<0.001	0.081	0.001	0.010	0.002	0.028	0.014	0.031	0.022
JUN	0.092	0.089	0.063	0.028	0.055	0.085	0.085	0.077	0.089	0.092	0.114
JUL	0.660	0.058	0.050	0.066	0.075	0.066	0.050	0.087	0.075	0.058	0.050
AUG	0.122	0.303	0.298	0.288	0.251	0.254	0.089	0.232	0.143	0.131	0.156
SEP	0.309	0.119	0.189	0.187	0.614	0.005	0.60	0.102	0.038	0.104	0.262
OCT	0.176	0.140	0.061	0.075	0.073	0.109	0.158	0.161	0.142	0.226	0.341
NOV	0.188	0.073	0.017	0.009	0.074	0.112	0.030	0.038	0.050	0.009	0.014
DEC	0.016	0.035	0.015	0.067	0.008	0.046	0.029	0.026	0.010	0.008	<0.001

[a]ND = No data.

CHARACTERISTICS OF THE SEDIMENTS TABLE 10

ANALYSIS OF SOLUBLE NITRITE (ppm) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	ND[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FEB	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002
MAR	0.003	0.004	0.001	0.002	0.002	0.002	0.002	0.004	<0.001	0.003	0.003
APR	0.003	0.001	0.006	0.002	0.007	0.002	0.002	0.002	0.014	0.003	<0.001
MAY	<0.001	0.005	0.002	<0.001	0.015	<0.001	0.004	<0.001	<0.001	0.003	0.006
JUN	0.012	0.007	0.007	0.028	0.007	0.007	0.007	0.010	0.007	0.007	0.007
JUL	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001
AUG	0.008	0.006	0.008	0.009	0.011	0.008	0.008	0.006	0.006	0.006	0.009
SEP	0.008	0.004	0.011	0.005	0.007	0.001	0.002	0.005	0.004	0.003	0.011
OCT	0.010	0.007	0.008	0.008	0.005	0.010	0.011	0.011	0.008	0.010	0.012
NOV	0.009	0.008	0.007	0.002	0.009	0.007	0.002	0.002	0.002	0.003	0.002
DEC	0.003	0.008	0.001	0.006	0.001	0.004	0.001	0.002	<0.001	<0.001	0.004

[a]ND = No data.

CHARACTERISTICS OF THE SEDIMENTS TABLE 11

ANALYSIS OF SOLUBLE AMMONIA (ppm) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.41	0.66	0.72	0.59	0.81	0.77	0.61	0.24	1.00	0.65	0.81
FEB	0.24	0.57	0.29	0.29	0.21	0.38	0.32	0.34	0.38	0.27	0.40
MAR	0.25	0.25	0.11	0.15	0.19	0.24	0.26	0.16	0.29	0.20	0.25
APR	0.31	0.42	0.11	0.20	0.58	0.48	0.28	0.29	0.31	0.21	0.68
MAY	0.45	0.05	0.10	0.60	0.15	0.10	0.20	0.10	0.55	0.20	0.45
JUN	0.71	0.62	0.07	0.47	0.36	0.69	0.32	0.19	0.38	0.33	0.30
JUL	0.46	0.93	0.14	0.97	0.95	0.86	0.68	0.24	0.22	0.14	0.23
AUG	0.18	0.02	0.11	0.39	0.21	0.07	0.15	0.12	0.17	0.12	0.09
SEP	0.33	0.18	0.16	0.46	0.40	0.77	0.36	0.15	0.15	0.43	0.74
OCT	0.28	0.59	0.17	0.62	0.67	0.24	0.24	0.28	0.15	0.37	0.31
NOV	0.85	0.32	0.28	0.37	0.27	0.25	0.24	0.25	0.20	0.22	0.31
DEC	0.27	0.04	0.95	0.25	0.17	0.27	0.29	0.29	0.28	0.61	0.77

CHARACTERISTICS OF THE SEDIMENTS TABLE 12

ANALYSIS OF SOLUBLE ORTHOPHOSPHATE (ppm) AT STATIONS
IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY - DECEMBER 1979

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.17	0.90	0.88	0.40	0.17	0.07	0.10	0.23	0.21	0.24	0.15
FEB	<0.01	0.05	0.08	0.12	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
MAR	0.02	0.04	0.04	0.02	0.05	0.03	0.07	0.03	0.08	0.02	0.04
APR	0.05	0.14	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
MAY	0.01	0.03	0.20	0.03	0.01	0.01	0.01	0.01	0.03	0.03	0.01
JUN	0.01	0.03	0.01	0.08	0.01	0.18	0.01	0.01	0.01	0.03	0.01
JUL	0.01	0.02	0.01	0.03	0.01	0.01	0.01	0.02	0.01	<0.01	<0.01
AUG	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
SEP	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01
OCT	0.02	0.05	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.03
NOV	0.07	0.03	0.01	0.04	0.01	0.02	<0.01	0.01	<0.01	<0.01	0.01
DEC	0.02	0.02	0.19	0.04	<0.01	<0.01	<0.01	0.48	<0.01	0.11	0.03

CHARACTERISTICS OF THE SEDIMENTS TABLE 13

METHODS FOR CHEMICAL ANALYSIS OF SEDIMENT AND INTERSTITIAL WATER
TURKEY POINT PLANT
1979

Parameter	Method	Reference
sulfate	turbidimetric (barium sulfate)	APHA, 14th edition, 1975, p. 493
sulfite	titrimetric (iodide-iodate)	APHA, 14th edition, 1975, p. 509
sulfide	spectrophotometric (p-phenylenediamine)	Strickland and Parsons, 1972, p. 41
nitrate-nitrogen	cadmium reduction method	APHA, 14th edition, 1975, p. 434
nitrite-nitrogen	spectrophotometric (diazotization)	APHA, 14th edition, 1975, p. 434
ammonia-nitrogen	spectrophotometric (phenol-hypochlorite)	Strickland and Parsons, 1972, p. 87
orthophosphate	spectrophotometric (ascorbic acid)	APHA, 14th edition, 1975, p. 481

CHARACTERISTICS OF THE SEDIMENTS TABLE 14

RANGES OF SELECTED PHYSICAL AND CHEMICAL PARAMETERS
TURKEY POINT PLANT
JANUARY-DECEMBER 1979

Station	pH	Salinity (ppt)	Temperature (°C)	Soluble sulfate (ppm)	Soluble nitrate (ppm)	Soluble nitrite (ppm)	Soluble ammonia (ppm)	Soluble orthophospate (ppm)
1	7.6-8.4	20.1-37.2	21.2-34.4	2750-3304	0.005-0.309	<0.001-0.012	0.18-0.71	<0.01-0.17
2	7.9-8.7	20.5-42.0	21.1-33.7	2830-3374	<0.001-0.442	<0.001-0.009	0.02-0.93	0.01-0.90
3	7.9-8.8	20.9-44.0	17.5-32.5	2399-3339	<0.001-2.712	<0.001-0.011	0.07-0.95	<0.01-0.88
4	7.9-8.9	18.3-48.0	19.0-34.2	2865-3450	0.009-0.288	<0.001-0.028	0.15-0.97	0.01-0.40
5	8.1-8.9	19.9-40.0	23.1-36.5	2448-3112	0.001-0.614	<0.001-0.015	0.15-0.95	<0.01-0.17
6	8.0-8.7	21.4-38.4	21.8-35.5	2539-3356	0.005-0.254	<0.001-0.010	0.07-0.86	<0.01-0.18
7	8.1-8.8	20.9-42.0	20.4-36.0	2782-3234	0.002-0.600	<0.001-0.011	0.15-0.68	<0.01-0.10
8	7.9-8.9	20.0-44.0	27.9-44.0	2626-3200	0.015-0.232	<0.001-0.011	0.10-0.34	<0.01-0.23
11	8.2-8.9	16.5-31.5	10.1-37.0	1687-2939	0.005-0.143	<0.001-0.014	0.15-1.00	<0.01-0.21
12	7.8-8.9	14.0-31.0	10.0-29.0	1521-3120	0.006-0.226	<0.001-0.010	0.12-0.65	<0.01-0.24
13	8.0-8.8	16.8-30.3	11.0-29.5	1592-3095	0.004-0.341	<0.001-0.012	0.09-0.81	<0.01-0.15

CHARACTERISTICS OF THE SEDIMENTS TABLE 15

RANGES FOR SELECTED PARAMETERS RECORDED AT STATIONS
IN BISCAYNE BAY/CARD SOUND (PREOPERATIONAL STUDY) AND IN
THE TURKEY POINT CANALS AND BISCAYNE BAY[a] (OPERATIONAL MONITORING STUDY)
TURKEY POINT PLANT
1970-1971 AND 1977 - 1979

	Preoperational study	Operational study		
Parameter	1970-1971	1977	1978	1979
pH (pH units)	7.0-7.8	7.4-8.5 (8.0-8.7)	7.2-8.7 (7.4-8.4)	7.6-8.9 (7.8-8.9)
salinity (ppt)	27.3-44.4	35.00-54.54 (23.69-35.54)	22.0-43.1 (11.6-37.7)	18.3-48.0 (14.0-31.5)
temperature (C°)	NAD	11.1-39.9 (19.1-33.0)	15.8-39.5 (18.5-33.9)	17.5-44.0 (10.0-37.0)
soluble sulfate (ppm)	NAD	2100-3818 (733-3448)	360-3950 (180-3100)	2399-3450 (1521-3120)
soluble nitrite (ppm)	<0.001-0.003	<0.001-0.017 (0.001-0.010)	<0.001-0.024 (<0.001-0.012)	<0.001-0.028 (<0.001-0.014)
soluble nitrate (ppm)	<0.001-0.023	0.014-0.460 (0.007-0.240)	0.002-0.346 (0.005-0.253)	<0.001-2.712 (<0.001-0.341)
soluble ammonia (ppm)	NAD	0.01-0.98 (<0.01-0.69)	<0.01-1.91 (0.24-1.78)	0.02-0.97 (0.09-1.00)
soluble orthophosphate (ppm)	<0.01-0.10	<0.01-0.13 (<0.01-0.04)	<0.01-0.24 (<0.01-0.17)	<0.01-0.90 (<0.01-0.24)

[a]Biscayne Bay values in parentheses.
[b]NAD-No adequate data.

CHARACTERISTICS OF THE SEDIMENTS TABLE 16

YEARLY AVERAGE VALUES FOR SELECTED PHYSICAL AND CHEMICAL PARAMETERS
TURKEY POINT PLANT
1979

Station	pH	Salinity (ppt)	Temperature (°C)	Soluble sulfate (ppm)	Soluble nitrate (ppm)	Soluble nitrite (ppm)	Soluble ammonia (ppm)	Soluble orthophospate (ppm)
1	8.0	28.9	28.3	2968	0.149	0.006	0.40	0.04
2	8.2	29.0	27.7	3009	0.118	0.005	0.39	0.11
3	8.4	29.9	26.6	2980	3.313	0.005	0.27	0.15
4	8.3	28.7	27.2	3062	0.079	0.007	0.47	0.07
5	8.4	30.6	29.9	2919	0.104	0.006	0.41	0.03
6	8.3	29.0	29.7	2974	0.075	0.005	0.43	0.04
7	8.4	29.7	29.8	3050	0.103	0.004	0.33	0.03
8	8.4	28.3	34.6	3021	0.080	0.005	0.22	0.09
11	8.6	22.8	24.1	2447	0.053	0.006	0.34	0.05
12	8.4	22.0	23.9	2465	0.058	0.004	0.31	0.06
13	8.4	22.6	23.9	2489	0.084	0.006	0.42	0.03

b. BENTHIC ORGANISMS

INTRODUCTION

This report documents trends in the benthic macroinvertebrate populations of the Turkey Point Plant cooling canal system. The plant initially used the once-through method of condenser cooling but, since 1973, it has used the canals as a closed-loop cooling system. This unique marine habitat was analyzed to determine the benthic species present and their relative abundances. A further object of the study was to assess the impact of operation of the facilities on the cooling canal system environment and compare the canal habitat to the adjacent lagoonal ecosystem, which was monitored during 3 years of baseline study (Bader and Roessler, 1972).

Benthic macroinvertebrates are animals large enough to be seen by the unaided eye and that can be retained by a U.S. Standard No. 30 sieve (0.595 millimeter mesh; EPA, 1973). They live at least part of their life cycles within or upon suitable substrata. Benthic macroinvertebrates are sensitive to external stress due to their relatively limited mobility and relatively long life span. As a result, benthic communities exhibit characteristics that are a function of environmental conditions in the recent past. Benthic communities have been shown to reflect the effects of temperature, salinity, depth, current, substrate, and chemical and organic pollutants. In addition, benthic macroinvertebrates are important

members of the food web as prey to many species of the upper water column (EPA, 1973).

MATERIALS AND METHODS

Benthic macroinvertebrates were collected and analyzed using methods and materials recommended by the EPA (1973), Holme and McIntyre (1971), APHA (1976), and NESP (1975).

Turkey Point cooling canal system substrates were sampled with an Ekman grab. The sample enclosed by the grab was 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 percent formalin (Williams, 1974). These stains color animal tissue red and enable faster, more accurate hand sorting of benthic samples. Preserved samples were placed in labeled containers and taken to the laboratory where they were hand sorted and the specimens identified to the lowest practicable taxon.

Three replicate grab samples were taken in May and October of 1979 at each of 11 sampling stations (Benthic Figure 1). Since the 1978 sampling, three of these stations have been established as control stations at the north end of the plant. Control Station 1 is in Biscayne Bay on shallow flats just offshore. Control Station 2 is located at the mouth of a small creek, and Control Station 3 is located some distance up this same creek. These stations were sampled for the first time in May 1979.

Sampling at canal Station RC.0 was hindered by the rocky substratum, which prevented penetration of the grab thus allowing the grab to shut without enclosing a sample. No reliable sampling could be performed at this station. (This station has now been relocated to a nearby, more suitable area. Data from this station will be received beginning in 1980). Benthic station RC. 2, even though not specifically associated with plankton station RC. 1 (Figure 1 - Zooplankton), sampled the same "key cut" canal as RC. 1. In 1980, station designation RC. 2 (Benthic Figure 1) in this report will be relocated to plankton station RC. 1.

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

The Shannon-Wiener 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. Use of these indices is based on the generally observed phenomenon that undisturbed environments support communities having relatively few species with large numbers of individuals and large numbers of species represented by only a few

individuals. 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 independent of sample size.

The Shannon-Wiener index of diversity (H'; Lloyd et al., 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 ith species.

Mean diversity as previously calculated is affected by both species richness and evenness and can 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 are generally greater than 3.0 and are usually less than 1.0 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 the Turkey Point Plant were of four main groups: polychaete marine worms, molluscs (snails and bivalves), crustaceans, and a miscellaneous group of diverse animals that were present irregularly and in small numbers (Benthic Tables 1 through 10). Temperature, salinity, and dissolved oxygen measurements were made during each biotic sampling (Benthic Table 11). The canals are characterized by higher temperatures and salinities than the control areas.

Canal Stations

During 1979, the density of macroinvertebrates in the canals varied considerably from station to station and ranged from 402 individuals/m^2 (Station F.1 in October) to 13,966 individuals/m^2 (Station WF.2 in May). The mean density of all stations combined was 9540 individuals/m^2 in May and 2627 individuals/m^2 in October. The May figure was the highest ever recorded from the Turkey Point canals while the October figure was the third lowest. This wide range in density is illustrative of the highly variable nature of the canal system infauna. Macrobenthos density was higher in spring than in fall and conformed to a fairly regular pattern of high spring density/low fall density noted over the past 5 years (Benthic Figure 2).

Mean biomass in the canals was 2.462 g/m^2 in May and 3.750 g/m^2 in October. These data are contrary to the trend of higher spring biomass and lower fall biomass that has been observed over the years (Benthic Figure 3). Biomass values ranged from 0.057 g/m^2 (Station F.1 in October) to 10.948 g/m^2 (Station RF.3, also in October). Most of the wide biomass variation was caused by the rare occurrence of a few larger specimens such as molluscs or brittle stars.

The mean index of diversity in the canals was 2.74 in May and 2.35 in October. Both values are high when compared to previous monitoring data (Benthic Figure 4); however, these mean values are

quite low for marine communities, which typically show values over 3.5. Station-by-station diversity indices ranged from 1.08 (Station WF.2 in May) to 4.05 (Station E3.2, also in May).

Control Stations

Control station populations were usually less dense than those at the canal stations but were of far greater diversity and biomass. During 1979, density at the control stations ranged from 1034 individuals/m^2 (Control Station 3 in May) to 10,043 individuals/m^2 (Control Station 2 in October) with an average density of 3973 individuals/m^2. This is in contrast to an average density of 6803 individuals/m^2 at the canal stations.

Biomass at the control stations ranged from 0.677 g/m^2 (Control Station 1 in May) to 14.727 g/m^2 (Control Station 2 in October). Average biomass for the three control stations during 1979 was 6.161 g/m^2 compared to 3.106 g/m^2 for the canal stations.

Control station diversity during 1979 was very high, the average diversity index being 4.27 with a range of 3.57 (Control Station 3 in May) to 4.74 (Control Station 1 in October). In comparison, the average diversity index for the canal stations was 2.55.

Density, biomass, and diversity at the control stations were generally higher in October 1979 than in May 1979, a trend exactly

opposite to those noted at the canal stations since 1975. More sampling at the control stations over a longer period of time would be necessary, however, before definite trends could be identified.

Comparison Between Stations

The number of species found at each station was analyzed using Sorensen's (1948) index of similarity:

$$\text{Similarity (\%)} = \frac{2C}{a + b} \times 100$$

where:

C = Number of species common to the two stations being compared

a = Number of species at the first station

b = Number of species at the second station.

The trellis diagram (Benthic Figure 5), resulting from the use of this index, shows that stations could be arranged into four distinct groups for comparative purposes: east stations (RC.0, E3.2, and RF.3), west stations (WF.2, W18.2, and W6.2), discharge (F.1), and control stations (1, 2, and 3). Data for these groups were compared statistically using t-tests at α=0.05, and no significant difference was found among the biomass data for any group of stations. With regard to density, the control group data were not statistically different from those of any of the three canal station groups; however, data for both east and west stations indicated populations significantly denser than at the discharge station.

For diversity, all groups were significantly different from each other with the control station group having the greatest diversity followed by the east group, the west group, and the discharge station in descending order. Within the canals, the east stations probably have the highest diversity due to the fact that, because of the generally counter-clockwise flow of the cooling water, they are farthest from thermal effluent discharged by the plant. In contrast to this diversity trend are the average temperatures for these same stations in 1979. The discharge station averaged 35.1°C, west stations averaged 29.9°C, and east stations averaged 27.2°C--a direct negative correlation with diversity. Control station temperatures averaged 23.6°C during 1979. Although salinities at the canal stations were higher than at the control stations, no similar correlation occurred.

A total of 33 species were found in the canals during May 1979, while 24 were found in October. These spring/fall figures closely approximated the normal seasonal species variation experienced in previous monitoring efforts. By way of contrast, the control stations varied much less and contained many more species, 53 species being found in May and 56 in October. Canal station fauna is primarily polychaete worms while species at the control stations are a more even representation of the major groups. It should be noted, however, that the control stations represent natural estuarine communities known for their great diversity while the canals represent a man-made habitat with no means of outside recruitment.

Community Composition

As in past monitoring, the canal stations were dominated by polychaete worms. While several other species are present in the canal system, the numerically important species (all polychaete worms) are limited to a few types. All are burrowing, sedentary, detritus or filter-feeding species. The bottom substrate, composed of fibrous peat and mud mixed with shell debris, is 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 et al. (1965) reported that polychaetes outnumbered other groups eight to one at an ocean sewage outfall. Polychaetes thus appear least affected in an area of elevated temperature, restricted circulation, and highly organic substrate characteristic of the Turkey Point canal system.

When compared to the canal stations, the control stations exhibit a greater balance between the major macroinvertebrate groups (Benthic Figure 6). Polychaetes formed 31 to 60 percent of the macroinvertebrate fauna at the control stations as opposed to 79 to 96 percent of the canal station fauna. In addition, the control

station macroinvertebrates exhibited a greater variety of feeding types and habitat preferences. Control Station 3 was the only control station having a substrate similar to that encountered in the canals, i.e., mud and peat. Control Station 1 has a sand/calcareous algae substrate while Control Station 2 has a sand/peat/seagrass substrate.

Comparison with Previous Studies

Some species were found in both baseline and present studies but these species were recruited (originally) from the adjacent Biscayne Bay and Card Sound estuarine ecosystems. In studies of these adjacent ecosystems (Bader, 1969; Tabb and Roessler, 1970; Bader and Roessler, 1971, 1972) 266 species of epifaunal macroinvertebrates (molluscs, large crustaceans, sponges, and echinoderms) were sampled by trawling. This large number of species does not include infaunal forms such as polychaete worms and small crustacean species which comprised the bulk of the species in the canal system. Many more species could be found in Biscayne Bay or Card Sound if the infaunal forms were counted. Although the similarity of these studies is relatively limited due to differing sampling methodologies, thermal regimes and substrates, they serve to emphasize the relatively low number of benthic macroinvertebrate species found in the canals as compared to adjacent marine ecosystems.

SUMMARY AND CONCLUSIONS

During 1979, no significant changes were observed in the macroinvertebrate fauna of the Turkey Point canal system when compared to data from previous monitoring. Density and diversity values recorded in 1979 were among the highest ever encountered in the canals. Macroinvertebrate biomass was near average. Although exceptions occur, data from the past 5 years indicate a fairly regular pattern of higher density, diversity and biomass in spring alternating with lower density, diversity and biomass in the fall.

When compared to control stations, the canal macroinvertebrate fauna is of somewhat higher density, lower biomass, and significantly lower diversity. This last trend is probably the result of 1) a lack of means of recruitment of new species to the canal system, 2) the elevated temperatures and salinities of the canals, and 3) the general unsuitability of the canal substrates for macroinvertebrates other than polychaete worms. The first two trends are a result of the dominance of the fauna by relatively small polychaete worm species.

The benthic macroinvertebrate community of the canal system has several species, but only those burrowing, sedentary, detritus or filter-feeding species better adapted to living in the thick, fibrous peat substrate (i.e., polychaete worms) can be expected to occur in significant number. In general, the community is poorly balanced compared to natural ecosystems where recruitment is

possible. The canal system is also subject to wide and sometimes irregular variation in density, biomass, and diversity.

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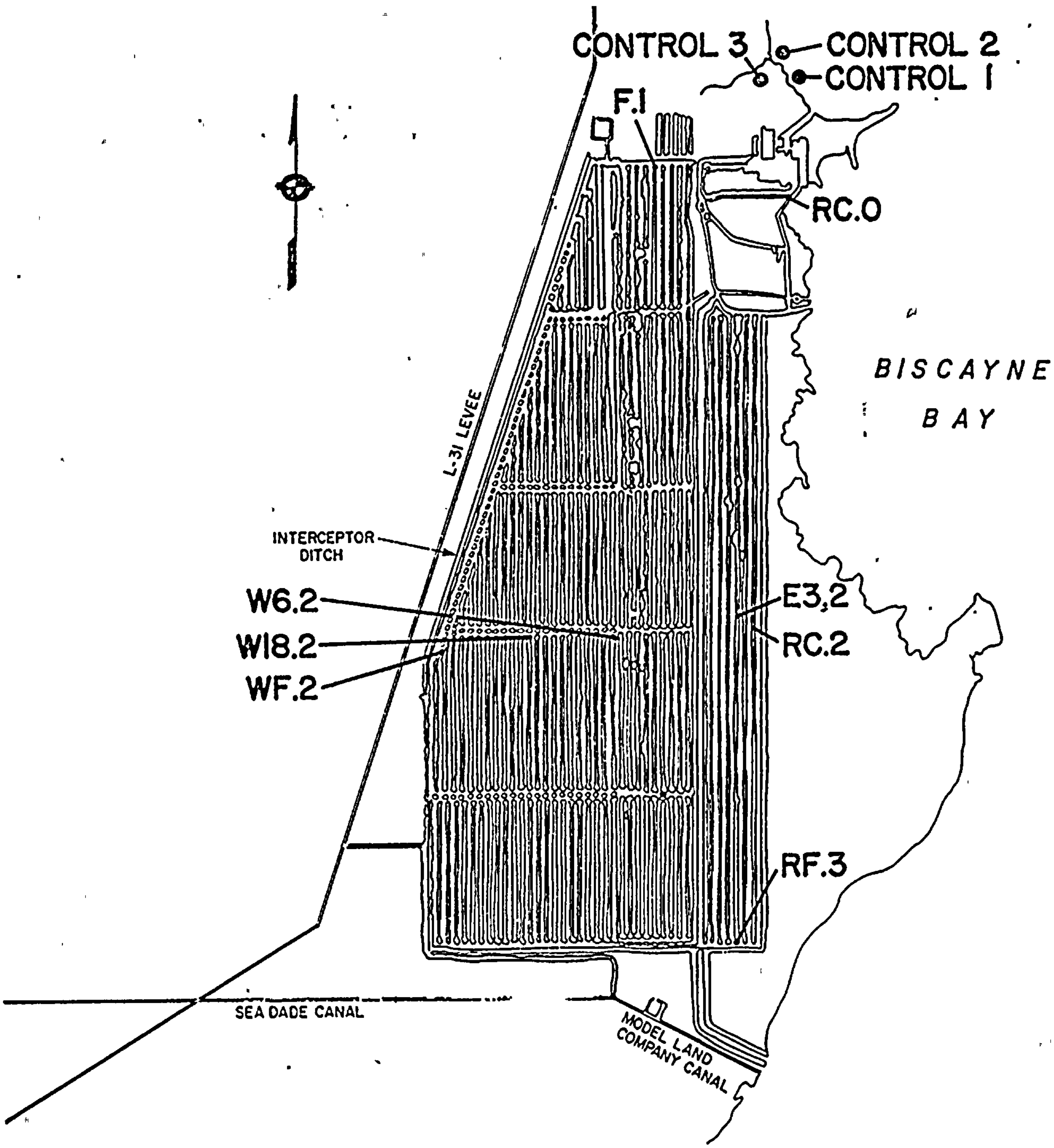
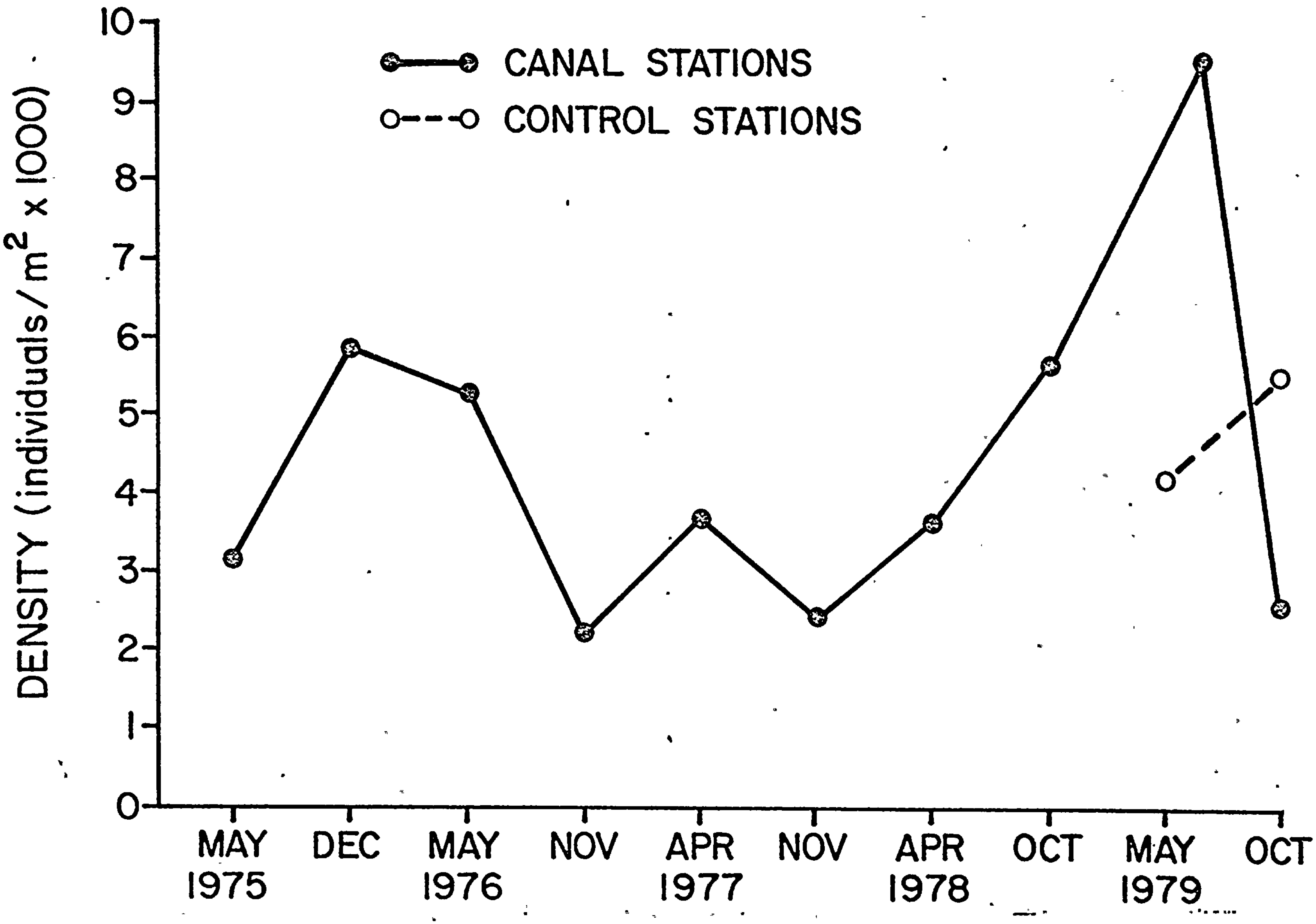
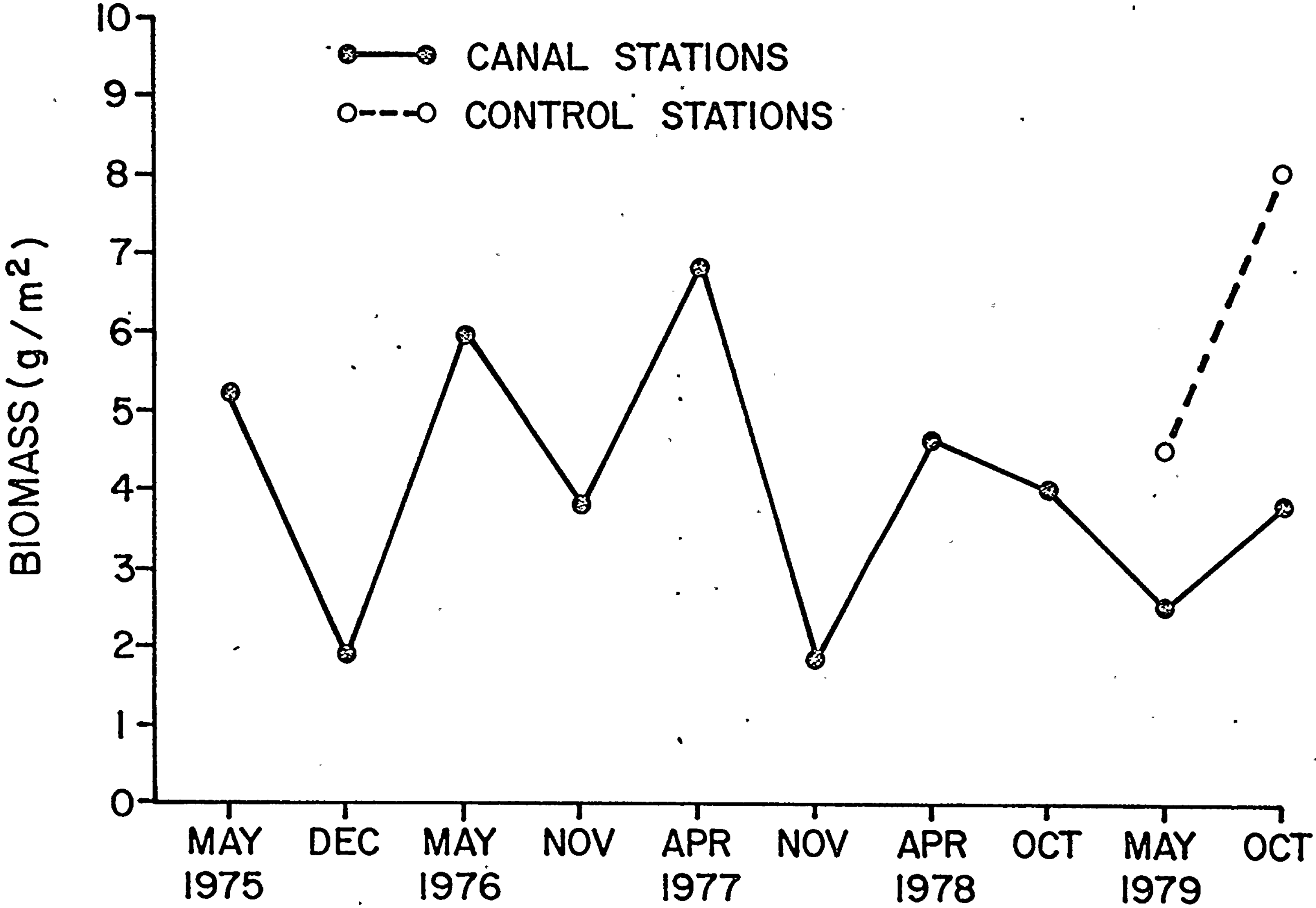


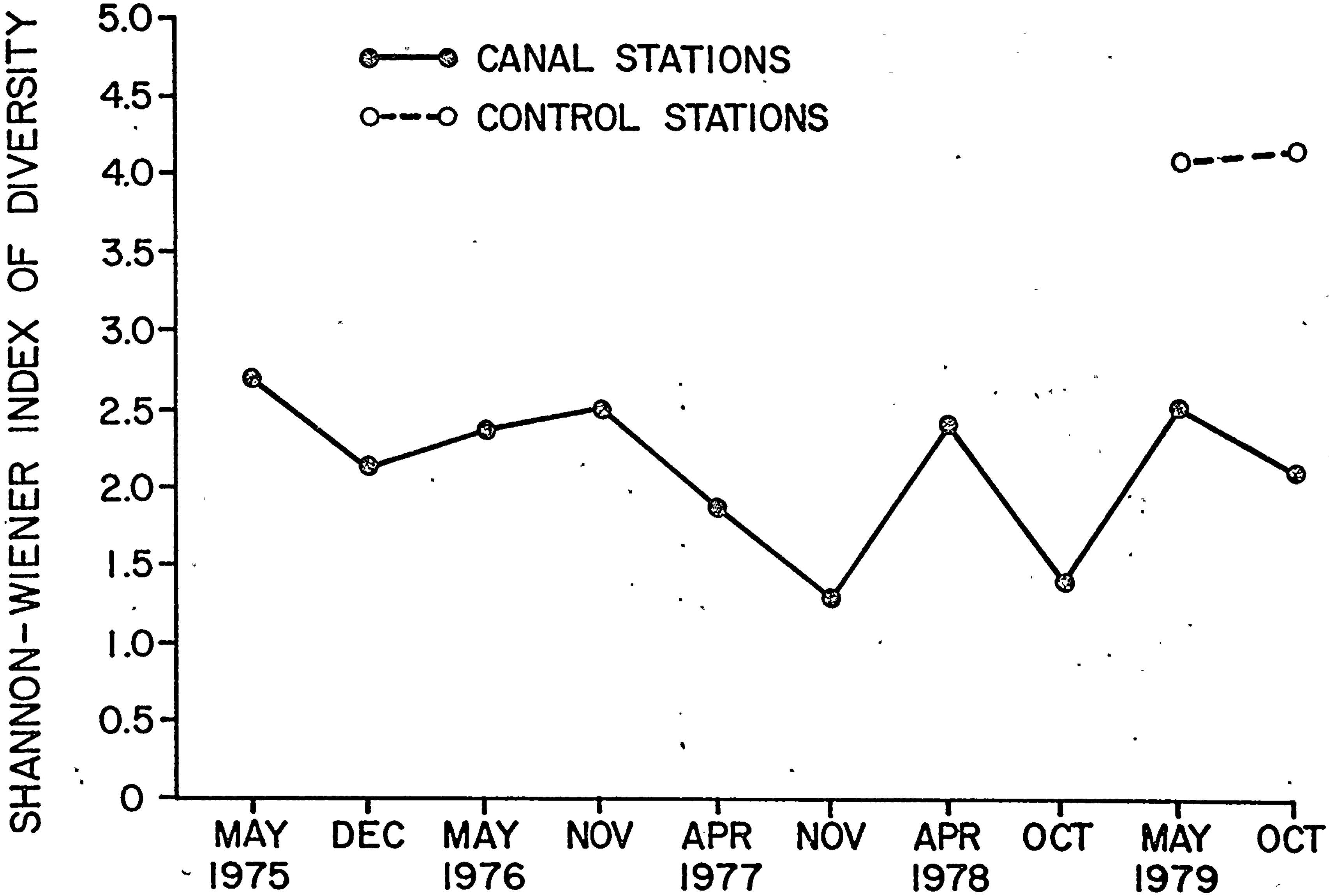
Benthic Figure 1. Benthic macroinvertebrate sampling station locations, Turkey Point site, 1979.



Benthic Figure 2. Mean number of benthic macroinvertebrates per square meter (all sampling stations combined), Turkey Point Plant, 1975-1979.



Benthic Figure 3. Mean benthic macroinvertebrate biomass per square meter (all sampling stations combined), Turkey Point Plant, 1975-1979.



Benthic Figure 4. Mean benthic macroinvertebrate species diversity (all sampling stations combined), Turkey Point Plant, 1975-1979.

	RC. 2	E.3. 2	RF. 3	WF. 2	W18. 2	W6. 2	F. 1	CONTROL 1	CONTROL 2	CONTROL 3
RC. 2		66.7	61.7	46.7	48.3	70.6	53.8	48.9	52.2	25.8
E.3. 2			71.8	42.4	56.3	81.1	48.3	41.4	44.1	35.3
RF. 3				53.3	55.2	64.7	38.5	29.1	28.6	19.4
WF. 2					52.2	57.1	60.0	24.5	28.0	24.0
W18. 2						66.7	52.6	25.0	36.7	25.0
W6. 2							58.3	34.0	40.7	27.6
F. 1								35.6	27.3	28.6
CONTROL 1									66.7	40.0
CONTROL 2										47.1
CONTROL 3										

TURKEY POINT STATION SIMILARITY
MAY 1979

	RC. 2	E.3. 2	RF. 3	WF. 2	W18. 2	W6. 2	F. 1	CONTROL 1	CONTROL 2	CONTROL 3
RC. 2		45.5	50.0	31.6	47.6	38.1	35.3	31.4	32.1	19.4
E3. 2			50.0	26.7	23.5	23.5	30.8	25.5	30.8	7.4
RF. 3				23.5	42.1	52.6	13.3	32.7	29.6	27.6
WF. 2					57.1	42.9	60.0	22.7	20.4	8.3
W18. 2						62.5	33.3	34.8	27.4	30.8
W6. 2							33.3	30.4	23.5	30.8
F. 1								19.0	17.0	18.2
CONTROL 1									74.1	39.2
CONTROL 2										42.6
CONTROL 3										

TURKEY POINT STATION SIMILARITY
OCTOBER 1979

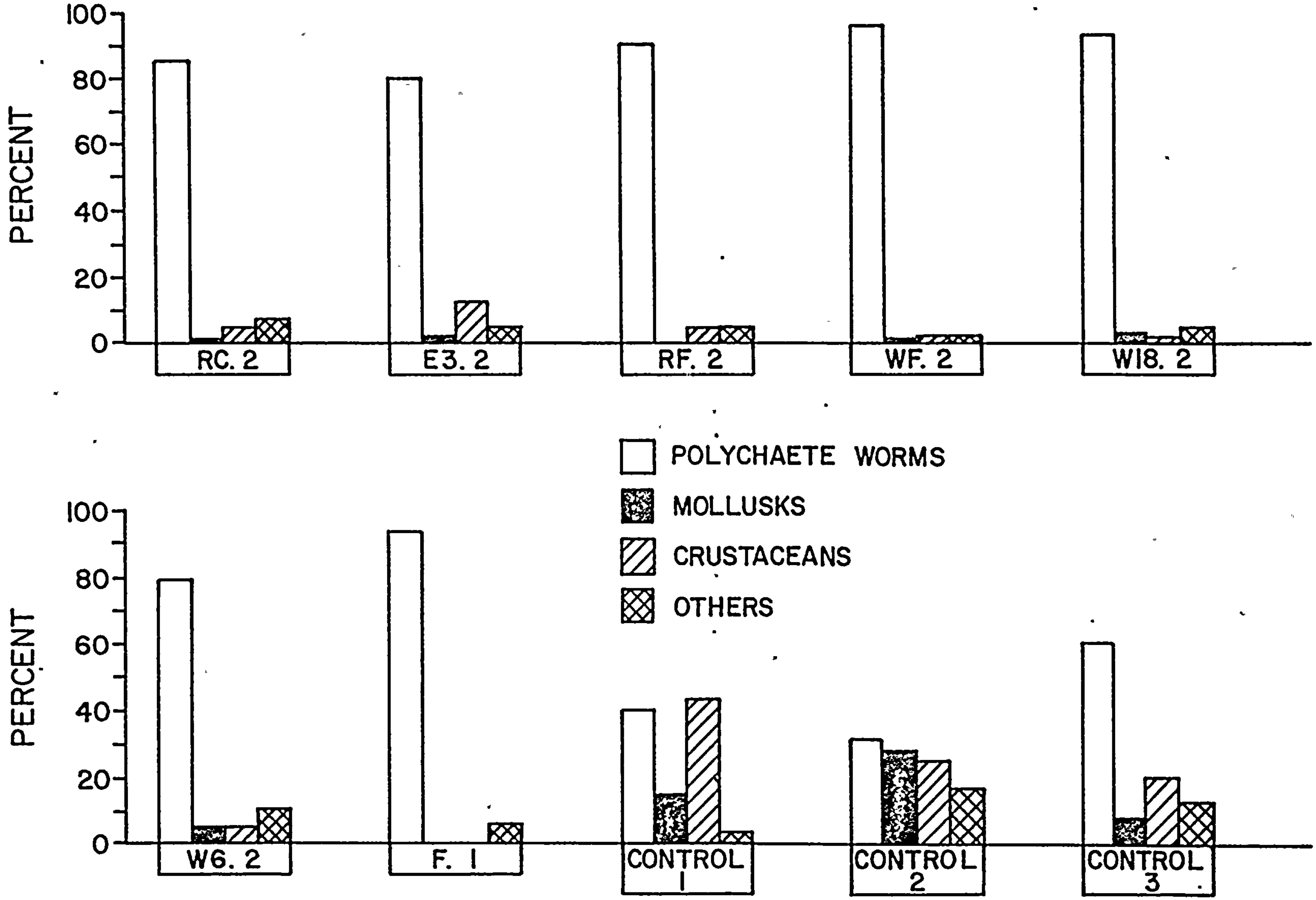
76—100% STRONG SIMILARITY

51—75% MODERATE SIMILARITY

26—50% FAIR SIMILARITY

0—25% WEAK SIMILARITY

Benthic Figure 5. Trellis diagram showing percentage of species similarity between sampling stations, Turkey Point Plant, 1979.



Benthic Figure 6. Structure of the benthic macroinvertebrate community by station, Turkey Point Plant, 1979.

BENTHIC TABLE 1

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION RC.2
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates May	Sum of 3 Replicates October
Class Polychaeta		
worms *Caulleriella killariensis*	28	4
Fabricia sp.	4	-
Glycera americana	4	4
Haploscoloplos foliosus	28	12
Sabella melanostigma	12	-
Nereis succinea	36	20
Paraonides lyra	212	64
Platynereis dumerilii	12	12
Prionospio heterobranchia texana	8	-
Sabella melanostigma	12	-
Schistomeringos rudolphi	156	40
Terebellides stroemi	52	4
Typosyllis sp.	8	4
Class Pelecypoda		
bivalves *Gouldia cerina*	8	4
Class Crustacea		
ostracods *Sarsiella americana*	4	8
tanaids *Leptochelia savignyi*	20	4
isopods *Sphaeroma quadridentatum*	4	-
amphipods *Hemiaegina minuta*	4	-
Phylum Echiurida		
echiuroid worms	48	16
Total individuals	648	196
Total biomass (g)	0.329	0.032
Density (No./m^2)	9310	2816
Biomass (g/m^2)	4.780	0.460
Index of diversity	3.04	2.99
Equitability	0.65	0.86

BENTHIC TABLE 2

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION E3.2
TURKEY POINT PLANT
1979

Species		Sum of 3 Replicates May	Sum of 3 Replicates October
Class Polychaeta			
worms	Caulleriella killariensis	32	-
	Haploscoloplos foliosus	40	32
	Sabella melanostigma	36	-
	Nereis succinea	60	4
	Paraonides lyra	140	-
	Platynereis dumerilii	16	-
	Prionospio heterobranchia texana	28	-
	Sabella melanostigma	36	-
	Schistomeringos rudolphi	60	12
	Scyphoproctus sp.	64	-
	Terebellides stroemi	44	112
	Trichobranchus glacialis	40	4
	Typosyllis sp.	56	44
Class Pelycypoda			
bivalves	Gouldia cerina	20	-
Class Crustacea			
ostracods	Cylindroleberis mariae	36	-
	Sarsiella americana	36	-
copepods	Harpacticoida sp.	4	-
isopods	Idotea metallica	20	-
amphipods	Grandidierella bonnieroides	4	-
	Lysianopsis alba	16	4
	Microdeutopus sp.	-	12
shrimp	Hippolyte pleuracantha	-	4
Phylum Echiurida			
echiuroid worms		44	-
Phylum Priapulida			
priapulid worms		12	-
Total individuals		808	228
Total biomass (g)		0.258	0.749
Density (No./m^2)		11,609	3276
Biomass (g/m^2)		3.701	10.761
Index of diversity		4.05	2.22
Equitability		1.15	0.69

BENTHIC TABLE 3

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION RF.3
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates May	October
Class Polychaeta		
worms *Fabricia* sp.	60	-
Glycera americana	124	4
Sabella melanostigma	44	12
Nereis succinea	12	32
Paraonides lyra	-	8
Platynereis dumerilii	4	-
Prionospio heterobranchia texana	184	12
Sabella melanostigma	44	12
Schistomeringos rudolphi	36	-
Terebellides stroemi	12	52
Trichobranchus glacialis	8	8
Typosyllis sp.	28	120
Class Pelecypoda		
bivalves *Gouldia cerina*	8	-
Class Crustacea		
ostracods *Cylindroleberis mariae*	4	-
copepods *Harpacticoida* sp.	4	-
cumaceans *Oxyurostylis smithi*	4	-
isopods *Idotea metallica*	12	-
amphipods *Microdeutopus* sp.	-	24
shrimp *Thor floridanus*	8	4
Phylum Echiurida		
echiuroid worms	8	8
Phylum Priapulida		
priapulid worms	48	-
Total individuals	608	284
Total biomass (g)	0.072	0.762
Density (No./m^2)	8736	4080
Biomass (g/m^2)	1.034	10.948
Index of diversity	3.18	2.62
Equitability	0.72	0.77

BENTHIC TABLE 4

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION WF.2
TURKEY POINT PLANT
1979

		Sum of 3 Replicates	
Species		May	October
Class Polychaeta			
worms	*Capitella capitata*	-	2
	Fabricia sp.	28	-
	Glycera americana	16	-
	Haploscoloplos foliosus	4	8
	Nereis succinea	20	60
	Platynereis dumerilii	20	70
	Prionospio heterobranchia texana	828	192
	Typosyllis sp.	12	-
Class Pelecypoda			
bivalves	*Lucina multilineata*	4	-
	Lyonsia floridana	4	4
Class Crustacea			
copepods	Harpacticoida sp.	16	-
mysids	*Taphromysis bowmani*	4	-
Phylum Priapulida			
priapulid worms		16	-
Total individuals		972	336
Total biomass (g)		0.068	0.054
Density (No./m^2)		13,966	4828
Biomass (g/m^2)		0.983	0.776
Index of diversity		1.08	1.62
Equitability		0.21	0.65

BENTHIC TABLE 5

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION W18.2
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates	
	May	October
Class Polychaeta		
worms *Haploscoloplos foliosus*	-	8
Nereis succinea	88	16
Paraonides lyra	476	16
Platynereis dumerilii	40	8
Prionospio heterobranchia texana	132	4
Terebellides stroemi	4	-
Typosyllis sp.	104	-
Class Gastropoda		
snails *Bulla striata*	8	-
Class Pelecypoda		
bivalves *Lyonsia floridana*	4	-
Tellina sp.	-	16
Class Crustacea		
copepods Harpacticoida sp.	8	-
Phylum Echiurida		
echiuroid worms	32	4
Phylum Priapulida		
priapulid worms	4	4
Total individuals	892	76
Total biomass (g)	0.151	0.130
Density (No./m^2)	12,816	1092
Biomass (g/m^2)	2.167	1.868
Index of diversity	2.15	2.77
Equitability	0.54	1.19

BENTHIC TABLE 6

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION W6.2
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates May	Sum of 3 Replicates October
Class Polychaeta		
worms *Capitella capitata*	-	4
Caulleriella killariensis	4	-
Haploscoloplos foliosus	4	-
Sabella melanostigma	8	-
Nereis succinea	72	28
Paraonides lyra	80	24
Platynereis dumerilii	8	-
Prionospio heterobranchia texana	128	40
Sabella melanostigma	8	-
Schistomeringos rudolphi	8	-
Terebellides stroemi	8	-
Typosyllis sp.	84	16
Class Pelecypoda		
bivalves *Lyonsia floridana*	28	-
Tellina sp.	-	4
Class Crustacea		
ostracods *Cylindroleberis mariae*	12	4
Sarsiella americana	4	-
copepods Harpacticoida sp.	12	-
Phylum Echiurida		
echiuroid worms	48	12
Phylum Priapulida		
priapulid worms	8	-
Total individuals	516	132
Total biomass (g)	0.277	0.096
Density (No./m^2)	7414	1897
Biomass (g/m^2)	3.977	1.379
Index of diversity	3.17	2.59
Equitability	0.80	1.03

BENTHIC TABLE 7

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION F.1
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates May	Sum of 3 Replicates October
Class Polychaeta		
worms *Capitella capitata*	80	4
Caulleriella killariensis	4	-
Haploscoloplos foliosus	24	4
Nereis succinea	32	-
Platynereis dumerilii	16	4
Prionospio heterobranchia texana	8	-
Typosyllis sp.	24	16
Phylum Echiurida		
echiuroid worms	16	-
Total individuals	204	28
Total biomass (g)	0.042	0.004
Density (No./m^2)	2931	402
Biomass (g/m^2)	0.598	0.057
Index of diversity	2.55	1.66
Equitability	0.99	1.01

BENTHIC TABLE 8

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
CONTROL STATION 1
TURKEY POINT PLANT
1979

Species		Sum of 3 Replicates May	October
Class Polychaeta			
worms	Arabella opalina	6	3
	Axiothella sp.	-	1
	Capitella capitata	10	5
	Caulleriella killariensis	6	1
	Diopatra cuprea	2	-
	Dorvillea sociabilis	1	2
	Glycera americana	2	-
	Haploscoloplos foliosus	3	5
	Laonome salmicidis	1	3
	Maldane sp.	2	4
	Nereis succinea	8	16
	Paraonides lyra	2	5
	Platynereis dumerilii	1	9
	Prionospio heterobranchia texana	13	6
	Laonome salmicidis	1	3
	Scalibregma sp.	1	1
	Trichobranchus glacialis	3	2
	Typosyllis sp.	8	28
Class Gastropoda			
snails	Caecum pulchellum	2	15
	Crepidula fornicata	1	1
	Cylindrobulla beaui	2	3
	Epitonium occidentale	-	9
	Eulima hypsella	-	3
	Persicula lavelleeana	1	-
	Prunum apicinum	-	8
	Rissoina striosa	-	3
Class Pelecypoda			
bivalves	Brachidontes exustus	1	1
	Cardita floridana	-	2
	Chione cancellata	-	1
	Tellidora cristata	-	3
	Tellina sp.	-	1
Class Crustacea			
copepods	Harpacticoida sp.	-	1
ostracods	Sarsiella americana	4	2
cumaceans	Oxyurostylis smithi	2	-
isopods	Erichsonella filiformis	6	4
	Sphaeroma quadridentatum	11	7

BENTHIC TABLE 8
(continued)
RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
CONTROL STATION 1
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates May	Sum of 3 Replicates October
Class Crustacea (cont'd)		
amphipods Ampelisca vadorum	1	-
Elasmopus rapax	3	16
Grandidierella bonnieroides	8	6
Lysianopsis alba	5	2
Melita sp.	28	22
Melita appendiculata	10	-
Microdeutopus sp.	5	12
Photis sp.	6	-
unidentified sp.	1	-
shrimp Hippolyte pleuracantha	-	5
Thor floridanus	-	3
crabs Pagurus longicarpus	-	4
Class Insecta		
marine chironomids Clunio sp.	6	-
Class Ophiurida		
brittle stars Ophioderma sp.	1	-
Phylum Echiurida		
echiuroid worms	3	4
Phylum Priapulida		
priapulid worms	-	2
Total individuals	176	231
Total biomass (g)	0.047	0.548
Density (No./m^2)	2529	3319
Biomass (g/m^2)	0.677	7.874
Index of diversity	4.54	4.74
Equitability	0.98	0.97

BENTHIC TABLE 9

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
CONTROL STATION 2
TURKEY POINT PLANT
1979

Species		Sum of 3 Replicates May	Sum of 3 Replicates October
Class Polychaeta			
worms	Aphroditidae sp.	-	8
	Arabella opalina	60	16
	Capitella capitata	-	40
	Caulleriella killariensis	20	4
	Diopatra cuprea	4	-
	Dorvillea sociabilis	20	36
	Haploscoloplos foliosus	32	8
	Laonome salmicidus	8	8
	Maldane sp.	12	4
	Nereis succinea	8	32
	Onuphis sp.	-	148
	Paraonides lyra	72	8
	Platynereis dumerilii	-	12
	Prionospio heterobranchia texana	20	56
	Laonome salmicidis	8	8
	Serpulidae sp.	-	8
	Terebellides stroemi	4	16
	Trichobranchus glacialis	-	4
	Typosyllis sp.	12	12
Class Gastropoda			
chitons	Acanthochitona pygmaea	4	16
snails	Astraea phoebia	8	-
	Bulla striata	12	4
	Caecum pulchellum	60	40
	Cerithium greeni	4	-
	Crepidula fornicata	12	4
	Epitonium occidentale	12	16
	Prunum apicinum	8	-
Class Pelecypoda			
bivalves	Brachidontes exustus	28	-
	Cardita floridana	-	4
	Gouldia cerina	4	-
	Lucina multilineata	8	-
	Lyonsia floridana	8	-
	Tellidora cristata	-	4
	Trigoniocardia antillarum	8	-

BENTHIC TABLE 9
(continued)
RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
CONTROL STATION 2
TURKEY POINT PLANT
1979

Species		Sum of 3 Replicates May	October
Class Crustacea			
ostracods	Cylindroleberis mariae	-	4
	Sarsiella americana	28	4
tanaids	Leptochelia savignyi	4	-
cumaceans	Oxyurostylis smithi	4	-
copepods	Harpacticoida sp.	4	12
isopods	Idotea metallica	-	12
	Sphaeroma quadridentatum	4	4
amphipods	Elasmopus rapax	-	4
	Grandidierella bonnieroides	12	4
	Luconacia incerta	-	8
	Lysianopsis alba	64	4
	Lysianassidae sp.	-	4
	Melita sp.	8	4
	Microdeutopus sp.	-	16
shrimp	Hippolyte pleuracantha	-	4
	Palaemonetes pugio	-	4
crabs	Pagurus longicarpus	-	4
sea spiders	Callipallene brevirostris	-	8
Class Insecta			
marine chironomids	Clunio sp.	36	-
Class Ophiurida			
brittle stars	Ophioderma sp.	4	-
	Ophiophragmus filograneus	4	3
Phylum Echiurida			
echiuroid worms		16	68
Phylum Priapulida			
priapulid worms		16	20
Total individuals		252	699
Total biomass (g)		0.772	1.025
Density (No./m^2)		3621	10,043
Biomass (g/m^2)		11.092	14.727
Index of diversity		4.62	4.48
Equitability		0.96	0.77

BENTHIC TABLE 10

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
CONTROL STATION 3
TURKEY POINT PLANT
1979

Species		Sum of 3 Replicates	
		May	October
Class Polychaeta			
worms	*Arabella opalina*	4	16
	Capitella capitata	-	16
	Dorvillea sociabilis	8	8
	Haploscoloplos foliosus	4	-
	Paraonides lyra	-	8
	Prionospio heterobranchia texana	-	56
	Terebellides stroemi	-	48
	Typosyllis sp.	8	-
Class Gastropoda			
snails	*Bulla striata*	-	8
	Cerithium greeni	-	8
	Crepidula fornicata	4	8
Class Crustacea			
ostracods	*Cylindroleberis mariae*	-	8
	Sarsiella americana	-	16
copepods	Harpacticoida sp.	-	4
isopods	*Sphaeroma quadridentatum*	4	8
amphipods	*Grandidierella bonnieroides*	4	16
	Lysianopsis alba	4	-
	Melita sp.	12	8
	Microdeutopus sp.	4	-
shrimp	*Alpheus armillatus*	-	1
Class Ophiurida			
brittle stars	*Ophiophragmus filograneus*	4	-
Phylum Echiurida			
echiuroid worms		8	16
Phylum Priapulida			
priapulid worms		4	4

BENTHIC TABLE 10
(continued)
RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
CONTROL STATION 3
TURKEY POINT PLANT
1979

Species	Sum of 3 Replicates May	Sum of 3 Replicates October
Total individuals	72	229
Total biomass (g)	0.091	0.090
Density (No./m^2)	1034	3290
Biomass (g/m^2)	1.305	1.293
Index of diversity	3.57	3.64
Equitability	1.32	1.00

BENTHIC TABLE 11

PHYSICAL DATA RECORDED DURING BENTHIC SAMPLING
TURKEY POINT PLANT
1979

Station	Date	Temperature (°C)	Salinity (°/₀₀)	Dissolved Oxygen (ppm)
RC.0	May	28.3	38.5	4.7
	October	29.9	41.0	4.2
RC.2	May	27.7	38.5	6.2
	October	29.8	41.5	5.0
E3.2	May	26.5	38.0	7.0
	October	30.7	42.0	8.4
RF.3	May	27.7	37.5	6.5
	October	30.0	41.5	4.8
WF.2	May	29.9	38.5	6.4
	October	34.0	41.5	5.2
W18.2	May	30.1	38.5	6.2
	October	33.4	41.5	6.2
W6.2	May	32.1	38.5	5.5
	October	33.2	41.0	6.1
F.1	May	37.2	38.5	4.6
	October	37.5	41.5	5.8
Control 1	May	27.0	35.0	10.2
	October	26.2	29.5	9.4
Control 2	May	26.9	32.0	5.9
	October	26.0	28.0	5.2
Control 3	May	27.5	30.5	5.2
	October	26.0	25.0	3.4

4. Recovery in the Grand Canal Discharge Area (ETS 4.1.1.1.4)

Introduction

A study of the revegetation of the Grand Canal Discharge Area (Figure 1) was conducted on a semi-annual basis. This study utilized three methods to map and evaluate the recovery of seagrasses and macroalgaes. A combination of aerial surveys, in situ density determinations and in situ transect surveys constituted the study.

Methods

Method 1 - Aerial Surveys

The overall revegetation of the previously affected Grand Canal Discharge Area was assessed qualitatively and quantitatively by aerial photographs taken from 2000 feet. Reference points were used to determine the scale of the photos. Tracings of specific areas of dominant grasses and macroalgae were made from the photographs (Figures 2 and 3).

Method 2 - Quadrat Stations

Quantitative measurements of seagrass and algal densities were made by counting and identifying the vegetation in six stations one square meter each permanently located on an east-west transect line at the mouth of the Discharge Area.

Method 3 - Transects

The less abundant species not represented in the square meter areas were surveyed by transects across the previously affected

area. Species identification, quantities present, and general conditions were noted. Also, this method served to ground truth the aerial photographs. Comparisons to previous years data, refer to F.P.&L. Annual and Semi Annual Environmental Monitoring Reports #1 - 12 (1973 - 1978).

Results and Discussion

Aerial Surveys

As in previous semi-annual Aerial Surveys, photographs indicated that the discharge area had revegetated almost entirely since the cessation of thermal effluent discharge. *Syringodium filliforme* was quite prevalent shortly after the discharge was closed. However, this grass is being replaced by *Thalassia testudinum*, and there was only one patch of *S. filliforme* left in the immediate discharge area. This grass was still quite prevalent further out from the mouth of Grand Canal. It was noted that due to heavy growth of *Laurencia sp.* in December, *S. filliforme* patches were difficult to discern from the photograph. Therefore the decreased number of patches in Figure 3, as compared with Figure 2, does not imply a drastic decrease in the *S. filliforme* density.

Quadrat Stations

Tables 1 and 2 contain data from the one square meter quadrats permanently staked out on the bottom. Sample points X-1, X-2, X-3, and X-4 were located approximately 100, 200, 400, and 600 feet east of the mouth of the canal respectively. Station X-2N was located

approximately 200 feet NNE of Station X-2. Stations X-2S was located approximately 200 feet SSE of Station X-2.

The data appearing in the tables represent counts of fasicles (sheathes of leaves). The data reported as greater than (>) were based on extrapolation of counts of plants in 1/16 of a square meter. The baseline data are not comparable to these data since the "baseline" authors made counts of blades (leaves) in their investigation. Therefore, the densities in Tables 1 and 2 appear much lower than baseline data (Bader & Roessler 1972).

Transect

Vegetation in the area of S-1 was very sparse; *Diplanthera wrightii* and macroalgaes dominated. In July scattered clumps of *Thalassia testudinum* were present. *Caulerpa sp., Halimeda sp.,* and *Penicillus sp.* were also present. In December the green algae component of the community changed and *Acetabularia crenulata, Batophora oerstedii,* and *Penicillus sp.* were common. The sediments in this area consisted of 4 to 6 inches of fine silt.

The area between stations X-1 and X-2 was characterized by a community dominated by *D. wrightii* with some *T. testudinum* present. In July, the green algaes *Caulerpa sp.* and *Penicillus sp.* were noted; however, in December only *Penicillus sp.* and *Laurencia sp.* were observed. The latter occurred in extremely heavy densities.

The grasses in the vicinity of X-2 consisted mainly of *D. wrightii* with patches of *T. testudinum.* The algaes *Caulerpa sp.* and *A. crenulata* were present in July, but were replaced by *B. oerstedii* and *Laurencia sp.* during December. Sediments in this area consisted of a mixture of grass blades.

The transect from station X-2 to X-3 represents a zone in which community dominance shifts from *D. wrightii* to *T. testudinum.* The algaes *A. crenulata, Caulerpa sp.,* and *Laurencia sp.* were noted in July while *Caulerpa sp., Laurencia sp,* and *B. oerstedii* occurred in December. Again, *Laurencia sp.* was present in very heavy densitites during December. Sediments reflected the make up of the community (i.e., a mixture of grass blades).

At Station X-3 *T. testudinum* dominated; *D. wrightii* was present. Generally speaking, blades of each species were longer and appeared healthier than their inshore counterparts. Heavy epiphytic encrustation was noted on both species. Sediments were composed of a mixture of grass blades and attained a depth of approximately 1 inch.

Between Station X-3 and X-4 *T. testudinum* increased its dominance in terms of biomass. *D. wrightii* was still present in large numbers; however, plants were reduced in size. Algaes were almost completely excluded and found only in areas, such as propeller scars, that had sparse *T. testudinum* growth. The sediments shifted

in composition from a mixture of grass blades to a nearly homogeneous compost of *T. testudinum* blades.

In the area of Station X-4 the community was dominated by *T. testudinum.* Some *D. wrightii* was present but densities of the species varied seasonally.

East of X-4 the community structure changed to a mixture of *D. wrightii, T. testudinum, Syringodium filliforme* and macroalgaes. Patches of *S. filliforme* dominated most of the area.

The southern and northern transects traversed several zones (Figures 2 and 3). The foregoing discussion describes these zones in detail. *Avrainvillea nigricans, Anadyomene stellata, Rhipocephalus sp., Dictoyota sp., Digenia sp., Halimeda sp.,* and *Rhizophora mangle* occurred along both transects. Densitites of these species were very low.

The sedimentation rate in the discharge area was so slight that it was difficult to measure.

Conclusions

The entire area previously affected remained revegetated. *S. filliforme* stands continued to move east away from the discharge and were being replaced by *T. testudinum* as had been observed in previous reports. This trend is expected to continue.

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

The Red Mangroves (*Rhizophora mangle*) reported will not become an important factor in this area. They were submerged in at least 18" of water at low tide and will probably die before they can break the surface.

Algaes appeared seasonally; *A. crenulata* and *Caulerpa sp.* were the dominant macroalgaes in July. In December, *Laurencia sp.* dominated; in fact, all stations except X-4 were entirely covered my a thick mat of this rhodophyte. The seasonal trend of algae is expected to continued.

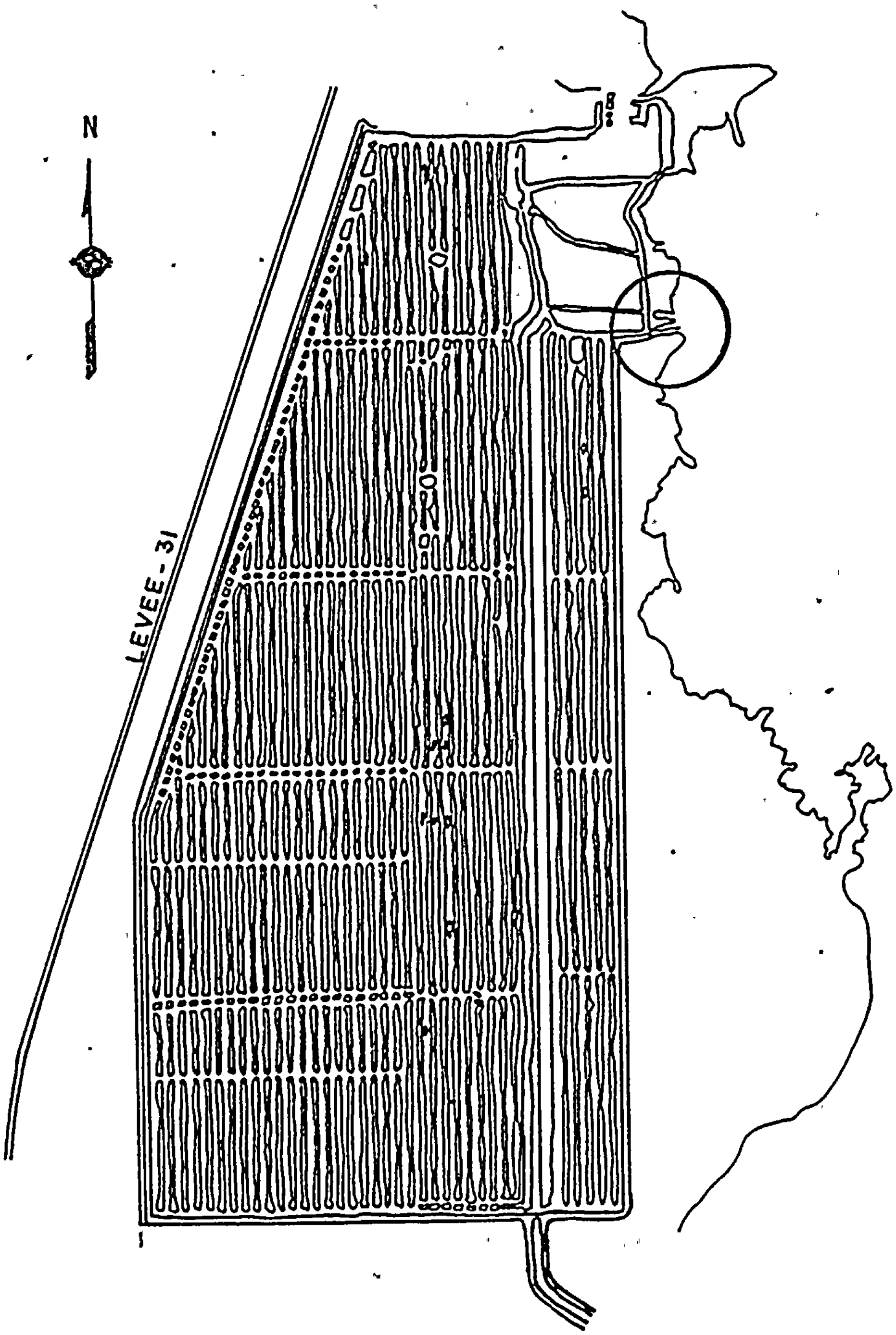


Figure 1. Location of Turkey Point Grand Canal Discharge, closed in March 1973.

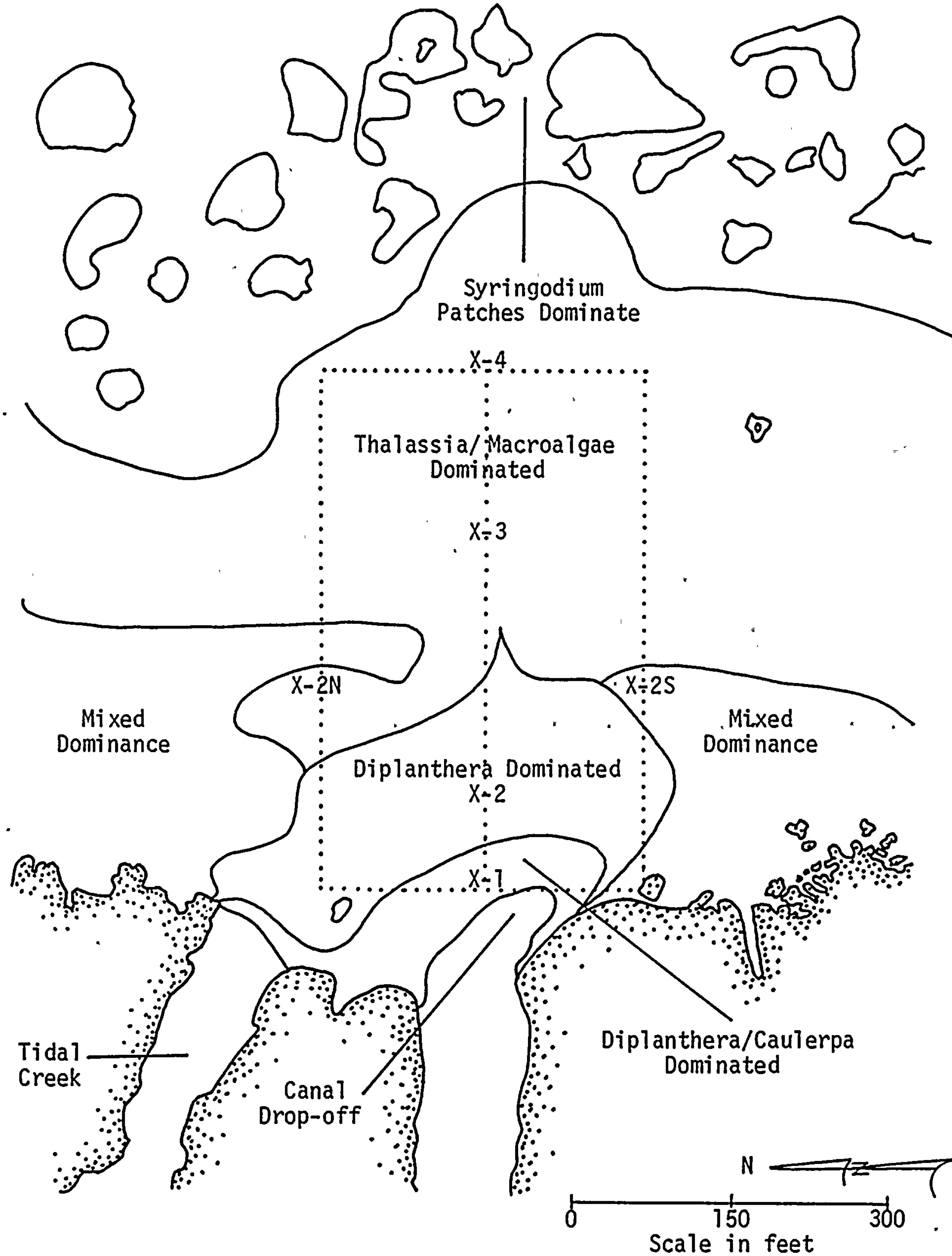


Figure 2. Tracing of Aerial Photograph for previously affected area at Turkey Point Grand Canal Discharge for July 1979.

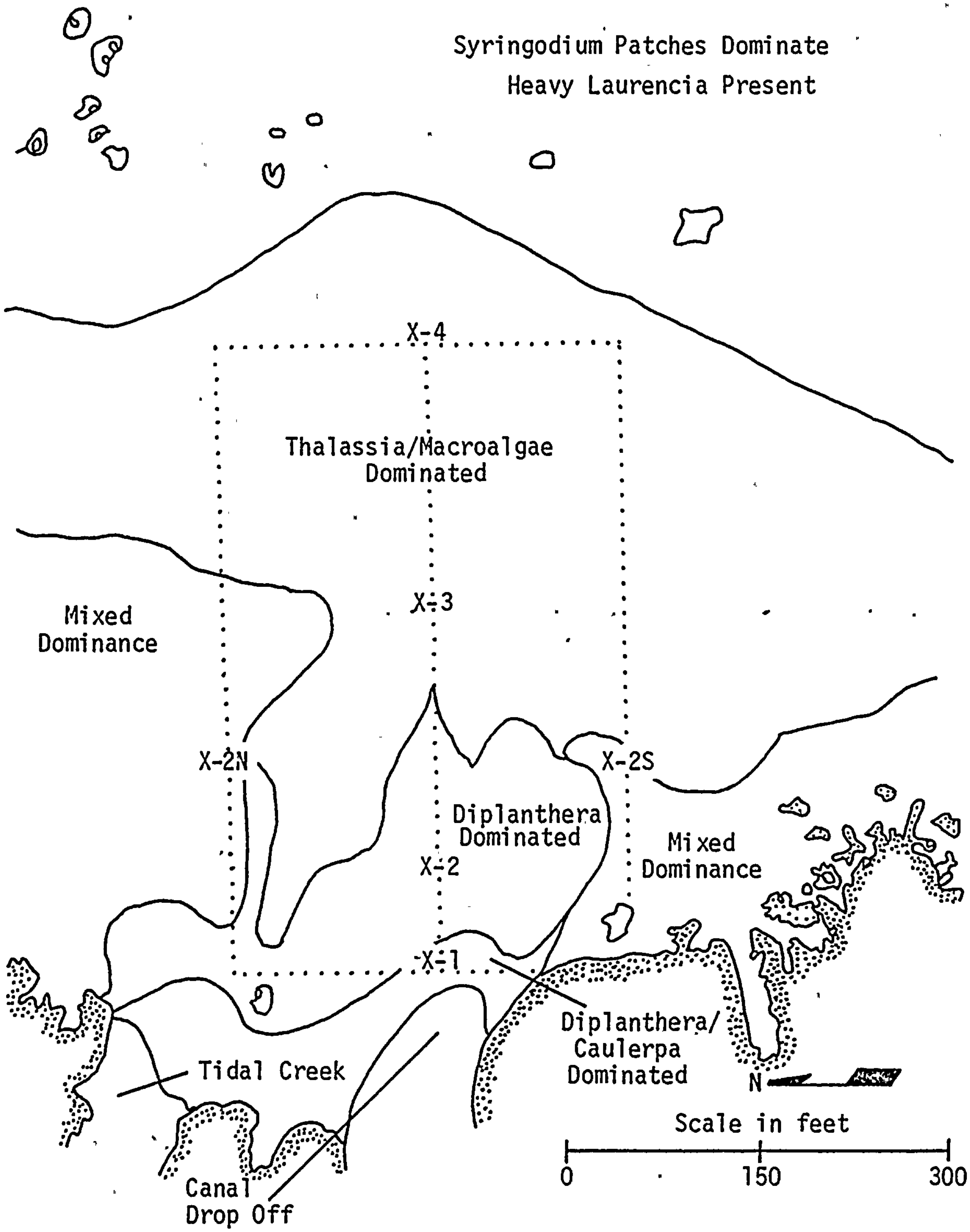


Figure 3. Tracing of Aerial Photograph for previously affected area at Turkey Point Grand Canal Discharge for December 1979.

Table 1. Quadrat Study of the Turkey Point Grand Canal Discharge for July, 1979.

STATION	X-1	X-2	X-3	X-4	X-2N	X-2S
ANGIOSPERMS:						
Diplanthera wrightii	+	>1500	>400	>1100	>400	>300
Thalassia testudinum	25	140	864	884	167	82
CHLOROPHYTA:						
Acetabularia crenulata	0	**	**	**	**	**
Anadyomene stellata	0	0	0	0	0	0
Avrainvillea nigricans	0	0	0	0	0	0
Batophora oerstedii	0	*	0	0	0	*
Caulerpa sp.	**	**	**	**	**	**
Halimeda sp.	1	0	2	1	2	0
Penicillus sp.	2	0	2	0	9	8
Rhipocephalus sp.	0	0	0	0	0	0
PHAEOPHYTA:						
Dictoyota sp.	0	0	0	0	0	0
RHODOPHORA:						
Digenia sp.	0	0	0	0	0	0
Laurencia sp.	0	*	0	*	*	**
OTHERS:						
Rhizophora mangle	0	0	0	1	0	0

+ Some *D. wrightii* were present at the sample point, but not in the 1/16 square areas used for density determinations.
* Present
** Common
*** Number of facicles

Table 2. Quadrat Study of the Turkey Point Grand Canal Discharge for December, 1979.

STATION	X-1	X-2++	X-3	X-4	X-2N	X-2S
ANGIOSPERMS:						
Diplanthera wrightii	+	**	200	+	250	200
Thalassia testudinum	44	*	392	584	144	176
CHLOROPHYTA:						
Acetabularia crenulata	**	0	0	0	0	*
Anadyomene stellata	0	0	0	0	0	0
Avrainvillea nigricans	0	0	0	0	0	0
Batophora oerstedii	**	*	0	*	0	*
Caulerpa sp.	0	*	0	1	0	*
Halimeda sp.	0	0	1	0	*	4
Penicillus sp.	*	0	0	0	0	1
Rhipocephalus sp.	0	0	0	0	0	0
PHAEOPHYTA:						
Dictoyota sp.	0	0	0	0	0	0
RHODOPHORA:						
Digenia sp.	0	0	0	0	0	0
Laurencia sp.	**	**	**	0	**	**
OTHERS:						
Rhizophora mangle	0	0	0	0	0	0

++ This station was completely covered with a 12-16" mat of *Laurencia sp.* Therefore quantitation of underlying Angiosperms was impossible.
+ Some *D. wrightii* were present at the sample point, but not in the 1/16 meters square areas used for density determinations.
* Present
** Common

5. Grasses and Macrophyton Within the Turkey Point Cooling Canal System (ETS 4.2.2.2)

Introduction

The purpose of this study was to qualitatively assess the diversity and extent of seagrasses and macroalgae within the canal system.

Methods

Most observations as well as identification and quantification were made in conjunction with other monitoring programs in the canal system. Comparisons to previous years data, refer to F.P.&L. Annual and Semi Annual Environmental Monitoring Reports #1 - 12 (1973 - 1978).

Discussion and Conclusions

Ruppia maritima (Ditch Grass) continued to be a grass of primary importance in the canal system. It was still confined to the southwest canals but was spreading north and east. This grass, which is considered a submergent form, grew to lengths of 4 to 8 feet. The length of the strands allowed it to reach the surface. These strands were heavily encrusted with epiphytic growth which further impeded water flow.

In the past, various biological, physical, and chemical methods of controlling this aquatic weed have been attempted with negative results. Another attempt, using a physical technique

known as "Rotovation" was made in September, 1979. The effectiveness of this procedure is undetermined at this time.

Also found in the canal system were the marine angiosperms *Diplanthera wrightii* (Shoalgrass), *Thallassia testudinum* (Turtle grass), and *Syringodium filliforme* (Manatee grass). The northernmost sections of the return canals continued to represent the most dense growth of these grasses in the canal system.

D. wrightii was particularly well represented by stands on both east and west sides. Its runners were normally attached to the substrate by rhizomes. Due to the finite growth habit of its fascicles, this species was thought to be of little consequence in restricting water movement. However, in dense stands the long runners overlapped each other in such a way that the rhizomes did not reach the substrate. The long floating strands thus developed the potential to obstruct water flow in a manner similar to *R. maritima*.

The amount of *S. filliforme* has doubled since last year. The circular stands of *S. filliforme* maintained the hollow shaped "donut" characteristic similar to those previously recorded for the same species at the mouth of the old Grand Canal Discharge. This characteristic might be the result of the depletion of some growth factors i.e., nutrient or trace element.

T. testudinum was found in Canal 3 East. This species showed no significant change in abundance since last year.

Various red and brown alga continued to be found along the rocky shoreline of most of the canals. This was particularly true of the deep collector and feeder canals. The red algae *Dasya sp.* reached lengths of 6 - 8 feet during the winter. *Dasya sp.* grew predominantly on rocks in the more shallow canals and was associated with high water velocity. *Laurencia sp.* was found scattered throughout the canal system. The brown algae *Sargassum sp.* occurred infrequently in the eastern canals of the system. However, densities were extremely low and this fucale was considered to be of insignificant consequence to the canal system's marine ecology and flow characteristics.

There was substantial green algal growth on solid substrates throughout the system. *Halimeda sp.* was found on small rocks in the southern end of the western canals and in the rocky shallows of the eastern canals. *Penicillus sp.* was prominent in the northeastern canals. *Caulerpa mexicana* occurred in varying densities systemwide; other species of *Caulerpa* were also present. *Batophora oerstedii* and *Acetabularia crenulata* were found as epiphytes on a variety of stable substrates in shallow water.

6. GROUNDWATER PROGRAM (4.1.1.2)

A summary report entitled Groundwater Monitoring Program, Turkey Point, Florida, prepared by FPL's consultant, Dames & Moore, is being forwarded with this report as required by ETS 4.1.1.2. The report was prepared for presentation to the South Florida Water Management District in July, 1979 and covers the period January 1, 1979 through June 30, 1979.

An arrangement was made with the South Florida Water Management District to prepare a report for the sampling period July 1, 1979 through June 30, 1980. In late August, 1980, Florida Power & Light will submit the required Groundwater Monitoring Report for the period July 1, 1979 through June 30, 1980. Since future reports will probably be prepared on an annual basis, subsequent reports will be submitted in late August for each preceding twelve month period.

B. TERRESTRIAL ENVIRONMENT

1. Revegetation of Cooling Canal Banks (ETS 4.2.1)

a. Natural Revegetation

Introduction

A quantitative study to monitor growth and reproduction of a plant species inhabiting the spoil berms was conducted. Data were gathered on a semi-annual basis from six permanent stations located within the Turkey Point Cooling Canal System (Figure 1).

Method

One 10 meter by 10 meter quadrat was permanently staked out at each of six stations on the canal system spoil berms. Growth and reproduction data were recorded and annual percent changes calculated for all species present within these quadrats (Tables 1-6). Two meter by ten meter quadrats established along the shoreline at each of the six stations were monitored to estimate red mangrove growth and reproduction rates (Tables 7). Comparisons to previous years data, refer to F.P.&L. Annual and Semi Annual Environmental Monitoring Report #1 - 12 (1973 - 1978).

Results and Discussion

Although a program for the control of Australian Pine (*Casuarina sp.*) is under development, it has not affected the five monitoring stations where *Casuarina sp.* were present as indicated by 5 to 95 percent increases in abundance at three stations this year (Tables 3, 4, and 6). Only two of the other 28 species at

these three stations showed an increase. Nineteen species showed a decrease in abundance (nine of which were 100 percent decreases). The number of *Casuarina sp.* continued to increase, keeping this exotic the system's most dominant plant.

Salt grass, *Distichlis spicata,* remained the primary ground cover on the older berms and continued to spread westward to the newer berms. At the four stations where salt grass was present, Station 408M showed no change, Station 310N showed a decrease of 89 percent, and Stations 105S and 505N showed increases of 31 percent and 100 percent respectively. This grass grew well even on clay soils and will serve as excellent hurricane protection for the berms. It was noted that the increases occurred at stations where *Casuarina sp.* was absent, and the decrease occurred at 310S where *Casuarina sp.* was present and had increased.

Although Saw Grass, *Cladium jamaicensis,* decreased at two of the three stations where it occurred, it was still considered an important ground cover and erosion inhibitor. *C. jamaicensis* continued to cover 2/3 of the area at Station 323S, but has decreased 13 percent and 17 percent at Stations 310N and 408M respectively. These decreases appeared to be a result of increased *Casuarina sp.* coverage.

Buttonwoods, *Conocarpus erectus,* were present at all the stations. Although the adult population increased at only one station

and remained unchanged at the others, the area occupied increased dramatically and seedlings were abundant. At Stations 505N and 105S seedlings were too numerous to count. Buttonwoods were a dominant species on most of the berms.

Red Mangroves, *Rhizophora mangle,* were found at only two of the six inland quadrats. There was a 23 percent decrease at Station 310N and no change at Station 105S. The shoreline quadrats showed only one change in the adult population, a 17 percent increase at Station 505N. The seedling population increased at two stations and decreased at three. The shoreline quadrat at Station 323S had no red mangroves. Established adults helped prevent erosion of the shoreline, but ironically many newly settled seedlings were dislodged by wave action eroding the banks.

Soil type continued to be the overt factor determining vegetation density. *Casuarina sp.* and *C. erectus* dominated heavy vegetation areas and tended to occupy the old tidal creeks and hammock areas where peat and muck substrates predominated. Salt grass was dominant on the clay/marl barrens.

The higher elevation caused by berm construction has allowed sufficient edaphic changes to permit non-mangrove community species such as *Baccharis halimifolia, Passiflora suberosa* and several new species (Table 8) to progressively invade from the western upland side of the system. *Schinus terebinthifolius,* the exotic Brazilian

Pepper Tree, continued to flourish over much of the canal system.

Comparison with available pre-operational vegetation data is inappropriate since construction of the canal system has completely disrupted the indigenous topography and vegetative communities in areas within the system. Areas south and west of the system are dealt with in another section of this report (Section 3.B.2).

Conclusions

Conclusions remained basically unchanged from 1978. Soil type continued to be the apparent factor determining vegetation density. *Casuarina sp.* and *Conocarpus erectus* dominated the peat and muck soils of the old tidal creeks and hammock areas, while salt grass and saw grass dominated the clay/marl barrens. *Casuarina sp.* have reduced species diversity and numbers in area where they dominated. The increased elevations resulting from berm construction have allowed upland species to invade the western areas of the canal system.

The Buttonwoods generally increased in size, but changes in total numbers of mature trees were low. Due to the increased number of seedlings taking hold this year; the number of mature trees should increase by 50% next year. The predicted rate of revegetation for salt grass is +25% and saw grass is expected to remain unchanged. The predictions for salt and saw grass were lower than last year because both species were competing with the *Casuarina sp.*

Casuarina sp. are expected to increase in number by only 10%. The areas dominated by *Casuarina sp.* developed large canopies and thick mats of "needles". This not only prevented the invasion of new species but also reduced the number of seedling *Casuarina sp.* this year.

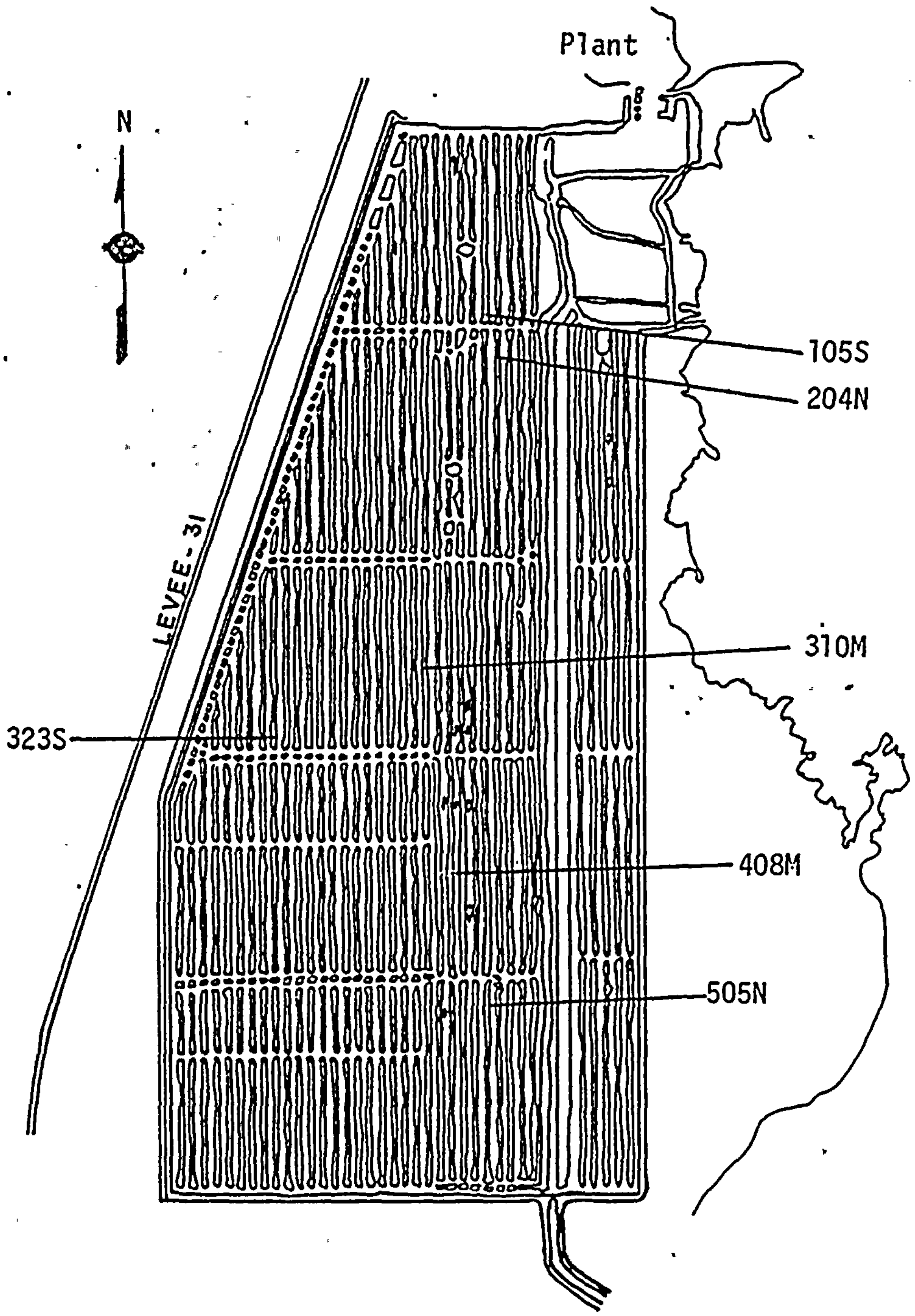


Figure 1. Natural Revegetation Test Sites at the Turkey Point Cooling Canal System.

Table 1. Percent change of species at light density vegetation station in the Turkey Point Cooling Canal System for 1979.

STATION 105S

SPECIES	PERCENT CHANGE
*Andropogon glomeratus**	
Baccharis halimifolia	+133
Conocarpus erectus	0
Distichlis spicata	+31
Erechtites hieracifolia	-100
Eupatorium capillifolium	+33
Juncus roemerianus	+20
Laguncularia racemosa[s]	+25
*Mikania scandens**	
Rhizophora mangle	0
*Schinus terebinthifolius**	

* New species this year

s Seedlings too numerous to count

Table 2. Percent change of species at light density vegetation station in the Turkey Point Cooling Canal System for 1979.

STATION 505N

SPECIES	PERCENT CHANGE
*Aster tenuifolius**	
*Baccharis halimifolia**	
Borrichia frutescens	+208
Casuarina equisetifolia	0
Conocarpus erectus[s]	0
Distichlis spicata	+100

* New species this year.

s Seedlings too numerous to count.

Table 3. Percent change of species at medium density vegetation station in the Turkey Point Cooling Canal System for 1979.

STATION 323S

SPECIES	PERCENT CHANGE
Acrostichum danaeifolium	0
Andropogon glomerutus[t]	
Aster tenuifolius[t]	
Baccharis halimifolia	-82
*Borrichia frutescens**	
Casuarina equisetifolia	+95
Cladium jamaicensis	0
Conocarpus erectus	+21
Eupatorium capillifolium[t]	
Juncus roemerianus	-100
Melanthera aspera	-100
*Mikania scandens**	
Passiflora suberosa	0
Pluchea rosea[t P]	
Schinus terebinthifolius	0
Solanum donianum	+50
Trema floridana	-100

* New species this year.

t Not present this year.

P Seasonal

Table 4. Percent change of species at medium density vegetation stations in the Turkey Point Cooling Canal System for 1979.

STATION 408M

SPECIES	PERCENT CHANGE
Acrostichum danaeifolium	-100
Andropogon glomerutus	0
Baccharis halimifolia[t]	
Casuarina equisetifolia[s]	+7
Cladium jamaicensis	-17
Conocarpus erectus	+71
Distichlis spicata	0
Eupatorium capillifolium	-100
Pluchea rosea[P]	-100
Pteris vittata	-78
Sabatia stellaris[t]	
Solanum donianum[t]	
Sonchus oleraceus	-100
Thelysteris normalis	-50

s Seedlings too numerous to count.

P Seasonal

t Not present this year.

Table 5. Percent change of species at heavy density vegetation stations in the Turkey Point Cooling Canal System for 1979.

STATION 204N

SPECIES	PERCENT CHANGE
Acrostichum danaeifolium	-100
Astera tenuifolius[t]	
Baccharis halimifolia	-74
Borrichia frutescens[t]	
Casuarina equisetifolia	0
Chamaesyce mesembryanthemifolia	-100
Conocarpus erectus	0
Erechtites hieracifolia[t]	
Eupatorium capillifolium[t]	
*Lantana camara**	
*Melanthria pendula**	
*Mikania scandens**	
*Passiflora suberosa**	
*Physalis angulata**	
Phytolacca rigida	+400
Pluchea rosea[t] P	
Sarcostemma clausa	+50
Schinus terebinthifolius	0
Solanum donianum	0
Solanum nigrens[t]	
Thelysteris normalis	-100

* New species this year. t Not present this year. P Seasonal

Table 6. Percent change of species at heavy density vegetation stations in the Turkey Point Cooling Canal System for 1979.

STATION 310N

SPECIES	PERCENT CHANGE
*Aster temifolus**	
Baccharis halimifolia	-50
Casuarina equisetifolia	+5
Conocarpus erectus	0
Cladium jamaicensis	-13
Distichlis spicata	-89
Laguncularia racemosa	-100
Rhabdadenia biflora	0
Rhizophora mangle	-23
Solanum donianum	-100
*Sporobolus virginicus**	

* New species this year.

Table 7. Percent change in Red Mangrove for 1979 at the vegetation stations in the Turkey Point Cooling Canal System.

NUMBER OF INDIVIDUALS

STATION	JANUARY 1979	MAY 1979	NOVEMBER 1979	PERCENT CHANGE
105S				
Mature	2	2	2	0
Seedlings	7	7	4	-43
204N				
Mature	1	1	1	0
Seedlings	12	12	16	+33
310N				
Mature	2	2	2	0
Seedlings	7	7	0	-100
323S				
Mature	0	0	0	0
Seedlings	0	0	0	0
408M				
Mature	0	10*	10	0**
Seedlings	0	48*	53	+10**
505N				
Mature	6	--	7	+17
Seedlings	15	--	11	-27

* Station moved

** Semi-annual percent change

Table 8. New species in the Turkey Point Cooling Canal System not observed at the vegetation stations in 1979.

Andropogon virginicua (Broomsedge)

Asimina sp. (Pond Apple)

Batis sp. (Saltwort)

Borrichia arborescens (Oxeyed Daisy)

Buccida spinosa

Chrysobalanus sp. (Cocoplum)

Coccoloba uvifera (Sea Grape)

Ficus aureus

Ipomoea sp. (Morning Glory)

Mikania batatifolia (Hempvine)

Metopium toxiferum (Poisonwood)

Sesuvium portulacastrum (Sea Purslane)

Solidago sp. (Goldenrod)

Waltheria indica

b. Soil Chemistry

Introduction

The purpose of this section was to determine pH, chloride and selected nutrients at three elevations on the berms in accordance with Environmental Technical Specification 4.2.1.1.

Methods

One hundred and fifty-two samples were collected at 52 sample sites covering the entire Turkey Point Cooling Canal System (Figure 1) and represented all major soil types. Sample sites were classified as follows:

Sites based on soils

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

Sites based on vegetative density

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

Levels

T top of berm
M middle of berm
L one foot above water level.

Samples were analyzed for pH, nitrogen, phosphorous, potassium,

calcium, chloride, and conductivity (Tables 1 and 2).

pH was measured using a glass electrode; potassium and calcium were determined using a Beckman DU-2 Flame Photometer. Nitrogen was determined using the Brucine Method. Phosphorous was determined using the Stannous Chloride Method. Conductivity was determined using a Modified Wheatstone Bridge. The data obtained were analyzed statistically using the P7D program of U.C.L.A. Biomedical Program Series P.

Comparisons to previous years data, refer to F.P.&L. Annual and Semi Annual Environmental Monitoring Reports #1 - 12 (1973-1978).

Results, Discussion and Conclusions

Selected soil chemistry parameters of the Turkey Point Cooling Canal Spoil Berms fluctuated primarily with the amount of rainfall. Generally chemical levels increased during the dry season only to decrease again during the wet season. This cyclic fluctuation was caused by salt water being drawn up through the mixed berm material by capillary action and concentrated along the surface by evaporation. These salts were then leached and/or washed away by rain during the wet season.

The hydrogen ion concentration continued to be a relatively stable parameter. The pH tended to become more alkaline during the wet season. The pH continued to be lowest at sites with factors of organic substrate, dense vegetation, and middle to upper elevations.

The higher pH values were found in the clay/marl substrates, sparser vegetation and lower elevation.

Nitrogen levels had been relatively stable. Nitrogen levels were highest in organic soils and at sites with heavy vegetation whereas the lowest values were obtained at grassy sites and in clay soils. Since the dry season of 1977-78, nitrogen levels have increased from an average 50-60 ppm to 158 ppm during the 1979 dry period. This appeared to be related to a geometric increase in vegetation in the canal system since the cessation of the Control Program in early 1976. Nitrogen fixation by a mycorrhiza associated with *Casuarina sp.* is suspected. With the restart of the Vegetation Control Program and subsequent reduction in *Casuarina sp.* nitrogen levels should develop a downward trend. There continued to be no apparent correlation between nitrogen and rainfall.

Phosphorous levels, while showing a slight increase in 1979, maintained an overall downward trend from the 1975 dry period (1.30 ppm) to the 1979 dry period (0.48 ppm). Phosphorous levels fluctuate inversely with rainfall.

Potassium levels continued the downward trend from the 1975 dry period (485 ppm) to the 1979 dry period (140 ppm). Potassium levels historically have fluctuated inversely with rainfall. All the high potassium values were from samples taken at the bottom elevations and were likely to have been moist with salt water.

Calcium levels have shown no trends as a function of time from 1975 to 1979 and there appeared to be no correlation to the wet and dry seasons. Sites with heavy vegetation and black organic soils yielded the highest mean values for calcium.

Chloride levels fluctuated inversely with both rainfall and elevation. The previous anticipated reduction trend in soils has not materialized, while salinity in the cooling system waters continued to increase (see Plankton Nutrient Table 1).

Conductivity levels increased slightly in 1979 but insufficiently to counteract an overall downward trend. Conductivity tended to fluctuate inversely with rainfall. As with chloride levels, the high values for conductivity were from the lower elevation samples.

There continued to be fair to good correlation between potassium, chloride, and conductivity regardless of soil or vegetation type.

Future yearly analysis will be done in a cumulative fashion, i.e. 1979 added to 1975-1978 and the composite samples were analysed, with possible yearly deviations specified.

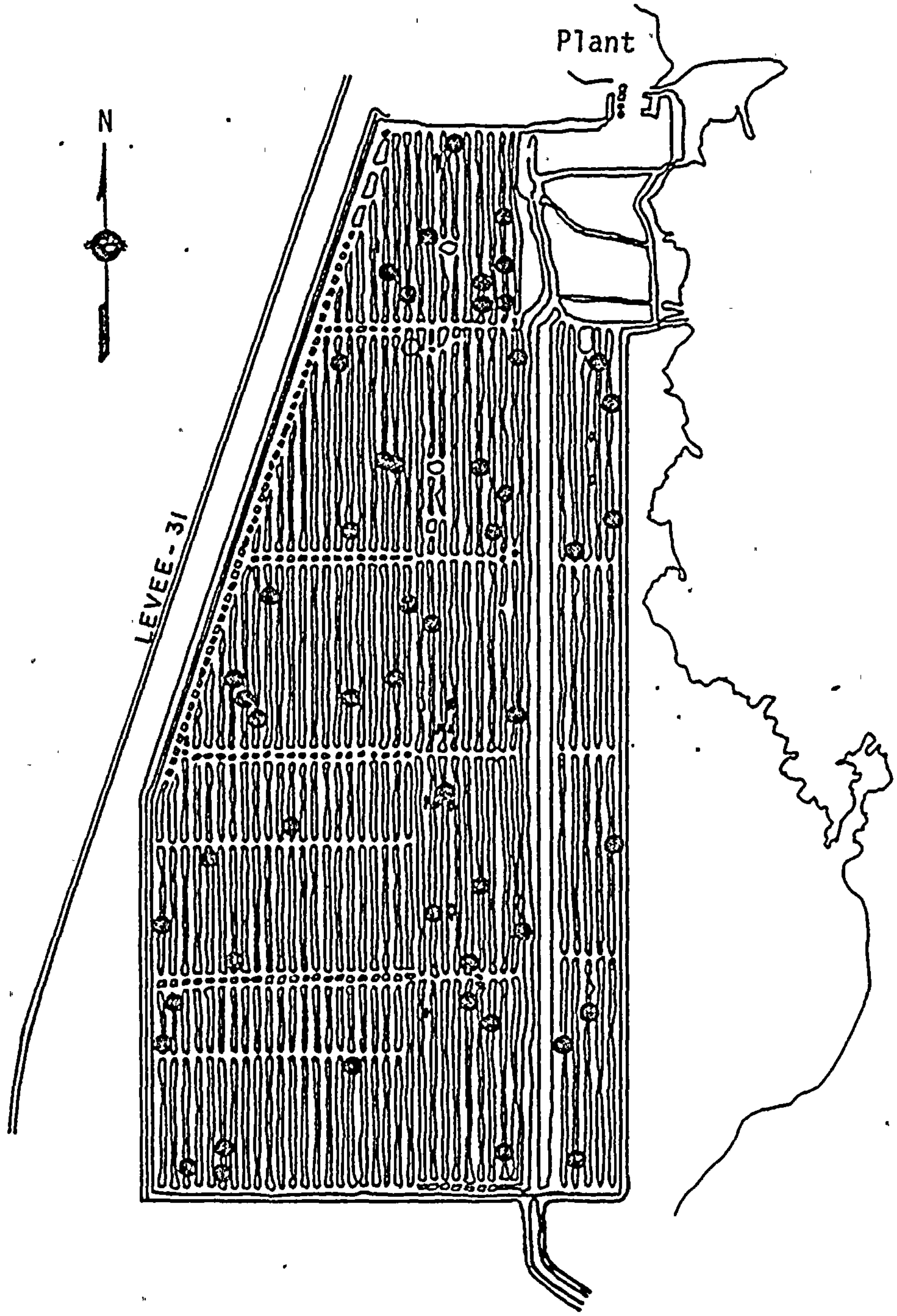


Figure 1. Soil Chemistry sample sites (⊛) at the Turkey Point Cooling Canal System.

Table 1. Soil test report from Turkey Point Cooling Canal System Berms for June 1979 covering the period January through May.

Sample	pH	NO_3*	P*	K*	Ca*	Cl*	Cond**
1 WT	7.4	120	<0.1	11	750	750	92
WM	7.0	190	<0.1	45	1300	2700	252
WL	7.4	27	0.2	760	1700	70400	2200
2 WT	5.6	140	<0.1	22	1950	1500	180
WM	5.7	240	0.1	25	2400	2300	240
WL	7.4	50	0.5	390	1200	48000	1000
3 WT	7.4	120	<0.1	75	800	3500	235
WM	7.5	75	0.1	79	900	5000	245
WL	7.8	19	1.0	260	550	32000	542
4 WT	7.8	105	<0.1	164	2100	6000	300
WM	7.8	90	<0.1	130	550	13600	340
WL	8.0	13	0.3	255	500	30400	490
5 WT	8.0	120	<0.1	53	1650	4000	150
WM	7.9	48	<0.1	65	1500	4800	225
WL	7.9	22	0.5	285	750	32000	480
6 WT	7.3	100	0.1	15	550	2000	114
WM	7.3	140	<0.1	100	1850	13400	450
WL	7.7	46	1.0	422	800	33600	660
7 WT	7.4	180	<0.1	20	800	2500	140
WM	7.2	125	<0.1	100	1550	12000	380
WL	7.4	35	0.3	500	750	35200	710
8 WT	7.5	140	<0.1	15	800	2000	126
WM	7.4	110	0.1	53	1300	7000	260
WL	7.9	18	1.0	270	600	18880	468
9 WT	7.7	115	<0.1	25	350	1500	82
WM	7.7	43	0.1	22	250	2500	160
WL	7.8	45	1.0	500	1100	80000	1200
WET	7.4	100	0.1	62	600	5000	218
WEM	7.4	95	0.1	65	900	6000	278
WEL	7.4	50	<0.1	380	1100	28800	630

*all these values in PPM.

**Conductivity in MHOS X 10^{-5}

4WT=all top elevation at clay sites. See methods section for further information.

WET=All east side top elevations combined

WEM=All east side middle elevations combined

WEL=All east side low elevations combined

Table 2. Soil test report from Turkey Point Cooling Canal System Berms for November 1979 covering the period June through December.

Sample	pH	NO_3*	P*	K*	Ca*	Cl*	Cond**
1 WT	7.8	180	<0.1	18	2400	3040	180
WM	7.4	260	2.0	30	800	3280	238
WL	7.3	190	<0.1	476	1400	24400	1100
2 WT	7.5	120	0.4	10	900	1760	120
WM	7.8	240	1.0	70	1100	8400	340
WL	7.4	120	0.1	310	1000	4000	770
3 WT	7.7	230	0.6	70	800	5200	205
WM	7.9	140	0.2	70	500	4800	240
WL	7.6	38	<0.1	220	600	4000	580
4 WT	8.3	220	1.0	112	400	8400	185
WM	8.1	140	<0.1	84	400	6400	370
WL	7.7	82	0.4	302	600	26400	650
5 WT	7.8	240	<0.1	40	800	3200	260
WM	7.9	170	2.0	70	500	5600	290
WL	7.7	44	<0.1	250	700	24000	600
6 WT	7.9	190	0.6	18	900	1000	137
WM	7.8	110	<0.1	30	1000	3600	290
WL	7.4	180	<0.1	346	1500	28000	760
7 WT	7.9	210	<0.1	22	600	3700	200
WM	7.6	220	0.4	64	1500	6400	330
WL	7.5	100	0.1	260	900	23200	650
8 WT	7.9	220	<0.1	64	1400	7000	355
WM	7.8	200	0.6	118	800	8000	400
WL	7.6	130	<0.1	346	1100	30400	600
9 WT	7.9	100	0.6	16	300	900	130
WM	8.1	64	2.0	40	500	3440	180
WL	7.7	95	<0.1	296	900	31200	660
WET	7.4	210	<0.1	54	1300	5200	275
WEM	7.3	220	<0.1	70	1500	9600	470
WEL	7.1	140	<0.1	230	1400	18400	530

*all these values in PPM.
**Conductivity in MHOS X 10^{-5}
4WT=All top elevation at clay sites. See methods sections for further information.
WET=All east side top elevations combined
WEM=All east side middle elevations combined
WEL=All east side low elevations combined

c. Soil Erosion

Introduction

Soil erosion data were collected and quantified to determine erosion rates due to soil oxidation, precipitation, and wind.

Methods

Soil erosion data were collected semi-annually. Two test sites were set up in the Turkey Point Cooling Canal System (Figure 1), 502N on Berm 2 at the north end of Section 5, and 530N on Berm 30, also at the north end of Section 5. The most common soil type in the system is mucky-clay, therefore, both stations were placed in areas predominantly of that edaphic characteristic. At each site, four pipes were driven through the berms and into the underlying rock. An "Averaging Cross" was then placed horizontally on each of the pipes. The distance from the tips of the cross to the berm surface was then measured. Comparison of these measurements allowed the determination of changes in the height of the berms. The "Run Through Trough Method" will be discontinued due to poor reliability.

Results

The "Averaging Cross" gave the most consistent data of the methods attempted. Analysis of the "Averaging Cross" data showed a net change of -0.023 inches on Berm 2, Section 5 and a net change of -0.069 inches for Berm 30, Section 5. The average erosion in 1979 was 0.046 inches. Rainfalls for the 1st and 2nd half of the year

were 10.62 inches and 22.75 inches respectively (Table 1).

Discussion

An attempt was made to relate the berm erosion rate (negative change) and the amount of rainfall (Figures 2 and 3). It appeared that there was a positive relationship between rainfall and erosion; however, the magnitude of the erosion rate differed between the wet and dry seasons.

The depressed erosion rate during the wet season and the relatively higher erosion rate during the dry season might be explained in the following way. During the rainy season (May to November) the soil was inundated frequently. Therefore, there was less effect by the wind since soil moisture held substrate particles together in a coherent mass. During the dry season (December to April) the soil dried out and cracked, forming dust. When this dust was carried by the wind, it had a scouring effect on the berms and created more dust. When the first rains occurred after a dry period, a relatively small amount of rain removed relatively large quantities of this loose material. The net effect of this sequence was a large amount of substrate displaced by relatively little precipitation.

Figures 4 and 5 show a definite positive relationship between rainfall and soil erosion. Station 502N was not affected to as great an extent by erosion factors as Station 530N.

The most dramatic effects of erosion were still found in simple qualitative observations. Wave action caused 1 to 2 feet deep scarps to be etched into berm shorelines. Shoreline survey stakes at various stations were seemingly getting closer to the shoreline. This observation will be quantified in future reports. Rocks and shells were seen sitting atop one and two inch pedestals of substrate material. Mud-slides were seen at various areas along the canal banks.

Conclusion

The foregoing discussion gave clear indications of water (rain and waves) and wind erosion. The inconsistent erosion per rainfall rate as demonstrated by Table 1 tends to indicate that berm erosion was primarily a combination of drying (fragmentation) and subsequent movement of particles by rainfall. Table 1 indicates an anticipated average rate of erosion for 1980 of approximately 0.05 inches.

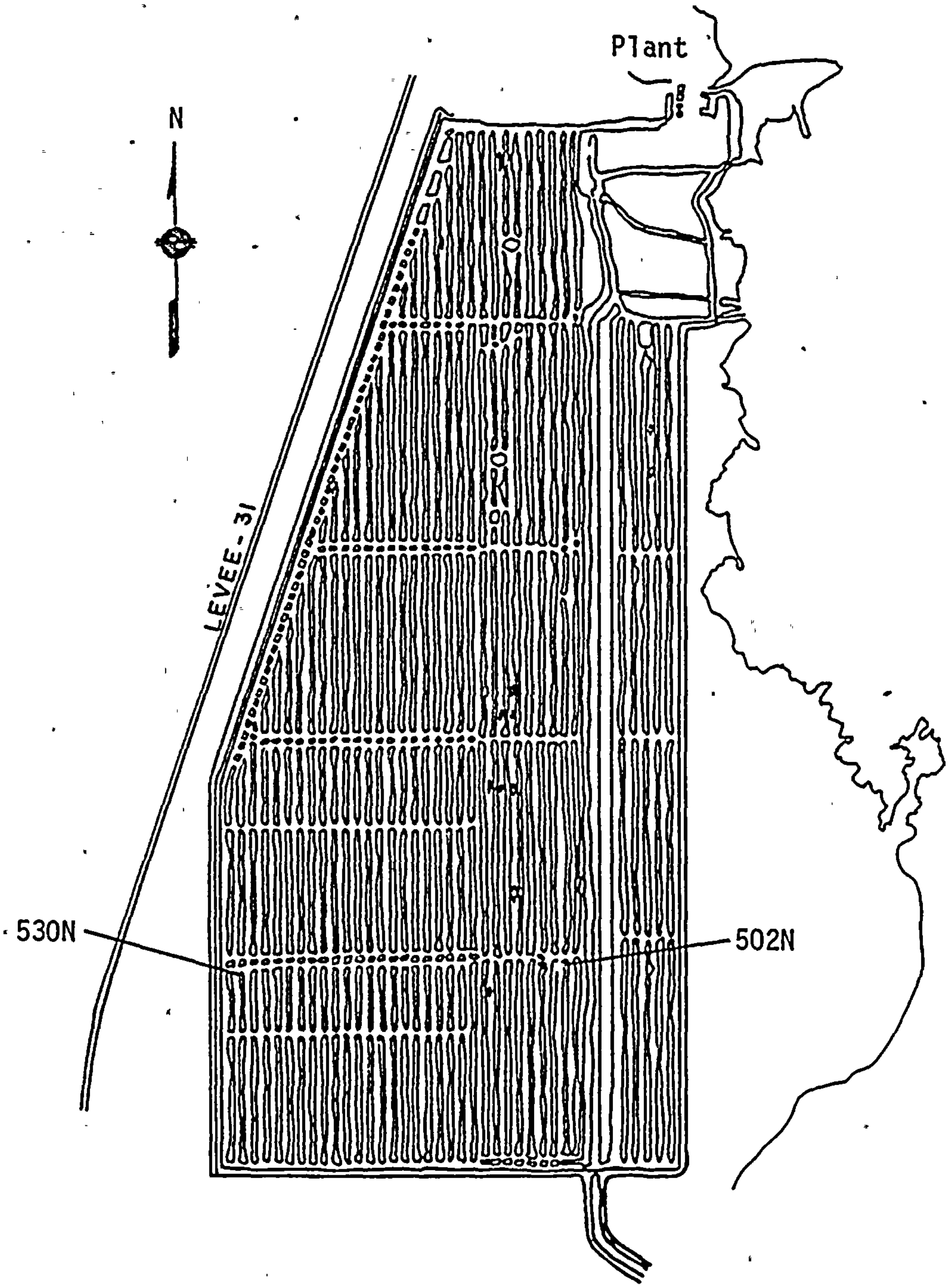


Figure 1. Soil Erosion Test Sites at the Turkey Point Cooling Canal System.

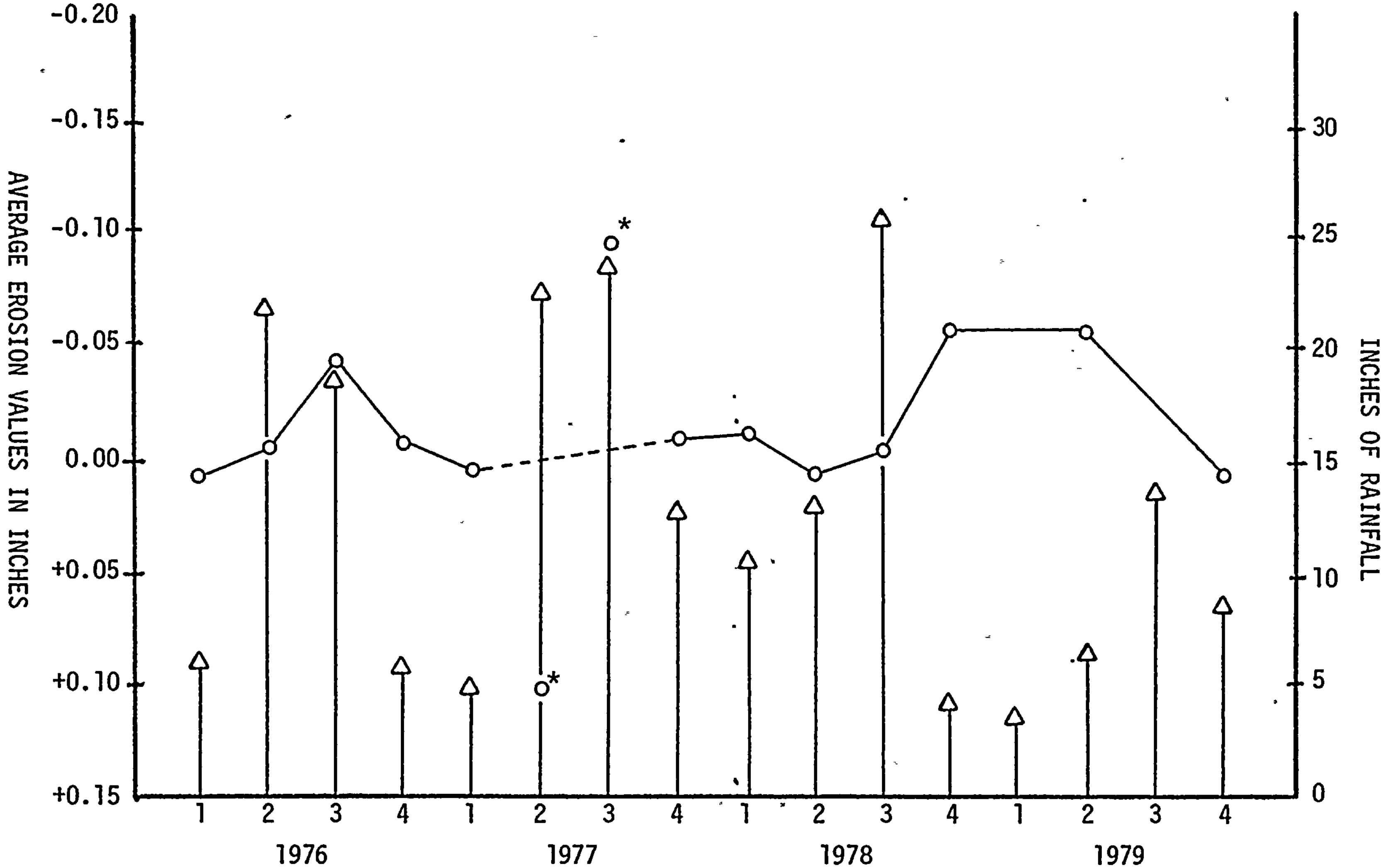


Figure 2. Soil erosion (O) and rainfall (Δ) averages for Turkey Point Station 502 per quarter for the years 1976 through 1979.
* See note on Table 1.

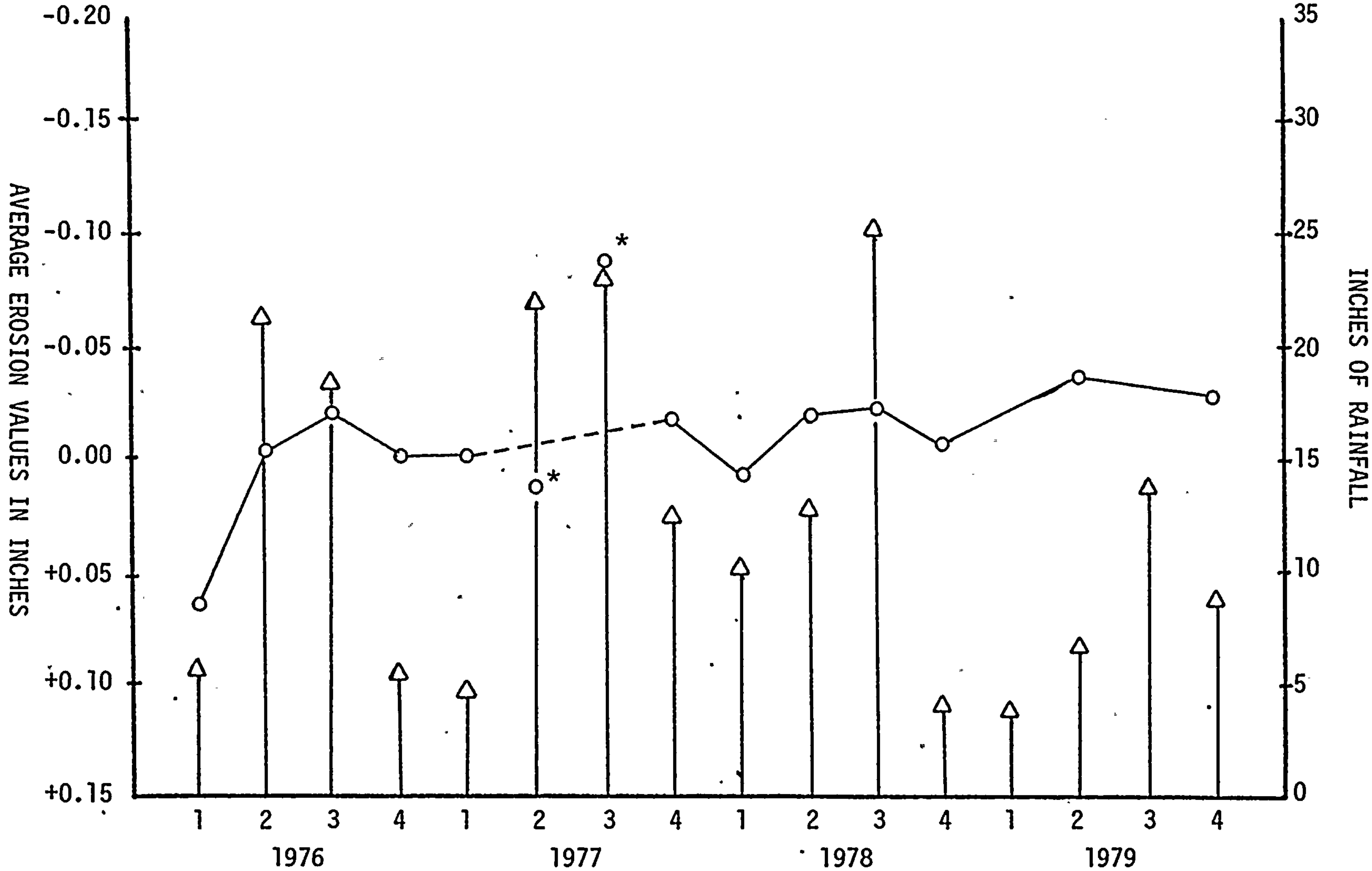


Figure 3. Soil erosion (O) and rainfall (Δ) averages for Turkey Point Station 530 per quarter for the years 1976 through 1979.
* See note on Table 1.

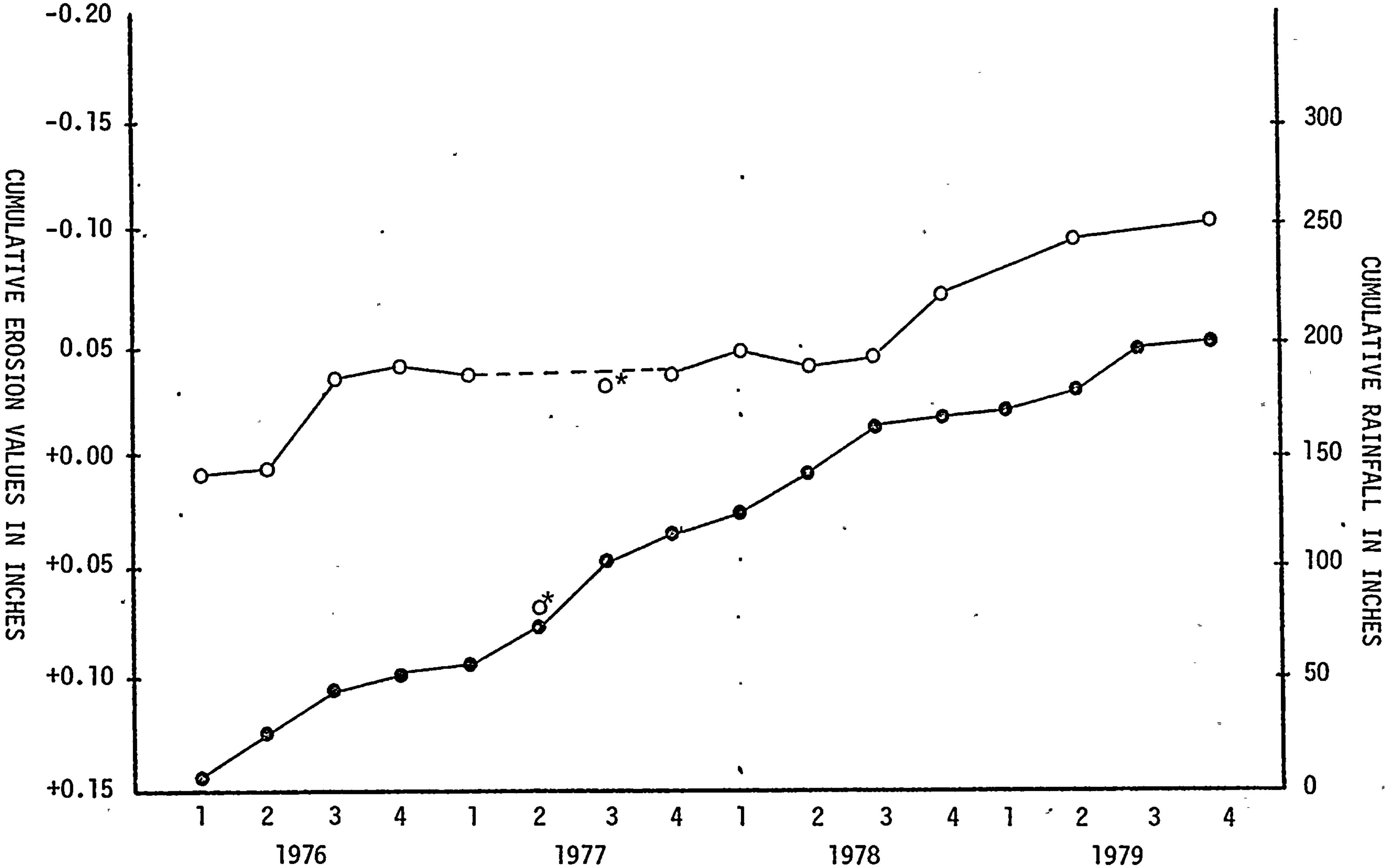


Figure 4. Cumulative soil erosion (O) and rainfall (⊙) at Turkey Point Soil Erosion Station 502 per quarter for the years 1976 through 1979.
* See note on Table 1.

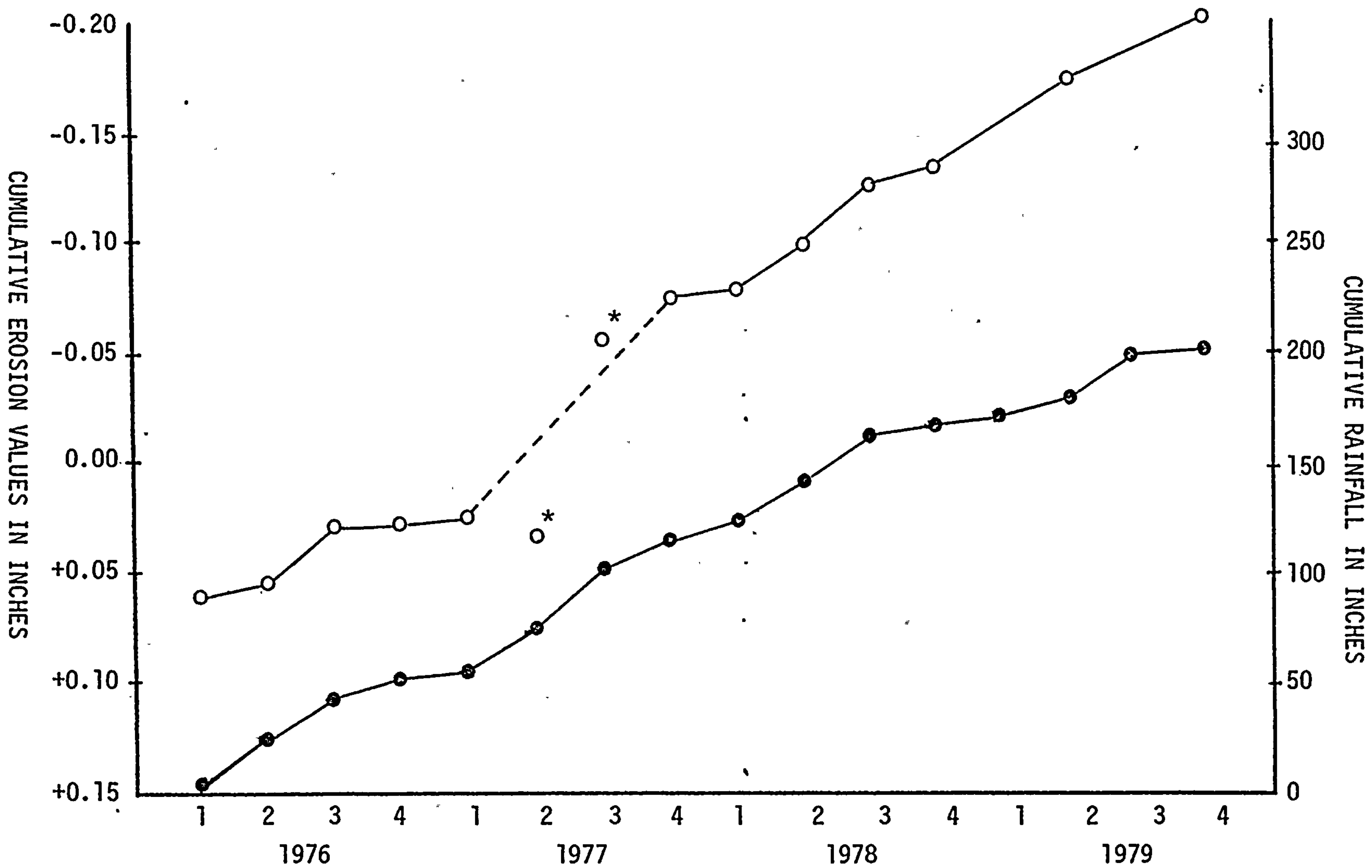


Figure 5. Cumulative soil erosion (O) and rainfall (●) at Turkey Point Soil Erosion Station 530 per quarter for the years 1976 through 1979.
* See note on Table 1.

Table 1. Rainfall, soil erosion, and erosion rate per quarter for the years 1976 through 1979 at Turkey Point Site.

YEAR	QUARTER	RAINFALL (inches)	EROSION (inches)	INCHES OF EROSION PER INCH OF RAINFALL
1976	1	5.80	+ .035	
	2	21.76	- .005	
	3	18.78	- .032	
	4	5.39	- .004	
	Total	51.73	- .006	-1.16×10^{-4}
1977	1	4.81	+ .001	
	2	22.16	+ .057*	
	3	23.56	- .093*	
	4	12.66	- .016	
	Total	63.19	- .051	-8.07×10^{-4}
1978	1	10.20	- .008	
	2	12.92	- .007	
	3	25.42	- .014	
	4	4.11	- .018	
	Total	52.65	- .046	-8.74×10^{-4}
1979	1	3.81	--	
	2	6.81	- .034	
	3	14.30	--	
	4	8.45	- .012	
	Total	33.37	- .046	-13.78×10^{-4}

NOTE: * An error was made in the 1977, 2nd quarter measurements indicating relatively high deposition. The 3rd quarter measurements were correct, but compensated for the 2nd quarter by indicating greater than normal erosion. The yearly average follows the norm.

(-) Denotes Erosion (+) Denotes Deposition

d. Faunal Survey

Introduction

The purpose of this section is to furnish a qualitative assessment of the fauna (birds, mammals, reptiles, and amphibians) found within the Turkey Point Cooling Canal System and compare it with the fauna of the surrounding area. The study area encompasses 6,800 acres of land needed for the cooling canal network and 28 acres of plant site (Figure 1).

Method

All faunal observations were recorded from diurnal observations made during routine monitoring. Since many species, especially mammals, have crepuscular and nocturnal habits, it is very likely that some species inhabiting the study area were not observed. Relative abundance was estimated by counting with the aid of binoculars. Small mammals, reptiles, and amphibians were brought back to the laboratory for identification and then released. Larger mammals were recorded from diurnal observation, natural deaths, and road kills.

Comparisons to previous years data, refer to F.P.&L. Annual and Semi Annual Environmental Monitoring Reports #1 - 12 (1973-1978).

Results

During 1979, 63 Avian species, 17 Reptilian species, 3 Amphibian species, and 6 Mammalian species were observed in the study

area. Notable among the observed species were: the Least Tern, *Sterna albifrons*, the Southern Bald Eagle, *Haliaeetus leucocephalus*, the American Crocodile, *Crocodylus acutus*, the Eastern Diamondback Rattlesnake, *Crotalus adamanteus*, the Green Tree Frog, *Hyla cinerea*, and the Bobcat, *Lynx rufus*.

Discussion

Table 1 is a list of 63 Avian species sighted in the study area for 1979. The birds occurred either as permanent residents, regular or casual visitors, or visitors that appeared only during migration. To the right of the birds' names in the tables are two columns containing information on the relative abundance and seasons of occurrence.

The Least Tern (*Sterna albifrons*) was common during the late spring and summer. This species found the spoil banks a suitable nesting ground. Four colonies were present in the system, however, only three nesting areas were found. Colonies consisted of 10 to 40 adults with 5 to 20 nests per colony.

The Common Nighthawk (*Chordeiles minor*) and the killdeer (*Charadrius vociferus vociferus*) also nested in the system. Altricial killdeer were observed, although the nesting areas were not located.

Table 2 is a list of 17 reptiles and 3 amphibians that

frequent the study area. To the right of the scientific names is the preferred habitat. All reptiles and amphibians were considered permanent residents of the study area.

Six adult and approximately seven sub-adult Crocodiles were residents of the southwest section of the canal system. They ranged in size from 2 feet to 12-1/2 feet long. It was confirmed that one sub-adult inhabiting the area was a hatchling from the 1978 season. The continuing intensive study of the Reptilian species led to the discovery of an active nest located on Spoil Berm 29 in the southwest corner of the canal system. At the conclusion of the 1979 nesting season, a total of 26 hatchlings had been captured, marked, and released.

Table 3 lists the mammals observed in the study area. The chiefly nocturnal Marsh Rabbit was rarely observed, however, based on the frequency of droppings it was considered quite common. The Black Rat was also quite common and was frequently found associated with man-made structures.

Surrounding Area

Data from the South Dade Preliminary Report was used to compare fauna of the study area to that of the surrounding area. The South Dade area was selected because of its habitat similarity. A total of 76 bird species, 18 species of reptiles and amphibians, and 10 species of mammals were observed in the surrounding area. In the

study area, a total of 63 Avian species, 20 Reptilian and Amphibian species, and 6 mammalian species were observed. The differences in the number of species observed in the surrounging area versus the study area can be attributed mainly to different methods of data collection. In the South Dade Baseline Study, conducted between 1973 and 1976, intensive diurnal monitoring, nocturnal monitoring, and trapping procedures were used. Data for the Turkey Point study area was collected using diurnal observations only.

Tables 4, 5, and 6 compare the fauna of the study area to that of the surrounding area. Thirty-eight species of birds, three species of mammals, and ten species of reptiles and amphibians were common to both areas during 1979.

Conclusions

The Turkey Point Cooling Canal System is different from the preconstruction habitat. The main modification affecting the terrestrial animal distribution was the disruption of uniform terrain and floral patterns. These changes in topography altered the large shallow tidal areas once open to a large diversity of small fish, shellfish and their associated predators and replaced it with a deeper closed basin without benefit of surface recharge or ready recruitment from the surrounding area.

The partial removal of the mangrove scrub, prairie, and tidal creeks necessary for construction of the cooling canals has

resulted in a decrease in natural cover for many animal species. In the past, the mangrove was the dominant vegetation type. Via its long range stability, primary nutrient source and cover, it represented the key to faunal population dynamics and species diversity. The emphasis of interpretation has shifted to the changes in land elevations and associated water levels as the key to species diversity. As the cooling canal berms continue to revegetate with different plant species, it is probable that animal populations which have adapted to life in this new environment will move into the area.

In summation, the conclusions as stated above were unchanged from 1978 with the exception that more emphasis is being shifted to the effects of altered ground elevations.

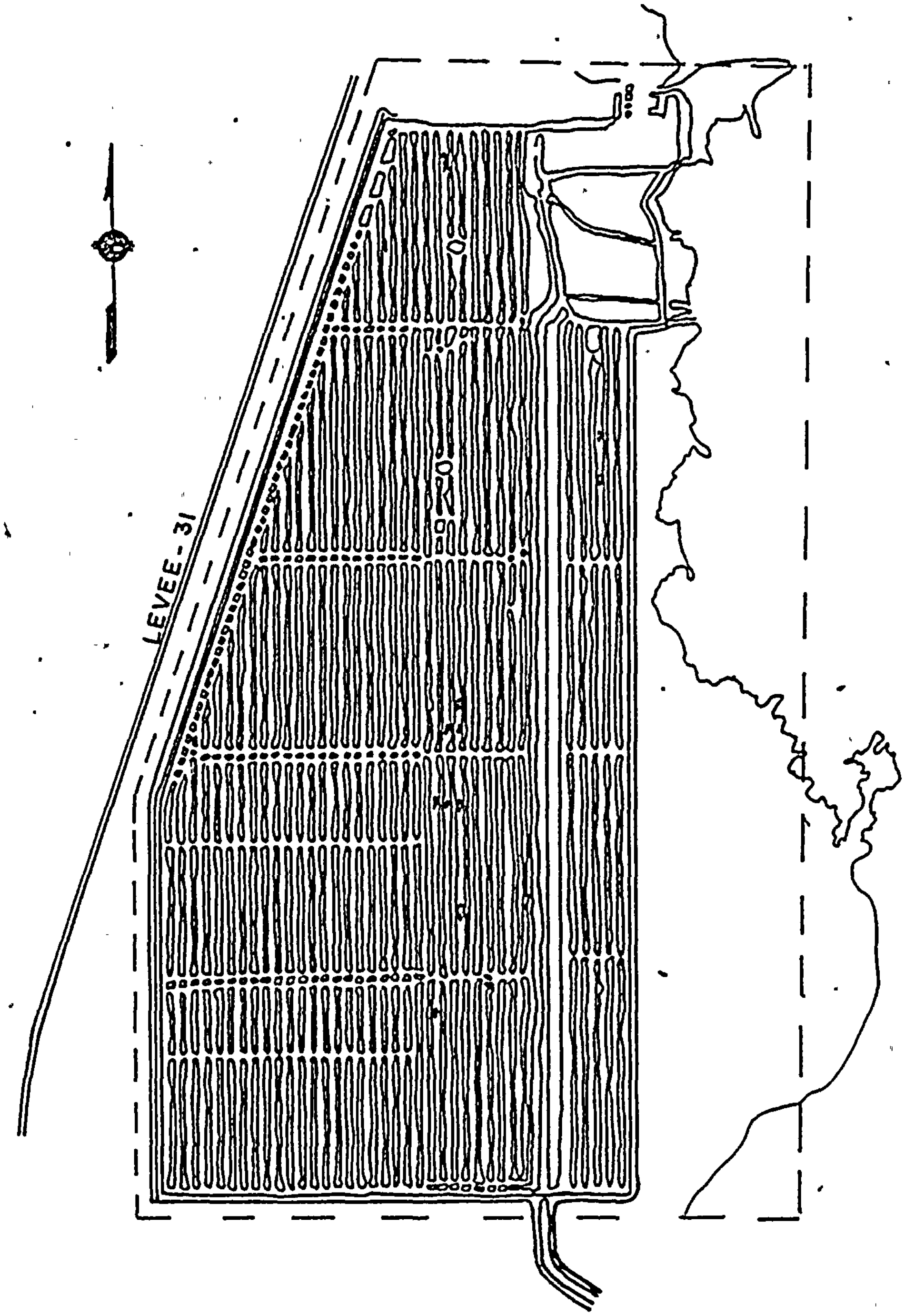


Figure 1. Map of the Turkey Point Site with Study Area outlined.

Table 1. A list of Birds observed in the Turkey Point Study Area for 1979.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
American Coot	*Fulica americana*	Common	Permanent
American Kestral	*Falco sparverius*	Uncommon	Winter
Bald Eagle	*Haliaeetus leucocephalus*	Uncommon	Permanent
Barn Owl	*Tyto alba pratincola*	Rare	Permanent
Barn Swallow	*Hirundo rustica erythrogaster*	Common	Fall
Belted Kingfisher	*Megaceryle alcyon alcyon*	Common	Permanent
Black Vulture	*Coragyps atratus*	Uncommon	Permanent
Boat-Tailed Grackle	*Cassidix mexicanus*	Common	Permanent
Broad Winged Hawk	*Buteo platypterus platypterus*	Uncommon	Transient
Brown Pelican	*Pelecanus occidentalis cardinensis*	Uncommon	Permanent
Cape May Warbler	*Dendroica tigrina*	Rare	Transient
Cardinal	*Richmondena cardinalis*	Common	Permanent
Caspian Tern	*Hydroprogne caspia*	Rare	Winter
Cattle Egret	*Bubuleus ibis*	Uncommon	Permanent
Common Crow	*Corvus brachyrhynchos*	Common	Permanent
Common Egret	*Casmerodius albus egretta*	Common	Permanent
Common Nighthawk	*Chordeiles minor*	Common	Permanent
Common Starling	*Sturnus vulgaris vulgaris*	Uncommon	Permanent
Common Tern	*Sterna hirundo hirundo*	Rare	Winter
Double-Crested Cormorant	*Phalacrocorax auritis*	Common	Permanent

Table 1. A list of Birds observed in the Turkey Point Study Area for 1979. (CONT'D)

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
Great Blue Heron	*Ardea herodias*	Common	Permanent
Great White Heron	*Ardea occidentalis occidentalis*	Common	Permanent
Green Heron	*Butorides virescens virescens*	Common	Permanent
Ground Dove	*Columbigallina passerina passerina*	Common	Permanent
Herring Gull	*Larus argentatus*	Common	Winter
Hooded Merganzer	*Lophodytes cucullatus*	Rare	Winter
House Sparrow	*Passer domesticus domesticus*	Common	Permanent
Killdeer	*Charadrius vociferus vociferus*	Common	Winter
Laughing Gull	*Larus atricilla*	Common	Permanent
Least Sandpiper	*Erolia minutilla*	Uncommon	Winter
Least Tern	*Sterna albifrons*	Common	Summer
Little Blue Heron	*Florida coerulea coerulea*	Common	Permanent
Louisiana Heron	*Hydranassa tricolor ruficollis*	Common	Permanent
Magnificent Frigatebird	*Fregata magnificens rothschildi*	Rare	Permanent
Marsh Hawk	*Circus cyaneus hudsonius*	Uncommon	Winter
Mockingbird	*Mimus polyglottos polyglottos*	Common	Permanent
Mottled Duck	*Anas fulvigula*	Common	Permanent
Mourning Dove	*Zenaidura macroura*	Common	Permanent
Osprey	*Pandion halioetus carolinensis*	Common	Permanent
Pied-billed Grebe	*Podilymbus podiceps podiceps*	Common	Permanent

Table 1. A list of Birds observed in the Turkey Point Study Area for 1979. (CONT'D)

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
Red-Bellied Woodpecker	*Centurus carolinus*	Uncommon	Permanent
Red-Brested Merganser	*Mergus serrator*	Common	Winter
Reddish Egret	*Dichromanassa rufescens rufescens*	Rare	Summer
Red-Tailed Hawk	*Buteo jamaicensis*	Rare	Summer
Red-Winged Blackbird	*Agelaius phoeniceus*	Common	Permanent
Ring-billed Gull	*Larus delawarensis*	Fairly Common	Winter
Roseate Spoonbill	*Ajaia ajaja*	Rare	Winter
Rock Dove	*Columba livia*	Fairly Common	Permanent
Royal Tern	*Thalasseus maximus maximus*	Uncommon	Winter
Semipalmated Plover	*Charadrius hiaticula semipalmatus*	Uncommon	Winter
Smooth Billed Ani	*Crotophaga ani*	Very Rare	Winter
Snowy Egret	*Leucophoyx thula thula*	Common	Permanent
Spotted Sandpiper	*Actitis macularia*	Uncommon	Winter
Tree Swallow	*Iridoprocne bicolor*	Rare	Winter
Turkey Vulture	*Cathartes aura*	Common	Permanent
White Ibis	*Guara alba*	Fairly Common	Permanent
Willet	*Catoptrophorus semipalmatus*	Uncommon	Winter
Wood Ibis	*Mycteria americana*	Rare	Permanent
Wurdemann's Heron	*Ardea wurdemanni*	Very Rare	Permanent
Yellow-bellied Sapsucker	*Sphyrapicus varius varius*	Very Rare	Winter

Table 1. A list of Birds observed in the Turkey Point Study Area for 1979.
(CONT'D)

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
Yellow-billed Cuckoo	*Coccyzus americanus americanus*	Rare	Summer
Yellow-Crowned Night Heron	*Nyctanassa violacea*	Rare	Permanent
Yellow-Shafted Flicker	*Colaptes auratus*	Uncommon	Permanent

Table 2. A list of Reptiles and Amphibians observed in the Turkey Point Study Area for 1979.

COMMON NAME	SCIENTIFIC NAME	PREFERRED HABITAT
American Crocodile	*Crocodylus acutus*	Salt or brackish water
American Alligator	*Alligator mississippiensis*	Fresh or brackish water.
Atlantic Green Turtle	*Chelonia mydas mydas*	Warm parts of the Atlantic
Florida Softshell Turtle	*Trionyx ferox*	Lakes, ponds, canals, roadside ditches
Southern Painted Turtle	*Chrysemys picta dorsalis*	Any fresh water body
Corn Snake	*Elaphe guttata guttata*	Woods, lots, and rocky areas
Eastern Diamond Back Rattlesnake	*Crotalus adamanteus*	Dry thickets
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	Meadows, marshes
Eastern Indigo Snake	*Drymarchon corais couperi*	Near thickets of dense natural vegetation
Scarlet Kingsnake	*Lampropeltis triangulum elapsoides*	Near woodland habitats
Southern Ringneck Snake	*Diadophis punctatus punctatus*	Near swamps, springs, and damp woods
Mangrove Water Snake	*Natrix fasciata compressicauda*	Salt or brackish water
Mud Snake	*Farancia abacura*	Swamps and lowlands
Yellow Rat Snake	*Elaphe obsoleta quadrivittata*	Extremely variable
South Eastern Fivelined Skink	*Eumeces inexpectatus*	On spoil banks
Brown Anole	*Anolis sagrei*	On ground near shrubs
Green Anole	*Anolis carolinensis carolinensis*	Shrubs and vines
Cuban Tree Frog	*Hyla septentrionalis*	Hides near moisture

Table 2. A list of Reptiles and Amphibians observed in the Turkey Point Study Area for 1979. (cont'd)

COMMON NAME	SCIENTIFIC NAME	PREFERRED HABITAT
Green Tree Frog	*Hyla cinerea*	Swamps, borders of lakes and streams
Southern Toad	*Bufo terrestris*	Sandy soils

Table 3. A list of Mammals observed in the Turkey Point Study Area for 1979.

COMMON NAME	SCIENTIFIC NAME	PREFERRED HABITAT
Black Rat	*Rattus rattus*	Buildings and occasionally in fields
Bobcat	*Lynx rufus*	Swamps
Cat	*Felis domestica*	Associated with man
Dog	*Canis familiaris*	Associated with man
Marsh Rabbit	*Sylvilagus palustris*	Berms, swamps, and hammocks
Raccoon	*Procyon lotor*	Along streams, berms

Table 4. A comparison of the Turkey Point Study Area Bird species to the Surrounding Area species for 1978 and 1978.

	1978	1979	Surrounding Area
American Bittern	X		X
American Coot	X	X	
American Goldfinch			X
American Kestrel	X	X	X
American Redstart			X
Anhinga			X
Bald Eagle	X	X	X
Barn Owl		X	
Barn Swallow	X	X	X
Belted Kingfisher	X	X	X
Black-bellied Plover	X		X
Black-crowned Night Heron			X
Black-necked Stilt	X		
Black Skimmer	X		X
Black Vulture	X	X	
Black-poll Warbler	X		X
Black-whiskered Vireo			X
Blue-gray Gnatcatcher	X		X
Blue Jay			X
Blue-winged Teal	X		
Boat-Tailed Grackle		X	X
Bobolink	X		X
Broadwinged Hawk	X	X	
Brown Pelican	X	X.	X
Cape May Warbler		X	
Cardinal	X	X	X
Caspian Tern		X	X
Cattle Egret	X	X	X
Cedar Waxwing			X
Chuck-Will's Widow			X
Clapper Rail			X
Common Crow	X	X	
Common Egret	X	X	X
Common Flicker			X
Common Grackle	X		X
Common Nighthawk	X	X	X
Common Snipe			X
Common Starling		X	
Common Tern		X	
Double-Crested Cormorant	X	X	X
Downy Woodpecker			X
Eastern Meadowlark	X		X
Eastern Phoebe			X
Florida Gallinule	X		
Glossy Ibis			X

Table 4. A comparison of the Turkey Point Study Area Bird
(CONT'D) species to the Surrounding Area species for 1978 and 1979.

	1978	1979	Surrounding Area
Gray Kingbird	X		X
Great Blue Heron	X	X	X
Great White Heron	X	X	
Green Heron	X	X	X
Ground Dove	X	X	
Herring Gull	X	X	X
Hooded Merganser		X	
House Sparrow	X	X	
House Wren	X		X
Killdeer	X	X	X
Laughing Gull	X	X	X
Least Sandpiper		X	
Least Tern	X	X	X
Little Blue Heron	X	X	X
Louisiana Heron	X	X	X
Magnificent Frigatebird	X	X	X
Marsh Hawk	X	X	
Merlin	X		X
Mockingbird	X	X	X
Mottled Duck	X	X	
Mourning Dove	X	X	
Northern Waterthrush	X		X
Osprey	X	X	X
Palm Warbler	X		X
Peregrine Falcon			X
Pie-billed Grebe	X	X	X
Pine Warbler	X		X
Prairie Warbler			X
Red-bellied Woodpecker	X	X	X
Red-brested Merganser	X	X	X
Reddish Egret	X	X	X
Red-shouldered Hawk			X
Red-Tailed Hawk		X	
Red-Winged Blackbird	X	X	X
Ring-Billed Gull	X	X	X
Roseate Spoonbill	X	X	X
Rock Dove	X	X	
Royal Tern		X	X
Sanderling			X
Savannah Sparrow	X		X
Screech Owl	X		X
Semipalmated Plover	X	X	
Sharp-Shinned Hawk			X
Smooth Billed Ani		X	
Snowy Egret		X	X

Table 4. A comparison of the Turkey Point Study Area Bird
(CONT'D) species to the Surrounding Area species for 1978 and 1979.

	1978	1979	Surrounding Area
Spotted Sandpiper		X	
Tree Swallow	X	X	X
Turkey Vulture	X	X	X
White-Crowned Pigeon	X		X
White-Eyed Vireo			X
White Ibis	X	X	
White Pelican	X		X
Willet		X	X
Wood Duck			X
Wood Ibis	X	X	
Wurdemann's Heron		X	
Yellowlegs			X
Yellowthroat	X		X
Yellow-Bellied Sapsucker		X	X
Yellow Billed Cuckoo		X	
Yellow-Crowned Night Heron	X	X	X
Yellow-Rumped Warbler			X
Yellow Shafted Flicker		X	
Yellow Warbler			X

Table 5. A comparison of the Turkey Point Study Area Reptiles and Amphibians for 1978 and 1979 to the Surrounding Area.

	1978	1979	SURROUNDING AREA
American Alligator		X	X
American Crocodile	X	X	X
Atlantic Green Turtle		X	
Bahaman Bark Anole			X
Brown Anole	X	X	
Corn Snake	X	X	X
Cuban Tree Frog		X	X
Eastern Diamond Back Rattlesnake		X	X
Eastern Garter Snake		X	X
Eastern Indigo Snake	X	X	X
Everglades Racer			X
Florida Cricket Frog			X
Florida King Snake		X	
Florida Softshell	X	X	X
Florida Water Snake			X
Green Anole	X	X	X
Green House Frog			X
Green Tree Frog			X
Key West Anole			X
Mangrove Water Snake	X	X	X
Mud Snake	X	X	
Pig Frog			X
Reef Gecko	X		
South Eastern Fivelined Skink	X	X	
Southern Leopard Frog			X
Southern Painted Turtle		X	
Southern Rinkneck Snake		X	
Southern Toad		X	
Yellow Rat Snake		X	

Table 6. A comparison of the Turkey Point Study Area Mammals to the Surrounding Area in species for 1978 and 1979.

	1978	1979	SURROUNDING AREA
Black Rat	X	X	X
Bobcat		X	X
Cotton Rat			X
Domestic Dog		X	
Dolphin			X
Domestic Cat	X	X	X
House Mouse			X
Manatee			X
Marsh Rabbit	X	X	X
Raccoon	X	X	X
Rice Rat			X
White Tailed Deer			X

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2. SAMPLING OF SELECTED SOIL AND FLORA WEST AND SOUTH OF COOLING CANAL SYSTEM (ETS 4.2.2.3)

a. SOIL STUDY (ETS 4.2.2.3)

Introduction

The purpose of the soil study was to conduct limited sampling of soil nutrients to the west and south of the Turkey Point canal system.

Materials and Methods

Soil samples were taken from the midpoint of Transects 1, 3, 5, 7, and 9 (Soil Study Figure 1). A small coring of several grams was taken after removal of the first inch of soil. A second sample was taken 12 inches below the first. All samples were preserved on ice and sent to the laboratory. An acidified sodium chloride extraction procedure was used for nitrite and nitrate procedures (Jackson, 1958). Nitrate was reduced to nitrite by cadmium in the column and the nitrite was analyzed using the diazotization method (APHA, 1976).

Nitrite and nitrate values were reported as nitrogen in μg/g of dry weight of sample (Soil Study Table 1).

Summary and Conclusions

Soil samples were collected and analyzed for nitrite and nitrate. There was no obvious correlation between nitrite and nitrate content and soil depth where samples were collected. Variations in nitrite content at the different sampling points were

negligible (0.16 to 0.42 µg/g dry soil), but variations in the nitrate content were much higher (<0.01 to 0.44 µg/g dry soil).

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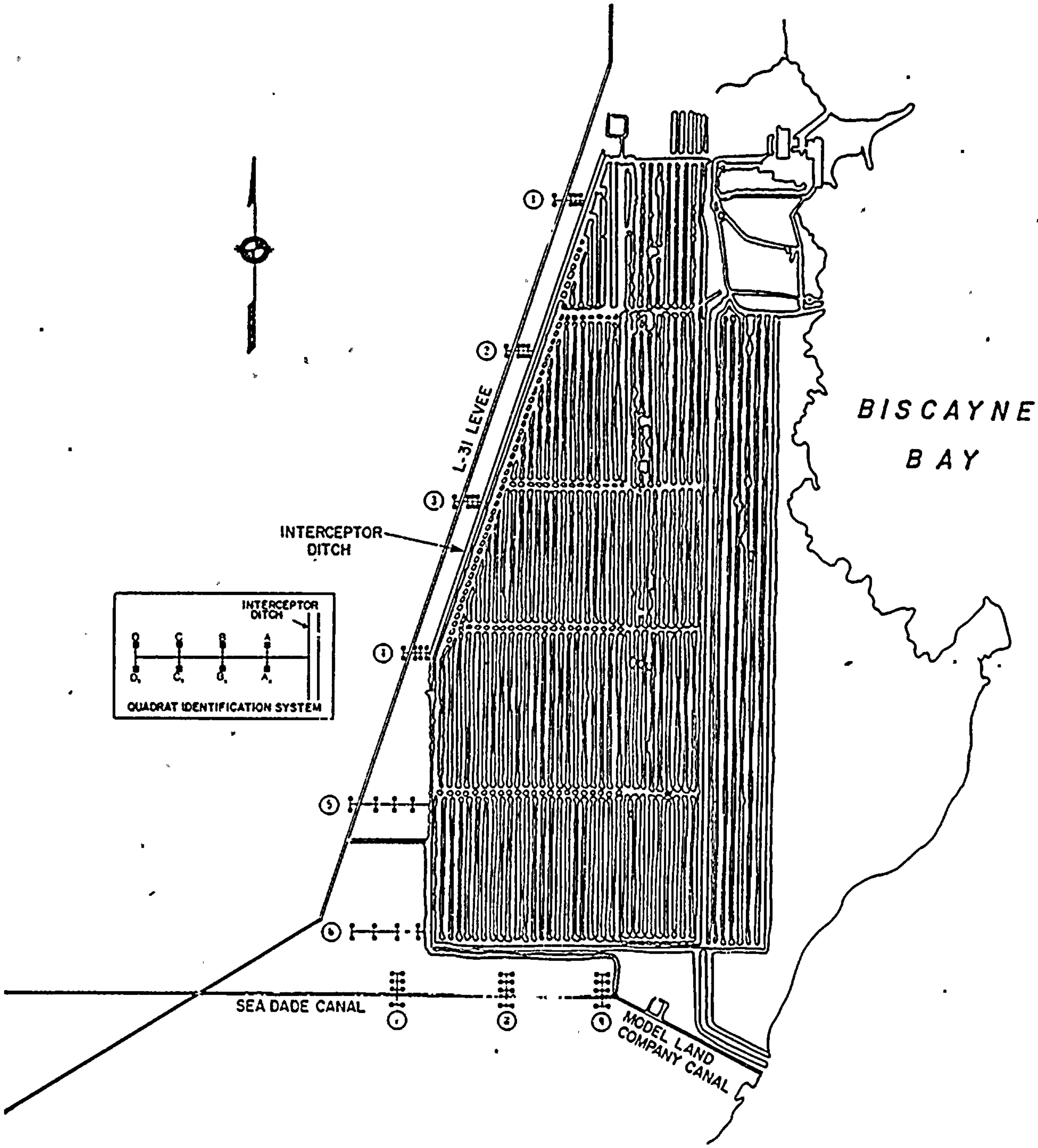

Soil Study Figure 1. Vegetation transects, Turkey Point site, 1979. Soil samples were collected from transects 1, 3, 5, 7, and 9.

SOIL STUDY TABLE 1

LABORATORY ANALYSIS OF 10 SOIL SAMPLES
TURKEY POINT PLANT
DECEMBER 1979

Transect number	Soil depth (in)	Nitrite Nitrogen (µg/g dry soil)	Nitrate Nitrogen (µg/g dry soil)
1	1	0.42	<0.01
	13	0.18	0.24
3	1	0.26	<0.01
	13	0.22	0.44
5	1	0.16	0.18
	13	0.16	0.16
7	1	0.21	<0.01
	13	0.34	<0.01
9	1	0.17	<0.01
	13	0.35	<0.01

b. VEGETATION STUDY (ETS 4.2.2.3)

INTRODUCTION

Background

The Turkey Point Plant and cooling canal system are located on the southeastern coast of Florida, about 37 km south of Miami in Dade County, and encompass an area of approximately 19 km^2. The site is bounded on the northeast by Biscayne Bay and on the southeast by Card Sound (Vegetation Figure 1).

The plant's closed cooling system is a recirculating network of canals which began functioning 18 February 1973. The canal system covers an area of approximately 2430 hectares (ha) of which nearly 64 percent (1560 ha) is water surface and 36 percent (870 ha) is spoil berm. The construction of these saline water-filled canals effectively created a "new" marine habitat extending nearly 7 km into the existing freshwater wetland communities.

South Florida coastal habitats are typically mangrove swamps fringing shallow marine bays. Moving inland, the vegetation gradually changes from one zone to another and eventually ends in freshwater wetlands where saw grass is dominant. The zones of vegetation lie more or less parallel to the shoreline and the vegetation of each successive zone is exposed to a lesser degree of salinity. The amount of salinity to which the vegetation is exposed is determined by the interaction of freshwater runoff resulting from rainfall and saline tidal waters.

The Turkey Point Plant is situated in a region subject to heavy periodic rainfall, approximately 127 to 152 cm per year. The topography of the region is low and flat, thus rainfall drainage is slow. The slight downward slope of the land, approximately 1.8 cm per 100 m, enables the runoff from the inland regions to drain into Card Sound. The volume of runoff resulting from a rainfall depends on the absorbing capacity of the aquifer and the elevation of this site above sea level. During the dry season (November through February) when groundwater levels are low, the aquifer will hold additional water, infiltration of surface water is greater, and runoff is small. During the wet season (March through October) when groundwater levels are near the ground surface, the aquifer has a reduced capacity to store water, and the amount of infiltration is small. Runoff is inhibited because of increased tidal levels in Card Sound. As a result, during the wet season, much of the plant site is covered with standing water that is continuous with tidal waters (Dames and Moore, 1976).

This natural equilibrium between freshwater runoff and tidal waters has been altered by the construction of drainage canals. The South Florida Water Management District's Canal L-31 is located west of the Turkey Point Plant. The Sea Dade Canal and Model Land Canal are located south of the site. These drainage canals were built in the late 1950's and 1960's, before baseline and operational monitoring studies were conducted to document the vegetation of the Turkey Point region. Because plant species respond to

changes in salinity, it is important to understand both the natural vegetation zones and the subsequent changes in freshwater availability that have occurred since drainage canals have directed surface water away from the site.

Purpose of the Study

The purpose of this continuing study is to identify impacts of the Turkey Point Plant cooling canal system operation on vegetation located south and west of the system.

Baseline data were taken prior to canal construction in 1972 to describe vegetation communities present on the site (ABI, 1978a). Additional studies were conducted in ecologically similar habitats at the South Dade site between 1973 and 1976 (ABI, 1978b). These studies provided vegetation data for comparision with post-operational canal system studies at Turkey Point.

Study Design

The study assumes that impacts, if any, on vegetational communities will be observed as a function of distance from the cooling canal system. By comparing biomass (amounts of plant matter) and species composition of vegetation adjacent to the canal system with those farther away from the system, changes, if any, will be readily observed. Samples therefore were taken along transects that originated adjacent to the cooling canal system and extended into the surrounding natural vegetation.

Baseline data were collected from the Turkey Point site (east of the present study area) in 1972. Additional data were collected from the South Dade site (southeast of the present study area) in 1974. These baseline data were used to identify the communities present while the distributions of the vegetational communities across the present study area were determined by the interpretation of aerial photographs. Transect locations were then chosen to provide equal sampling in each of the major vegetational communities on the site.

MATERIALS AND METHODS

Field Methods

Quantitative data have been collected along nine transects during each dry season since 1975. The 1979 data on species composition and biomass were collected in late October 1979. Transects 1 through 6 run east to west adjacent to the western border of the canal system. They have been established so that three transects intersect tree islands and three intersect grasslands. Transects 7 through 9 run north-south adjacent to the southern border of the canal system (Vegetation Figure 1).

All of the transects were specifically selected in order to adequately sample vegetation from each of the three major communities. The dominant vegetational community to the west of the cooling canal system is a grassland characterized by saw grass, salt rush, and salt grass. It is interrupted by the second

community, which consists of tree islands or hammocks characterized by mangrove species and buttonwoods. South of the cooling canal system is the third community which is comprised of mangroves and which occupies the transition zone between the freshwater communities (saw grass prairie) to the west of the study area and the salt-water communities to the east.

To estimate the effect on vegetation of distance from the cooling system, four sampling points were established at predetermined distance intervals along each transect. At each sampling point, two 5x5-m (25-m^2) quadrats are located on opposite sides of the transect line as shown in the insert of Vegetation Figure 1. For example, for the grassland community (transects 1, 3, and 5), quadrats A and A' sample vegetation adjacent to the cooling canal system while quadrats D and D' sample vegetation farthest away from the system. This sampling pattern yields six replicate quadrats at each distance per community.

Because much of the sampled vegetation lay between the drainage canals (L-31, Model Land, and Sea Dade) and the Turkey Point cooling canal system, suitable control quadrats had to be located outside the influence of these systems. Control quadrats for east-west Transects 1 through 5 were located west of Canal L-31; controls for Transect 6 were located east of Canal L-31; controls for the north-south Transects 7 through 9 were located south of the Sea Dade Canal.

Community species composition was estimated by frequency, which is defined as the number of quadrats in which the species occurred divided by the total number of quadrats. The resulting values estimate the probabilities of encountering at least one individual of the species in one quadrat.

Biomass was estimated by a volume-density index developed for this study. This index estimates the volume (height x radius^2) and weights it by the density of individuals within the volume (Vegetation Figure 2). This method is analogous to traditional measures of yield (Greig-Smith, 1964) and shares the advantage of the traditional measures in that it can be determined easily in the field. The volume-density index has the further advantage of allowing comparisons of species with different growth forms.

Statistical Methods

A statistical approach has been adopted to identify the impacts of cooling canal system operation on the vegetation. To facilitate this approach, it is necessary to restate the objectives clearly as questions to be answered (Steele and Torrie, 1960). Specifically, if an impact were to occur as a result of system operation, changes in composition and/or biomass of the vegetational communities could be detected by answering the following questions:

1. Is the change greatest adjacent to the cooling canal system and less farther from the system,

2. Is the change greater this year as compared with previous years,

3. Are both of the above true, that is, does the change increase with time and is it greatest adjacent to the cooling canal system?

If the answer to any one of these questions is affirmative according to the data, the conclusion that an impact has occurred may be drawn. The associated null hypotheses, about which statistical statements of confidence in the conclusion can be made, are:

1. There are no differences between the data at different distances from the cooling system,

2. There are no differences between the data of any one year and that of the previous year(s),

3. The effects of distance and of years are independent; that is, there is no interaction between distance and years.

The statistical test used for composition data was analysis of frequencies with G as the test criterion (Sokal and Rohlf, 1969). For biomass data, the statistical test used was multivariate analysis of variance (SAS, 1979) with the F-ratio as the test criterion. Biomass data are strongly skewed, and biomass changes exponentially so these data were transformed by taking natural logarithms of the values (Sokal and Rohlf, 1969).

The critical region adopted for these tests was chosen to provide 95 percent confidence (α=0.05) about the null hypotheses of no effect. Whenever these criteria were met during this study, the results were designated as "(statistically) significant". The

independent variables for the analyses are 1) distance from the cooling canal system and 2) calendar year in which the data were collected. The dependent variables are 1) frequencies of each species and 2) volume density index for each common species.

In each analysis, the hypotheses were tested using synthetic indices of composition and biomass for each of the major vegetational communities (grassland, tree island, and mangrove). Thus, the critical tests of the hypotheses determined not only statistical significance, as defined above, but also the ecological significance to the ecosystem (Collier et al., 1973). The community index used for the composition data was derived from the Shannon-Weiner diversity index (Watt, 1968). The community index used for the biomass data was derived from Goodall's vector space approach to community analysis (Greig-Smith, 1964). These indices were chosen because they allow an examination of the individual species' contributions to the overall community effects. If a community effect were detected, then individual species were examined to identify the ecological significance of the change in the community.

Although the statistical design was constructed to detect changes attributable to the cooling canal system, the study also may detect impacts caused by some other event. Correct interpretation of the data requires identification of the manner in which vegetation would be affected by different causes. It has been

determined that an impact due to the cooling system would 1) be greater the closer to the source and 2) that its effect on the composition of species would become greater annually. This reasoning was put to the test when, in January 1977, a killing freeze occurred at the Turkey Point site (ABI, 1978c). A statistically significant change in species composition took place between the data collected during the December 1977 sampling program and those of the previous years. The observed change was abrupt both adjacent to and distant from the cooling canal and the effect on the composition of species became smaller, not larger, the following years. Therefore, this change, although statistically significant, cannot be attributed to the cooling canal system.

RESULTS AND DISCUSSIONS

Plant Species at Turkey Point

A total of 177 different plant species (Vegetation Table 1) have been observed in Turkey Point and South Dade studies. The average number of species per study was 64, of which 15 species were present in all studies. Only 20 species had frequencies greater than or equal to 5 percent, including all 15 of the species which have always been present during the study years.

In the 1979 study, 67 species were observed. This value is not significantly different from the average (64 species) for all studies (Pearson and Hartley, 1966). What is significant is that only a small number of species was observed for the first time in 1979 (Vegetation Figure 3).

From 1974 through 1976, a decreasing number of new species was observed each year. In a stable plant community, this would be expected because a small number of the more uncommon species might be discovered with each year's sampling effort. In 1977, however, the number of new species increased, suggesting a change in the previously stable plant communities. During the past 2 years, the number of species observed for the first time has again steadily decreased. This phenomenon indicates that the composition of species at Turkey Point has reached a new, post-freeze stability.

Community Composition, 1979 Study

The community composition in 1979 was significantly different from the composition of the communities combined over the previous 4 years. Therefore, additional data analysis is required to determine whether the observed impact is attributable to the cooling canal system or to some other cause.

To eliminate the effects of the freeze of 1977, the data from the previous 4 years were separated into the pre-freeze years (1975 and 1976) and the post-freeze years (1977 and 1978). The community composition in 1979 was significantly different from the pre-freeze composition and was not different from the post-freeze composition (Vegetation Table 2).

In order to identify the ecological implications of the above results, each species' contribution to the over-all difference be-

tween 1979 and the pre-freeze years was examined (Vegetation Figure 4; Vegetation Table 2). Eight species showed significant differences between 1979 and the pre-freeze years. Although the frequencies of aster, leather fern, and sea daisy were significantly different before and after the freeze, their frequencies in 1979 apparently are returning to values observed before the freeze. For salt grass, cabbage palm, and Brazilian pepper, an abrupt change took place between 1976 and 1977. But because no change has been exhibited since then, the change cannot be attributed to the cooling canal system. It probably represents the effects of the freeze.

On the other hand, clubrush and blechnum fern have shown increasing amounts of change with time. Therefore, the change in frequency for both clubrush and blechnum fern is attributable to the cooling canal system. Blechnum fern is intolerant of saline conditions (Long and Lakela, 1971), while all of the species which have become more frequent since the freeze (clubrush, aster, sea daisy, and salt grass) are salt tolerant. This suggests that a possible mechanism for the impact of the cooling canal system is a change in the salinity adjacent to the system. Only one species, groundsel, showed a significant difference between 1979 and the previous post-freeze years. This species was absent in 1975 through 1977, and was more frequent in 1979 than in 1978. It too is a salt-tolerant species.

The observed significant difference between the composition of the vegetation in 1979 and the composition of the vegetation in previous years was attributed primarily to the freeze of 1977. For those species which had a significant contribution to the observed difference between the community composition in 1979 and the pre-freeze years, there appears to be a pattern in which only the salt-tolerant species are recovering from the effects of the freeze.

Community Composition, Comparison With Baseline

The community composition for 1979 was significantly different from the community composition for both the 1972 Turkey Point baseline study and for the 1974 South Dade baseline study. To detect the onset of this difference, the community composition for the first year of the operational monitoring program (1975) was compared to both of the baseline studies. The community composition for the 1975 Turkey Point study was also significantly different from both baseline studies. Because this study occurred before the 1977 freeze, the differences between the 1979 data and the baseline data cannot be attributed to this natural event.

In order to determine the ecological implications of the above results, the common species' contributions to the differences between the operational monitoring data and the baseline data were examined (Vegetation Table 3). Generally, the saw grass prairie (and associated hammocks) species--saw grass, buttonwood, cabbage palm, and blechnum fern--had higher frequencies in the Turkey Point

operational monitoring data than in the baseline data. On the other hand the salt-tolerant species--red mangrove, salt grass and leather fern--had higher frequencies in the baseline studies than in the operational monitoring studies. These differences remained consistent throughout all of the data, rather than increasing with time as predicted. Therefore, the observed significant differences in the community composition between the operational monitoring studies and the baseline studies cannot be attributed to the cooling canal system.

The differences are probably due to the geographic differences among the studies. The Turkey Point operational monitoring studies were located further from the shoreline than either the Turkey Point baseline study or the South Dade baseline study. Thus, the observed differences in the data are probably due to the differences in vegetation zones represented in the study areas.

Biomass, 1979 Study

Vegetation volume-density indices by transect are presented in Vegetation Tables 4 through 6. These data were combined with all of the previous data for the 12 most common species (whose frequencies are greater than 10 percent) and used for the long-term analysis (Vegetation Table 7). These species accounted for approximately 70 percent of the observations.

Analysis of biomass for a single year is valuable only for the information it conveys in detecting long-term trends.

Biomass, Long-Term Analysis

Community biomass differed significantly between years. Therefore, to identify the ecological implications, each species' contributions to this observed difference were examined.

Five species showed significant differences between years. Of these, four species--saw grass, buttonwood, red mangrove, and leather fern--decreased in biomass (Vegetation Figure 5) by a factor of 10 between 1976 and 1977. The saw grass, buttonwood, and red mangrove biomass increased somewhat between 1978 and 1979. The biomass of leather fern remained consistent between 1978 and 1979. The fifth species, aster, showed a significant change in biomass. Rare prior to 1977, aster has become established and is maintaining a low biomass. Each of the significant changes in individual species biomass between years represents an abrupt change between December 1976 and December 1977. Therefore, the observed changes reflect not only the impact of the freeze of January 1977 but also each species' ability to recover or to invade following this natural event.

Biomass of each of the three communities did not show a significant difference between quadrats adjacent to the cooling canal system and those quadrats farther away. However, the biomass of

some of the common species did show ecologically significant differences with distance from the cooling canal system.

Four species--Australian pine, saw grass, rush, and leather fern--showed significant differences between distances (Vegetation Figure 6). Australian pine is an introduced species spreading rapidly in south Florida (Long and Lakela, 1971). Such successfully introduced species tend to colonize disturbed land, such as the dikes within the cooling system. The biomass of Australian pine was greatest adjacent to the system and decreased with distance from it. This probably represents an expansion of the species from the disturbed land of the cooling system into the surrounding natural vegetation.

In part, the change in saw grass biomass with distance from the cooling system was caused by the rarity of this species in the southern-most mangrove community quadrats. Because saw grass is a freshwater wet prairie species (Long and Lakela, 1971), and these quadrats are on the most seaward portion of the transects, the absence of saw grass is not surprising. However, saw grass also had less biomass in the quadrats closest to the cooling system, particularly in the grassy transects. This effect appears to have become more pronounced with time.

Not only was the biomass of this freshwater species reduced near the cooling system, but also the biomass of two salt-tolerant

species was increased adjacent to the cooling system. Rush and leather fern are salt flat and brackish coastal hammock species, respectively (Long and Lakela, 1971). The observed change in species biomass suggests an increase in the salinity of the water adjacent to the cooling system. When all species are considered together as a single ecosystem, this change in saw grass, rush and leather fern did not significantly affect community structure. Therefore, it appears that the operation of the cooling system has affected the vegetation although the magnitude of this effect is small.

SUMMARY AND CONCLUSIONS

A total of 177 different plant species have been observed in the various Turkey Point and South Dade studies. Examination of the number of species observed for the first time each year revealed that there have been no major changes in the species list since the change that occurred between December 1976 and December 1977, following the freeze of January 1977.

Community composition showed a significant change attributable to the freeze of 1977. There was evidence in the 1979 study that salt-tolerant species had recovered from the freeze. However, the presence of brackish water in the cooling canal system may have affected the ability of other less-salt tolerant vegetation to recover from natural disturbances.

Community composition from the 1979 operational monitoring study was significantly different from both the 1972 Turkey Point baseline data and from the 1974 South Dade baseline data. Analysis of the contribution of individual species to the observed differences revealed that these differences could be accounted for by the differences in the distances of the three study areas from the shoreline. The baseline data showed higher frequencies for salt-tolerant species and lower frequencies for salt-intolerant species than did the operational monitoring data. This difference is primarily caused by differences in the vegetation zones in which the two studies were located.

Two significant differences were detected in the biomass data. These differences were between years from the closing of the cooling canal system in 1973 to the present, and between sampling points adjacent to and distant from the cooling canal system.

The biomass of five species differed significantly over time. These differences reflect the impact of the freeze of 1977 and the ability of these species to recover from this natural event.

Four species showed significant differences with distance from the cooling canal system. The biomass of Australian pine was higher adjacent to the cooling system but this species appears to be spreading from the disturbed land of the spoil banks into the surrounding natural vegetation. Saw grass, a freshwater species,

showed lower biomass adjacent to the cooling canal system. In the transects where saw grass was reduced, two salt-tolerant species, rush and leather fern, showed higher biomass than elsewhere. Thus, it appears that the operation of the cooling system has affected the vegetation by increasing salinities adjacent to the western perimeter of the cooling canals. The magnitude of this effect is small compared to the effect of natural events such as the freeze of 1977.

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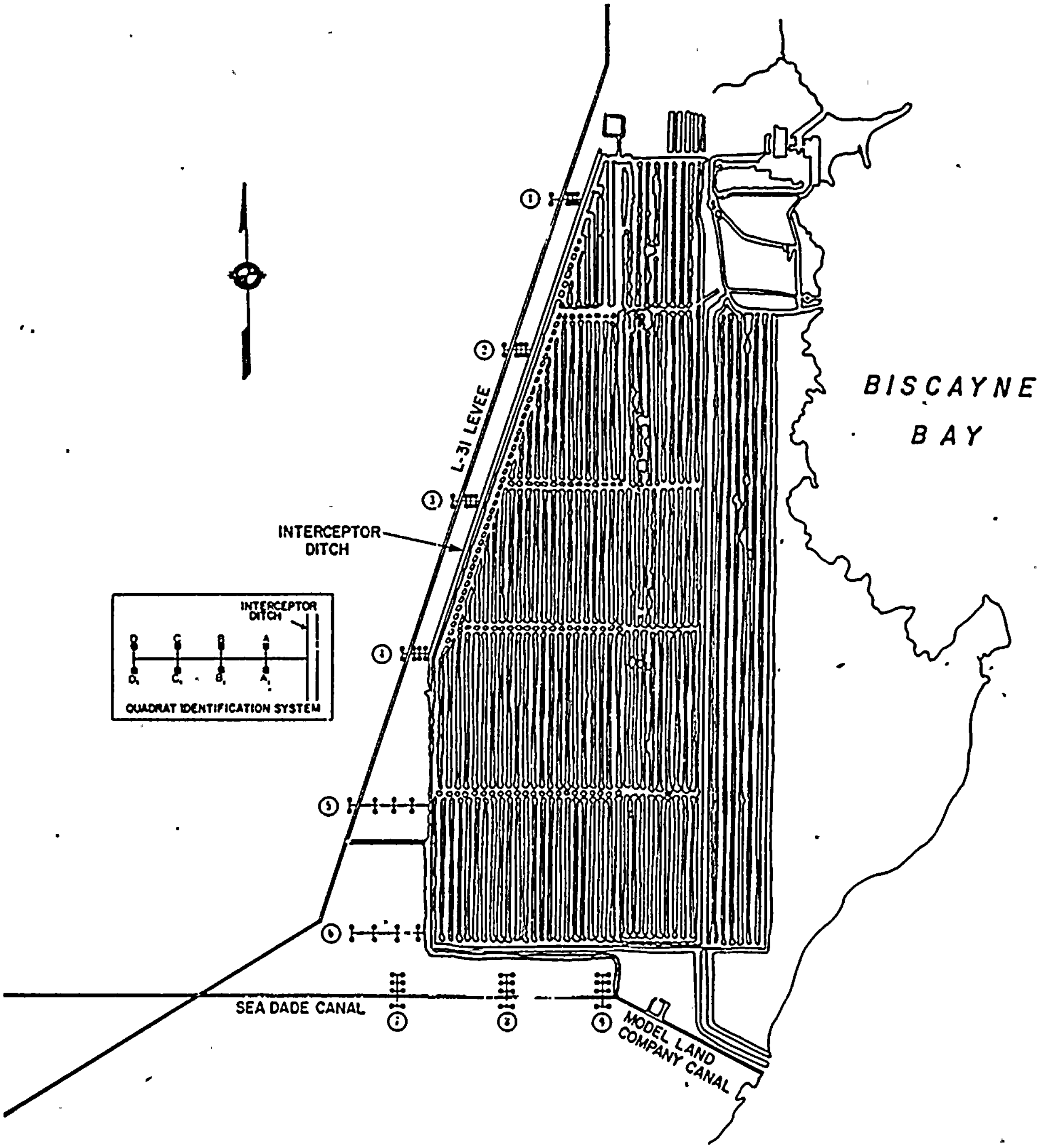


Vegetation Figure 1. Location of vegetation sampling transects. Turkey Point site, 1979.

Example 1. Saw grass (Cladium sp.)

$$\underline{\text{Cladium}}\ \text{index} = \frac{N.H.R^2}{A}$$

where:

A = Area of sample in meters

N = Number of graminoid samples

H = Height of grass blades in cm

R = Radius of clumps in cm (gathered, compressed, and measured at widest point).

sample values

A = 1.0

N = 240

H = 142.2

R = 1.59

$$\text{Cladium Index} = \frac{(240)(142.2()2.52)}{1.0} = 86{,}002.56$$

Example 2. Woody shrub (Conocarpus)

$$\underline{\text{Conocarpus}}\ \text{index} = N.H.R^2$$

where:

N = Number of shrubs of same dimensions

H = Shrub height in cm

R = Maximum radius of trunk

sample values

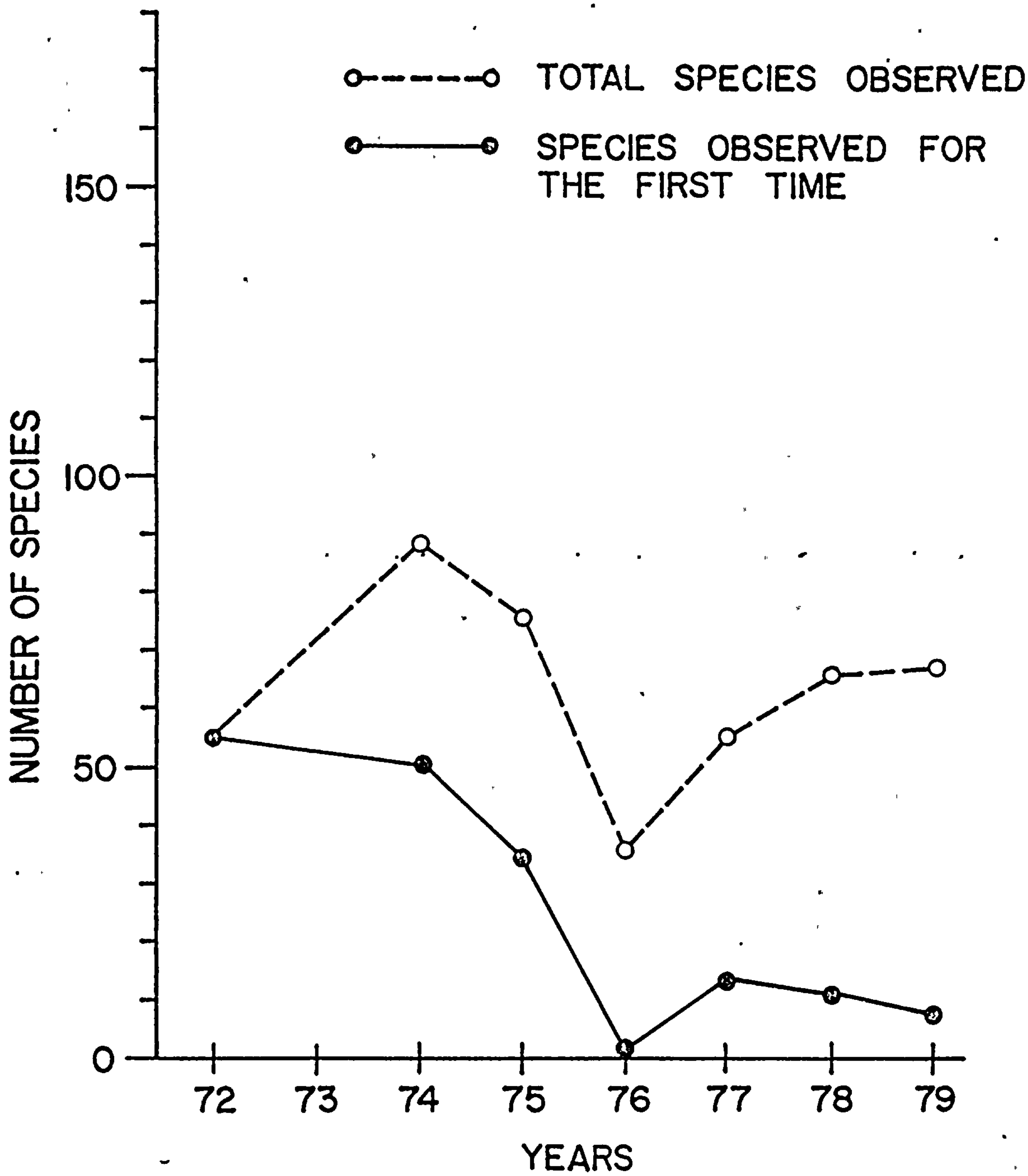
N = 1.0

H = 365.8

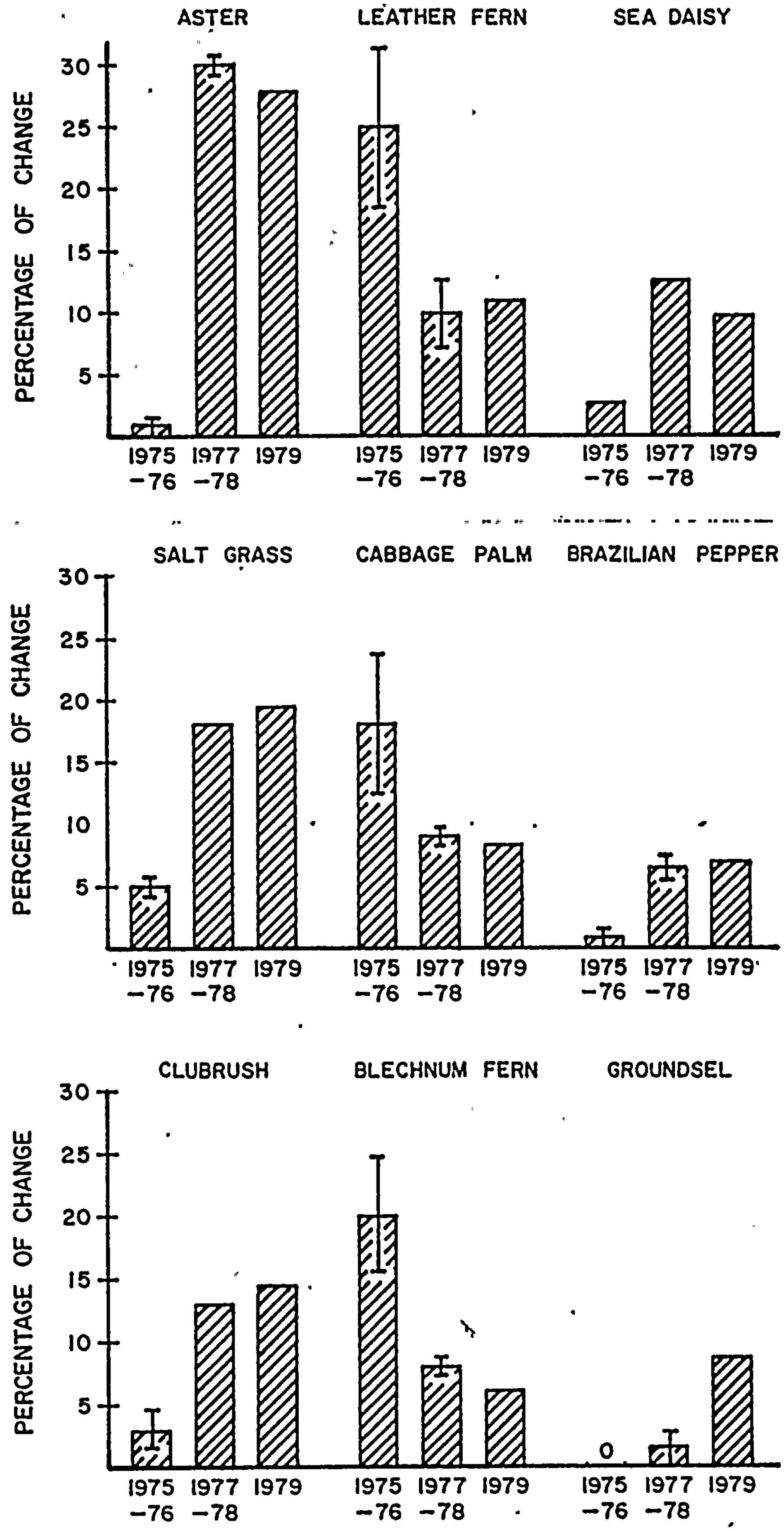
R = 6.45^2

Conocarpus Index = (1.0)(365.8)(6.45) = 15,218.19

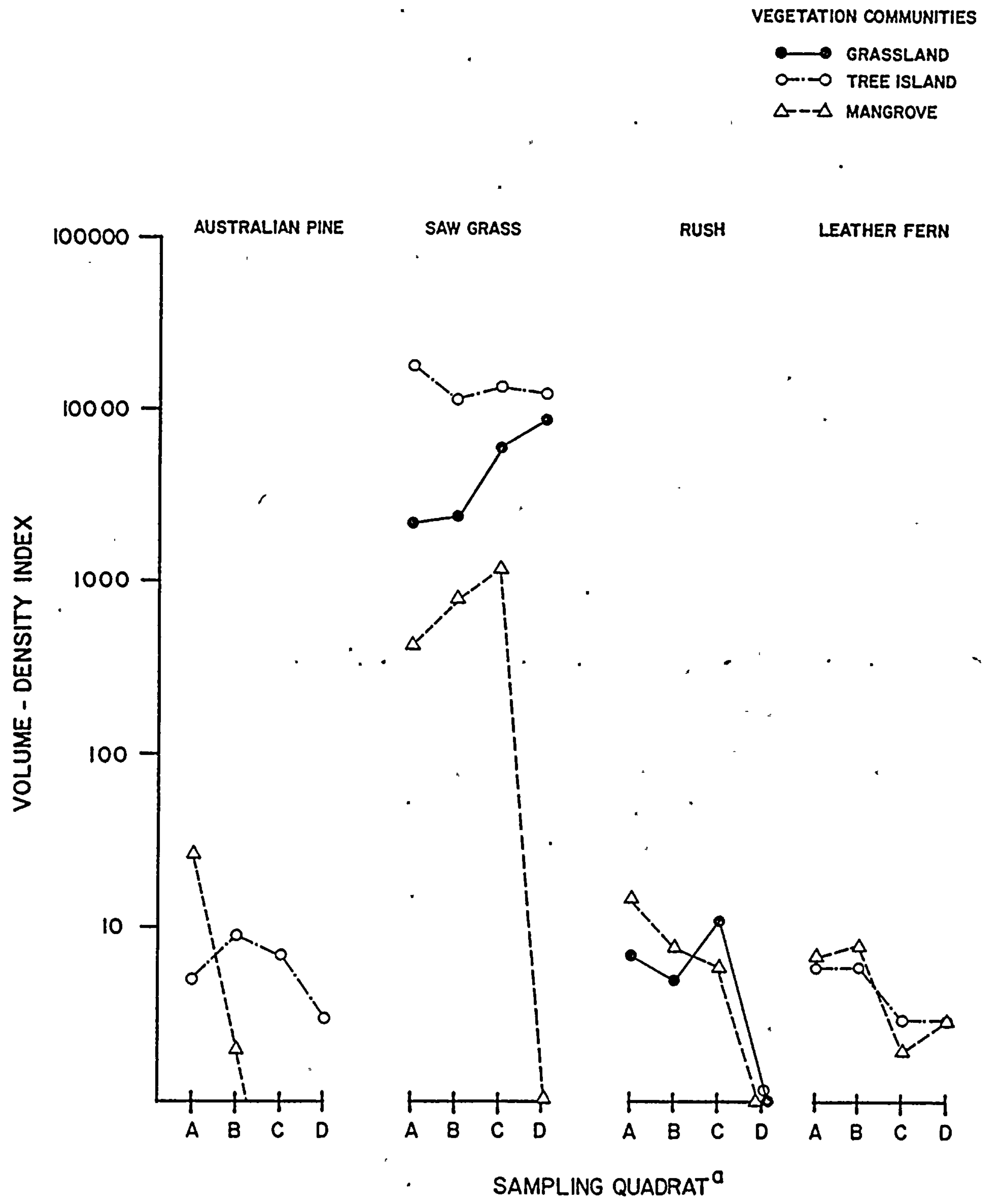
Vegetation Figure 2. Examples of volume-density index calculations of a graminoid and woody plant species, Turkey Point Plant, 1979.



Vegetation Figure 3. Number of plant species observed, Turkey Point Plant, 1975-1979.



Vegetation Figure 4. Mean percentage and range of significant changes in the frequencies of selected species, Turkey Point Plant, 1975-1979.



[a]Sampling quadrats A through D represent sampling points of increasing distance from the cooling canal system; A is adjacent to the cooling canal, D is farthest from it (see Vegetation Figure 1.

Vegetation Figure 6. Comparisons of average biomass for selected species with increasing distances from the cooling canal system, Turkey Point Plant, 1975-1979.

VEGETATION TABLE 1

PLANT SPECIES OBSERVED AND FREQUENCY OF OCCURRENCE
TURKEY POINT PLANT
1972-1979

Species	Common name	Frequency (%)							
		1972	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	Mean
Acrostichum aureum	leather fern	15.9	10.0	30.6	18.1	6.9	12.5	11.1	15.0
Agalinis sp.	false foxglove	2.4	-	-	-	-	-	-	0.3
Annona glabra	pond apple	3.7	3.3	1.4	1.4	-	-	-	1.4
Ardisia escallonoides	marlberry	-	-	-	-	4.2	-	-	0.6
Asclepias sp.	milkweed	3.7	0.5	-	-	-	-	-	0.6
Aster sp.	aster	-	0.5	-	-	30.6	29.2	27.8	12.6
Aster tenuifolius v. aphyllus	aster	-	-	1.4	-	-	-	-	0.2
Avicennia germinans (Avicennia nitida)[d]	black mangrove	-	5.2	1.4	-	4.2	-	2.8	1.9
Baccharis sp.	groundsel, saltbush	-	-	4.2	-	11.1	4.2	-	2.8
B. angustifolia	false willow	1.2	7.1	1.4	-	-	5.6	4.2	2.8
B. dioica	groundsel	-	-	-	-	-	-	1.4	0.2
B. glomeruliflora	groundsel tree	-	-	-	-	-	4.2	4.2	1.2
B. halimifolia	groundsel	12.2	6.2	1.4	-	-	2.8	8.3	4.4
Bacopa monnieri	water hyssop	-	-	1.4	-	-	-	-	0.2
Batis maritima	saltwort	-	4.3	1.4	-	-	-	-	0.8
Blechnum serrulatum	blechnum fern	9.8	5.2	23.6	15.3	6.9	8.3	5.6	10.7
Borrichia arborescens	sea oxeye daisy	-	1.4	-	-	-	1.4	-	0.4
B. frutescens	sea daisy	6.1	16.2	2.8	2.8	12.5	12.5	9.7	8.9
Bucida spinosa	spiny bucida	-	-	1.4	-	-	-	-	0.2
Cakile fusiformis	sea rockets	-	-	-	-	1.4	-	-	0.2
Calopogon sp.	grass pink	-	0.5	-	-	-	-	-	0.1
Calyptranthes pallens	pale lidflower	-	-	1.4	-	-	-	-	0.2
Cassytha filiformis	love vine, dodder	-	-	1.4	-	-	-	2.8	0.6
Casuarina equisetifolia	Australian pine	12.2	5.7	13.9	12.5	8.3	12.5	9.7	10.7
Celtis laevigata	hackberry	-	-	1.4	-	-	-	-	0.2
Cephalanthus occidentalis	buttonbush	-	4.8	-	1.4	1.4	-	-	1.1
Chamaesyce sp.	spurge	-	-	-	-	-	1.4	-	0.2
Chiococca alba	snowberry	4.9	5.2	5.6	-	4.2	-	5.6	3.6
Chloris sp.	finger grass	-	0.5	-	-	-	-	-	0.1
Chrysobalanus icaco	coco plum	1.2	1.9	4.2	6.9	-	4.2	-	2.6
Cladium jamaicensis (Mariscus jamaicensis)	saw grass	74.4	44.3	83.3	80.6	81.9	86.1	84.7	76.5
Coccothrinax argentata	silver palm	-	-	1.4	-	-	-	-	0.2
Cocos nucifera	coconut palm	1.2	-	-	-	-	-	-	0.2
Colubrina elliptica (Colubrina reclinata)	nakedwood	2.4	-	-	-	-	-	-	0.3
Conocarpus erecta	buttonwood	65.9	30.5	77.8	76.4	70.8	77.8	73.6	67.5
Crinum americanum	string lily	-	2.4	1.4	1.4	-	-	-	0.7
Cuscuta sp.	dodder	1.2	2.4	-	-	-	1.4	-	0.7
Cuscuta americana	dodder	-	0.5	-	-	-	-	-	0.1
Cyanchum palustre	vine milkweed	-	2.4	-	-	-	-	-	0.3
CYPERACEAE	sedge	-	-	-	-	1.4	1.4	-	0.4
Dalbergia amerimnon (Dalbergia brownii)	(no common name)[e]	-	1.4	-	-	-	-	-	0.2
D. ecastophyllum	(no common name)	-	-	-	1.4	-	-	-	0.2
Dichromena floridensis	(no common name)	-	-	-	-	-	1.4	-	0.2
Dipholis salicifolia	bustic	-	-	1.4	1.4	4.2	1.4	1.4	1.4
Distichilis spicata	salt grass	20.7	49.0	4.2	5.6	18.1	18.1	19.4	19.3
Eleocharis sp.	clubrush, spikerush	1.2	1.0	-	-	-	-	-	0.3
Eleocharis cellulosa	clubrush, spikerush	1.2	-	1.4	4.2	12.5	12.5	13.9	6.5
Eleusine indica	yard grass	-	1.0	-	-	-	-	-	0.1
Encyclia tampensis	butterfly orchid	-	-	1.4	-	-	-	-	0.2
Eugenia sp.	(no common name)	-	-	-	-	-	-	1.4	0.2
E. axillaris	white stopper	2.4	-	1.4	2.8	1.4	-	-	1.1
E. confusa	ironwood	-	-	-	-	-	2.8	-	0.4
E. myrtoides (Eugenia buxifolia)	Spanish stopper	2.4	-	-	-	-	1.4	1.4	0.7

VEGETATION TABLE 1
(continued)
PLANT SPECIES OBSERVED AND FREQUENCY OF OCCURRENCE
TURKEY POINT PLANT
1972-1979

Species	Common name	Frequency (%)							
		1972	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	Mean
Eulophia alta	wild coco	-	-	1.4	-	-	-	-	0.2
Eupatorium capillifolium	dog fennel	-	7.1	1.4	-	1.4	5.6	1.4	2.4
Ficus aurea	strangler fig	-	-	2.8	-	-	-	-	0.4
F. citrifolia	wild banyan tree	3.7	3.8	1.4	1.4	-	-	-	1.5
Fimbristylis sp.	sedge	-	-	1.4	-	2.8	-	-	0.6
Flaveria sp.	(no common name)	-	-	-	-	-	-	1.4	0.2
Forestiera segregata	Florida privet	-	-	-	-	2.8	-	1.4	0.6
Fuirena sp.	umbrella grass	1.2	0.5	-	-	-	-	-	0.2
F. scirpoidea	umbrella grass	1.2	3.3	-	-	1.4	-	1.4	1.0
Galium hispidulum	bedstraw	-	-	1.4	-	-	-	-	0.2
G. obtusum	bedstraw	-	-	-	-	-	-	1.4	0.2
Hydrocotyle umbellata	marsh pennywort	-	3.3	-	-	-	-	-	0.5
Hypericum sp.	St. John's wort	-	-	-	-	6.9	6.9	-	2.0
Ilex cassine	dahoon holly	6.1	5.2	4.2	5.6	2.8	1.4	1.4	3.8
Ipomoea sp.	morning glory	2.4	-	-	-	-	-	-	0.3
I. sagittata	glades morning glory	-	4.3	5.6	-	8.3	20.8	1.4	5.8
Jacquemontia curtissii	(no common name)	-	-	-	-	2.8	-	2.8	0.8
J. reclinata	(no common name)	-	-	-	-	-	4.2	-	0.6
Juncus roemerianus	rush	15.9	17.6	22.2	13.9	13.9	19.4	22.2	17.9
Kosteletzkya virginica	salt marsh willow	-	0.5	-	-	-	-	-	0.1
Lachnanthes caroliniana	red root	-	0.5	-	-	-	-	-	0.1
Laguncularia racemosa	white mangrove	9.8	34.8	23.6	30.6	41.7	33.3	29.2	29.0
Lantana involucrata	lantana	-	0.5	-	1.4	2.8	2.8	1.4	1.3
L. microcephala	lantana	-	-	-	-	-	-	1.4	0.2
Lippia nodiflora	capeweed	-	1.0	-	-	-	-	-	0.1
Ludwigia sp.	(no common name)	-	-	-	-	-	-	1.4	0.2
L. microcarpa	water purslane	-	-	1.4	-	-	-	-	0.2
L. peruviana	primrose willow	-	1.0	-	-	-	-	-	0.1
L. repens	water purslane	-	-	-	-	-	5.6	4.2	1.4
Lycium carolinianum	Christmas berry	-	-	2.8	2.8	-	-	-	0.8
Lythrum alatum	loosestrife	-	-	-	-	-	-	1.4	0.2
Magnolia virginiana	sweet bay, swamp bay	-	3.8	2.8	-	2.8	1.4	1.4	1.7
Metopium toxiferum	poisonwood	4.9	1.9	2.8	4.2	8.3	8.3	8.3	5.5
Mikania batatifolia	hemp vine	-	-	1.4	-	-	5.6	-	1.0
M. scandens	climbing hempvine	4.9	4.8	-	-	1.4	1.4	1.4	2.0
Myrica cerifera	wax myrtle	4.9	5.2	5.6	9.7	6.9	6.9	5.6	6.4
Myrsine guianensis (Rapanea guianensis)	myrsine	4.9	5.7	4.2	5.6	5.6	8.3	6.9	5.9
Nectandra coriacea	lancewood	-	-	1.4	-	-	-	-	0.2
Nephrolepis biserrata	Boston fern	-	-	2.8	-	-	-	-	0.4
N. exaltata	Boston fern	-	0.5	-	-	-	-	-	0.1
Osmunda cinnamonea	royal fern	-	0.5	-	-	-	-	-	0.1
O. regalis v. spectabilis	royal fern	-	2.4	1.4	-	-	-	-	0.5
Panicum sp.	panic grass	-	-	1.4	-	-	-	-	0.2
P. dichotomum	panic grass	-	-	-	-	-	-	1.4	0.2
Parthenocissus quinquefolia	Virginia creeper	4.9	4.8	1.4	-	-	-	-	1.6
Paspalum sp.	(no common name)	-	3.3	-	-	-	-	-	0.5
Passiflora suberosa	corky-stemmed passion flower	-	-	-	-	1.4	1.4	-	0.4
Peltandra virginica	(no common name)	-	2.4	-	-	-	-	-	0.3
Penstemon sp.	beardtongue	-	0.5	-	-	-	-	-	0.1
Persea borbonia	red bay	4.9	-	5.6	5.6	4.2	1.4	1.4	3.3
P. palustris	swamp bay	-	3.3	-	-	-	-	-	0.5
Phlebodium sp.	golden polypody	-	-	-	-	-	1.4	1.4	0.4
P. aureum	golden polypody	4.9	-	1.4	-	-	-	-	0.9
Phyllanthus	(no common name)	-	-	-	-	-	-	1.4	0.2

VEGETATION TABLE 1
(continued)
PLANT SPECIES OBSERVED AND FREQUENCY OF OCCURRENCE
TURKEY POINT PLANT
1972-1979

Species	Common name	Frequency (%) 1972	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	Mean
Pinguicula pumila	butterwort	-	-	-	-	1.4	1.4	-	0.4
Pisonia sp.	cockspur	-	-	-	-	2.8	-	-	0.4
P. aculeata	devil's claw	-	-	2.8	-	-	-	-	0.4
P. discolor (*Torrubia longifolia*)	blolly, beef tree	1.2	-	-	-	-	4.2	1.4	1.0
Pithecellobium unguis-cati	catclaw	1.2	-	-	-	-	-	-	0.2
Pluchea purpurascens	camphorweed	2.4	-	1.4	1.4	1.4	-	-	0.9
P. rosea	marsh fleabane	-	6.2	-	-	-	1.4	-	1.1
Polygala sp.	milkwort	-	0.5	-	-	-	-	-	0.1
Polygala cruciata	milkwort	-	-	-	-	1.4	-	-	0.2
P. grandiflora	milkwort	-	1.4	1.4	-	-	-	-	0.4
Polygonum sp.	knotweed, smartweed	-	1.0	-	-	-	-	-	0.1
Pontederia lanceolata	pickerelweed	-	0.5	-	1.4	-	-	-	0.3
Proserpinaca sp.	mermaid weed	-	-	-	-	1.4	4.2	2.8	1.2
P. palustris	swamp mermaid	-	4.3	-	-	-	-	1.4	0.8
Psilotum nudum	whisk fern	-	-	1.4	-	-	-	-	0.2
Psychotria ligustrifolia	wild coffee	-	-	-	-	-	-	1.4	0.2
Pteris vittata	brake fern	-	-	1.4	-	-	-	1.4	0.4
Randia aculeata	white indigoberry	-	0.5	-	-	1.4	4.2	2.8	0.9
Rhexia sp.	meadow beauty	1.2	0.5	-	-	-	-	-	0.2
R. mariana	meadow beauty	-	-	-	-	-	1.4	1.4	0.4
Rhizophora mangle	red mangrove	50.0	46.2	36.1	50.0	29.2	31.9	33.3	39.5
Rhus sp.	sumac	-	-	-	-	-	1.4	-	0.2
Rhynchospora sp.	beak rush	-	-	1.4	-	-	-	-	0.2
Sabal palmetto	cabbage palm	13.4	4.3	23.6	12.5	8.3	9.7	8.3	11.4
Sabatia sp.	marsh pink	4.9	1.0	-	-	-	-	-	0.8
S. grandiflora	marsh pink	-	-	-	-	1.4	-	1.4	0.4
Salicornia virginica (*Salicornia perrenis*)	perennial glasswort	-	8.6	1.4	-	1.4	2.8	2.8	2.4
Salix caroliniana (*Salix longipes*)	coastal plain willow	-	2.9	1.4	-	-	1.4	1.4	1.0
Samolus ebracteatus	water pimpernel	-	-	1.4	-	1.4	-	-	0.4
Sarcostemma clausa	white vine	-	-	1.4	-	-	-	-	0.2
Schinus terebinthifolius	Brazilian pepper	6.1	5.7	1.4	-	6.9	5.6	6.9	5.0
Schoenus nigricans	(no common name)	-	1.0	-	-	6.9	6.9	8.3	3.3
Serenoa repens	saw palmetto	1.2	1.0	-	1.4	-	-	-	0.5
Sesuvium maritimum	sea purslane	-	-	5.6	4.2	-	-	-	1.4
S. portulacastrum	sea purslane	1.2	6.2	-	-	-	-	-	1.1
Setaria sp.	foxtail grass	-	0.5	-	-	-	-	-	0.1
Smilax sp.	briar	3.7	-	-	-	-	-	-	0.5
S. auriculata	earleaf briar	-	-	1.4	-	-	-	-	0.2
S. bona-nox	green briar	-	0.5	-	-	-	-	-	0.1
S. laurifolia	bamboo vine	-	1.4	-	-	-	-	-	0.2
Solanum blodgettii	nightshade	-	-	20.8	13.9	19.4	20.8	18.1	13.3
S. erianthum (*Solanum verbascifolium*)	potato tree	13.4	8.1	-	-	-	-	-	3.1
Solidago microcephala	goldenrod	-	-	-	-	-	1.4	-	0.2
S. tortifolia	goldenrod	-	-	-	-	1.4	-	-	0.2
Sophora tomentosa	necklace pod	-	0.5	1.4	-	-	-	-	0.3
Stenandrium sp. (*Gerardia* sp.)	(no common name)	1.2	-	-	-	-	-	-	0.2
Suriana maritima	bay cedar	-	0.5	-	-	-	-	-	0.1
Swietenia mahagoni	West Indian mahogany	1.2	0.5	-	2.8	2.8	2.8.	2.8	1.8
Talinum sp.	flame flowers	-	-	-	-	1.4	-	-	0.2
T. paniculatum	flame flower	-	2.4	-	-	-	-	1.4	0.5
Thelypteris sp.	(no common name)	1.2	-	-	-	-	2.8	2.8	1.0
T. augescens	(no common name)	-	-	1.4	-	-	-	-	0.2
Tillandsia balbisiana	air plant	-	0.5	-	-	-	-	-	0.1

VEGETATION TABLE 1
(continued)
PLANT SPECIES OBSERVED AND FREQUENCY OF OCCURRENCE
TURKEY POINT PLANT
1972-1979

Species	Common name	Frequency (%)							
		1972	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	Mean
T. circinata	air plant	-	-	-	-	2.8	4.2	1.4	1.2
T. fasciculata	air plant	-	-	1.4	-	-	-	-	0.2
T. flexuosa	twisted air plant	-	-	1.4	2.8	2.8	4.2	-	1.6
T. utriculata	air plant	2.4	-	-	-	-	-	-	0.4
T. valenzuelana	soft-leaf air plant	-	-	1.4	-	-	-	-	0.2
Toxicodendron radicans	poison ivy	6.1	7.1	1.4	-	-	2.8	1.4	2.7
Trema lamarkiana	West Indian trema	7.3	2.9	1.4	1.4	-	-	-	1.9
T. micrantha	Florida trema	4.9	2.9	-	-	-	1.4	1.4	1.5
Typha sp.	cattail	-	-	-	2.8	1.4	2.8	2.8	1.4
T. domingInensis	southern cattail	-	0.5	-	-	-	-	-	0.1
Vanilla inodora	scentless vanilla	-	0.5	-	-	-	-	-	0.1
Verbena bonariensis	vervain	-	1.9	-	-	-	-	-	0.3
Vitis rotundifolia	muscadine grass	2.4	5.7	1.4	-	-	4.2	2.8	2.4
Vittaria lineata	shoestring fern	3.7	-	1.4	-	-	1.4	-	0.9
Xyris sp.	yellow-eyed grass	-	-	-	-	-	1.4	1.4	0.4
X. brevifolia	yellow-eyed grass	-	-	-	-	-	4.2	-	0.6
Zanthoxylum fagara	wild lime	-	0.5	-	-	-	-	-	0.1
TOTAL NUMBER OF SPECIES OBSERVED ANNUALLY		56	88	76	36	56	66	67	
CUMULATIVE NUMBER OF SPECIES OBSERVED		56	105	138	140	155	167	177	

[a]Turkey Point site prior to construction of the cooling canal system (ABI, 1978a.)

[b]South Dade site adjacent to the cooling canal system (ABI, 1978b.)

[c]Turkey Point site, annual operational monitoring (ABI 1976, 1977, 1978c, 1979.)

[d]The name in parentheses is a synonym for the species preceeding it in the list, according to Long and Lakela (1971). These synonyms appear in some of the cited references.

[e]Long and Lakela (1971) do not give common names for these uncommon species.

VEGETATION TABLE 2

COMPARISONS OF 1979 FREQUENCY DATA WITH PREVIOUS DATA
TURKEY POINT PLANT

Species	Frequencies (%)		
	1975-1976[a]	1977-1978[b]	1979
saw grass (Cladium)	81.9	84.0	84.7
buttonwood (Conocarpus)	80.5	74.3	73.6
red mangrove (Rhizophora)	43.7	30.5	33.3
white mangrove (Laguncularia)	27.1	32.6	29.2
aster (Aster)	0.7*	30.5	27.8
rush (Juncus)	18.0	21.0	22.2
saltgrass (Distichilis)	4.9*	18.1	19.4
nightshade (Solanum)	17.3	20.1	18.1
clubrush (Eleocharis)	2.1*	12.5	13.9
leather fern (Acrostichum)	24.3*	9.7	11.1
Australian pine (Casuarina)	13.2	10.4	9.7
sea daisy (Borrichia)	2.8*	12.5	9.7
cabbage palm (Sabal)	18.0*	9.0	8.3
poisonwood (Metopium)	3.5	8.3	8.3
schoenus (Schoenus)	0.0	6.9	8.3
myrsine (Myrsine)	4.9	6.9	6.9
Brazilian pepper (Schinus)	0.7*	6.7	6.9
blechnum fern (Blechnum)	19.4*	7.6	5.6
wax myrtle (Myrica)	7.6	6.9	5.6
groundsel (Baccharis halimifolia)	0.0	1.4*	8.3

[a]Pre-freeze years.

[b]Post-freeze years.

*Significant difference from 1979 frequencies (G-test, $\alpha<0.05$).

VEGETATION TABLE 3

COMPARISONS OF OPERATIONAL MONITORING DATA WITH BASELINE DATA
TURKEY POINT PLANT
1972 - 1979

Species	Frequencies (%)				G-test			
	1979	1975[a]	1974[b]	1972[c]	79-74	79-72	75-74	75-72
saw grass (Cladium)	84.7	83.3	44.3	74.4	50.65*	4.49	46.87*	3.31
buttonwood (Conocarpus)	73.6	77.8	30.5	65.1	56.59*	1.99	68.36*	4.86*
red mangrove (Rhizophora)	33.3	36.1	46.2	50.0	4.92*	8.16*	33.11*	5.63*
white mangrove (Laguncularia)	29.2	23.6	34.8	9.8	1.04	21.15*	0.23	11.62*
rush (Juncus)	22.2	22.2	17.6	15.9	1.00	1.96	4.23*	1.96
salt grass (Distichilis)	19.4	4.2	49.0	0.7	27.15*	0.07	72.26*	16.52*
leather fern (Acrostichum)	11.1	30.6	10.0	15.9	0.10	1.35	23.22*	9.59*
Australian pine (Casaurina)	9.7	13.9	5.7	12.2	1.81	0.44	6.55*	0.18
sea daisy (Borrichia)	9.7	23.6	16.2	6.1	2.53	1.41	13.75*	1.72
cabbage palm (Sabal)	8.3	23.6	4.3	13.4	2.26	1.81	7.14*	5.46*
poisonwood (Metopium)	8.3	2.8	1.9	4.9	8.79*	1.52	0.02	0.82
Brazilian pepper (Schinus)	6.9	1.4	5.7	6.1	0.19	0.09	0.77	3.99*
blechnum fern (Blechnum)	5.6	23.6	5.2	9.8	0.02	1.71	27.69*	8.75*

[a] Initial operational monitoring data (ABI, 1976).

[b] South Dade baseline data (ABI, 1978b).

[c] Turkey Point baseline data (ABI, 1978a).

*Significant at $\alpha < 0.05$.

VEGETATION TABLE 4

VOLUME-DENSITY INDEX OF GRASSLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Cladium jamaicensis	1	45	2600	64998	0	14943	60579	27×10^6	84218
	3	68365	46242	10208	115925	28929	21687	24798	97384
	5	13526	36885	19817	25919	29×10^7	12413	49786	26585
Conocarpus erecta	1	0	9408	20194	270	28400	9004	1284	4644
	3	0	0	1343	2133	0	614	0	0
	5	2421	0	4783	13546	731	9	740	0
Juncus roemerianus	1	5640	4727	347	2941	10797	278	0	481
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	545	204	0	0
Aster sp.	1	0	0	4	0	0	2	6	0
	3	0	0	14	0	0	2	0	0
	5	0	0	19	2	9	11	2	5
Distichilis spicata	1	14	0	0	3265	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0
Eleocharis cellulosa	1	3785	28987	1257	388	598	56	1204	71
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	9	191
Typha sp.	1	0	0	0	0	11540	1786	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0

VEGETATION TABLE 5

VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Cladium jamaicensis	2	27140	9320	82632	67192	37079	92339	38448	90049
	4	34940	34914	69108	190475	15069	16644	400270	24383
	6	149732	44040	84308	21641	4486	73014	11494	106872
Conocarpus erecta	2	18019	279619	387	2689	28142	0	7446	41625
	4	21379	415	57126	67895	6652	67769	4800	63
	6	1782	0	36000	643	0	3087	3969	369
Rhizophora mangle	2	4769	7695	228	31054	54140	1432	1746	1818
	4	0	7865	0	0	0	0	0	0
	6	17363	0	0	0	0	0	0	0
Laguncularia racemosa	2	175	200	174	5652	16699	13398	0	0
	4	0	0	0	0	42250	6133	0	0
	6	0	0	18029	0	0	0	0	0
Solanum blodgettii	2	0	0	0	0	0	67	0	0
	4	0	575	0	0	6803	2409	145	0
	6	27	40	153	0	720	5	22	476
Acrostichum aureum	2	0	0	0	0	0	14	0	0
	4	0	0	0	1375	0.3	47	0	0
	6	224	0	6684	0	0	0	0	0

VEGETATION TABLE 5
(continued)
VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Aster sp.	2	0	0	0	0	0	0	0	0
	4	3	0	0	0	0	0	0	12
	6	0	0	0	0	0	0	0	0
Blechnum serrulatum	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	931	0.3	0
	6	3791	0	0	0	0	70	0	0
Sabal palmetto	2	0	0	0	0	0	0	0	0
	4	0	0	0	1006720	1089000	0	740600	0
	6	256250	0	303750	0	97200	0	0	0
Casaurina equisetifolia	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	791371	0	0	111132	0	4	10	0
Metopium toxiferum	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	2	0	58	0	11877	19611	17091	51955
Myrsine guianensis	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	2160	0	0	0	1448	744	1319	1242

VEGETATION TABLE 5
(continued)
VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Schinus terebinthifolius	2	0	0	0	0	0	0	0	
	4	0	0	0	0	5	24	0	
	6	0	0	6125	0	104	6125	0	
Myrica cerifera	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	49338	0	0	0	200	0	1249	2011
Baccharis spp.	2	3	0	0	0	0	0	0	4
	4	0	0	0	0.1	853	39	0	0
	6	0	0	0	0	0	189	17	0
Chiococca alba	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	3	0	539	19
Ludwigia repens	2	0	0	0	0	0	9	0	0
	4	0	0	0	0	48	124	0	0
	6	0	0	0	0	0	0	0	0
Proserpinaca sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	2	0	0	3	0	0

VEGETATION TABLE 5
(continued)
VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Swietenia mahagoni	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	119524	1150002	0	0
Thelypteris sp.	2	0	0	0	0	0	0	0	0
	4	42	0	297	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Dipholis salicifolia	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	256000
Eugenia myrtoides	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0.2	0	0
Ilex cassine	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	5	0
	6	0	0	0	0	0	0	0	0
Lantana involucrata	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	294

VEGETATION TABLE 5
(continued)
VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

Species	Transect	Quadrats							
		A1	A2	B1	B2	C1	C2	D1	D2
Magnolia virginiana	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	8750	0	0	0
Mikania scandens	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	12	0	0
	6	0	0	0	0	0	0	0	0
Phlebodium sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	2	0	0	0
Rhexia mariana	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	8	0	0
	6	0	0	0	0	0	0	0	0
Salix caroliniana	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	864	0	0	0
	6	0	0	0	0	0	0	0	0
Toxicodendron radicans	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	2	0	0

VEGETATION TABLE 5
(continued)
VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Trema micrantha	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	438	0	0	0
Galium obtusum	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	7500	0
Persea borbonia	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	1378	0	0
Lantana microcephala	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	941	0
Ranchia aculeata	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	1	0	707
Pisonia discolor	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	369	0	0

VEGETATION TABLE 5
(continued)
VOLUME-DENSITY INDEX OF TREE ISLAND TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Psychotria ligustrifolium	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	27
Eupatorium capillifolium	2	0	0	0	0	0	0	0	0
	4	0	19	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Pteris vittata	2	4	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Panicum dichotonium	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	4	0
	6	0	0	0	0	0	0	0	0
Forestiera seggregata	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	4	0	0	0	0
Eugenia myrtoides	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0.1	0	0

VEGETATION TABLE 6

VOLUME-DENSITY INDEX OF MANGROVE TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Cladium jamaicensis	7	45645	11461	38239	46975	5532	64175	0	35
	8	3847	10220	46264	84124	7532	7465	0	0
	9	0	0	0	0	120	0	0	0
Conocarpus erecta	7	0	661	0	6934	1773	1454	198	15336
	8	1040	2368	42209	10778	25936	9506	0	0
	9	24321	0	377	0	3052	2628	0	0
Rhizophora mangle	7	0	0	0	0	0	0	0	0
	8	0	23	38400	577	0	1764	263	3645
	9	346800	37726	25942	104418	4269	33837	40509	116615
Laguncularia racemosa	7	0	0	0	0	0	0	5	22
	8	0	0	0	37289	0	6573	133	11591
	9	14497	5632	0	852	0	242	1206	7209
Solanum blodgettii	7	0	0	0	0	0	0	0	0
	8	0	0	0	2239	0	0	0	0
	9	0	0	0	0	0	0	0	0
Juncus roemerianus	7	0	0	0	0	0	0	0	0
	8	3838	1659	13596	0	13106	0	0	0
	9	0	0	0	0	0	0	0	0

VEGETATION TABLE 6
(continued)
VOLUME-DENSITY INDEX OF MANGROVE TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Acrostichum aureum	7	0	0	0	0	0	0	0	0
	8	0	0	0	2852	0	0	0	0
	9	84933	0	0	0	0	0	0	0
Aster sp.	7	1	1	0	0	0.5	9	0	37
	8	0	0	0	0	0	0	0	0
	9	0	1	6	0	0	0	0	0
Casaurina equisetifolia	7	0	0	0	0	0	0	0	0
	8	37066	900000	0	532400	0	0	0	0
	9	0	0	0	0	0	0	0	0
Distichilis spicata	7	0	0	0	0	0	0	350	2406
	8	0	0	0	0	0	0	755	2237
	9	0	88	85	168	103	357	371	1129
Borrichra frutescens	7	0	0	0	0	0	0	13	107
	8	0	0	0	0	0	0.1	0	10
	9	593	0	22	0	0	37	0	0
Schoenus nigricans	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	527	0	0
	9	0	1971	374	711	506	1425	0	0

VEGETATION TABLE 6
(continued)
VOLUME-DENSITY INDEX OF MANGROVE TRANSECTS
TURKEY POINT CANAL SYSTEM
1979

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Baccharis spp.	7	0	0	7	0	0	0	0	0
	8	0	0	0.1	0	0	2	0	0
	9	0	0	0	0	0	0	0	0
Avicennia germinans	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	47	654
	9	0	0	0	0	0	0	0	0
Salicornia virginica	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	113	8
	9	0	0	0	0	0	0	0	0
Sabbatia grandiflora	7	0	0	0	0	0	0	0	0
	8	0	1	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0
Lythrum alatum	7	0	0	0	0	0	0	0	0
	8	0	1	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0

VEGETATION TABLE 7

LONG-TERM ANALYSIS OF VARIANCE FOR THE 12 MOST COMMON SPECIES[a]
TURKEY POINT PLANT
1975 - 1979

Species	F-ratio		
	Years[b]	Distance[c]	Year x distance
saw grass (Cladium)	4.62*	5.60*	0.14
buttonwood (Conocarpus)	6.76*	1.44	1.13
red mangrove (Rhizophora)	5.09*	0.50	0.69
white mangrove (Laguncularia)	1.49	0.53	1.06
nightshade (Solanum)	1.02	0.74	0.47
rush (Juncus)	1.54	3.94*	0.51
leather fern (Acrostichum)	4.16*	6.79*	1.14
aster (Aster)	6.06*	1.14	0.75
blechnum fern (Blechnum)	1.86	1.93	0.48
cabbage palm (Sabal)	2.52	0.93	1.01
Australian pine (Casuarina)	0.25	6.94*	0.94
salt grass (Distichilis)	2.35	2.17	0.25
Degrees of freedom	4	3	12

*Significant at $\alpha<0.05$.

[a]Analysis of variance does not indicate whether the biomass increased or decreased over time or with distance. That information is obtained by examination of each species (see text).

[b]A significant value (*) indicates a change in biomass from 1975 to 1979.

[c]A significant value (*) indicates a change in biomass between vegetation adjacent to the cooling canal system and that farther away from the system.

3. ANNUAL AERIAL PHOTOGRAPH ANALYSIS (ETS 4.2.2.1)

The 1979 color infrared aerial photograph of the Turkey Point cooling canal system shows healthy and vigorous vegetative growth along the canal embankments and in the areas to the east, south, and west of the canal system. The canal bank vegetation is primarily exotic Australian pine and herbaceous ground cover species that stabilize the spoil berms. These species are adapted to the environmental conditions found on the canal banks. Salt-tolerant mangrove swamps fringe Biscayne Bay to the east of the canal system, and moving inland to the west, freshwater wetland species dominated by sawgrass are found.

A comparative analysis of the 1978 and 1979 aerial photographs shows:

1. Little or no change in vegetative cover on embankments within the cooling canal system or in the areas to the east, south, and west of the canal system.
2. The growth pattern of canal bank vegetation continues to follow a hydrologic gradient which originates to the west of the canal system.

In summary, no major changes in vegetation growth have occurred between 1978 and 1979. Revegetation of the Turkey Point canal banks by native species continues at a slow rate.

IV. CHANGES IN SURVEY PROCEDURES (ETS 5.4.1.(3))

A. BENTHOS & PLANKTON SAMPLE STATION RELOCATION

Due to a rocky substrate at sample station RC-0, benthic sampling at this location has not been possible. Beginning in 1980, sampling station RC-0 for benthos and plankton will be relocated approximately 1,000 feet to the northeast. Fish and shellfish sampling will remain at the old station RC-0, because the new RC-0 station has swift current and strong eddies which prevents proper "setting" of the gill net.

B. COOLING CANAL SYSTEM TEMPERATURE MONITORING

A complete new primary temperature monitoring system for Turkey Point Units 3 and 4 intake and Lake Warren outlet went into operation in mid-December, 1979. The new system significantly upgrades the monitoring of temperatures in the Turkey Point Cooling Canal System and thus, provides more accurate information for temperature monitoring important to plant operation and determination of thermal impact on canal system biota.

V. STUDIES NOT REQUIRED BY THE ETS (5.4.1.(4))

A. DILUTION PUMPING PROJECT

The Turkey Point plant condensers have experienced calcium carbonate scaling to such a degree that the unit efficiencies have been impacted. A dilution test was conducted in 1978 to examine the effectiveness of adding sea water from Card Sound to the cooling canal water as a means of diluting calcium concentration in the cooling water and to reduce the rate of condenser scaling.

Dilution water was pumped over the closure dam into the cooling canal system from Card Sound Canal. It mixed with cooling system water as it flowed north toward the plant intake. Pumping began July 25, 1978 and continued through early November, 1978. Three pumps, each with a normal output of 100 cfs were used; however, this capacity was rarely reached by any of the pumps. Average pumping rates were approximately 200 cfs or less throughout the test.

The groundwater monitoring program was reviewed. with the South Florida Water Management District (SFWMD) prior to initiation of this test and was temporarily augmented for the brief test period. No changes to FPL's official agreement with SFWMD were made.

The results of the effect of the "Dilution Pumping" on the chemistry of the cooling canal system are somewhat inconclusive, since the statements of two independent consultants engaged on the project had differing explanations for the minor changes that did occur in the water chemistry. One consultant stated that the salinity reduction and the increase in canal water level noted during the test were coincidental with the period of dilution pumping. The other consultant concluded that these changes were influenced primarily by rainfall events.

As to the main thrust of the Dilution Pumping Project, (i.e. the decrease of condenser scaling) it was observed that no substantial decrease in scaling of the plant condensers occurred as a direct result of pumping in seawater at the rate of 150 to 200 cfs.

It should be noted that an Amertap System, a continuous mechanical method of condenser tube cleaning, had been installed on Unit No. 3 condensers and was being evaluated at this same period of time. The evaluation of the Amertap System proved satisfactory enough to proceed with the installation of the Amertap System on Unit No. 4.

The Amertap Systems have been performing in a satisfactory manner on both units and, therefore, it is not anticipated, at this time, that any further studies on condenser scaling problems will be necessary.

B. PTP CROCODILE PROGRAM - 1979

A field program to determine the population dynamics and ecology of the American Crocodile, Crocodylus acutus, continued into its third year. Funding for the 1979 work was provided by Florida Power & Light Company and the U. S. Fish and Wildlife Service. The staff biologists of the contractor (Connell, Metcalf & Eddy) also donated field time to this program.

It is estimated that at least sixteen (16) crocodiles reside on or near the Turkey Point property, as determined by sightings, captures and radiotelemetry. All age groups (adults, subadults and hatchlings) are represented in the population, and the animals are known to use the property for feeding, loafing, mating and nesting. One mortality (female adult) was noted on October 26, 1979.

VI. VIOLATIONS OF THE ETS (ETS 5.4.1 (5))

No violations of the ETS occurred during 1979 at the Turkey Point Plant.

VII. REPORTABLE EVENTS, CHANGES TO THE ETS, PERMITS OR CERTIFICATES (ETS 5.0)

None