FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT ANNUAL NON-RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT 1980

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT
ANNUAL NON-RADIOLOGICAL ENVIRONMENTAL
MONITORING REPORT 1980

TABLE OF CONTENTS

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, 1980 through December 31, 1980.

II. ABIOTIC MONITORING

A. Thermal (ETS 3.1.1)

Introduction

This monitoring provides temperature data for the power plant intake and discharge circulating cooling water.

Materials and Methods

Data are collected continuously at each station by an array of three R.T.D.s (Resistance Temperature Devices) and a Leeds and Northrup Speedomax 250 Chart Recorder. The inlet temperature monitoring system is located at the intake canal of Units 3 and 4. The discharge temperature monitoring system is located at the outlet end of the Lake Warren basin (Figure 1). Data are summarized hourly.

Results and Discussion

Tables 1 through 12 present a summary of the Units 3 and 4 inlet and Lake Warren outlet mean condenser cooling water temperatures for the period from January 1, 1980 through December 31, 1980. A comparison of modal temperatures for inlet and outlet appear in Figure 2 and demonstrates the most frequent temperature difference (Δt) across the plant.

Conclusions

The temperature data observed during 1980 showed no unusual occurrences nor did they differ significantly from previous years.

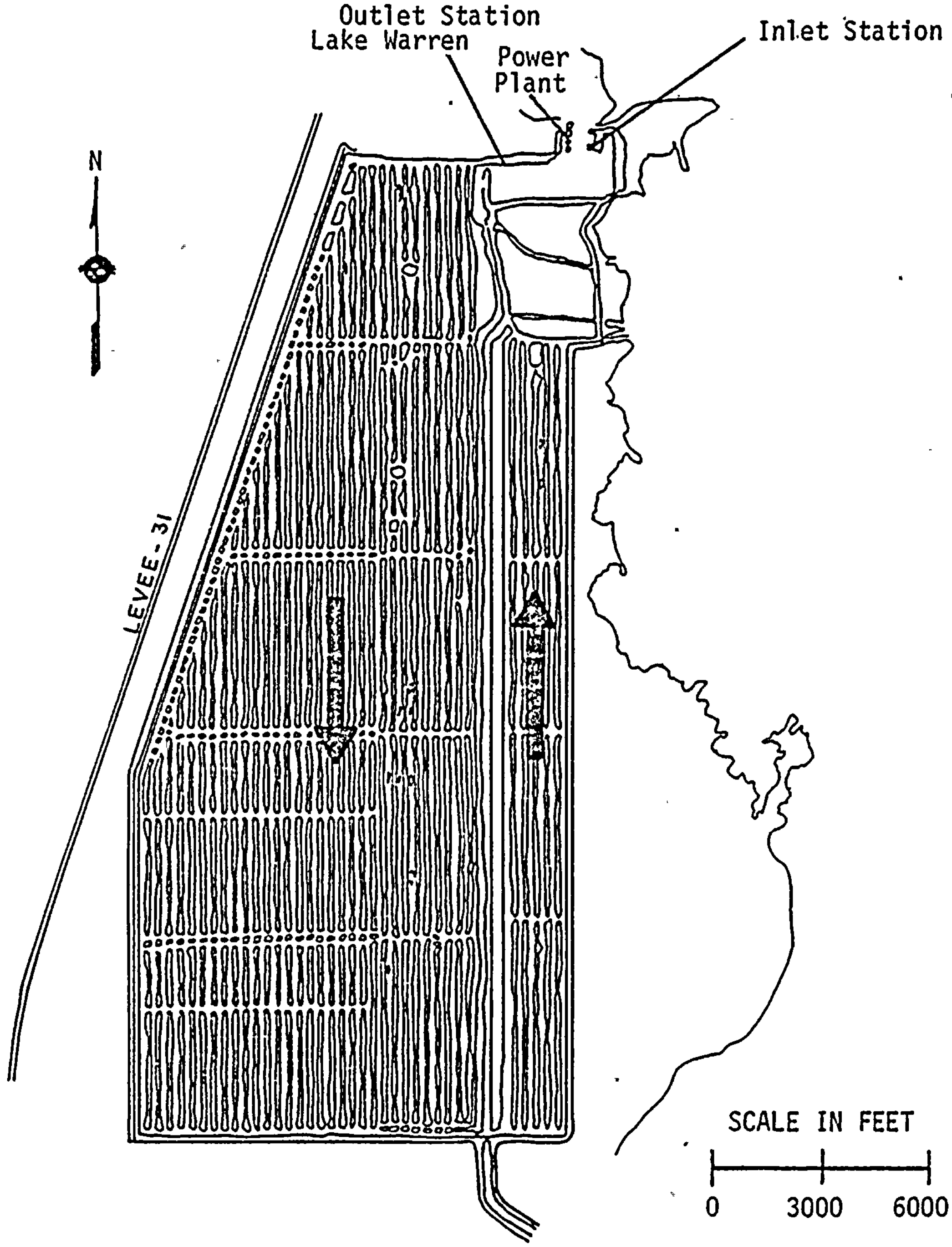


Figure 1. Temperature monitoring stations for the Turkey Point Cooling Canal System 1980.

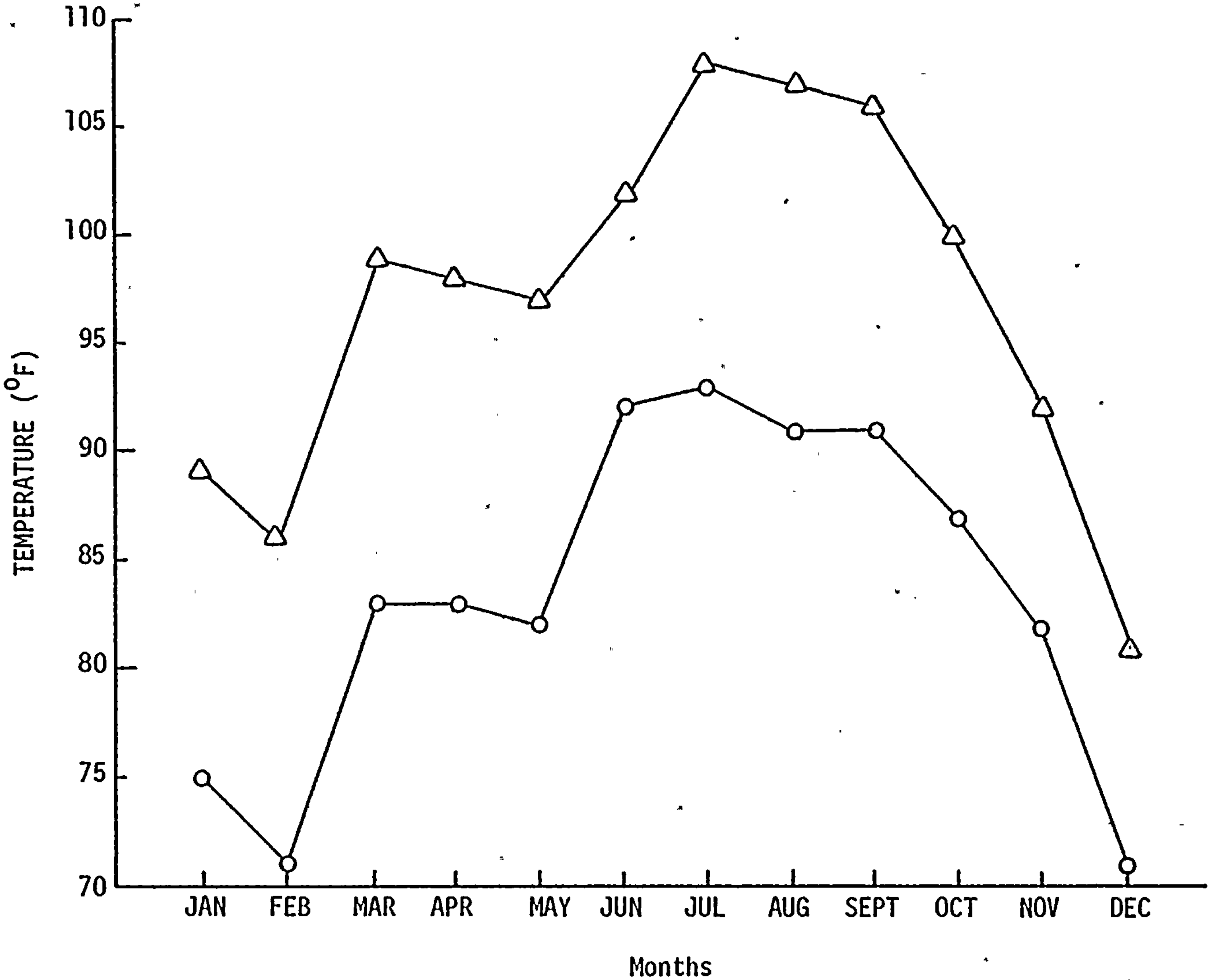


Figure 2. Modal temperatures for inlet (○) and outlet (Δ) by month, Turkey Point Power Plant 1980.

Table 1. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for January 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	81	0.0	0	96	0.0
13	80	1.7	16	95	2.2
39	79	7.0	36	94	7.0
68	78	16.1	44	93	12.9
96	77	29.0	30	92	16.9
73	76	38.8	57	91	24.6
144	75	58.2	83	90	35.8
82	74	69.2	86	89	47.3
21	73	72.0	79	88	57.9
30	72	76.1	29	87	61.8
39	71	81.3	37	86	66.8
42	70	87.0	29	85	70.7
16	69	89.1	42	84	76.3
29	68	93.0	45	83	82.4
21	67	95.8	49	82	89.0
20	66	98.5	29	81	92.9
6	65	99.3	28	80	96.6
5	64	100.0	16	79	98.8
			4	78	99.3
			5	77	100.0

Table 2. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for February 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	85	0.0	0	101	0.0
4	84	0.6	3	100	0.4
17	83	3.0	9	99	1.7
30	82	7.3	17	98	4.2
11	81	8.9	11	97	5.7
19	80	11.6	11	96	7.3
30	79	15.9	22	95	10.5
54	78	23.7	15	94	12.6
38	77	29.2	19	93	15.4
45	76	35.6	17	92	17.8
34	75	40.5	32	91	22.4
53	74	48.1	19	90	25.1
51	73	55.5	39	89	30.7
50	72	62.6	53	88	38.4
55	71	70.5	67	87	48.0
31	70	75.0	71	86	58.2
28	69	79.0	40	85	63.9
39	68	84.6	23	84	67.2
19	67	87.4	10	83	68.7
16	66	89.7	19	82	71.4
17	65	92.1	12	81	73.1
22	64	95.3	44	80	79.5
14	63	97.3	33	79	84.2
16	62	99.6	31	78	88.6

Table 2. (CONT'D) Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for February 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
3	61	100.0	24	77	92.1
			14	76	94.1
			5	75	94.8
			11	74	96.4
			20	73	99.3
			3	72	99.7
			2	71	100.0

Table 3. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for March 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	89	0.0	0	104	0.0
16	88	2.2	17	103	2.3
24	87	5.4	22	102	5.2
32	86	9.7	46	101	11.4
78	85	20.2	88	100	23.3
98	84	33.3	90	99	35.3
109	83	48.0	60	98	43.4
55	82	55.4	71	97	53.0
60	81	63.4	68	96	62.1
58	80	71.2	54	95	69.4
48	79	77.7	45	94	75.4
29	78	81.6	34	93	80.0
22	77	84.5	24	92	83.2
22	76	87.5	26	91	86.7
10	75	88.8	13	90	88.4
6	74	89.7	8	89	89.5
9	73	90.9	5	88	90.2
4	72	91.4	11	87	91.7
5	71	92.1	10	86	93.0
7	70	93.0	5	85	93.7
3	69	93.4	5	84	94.4
8	68	94.5	2	83	94.6
5	67	95.2	2	82	94.9
21	66	98.0	7	81	95.8
3	65	98.4	10	80	97.2

Table 3. Temperature - Time Duration Curves for Turkey Point
(CONT'D) Power Plant's circulating cooling water for March 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
10	64	99.7	4	79	97.7
2	63	100.0	4	78	98.3
			1	77	98.4
			6	75	99.2
			1	74	99.3
			5	73	100.0

Table 4. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for April 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	90	0.0	0	106	0.0
8	89	1.1	9	105	1.3
20	88	3.9	20	104	4.0
40	87	9.5	24	103	7.4
44	86	15.6	28	102	11.3
67	85	25.0	54	101	18.8
96	84	38.4	75	100	29.3
105	83	53.0	88	99	41.6
98	82	66.7	67	98	50.9
70	81	76.4	75	97	61.4
66	80	85.6	58	96	69.5
36	79	90.7	57	95	77.4
31	78	95.0	42	94	83.3
24	77	98.3	19	93	85.9
9	76	99.6	29	92	90.0
3	75	100.0	25	91	93.4
			8	90	94.6
			8	89	95.7
			10	88	97.1
			6	87	97.9
			5	86	98.6
			8	85	99.7
			2	84	100.0

Table 5. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for May 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	90	0.0	0	106	0.0
26	89	3.5	6	105	0.8
55	88	10.9	44	104	6.7
76	87	21.1	69	103	16.0
76	86	31.3	47	102	22.3
61	85	39.5	36	101	27.2
77	84	49.9	80	100	37.9
89	83	61.8	53	99	45.0
112	82	76.9	59	98	53.0
89	81	88.8	83	97	64.1
55	80	96.2	67	96	73.1
28	79	100.0	62	95	81.5
			33	94	85.9
			24	93	89.1
			4	92	89.7
			2	91	89.9
			1	90	90.1
			4	89	90.6
			23	88	93.7
			14	87	95.6
			25	86	98.9
			3	85	99.3
			4	84	99.9
			1	83	100.0

Table 6. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for June 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	95	0.0	0	111	0.0
28	94	3.9	1	110	0.1
72	93	13.9	31	109	4.4
93	92	26.8	48	108	11.1
56	91	34.6	62	107	19.7
60	90	42.9	38	106	25.0
75	89	53.3	67	105	34.3
56	88	61.1	65	104	43.3
60	87	69.4	80	103	54.4
33	86	74.0	53	102	61.8
66	85	83.2	42	101	67.6
66	84	92.4	41	100	73.3
34	83	97.1	42	99	79.2
17	82	99.4	23	98	82.4
4	81	100.0	25	97	85.8
			21	96	88.7
			37	95	93.9
			22	94	96.9
			15	93	99.0
			7	92	100.0

Table 7. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for July 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	97	0.0	0	112	0.0
15	96	2.0	6	111	0.8
52	95	9.0	33	110	5.2
138	94	27.6	95	109	18.0
117	93	43.3	108	108	32.5
78	92	53.8	101	107	46.1
94	91	66.4	107	106	60.5
79	90	77.0	76	105	70.7
73	89	86.8	48	104	77.2
43	88	92.6	52	103	84.1
50	87	99.3	62	102	92.5
5	86	100.0	26	101	96.0
			13	100	97.7
			17	99	100.0

Table 8. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for August 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	96	0.0	0	111	0.0
30	95	4.0	32	110	4.3
86	94	15.6	87	109	16.0
157	93	36.7	111	108	30.9
121	92	53.0	156	107	51.9
161	91	74.6	129	106	69.2
89	90	86.6	80	105	80.0
19	89	89.1	73	104	89.8
49	88	95.7	30	103	93.8
20	87	98.4	19	102	96.4
12	86	100.0	17	101	98.7
			2	100	98.9
			1	99	99.1
			1	98	99.2
			4	97	99.7
			2	96	100.0

Table 9. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for September 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	94	0.0	0	109	0.0
4	93	0.6	39	108	5.4
71	92	10.4	97	107	18.9
171	91	34.2	124	106	36.1
168	90	57.5	118	105	52.5
147	89	77.9	113	104	68.2
70	88	87.6	96	103	81.5
37	87	92.8	45	102	87.8
37	86	97.9	41	101	93.5
15	85	100.0	21	100	96.4
			17	99	98.7
			5	98	99.4
			4	97	100.0

Table 10. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for October 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	93	0.0	0	109	0.0
30	92	4.0	33	108	4.4
47	91	10.4	16	107	6.6
17	90	12.7	25	106	10.0
37	89	17.6	27	105	13.6
54	88	24.9	29	104	17.5
97	87	38.0	45	103	23.6
81	86	48.9	48	102	30.0
81	85	59.8	50	101	36.7
67	84	68.8	71	100	46.3
29	83	72.7	55	99	53.7
53	82	79.8	44	98	59.6
76	81	90.0	46	97	65.8
44	80	96.0	50	96	72.5
26	79	99.5	32	95	76.9
3	78	99.9	49	94	83.4
1	76	100.0	27	93	87.1
			20	92	89.8
			15	91	91.8
			26	90	95.3
			11	89	96.8
			5	88	97.4
			2	87	97.7
			3	86	98.1
			4	85	98.7
			6	84	99.5
			3	83	99.9
			1	7	100.0

Table 11. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for November 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	88	0.0	0	102	0.0
16	87	2.2	12	101	1.7
3	86	2.6	22	100	4.7
3	85	3.1	47	99	11.2
44	84	9.2	43	98	17.2
35	83	14.0	41	97	22.9
99	82	27.8	44	96	29.0
77	81	38.5	29	95	33.1
95	80	51.7	52	94	40.3
38	79	56.9	51	93	47.4
52	78	64.2	53	92	54.7
46	77	70.6	27	91	58.5
17	76	72.9	29	90	62.5
54	75	80.4	33	89	67.1
32	74	84.9	47	88	73.6
33	73	89.4	36	87	78.6
37	72	94.6	31	86	82.9
12	71	96.2	27	85	86.7
3	70	96.7	11	84	88.2
3	69	97.1	7	83	89.2
3	68	97.5	12	82	90.8
11	67	99.0	11	81	92.4

Table 11. Temperature - Time Duration Curves for Turkey Point
(CONT'D) Power Plant's circulating cooling water for November 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
7	66	100.0	6	80	93.2
			3	79	93.6
			4	78	94.2
			3	77	94.6
			2	76	94.9
			10	75	96.2
			15	74	98.3
			8	73	99.4
			4	72	100.0

Table 12. Temperature - Time Duration Curves for Turkey Point Power Plant's circulating cooling water for December 1980.

UNITS 3 & 4 INLET			LAKE WARREN OUTLET		
Number of Hours	Temperature °F	Accumulated Time - %	Number of Hours	Temperature °F	Accumulated Time - %
0	79	0.0	0	94	0.0
22	78	3.0	3	93	0.4
17	77	5.2	15	92	2.4
30	76	9.3	13	91	4.2
62	75	17.6	15	90	6.2
83	74	28.8	42	89	11.8
85	73	40.2	45	88	17.9
63	72	48.7	57	87	25.6
111	71	63.7	37	86	30.6
76	70	73.9	50	85	37.3
21	69	76.7	60	84	45.4
30	68	80.8	51	83	52.2
58	67	88.6	45	82	58.3
39	66	93.8	80	81	69.0
12	65	95.4	57	80	76.7
22	64	98.4	41	79	82.2
9	63	99.6	39	78	87.5
3	62	100.0	22	77	90.4
			23	76	93.5
			15	75	95.6
			6	74	96.4
			12	73	98.0
			6	72	98.8
			6	71	99.6
			3	70	100.0

Table 13. Inlet and outlet circulating cooling water for Turkey Point Power Plant from 1975 through 1980.

	MAXIMUM INLET TEMPERATURE						MAXIMUM OUTLET TEMPERATURE					
MONTH	1975	1976	1977	1978	1979	1980	1975	1976	1977	1978	1979	1980
January	86	80	75	78	78	80	99	96	90	91	90	95
February	89	83	82	77	82	84	101	98	99	90	93	100
March	92	86	85	86	81	88	102	102	103	101	94	103
April	90	86	84	87	87	89	101	102	100	101	102	105
May	92	87	91	92	89	89	105	105	105	108	103	105
June	96	90	94	95	92	94	110	106	109	111	108	110
July	94	94	93	96	96	96	109	111	110	111	112	111
August	93	94	94	94	95	95	109	110	111	108	112	110
September	93	92	95	92	91	93	108	108	110	106	107	108
October	89	89	92	91	91	92	104	104	108	104	108	108
November	82	83	84	87	88	87	97	96	100	100	103	101
December	80	83	84	86	83	78	97	97	97	99	95	93

B. Chemical Concentrations (ETS 3.1.2)

Introduction

This monitoring provides data bases for the determination of water quality and compliance with chemical limits set forth for the cooling canal water.

Materials and Methods

Monthly grab samples were taken at the discharge side of the plant at the outlet from Lake Warren (Figure 1) and analyzed for copper, zinc, and chemical oxygen demand (COD). Copper and zinc were analyzed using a Perkin-Elmer Model 306 Atomic Absorption Spectrophotometer (EPA, 1979). COD's were analyzed using techniques outlined in Standard Methods (APHA, 1975).

Weekly grab samples were taken at the same location and analyzed for pH, dissolved oxygen and salinity (Table 1). The instruments used were an Orion Model 401 Ion Analyzer, Y.S.I. polarographic probe/oxygen meter and American Optical T/C refractometer respectively.

Results and Discussion

The results of the 1980 chemical monitoring program for copper, zinc and COD are given in Table 1. Copper and zinc are further compared with data from 1976 through 1980 in Figures 2 and 3. COD data for 1979-1980 are presented in Figure 4.

These comparisons demonstrate that no unusual levels of copper or zinc were observed during 1980. On the average the COD values for 1980 were lower than those reported for 1979 but they were within the ranges reported for 1977 through 1979 (FPL, 1979).

The values for pH have increased from 7.9 in 1975 to 8.0 in 1980. Dissolved oxygen continues to fluctuate inversely with power plant loading i.e. electrical generation per unit time. Salinity has increased slowly over the years from a yearly average of 36.5 o/oo in 1975 to 42.1 o/oo in 1980.

Table 2 reports the quantities of chemicals used in the operation of Units 3 and 4. The assumption is that ultimately they 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 listed quantities of chemicals are based on plant chemical usage from which only estimates of chemicals discharged to the canal system can be determined since wastewater is transported in aqueous solution through neutralizing and settling ponds, where processes of sedimentation, neutralization and precipitation are carried out before discharge.

Two adjacent fossil units also discharged similar water treatment related chemicals to the canal system, although in lesser quantities than from Units 3 and 4.

LITERATURE CITED

APHA-AWWA-WPCF. 1975. Standard methods for the examination of water and wastewater. 14th ed. APHA Wash. D.C. 1193 pp.

Florida Power & Light Co. 1979. Turkey Point Units 3 & 4 non-radiological environmental monitoring report no. 13. Miami, Florida.

U.S. Environmental Protection Agency Environmental Monitoring and Support Laboratory. 1979. Methods for chemical analysis of water and wastes. EPA. Cincinnati, Ohio. 430 pp.

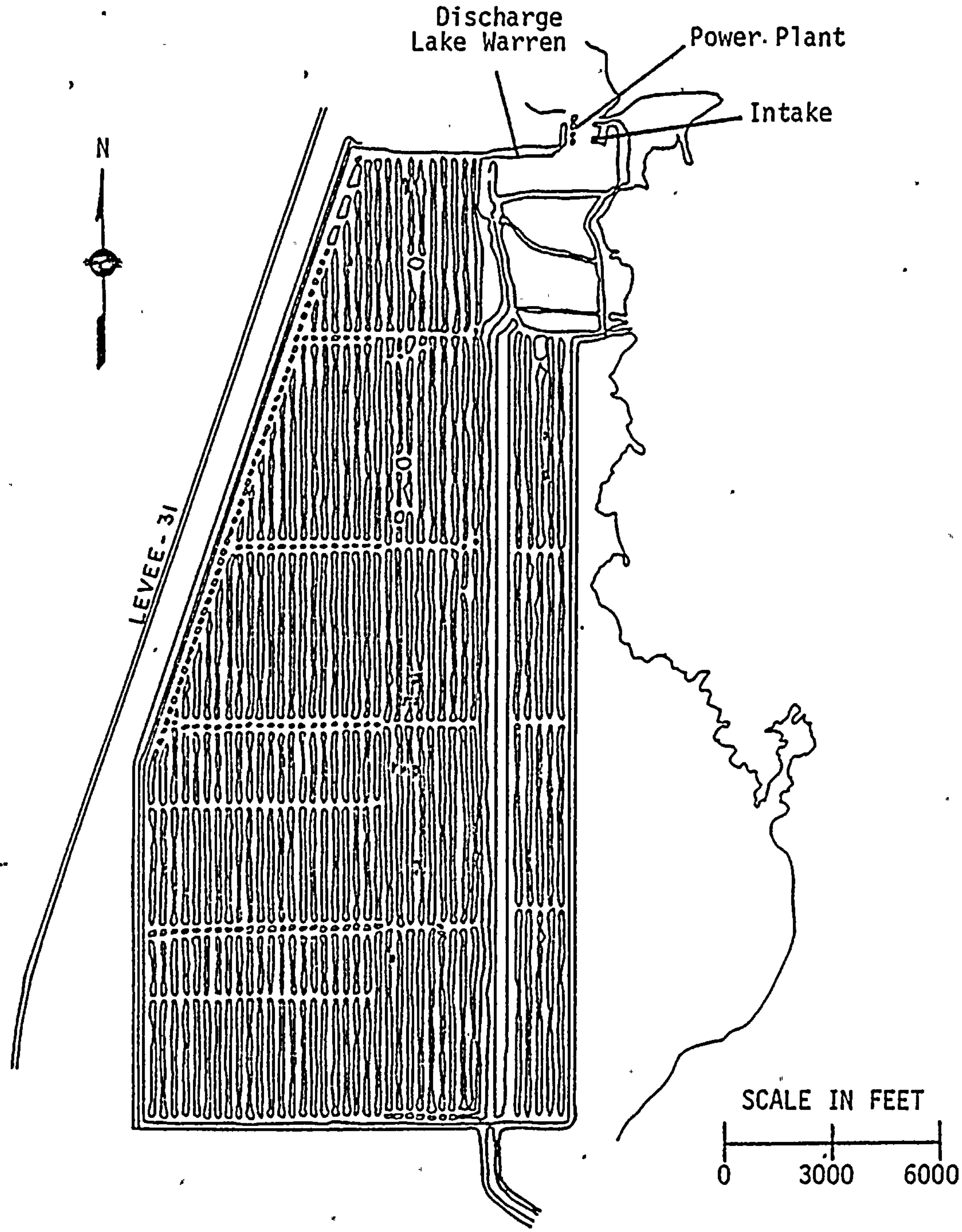


Figure 1. The location of the discharge chemical sample point at Turkey Point Power Plant 1980.

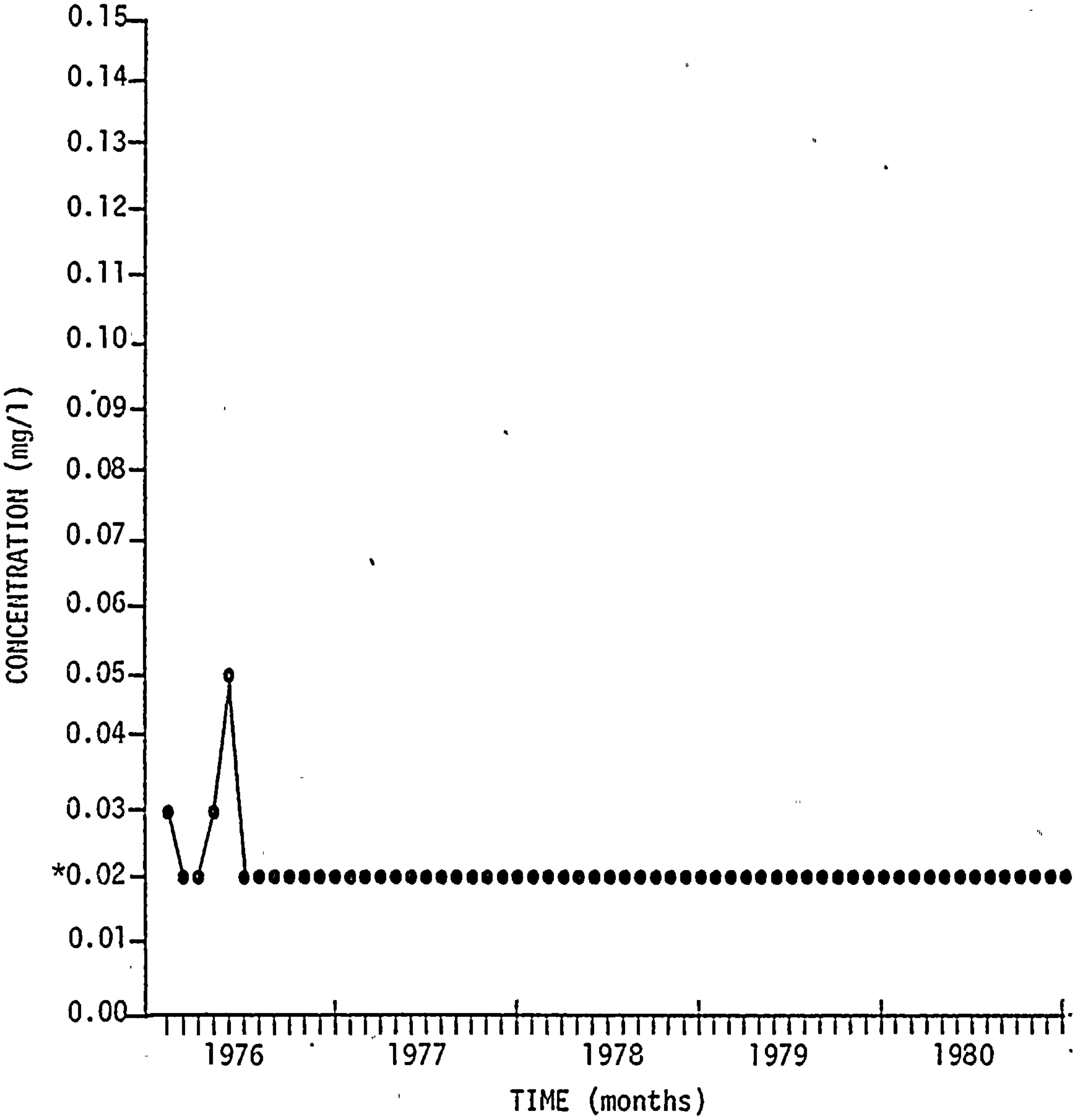


Figure 2. Monthly copper in mg/l at the discharge of the Turkey Point Power Plant for 1976 through 1980.

NOTE: * Lower limit of detection is 0.02 mg/l. All values since June 1976 were <0.02 mg/l.

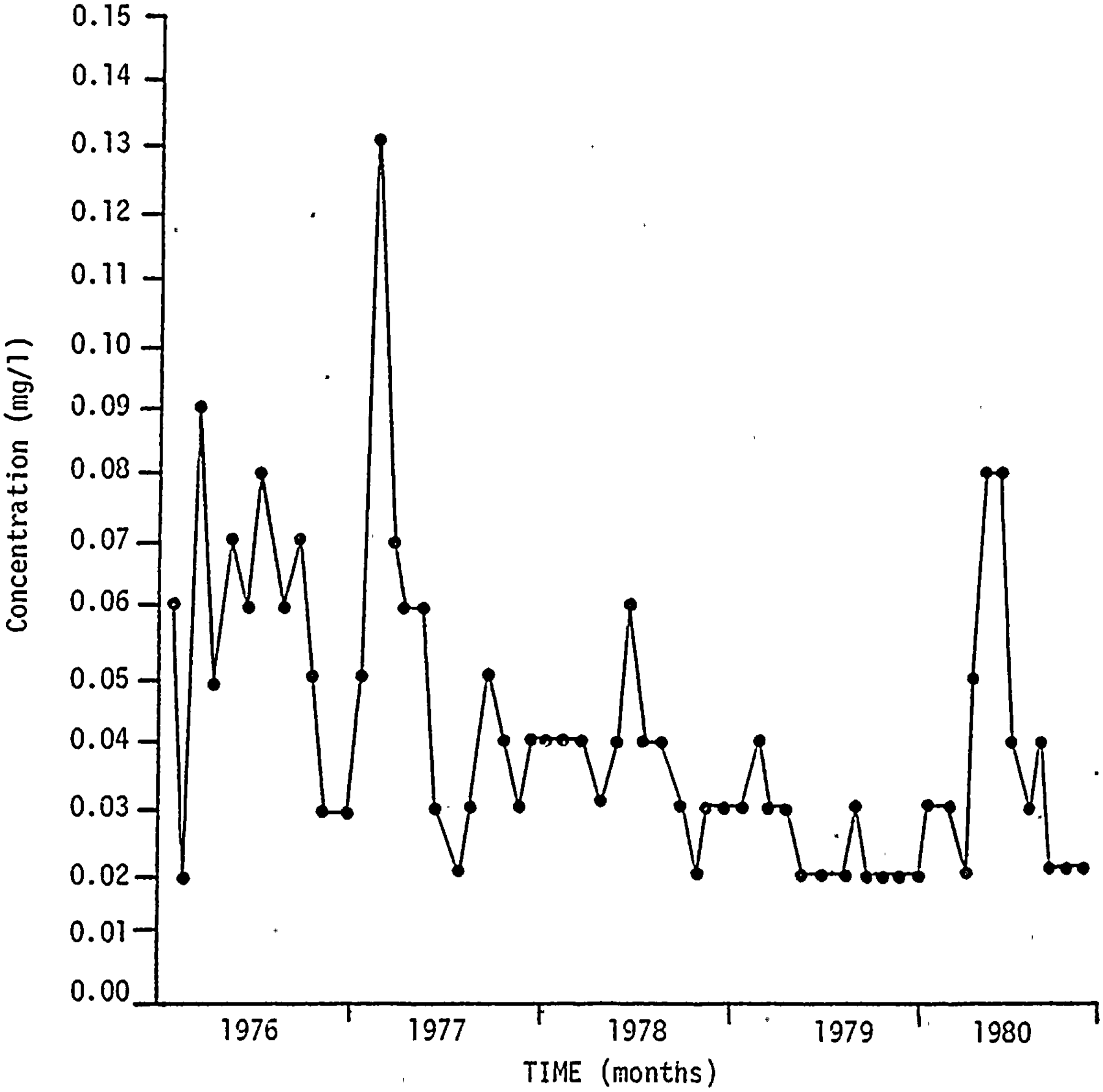


Figure 3. Monthly zinc in mg/l at the discharge of the Turkey Point Power Plant for 1976 through 1980.

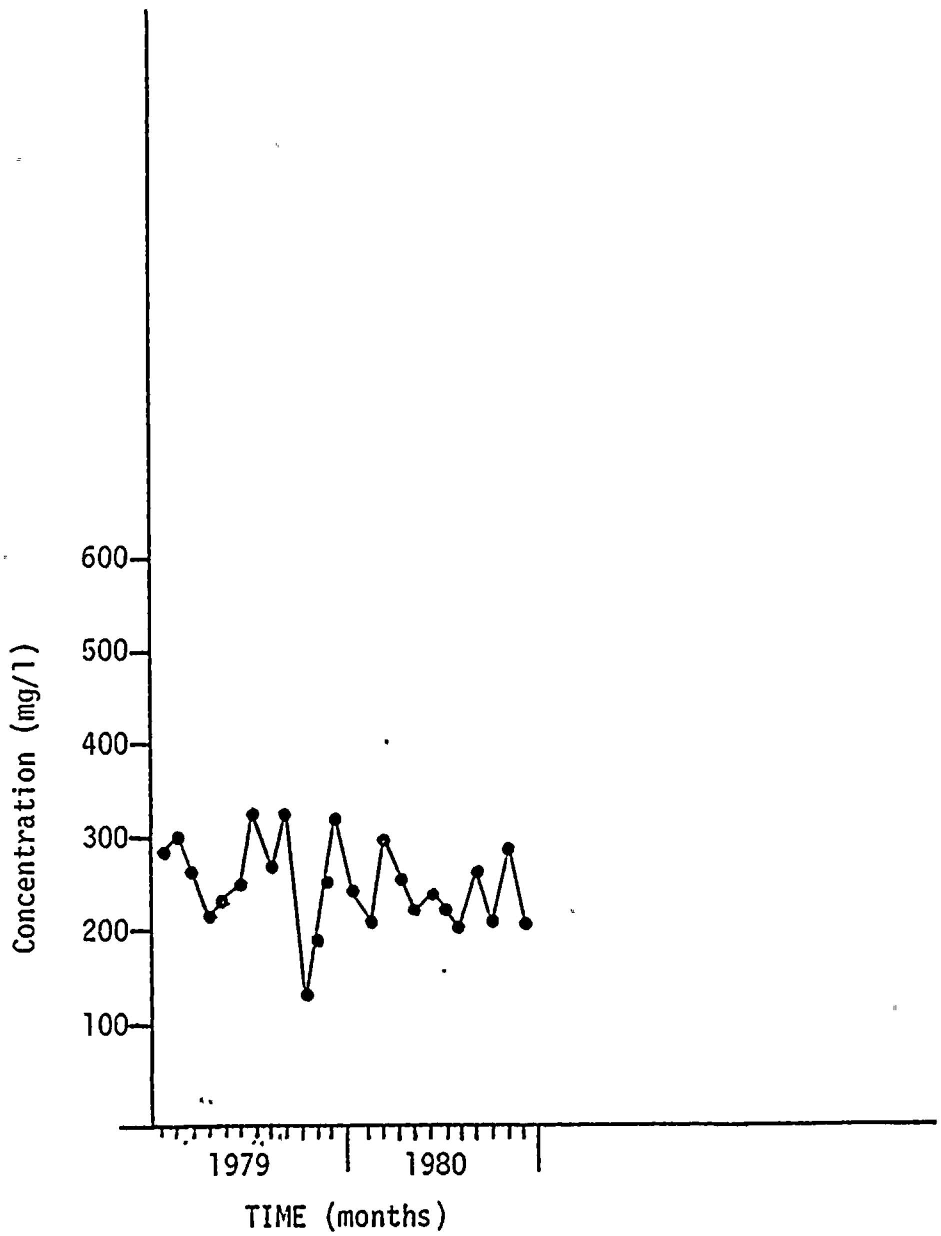


Figure 4. Monthly COD in mg/l at the discharge of the Turkey Point Power Plant for 1979 through 1980.

NOTE: COD concentrations for 1976 through 1978 can be found in the 1979 Annual Environmental Monitoring Report.

Table 1. Chemical parameters found in the Turkey Point Power Plant Discharge for 1980.

Monthly				Weekly			
DATE	COD mg/l	Cu mg/l	Zn mg/l	DATE	pH std. units	D.O. mg/l	Salinity o/oo
Jan.	240*	<0.02	0.03	01/03/80	8.0	5.4	41.0
				01/10/80	8.0	3.4	42.0
				01/17/80	8.0	4.4	42.0
				01/24/80	8.0	3.6	42.0
				01/31/80	8.0	3.0	40.0
Feb.	208*	<0.02	0.03	02/07/80	8.0	3.6	42.0
				02/14/80	8.0	3.6	42.0
				02/21/80	8.0	3.8	40.0
				02/28/80	8.0	5.8	43.0
March	300	<0.02	0.02	03/06/80	8.0	6.0	44.0
				03/13/80	8.0	4.0	42.0
				03/20/80	8.0	4.0	42.0
				03/27/80	8.0	3.4	41.0
April	267	<0.02	0.05	04/03/80	8.0	4.4	43.0
				04/10/80	8.0	5.2	41.0
				04/17/80	8.0	5.2	42.0
				04/24/80	8.0	4.3	43.0
May	213*	<0.02	0.08	05/01/80	8.1	4.2	43.0
				05/07/80	8.1	5.2	44.0
				05/15/80	8.0	3.6	45.0
				05/22/80	8.0	3.6	44.0
				05/29/80	8.0	4.0	42.0
June	246*	<0.02	0.04	06/05/80	8.0	3.8	44.0
				06/12/80	8.0	3.6	42.0
				06/19/80	8.0	4.2	42.0
				06/26/80	8.0	3.2	40.0
July	226*	<0.02	0.04	07/03/80	8.2	4.4	42.0
				07/10/80	8.0	3.7	43.0
				07/17/80	8.0	4.1	44.0
				07/24/80	7.9	3.2	42.0
August	196*	<0.02	0.03	08/01/80	8.1	3.3	42.0
				08/07/80	8.1	4.1	42.0
				08/14/80	8.0	4.2	41.0
				08/21/80	8.0	4.1	42.0
				08/28/80	7.9	4.3	42.0
Sept.	261	<0.02	0.04	09/04/80	7.9	5.1	40.0
				09/11/80	8.0	4.3	40.0
				09/18/80	7.9	4.9	40.0
				09/25/80	8.0	4.3	42.0

Table 1. Chemical parameters found in the Turkey Point
(cont'd) Power Plant Discharge for 1980.

Monthly				Weekly			
DATE	COD. mg/l	Cu mg/l	Zn mg/l	DATE	pH std. units	D.O. mg/l	Salinity o/oo
October	214*	<0.02	0.03	10/02/80	8.0	5.8	42.0
				10/09/80	7.8	5.2	40.0
				10/16/80	8.0	4.1	40.0
				10/23/80	7.8	4.4	40.0
				10/30/80	7.8	6.1	41.0
Nov.	284	<0.02	0.02	11/06/80	8.0	4.1	40.0
				11/13/80	8.0	4.3	39.0
				11/20/80	7.8	5.2	37.0
				11/26/80	7.8	4.1	36.0
Dec.	207*	<0.02	0.02	12/04/80	7.9	4.9	39.0
				12/11/80	8.0	4.0	38.0
				12/18/80	8.0	4.3	40.0
				12/24/80	8.0	4.9	39.0
				12/31/80	8.1	5.8	40.0

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

Table 2 Chemicals discharged to the Turkey Point Power Plant Cooling Canal System during January through June of 1980.

CHEMICALS	January	February	March	April	May	June
Amerfloc* 275	23	23	33	29	26	26
Ammonium Hydroxide	53	0	0	0	68	84
Bentonite Clay	1226	1425	1744	1590	1409	1393
Boric Acid	4294	1790	2675	3172	4270	3255
Chlorine	0	0	0	0	0	0
Concentrated (50%) Sodium Hydroxide	79 189	92 969	89 716	87 074	117 673	88 059
Concentrated Sulfuric Acid	114 534	124 669	140 454	135 815	75 029	123 689
HTH - Calcium Hypochlorite	0	0	0	0	0	0
Hydrated Lime	18 577	21 798	27 909	24 645	20 748	21 798
Hydrazine	375	0	0	0	625	138
Potassium Chromate	30	25	40	0	0	6
Potassium Dichromate	5	28	0	15	40	55
Salt	0	0	0	0	0	0
Sodium Hexametaphosphate	0	8	10	9	0	0

NOTE: * Coagulant Aid
All values in pounds.

Table 2. (cont'd) Chemicals discharged to the Turkey Point Power Plant Cooling Canal System during July through December of 1980.

CHEMICALS	July	August	September	October	November	December
Amerfloc* 275	26	24	25	29	28	23
Ammonium Hydroxide	0	0	0	101	8	0
Bentonite Clay	1651	1509	1645	1792	1655	1213
Boric Acid	4940	2668	510	4010	10 614	856
Chlorine	0	0	0	0	0	0
Concentrated (50%) Sodium Hydroxide	94 284	88 848	102 603	77 504	82 902	55 872
Concentrated Sulfuric Acid	134 743	131 559	142 995	112 008	127 548	88 920
HTH - Calcium Hypochlorite	0	0	0	0	0	0
Hydrated Lime	24 733	23 059	16 048	26 358	24 641	18 261
Hydrazine	0	0	0	101	22	0
Potassium Chromate	75	50	38	15	25	60
Potassium Dichromate	27	24	0	25	58	25
Salt	0	0	0	0	0	0
Sodium Hexametaphosphate	25	19	0	19	23	25

NOTE: * Coagulant Aid
All values in pounds.

III. BIOTIC MONITORING

A. AQUATIC ENVIRONMENT

1. Plankton (ETS 4.1.1.1.1)

a. Zooplankton - physical data

Introduction

This monitoring serves "to compare the physical parameters of the water in the cooling canal system with those in the adjacent lagoon (Biscayne Bay/Card Sound) and determine the ability of the cooling canal system to support biological life" (ETS 4.1.1.1).

Materials and Methods

Samples were collected quarterly during plankton sampling at various stations in the Turkey Point Cooling Canal System and southern Biscayne Bay/Card Sound (Figures 1 and 2).

Temperature was measured using a Y.S.I. Telethermometer. Its accuracy was ± 0.15^{o}C with a meter readability of 0.2^{o}C. Salinities were determined using an American Optical T/C Refractometer. This instrument's accuracy was ± 0.10 o/oo with a readability of 0.5 o/oo. Dissolved oxygen (D.O.) was measured using a Y.S.I. Polarographic probe and oxygen meter. The accuracy of this instrument was ± 0.20 mg/l with an instrument readability of 0.1 mg/l. All instruments were calibrated before each sampling date and all measurements were made in the top meter of the water column.

Results

Tabular results of the physical data for 1980 can be found on Table 1 (canal system) and Table 3 (Biscayne Bay/Card Sound) at the end of the zooplankton organism section.

The temperatures in the canal system for 1980 ranged from a maximum of 42.7^{o}C to a minimum of 21.5^{o}C with a mean of 29.7^{o}C. The maximum reading was recorded at station F.1 nearest the power plant discharge. The temperature in the bay for 1980 ranged from a maximum of 32.0^{o}C to a minimum of 19.5^{o}C with a mean of 26.2^{o}C. The mean temperature for the canal system was 3.5^{o}C higher than the bay temperature.

The salinity in the canal system for 1980 ranged from a maximum of 45.0 o/oo to a minimum of 38.0 o/oo, with a mean of 41.7 o/oo. There was an average increase of 0.9 o/oo in salinity in the canal system from 1979 to 1980. The lowest salinity in the canal system was 38.0 o/oo and occurred at station WF.2. The salinity in the bay for 1980 ranged from a maximum of 38.0 o/oo to a minimum of 25.0 o/oo, with a mean of 33.6 o/oo. The average salinity in the canal system was 8.1 o/oo higher than the bay.

The D.O. in the canal system for 1980 ranged from a maximum of 8.1 mg/l to a minimum of 2.2 mg/l with a mean of 5.0 mg/l. In the bay, D.O. ranged from a maximum of 7.5 mg/l to a minimum of 4.1 mg/l

with a mean of 5.9 mg/l.

Discussion

Temperatures in both canal system and bay were within ranges observed for previous years (Tables 1 and 3). The maximum bay temperature was typical of the deeper waters of the bay and Card Sound area but did not reflect the higher temperatures known to occur on the tidal flats due to solar heating.

The increase of 0.9 o/oo in the canal salinity was consistent with the slow rise observed since 1976 (Table 1). This increasing salinity is due to the constant evaporation and hence concentration of dissolved solids in the canal system. The low salinity that occurred at station WF.2 was due, in part, to the pumping of brackish water into the canals from the Interceptor Ditch (Figure 1) at a point just north of WF.2. Salinities in the bay were within the ranges noted in previous years and showed the typical seasonal fluctuation with wet and dry seasons (FPL, 1979).

Dissolved oxygen levels in the canal system were generally lower than those of the bay (Table 1). This is due to the decrease in oxygen solubility with increases in temperature and salinity. The level of dissolved oxygen is of fundamental importance to inhabitants, although response of individual species or a group of species may be highly variable (Perkins, 1974). Although lower than the bay levels, the D.O.

levels in the canal system were sufficient to support the established biota.

There was no notable difference exhibited between physical data recorded for Biscayne Bay/Card Sound during 1980 and that obtained during baseline bay monitoring (Bader and Roessler, 1972).

Conclusions

Temperature, salinity, and dissolved oxygen levels are not significantly different from previous years (1975-1979) with the exception of salinity.

There is nothing in the physical data to indicate conditions restrictive to biological life in the canal system with the exception of the immediate circulating cooling water discharge area. The discharge is species selective as a result of elevated and fluctuating temperatures.

No significant changes occurred in physical parameters in the bay as a result of power plant operation.

a. Zooplankton - nutrient data

Introduction

This program compares the chemical parameters of the water in the cooling canal system with those in the adjacent lagoon and determines the ability of the cooling system to support biological life (ETS 4.1.1.1).

Materials and Methods

Samples were collected quarterly from 12 sample points within the Turkey Point Cooling Canal System and five control sample points in southern Biscayne Bay/Card Sound (Figures 1 and 2).

Acid washed, clear glass containers with ground glass stoppers were used for the ammonia samples. Five milliliters of Phenol/Ethanol solution were added as the preservative. Acid washed, dark glass containers with ground glass stoppers 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 the EPA method (1979). Data were reported in milligrams per liter.

Results

Tabular results for nutrient data for 1975 through 1980 can be found on Table 1 (canal system) and Table 3 (Biscayne Bay/Card Sound) at the end of the zooplankton organism section.

Ammonia

Ammonia (NH_3) levels in the canal system ranged from undectable to 0.104 mg/l with a mean of 0.047 mg/l. At the bay control stations the minimum level was 0.014 mg/l and the maximum level was 0.061 mg/l with an average value of 0.034 mg/l.

The highest ammonia levels in the canal system were found at station WF.2 while those in the bay occurred at station Y-2.

Nitrite

Nitrite (NO_2) levels in the canal system ranged from undectable to 0.023 mg/l with a mean of 0.013 mg/l. At the bay control stations levels ranged from undetectable to 0.012 mg/l with a mean of 0.005 mg/l. The average canal value was approximately three times the average bay control value. The highest nitrite levels for the canal system were found at stations WF.2 and F.1 while the maximum value for the bay occurred at station 12.

Nitrate

Nitrate (NO_3) levels in the canal system were between 0.002 mg/l and 0.596 mg/l. At the bay control stations the minimum level was 0.003

mg/l and the maximum level was 0.233 mg/l. The average values for the canal system and bay were 0.217 mg/l and 0.057 mg/l respectively. Peak values for this chemical constituent occurred at station F.1 in the canal system and station 12 in the bay.

Inorganic Phosphate

Inorganic phosphate (IPO_4) levels in the canal system were between 0.002 mg/l and 0.017 mg/l. At the bay control stations the minimum level was undectable and the maximum level was 0.024 mg/l. The mean value for the canal system was 0.010 mg/l; the bay mean value was 0.007 mg/l. Highest values of inorganic phosphate in the canal system and bay occurred at stations E3.2 and X-3 respectively.

Total Phosphate

Total phosphate (TPO_4) levels in the canal system were between 0.010 mg/l and 0.079 mg/l with a mean of 0.043 mg/l. At the bay control stations the minimum level was 0.002 mg/l and the maximum levels was 0.091 mg/l with an average of 0.032 mg/l. The highest values occurred at stations E3.2 in the canal system and X-3 in the bay.

Discussion

The large difference in ammonia values for bay and canal system was not as pronounced this year as last (FPL, 1979). The elevated ammonia values of WF.2 were again the result of Interceptor Ditch pumping. Nitrites in the canal system continued the established

decreasing trend (FPL, 1978, 1979). Nitrites in the bay appeared to be increasing, however the increase was slight and the overall trend (FPL, 1973-1980) is best described as variable. Nitrates decreased significantly in both canal system and bay. The decrease in the canal system represents a departure from the previously stated increasing trend (FPL, 1973-1979). It is difficult to ascribe any singular cause to this anomalous result. Most likely, it was due to a natural decrease of available nitrates, as evidenced by reduced nitrates in the bay. Both phosphates followed the same variable trends with small average increases in both bay and canal system over last year.

In comparison, nutrient values for Biscayne Bay/Card Sound and the canal system are similar to values obtained in Card Sound during the baseline studies (Bader, 1969; Tabb & Roessler, 1970; Bader & Roessler, 1971; Bader & Roessler, 1972; Gerchakov *et al*, 1972).

Conclusions

Generally, nutrient levels in the canal system were higher than levels in the bay and Card Sound. The apparent decreasing trends of the ammonia and nitrite observed for the canal system in previous years were repeated in 1980. There is nothing in the chemical data to indicate conditions restrictive to the canal system supporting biological life.

a. Zooplankton - organisms

Introduction

This report qualitatively and quantitatively assesses planktonic primary consumers present in the cooling canal system and adjacent lagoons in order "to follow biological succession and determine the biological stability of the system" (ETS 4.1.1.1).

Materials and Methods

Samples were collected quarterly at plankton stations in the Turkey Point Cooling Canal System and southern Biscayne Bay/Card Sound (Figures 1 and 2). A 5 inch diameter Clarke-Bumpus sampling apparatus with a number 10 mesh (158 micron) net and bucket was used to entrain zooplankters. Plankton tows were performed in the top meter of the water column at speeds of 1 to 3 knots. Each tow lasted 5 minutes in the canal system and 3 minutes in the bay. Zooplankton densities were obtained using the Lackey Drop Method (APHA, 1975) and the volume of water sampled.

Biomass was determined using a volume displacement technique (UNESCO, 1974; Yentsch and Hebard, 1957) and is expressed in terms of volume of water displaced. The method proved acceptable for bay samples, however, it was not sensitive enough to determine the very low biomasses known to occur in the canal system and was subject to interference due to detritus.

Zooplankton organisms were divided into the following six categories:

a. Copepods included cyclopoid, harpacticoid, 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 Plankton included all other zooplankton not included in the first five categories.

Results

Tabular results for zooplankton organism data for 1975 through 1980 can be found on Table 2 (canal system) and Table 4 (Biscayne/Card Sound).

Copepods

The mean copepod levels for the canal system decreased from 0.136 organisms per liter in 1979 to 0.095 organisms per liter in 1980. The percent of total plankton population represented by copepods increased from 29 percent in 1979 to 49 percent in 1980.

The mean level of copepods in the bay decreased from 7.200 organisms per liter in 1979 to 5.269 in 1980. Copepods represented 79 percent of the plankton population. This is an increase of almost 6 percent from 1979.

Gastropods

The gastropod veligers decreased in the canal system from an average of 0.302 organisms per liter or 64 percent of the total plankton population in 1979 to 0.076 or 39 percent in 1980.

In Biscayne Bay and Card Sound, the mean gastropod concentration decreased from 1.569 organisms per liter or 16 percent of the total plankton in 1979 to 0.682 organisms per liter or 10 percent in 1980.

Bivalve Larvae

Bivalve larvae densities in the canal system increased slightly from 0.001 organisms in 1979 to 0.002 in 1980. This was an increase from 0.02 percent to 1.0 percent of the total plankton population.

The mean concentration for bivalve larvae in the bay decreased from 0.102 organisms per liter or 1.0 percent of the total plankton in 1979 to 0.087 or 1.3 percent in 1980.

Copepod and Cirriped Nauplii

The mean copepod nauplii concentration in the canal system for 1979 was 0.001 organisms per liter, or 0.2 percent of the total plankton population, relative to 0.002 organisms per liter or 1.0 percent in 1980.

The cirriped nauplii were noted in the canal samples but were never present at a concentration greater than 0.009 per liter.

In Biscayne Bay and Card Sound, the mean copepod nauplii concentration was 0.067 organisms per liter or 0.7 percent of total plankton populations in 1979 and 0.097 or 1.5 percent in 1980, while cirriped nauplii concentration was 0.027 organisms per liter or 0.3 percent in 1979 and only 0.011 organisms per liter or 0.2 percent in 1980.

Other Plankton

The mean density of the other plankton in the canal system decreased slightly from 0.027 organisms per liter or 6 percent of the total plankton population in 1980 to 0.018 organisms per liter or 9 percent in 1980.

Total Plankton

Densities of the total plankton in the canal system decreased from 0.472 organisms per liter in 1979 to 0.193 in 1980. This is a decrease of 60 percent.

In Biscayne Bay and Card Sound total plankton densities decreased by 32 percent from 9.808 organisms per liter in 1979 to 6.655 organisms per liter in 1980.

Zooplankton Biomass

The zooplankton biomass for the canal system for 1980 could not be measured by the same methods used for Biscayne Bay/Card Sound due to interferences mentioned previously. The mean displacement of zooplankton

per cubic meter of bay sample was 6.65×10^{-6} milliliters for 1980. Biomass values per quarter are shown in Table 5.

Discussion

Copepods

The mean concentration for copepods in the canal system continued to fluctuate around 0.010 organisms per liter. The ratio of the mean bay concentration to the mean canal concentrations continued to increase as it has since 1975 i.e. 24-fold in 1975, 31-fold in 1976, 39-fold in 1977, 36-fold in 1978, 53-fold in 1979 and 55-fold in 1980. During 1980 for both bay and canal system copepods, a decrease in density represented a larger percent of the total plankton population. This was due to a decrease in the total plankton count.

Gastropods

Gastropods are highly adventitious organisms capable of thriving in a broad range of habitats and changing conditions. Planktonic gastropod veligers occurred at fewer stations this year, yet still represented 39 percent of the total plankton. This is not unusual since gastropod veligers demonstrate a relatively short planktonic stage. Throughout the system increased densities of adult gastropods were observed along the canal shorelines. This included stations F.1 and WF.2 which were atypical and unstable relative to the rest of the canal system. Station F.1, nearest the discharge, had high thermal fluctuations, and WF.2 in the southwest corner had the greatest variation in

chemical characteristics.

Although several "blooms" occurred, gastropod concentrations remained fairly uniform throughout the year. In general, their 1980 mean density in the bay was 9 times greater than their density in the canal system (Tables 2 and 4). In comparison, during 1979 there was only a 5 fold difference in mean density levels between bay and canal system.

Bivalve Larvae

Thermal exclusion of these larvae during initial open mode operation (i.e. 1968-1972) and subsequent inadequate adult base populations continued to be the apparent reasons for bivalve larvae being almost totally absent from the canal system. The mean concentration for bivalve larvae in the bay during 1980 has dropped by 15 percent compared to 1979.

Copepod and Cirriped nauplii

Copepod nauplii were noted in the canal system during each quarter. Occurrences remained sporadic and densities never exceeded 0.026 organisms per liter.

Cirriped nauplii concentrations in the canal system were also very low. This organism was found only during the second quarter of 1980 and only at station F.1.

In Biscayne Bay and Card Sound, copepod and cirriped nauplii continued to be present at low levels.

Both nauplii were too small to be adequately sampled by a #10 mesh (158 micron) net, and these concentrations were not representative of actual population densities.

Other Plankton

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

The difference in density levels between the bay and canal system appeared to be increasing until this year when it seemed to stabilize. The bay density was 4-fold higher than the canal system in 1976, 11-fold higher in 1977, 18-fold higher in 1978, 31-fold higher in 1979, and 28-fold higher in 1980. This increase is a result of the increases in the densities of "other plankton." Concentrations of identified plankton in the canal system have showed little fluctuation.

Total Plankton

Zooplankton concentrations in the canal system were consistently lower than those found in Biscayne Bay and Card Sound. The bay total plankton density was 19-fold higher in 1975 and 1976, 17-fold higher in 1977, 32-fold higher in 1978, 21-fold higher in 1979, and 34-fold

higher than the canal system in 1980. The fluctuations in the density trend were due to large increases or decreases in bay plankton populations. The canal system showed little variability in population density.

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, equipment type, and taxonomic categories.

Conclusions

The cooling canal system stations showed limited variation of zooplankton populations and had densities and diversities similar to previous reporting periods. Conditions were indicative of good stability in this environment.

The plankton densities in Biscayne Bay and Card Sound fluctuated as they have in the past. The fluctuations in bay plankton populations are primarily a result of plankton "blooms" and are thought to be directly related to seasonality, agricultural run-off and domestic pollution.

The ratio among the six groups of zooplankton collected in the canal system is directly comparable to that of the zooplankton of Biscayne Bay.

LITERATURE CITED

APHA-AWWA-WPCF. 1975. Standard methods for the examination of water and wastewater. 14th ed. APHA Wash. D.C. 1193 pp.

Bader, R.G. 1969. An ecological study of South Biscayne Bay in the vicinity of Turkey Point. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, Florida.

Bader, R.G. and M.A. Roessler. 1971. An ecological study of South Biscayne Bay and Card Sound. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, Florida.

Bader, R.G. and M.A. Roessler. 1972. An ecological study of South Biscayne Bay and Card Sound. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, Florida.

Florida Power & Light Co. 1973-1979. Turkey Point Units 3 & 4 non-radiological environmental monitoring report nos. 1-13. Miami, Florida.

Perkins, E.J. 1974. The biology of estuaries and coastal waters. Academic Press, London. 678 pp.

Segar, Douglas A., Sol M. Gerchakov, Tod S. Johnson. 1971. An ecological study of South Biscayne Bay and Card Sound, chemistry appendicies. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, Florida.

Tabb, D.C. and M.A. Roessler. 1970. An ecological study of South Biscayne Bay in the vicinity of Turkey Point. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, Florida.

U.S. Environmental Protection Agency Office of Research and Development. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. Weber, Cornelius I. ed. Cincinnati, Ohio.

U.S. Environmental Protection Agency Environmental Monitoring and Support Laboratory. 1979. Methods for chemical analysis of water and wastes. EPA. Cincinnati, Ohio. 430 pp.

Yentsch, C.S., Hebard. 1957. A gauge for determining plankton volume by the Mercury Immersion Method. Journal du Consiel, Vol. XXII, No. 2. pp. 184-190.

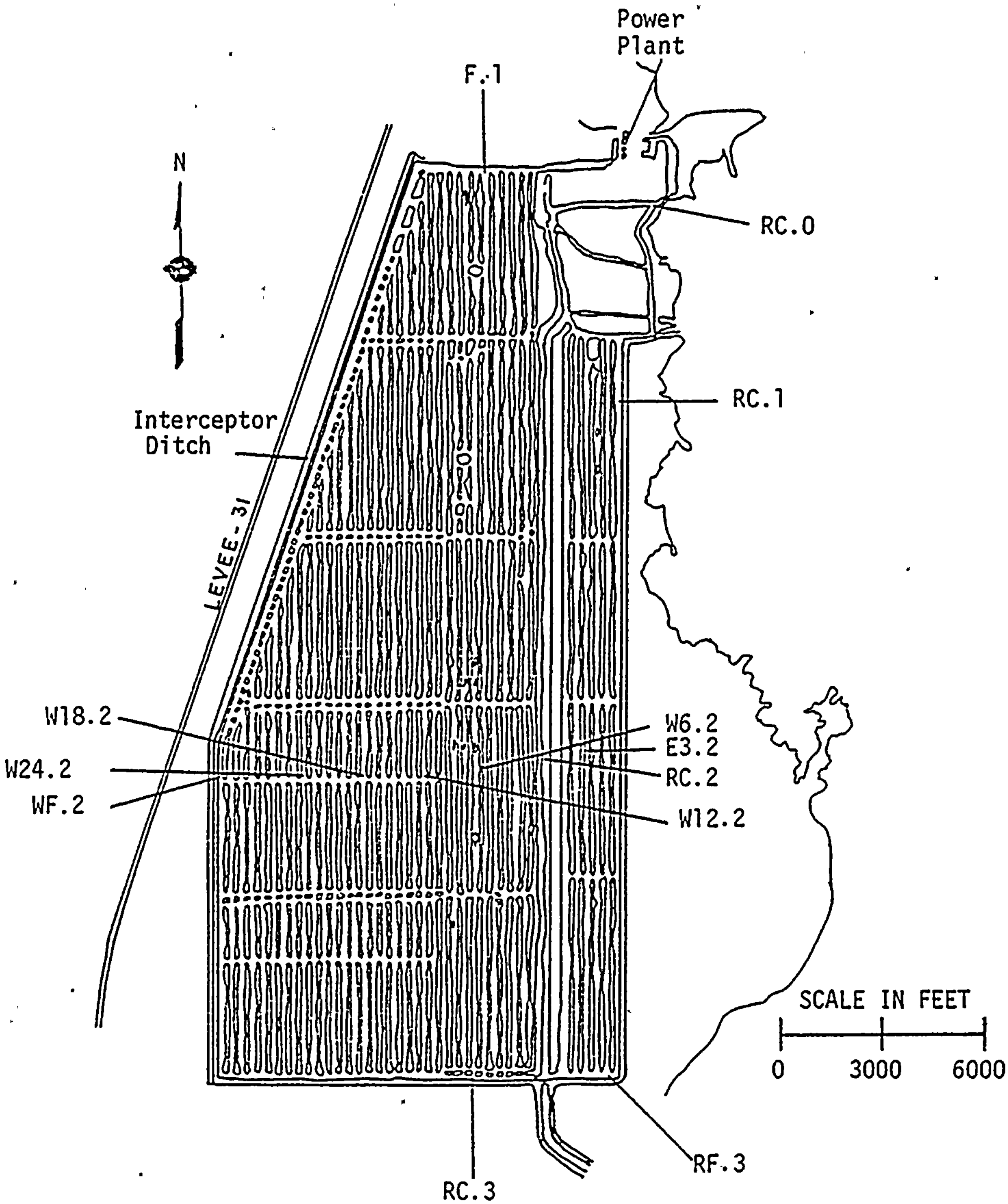


Figure 1. Physical, nutrient, and zooplankton sample sites at the Turkey Point Cooling Canal System 1980.

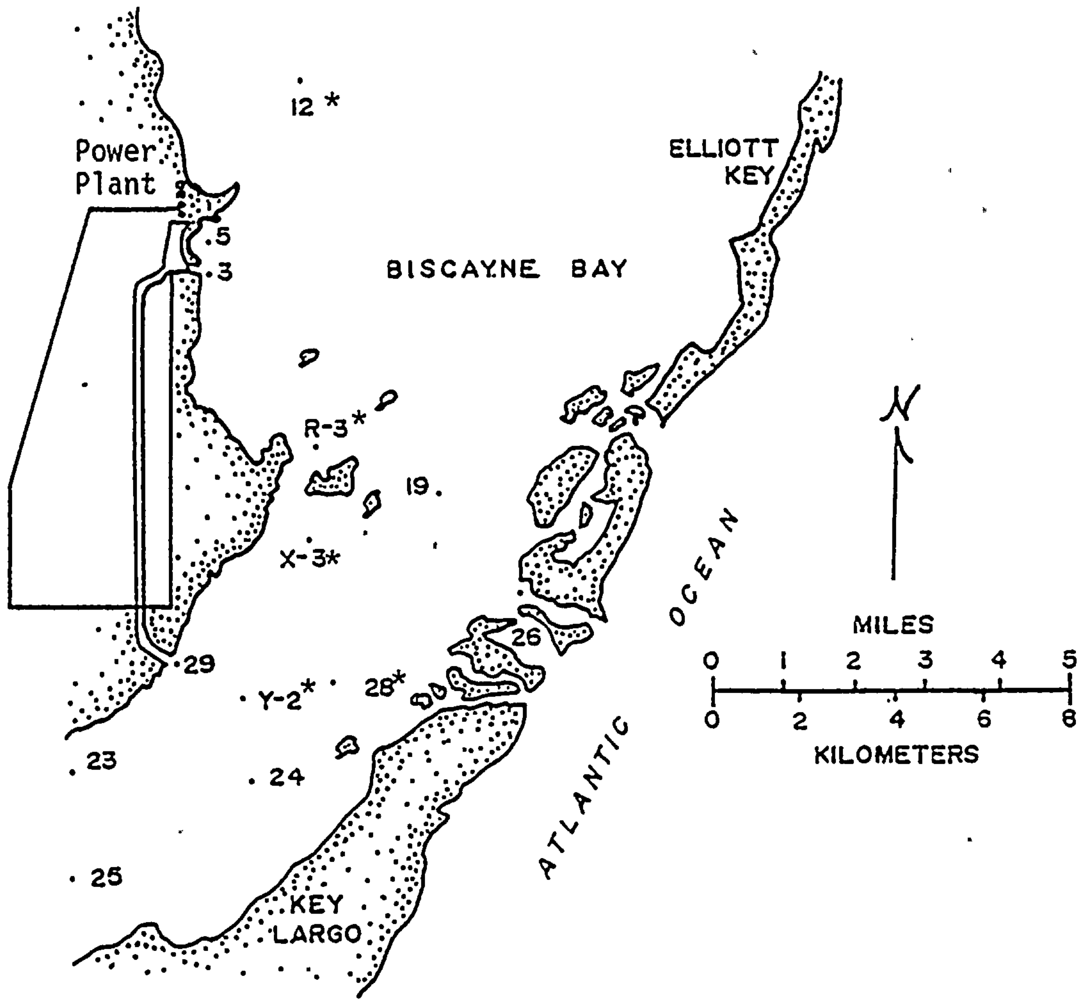


Figure 2. Physical, nutrient and zooplankton sample sites in Biscayne Bay/Card Sound Turkey Point Power Plant 1980.

NOTE: *Indicates nutrient sample sites.

Table 1. Composite physical and nutrient data for years 1975 through 1980 showing the maximum, minimum and mean for all plankton stations in the Turkey Point Cooling Canal System.

		1975	1976	1977	1978	1979	1980
Temperature °C	Max.	42.0	41.6	40.0	42.5	44.0	42.7
	Mean	29.2	28.3	29.2	29.2	29.8	29.7
	Min.	22.0	18.5	19.2	18.0	24.0	21.5
Salinity o/oo	Max.	42.0	40.0	41.5	43.5	46.0	45.0
	Mean	36.7	36.6	37.7	37.3	40.8	41.7
	Min.	30.0	26.0	28.5	29.5	36.5	38.0
Dissolved Oxygen mg/l	Max.	6.2	8.4	7.4	6.4	7.9	8.1
	Mean	5.2	5.4	4.8	5.0	5.3	5.0
	Min.	4.0	4.1	2.6	3.3	3.2	2.2
NH_3 mg/l	Max.	0.270	0.463	0.284	0.208	0.169	0.104
	Mean	0.095	0.072	0.093	0.049	0.068	0.047
	Min.	0.034	0.012	0.015	0.008	0.011	0.000
NO_2 mg/l	Max.	0.078	0.060	0.055	0.041	0.029	0.023
	Mean	0.031	0.028	0.025	0.019	0.016	0.013
	Min.	0.008	0.010	0.004	0.005	0.002	0.000
NO_3 mg/l	Max.	0.666	0.960	0.769	1.373	1.649	0.596
	Mean	0.249	0.474	0.287	0.476	0.553	0.217
	Min.	0.021	0.042	0.007	0.040	0.009	0.002
IPO_4 mg/l	Max.	0.090	0.048	0.143	0.033	0.019	0.017
	Mean	0.024	0.026	0.021	0.017	0.008	0.010
	Min.	0.005	0.008	0.010	0.007	0.000	0.002
TPO_4 mg/l	Max.	0.086	0.098	0.098	0.072	0.064	0.079
	Mean	0.054	0.058	0.049	0.048	0.036	0.043
	Min.	0.021	0.019	0.011	0.029	0.009	0.010

Table 2. Composite zooplankton data for years 1975 through 1980 showing the maximum, minimum and mean for all stations in the Turkey Point Cooling Canal System.

		1975	1976	1977	1978	1979	1980
Copepods	Max.	0.430	0.630	0.440	0.682	0.560	0.533
	- Mean	0.072	0.100	0.096	0.148	0.136	0.095
	Min.	0.000	0.000	0.000	0.008	0.000	0.000
Gastropods	Max.	0.060	2.530	3.380	0.325	6.550	0.827
	- Mean	0.006	0.064	0.153	0.036	0.302	0.076
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Bivalves	Max.	0.000	0.000	0.040	0.010	0.022	0.026
	- Mean	0.000	0.000	0.001	0.000	0.001	0.002
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Copepod Nauplii	Max.	0.030	0.010	0.220	0.060	0.011	0.026
	- Mean	0.002	0.001	0.007	0.006	0.001	0.002
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Cirriped Nauplii	Max.	0.000	0.240	0.020	0.030	0.010	0.009
	- Mean	0.000	0.004	0.002	0.005	0.001	0.000
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Other Plankton	Max.	0.510	0.680	0.620	0.120	0.240	0.086
	- Mean	0.030	0.049	0.036	0.017	0.027	0.018
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Total Plankton	Max.	0.620	2.610	3.490	0.844	6.990	0.943
	- Mean	0.110	0.210	0.291	0.210	0.472	0.194
	Min.	0.000	0.000	0.010	0.008	0.000	0.012

NOTE: All values in organisms per liter.

Table 3. Composite physical and nutrient Biscayne Bay/Card Sound data for years 1975 through 1980 showing the maximum, minimum and mean for all plankton stations.

		1975	1976	1977	1978	1979	1980
Temperature °C	Max.	32.0	32.4	32.1	31.9	32.7	32.0
	Mean	27.7	26.0	26.2	25.7	25.7	26.2
	Min.	21.4	17.5	18.7	15.5	19.9	19.5
Salinity o/oo	Max.	42.5	40.0	38.0	38.5	41.5	38.0
	Mean	37.5	35.2	33.5	33.7	34.3	33.6
	Min.	28.0	21.0	28.0	24.0	21.5	25.0
Dissolved Oxygen mg/l	Max.	10.6	8.8	8.3	7.8	9.2	7.5
	Mean	6.7	6.8	5.6	5.6	6.0	5.9
	Min.	4.4	5.0	3.3	3.6	4.4	4.1
NH_3 mg/l	Max.	0.060	0.044	0.098	0.134	0.059	0.061
	Mean	0.022	0.022	0.032	0.028	0.025	0.034
	Min.	0.006	0.007	0.004	0.004	0.007	0.014
NO_2 mg/l	Max.	0.012	0.028	0.009	0.023	0.018	0.012
	Mean	0.006	0.005	0.003	0.004	0.007	0.005
	Min.	0.002	0.001	0.000	0.000	0.002	0.000
NO_3 mg/l	Max.	0.061	0.164	0.112	0.527	0.237	0.233
	Mean	0.022	0.052	0.034	0.085	0.103	0.057
	Min.	0.002	0.002	0.001	0.009	0.022	0.003
IPO_4 mg/l	Max.	0.011	0.019	0.019	0.011	0.025	0.024
	Mean	0.007	0.007	0.007	0.007	0.008	0.007
	Min.	0.002	0.002	0.002	0.002	0.000	0.000
TPO4 mg/l	Max.	0.028	0.055	0.151	0.021	0.066	0.091
	Mean	0.017	0.016	0.017	0.012	0.027	0.032
	Min.	0.012	0.006	0.004	0.006	0.009	0.002

Table 4. Composite zooplankton Biscayne Bay/Card Sound data for years 1975 through 1980 showing the maximum, minimum and mean for all stations.

		1975	1976	1977	1978	1979	1980
Copepods	Max.	9.570	15.050	17.090	27.360	18.320	11.890
	Mean	1.696	3.075	3.799	5.341	7.200	5.269
	Min.	0.030	0.030	0.050	0.026	0.060	0.288
Gastropods	Max.	0.980	6.290	10.540	7.029	17.890	3.500
	Mean	0.104	0.396	0.576	0.849	1.569	0.682
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Bivalves	Max.	0.550	0.370	1.670	2.667	0.450	1.316
	Mean	0.019	0.027	0.074	0.129	0.102	0.087
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Copepod Nauplii	Max.	0.500	0.280	0.083	1.500	0.217	0.862
	Mean	0.032	0.030	0.111	0.139	0.067	0.097
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Cirriped Nauplii	Max.	0.130	1.000	0.490	0.264	0.240	0.234
	Mean	0.011	0.652	0.046	0.016	0.027	0.011
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Other Plankton	Max.	3.260	1.330	5.190	2.584	4.800	2.145
	Mean	0.263	0.204	0.409	0.309	0.849	0.509
	Min.	0.010	0.000	0.000	0.000	0.012	0.000
Total Plankton	Max.	11.600	18.980	24.350	35.820	41.630	16.680
	Mean	2.124	3.790	5.030	6.727	9.808	6.655
	Min.	0.030	0.040	0.150	0.039	0.080	0.418

NOTE: All values in organisms per liter.

Table 5. Mean zooplankton biomass values for the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound for 1980.

	Biomass (ml/m^3)	
	Canals	Bay
First Quarter (February)	*	7.87×10^{-6}
Second Quarter (May)	*	7.86×10^{-6}
Third Quarter (August)	*	5.36×10^{-6}
Fourth Quarter (November)	*	5.73×10^{-6}
Yearly Mean	*	6.65×10^{-6}

NOTE: *See Materials and Methods "detrital interference and sensitivity."

b. Phytoplankton - chlorophyll a, biomass, and primary productivity

Introduction

Chlorophyll _a_, biomass, and primary producitivity were determined quarterly at 13 stations. Eight of these stations were located in the canal system (Figure 1), and five were located in the Biscayne Bay/Card Sound area (Figure 2).

Chlorophyll is a pigment contained in the chloroplasts of plant cells; its theorized 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. Chlorophyll _a_ is routinely used to estimate phytoplankton biomass and primary productivity.

Materials and Methods

Chlorophyll _a_ determinations were made using the Trichromatic Method[1] (ASTM, 1980, APHA, 1975). Two samples of one liter each were

---

[1]The Trichromatic method of analysis was used to determine the chlorophyll _a_ content of a quality control sample from the Environmental Protection Agency's monitoring and support laboratory. Values obtained were within 6 percent of the reference value for the sample. This is within the acceptable limit of 10 percent set by the EPA for this method of analysis.

taken at each of the 13 stations and concentrated using Whatman GF/C 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 was determined using a Beckman 25 UV-Visible Light Spectrophotometer and a 5 centimeter path length.

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 (APHA, 1975).

Primary Productivity

By knowing the concentration 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 meterological tower. A table by Ryther and 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. 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 of 0.15/m was used. The estimated value for the extinction coefficient of the bay was verified using a submarine photometer on loan from the National Oceanic and Atmospheric Administration. The average value for the extinction coefficient for the bay measured by the instrument was 0.153/m. Comparisons of Secchi Disc coefficients with coefficients determined by the instrument showed excellent agreement.

Results

Table 1 shows the mean chlorophyll _a_ values for the canal system and Biscayne Bay for the quarters of 1980. The 1978 average chlorophyll _a_ value in the canal system was 0.35 mg/m^3. The 1979 mean value was 0.43 mg/m^3, while this year's (1980) mean value was 0.63 mg/m^3. Chlorophyll _a_ values in Biscayne Bay decreased from a mean value of 0.20 mg/m^3 in 1978 to 0.16 mg/m^3 in 1979 and to 0.16 mg/m^3 in 1980 (Figure 3).

Mean biomass values for all stations appear in Table 1. The average biomass value in the canal system was 22.08 mg/m^3 in 1978, 28.61 mg/m^3 in 1979, and 41.88 mg/m^3 in 1980. Biscayne Bay values were 12.97 mg/m^3 in 1978, 11.04 mg/m^3 in 1979, and 10.62 mg/m^3 in 1980 (Figure 4).

The mean primary production estimate for the canal system for 1980 was 0.063 $gC/(m^2 \cdot day)$. This reflects an increase over the previous three years. The mean primary productivity value in the canal system was 0.055 $gC/(m^2 \cdot day)$ in 1978 and 0.057 $gC/(m^2 \cdot day)$ in 1979. Conversely, the bay mean estimate showed a slight decrease when compared to the three previous years. The mean primary productivity value for Biscayne Bay was 0.147 $gC/(m^2 \cdot day)$ in 1978 and 0.084 $gC/(m^2 \cdot day)$ in 1979. The 1980 bay value was 0.082 $gC/(m^2 \cdot day)$ (Figure 5).

Discussion

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. The chlorophyll of a whole euphotic zone fluctuates as a function of available nutrients, predation, and conditions favoring high turnover rates (Odum, 1975).

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 elevated 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 probably being utilized by the macrophytes or otherwise tied-up in relatively long turnaround cycles i.e. biogeochemical cycles, etc.

The 1980 chlorophyll a values for both the canal system and the bay fall within the range of baseline values for Biscayne Bay as determined by Bader & Roessler (FPL, 1972).

Biomass values were higher in the canal system than the bay. This is expected since biomass values are a function of the chlorophyll a. These data cannot be validly compared with the Bader & Roessler (FPL, 1972) baseline biomass data since different analytical methods were employed.

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 as well as organic debris which produced turbidity. The color and turbidity were expected by-products of impoundment. The lowest primary production estimates were exhibited in the canal system at stations where water velocities were relatively high. Again, no conclusions from the baseline and present

primary productivity estimates can be made due 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 1980 the highest primary productivity estimates in Biscayne Bay occurred in the third quarter. This increase was correlated to the generally higher nutrient levels and the longer photoperiod mentioned earlier. This seasonal fluctuation is consistent with those that occurred in previous years (FPL 1978, 1979).

Conclusions

Chlorophyll *a* and biomass values tended to be higher in the cooling canals than the bay. This can be attributed to the higher nutrient levels in the cooling canal system. The primary productivity values of the bay are greater than those of the cooling canal system. The difference is attributed to the disparity in light penetration between the two systems.

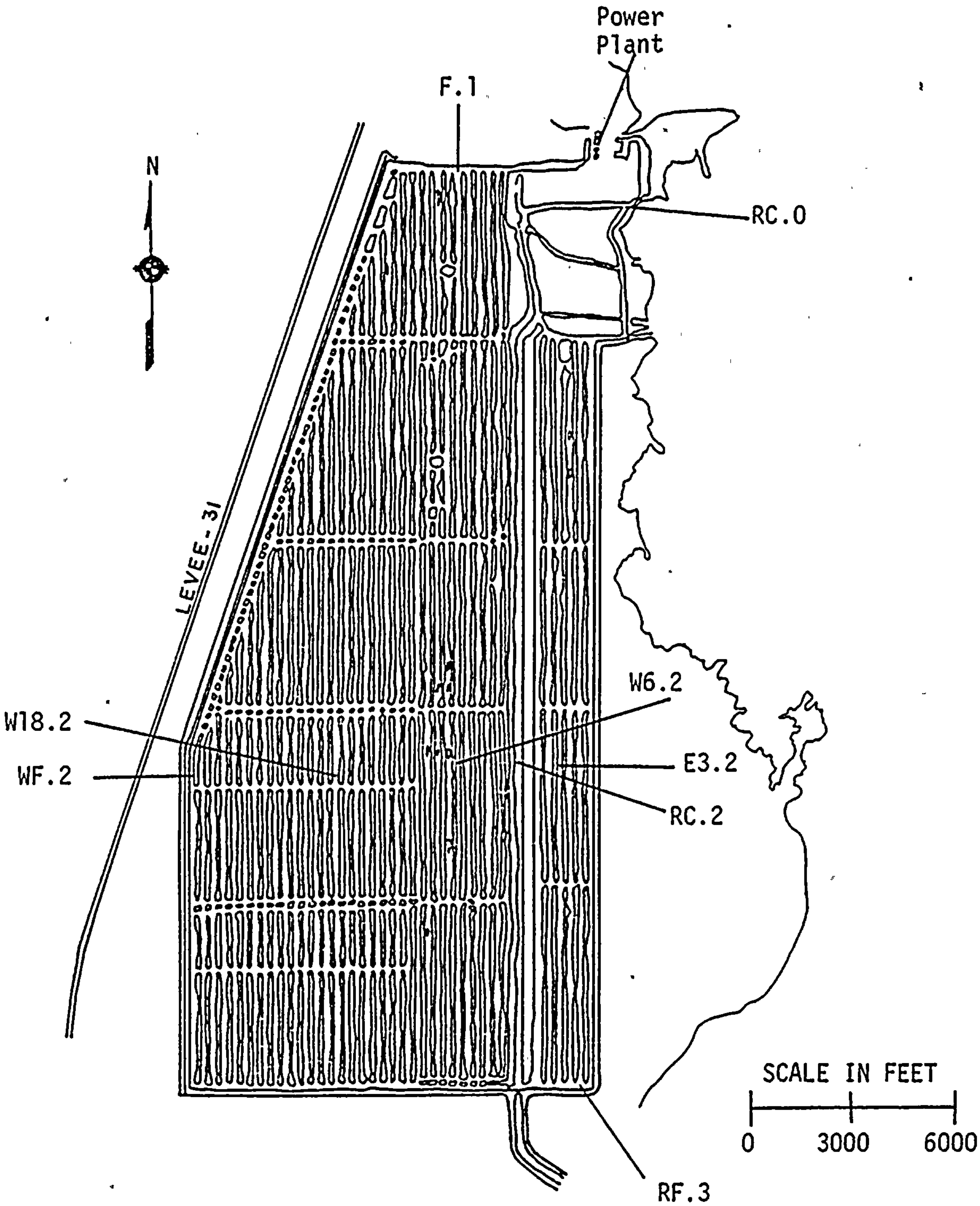


Figure 1. Chlorophyll a sample sites in the Turkey Point Cooling Canal System 1980.

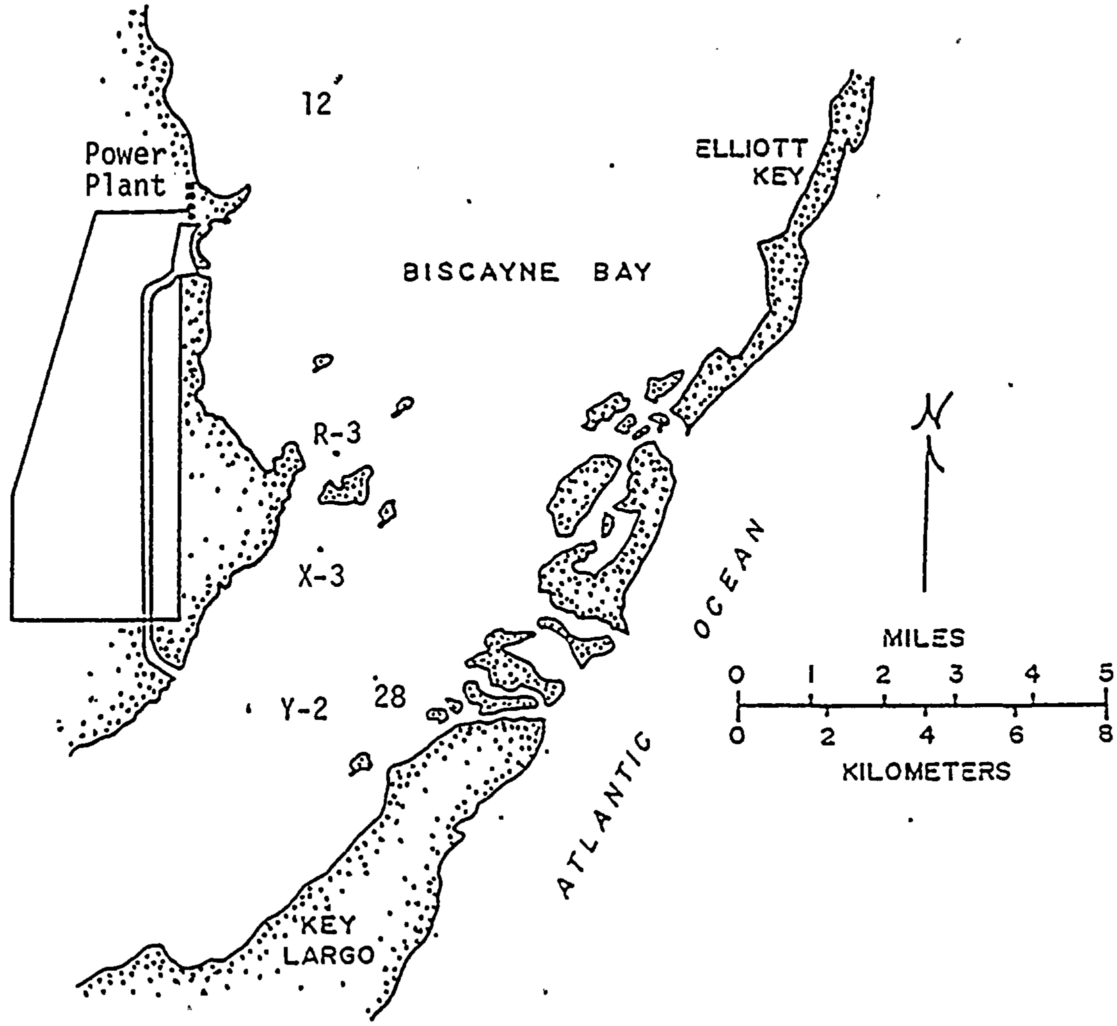


Figure 2. Chlorophyll a sample sites in Biscayne Bay and Card Sound associated with the Turkey Point Cooling Canal System 1980.

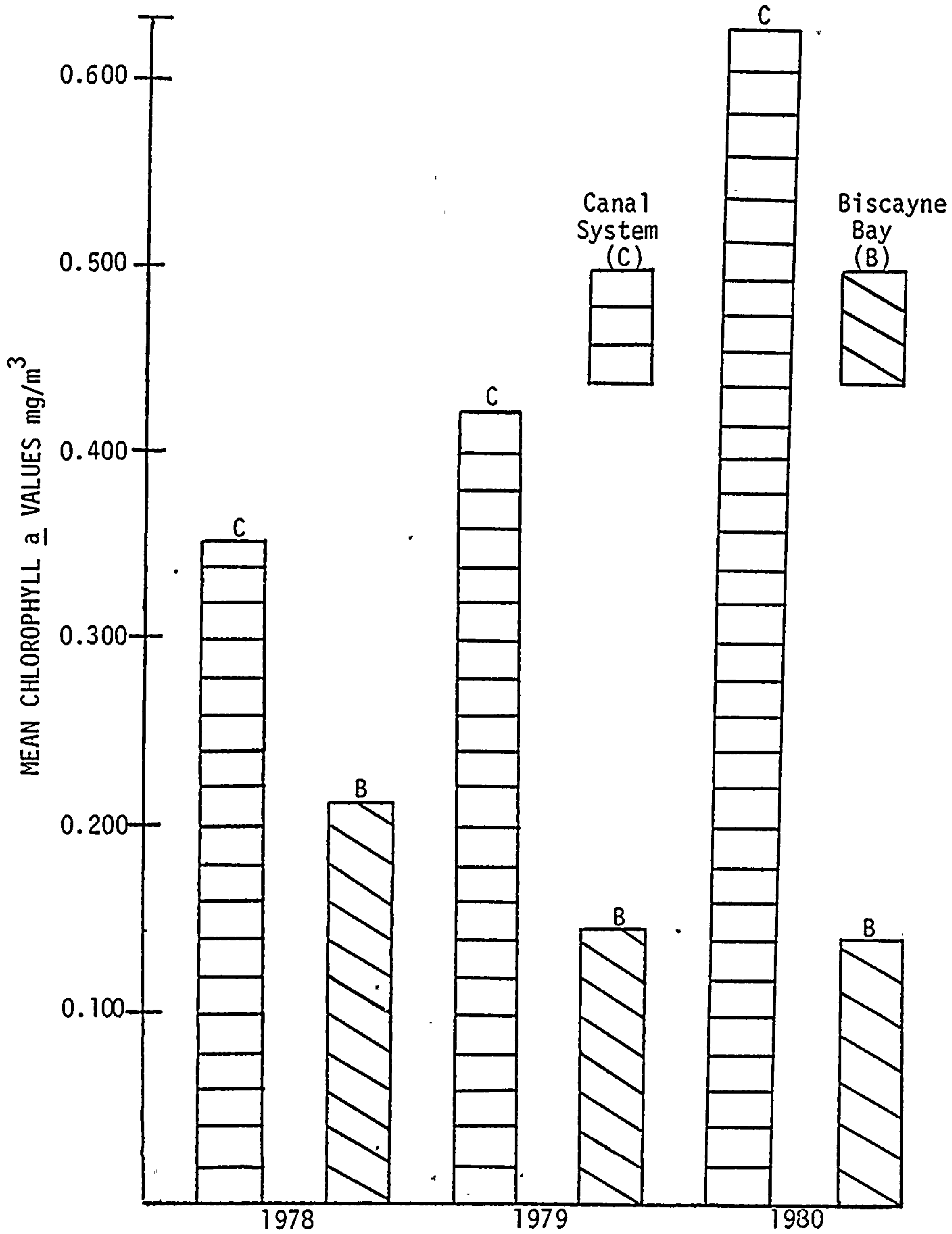


Figure 3. A comparison of 1978 through 1980 mean Chlorophyll a values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound.

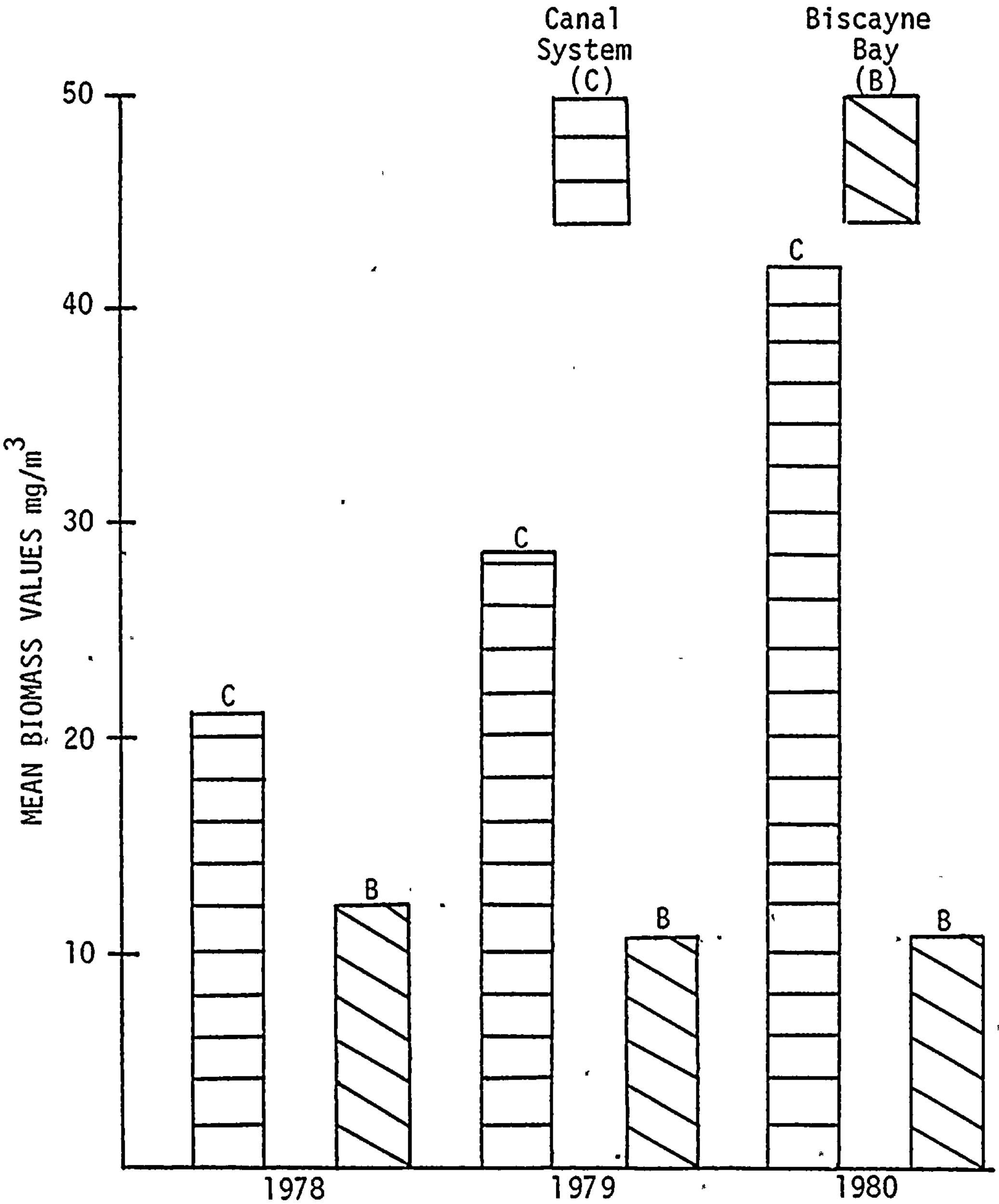


Figure 4. A comparison of 1978 through 1980 mean Biomass values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound.

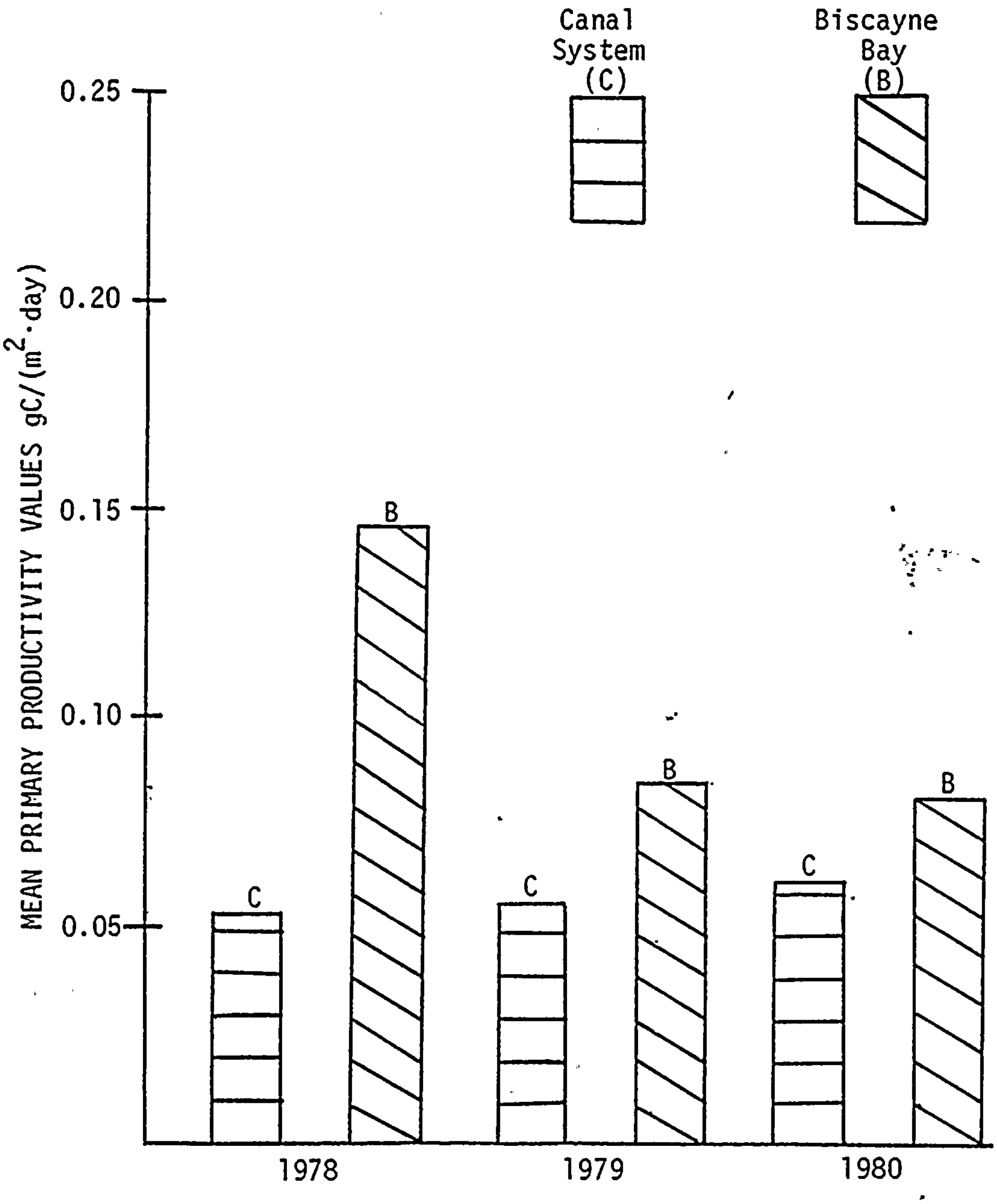


Figure 5. A comparison of 1978 through 1980 mean Primary Productivity values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound.

Table 1. Mean chlorophyll a, biomass and primary productivity values for the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound for 1980.

	Chlorophyll a mg/m^3		Biomass mg/m^3		Primary Productivity gC/(m^2·day)	
	Canals	Bay	Canals	Bay	Canals	Bay
First Quarter (February)	0.45	0.12	29.80	7.81	0.031	0.060
Second Quarter (May)	0.61	0.17	40.59	11.04	0.074	0.086
Third Quarter (August)	1.03	0.22	69.16	15.01	0.118	0.116
Fourth Quarter (November)	0.41	0.13	27.94	8.60	0.029	0.066
Yearly Mean	0.62	0.16	41.87	10.61	0.063	0.082

b. Phytoplankton - organisms

Introduction

This report compares phytoplankton populations occurring in the cooling canal system and adjacent lagoons with those of previous reports (FPL, 1973-1979) in order to follow biological succession and biological stability of the system.

Materials and Methods

The subsurface water samples were collected quarterly (February, May, August, and November) by personnel operating from surface craft. These samples were reduced in volume, sedimented, preserved and examined for species and abundance of organisms. Procedures were as in the previous reports (FPL, 1977). An 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.

In order to bring the names of organisms into better correspondence with presently accepted nomenclature, four diatom names are changed in this report from the names used in the previous Annual Environmental Monitoring Reports. They are for 1979 and 1980 respectively: *Licmophora "Actinella"* to *Campylostylus sp; Cymatopleura solea* to *Nitzschia constricta; Pleurosigma sp.* to *Pleurosigma spenceri; Synedra superba* to *Synedra fulgens*.

A series of stations in the August 1980 sampling included substantial numbers of plant fibers of unknown origin. The plant fibers formed into an intertwining web upon centrifugation and tended to trap a few phytoplankton cells in the mat thus formed. A small inaccuracy in the enumeration process may have been introduced as a result of this entrapment. Essentially comparable amounts of fibers were found in the following August samples: Canal samples: RC.0, E3.2; Bay samples: 3, 12, 19, 25, 26, 29, X-3, R-3.

Results

A total of 101 species were identified in the canal system, including 58 of which were considered common and relatively abundant, and 31 others which were of sporadic occurrence. A total of 125 species were identified in bay waters, including 89 common and relatively abundant species, and 39 others of sporadic occurrence. These species were nearly all recorded in previous studies of these waters, in similar or comparable numbers.

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

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

As in previous surveys, diatoms represented the largest component of the phytoplankton in both canal system and bay. Diatoms were over twice as abundant in the canal system as in the bay.

Discussion

As in previous years, considerable population fluctuations were noted in canal waters in 1980. A population peak for *Rhodomonas sp.* was observed in February samples, of *Amphora* in August and November, of *Cyclotella* in May and of *Synedra fulgens* in August.

As in 1979, blue-green algae were the principal group of organisms showing greater diversity in the canal system than in the bay. Species diversity in 1980 was slightly higher in the bay and slightly lower in the canal system than in 1979. Such fluctuations are to be expected, and no trend is evident in these results. The same is true for the total number of organisms, which appeared higher in 1980 (451 000 for the canal system, 271 000 for the bay) than in 1979 (416 000 in the canal system, 236 000 in the bay), but these figures represent no significant change.

No evidence for significant change in the content of principal phytoplankton nutrients was evident in the chemical data. This was true both for the canal system and for the bay.

Conclusions

The majority of the phytoplankton organisms and groups showed no drastic changes in numbers or diversity and hence provided evidence for biological stability of the canal system. Most of the organisms had been observed in previous years. The fact that certain organisms present in the bay did not regularly occur in the canal system was recorded in previous reports. This was to be expected in view of the detrital sedimentation and higher temperatures of the canal system producing a lower species diversity and greater number of organisms. Thus the phytoplankton populations do not suggest any marked changes from conditions existing in the canal system prior to the report period.

The proportion existing between the different taxonomic groupings of phytoplankton was comparable for both canal system and bay. The canal system populations paralleled those observed in previous reports and represented a population which is apparently normal for the canal system environment.

No marked trends over the 1980 sampling period, as compared to previous years' sampling periods, were observed.

LITERATURE CITED

APHA-AWWA-WPCF. 1975. Standard methods for the examination of water and wastewater. 14th ed. APHA Wash. D.C. 1193 pp.

ASTM. 1980. Annual book of ASTM standards. Philadelphia, PA. 1232 pp.

Bader, R.G. and Roessler, M.A. 1972. An ecological study of South Biscayne Bay and Card Sound. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, FL.

Florida Power & Light Co. 1979. Turkey Point Units 3 & 4 non-radiological environmental monitoring report nos. 1. Miami, Florida.

Ryther, J.H., Yentsch, C.S. 1957. The estimation of phytoplankton production in the ocean from chlorophyll and light data. Limnol. and Oceanogr. 2:281-286.

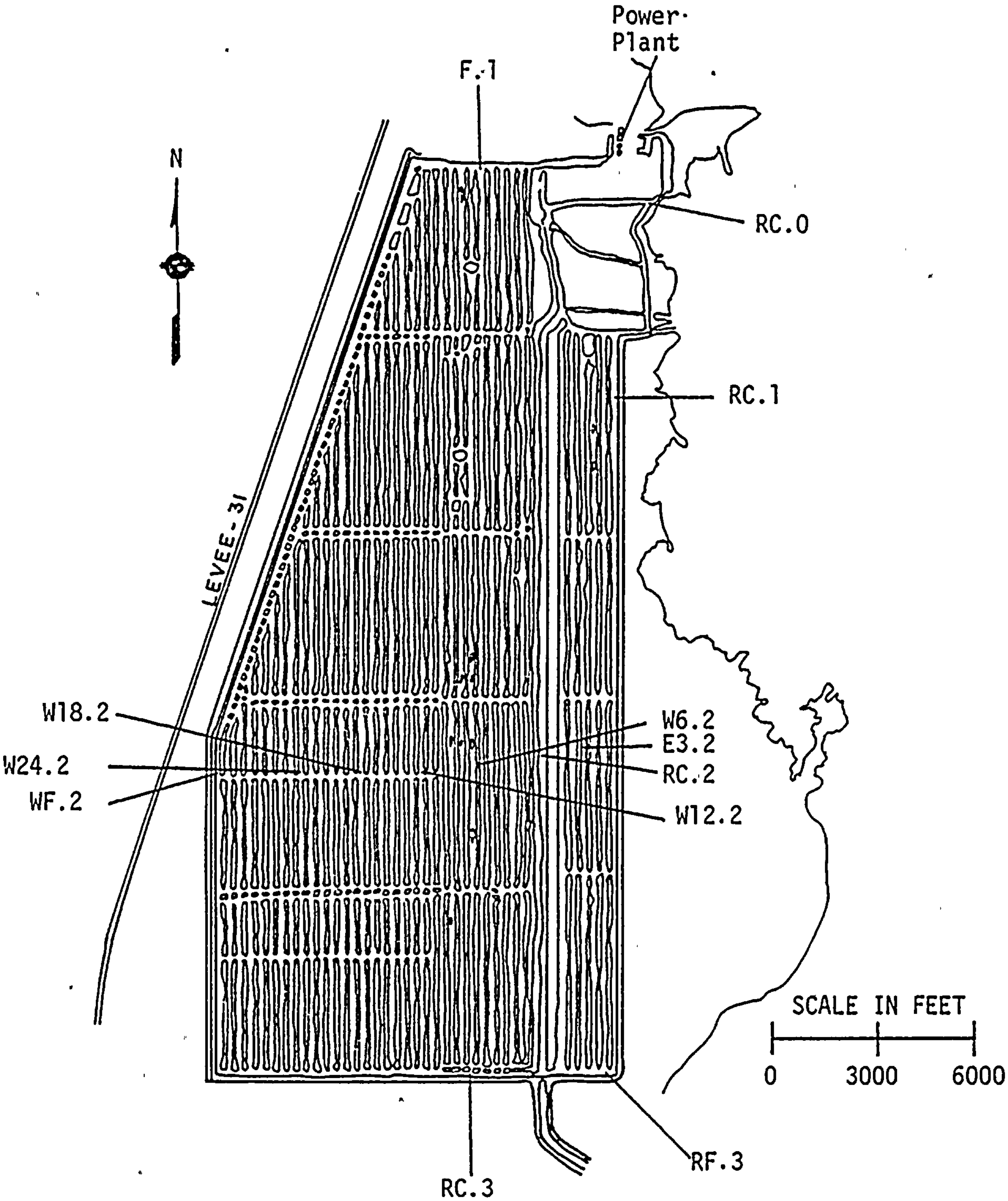


Figure 1. Phytoplankton sample sites in the Turkey Point Cooling Canal System 1980.

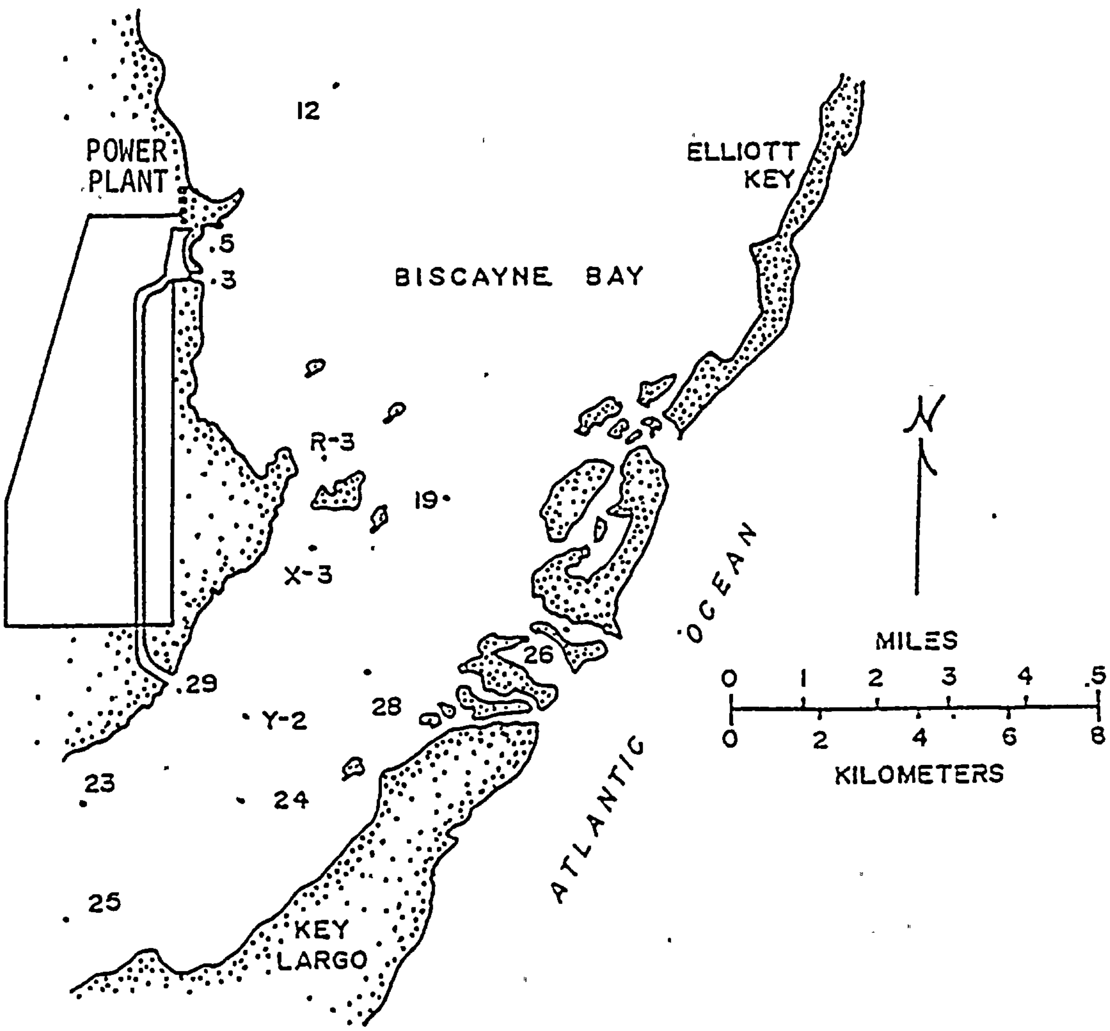


Figure 2. Phytoplankton sample sites in Biscayne Bay and Card Sound adjacent to the Turkey Point Cooling Canal System. 1980.

Table 1. Counts of the principal phytoplankton organisms found in the Turkey Point Cooling Canal System in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the 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 sp.	3	107	5	118	10	1338	9	527
Blue-green algae								
Anabaena sp.	5	217	4	310	8	5181	6	501
Aphanocapsa sp.	1	93	1	31	3	93	2	281
Arthrospira jenneri	1	7	1	31	1	4	1	10
Chroococcus gigantea	4	74	2	76	9	523	6	1475
Chroococcus sp.	4	124	2	66	7	496	4	132
Gloeocapsa sp.	-	-	1	31	-	-	-	-
Gomphosphaeria aponina	1	4	5	291	6	167	6	281
Johannesbaptistia pellucida	1	35	3	455	1	31	2	8
Lyngbya sp.	-	-	-	-	-	-	2	90
Merismopedia sp.	2	93	4	248	3	66	3	197
Microcystis sp.	2	62	-	-	-	-	5	197
Oscillatoria sp. (3-8μ)	2	93	9	601	7	3849	8	344
Oscillatoria sp. (3-12μ)	2	35	4	62	10	566	6	1579
Oscillatoria sp. (over 12μ)	-	-	3	66	5	262	5	914
Schizothrix calcicola	3	124	-	-	3	248	2	80
Spirulina major	2	93	2	66	-	-	-	-
S. minor	1	31	2	66	5	407	4	217
Green algae								
Chlorella sp.	-	-	1	155	-	-	-	-
Chlamydomonas sp.	2	62	4	217	-	-	2	124

Table 1. (cont'd) Counts of the principal phytoplankton organisms found in the Turkey Point Cooling Canal System in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Green algae (cont'd)								
Pyramidomonas sp.	1	31	7	528	-	-	1	31
Euglenoids								
Cylindromonas sp.	1	31	1	31	-	-	-	-
Euglena sp.	-	-	-	-	1	4	6	131
Eutreptia sp.	-	-	10	976	2	28	10	3670
Undet. Euglenoids	-	-	1	31	-	-	-	-
Silicoflagellates								
Dictyocha fibula	1	15	2	97	-	-	1	31
Cryptomonads								
Cryptomonas sp.	6	496	11	1116	7	1085	4	131
Rhodomonas sp.	10	9455	12	4247	6	1116	5	528
Flagellates (*incertae sedis*)	9	713	11	6721	6	1488	6	5766
Dinoflagellates								
Amphidinium sp.	7	527	8	1054	2	62	9	1178
Ceratium furca	-	-	2	35	-	-	3	280
Exuviaella marina	-	-	5	65	2	8	-	-
E. minor	3	124	8	431	3	156	4	248
E. oblonga	9	718	11	1058	4	178	4	25
Gymnodinium albulum	11	589	5	217	2	93	1	62
G. foliaceum	7	868	10	1023	3	186	3	434

Table 1. (cont'd) Counts of the principal phytoplankton organisms found in the Turkey Point Cooling Canal System in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Dinoflagellates (cont'd)								
G. splendens	-	-	-	-	-	-	1	124
Gymnodinium (small) Unk.	11	1178	12	14 680	9	2201	9	22 828
Gymnodinium (large) Unk.	2	62	1	62	5	341	5	589
Peridinium achromaticum	-	-	3	93	-	-	-	-
P. depressum	1	31	-	-	-	-	-	-
P. divergens	-	-	2	135	-	-	3	100
P. hirobis	-	-	1	155	-	-	2	93
P. trochoideum	4	155	-	-	-	-	-	-
P. variegatum	-	-	-	-	1	31	-	-
Peridinium sp.	8	930	7	403	6	248	2	249
Peridiniopsis rotundata	1	31	3	124	3	66	-	-
Prorocentrum gracile	1	4	-	-	-	-	2	35
P. micans	-	-	-	-	-	-	-	-
Protoceratium reticulatum	2	35	-	-	-	-	1	4
Pyrocystis sp.	-	-	1	4	-	-	4	108
Pyrodinium bahamiense	-	-	-	-	-	-	2	499
Unidentified Dinoflagellates	11	2922	7	189	8	2356	3	749
Diatoms								
Amphiprora alata	7	310	4	190	6	256	2	135
A. minuta	7	186	4	461	9	620	5	589
A. paludosa	5	31	2	95	5	279	1	496
Amphiprora sp.	-	-	6	685	2	155	1	62
Amphora alata	4	248	-	-	-	-	2	124
A. ocellata	-	-	-	-	1	4	2	124

Table 1. (cont'd) Counts of the principal phytoplankton organisms found in the Turkey Point Cooling Canal System in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the 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)								
Amphora sp.	-	-	7	1152	12	15 584	11	13 380
Biddulphia sp.	1	7	-	-	-	-	-	-
Campylostylus sp.	2	124	5	150	11	4414	9	1482
Campylodiscus sp.	-	-	-	-	-	-	2	200
Campylosira cymbelliformis	2	62	2	62	9	1247	7	1553
Chaetoceras sp.	-	-	-	-	1	31	11	5586
Cocconeis sp.	12	2821	12	2697	4	713	8	1762
Coscinodiscus concinnus	-	-	-	-	-	-	2	124
Cyclotella sp.	10	15 441	12	89 204	6	465	11	5952
Cymbella sp.	2	62	4	248	2	93	3	162
Fragilaria sp.	-	-	-	-	-	-	1	8
Grammatophora sp.	1	31	-	-	-	-	-	-
Gyrosigma balticum	-	-	-	-	-	-	2	12
Licmophora abbreviata	1	31	2	93	-	-	1	62
L. flabellata	5	410	11	1057	9	253	8	525
L. grandis	-	-	-	-	-	-	1	4
Navicula amphibola	2	128	6	108	10	573	9	4064
Naviculoid diatoms	7	12 714	10	48 037	11	50 716	12	11 918
Nitzschia acicularis	7	744	6	717	3	248	7	929
N. asterionelloides	3	186	4	279	-	-	-	-
N. closterium	10	496	7	558	6	496	5	279
N. longa	1	31	-	-	-	-	2	66
N. longissima	11	1517	7	1003	-	-	3	279
N. lorenziana	-	-	-	-	1	31	-	-
N. sigma	-	-	-	-	2	93	-	-
N. sigmoidea	-	-	-	-	-	-	1	7

Table 1. (cont'd) Counts of the principal phytoplankton organisms found in the Turkey Point Cooling Canal System in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the 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)								
N. constricta	9	806	11	1552	1	31	10	1333
Pleurosigma brebissonii	7	620	5	1116	8	975	5	1148
P. spenceri	10	288	8	197	10	13 248	12	1246
P. lineare	3	278	2	62	-	-	5	146
Synedra asterionelloides	-	-	2	93	1	4	-	-
S. acicularis	2	97	5	248	1	31	3	342
S. affinis	1	62	-	-	-	-	5	651
S. crystallina	1	31	4	4	-	-	3	324
S. hennedyiana	-	-	-	-	1	31	-	-
S. fulgens	1	93	4	589	9	9631	7	4298
S. undulata	-	-	1	4	-	-	-	-
Synedra sp.	5	434	1	62	6	407	1	31
Surirella sp.	3	97	-	-	-	-	1	31
Thallassiosira sp.	6	806	1	31	-	-	-	-
Unidentified Diatoms	9	1956	5	200	6	565	8	930
Rhizopods								
Amoeba sp.	-	-	-	-	-	-	1	62
Ciliates								
Dysteris sp.	-	-	1	31	-	-	-	-
Favella panamensis	-	-	1	35	-	-	-	-
Metacylis corbula	-	-	-	-	-	-	1	4
M. juergensenii	-	-	-	-	-	-	2	8
Orthodon sp.	-	-	-	-	-	-	1	31
Strobilidium sp.	-	-	-	-	-	-	1	31

Table 1. (cont'd) Counts in the principal phytoplankton organisms found in the Turkey Point Cooling Canal System in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Ciliates (cont'd)								
Tintinnopsis strigosa	-	-	-	-	-	-	1	17
T. tubulosoides	-	-	5	139	3	51	7	707
Tintinnus sp.	1	4	1	4	-	-	1	62
Unidentified Ciliates	2	97	1	35	5	372	4	596
Metazoa								
Copepods	10	152	10	750	1	31	10	319
Undet. Larvae	2	11	4	92	1	4	2	42
Nematodes	1	7	1	4	5	91	3	145
Gastropods	2	11	6	111	2	39	3	25
Bivalves	-	-	1	31	-	-	4	167
Eggs	6	132	2	8	4	43	3	76
Cells (*Incertae sedis*)	11	14291	11	11284	11	7688	12	9091

Table 2. Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred: Column B indicates the 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 sp.	5	167	1	4	7	350	5	177
Blue-green algae								
Anabaena sp.	1	31	1	31	5	434	7	761
Aphanocapsa sp.	6	232	2	62	-	-	3	128
Arthrospira jenneri	1	15	1	4	4	279	2	11
Chroococcus gigantea	3	93	-	-	2	8	-	-
Chroococcus sp.	4	84	7	287	6	407	4	342
Gloeocapsa sp.	2	34	2	93	1	4	-	-
Gomphosphaeria aponina	8	315	6	174	10	428	7	137
Johannesbaptistia pellucida	8	291	9	579	3	124	5	198
Merismopedia sp.	-	-	2	62	1	31	3	128
Microcystis sp.	1	31	-	-	-	-	1	62
Oscillatoria sp. (3-8μ)	3	50	2	8	3	107	3	279
Oscillatoria sp. (9-12μ)	2	46	3	39	4	338	5	418
Oscillatoria sp. (over 12μ)	-	-	-	-	4	182	1	35
Schizothrix calcicola	4	170	1	62	2	62	1	31
Spirulina major	1	155	-	-	1	31	-	-
S. minor	2	46	2	62	2	62	3	124
Green algae								
Chlorella sp.	-	-	-	-	-	-	1	93
Chlamydomonas sp.	1	46	1	62	3	62	2	93
Pyramidomonas sp.	2	217	4	496	7	341	6	527

Table 2. (cont'd) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Euglenoids								
Cylindromonas sp.	4	185	1	31	-	-	-	-
Euglena sp.	-	-	-	-	-	-	1	4
Eutreptia sp.	1	62	-	-	4	193	2	55
Undet. Euglenoids	6	465	3	186	2	62	2	93
Silicoflagellates								
Dictyocha fibula	1	15	2	97	-	-	1	31
Cryptomonads								
Cryptomonas sp.	2	124	11	1457	10	961	8	527
Rhodomonas sp.	11	1577	11	5859	13	12 152	8	1860
Flagellates (*Incertae sedis*)	13	2774	12	4185	10	1860	10	12 722
Dinoflagellates								
Amphidinium sp.	13	1518	11	985	6	620	9	1023
Ceratium furca	10	670	9	444	8	374	9	270
Cochlodinium sp.	2	66	1	31	2	35	-	-
Dinophysis sp.	-	-	-	-	-	-	1	4
Diplopsalis lenticularis	-	-	1	31	1	62	-	-
Exuviaella apora	-	-	1	31	-	-	-	-
E. marina	2	8	2	11	5	26	3	12
E. minor	2	155	8	425	4	190	3	93
E. oblonga	8	432	13	475	8	329	6	121
Gonyaulax digitale	1	45	-	-	-	-	-	-

Table 2. (cont'd) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Dinoflagellates (cont'd)								
Gonyaulax sp.	-	-	-	-	3	155	-	-
Gymnodinium albulum	5	744	3	186	-	-	1	31
G. breve	-	-	-	-	-	-	1	31
G. foliaceum	-	-	5	217	4	124	-	-
G. spendens	-	-	1	4	8	253	1	31
Gymnodinium (small) (Unk.)	9	1162	13	8060	11	15 056	12	22 568
Gymnodinium (large) (Unk.)	2	62	2	62	10	4609	8	527
Gyrodinium pingue	1	31	3	93	7	190	1	93
Oxytoxum sp.	-	-	-	-	1	31	2	35
Peridinium achromaticum	1	31	1	43	-	-	1	124
P. conicum	-	-	-	-	1	31	1	62
P. depressum	2	14	2	14	4	26	2	27
P. divergens	-	-	4	163	1	31	1	31
P. hirobis	5	124	4	132	2	8	4	159
P. trochoideum	4	108	5	558	6	248	2	124
Peridinium sp.	11	1640	11	2573	2	62	1	31
Peridiniopsis rotundata	-	-	7	132	2	62	1	31
Prorocentrum gracile	1	4	4	83	9	250	5	50
P. micans	9	151	7	139	10	442	5	29
Protoceratium reticulatum	5	128	6	167	5	29	6	81
Pyrocystis sp.	8	246	9	328	12	1102	9	383
Pyrodinium bahamense	6	441	13	1459	9	778	9	1340
Unidentified Dinoflagellates	13	7667	13	7258	6	1674	6	744
Diatoms								
Amphiprora alata	3	69	4	97	-	-	5	155

Table 2. (cont'd) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the 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)								
A. minuta	2	139	4	248	4	248	4	217
A. paludosa	1	31	2	62	-	-	2	94
Amphiprora sp.	3	124	6	263	8	589	3	124
Amphora alata	5	263	1	186	-	-	-	-
A. ocellata	4	139	1	31	4	97	6	166
A. sp.	3	77	5	255	4	190	7	799
Campylostylus sp.	1	31	-	-	6	331	2	80
Campylodiscus sp.	1	62	-	-	1	4	1	4
Campylosira cymbelliformis	-	-	-	-	3	97	3	186
Chaetoceras sp.	2	62	1	155	1	31	4	97
Climacosphenia sp.	-	-	1	4	-	-	1	4
Cocconeis sp.	10	1440	12	1217	11	3084	9	2821
Coscinodiscus concinnus	-	-	-	-	8	68	7	181
Cyclotella sp.	10	3043	10	5737	12	3084	9	2108
Cymbella sp.	6	185	1	31	4	124	7	403
Fragilaria sp.	1	31	-	-	-	-	2	155
Grammatophora sp.	-	-	-	-	-	-	1	10
Gyrosigma balticum	-	-	-	-	1	10	-	-
Licmophora abbreviata	4	620	4	279	1	31	3	124
L. flabellata	6	260	10	883	9	226	8	635
L. grandis	1	4	3	18	2	66	1	4
Navicula amphibola	1	31	7	109	9	526	9	411
N. hamulifera	-	-	-	-	-	-	7	60
N. pandura	3	50	3	145	2	66	2	8
N. scopulorum	-	-	2	24	1	31	-	-
Naviculoid diatoms	13	5454	13	18 663	13	19 220	10	30 772

Table 2. (cont'd) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the 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)								
Nitzschia acicularis	4	217	4	310	9	1564	5	499
N. asterionelloides	3	170	7	250	7	872	2	93
N. clausii	1	62	-	-	1	31	2	93
N. closterium	5	201	7	217	5	310	3	248
N. longa	1	93	-	-	-	-	-	-
N. longissima	10	976	9	527	8	248	6	465
N. lorenziana	1	24	-	-	-	-	-	-
N. sigma	-	-	-	-	2	66	4	201
N. sigmoidea	1	4	1	4	1	4	2	8
N. constricta	9	495	10	3255	12	1953	8	2046
Pleurosigma brebissonii	1	31	3	93	2	62	1	35
P. spenceri	3	43	2	69	9	370	8	191
P. lineare	-	-	10	360	5	47	6	479
Striatella sp.	2	62	3	127	7	899	6	197
Synedra asterionelloides	1	62	1	4	-	-	2	93
S. acicularis	3	93	5	222	4	217	2	155
S. crystallina	4	83	9	220	5	104	8	319
S. hennedyiana	-	-	-	-	1	62	3	39
S. laevigata	-	-	-	-	3	79	4	47
S. fulgens	-	-	2	66	4	190	6	372
S. undulata	1	15	3	66	1	4	-	-
Synedra sp.	4	217	3	124	5	310	6	403
Surirella sp.	2	62	4	70	3	193	2	31
Thalassiosira sp.	2	93	2	155	-	-	3	66
Orthoneis sp.	1	31	-	-	-	-	-	-
Unidentified Diatoms	12	1488	12	1093	6	531	9	845

Table 2. (cont'd) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Rhizopods								
Amoeba sp.	-	-	1	31	1	62	1	4
Ciliates								
Acanthostomella	-	-	1	4	-	-	-	-
Cyclidium sp.	1	31	-	-	-	-	-	-
Coxliella sp.	1	15	-	-	1	4	2	35
Dysteria sp.	-	-	2	35	-	-	-	-
Favella panamensis	1	35	8	173	-	-	1	4
Metacylis corbula	-	-	-	-	-	-	3	62
M. juergensenii	5	196	7	135	3	39	4	25
Steensrupiella sp.	2	132	-	-	-	-	-	-
Strobilidium sp.	1	31	1	31	1	31	1	62
Strombidium conicum	2	93	3	97	1	31	6	465
S. strobilus	7	728	2	35	1	31	-	-
Strombidium sp.	3	81	1	41	1	35	1	31
Tintinnopsis apertus	-	-	1	4	-	-	1	38
T. bermudense	-	-	1	4	-	-	-	-
T. platensis	1	31	-	-	-	-	-	-
T. rectus	-	-	8	359	-	-	5	322
T. strigosa	1	4	11	552	2	70	5	278
T. tubulosoides	5	395	5	176	3	39	4	296
Tintinnus sp.	2	121	-	-	-	-	1	4
Unidentified Ciliates	13	2131	13	1565	8	880	8	1412

Table 2. (cont'd) Counts of the principal phytoplankton organisms found in the 13 Biscayne Bay/Card Sound samples in 1980. Column A indicates the number of stations at which it occurred; Column B indicates the total number of organisms or colonies per 0.5 liter.

	February		May		August		November	
	A	B	A	B	A	B	A	B
Metazoa								
Copepods	12	846	11	384	11	243	10	386
Undet. Larvae	7	124	7	74	5	129	7	75
Nematodes	1	31	-	-	-	-	2	8
Gastropods	6	117	2	11	5	51	5	57
Crab larvae	1	4	-	-	-	-	-	-
Rotifers	-	-	-	-	-	-	1	4
Bivalves	-	-	1	31	6	81	6	113
Medusae	-	-	1	4	-	-	-	-
Eggs	2	11	4	84	1	31	4	93
Cells (*Incertae sedis*)	13	22 056	13	11 876	13	9176	9	11 160

Table 3. Species of rare occurrence found in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound in addition to Tables 1 and 2 for 1980.

CANALS	
SPECIES	STATION
Achnanthes longipes	F.1
Chroococcus lacustris	RF.3
Polycheate larvae	RC.2
Unknown Chrysophyceae	E3.2

BAY	
Amphora commutata	3
Eutreptia hirudoidea	3
Exuviaella perforata	3
Prorentrum schilleri	5
Trochophore larva	5
Nitzschia paradoxa	12
Triceratium sp.	19
Synedra gallioni	23
Vacuolaria sp.	24
Hydroid	24
Eucapsis sp.	26
Amphidinium phaeocysticola	28
Synedra ulna	29
Tintinnopsis urnula	29
Gyrodinium spirale	Y-2
Tintinnopsis lindeni	Y-2

Table 4. Species diversity of the respective groups of phytoplankton organisms found in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound in 1979 and 1980.

GROUPS	1979 CANALS	1979 BAY	1980 CANALS	1980 BAY
Sulfur organisms	2	1	1	1
Blue-green algae	25	18	18	17
Green algae	4	5	3	3
Euglenoids	5	4	4	5
Silicoflagellates	0	1	1	1
Cryptomonads	3	2	2	2
Dinoflagellates	16	33	23	40
Diatoms	59	60	48	58
Rhizopods	1	1	1	1
Flagellates	1	1	1	1
Ciliates	6	23	11	23
Metazoa	8	8	7	11
Total	130	157	120	163

Table 5. Counts by taxonomic group of organisms found in the Canal System and Bay in 1980. Population totals are in each case for the 0.5 liters Canal and Bay samples.

Groups	Feb.		May		Aug.		Nov.		Sub-totals		Total
	Canals	Bay	Canals	Bay	Canals	Bay	Canals	Bay	Canals	Bay	By Group
Blue-greens	1085	1593	2400	1463	11 893	2900	6312	2840	21 690	8796	30 486
Dinoflagellates	8174	15 447	19 728	24 273	5926	26 727	27 605	28 340	61 433	94 787	156 220
Diatoms	41 150	15 787	150 940	35 641	99 194	36 239	60 302	47 291	351 586	134 958	486 544
Ciliates	101	4024	209	3211	423	1161	1450	3034	2183	11 430	13 613
Flagellates *(Incertae sedis)*	713	2774	6721	4185	1488	1860	5766	12 772	14 688	21 591	36 279
Subtotals	51 223	36 925	179 998	68 773	118 924	68 887	101 435	94 277	451 480	271 562	
Totals by month - Canals and Bay combined	90 848		248 771		187 811		195 712				723 142 (Grand Total)

2. Fish (ETS 4.1.1.1.2)

Introduction

This study characterizes and documents population changes that occur in the fish fauna within the Turkey Point Cooling Canal System. To place these changes in perspective, the canal fauna are compared to that of Biscayne Bay/Card Sound (Nugent, 1970).

Populations of fish within the 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 to determine the species present, their relative abundance, life history stages, biomass, and size. Species that demonstrate a variety of life history stages are considered to be reproducing and established in the canals, while those represented only by adults are not reproducing and could be expected to be lost through natural attrition.

Materials and Methods

Fish were collected monthly from January through December 1980 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. Water depth at Stations 3, 5, 6, and 7 averaged less than 1 m. Stations 9 and 10 were in a backwater area and small pond, respectively, adjacent to 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 whenever possible, counted, measured to the nearest millimeter, and weighed to the nearest gram. Fish were measured from the tip of the snout to the caudal peduncle (standard length). Fish nomenclature was in accordance with Böhlke and Chaplin (1968).

Results

A total of 17 species of fish represented by 8412 individuals were collected in the canals during 1980 (Table 1). The majority of these individuals were small forage fish collected by minnow traps.

The killifish family (Cyprinodontidae) comprised 93.2 percent of the total number of fish collected in 1980. The sheepshead minnow and goldspotted killifish were the predominant species found with 4672 and 3153 individuals, respectively (Table 1). Other members of this family collected were the rainwater, marsh, and gulf killifish. Killifish are generally less than 65mm in length and, because of their small size, comprised only 17.9 percent of the total biomass of the fish collected.

The livebearer family (Poecilidae) was represented by the sailfin molly and mosquitofish. Live bearers comprised 2.7 percent of the total number of fish collected during 1980 and, due to their small size, comprised only 0.7 percent of the total fish biomass (Table 1).

The balance of the fish collected in 1980 comprised only 4.1 percent of the total number but accounted for 81.4 percent of the total biomass. The collection of a relatively few large individuals such as bonefish, barracuda, and snapper accounted for most of the biomass (Table 1).

Discussion

Actively reproducing populations of killifish and livebearers within the canals were evidenced by the occurrence of juveniles as well as adults (Table 1) and the continued abundance of these fish over the six years sampled (Table 2). Although not as abundant as the killifish, crested gobies and gulf toadfish were also collected as juveniles and adults and are considered established in the system. No juvenile silver jennys or spotfin mojarras were collected during 1980. Mosquitofish were collected for the first time in the canal system during 1980.

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 nonreproducing 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. These fish (such as *Sphyraena barracuda*, *Albula vulpes*, and *Caranx hippos*) 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 slightly over subsequent years until 1980 (Figure 2). Minnow trap CPUE for this year was the highest ever recorded. The large expanse of generally shallow water provided an ideal situation for forage fish. This and the decrease in the number of predatory species may be a cause for the increase in their populations. The gill net CPUE, indicative of populations of larger fish, decreased substantially after the 1975 study and has decreased slowly over subsequent years.

Eighty species of fish were collected by trawling in south Biscayne Bay and Card Sound during the baseline survey for the Turkey Point Plant (Bader and Roessler, 1971). This can be compared to 42 species collected in the canal system from 1974 through 1978 and a total of 25 species were collected in 1979 and 1980. Although the different collecting methods, between Bader 1971 and later works, may have accounted for some of the difference in the number of species, it appears that many species found in the bay and sound 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 fish. These 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 also found more species than were found in the canal system. This is a further indication that certain fish species in the area may not have entered the canal before it was closed in 1973.

In general studies conducted during 1979 and 1980 have shown that the fish which became isolated in the canals were primarily the common, and often abundant species found by Nugent outside the canal system. The few species collected from 1974 through 1978 which were not found by Nugent (Table 3) were mainly small fish collected by minnow traps, a collection method which Nugent did not use.

Conclusions

Populations of fish 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 fish in the killifish and livebearer families, have adopted relatively well in the canals. Other fish, 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 fish.

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 and thus did not become entrapped in the canals. All fish found within the canals were members of species which were common or abundant outside the canal system in adjacent waters.

LITERATURE CITED

Bader, R.G. and M.A. Roessler. 1971. An ecological study of South Biscayne Bay and Card Sound. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, FL.

Böhlke, J.E., Chaplin C.C.G. 1968. Fishes of the Bahamas and adjacent tropical waters. Acad. of Nat. Sci. of Phila. 753 pp.

Florida Power & Light Co. 1973-1979. Turkey Point Units 3 & 4 non-radiological environmental monitoring report nos. 1-13, Miami, Florida.

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

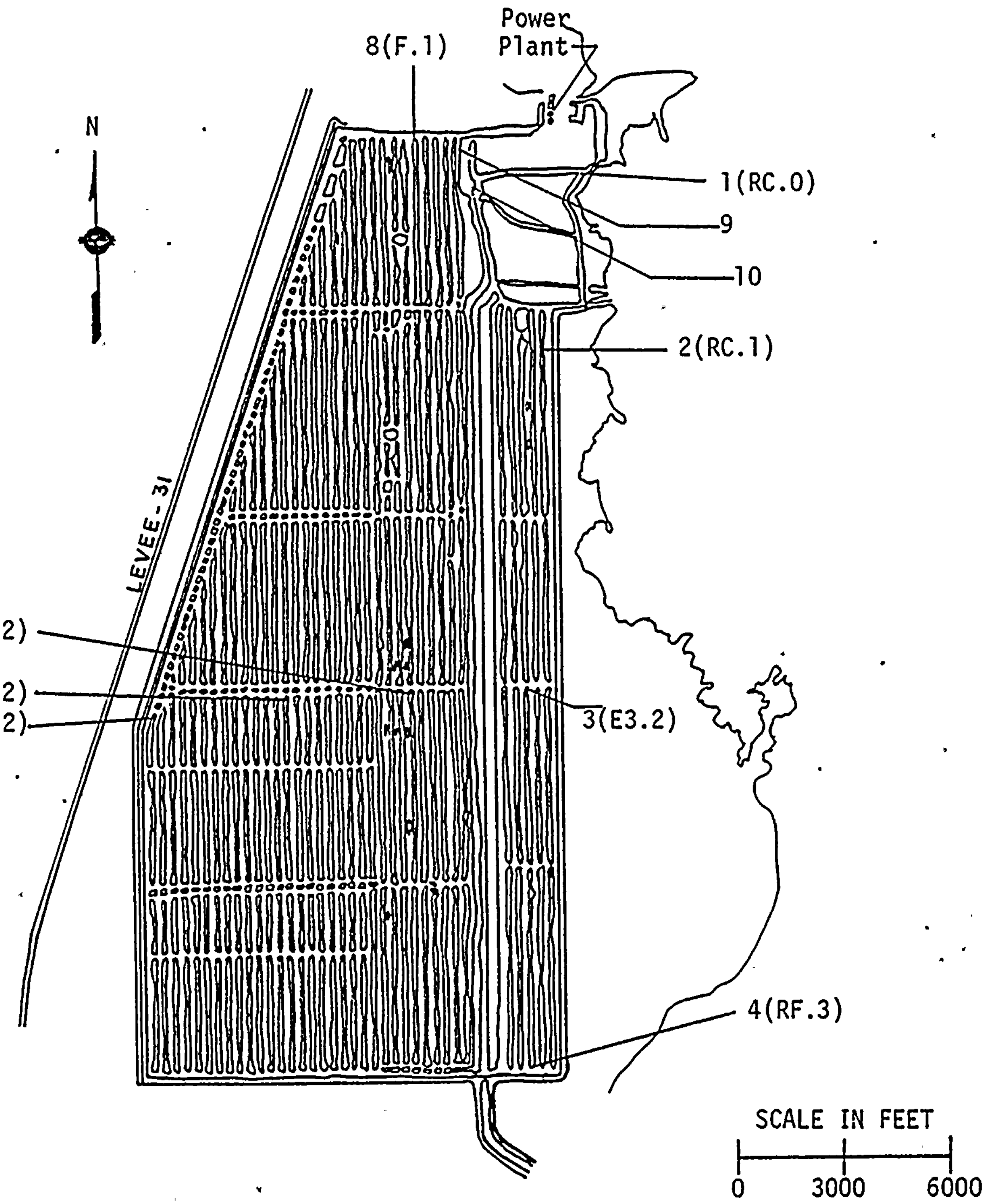


Figure 1. Fish sampling station locations, Turkey Point Cooling Canal System 1980.

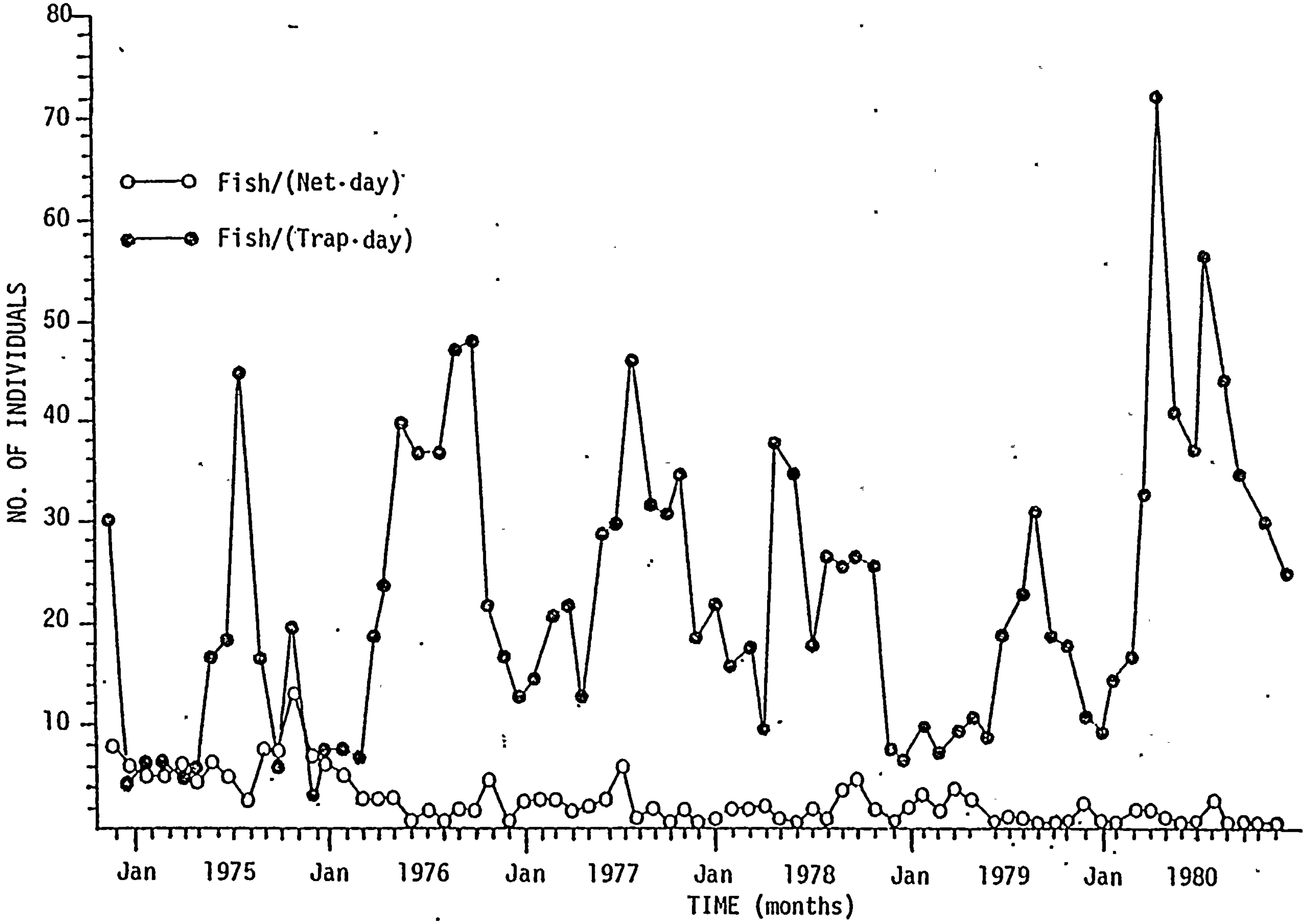


Figure 2. Minnow trap and gill net catch per unit effort in Turkey Point Cooling Canal System for December 1974 through December 1980.

Table 1. Fish collected within the Turkey Point Cooling Canal System for January through December 1980.

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition of fishes by: Number	Weight
sheepshead minnow *(Cyprinodon variegatus)*[c]	4672	20-55	3824	55.5	7.8
goldspotted killifish *(Floridichthys carpio)*[c]	3153	19-60	4783	37.5	9.8
sailfin molly *(Poecilia latipinna)*[c]	228	20-59	342	2.7	0.7
crested goby *(Lophogobius cyprinoides)*[c]	204	21-84	895	2.4	1.8
yellowfin mojarra *(Gerres cinereus)*	87	115-224	15488	1.0	31.8
gulf toadfish *(Opsanus beta)*[c]	23	55-152	433	0.3	0.9
silver jenny *(Eucinostomus gula)*	8	106-127	389	≤.1	0.8
gray snapper *(Lutjanus griseus)*	8	220-998	6048	≤.1	12.4
great barracuda *(Sphyraena barracuda)*	7	480-650	10260	≤.1	21.0
gulf killifish *(Fundulus grandis)*[c]	7	48-105	107	≤.1	0.2
rainwater killifish *(Lucania parva)*[c]	6	23-33	4	≤.1	≤.1
bonefish *(Albula vulpes)*	3	457-510	5429	≤.1	11.1
mosquito fish *(Gambusia affinis)*	2	33-34	1	≤.1	≤.1
spotfin mojarra *(Eucinostomus argenteus)*	1	144	66	≤.1	0.1
drum (SCIAENIDAE)	1	375	685	≤.1	1.4
atlantic needlefish *(Strongylura marina)*	1	218	16	≤.1	≤.1
marsh killifish *(Fundulus confluentus)*	1	35	1	≤.1	≤.1

NOTE: [c]Species which are reproducing in the canal system.

Table 2. Fish collected within the Turkey Point Cooling Canal System for 1975 through 1980.

Species[a]	Number of individuals per year					
	1975[b]	1976[b]	1977[b]	1978[b]	1979[b]	1980[b]
sheepshead minnow *(Cyprinodon variegatus)*[c]	358	2181	2207	1212	1091	4672
goldspotted killifish *(Floridichthys carpio)*[c]	1949	3351	3392	3233	1984	3153
sailfin molly *(Poecilia latipinna)*[c]	111	341	762	173	48	228
crested goby *(Lophogobius cyprinoides)*[c]	15	27	53	73	154	204
yellowfin mojarra *(Gerres cinereus)*	68	55	59	29	58	87
gulf toadfish *(Opsanus beta)*[c]	0	1	8	6	13	23
silver jenny *(Eucinostomus gula)*	4	1	14	21	44	8
gray snapper *(Lutjanus griseus)*	28	16	9	4	9	8
great barracuda *(Sphyraena barracuda)*	12	3	4	6	8	7
gulf killifish *(Fundulus grandis)*[c]	0	10	13	2	0	7
rainwater killifish *(Lucania parva)*[c]	18	2	7	13	10	6
bonefish *(Albula vulpes)*	9	8	11	8	6	3
mosquitofish *(Gambusia affinis)*	0	0	0	0	0	2
spotfin mojarra *(Eucinostomus argenteus)*	8	3	2	13	3	1
drum (SCIAENIDAE)	0	0	0	0	0	1
Atlantic needlefish *(Strongylura marina)*	0	1	0	0	0	1
marsh killifish *(Fundulus confluentus)*[c]	0	5	12	4	1	1
tidewater silverside *(Menidia beryllina)*	15	3	8	1	3	0
striped mojarra *(Eugerees plumieri)*	3	3	2	1	3	0
schoolmaster *(Lutjanus apodus)*	9	8	10	4	2	0
sharksucker *(Echeneis naucrates)*	0	1	0	0	2	0
bluestriped grunt *(Haemulon sciurus)*	31	9	4	2	1	0
crevalle jack *(Caranx hippos)*[obs]	1	0	1	1	1	0
sailors choice *(Haemulon parrai)*	17	11	1	0	1	0
Atlantic spadefish *(Chaetodipterus faber)*[obs]	3	3	0	0	1	0
pike killifish *(Belonesox belizanus)*[c,obs]	2	2	3	15	0	0
snook *(Centropomus undecimalis)*	0	0	1	4	0	0
sea catfish *(Arius felis)*	18	0	2	2	0	0

Table 2. (CONT'D) Fish collected within the Turkey Point Cooling Canal System for 1975 through 1980.

Species[a]	Number of individuals per year 1975[b]	1976[b]	1977[b]	1978[b]	1979[b]	1980[b]
redfin needlefish *(Strongylura notata)*[c, obs]	0	0	0	1	0	0
pinfish *(Lagodon rhomboides)*	0	1	4	1	0	0
hardhead silverside *(Atherinomorus stipes)*	17	0	20	0	0	0
striped mullet *(Mugil cephalus)*[obs]	7	13	0	0	0	0
ladyfish *(Elops saurus)*	4	2	1	0	0	0
lined seahorse *(Hippocampus erectus)*	0	1	0	0	0	0
permit *(Trachinotus falcatus)*	0	1	0	0	0	0
sheepshead *(Archosargus probatocephalus)*	0	0	1	0	0	0
fat sleeper *(Dormitator maculatus)*	0	0	1	0	0	0
blue runner *(Caranx crysos)*	1	0	0	0	0	0
gulf kingfish *(Menticirrhus littoralis)*	1	0	0	0	0	0
banner goby *(Microgobius microlepis)*	1	0	0	0	0	0
checkered puffer *(Sphoeroides testudineus)*	1	0	0	0	0	0
pipefish *(Syngnathus sp.)*	2	0	0	0	0	0
goby *(Gobionellus sp.)*	2	0	0	0	0	0
lookdown *(Selene vomer)*	2	0	0	0	0	0
Total fishes	2723	6063	6595	4829	3443	8412

NOTE: [a]Ranked from most abundant to least abundant as they were found in collections taken during 1980.

[b]Reference Annual Environmental Monitoring Reports Turkey Point Plant 1973 through 1979.

[c]Species which are reproducing in the canals.

[obs]Observed, but not collected during 1980 program.

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

Species	Nugent Aug 1968-Jan 1970	Applied Biology[a] Dec 1974-Dec 1978	LU/TP[b] Jan 1979-Dec 1980
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
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 *(Epinephelus itajara)*	X		

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

Species	Nugent Aug 1968-Jan 1970	Applied Biology[a] Dec 1974-Dec 1978	LU/TP[b] Jan 1979-Dec 1980
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		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
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 *(Lactophrys 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 *(Lepisosteus platyrhineus)*	X		

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

Species	Nugent Aug 1968-Jan 1970	Applied Biology[a] Dec 1974-Dec 1978	LU/TP[b] Jan 1979-Dec 1980
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 *(Eugerees 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
tripletail *(Lobotes surinamensis)*	X		
white mullet *(Mugil curema)*	X		
yellowfin mojarra *(Gerres cinereus)*	X	X	X

NOTE: [a]Reference Annual Environmental Monitoring Reports Turkey Point Plant 1974-1978.
[b]Reference Annual Environmental Monitoring Reports Turkey Point Plant 1979-1980.

3. Benthos (ETS 4.1.1.1.3)

a. Characteristics of the Sediments

Introduction

This study of the characteristics of the sediments has been designed to determine the pH, salinity and temperature and to monitor selected nutrients in the interstitial (pore) water and sediments of the Turkey Point Cooling Canal System. To assess biological changes resulting from operation of the Turkey Point Plant, results of sediment analysis from samples collected in the cooling canal system have been compared with data from samples collected at three control areas outside of the canals.

From September 1970 through May 1971, preoperational chemical data were collected in Biscayne Bay and Card Sound (RSMAS, 1971, 1972). These studies differed from the existing operational monitoring program in many aspects (Characteristics of the Sediments Table 1). Nevertheless, operational 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.

A closed cooling canal network is potentially an oxygen-poor system. Anoxic conditions occur if waters are exposed to high temperatures, poor circulation and high oxygen consumption caused by an excess of organic matter. In contrast, most of the world's oceans are well mixed, maintain low temperatures and contain some dissolved oxygen. Evidence of anoxic conditions would be observed first in the interstitial water of the

sediment-water interface. The Turkey Point Canal System is potentially oxygen poor because the heated water from the power plant discharge is not mixed with adjacent Biscayne Bay waters. Additionally, the canal system is located in the subtropics that are characterized by the high production of organic material.

During 1980, sulfuric acid, sodium hydroxide, hydrated lime and lesser quantities of other chemicals were discharged into the circulating water system in the amounts shown in Section II.B-Table 2. 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). During the first half of 1980, samples were collected in 1-liter screwcap polypropylene bottles. After July, the collection method was refined so that sediment and interstitial water samples were collected in cylindrical polypropylene cores approximately 5 cm in diameter and 45 cm in length. All samples were 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. Sediment from the core samples collected at canal and bay stations also was analyzed for insoluble sulfide content. 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.

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 the deleterious effects of oxygenation, these samples were kept at 4°C and analyzed without filtration.

The pH of sediment samples was measured with a standard Corning Model 10 pH meter. Salinity was measured with a YSI Model 33 meter. Temperature was measured in the field using a YSI Model 42 single channel 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 important in aquatic chemical and biological systems because 1) changes in pH affect dissociation of weak acids and bases 2) the degree of dissociation affects the toxicity

of many compounds 3) pH affects the solubility of metals from suspended solids and bottom sediments, and 4) changes in ph directly influence physiological changes in marine organisms.

The pH values of the cooling canal system sediments ranged from 7.0 to 8.3. Measurements for Biscayne Bay stations ranged from 7.2 to 8.3 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 pore-waters (Goldberg, 1974). Comparison of the yearly average values (Characteristics of the Sediments Table 16) shows very small variations between canal stations (7.6 to 7.8 pH units) and Biscayne Bay stations (7.7 to 8.0 pH units). The pH range of the canal stations was apparently not affected by the additions of various chemicals from the power plant to the circulating cooling water system.

Salinity

Salinity is a measure of the salt content of water. Marine organisms vary in their ability to tolerate salinity changes. In deep water and open sea where salinity ranges vary only from 34 to 36 ppt, animals are sensitive to relatively small salinity changes. In the coastal regions and estuaries where wide salinity variations may occur, organisms adapted to these habitats are more tolerant of salinity changes.

During 1980, the salinity of the sediments ranged from 8.2 to 35.8 ppt at Biscayne Bay stations and from 21.0 to 39.0 ppt in the Turkey Point canal system (Characteristics of the Sediments Tables 3 and 15).

In 1979, these ranges were from 14.0 to 31.5 ppt for Biscayne Bay stations and from 18.3 to 48.0 ppt for the Turkey Point canal system (ABI, 1980). The average yearly sediment salinity at the adjacent Biscayne Bay sampling stations was 29.6 ppt in 1977, 22.2 ppt in 1978, 22.5 ppt in 1979, and 23.9 ppt in 1980. The average yearly sediment salinity in the canal system was 38.4 ppt in 1977, 30.4 ppt in 1978, 29.3 ppt in 1979, and 31.3 ppt in 1980.

In a closed marine system such as the Turkey Point Plant Cooling Canals, evaporation could theoretically increase sediment salinity to a level that the life forms present in the system could not tolerate. Data show that there was only a slight increase in sediment salinity from 1979 to 1980 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 with high values generally occurring in March or April and low salinity values occurring in November or December (Characteristics of the Sediments Table 3). These variations likely 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 and solar heating of the canals. 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 not only the fish, benthic organisms and aquatic plants but also the bacterial populations living in the sediment.

Temperatures ranged from 10.2° to 30.3°C at control stations in Biscayne Bay and from 13.0° to 43.0°C in the cooling canals (Characteristics of the Sediments Tables 4 and 15). In 1979, temperatures ranged from 10.0° to 37.0°C at the Biscayne Bay stations and 17.5° to 44.0°C in the canal system (ABI, 1980). There was a definite difference between sampling stations in the yearly average temperature values (Characteristics of the Sediments Table 16). Biscayne Bay stations had lower temperatures than canal stations. The highest average temperature (35.6°C) was recorded at canal Station 8, lower temperatures were found at Stations 5, 6, and 7 (30.6° to 31.5°C), and the lowest readings were at Stations 1, 2, 3 and 4 (26.0° to 26.7°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 that can exclude some biota occurring in the other parts of the Turkey Point canal system (Roessler and Tabb, 1974).

Sulfur

Sulfur occurs in a number of forms in marine water but only sulfate and sulfide are of major importance. 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 redox process (sulfate-sulfide conversion) is active. Because the Turkey Point canal network is a closed system, it is a potentially anoxic environment in which sulfide could build up within the sediment through depletion of available sulfate.

During 1980, the sulfate concentration ranged from 2115 to 3611 ppm in the cooling canals and from 959 to 3215 ppm at Biscayne Bay stations (Characteristics of the Sediments Tables 5 and 15). In 1979, these values ranged from 2399 to 3450 ppm in the cooling canals (ABI, 1980) and from 1521 to 3120 ppm at Biscayne Bay stations. The 1980 data (Characteristics of the Sediments Table 16) showed that the average yearly sulfate concentration in the canal waters (3095 ppm) was about 34 percent higher than in Biscayne Bay samples (2311 ppm). The average yearly sulfate concentration in the canal waters increased only slightly from the 1979 value of 2998 ppm, but in Biscayne Bay the average sulfate concentration decreased by 156 ppm (2467 ppm in 1979). There was no difference in the average yearly sulfate concentrations at the canal stations.

Soluble sulfite and sulfide (Characteristics of the Sediments Tables 6 and 7) were generally below the detection limits of the method employed --<0.1 and <0.05 ppm, respectively. The extreme value of 23.0 ppm

sulfite was observed only in January 1980 at Station 1 and can be regarded as a random occurrence.

Insoluble sulfide values in the cooling canals ranged from <0.05 to 8.90 μg/g wet weight of soil (Characteristics of the Sediments Table 8) and in Biscayne Bay from <0.05 to 2.96 μg/g wet weight of soil. These values were in the same general ranges as in 1979 when they were <0.05 to 8.37 μg/g wet weight of soil for the cooling canals (ABI, 1980) and <0.05 to 2.83 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^+ (ammonium). 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 ammonium were analyzed in the interstitial water of Turkey Point Cooling Canal samples.

During 1980, nitrate concentrations ranged from <0.003 to 0.746 ppm in the cooling canals and from 0.004 to 0.404 ppm at Biscayne Bay control stations (Characteristics of the Sediments Tables 9 and 15). In 1979,

with the exception of one random value, these ranges were very similar: <0.001 to 0.660 ppm in the cooling canals and <0.001 to 0.341 ppm for the Biscayne Bay stations (Characteristics of the Sediments Table 15). The 1980 yearly average values were very close for all cooling canal stations but higher than for Biscayne Bay stations (Characteristics of the Sediments Table 16). Comparison with Biscayne Bay stations and 1979 values indicates that during 1980 there was no depletion of nitrate which might indicate anoxic conditions in the cooling canals.

During 1980, nitrite concentrations ranged from <0.001 to 0.084 ppm in the cooling canals and from <0.001 to 0.070 ppm for the Biscayne Bay stations (Characteristics of the Sediments Tables 10 and 15). In 1979, these ranges were somewhat lower, <0.001 to 0.028 in the cooling canals and <0.001 to 0.014 ppm for the Biscayne Bay stations. The yearly average value for canal stations was 0.008 ppm and 0.010 ppm for Biscayne Bay stations. This constancy in nitrite concentrations indicates that during 1980 there was no depletion of nitrite in the cooling canals due to anoxic conditions.

Ammonium values found in the Turkey Point Canal System during 1980 ranged from 0.10 to 6.02 ppm (Characteristics of the Sediments Tables 11 and 15). These values were higher than the control stations' values, which ranged from 0.08 to 1.74 ppm. In 1979, the range of ammonium values at the cooling canals (0.02 to 0.97 ppm) more closely resembled the range of values at the Biscayne Bay stations (0.09 to 1.00 ppm). The 1980 yearly average value was 0.74 ppm for the canal stations and 0.53

ppm for Biscayne Bay stations (Characteristics of the Sediments Table 16). This similarity in average ammonium 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 ammonium and, to a lesser extent, sulfide.

During 1980, orthophosphate values in interstitial waters ranged from <0.01 to 0.15 ppm in the cooling canals (Characteristics of the Sediments Tables 12 and 15) and from <0.01 to 0.08 ppm at the control stations in Biscayne Bay. In 1979, orthophosphate values were from <0.01 to 0.90 ppm in the cooling canals and from <0.01 to 0.24 ppm for the Biscayne Bay stations. Yearly average values in 1980 were similar for canal and Biscayne Bay stations (Characteristics of the Sediments Table 16). From 1979 to 1980, there was no increase in orthophosphate concentrations in the interstitial waters of the cooling canals. This trend indicates that the sediments were not anoxic.

Comparison With Preoperational Data

Parameters monitored, analytical methods and sampling locations differed between the preoperational studies (RSMAS, 1971, 1972) and the operational study (Characteristics of the Sediments Table 1). However, the values 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 1977-80 (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 1980 (8.2 to 35.8 ppt). This difference probably was 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 1980 (0.004 to 0.404 ppm). Differences in preservation and analysis methods used in these studies could account for this discrepancy. Nitrite and orthophosphate values were in the same range during the 1970-71 and 1980 monitoring.

Summary and Conclusions

Characteristics of the sediment and interstitial water were analyzed from eight sampling stations in the Turkey Point Plant Cooling Canals and from three control stations in Biscayne Bay. These samples were measured monthly for pH, salinity, temperature and selected nutrients.

In the cooling canals, salinity, temperature, sulfate and nitrate values of sediment samples were higher than in Biscayne Bay. Temperatures of 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. The slightly higher nitrate values in the cooling canals show that there was no depletion of nitrate due to anoxic conditions. All other parameters were in the same range as values from control stations.

Comparisons of 1980 data with those of the preoperational study indicate that no detectable impact on physical or chemical parameters has resulted from plant operation.

LITERATURE CITED

ABI. 1978. Ecological monitoring of selected parameters at the Turkey Point Plant, annual report 1977. AB-100. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1979. Annual non-radiological environmental monitoring report, 1978. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1980. Annual non-radiological environmental monitoring report, 1979. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

APHA. 1975. Standard methods for the examination of water and wastewater, 14th ed. American Public Health Association, Washington, D.C. 1193 pp.

Brooks, R.R., B.J. Presley, and I.R. Kaplan. 1968. Trace elements in the interstitial waters of marine sediments. Geochim. Cosmochim. Acta. 32:397-414.

Goldberg, E.D., ed. 1974. The sea. Vol. 5. John Wiley and Sons, Inc., New York, N.Y. 614 pp.

Kester, D.R., and R.M. Pytkowicz. 1967. Determination of the apparent dissociation constants of phosphoric acid in seawater. Limnol. and Oceang. 12:243-252.

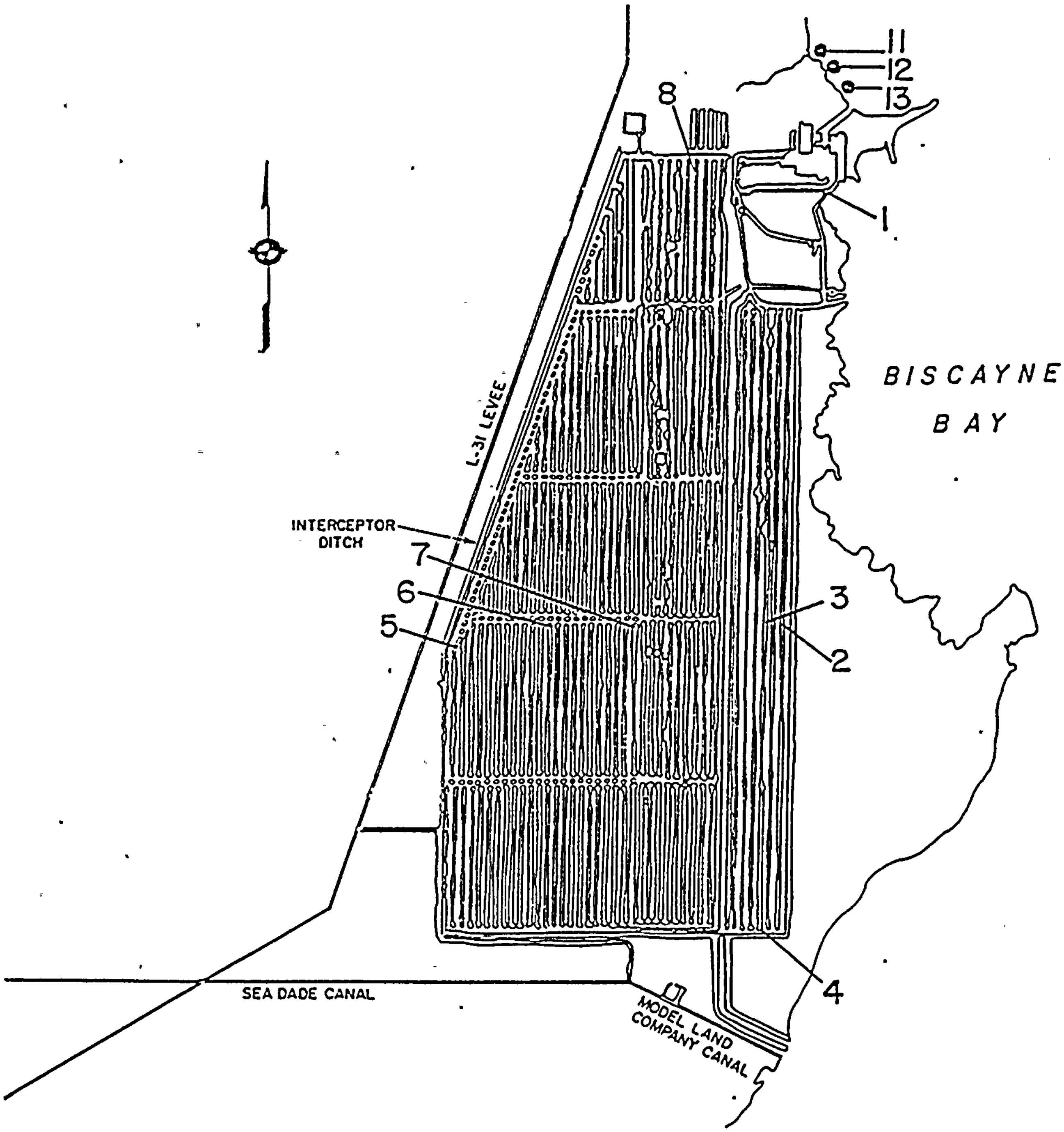
Roessler, M.A., and D.C. Tabb. 1974. Studies of effects of thermal pollution in Biscayne Bay, Florida. EPA-660/3-74-1003. Office of Research and Development. USEPA, Washington, D.C.

RSMAS. 1971. An ecological study of south Biscayne Bay and Card Sound. Prepared by Rosenstiel School of Marine and Atmospheric Science, University of Miami, for U.S. Atomic Energy Commission and Florida Power & Light Co.

_____. 1972. An ecological study of south Biscayne Bay and Card Sound chemistry appendices. Prepared by Rosenstiel School of Marine and Atmospheric Science, University of Miami, for U.S. Atomic Energy Commission and Florida Power & Light Co.

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

Thorstenson, D.C. 1970. Equilibrium distribution of small organic molecules in natural waters. Geochim. Cosmochim. Acta. 34:745-700.



Characteristics of the Sediments Figure 1. Chemistry sampling locations, Turkey Point Plant, 1980.

Characteristics of the Sediments Table 1. Parameters Measured During the Preoperational Studies and 1980 Operational Study at the Turkey Point Plant Site.

	Preoperational studies* 1970-1971		Operational study 1980		
Parameter	Water	Sediment	Interstitial water	Water	Sediment
Alkalinity	X				
Ammonium			X		
Dissolved inorganic carbon	X				
Dissolved organic carbon	X	X			
Dissolved oxygen	X				
Nitrate	X		X		
Nitrite	X		X		
pH		X			X
Orthophosphate	X		X		
Radioactivity	X	X			
Salinity	X			X	
Silica	X				
Sulfate			X		
Sulfide				X	X
Sulfite				X	
Temperature	X	X			
Trace metals	X	X			

*RSMAS, 1971, 1972.

Characteristics of the Sediments Table 2. pH of Sediments at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	7.8	8.1	8.3	8.2	8.0	8.0	8.2	8.2	8.0	7.9	8.1
FEB	8.0	8.0	8.0	7.8	7.2	8.1	8.1	8.2	7.7	7.8	7.9
MAR	7.7	7.8	8.1	8.2	8.1	8.0	7.9	7.8	8.0	7.9	8.2
APR	7.9	8.0	8.0	8.1	8.1	7.9	8.0	8.2	8.1	8.0	8.2
MAY	8.0	7.7	8.0	8.0	7.9	7.9	8.1	7.8	8.3	8.2	8.2
JUN	8.1	7.9	8.0	7.8	7.8	7.8	8.0	8.0	8.2	8.0	8.2
JUL	7.8	7.8	8.1	8.0	8.0	8.0	7.8	8.1	8.0	8.0	7.9
AUG	7.8	7.2	7.4	7.2	7.3	7.7	7.1	7.4	7.8	7.4	7.6
SEP	7.8	7.3	7.2	7.4	7.6	7.6	7.8	7.4	7.8	7.5	7.8
OCT	7.6	7.7	8.0	7.8	7.5	7.4	7.6	7.7	7.5	7.5	8.0
NOV	7.0	7.1	7.1	7.4	7.3	7.1	7.0	7.1	7.7	7.2	8.0
DEC	7.0	7.5	7.4	7.4	7.1	7.3	7.2	7.3	7.4	7.2	7.4

Characteristics of the Sediments Table 3. Salinity (ppt) of Sediments at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	34.8	33.2	34.0	33.8	34.5	33.5	33.8	35.2	23.0	22.8	22.0
FEB	34.0	33.0	33.0	34.5	34.0	33.5	34.0	33.0	21.0	22.0	21.5
MAR	34.9	37.2	36.5	35.1	36.8	38.3	39.0	38.8	27.6	27.2	27.8
APR	38.2	35.8	37.9	37.9	34.0	37.3	36.8	38.1	31.9	31.8	33.0
MAY	24.5	25.5	25.5	24.0	24.0	25.5	21.0	24.0	21.5	20.0	21.5
JUN	33.1	31.1	34.9	32.8	31.9	33.2	31.8	33.6	27.0	27.2	27.2
JUL	34.2	32.9	33.2	33.3	33.2	34.2	33.1	33.9	28.2	27.8	28.2
AUG	36.2	37.1	33.9	35.2	35.1	32.1	35.8	25.2	35.8	25.2	25.7
SEP	31.0	32.2	33.1	30.1	32.0	32.1	31.2	28.0	25.1	23.2	24.0
OCT	25.7	24.7	24.6	24.2	26.1	25.9	26.8	26.0	18.9	21.4	19.4
NOV	26.9	25.9	23.9	23.0	25.9	22.2	22.2	21.8	23.8	24.2	23.9
DEC	33.8	24.7	23.5	29.3	28.5	31.5	31.0	29.3	9.5	8.2	10.9

Characteristics of the Sediments Table 4. Temperature (°C) of Sediment Surface at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	13.0	15.9	16.0	17.9	22.8	22.7	22.8	27.5	13.4	12.9	13.0
FEB	17.5	17.0	14.5	16.8	21.0	21.1	21.2	23.9	10.9	10.2	10.3
MAR	28.5	27.0	26.8	29.0	33.1	33.0	32.8	37.7	23.0	23.0	23.8
APR	27.8	27.4	26.0	27.7	31.0	31.2	31.2	36.2	26.2	26.2	26.4
MAY	30.2	29.9	28.5	28.9	35.0	34.5	34.3	39.0	22.5	24.5	24.0
JUN	31.0	30.6	30.2	31.7	35.4	33.3	32.5	39.5	28.8	29.0	29.0
JUL	33.9	32.2	31.7	33.3	36.7	34.8	35.6	41.8	29.9	30.3	30.0
AUG	34.9	34.0	32.7	33.9	39.2	36.0	36.1	43.0	29.2	29.8	29.7
SEP	33.0	32.0	31.0	32.0	35.0	36.0	36.2	41.5	27.2	27.9	28.0
OCT	22.2	22.3	26.9	27.1	31.8	29.4	29.7	35.1	24.9	24.9	24.9
NOV	28.3	28.1	26.9	27.7	32.1	30.5	30.5	36.4	23.8	24.0	24.0
DEC	20.5	21.5	21.5	22.2	24.9	24.2	24.2	25.0	20.1	20.1	20.2

Characteristics of the Sediments Table 5. Analysis of Soluble Sulfate (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	3182	3043	3026	2974	3008	3130	3026	3146	2000	1930	1896
FEB	3248	3251	3228	3029	3101	3219	3486	3248	1990	1957	2030
MAR	3283	3300	3267	3250	3198	3250	3387	3164	2615	2495	2701
APR	3081	3184	3177	3175	2924	3051	3113	3257	2829	2957	2850
MAY	3501	3430	3515	3517	3402	3517	3465	3494	3215	3143	3203
JUN	3522	3395	3413	3486	3449	3413	3323	3504	2944	2962	2962
JUL	3611	2476	2657	2547	3363	2462	2580	2504	2465	2360	2301
AUG	2469	2497	2573	2550	2521	2412	2440	2693	2355	2639	2242
SEP	2787	3037	2578	2935	2115	2643	2904	2526	1881	2301	1925
OCT	3264	3142	3162	3167	2660	3189	3248	3061	2491	2491	2489
NOV	3496	3503	3209	3389	3019	3364	3395	3433	1597	1801	1839
DEC	3079	3154	3247	3257	2455	3240	3144	3247	1132	959	1263

Characteristics of the Sediments Table 6. Analysis Results of Soluble Sulfite (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	23.0	<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	5.0	<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	0.5	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 Results of Soluble Sulfide (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
FEB	0.06	<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	0.08	<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	0.15	<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	0.07	<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 Results of Insoluble Sulfide (μg/g wet weight sediment) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	1.28	3.25	0.92	1.02	0.42	1.44	0.85	0.33	0.08	0.65	0.08
FEB	4.06	3.51	2.45	3.38	0.70	<0.05	0.50	<0.05	0.12	0.80	0.32
MAR	0.32	3.63	0.12	0.30	1.48	3.24	0.65	0.48	0.20	0.19	0.13
APR	0.18	0.27	0.32	0.67	0.53	1.02	0.31	0.79	0.64	0.53	0.73
MAY	5.05	4.72	2.30	0.87	0.68	5.00	0.59	0.99	0.81	1.23	0.54
JUN	<0.05	0.21	0.59	0.14	0.77	0.28	0.55	0.83	0.27	0.33	0.30
JUL	3.02	2.85	8.90	1.20	0.30	0.25	<0.05	1.99	1.51	2.14	2.38
AUG	0.80	0.27	3.93	0.09	0.05	0.07	0.15	0.17	0.22	0.06	0.60
SEP	6.28	7.87	2.57	0.51	0.20	0.94	0.62	0.63	0.84	2.96	0.71
OCT	1.50	6.00	0.15	1.13	4.10	0.36	0.11	0.32	1.31	1.57	0.14
NOV	5.90	0.22	5.66	0.31	0.14	<0.05	2.16	<0.05	<0.05	1.36	0.09
DEC	2.88	0.16	0.11	6.42	3.86	0.41	0.58	1.04	1.71	1.54	1.49

Characteristics of the Sediments Table 9. Analysis Results of Soluble Nitrate (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.014	0.030	0.139	0.022	0.026	0.135	0.022	0.036	0.012	0.024	0.011
FEB	0.068	0.016	0.018	0.055	0.054	0.069	0.056	0.010	0.015	0.029	0.004
MAR	0.035	<0.003	0.029	0.026	0.103	0.035	0.118	0.130	0.078	0.021	0.087
APR	0.040	0.067	0.025	0.035	0.013	0.009	0.037	0.103	0.004	0.004	0.025
MAY	0.092	0.058	0.080	0.170	0.014	0.057	0.066	0.031	0.030	0.024	0.045
JUN	0.146	0.073	0.182	0.072	0.033	0.056	0.026	0.016	0.048	0.024	0.031
JUL	0.048	0.073	0.205	0.060	0.201	0.077	0.056	0.167	0.100	0.029	0.026
AUG	0.341	0.020	0.118	0.135	0.392	-*	-*	-*	0.182	0.191	0.146
SEP	0.207	0.021	0.107	0.116	0.038	0.013	0.215	0.070	0.175	0.136	0.041
OCT	0.327	0.116	0.088	0.170	0.321	0.219	0.051	0.005	0.110	0.020	0.078
NOV	0.079	0.051	0.056	0.099	0.043	0.193	0.064	0.042	0.156	0.043	0.071
DEC	0.156	0.636	0.188	0.052	-*	0.348	0.746	0.069	0.404	0.319	0.371

*No data.

Characteristics of the Sediments Table 10. Analysis Results of Soluble Nitrite (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.003	0.004	0.008	0.004	0.004	0.008	0.007	0.010	0.002	0.002	<0.001
FEB	0.009	0.003	0.006	0.007	0.005	0.016	0.004	0.010	0.002	0.006	0.005
MAR	0.006	0.004	0.002	0.006	0.004	0.005	0.003	0.013	0.007	0.001	0.037
APR	0.002	0.003	<0.001	0.001	<0.001	0.003	0.001	0.008	0.001	0.001	<0.001
MAY	0.003	0.001	<0.001	0.002	0.002	0.003	0.002	0.005	0.001	0.001	0.001
JUN	0.005	0.001	0.006	0.003	0.004	0.003	0.003	0.004	0.004	0.003	0.002
JUL	0.002	0.001	0.001	0.002	0.006	0.003	0.003	0.005	0.004	0.001	0.001
AUG	0.002	0.003	0.001	0.005	0.028	-*	-*	-*	0.004	0.005	0.005
SEP	0.006	0.003	0.006	0.004	0.003	0.002	0.005	0.003	0.002	0.039	0.002
OCT	0.008	0.025	0.044	0.017	0.084	0.010	<0.001	<0.001	0.007	0.015	0.014
NOV	0.032	0.022	0.025	0.024	0.027	0.022	0.029	0.016	0.070	0.024	0.026
DEC	0.010	0.011	0.013	0.008	0.006	0.004	0.006	0.007	0.020	0.028	0.018

*No data.

Characteristics of the Sediments Table 11. Analysis Results of Soluble Ammonium (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.52	0.41	0.30	0.69	0.38	0.24	0.32	0.28	0.18	0.20	0.16
FEB	0.28	0.72	0.22	0.35	0.20	0.13	0.46	0.26	0.19	0.36	0.35
MAR	0.54	0.71	0.36	0.48	1.05	0.73	0.44	0.42	0.46	0.25	0.31
APR	0.82	0.46	0.21	0.43	0.58	0.86	0.43	0.19	0.34	0.28	0.32
MAY	0.20	0.58	0.14	0.40	0.31	0.23	0.12	0.20	0.16	0.08	0.18
JUN	0.52	1.10	0.31	0.66	0.30	0.49	0.51	0.12	0.26	0.29	0.26
JUL	0.79	0.41	0.28	1.05	0.45	0.22	0.20	0.12	0.44	0.33	0.28
AUG	5.29	2.65	3.77	0.10	0.87	2.16	6.02	-*	1.08	1.74	1.26
SEP	1.94	1.65	0.34	0.49	0.40	0.64	0.77	0.76	0.49	1.44	0.52
OCT	1.17	0.67	0.62	0.36	0.87	1.08	0.68	2.63	0.69	0.88	1.04
NOV	1.53	0.45	1.49	0.35	0.82	0.34	0.39	0.70	-*	0.24	0.62
DEC	0.38	0.41	0.66	0.86	-*	0.13	0.56	0.36	0.88	0.89	1.54

*No data.

Characteristics of the Sediments Table 12. Analysis Results of Soluble Orthophosphate (ppm) at Stations in the Turkey Point Canals and Biscayne Bay During 1980.

	Station location and number										
	Turkey Point Canal System								Biscayne Bay		
Month	1	2	3	4	5	6	7	8	11	12	13
JAN	0.10	0.03	0.04	0.04	0.03	0.02	0.03	0.02	0.01	0.02	0.01
FEB	0.05	0.15	0.01	0.06	0.01	0.02	0.04	0.02	0.01	0.01	0.02
MAR	0.02	0.01	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01
APR	0.14	0.04	0.02	0.03	0.02	0.03	0.03	0.02	0.02	0.01	0.01
MAY	0.06	0.12	0.01	0.03	0.01	0.01	0.02	0.01	0.02	0.01	0.01
JUN	0.05	0.04	0.01	0.04	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01
JUL	0.05	0.01	0.01	0.05	0.07	0.01	0.01	0.01	0.02	0.01	0.01
AUG	0.07	0.04	0.04	<0.01	0.01	-*	0.05	-*	0.01	0.02	0.02
SEP	0.07	0.06	0.01	0.03	<0.01	0.02	0.03	0.03	0.01	0.01	<0.01
OCT	0.04	0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01
NOV	0.10	0.01	0.01	0.01	0.07	<0.01	0.01	0.01	0.08	<0.01	0.01
DEC	<0.01	<0.01	<0.01	<0.01	-*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

*No data.

Characteristics of the Sediments Table 13. Methods for Chemical Analysis of Sediment and Interstitial Water at the Turkey Point Plant During 1980.

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 at the Turkey Point Plant During 1980.

Station*	pH	Salinity (ppt)	Temperature (°C)	Soluble sulfate (ppm)	Soluble nitrate (ppm)	Soluble nitrite (ppm)	Soluble ammonium (ppm)	Soluble orthophosphate (ppm)
1	7.0-8.1	24.5-38.2	13.0-34.9	2469-3611	0.014-0.341	0.002-0.032	0.20-5.29	<0.01-0.10
2	7.1-8.1	24.7-37.2	15.9-34.0	2476-3503	0.003-0.636	0.001-0.025	0.41-2.65	0.01-0.15
3	7.1-8.3	23.5-37.9	14.5-32.7	2573-3515	0.018-0.205	<0.001-0.044	0.14-3.77	<0.01-0.04
4	7.2-8.2	23.0-37.9	16.8-33.9	2550-3517	0.022-0.170	0.001-0.024	0.10-1.05	<0.01-0.06
5	7.1-8.1	24.0-36.8	21.0-39.2	2115-3449	0.013-0.392	<0.001-0.084	0.20-1.05	<0.01-0.07
6	7.1-8.1	22.2-38.3	21.1-36.0	2412-3517	0.009-0.348	0.002-0.022	0.13-2.16	<0.01-0.03
7	7.0-8.2	21.0-39.0	21.2-36.2	2440-3486	0.022-0.746	<0.001-0.029	0.12-6.02	0.01-0.05
8	7.1-8.2	21.8-38.8	23.9-43.0	2504-3504	0.010-0.167	<0.001-0.016	0.12-2.63	<0.01-0.03
11	7.4-8.3	9.5-35.8	10.9-29.9	1132-3215	0.012-0.404	0.001-0.070	0.16-1.08	<0.01-0.08
12	7.2-8.2	8.2-31.8	10.2-30.0	959-3495	0.004-0.319	0.001-0.039	0.08-1.74	<0.01-0.02
13	7.4-8.2	10.9-33.0	10.3-30.0	1263-3203	0.004-0.371	<0.001-0.026	0.16-1.54	<0.01-0.02

*Stations 1-8 are in the Turkey Point Plant Cooling Canal System; Stations 11-13 are in Biscayne Bay.

Characteristics of the Sediments Table 15. Ranges for Selected Parameters Recorded at Stations in Biscayne Bay/Card Sound (Preoperational Studies) and in the Turkey Point Canals and Biscayne Bay (Operational Monitoring Studies).

	Preoperational studies	Operational studies			
Parameter	1970-1971[a]	1977[b]	1978[c]	1979[d]	1980
pH (pH units)	7.0-7.8	7.4-8.5 (8.0-8.7)[e]	7.2-8.7 (7.4-8.4)	7.6-8.9 (7.8-8.9)	7.0-8.3 (7.2-8.3)
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)	21.0-39.0 (8.2-35.8)
Temperature (C°)	-*	11.1-39.9 (19.1-33.0)	15.8-39.5 (18.5-33.9)	17.5-44.0 (10.0-37.0)	13.0-43.0 (10.2-30.3)
Soluble sulfate (ppm)	-*	2100-3818 (733-3448)	360-3950 (180-3100)	2399-3450 (1521-3120)	2115-3611 (959-3215)
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)	<0.003-0.746 (0.004-0.404)
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)	<0.001-0.084 (<0.001-0.070)
Soluble ammonium (ppm)	-*	0.01-0.98 (<0.01-0.69)	<0.01-1.91 (0.24-1.78)	0.02-0.97 (0.09-1.00)	0.10-6.02 (0.08-1.74)

Characteristics of the Sediments Table 15 (cont'd). Ranges for Selected Parameters Recorded at Stations in Biscayne Bay/Card Sound (Preoperational Studies) and in the Turkey Point Canals and Biscayne Bay (Operational Monitoring Studies).

	Preoperational studies	Operational studies			
Parameter	1970-1971[a]	1977[b]	1978[c]	1979[d]	1980
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)	<0.01-0.15 (<0.01-0.08)

[a]RSMAS, 1971, 1972.

[b]ABI, 1978.

[c]ABI, 1979.

[d]ABI, 1980.

[e]Biscayne Bay values in parentheses.

*No adequate data.

Characteristics of the Sediments Table 16. Yearly Average Values for Selected Physical and Chemical Parameters From the Turkey Point Canal and Biscayne Bay During 1980.

Station*	pH	Salinity (ppt)	Temperature (°C)	Soluble sulfate (ppm)	Soluble nitrate (ppm)	Soluble nitrite (ppm)	Soluble ammonia (ppm)	Soluble orthophosphate (ppm)
1	7.7	32.3	26.7	3210	0.129	0.007	1.16	0.06
2	7.7	31.1	26.5	3118	0.097	0.007	0.85	0.04
3	7.8	31.2	26.0	3088	0.103	0.010	0.72	0.02
4	7.8	31.1	27.4	3106	0.084	0.007	0.52	0.03
5	7.6	31.3	31.5	2934	0.112	0.014	0.57	0.02
6	7.7	31.6	30.6	3074	0.110	0.007	0.60	0.01
7	7.7	31.4	30.6	3126	0.132	0.006	0.91	0.02
8	7.8	30.6	35.6	3106	0.062	0.007	0.55	0.01
11	7.9	24.4	23.3	2293	0.110	0.010	0.47	0.02
12	7.7	23.4	23.5	2333	0.072	0.010	0.58	0.01
13	8.0	23.8	23.5	2308	0.078	0.009	0.57	0.01

*Stations 1-8 are in the Turkey Point Plant Cooling Canal System; Stations 11-13 are in Biscayne Bay.

b. Benthic Organisms

Introduction

This report documents trends in the benthic macroinvertebrate populations of the Turkey Point Plant Cooling Canal System. This unique marine habitat was analyzed to determine the benthic species present and their relative abundances. A further objective of the study was to assess the impact of power plant operation on the cooling canal system environment and to 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 retained by a U.S. Standard No. 30 sieve (0.595-mm mesh; EPA, 1973). They live at least part of their life cycles within or upon suitable substrata. Benthic macroinvertebrates are sensitive to external stress due to their 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 water column (EPA, 1973).

Materials and Methods

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

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. 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 1980 at each of 11 sampling stations (Benthic Figure 1). 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.

Prior to 1980, sampling at canal Station RC.0 was hindered by the rocky substratum that prevented penetration of the grab thus allowing the grab to shut without enclosing a sample. No reliable sampling could be

performed at this station. In 1980, this station was relocated to a nearby area. Former benthic Station RC.2, even though not specifically associated with plankton Station RC.1 (Section III.A.1.a - Figure 1), sampled the same key cut canal as RC.1. In 1980, station designation RC.2 (Benthic Figure 1) in this report was transferred to plankton Station RC.1.

Biomass analyses of the samples were made on an ash-free 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 additional tools for measuring the environmental quality and the effect of induced stress on the structure of a macroinvertebrate community. 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.

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.

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 11). Temperature, salinity and dissolved oxygen measurements were made during each biotic sampling (Benthic Table 12). The canals are characterized by higher temperatures and salinities than the control areas.

Canal Stations

During 1980, the density of macroinvertebrates in the canals varied considerably from station to station and ranged from no individuals/m^2 (Station F.1 in October; Benthic Table 8) to 25,690 individu-

als/m^2 (Station E3.2 in October; Benthic Table 3). This wide range in density illustrates the highly variable nature of the canal system infauna. Macrobenthos density was higher in the spring than in the fall and conformed to a fairly regular pattern of high spring density/low fall density noted over the past 6 years (Benthic Figure 2). The mean density of all stations combined was 9575 individuals/m^2 in April and 8858 individuals/m^2 in October. The April number was the highest mean ever recorded from the canal system and was very similar to the number recorded in 1979. The October figure was very high compared to previous monitoring studies.

Mean biomass in the canals was 11.555 g/m^2 in April and 2.337 g/m^2 in October. These means are, respectively, the highest and lowest mean biomasses ever observed in the canals. The present data conform to the trend of higher spring biomass and lower fall biomass that has been observed in every year of the study except 1979 (Benthic Figure 3). Biomass values ranged from 0.00 g/m^2 (Station F.1 in October; Benthic Table 8) to 23.45 g/m^2 (Station WF.2 in April; Benthic Table 5). Most of the wide biomass variation was caused by the occurrence of larger specimens such as molluscs or brittle stars. In general, however, the benthic fauna was composed of small-sized individuals.

The mean index of diversity in the canals was 3.36 in April and 2.39 in October. Both values are high when compared to previous monitoring data (Benthic Figure 4); however, these mean values are somewhat lower than usually observed for marine communities, which typically show values

over 3.5 (Bader and Roessler, 1971, 1972; Holme and McIntyre, 1971). Station-by-station diversity indices ranged from 0.00 (Station F.1 in October; Benthic Table 8) to 4.53 (Station RC.1 in April; Benthic Table 2).

As noted above, macroinvertebrate density, biomass and diversity were generally higher at the canal stations during 1980 than in previous years (Benthic Figures 2, 3 and 4). These increases were, in part, caused by inclusion of data from previously unsampled Stations RC.0 and RC.1. These stations usually have denser and markedly more diverse benthic communities than the other canal stations. Comparison of mean density, biomass and diversity data for only those stations common to both the 1979 and 1980 monitoring studies showed that inclusion of RC.0 and RC.1 data exerted a general increasing effect on mean density, little or no effect on mean biomass and a large increasing effect on diversity (Benthic Table 13).

Control Stations

Control station density was as highly variable as at the canal stations and ranged from 4138 individuals/m^2 (Control Station 3 in April; Benthic Table 11) to 32,500/m^2 (Control Station 2 in April; Benthic Table 10). Overall mean densities were 14,380/m^2 in April and 15,310/m^2 in October (Benthic Figure 2). The annual mean density of 14,842/m^2 contrasts sharply with the annual mean density of 9216/m^2 at the canal stations.

Biomass at the control stations ranged from 0.22 g/m^2 (Control Station 3 in October; Benthic Table 11) to 26.76 g/m^2 (Control Station 2 in April; Benthic Table 10). Mean biomass was 12.05 g/m^2 in April and 2.34 g/m^2 in October (Benthic Figure 3), a reversal of the trend noted in 1979. Annual mean biomass at the control stations during 1980 was 6.04 g/m^2 compared to 6.95 g/m^2 for the canal stations. This was also a reversal of the trend observed in 1979 when mean control station biomass was twice that of the mean at the canal stations. As in the canal stations, the wide variation in biomass was a result of the occurrence of larger specimens such as molluscs or brittle stars.

Control station diversity during 1980 was very high. The annual mean control station diversity index was 4.28 and ranged from 3.51 (Control Station 3 in October; Benthic Table 11) to 5.20 (Control Station 2 in April; Benthic Table 10). In comparison, the annual mean diversity index for the canal stations was 2.88. Mean control station diversity was 4.47 in April and 4.10 in October (Benthic Figure 4).

Biomass and diversity at the control stations were generally higher in April than in October 1980, a trend opposite to that noted at the control stations in 1979. Density at the control stations was higher in October than in April 1980, which was similar to the trend observed in 1979. More sampling at the control stations over a longer period of time would be necessary before definite trends at the control stations could be identified.

Comparison of Station Groups

The trellis diagram (Benthic Figure 5) resulting from the use of Sorensen's index of community similarity shows that stations could be arranged into four distinct groups for comparative purposes: east stations (RC.0, RC.1, 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 for 1975-1980 were compared statistically using t-tests at P=0.05, and no significant difference was found among the biomass data for any group of stations. With regard to density, the east group, west group and control group data were not statistically different from each other; however, data for each of these three station groups indicated populations significantly denser than that found at the discharge station. Many of these same trends were observed in 1979 (ABI, 1980). Inclusion in these analyses of the higher density, biomass and diversity data from Stations RC.0 and RC.1 did not substantially change the results of the statistical tests or the direction of the indicated trends.

Analysis of species diversity indicated that all groups were significantly different from each other with the control 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 because these stations are located farthest from the thermal effluent discharged by the plant.

This trend in diversity contrasts with the trend in monthly average temperatures for these same stations in 1980 (Section III.A.3.a - Table

4). The discharge station averaged 35.7°C, west stations averaged 31.0°C, and east stations averaged 26.7°C--an inverse relationship with diversity. Control station temperatures averaged 23.6°C during 1980.

Although the annual mean salinity of 41.2 ppt at the canal stations was significantly higher than the annual mean of 28.7 ppt at the control stations, no correlation was found between salinity and either density, biomass or diversity.

Community Composition

As in past monitoring, the canal stations were dominated by polychaete worms (Benthic Figure 6). While several other species are present in the canal system, the numerically important species, polychaete worms, are limited to a few types. All are burrowing, sedentary, and detritus or filter-feeding species. The bottom substrate, composed of fibrous peat and mud mixed with shell debris, is a 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 8 to 1 at an ocean sewage outfall. Polychaetes thus appear least

affected in an area of elevated temperature and salinity, restricted circulation, and highly organic substrate characteristic of the Turkey Point Cooling Canal System.

When compared to the canal stations, the control stations exhibited a slightly better balance between the major macroinvertebrate groups (Benthic Figure 6). Polychaetes formed 69 percent of the macroinvertebrate fauna at the control stations as opposed to 78 percent of the canal station fauna. These percentage compositions were quite different from those found in 1979 when polychaetes formed only 48 percent of the fauna at the control stations and 86 percent of the canal station fauna. The control station macroinvertebrates exhibited a greater variety of feeding types and habitat preferences than the canal station macroinvertebrates. Control Station 3 was the only control station with a mud and peat substrate similar to that encountered in the canals. Control Station 1 has a sand/calcareous algae substrate, and Control Station 2 has a sand/peat/seagrass substrate. Because of the more similar substrate type, the community structure of Control Station 3 was more like that of the canal stations than Control Stations 1 or 2.

Comparison with Previous Studies

Some species were found in both baseline and operational studies, but these species were originally recruited 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 including

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 that 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. However, the similarity of these studies is relatively limited due to differing sampling methodologies, thermal regimes and substrates.

Summary and Conclusions

During 1980, no significant changes were observed in the macroinvertebrate fauna of the Turkey Point Canal System when compared to data from previous monitoring. Density, biomass and diversity values recorded in 1980 were among the highest ever encountered in the canals. Although a few exceptions occurred, data from the past 6 years indicated 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 had lower density, similar biomass, and statistically 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 benthic macroinvertebrate community of the canal system has many species, but only those burrowing, sedentary, and detritus or filter-feeding species adapted to living in the thick, fibrous peat substrate (i.e., polychaete worms) can be expected to occur in significant numbers. In general, the community structure is poorly balanced compared to natural ecosystems. The canal system macroinvertebrate population is also subject to wide and sometimes irregular variations in density, biomass and diversity.

LITERATURE CITED

ABI. 1980. Florida Power & Light Company Turkey Point Plant annual non-radiological environmental monitoring report, 1979. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

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

Bader, R.G. 1969. An ecological study of south Biscayne Bay in the vicinity of Turkey Point. Progress report from University of Miami to AEC.

Bader, R.G., and M.A. Roessler. 1971. An ecological study of south Biscayne Bay and Card Sound. Progress report from University of Miami to AEC and Florida Power & Light Co., Miami, Fla.

____________________. 1972. An ecological study of south Biscayne Bay and Card Sound. Progress report to AEC and Florida Power & Light Co., Miami, Fla.

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

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

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

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

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

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

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

LITERATURE CITED (continued)

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

________. 1959. An ecological study of pollution in Los Angeles-Long Beach Harbors, California. Allan Hancock Occ. Paper 22. 119 pp.

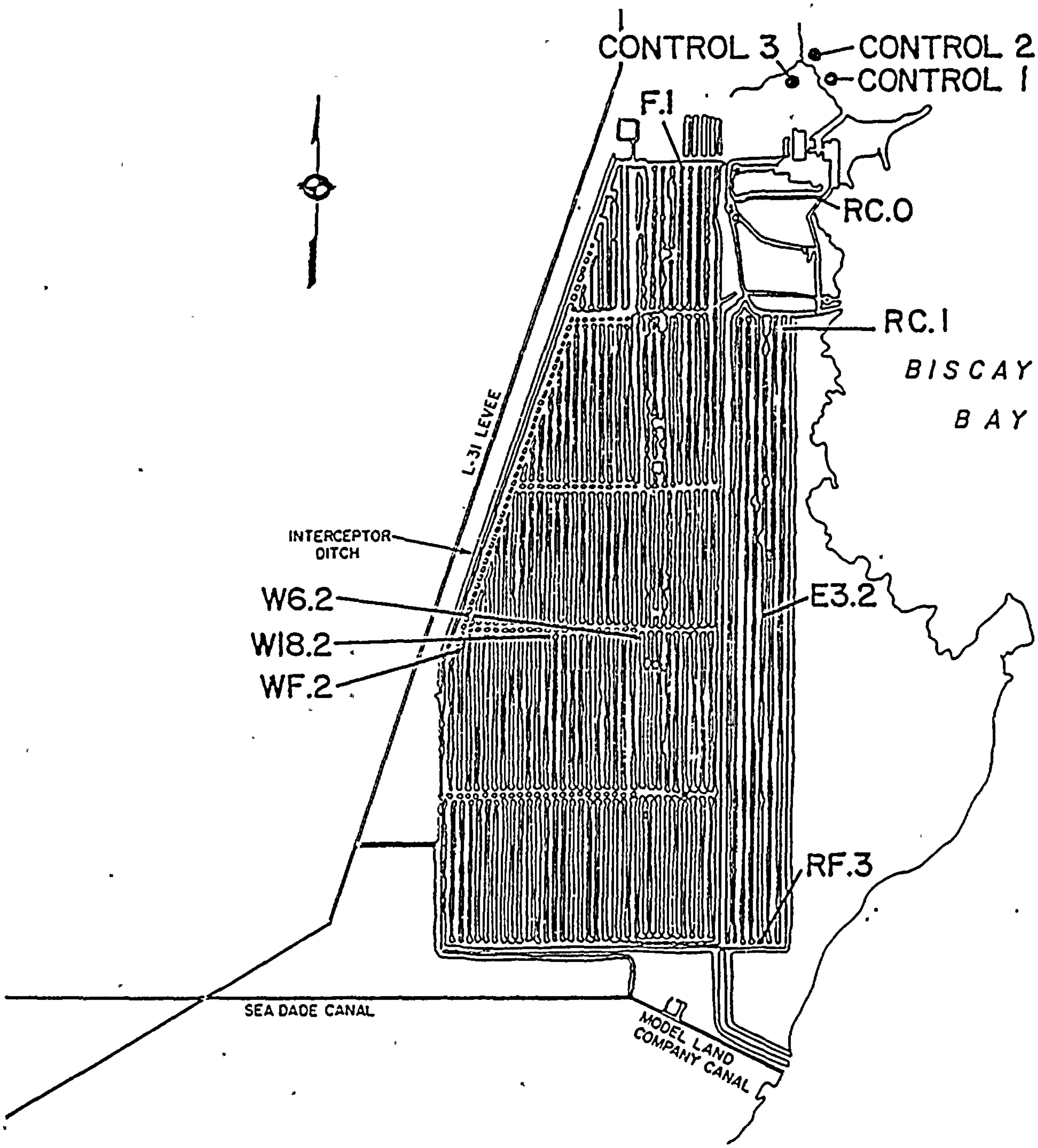
Sorensen, T. 1948. A method of establishing groups of equal amplitude in plant society based on similarity of species content. K. Danske Vidensk. Selsk. 5:134.

Tabb, D.C., and M.A. Roessler. 1970. An ecological study of south Biscayne Bay in the vicinity of Turkey Point. Progress report from University of Miami to FWPCA.

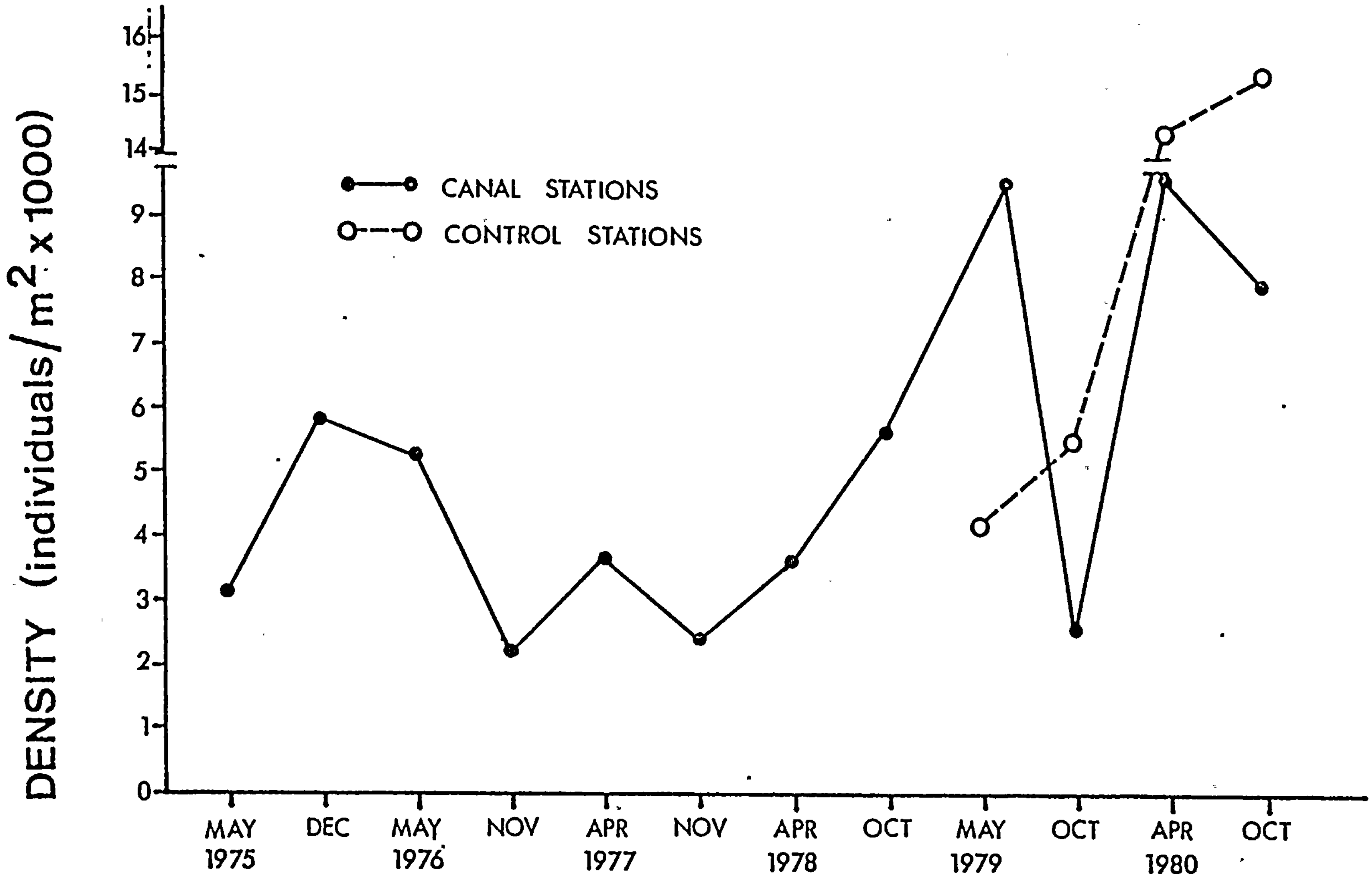
Warinner, J.E., and M.L. Brehmer. 1965. The effects of thermal effluents on marine organisms. Proc. 19th Industrial Waste Conf. Purdue Univ. Eng. Ext. Ser. 117:479-492.

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

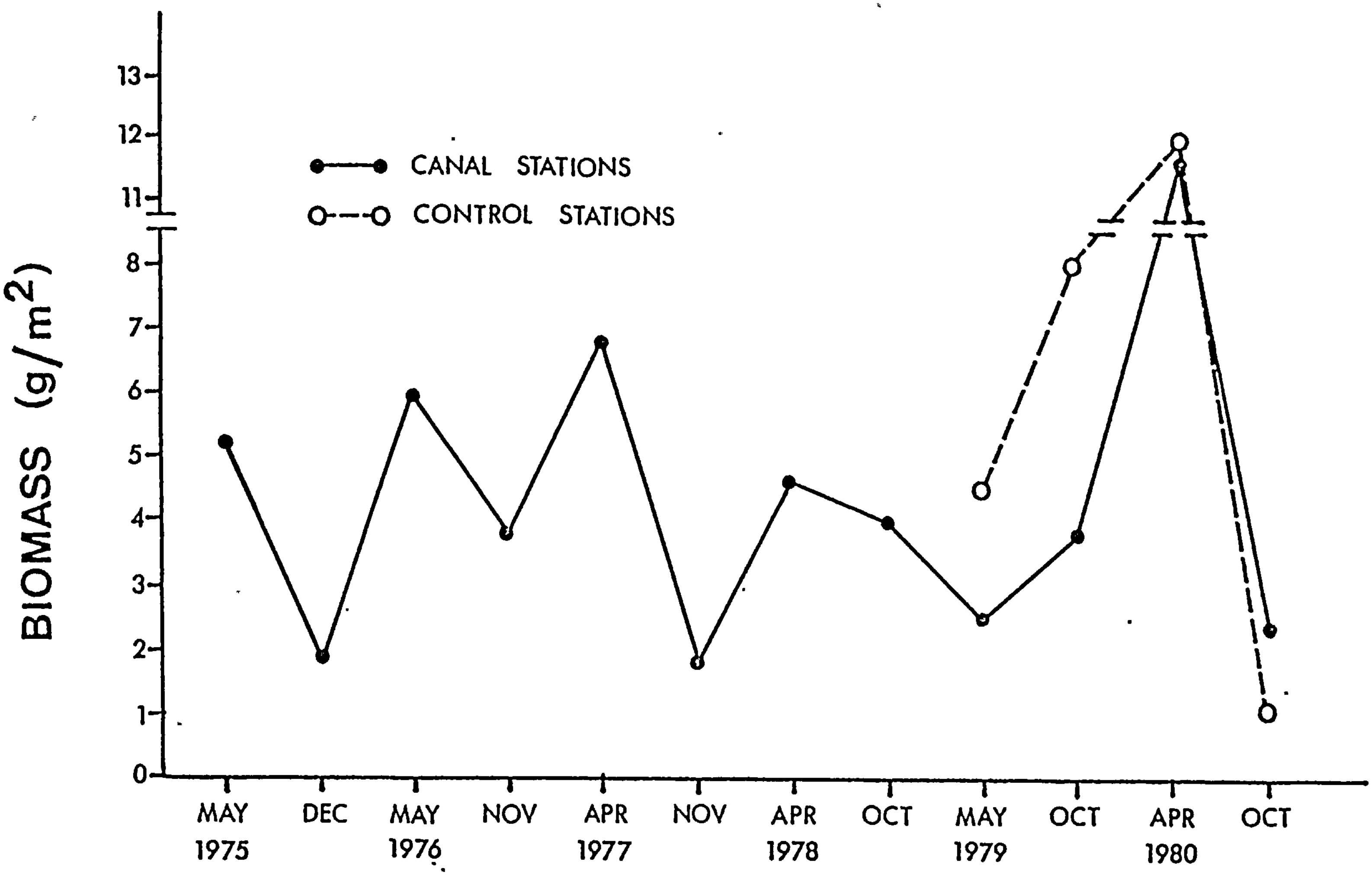
Williams, G.E., III. 1974. New techniques to facilitate handpicking macrobenthos. Trans. Amer. Micros. Soc. 93(2):220-226.



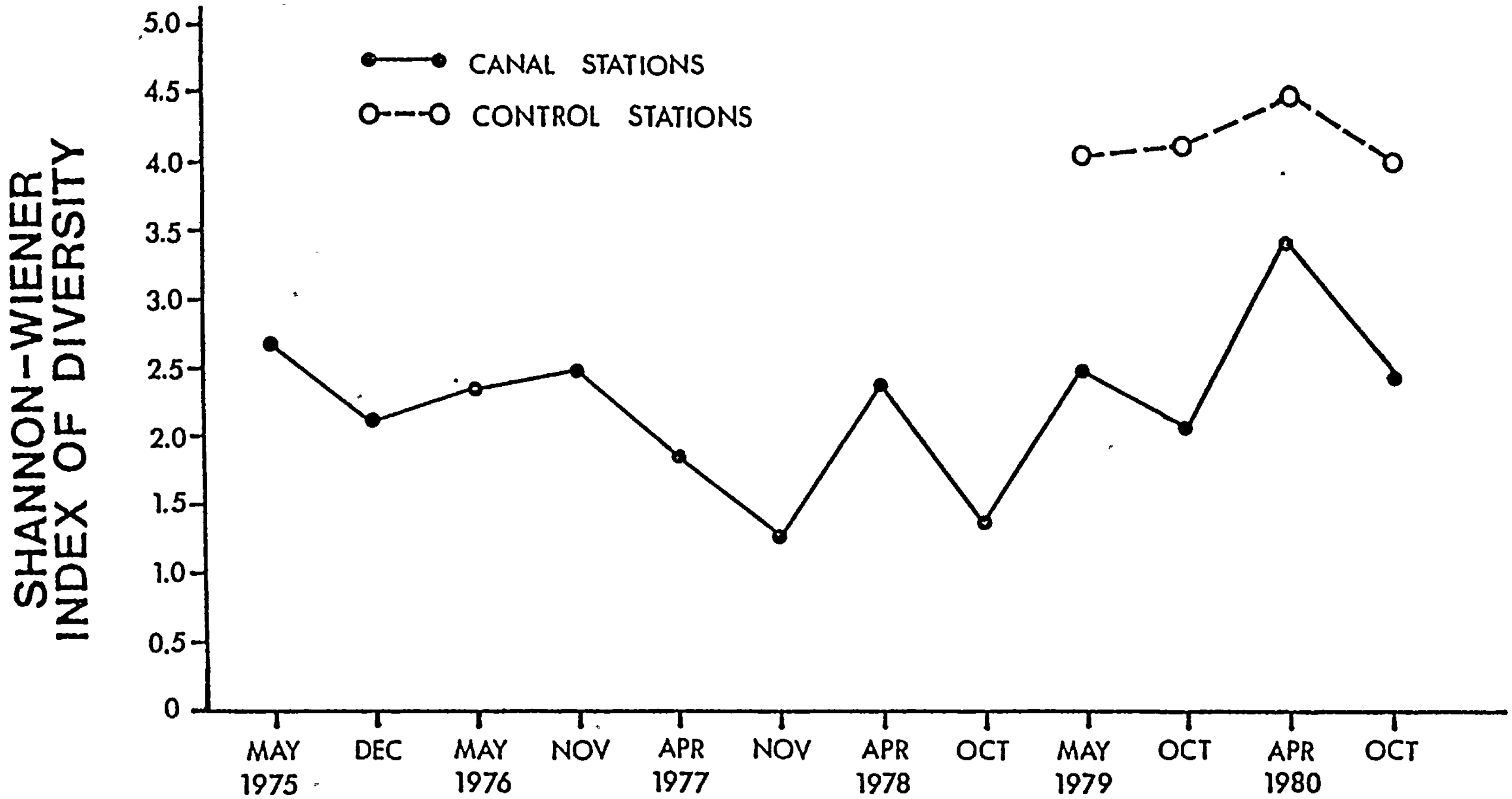
Benthic Figure 1. Benthic macroinvertebrate sampling station locations, Turkey Point site, 1980.



Benthic Figure 2. Mean number of benthic macroinvertebrates per square meter (all sampling stations combined), Turkey Point Plant, 1975-1980.



Benthic Figure 3. Mean benthic macroinvertebrate biomass per square meter (all sampling stations combined), Turkey Point Plant, 1975-1980.



Benthic Figure 4. Mean benthic macroinvertebrate species diversity (all sampling stations combined), Turkey Point Plant, 1975-1980.

Station	RC.0	RC.1	E3.2	RF.3	WF.2	W18.2	W6.2	F1	C1	C2	C3
RC.0		29.9	49.5	35.1	25.4	16.2	23.9	7.3	22.0	23.5	30.0
RC.1			62.5	45.2	12.7	12.9	32.8	7.3	29.3	27.9	47.5
E3.2				48.1	14.7	9.0	25.0	3.3	18.4	34.2	37.7
RF.3					32.7	20.8	26.4	9.8	26.5	25.9	39.4
WF.2						59.5	42.9	46.7	35.1	20.3	32.7
W18.2							39.0	48.3	21.4	9.4	14.8
W6.2								17.7	32.8	19.7	33.9
F1									12.2	8.3	8.5
C1										40.8	46.0
C2											40.0
C3											

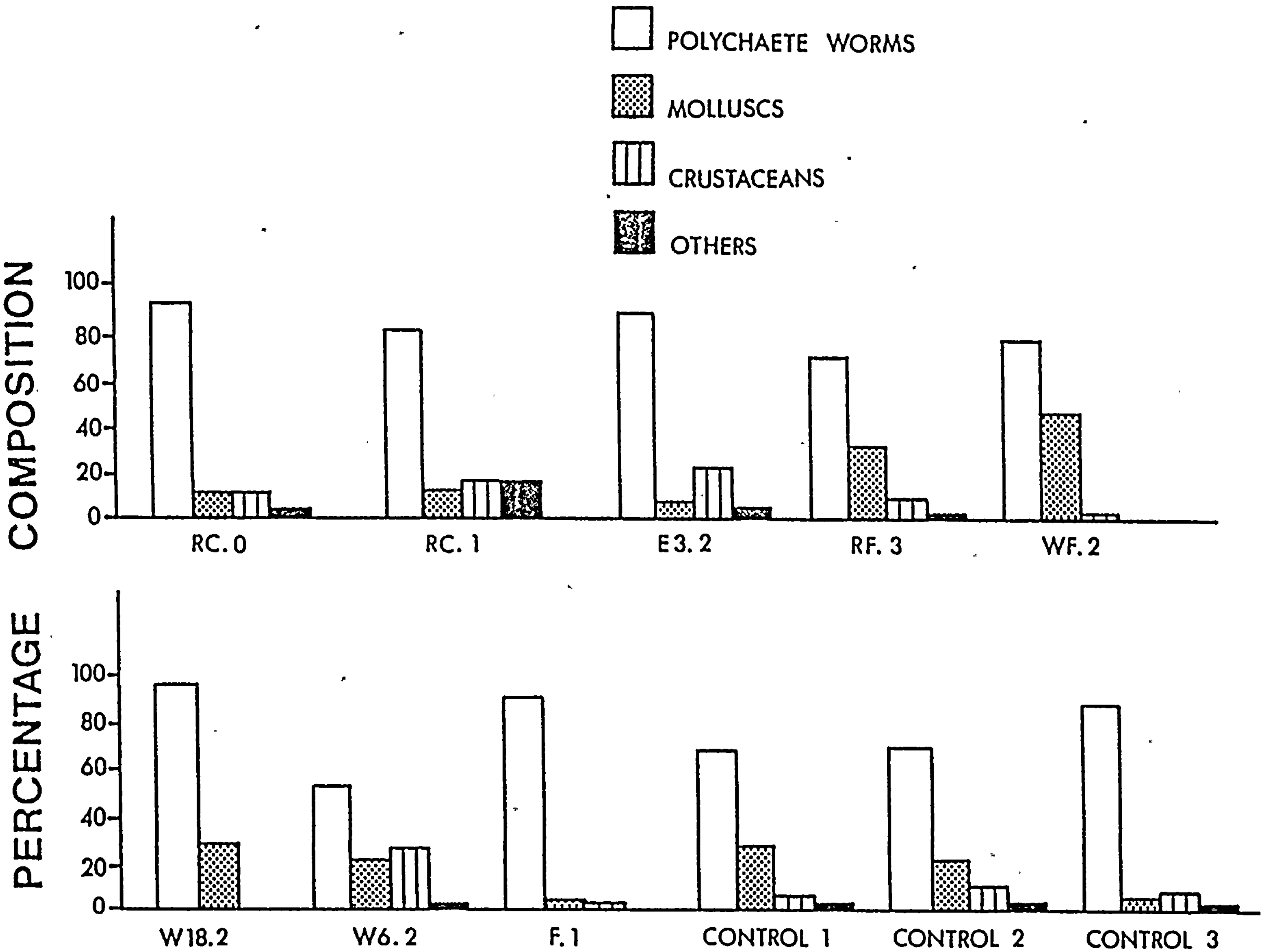
TURKEY POINT STATION SIMILARITY
APRIL 1980

- 76-100% STRONG SIMILARITY
- 51-75% MODERATE SIMILARITY
- 26-50% FAIR SIMILARITY
- 0-25% WEAK SIMILARITY

Station	RC.0	RC.1	E3.2	RF.3	WF.2	W18.2	W6.2	F1	C1	C2	C3
RC.0		32.7	40.6	34.4	5.1	14.3	13.0	–	16.9	38.5	27.6
RC.1			40.8	53.0	16.7	7.4	32.3	–	17.9	38.3	32.6
E3.2				51.7	12.1	5.5	7.5	–	15.4	33.0	30.8
RF.3					12.1	22.2	35.0	–	27.7	23.3	26.9
WF.2						36.4	26.7	–	0.0	2.6	0.0
W18.2							66.7	–	14.0	0.0	13.3
W6.2								–	29.8	2.4	5.9
F1	–	–	–	–	–	–	–		–	–	–
C1								–		23.4	33.9
C2								–			30.9
C3								–			

TURKEY POINT STATION SIMILARITY
OCTOBER 1980

Benthic Figure 5. Trellis diagrams showing percentages of species similarity between sampling stations, Turkey Point Plant, 1980.



Benthic Figure 6. Structure of the benthic macroinvertebrate community by station, Turkey Point Plant, 1980.

Benthic Table 1. Results of Benthic Macroinvertebrate Sampling at Station RC.0 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Aricidea fragilis*	-	2
A. philbinae	-	6
A. taylori	28	66
Armandia maculata	-	2
Capitellidae sp.	2	-
Caulleriella alata	2	-
Cirriformia filigena	-	60
Cirrophorus lyriformis	22	130
Exogone dispar	24	8
E. verugera	8	-
Exogone sp.	-	4
Fabricia sp.	76	154
Flabelligeridae sp. A	12	-
Heteromastus filiformis	-	10
Laeonereis culveri	2	-
Naineris laevigata	-	70
N. setosa	2	-
Odontosyllis fulgurans	10	-
Ophryotrocha puerilis	2	-
Paraonides lyra	30	76
Pionosyllis sp. A	2	-
Prionospio heterobranchia texana	2	4
Sabella melanostigma	52	2
Schistomeringos rudolphi	30	62
Scyphoproctus sp. A	16	-
Sphaerosyllis sp. A	2	-
Spio sp. A	4	-
Tharyx annulosus	6	6
Tharyx cf. *setigera*	8	-
Trichobranchus glacialis	2	-
Tubificidae sp.	-	12
Tubificoides sp.	-	12
Typosyllis annularis	14	4
Typosyllis sp. A	4	2
Typosyllis sp. B	2	2

Benthic Table 1 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station RC.0 at the Turkey Point Plant During 1980.

Species		Sum of 3 replicates April	Sum of 3 replicates October
Class Gastropoda			
snails	*Haminoea antillarum*	-	2
	Rissoina cancellata	2	-
	Vermicularia spirata	4	-
Class Pelecypoda			
bivalves	*Carditamera floridana*	6	-
	Chione cancellata	-	4
	Codakia costata	6	-
	Lucina nassuala	4	4
	Parastrarte triquetra	-	4
	Polymesoda maritima	-	2
	Transenella conradina	4	14
Class Crustacea			
ostracods	*Parasterope pollex*	10	2
	Sarsiella zostericola	18	2
copepods	Copepoda sp.	-	16
isopods	Asellota sp.	2	-
amphipods	*Cerapus tubularis?*	2	-
Class Insecta			
	Collembola sp.	-	4
Class Pantopoda			
sea spiders	*Ammothella ryulosa*	-	6
	Ammothella sp.		
Class Ophiuroidea	*Amphioplus abditus*	-	4
	Amphioplus thrombodes	2	-
	Amphioplus sp.	-	2
	Amphiuridae sp.	2	-
Phylum Nemertinea		16	92

Benthic Table 1 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station RC.0 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Total individuals	444	842
Total biomass (g)	0.0835	0.0456
Density (no./m^2)	6379	12,100
Biomass (g/m^2)	1.20	0.655
Index of diversity	4.51	3.77
Equitability	0.77	0.57

Benthic Table 2. Results of Benthic Macroinvertebrate Sampling at Station RC.1 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Arabella mutans*	2	-
Aricidea taylori	2	-
Axiothella mucosa	2	-
Branaclavata sp.	2	-
Branchiomma nigromaculata	6	-
Capitella capitata	-	8
Caulleriella killariensis	12	8
Ceratonereis mirabilis	26	-
Cirratulus? sp. A	30	-
Cirriformia filigera?	-	4
Cirrophorus lyriformis	12	-
Exogone verugera	104	-
Fabricia sp.	124	8
Langerhansia cornuta	12	-
Naineris laevigata	62	4
Nematonereis sp. A	-	-
Nereidae sp.	10	-
Opisthosyllis sp. A	10	-
Parahesione luteola	2	-
Paraonides lyra	148	32
Pista cf. *palmata*	2	-
Podarke obscura	2	-
Prionospio heterobranchia texana	42	-
Proscoloplos sp. A	4	-
Sabella melanostigma	172	-
Sabellidae sp. A	8	-
Schistomeringos rudolphi	54	28
Scyphoproctus sp. A	6	-
Sphaerosyllis sp. A	14	-
Sphaerosyllis sp. B	-	-
Spirorbis corrugatus	20	-
Syllides sp.	2	-
Terebellides stroemi	32	-
Terebellidae sp.	2	-
Tharyx cf. *setigera*	2	-
Trichobranchus glacialis	22	-

Benthic Table 2 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station RC.1 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Class Polychaeta (continued)		
Typosyllis annularis	564	44
Typosyllis sp. A	74	64
Typosyllis sp. B	280	40
Typosyllis sp. C	-	8
Tubificoides sp.	-	12
Class Gastropoda		
snails *Batillaria minima*	-	4
Bulla striata	4	20
Cerithium atratum	2	-
C. eburneum	4	-
C. muscarum	2	-
Cylindrobulla beauii	8	-
Haminoea antillarum	-	8
Modulus modulus	4	4
Prunum apicinum	12	4
Class Pelycypoda		
bivalves *Codakia* sp.	2	-
Opisthobranchia sp.	2	-
Polygreulima sp. A	2	-
Polygreulima sp.	12	4
Tivela floridana	6	-
Class Crustacea		
copepods Harpacticoida sp.	30	-
Copepoda sp.	4	4
isopods *Cymodoce faxoni*	2	-
Astellota sp.	58	-
Erichsonella filiformis	8	-
amphipods *Cymadusa compta*	10	-
Grandidierella bonnieroides	-	4
Lysianopsis alba	2	-
shrimp *Thor* sp.	4	-
Thor floridanus	8	-

Benthic Table 2 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station RC.1 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Pantopoda		
sea spiders <u>Anoplodactylus pectinus</u>	4	-
Class Ophiuroidea		
brittle stars <u>Amphioplus thrombodes</u>	2	-
<u>Amphipholis squamata</u>	6	-
Amphiuridae sp.	4	-
Class Holothuroidea		
sea cucumbers <u>Leptosynapta</u> sp.	4	-
<u>Synaptula hydriformis</u>	112	4
Phylum Nemertinea	22	-
Total individuals	1648	272
Total biomass (g)	1.6002	0.1261
Density (no./m^2)	23,678	3908
Biomass (g/m^2)	23.00	1.81
Index of diversity	4.53	3.63
Equitability	0.54	0.89

Benthic Table 3. Results of Benthic Macroinvertebrate Sampling at Station E3.2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Arabella mutans*	2	-
Arabella sp.	-	4
Aricidea taylori	34	-
Branchiomma nigromaculata	-	8
Capitellidae sp.	14	8
Caulleriella alata	2	-
C. killariensis	2	-
Caulleriella sp.	-	-
Ceratonereis mirabilis	10	4
Cirratulus? sp. A	20	-
Cirriformia filigera	2	8
Cirrophorus lyriformis	12	-
Exogone verugera	2	144
Fabricia sp.	14	408
Laeonereis culveri	2	8
Lanicides toboguille	8	8
Naineris laevigata	28	492
Naineris setosa	20	-
Notomastus latericeus	4	-
Opisthosyllis sp. A	8	-
Paraonides lyra	40	-
Pista cf. *palmata*	2	-
Prionospio heterobranchia texana	10	16
Sabella melanostigma	16	-
Schistomeringos rudolphi	166	16
Scyphoproctus sp. A	126	8
Terebellides stroemi	26	-
Tharyx cf. *setigera*	10	-
Trichobranchus glacialis	30	-
Typosyllis annularis	2	20
Typosyllis hyalina	6	56
Typosyllis sp. A	32	72
Typosyllis sp. B	12	356

Benthic Table 3 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station E3.2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Class Gastropoda		
snails *Acteocina?* sp.	2	-
Batillaria minima	-	20
Bulla striata	2	24
Cerithium lutosum	-	12
Cylindrobulla beauii	10	4
Haminoea antillarum	-	8
Mangelia sp.	-	4
Modulus modulus	2	-
Class Pelycypoda		
bivalves *Mysella* sp.	-	4
Class Crustacea		
ostracods *Parasterope pollex*	6	4
Ostracoda sp. A	6	-
copepods Copepoda sp.	-	12
tanaids *Hargeria rapax*	2	-
isopods *Cymodoce faxoni*	4	-
Asellota sp.	126	-
amphipods *Corophium acutum*	2	-
Cymadusa compta	28	-
Lysianopsis alba	84	-
shrimp *Thor* sp.	12	-
Thor floridanus	2	-
Class Ophiuroidea		
brittle stars *Amphioplus thrombodes*	12	-
Amphipholis squamata	8	-
Amphiuridae sp.	2	-
Ophiuroidea sp.	-	4
Class Holothuroidea		
sea cucumbers *Synaptula hydriformis*	8	20
Phylum Nemertinea	44	36

Benthic Table 3 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station E3.2 at the Turkey Point Plant During 1980.

	Sum of 3 replicates	
Species	April	October
Total individuals	1024	1788
Total biomass (g)	0.438	0.130
Density (no./m^2)	14,713	25,690
Biomass (g/m^2)	6.30	1.87
Index of diversity	4.45	3.11
Equitability	0.66	0.42

Benthic Table 4. Results of Benthic Macroinvertebrate Sampling at Station RF.3 at the Turkey Point Plant During 1980.

Species		Sum of 3 replicates	
		April	October
Class Polychaeta			
worms	*Aricidea philbinae*	-	4
	A. taylori	-	4
	Branchiomma nigromaculata	-	44
	Capitella capitata	6	4
	Caulleriella alata	2	-
	Ceratonereis mirabilis	2	-
	Cirratulus? sp. A	2	-
	Cirriformia filigera	-	20
	Exogone verugera	44	4
	Fabricia sp.	58	28
	Haploscoloplos foliosis	-	40
	Laeonereis culveri	-	64
	Lumbrinereis impatiens	34	-
	Naineris laevigata	4	4
	Ophryotrocha puerilis	16	-
	Paraonides lyra	8	-
	Prionospio heterobranchia texana	86	-
	Pseudopolydora antennata	10	-
	Sabella melanostigma	6	-
	Schistomeringos rudolphi	8	-
	Terebellides stroemi	28	-
	Tharyx cf. *setigera*	10	-
	Trichobranchus glacialis	8	8
	Typosyllis annularis	-	8
	Typosyllis hyalina	32	492
	Typosyllis sp. A	-	64
	Typosyllis sp. B	2	4
Class Gastropoda			
snails	*Arcopsis adamsi*	-	4
	Batillaria minima	-	452
	Cerithium muscarum	2	4
	Cylindrobulla beauii	28	4
	Haminoea antillarum	-	4
	Prunum apicinum	2	8
	Turbonilla? sp.	2	-

Benthic Table 4 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station RF.3 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Pelycypoda		
bivalves *Arcopsis adamsi*	-	4
Lyonsia hyalina	-	32
Class Crustacea		
copepods Harpacticoida sp.	2	-
isopods Asellota sp.	18	-
amphipods *Cymadusa compta*	2	32
Elasmopus sp.	2	-
Class Pantopoda		
sea spiders *Achelia sawayai*	-	2
Ammothella sp.	-	4
Anoplodactylus pectinus	-	8
Callipallene brevirostris	2	-
Class Ophiuroidea		
brittle stars *Amphioplus thrombodes*	2	-
Class Holothuroidea		
sea cucumbers *Synaptula hydriformis*	10	4
Thyonmella gemmata	-	4
Total individuals	438	1358
Total biomass (g)	0.1836	0.8418
Density (no./m^2)	6393	19,511
Biomass (g/m^2)	2.64	12.09
Index of diversity	3.96	2.78
Equitability	0.73	0.33

Benthic Table 5. Results of Benthic Macroinvertebrate Sampling at Station WF.2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Class Polychaeta		
worms *Aricidea philbini*	404	-
Capitella capitata	4	-
Exogone verugera	4	-
Haploscoloplos foliosis	10	-
Haploscoplos sp.	6	-
Laeonereis culveri	30	8
Marphysa sanguinea	2	-
Naineris laevigata	2	-
Ophryotrocha puerilis	8	-
Prionospio heterobranchia texana	60	-
Pseudopolydora antennata	8	-
Syllides verrilli	4	-
Typosyllis sp. A	20	-
Class Gastropoda		
snails *Acteocina canaliculata*	8	-
Batillaria minima	50	100
Caecum strigosum	-	4
Class Pelycypoda		
bivalves *Lyonsia hyalina*	8	-
Transenella conradina	4	-
Class Crustacea		
tanaids *Hargeria rapax*	2	-
amphipods *Cymadusa compta*	-	4
Grandidierella bonnieroides	2	-
Total individuals	636	116
Total biomass (g)	0.6318	0.0973
Density (no./m^2)	9140	1667
Biomass (g/m^2)	23.45	1.40
Index of diversity	2.15	0.786
Equitability	0.37	0.49

Benthic Table 6. Results of Benthic Macroinvertebrate Sampling at Station W18.2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Aricidea philbinae*	364	140
Capitella capitata	8	-
Haploscoloplos foliosis	2	44
Haploscoloplos sp.	2	-
Laeonereis culveri	52	68
Prionospio heterobranchia texana	18	-
Pseudopolydora antennata	6	-
Syllides verrilli	2	4
Class Gastropoda		
snails *Aceteocina canaliculata*	8	16
Batillaria minima	12	24
Bulla striata	6	-
Calotrophon ostrearuns	2	-
Cerithium eburneum	2	-
C. lutosum	4	-
C. muscarum	10	-
Class Pelycypoda		
bivalves *Polymesoda maritima*	12	8
Transenella conradina	2	-
Total individuals	514	304
Total biomass (g)	0.8458	0.0153
Density (no./m^2)	7385	4368
Biomass (g/m^2)	12.15	0.22
Index of diversity	1.83	2.14
Equitability	0.26	0.84

Benthic Table 7. Results of Benthic Macroinvertebrate Sampling at Station W6.2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Aricidea philbinae*	56	24
A. taylori	32	-
Capitella capitata	-	8
Ceratonereis mirabilis	24	-
Haploscoloplos foliosis	-	52
Laeonereis culveri	6	16
Orbiniidae sp.	-	4
Prionospio heterobranchia texana	60	-
Typosyllis sp. A	88	-
Typosyllis sp. B	22	-
Class Gastropoda		
snails *Acteocina canaliculata*	4	12
Batillaria minima	2	72
Bulla striata	2	-
Cerithium lutosum	12	20
Haminoea antillarum	8	-
H. succinea	2	-
Class Pelycypoda		
bivalves *Lyonsia hyalina*	16	-
Polymesoda maritima	-	4
Class Crustacea		
ostracods Haplocytheridea? sp. A	4	-
tanaids *Hargeria rapax*	4	-
amphipods *Cymadusa compta*	108	-
Gitanopsis tortugae	6	-
Grandidierella bonnieroides	2	-
Melita elongata	4	-
Melita sp.	36	-
Photidae sp.	2	-
Class Pantopoda		
sea spiders *Anoplodactylus pectinus*	-	4
Class Ophiuroidea		
brittle stars *Amphioplus thrombodes*	2	-

Benthic Table 7 (cont'd). Results of Benthic Macroinvertebrate Sampling at Station W6.2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Holothuroidea		
sea cucumbers *Thyonmella gemmata*	6	-
Total individuals	504	252
Total biomass (g)	0.565	0.0454
Density (no./m^2)	7241	3621
Biomass (g/m^2)	22.50	0.652
Index of diversity	3.53	2.91
Equitability	0.72	1.04

Benthic Table 8. Results of Benthic Macroinvertebrate Sampling at Station F.1 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Capitella capitata*	78	-
Haploscoloplos foliosis	8	-
Laeonereis culveri	4	-
Marphysa sanguinea	2	-
Nereidae sp.	2	-
Prionospio heterobranchia texana	2	-
Syllides verrilli	8	-
Class Gastropoda		
snails *Batillaria minima*	6	-
Cerithium lutosum	2	-
Class Crustacea		
amphipods *Ampelisca vadorum*	2	-
mysids Decapod mysis	2	-
Total individuals	116	-
Total biomass (g)	0.0837	-
Density (no./m^2)	1667	-
Biomass (g/m^2)	1.203	-
Index of diversity	1.91	-
Equitability	0.450	-

Benthic Table 9. Results of Benthic Macroinvertebrate Sampling at Control Station 1 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Class Polychaeta		
worms *Arenicola cristata*	2	-
Aricidea philbinae	6	208
Axiothella mucosa	26	124
Capitella capitata	36	72
C. jonesi	2	-
Ceratonereis mirabilis	-	20
Exogone verugera	6	4
Fabricia sp.	64	28
Glycinde solitaria	-	4
Haploscoloplos foliosis	-	28
Langerhansia cornuta	-	12
Neanthes acuminata	-	16
Nereidae sp.	2	-
Paraonides lyra	2	-
Polydora ligni	-	4
Prionospio heterobranchia texana	16	-
Sabellidae sp. A	2	-
Scolelepis texana	2	4
Scyphoproctus sp. A	2	-
Spio pettiboneae	4	-
Typosyllis sp. A	12	8
Class Gastropoda		
snails *Acteocina canaliculata*	20	4
Alvania auberiara	-	8
Caecum pulchellum	4	40
Cerithium muscarum	2	24
Diastoma varium	2	-
Granulina ovuliformis	-	8
Odostomia? sp.	2	-
Prunum apicinum	-	8
Prunum sp.	2	-
Sayella fusca	-	4
Turbonilla sp.	-	4

Benthic Table 9 (cont'd). Results of Benthic Macroinvertebrate Sampling at Control Station 1 at the Turkey Point Plant During 1980.

Species		Sum of 3 replicates April	Sum of 3 replicates October
Class Pelycypoda			
bivalves	*Anomalocardia auberiana*	18	4
	Branchidontes exustus	2	-
	Laevicardium mortoni?	-	4
	Lyonsia hyalina	4	24
	Parastarte triquetra	48	52
	Tellina tampaensis	46	4
	Transenella conradina	-	48
Class Crustacea			
ostracods	Haplocytheridia? sp. A	2	12
	Parasterope pollex	2	-
	Sarsiella zostericola	10	-
	Sarsiella sp. A	2	28
tanaids	*Hargeria rapax*	4	-
isopods	*Edotea* sp.	2	-
mysids	*Taphromysis bowmani*	-	4
amphipods	Aoridae sp.	-	4
	Elasmopus levis	-	4
	Grandidierella bonnieroides	2	-
	Melita sp.	4	-
	Rudilemboides sp.	2	-
Class Insecta			
marine chironanids	*Clunio* sp.	4	-
Class Ophiuroidea			
brittle stars	Ophiuroidea sp.	4	-
Class Holothuroidea			
sea cucumbers	*Leptosynapta* sp.	-	4
Phylum Nemertinea		56	12
Phylum Sipuncula		28	172
Total individuals		452	1012
Total biomass (g)		0.3544	0.0659
Density (no./m^2)		6494	18,540
Biomass (g/m^2)		5.09	0.95
Index of diversity		4.19	3.97
Equitability		0.71	0.64

Benthic Table 10. Results of Benthic Macroinvertebrate Sampling at Control Station 2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates	
	April	October
Class Polychaeta		
worms *Aricidea philbinae*	2	-
Armandia maculata	4	12
Axiothella mucosa	56	-
Brania clavata	16	24
Branchioasychis americana	2	-
Branchiomma nigromaculata	-	8
Capitella capitata	6	4
C. jonesi	8	8
Caulleriella alata	18	12
Ceratonereis mirabilis	-	20
Exogone dispar	46	32
E. verugera	52	364
Fabricia sp.	420	240
Gyptis brevipalpa	4	8
Haploscoloplos foliosis	14	-
H. fragilis	-	4
Haplosyllis spongicola	-	28
Hydroides dianthus	2	-
Lanicides toboquille	4	8
Langerhansia cornuta	4	-
L. ferrugina	-	4
Lumbrineris sp.	4	-
Maldanidae sp.	-	32
Marphysa sanguinea	2	-
Naineris laevigata	4	4
N. setosa	10	-
Neanthes acuminata	6	4
Henatonereis sp. A	2	-
Nereidae sp.	6	-
Nereis sp. A	-	4
Notomastus latericeus	20	-
Opisthosyllis sp. A	-	4
Orbiniidae sp.	-	4
Paraonides lyra	82	188

Benthic Table 10 (cont'd). Results of Benthic Macroinvertebrate Sampling at Control Station 2 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Class Polychaeta (continued)		
Pista cristata	2	-
Platynereis dumerilii	2	4
Podarke obscura	8	-
Polydora ligni	2	12
Prionospio heterobranchia texana	114	24
Sabellidae sp. A	40	-
Schistomeringos rudolphi	38	48
Scoloplos rubra	-	4
Scyphoproctus sp. A	26	8
Serpulidae sp. A	-	16
Sphaerosyllis sp. A	8	48
Spirorbis corrugatus	4	32
Streblosoma hartmanae	36	4
Terebellidae sp.	14	-
Tharyx annulosus	6	4
Tubificidae sp.	8	-
Tubificoides sp.	16	28
Typosyllis annularis	-	52
T. hyalina	-	16
Typosyllis sp. A	44	52
Typosyllis sp. B	10	16
Class Gastropoda		
limpets Acmaea sp.	2	-
chitons Ischnochitin sp.	84	12
Ischnochitin cf. pseudovirgatus	-	44
snails Acteocina canaliculata	2	-
Alvania sp.	-	40
Caecum pulchellum	154	84
Columbella rusticoides	2	-
Crassispira leucocyma	2	-
Crepidula maculosa	16	-
Crepidula sp.	-	4
Cyclostremiscus pentagonis	-	4
Cylindrobulla beauii	2	16

Benthic Table 10 (cont'd). Results of Benthic Macroinvertebrate Sampling at Control Station 2 at the Turkey Point Plant During 1980.

Species		Sum of 3 replicates April	Sum of 3 replicates October
Class Gastropoda (continued)			
	Granulina ovuliformis	2	-
	Modulus modulus	28	-
	Nassarius vibex	10	-
	Odostomia? sp.	2	-
	Prunum apicinum	12	4
	Rissoina catesbyana	82	12
	Turbonilla (*chemitzia*) sp.	2	-
	Urosalpinx perrugata	2	-
	Vermicularia spirata	2	-
Class Pelycypoda			
bivalves	*Arcopsis adamsi*	2	-
	Branchidontes exustus	120	28
	Carditamera floridana	32	16
	Chione cancellata	4	-
	Laevicardium mortoni?	2	-
	Laevicardium sp.	2	-
	Lyonsia hyalina	2	-
	Modiolus americanus	2	-
	Tellina tampaensis	4	-
Class Gastropoda			
ostracods	*Sarsiella zostericola*	2	-
copepod	Copepoda sp.	12	-
cumaceans	Cumacea sp.	12	-
	Cumacea sp. B	4	-
tanaids	*Apseudes* sp. A	2	-
	Hargeria rapax	36	8
	Pagurapseudes? sp. A	4	16
	Tanaidacea sp.	-	4
	Zeuxo? sp.	-	4
isopods	*Apanthura magnifica*	4	-
	Cleantis planicauda	2	-
	Cymodusa faxoni	16	8
	Erichsonella filiformis	16	4
	Paracerceis? sp.	-	4
	Ostracoda sp. B	-	4

Benthic Table 10 (cont'd). Results of Benthic Macroinvertebrate Sampling at Control Station 2 at the Turkey Point Plant During 1980.

		Sum of 3 replicates	
Species		April	October
Class Gastropoda (continued)			
amphipods	*Amphithoe longimana*	2	-
	Cerapus tubularis	8	-
	Corophium sp.	10	-
	Cymadusa compta	24	28
	Cymadusa sp.	-	12
	Elasmopus poecillimanus	2	-
	Elasmopus sp.	4	-
	Elasmopus sp. A	4	-
	Elasmopus levis	-	4
	Gitonopsis tortugae	16	-
	Grandidierella bonnieroides	24	-
	Lembos websteri?	2	-
	Leucothoe spinicarpa	-	24
	Lysianopsis alba	44	16
	Melita appendiculata	34	8
	M. elongata	6	-
	Melita sp.	4	-
	Rudiolemboides sp.	2	-
shrimp	Caridea sp.	-	8
	Caridean postlarva	2	-
	Penaeus duorarum	-	4
	Thor sp.	2	-
crabs	*Pagurus bonairensis*	6	-
	Portunidae sp.	2	-
Class Insecta			
marine chironomid	*Clunio* sp.	2	-
Class Pantopoda			
sea spiders	*Achelia sawayai*	2	-
	Ammotheidae sp.	-	4
	Callipalene emaciata	2	-
Class Ophiuroidea			
brittle stars	*Amphioplus abditus*	-	4
	A. thrombodes	4	-
	Amphiuridae sp.	-	4
	Ophiactis sp.	-	4
	Ophiuroidea sp.	-	4

Benthic Table 10 (cont'd). Results of Benthic Macroinvertebrate Sampling at Control Station 2 at the Turkey Point Plant During 1980.

Species		Sum of 3 replicates	
		April	October
Class Holothuroidea			
sea cucumbers	*Leptosynapta* sp.	50	28
	Synaptula hydriformis	2	-
Phylum Nematoda		100	-
Phylum Nemertinea		42	40
Phylum Platyhelminthes		12	8
Phylum Sipuncula		26	8
Total individuals		2262	1832
Total biomass (g)		0.8624	0.1352
Density (no./m^2)		32,500	26,322
Biomass (g/m^2)		26.76	1.94
Index of diversity		5.20	4.81
Equitability		0.52	0.56

Benthic Table 11. Results of Benthic Macroinvertebrate Sampling at Control Station 3 at the Turkey Point Plant During 1980.

Species	Sum of 3 replicates April	Sum of 3 replicates October
Class Polychaeta		
worms *Capitella capitata*	2	-
Caulleriella alata	-	4
Ceratonereis mirabilis	-	12
Cirratulus? sp. A	4	4
Exogene verugera	6	24
Fabricia sp.	12	52
Haploscoloplos foliosis	-	4
Langerhansia cornuta	10	-
Lumbrineris impatiens	-	4
Neanthes acuminata	6	-
Parahesione luteola	2	-
Paraonides lyra	12	116
Podarke obscura	4	-
Prionospio heterobranchia texana	20	4
Sabellidae sp. A	2	-
Schistomoringos rudolphi	-	8
Serpulidae sp. A	4	12
Sphaerosyllis sp. A	8	8
Spio pettiboneae	4	-
Spirorbis corrugatus	4	-
Trichobranchus glacialis	-	4
Tubificidae sp.	96	28
Tubificoides sp.	24	8
Typosyllis sp. A	2	4
Typosyllis sp. B	4	-
Class Gastropoda		
snails *Acteocina canaliculata*	2	-
Caecum pulchellum	4	-
Crepidula maculosa	4	-
Haminoea succinea	8	-
Prunum apicinum	2	-
Turbonilla (Pyriguscus) interrupta?	2	-
Class Pelycypoda		
bivalves *Branchidontes exustus*	2	-
Lucina nassula	2	-
Lyonsia hyalina	-	4
Macoma constricta	2	-

Benthic Table 11 (cont'd). Results of Benthic Macroinvertebrate Sampling at Control Station 3 at the Turkey Point Plant During 1980.

Species		Sum of 3 replicates April	Sum of 3 replicates October
Class Crustacea			
ostracods	*Sarsiella zostericola*	2	4
copepods	Harpacticoida sp.	4	-
tanaids	*Hargeria rapax*	6	-
amphipods	*Ampelisca vadorum*		-
	Cymadusa compta	-	4
	Gitanopsis tortugae	-	4
	Grandidierella bonnieroides	4	12
	Lysianopsis alba	2	-
snapping shrimp	*Alpheus* sp.	2	-
Class Ophiuroidea			
brittle stars	Amphiuridae sp.	2	-
	Ophiphragmus filogranula	2	-
	Ophiuroidea sp.	-	4
Phylum Nemertinea		14	24
Total individuals		288	352
Total biomass (g)		0.2992	0.0156
Density (no./m^2)		4138	5057
Biomass (g/m^2)		4.30	0.22
Index of diversity		4.01	3.51
Equitability		0.65	0.71

Benthic Table 12. Physical Data Recorded During Benthic Sampling at the Turkey Point Plant During 1980.

Station	Month	Temperature (°C)	Salinity (ppt)	Dissolved oxygen (ppm)
RC.0	April	30.0	43.0	4.7
	October	29.3	38.0	3.6
RC.2	April	30.0	43.0	8.1
	October	29.8	38.0	5.8
E3.2	April	31.5	43.0	8.8
	October	29.9	38.0	7.4
RF.3	April	34.0	43.0	7.4
	October	30.2	40.0	3.3
WF.2	April	35.0	42.0	6.8
	October	34.9	38.0	5.3
W18.2	April	29.0	43.0	4.3
	October	33.8	38.0	5.4
W6.2	April	28.5	43.0	5.4
	October	33.7	40.0	4.6
F.1	April	33.0	43.0	4.3
	October	36.5	39.0	4.0
Control 1	April	24.6	34.0	8.5
	October	25.9	22.0	3.3
Control 2	April	24.5	35.0	6.3
	October	27.8	23.0	4.2
Control 3	April	25.0	35.0	6.7
	October	27.3	23.0	2.5

Benthic Table 13. Comparison of the Adjusted Mean Density, Biomass and Diversity of the Turkey Point Canal Stations*

Parameter	Month	1979 data	Month	1980 data
Density ($no./m^2$)	May	9579	April	7757
	October	2596	October	9143
Biomass (g/m^2)	May	2.077	April	11.173
	October	4.084	October	2.705
Diversity	May	2.70	April	2.97
	October	2.25	October	1.96

*Because of different stations sampled in 1979 and 1980, only means of the data from stations common to both years are presented here. These common stations are E3.2, RF.1, WF.2, W18.2, W6.2 and F.1. The above data are as plotted in Benthic Figures 2, 3 and 4 with the omission of data from Station RC.2 for 1979 and Stations RC.0 and RC.1 for 1980.

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

Introduction

This study determines the nature and extent of recovery of grasses and macroalgae in the old Grand Canal Discharge Area. The discharge was open to the bay from 1967 to its closing in 1973. Area damage was a result of both thermal and velocity effects of the effluent.

Materials and Methods

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

Method 1 - Aerial Surveys

The overall revegetation of the previously affected Grand Canal Discharge Area was assessed using aerial photographs taken from an altitude of 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). Also a plane table survey (Figure 4) was carried out using a Keuffel and Esser paragon conventional expedition alidade and a fiberglass Philadelphia rod.

Method 2 - Quadrat Stations

Quantitative measurements of seagrass and algal densities were made by counting and identifying the vegetation at six stations of one square meter each. These stations are permanently located on an east-west transect line normal to the mouth of the former discharge canal.

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, relative abundance, and general conditions were noted. The procedure also served as ground truthing for the aerial photographs.

Results

Annual

The alidade analysis revealed a total affected area of 0.46 acres (Figure 4). This roughly corresponds to the velocity scarp (canal drop off) visible in the aerial photographs (Figures 2 and 3).

June 1980

The analysis of the aerial photograph and transect swim indicated four community zones in the previously affected area (Figure 2). They were a *Thalassia* community with *Syringodium* patches, a mixed *Thalassia*/*Halodule* community, a *Halodule* community, and a *Thalassia* community. Results of the density analysis are summarized in Table 1; *Thalassia testudinum* was dominant in all quadrats with the exception of X-2N.

Seven types of macroalgae were noted in density quadrats (Table 1).

December 1980

An additional zone was apparent during this monitoring period. This zone was the *Thalassia/Macroalgae* zone (Figure 3). *T. testudinum* again was the dominant seagrass in terms of number of fascicles per square meter (Table 2). Five macroalga were present in the density quadrats.

Discussion

In June 1980, vegetation in the area of X-1 was composed of sparse *T. testudinum* and *Halodule wrightii*. *Caulerpa sp.* was very abundant to the west of X-1, in the vicinity of the former discharge canal drop off.

The area between X-1 and X-2 was dominated by *H. wrightii* and patches of *T. testudinum* and *Caulerpa sp.* The area in the vicinity of X-2 was dominated by *T. testudinum.* The algae *Acetabularia crenulata, Batophora oerstedi, Penicillus sp.* and *Laurencia sp.* were present in this area.

The community between X-2 and X-3 was dominated by *T. testudinum* as was the area between X-3 and X-4. *H. wrightii* was present sparsely in these areas. Several alga were present along this portion of the transect e.g., *Sargassum sp., Laurencia sp., A. crenulata, Halimeda sp.* and *Penicillus sp.*

In the vicinity of X-4 the community was comprised mainly of *T. testudinum*, however, *Syringodium filiforme* and several species of algae were present. The north transect showed slightly different seagrass community patterns. Proceeding from the coastline to the east the following zones were traversed: *H. wrightii* dominance, mixed dominance, *T. testudinum* dominance and *T. testudinum* dominance with *S. filiforme* patches (Figure 2). The south transect reflected the same pattern as the north transect.

Sediments in the vicinity of all stations with the exception of X-1 were greater than six inches deep and were comprised of seagrass blades and mangrove leaves. The silt in the area of X-1 was very shallow and composed of fine detritus.

During December 1980, vegetation in the area of X-1 was very sparse, with *T. testudinum* the only seagrass present, and various macroalga present. The macroalgae present consisted primarily of *Penicillus sp.* and *Laurencia sp.* The bottom characteristics in this area go from deep and rocky to shallow areas layered with 1 to 3 inches of fine silt.

The area between stations X-1 and X-2 had three different seagrass communities. The communities present from west to east were a *H. wrightii* community to a community with a mixture of *H. wrightii* and *T. testudinum* (mixed zone) to a *T. testudinum* community. The macro-

algae present among these communities were dominated by *Penicillus sp.* and *Caulerpa sp.*

At X-2 the area was dominated by *T. testudinum* with some *H. wrightii* present. The sediments in this area consisted of 6-8 inches of decaying grass blades and mangrove leaves.

The transect between X-2 and X-3 was a community dominated by *T. testudinum* with some *H. wrightii* present. The macroalga in this area were *A. crenulata, Penicillus sp., Digenia sp., Rhipocephalus sp., Caulerpa sp., Sargassum., Udotea sp.* and *Avrainvillea sp.*

At X-3 the dominant seagrass was *T. testudinum* with some *H. wrightii* present. Macroalga present at this station were *Laurencia sp., Halimeda sp., Caulerpa sp.,* and *A. crenulata.* Sediments were of the same nature and depth as X-2.

From X-3 to X-4 the dominant seagrass was *T. testudinum.* Sparsely scattered among the *T. testudinum* and *H. wrightii.* The macroalga present were *A. crenulata, Penicillus sp., Rhipocephalus sp., Digenia sp., Sargassum sp., Laurencia sp., Udotea sp.,* and *Avrainvillea sp.*

The area east of X-4 went from a community dominated by *T. testudinum* to a community dominated by *H. wrightii. S. filiforme* was mixed in with both *T. testudinum* and *H. wrightii* communities. East

of X-4 to a distance of approximately 300 feet no large clumps of *S. filiforme* were found.

The north transect swim went through various zones. The zones from west to east were a zone of patchy *T. testudinum* and *H. wrightii* to a mixed zone to a zone dominated by *T. testudinum.* Within these various zones were found sparse amounts of *Syringodium* and macroalga. The macroalgae found were *Anadyomene stellata, Laurencia sp., Penicillus sp., Caulerpa sp.,* and *Sargassum sp.*

The south transect swim went through various zones from west to east. The zones went from a mixed zone to a *H. wrightii/T. testudinum/ S. filiforme* zone to a *T. testudinum/*macroalgae zone. Present among these zones was small amounts of *S. filiforme.* Small mangrove seedlings were also located along this transect. Macroalgae present were *Udotea sp., Penicillus sp., Rhipocephalus sp., Sargassum sp., Digenia simplex,* and *Laurencia sp.* The lower densities of *T. testudinum* at X-1 can be explained by the depth of this station and the rocky substratum.

In pre-operational data, Thorhaug (Bader and Roessler, 1972) reported that depth of water, wave action, turbidity and salinity were factors affecting local distribution; she also found that the "Areas of lesser sediment in mid Card Sound sustain large populations of major macroalgae as opposed to *Thalassia* because of the latters

extensive root and rhizome system which is impeded by rocky outcroppings in mid bay."

In general, all stations exhibited a seasonal fluctuation of grass and macroalgal densities with lower densities occurring during the summer months. This decrease in density agreed with the supposition of a natural summer stress period proposed by Thorhaug (Bader and Roessler, 1972). The densitites of all stations, except X-1, appeared essentially the same as those found in the baseline report (Bader and Roessler, 1972). However, they were not directly comparable since the units of enumeration used in these studies differed. The present study used fascicles (sheaths of blades) per square meter while the baseline study used blades per square meter as an indication of density.

Conclusions

The previously affected area has revegetated and supports a seagrass/macroalgae community very similar to those described in the baseline report (Bader and Roessler, 1972). The "non-recovered" area (0.46 acres) at the mouth of the former discharge will continue to recover at a slow rate and will not support a community of similar density until a suitable sediment base is established.

LITERATURE CITED

Bader, R.G. and Roessler, M.A. 1972. An ecological study of South Biscayne Bay and Card Sound. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, FL.

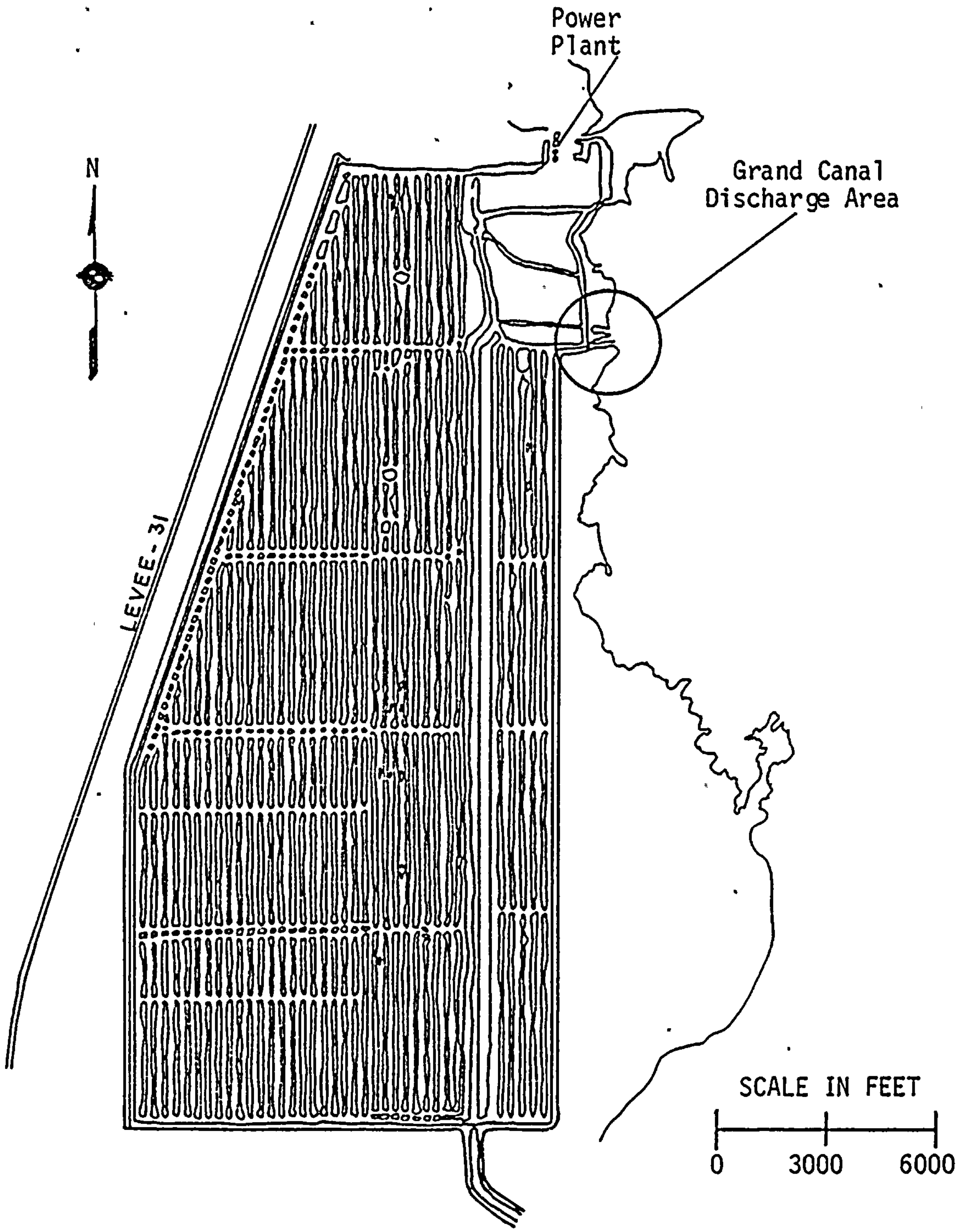


Figure 1. Location of Turkey Point Power Plant Grand Canal Discharge, closed in February 1973.

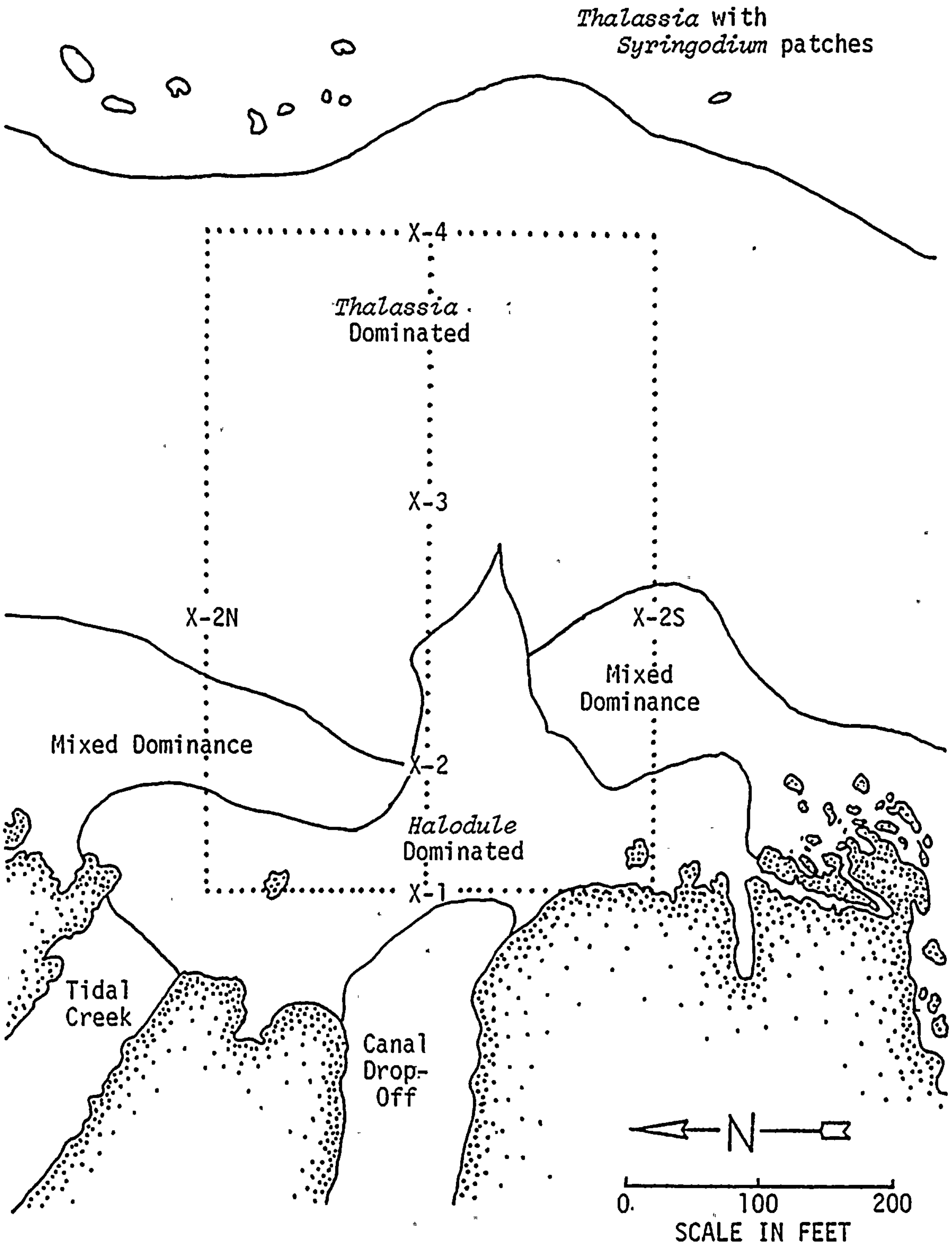


Figure 2 . Tracing of Aerial Photograph of previously affected area at Turkey Point Power Plant, Grand Canal Discharge for June 1980.

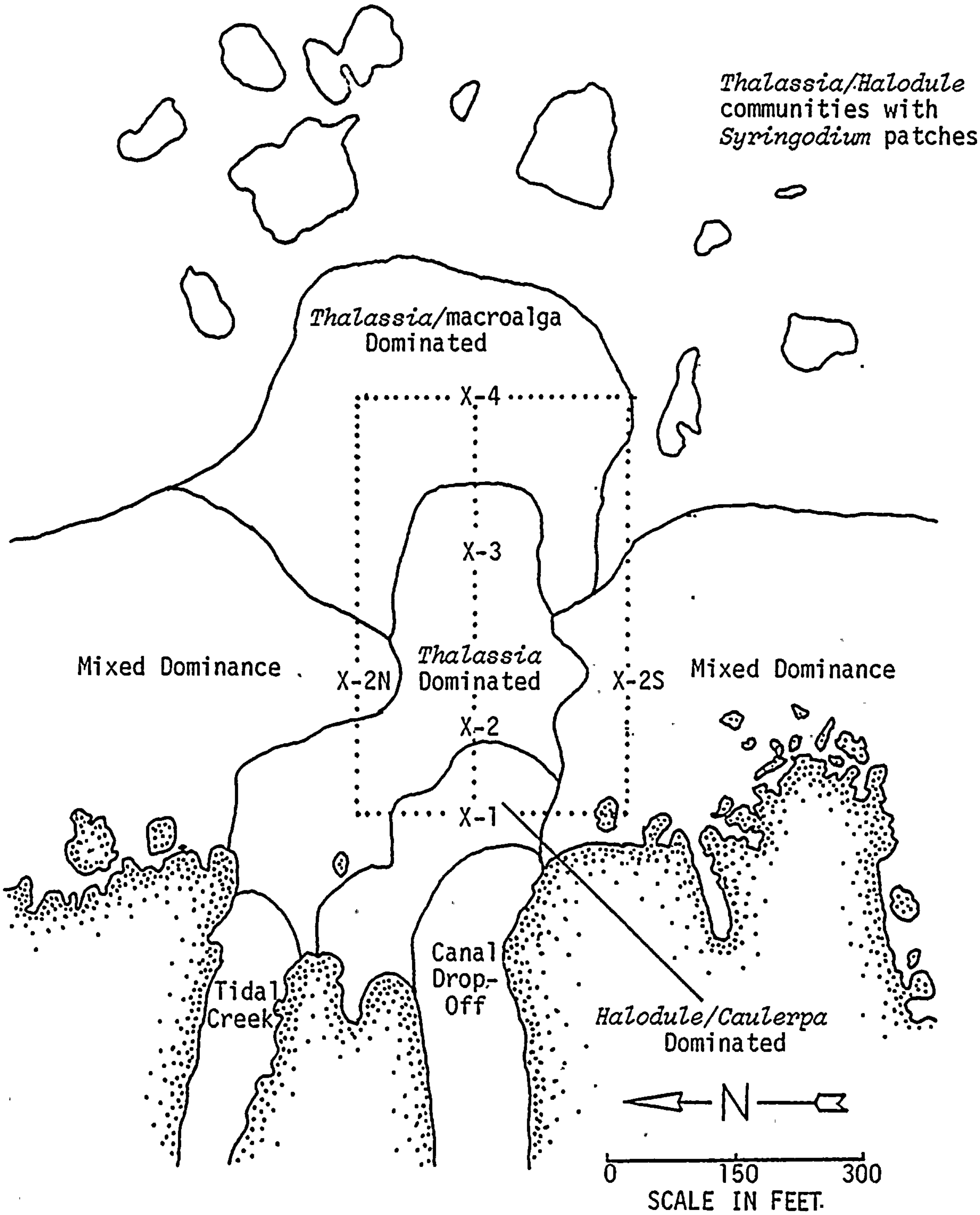


Figure 3 . Tracing of Aerial Photograph of previously affected area at Turkey Point Power Plant Grand Canal Discharge for December 1980.

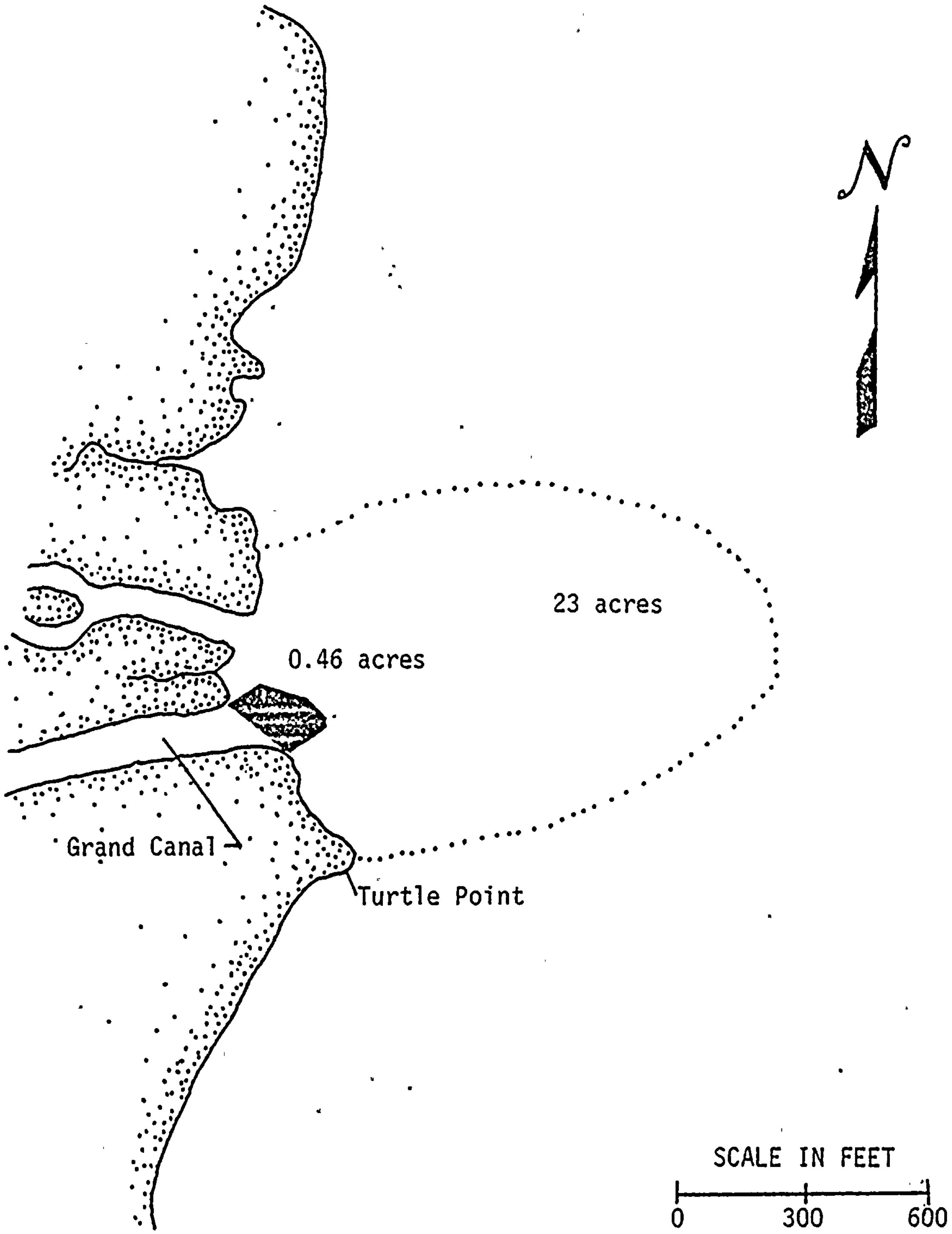


Figure 4. Comparison of plane table surveys of previously affected Turkey Point Power Plant, Grand Canal Discahrge Area after Thorhaug, October 1971 (dotted line), Florida Power & Light, June 1980 (blackened area).

Table 1. Quadrat Study of the Turkey Point Power Plant, Grand Canal Discharge for June, 1980.

STATION	X-1	X-2	X-3	X-4	X-2N	X-2S
ANGIOSPERMS:						
*Halodule wrightii***	12	+	196	180	16	88
*Thalassia testudinum***	60	52	648	504	+	132
CHLOROPHYTA:						
Acetabularia crenulata	*	*	*	*	*	*
Anadyomene stellata	-	-	-	-	-	-
Avrainvillea nigricans	-	-	*	-	-	-
Batophora oerstedi	*	*	-	-	*	*
Caulerpa sp.	-	-	-	-	-	*
Halimeda sp.	-	-	*	*	-	*
Penicillus sp.	-	*	*	-	-	*
Rhipocephalus sp.	-	-	-	-	-	-
PHAEOPHYTA:						
Dictyota sp.	-	-	-	-	-	-
RHODOPHORA:						
Digenia sp.	-	-	-	-	-	-
Laurencia sp.	-	*	*	-	-	*
OTHERS:						
Rhizophora mangle	-	-	-	-	-	-

NOTE: + Some seagrass was present at the sample point, but not in the 1/16 meters square areas used for density determinations.
* Present
** Number of fascicles/m^2.

Table 2. Quadrat Study of the Turkey Point Power Plant, Grand Canal for December 1980.

STATION	X-1	X-2	X-3	X-4	X-2N	X-2S
ANGIOSPERMS:						
*Halodule wrightii***	116	168	76	56	172	220
*Thalassia testudinum***	104	196	272	412	256	244
CHLOROPHYTA:						
Acetabularia crenulata	-	-	*	-	*	*
Anadyomene stellata	-	-	-	-	-	-
Avrainvillea nigricans	-	-	-	-	-	-
Batophora oerstedi	*	-	-	-	-	-
Caulerpa sp.	*	*	*	-	*	*
Halimeda sp.	-	-	*	-	*	*
Penicillus sp.	*	*	-	-	*	*
Rhipocephalus sp.	-	-	-	-	-	-
PHAEOPHYTA:						
Dictyota sp.	-	-	-	-	-	-
RHODOPHORA:						
Digenia sp.	-	-	-	-	-	-
Laurencia sp.	-	-	*	*	*	*
OTHERS:						
Rhizophora mangle	-	-	-	-	-	-

NOTE: * Present
** Number of fascicles/m^2.

5. Grasses and Macrophyton Invasion/Revegetation (ETS 4.2.2.2)

Introduction

This study qualitatively assesses the diversity and extent of seagrasses and macroalga within the canal system. They are important to study since they are potentially detrimental to the thermal and hydraulic efficiency of the cooling canal system.

Materials and Methods

Observation, identification, and quantification of seagrasses and macrophyton were made during periodic surveys in conjunction with other monitoring programs in the canal system.

Results

Fifteen genera of seagrasses and macrophyton were found in the canal system during 1980 (Table 1) as compared to twelve for 1979 and eleven reported during the Baseline Study (Bader and Roessler, 1972). Concentrations of these plants were scattered throughout the canal system with dense assemblages of seagrasses/macrophyton in the southwest corner and the eastern canals (Figure 1).

The effectiveness of "Rotovation" (FPL, 1979) was determined this year. It was found that the removal of *Ruppia maritima* and subsequent benefit was temporal. *R. maritima* density was approximately the same in the test canal as in the control. The grass also appeared to be more uniformly distributed in the test canal than the control canal.

An abundance of the angiosperm *Halophila englemanni* was noted in the eastern canals (Table 2).

Discussion

R. maritima (Widgeon grass or Ditch grass) continued to be the seagrass of primary importance in the canal system. It was confined to the southwest canals but continued to spread north and east as in 1979 (FPL, 1979). This grass, which is considered a submergent form, grew to lengths of 4 to 8 feet and often occupied the water column from substrate to surface. Seasonally the strands become heavily encrusted with epiphytic growth and impede water flow in the cooling canal system.

In the past, various biological, physical, and chemical methods of controlling this aquatic weed have been attempted with negative results. During 1979 a technique known as "Rotovation" was employed to disrupt *R. maritima.* This technique proved effective only on a temporary basis. After a year the ditch grass had completely recovered and showed no significant difference from the control in terms of biomass.

In March of 1980 another physical technique utilizing a "Drag Bar" was tested. Final evaluation of this technique's effectiveness is pending.

Also found in the canal system were the marine angiosperms *Halodule wrightii* (formerly known as *Diplanthera wrightii*), Shoalgrass; *H. englemanni,* no common name; *Thalassia testudinum,* Turtle grass; and *Syringodium filiforme,* Manatee grass. The northernmost sections of the eastern canals continued to represent the area with the heaviest growth in the canal system of the latter two grasses.

H. wrightii was particularly well represented by stands on both east and west sides. Due to the finite growth habit of its fascicles, this speces was thought to be of little consequence in restricting water movement. This species has runners which are normally attached to the substrate by rhizomes. However, in dense stands these long runners overlapped each other in such a way that the rhizomes did not reach the substrate. Hence, long floating strands develop with the potential to obstruct water flow in a manner similar to *R. maritima.*

S. filiforme and *T. testudinum* showed no significant changes in abundance since last year. *H. englemanni* was noted in this system for the first time.

Various red and brown alga continued to be found along the rocky shoreline of most of the canals. *Dasya sp.* grew predominantly in the winter months on rocks in the shallower 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 little consequence to the canals system's marine ecology and flow characteristics. In greater densities this algae has the potential of becoming a major flow inhibitor.

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

Five genera were found in the canal system that were not reported during the Baseline Study (Bader and Roessler, 1972; Table 1). Three genera were reported during the Baseline Study in adjacent Biscayne Bay/Card Sound that have not been found in the system. These differences are considered of little consequence.

Conclusions

Macroalga and to a lesser extent the seagrasses dominate the eastern canals and southwest canals. *R. maritima* and *H. wrightii* continue to dominate the southwest corner of the system on an alternating seasonal cycle and will continue to spread rapidly unless an effective method of control can be found. The continued spread and

concentration of these aquatic weeds will reduce the efficiency of the cooling canals, which serve as a heat sink for the power plant.

LITERATURE CITED

Bader, R.G. and Roessler, M.A. 1972. An ecological study of South Biscayne Bay and Card Sound. AT (40-1) - 3801 - 31. Florida Power & Light Co. and Rosenstiel School of Marine and Atmos. Sci., Univ. of Miami, Miami, FL.

Florida Power & Light Co. 1979. Turkey Point Unit 3 & 4 non-radiological environmental monitoring report no. 13. Miami, Florida.

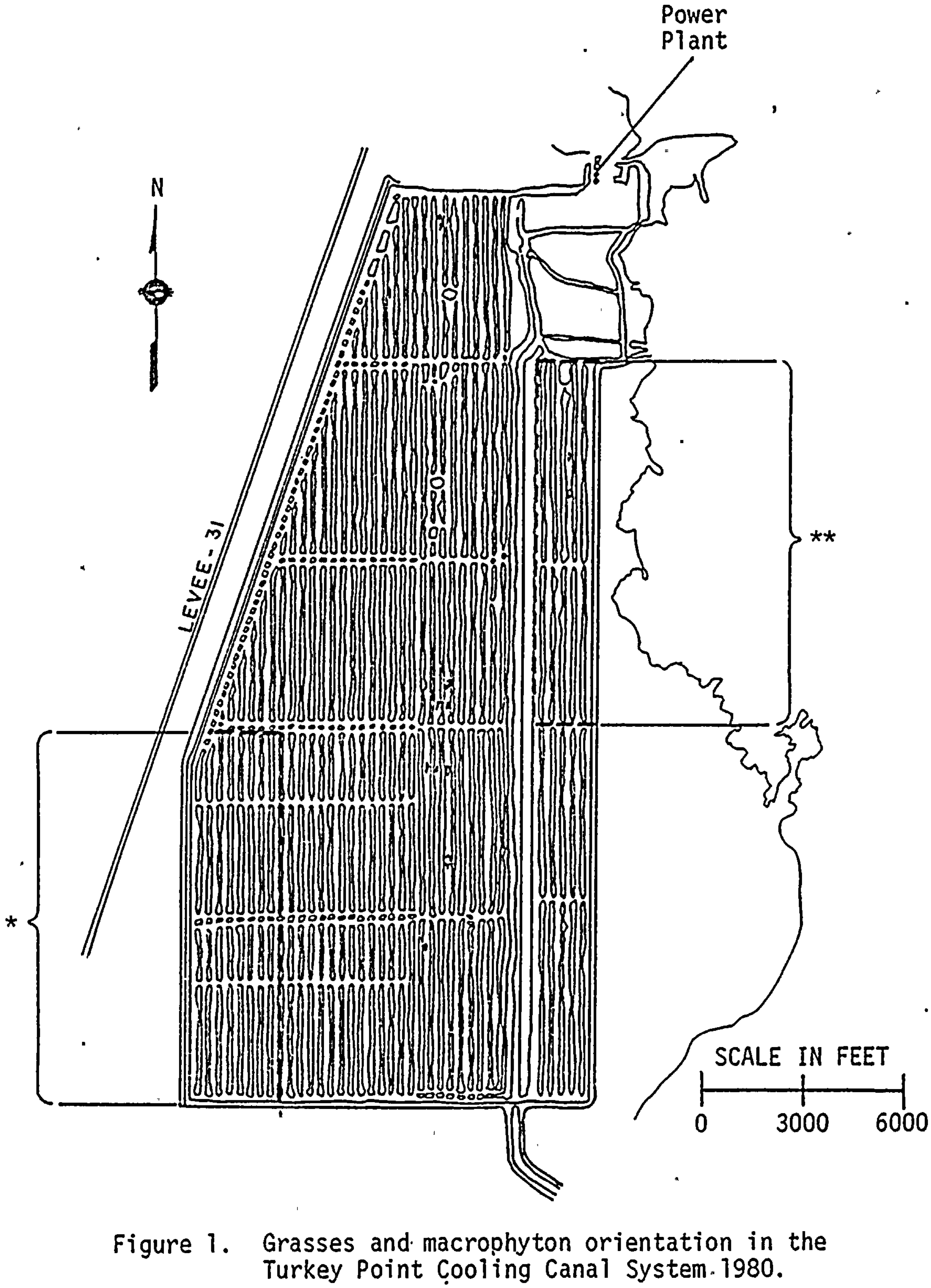


Figure 1. Grasses and macrophyton orientation in the Turkey Point Cooling Canal System 1980.

NOTE: *Area dominated by *Ruppia maritima* and *Halodule wrightii*.
**Macroalga dominance, seagrasses present to lesser extent..

Table 1. Comparison of macrophyton and seagrass species found during the baseline study with those in the Turkey Point Cooling Canal System for 1979 and 1980.

Scientific Name	Baseline* 1972	1979	1980
Acetabularia crenulata	X	X	X
Avrainvillea sp.	X		
Anodymene stellata			X
Batophora oerstedi	X	X	X
Caulerpa spp.	X	X	X
Dasya sp.		X	X
Halimeda spp.	X	X	X
*Halodule wrightii***	X	X	X
Halophila englemanni			X
Laurencia sp.	X	X	X
Penicillus spp.	X	X	X
Rhipocephalus spp.	X		X
Ruppia maritima		X	X
Sargassum sp.		X	X
Syringodium filiforme		X	X
Thalassia testudinum	X	X	X
Udotea sp.	X		

NOTE: * Bader and Roessler, 1972
** Formerly named *Diplanthera wrightii*.

Table 2. Relative abundance of seagrass and macrophyton species in the Turkey Point Cooling Canal System during 1980.

Scientific Name	Classification	Relative Abundance	Locale
Halodule wrightii	Seagrass	Common	Systemwide
Halophila englemanni	Seagrass	Common	East Canals
Ruppia maritima	Seagrass	Common	Southwest canals
Syringodium filiforme	Seagrass	Rare	East canals
Thalassia testudinum	Seagrass	Rare	East canals
Acetabularia crenulata	Green Algae	Common	Systemwide*
Anodymene stellata	Green Algae	Rare	East canals
Batophora oerstedi	Green Algae	Common	Systemwide*
Caulerpa spp.	Green Algae	Common	East canals
Halimeda spp.	Green Algae	Common	East canals
Penicillus spp.	Green Algae	Rare	East canals
Rhipocephalus spp.	Green Algae	Rare	East canals
Dasya sp.	Red Algae	Common	Systemwide in Rocky canals
Laurencia sp.	Red Algae	Common	East canals
Sargassum sp.	Brown Algae	Rare	East canals

NOTE: * Usually found on rocks or as an epiphyte.

6. GROUNDWATER PROGRAM (ETS 4.1.1.2)

A summary report entitled Groundwater Monitoring Program, Turkey Point, Florida, prepared by Florida Power & Light Company's consultant Dames & Moore, for period July 1, 1980 through June 30, 1981 will be forwarded to NRC by August 30, 1981.

B. TERRESTRIAL ENVIRONMENT

1. Revegetation of Cooling Canal Banks (ETS 4.2.1)

a. Natural Revegetation

Introduction

This study assesses and measures the growth rates of the floristic species that colonize the spoil berms created by constructing the cooling canals.

Materials and Methods

Data were gathered on a semi-annual basis from six permanent stations located within the Turkey Point Cooling Canal System (Figure 1). One 10 meter by 10 meter quadrat was permanently staked out at each of the six stations on the canal system spoil berms. Growth and reproduction data were recorded 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 reinvasion rates (Table 7). Tabulated data were presented as number of individuals rather than the percent change in the number of individuals. After carefully studying past data, it was determined that the "percent change" data can be misleading and ambiguous.

Results

Tables 1 - 6 depicted the changes in the number of individuals of all species observed in the six monitoring quadrats since the natural vegetation program began in 1975. Historical data for all

species found during this program can be found in Table 8.

Stations 105S and 505N with low density vegetation showed a slight shift from the dominance of large tree species to that of small plant species and grasses when comparing 1979 and 1980 data. Four of the six tree species remained unchanged in numbers while two of the five grass species increased over 250 percent. Small plant species such as *Baccharis halimifolia, Borrichia frutescens* and *Aster tenuifolius* showed population increases of over 100 percent.

During 1980 at one medium density vegetation station, 408M, both dominant tree species decreased drastically, when compared to 1979, as a result of a weed control program. Species of grasses such as *Cladium jamaicensis* and *Distichilis spicata* showed slight changes in coverage. There were great increases in the percent of smaller plant species such as *Thelypteris normalis* (1200 percent increase) and *Pteris vittata* (800 percent increase). Eight new species were observed at Station 408M this year.

The other medium density vegetation station, 323S, was the only monitoring site not treated by the weed control program. The station continued to exhibit the trends set in 1979 with a 76 percent increase in the Australian Pine (*Casuarina equisetifolia*) population, while all other species either decreased in number or showed no change.

The two heavy density vegetation stations, 204N and 310M, had the largest decrease in the tree population with five species decreasing in numbers and one remaining unchanged when comparing 1979 and 1980 data. This decrease was a result of a weed control program necessary to maintain cooling canal efficiency. Over one half of Station 310N was covered with grass. *C. jamaicensis* increased in coverage by 169 percent and *D. spicata* increased by 800 percent. Existing small plant species *Rhabdádenia biflora, Melothria pendula, Solanum donianum* and *Physalis angulata* increased in numbers by 100, 100, 450, and 1500 percent respectively, while three new species were recorded this year.

Red Mangrove, *Rhizophora mangle,* were found at two of the six inland quadrats. There was a 40 percent decrease at Station 310N and no change at Station 105S. The shoreline quadrats, Table 7, showed two changes in the adult population, a 30 percent decrease at Station 408M and a 114 percent increase at Station 505N. The seedling population decreased at four stations and remained unchanged at one. The shoreline quadrat at Station 323S had no red mangroves. Established adults help prevent erosion of the shoreline, but some newly settled seedlings were dislodged by wave action eroding the banks.

Discussion

A vegetation control program has been underway for over a year. This program was designed to control vegetation over 3 feet in height which inhibit wind flow across the waters surface, reduce evaporative cooling and thereby reduce cooling canal efficiency. Its effect was

clearly evidenced in 1980. Five of the six monitoring stations have received herbicide application. Three of these five stations showed substantial decreases in *C. equisetifolia*.

Salt grass, *D. spicata,* remained the primary ground cover on the older berms and continued to spread westward to the newer berms. This grass grew well even on clay soils and should serve as excellent hurricane protection for the berms. Increases in this species occurred at stations where *C. equisetifolia* was absent, and a decrease occurred at 310S where *C. equisetifolia* had increased.

Although saw grass, *C. jamaicensis,* only occurred at 3 stations, system wide it was still considered an important ground cover and erosion inhibitor.

Buttonwoods, *Conocarpus erectus,* were present at all the stations. The adult population decreased at three stations and remained unchanged at the other three. Seedlings were too numerous to count at stations 505N, 323S, and 105S.

Soil type continued to be the overt factor determining vegetation density. *C. equisetifolia* and *C. erectus* dominated heavy vegetation areas and tended to occupy the tidal creeks and hammock areas where peat and muck substrates were prevalent. Salt grass was dominant on the marl barrens.

The higher elevation caused by berm construction has allowed sufficient edaphic changes to permit non-mangrove community species such as *B. halimifolia, Passiflora suberosa* and several new species (Tables 1 - 6) 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 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 III.B.2).

The decrease in large tree species has had a dramatic effect on most small species. Significant increases in *D. spicata, Andropogon glomeratus, S. donianum, A. tenuifolius* and numerous other species were observed in 1980 as compared to 1979. These increases in previously declining or rare species can be explained in the following manner. The 1980 vegetation control program was primarily done by helicopter with a resultant vertical delivery of the herbicide. The herbicide application was intended for Australian Pines, however other trees making up the canopy were affected. In areas of dense concentration of these large species, little or no herbicide reached the ground. The large species died while the smaller under story plants were relatively unaffected. The small plants, previously shaded by the large species, have increased light and nutrient resources and

proliferated accordingly.

Conclusions

Soil type continued to be the apparent factor determining vegetation density. *C. equisetifolia* and *C. 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. *C. equisetifolia* reduced the number of species and the diversity in areas where it dominated. In those areas where the weed control program was underway, the inverse occurred. The increased elevations resulting from berm construction have allowed upland species to invade the western areas of the canal system.

The total number of mature buttonwoods had decreased sharply as compared to 1979. The increased number of seedlings taking hold this year, provided they are unaffected by the herbicide spraying, are expected to increase the adult population.

The rates of revegetation of salt grass and saw grass is expected to increase as a result of a reduction in competition from the large *C. equisetifolia* and *C. erectus*.

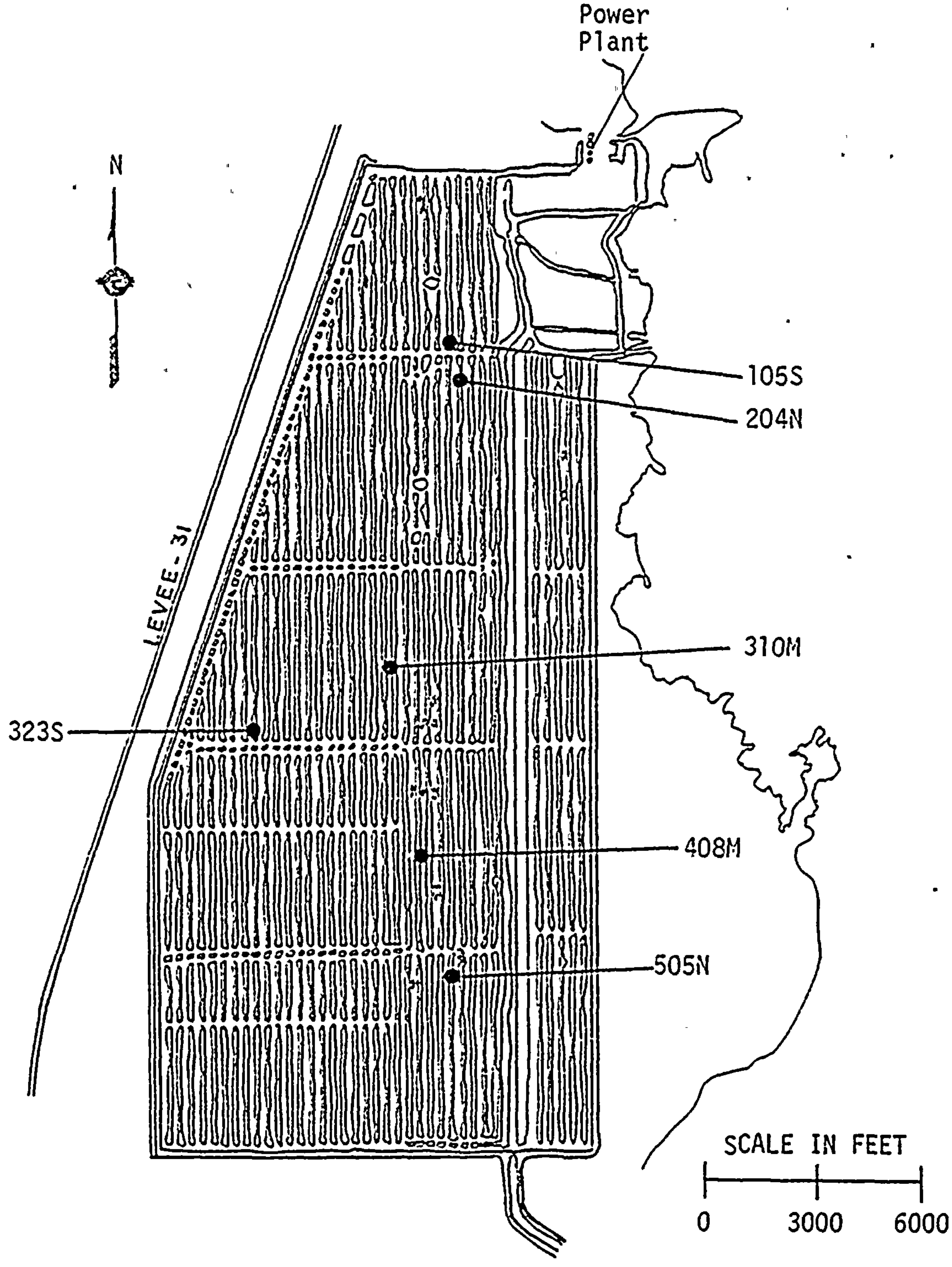


Figure 1. Natural revegetation test sites at the Turkey Point Cooling Canal System 1980.

Table 1. Number of individuals of species at light vegetation station 105S in the Turkey Point Cooling Canal System 1975-1980.

SPECIES	1975			1976				1977				1978				1979		1980	
	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	May	Nov.	May	Nov.
Rhizophora mangle	8	6	7	7	7	6	7	5	4	7	7	7	7	7	7	7	7	7	7	7
Laguncularia racemosa	6	8	10	7	9	6	6	6	5	7	8	8	8	8	8	8	8	10	10	10
Conocarpus erectus	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
*Distichilis spicata**	1	2	4	4	7	8	10	9	9	18	15	20	22	30	35	35	35	46	40	35
Juncus roemerianus	70	43	46	49	19	18	26	19	30	47	30	33	25	15	5	5	5	6	5	4
Solanum donianum													1	1	2	2	2	15	14	20
Erechtites hieracifolia															2	2	2	0	0	0
Baccharis halimifolia															1	3	3	3	4	4
Eupatorium capillifolium															3	3	3	2	2	0
Schinus terebinthifolius																		2	3	0
Andropogon glomeratus																		1	1	3
Mikania scandens																		1	3	1
Casuarina equisetifolia																				1

NOTE: * denotes counts per m^2

Table 2. Number of individuals of species at light vegetation station 505N in the Turkey Point Cooling Canal System 1975-1980.

SPECIES	1975			1976				1977				1978				1979			1980	
	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	May	Nov.	May	Nov.
Conocarpus erectus	5	6	6	5	5	7	6	5	5	5	5	5	4	4	4	4	4	4	4	4
Borrichia frutescens	3	1	60	40	4	3	4	5	5	5	5	7	8	12	13	13	13	40	38	47
*Distichilis spicata**			.3	0	0	0	.3	.5	.3	.5	1	2	2	2	2	2	2	4	6	10
Casuarina equisetifolia																1	1	1	3	7
Aster tenuifolius																		39	84	120
Baccharis halimifolia																		3	1	8
Andropogon glomeratus																			1	1

NOTE: * denotes counts per m^2

Table 3. Number of individuals of species at medium vegetation station 323S in the Turkey Point Cooling Canal System 1975-1980.

SPECIES	1975			1976				1977				1978				1979			1980	
	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	May	Nov.	May	Nov.
Conocarpus erectus	8	5	4	9	5	11	15	18	19	18	19	22	23	23	24	24	24	20	26	20
Casuarina equisetifolia	18	15	10	9	8	12	9	12	18	17	18	19	19	19	19	19	33	37	55	65
Cladium jamaicensis	225	350	316	370	500	700	875	376	TNTC	TNTC	35*	35*	50*	65*	65*	65*	65*	65*	65*	65*
Juncus roemerianus	11	22	25	35	43	61	65	82	102	74	65	32	39	20	14	14	14	0	0	0
Solanum donianum	2	7	15	13	7	11	16	40	9*	38	61	73	89	89	104	107	163	160	149	169
Ipomoea sagittata	2	5	14	9	6	5	7	0	11	1	1	0	0	0	0	0	0	0	0	0
Pluchea rosea	3	8	18	23	15	31	TNTC	0	57	3	8	5	0	2	0	0	0	0	0	0
Eupatorium capillifolium	6	4	9	17	10	6	6	6	0	4	9	8	8	8	0	0	0	0	0	0
Aster tenuifolius			7	0	0	0	0	8	19	0	0	5	0	0	0	0	0	0	0	0
Sabatia stellaris					26	32	4	0	7	0	0	0	0	0	0	0	0	0	0	0
Schinus terebinthifolis					1	1	1	1	1	1	1	2	2	2	1	1	1	1	2	1
Acrostichum danaeifolium					2	2	4	18	13	1	3	3	3	3	3	3	3	3	4	3
Baccharis halimifolia					1	1	9	20	17	15	19	24	20	22	22	22	23	4	3	1
Passiflora suberosa					1	1	1	1	1	1	1	1	1	1	4	4	2	4	3	3
Andropogon glomeratus								1	2	0	0	2	0	2	0	0	0	0	0	0
Trema floridana										1	1	0	0	0	1	1	0	0	0	0
Mikania scandens																		5	0	1
Borrichia frutescens																		1	0	0

NOTE: * denotes counts per m^2
TNTC - Too numerous to count

Table 4. Number of individuals of species at medium vegetation station 408M in the Turkey Point Cooling Canal System 1975-1980.

SPECIES	1975			1976				1977				1978				1979			1980	
	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	May	Nov.	May	Nov.
Conocarpus erectus	7	8	2	2	1	2	5	5	8	7	7	7	7	7	7	7	7	12	8	3
Casuarina equisetifolia	135	162	3	3	10	18	61	32	85	79	130	139	140	140	140	145	150	155	162	11
Cladium jamaicensis	4	12	10	13	18	14	14	3	16	10	11	14	13	12	12	12	12	10	7	5
*Distichilis spicata**			.3	.5	.5	1	2	2	4	5	5	9	9	9	9	9	9	9	9	12
Rhizophora mangle			1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabatia stellaris					4	9	0	0	1	1	1	1	0	4	0	0	0	0	4	1
Pteris vittata					2	9	11	33	47	40	42	50	40	30	20	18	16	4	0	32
Thelysteris normalis					1	7	10	9	6	7	6	8	7	4	4	4	4	2	9	24
Baccharis halimifolia					1	1	1	1	2	1	1	3	3	3	0	0	0	0	3	5
Solanum donianum						1	2	2	0	2	1	1	1	1	1	0	0	0	0	0
Acrostichum danaeifolium								6	5	0	2	2	2	2	2	2	2	0	0	40
Sonchus oleraceus								1	2	1	1	1	1	1	1	1	1	0	0	0
Eupatorium capillifolium											3	3	4	6	4	6	6	0	0	11
Andropogon glomeratus											8	6	0	14	50	50	50	2*	1*	8
Pluchea rosea											2	2	1	1	1	1	1	0	0	43
Salix caroliniana																				3
Aster tenuifolius																				1
Vallesia antillana																				1

NOTE: * denotes counts per m^2

Table 5. Number of individuals of species at heavy vegetation station 204N in the Turkey Point Cooling Canal System 1975-1980.

SPECIES	1975			1976				1977				1978				1979			1980	
	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	May	Nov.	May	Nov.
Baccharis halimifolia	8	4	4	3	1	0	0	0	11	18	23	42	35	40	40	50	50	13	8	0
Conocarpus erectus	13	10	11	11	11	0	1	2	3	2	2	2	2	2	2	2	2	2	2	1
Casuarina equisetifolia	31	13	13	20	0	0	8	10	13	31	31	32	30	30	36	37	40	37	38	24
Acrostichum danaeifolium	1	1	1	3	1	0	4	2	3	4	4	5	5	5	2	2	2	0	0	0
Eupatorium capillifolium	1	0	0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	0
Borrichia frutescens	103	140	175	50	16	30	24	21	43	43	45	4	0	0	0	0	0	0	0	0
Rhabdadenia biflora	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus oleraceus			2	0	0	0	0	0	1	0	0	5	0	0	0	0	0	0	0	1
Solanum nigrescens							1	2	1	0	0	3	3	3	0	0	0	0	0	0
Solanum donianum								1	4	1	1	10*	10*	10*	2	2	2	2	1	9
Chamaesyce mesembryanthemifolia								1	0	0	6	4	1	0	1	2	2	0	0	0
Pluchea rosea									29	25	40	50	20	0	0	0	0	0	0	0
Sarcostemma clausa										1	1	1	2	3	10*	15*	15*	90*	90*	2
Mikania scandens										2	2	2	25*	50*	50*	40*	40*	3	0	95*
Physalis angulata											1	1	0	0	0	0	0	1	0	0
Thelysteris normalis											1	1	4	3	2	2	2	0	0	0
Aster tennifolius												3	0	0	0	0	0	0	0	0
Phytolacca rigida												4	5	7	9	1	1	5	3	0
Erechtites hieracifolia												5	30	25	0	0	0	0	0	3
Schinus terebinthifolius															1	1	1	1	0	0
Melothria pendula																		3	6	50*
Lantana camara																		1	2	1
Passiflora suberosa																		1	1	1

NOTE: * denotes counts per m^2

Table 6. Number of individuals of species at heavy vegetation station 310N in the Turkey Point Cooling Canal System 1975-1980.

SPECIES	1975 Apr.	1975 July	1975 Oct.	1976 Jan.	1976 Apr.	1976 July	1976 Oct.	1977 Jan.	1977 Apr.	1977 July	1977 Oct.	1978 Jan.	1978 Apr.	1978 July	1978 Oct.	1979 Jan.	1979 May	1979 Nov.	1980 May	1980 Nov.
Rhizophora mangle	25	21	12	7	6	7	9	9	8	10	11	12	13	13	13	13	13	10	10	6
Casuarina equisetifolia	78	28	15	10	37	37	42	37	39	42	44	46	48	43	43	43	45	45	58	25
Cladium jamaicensis	180	405	500	510	TNTC	TNTC	600	620	600	9*	12*	14*	15	14	15	15	15	13	15	35
*Distichlis spicata**	2	3	5	6	5	4	6	4	4	8	8	12	12	12	10	9	9	1	1	8
Baccharis halimifolia	1	1	0	0	0	1	0	0	0	1	2	2	2	2	2	2	2	1	1	0
Melanthera parvifolia			24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus oleraceus			4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conocarpus erectus				3	3	2	4	4	6	5	6	8	8	8	8	8	8	1	2	1
Rhabdadenia biflora						1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Laguncularia racemosa							1	1	1	1	1	1	1	1	1	1	1	0	0	0
Acrostichum danaeifolium							1	1	0	0	1	0	0	0	0	0	0	0	0	0
Thelysteris normalis								2	4	1	0	0	0	0	0	0	0	0	0	0
Schinus terebinthifolius									2	0	0	0	0	0	0	0	0	0	0	0
Solanum donianum															2	2	2	0	0	0
*Sporobolus virginicus**																		6	0	0
Aster tenuifolius																		1	0	1
Mikania scandens																				12

NOTE: * denotes counts per m^2
TNTC - Too numerous to count

Table 7. Number of individuals of red mangrove at stations in the Turkey Point Cooling Canal System 1979-1980.

STATION	1979			1980	
	JAN.	MAY	NOV.	MAY	NOV.
105S					
Mature	2	2	2	2	2
Seedlings	7	7	4	3	3
204N					
Mature	1	1	1	1	1
Seedlings	12	12	16	14	7
310N					
Mature	2	2	2	2	2
Seedlings	7	7	0	0	0
323S					
Mature	0	0	0	0	0
Seedlings	0	0	0	0	0
408M*					
Mature	0	10	10	14	7
Seedlings	0	48	53	27	2
505N					
Mature	6	N.D.	7	14	15
Seedlings	15	N.D.	11	5	4

NOTE: N.D. - No data taken.

Table 8 . Historical list of species found in Turkey Point Natural Revegetation Program 1975-1980.

Common Name	Scientific Name
Australian Pine	*Casuarina equisetifolia*
Beard Grass	*Andropogon glomeratus*
Black-Nightshade	*Solanum nigrescens*
Black Rush (Needle Rush)	*Juncus roemerianus*
Blodgett's Potatoe	*Solanum donianum*
Brake Fern	*Pteris vittata*
Brazilian Pepper	*Schinus terebinthifolius*
Buttonwood	*Conocarpus erectus*
Climbing Hempweed (Hempvine)	*Mikania scandens*
Club Rush (Spike Rush)	*Eleocharis sp.*
Coastal Plains Willow	*Salix caroliniana*
Corky-Stemmed Passion Flower	*Passiflora suberosa*
Creeping Cucumber	*Melothria pendula*
Devil's Potatoe	*Echites sp.*
Dog Fennel	*Eupatorium capillifolium*
Fireweed (Burnweed)	*Erechtites hieracifolia*
Florida Trema (Nettle Tree)	*Trema floridana*
Golden Rod	*Solidago stricta*
Glades Morning Glory	*Ipomoea sagittata*
Ground Cherries	*Physalis angulata*
Lantana	*Lantana camara*
Leather Fern (Mangrove Fern)	*Acrostichum danaeaefolium*
Mallow Family	*Sida rubromarginata*
Mangrove Rubber Vine	*Rhabdadenia biflora*
Marsh Fleabane	*Pluchea rosea*
Marsh Pink	*Sabatia stellaris*
Oleander	*Vallesia antillana*
Pokeweed (Inkberry)	*Phytolacca rigida*
Red Mangrove	*Rhizophora mangle*
Rohrb	*Melanthera aspera*
Rubber Vine	*Rhabdadenia biflora*

Table 8 . Historical list of species found in Turkey
(CONT'D) Point Natural Revegetation Program 1975-1980.

Common Name	Scientific Name
Saltbush (Groundsel)	*Baccharis halimifolia*
Saltgrass	*Distichilis spicata*
Saltmarsh Aster	*Aster tenuifolius*
Sawgrass	*Cladium jamaicensis*
Schmidel	*Thelypteris sp.*
Sea Oxeye (Oxeye Daisy, Sea Daisies)	*Borrichia frutescens*
Sea Purslane	*Sesuvium portulacastrum*
Sow Thistle	*Sonchus oleraceus*
Umbrella Grass	*Fuirena sp.*
Virginia Dropseed	*Sporobolus virginicus*
White Mangrove	*Laguncularia racemosa*
White Vine	*Sarcostemma clausa*

b. Soil Chemistry (ETS 4.2.1.1)

Introduction

This monitoring determines pH, nitrogen, phosphorous, potassium, calcium, chloride, and conductivity at three elevations of the berms and determines the rate and extent of soil recovery after the canal system construction.

Materials and Methods

One hundred fifty nine samples were collected on a semi-annual basis at 53 sample sites that represented all major soil types throughout the canal system (Figure 1). Samples were taken from each of 3 berm levels at a depth of 12 inches using a spade type geotome. They were placed in Whirl Paks for transportation to the laboratory. When all sampling was complete, samples were separated by soil type for elevation and then were mixed accordingly. The resulting composite samples were analyzed for the characteristics mentioned previously.

Sample sites were abbreviated as follows:

A number (1-9) for the soil types.

Soil type based on composition:

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

Soil type based on vegetative density:

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

A "W" designated the west side of the system while a "WE" designated the east side of the system.

A "T", "M" or "L" designated the berm elevation at which the samples were taken.

Elevation:

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). The pH was measured using a glass electrode; potassium and calcium were determined using a Beckman DU-2 Flame Photometer (APHA, 1975). Nitrogen was determined using the Brucine Method (APHA, 1975). Phosphorous was determined using the Stannous Chloride Method (APHA, 1975). Conductivity was determined using a modified Wheatstone Bridge. The resulting data were analyzed statistically using the P7D program of U.C.L.A. Biomedical Program Series P.

Results

Nutrient data for all sample sites for May and December are listed on Tables 1 and 2. The ranges of the nutrient values and the sample sites having the highest nutrient values can be found on Table 3.

Discussion

The pH exhibited a highly significant ($\alpha = 0.01$) variance within successive years. It continued to be lowest at stations with organic substrates, dense vegetation and middle to upper elevations. The higher pH values were found in the mucky-clay substrates, areas of sparse vegetation and low elevations.

Nitrogen levels were highest in organic soils and at sites with heavy vegetation; conversely, the lowest values were obtained at grassy sites and in clay soils. Last year's prediction that the nitrogen levels would develop a downward trend was accurate. There was an approximate 50 percent decrease in nitrogen levels during the dry period of 1980. With the continued reduction of *Casuarina sp.* due to the Vegetation Control Program, nitrogen levels should continue on a downward trend. There continued to be no apparent correlation between nitrogen and rainfall ($r = 0.13$).

Phosphorous levels during the 1980 dry period showed an approximate 50 percent increase from the 1979 dry period values. In most canal system soil types phosphorous levels fluctuate inversely with

rainfall.

Potassium levels continued the downward trend from the 1975 dry period (485 ppm) to the 1980 dry period (102 ppm). All the high potassium values were from samples taken at the lower berm elevations and were likely inundated with salt water, hence, they were typical of water chemistry rather than of soil chemistry.

Calcium levels have shown no significant variance ($\alpha = 0.05$) as a function of time from 1975 through 1980 and there appeared to be no correlation to the wet and dry seasons. Sites with heavy vegetation and organic soils yielded the highest mean values for calcium.

Chloride values were slightly lower in 1980 than in 1979. The decrease was not sufficient enough to consider it the beginning of a downward trend. The mean salinities in the cooling system waters continued to increase (Section III.A.1.a).

Conductivity levels steadily increased in 1978, 1979 and 1980. It appears that the previously noted downward trend has been reversed. The high values for conductivity were from the lower elevation samples.

Conclusions

The pH values at the stations within the canal system were more alkaline than the range cited as best for plant growth (Hartmann & Kester, 1975). The levels of potassium in the canal system were within

the historical ranges for this geographic area (Black, 1968). Neither potassium nor nitrogen were considered limiting on the berms. Phosphorous was present in very small quantities, due to the very high calcium levels (Black, 1968). Chloride levels increased at low levels on the berms and followed chloride levels in the canals. It can be concluded that the limiting chemical factors on the berms are phosphorous and chloride. On the lower parts of the berms, chloride tended to exclude all but the salt tolerant species while the low levels of phosphorous on the berms tended to exclude all but heartiest pioneer and exotic species.

LITERATURE CITED

APHA-AWWA-WPCF. 1975. Standard methods for the examination of water and wastewater. 14th ed. APHA Wash. D.C. 1193 pp.

Black, C.A. 1968. Soil-plant relationships. Second Ed. John Wiley and Sons, Inc.: New York. 792 pp.

Harmann, Hudson; Kester, Dale. 1975. Plant propagation principles and practices. Third Ed. Prentice Hall, Inc. Englewood Cliffs, New Jersey. 662 pp.

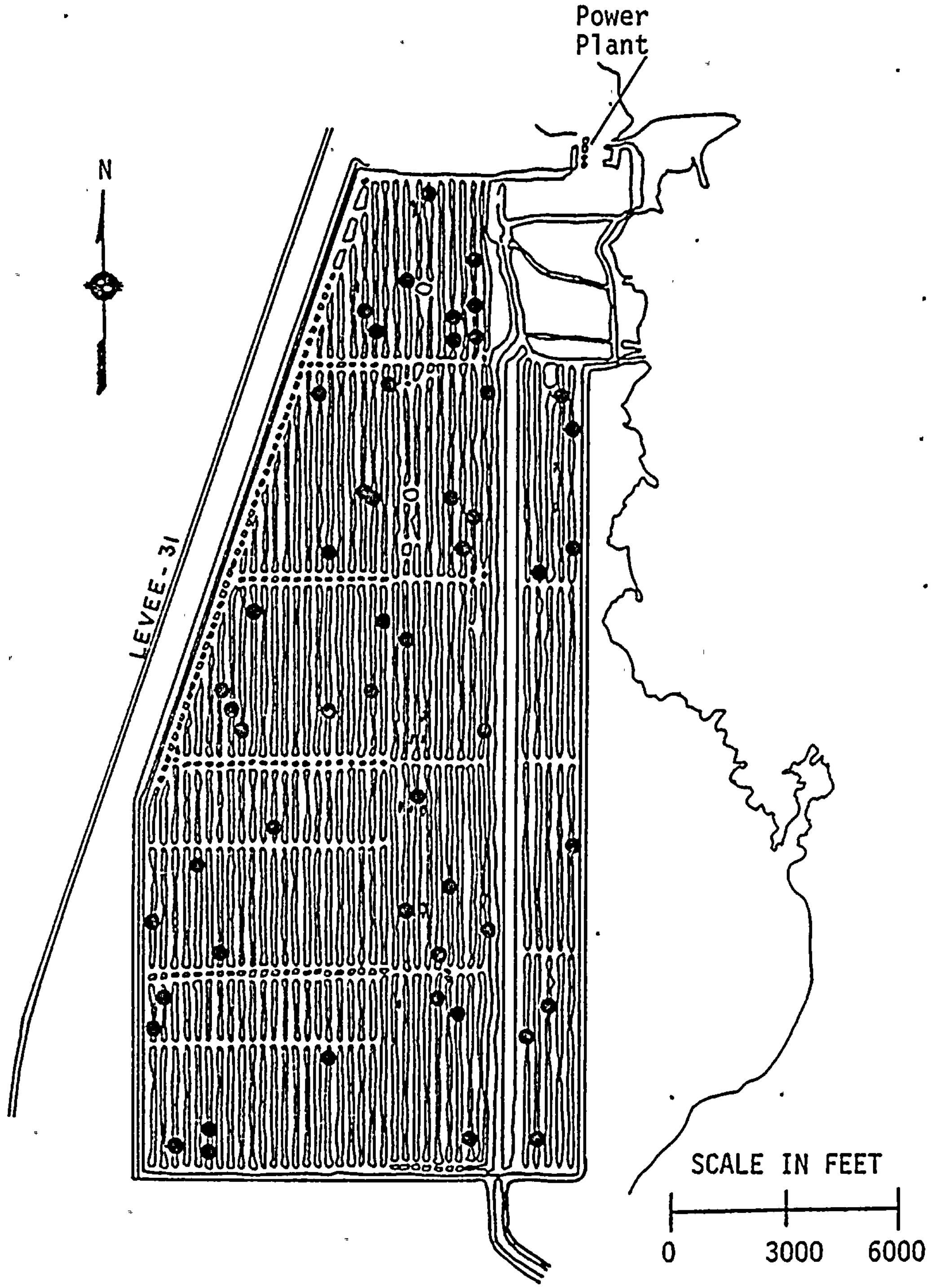


Figure 1. Soil Chemistry sample sites (●) in the Turkey Point Cooling Canal System 1980.

Table 1. Chemical summary of soils for Turkey Point Cooling Canal System berms during May 1980.

Sample* Sites	pH	NO_3**	P**	K**	Ca**	Cl**	Cond.***
1 WT	7.5	70	1.0	20	1000	2100	270
WM	7.1	150	0.1	50	2500	6000	330
WL	7.8	<0.1	1.0	450	1000	85 000	1800
2 WT	7.5	30	2.0	20	1500	1500	220
WM	7.3	20	<0.1	20	1500	6000	500
WL	7.8	<0.1	0.3	200	1500	42 000	1100
3 WT	7.6	90	1.0	50	500	6500	520
WM	7.9	20	<0.1	80	500	7000	510
WL	8.0	10	0.2	90	500	18 500	700
4 WT	8.1	50	<0.1	50	1000	7000	500
WM	8.1	20	<0.1	60	500	9000	500
WL	8.1	4	0.1	200	500	32 000	1100
5 WT	7.9	70	1.0	20	500	4700	340
WM	7.8	30	<0.1	20	500	5000	400
WL	7.9	7	1.0	170	1000	34 500	1000
6 WT	7.2	80	4.0	20	1000	3500	300
WM	7.3	70	<0.1	60	2000	8500	500
WL	8.0	<0.1	0.2	200	500	29 000	1100
7 WT	7.3	90	2.0	50	1500	4300	400
WM	7.6	50	3.0	50	1000	8000	450
WL	7.8	60	2.0	350	1000	50 000	1400
8 WT	7.5	50	2.0	50	2500	4600	400
WM	7.6	50	<0.1	20	2500	8500	520
WL	8.1	10	1.0	250	1000	47 000	1100
9 WT	7.9	40	0.2	20	500	2600	180
WM	7.4	30	3.0	20	500	3700	380
WL	7.8	10	1.0	200	500	37 500	1000
WET	7.5	40	<0.1	20	500	2100	260
WEM	7.7	50	4.0	60	1000	4500	320
WEL	7.6	40	<0.1	200	2000	17 500	850

NOTE: * See materials and methods for abbreviations of sample sites.
** All these values in mg/kg
*** Conductivity in MHOS X 10^{-5}

Table 2. Chemical summary of soils for Turkey Point Cooling Canal System berms during December 1980.

Sample* Sites	pH	NO_3**	P**	K**	Ca**	Cl**	Cond.***
1 WT	7.8	75	0.1	85	800	800	160
WM	7.6	48	0.1	155	600	560	170
WL	8.1	11	0.3	140	1500	10 000	690
2 WT	7.7	48	0.1	75	800	480	115
WM	7.9	44	2.0	125	900	1100	180
WL	7.9	44	0.1	69	800	7200	600
3 WT	7.9	85	0.2	275	900	1800	380
WM	8.2	55	0.1	255	1200	1900	320
WL	8.2	16	0.5	212	700	8800	900
4 WT	8.1	70	1.0	315	1000	3000	450
WM	8.3	70	0.1	535	900	3000	450
WL	8.4	6	0.1	108	800	10 800	900
5 WT	8.0	110	0.1	145	800	1500	280
WM	8.2	65	0.1	275	700	2200	300
WL	8.1	40	0.1	284	700	14 800	1000
6 WT	7.9	95	1.0	60	800	540	130
WM	8.3	44	1.0	75	800	560	110
WL	8.1	6	1.0	168	800	10 800	700
7 WT	7.7	31	1.0	85	600	1000	200
WM	8.0	75	0.5	120	700	1000	210
WL	7.5	40	0.1	60	500	6200	500
8 WT	8.1	46	6.0	320	700	1300	210
WM	8.2	75	0.1	110	700	940	190
WL	8.1	17	0.1	120	1000	8200	1000
9 WT	8.1	40	0.1	110	200	540	120
WM	8.4	24	0.1	85	400	720	85
WL	8.2	18	0.2	180	1000	11 600	700
WET	7.6	45	0.1	180	800	800	160
WEM	7.8	46	0.4	125	400	1200	170
WEL	8.0	19	0.1	160	1400	10 000	700

NOTE: * See materials and methods for abbreviations of sample sites.
** All these values in mg/kg
*** Conductivity in MHOS X 10^{-5}

Table 3. The ranges of the nutrient values and the sample site with the highest nutrient value for the Turkey Point Cooling Canal System during 1980.

MAY			DECEMBER		
NUTRIENT	RANGE	SAMPLE SITE OF HIGHEST NUTRIENT VALUE	NUTRIENT	RANGE	SAMPLE SITE OF HIGHEST NUTRIENT VALUE
pH	7.1-8.1 pH	4WL, 4WM, 4WT, 8WL	pH	7.5-8.4 pH	4WL, 9WM
Nitrate	0.1-150 mg/kg	1WM	Nitrate	6-110 mg/kg	5WT
Phosphorous	0.1-4.0 mg/kg	6WT	Phosphorous	0.1-6.0 mg/kg	8WT
Potassium	20-450 mg/kg	1WL	Potassium	60-535 mg/kg	4WM
Calcium	500-2500 mg/kg	1WM, 8WM, 8WT	Calcium	200-1500 mg/kg	1WL
Chloride	1500-85 000 mg/kg	1WL	Chloride	480-14 800 mg/kg	5WL

c. Soil Erosion (ETS 4.2.1)

Introduction

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

"Erosion, in its physical aspects, is simply the accomplishment of a certain amount of work in tearing apart and transporting soil material" (Stallings, 1957). It is important to study since it adversely affects soil fertility and can cause sedimentation in the canals thus reducing the thermal and hydraulic efficiency of the canal system.

Materials and Methods

Soil erosion data were collected semi-annually at two test sites in the 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 with predominantly that edaphic characteristic. At each site, four pipes were driven through the berms and into the underlying rock to serve as permanent reference points. A stainless steel "averaging cross" (Figure 2) was placed horizontally on each of the pipes. The distance "l" from the tips of the cross to the berm surface was then measured. Comparison of these measurements from sampling period to sampling period allowed the determination of the berms.

Canal bank erosion figures were obtained by measuring the distance between two posts driven in the ground (Figure 3). The distance between the water edge and the post in the water was measured. The difference in length of the latter measurement was considered the erosion value.

Results

The "averaging cross" data showed a net change of -0.019 feet on Berm 2, Section 5 and a net change of -0.047 feet on Berm 30, Section 5. The average erosion in 1980 was -0.033 feet. Rainfall for the first and second half of the year was 12.44 and 30.84 inches respecitively (Table 1). Canal bank erosion values appear in Table 2.

Discussion

An attempt was made to relate berm erosion rate to rainfall. The years data showed a significant correlation between the wet and dry seasons and erosion. During the dry season (December to April) there was deposition of soil from other sources to the berms (Figures 4 and 5). During the wet season (April to November) the amount of rainfall promoted a rather large amount of erosion.

During the 1980 rainy season, rain fell for short periods of time and in relatively large amounts. The intensity of this rainfall undoubtedly enhanced the erosion of the berms. In previous years, rain fell frequently with lesser intensity. This rainfall pattern allowed saturation of the soil and a subsequent increase in cohesivity (FPL

1978, 1979). The anomalous reversal in erosion rates by wet/dry seasons was nothing more than a reflection of the different rainfall pattern that occurred in 1980.

The cumulative erosion and rainfall (Figures 6 and 7) show a positive correlation at both stations. This is expected even with the seasonal fluctuation of rates. Station 502 is not affected to the extent that Station 530 is. No baseline data are available for comparison.

Shoreline erosion apparently increased over the last year, the amount of berm that is underwater between the reference posts is increasing (Table 2). This observation is not fully quantified. Water levels can vary, thus the measurements will vary accordingly. The present method of measurement is dependent upon plant condenser cooling water pump status, wind and tidal conditions.

Conclusions

During 1980 the cooling canal berms eroded at a rate which do not differ significantly from 1979. No increase in erosion can be expected to occur other than that due to the intrinsic seasonal fluctuation apparent in the historical data. Shoreline data are inconclusive.

LITERATURE CITED

Florida Power & Light Co. 1978, 1979. Turkey Point Units 3 & 4 non-radiological environmental monitoring report nos. 12 & 13, Miami, Florida.

Stallings, J.H. 1957. Soil conservation. Prentice Hall, Englewood Cliffs, N.J. 575 pp.

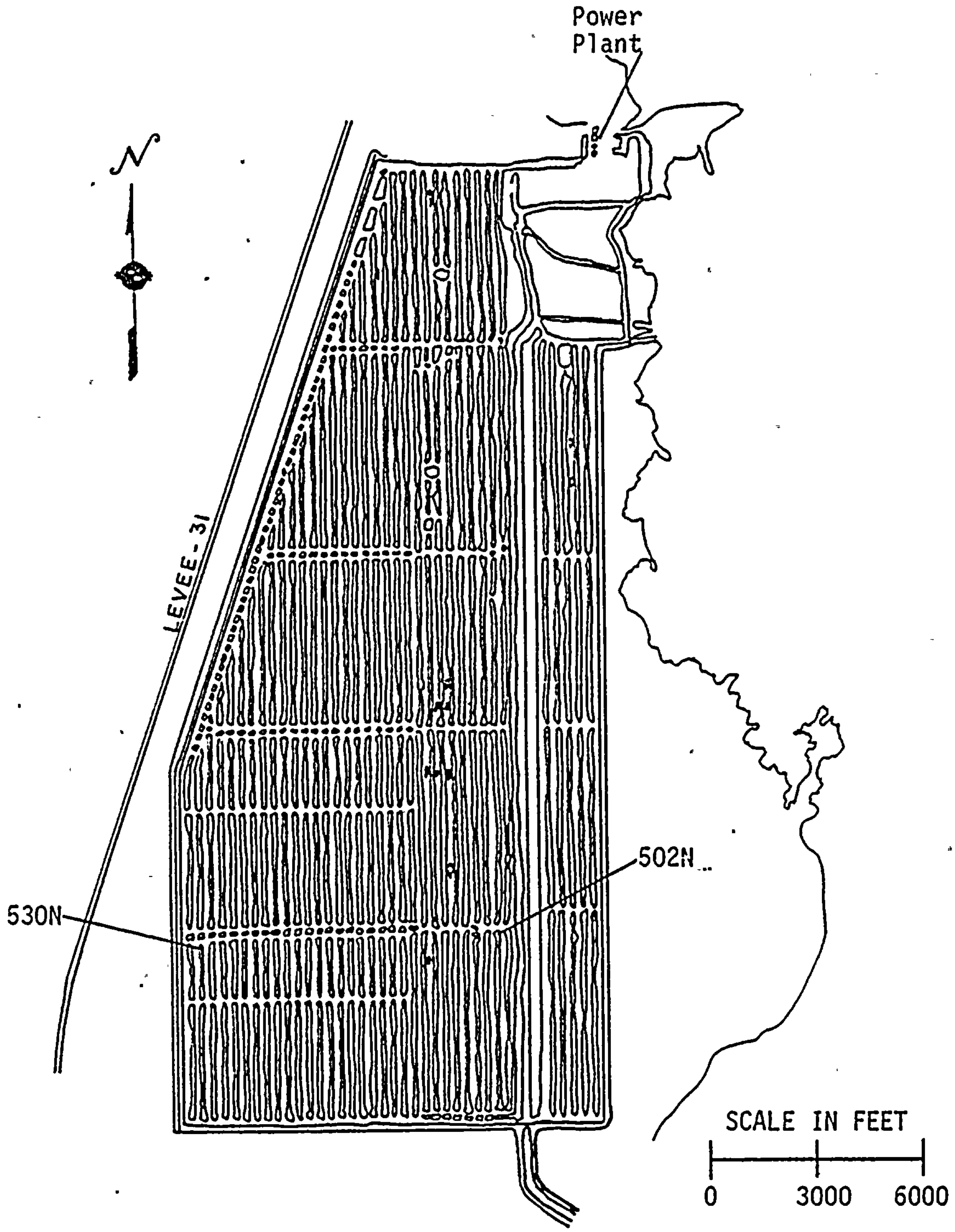


Figure 1. Soil erosion test sites at the Turkey Point Cooling Canal System 1980.

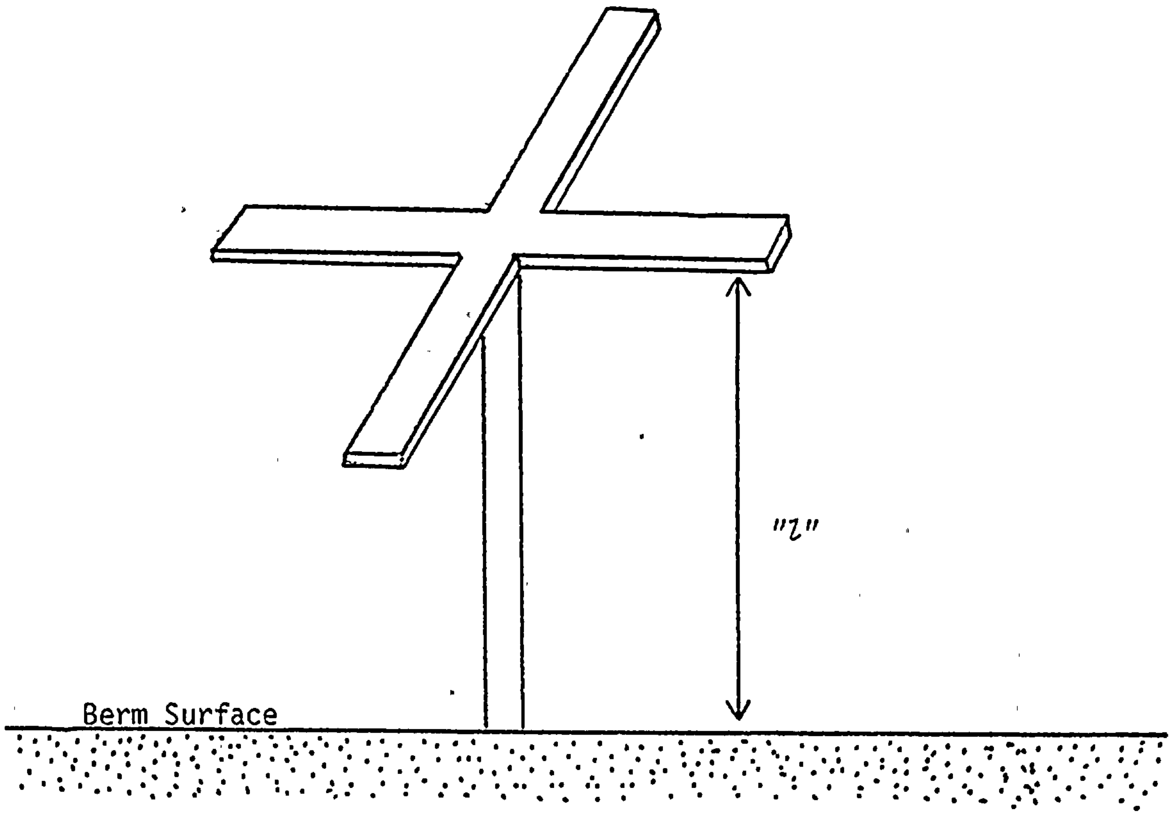


Figure 2. An illustration of the averaging cross used for soil erosion measurements in the Turkey Point Cooling Canal System 1980.

Table 2. Measurements of erosion on canal banks at the Turkey Point Cooling Canal System 1980.

DATE	DISTANCE FROM POST TO POST (FEET) (A)	DISTANCE FROM WATER EDGE TO POST (FEET) (B)	NET CHANGE
Station 502			
11/79	3.25	0.76	
05/80	3.25	0.82	+0.06
11/80	3.34	1.02	+0.20
Station 530			
11/79	2.93	0.66	
05/80	2.94	0.61	-0.05
11/80	2.94	1.81	+1.20

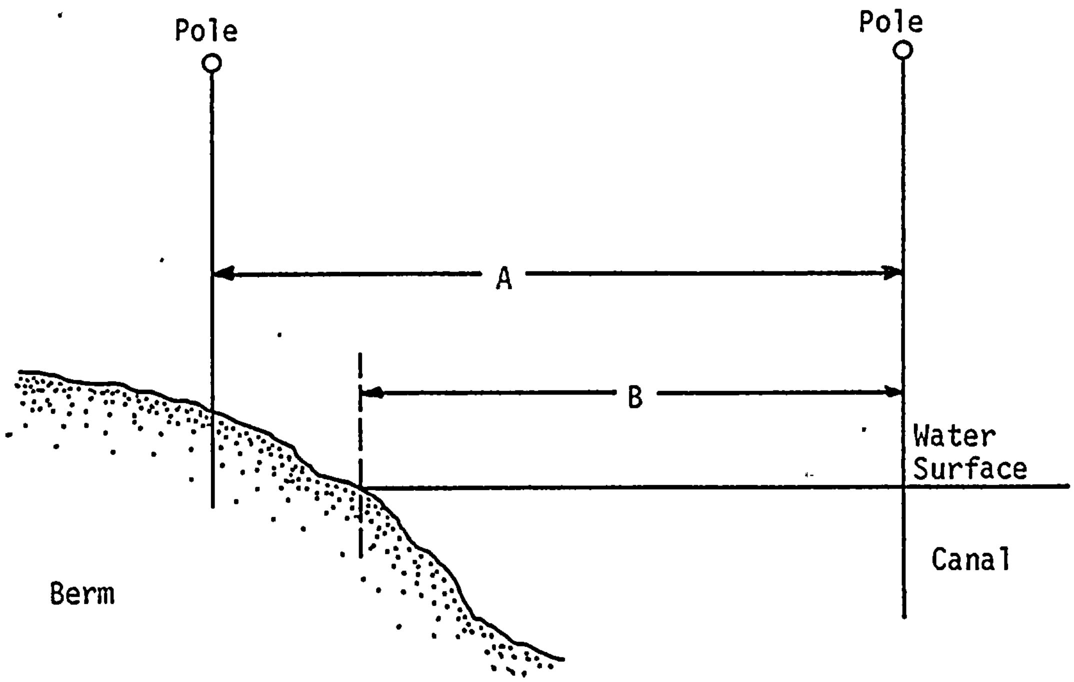


Figure 3. A diagramatic representation of the method used for quantifying canal bank erosion, Turkey Point Power Plant 1980.

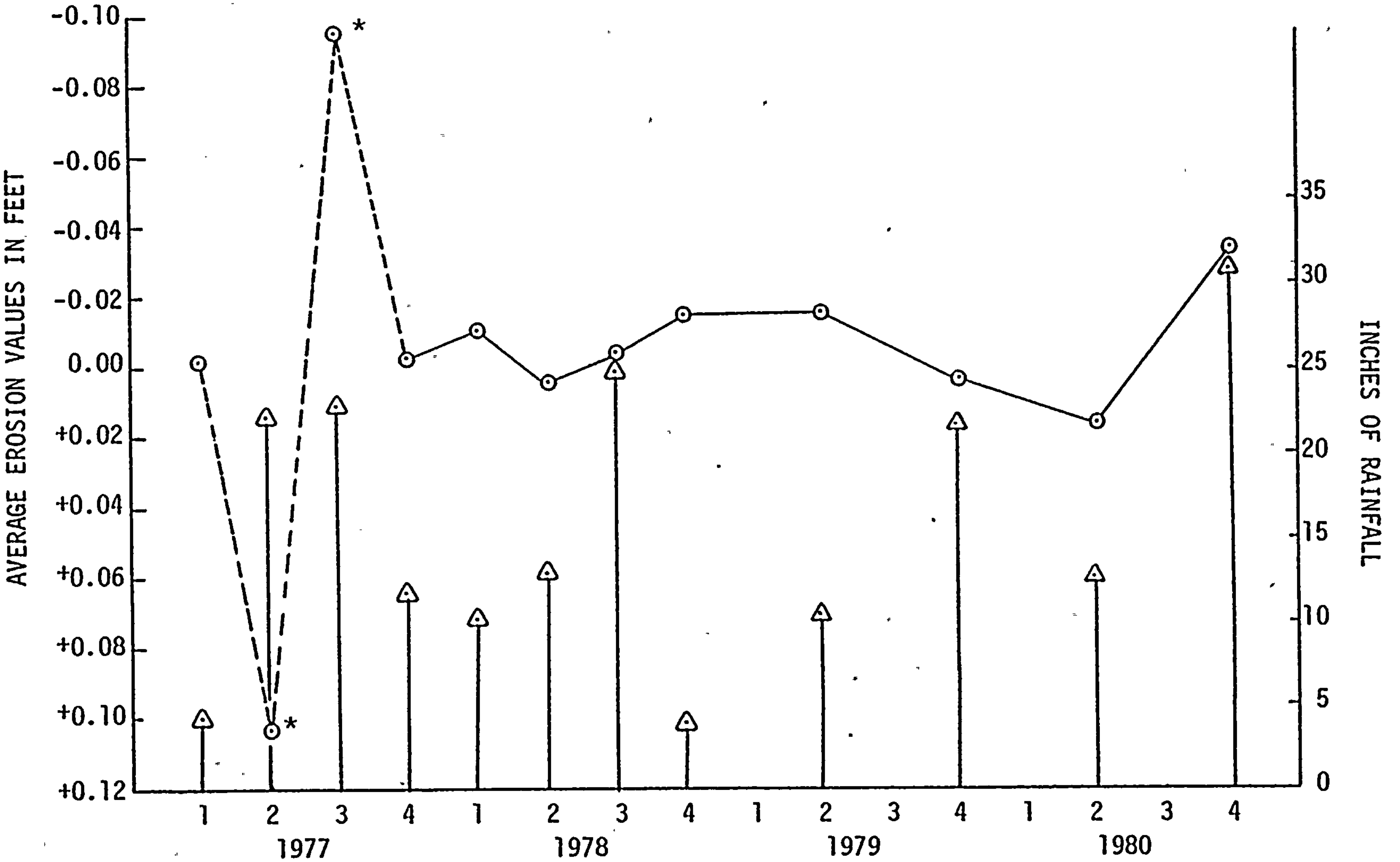


Figure 4 . Soil erosion (o) and rainfall (Δ) averages for Turkey Point Power Plant Station 502 per quarter for the years 1976 through 1980.
NOTE: * See note on Table 1.

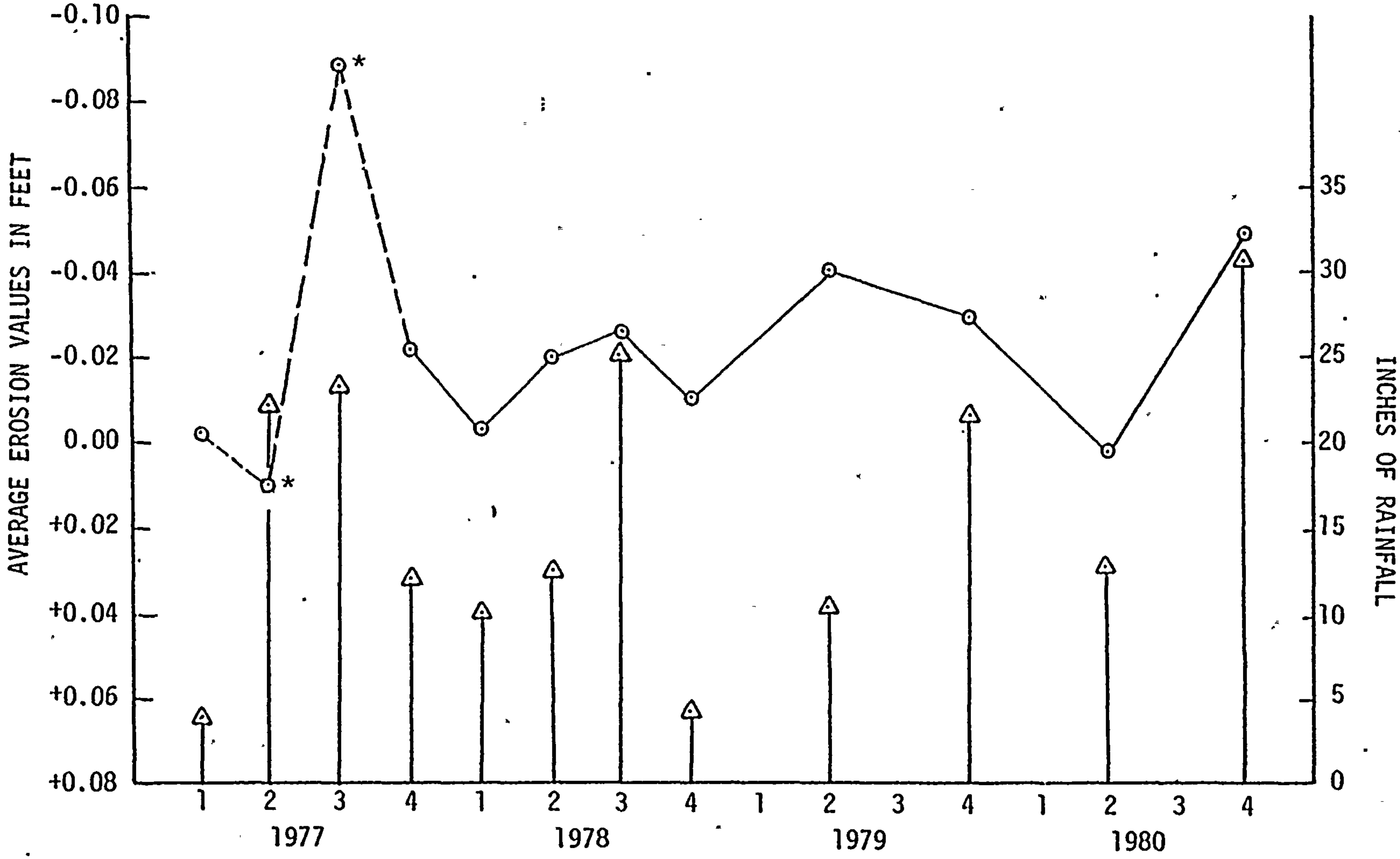


Figure 5 . Soil erosion (○) and rainfall (Δ) averages for Turkey Point Power Plant Station 530 per quarter for years 1977 through 1980.
NOTE: *See note on Table 1.

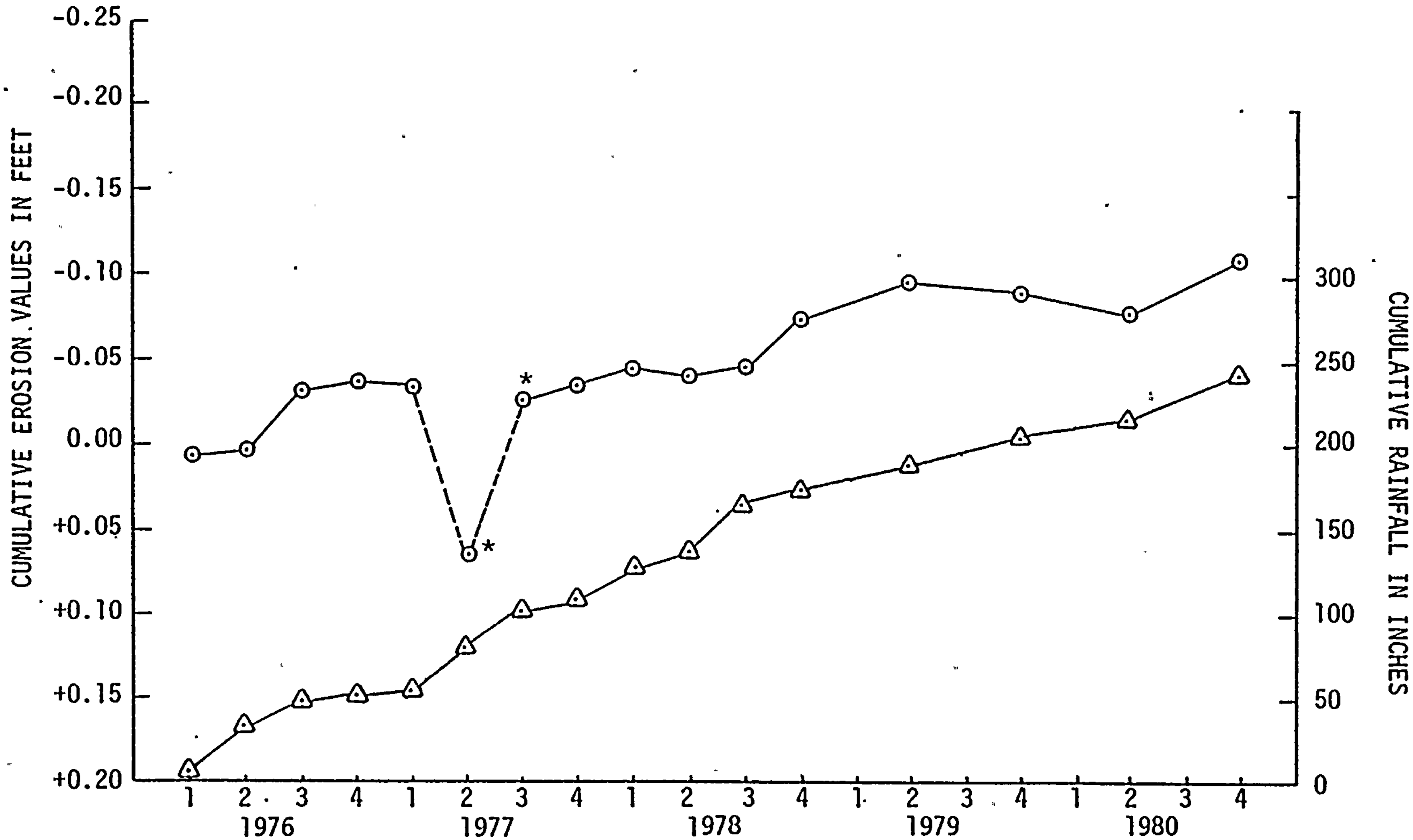


Figure 6. Cumulative soil erosion (○) and rainfall (Δ) at Turkey Point Power Plant Soil Erosion Station 502 per quarter for the years 1976 through 1980.
NOTE: * See note on Table 1.

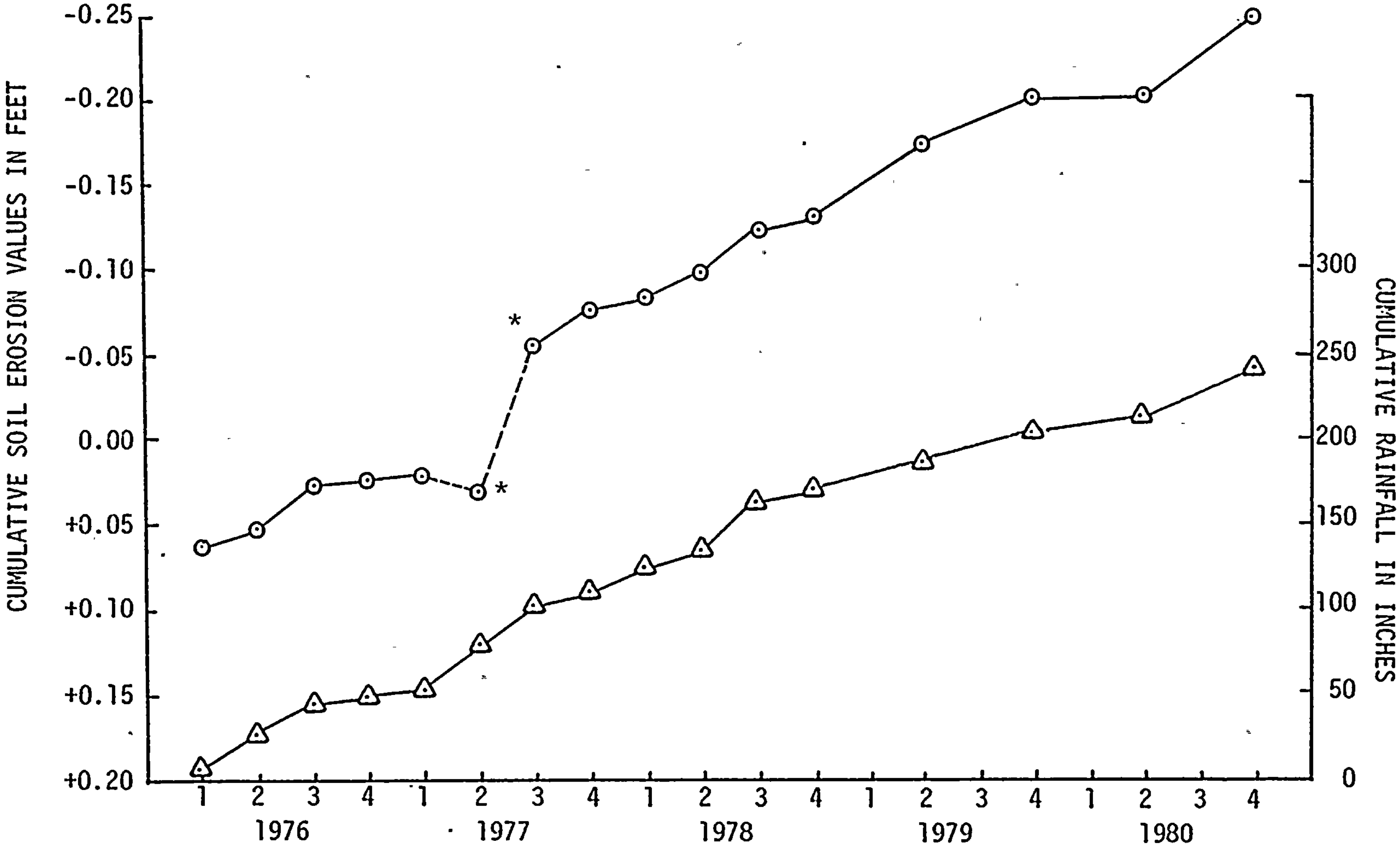


Figure 7. Cumulative soil erosion (o) and rainfall (Δ) at Turkey Point Power Plant Soil Erosion Station 530 per quarter for the years 1976 through 1980.

NOTE: * See note on Table 1.

Table 1. Rainfall, soil erosion, and erosion rate per quarter for the years 1976 through 1980 at Turkey Point

YEAR	QUARTER	RAINFALL (inches)	EROSION (feet)	FEET OF EROSION PER INCH OF RAINFALL
1976	1	5.80	+0.035	
	2	21.76	-0.005	
	3	18.78	-0.032	
	4	5.39	-0.004	
	Total	51.73	-0.006	-1.16×10^{-4}
1977	1	4.81	+0.001	
	2	22.16	+0.057*	
	3	23.56	-0.093*	
	4	12.66	-0.016	
	Total	63.19	-0.051	-8.07×10^{-4}
1978	1	10.20	-0.008	
	2	12.92	-0.007	
	3	25.42	-0.014	
	4	4.11	-0.018	
	Total	52.65	-0.047	-8.93×10^{-4}
1979	1	----	----	
	2	10.62	-0.034	
	3	----	----	
	4	22.75	-0.012	
	Total	33.37	-0.046	-13.78×10^{-4}
1980	1	----	----	
	2	12.44	+0.008	
	3	----	----	
	4	30.84	-0.042	
	Total	43.28	-0.034	-7.85×10^{-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

This section furnishes a qualitative assessment of the fauna (birds, mammals, reptiles, and amphibians) found in association with the Turkey Point Cooling Canal System and compares it with the fauna of the surrounding area (ABI, 1978a). The study area encompasses 6,800 acres of land needed for the cooling canal network, selected coast line, associated canals and 28 acres for plant site (Figure 1).

Materials and Methods

Most faunal estimates were made by visual observation during routine monitoring. Some non-destructive sampling was carried out on small mammals, reptiles and amphibians. Captured organisms were released after identification. Large mammals' abundance was estimated from visual observation, road kills and natural deaths. Due to the opportunistic nature of the program, it is quite likely that some species inhabiting the study area were not observed and therefore the data constitute a conservative estimate of faunal populations.

Results

Sixty-five Avian species, 10 Reptilian species, 1 Amphibian species, and 8 Mammalian species were observed in the study area during 1980. Among the observed species were: the Least Tern, *Sterna albifrons;* the Southern Bald Eagle, *Haliaeetus leucocephalus;* the American Crocodile, *Crocdylus acutus;* the Eastern Diamondback

Rattlesnake, *Crotalus adamanteus;* the Green Tree Frog, *Hyla cinerea;* the Bobcat, *Lynx rufus;* and the Manatee, *Trichechus manatus*.

Discussion

Table 1 is a list of 65 Avian species sighted in the study area for 1980. 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 Table 1 are two columns containing information on the relative abundance and seasonal occurrence. A total of 63 Avian species were sighted during 1979. The increase in the total number of species sighted from 1979-1980 was not considered significant.

The Least Tern (*Sterna albifrons*) was common during the late spring and summer. This species found the spoil banks a suitable nesting ground. No nests were found this year, however, young birds were commonly found on the spoil banks.

The Common Nighthawk (*Chordeiles minor*) and the Killdeer (*Charadrius vociferus vociferus*) also nested in the system. As in past years, young Killdeer were observed in and around the canal system during 1980.

Table 2 is a list of 10 reptiles and 1 amphibian that were observed in 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.

Five adult, three sub-adult, and six juvenile crocodiles were observed in the southwest corner of the canal system. They ranged in length from one foot to twelve and one-half feet. One juvenile was a hatchling from the 1978 season, three were from the 1979 season and two were juveniles not previously captured were thought to be part of the 1979 hatch. No active nest sites or hatchlings were discovered during 1980.

Table 3 lists the mammals observed in the study area. It was confirmed, through nocturnal monitoring, that the Marsh Rabbit and Racoon were quite common. Manatees were occasional visitors to the deep, quiet, Card Sound and Sea Dade Canals just south and outside of the canal system.

Surrounding Area

Data from the South Dade Preliminary Report (ABI, 1978a) were 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 65 Avian species, 11 Reptilian and Amphibian species, and 8 Mammalian species were observed. The differences in the number of species observed in the surrounding area versus the study area can be attributed mainly to different methods of data collection. In the South Dade Baseline Study (ABI, 1978a)

conducted between 1973 and 1976, intensive diurnal monitoring, nocturnal monitoring, and trapping procedures were used. Data for the Turkey Point study area were collected using visual observations and opportunistic capture techniques.

Tables 4, 5, and 6 compare the fauna of the study area to that of the surrounding area. Forty one species of birds, seven species of mammals and seven species of reptiles and amphibians were common to both areas during 1980.

Conclusions

There were no significant changes from the 1979 reporting period.

LITERATURE CITED

Applied Biology, Inc. 1978a. Evaluation of ecological studies conducted at Turkey Point and the South Dade study area for FPL. ABI. 1978a.

Applied Biology, Inc. 1978b. Baseline ecological study of a subtropical terrestrial biome in southern Dade County, Florida for FPL. ABI. 1978b.

Burt, William H., Grossengerder, Richard P. 1976. A field guide to the mammals, field marks of all North American species found north of Mexico. Houghton Mifflin Co. Boston. 289 pp.

Conant, Roger. 1975. A field guide to reptiles and amphibians of eastern and central North America. Second Ed. Houghton Mifflin Co. Boston. 429 pp.

Florida Power & Light Co. 1973-1979. Turkey Point Units 3 & 4 non-radiological environmental monitoring report nos. 1-13. Miami, Florida.

Peterson, Roger T. 1947. A field guide to the birds. Second Revised Ed. Houghton Mifflin Co. Boston. 230 pp.

Robbins, C.S., Bruun, B., Zin, H.S. 1966. A guide to field identification, birds of North America. Golden Press. New York. 340 pp.

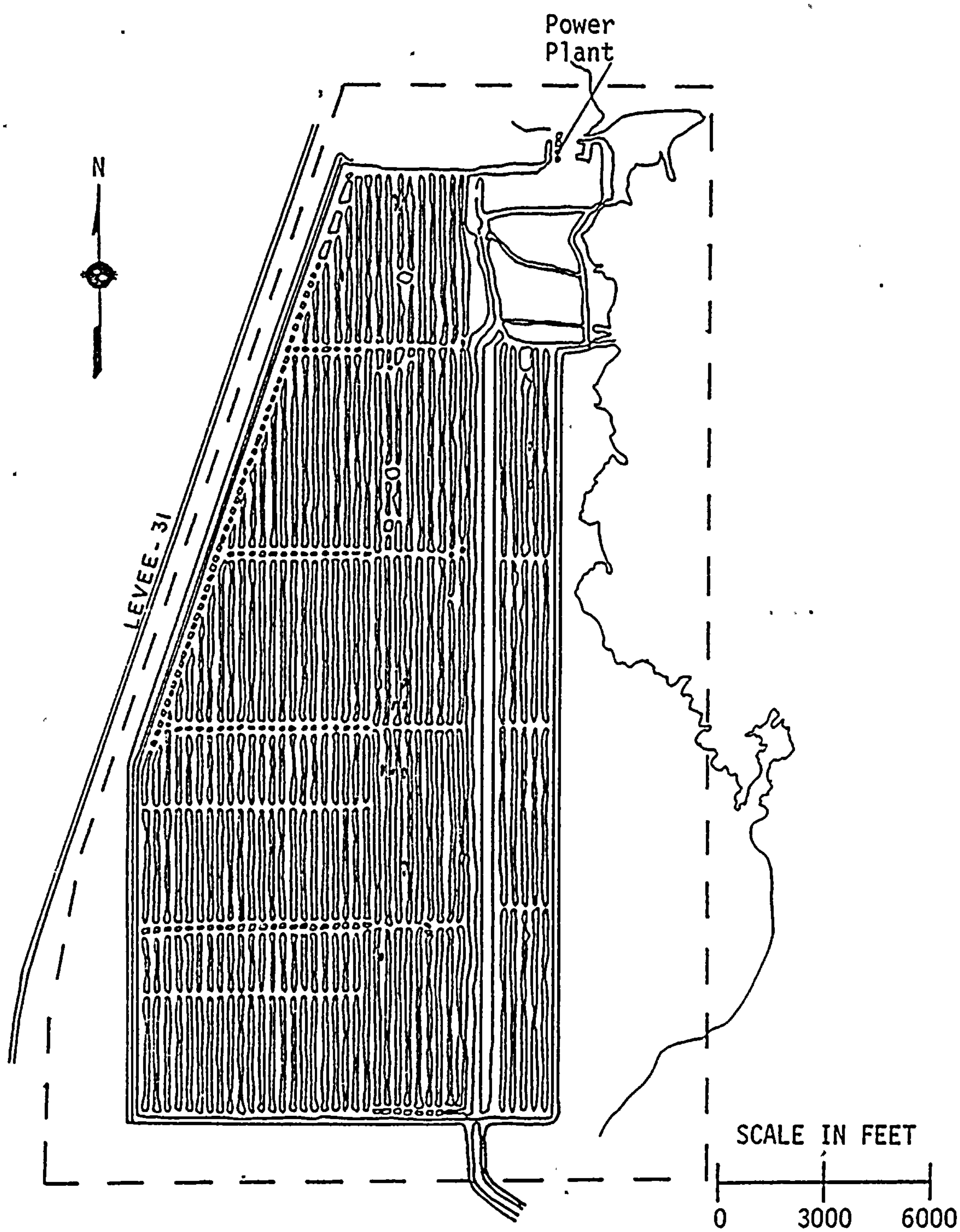


Figure 1. Faunal study area (outline) for Turkey Point Cooling Canal System 1980.

Table 1. A list of Birds observed in the Turkey Point Study Area for 1980.

COMMON NAME	SCIENTIFIC NAME*	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
American Bittern	*Botaurus lentiginosus*	Rare	Transient
American Coot	*Fulica americana*	Common	Permanent
American Kestrel	*Falco sparverius*	Uncommon	Winter
Anhinga	*Anhinga anhinga leucogaster*	Rare	Permanent
Bald Eagle	*Haliaeetus leucocephalus*	Uncommon	Permanent
Barn Swallow	*Hirundo rustica erythrogaster*	Common	Fall
Belted Kingfisher	*Megaceryle alcyon alcyon*	Common	Winter
Black-necked Stilt	*Himantopus mexicanus*	Uncommon	Summer
Black Skimmer	*Rynchops nigra*	Uncommon	Winter
Blue-gray Gnatcatcher	*Polioptila caerulea caerulea*	Uncommon	Permanent
Blue-winged Teal	*Anas discors*	Rare	Winter
Boat-tailed Grackle	*Cassidix mexicanus*	Common	Permanent
Bobwhite	*Colinus virginianus*	Rare	Permanent
Brown Pelican	*Pelecanus occidentalis carolinensis*	Uncommon	Permanent
Cardinal	*Richmondena cardinalis*	Common	Permanent
Cattle Egret	*Bubulcus ibis*	Uncommon	Permanent
Common Crow	*Corvus brachyrhynchos*	Common	Permanent
Common Egret	*Casmerodius albus egretta*	Common	Permanent
Common Grackle	*Quiscalus quiscula*	Uncommon	Permanent
Common Nighthawk	*Chordeiles minor*	Common	Summer
Common Starling	*Sturnus vulgaris vulgaris*	Uncommon	Permanent

Table 1. A list of birds observed in the Turkey Point Study Area for 1980. (CONT'D)

COMMON NAME	SCIENTIFIC NAME*	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
Double-crested Cormorant	*Phalacrocorax auritis*	Common	Permanent
Eastern Painted Bunting	*Passerina ciris ciris*	Rare	Winter
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 vodiferus 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*	Common	Winter
Mockingbird	*Mimus polyglottos polyglottos*	Common	Permanent
Mottled Duck	*Anal fulvigula*	Common	Permanent
Mourning Dove	*Zenaidura macroura*	Uncommon	Permanent
Osprey	*Pandion halioetus carolinensis*	Common	Permanent

Table 1. A list of birds observed in the Turkey Point Study Area for 1980. (CONT'D)

COMMON NAME	SCIENTIFIC NAME*	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
Pied-billed Grebe	*Podilymbus podiceps podiceps*	Common	Winter
Reddish Egret	*Dichromanassa rufescens rufescens*	Rare	Summer
Red-shouldered Hawk	*Buteo lineatus*	Rare	Permanent
Red-winged Blackbird	*Agelaius phoeniceus*	Common	Permanent
Ring-billed Gull	*Larus delawarensis*	Fairly Common	Winter
Robin	*Turdus migratorius*	Uncommon	Winter
Roseate Spoonbill	*Ajaia ajaja*	Rare	Winter
Ruddy Turnstone	*Arenaria interpres*	Uncommon	Summer
Sanderling	*Crocethia alba*	Rare	Transient
Semipalmated Plover	*Charadrius hiaticula semipalmatus*	Uncommon	Winter
Short-billed Dowitcher	*Limnodromus scolopaceus*	Rare	Winter
Smooth-billed Ani	*Crotophaga ani*	Very Rare	Winter
Snowy Egret	*Leucophoyx thula thula*	Common	Permanent
Swallow-tailed Kite	*Elanoides forficatus forficatus*	Very Rare	Permanent
Tree Swallow	*Iridoprocne bicolor*	Rare	Winter
Turkey Vulture	*Cathartes aura*	Common	Permanent
White-eyed Vireo	*Vireo griseus*	Uncommon	Winter
White Ibis	*Guara alba*	Fairly Common	Permanent
White Pelican	*Pelecanus erythrorhynchos*	Uncommon	Winter
Willet	*Catoptrophorus semipalmatus*	Uncommon	Winter
Wood Ibis	*Mycteria americana*	Rare	Winter

Table 1. A list of birds observed in the Turkey Point Study Area for 1980. (CONT'D)

COMMON NAME	SCIENTIFIC NAME*	RELATIVE ABUNDANCE	SEASON OF OCCURRENCE
Würdemann's Heron	*Ardea wurdemanni*	Very Rare	Permanent
Yellow-crowned Night Heron	*Nyctanassa violacea*	Rare	Permanent

NOTE: * Binomial nomenclature by Peterson, 1947. Robbins, et al., 1966.

Table 2. A list of reptiles and amphibians observed in the Turkey Point Study Area for 1980.

COMMON NAME	SCIENTIFIC NAME*	PREFERRED HABITAT
American Alligator	*Alligator mississippiensis*	Fresh or brackish water
American Crocodile	*Crocodylus acutus*	Salt or brackish water
Atlantic Loggerhead Turtle	*Caretta caretta caretta*	Tropical and subtropical Atlantic
Eastern Diamond Back Rattlesnake	*Crotalus adamanteus*	Dry thickets
Eastern Indigo Snake	*Drymarchon corais couperi*	Near thickets of dense vegetation
Mangrove Water Snake	*Natrix fasciata compressicauda*	Salt or brackish water
Mud Snake	*Farancia abacura*	Swamps and lowlands
Southeastern Fivelined Skink	*Eumeces inexpectatus*	On spoil banks
Brown Anole	*Anolis sagrei*	On ground near shrubs
Green Anole	*Anolis carolinensis carolinensis*	Shrubs and vines
Green Tree Frog	*Hyla cinerea*	Swamps, borders of lakes and streams

NOTE: * Binomial nomenclature by Conant, 1975.

Table 3. A list of mammals observed in the Turkey Point Study Area for 1980.

COMMON NAME	SCIENTIFIC NAME*	PREFERRED HABITAT
Bobcat	*Lynx rufus*	Swamps
Domestic Cat	*Felis domestica*	Associated with man
Domestic Dog	*Canis familiaris*	Associated with man
Marsh Rabbit	*Sylvilagus palustris*	Berms, swamps, and hammocks
Manatee	*Trichechus manatus*	Shallow, protected, coastal waters
Raccoon	*Procyon lotor*	Along berms
Rice Rat	*Oryzomys palutris*	Marshy areas and grasses
Whitetail Deer	*Odocoileus viginianus*	Forests and swamps

NOTE: * Binomial nomenclature by Burt, et al., 1976.

Table 4. A comparison of the Turkey Point Study Area bird species for 1978, 1979, and 1980 to the Surrounding Area species.

	SURROUNDING AREA	1978	1979	1980
American Bittern	X	X		X
American Coot		X	X	X
American Goldfinch	X			
American Kestrel	X	X	X	X
American Redstart	X			
Anhinga	X			X
Bald Eagle	X	X	X	X
Barn Owl			X	
Barn Swallow	X	X	X	X
Belted Kingfisher	X	X	X	X
Black-bellied Plover	X	X		
Black-crowned Night Heron	X			
Black-necked Stilt		X		X
Black Skimmer	X	X		X
Black Vulture		X	X	
Black-poll Warbler	X	X		
Black-whiskered Vireo	X			
Blue-gray Gnatcatcher	X	X		X
Blue Jay	X			
Blue-winged Teal		X		X
Boat-tailed Grackle	X		X	X
Bobolink	X	X		
Bobwhite				X
Broadwinged Hawk		X	X	
Brown Pelican	X	X	X	X
Cape May Warbler			X	
Cardinal	X	X	X	X
Caspian Tern	X		X	
Cattle Egret	X	X	X	X
Cedar Waxwing	X			
Chuck-will's Widow	X			
Clapper Rail	X			
Common Crow		X	X	X
Common Egret	X	X	X	X
Common Flicker	X			
Common Grackle	X	X		X
Common Nighthawk	X	X	X	X
Common Snipe	X			
Common Starling			X	X
Common Tern			X	
Double-crested Cormorant	X	X	X	X
Downy Woodpecker	X			
Eastern Meadowlark	X	X		

Table 4. (CONT'D) A comparison of the Turkey Point Study Area bird species for 1978, 1979, and 1980 to the Surrounding Area species.

	SURROUNDING AREA	1978	1979	1980
Eastern Painted Bunting				X
Eastern Phoebe	X			
Florida Gallinule		X		
Glossy Ibis	X			
Gray Kingbird	X	X		
Great Blue Heron	X	X	X	X
Great White Heron		X	X	X
Green Heron	X	X	X	X
Ground Dove		X	X	X
Herring Gull	X	X	X	X
Hooded Merganser			X	X
House Sparrow		X	X	X
House Wren	X	X		
Killdeer	X	X	X	X
Laughing Gull	X	X	X	X
Least Sandpiper			X	X
Least Tern	X	X	X	X
Little Blue Heron	X	X	X	X
Louisiana Heron	X	X	X	X
Magnificent Frigatebird	X	X	X	X
Marsh Hawk		X	X	X
Merlin	X	X		
Mockingbird	X	X	X	X
Mottled Duck		X	X	X
Mourning Dove		X	X	
Northern Waterthrush	X	X		
Osprey	X	X	X	X
Palm Warbler	X	X		
Peregrine Falcon	X			
Pied-billed Grebe	X	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	X
Red-headed Woodpecker				X
Red-shouldered Hawk	X			X
Red-tailed Hawk			X	
Red-winged Blackbird	X	X	X	X
Ring-billed Gull	X	X	X	X
Robin				X
Rock Dove		X	X	
Roseate Spoonbill	X	X	X	X

Table 4. (CONT'D) A comparison of the Turkey Point Study Area bird species for 1978, 1979, and 1980 to the Surrounding Area species.

	SURROUNDING AREA	1978	1979	1980
Royal Tern	X		X	
Ruddy Turnstone				X
Sanderling	X			X
Savannah Sparrow	X	X		
Screech Owl	X	X		
Semipalmated Plover		X	X	X
Sharp-shinned Hawk	X			
Short-billed Dowitcher				X
Smooth-billed Ani		X		X
Snowy Egret	X		X	X
Spotted Sandpiper			X	
Swallow-tailed Kite				X
Tree Swallow	X	X	X	X
Turkey Vulture	X	X	X	X
White-crowned Pigeon	X	X		
White-eyed Vireo	X			X
White Ibis		X	X	X
White Pelican	X	X		X
Willet	X		X	X
Wood Duck	X			
Wood Ibis		X	X	X
Wurdemann's Heron		X		X
Yellowlegs	X			
Yellowthroat	X	X		
Yellow-bellied Sapsucker	X		X	
Yellow-billed Cuckoo			X	
Yellow-crowned Night Heron	X	X	X	X
Yellow-rumped Warbler	X			
Yellow-shafted Flicker			X	
Yellow Warbler	X			

Table 5 . A comparison of the Turkey Point Study Area mammalian species for 1978, 1979, and 1980 to Surrounding Area species.

	SURROUNDING AREA	1978	1979	1980
Black Rat	X	X	X	
Bobcat	X		X	X
Cotton Rat	X			
Domestic Dog			X	X
Dolphin	X			
Domestic Cat	X	X	X	X
House Mouse	X			
Manatee	X			X
Marsh Rabbit	X	X	X	X
Raccoon	X	X	X	X
Rice Rat	X			X
Whitetail Deer	X			X

Table 6. A comparison of the Turkey Point Study Area amphibian and reptilian species for 1978, 1979, and 1980 to the Surrounding Area species.

	SURROUNDING AREA	1978	1979	1980
American Alligator	X		X	X
American Crocodile	X	X	X	X
Atlantic Green Turtle			X	
Atlantic Loggerhead Turtle				X
Bahaman Bark Anole	X			
Brown Anole		X	X	X
Corn Snake	X	X	X	
Cuban Tree Frog	X		X	
Eastern Diamondback Rattlesnake	X		X	X
Eastern Garter Snake	X		X	
Eastern Indigo Snake	X	X	X	X
Everglades Racer Snake	X			
Florida Cricket Frog	X			
Florida King Snake			X	
Florida Softshell Turtle	X	X	X	
Florida Water Snake	X			
Green Anole	X	X	X	X
Green House Frog	X			
Green Tree Frog	X			X
Key West Anole	X			
Mangrove Water Snake	X	X	X	X
Mud Snake		X	X	X
Pig Frog	X			
Reef Gecko	X			
Southeastern Five-lined Skink		X	X	X
Southern Leopard Frog	X			
Southern Painted Turtle			X	
Southern Ringneck Snake			X	

Table 6. (CONT'D) A comparison of the Turkey Point Study Area amphibian and reptilian species for 1978, 1979, and 1980 to the Surrounding Area species.

	SURROUNDING AREA	1978	1979	1980
Southern Toad			X	
Yellow Rat Snake			X	

2. Sampling of Soil and Vegetation West and South of the Cooling canal system (ETS 4.2.2.3)

a. Soil Study

Introduction

The soil study was conducted to measure nitrite and nitrate levels in soils to the west and south of the Turkey Point Plant Cooling 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 top 3 cm of soil. A second sample was taken 30 cm 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 analyses (Jackson, 1958). Nitrate was reduced to nitrite in a cadmium column and the nitrite was analyzed using the diazotization method (APHA, 1976).

Nitrite and nitrate values were reported as nitrogen in micrograms per gram of dry weight of sample (Soil Study Table 1).

Summary and Conclusions

Soil samples were collected and analyzed for nitrite and nitrate. Levels of both nitrite and nitrate were higher in 1980 than in previous years. The range of nitrite at different sampling points was 0.31 to 6.83 μg/g dry soil in 1980 (Soil Study Table 1) as com-

pared with a range of 0.16 to 0.42 μg/g dry soil in 1979 (ABI, 1980). Nitrate ranged from 5.17 to 103.17 μg/g dry soil in 1980 as compared with a range of <0.01 to 0.44 μg/g dry soil in 1979. There was no obvious correlation between nitrite and nitrate content and soil depth where samples were collected.

Most soil nitrogen is found in organic matter that is decomposed by soil microorganisms into an ammonium compound. This nitrogen is first oxidized to nitrite and then to nitrate. The two oxidation changes are called nitrification. These microbiological transformations are influenced profoundly by soil conditions. When soil is cold, waterlogged, or excessively acid, nitrification progresses slowly. The most favorable conditions for nitrification are 1) adequate soil aeration, 2) temperatures from 27° to 32°C, 3) moderate soil moisture, and 4) an abundance of exchangeable bases (Brady, 1974).

The soils west and south of the Turkey Point cooling canal system are likely to be highly organic peat. Organic soils are characterized by a high calcium oxide content and, therefore, an abundance of exchangeable bases even though the soils are often acidic. In the presence of a high hydrogen ion concentration, more nitrate accumulation takes place than that common in mineral soils with the same low pH. Consequently, the nitrite and nitrate values found in the 1980 soil samples probably reflect this accumulation. Nitrite and nitrate values were greater in the grasssland (Transects

1, 3 and 5) where greater soil aeration may have occurred than in the mangrove swamp (Transects 7 and 9) where standing water can be expected year round. The combination of soil characteristics and environmental factors that influence the nitrification process accounts for the high variability found in soil nitrite and nitrate concentrations.

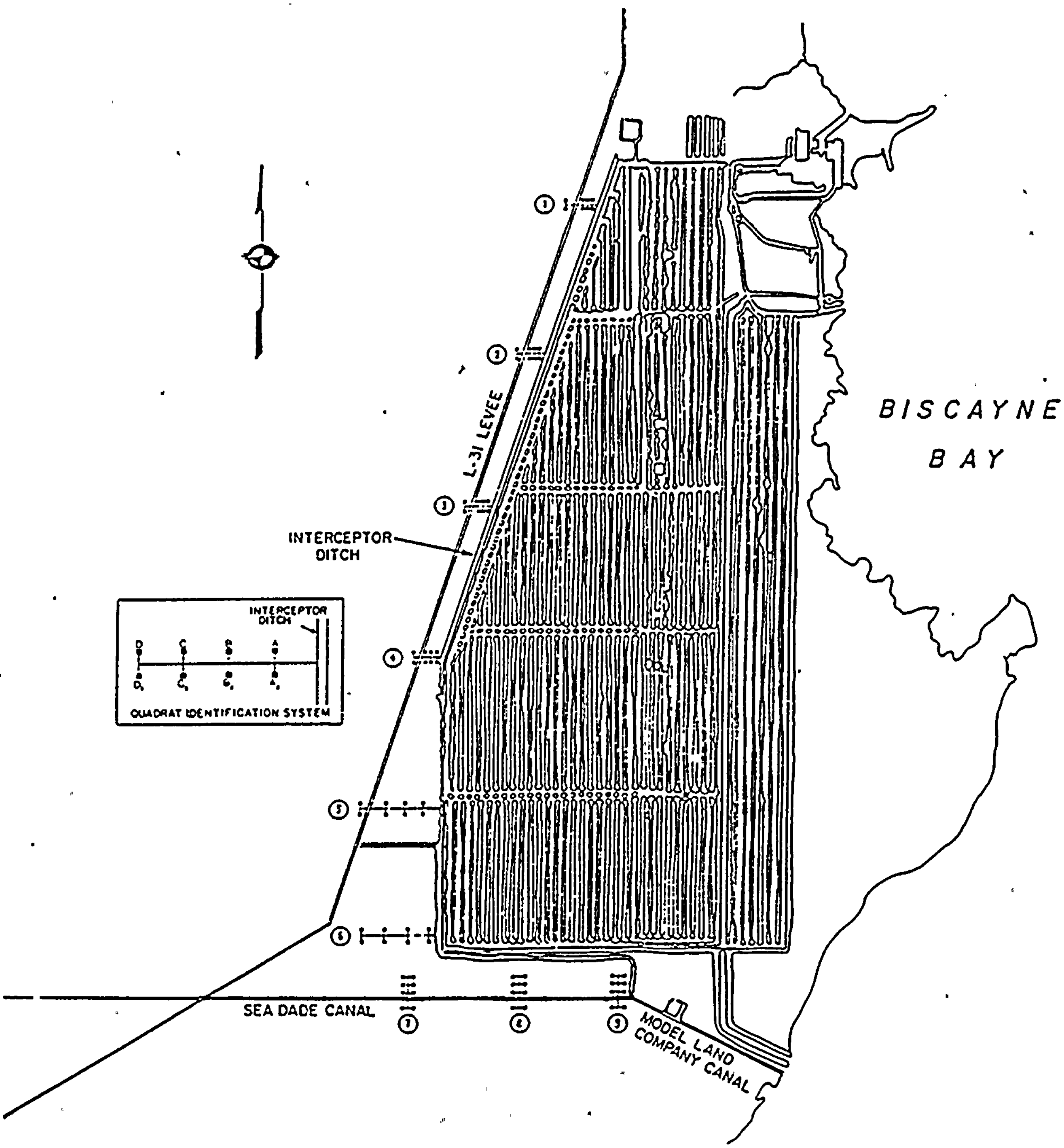
LITERATURE CITED

ABI. 1980. Annual non-radiological environmental monitoring report, 1979. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

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

Brady, N.C. 1974. The nature and properties of soil. MacMillan Publishing Co., Inc., New York. pp. 29, 366, 430.

Jackson, M.L. 1958. Soil chemical analysis. Prentice-Hall, Incorporated, Englewood Cliffs, N.J. pp. 193-194.



Soil Study Figure 1. Vegetation transects, Turkey Point site, 1980. Soil samples were collected from transects 1, 3, 5, 7 and 9.

Soil Study Table 1. Laboratory Analysis of 10 Soil Samples From the Turkey Point Site During 1980.

Transect number	Soil depth (cm)	Nitrite nitrogen (μg/g dry soil)	Nitrate nitrogen (μg/g dry soil)
1	3	1.83	25.89
	33	4.50	57.17
3	3	6.83	103.17
	33	3.01	61.37
5	3	1.03	9.08
	33	1.18	10.04
7	3	1.56	8.46
	33	0.62	5.17
9	3	0.61	7.09
	33	0.31	5.90

b. Vegetation Study (ETS 4.2.2.3)

Introduction

Salinity is the major factor that determines the composition and distribution of plant communities along southeast Florida's coast, location of the Turkey Point Plant. The interaction of tidal waters and freshwater runoff from rain creates a salinity gradient that ranges from salt water along the coast to fresh water inland. Following this gradient, the mangrove swamps that fringe shallow marine bays give way to buttonwood tree islands, salt marshes and eventually inland freshwater wetlands dominated by saw grass.

The climate and topography of this area strongly influence the interaction of tidal waters and freshwater runoff that produce the salinity gradient. Runoff varies seasonally with rainfall. About 152 cm of rain a year falls in the area, primarily from March through October. The slight slope of the land, approximately 1.8 cm per 100 m, causes fresh water from inland regions to drain southeastward into Card Sound (Vegetation Figure 1). During this wet season, groundwater is near the surface. During the dry season (November through February), when groundwater levels are low, infiltration of surface water is greater and freshwater runoff is reduced.

The natural equilibrium between freshwater runoff and tidal waters has been altered in recent years by the construction of Canal L-31 west of the Turkey Point Plant, the Sea Dade and Model Land Canals south of the site, and the Turkey Point Plant Cooling Canal System. The natural southeasterly flow of runoff and groundwater from inland regions has been diverted towards these canals and away from the plant communities located south and west of the Turkey Point system (Vegetation Figure 1). Therefore, the purpose of this continuing study is to identify the long-term operational impacts of the Turkey Point Plant Cooling Canal System on vegetation located south and west of the system.

Materials and Methods

Study Design

The vegetation in the vicinity of the cooling canal system was classified into three plant community types for sampling and data analysis. These categories were 1) the saline mangrove swamp south of the system, 2) the brackish grassland of saw grass, salt rush and salt grass to the west, and 3) mangrove and buttonwood tree islands within the grasslands. Each of these communities was sampled to identify potential impacts of the canal system on vegetation composition and biomass.

The specific location of sampling stations within each community was determined by the interpretation of aerial photos. Sampling transects were chosen to provide equal sampling in each of the major vegetation communities on the site.

The study design assumes that impacts on vegetation attributable to the cooling canal system will decrease with distance from the system. Sample quadrat locations were selected along transects that originated adjacent to the cooling canal and extended into the surrounding vegetation west and south of the system. Thus, by comparing the composition and biomass of vegetation adjacent to and farther away from the canal system, changes attributable to operation of the Turkey Point Plant Cooling Canal System can be readily observed.

Field Methods

Quantitative data have been collected along nine transects once during each dry season since 1975. The 1980 sampling was conducted in early November.

Transects 1 through 6 run east to west adjacent to the western border of the canal system (Vegetation Figure 1). These transects were selected so that three intersect tree islands and three intersect grasslands. Transects 7 through 9 run north-south adjacent to the southern border of the canal system and intersect mangrove communities.

Four sampling points were established at predetermined intervals along each transect to identify canal system effects on vegetation with distance from the canal. At each sampling point, two 5 x 5-m (25-m^2) quadrats were located on opposite sides of the

transect line as shown in the insert of Vegetation Figure 1. Thus, for the grassland community (Transects 1, 3 and 5), quadrats A and A' represent vegetation adjacent to the canal system and quadrats D and D' represent vegetation farthest away from the system. This sampling design yields six replicate quadrats per community and distance from the canal system.

Statistical Methods

The statistical approach used to detect impacts of cooling canal system operation on the vegetation answered the following questions:

1. Is there a change in composition and/or biomass of vegetation communities that is greater adjacent to the canal system and less farther away from the system,
2. Is the change greater this year than in previous years,
3. Are both of the above true; that is, does the change increase with time and is it greatest adjacent to the canal system?

If the answer to any one of these questions is affirmative, it may be concluded that canal system impact has occurred. If the following associated null hypotheses are accepted according to the data, no effects can be attributed to the canal system:

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.

Composition was estimated by frequency. Frequency is defined as the number of quadrats in which a species occurred divided by the total number of quadrats sampled. The resulting values estimate the probability of finding at least one individual of the species in one quadrat. Analysis of frequencies with G as the test criterion (Sokal and Rohlf, 1969) was used to detect changes in species composition.

Biomass was estimated by a volume-density index developed for this study. This index estimates the volume (height x radius^2) and weighs it by the density of individuals within the volume (Vegetation Figure 2). This method is analagous to traditional measures of yield and was derived from Goodall's vector space approach to community analyses (Greig-Smith, 1964). It shares the advantage of the traditional measures in that it can be determined easily in the field and has the further advantage of allowing comparisons of species with different growth forms. Multivariate analysis of variance (SAS, 1979) with the F-ratio as the test criterion was used to detect changes in biomass. Because biomass data are strongly skewed and biomass changes exponentially due to the rate of plant growth, the data were transformed by taking natural logarithms of the values (Sokal and Rohlf, 1969).

Whenever the hypotheses tested were proven to be true with 95 percent confidence (P=0.05), 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.

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 indices were chosen because they allow an examination of the individual species' contributions to overall community effects. If a community effect was 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 canal system, the study design can also detect impacts from other events. Correct interpretation of the data requires identification of the manner in which vegetation would be affected by different causes.

Comparison With Baseline Data

The data collected in this continuing study were compared with Turkey Point baseline data collected east of the present study area prior to cooling canal construction in 1972 (ABI, 1978a). Additional baseline data were collected from the South Dade site, southeast of the present study area, in 1974 (ABI, 1978b).

Results and Discussion

Plant Species at Turkey Point

A total of 179 plant species (Vegetation Table 1) have been observed in the Turkey Point and South Dade studies. The average number of species was 64 per study. Fifteen species were present in all studies and only 18 species had frequencies greater than or equal to 5 percent, including 14 of the species that have been present during every study year. In the 1980 study, 66 species were observed. This value is not significantly different from the average (64 species) for all studies (Pearson and Hartley, 1966).

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. The major cause of this change was a killing freeze that occurred in January 1977 (ABI, 1978). During the past 3 years, the number of species observed for the first time has again steadily decreased. In 1980, only two species were observed for the first time (Vegetation Figure 3). This phenomenon indicates that the composition of species at Turkey Point has reached a new, post-freeze stability.

The freeze also caused a statistically significant change in species composition between the December 1977 sampling program and

those of the previous years. The observed change was abrupt both adjacent to and distant from the canal system and the effect on the composition of species became smaller the following years. Therefore, this change, although statistically significant, could not be attributed to the cooling canal system.

Community Composition, 1980 Study

Overall community composition in 1980 was not significantly different from community composition in each of the previous 3 post-freeze years but was significantly different from that of the pre-freeze years (1975-1976; G=65.50, $P \leq 0.05$). These results show that, in terms of overall composition, there is no impact attributable to the canal system because there is no increasing change with time. There was, however, an apparent freeze impact that has lasted through 1980.

To identify the ecological implications of the above results, differences in the frequency of occurrence of each species between 1980 and the pre-freeze years was examined (Vegetation Figure 4; Vegetation Table 2). Of the 23 species with frequencies greater than 5 percent in 1980, 10 showed significant differences in frequency between 1980 and pre-freeze years. Of these 10 species, 8 have increased in frequency (aster, salt grass, groundsel, sea daisy, clubrush, schoenus, climbing hempvine and Brazilian pepper) and two (leather fern and cabbage palm) have decreased in frequency since the freeze. For all of these 10 species, except climbing

hempvine, an abrupt change in frequency took place between 1976 and 1977 (Vegetation Figure 4) and no significant changes occurred between the 3 post-freeze years and 1980 (Vegetation Table 2).

The species that abruptly increased in frequency after the freeze (1977) are predominantly salt-tolerant herbaceous and woody species (salt grass, clubrush, schoenus, aster, sea daisy, Brazilian pepper and groundsel). These species apparently benefited from the effects of the freeze by expanding their distribution throughout the site. However, the somewhat less salt-tolerant leather fern and cabbage palm were adversely affected by the freeze as shown by their sharply reduced frequencies. Since the freeze only two species (climbing hempvine and glades morning glory) have shown changes in frequency with time. Therefore, the freeze and not the cooling canals was responsible for the significant differences in frequency noted between 1976 and 1980.

An abrupt increase in the frequency of climbing hempvine and glades morning glory occurred between 1979 and 1980 (Vegetation Table 2), indicating possible successional changes in community composition. Blechnum fern was the only species that was significantly more frequent before the freeze than in 1979. However, in 1980, the frequency of this fern increased to the point where there were no longer significant frequency differences between 1980 and pre-freeze years. This indicates that the effects of the freeze on this species had dissipated by 1980.

Community Composition, Comparison With Baseline

The community composition for 1980 was significantly different from the community composition for both the 1972 Turkey Point Baseline Study (ABI, 1978a) and the 1974 South Dade Baseline Study (ABI, 1978b; $G=24.16$ and 36.58, respectively, $P \leq 0.05$).

To determine the ecological implications of these results, the contribution of common species to the differences observed between the operational monitoring data and the baseline data were examined (Vegetation Table 3). Generally, species that showed significant frequency differences between studies had greater frequencies in 1980 than in either baseline study. The saw grass prairie and associated hammocks species such as saw grass, buttonwood, white mangrove, rush and poisonwood had greater frequencies in the 1980 study than in the baseline data. However, more salt-tolerant species, such as red mangrove and salt grass, had higher frequencies in the baseline studies than in the 1980 operational monitoring study. Frequencies of these species were fairly constant from 1979 to 1980, indicating that differences were not increasing over time (ABI, 1979, 1980). Therefore, the significant differences observed in community composition between the baseline studies (ABI, 1978a, 1978b) and the 1980 study cannot be attributed to the cooling canal system. The observed differences in frequency are probably due to differences in sampling locations among the studies. The Turkey Point operational monitoring study stations are further from the shoreline than those of either the Turkey Point Baseline Study or the South Dade Baseline Study.

Biomass, 1980 Study

Vegetation volume-density indices by transect for 1980 are presented in Vegetation Tables 4 through 6. Data from 1980 were combined with all of the previous data for the 12 most common species (mean frequencies greater than 10 percent; Vegetation Table 1) and used for the long-term analysis. These 12 species accounted for 65 percent of the 1980 observations.

Biomass, Long-Term Analysis

Community biomass differed significantly among years. The contribution of each species to this observed difference was examined to identify the source of the variance.

Six species showed significant biomass differences among years. Four of these species, saw grass, buttonwood, red mangrove, and leather fern, decreased in biomass by a factor of 10 between 1976 and 1977 (Vegetation Figure 5). Since the freeze, all of these species have exhibited varying degrees of biomass recovery. By 1980, saw grass, red mangrove and leather fern biomass increased to levels that were not significantly different from those of pre-freeze years (1975-1976). Recovery was generally greatest in the tree island and mangrove communities. Cabbage palm biomass increased to pre-freeze levels only in tree island communities. In contrast, buttonwood biomass has decreased since the freeze, especially in grassland communities. This is not surprising since this shrub is one of the most susceptible to frost. The effects of the

freeze on buttonwood is evident in its top-killed branches. Also, many-stemmed shrubs have been formed from the freeze-affected root systems. The sixth species, aster, was rare prior to 1977 but has now become established and is maintaining a low biomass. Each significant change in individual species' biomass represents an abrupt change between pre-freeze December 1976 and post-freeze December 1977. Therefore, the observed changes reflect not only the impact of the freeze of January 1977 but also the ability of each species to recover or to invade following this natural event.

In addition to freeze effects, the biomass of some of the common species showed ecologically significant differences with distance from the canal system. These species were Australian pine, saw grass, rush, leather fern and buttonwood (Vegetation Figure 6). Except for buttonwood, biomass for these species was higher at quadrats closer to the canal system than those farther away. This suggests that these four species have been affected by the canal system. However, there was also evidence of effects attributable to the Sea Dade and Model Land Company canals; these four species showed significantly lower biomass values at all D quadrats, which lie adjacent to these canals and furthest from the Turkey Point Canal System.

Each of the species that showed significant differences in biomass with distance from the canal system has specific ecological requirements. Therefore, the response of each species to the pres-

ence of the canals is different and it is difficult to determine specifically how these canal systems have caused biomass changes.

Australian pine is an introduced species that is spreading rapidly in south Florida (Long and Lakela, 1971) by colonizing disturbed land, such as the spoil berms within the cooling system. This tree does best on mineral soil without competing vegetation and does not invade mangrove associations or wetlands that are flooded most of the year (Craighead, 1971). The biomass of Australian pine was greatest adjacent to the canal system and decreased with distance from it. This probably represents the inability of the species to expand from the disturbed land of the cooling system into the surrounding natural wetland vegetation.

Saw grass biomass was low in the southern-most mangrove community quadrats. This is not surprising 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.. No adverse canal system impacts on this species were indicated, however, as evidenced by the lack of a consistent pattern of increasing differences in biomass with distance from the canal system. Only quadrat D exhibited significantly less biomass than the quadrats closest to the canal system (A,B,C) which suggests possible impacts attributable to the Sea Dade and Model Land Company canals.

The biomass of rush and leather fern, two salt-tolerant species, was greater adjacent to the cooling system than farther from it. Rush is usually found on salt flats and leather fern is a brackish coastal hammock species (Long and Lakela, 1971). Buttonwood exhibited significantly less biomass adjacent to and furthest from the canal system than at intermediate distances.

Summary and Conclusions

A total of 179 plant species have been observed in all of the Turkey Point (ABI, 1976, 1977, 1978c, 1979, 1980) and South Dade Studies (ABI, 1978a, 1978b). 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 1980 study that both freshwater and salt-tolerant species had recovered from the freeze. However, salt-tolerant species seem to have recovered more quickly than salt-intolerant ones.

Community composition in the 1980 operational monitoring study was significantly different from both the 1972 Turkey Point baseline data (ABI, 1978a) and from the 1974 South Dade baseline data (ABI, 1978b). Baseline data showed higher frequencies for salt-

tolerant species and lower frequencies for salt-intolerant species than did the operational monitoring data. Differences in sampling locations in the studies probably accounted for the observed differences.

Two general trends in vegetation biomass are evident. First, the biomass of six common species differed significantly among years. These differences reflect the impact of the freeze of 1977 and the ability of these species to recover from this natural event. Secondly, the biomass of five common species differed significantly with distance from the canal system. The biomass of these five species also showed differences that may be related to the presence of Sea Dade and Model Land Company Canals; biomass values of these species were significantly lower adjacent to these canals than farther from them. The biomass of Australian pine, rush, leather fern and saw grass was higher adjacent to the canal system than farther from it. Buttonwood exhibited lowest biomass both adjacent to and farthest from the system. It appears that the Turkey Point Canal System has caused a slight increase in the relative abundance and biomass of some salt-tolerant species adjacent to the western perimeter of the cooling canals. However, the magnitude of this effect is small compared to the effect of natural events such as the freeze of 1977.

LITERATURE CITED

ABI. 1976. Ecological monitoring of selected parameters at the Turkey Point Plant, annual report 1975. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1977. Ecological monitoring of selected parameters at the Turkey Point Plant, annual report 1976. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1978a. Evaluation of ecological studies conducted at Turkey Point and the South Dade study area. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1978b. Baseline ecological study of a subtropical terrestrial biome in southern Dade County, Florida. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1978c. Ecological monitoring of selected parameters at the Turkey Point Plant, annual report, 1977. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1979. Turkey Point Plant, annual non-radiological monitoring report, 1978. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

___. 1980. Turkey Point Plant, annual non-radiological monitoring report, 1979. Sections prepared by Applied Biology, Inc., for Florida Power & Light Co., Miami, Fla.

Collier, B.D., G.W. Cox, A.W. Johnson, and P.C. Miller. 1973. Dynamic ecology. Prentice-Hall, Inc., Englewood Cliffs, N.Y.

Craighead, F.C. 1971. The trees of south Florida, Vol. I. The natural environments and their succession. U. Miami Press, Coral Gables, Fla. 212 pp.

Greig-Smith, P. 1964. Quantitative plant ecology, second edition. Plenum Press, New York, N.Y.

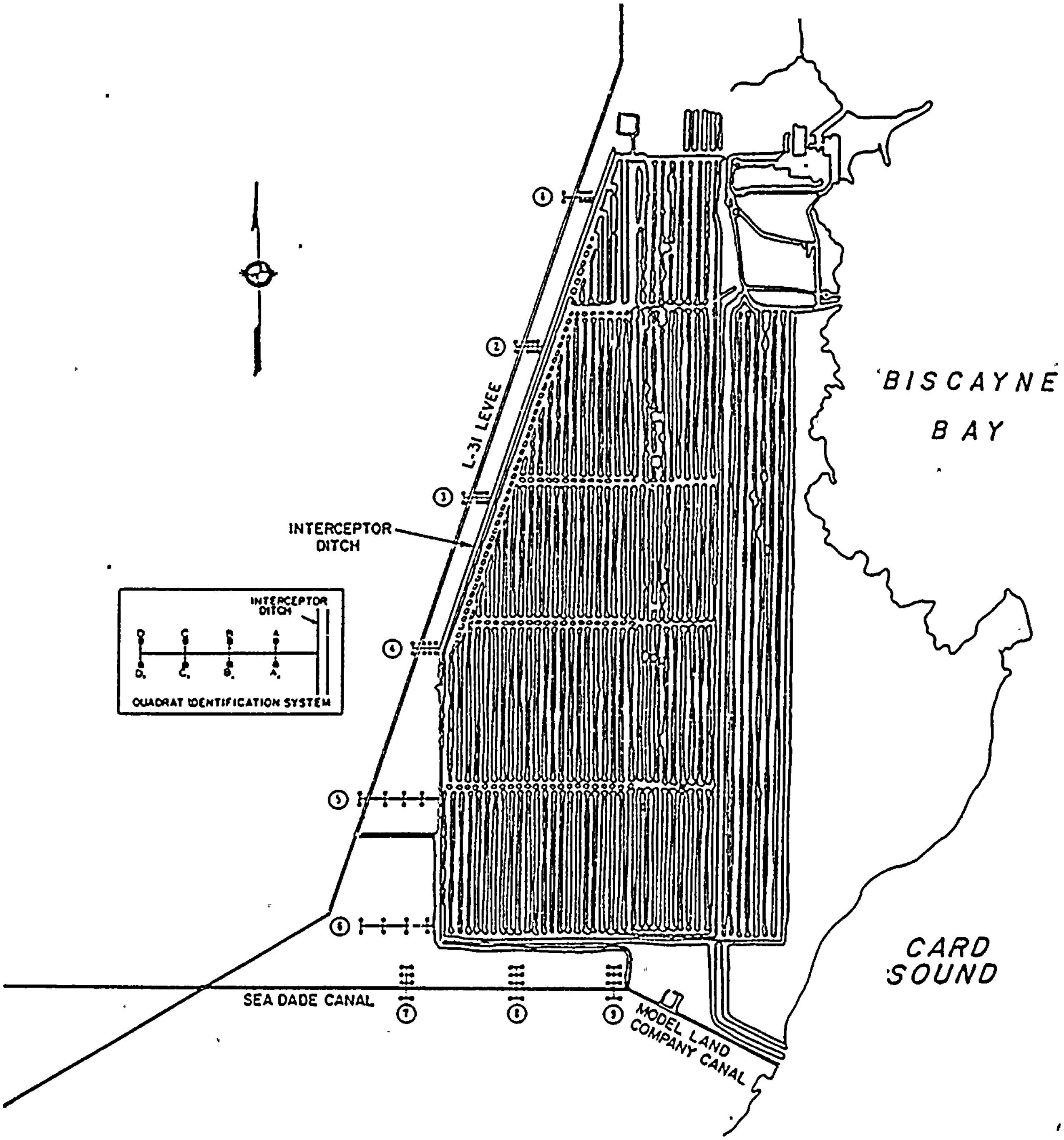
Long, R.W., and O. Lakela. 1971. A flora of tropical Florida. Univ. of Miami Press, Coral Gables, Fla.

Pearson, E.S., and H.O. Hartley, eds. 1966. Biometrika tables for statisticians, Vol. I. Cambridge Univ. Press, Cambridge, Mass.

LITERATURE CITED (continued)

SAS. 1979. SAS user's guide, 1979 edition. SAS Institute, Raleigh, N.C.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Company, San Francisco, Calif.



Vegetation Figure 1. Location of vegetation sampling transects. Turkey Point site, 1980.

Example 1. Saw grass (*Cladium* sp.)

where: $\textit{Cladium} \text{ index} = \frac{NHR^2}{A}$

N = Number of graminoid plants;

H = Average height per plant, in centimeters = $\frac{\text{Total WH}}{T}$,

WH = Weighted height per plant, in centimeters = PC,

P = Number of plants per clump,

C = Clump height,

T = Total number of plants measured;

R = Radius per plant, in centimeters (gathered, compressed and measured at widest point) = $\frac{D}{2}$;

D = Average diameter per plant, in centimeters = $\frac{D'}{T'}$

D' = Total diameter of all measured plants,

T = Total number of plants measured.

sample values	N = 240	R = 1.592
	H = 142.2	A = 1.0

$$\textit{Cladium} \text{ Index} = \frac{(240)(142.2)(1.59)^2}{1.0} = 86{,}002.56$$

Vegetation Figure 2a. Examples of volume-density index calculations of a graminoid and woody plant species, Turkey Point Plant, 1980.

Example 2. Woody shrub (*Conocarpus*)

Conocarpus index = NHR^2

where: N = Number of shrubs of similar dimensions (seedlings measured separately);

H = Average shrub height, in centimeters = $\frac{H'}{N'}$,

H' = Total height of all measured shrubs,

N' = Total number of shrubs measured;

R = Radius per shrub, in centimeter = $\frac{D}{2}$

D = Average diameter per shrub, in centimeters = $\frac{D'}{N'}$

D' = Total diameter of all measured shrubs,

N' = Total number of shrubs measured.

sample values

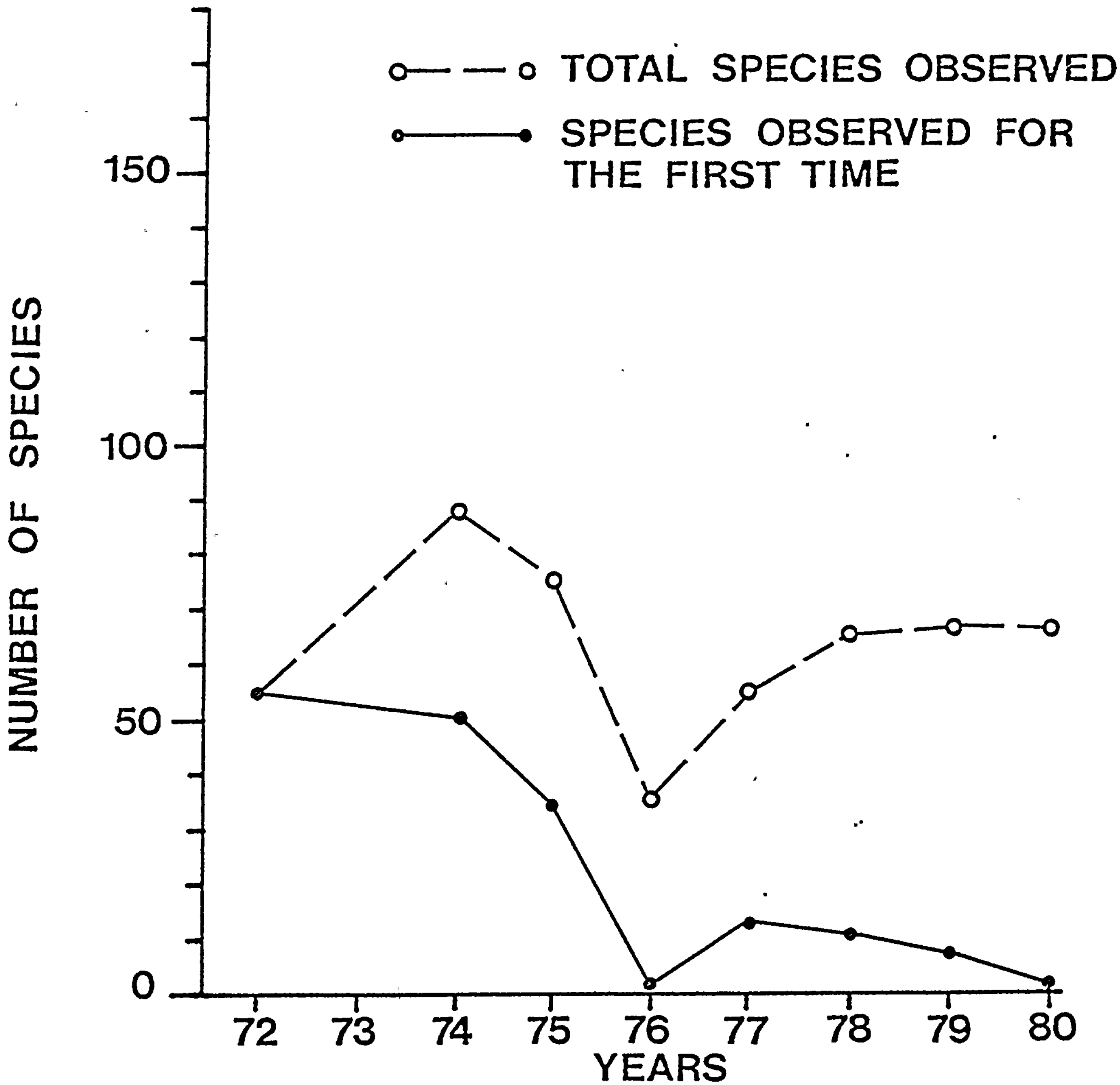
N = 1.0

H = 365.8

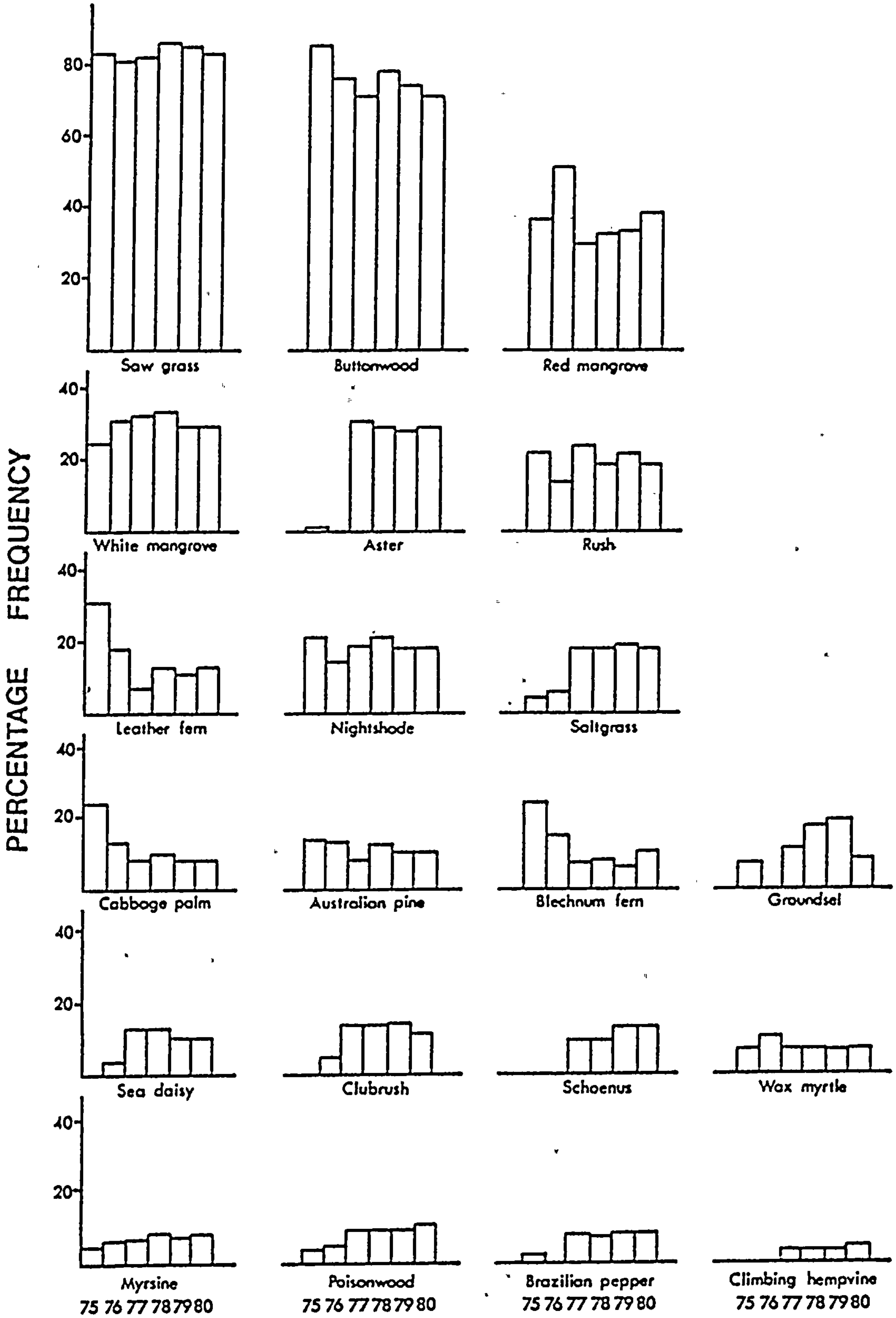
R = 6.452

Conocarpus Index = $(1.0)(365.8)(6.45)^2$ = 15,218.19

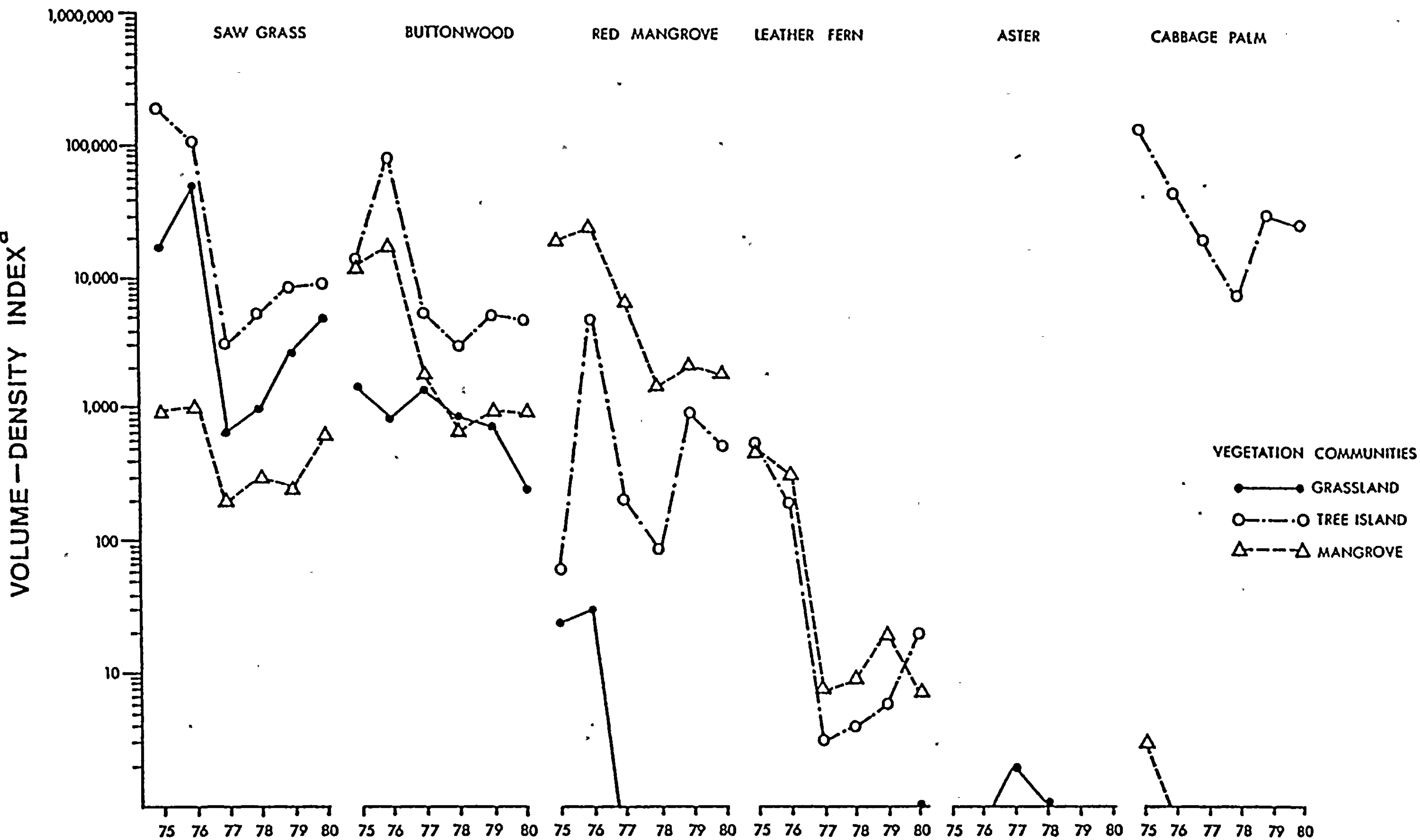
Vegetation Figure 2b. Examples of volume-density index calculations of a graminoid and woody plant species, Turkey Point Plant, 1980.



Vegetation Figure 3. Number of plant species observed, Turkey Point Plant, 1972-1980.

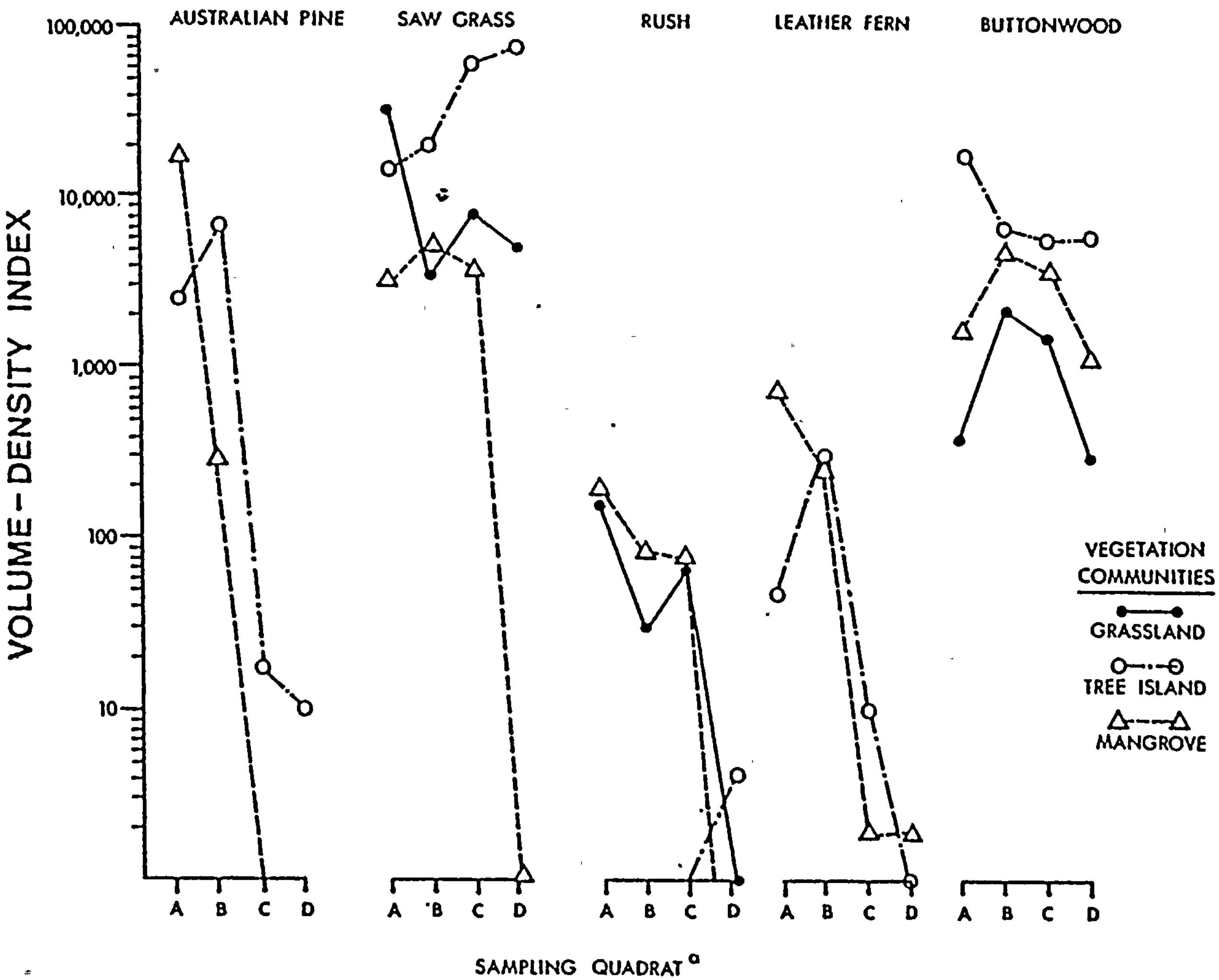


Vegetation Figure 4. Comparison of yearly frequency of common species, Turkey Point Plant, 1975-1980.



[a]Values are the geometric mean of the index for each community per year.

Vegetation Figure 5. Comparison of average biomass for selected species, Turkey Point Plant, 1975-1980.



[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, 1975-1980.

Vegetation Table 1. Plant Species Observed and Frequency of Occurrence at the Turkey Point Plant During 1972-1980.

Species	Common name	Frequency (%)								
		1972[a]	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	1980[c]	Mean
Acrostichum aureum	leather fern	15.9	10.0	30.6	18.1	6.9	12.5	11.1	12.5	14.7
Agalinis sp.	false foxglove	2.4	-	-	-	-	-	-	-	0.3
Annona glabra	pond apple	3.7	3.3	1.4	1.4	-	-	-	1.4	1.4
Ardisia escallonoides	marlberry	-	-	-	-	4.2	-	-	-	0.5
Asclepias sp.	milkweed	3.7	0.5	-	-	-	-	-	-	0.5
Aster sp.	aster	-	0.5	-	-	30.6	29.2	27.8	29.2	14.7
Aster tenuifolius v. aphyllus	aster	-	-	1.4	-	-	-	-	-	0.2
Avicennia germinans (Avicennia nitida)[d]	black mangrove	-	5.2	1.4	-	4.2	-	2.8	2.8	2.1
Baccharis sp.	groundsel, saltbush	-	-	4.2	-	11.1	4.2	-	1.4	2.6
B. angustifolia	false willow	1.2	7.1	1.4	-	-	5.6	4.2	5.6	3.1
B. dioica	groundsel	-	-	-	-	-	-	1.4	-	0.2
B. glomeruliflora	groundsel tree	-	-	-	-	-	4.2	4.2	2.8	1.4
B. halimifolia	groundsel	12.2	6.2	1.4	-	-	2.8	8.3	4.2	4.4
Bacopa monnieri	water hyssop	-	-	1.4	-	-	-	-	-	0.2
Batis maritima	saltwort	-	4.3	1.4	-	-	-	-	-	0.7
Blechnum serrulatum	blechnum fern	9.8	5.2	23.6	15.3	6.9	8.3	5.6	9.7	10.6
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	12.5	9.4
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	5.6	1.2
Casuarina equisetifolia	Australian pine	12.2	5.7	13.9	12.5	8.3	12.5	9.7	9.7	10.6
Celtis laevigata	hackberry	-	-	1.4	-	-	-	-	-	0.2
Cephalanthus occidentalis	buttonbush	-	4.8	-	1.4	1.4	-	-	-	1.0
Chamaesyce sp.	spurge	-	-	-	-	-	1.4	-	-	0.2
Chiococca alba	snowberry	4.9	5.2	5.6	-	4.2	-	5.6	1.4	3.4
Chloris sp.	finger grass	-	0.5	-	-	-	-	-	-	0.1
Chrysobalanus icaco	coco palm	1.2	1.9	4.2	6.9	-	4.2	-	-	2.3
Cladium jamaicensis (Mariscus jamaicensis)	saw grass	74.4	44.3	83.3	80.6	81.9	86.1	84.7	83.3	77.3
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	70.8	68.0
Crinum americanum	string lily	-	2.4	1.4	1.4	-	-	-	-	0.7
Cuscuta sp.	dodder	1.2	2.4	-	-	-	1.4	-	-	0.6
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
Damifino sp.	(no common name)	-	-	-	-	-	-	1.4	1.4	0.2
Dichromena floridensis	(no common name)	-	-	-	-	-	1.4	-	1.4	0.4
Dipholis salicifolia	bustic	-	-	1.4	1.4	4.2	1.4	1.4	2.8	1.8
Distichlis spicata	salt grass	20.7	49.0	4.2	5.6	18.1	18.1	19.4	18.0	19.1
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	11.1	7.1
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	-	-	-	1.0
E. confusa	ironwood	-	-	-	-	-	2.8	-	-	0.4
E. myrtoides (Eugenia buxifolia)	Spanish stopper	2.4	-	-	-	-	1.4	1.4	4.2	1.2

Vegetation Table 1 (cont'd). Plant Species Observed and Frequency of Occurrence at the Turkey Point Plant During 1972-1980.

Species	Common name	Frequency (%)								
		1972[a]	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	1980[c]	Mean
Eulophia alta	wild coco	-	-	1.4	-	-	-	-	-	0.2
Eupatorium capillifolium	dog fennel	-	7.1	1.4	-	1.4	5.6	1.4	-	2.1
Ficus aurea	strangler fig	-	-	2.8	-	-	-	-	-	0.4
F. citrifolia	wild banyon tree	3.7	3.8	1.4	1.4	-	-	-	-	1.3
Fimbristylis sp.	sedge	-	-	1.4	-	2.8	-	-	-	0.5
Flaveria sp.	(no common name)	-	-	-	-	-	-	1.4	1.4	0.4
Forestiera segregata	Florida privet	-	-	-	-	2.8	-	1.4	1.4	0.7
Fuirena sp.	umbrella grass	1.2	0.5	-	-	-	-	-	-	0.2
F. scirpoidea	umbrella grass	1.2	3.3	-	-	1.4	-	1.4	-	0.9
Galium hispidulum	bedstraw	-	-	1.4	-	-	-	-	-	0.2
G. obtusum	bedstraw	-	-	-	-	-	-	1.4	2.8	0.5
Habenaria sp.		-	-	-	-	-	-	-	1.4	1.4
Hydrocotyle umbellata	marsh pennywort	-	3.3	-	-	-	-	-	-	0.4
Hypericum sp.	St. John's wort	-	-	-	-	6.9	6.9	-	2.8	2.1
Ilex cassine	dahoon holly	6.1	5.2	4.2	5.6	2.8	1.4	1.4	4.2	3.9
Ipomoea sp.	morning glory	2.4	-	-	-	-	-	-	-	0.3
I. sagittata	glades morning glory	-	4.3	5.6	-	8.3	20.8	1.4	9.7	6.3
Jacquemontia curtissii	(no common name)	-	-	-	-	2.8	-	2.8	2.8	1.1
J. reclinata	(no common name)	-	-	-	-	-	4.2	-	-	0.5
Juncus roemerianus	rush	15.9	17.6	22.2	13.9	13.9	19.4	22.2	19.4	18.1
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	29.2	29.0
Lantana involucrata	lantana	-	0.5	-	1.4	2.8	2.8	1.4	1.4	1.5
L. microcephala	lantana	-	-	-	-	-	-	1.4	1.4	0.4
Lippia nodiflora	capeweed	-	1.0	-	-	-	-	-	-	0.1
Ludwigia sp.	(no common name)	-	-	-	-	-	-	1.4	5.6	0.9
L. microcarpa	water purslane	-	-	1.4	-	-	-	-	-	0.2
L. peruviana	primrose willow	-	1.0	-	-	-	-	-	-	0.1
L. repens	water purslane	-	-	-	-	-	5.6	4.2	4.2	1.8
Lycium carolinianum	Christmas berry	-	-	2.8	2.8	-	-	-	-	0.7
Lythrum alatum	loosestrife	-	-	-	-	-	-	1.4	1.4	0.4
Magnolia virginiana	sweet bay, swamp bay	-	3.8	2.8	-	2.8	1.4	1.4	2.8	1.9
Metopium toxiferum	poisonwood	4.9	1.9	2.8	4.2	8.3	8.3	8.3	9.7	6.1
Mikania batatifolia	hemp vine	-	-	1.4	-	-	5.6	-	1.4	1.1
M. scandens	climbing hempvine	4.9	4.8	-	-	1.4	1.4	1.4	6.9	2.6
Myrica cerifera	wax myrtle	4.9	5.2	5.6	9.7	6.9	6.9	5.6	6.9	6.5
Myrsine guianensis (*Rapanea guianensis*)	myrsine	4.9	5.7	4.2	5.6	5.6	8.3	6.9	8.3	6.2
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	-	-	-	-	-	1.4
Paspalum sp.	(no common name)	-	3.3	-	-	-	-	-	-	0.4
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	4.2	3.4
P. palustris	swamp bay	-	3.3	-	-	-	-	-	-	0.4
Phlebodium sp.	golden polypody	-	-	-	-	-	1.4	1.4	1.4	0.5
P. aureum	golden polypody	4.9	-	1.4	-	-	-	-	-	0.8
Phyllanthus	(no common name)	-	-	-	-	-	-	1.4	1.4	0.4

Vegetation Table 1 (cont'd). Plant Species Observed and Frequency of Occurrence at the Turkey Point Plant During 1971-1980.

Species	Common name	Frequency (%) 1972[a]	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	1980[c]	Mean
Pinguicula pumila	butterwort	-	-	-	-	1.4	1.4	-	1.4	0.5
Pisonia sp.	cockspur	-	-	-	-	2.8	-	-	-	0.4
P. aculeata	devil's claw	-	-	2.8	-	-	-	-	-	0.4
P. discolor	biolly, beef tree	1.2	-	-	-	-	4.2	1.4	2.8	1.2
(Torrubia longifolia)										
Pithecellobium unguis-cati	catclaw	1.2	-	-	-	-	-	-	-	0.2
Pluchea purpurascens	camphorweed	2.4	-	1.4	1.4	1.4	-	-	-	0.8
P. rosea	marsh fleabane	-	6.2	-	-	-	1.4	-	-	1.0
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	-	-	-	-	0.2
Proserpinaca sp.	mermaid weed	-	-	-	-	1.4	4.2	2.8	-	1.1
P. palustris	swamp mermaid	-	4.3	-	-	-	-	1.4	4.2	1.2
Psilotum nudum	whisk fern	-	-	1.4	-	-	-	-	-	0.2
Psychotria ligustrifolia	wild coffee	-	-	-	-	-	-	1.4	-	0.2
Pteris vittata	brake fern	-	-	1.4	-	-	-	1.4	1.4	0.4
Randia aculeata	white indigoberry	-	0.5	-	-	1.4	4.2	2.8	2.8	1.5
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	37.5	39.3
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	8.3	11.1
Sabatia sp.	marsh pink	4.9	1.0	-	-	-	-	-	-	0.7
S. grandiflora	marsh pink	-	-	-	-	1.4	-	1.4	-	0.4
Salicornia virginica	perennial glasswort	-	8.6	1.4	-	1.4	2.8	2.8	1.4	2.3
(Salicornia perrenis)										
Salix caroliniana	coastal plain willow	-	2.9	1.4	-	-	1.4	1.4	1.4	1.1
(Salix longipes)										
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	6.9	4.9
Schoenus nigricans	(no common name)	-	1.0	-	-	6.9	6.9	8.3	8.3	3.9
Serenoa repens	saw palmetto	1.2	1.0	-	1.4	-	-	-	-	0.5
Sesuvium maritimum	sea purslane	-	-	5.6	4.2	-	-	-	-	1.2
S. portulacastrum	sea purslane	1.2	6.2	-	-	-	-	-	-	0.9
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	18.1	13.9
S. erianthum	potato tree	13.4	8.1	-	-	-	-	-	-	2.7
(Solanum verbascifolium)										
Solidago microcephala	goldenrod	-	-	-	-	-	1.4	-	-	0.2
S. tortifolia	goldenrod	-	-	-	-	1.4	-	-	-	0.2
Sophora tomentosa	necklace pod	-	0.5	1.4	-	-	-	-	-	0.2
Stenandrium sp.	(no common name)	1.2	-	-	-	-	-	-	-	0.2
(Gerardia sp.)										
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	2.8	2.0
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	2.8	1.2
T. augescens	(no common name)	-	-	1.4	-	-	-	-	-	0.2
Tillandsia balbisiana	air plant	-	0.5	-	-	-	-	-	-	0.1

Vegetation Table 1 (cont'd). Plant Species Observed and Frequency of Occurrence at the Turkey Point Plant During 1971-1980.

Species	Common name	Frequency (%) 1972[a]	1974[b]	1975[c]	1976[c]	1977[c]	1978[c]	1979[c]	1980[c]	Mean
T. circinata	air plant	-	-	-	-	2.8	4.2	1.4	2.8	1.4
T. fasciculata	air plant	-	-	1.4	-	-	-	-	-	0.2
T. flexuosa	twisted air plant	-	-	1.4	2.8	2.8	4.2	-	-	1.4
T. utriculata	air plant	2.4	-	-	-	-	-	-	-	0.3
T. valenzuelana	soft-leaf air plant	-	-	1.4	-	-	-	-	-	0.2
Toxicodendron radicans	poison ivy	6.1	7.1	1.4	-	-	2.8	1.4	2.8	2.7
Trema lamarkiana	West Indian trema	7.3	2.9	1.4	1.4	-	-	-	-	1.6
T. micrantha	Florida trema	4.9	2.9	-	-	-	1.4	1.4	2.8	1.7
Typha sp.	cattail	-	-	-	2.8	1.4	2.8	2.8	2.8	1.6
T. domingInensis	southern cattail	-	0.5	-	-	-	-	-	-	0.1
Vanilla inodora	scentless vanilla	-	0.5	-	-	-	-	-	-	0.1
Verbena bonariensis	vervain	-	1.9	-	-	-	-	-	-	0.2
Vitis rotundifolia	muscadine grass	2.4	5.7	1.4	-	-	4.2	2.8	4.2	2.6
Vittaria lineata	shoestring fern	3.7	-	1.4	-	-	1.4	-	1.4	1.0
Xyris sp.	yellow-eyed grass	-	-	-	-	-	1.4	1.4	2.8	0.7
X. brevifolia	yellow-eyed grass	-	-	-	-	-	4.2	-	1.4	0.7
Zanthoxylum fagara	wild lime	-	0.5	-	-	-	-	-	-	0.1
TOTAL NUMBER OF SPECIES OBSERVED ANNUALLY		56	88	76	36	56	66	67	66	
CUMULATIVE NUMBER OF SPECIES OBSERVED		56	105	138	140	155	167	177	179	

[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, 1980.)

[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 Yearly Frequency Data at the Turkey Point Plant From 1975 to 1980.

Species	Frequencies (%)				
	1975-1976[a]	1977[b]	1978[b]	1979[b]	1980[b]
saw grass (Cladium)	81.9	81.9	86.1	84.7	83.3
buttonwood (Conocarpus)	80.5	70.8	77.8	73.6	70.8
red mangrove (Rhizophora)	43.7	29.2	31.9	33.3	37.5
white mangrove (Laguncularia)	27.1	41.7	33.3	29.2	29.2
aster (Aster)	0.7*	30.6	29.2	27.8	29.2
rush (Juncus)	18.0	13.9	19.4	22.2	19.4
nightshade (Solanum)	17.3	19.4	20.8	18.1	18.1
saltgrass (Distichilis)	4.9*	18.1	18.1	19.4	18.0
groundsel (Baccharis spp.)	3.5*	11.1	16.8	18.1	14.0
leather fern (Acrostichum)	24.3*	6.9	12.5	11.1	12.5
sea daisy (Borrichia)	2.8*	12.5	12.5	9.7	12.5
clubrush (Eleocharis)	2.1*	12.5	12.5	13.9	11.1
blechnum fern (Blechnum)	19.4	6.9	8.3	5.6	9.7
Australian pine (Casuarina)	13.2	8.3	12.5	9.7	9.7
glades morning glory (Ipomoea)	2.8	8.3	20.8	1.4*	9.7
poisonwood (Metopium)	3.5	8.3	8.3	8.3	9.7
myrsine (Myrsine)	4.9	5.6	8.3	6.9	8.3
cabbage palm (Sabal)	18.0*	8.3	9.7	8.3	8.3
schoenus (Schoenus)	0.0*	6.9	6.9	8.3	8.3
climbing hempvine (Mikania)	0.0*	1.4	1.4	1.4*	6.9
wax myrtle (Myrica)	7.6	6.9	6.9	5.6	6.9
Brazilian pepper (Schinus)	0.7*	6.9	5.6	6.9	6.9
ludwigia (Ludwigia)	0.0	0.0	0.0	1.4	5.6

[a]Pre-freeze years.

[b]Post-freeze years.

*Significant difference from 1980 frequencies (G-test, $P \leq 0.05$).

Vegetation Table 3. Comparisons of 1980 Operational Monitoring and Baseline Frequencies at the Turkey Point Plant During 1972, 1974 and 1980.

Species	Frequencies (%)			G-test	
	1972[a]	1974[b]	1980	1980-1974	1980-1972
saw grass (Cladium)	74.4	44.3	83.3	8.64*	0.32
buttonwood (Conocarpus)	65.1	30.5	70.8	11.80*	0.16
red mangrove (Rhizophora)	50.0	46.2	37.5	0.60	1.29
white mangrove (Laguncularia)	9.8	34.8	29.2	0.35	7.33*
rush (Juncus)	15.9	17.6	19.4	0.04	0.35
salt grass (Distichilis)	0.7	49.0	18.0	10.50*	14.40*
leather fern (Acrostichum)	15.9	10.0	12.5	0.20	0.39
Australian pine (Casuarina)	12.2	5.7	9.7	0.63	0.20
sea daisy (Borrichia)	6.1	16.2	12.5	0.46	1.60
cabbage palm (Sabal)	13.4	4.3	8.3	1.02	0.96
poisonwood (Metopium)	4.9	1.9	9.7	4.08*	0.99
Brazilian pepper (Schinus)	6.1	5.7	6.9	0.09	0.04
blechnum fern (Blechnum)	9.8	5.2	9.7	0.84	0.00

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

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

*Significant at $P \leq 0.05$.

Vegetation Table 4. Volume-Density Index of Grassland Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Cladium jamaicensis	1	0	332	6109	0	138656	3112	10407	3156
	3	4221	2533	2907	3733	4497	2206	5485	2470
	5	2006	2785	2007	1569	1311	2434	4599	2280
Conocarpus erecta	1	0	104	371	4	19	2533	301	438
	3	0	0	437	1007	0	217	0	0
	5	92	0	857	6372	183	2	443	0
Juncus roemerianus	1	110	312	26	172	110	16	0	6
	3	0	0	0	0	26	91	0	0
	5	0	0	0	0	0	0	0	0
Aster sp.	1	0	0	0	0	0	0	0	0
	3	0	0	12	*	0	*	0	0
	5	0	0	2	2	3	*	1	2
Distichilis spicata	1	1	0	0	155	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	670	3333	219	972	70	0	0	4
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	42	111
Typha sp.	1	0	0	0	0	901	621	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0

* = Present.

Vegetation Table 4 (cont'd). Volume-Density Index of Grassland Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Ipomoea sagittata	1	0	0	0	0	0	0	0	0
	3	0	0	*	0	0	0	0	0
	5	0	0	0	0	0	0	0	0
Rhizophora mangle	1	0	0	0	12	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0
Baccharis spp.	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	P	0	0	*	0
Acrostichum aureum	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	2785	0	0	0	0	0	0
Eupatorium capillifolium	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	P	0	0	0

* = Present.

Vegetation Table 5. Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Cladium jamaicensis	2	3587	6665	6368	19697	16381	7088	7272	21324
	4	4368	1120	6178	16169	3994	3273	29594	4049
	6	31054	7554	7917	2052	633	113	3577	14334
Conocarpus erecta	2	8971	68483	65	5288	11653	878	2568	4144
	4	2602	1432	6605	2083	400	4550	3680	79
	6	0	281	25794	48	0	2203	1840	46
Rhizophora mangle	2	609	2481	43	8302	47	1126	243	1250
	4	50	549	0	0	0	0	0	0
	6	0	3847	0	0	0	0	0	0
Laguncularia racemosa	2	348	618	77	6057	6647	6713	0	0
	4	0	0	0	0	20000	9113	0	0
	6	0	0	11485	0	0	0	0	0
Solanum blodgettii	2	0	0	0	0	0	17	0	0
	4	0	48	0	0	542	215	36	0
	6	10	0	104	0	204	55	20	12
Acrostichum aureum	2	0	0	0	0	0	3	0	0
	4	15	2	0	448	7	57	0	0
	6	0	3	13141	0	0	0	0	0

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
		Quadrats							
<u>Aster</u> sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	68
	6	0	0	0	0	0	0	0	0
<u>Blechnum serrulatum</u>	2	0	0	0	0	0	0	0	0
	4	3	0	0	0	1014	344	36	0
	6	1423	131	0	0	0	200	0	0
<u>Sabal palmetto</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	98000	153125	0	119788	0
	6	153125	0	132300	0	17113	0	0	0
<u>Casurina equisetifolia</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	121875	0	14266	0	4	18	0
<u>Metopium toxiferum</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	1	1	*	0	5281	12	817	17563
<u>Myrsine guianensis</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	242	257	0	0	210	56	28	40

* = Present.

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
		Quadrats							
Schinus terebinthifolius	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	*	0	0	0
	6	0	0	10585	0	2	977	0	0
Myrica cerifera	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	21076	0	0	57	0	805	1067
Baccharis spp.	2	P	0	0	0	0	0	P	0
	4	0	0	0	0	335	79	163	0
	6	0	0	0	0	0	141	0	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	0	223	0	0
Ludwigia spp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	P	7	48	0
	6	0	0	0	0	0	0	0	0
Proserpinaca palustris	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	P	7	1	0
	6	0	0	0	0	0	0	0	0

* = Present.

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats 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	1009	7699	0	0
Thelypteris sp.	2	0	0	0	0	0	0	0	0
	4	0	441	18	0	0	0	0	0
	6	0	0	0	0	0	0	0	6
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	2	0	6
Eugenia spp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	1	51	0	66
Ilex cassine	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	16	1
	6	0	3403	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	110

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

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	2000	1	0	0
Mikania scandens	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	*	*	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
Salix caroliniana	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	675	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	*	0	*

* = Present.

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats 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	125	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	*	0
Persea borbonia	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	344	0
	6	0	0	0	0	220	33199	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	393	0
Randia 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	223	7	4
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	100	0	19215

* = Present.

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Annona glabra	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	30	0	0	0
	6	0	0	0	0	0	0	0	0
Ipomoea sagittata	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	1	1
	6	0	0	0	0	0	0	0	0
Vitis rotundifolia	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	5
Habenaria sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	10	0	0	0
Lythrum alatum	2	1	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
Cassytha filiformis	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	9	0	0	0	0	0	0

Vegetation Table 5 (cont'd). Volume-Density Index of Tree Island Transects at the Turkey Point Canal System During 1980.

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Juncus roemerianus	2	0	0	0	0	0	0	134	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Vittaria lineata	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	1	0	0	0
Hypericum sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	*	0	10	0
	6	0	0	0	0	0	0	0	0
Flaveria sp.	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	4	0
Damifino sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	*	0	0	0
	6	0	0	0	0	0	0	0	0

* = Present.

Vegetation Table 6. Volume-Density Index of Mangrove Transects at the Turkey Point Canal System During 1980.

		Quadrats							
Species	Transect	A1	A2	B1	B2	C1	C2	D1	D2
Cladium jamaicensis	7	3522	1581	3985	2132	3797	2569	0	105
	8	916	2922	1309	18930	2560	926	0	0
	9	0	0	0	0	31	0	0	0
Conocarpus erecta	7	0	513	0	1866	932	348	17	973
	8	194	686	46213	2823	9393	2579	0	0
	9	0	0	0	0	786	658	0	0
Rhizophora mangle	7	0	0	0	0	0	0	0	0
	8	0	8	1550	250	0	1092	66	329
	9	61898	243	184	5777	125	14346	163	1671
Laguncularia racemosa	7	0	0	0	0	0	0	46	200
	8	0	0	4530	5582	0	827	279	3655
	9	1234	655	0	40	0	0	69	245
Solanum blodgettii	7	0	0	0	0	0	0	0	0
	8	0	6	0	31	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	450	184	126	0	297	0	0	0
	9	0	0	0	0	0	0	0	0

Vegetation Table 6 (cont'd). Volume-Density Index of Mangrove Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Acrostichum aureum	7	*	0	0	0	0	0	0	0
	8	0	0	0	351	0	0	0	0
	9	10686	0	0	0	0	0	0	0
Aster sp.	7	0	*	1	*	1	1	0	8
	8	0	0	0	0	0	0	0	0
	9	0	0	1	0	0	0	0	0
Casurina equisetifolia	7	0	0	0	0	0	0	0	0
	8	12094	100000	0	132250	0	0	0	0
	9	0	0	0	0	0	0	0	0
Distichilis spicata	7	0	0	0	0	0	0	80	348
	8	0	0	0	0	0	0	177	81
	9	0	16	9	4	12	12	76	44
Borrichia frutescens	7	0	0	0	0	0	0	P	13
	8	0	0	0	0	0	0	1	*
	9	40	0	6	0	4	1	3	0
Schoenus nigricans	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	69	0	0
	9	0	85	101	15	403	82	0	19

* = Present.

Vegetation Table 6 (cont'd). Volume-Density Index of Mangrove Transects at the Turkey Point Canal System During 1980.

Species	Transect	Quadrats A1	A2	B1	B2	C1	C2	D1	D2
Avicennia germinans	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	77	26
	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	30	0
	9	0	0	0	0	0	0	0	0
Ipomoea sagittata	7	0	0	0	0	0	0	0	0
	8	0	0	0	1	0	0	0	0
	9	0	0	0	0	0	0	0	0

3. Annual Aerial Photographs (ETS 4.2.2.1)

The 1980 Turkey Point study aerial photograph taken in February 1981) shows healthy and vigorous vegetative growth to the east, south and west of the canal system. Since 1979, there has been no noticeable change in the cover or vigor of mangrove swamps to the east and south of the canal system or the freshwater marshes to the west.

Some changes, however, in canal embankment vegetation were noted. Infrared reflectance along the east and west banks of the grand canal was lower in the 1980 study than in the previous year. Reflectance was also lower along several canal banks in the middle of the northern half of the system. Lower reflectance indicates decreased productivity of the exotic Australian pines and herbaceous ground cover species that stabilize the spoil berms. This decrease probably resulted from vegetation control spraying along the canal banks in 1980.

Besides these differences within the canal system, no major changes were noted in vegetative growth and/or cover in the area adjacent to the canal system.

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

A. Sample collection methods for sediment and interstitial water (ETS 4.1.1.1.3) were refined during 1980. During the first part of 1980 samples were collected in 1-liter screw cap polypropylene bottles and after July, the samples were collected in cylindrical polypropylene cores.

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

A. AMERICAN CROCODILE STUDIES-SITE MANAGEMENT PROGRAM

Site Management Program for the endangered American Crocodile, *Crocodylus acutus*, at the Turkey Point Power Plant Site draft report, January 1981

B. AMERICAN CROCODILE STUDIES-POPULATION STUDIES

The population of the American Crocodile, *Crocodylus acutus* (Reptilia, Crocodilidae) at the Turkey Point Power Plant Site - Annual Report, January 1981

C. HEAVY METALS BIOACCUMULATION STUDIES

Heavy metals bioaccumulation in Turkey Point Cooling Canal System; semi-annual analyses performed for cadmium, chromium, copper, manganese, mercury, nickel, vanadium, and zinc from a vertebrate organism and an invertebrate organism

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

No violations of the ETS occurred during 1979 at the Turkey Point Plant relative to cooling canal system operation.

VII. UNUSUAL EVENTS; CHANGES TO ETS, PERMITS OR CERTIFICATES (ETS 5.0)

A. A National Pollutant Discharge Elimination System (NPDES) Permit Application was filed on April 3, 1980 and amended November 15, 1980.

B. A Resource Conservation and Recovery Act (RCRA) Application was filed on November 19, 1980.