FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT
ANNUAL NON-RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT 1982

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I. INTRODUCTION

This report is submitted in accordance with Section 5.4.1 of Appendix B to Operating License DPR-31 and DPR-41. It constitutes the Annual Non-Radiological Environmental Monitoring Report Number 16 for the period of January 1, 1982 through December 31, 1982.

II. ABIOTIC MONITORING

A. Thermal (ETS 3.1.1)

Introduction

This monitoring provides Turkey Point Power Plant intake and discharge cooling water temperature data.

Materials and Methods

Data were collected continuously at both stations by an array of three resistance type temperature sensors and a Leeds and Northrup Speedomax 250 Chart Recorder. On July 24, 1982 the Leeds and Northrup equipment was replaced with two Hydrolab 2000 series submersible thermographs, recording four times every hour, at each station. The intake 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 were summarized hourly.

Results and Discussion

The summaries of the Units 3 and 4 intake and discharge mean cooling water temperatures for 1982 are presented in Tables 1 - 12. The monthly maximum intake and discharge temperatures from 1977-1982 are presented in Table 13. A comparison of modal temperatures for intake and discharge appears in Figure 2 and demonstrates the most frequent cooling water temperature difference (Δt) across the plant condensers.

Conclusion

Examination of the temperature data obtained during 1982 reveals nothing unusual nor do the results differ notably from previous years.

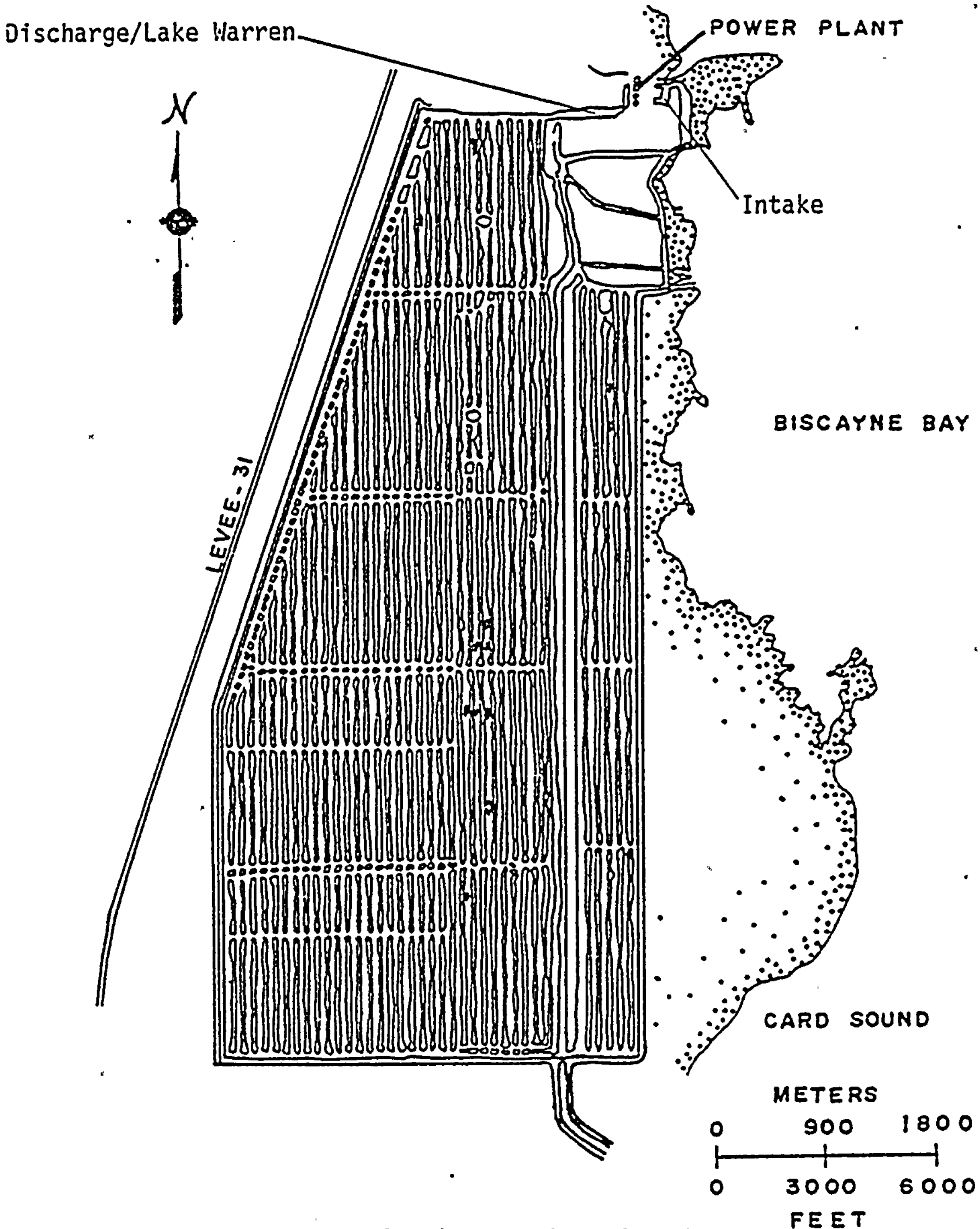


Figure 1. Temperature monitoring stations for the Turkey Point Cooling Canal System, 1982.

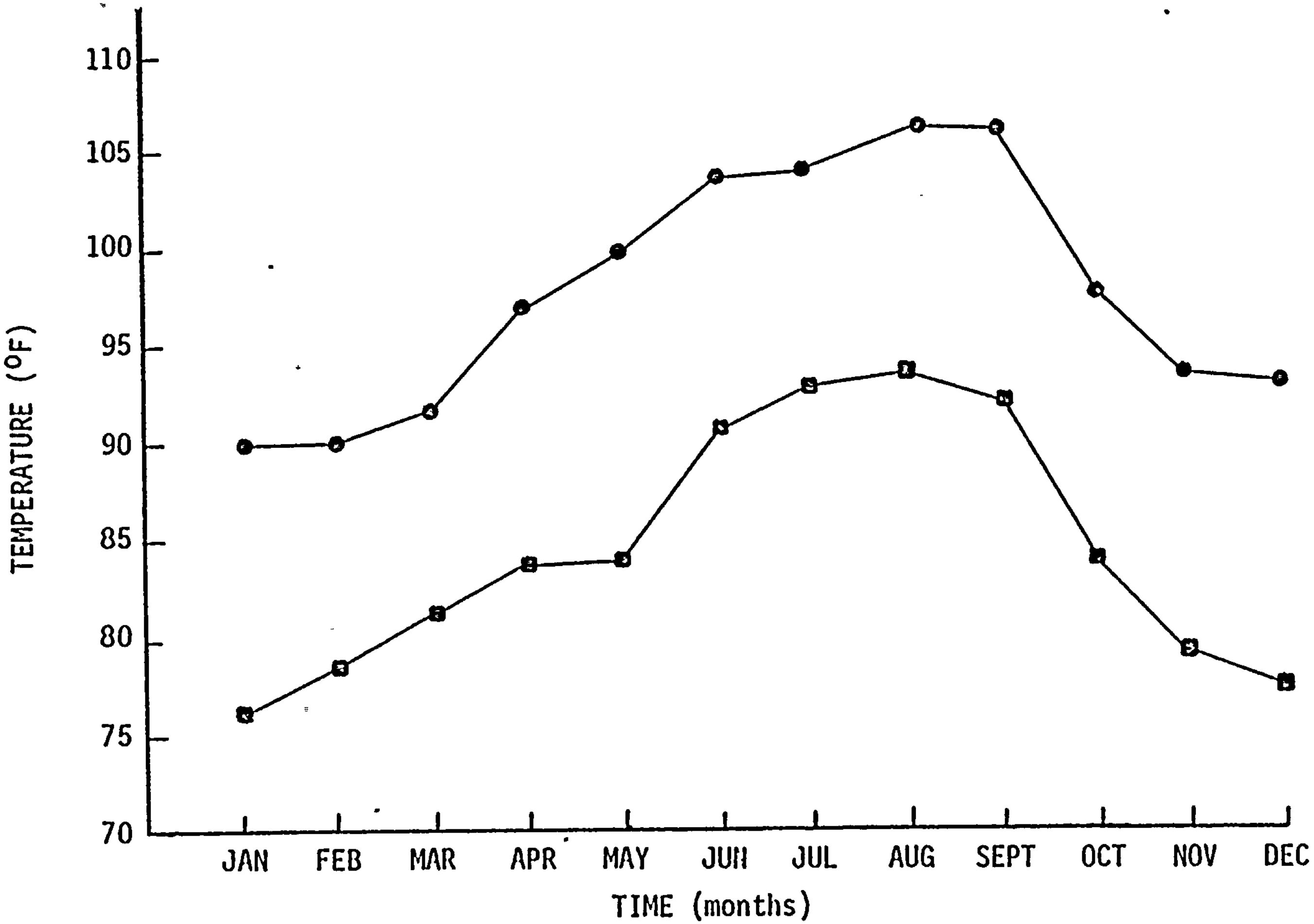


Figure 2. Modal temperatures for intake (■) and discharge (●) monitoring stations by month, Turkey Point Power Plant, 1982.

Table 1. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, January 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (°F)	Time Accumulated (%)	Number of Hours	Temperature (°F)	Time Accumulated (%)
0	82	0.0	0	98	0.0
14	81	1.9	11	97	1.5
50	80	8.6	21	96	4.3
47	79	14.9	56	95	11.8
95	78	27.7	62	94	20.2
103	77	41.6	50	93	26.9
60	76	49.7	47	92	33.2
27	75	53.3	46	91	39.4
35	74	58.0	72	90	49.1
13	73	59.8	36	89	54.0
45	72	65.8	45	88	60.0
46	71	72.0	29	87	63.9
29	70	75.0	31	86	68.1
38	69	81.0	27	85	71.7
35	68	85.7	36	84	76.6
22	67	88.7	39	83	81.8
27	66	92.3	25	82	85.2
9	65	93.5	21	81	88.0
17	64	95.8	27	80	91.7
17	63	98.1	37	79	96.6
5	62	98.8	15	78	98.7
8	61	99.9	2	77	98.9
1	60	100.0	2	76	99.2
			3	75	99.6
			3	74	100.0

Table 2. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, February 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (°F)	Time Accumulated (%)	Number of Hours	Temperature (°F)	Time Accumulated (%)
0	84	0.0	0	99	0.0
6	83	0.9	9	98	1.3
18	82	3.6	15	97	3.6
26	81	7.5	10	96	5.1
88	80	20.6	34	95	10.1
135	79	40.7	57	94	18.7
147	78	62.7	78	93	30.3
110	77	79.1	51	92	37.9
63	76	88.5	47	91	44.9
20	75	91.5	55	90	53.1
12	74	93.3	49	89	60.4
25	73	97.0	28	88	64.6
5	72	97.8	41	87	70.7
4	71	98.4	52	86	78.5
7	70	99.4	37	85	84.0
4	69	100.0	28	84	88.2
			18	83	90.9
			27	82	94.9
			21	81	98.1
			6	80	99.0
			7	79	100.0

Table 3. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, March 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	87	0.0	0	103	0.0
18	86	2.4	14	102	1.9
23	85	5.5	7	101	2.8
77	84	15.9	68	100	12.0
96	83	28.8	59	99	19.9
120	82	44.9	60	98	28.0
71	81	54.4	63	97	36.4
47	80	60.8	79	96	47.0
15	79	62.8	50	95	53.8
44	78	68.7	33	94	58.2
55	77	76.1	43	93	64.0
35	76	80.8	43	92	69.8
39	75	86.0	42	91	75.4
40	74	91.4	35	90	80.1
31	73	95.6	51	89	87.0
25	72	98.9	35	88	91.7
8	71	100.0	31	87	95.8
			17	86	98.1
			7	85	99.1
			4	84	99.6
			0	83	99.6
			1	82	99.7
			1	81	99.9
			1	80	100.0

Table 4. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, April 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	91	0.0	0	109	0.0
24	90	3.3	5	108	0.7
38	89	8.6	16	107	3.0
38	88	13.9	26	106	6.6
54	87	21.4	28	105	10.6
51	86	28.5	29	104	14.7
70	85	38.2	28	103	18.6
69	84	47.8	32	102	23.2
51	83	54.9	58	101	31.4
46	82	61.3	23	100	34.6
66	81	70.5	27	99	38.4
75	80	80.9	18	98	41.0
85	79	92.8	39	97	46.5
29	78	96.8	91	96	59.3
19	77	99.4	63	95	68.2
4	76	100.0	53	94	75.7
			52	93	83.1
			45	92	89.4
			28	91	93.4
			19	90	96.0
			14	89	98.0
			6	88	98.9
			2	87	99.2
			5	86	99.9
			1	85	100.0

Table 5. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, May 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	91	0.0	0	109	0.0
12	90	1.6	1	108	0.1
55	89	9.0	2	107	0.4
77	88	19.3	29	106	4.3
44	87	25.2	38	105	9.4
61	86	33.4	21	104	12.2
35	85	38.1	44	103	18.1
68	84	47.2	63	102	26.6
99	83	60.5	46	101	32.8
58	82	68.3	76	100	43.0
92	81	80.7	80	99	53.8
76	80	90.9	84	98	65.2
44	79	96.8	84	97	76.6
16	78	99.0	73	96	86.4
7	77	100.0	34	95	91.0
			37	94	96.0
			13	93	98.0
			11	92	99.3
			1	91	99.4
			1	90	99.5
			1	89	99.6
			1	88	99.7
			2	87	100.0

Table 6. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, June 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (°F)	Time Accumulated (%)	Number of Hours	Temperature (°F)	Time Accumulated (%)
0	97	0.0	0	113	0.0
1	96	0.1	13	112	1.8
37	95	5.2	29	111	5.8
41	94	10.9	55	110	13.4
45	93	17.2	59	109	21.6
75	92	27.6	59	108	29.8
70	91	37.3	34	107	34.5
90	90	49.8	28	106	38.4
73	89	60.0	9	105	39.7
68	88	69.5	17	104	42.3
39	87	74.9	43	103	48.3
39	86	80.3	49	102	55.1
25	85	83.7	48	101	61.8
20	84	86.5	50	100	68.7
49	83	93.3	83	99	80.2
33	82	97.9	54	98	87.7
15	81	100.0	32	97	92.1
			35	96	97.0
			14	95	98.8
			2	94	99.1
			5	93	99.7
			2	92	100.0

Table 7. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, July 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (°F)	Time Accumulated (%)	Number of Hours	Temperature (°F)	Time Accumulated (%)
0	97	0.0	0	112	0.0
5	96	0.7	5	111	0.7
38	95	5.9	61	110	9.5
75	94	16.1	49	109	16.5
134	93	34.3	22	108	19.7
204	92	61.8	16	107	22.0
136	91	80.3	38	106	27.5
124	90	97.2	24	105	30.9
21	89	100.0	86	104	43.2
			65	103	52.5
			88	102	65.1
			56	101	73.1
			67	100	82.8
			18	99	85.4
			16	98	87.7
			30	97	92.0
			17	96	94.4
			13	95	96.3
			14	94	98.3
			12	93	100.0

Table 8. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, August 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	97	0.0	0	113	0.0
26	96	3.5	14	112	1.9
99	95	16.8	39	111	7.1
69	94	26.1	56	110	14.6
95	93	38.9	84	109	25.9
59	92	46.8	62	108	34.2
102	91	60.5	74	107	44.1
122	90	76.9	56	106	51.6
98	89	90.1	64	105	60.2
42	88	95.7	82	104	71.2
7	87	96.6	62	103	79.5
15	86	98.6	45	102	85.5
10	85	100.0	24	101	88.7
			27	100	92.3
			18	99	94.7
			12	98	96.3
			18	97	98.7
			4	96	99.4
			3	95	100.0

Table 9. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, September 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	95	0.0	0	111	0.0
18	94	2.5	5	110	0.7
81	93	13.8	29	109	4.7
119	92	30.3	56	108	12.5
144	91	50.3	106	107	27.2
110	90	65.6	94	106	40.3
72	89	75.6	62	105	48.9
73	88	85.7	91	104	61.5
39	87	91.1	66	103	70.7
26	86	94.7	91	102	83.3
15	85	96.8	47	101	89.8
18	84	99.3	30	100	94.0
5	83	100.0	26	99	97.6
			12	98	99.3
			4	97	99.9
			1	96	100.0

Table 10. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, October 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	92	0.0	0	107	0.0
33	91	4.4	2	106	0.3
74	90	14.3	28	105	4.1
108	89	28.8	42	104	9.9
20	88	31.5	16	103	12.1
8	87	32.6	43	102	18.0
47	86	38.9	44	101	24.0
40	85	44.3	25	100	27.4
31	84	48.5	54	99	34.8
40	83	53.9	43	98	40.7
44	82	59.8	27	97	44.4
58	81	67.6	29	96	48.4
61	80	75.8	31	95	52.7
50	79	82.5	54	94	60.1
45	78	88.5	51	93	67.1
13	77	90.2	46	92	73.4
13	76	91.9	31	91	77.7
35	75	96.6	36	90	82.6
23	74	99.7	35	89	87.4

Table 10. (Cont'd) Time durations and temperatures for Turkey Point Power Plant condenser cooling water, October 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN OUTLET DISCHARGE		
Number of Hours	Temperature (°F)	Time Accumulated (%)	Number of Hours	Temperature (°F)	Time Accumulated (%)
1	73	100.0	16	88	89.6
			5	87	90.3
			13	86	92.1
			9	85	93.3
			1	84	93.4
			14	83	95.3
			9	82	96.5
			10	81	97.9
			14	80	100.0

Table 11. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, November 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (°F)	Time Accumulated (%)	Number of Hours	Temperature (°F)	Time Accumulated (%)
0	87	0.0	0	101	0.0
12	86	1.7	6	100	0.9
26	85	5.3	31	99	5.3
30	84	9.5	22	98	8.4
22	83	12.6	36	97	13.5
52	82	19.8	49	96	20.5
67	81	29.1	71	95	30.6
78	80	39.9	59	94	39.0
69	79	49.5	52	93	46.4
50	78	56.4	30	92	50.7
163	77	79.0	36	91	55.8
74	76	89.3	43	90	61.9
23	75	92.5	17	89	64.3
12	74	94.2	23	88	67.6
24	73	97.5	21	87	70.6
16	72	100.0	19	86	73.3
			39	85	78.8
			53	84	86.3
			31	83	90.7
			18	82	93.3
			12	81	95.0
			15	80	97.1
			14	79	99.1
			7	78	100.0

Table 12. Time durations and temperatures for Turkey Point Power Plant condenser cooling water, December 1982.

UNITS 3 & 4 INTAKE			LAKE WARREN DISCHARGE		
Number of Hours	Temperature (^{o}F)	Time Accumulated (%)	Number of Hours	Temperature (^{o}F)	Time Accumulated (%)
0	82	0.0	0	98	0.0
10	81	1.3	16	97	2.2
48	80	7.8	31	96	6.4
194	79	33.9	108	95	20.9
62	78	42.2	57	94	28.6
52	77	49.2	43	93	34.4
43	76	55.0	44	92	40.3
56	75	62.5	49	91	46.9
42	74	68.1	69	90	56.2
32	73	72.4	29	89	60.1
35	72	77.1	41	88	65.6
48	71	83.6	27	87	69.2
58	70	91.4	40	86	74.6
20	69	94.1	53	85	81.7
26	68	97.6	32	84	86.0
5	67	98.3	38	83	91.1
5	66	99.0	39	82	96.3
8	65	100.0	10	81	97.6
			4	80	98.1
			11	79	99.6
			3	78	100.0

Table 13. Intake and Discharge condenser cooling water temperatures for Turkey Point Power Plant from 1977 through 1982.

MONTH	MAXIMUM INTAKE TEMPERATURE (°F) 1977	1978	1979	1980	1981	1982	MAXIMUM DISCHARGE TEMPERATURE (°F) 1977	1978	1979	1980	1981	1982
January	75	78	78	80	79	81	90	91	90	95	94	97
February	82	77	82	84	81	83	99	90	93	100	96	98
March	85	86	81	88	81	86	103	101	94	103	96	102
April	84	87	87	89	87	90	100	101	102	105	101	108
May	91	92	89	89	89	90	105	108	103	105	104	108
June	94	95	92	94	92	96	109	111	108	110	109	112
July	93	96	96	96	94	96	110	111	112	111	109	111
August	94	94	95	95	93	96	111	108	112	110	110	112
September	95	92	91	93	91	94	110	106	107	108	108	110
October	92	91	91	92	89	94	108	104	108	108	106	110
November	84	87	88	87	81	86	100	100	103	101	91	100
December	84	86	83	78	83	81	97	99	95	93	99	97

B. Chemical Concentrations (ETS 3.1.2)

Introduction

This monitoring provides data for the determination of Turkey Point Canal water quality characteristics and their relative changes as a result of power plant operation.

Materials and Methods

Monthly water samples were taken at the discharge side of the plant in Lake Warren (Figure 1) and analyzed for copper, zinc and chemical oxygen demand (C.O.D.). Copper and zinc were analyzed using a Perkin-Elmer Model 306 Atomic Absorption Spectrophotometer through March. After March a Perkin-Elmer Model 5000 Atomic Absorption Spectrophotometer was used. The C.O.D. was analyzed using the Hach Microdigestion Procedure.

Weekly water samples were taken at the same location and analyzed for pH, dissolved oxygen (D.O.) and salinity. Instrumentation utilized included an Orion Model 401 Ion Analyzer, a Yellow Springs Instrument Polarographic Probe/Oxygen Meter and an American Optical T/C Refractometer respectively.

Results

The results of the 1982 chemical monitoring program for copper, zinc, C.O.D., pH, D.O. and salinity are given in Table 1.

The quantities of bulk chemicals used in the operation of Units 3 and 4 are reported in Tables 2 and 3.

Discussion

The values for copper have remained below the 0.02 mg/l detection limit since June 1976. The values for zinc have remained below detection limits since September 1980 with the exception of one questionable value in September 1982 (Figure 2). Comparisons demonstrate that no unusual high levels of copper or zinc were observed during 1982. The C.O.D. data for 1979 through 1982 are presented in Figure 3. Values reported for 1982 were elevated compared to 1981. These elevated results are due to a change in analytical methodology and do not necessarily reflect an actual change in C.O.D. values.

The 1982 pH values ranged from 8.0 - 8.2 with an average value of 8.1. The average pH value for 1982 was the same as that for 1981. The cooling system pH appears to be stabilizing. Dissolved oxygen continued to fluctuate inversely with power plant loading (i.e. electrical generation per unit time). The yearly average salinity decreased from 38.6 o/oo in 1981 to 37.5 o/oo in 1982. This was due primarily to the heavy rainfall during 1982. This rainfall not only lowered the year's average salinity but prevented the system's complete recovery from the unusually low salinity caused by heavy rainfall in August and September of 1981.

The chemical quantities listed in Tables 2 and 3 are based on power plant bulk chemical usage. Most of the chemicals were used for water treatment processes necessary to produce high quality water for steam production. Only estimates of chemical quantities discharged to the canal system can be made since treatment processes of sedimentation, neutralization and precipitation are carried out before the water is discharged.

Conclusions

Copper levels continue to be below detectable limits. All zinc levels with the exception of September 1982, are below detectable limits. Elevated C.O.D. values for 1982 are the result of a change in analytical procedure as opposed to an actual increase in C.O.D. values over the historical range.

Although in lesser quantities than from Units 3 and 4, two adjacent fossil fueled electric generating units also discharged similar water treatment related chemicals to the canal system. Any chemicals from the plant ultimately reaching the cooling water during plant operations have had no measurable effect on cooling system water quality.

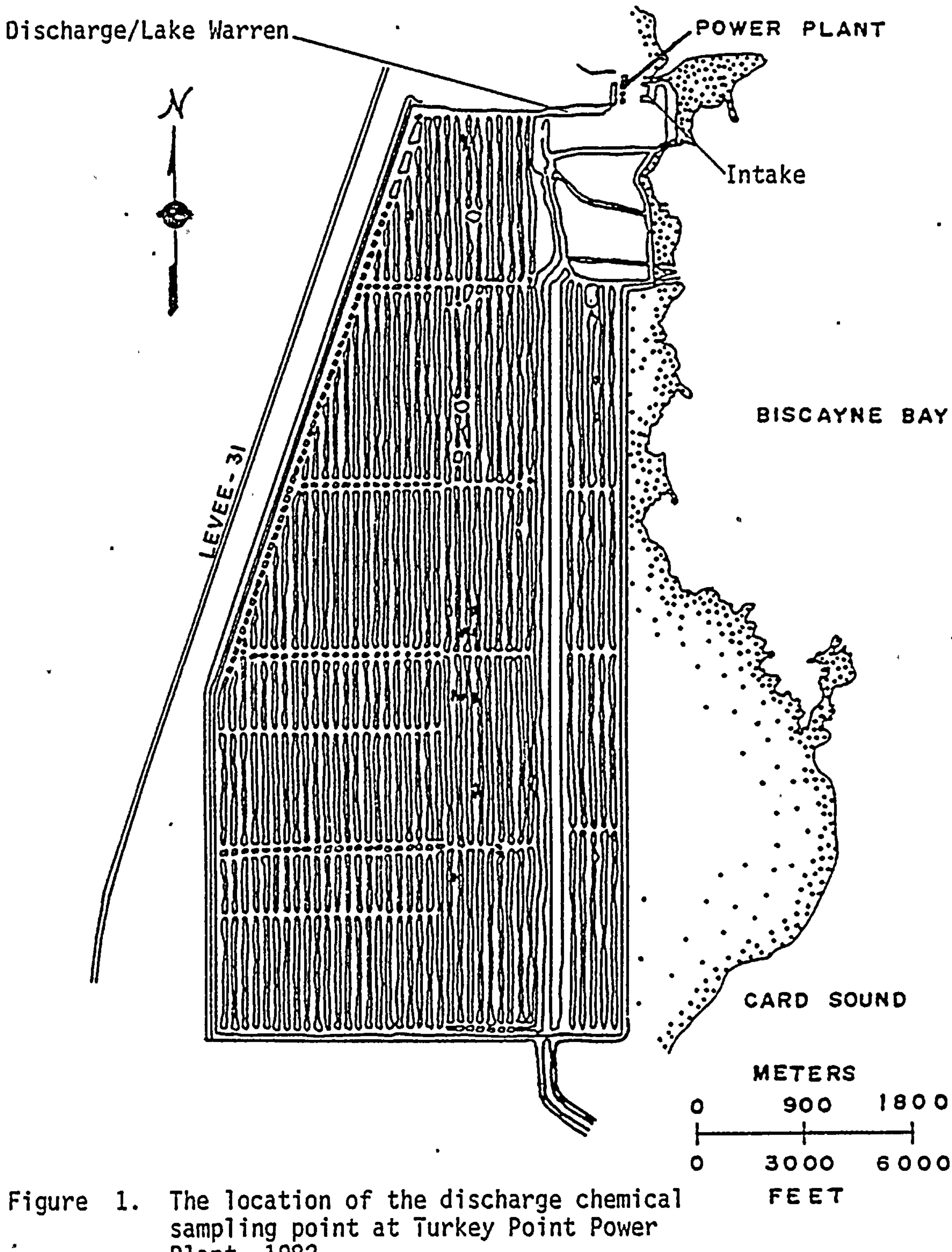


Figure 1. The location of the discharge chemical sampling point at Turkey Point Power Plant, 1982.

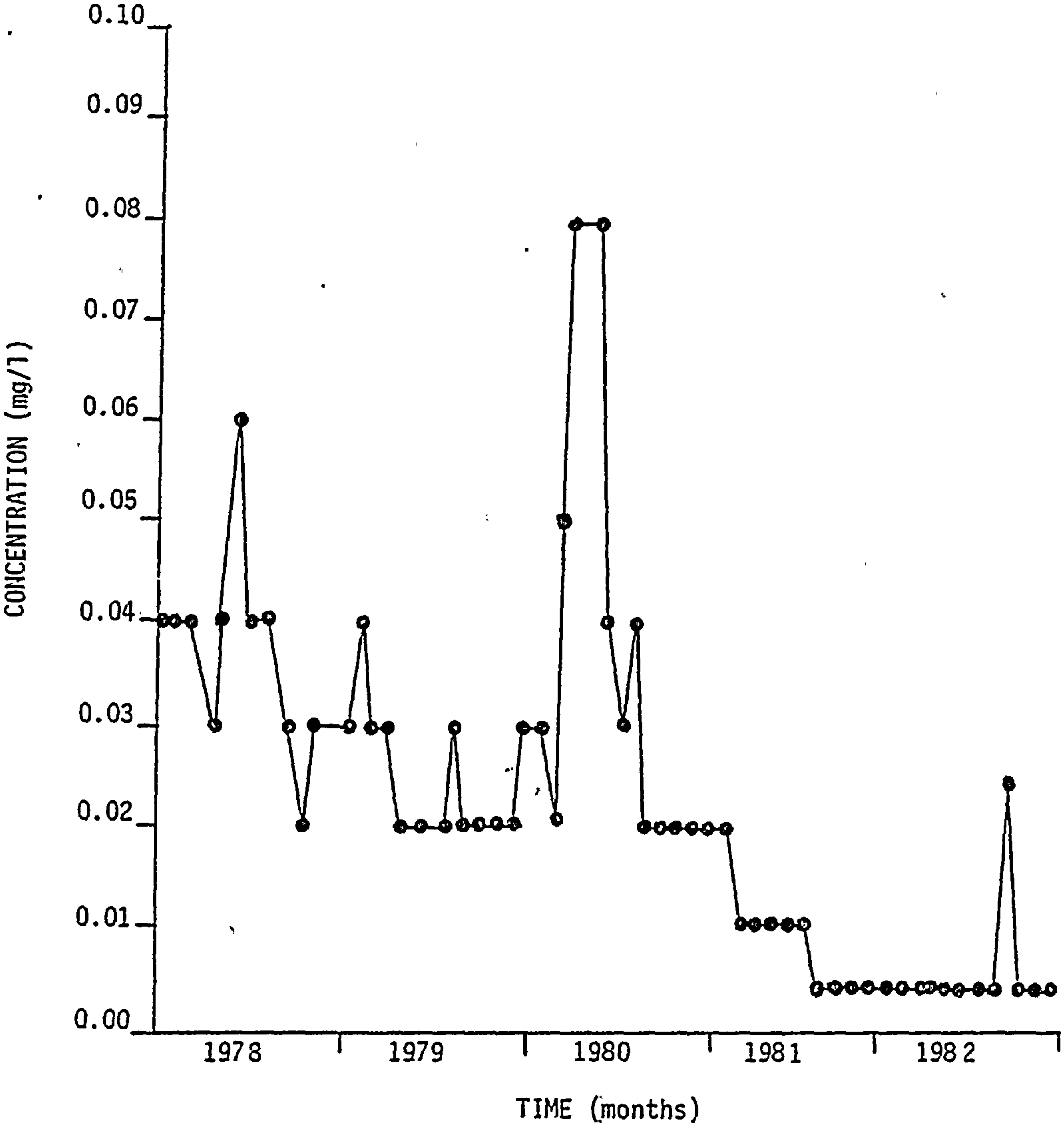


Figure 2. Monthly zinc values at the outlet of Lake Warren, Turkey Point Power Plant, 1978-1982

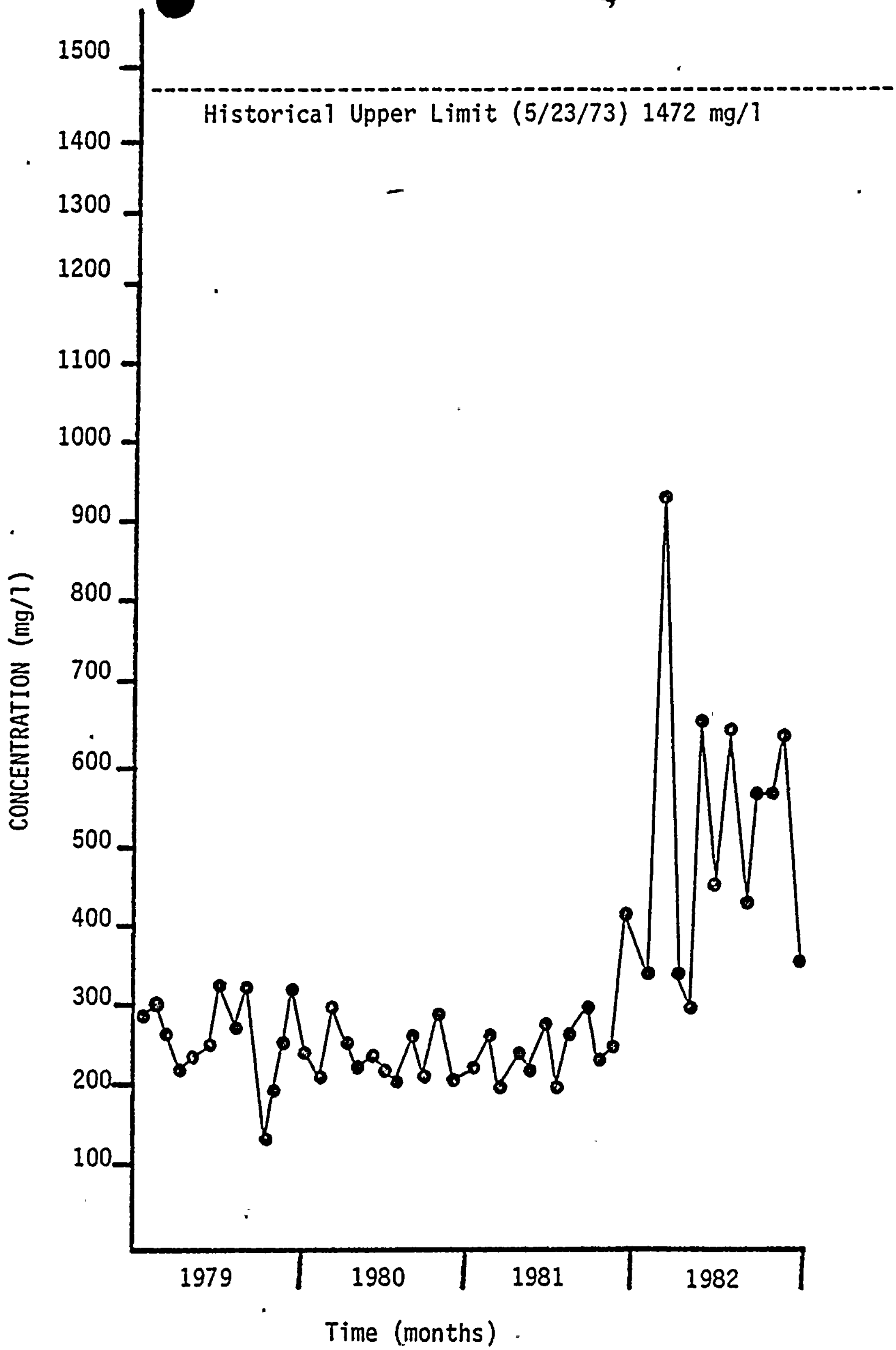


Figure 3. Monthly C.O.D. values at the outlet of Lake Warren, Turkey Point Power Plant 1979-1982.

Table 1. Values of selected chemical parameters monitored at the outlet of Lake Warren, Turkey Point Power Plant, 1982

MONTHLY				WEEKLY			
Date	C.O.D. (mg/l)	Cu (mg/l)	Zn (mg/l)	Date	pH (std. units)	D.O. (mg/l)	Salinity (o/oo)
Jan.	347	<0.02	<0.005	01/07	8.1	4.8	34.0
				01/14	8.1	5.4	35.0
				01/21	8.2	6.0	33.0
				01/28	8.1	5.4	35.0
Feb.	931	<0.02	<0.005	02/04	8.1	4.8	36.0
				02/11	8.1	4.4	35.0
				02/18	8.1	4.3	36.0
				02/25	8.1	4.7	36.0
Mar.	335	<0.02	<0.005	03/04	8.1	4.8	37.0
				03/11	8.1	5.4	38.0
				03/18	8.1	4.7	40.0
				03/25	8.0	2.9	40.0
Apr.	299	<0.02	<0.005	04/01	8.1	4.5	38.0
				04/08	8.1	4.6	38.0
				04/15	8.1	4.0	38.0
				04/22	8.1	3.8	40.0
				04/29	8.1	4.5	34.0
May	665	<0.02	<0.005	05/06	8.1	5.0	36.0
				05/13	8.2	4.4	38.0
				05/20	8.2	4.2	40.0
				05/27	8.0	4.1	40.0
Jun.	455	<0.02	<0.005	06/03	8.0	4.5	32.0
				06/10	8.1	4.3	34.0
				06/21	8.0	4.9	35.0
				06/25	8.1	3.7	36.0
Jul.	642	<0.02	<0.005	07/01	8.1	3.2	38.0
				07/08	8.1	4.5	39.0
				07/15	8.1	3.8	39.0
				07/22	8.1	3.8	40.0
				07/29	8.1	3.8	40.0
Aug.	438	<0.02	<0.005	08/05	8.1	3.9	42.0
				08/12	8.1	4.2	40.0
				08/19	8.1	4.1	38.0
				08/26	8.1	3.8	38.0
Sep.	584	<0.02	0.025	09/03	8.0	4.4	40.0
				09/09	8.0	4.2	41.0

Table 1. (Cont'd) Values of selected chemical parameters monitored at the outlet of Lake Warren, Turkey Point Power Plant, 1982.

	MONTHLY				WEEKLY		
Date	C.O.D. (mg/l)	Cu (mg/l)	Zn (mg/l)	Date	pH (std. units)	D.O. (mg/l)	Salinity (o/oo)
				09/16	8.1	3.8	42.0
				09/23	8.0	3.7	42.0
				09/30	8.0	3.6	40.0
Oct.	584	<0.02	<0.005	10/07	8.0	4.3	36.0
				10/14	8.1	4.0	38.0
				10/21	8.1	4.2	38.0
				10/28	8.0	5.2	38.0
Nov.	642	<0.02	<0.005	11/04	8.0	4.2	40.0
				11/11	8.1	4.4	35.0
				11/18	8.0	4.8	34.0
				11/24	8.2	4.9	36.0
Dec.	362	<0.02	<0.005	12/02	8.0	5.0	36.0
				12/09	8.0	4.8	36.0
				12/16	8.0	5.4	38.0
				12/23	8.0	5.8	38.0
				12/30	8.1	4.2	38.0

Table 2. Chemical usage during operations of the Turkey Point Power Plant Units 3 & 4 for January through June, 1982.

CHEMCIALS[a]	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Amerfloc 275[b]	17	14	19	12	0	77
Ammonium Hydroxide (58%)	14	113	136	0	0	0
Bentonite Clay	963	583	1015	1361	1801	1305
Boric Acid	1094	5787	4645	8340	2678	8732
Coagulant Aid	0	0	0	0	0	0
Chlorine	0	0	0	0	0	0
Concentrated Sodium Hydroxide (50%)	39 888	21 705	41 023	84 777	71 494	78 599
Concentrated Sulfuric Acid (93%)	61 898	43 235	66 369	88 645	115 192	82 536
Drewfloc 2270[b]	0	0	0	0	87	0
Hydrated Lime	15 272	948	15 558	20 825	26 942	19 539
Hydrazine (35%)	99	750	250	0	0	0
Potassium Chromate	50	50	50	0	50	0
Potassium Dichromate	28	30	5	24	10	0
Sodium Hexametaphosphate	0	25	0	5	5	9

[a] All values in pounds.
[b] Trade name for a coagulant aid.

Table 3. Chemical usage during operations of the Turkey Point Power Plant Units 3 & 4 for July through December, 1982.

CHEMICALS[a]	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Amerfloc 275[b]	65	58	0	0	0	0
Ammonium Hydroxide (58%)	18	0	0	0	18	0
Bentonite Clay	1259	1562	1368	1168	1100	1058
Boric Acid	9591	12 209	7354	7927	10 155	6947
Coagulant Aid	0	0	56	63	55	54
Chlorine	0	0	0	0	0	0
Concentrated Sodium Hydroxide (50%)	67 998	81 792	64 119	68 011	41 189	64 106
Concentrated Sulfuric Acid (93%)	87 083	100 801	89 564	94 983	61 454	57 152
Drewfloc 2270[b]	0	0	0	0	0	0
Hydrated Lime	18 050	25 213	10 852	19 121	16 429	17 298
Hydrazine (35%)	66	0	0	66	99	0
Potassium Chromate	25	50	0	0	0	0
Potassium Dichromate	25	9	29	9	40	16
Sodium Hexametaphosphate	11	11	10	6	17	16

[a]All values in pounds.
[b]Trade name for a coagulant aid.

III. BIOTIC MONITORING

A. AQUATIC ENVIRONMENT

1. Plankton (ETS 4.1.1.1.1)

a. Zooplankton

(1) physical data

Introduction

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

Materials and Methods

Physical data were collected quarterly during plankton sampling at various stations in the Turkey Point Cooling Canal System and southern Biscayne Bay/Card Sound hereafter referred to as the canal system and the bay respectively (Figures 1 and 2).

Water temperature was measured using a Yellow Springs Instruments (Y.S.I.) Telethermometer with an accuracy of $\pm$ 0.15°C and a readability of 0.2°C. Salinities were determined using an American Optical T/C Refractometer with an accuracy of 0.10 o/oo and 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 a readability of 0.1 mg/l. All instruments were

calibrated before sampling and all measurements were made in the top meter of the water column.

Results

Results of the physical data for 1982 can be found in Table 1 (canal system) and Table 2 (bay) at the end of the Zooplankton Organism Section.

The water temperatures during plankton monitoring in the canal system for 1982 ranged from 37.8 to 24.0°C with a mean of 28.3°C. The maximum reading was recorded at Station F.1 nearest the power plant discharge. Temperatures during plankton monitoring in the bay for 1982 ranged from 30.5 to 21.0°C with a mean of 24.8°C. The mean temperature for the canal system was 3.5°C higher than the bay temperature.

The salinity during plankton monitoring in the canal system for 1982 ranged from 41.0 to 36.0 o/oo with a mean of 37.8 o/oo. There was an average decrease of 2.1 o/oo in salinity in the canal system from 1981 to 1982. The salinity during plankton monitoring in the bay for 1982 ranged from 36.0 to 9.0 o/oo, with a mean of 31.3 o/oo. This was a 2.2 o/oo decrease from the 1981 mean bay salinity. The lowest salinity in the bay occurred at a near shore station following a week of heavy rainfall in November. The average salinity in the canal system was 6.5 o/oo higher than in the bay.

The D.O. during plankton monitoring in the canal system for 1982 ranged from 9.2 to 3.3 mg/l with a mean of 5.6 mg/l. In the bay, during plankton monitoring, D.O. ranged from 8.6 to 4.7 mg/l with a mean of 6.9 mg/l.

Discussion

Water temperatures in both the canal system and the bay were within ranges observed for previous years (Tables 1 and 2). The maximum bay temperature was typical of the deeper waters of the bay area but did not reflect the higher temperatures known to occur on the tidal flats due to solar heating.

The decrease of 2.1 o/oo in mean salinity of the canal system from 1981 to 1982 was due to the system's slow recovery from heavy rainfall atypical to a decade of near drought conditions. In addition two of the four plankton samplings occurred just after periods of heavy rainfall. Salinities in the bay were also lower than noted in previous years. This was attributed to the aforementioned precipitation and subsequent heavy discharge from the South Florida Water Management District's Flood Control Canals which drain large upland areas into the bay.

Dissolved oxygen levels in the canal system were generally lower than those in the bay (Tables 1 and 2). This was due to the higher water temperature and salinity in the canal system as compared to the

bay and reflects the principle that oxygen solubility decreases with increases in temperature and salinity. The level of dissolved oxygen in the water column is of fundamental importance to the biota. Responses of individual species or a group of species to dissolved oxygen 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 between physical data for the bay obtained during 1982 and that obtained during baseline monitoring in the bay (Bader and Roessler, 1972).

Conclusions

Temperature and dissolved oxygen levels in both canal and bay are not noticably different from previous years. The variation in the mean salinity from that previously observed is the result of heavy rainfall atypical to the past decade's near drought conditions.

The physical data do not indicate conditions restrictive to biological life in the canal system with the exception of the condenser water discharge area. The discharge area is species selective as a result of elevated and fluctuating temperatures.

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

a. Zooplankton

(2) nutrient data

Introduction

This section compares the nutrient parameters of the water in the Turkey Point Cooling Canal System with those in the adjacent lagoon (Biscayne Bay/Card Sound) to determine the ability of the cooling system to support biological life (ETS 4.1.1.1).

Materials and Methods

Samples were collected quarterly in the top meter of the water column at 12 sample locations within the Turkey Point Cooling Canal System and five control locations in southern Biscayne Bay/Card Sound hereafter referred to as the canal system and the bay respectively (Figures 1 and 2).

Acid washed, clear glass containers with ground glass stoppers were used for the ammonia samples, with 5 ml of phenol/ethanol solution added as the preservative. Acid washed, dark glass containers with ground glass stoppers were used for the other nutrient samples with 0.5 ml of 0.2N mercuric chloride added as the preservative.

All analyses were performed with either a Beckman DU-2 Spectrophotometer or a Technicon (CS-M-6) Autoanalyzer. Nitrite, nitrate and inorganic phosphate were determined by Technicon Methodology as modified by Klaus Grasshoff. Ammonia was determined

using the Phenol-Hypochlorite Method and total phosphate was measured using the Ascorbic Acid Method.

Results

Results of nutrient data for 1982 can be found in Table 1 (canal system), Table 2 (bay) and Table 5 (canal system and bay by quarter) at the end of the Zooplankton Organism Section.

Ammonia

Ammonia (NH_3) values in the canal system ranged from 0.142 to 0.021 mg/l with a mean of 0.058 mg/l. At the bay control stations the maximum value was 0.074 mg/l and the minimum value was 0.018 mg/l with an average value of 0.033 mg/l. The highest ammonia values in the canal system were found at Stations WF.2, while those in the bay occurred at Stations R-3.

Nitrite

Nitrite (NO_2) values in the canal system ranged from 0.083 to 0.003 mg/l with a mean of 0.040 mg/l. At the bay control stations values ranged from 0.037 to 0.000 mg/l with a mean of 0.020 mg/l. The average canal value was twice the average bay control value. The highest nitrite values for the canal system were found at Stations F.1 while the maximum values for the bay were found at Station 28.

Nitrate

Nitrate (NO_3) values in the canal system ranged from 2.120 to 0.014 mg/l. Values at the bay control stations ranged from 1.184 to 0.006 mg/l. The average values for the canal system and the bay were 0.732 mg/l and 0.203 mg/l, respectively. Highest values occurred at Station F.1 in the canal system and Station R-3 in the bay.

Inorganic Phosphate

Inorganic phosphate (IPO_4) values in the canal system ranged from 0.019 to 0.005 mg/l. The values for the bay control stations ranged from 0.010 to 0.005 mg/l. The mean value for the canal system was 0.010 mg/l; the mean value for the bay 0.008 mg/l. Highest values of inorganic phosphate in the canal system occurred at Station WF.2, while inorganic phosphate in the bay system occurred at Stations R-3, Y-2, X-3, 12, and 28.

Total Phosphate

Total phosphate (TPO_4) values in the canal system ranged from 0.068 to 0.012 mg/l with a mean of 0.045 mg/l. The values for the bay control stations ranged from 0.062 to 0.001 mg/l with a mean of 0.036 mg/l. The highest values occurred at Stations RC.1 and RC.0 in the canal system and station X-3 in the bay.

Discussion

The mean ammonia values for 1982 in both the canal system and the bay were similar to those values noted for 1979-1980, but were less than the values for 1981. The results for 1981 were considered atypical due to high run off into the system and bay.

Nitrite and nitrate mean values in both the canal system and the bay increased notably during 1982 compared to historical data (Table 1 and 2).

Inorganic and total phosphate values for 1982 remained similar to historical values in both the canal system and the bay.

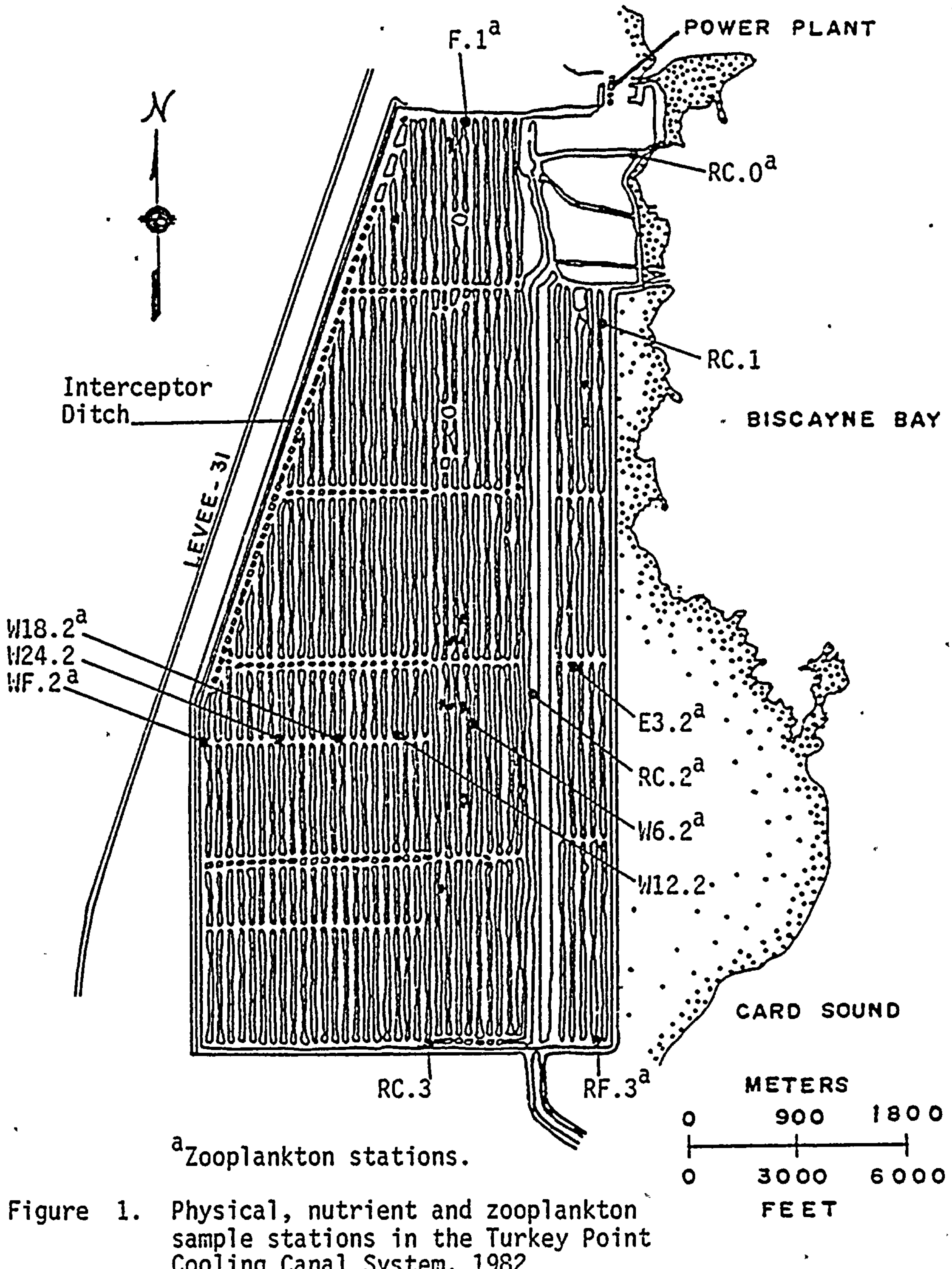
The mean nutrient values for most parameters are elevated, because the fourth quarter samples were taken after a week of heavy rain (5.5 inches), which resulted in increased area runoff (Table 5).

Nutrient values for both the bay and the canal system were similar to values obtained in Card Sound during the baseline studies (Bader, 1969; Tabb & Roessler, 1970; Bader & Roessler, 1971; Bader & Roessler, 1972; Segar, 1971).

Conclusions

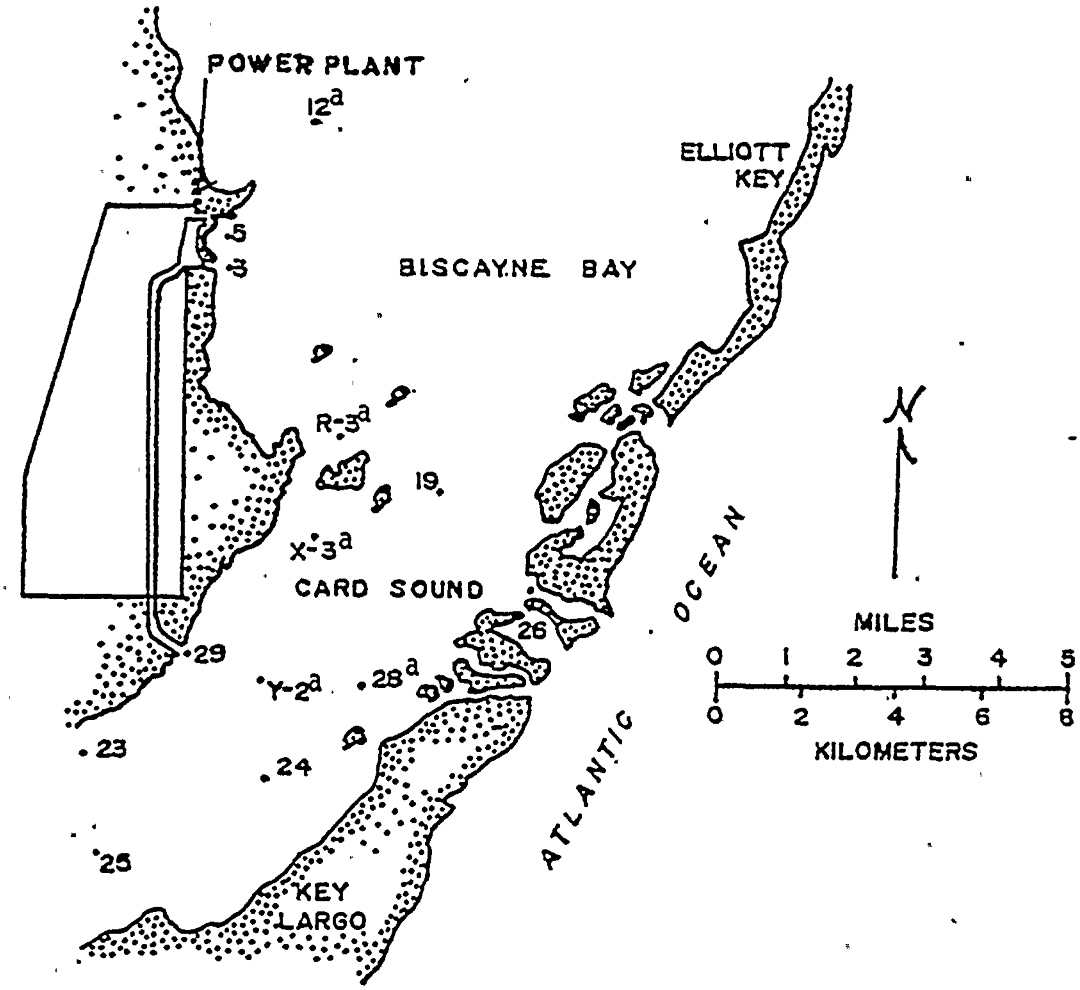
Generally, nutrient levels in the canal system are higher than levels in the bay. However, no long term trends are apparent in the

individual nutrient parameters monitored. The nutrient data does not indicate conditions restrictive to biological life in the canal system.



[a]Zooplankton stations.

Figure 1. Physical, nutrient and zooplankton sample stations in the Turkey Point Cooling Canal System, 1982



[a]Indicates nutrient sample stations.

Figure 2. Physical, nutrient and zooplankton sample stations in Biscayne Bay/Card Sound for the Turkey Point Power Plant, 1982.

A. Zooplankton

(3) organisms

Introduction

This section qualitatively and quantitatively assesses the major groups of zooplankton organisms present in the cooling canal system and the adjacent lagoon (Biscayne Bay/Card Sound) in order "to follow biological succession and determine the biological stability of the system" (ETS 4.1.1.1).

Material and Methods

Plankton samples were collected quarterly at stations in the Turkey Point Cooling Canal System and southern Biscayne Bay/Card Sound, hereafter referred to as the canal system and the bay respectively (Figures 1 and 2). A 5 inch diameter Clarke-Bumpus apparatus with a number 10 mesh (158 μm) net and bucket was used to sample 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 determined using the Lackey Drop Method (APHA, 1980) and the volume of water sampled.

Zooplankton organisms were divided into the following six categories: Copepods, Gastropods, Bivalve Larvae, Copepod Nauplii, Cirriped Nauplii, and Other Plankton.

Biological stability of the canal system was assessed by comparing the annual mean percent (1977-1982) of the combined Gastropod and Copepod fractions of the canal system to that of the bay. These two groups were used because they have historically comprised over 80% of all zooplankton collected. Means were computed separately for the canal system and bay using the following equations:

$$X_{FY} = X_{GY} + X_{CY}$$

$$X_T = \sum_{Y=1}^{Z} X_{FY}$$

$$\overline{X}_F = \frac{X_T}{Z}$$

X_{GY} = the percent of total plankton represented by Gastropods in a specific year

X_{CY} = the percent of total plankton represented by Copepods in a specific year

X_{FY} = the percent of total plankton represented by both Copepods and Gastropods (Copepod/Gastropod fraction) in a specific year

Z = number of years in data base

X_T = sum of all X_{FY} in data base

X_F = the mean percent of total plankton represented by the Copepod/Gastropod fraction over all years in the data base.

Biomass was determined using a volume displacement technique (UNESCO, 1974; Yentsch and Hebard, 1957) and was expressed in terms of volume of water displaced. The method proved acceptable for bay

samples, however, it was not sensitive enough to measure the very low biomass known to occur in the canal system and was subject to interference due to particulate matter.

Results

Zooplankton organism densities for 1977 through 1982 can be found in Table 3 (canal system) and Table 4 (bay). The percent of the total plankton each group represents can be found in Table 5 (canal system) and Table 6 (bay).

The gastropod/copepod fraction over time was used as an index of stability. The canal system compared favorably to the bay. The mean gastropod/copepod fraction for the canal system was 88.2 with a standard deviation of 2.8 while that for the bay was 88.7 with a standard deviation 5.0.

The zooplankton biomass in the canal system for 1982 could not be measured due to interferences mentioned previously. The annual mean zooplankton biomass value of bay samples was 0.53×10^{-2} ml/l for 1982. Biomass values for the four quarters were 0.54×10^{-2} ml/l, 0.70×10^{-2} ml/l, 0.61×10^{-2} ml/l, and 0.28×10^{-2} ml/l, respectively.

Discussion

Due to the frequency of sampling, relative abundance is thought to be a better indicator for trend analysis than densities.

Based on the relative abundance of major constituents of the plankton populations i.e. copepods and gastropods (Table 5) there appears to be a decrease in gastropods in the canal system.

Since biological stability is gauged on the relative abundance of the major constituents of the total plankton, and since in these cases over 80 percent of the "total plankton" are found in only 2 groups it therefore follows that copepods show some degree of long term increase in the canal system.

An inadequate adult base population is the most likely cause for the low mean density of bivalve larvae in the canal system. The concentrations have not exceeded 3 percent of the total canal system plankton population over the past 6 years.

The 1982 bivalve densities in the bay remained relatively the same as those in 1981. This group was the second least abundant zooplankter sampled and has continued to comprise only 1.0 - 2.0 percent of the total bay zooplankton since 1977.

Copepod nauplii were found in the canal system during the first and second quarters of 1982. The occurrences of this group were sporadic and their densities low. Copepod nauplii continued to be collected in very low concentrations in the bay. Copepod nauplii densities and percentages in both the canal system and the bay have not changed notably in 6 years.

Cirriped nauplii were found only once in the canal system in 1982. This supported the data from previous years in which cirriped nauplii were observed in low and sporadic density levels. Cirriped nauplii were collected in very low concentrations in the bay as they have been in the past.

Both cirriped and copepod nauplii are too small to be adequately sampled by a #10 mesh (158 um) net, therefore the concentrations reported may not be representative of actual population densities.

The group "other plankton" includes the fish larvae, zoea and megalops of various crustaceans, cladocerans, ostracods, chaetognaths, tunicate larvae, polychaete larvae, echinopluteii, bipinnaria, and medusae.

The difference in "other plankton" densities between the bay and canal system was considerably less during 1982. The bay density was 20 times higher than the canal system density for 1981 and was 16 times

higher for 1982. This was due primarily to greater increases in the percent of "other plankton" in the canal system.

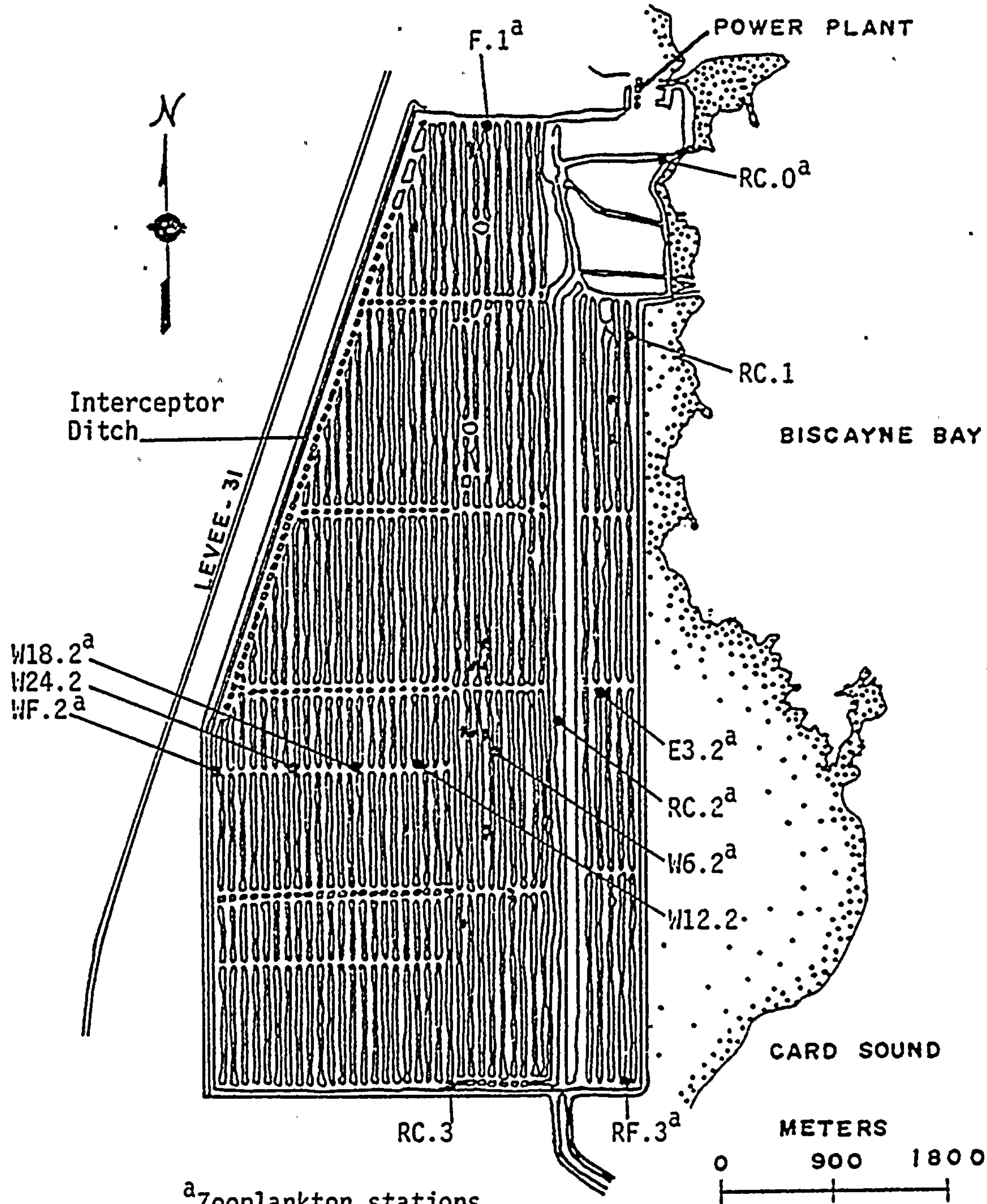
Densities of "other plankton" in the canal system started decreasing in 1976. Their densities now appear to have leveled off. This is a reflection of the absence of all the aforementioned "other plankton" with the exception of polychaete larvae.

Zooplankton concentrations in the canal system were consistently lower than those found in the bay. The total plankton density in the bay decreased 20 percent from that in 1981 but was still 40 times higher than that in the canal system. Total plankton density in the canal system decreased 18 percent from that in 1981. The difference in plankton densities between bay and canal system continued to increase.

Data for 1982 were not comparable to the pre-operational data because of the different methods of collection and quanitification that were employed i.e. different plankton net sizes, equipment types, and taxonomic categories.

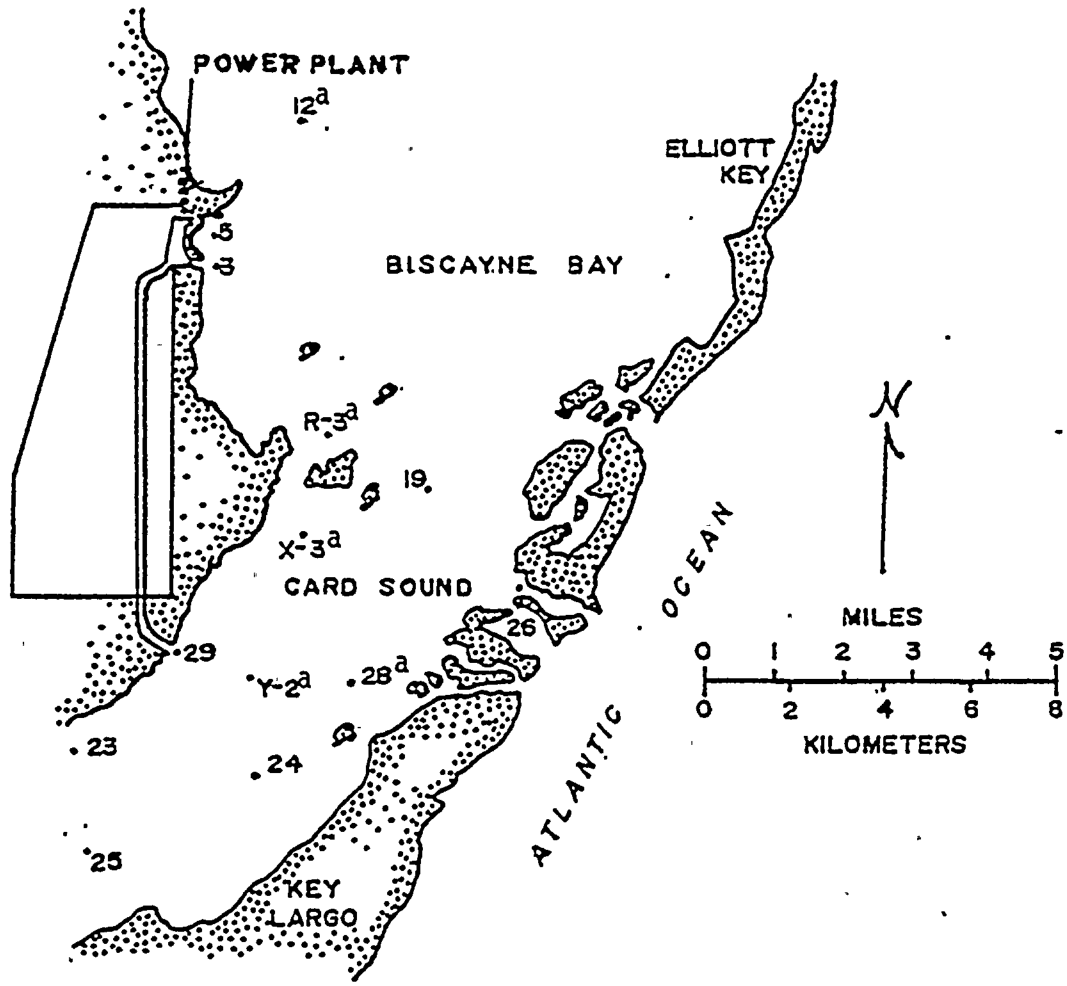
Conclusions

The canal system zooplankton populations show limited variations and have densities and diversities similar to previous reporting periods. Percent composition of the major constituents of the canal zooplankton indicate biological stability of the canal system relative to those major constituents.



[a]Zooplankton stations.

Figure 1. Physical, nutrient and zooplankton sample stations in the Turkey Point Cooling Canal System, 1982



[a]Indicates nutrient sample stations.

Figure 2. Physical, nutrient and zooplankton sample stations in Biscayne Bay/Card Sound for the Turkey Point Power Plant, 1982.

Table 1. Composite physical and nutrient data for years 1977 through 1982 showing the maximum, minimum and mean for all plankton stations in the Turkey Point Cooling Canal System.

PARAMETERS		1977	1978	1979	1980	1981	1982
	Max.	40.0	42.5	44.0	42.7	42.0	37.8
Temperature -	Mean	29.2	29.2	29.8	29.7	29.2	28.3
(°C)	Min.	19.2	18.0	24.0	21.5	24.0	24.0
	Max.	41.5	43.5	46.0	45.0	46.0	41.0
Salinity -	Mean	37.7	37.3	40.8	41.7	39.9	37.8
(o/oo)	Min.	28.5	29.5	36.5	38.0	26.0	36.0
Dissolved	Max.	7.4	6.4	7.9	8.1	8.3	9.2
Oxygen -	Mean	4.8	5.0	5.3	5.0	5.3	5.6
(mg/l)	Min.	2.6	3.3	2.2	3.0	2.2	3.3
	Max.	0.284	0.208	0.169	0.104	0.218	0.142
NH_3 -	Mean	0.093	0.049	0.068	0.047	0.089	0.058
(mg/l)	Min.	0.015	0.008	0.011	0.000	0.044	0.021
	Max.	0.055	0.041	0.029	0.023	0.041	0.083
NO_2 -	Mean	0.025	0.019	0.016	0.013	0.010	0.040
(mg/l)	Min.	0.004	0.005	0.002	0.000	0.001	0.003
	Max.	0.769	1.373	1.649	0.596	1.612	2.120
NO_3 -	Mean	0.287	0.476	0.553	0.217	0.547	0.732
(mg/l)	Min.	0.007	0.040	0.009	0.002	0.016	0.014
	Max.	0.143	0.033	0.019	0.017	0.024	0.019
IPO_4 -	Mean	0.021	0.017	0.008	0.010	0.010	0.010
(mg/l)	Min.	0.010	0.007	0.000	0.002	0.008	0.005
	Max.	0.098	0.072	0.064	0.079	0.057	0.068
TPO_4 -	Mean	0.049	0.048	0.036	0.043	0.029	0.045
(mg/l)	Min.	0.011	0.029	0.009	0.010	0.004	0.012

Note: Zeros indicate values below detection limits.

Table 2. Composite physical and nutrient data for years 1977 through 1982 showing the maximum, minimum and mean for all plankton stations in Biscayne Bay/Card Sound.

PARAMETERS		1977	1978	1979	1980	1981	1982
	Max.	32.1	31.9	32.7	32.0	32.5	30.5
Temperature -	Mean	26.2	25.7	25.7	26.2	26.2	24.8
(^{o}C)	Min.	18.7	15.5	19.9	19.5	21.0	21.0
	Max.	38.0	38.5	41.5	38.0	41.0	36.0
Salinity -	Mean	33.5	33.7	34.3	33.6	33.5	31.3
(o/oo)	Min.	28.0	24.0	21.5	25.0	19.5	9.0
Dissolved	Max.	8.3	7.8	9.2	7.5	8.1	8.6
Oxygen -	Mean	5.6	5.6	6.0	5.9	6.8	6.9
(mg/l)	Min.	3.3	3.6	4.4	4.1	5.2	4.7
	Max.	0.098	0.134	0.059	0.061	0.074	0.074
NH_3 -	Mean	0.032	0.028	0.025	0.034	0.045	0.033
(mg/l)	Min.	0.004	0.004	0.007	0.014	0.005	0.018
	Max.	0.009	0.023	0.018	0.012	0.009	0.037
NO_2 -	Mean	0.003	0.004	0.007	0.005	0.004	0.020
(mg/l)	Min.	0.000	0.000	0.002	0.000	0.000	0.000
	Max.	0.112	0.527	0.237	0.233	0.322	1.184
NO_3 -	Mean	0.034	0.085	0.103	0.057	0.098	0.203
(mg/l)	Min.	0.001	0.009	0.002	0.003	0.012	0.006
	Max.	0.019	0.011	0.025	0.024	0.028	0.010
IPO_4 -	Mean	0.007	0.007	0.008	0.007	0.009	0.008
(mg/l)	Min.	0.002	0.002	0.000	0.000	0.000	0.005
	Max.	0.151	0.021	0.066	0.091	0.050	0.062
TPO_4 -	Mean	0.017	0.012	0.027	0.032	0.025	0.036
(mg/l)	Min.	0.004	0.006	0.009	0.002	0.006	0.001

Note: Zeros indicate values below detection limits.

Table 3. Composite zooplankton data for years 1977 through 1982 showing the maximum, minimum and mean for all stations in the Turkey Point Cooling Canal system

ORGANISMS[a]		1977	1978	1979	1980	1981	1982
Copepods	Max.	0.440	0.682	0.560	0.533	0.626	0.620
	-Mean	0.096	0.148	0.136	0.095	0.187	0.151
	Min.	0.000	0.008	0.000	0.000	0.021	0.000
Gastropods	Max.	3.380	0.325	6.550	0.827	0.580	0.345
	-Mean	0.153	0.036	0.302	0.076	0.065	0.046
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Bivalves	Max.	0.040	0.010	0.022	0.026	0.103	0.054
	-Mean	0.001	0.000	0.001	0.002	0.007	0.003
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Copepod Nauplii	Max.	0.220	0.060	0.011	0.026	0.118	0.009
	-Mean	0.007	0.006	0.001	0.002	0.009	0.001
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Cirriped Nauplii	Max.	0.020	0.030	0.010	0.009	0.000	0.007
	-Mean	0.002	0.005	0.001	0.000	0.000	0.000
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Other Plankton	Max.	0.620	0.120	0.240	0.086	0.335	0.248
	-Mean	0.036	0.017	0.027	0.018	0.022	0.036
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Total Plankton	Max.	3.490	0.844	6.990	0.943	0.738	0.879
	-Mean	0.291	0.210	0.472	0.194	0.281	0.231
	Min.	0.010	0.008	0.000	0.012	0.031	0.007

[a] All values in organisms per liter.

Table 4. Composite zooplankton data for years 1977 through 1982 showing the maximum, minimum and mean for all stations in Biscayne Bay/Card Sound.

ORGANISMS[a]		1977	1978	1979	1980	1981	1982
Copepods	Max.	17.090	27.360	18.320	11.890	23.396	22.951
	-Mean	3.799	5.341	7.200	5.269	6.392	6.156
	Min.	0.050	0.026	0.060	0.288	0.263	0.615
Gastropods	Max.	10.540	7.029	17.890	3.500	74.208	50.544
	-Mean	0.576	0.849	1.569	0.682	4.551	2.362
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Bivalves	Max.	1.670	2.667	0.045	1.316	1.649	4.170
	-Mean	0.074	0.129	0.102	0.087	0.218	0.175
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Copepod Nauplii	Max.	0.083	1.500	0.217	0.862	0.967	0.804
	-Mean	0.111	0.139	0.067	0.097	0.131	0.075
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Cirriped Nauplii	Max.	0.490	0.264	0.240	0.234	0.532	0.321
	-Mean	0.046	0.016	0.027	0.011	0.034	0.018
	Min.	0.000	0.000	0.000	0.000	0.000	0.000
Other Plankton	Max.	5.190	2.584	4.800	2.145	1.393	2.438
	-Mean	0.409	0.309	0.849	0.509	0.445	0.581
	-Min	0.000	0.000	0.000	0.012	0.000	0.000
Total Plankton	Max.	24.350	35.280	41.630	16.680	86.998	73.986
	-Mean	5.030	6.727	9.808	6.655	11.744	9.348
	Min.	0.150	0.039	0.080	0.418	0.405	0.720

[a] All values in organisms per liter.

Table 5. Average quarterly nutrient values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay, 1982.

NUTRIENTS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	CANALS	BAY	CANALS	BAY	CANALS	BAY	CANALS	BAY
NH_3 (mg/l)	0.059	0.025	0.052	0.028	0.038	0.031	0.085	0.047
NO_2 (mg/l)	0.044	0.002	0.050	0.014	0.012	0.004	0.055	0.028
NO_3 (mg/l)	0.164	0.024	0.769	0.025	0.141	0.073	1.852	0.702
IPO_4 (mg/l)	0.011	0.008	0.012	0.008	0.007	0.007	0.011	0.010
TPO_4 (mg/l)	0.045	0.024	0.061	0.051	0.031	0.030	0.042	0.039

Table 6. Composite zooplankton data for years 1977 through 1982 showing the percent of total plankton for all stations in the Turkey Point Cooling Canal System.

ORGANISMS	1977	1978	1979	1980	1981	1982
Copepods	33.0	70.5	28.8	49.0	66.5	65.4
Gastropods	52.6	17.1	64.0	39.1	23.1	19.9
Bivalves	0.3	0.0	0.2	1.0	2.5	1.3
Copepod Nauplii	2.4	2.9	0.2	1.0	3.2	0.4
Cirriped Nauplii	0.7	2.4	0.2	0.0	0.0	0.0
Other Plankton	12.4	8.1	5.7	9.2	8.0	15.6

Table 7. Composite zooplankton data for years 1977 through 1982 showing the percent of total plankton for all stations in Biscayne Bay/Card Sound.

ORGANISMS	1977	1978	1979	1980	1981	1982
Copepods	77.5	79.4	73.4	79.2	54.4	65.9
Gastropods	11.5	12.6	16.0	10.2	38.8	25.3
Bivalves	1.5	1.9	1.0	1.3	1.9	1.9
Copepod Nauplii	2.2	2.1	0.7	1.5	1.1	0.8
Cirriped Nauplii	0.9	0.2	0.3	0.2	0.3	0.2
Other Plankton	8.1	4.6	8.7	7.6	3.8	6.2

b. Phytoplankton

(1) Chlorophyll a, biomass and primary productivity.

Introduction

This section compares phytoplankton chlorophyll a, biomass and primary productivity values measured in the cooling canal system with those in the adjacent lagoon (Biscayne Bay/Card Sound) to determine the cooling canal system's ability to support biological life (ETS 4.1.1.1). Chlorophyll a is used to estimate biomass and primary productivity values.

Materials and Methods

Chlorophyll a, biomass, and primary productivity were determined quarterly at 13 stations. Eight of these stations were located in the Turkey Point Cooling Canal System and five were located in the Biscayne Bay/Card Sound area hereafter referred to as the canal system and the bay respectively (Figures 1 and 2).

Chlorophyll a

Chlorophyll a determinations were made using the Trichromatic Method (APHA, 1980). Grab samples, taken in the top meter of the water column at each of the 13 stations were cooled and concentrated. Pigments were extracted from the concentrated samples by homogenizing the impinged sample with a tissue grinder, steeping in an aqueous acetone solution, and decanting the supernatant. Optical

density of the extracts were determined using a Beckman 25 UV-Visible Light Spectrophotometer with a 5 cm path length.

Biomass

"Chlorophyll a constitutes approximately 1 to 2 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 of 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, 1980).

Primary Productivity

Primary productivity was estimated by using chlorophyll a values, surface solar radiation values and extinction coefficients in equations derived by Ryther and Yentsch (1957). Surface radiation values were taken at a nearby coastal meteorological facility. 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. However, due to the shallowness and water clarity, it was not possible to obtain Secchi Disc readings at sample stations in the bay. Consequently, an estimated extinction coefficient of 0.15/m was used (Ryther and Yentsch, 1957).

Results

The mean chlorophyll a values, biomass, and primary productivity for the canal system and the bay for 1982 are shown in Table 1.

Discussion

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

Chlorophyll a

The mean chlorophyll a value in the canal system was 0.43 mg/m^3 in 1979, 0.63 mg/m^3 in 1980, 0.53 mg/m^3 in 1981 and 0.37 mg/m^3 in 1982. The mean chlorophyll a value in the bay was 0.16 mg/m^3 in 1979 and 1980, 0.47 mg/m^3 in 1981 and 0.18 mg/m^3 in 1982 (Figure 3).

The highest values for chlorophyll a occurred in the canal system during quarters with long photoperiods and occurred in the bay during quarters with long photoperiods and/or high nutrient values. Bader and Roessler (1972) observed that rain causes nutrient rich run-off to enter the bay. The resultant nutrient loading causes a buildup of phytoplankton and benthic flora. This in turn leads to increases in chlorophyll a levels in the receiving waters. The elevated chlorophyll a values in the canal system were attributed to its high phytoplankton level, which in turns correspond to its relatively high stable nutrient levels.

The 1982 chlorophyll a values for both the canal system and the bay fell within the (0.05-5.0 mg/m^3) range of baseline values for Biscayne Bay as reported by Bader and Roessler (1972).

Biomass

The average annual biomass in the canal system was 28.81 mg/m^3 in 1979, 42.21 mg/m^3 in 1980, 35.51 mg/m^3 in 1981 and 24.79 mg/m^3 in 1982. Annual biomass in the bay was 10.73 mg/m^3 in 1979 and 1980, 31.49 mg/m^3 in 1981 and 12.06 mg/m^3 in 1982 (Figure 4).

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

Primary Productivity

The annual mean primary productivity for the canal system was 0.057 $gC/(m^2 \cdot day)$ in 1979, 0.063 $gC/(m^2 \cdot day)$ in 1980, 0.048 $gC/(m^2 \cdot day)$ in 1981 and 0.030 $gC/(m^2 \cdot day)$ in 1982. The annual mean primary productivity for the bay was 0.084 $gC/(m^2 \cdot day)$ in 1979, 0.082 $gC/(m^2 \cdot day)$ in 1980, 0.242 $gC/(m^2 \cdot day)$ in 1981 and 0.050 $gC/(m^2 \cdot day)$ in 1982 (Figure 5).

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. Greater light attenuation in the canal system waters was thought to be the result of high tannin and lignin concentrations which produced color, and organic debris which in turn increased turbidity. The lowest primary productivity estimates were recorded in the canal system at stations where water velocities caused increased turbidity. The highest primary productivity estimates during 1982 for the canal system and the bay occurred in the first and fourth quarters respectively. No comparisons between the baseline and present primary productivity estimates could be made because of the differences in the methodologies employed.

Conclusions

Chlorophyll a and biomass values are higher in the cooling canals than the bay. This is 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. This difference is caused by the disparity in light penetrations between the two systems, i.e. primary productivity includes a light extinction coefficient in its equation. These data do not indicate conditions restrictive to biological life in the canal system.

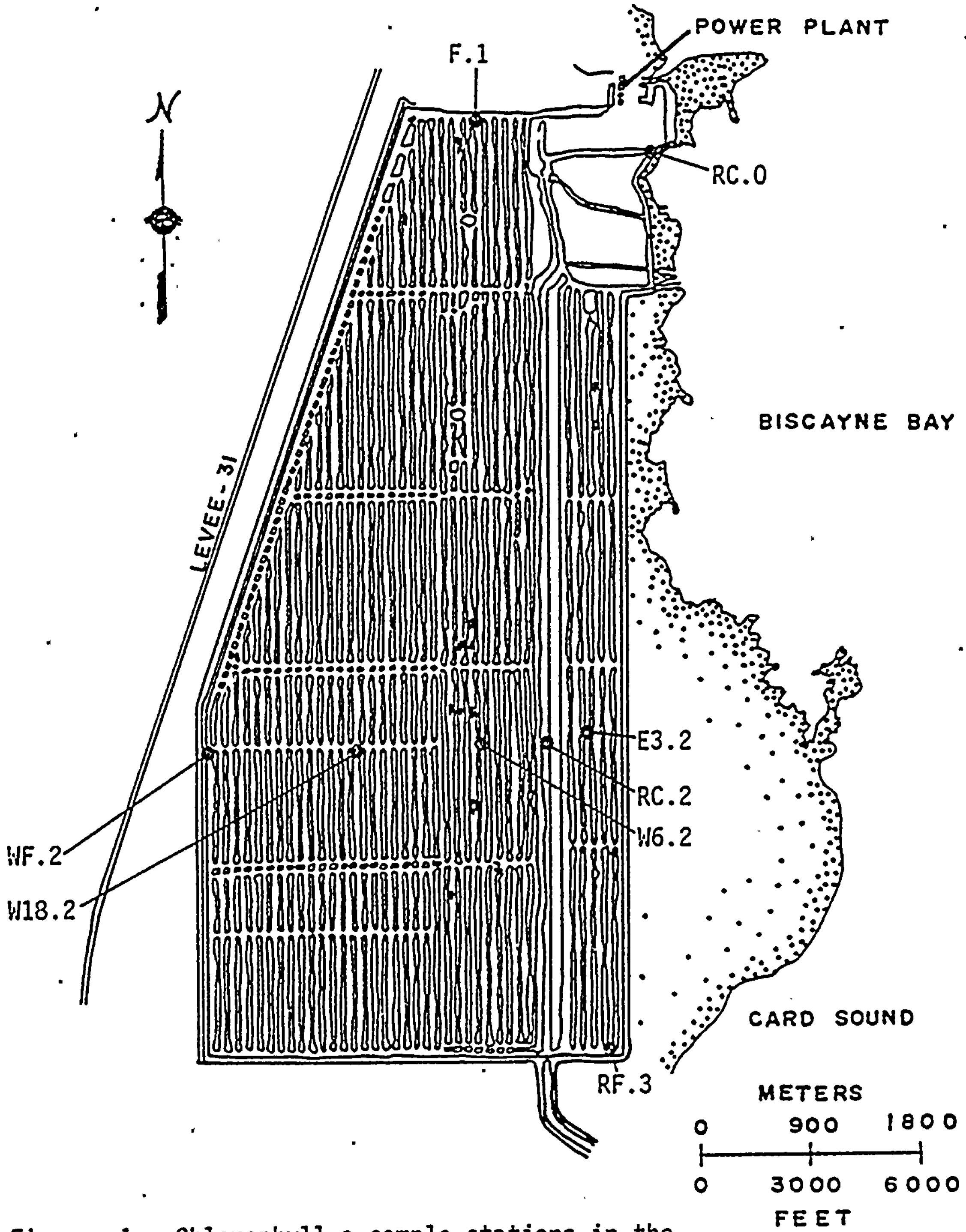


Figure 1. Chlorophyll a sample stations in the Turkey Point Cooling Canal System, 1982.

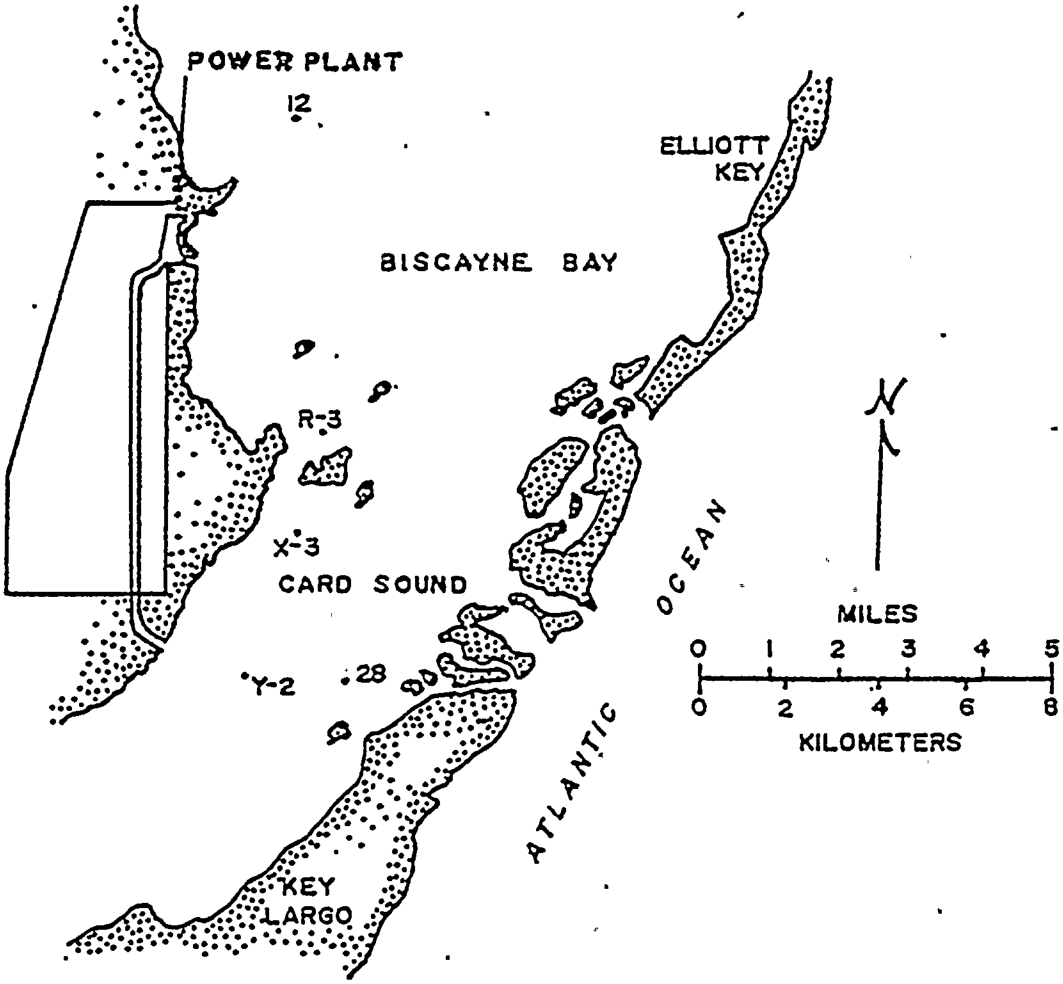


Figure 2. Chlorophyll a sample stations in Biscayne Bay and Card Sound associated with the Turkey Point Cooling Canal System, 1982.

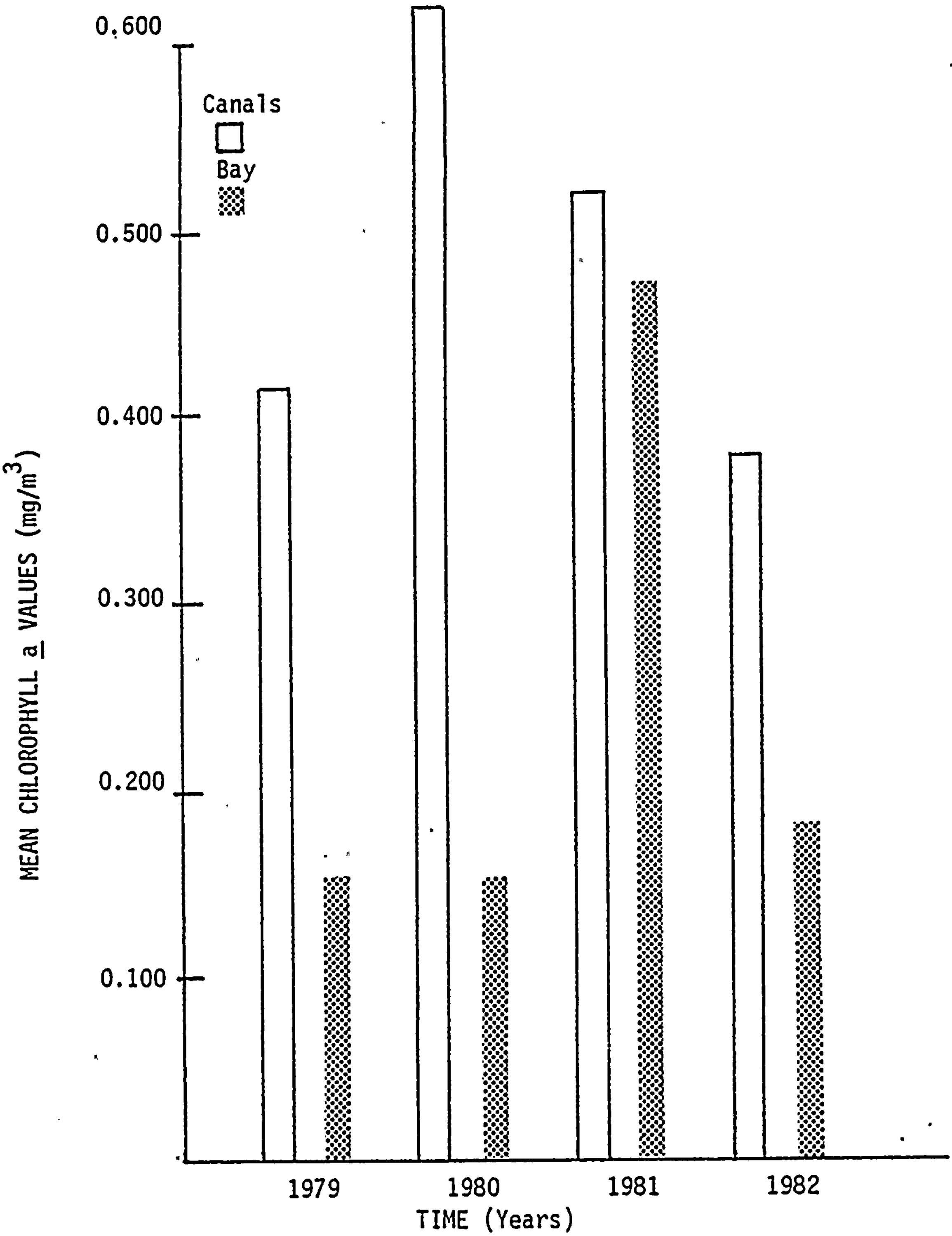


Figure 3. A comparison of mean chlorophyll a values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound, 1979-1982

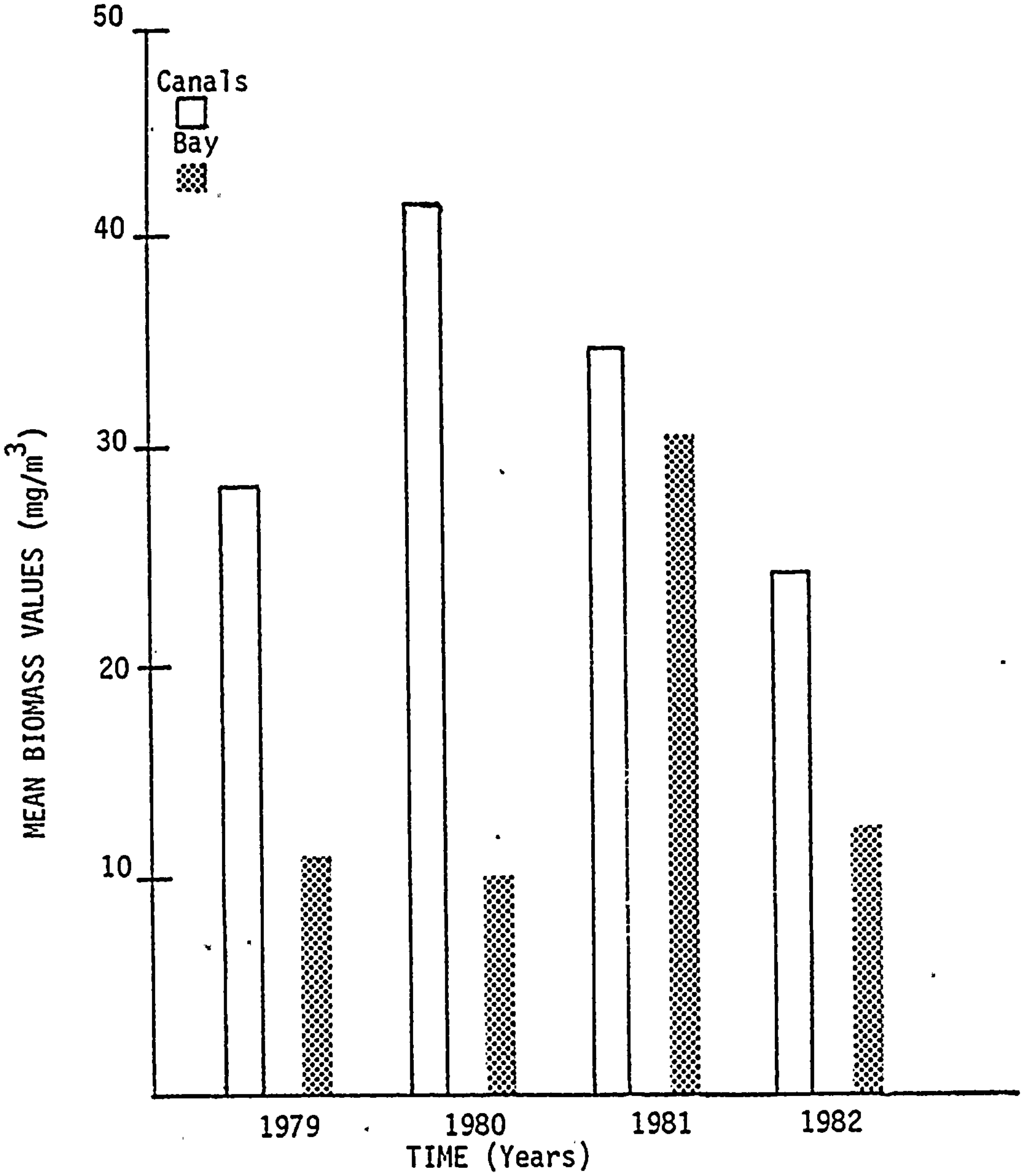


Figure 4. A comparison of mean biomass values for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound, 1979-1982

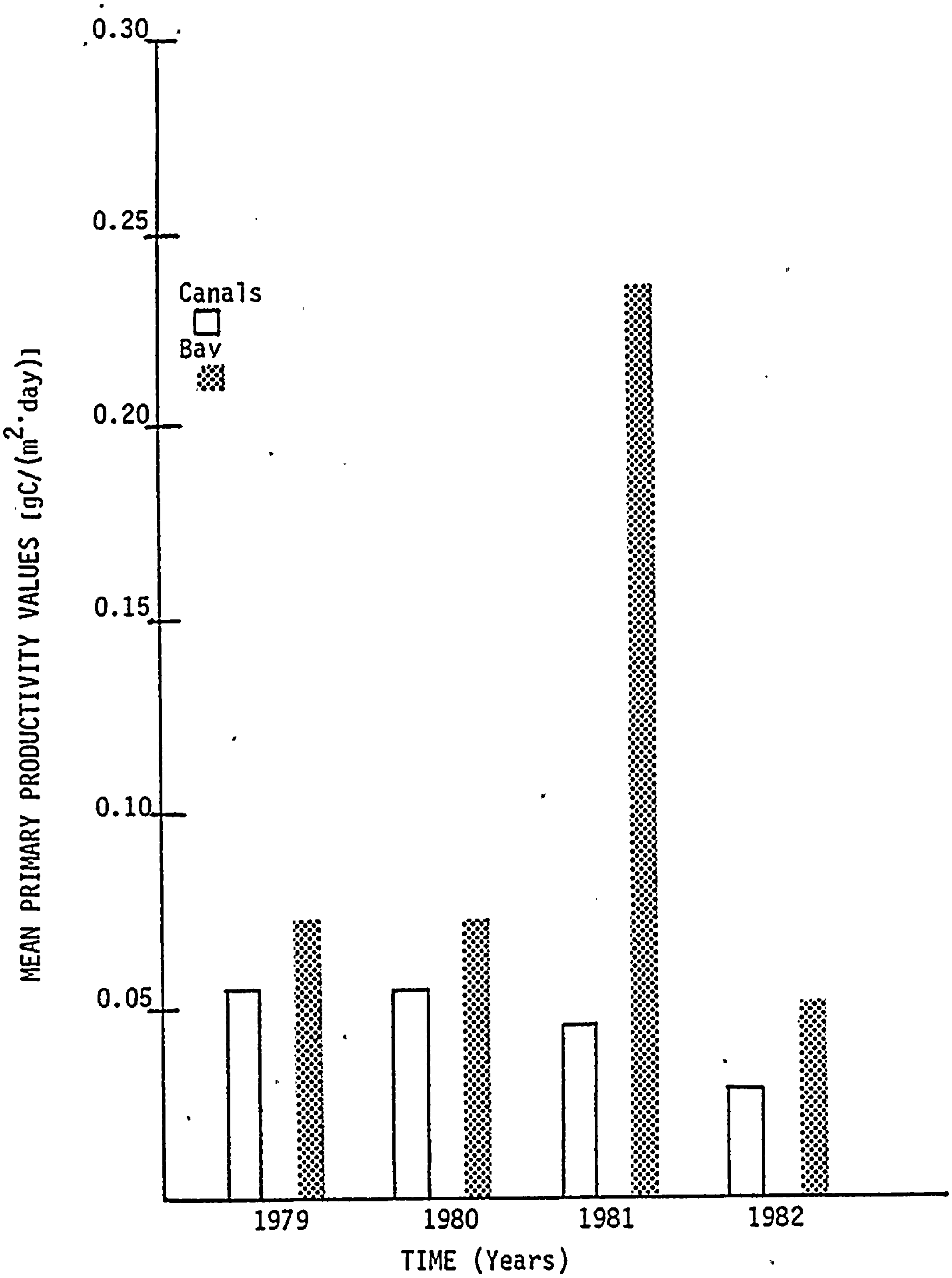


Figure 5. A comparison of mean primary productivity for all stations in the Turkey Point Cooling Canal System and Biscayne Bay/ Card Sound, 1979-1982

Table 1. Mean chlorophyll a, biomass and primary productivity values for the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound for 1982.

DATA PERIOD	CHLOROPHYLL a (mg/m^3)		BIOMASS (mg/m^3)		PRIMARY PRODUCTIVITY [$gC/(m^2 \cdot day)$]	
	Canals	Bay	Canals	Bay	Canals	Bay
First Quarter (February)	0.42	0.10	28.60	6.68	0.046	0.052
Second Quarter (May)	0.61	0.10	41.04	6.64	0.037	0.051
Third Quarter (August)	0.22	0.27	14.54	17.78	0.020	0.118
Fourth Quarter (November)	0.24	0.26	16.05	17.13	0.016	0.133
Yearly Mean	0.37	0.18	25.06	12.05	0.030	0.050

b. Phytoplankton

(2) organisms

Introduction

This report compares phytoplankton populations occurring in the Turkey Point Cooling Canal System and adjacent lagoon (Biscayne Bay/ Card Sound) with those of previous reports (FPL, 1973-1981) in order to follow biological succession and determine the biological stability of the cooling canal system.

Material and Methods

Samples were collected quarterly (February, May, August and November) in the top meter of the water column at 12 stations in the Turkey Point Cooling Canal System and 13 stations in Biscayne Bay/Card Sound, hereafter referred to as the canal system and the bay respectively, (Figures 1 and 2). These samples were sedimented, reduced in volume, preserved in 5% formalin and examined for species and abundance of organisms. Procedures were as reported in previous reports (FPL, 1977).

Because the traditional method of preserving samples (5% formalin) is known to cause erroneous identification of diatoms at the species level, many diatoms were identified only to genus. This is based upon the understanding, widely accepted by aquatic biologists, that relatively few diatoms can be determined to species level without clearing. Since the methods employed did not permit clearing, only

those diatoms with distinctive outline features could be accurately identified.

Results

A total of 133 organisms were identified in the canal system, including 28 considered common and relatively abundant, and 39 of sporadic occurrence. A total of 160 organisms were identified in the bay including 40 common and relatively abundant species, and 46 others of sporadic occurrence. Most of these organisms were recorded in previous studies in comparable numbers. Counts of the principal organisms appear in Tables 1 and 2 for the canal system and bay respectively.

The diversity of the phytoplankton populations (Table 3) was expressed as the number of different organisms identified for selected groups. A summary of organisms by principal taxonomic groups per quarter for both the canal system and bay are listed in Table 4. The table also gives total counts for the year by group, and total counts by quarters.

Diatoms represented the largest component of the phytoplankton in both the canal system and the bay. Diatoms continue to be generally twice as abundant in the canal system as in the bay.

Discussion

Considerable fluctuations in populations occurred seasonally in both the canal system and the bay. Most organisms or groups of organisms have appeared in previous years and have often been represented by large populations. The most conspicuous canal system population peaks were those of Rhodomonas sp. in February, Cyclotella sp. and Naviculoid diatoms in May, and Flagellates (incertae sedis) in February and November. Lesser population peaks occurred in the bay i.e. Ceratium sp. in May and Cocconeis sp. in February. Such "blooms" have been previously observed, especially in the canals, which because of their linear nature and temperature gradient, constitute a series of microhabitats imperfectly isolated from other parts of the same system. There was no evidence from these population build-ups that any significant environmental changes have occurred.

The total count of organisms in specific groups in the canal system was slightly higher in 1982 than in 1981 (Table 4), but does not indicate that there was an overall increase in phytoplankton populations. The high May count for diatoms in the canals was largely due to a single genus, Cyclotella sp. which was present in densities greater than 20,000 per 0.5 liter at Stations F.1, RC.0, RC.2, W6.2, W12.2 and W24.2. If it were not for this dense population, limited chiefly to the six stations mentioned, the yearly total for 1982 would have been much lower than in 1981.

The species diversity was also greater in 1982 than in previous years. This was most likely due to increased familiarity with study area biota making subtle species differences more readily apparent.

Conclusion

The majority of the phytoplankton organisms and groups show no major changes in numbers or diversity and hence suggest evidence for biological stability of the canal system. Most of the organisms observed were found in previous study years. The fact that certain organisms present in the bay do not regularly occur in the canal system has been documented in previous annual reports. This is to be expected in view of the lack of recruitment and higher temperatures of the canal system. Thus, the phytoplankton populations do not suggest any marked changes from conditions existing in the canal system prior to this report period.

The proportion existing between the different taxonomic groupings of phytoplankton is comparable for both canal system and bay. The canal system populations parallel those observed in previous reports (FPL, 1973-1981) and represent populations which are apparently normal for the canal system.

No marked changes were observed during 1982, when compared to previous sampling periods.

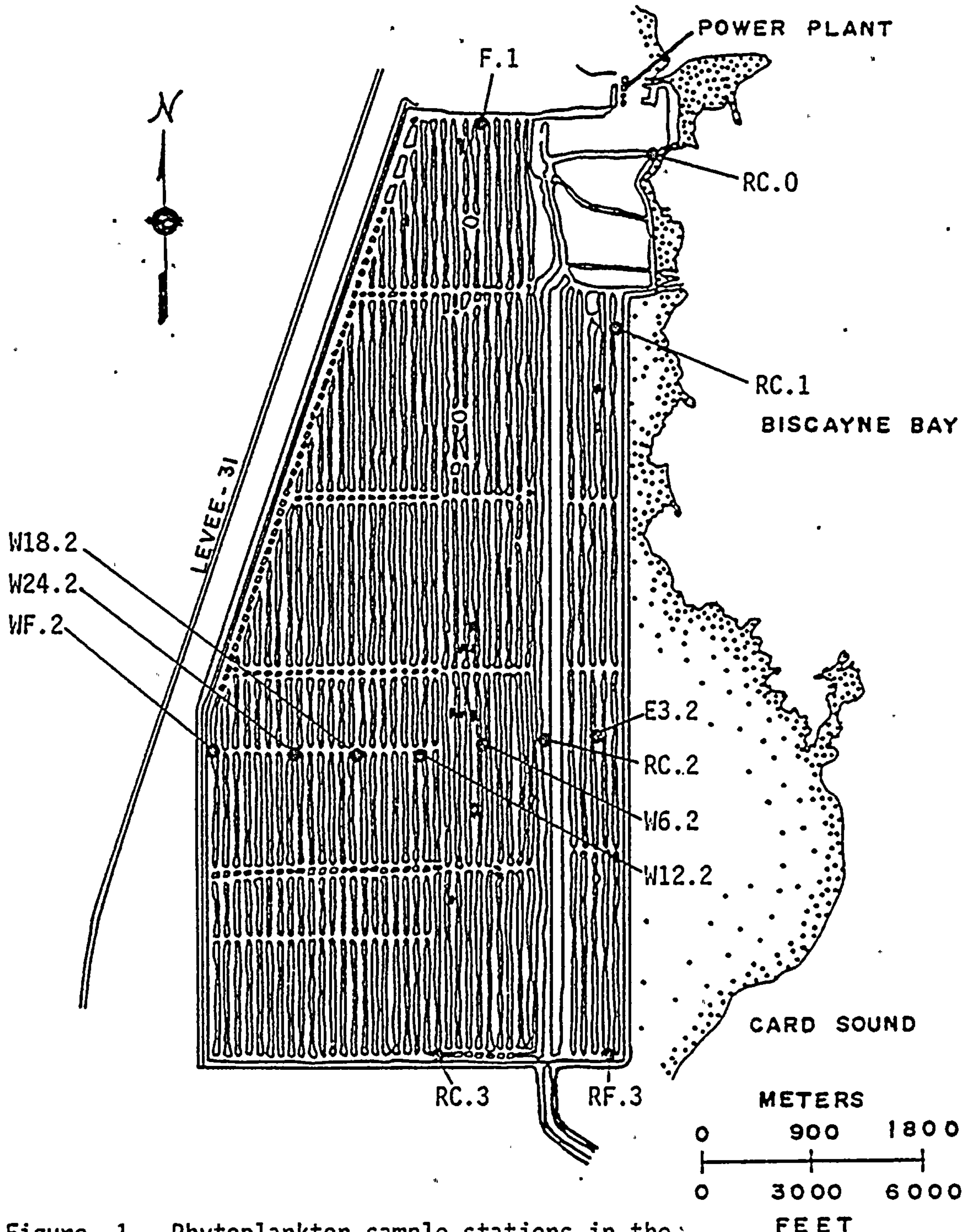


Figure 1. Phytoplankton sample stations in the Turkey Point Cooling Canal System, 1982

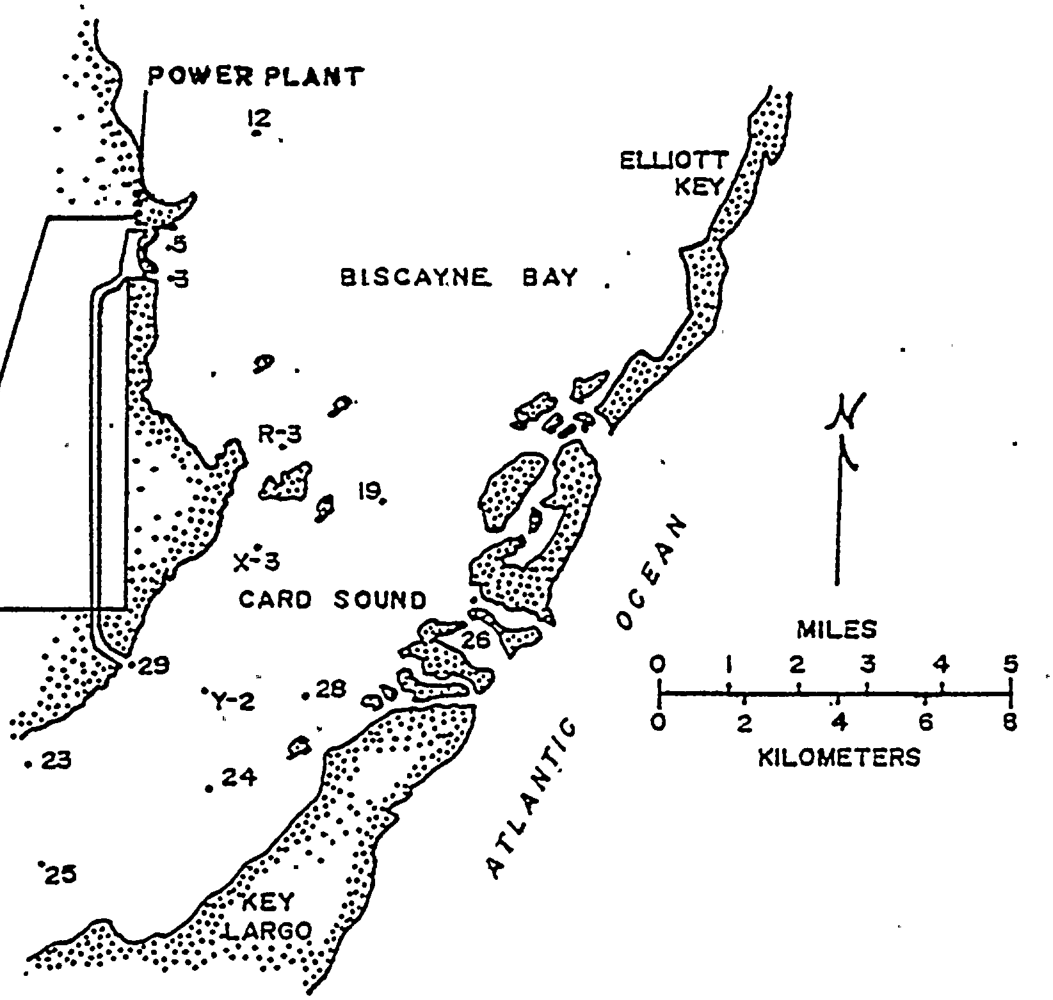


Figure 2. Phytoplankton sample stations in Biscayne Bay and Card Sound adjacent to the Turkey Point Cooling Canal System, 1982.

Table 1. Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Sulfur organisms								
Beggiatoa sp. (2-5 m)	1	30	2	60	6	219	1	30
Beggiatoa sp. (10 m)	4	60	3	99	6	99	6	120
Beggiatoa sp. (14 m)	---	---	3	9	4	75	4	42
Beggiatoa sp. (20-22 m)	---	---	4	42	2	18	1	3
Beggiatoa sp. (28-42 m)	5	69	---	---	1	6	---	---
Macromonas sp.	2	60	3	123	1	30	---	---
Thiospirillum sp.	---	---	---	---	3	120	---	---
Blue-green algae								
Anabaena sp.	4	240	7	450	8	255	5	360
Anacystis sp.	---	---	---	---	4	420	1	60
Aphanocapsa sp.	---	---	---	---	4	930	2	90
Aphanothece sp.	---	---	---	---	2	120	---	---
Arthrospira jenneri	1	30	---	---	1	30	1	30
Chroococcus gigantea	1	3	---	---	4	123	1	6
Chroococcus sp.	2	33	1	60	4	270	2	45
Gloeocapsa sp.	1	30	---	---	---	---	1	15
Gomphosphaeria aponina	1	3	1	3	3	120	1	6

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Blue-green algae (Cont'd)								
Johannesbaptistia sp.	4	93	1	60	3	54	2	9
Lyngbya sp.	---	---	---	---	1	30	1	24
Merismopedia sp.	---	---	---	---	2	33	---	---
Oscillatoria sp. (1-2μm)	3	87	---	---	6	1191	4	186
Oscillatoria sp. (3-4μm)	1	3	5	420	9	1313	---	---
Oscillatoria sp. (6-10μm)	2	63	3	15	10	721	8	417
Oscillatoria sp. (11-14μm)	2	15	---	---	5	159	---	---
Oscillatoria sp. (15-16μm)	---	---	1	6	2	60	---	---
Oscillatoria sp. (20-50μm)	1	12	2	15	4	123	3	12
Schizothrix sp.	2	60	5	450	7	810	2	180
Spirulina minor	2	48	3	273	4	153	2	183
Green algae								
Chlamydomonas sp.	5	1050	3	570	---	---	8	4080
Pyramidomonas sp.	4	1830	9	5550	---	---	10	3350
Euglenoids								
Eutreptia hirudoidea	---	---	---	---	---	---	1	30
E. viridis	6	197	11	720	1	30	12	759

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Euglenoids (Cont'd)								
Unidentified Euglenoids	---	---	---	---	4	266	1	60
Cryptomonads								
Cryptomonas caudata	---	---	---	---	---	---	4	1570
Cryptomonas sp.	11	2360	11	4950	10	450	10	5970
Rhodomonas (elongate form)	---	---	1	30	---	---	---	---
Rhodomonas (short form)	12	24 440	9	1740	6	420	11	3432
Dinoflagellates								
Amphidinium klebsi	---	---	---	---	1	30	---	---
Amphidinium sp.	4	180	9	2250	8	750	10	1680
Ceratium furca	1	3	1	3	---	---	5	180
Exuviaella baltica	1	30	2	90	3	130	---	---
E. marina	---	---	2	6	2	6	---	---
E. oblonga	8	786	12	615	4	264	12	348
Gonyaulax digitale	---	---	---	---	---	---	1	120
G. tamarense	---	---	5	390	1	30	---	---
Gonyaulax sp.	---	---	1	60	---	---	---	---
Gymnodinium albulum	---	---	7	780	4	210	3	180

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Dinoflagellates (Cont'd)								
Gymnodinium breve	---	---	1	60	---	---	---	---
G. foliaceum	2	330	1	30	4	483	5	255
G. splendens	---	---	---	---	---	---	1	3
G. vitellago	2	240	2	90	---	---	8	930
Gymnodinium spp. (small)	12	7860	12	5580	10	1380	12	7860
Gymnodinium spp. (large)	8	660	9	2400	8	1290	10	2400
Gyrodinium lachryma	---	---	---	---	---	---	1	60
Peridinium achromaticum	3	510	1	30	---	---	---	---
P. brevipes	---	---	---	---	1	30	---	---
P. divergens	---	---	---	---	---	---	1	3
P. graui	---	---	2	120	---	---	---	---
P. hirobis	---	---	---	---	---	---	10	522
P. nudum	---	---	2	120	---	---	---	---
P. triqueta	1	60	---	---	---	---	---	---
P. trochoideum	3	240	5	500	1	30	10	1140
Peridinium sp.	9	2220	5	570	5	630	7	234
Peridiniopsis rotundata	2	63	---	---	---	---	---	---
Prorocentrum micans	---	---	1	3	---	---	---	---

Table 1. Counts of the principal plankton organisms found in the Turkey Point Cooling
(Cont'd) Canal System, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Dinoflagellates (Cont'd)								
<u>Protoceratium</u> <u>reticulatum</u>	---	---	1	3	---	---	---	---
<u>Pyrocystis</u> sp.	---	---	1	3	1	30	3	12
<u>Pyrodinium</u> <u>bahamense</u>	---	---	1	3	---	---	8	54
Unidentified Dinoflagellates	8	1410	10	1200	11	2694	10	1330
Other Flagellates[c]								
<u>Chrysochromulina</u> sp.	---	---	---	---	---	---	5	660
<u>Rhabdosphaera</u> sp.	2	60	7	720	8	330	6	450
Flagellates (<u>incertae</u> <u>sedis</u>)	11	16 440	12	7560	12	2390	12	21 390
Diatoms								
<u>Amphiprora</u> <u>alata</u>	4	330	5	540	6	360	4	183
<u>A</u>. <u>minuta</u>	8	1140	10	2220	7	363	1	120
<u>A</u>. <u>paludosa</u>	---	---	2	120	4	480	3	960
<u>Amphiprora</u> sp.	1	60	1	60	4	270	9	990
<u>Amphora</u> <u>alata</u>	1	30	3	183	4	180	4	240
<u>A</u>. <u>ovalis</u>	1	90	---	---	4	750	---	---
<u>A</u>. <u>commutata</u>	---	---	---	---	1	30	---	---
<u>A</u>. <u>inflexa</u>	---	---	1	60	---	---	1	60

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Diatoms (Cont'd)								
Amphora sp.	3	300	3	330	11	3360	11	3080
Bacillaria paxillifer	1	3	---	---	---	---	1	30
Bacteriastrum sp.	---	---	---	---	1	60	1	3
Campylosira cymbelliformis	---	---	1	60	9	2700	5	390
Campylostylus striatus	2	33	5	108	11	1891	8	60
Chaetoceras sp.	1	3	2	90	---	---	4	273
Cocconeis hustedti	6	900	8	1650	6	690	11	1380
C. placentula	3	150	---	---	---	---	---	---
Cocconeis sp.	5	390	7	2370	7	840	2	120
Cyclotella glomerata	---	---	10	2530	---	---	11	3322
Cyclotella sp.	12	13 650	12	191 500	2	90	12	7764
Fragilaria islandica	2	270	---	---	2	90	---	---
Fragilaria sp.	4	510	10	6420	6	270	7	465
Gyrosigma balticum	---	---	2	6	4	18	1	3
Licmophora gracilis	---	---	---	---	---	---	2	120
L. flabellata	6	174	6	228	8	147	5	51
L. grandis	1	30	1	60	---	---	---	---
Licmophora sp.	2	81	1	30	---	---	1	9

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Diatoms (Cont'd)								
Navicula amphibola	1	60	---	---	2	78	3	93
Unidentified Naviculoids	12	20 850	12	67 020	12	21 390	12	8030
Nitzschia acicularis	11	6110	8	2010	3	90	7	450
N. closterium	5	930	5	1390	2	90	4	270
N. incurva	---	---	---	---	1	120	---	---
N. longa	2	60	1	30	1	30	1	3
N. longissima	12	12 186	10	4080	---	---	2	63
N. panduraeformis	7	480	7	840	11	1620	10	1665
Nitzschia sp.	5	670	---	---	---	---	4	180
Pleurosigma angustatum	4	36	8	108	11	1673	3	9
P. brebissonii	2	6	2	120	6	1230	5	333
P. elongatum	5	45	3	34	5	114	4	36
P. lineare	---	---	1	180	---	---	---	---
P. tenuissima	---	---	---	---	---	---	1	3
Pleurosigma sp.	2	33	---	---	2	63	---	---
Striatella sp.	---	---	---	---	1	30	---	---
Surirella sp.	2	90	6	363	2	33	---	---
Synedra acicularis	---	---	---	---	4	1533	---	---

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Diatoms (Cont'd)								
Synedra actinastroides	---	---	1	60	1	210	1	3
S. crystallina	5	483	---	---	---	---	---	---
S. fulgens	1	30	1	180	8	1680	1	60
S. hennedyiana	1	3	---	---	3	84	9	462
S. pulchella	---	---	---	---	3	210	---	---
S. superba	1	180	---	---	3	150	8	1890
S. undulata	---	---	1	60	---	---	---	---
Synedra sp.	2	240	1	60	---	---	6	495
Skeletonema sp.	---	---	---	---	1	30	1	3
Thalassiosira sp.	3	120	1	60	---	---	8	825
Tropidoneis sp.	---	---	1	30	---	---	---	---
Unidentified Diatoms	9	1920	10	1260	6	270	8	1140
Ciliates								
Askenasia sp.	1	3	---	---	1	30	3	57
Aspidisca sp.	1	3	---	---	---	---	---	---
Dysteria sp.	---	---	---	---	2	33	---	---
Favella panamensis	5	27	1	30	---	---	---	---

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Ciliates (Cont'd)								
Favella sp.	---	---	---	---	---	---	2	6
Metacylis juergensenii	1	3	---	---	---	---	---	---
M. vitreoides	---	---	---	---	---	---	4	27
Strobilidium sp.	10	1965	---	---	---	---	---	---
Strombidium conicum	---	---	---	---	---	---	2	210
Tintinnopsis tubulosoides	1	60	2	210	---	---	9	161
Tintinnopsis sp.	---	---	5	270	---	---	---	---
Unidentified Ciliates	11	816	8	660	7	660	9	351
Rhizopods								
Amoeba sp.	1	60	---	---	1	30	---	---
Metazoa								
Nematodes	2	6	2	6	6	63	9	51
Cercariae	---	---	2	63	---	---	---	---
Rotifers	1	30	---	---	1	3	---	---
Polychaeta	1	3	---	---	---	---	3	12
Gastropods	---	---	6	111	5	60	4	15
Bivalves	4	18	4	15	1	3	3	21

Table 1. (Cont'd) Counts of the principal plankton organisms found in the Turkey Point Cooling Canal System, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Metazoa (Cont'd)								
Copepods	8	72	8	108	7	60	9	144
Unidentified Larvae	2	12	---	---	3	12	3	12
Eggs	3	75	5	195	3	33	3	12
Cells (*incertae sedis*)	12	5340	12	6160	10	1860	10	1680

[a]Number of stations at which it occurred.
[b]Total number of organisms or colonies per 0.5 liter.
[c]Includes Silicoflagellates and Flagellates (*incertae sedis*).

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Sulfur organisms								
Beggiatoa sp. (2μm)	---	---	---	---	1	30	---	---
Beggiatoa sp. (7μm)	---	---	---	---	1	12	---	---
Beggiatoa sp. (10μm)	1	30	2	39	4	351	5	450
Beggiatoa sp. (14μm)	---	---	---	---	3	66	2	395
Beggiatoa sp. (20-42μm)	---	---	---	---	2	66	2	6
Chlorochromatium sp.	---	---	---	---	---	---	1	60
Macromonas sp.	2	60	---	---	1	60	---	---
Blue-green algae								
Anabaena sp.	1	30	1	60	5	102	7	1446
Anacystis sp.	---	---	---	---	---	---	4	210
Aphanocapsa sp.	1	30	---	---	3	78	---	---
Arthrospira jenneri	---	---	1	6	2	78	5	216
Chroococcus gigantea	---	---	---	---	1	12	3	150
Chroococcus sp.	3	120	---	---	3	72	5	210
Gloeocapsa sp.	---	---	2	36	---	---	---	---
Gomphosphaeria aponina	4	99	5	180	2	27	2	33
Johannesbaptistia sp.	2	33	5	75	5	69	5	210
Merismopedia sp.	1	30	1	30	---	---	3	93

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound,
(Cont'd) 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Blue-green algae (Cont'd)								
Oscillatoria sp. (3-4μm)	1	60	---	---	1	3	9	660
Oscillatoria sp. (6-10μm)	---	---	---	---	1	21	---	---
Oscillatoria sp. (11-14μm)	---	---	1	3	6	862	7	600
Oscillatoria sp. (15-16μm)	1	30	---	---	1	30	3	93
Oscillatoria sp. (20-50μm)	---	---	---	---	4	99	6	30
Schizothrix sp.	3	150	---	---	---	---	3	120
Spirulina minor	---	---	2	6	1	12	1	30
Green algae								
Chlamydomonas sp.	3	90	6	870	5	210	3	210
Pyramidomonas sp.	6	240	10	1320	11	4110	12	3030
Scenedesmus sp.	---	---	---	---	---	---	2	123
Tetraedron sp.	---	---	---	---	---	---	1	60
Euglenoids								
Cylindromonas sp.	---	---	1	60	1	240	---	---
Eutreptia hirudoidea	3	90	---	---	---	---	---	---
E. viridis	1	9	3	63	2	75	1	30
Unidentified Euglenoids	2	60	4	180	5	640	7	720

Table 2. (Cont'd) Counts of the principal plankton organisms found in Biscayne Bay/Card Sound, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Cryptomonads								
Cryptomonas sp.	2	60	7	285	11	1110	9	4560
Rhodomonas (elongate form)	2	2070	4	3000	---	---	---	---
Rhodomonas (short form)	10	3510	10	7335	12	6425	13	75 144
Dinoflagellates								
Amphidinium klebsi	---	---	---	---	3	180	1	60
A. phaeocysticola	---	---	---	---	2	60	---	---
Amphidinium sp.	9	755	12	1140	13	2295	12	2040
Ceratium furca	8	114	12	2739	11	159	13	321
C. fusus	---	---	1	3	2	6	1	3
Cochlodinium sp.	2	6	---	---	---	---	3	120
Dinophysis sp.	---	---	1	5	2	21	2	63
Diplopsalis sp.	---	---	1	30	---	---	1	120
Exuviaella baltica	6	363	10	1323	11	1230	12	2946
E. marina	3	18	3	36	2	42	2	6
E. oblonga	8	261	11	495	8	603	8	246
Gonyaulax digitale	---	---	1	3	4	153	2	33
G. tamarense	---	---	---	---	3	390	---	---

Table 2. (Cont'd) Counts of the principal plankton organisms found in Biscayne Bay/Card Sound, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Dinoflagellates (Cont'd)								
Gonyaulax sp.	---	---	---	---	2	75	---	---
Gymnodinium albulum	---	---	2	120	2	90	4	240
G. breve	---	---	2	60	---	---	---	---
G. foliaceum	1	30	---	---	4	135	2	90
G. splendens	1	3	1	3	4	36	2	6
G. vitellago	8	450	5	360	---	---	8	1080
Gymnodinium spp. (small)	13	3545	11	6730	13	7162	13	8468
Gymnodinium spp. (large)	6	180	6	316	4	147	8	840
Gyrodinium pingue	1	30	---	---	5	450	9	612
G. lachryma	---	---	---	---	1	3	1	3
Peridinium achromaticum	1	30	2	90	---	---	---	---
P. brevipes	1	90	---	---	---	---	1	60
P. depressum	---	---	---	---	8	63	---	---
P. divergens	1	30	---	---	---	---	---	---
P. globulus	---	---	---	---	---	---	1	30
P. graui	1	30	---	---	2	18	---	---
P. hirobis	2	33	3	90	4	123	2	60

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound,
(Cont'd) 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Dinoflagellates (Cont'd)								
Peridinium nudum	1	30	---	---	2	90	---	---
P. triqueta	1	270	---	---	1	20	---	---
P. trochoideum	6	300	7	630	8	750	4	270
Peridinium sp.	11	1215	11	1140	7	780	8	660
Peridiniopsis rotundata	2	120	4	150	4	15	3	12
Peridiniopsis sp.	---	---	---	---	---	---	1	30
Prorocentrum gracile	2	6	5	60	2	9	2	120
P. micans	5	138	11	288	4	36	8	103
Protoceratium reticulatum	8	96	8	207	9	336	7	123
Pyrocystis sp.	5	105	4	21	10	366	12	216
Pyrodinium bahamense	6	175	10	738	11	771	7	102
Unidentified Dinoflagellates	8	675	11	2244	11	3300	10	810
Other Flagellates[c]								
Bodo sp.	---	---	2	90	---	---	3	180
Chrysochromulina sp.	1	30	---	---	---	---	---	---
Rhabdosphaera sp.	1	60	1	60	3	150	2	123
Dictyocha sp.	3	150	2	60	1	15	---	---

Table 2. (Cont'd) Counts of the principal plankton organisms found in Biscayne Bay/Card Sound, 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Other Flagellates[c] (Cont'd)								
Flagellates (*incertae sedis*)	13	6330	12	10 005	13	14 520	13	15 300
Diatoms								
Achnanthes coactata	---	---	---	---	---	---	2	360
Amphiprora alata	1	3	3	81	2	60	---	---
A. minuta	3	195	4	219	4	150	---	---
Amphiprora sp.	---	---	---	---	1	60	---	---
Amphora alata	2	45	5	228	1	48	5	390
A. ovalis	2	90	3	63	1	30	1	30
A. inflexa	2	90	3	66	3	150	7	195
Amphora sp.	7	243	7	258	11	573	9	1050
Bacteriastrum sp.	---	---	---	---	1	30	3	180
Campylosira cymbelliformis	2	90	---	---	---	---	2	180
Campylostylus striatus	---	---	1	3	5	45	1	9
Chaetoceras sp.	3	120	2	63	6	5010	2	420
Cocconeis hustedti	4	960	6	650	8	510	10	3510
C. placentula	1	120	3	90	2	160	6	390
Cocconeis sp.	5	3075	6	225	4	180	2	180

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound,
(Cont'd) 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Diatoms (Cont'd)								
Coscinodiscus sp.	1	9	3	63	2	18	1	12
Cyclotella glomerata	5	300	6	555	10	2160	9	660
Cyclotella sp.	10	945	12	1635	5	630	11	1920
Cymatosira sp.	1	3	---	---	---	---	---	---
Diploneis sp.	---	---	2	60	2	18	---	---
Fragilaria islandica	---	---	---	---	3	1008	---	---
Fragilaria sp.	1	30	3	120	3	120	1	60
Leptocylindris sp.	2	30	---	---	---	---	---	---
Licmophora flabellata	6	78	5	111	6	246	4	126
L. grandis	4	18	4	72	---	---	6	186
Licmophora sp.	1	30	3	213	4	183	6	159
Navicula amphibola	3	150	2	18	8	393	9	414
N. pandura	2	39	---	---	2	144	1	3
N. scopulorum	---	---	1	3	1	3	1	30
Unidentified Naviduloids	13	2520	12	5295	13	7483	13	960
Nitzschia acicularis	3	165	3	111	11	2870	4	186
N. closterium	3	90	6	198	---	---	3	120

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound,
(Cont'd) 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Diatoms (Cont'd)								
Nitzschia incurva	---	---	---	---	---	---	4	123
N. longa	2	90	---	---	3	93	1	3
N. longissima	6	306	7	266	---	---	2	60
N. panduraeformis	8	435	12	2055	10	750	11	3300
N. sigma	2	60	---	---	---	---	---	---
N. sigmoidea	1	3	---	---	---	---	---	---
Nitzschia sp.	2	45	2	63	1	60	1	180
Pleurosigma angustatum	---	---	---	---	---	---	2	6
P. brebissonii	1	3	---	---	---	---	---	---
P. elongatum	6	102	3	108	3	72	6	141
P. fasciola	---	---	---	---	---	---	1	60
P. macilento	---	---	---	---	---	---	1	60
P. tenuissima	---	---	---	---	---	---	1	3
Rhopalodia sp.	1	30	---	---	---	---	---	---
Skeletonema sp.	---	---	1	150	---	---	---	---
Striatella sp.	3	75	6	132	4	476	5	129
Surirella sp.	2	18	1	15	1	15	3	93

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound,
(Cont'd) 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Diatoms (Cont'd)								
Synedra acicularis	---	---	---	---	2	90	---	---
S. actinastroides	---	---	---	---	6	663	6	156
S. crystallina	---	---	---	---	2	27	1	39
S. fulgens	1	6	---	---	---	---	1	60
S. gallionii	---	---	---	---	1	120	---	---
S. hennedyiana	---	---	---	---	---	---	1	3
S. undulata	1	30	2	6	1	3	---	---
Synedra sp.	4	240	3	420	10	1350	8	780
Thalassiosira sp.	3	150	1	60	3	45	1	30
Unidentified Diatoms	6	510	11	798	6	600	7	630
Ciliates								
Askenasia sp.	---	---	---	---	---	---	5	210
Coxliella sp.	---	---	---	---	1	12	---	---
Craterella sp.	1	270	3	153	---	---	---	---
Dysteria sp.	---	---	---	---	---	---	1	3
Favella sp.	---	---	---	---	1	6	5	84
Metacylis corbula	---	---	---	---	---	---	8	180

Table 2. (Cont'd) Counts of the principal plankton organisms found in Biscayne Bay/Card Sound, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Ciliates (Cont'd)								
Metacylis juergensenii	4	57	6	72	2	24	4	39
Strobilidium sp.	---	---	1	30	---	---	---	---
Strombidium conicum	4	165	10	252	1	100	7	402
S. strobilus	3	63	2	24	1	3	1	30
Strombidium sp.	3	93	6	126	7	258	8	498
Tintinnus apertus	---	---	---	---	1	3	---	---
T. procurus	---	---	---	---	1	3	---	---
Tintinnus sp.	---	---	1	3	---	---	---	---
Tintinnopsis beroidea	---	---	---	---	1	60	---	---
Tintinnopsis dadayi	---	---	---	---	---	---	1	3
T. lobienkoi	---	---	---	---	1	3	---	---
T. tubulosa	---	---	---	---	1	3	4	39
T. tubulosoides	2	60	4	96	1	3	9	195
T. urnula	---	---	---	---	---	---	1	3
T. wailesi	2	33	5	162	6	54	7	48
Tintinnopsis sp.	1	90	1	3	---	---	---	---
Undellopsis sp.	---	---	1	30	---	---	---	---

Table 2. Counts of the principal plankton organisms found in Biscayne Bay/Card Sound,
(Cont'd) 1982.

ORGANISMS	FEBRUARY		MAY		AUGUST		NOVEMBER	
	a	b	a	b	a	b	a	b
Ciliates (Cont'd)								
Xystonellopsis sp.	---	---	1	30	---	---	---	---
Unidentified Ciliates	8	669	12	1266	12	1989	13	6630
Rhizopods								
Amoeba sp.	---	---	3	60	---	---	1	3
Metazoa								
Nematodes	2	6	---	---	2	39	4	12
Cercariae	3	12	1	30	2	21	7	86
Rotifers	---	---	---	---	1	3	2	12
Polychaetes	1	3	---	---	---	---	---	---
Gastropods	5	51	3	21	10	186	7	24
Bivalves	4	42	2	33	6	30	1	3
Copepods	6	84	10	366	10	129	10	138
Ostracods	---	---	---	---	---	---	1	3
Ophiopluteus	---	---	---	---	1	3	1	6
Unidentified Larvae	5	29	5	48	4	12	7	66
Eggs	4	171	4	72	3	48	5	33

Table 2. (Cont'd) Counts of the principal plankton organisms found in Biscayne Bay/Card Sound, 1982.

ORGANISMS	FEBRUARY a	FEBRUARY b	MAY a	MAY b	AUGUST a	AUGUST b	NOVEMBER a	NOVEMBER b
Cells (*incertae sedis*)	13	4845	13	7985	13	4848	10	15 240

[a]Number of stations at which it occurred.
[b]Total number of organisms or colonies per 0.5 liter.
[c]Includes Silicoflagellates and Flagellates (*incertae sedis*).

Table 3. Diversity of the respective groups of plankton found in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound, 1979-1982.

GROUPS	1979		1980		1981		1982	
	Canals	Bay	Canals	Bay	Canals	Bay	Canals	Bay
Sulfur organisms	2	1	1	1	5	2	7	7
Blue-green algae	25	18	18	17	15	18	20	17
Green algae	4	5	3	3	3	5	2	4
Euglenoids	5	4	4	5	6	8	2	3
Cryptophytes	3	2	2	2	2	2	4	3
Dinoflagellates	16	33	23	40	22	34	29	39
Other Flagellates[a]	1	2	2	2	1	2	3	5
Diatoms	59	60	48	58	40	45	54	57
Ciliates	6	23	11	23	14	22	11	24
Rhizopoda	1	1	1	1	1	1	1	1
Total	122	149	113	152	109	139	133	160

[a]Includes Silicoflagellates and Flagellates (*incertae sedis*)

Table 4. Counts by taxonomic group of planktonic organisms monitored in the Turkey Point Cooling Canal System and Biscayne Bay/Card Sound, 1982.

GROUPS	FEB.		MAY		AUG.		NOV.		SUB-TOTALS		TOTAL
	Canals	Bay	Canals	Bay	Canals	Bay	Canals	Bay	Canals	Bay	By Group
Blue-green algae	720[a]	582	1752	396	6915	1465	1623	4101	11 010	6544	17 554
Dinoflagellates	14 592	9098	14 906	19 021	8257	19 924	17 311	19 893	55 066	67 936	123 002
Flagellates[b]	16 440	6330	7560	10 005	2390	14 520	21 390	15 300	47 780	46 155	93 935
Diatoms	62 676	11 541	286 450	14 473	43 317	26 646	35 636	17 586	428 079	70 246	498 325
Ciliates	2877	1500	1170	2247	723	2521	812	8364	5582	14 632	20 214
Sub-totals	97 305	29 051	311 838	46 142	61 602	65 076	76 772	65 244	547 517	205 513	
Totals[c]	126 356		357 980		126 678		142 016		753 030 (Grand Total)		

[a]Population totals are expressed in terms of organisms per 0.5 liters.
[b]*Incertae sedis*
[c]By month - Canals and Bay combined.

2. Fish (ETS 4.1.1.1.2)

Introduction

Populations of fish within the Turkey Point Cooling Canal System were isolated from Biscayne Bay/Card Sound habitats, hereafter referred to as the canal system and the bay, respectively when the canal system was closed off from the bay in February 1973.

The ongoing monitoring program characterizes and documents population changes that occur in the fish fauna within the canal system and compares them to that of the bay as reported by Nugent in 1970.

Material and Methods

Fish were collected monthly at ten stations in the canal system to determine the species present, their relative abundance, life history stages, weight, and size. Species that demonstrated a variety of life history stages were considered to be established and reproducing in the canal system, while those represented only by adults were not considered to be reproducing and are expected to be lost through natural attrition.

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 set perpendicular to shore in water depths 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 baited with mullet and set near the edges of the canals at water depths of from 39 to 50 cm.

The sampling method at each station was determined primarily by the water depth at the sampling site. Gill nets were set at Stations 1, 2, 4 and 8; the minnow traps were set 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 tenth of a gram. Fish were measured from the tip of the snout to the caudal peduncle (standard length). Fish nomenclature was in accordance with the AFS List (1980).

Results

A total of 16 species represented by 4305 individuals was collected in the canal system during 1982 (Table 1). The majority of these individuals were small forage fish collected by minnow traps.

The killifish family (Cyprinodontidae) comprised 89.1 percent of the total number of fish collected in 1982. The goldspotted killifish and sheepshead minnow were the predominant species found with 2228 and 1562 individuals respectively (Table 1). All members of the killifish family were generally less than 68 mm in length, and because of their small size, made up only 9.4 percent of the total weight of the fish collected.

The livebearer family (Poeciliidae) was represented by the sailfin molly and pike killifish. Livebearers comprised 6.8 percent of the total number of fish collected during 1982 and, due to their small size, made up only 1 percent of the total fish weight (Table 1).

The balance of the fish collected in 1982 comprised only 4.1 percent of the total number but accounted for 89.6 percent of the total weight. The collection of relatively few large individuals such as bonefish, barracuda, crevalle jack, mojarra and snapper accounted for the majority of the weight (Table 1).

Discussion

Actively reproducing populations of killifish and livebearers within the canal system were evidenced by the occurrence of juveniles as well as adults (Table 1) and their continued abundance (Table 2). Crested gobies and gulf toadfish, although not as abundant as the killifish, were also collected as juveniles and adults and are considered established in the canal system.

Redfin needlefish were frequently observed in the canal system and are considered established, however, they were generally not collected because of the sampling methods employed. Needlefish were a prominent predator in the canal system 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 closed canal system as indicated by both an absence of juveniles and a decline in number collected (Table 2). The species that were not reproducing within the canal system generally spawn at sea. These fish (e.g. barracuda, bonefish, and crevelle jack) have pelagic eggs and larvae which develop offshore. Confinement to the closed canal system does not appear to be conducive to spawning nor the subsequent development of eggs and larvae.

Changes which occurred in fish populations in the canal system were reflected in the data when plotted as catch per unit effort (C.P.U.E.). The minnow trap C.P.U.E., is indicative of populations of the small forage species. After an initial increase in minnow trap C.P.U.E. from 1975 through 1977 (FPL, 1978), C.P.U.E. has stabilized to a range normal to the canal system (Figure 2). The large expanse of generally shallow water provided an ideal habitat for forage fish. This fact and the decrease in the number of predatory species is considered the cause for their established populations. The gill net C.P.U.E., indicative of populations of larger fish, decreased substantially from 1975 through 1976 and has continued a slow decline through 1982 (FPL 1973-1982).

Eighty species of fish were collected by trawling in southern 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 for 1974 through 1978 and 45 species collected from 1979-1982 (Table 3). Although the different collection methods between the baseline survey and later surveys may have accounted for some of the difference in the number of species, it appears that many species found in the bay simply did not enter the canal system during the period the canal system was open to the bay.

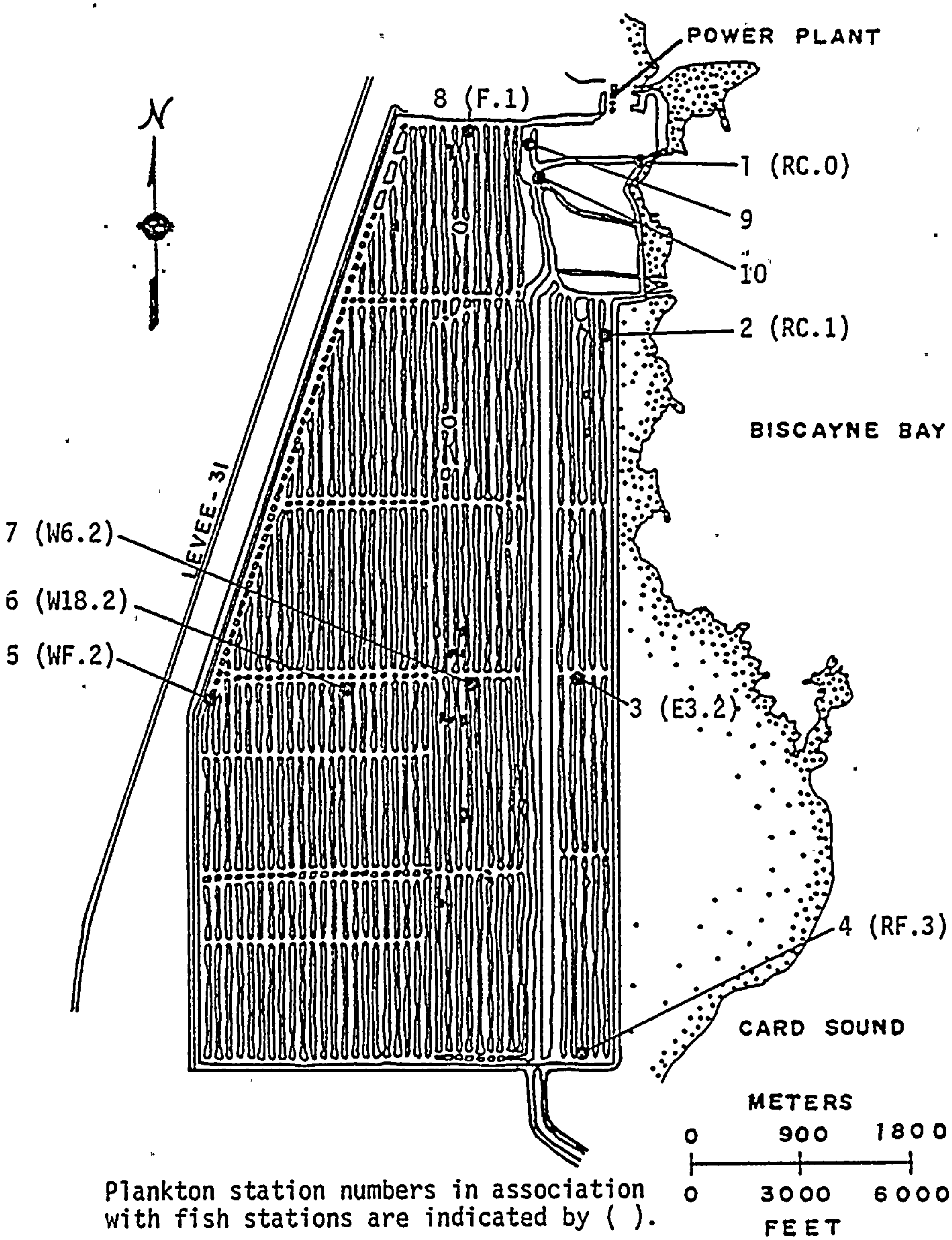
The surveys conducted by Nugent (1970) with gill nets and large fish traps in the immediate vicinity of the power plant resulted in the collection of 52 species of fish. These studies were conducted in tidal creeks and other nearshore areas so that the species found were highly representative of those collected in the canal system (Table 3).

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

Conclusion

Populations of fish within the Turkey Point Cooling Canal System became isolated from Biscayne Bay/Card Sound, when the canal system was closed off in February 1973. Certain species, particularly forage fish in the killifish and livebearer families, have adapted well in the canal system. Other fish, such as snappers, jacks and barracuda, are not able to reproduce within the canals and their numbers have been reduced through natural attrition. This reduction in predator species and the favorable habitat account for the continued abundance of the forage fish.

Study comparisons indicate that several species found in Biscayne Bay and Card Sound adjacent to the canal system did not enter when the canal system was open. All fish found within the canals are members of species which were common or abundant outside the canal system in adjacent waters.



Plankton station numbers in association with fish stations are indicated by ( ).

Figure 1. Fish sampling station locations, Turkey Point Cooling Canal System, 1982.

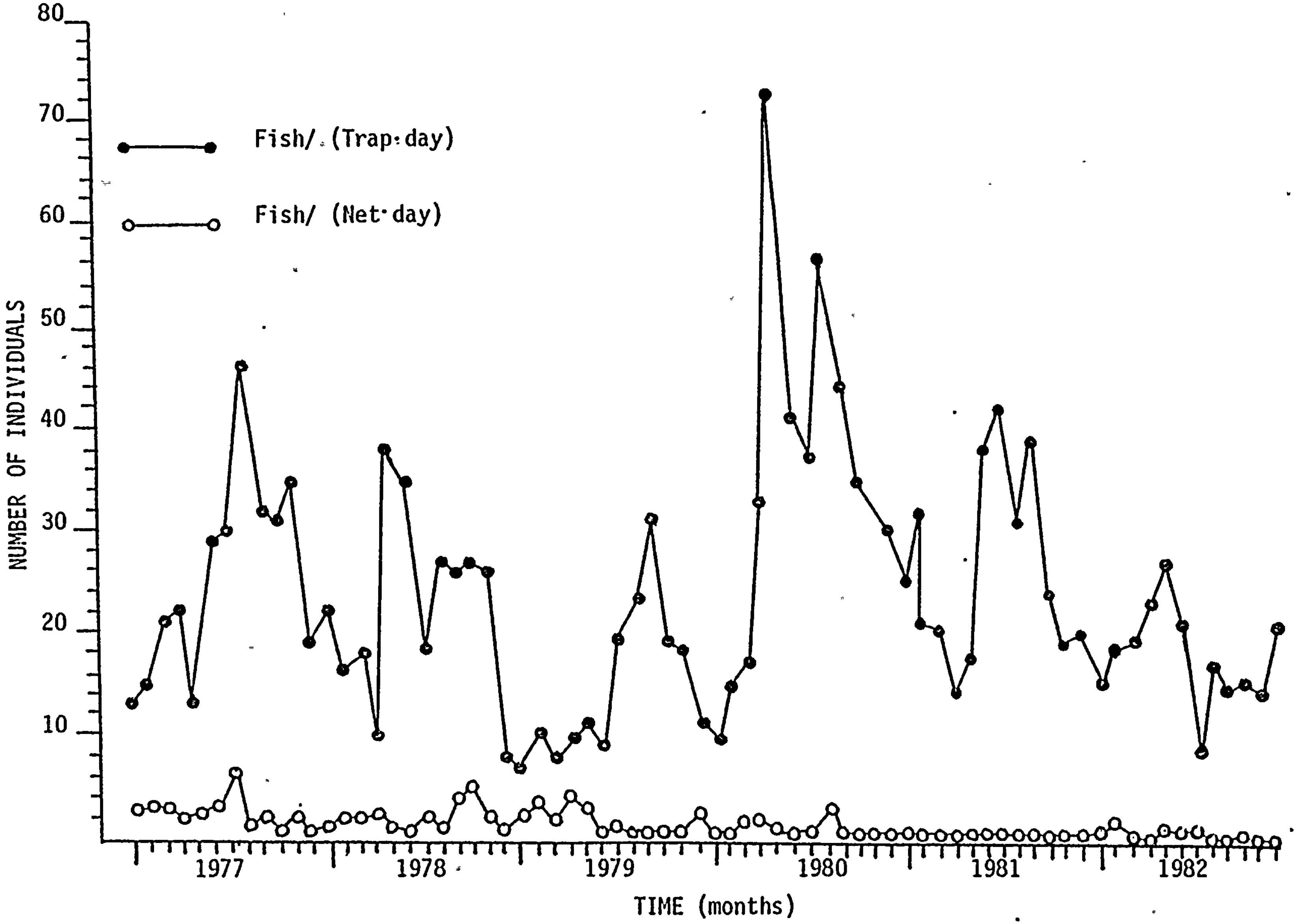


Figure 2. Minnow trap and gill net catch per unit effort in Turkey Point Cooling Canal System, 1977-1982.

Table 1. Fish collected within the Turkey Point Cooling Canal System, 1982.

COMMON NAME	SCIENTIFIC NAME	NUMBER OF INDIVIDUALS	RANGE OF LENGTHS (mm)	TOTAL WEIGHT (g)	% COMPOSITION BY (NO.)	(WT.)
Goldspotted Killifish	*Floridichthys carpio*[a]	2228	20-68	4181.7	51.8	6.5
Sheepshead Minnow	*Cyprinodon variegatus*[a]	1562	16-48	1467.7	36.3	2.3
Sailfin Molly	*Poecilia latipinna*[a]	286	19-64	568.7	6.6	0.9
Crested Goby	*Lophogobius cyprinoides*[a]	92	32-80	424.2	2.1	0.7
Gulf Toadfish	*Opsanus beta*[a]	39	24-240	1132.6	0.9	1.8
Gulf Killifish	*Fundulus grandis*[a]	23	68-115	395.0	0.5	0.6
Rainwater Killifish	*Lucania parva*[a]	21	21-38	15.8	0.5	<0.1
Yellowfin Mojarra	*Gerres cinereus*	15	180-265	3917.1	0.4	6.1
Gray Snapper	*Lutjanus griseus*	14	290-584	17 218.1	0.3	26.7
Pike Killifish	*Belonesox belizanus*[a]	8	54-100	54.5	0.2	0.1
Bonefish	*Albula vulpes*	4	526-580	1149.5	0.1	17.8
Great Barracuda	*Sphyraena barracuda*	4	688-820	8705.4	0.1	13.5
Redfin Needlefish	*Strongylura notata*[a]	4	218-295	88.1	0.1	<0.1
Crevalle Jack	*Caranx hippos*	2	720-756	14 857.6	<0.1	23.0
Marsh Killifish	*Fundulus confluentus*[a]	2	32-48	3.3	<0.1	<0.1
Tidewater Silverside	*Menidia peninsulae*	1	42	0.9	<0.1	<0.1

[a]Species presumed to be reproducing because of the presence of juveniles.

Table 2. Fish collected within the Turkey Point Cooling Canal System, 1978-1982.

COMMON NAME[a]	SCIENTIFIC NAME	NUMBER OF INDIVIDUALS PER YEAR				
		1978[b]	1979[c]	1980[c]	1981[c]	1982[c]
Goldspotted Killifish	*Floridichthys carpio*[d]	3233	1984	3153	3579	2228
Sheepshead Minnow	*Cyprinodon variegatus*[d]	1212	1091	4672	2521	1562
Sailfin Molly	*Poecilia latipinna*[d]	173	48	228	153	286
Crested Goby	*Lophogobius cyprinoides*[d]	73	154	204	81	92
Gulf Toadfish	*Opsanus beta*[d]	6	13	23	26	39
Gulf Killifish	*Fundulus grandis*[d]	2	0	7	13	23
Rainwater Killifish	*Lucania parva*[d]	13	10	6	16	21
Yellowfin Mojarra	*Gerres cinereus*	29	58	87	34	15
Gray Snapper	*Lutjanus griseus*	4	9	8	3	14
Pike Killifish	*Belonesox belizanus*[d]	15	0	0	4	8
Great Barracuda	*Sphyraena barracuda*	6	8	7	1	4
Bonefish	*Albula vulpes*	8	6	3	4	4
Redfin Needlefish	*Strongylura notata*[d]	2	0	0	0	4
Marsh Killifish	*Fundulus confluentus*[d]	4	1	1	0	2
Crevalle Jack	*Caranx hippos*	1	1	0	0	2
Tidewater Silverside	*Menidia peninsulae*	1	3	0	7	1
Silver Jenny	*Eucinostomus gula*	21	44	8	2	0
Sea Catfish	*Arius felis*	4	0	0	0	0
Atlantic Needlefish	*Strongylura marina*	0	0	1	1	0

Table 2. Fish collected within the Turkey Point Cooling Canal System, 1978-1982. (Cont'd)

COMMON NAME[a]	SCIENTIFIC NAME	NUMBER OF INDIVIDUALS PER YEAR				
		1978[b]	1979[c]	1980[c]	1981[c]	1982[c]
Ladyfish	*Elops saurus*	0	0	0	1	0
Mosquitofish	*Gambusia affinis*	0	0	2	0	0
Spotfin Mojarra	*Eucinostomus argenteus*	13	3	1	0	0
Drum	SCIAENIDAE	0	0	1	0	0
Striped Mojarra	*Diapterus plumieri*	1	3	0	0	0
Schoolmaster	*Lutjanus apodus*	4	2	0	0	0
Sharksucker	*Echeneis naucrates*	0	2	0	0	0
Bluestriped Grunt	*Haemulon sciurus*	2	1	0	0	0
Sailors Choice	*Haemulon parrai*	0	1	0	0	0
Atlantic Spadefish	*Chaetodipterus faber*[e]	0	1	0	0	0
Snook	*Centropomus undecimalis*	4	0	0	0	0
Pinfish	*Lagodon rhomboides*	1	0	0	0	0
Total fishes		4829	3443	8412	6443	4305

[a] Ranked from most abundant to least abundant, based on 1982 collections.
[b] FPL, 1973-1978
[c] FPL, 1979-1982
[d] Species which are reproducing.
[e] Observed, but not collected during 1982.

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.

COMMON NAME	SCIENTIFIC NAME	NUGENT AUG. 1968 THRU JAN. 1970	A.B.I.[a] DEC. 1974 THRU DEC. 1978	FPL/LU[b] JAN. 1979 THRU DEC. 1982
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
Bluestriped 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	---	X
Fat Sleeper	Dormitator maculatus	---	X	---
Fat Snook	Centropomus parallelus	X	---	---
Goby	Gobionellus sp.	---	X	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.

COMMON NAME	SCIENTIFIC NAME	NUGENT AUG. 1968 THRU JAN. 1970	A.B.I.[a] DEC. 1974 THRU DEC. 1978	FPL/LU[b] JAN. 1979 THRU DEC. 1982
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	---	---
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

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.

COMMON NAME	SCIENTIFIC NAME	NUGENT AUG. 1968 THRU JAN. 1970	A.B.I.[a] DEC. 1974 THRU DEC. 1978	FPL/LU[b] JAN. 1979 THRU DEC. 1982
Mosquitofish	Gambusia affinis	X	---	X
Mummichog	Fundulus heteroclitus	X	---	---
Nurse Shark	Ginglymostoma cirratum	X	---	---
Permit	Trachinotus flacatus	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
Sailors Choice	Haemulon parrai	X	X	X
Sargussumfish	Histrio histrio	X	---	---
Scrawled Cowfish	Lactophrys quadricornis	X	---	---
Schoolmaster	Lutjanus apodus	X	X	X
Sea Catfish	Arius felis	X	X	X
Sharksucker	Echeneis naucrates	---	X	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.

COMMON NAME	SCIENTIFIC NAME	NUGENT AUG. 1968 THRU JAN. 1970	A.B.I.[a] DEC. 1974 THRU DEC. 1978	FPL/LU[b] JAN. 1979 THRU DEC. 1982
Sheepshead	Archosargus probatocephalus	X	X	X
Sheepshead Minnow	Cyprinodon variegatus	X	X	X
Shortnose Gar	Lepisisteus platostamus	X	---	---
Silver Jenny	Eucinostomus gula	X	X	X
Snook	Centropomus undecimalis	X	X	X
Southern Stingray	Dasyatis americana	X	---	---
Spot	Leiostomus xanthurus	X	---	---
Spotfin Mojarra	Eucinostomus argenteus	X	X	X
Spotted Seatrout	Cynoscion nebulosus	X	---	---
Striped Mojarra	Diapterus plumieri	X	X	X
Striped Mullet	Mugil cephalus	X	X	X
Tarpon	Megalops atlantica	X	---	X
Tarpon Snook	Centropomus pectinatus	X	---	---
Tidewater Silverside	Menidia peninsulae	---	X	X
Tripletail	Lobotes surinamensis	X	---	---
White Mullet	Mugil curema	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.

COMMON NAME	SCIENTIFIC NAME	NUGENT AUG. 1968 THRU JAN. 1970	A.B.I.[a] DEC. 1974 THRU DEC. 1978	FPL/LU[b] JAN. 1979 THRU DEC. 1982
Yellowfin Mojarra	Gerres cinereus	X	X	X

[a]FPL, 1974-1978
[b]FPL, 1979-1982

3. Benthos (ETS 4.1.1.1.3)

a. Characteristics of the Sediments

Introduction

This study of the characteristics of the sediments is 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, hereafter referred to as the canal system. To assess potential biological changes resulting from operation of the Turkey Point Plant, results of sediment analysis from samples collected in the canal system are compared with data from samples collected at three control areas in adjacent Biscayne Bay, hereafter referred to as the bay (Figure 1).

From September 1970 through May 1971, preoperational chemical data were collected in the bay and Card Sound (RSMAS, 1971, 1972). These studies differed from the existing operational monitoring program in many aspects (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 canal system.

Water and sediments in the canal system are potentially oxygen poor for several reasons related to system design and location. The canals are a closed system used for heat dissipation. Heated water from the power plant discharge does not mix with water outside the system but is circulated through the canals and then re-enters the plant.

Additionally, the canal system is located in the subtropics that are characterized by the high production of organic material. Evidence of anoxic conditions, if present, would be observed first in the interstitial water of the sediment-water interface.

Various chemicals used in Turkey Point Plant operations (Section II.B - Table 2 and 3) are considered in evaluating the results of the chemistry program (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 (Figure 1). 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, nitrate, nitrite, ammonium and orthophosphate. Standard analytical methods (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 hydrogen sulfide, 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 the sediment samples was measured with a standard Corning Model 10 pH meter. Salinity was measured with a Yellow Springs Instrument (YSI) Model 33 salinity-conductivity-temperature (S-C-T) meter. Temperature was measured in the field using a YSI Model 42 single channel temperature meter.

Results

The results of analyses of sediment samples collected monthly from canal and bay stations are presented in Tables 2 through 12. The following physical and chemical parameters were measured: pH, salinity, temperature, soluble sulfate, soluble sulfite, soluble sulfide, insoluble sulfide, soluble nitrate, soluble nitrite, soluble ammonium and soluble orthophosphate. The ranges of selected parameters measured in 1982 are presented in Table 14. No values were appreciably outside the historic range measured in past studies. Each parameter is discussed in light of changes from 1981 to 1982 and differences between canal and bay station values.

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 6.5 to 8.4. Measurements for Biscayne Bay stations ranged from 7.0 to 8.8 (Tables 2 and 14). These values are close to the narrow range of 6.8 to 8.2 found for most marine porewaters (Goldberg, 1974). Comparison of 1982 average values (Table 15) shows very small variations among canal stations (7.5 to 7.9) and Biscayne Bay stations (8.0 to 8.2).

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 from only 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 1982, the salinity of the sediments ranged from 20.0 to 35.0 ppt in the canal system and from 10.0 to 30.0 ppt at bay stations (Tables 3 and 16). In 1981, these ranges were from 18.0 to 46.0 ppt for the canal system and from 1.5 to 40.0 ppt for the bay stations (Table 16). The average yearly sediment salinity in the canal system was 30.4 ppt in 1978, 29.3 ppt in 1979, 31.3 ppt in 1980, 30.5 ppt in 1981, and 29.0 ppt in 1982 (Table 17). The average yearly sediment salinity at the adjacent bay sampling stations was 22.2 ppt in 1978, 22.5 ppt in 1979, 23.9 ppt in 1980, 23.4 ppt in 1981, and 22.8 ppt in 1982. Because the bay stations are located at the end of a relatively large drainage area which receives freshwater runoff, the lower salinity here is not surprising.

There was no increase in sediment salinity from 1981 to 1982 in the canal system, although values were higher in the canals than at control stations in the bay. Seasonal variations in salinity were also noted with high values generally occurring in May and low salinity values occurring in November or December (Table 3). It is likely that the low salinity in November and December resulted from seasonal rainfall in the Turkey Point area.

Temperature

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 in the Turkey Point Canal System reflected the thermal discharge from the power plant and solar heating of the canals. Temperatures ranged from 16.9 to 42.0°C in the canal system and from 19.4 to 30.0°C at control stations in the bay (Tables 4 and 16). In 1981, temperatures ranged from 12.4 to 42.5°C in the canal system and from 11.1 to 29.6°C in the bay stations (Table 16). Canal system stations had higher yearly average temperatures than bay stations (Table 17). The highest average temperature (36.3°C) was recorded at canal Station 8, lower temperatures were found at Stations 5, 6, and 7 (29.9 to 30.9°C), and the lowest readings were at Stations 1, 2, 3 and 4 (26.6 to 29.1°C; Table 15). 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 re-enters the plant near Station 1. Temperatures observed at Station 8 were in a range that could exclude some biota occurring in the other parts of the 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-sul-

fide conversion) is active. Because the Turkey Point canal network is a closed system, there is potential for anoxic conditions to exist in which sulfide could build up within the sediment through depletion of available sulfate.

During 1982, the sulfate concentration ranged from 1681 to 4625 ppm in the canal system and from 620 to 3591 ppm at the bay stations (Table 16). In 1981, these values ranged from 1569 to 4841 ppm in the cooling canals and from 887 to 3519 ppm at the bay stations (Table 16). The average yearly sulfate concentration in the canal waters was about 25 percent higher than in the bay samples (2243 ppm; Table 17). The average yearly sulfate concentration in the canal waters decreased from 3018 ppm in 1981 to 2807 ppm in 1982. In the bay, sulfate concentrations increased slightly from 2212 ppm in 1981 to 2243 ppm in 1982.

Soluble sulfite values in 1982 ranged from <2.0 to 5.0 ppm in the canal system and from <2.0 to 3.0 ppm at the bay stations (Table 6). In 1981, sulfite levels ranged from <2.0 to 23.0 ppm in the canal system and from <2.0 to 15.0 ppm in the bay (FPL, 1982).

During 1982, levels of soluble sulfide (Table 7) were generally below the detectable limit of 0.05 ppm for the analytical method used. Similarly low levels were observed in 1981.

Insoluble sulfide values in the canal system ranged from <0.05 to 14.62 µg/g wet weight of soil and in the bay from <0.05 to 3.07 µg/g wet

weight of soil (Table 8). The yearly average value of insoluble sulfide at canal stations was 1.72 μg/g in 1982 as compared to 1.49 μg/g wet weight of soil in 1981. At the bay stations, the yearly average value was 0.88 μg/g in 1982 as compared to 0.94 μg/g wet weight of soil in 1981. The levels of sulfur (including sulfate, sulfite, soluble and insoluble sulfide) detected in canal system samples indicate that these sediments are 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 interstitial waters 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 canal system samples.

During 1982, nitrate concentrations ranged from <0.001 to 33.337 ppm in the canal system and from 0.002 to 22.716 ppm at the bay stations (Tables 9 and 16). In 1981, these ranges were: 0.014 to 0.914 ppm in the cooling canals and <0.001 to 0.367 ppm for the bay stations (Table 16). The range of values in 1982 was greater than in past years primarily because of a few high values measured in January 1982 (Table 9). The average nitrate concentration at canal system stations in 1982 was 0.584 ppm as compared with a 1981 average value of 0.109 ppm (Table 17). At the bay stations, the average nitrate concentration was 0.715 ppm in

1982 and 0.083 ppm in 1981. The higher average nitrate values measured in 1982 in canal as well as bay stations resulted from a few high values measured in January 1982. The overall moderate increase in nitrate values during 1982 shows that there was no depletion of nitrate that might indicate anoxic conditions in the cooling canals.

During 1982, nitrite concentrations ranged from 0.001 to 0.163 ppm in the canal system and from 0.001 to 0.013 ppm for the bay stations (Tables 10 and 16). In 1981, these ranges were similar, 0.002 to 0.046 in the canal system and 0.002 to 0.033 ppm for the bay stations. The yearly average value for canal stations was 0.010 ppm and 0.006 ppm for the bay stations (Table 17). This constancy in nitrite concentrations indicates that during 1982 there was no depletion of nitrite in the canal system due to anoxic conditions.

Ammonium concentrations measured in the canal system during 1982 ranged from 0.16 to 4.08 ppm (Tables 11 and 16). These values were similar to control station values, which ranged from 0.11 to 7.51 ppm. In 1981, the range of ammonium values in the canal system (<0.01 to 6.66 ppm) was higher than the range of values at the bay stations (0.28 to 10.0 ppm). The 1982 yearly average value was 1.08 ppm for the canal stations and 1.16 ppm for the bay stations (Table 17). Yearly average values were 1.18 ppm ammonium at the canal stations and 2.25 ppm at the bay stations in 1981. Comparison with the bay stations and 1981 values indicates that during 1982 there was no increase in ammonium concentrations that might indicate anoxic conditions 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) with ammonium and, to a lesser extent, sulfide.

During 1982, orthophosphate values in interstitial waters ranged from <0.01 to 0.11 ppm in the cooling canals (Tables 12 and 16) and from <0.01 to 0.05 ppm at the control stations in Biscayne Bay. In 1981, orthophosphate values ranged from <0.01 to 0.55 ppm in the canal system and from <0.01 to 0.10 ppm for the bay stations. Yearly average values in 1982 were less than the detection limit of 0.01 ppm at canal system and bay stations (Table 17). From 1981 to 1982, there was no increase in orthophosphate concentrations in the interstitial waters of the cooling canals, thereby indicating 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 (Table 1). However, the values for the same parameters generally were in similar ranges. The pH range of 7.0 to 7.8 found in Card Sound sediments in 1970-71 is lower than the pH range found during 1982 (7.0-8.8; Table 16). The salinity of Biscayne Bay/Card Sound water

during the 1970-71 sampling was slightly higher (27.3 to 44.4 ppt) than that of sediments in Biscayne Bay control stations in 1982 (10.0 to 30.0 ppt). Differences in pH and salinity probably resulted from differences in amounts of rainfall and from differences in station locations between the preoperational and present operational studies. The range of nitrate values (<0.001 to 0.023 ppm) found during the preoperational study was lower than that found in 1982 (0.002 to 22.716). 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 1982 monitoring.

Conclusion

In the canal system, salinity, temperature and sulfate values of sediment samples are higher than in the bay. Temperatures of the cooling canal sediments are influenced by plant operations as shown by the decrease in temperature at stations farther from the plant discharge. Salinity and sulfate values are influenced by outside factors such as water evaporation and rainfall.

Anoxic conditions result when ammonium, sulfide and phosphate concentrations increase. In the canal system, average ammonium values in 1982 are slightly lower than in 1981, ammonium values in the bay also decreased since last year (Table 17). These results suggest that environmental conditions such as drought, which may have caused high concentrations in 1981 were temporary and no longer are of concern in 1982. Sulfate and orthophosphate values are similar to those of previous years

at canal and bay stations. The high nitrate values in the canal system show that there is no depletion of nitrate due to anoxic conditions. All other parameters are in the same range as values from control stations.

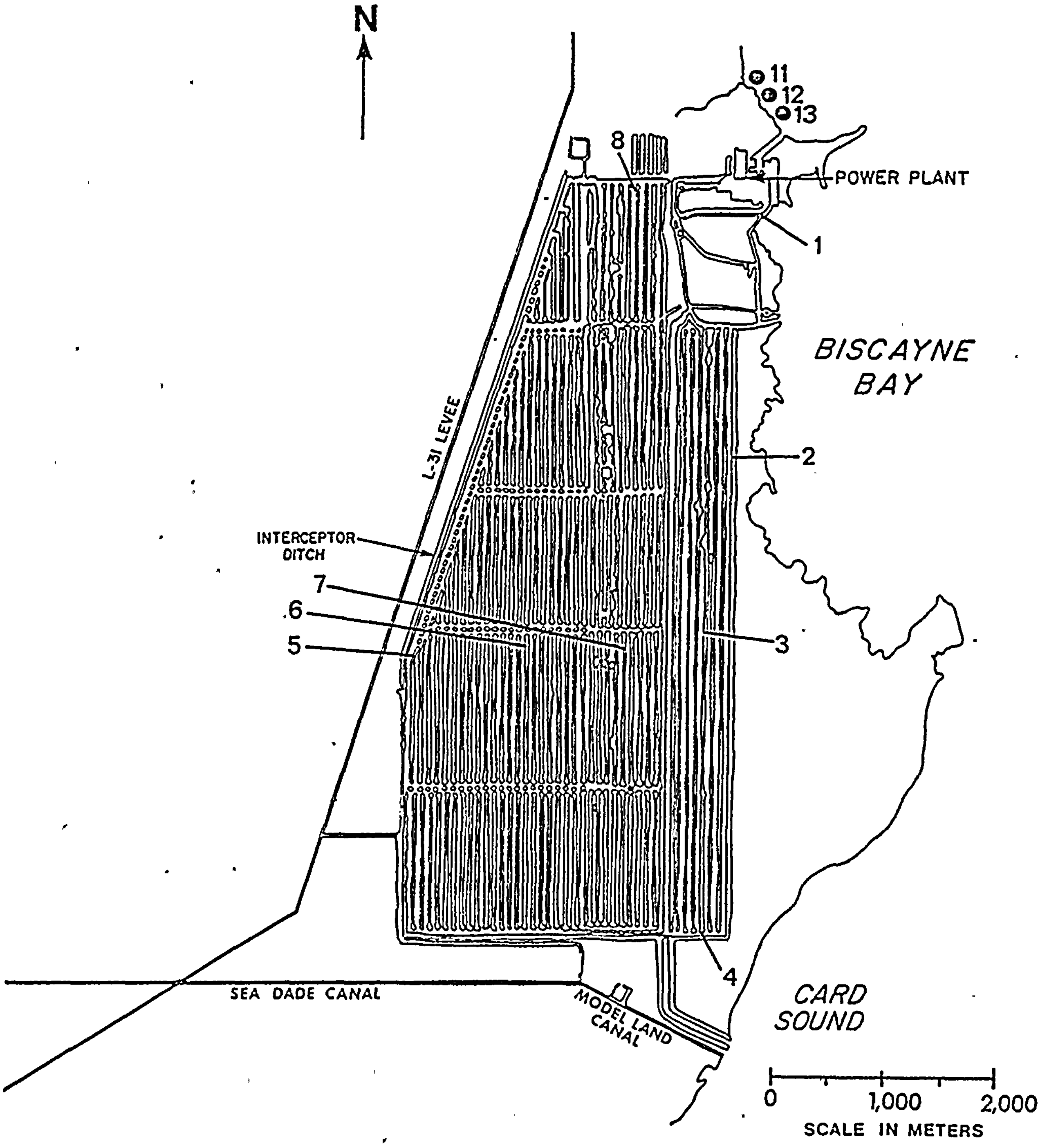


Figure 1. Chemistry sampling locations, Turkey Point Plant, 1982.

Table 1. Parameters measured during the preoperational studies and 1982 operational study at the Turkey Point Plant Site.

PARAMETER	PREOPERATIONAL STUDIES[a] 1970-1971		OPERATIONAL STUDY 1982		
	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			

[a]RSMAS, 1971, 1972.

Table 2. pH of sediments at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	7.7	7.9	8.1	8.1	8.2	8.1	8.0	8.2	8.8	8.6	8.1
Feb.	7.7	8.0	7.9	8.1	8.1	8.0	7.9	8.3	8.5	8.4	8.2
Mar.	7.6	7.8	7.9	7.5	8.0	8.1	8.2	8.0	8.7	8.4	8.6
Apr.	7.5	7.5	8.0	8.0	8.2	8.4	8.3	8.3	8.4	8.3	8.4
May	7.8	7.7	7.8	7.9	8.0	7.9	8.1	8.1	8.6	8.8	8.0
Jun.	7.5	7.9	7.9	8.1	8.3	8.1	8.1	8.1	8.4	8.8	8.0
Jul.	7.9	7.4	7.6	7.7	7.8	8.0	7.7	7.7	8.2	8.3	8.4
Aug.	7.6	7.5	7.8	7.5	7.6	7.5	7.2	7.3	7.4	8.1	7.6
Sep.	7.3	7.5	7.6	7.4	7.7	7.7	7.6	7.7	8.6	7.5	7.0
Oct.	8.0	8.2	7.8	7.9	8.0	8.1	7.9	8.0	8.0	8.3	8.8
Nov.	6.5	6.8	6.5	7.3	6.7	6.9	6.8	6.8	8.0	8.0	8.0
Dec.	7.1	7.2	7.1	7.3	7.7	7.2	7.0	7.3	7.0	7.0	7.0

TP1
BTABLE2

Table 3. Salinity (ppt) of sediments at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	26.0	26.0	29.0	29.0	25.0	29.0	28.0	29.0	23.0	26.0	25.0
Feb.	31.0	31.0	31.0	31.0	30.0	31.0	31.0	28.0	26.0	26.0	26.0
Mar.	31.0	31.0	33.0	31.0	28.0	32.0	30.0	31.0	30.0	30.0	30.0
Apr.	29.0	29.0	29.0	29.0	29.0	31.0	31.0	28.0	30.0	30.0	30.0
May	35.0	34.0	34.0	34.0	33.0	34.0	34.0	33.0	20.0	19.0	19.0
Jun.	28.0	28.0	29.0	28.0	28.0	28.0	28.0	28.0	23.0	22.0	23.0
Jul.	29.0	29.0	29.0	29.0	29.0	27.0	28.0	25.0	23.0	19.0	24.0
Aug.	20.0	24.5	24.9	26.6	27.2	27.5	25.7	22.8	23.6	23.8	23.2
Sep.	24.9	26.0	27.2	26.8	24.8	26.7	27.1	27.3	21.2	21.8	21.6
Oct.	29.2	30.4	32.8	31.8	33.2	29.3	34.1	34.2	27.8	25.5	29.0
Nov.	32.2	33.5	32.3	34.0	32.2	30.8	33.2	31.5	10.4	10.3	10.0
Dec.	24.0	25.1	24.0	24.5	23.5	24.2	25.0	25.1	16.0	16.7	17.0

Table 4. Temperature (°C) of sediment surface at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	26.2	25.7	24.0	25.8	27.8	27.5	27.2	32.0	23.3	23.3	23.5
Feb.	22.0	21.0	16.9	19.2	23.0	21.5	21.5	29.9	20.0	19.5	19.4
Mar.	28.4	28.8	26.3	26.8	28.2	28.5	29.0	37.2	25.0	25.3	25.8
Apr.	25.8	25.6	25.2	26.1	30.9	29.8	30.0	34.5	25.8	25.0	25.0
May	28.4	28.3	26.5	28.4	31.5	30.8	31.2	36.9	24.3	24.7	24.7
Jun.	32.9	32.6	31.8	32.8	35.2	34.2	34.8	40.5	29.1	29.2	29.8
Jul.	33.4	32.7	30.2	31.7	34.0	32.6	33.6	38.3	28.8	28.8	28.9
Aug.	32.2	31.0	29.1	30.9	34.7	32.8	33.2	40.0	27.3	27.4	27.7
Sep.	34.0	32.9	30.2	32.8	34.6	33.8	34.7	42.0	29.3	29.2	29.5
Oct.	31.1	30.0	30.0	31.1	34.8	33.0	33.7	39.0	30.0	30.0	30.0
Nov.	24.2	24.7	24.7	25.0	28.1	27.3	27.8	31.5	23.0	22.9	23.0
Dec.	26.0	25.4	24.8	25.8	28.5	27.2	27.8	34.3	23.3	23.5	23.5

Table 5. Analysis of soluble sulfate (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	1866	2322	2358	2531	2157	2300	2174	2433	2034	2098	2011
Feb.	2692	2866	2694	1943	2392	2660	2652	2620	2345	2120	2416
Mar.	2838	2766	2766	2451	2651	2786	2807	2807	2885	2967	2810
Apr.	2642	2899	2944	3014	3048	3118	3113	2814	2840	2976	2274
May	2881	2975	2393	2558	2918	3270	2905	2823	1760	1545	1431
Jun.	2721	2777	2666	2908	2791	2851	2976	2856	2357	2399	2378
Jul.	2566	2738	2711	2632	2356	2759	2893	2641	2468	2393	2318
Aug.	3254	3373	3246	3552	4366	4625	4088	2958	3234	3591	3354
Sep.	3046	3151	3094	3236	2810	3190	3200	2987	2286	2561	2487
Oct.	2757	2715	2755	2814	2745	2819	2814	2753	2428	2417	2397
Nov.	2592	2546	2507	2901	1681	2744	2627	2439	620	883	827
Dec.	2837	2749	2828	2761	2791	2781	2777	2877	1677	1567	1597

Table 6. Analysis of soluble sulfite (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	<2.0[a]	<2.0	<2.0	2.0	<2.0	2.0	<2.0	<2.0	<2.0	<2.0	2.0
Feb.	<2.0	<2.0	<2.0	2.0	2.0	<2.0	<2.0	2.0	<2.0	2.0	<2.0
Mar.	<2.0	<2.0	2.0	<2.0	<2.0	<2.0	2.0	<2.0	<2.0	<2.0	<2.0
Apr.	<2.0	<2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0
May	<2.0	<2.0	<2.0	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Jun.	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	<2.0	2.0	<2.0	<2.0	<2.0
Jul.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Aug.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sep.	<2.0	5.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Oct.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nov.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dec.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

[a]Detection limit is 2.0 ppm.

Table 7. Analysis of soluble sulfide (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	<0.05[a]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09
Feb.	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mar.	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Apr.	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
May	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Jun.	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Jul.	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aug.	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	0.10	<0.05	0.06	<0.05	0.10
Sep.	<0.05	0.90	<0.05	<0.05	<0.05	<0.05	0.10	<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	0.07	<0.05

[a]Detection limit is 0.05 ppm.

Table 8. Analysis of insoluble sulfide (μg/g wet weight sediment) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	0.10	0.23	0.33	6.05	0.14	0.46	0.20	2.20	0.05	0.79	2.18
Feb.	9.59	3.58	1.26	2.70	0.19	0.05	0.08	0.17	0.94	3.07	2.99
Mar.	2.16	0.51	2.90	0.08	1.25	<0.05[a]	1.42	0.39	0.05	0.07	1.30
Apr.	0.08	0.04	0.23	6.02	0.32	0.31	0.09	0.43	0.06	0.06	0.02
May	12.52	14.62	14.25	9.01	1.73	0.07	1.56	<0.05	0.30	0.08	1.80
Jun.	1.20	2.94	0.16	2.61	1.95	2.15	0.48	0.14	0.46	1.58	2.84
Jul.	1.31	1.15	11.48	1.59	0.14	0.44	0.26	0.21	0.12	0.75	2.17
Aug.	1.63	4.49	0.14	4.62	1.74	<0.05	<0.05	0.18	0.86	1.47	1.71
Sep.	3.15	0.10	3.50	0.84	0.52	0.67	0.11	0.19	0.08	0.08	0.21
Oct.	0.16	0.09	0.29	0.24	0.12	0.10	0.45	0.06	0.13	0.07	0.04
Nov.	0.14	<0.05	0.18	0.06	0.06	0.09	0.48	0.82	0.46	0.05	<0.05
Dec.	2.28	0.42	6.14	2.69	0.23	0.20	0.53	1.81	1.71	0.69	2.37

[a]Detection limit is 0.05 ppm.

Table 9. Analysis of soluble nitrate (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	33.337	0.268	4.104	0.343	0.671	0.443	269.349[a]	0.063	0.293	0.084	22.716
Feb.	0.051	0.052	0.055	0.356	0.242	0.074	0.091	0.080	0.068	0.074	0.119
Mar.	0.043	0.016	0.011	0.007	0.008	0.006	0.009	0.012	0.141	0.009	0.010
Apr.	1.810	0.068	0.109	0.027	0.035	0.113	0.075	0.042	0.027	0.016	0.034
May	<0.001[b]	0.023	<0.001	0.033	<0.001	6.662	0.020	0.002	0.002	0.009	0.105
Jun.	0.097	0.056	0.093	0.050	0.099	0.095	0.087	0.114	0.138	0.077	0.067
Jul.	0.063	0.058	0.084	0.057	0.105	0.501	0.176	0.117	0.068	0.077	0.151
Aug.	0.014	0.222	0.077	0.023	0.040	0.098	0.026	0.032	0.004	0.026	0.035
Sep.	0.058	0.044	0.046	0.421	0.041	0.030	0.057	0.056	0.199	0.042	0.049
Oct.	0.138	0.220	0.039	0.040	0.081	0.023	0.021	0.038	0.053	0.086	0.085
Nov.	0.047	0.023	0.176	0.072	0.095	0.148	0.081	0.140	0.067	0.159	0.148
Dec.	0.312	0.287	0.254	0.256	0.235	0.266	0.246	0.253	0.181	0.164	0.173

[a]This unusually high value was excluded from calculations of averages.

[b]Detection limit is 0.001 ppm.

Table 10. Analysis of soluble nitrite (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	0.010	0.017	0.014	0.011	0.013	0.015	0.025	0.011	0.009	0.009	0.013
Feb.	0.008	0.007	0.005	0.016	0.010	0.007	0.012	0.009	0.006	0.007	0.007
Mar.	0.003	0.002	0.001	0.001	0.002	0.002	0.003	0.002	0.003	0.001	0.002
Apr.	0.006	0.005	0.006	0.003	0.006	0.006	0.007	0.004	0.003	0.003	0.004
May	0.008	0.011	0.004	0.013	0.008	0.080	0.016	0.011	0.009	0.008	0.012
Jun.	0.005	0.004	0.005	0.005	0.003	0.003	0.007	0.007	0.003	0.003	0.003
Jul.	0.008	0.006	0.011	0.010	0.010	0.009	0.008	0.008	0.006	0.007	0.008
Aug.	0.012	0.014	0.013	0.005	0.006	0.010	0.007	0.009	0.004	0.006	0.006
Sep.	0.006	0.005	0.004	0.005	0.005	0.005	0.005	0.005	0.009	0.005	0.005
Oct.	0.005	0.163	0.008	0.004	0.004	0.003	0.003	0.003	0.004	0.006	0.004
Nov.	0.006	0.008	0.008	0.007	0.005	0.006	0.007	0.008	0.006	0.011	0.005
Dec.	0.004	0.010	0.005	0.003	0.006	0.003	0.004	0.006	0.003	0.002	0.002

Table 11. Analysis of soluble ammonium (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	2.37	1.40	1.62	1.27	1.02	1.46	1.37	1.05	1.40	1.14	1.84
Feb.	2.26	0.72	0.95	0.65	0.27	0.44	0.24	0.54	0.52	1.15	3.40
Mar.	1.09	1.08	1.26	2.04	0.52	0.72	0.22	0.66	0.67	0.11	0.47
Apr.	1.87	0.20	0.18	0.64	0.34	0.16	0.30	0.26	0.44	0.96	1.37
May	0.79	1.15	4.08	0.75	0.39	0.44	0.64	0.40	0.48	0.39	2.38
Jun.	1.02	1.46	1.00	0.67	0.77	0.75	0.58	0.90	0.75	1.02	1.01
Jul.	2.62	1.87	1.07	0.42	0.69	0.45	0.36	0.65	0.74	0.24	7.51
Aug.	4.04	2.36	1.04	2.66	1.09	1.00	0.75	1.61	0.54	1.29	1.94
Sep.	2.08	0.59	0.38	0.58	1.00	1.03	0.52	0.63	0.55	0.40	2.07
Oct.	4.06	0.90	0.86	1.05	0.86	0.73	0.91	2.61	0.58	1.02	0.91
Nov.	1.99	1.50	2.05	1.34	0.40	0.60	0.46	1.73	1.04	0.50	1.49
Dec.	1.49	0.84	1.78	0.73	0.43	0.78	0.66	0.85	0.72	0.20	0.64

Table 12. Analysis of soluble orthophosphate (ppm) at stations in the Turkey Point Canals and Biscayne Bay, 1982.

MONTHS	STATION LOCATION AND NUMBER										
	Turkey Point Canal System								Biscayne Bay		
	1	2	3	4	5	6	7	8	11	12	13
Jan.	0.02	<0.01[a]	0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01
Feb.	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mar.	<0.01	0.01	<0.01	0.04	<0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01
Apr.	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
May	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Jun.	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Jul.	0.04	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aug.	0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sep.	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01
Oct.	0.11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.04	<0.01	0.05
Nov.	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dec.	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

[a] Detection limit is 0.01 ppm.

Table 13. Methods for chemical analysis of sediment and interstitial water at the Turkey Point Plant, 1982.

PARAMETER	METHOD	REFERENCE
Sulfate	turbidimetric (barium sulfate)	APHA, 15th edition, 1980, p. 439
Sulfite	titrimetric (iodide-iodate)	APHA, 15th edition, 1980, p. 451
Sulfide	spectrophotometric (p-phenylenediamine)	Strickland and Parsons, 1972, p. 41
Nitrate nitrogen	automated cadmium reduction method	APHA, 15th edition, 1980, p. 376
Nitrite nitrogen	automated diazotization method	APHA, 15th edition, 1980, p. 376
Ammonia nitrogen	automated phenate method	APHA, 15th edition, 1980, p. 363
Orthophosphate	spectrophotometric (ascorbic acid)	APHA, 15th edition, 1980, p. 420

Table 14. Ranges of selected physical and chemical parameters at stations in the Turkey Point Canals and Biscayne Bay, 1982.

STATION[a]	pH	SALINITY (ppt)	TEMPERATURE (C°)	SOLUBLE SULFATE (ppm)	SOLUBLE NITRATE (ppm)	SOLUBLE NITRITE (ppm)	SOLUBLE AMMONIUM (ppm)	SOLUBLE ORTHOPHOSPHATE (ppm)
1	6.5-8.0	20.0-35.0	22.0-34.0	1866-3254	<0.001-33.337	0.003-0.012	0.79-4.06	<0.01-0.11
2	6.8-8.2	24.5-34.0	21.0-32.7	2322-3373	0.016-0.287	0.002-0.163	0.20-2.36	<0.01-0.03
3	6.5-8.1	24.0-34.0	16.9-31.8	2358-3246	<0.001-4.104	0.001-0.014	0.18-4.08	<0.01-0.01
4	7.3-8.1	24.5-34.0	19.2-32.8	2451-3552	0.007-0.421	0.001-0.016	0.42-2.66	<0.01-0.04
5	6.7-8.3	23.5-33.2	23.0-35.2	1681-4366	<0.001-0.671	0.002-0.013	0.27-1.09	<0.01-<0.01
6	6.9-8.4	24.2-34.0	21.5-34.2	2300-4625	0.006-6.662	0.002-0.080	0.16-1.46	<0.01-0.01
7	6.8-8.3	25.0-34.1	21.5-34.8	2174-4088	0.009-0.246	0.003-0.025	0.22-1.37	<0.01-0.01
8	6.8-8.3	22.8-34.2	29.9-42.0	2433-2987	0.002-0.253	0.002-0.011	0.26-1.73	<0.01-0.01
11	7.0-8.8	10.4-30.0	20.0-30.0	620-3234	0.002-0.293	0.003-0.009	0.44-1.40	<0.01-0.05
12	7.0-8.8	10.3-30.0	19.5-30.0	883-3591	0.009-0.164	0.001-0.011	0.11-1.29	<0.01-<0.01
13	7.0-8.8	10.0-30.0	19.4-30.0	827-3354	0.010-22.716	0.002-0.013	0.47-7.51	<0.01-0.05

[a]Stations 1-8 are in the Turkey Point Cooling Canal System; Stations 11-13 are in Biscayne Bay.

Table 15. Yearly average values for selected physical and chemical parameters at stations in the Turkey Point Canals and Biscayne Bay, 1982.

STATION[a]	pH	SALINITY (ppt)	TEMPERATURE (C°)	SOLUBLE SULFATE (ppm)	SOLUBLE NITRATE (ppm)	SOLUBLE NITRITE (ppm)	SOLUBLE AMMONIUM (ppm)	SOLUBLE ORTHOPHOSPHATE (ppm)
1	7.5	28.3	28.7	2724	2.998	0.007	2.14	0.03
2	7.6	29.0	29.1	2823	0.111	0.021	1.17	0.01
3	7.7	29.6	26.6	2747	0.421	0.007	1.36	<0.01
4	7.7	29.6	28.0	2775	0.140	0.007	1.07	<0.01
5	7.9	28.6	30.9	2726	0.138	0.007	0.65	<0.01
6	7.8	29.2	29.9	2992	0.705	0.012	0.71	<0.01
7	7.7	29.6	30.4	2919	0.081	0.009	0.58	<0.01
8	7.8	28.6	36.3	2751	0.079	0.007	0.99	<0.01
11	8.2	22.8	25.8	2245	0.103	0.005	0.70	0.01
12	8.2	22.5	25.7	2293	0.069	0.006	0.70	<0.01
13	8.0	23.2	25.9	2192	1.974	0.006	2.09	0.01

[a]Stations 1-8 are in the Turkey Point Cooling Canal System; Stations 11-13 are in Biscayne Bay.

[b]To calculate yearly means for orthophosphate, the value <0.01 ppm was considered equal to 0.

Table 16. 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).

PARAMETER	PREOPERATIONAL STUDIES	OPERATIONAL STUDY				
	1970-1971[a]	1978[b]	1979[b]	1980[b]	1981[b]	1982
pH (pH units)	7.0-7.8	7.2-8.7 (7.4-8.4)[c]	7.6-8.9 (7.8-8.9)	7.0-8.3 (7.2-8.3)	7.2-8.6 (7.7-9.4)	6.5-8.4 (7.0-8.8)
Salinity (ppt)	27.3-44.4	22.0-43.1 (11.6-37.7)	18.3-48.0 (14.0-31.5)	21.0-39.0 (8.2-35.8)	18.0-46.0 (1.5-40.0)	20.0-35.0 (10.0-30.0)
Temperature (C°)	-[d]	15.8-39.5 (18.5-33.9)	17.5-44.0 (10.0-37.0)	13.0-43.0 (10.2-30.3)	12.4-42.5 (11.1-29.6)	16.9-42.0 (19.4-30.0)
Soluble sulfate (ppm)	-[d]	360-3950 (180-3100)	2399-3450 (1521-3120)	2115-3611 (959-3215)	1569-4841 (887-3519)	1681-4625 (620-3591)
Soluble nitrate (ppm)	<0.001-0.023	0.002-0.346 (0.005-0.253)	<0.001-2.712 (<0.001-0.341)	<0.003-0.746 (0.004-0.404)	0.014-0.914 (<0.001-0.367)	<0.001-33.337 (0.002-22.716)
Soluble nitrite (ppm)	<0.001-0.003	<0.001-0.024 (<0.001-0.012)	<0.001-0.028 (<0.001-0.014)	<0.001-0.084 (<0.001-0.070)	0.002-0.046 (0.002-0.033)	0.001-0.163 (0.001-0.013)
Soluble ammonium (ppm)	-[d]	<0.01-1.91 (0.24-1.78)	0.02-0.97 (0.09-1.00)	0.10-6.02 (0.08-1.74)	<0.01-6.66 (0.28-10.00)	0.16-4.08 (0.11-7.51)
Soluble orthophosphate	<0.01-0.10	<0.01-0.24 (<0.01-0.17)	<0.01-0.90 (<0.01-0.24)	<0.01-0.15 (<0.01-0.08)	<0.01-0.55 (<0.01-0.10)	<0.01-0.11 (<0.01-0.05)

[a]RSMAS, 1971, 1972.

[b]FPL, 1979-1982.

[c]Biscayne Bay values in parentheses.

[d]No adequate data.

Table 17. Annual average values for selected physical and chemical parameters in the Turkey Point Canals and Biscayne Bay, 1978-1982.

PARAMETER	1978[a]	1979[a]	1980[a]	1981[a]	1982[a]
pH (pH units)[b]	7.9 (8.0)[c]	8.3[d] (8.5)	7.7 (7.9)	7.9 (8.4)	7.7 (8.1)
Salinity (ppt)	30.4 (22.2)	29.3 (22.5)	31.3 (23.9)	30.5 (23.4)	29.0 (22.8)
Temperature (C°)	28.8 (25.3)	29.2 (23.9)	29.4 (23.4)	27.6 (23.4)	30.0 (25.8)
Soluble sulfate (ppm)	2528 (1898)	3000 (2467)	3095 (2311)	3018 (2212)	2807 (2243)
Soluble nitrate (ppm)	0.089 (0.036)	0.503 (0.065)	0.104 (0.087)	0.109 (0.083)	0.584[e] (0.715)
Soluble nitrite (ppm)	0.004 (0.003)	0.005 (0.005)	0.008 (0.010)	0.010 (0.008)	0.010 (0.006)
Soluble ammonium (ppm)	0.44 (0.54)	0.37 (0.36)	0.74 (0.54)	1.18 (2.25)	1.08 (1.16)
Soluble orthophosphate	0.05 (0.01)	0.07 (0.05)	0.03 (0.01)	0.02 (0.01)	<0.01 (<0.01)

[a]FPL, 1979-1982.

[b]Because pH is a logarithmic scale, arithmetic mean values are inaccurate but are used here for comparative purposes only.

[c]Biscayne Bay values are in parentheses.

[d]Mean of 10 months sampled in 1979.

[e]If high values from Stations 1 and 13 in January 1982 are excluded from averages, mean nitrate concentrations for the canal system and the bay are 0.239 and 0.087 ppm, respectively.

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 abundance. A further objective of the study was to assess the impact of power plant operation on the cooling canal system environment since operation began and to compare the canal habitat to the adjacent lagoonal (Biscayne Bay) 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 stresses 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 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 for 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), EPA (1973), NESP (1975) and APHA (1980).

Turkey Point Cooling Canal System substrates were sampled semi-annually with an Ekman grab. The sample 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 with 5-percent formalin (Williams, 1974). 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. Temperature, salinity and dissolved oxygen measurements were made concurrently with each biotic sampling.

Three replicate grab samples were taken in May and October of 1982 at each of 11 sampling stations (Figure 1). In addition to the eight sampling stations in the canal system that have been sampled for nine years, three control stations were established in 1979 in Biscayne Bay north of the plant site. Control Station 1 is located on shallow flats just offshore. Control Station 2 is at the mouth of a small creek, and Control Station 3 is some distance up this same creek.

Biomass analyses of the samples were made on an ash-free dry weight basis (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 dividing the sum by 0.0696 m^2, the area sampled by three Ekman grabs.

The Shannon-Wiener index of diversity and the equitability component were also computed from the data. Species diversity has two components: the number of species (species richness) and the distribution of individuals among the species (species evenness). The inclusion of this latter component renders the diversity index relatively independent of sample size.

The Shannon-Wiener index of diversity ($\bar{d}$; Lloyd et al., 1968) calculates mean diversity and is recommended by the EPA (1973):

$$\bar{d} = \frac{C}{N}\left(N \log_{10} N - \Sigma n_i \log_{10} n_i\right)$$

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 above, 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).

The structure of the macroinvertebrate communities at each station was compared 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

Benthic macroinvertebrates collected in the Turkey Point Plant area were representatives of four main groups: polychaete worms, molluscs (snails and bivalves), crustaceans and a miscellaneous group of diverse organisms that were present irregularly and in small numbers (Tables 1 through 11). Benthic macroinvertebrate density, biomass and diversity at the Turkey Point Canal stations were generally lower than in 1980 and 1981, but were well within the ranges of values encountered since 1975 (Figures 2, 3 and 4). No significant changes in the benthic fauna of the canal system were indicated. The slight downward trend in benthic density, biomass, and diversity noted in 1982 after peaks in 1980-1981 are probably the result of annual cyclic variation superimposed upon the

usual seasonal cyclic variation. Benthic density at the control stations was generally higher than at most of the canal stations (with the exception of stations on the east side of the system). Biomass and diversity were also generally higher at the control stations than at the canal stations.

The canals were characterized by generally higher temperatures and salinities than were the control areas (Table 12). These environmental factors and differing substrates combine to make community structure at the control stations much different from that of the canal stations.

Discussion

Canal Stations

In 1982, the density of macroinvertebrates sampled in the canals varied considerably from station to station, ranging from 230 individuals/m^2 (Station F.1 in May and October; Table 8) to 11,092 individuals/m^2 (Station RF.3 in October; Table 4). Macrobenthos density was higher in October than in May, just the reverse of a fairly regular pattern of high May density/low October density noted over the past years (Figure 2). The mean density of all canal stations combined was 3613 individuals/m^2 in May and 4727 individuals/m^2 in October (Figure 2). The May 1982 mean density figure was among the lowest of May values recorded in the canals since 1975. This low value, following a record high mean density in May 1981 (FPL, 1982), illustrates the highly variable nature of the benthic macroinvertebrate fauna of the canal system. The October mean density figure was lower than in recent years but was moderate when compared to October means from all previous years (Figure 2).

Mean biomass in the canals was 2.159 g/m^2 in May and 5.044 g/m^2 in October (Figure 3). The May 1982 value was the lowest May mean biomass ever recorded in the canals while the October 1982 value was the second highest ever recorded in October. Again, the highly variable nature of the canal benthic fauna is well illustrated by the seasonal and annual variations in these means (Figure 3). As with the mean density values, mean biomass was higher in October than in May, which is the reverse of the general trend observed in previous monitoring studies. Biomass values ranged from 0.057 g/m^2 (Station W18.2 in May; Table 6) to 27.546 g/m^2 (Station RF.3 in October; Table 4). Most of the wide variation in biomass was caused by the chance occurrence of larger specimens, such as brittle stars, sea cucumbers, and molluscs. Generally, however, the benthic fauna was composed of individuals of small size which, in turn, caused biomass values at the canal stations to be low when compared to those of natural habitats elsewhere in Florida (Bader and Roessler, 1972; Young and Young, 1977; Gore, et al., 1981).

The mean index of diversity in the canals was 3.11 in May and 2.43 in October, thus conforming to the trend of higher spring diversity which has been observed in previous years of monitoring. Both means were slightly higher than the means reported in any previous year except 1981 (Figure 4). Diversity indices ranged from 0.00 (Station F.1 in October; Table 8) to 4.32 (Station RC.1 in May; Table 2). The 0.00 index of diversity has only occurred once prior to 1982 (October, 1980) when it also occurred at Station F.1, the plant discharge. The 4.32 index of diversity was one of the highest indices calculated for a canal station.

Diversity values over 3.5 are typically reported for natural marine habitats (Holme and McIntyre, 1971; Bader and Roessler, 1971 and 1972). Only six of the 16 indices calculated for canal stations in 1982 exceeded 3.5 (Tables 1 through 8).

Control Stations.

Control station density was also highly variable, ranging from 2759 individuals/m^2 (Control Station 3 in October; Table 11) to 12,816 individuals/m^2 (Control Station 1 in October; Table 9). Overall mean densities were 7126 individuals/m^2 in May and 7529 individuals/m^2 in October (Figure 2). The annual mean density of 7328 individuals/m^2 at the control stations was much higher than the annual mean of 4170 individuals/m^2 at the canal stations (Table 13). Control station density was considerably lower in 1982 than in 1980-1981 (Figure 2).

Biomass values at the control stations ranged from 1.621 g/m^2 (Control Station 3 in May; Table 11) to 2.287 g/m^2 (Control Station 2 in October; Table 10). Mean biomass was 1.71 g/m^2 in May and 1.92 g/m^2 in October (Figure 3). The 1982 annual mean biomass at the control stations was 1.80 g/m^2 while the mean biomass for the canal stations was twice that figure, 3.60 g/m^2. A similar circumstance occurred in 1979 (FPL, 1980). This was followed by 1980 when the means were approximately equal and 1981 when the control station mean was twice that of the canal station mean (FPL, 1980, 1981, 1982). Much of the wide variation in biomass values can be attributed to the irregular occurrence of larger specimens of molluscs or echinoderms.

Control station diversity ranged from 1.68 (Control Station 1 in October; Table 9) to 4.49 (Control Station 2 in October; Table 10). Mean control station diversity varied very little, from 3.04 in May to 3.09 in October (Table 13). While annual mean diversity for the control stations was higher than that of the canal stations, diversity was much lower in 1982 than in any previous year in which the control stations have been monitored (FPL, 1980, 1981, 1982).

In previous years, there has been a trend for biomass, density and diversity to be higher in May than October. Just the reverse was true in 1982, as were many of the usual trends at the canal stations. These trend reversals are not viewed as being significant because they occurred at both canal and control stations and because monitoring takes place only semi-annually in a highly variable ecosystem.

Comparison of Station Groups

In previous reports (FPL, 1980, 1981, 1982), trellis diagrams resulting from the use of Sorensen's (1948) index have identified four groups of stations based on community species similarity (Figure 5). These groups are the control group (Control Stations 1, 2 and 3); the east group (Stations RC.0, RC.1, E3.2 and RF.3); the west group (Stations WF.2, W18.2 and W6.2); and the discharge group (Station F.1). The annual mean density, biomass, and diversity of these groups were compared statistically using t-tests at the P=0.05 level. Analysis of the data showed that the east and control groups had significantly higher density

than either the west or discharge groups (Figure 6). In addition, the west group was significantly more densely populated than the discharge. The east and control groups were not significantly different from one another as were the west and discharge groups. A comparison of the group means illustrates the general counter-clockwise increase in density from a low point at the discharge (Figure 1), through the west group, to the east group, and then to the control group (Table 14). The trend of increasing mean density with distance from the plant discharge coincides with a trend of decreasing mean water temperature with distance from the discharge (Table 14).

When tested statistically by use of correlation coefficients, this inverse relationship of density to temperature was not statistically significant in 1982 (Table 15). The correlation has been significant in some previous years (FPL, 1980-1982). In sub-tropical habitats, temperature is frequently a major determinant of benthic community well-being. Many researchers have stated that the faunas of tropical or subtropical areas can thrive at or near their upper incipient lethal temperatures (Mayer, 1914; Gunter, 1957; Naylor, 1965; Bader and Roessler, 1972). No significant correlations of density with either salinity or dissolved oxygen concentration were found (Tables 14 and 15).

When biomass was compared in the same manner, the only significant difference found was that the control group had greater biomass than the discharge group (Figure 6). No other group comparisons had significant differences. Biomass was similar to density in that it increased in a

general counter-clockwise direction within the canal system accompanied by a coincident decrease in temperature (Table 14). However, this relationship was not statistically significant in 1982 (Table 15). No correlation of biomass with salinity was significant; however, a significant negative correlation of biomass with dissolved oxygen concentration occurred in October. This correlation was strongly influenced by outlying extreme values on either end of the wide range of biomass values encountered at the canal stations. Therefore, this relationship is believed to be a statistical artifact with no biological significance. Diversity also was negatively correlated with dissolved oxygen concentration in October; but, again, no biological significance was indicated.

Mean diversity values followed a similar counter-clockwise trend shown by mean biomass values (Table 14). The negative correlation between diversity and temperature was strong in May and statistically significant in October (Table 15). No correlation with salinity was found, but a significant positive correlation with dissolved oxygen concentration existed in May. When compared statistically, the control group had significantly greater diversity than the discharge group while the east group was significantly more diverse than either west or discharge groups (Figure 6).

From the preceding data it may be seen that environmental conditions and benthic community well-being improve with distance from the plant discharge. A rough comparison of mean data showed that control stations

had generally greater density, lower biomass, and greater diversity than the canal stations. The relatively low control station biomass of 1982 was an unusual occurrence not found in previous monitoring (FPL, 1980, 1981 and 1982).

Community Composition

As in the past years of monitoring, the canal stations were dominated by polychaetes (Figure 7). Other groups composed relatively small proportions of the canal station benthic fauna. The numerically important species of polychaetes are limited to a few types, specifically *Prionospio heterobranchia texana*, *Typosyllis* spp., *Laeonereis culveri* and *Naineris* spp. (Tables 1 through 11). All are burrowing, deposit feeders/omnivores (Fauchald and Jumars, 1978). The bottom substrate of the canals, which is composed of fibrous peat and mud mixed with shell debris (except Station F.1), is an environment to which these worms are well adapted.

Polychaetes are known to be more tolerant of wide variations in environmental conditions than are most other marine organisms. Several studies have shown that polychaetes are among the only organisms able to survive 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. From the preceding studies, polychaetes appear to be the group of orga-

nisms most tolerant of elevated temperature and salinity regimes, restricted circulation, and highly organic substrates that are characteristic of the Turkey Point Cooling Canal System.

Compared to the canal stations, the control stations showed higher proportions of molluscs and arthropods (Figure 7). All three control stations were, in fact, dominated by arthropods, the degree of dominance ranging from 49.1 to 65.9 percent. This contrasts sharply with the canal stations where polychaetes comprised 62.3 to 94.6 percent of the benthic fauna. An exception to the polychaete dominance at the canal stations was Station F.1 where molluscs dominated and polychaetes were of secondary importance. The prime reason for this difference was the substrate at Station F.1. These substrates are continually swept by discharge currents, therefore, there is no accumulation of mud or peat. The substrate is primarily sand and shell debris. The quality of substrates are a known determinant of benthic community structure (Rhoads and Young, 1970).

Comparison of the community structure of the station groups also showed the influence of substrate quality on the benthic fauna. The east and west groups had very similar structures (Figure 8) as both station groups have soft, mud and peat substrates. The discharge and control groups reflect the presence of their sandy substrates through dominance of their benthic faunas by molluscs and arthopods, respectively.

Comparison with Previous Studies

Some species found in both baseline and operational studies were recruited originally from the adjacent Biscayne Bay and Card Sound estuarine ecosystems. In studies of these adjacent ecosystems, 266 species of epifaunal macroinvertebrates, including molluscs, large crustaceans, sponges and echinoderms, were sampled by trawling (Bader, 1969; Tabb and Roessler, 1970; Bader and Roessler, 1971 and 1972). This large number of species does not include infaunal organisms such as polychaete worms and small crustaceans that comprise the bulk of the species in the canal system. Many more species could be found in Biscayne Bay or in Card Sound if these infaunal forms were included in faunal surveys. Differing sampling methodologies, thermal regimes and substrates limited the applicability of these studies to the present monitoring study.

Conclusion

During 1982, no significant changes in the macroinvertebrate fauna of the Turkey Point Canal system were observed. Although 1982 benthic density, biomass and diversity were generally lower than in recent years (1980-1981), the means of these community parameters fell within ranges established by previous studies. Some long-standing seasonal trends of higher density, biomass and diversity in the spring were reversed during 1982; however, these trends were also reversed at the control stations so no particular significance was attached to this reversal.

Density, biomass and diversity in the canal system generally increase with distance from the plant discharge. However, density, biomass and diversity at the canal stations are usually lower than at the control stations. Probable causes of this difference are the generally higher temperature and salinity of the canal system and a lack of means of recruitment of new species to the canal system. The benthic fauna of the canal stations is dominated by polychaetes while the control stations are dominated by arthropods. This difference is related to substrate quality as well as the differences in environmental quality stated above.

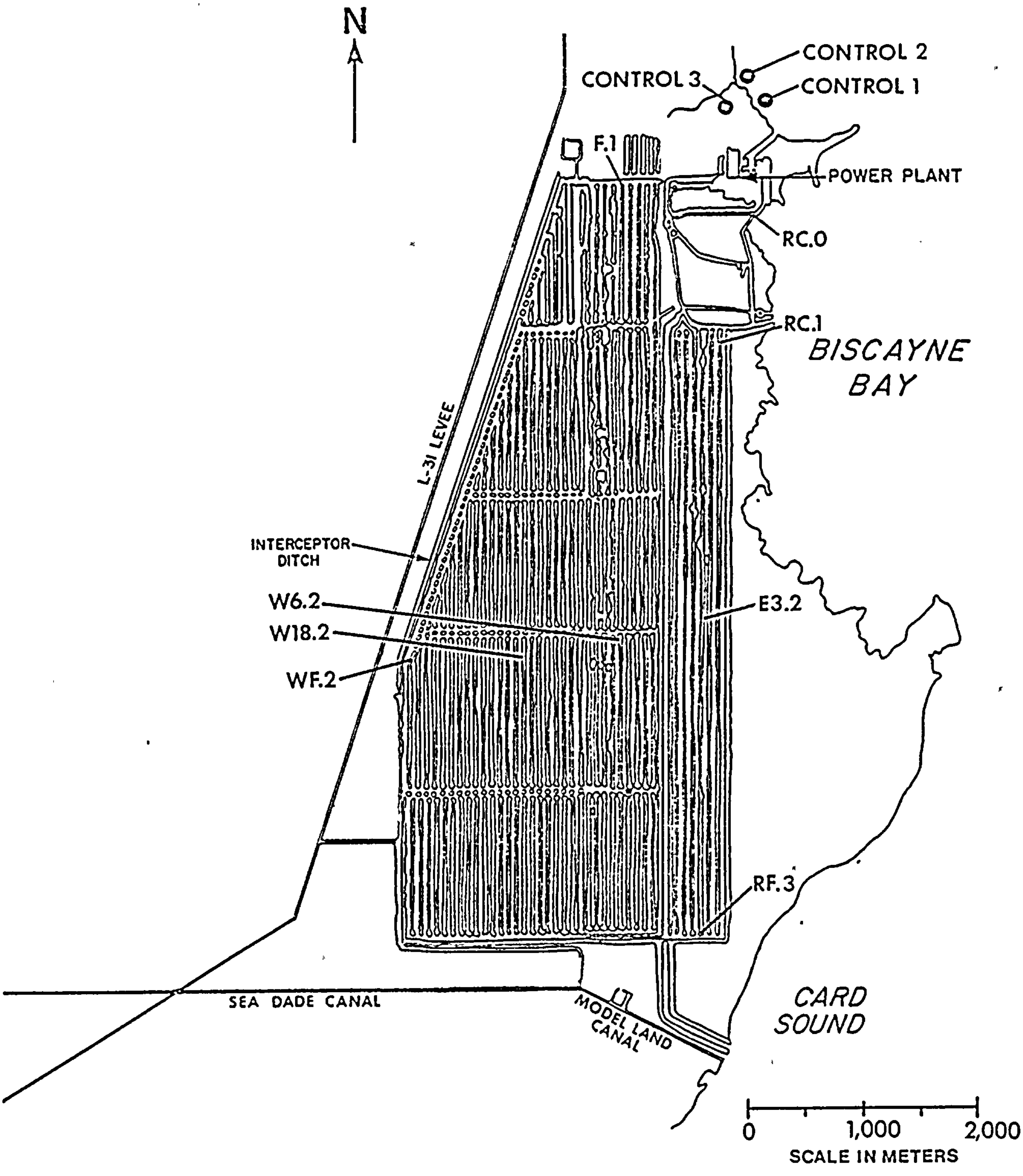


Figure 1. Benthic macroinvertebrate sampling station locations, Turkey Point site, 1982.

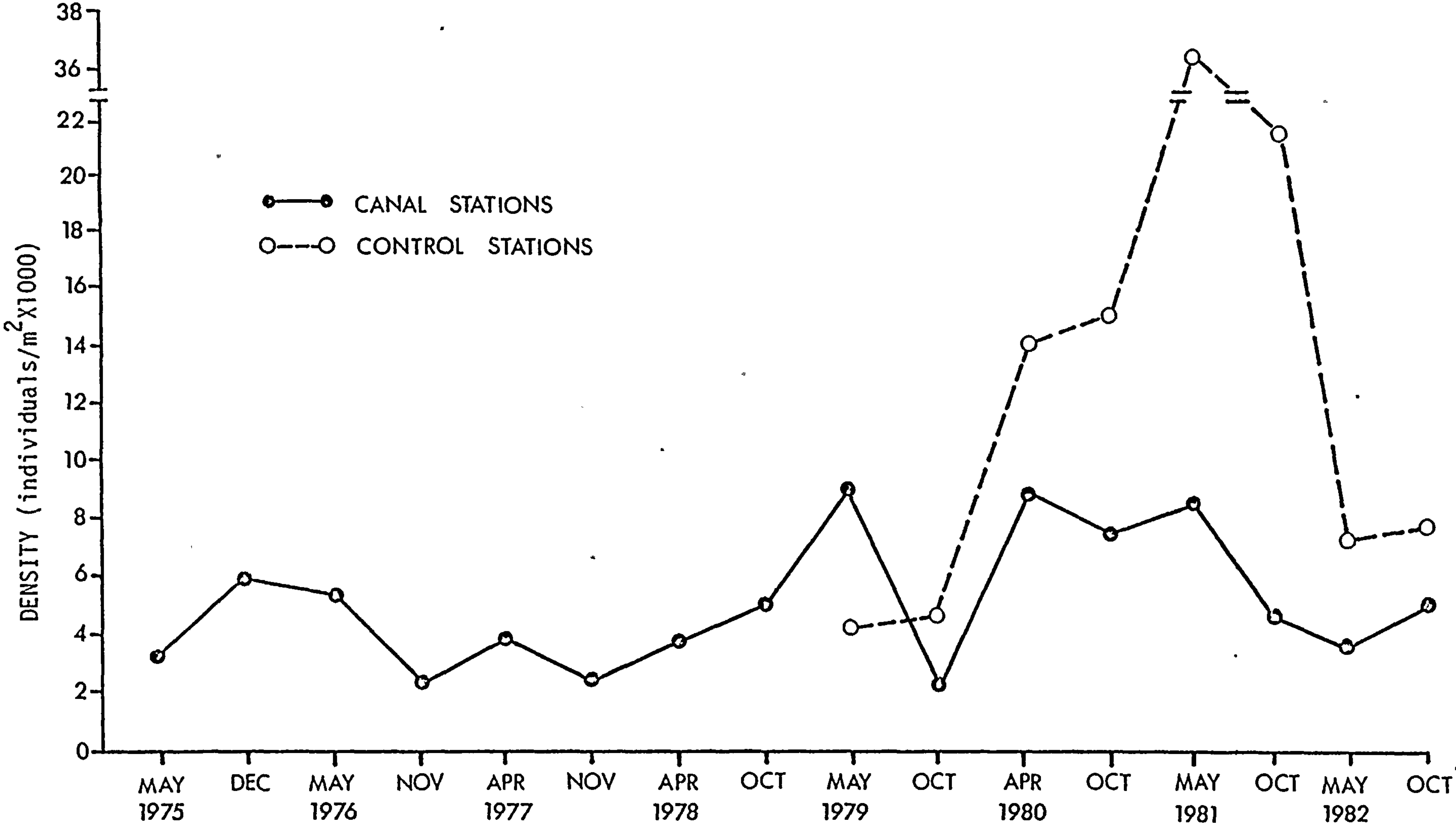


Figure 2. Mean number of benthic macroinvertebrates per square meter (all sampling stations combined), Turkey Point Plant, 1975-1982.

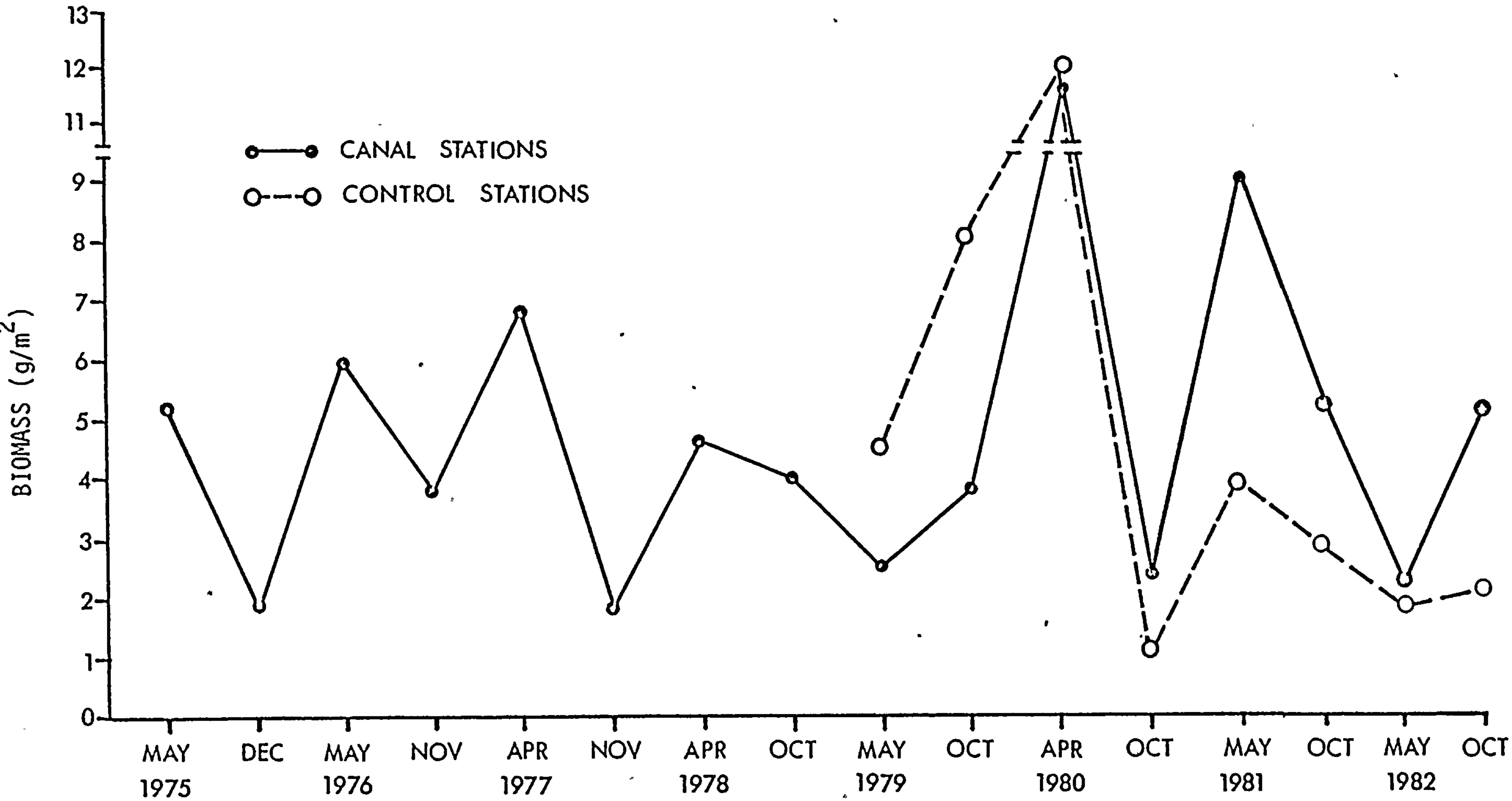


Figure 3. Mean benthic macroinvertebrate biomass per square meter (all sampling stations combined), Turkey Point Plant, 1975-1982.

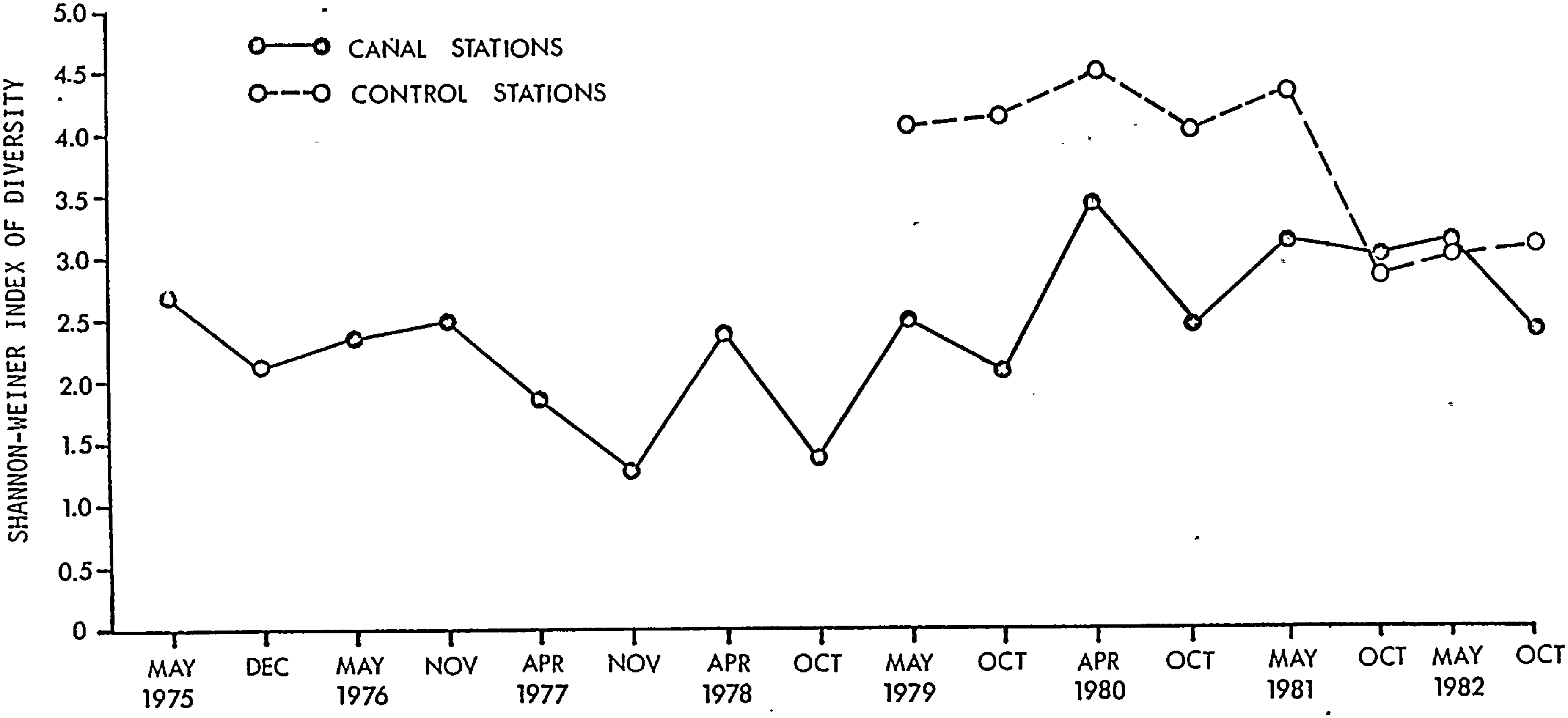


Figure 4. Mean benthic macroinvertebrate species diversity (all sampling stations combined), Turkey Point Plant, 1975-1982.

Station	RC.0	RC.1	E3.2	RF.3	WF.2	W18.2	W6.2	F1	C1	C2	C3
RC.0		31.0	60.0	23.3	12.0	15.7	11.5	4.7	25.6	22.0	24.2
RC.1			38.2	38.6	15.8	20.5	33.3	12.9	33.3	21.1	37.0
E3.2				38.0	16.7	23.0	35.5	11.3	27.3	34.5	36.8
RF.3					16.3	24.0	31.4	4.8	33.8	27.0	25.0
WF.2						51.6	43.8	26.1	27.6	11.1	13.0
W18.2							54.6	16.7	20.4	16.6	11.8
W6.2								16.0	20.0	15.1	12.5
F1									11.8	7.3	5.1
C1										41.9	29.7
C2											33.8
C3											

TURKEY POINT STATION SIMILARITY
MAY 1981

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		20.3	11.1	17.5	11.8	17.1	5.9	7.7	11.4	6.0	21.1
RC.1			40.8	55.0	0.0	12.5	12.8	5.1	12.5	20.0	23.5
E3.2				38.3	8.3	16.0	25.0	12.5	0.0	3.5	7.1
RF.3					8.9	17.4	13.3	0.0	13.0	25.6	20.4
WF.2						52.2	45.5	14.3	43.5	14.6	5.4
W18.2							43.5	0.0	25.0	7.1	7.4
W6.2								14.3	26.1	7.3	15.4
F1									13.3	4.3	0.0
C1										28.6	22.2
C2											30.5
C3											

TURKEY POINT STATION SIMILARITY
OCTOBER 1981

Figure 5. Trellis diagrams showing percentages of species similarity between sampling stations, Turkey Point Plant, 1981.

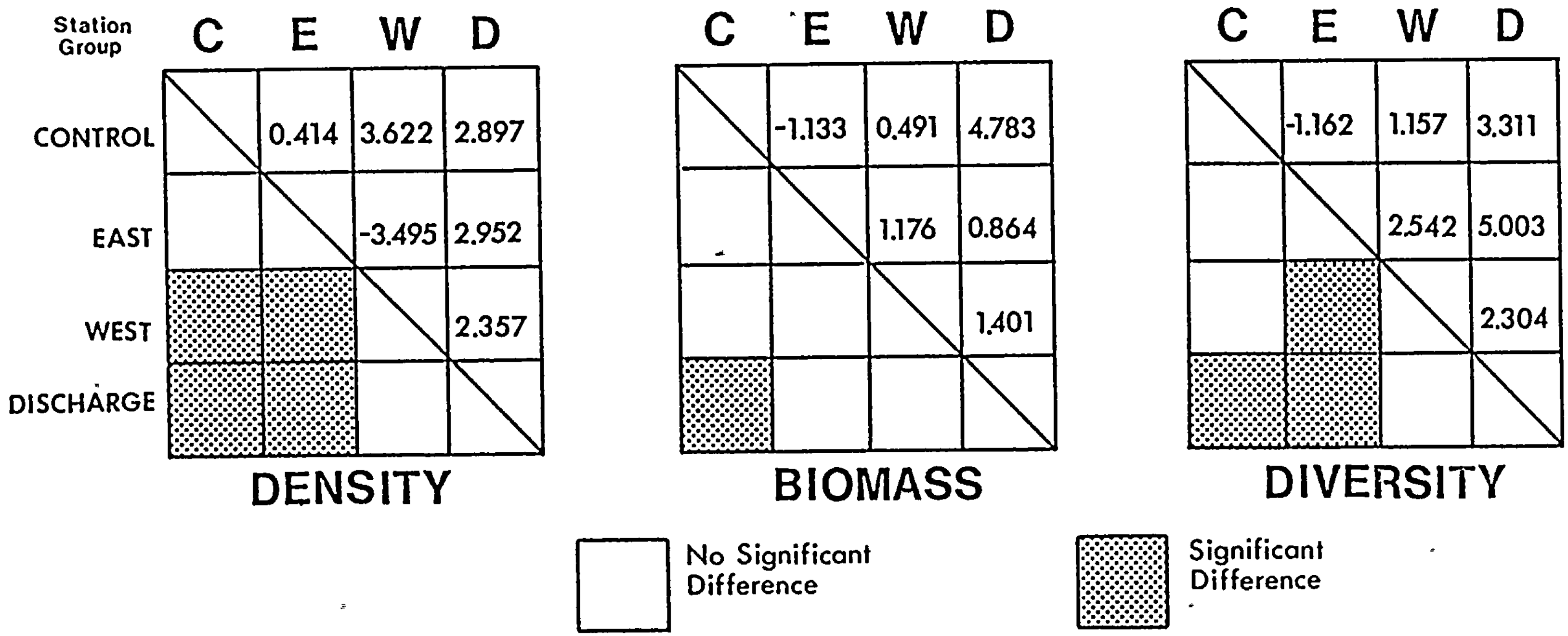


Figure 6. Trellis diagrams showing the results of statistical testing of mean macroinvertebrate density, biomass and diversity by station group. Turkey Point Plant, 1982.

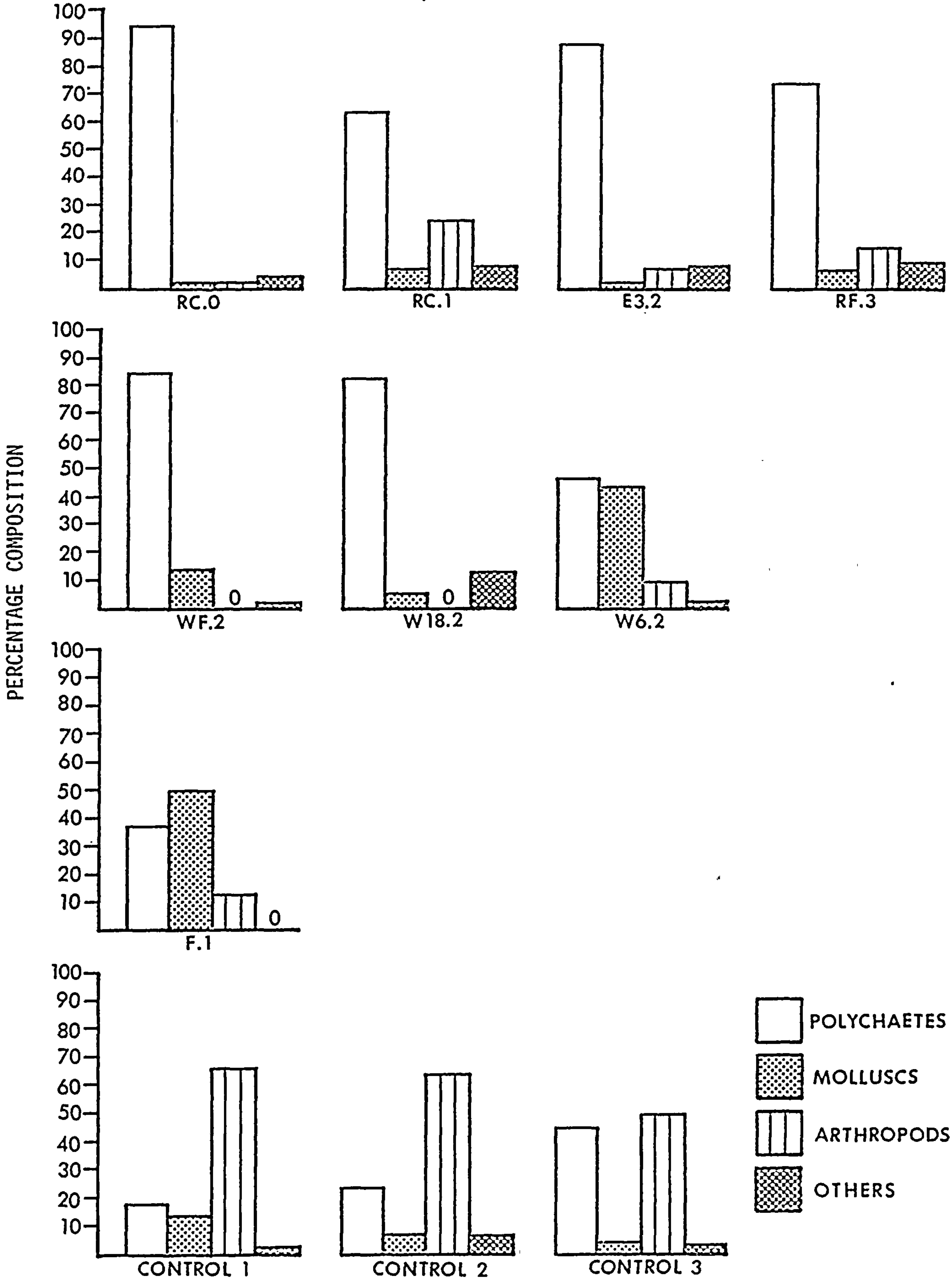


Figure 7. Structure of the benthic macroinvertebrate community by station, Turkey Point Plant, 1982.

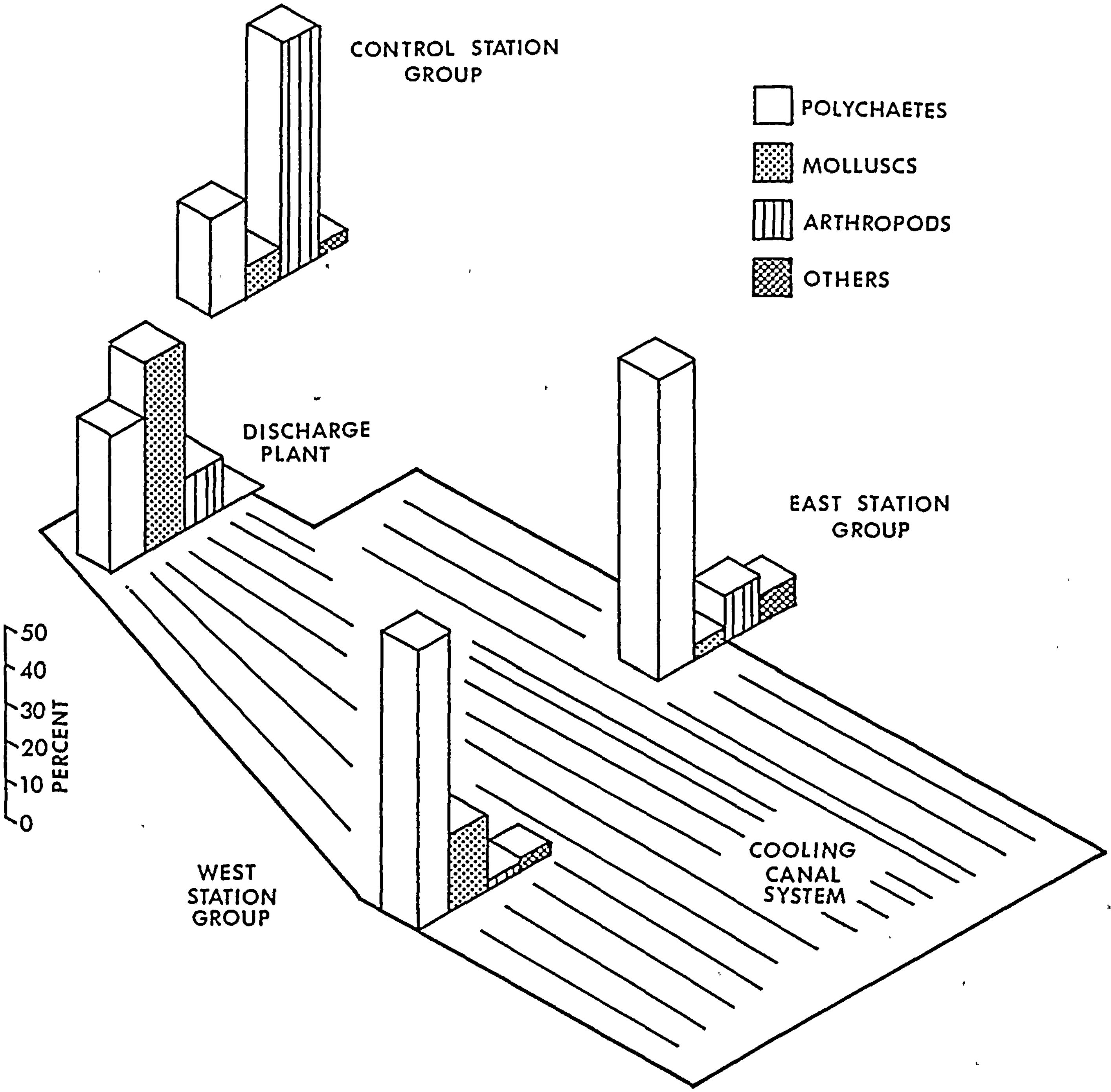


Figure 8. Comparison of mean percentage composition of the benthic fauna among the station groups, Turkey Point Plant, 1982.

Table 1. Results of benthic macroinvertebrate sampling at Station RC.0 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Aricidea taylori	9	-
Armandia maculata	4	-
Branchiomma nigromaculata	8	20
Capitella capitata	4	-
Caulleriella alata	4	-
Ceratocephala oculata	4	-
Cirratulus sp.	4	-
Cirriformia filigera	-	8
Exogone arenosa	-	8
E. dispar	-	16
E. verugea	4	-
Eurythoe complanata	-	8
Fabricia sp.	36	4
Flabelligeridae sp. A	16	12
Haplosyllis spongicola	20	-
Langerhansia cornuta	8	-
Lanicides toboquille	-	20
Marphysa sanguinea	4	20
Mediomastus californiensis	8	-
Naineris setosa	-	4
Nematonereis sp. A	8	-
Paraonides lyra	132	12
Prionospio heterobranchia texana	-	8
Pseudovermilia occidentalis	8	4
Sabella melanostigma	-	332
S. microphthalma	8	-
Salmacina sp.	4	-
Schistomeringos rudolphi	4	-
Spionidae sp.	4	-
Spio sp.	8	-
Syllides verrilli	12	-
Terebella lapidaria	-	8
Tharyx annulosus	-	16
Tubificidae sp.	16	4
Typosyllis sp. A	-	12
Typosyllis sp. B	8	-
T. hyalina	8	12
Class Pelecypoda (bivalves)		
Codakia orbiculata	8	-
Class Crustacea (ostracods)		
Sarsiella sp. A	4	-
Sarsiella sp. B	4	-

Table 1. (cont'd) Results of benthic macroinvertebrate sampling at Station RC.0 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Ophiuroidea (brittle stars)		
unidentified specimen	4	-
Class Anthozoa (sea anemones)		
unidentified specimen	4	-
Phylum Porifera (sponges)	4	8
Phylum Platyhelminthes (flat worms)	-	8
Phylum Nematoda (nematodes)	4	-
Total individuals	416	544
Total biomass (g)	0.197	0.114
Density (no./m^2)	5977	7816
Biomass (g/m^2)	2.833	1.638
Index of diversity	4.05	2.58
Equitability	0.71	0.39

Table 2. Results of benthic macroinvertebrate sampling at Station RC.1 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Arabella mutans	4	-
Armandia maculata	4	-
Brania clavata	-	4
Branchiomma nigromaculata	4	-
Capitella capitata	-	48
Ceratonereis mirabilis	8	4
Cirriformia filigera	4	-
Exogone verugea	4	-
Fabricia sp.	8	8
Laeonereis culveri	-	4
Naineris laevigata	8	20
N. setosa	-	4
Paraonides lyra	8	-
Pista cristata	4	-
Prionospio heterobranchia texana	40	-
Sabella melanostigma	24	8
S. microphthalma	12	-
Scyphoproctus sp. A	8	-
Spirorbis corrugatus	4	-
Typosyllis sp. A	40	64
Typosyllis sp. B	84	20
Typosyllis annularis	40	-
Tubificidae sp.	80	80
Class Gastropoda (snails)		
Balcis conoidea	4	-
Bulla striata	-	8
Cerithium muscarum	-	4
Eulimidae sp.	-	4
Haminoea antillarum	-	4
H. succinea	4	4
Modulus modulus	-	4
Prunum apicinum	4	-
Triphora nigrocincta	-	4
Turveria sp. A	-	4
unidentified gastropod (damaged)	12	-
Class Pelycypoda (bivalves)		
Gemma gemma	-	8
Class Pycnogonida (sea spiders)		
Achelia sawayi	4	-
Ammothella sp.	4	-
Callipallene brevirostris	4	-

Table 2. (cont'd) Results of benthic macroinvertebrate sampling at Station RC.1 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Crustacea (isopods, amphipods, insects)		
Bagatus stylodactylus	4	-
Bagatus sp.	96	-
Cymodoce faxoni	4	-
Cymadusa sp.	-	44
Elasmopus sp.	-	4
E. rapax	44	16
Grandidierella bonnieroides	16	-
Melita sp.	4	-
Collembola sp.	-	8
Class Holothuroidea (sea cucumbers)		
Synaptula sp.	4	-
S. hydriformis	4	8
Thyonella gemmata	-	8
Class Anthozoa (sea anemone)		
unidentified specimen	4	-
Class Scyphozoa (jellyfish)		
Cassiopeia xamachana	-	4
Phylum Nemertinea (proboscis worms)	12	-
Phylum Nematoda (nematodes)	-	32
Total individuals	640	420
Total biomass (g)	0.388	0.354
Density (no./m^2)	9195	6034
Biomass (g/m^2)	5.575	5.086
Index of diversity	4.32	3.87
Index of equitability	0.75	0.82

Table 3. Results of benthic macroinvertebrate sampling at Station E3.2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Arabella mutans	4	-
Aricidea philbinae	-	4
Armandia maculata	12	-
Capitella capitata	16	-
Ceratonereis mirabilis	8	-
Exogone verugea	-	8
Fabricia sp.	8	8
Haploscoloplos foliosus	16	20
Laeonereis culveri	4	-
Marphysa singuinea	-	4
Neanthes acuminata	20	-
Naineris laevigata	136	140
Paraonides lyra	-	4
Prionospio heterobranchia texana	108	4
Scyphoproctus sp. A	4	-
Spirorbis corrugatus	12	-
Typosyllis sp. A	36	76
Typosyllis sp. B	-	68
Class Gastropoda (snails)		
Bulla striata	-	4
Prunum apicinum	4	-
Class Pycnogonida (sea spiders)		
Callipallene brevirostris	-	4
Class Crustacea (copepods and amphipods)		
Copepoda sp.	12	-
Elasmopus levis	20	4
Grandidierella bonnieroides	4	-
Class Holothuroidea (sea cucumbers)		
Synaptula hydriformis	4	40
Thyonella gemmata	4	-
Class Scyphozoa (jellyfish)		
Cassiopeia xamachana	-	8

Table 3. (cont'd) Results of benthic macroinvertebrate sampling at Station E3.2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Total individuals	420	408
Total biomass (g)	0.110	0.060
Density (no./m^2)	6034	5862
Biomass (g/m^2)	1.586	0.865
Index of diversity	3.07	2.89
Equitability	0.66	0.65

Table 4. Results of benthic macroinvertebrate sampling at Station RF.3 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Armandia maculata	4	-
Branchiomma nigromaculata	-	72
Ceratonereis mirabilis	-	4
Exogone verugea	4	20
Fabricia sp.	-	28
Langerhansia cornuta	-	4
Lanicides toboquille	-	4
Laeonereis culveri	4	-
Nematonereis sp. A	-	4
Paraonides lyra	4	-
Prionospio heterobranchia texana	-	164
Sabella melanostigma	-	68
Schistomeringos pectinata	-	24
Trichobranchus glacialis	-	4
Typosyllis sp. A	16	100
Typosyllis sp. B	8	68
T. annularis	-	8
Class Gastropoda (snails)		
Bulla striata	-	12
Cerithium lutosum	-	4
C. muscarum	4	4
Modulus modulus	-	16
Prunum apicinum	4	-
Class Pycnogonida (sea spiders)		
Ammothella rugulosa	-	24
Ammothella sp.	-	28
Pycnogonida sp.	-	4
Class Crustacea (isopods, amphipods, shrimp)		
Cymadoce faxoni	4	4
Cymadusa sp.	8	32
Elasmopus sp.	-	4
Gitanopsis tortugae	-	4
Maera sp.	-	4
Caridea sp. (damaged)	-	4
Collembola sp. (insect)	4	-
Class Holothuroidea (sea cucumbers)		
Synaptula hydriformis	4	-
Thyonella gemmata	-	8

Table 4. (cont'd) Results of benthic macroinvertebrate sampling at Station RF.3 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Scyphozoa (jelly fish)		
Cassiopeia xamachana	4	-
Phylum Nemertinea (proboscis worms)	4	40
Phylum Platyhelminthes (flat worms)	-	8
Total individuals	76	772
Total biomass (g)	0.180	1.917
Density (no./m^2)	1092	11,092
Biomass (g/m^2)	2.586	27.546
Index of diversity	3.62	3.93
Equitability	1.26	0.74

Table 5. Results of benthic macroinvertebrate sampling at Station WF.2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Aricidea philbinae	24	-
Capitella capitata	-	4
Haploscoloplos sp.	4	-
Laeonereis culveri	160	196
Marphysa sanguinea	12	-
Prionospio heterobranchia texana	12	4
Class Gastropoda (snails)		
Cerithium lutosum	-	52
Cylichnella canaliculata	4	-
Class Pelycypoda (bivalves)		
Lyonsia floridana	4	-
Polymesoda maritima	4	-
Tivela floridana	-	4
Class Anthozoa (sea anemones)		
unidentified specimen	4	-
Phylum Nemertinea (proboscis worms)	4	-
Total individuals	232	260
Total biomass (g)	0.094	0.192
Density (no./m^2)	3333	3736
Biomass (g/m^2)	1.351	2.753
Index of diversity	1.80	1.05
Equitability	0.41	0.50

TP1
BENTABLE5

Table 6. Results of benthic macroinvertebrate sampling at Station W18.2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Arabella mutans	4	-
Aricidea philbinae	12	16
Ceratonereis mirabilis	-	4
Laeonereis culveri	20	40
Typosyllis sp. A	16	20
Class Gastropoda (snails)		
Cylichnella canaliculata	-	4
Class Pelycypoda (bivalves)		
Lyonsia floridana	4	-
Phylum Nemertinea (proboscis worms)	8	12
Total individuals	64	96
Total biomass (g)	0.004	0.032
Density (no./m^2)	920	1379
Biomass (g/m^2)	0.057	0.460
Index of diversity	2.35	2.19
Equitability	1.15	1.01

Table 7. Results of benthic macroinvertebrate sampling at Station W6.2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Aricidea philbinae	-	8
Armandia maculata	4	-
Branchiomma nigromaculata	8	-
Ceratonereis mirabilis	20	4
Haploscoloplos sp.	-	4
Langerhansia cornuta	8	-
Prionospio heterobranchia texana	8	-
Sabella melanostigma	4	-
Sphaerosyllis sp. B	4	-
Terebellidae sp.	4	-
Typosyllis sp. A	20	20
T. annularis	4	-
Class Gastropoda (snails)		
Blauneria heteroclita	4	-
Bulla striata	4	-
Cerithidae (damaged)	-	4
Cerithium lutosum	-	44
Cylindrobulla beauii	8	-
Cylichnella canaliculata	-	4
Oxynoidae sp.	4	-
Gastropoda (damaged)	4	12
Class Pelycypoda (bivalves)		
Lyonsia floridana	8	4
Polymesoda maritima	8	-
Tivela floridana	-	4
Class Pynogonida (sea spiders)		
Anoplodactylus pectinus	4	-
Class Crustacea (ostracods, amphipods)		
Haplocytheridea sp. A	8	-
Cymadusa sp.	12	-
Phylum Nemertinea (proboscis worms)	-	4
Total individuals	148	112
Total biomass (g)	0.216	0.112
Density (no./m^2)	2126	1609
Biomass (g/m^2)	3.098	1.609
Index of diversity	4.13	2.92
Equitability	1.22	0.88

Table 8. Results of benthic macroinvertebrate sampling at Station F.1 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Laeonereis culveri	8	-
Marphysa sanguinea	4	-
Class Gastropoda (snails)		
Batillaria minima	-	16
Class Crustacea (shrimp)		
Alpheus sp.	4	-
Total individuals	16	16
Total biomass (g)	0.013	0.028
Density (no./m^2)	230	230
Biomass (g/m^2)	0.184	0.402
Index of diversity	1.50	0.00
Equitability	1.19	1.00

Table 9. Results of benthic macroinvertebrate sampling at Control Station 1 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Aricidea philbinae	8	-
Capitella capitata	4	40
Haploscoloplos sp.	20	-
H. foliosus	-	48
H. fragilis	4	-
Paraonides lyra	-	4
Polydora ligni	4	88
Tubificidae	4	12
Class Pelycypoda (bivalves)		
Gemma gemma	-	4
Lucina pectinata	4	-
Polymesoda maritima	164	-
Sayella crosseana	-	4
Tagelus plebius	4	-
Class Crustacea (tanaids, amphipods, shrimp, insects)		
Hargeria rapax	96	636
Gammarus mucronatus	40	-
Grandidierella bonnieroides	-	12
Caridea sp. (immature)	8	-
Chironomidae sp.	8	8
Diptera sp.	52	4
Phylum Nemertinea (proboscis worms)	-	24
Phylum Nematoda (nematodes)	-	4
Phylum Platyhelminthes (flat worms)	-	4
Total individuals	420	892
Total biomass (g)	0.126	0.082
Density (no./m^2)	6034	12,816
Biomass (g/m^2)	1.810	1.184
Index of diversity	2.63	1.68
Equitability	0.61	0.29

Table 10. Results of benthic macroinvertebrate sampling at Control Station 2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
Species	May	October
Class Polychaeta (worms)		
Aricidea philbinae	-	8
Branchiomma nigromaculata	-	4
Capitella capitata	4	12
Ceratonereis mirabilis	-	16
C. singularis	-	4
Fabricia sp.	24	4
Haploscoloplos foliosus	-	8
H. fragilis	20	-
Haploscoloplos sp.	16	-
Langerhansia ferruginea	-	8
Lanicides toboquille	-	4
Parahesione luteola	-	12
Prionospio heterobranchia texana	4	4
Spirorbis sp.	-	48
Tubificidae sp.	12	8
Typosyllis sp. A	-	40
Typosyllis sp. B	-	4
Class Gastropoda (snails)		
Batillaria minima	-	12
Caecum pulchellum	-	12
Cerithidea costata	-	4
Class Pelecypoda (bivalves)		
Anomalocardia auberiana	4	-
Brachidontes sp.	-	4
Parastarte triquetra	8	-
Polymesoda maritima	20	-
Tellina tampaensis	4	-
Class Crustacea (barnacles, tanaids, isopods, amphipods)		
Balanus sp.	8	-
Apseudes sp. A	4	4
Apseudes sp. B	80	-
Hargeria rapax	140	28
Cymodoce faxoni	20	-
Cymadusa sp.	4	24
Cymadusa compta	-	8
Elasmopus levis	-	16
Erichsonella filiformis	4	4
Gammarus mucronatus	16	4
Gitanopsis tortugae	-	12
Grandidierella bonnieroides	144	64
Melita sp.	-	52
M. elongata	-	12

Table 10. (cont'd) Results of benthic macroinvertebrate sampling at Control Station 2 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
Species	May	October
Class Crustacea (cont'd)		
Sphaeromatidae sp.	-	4
unidentified Amphipoda	-	12
Chironomidae sp.	4	-
Phylum Nematoda (nematodes)	4	4
Phylum Nemertinea (proboscis worms)	32	20
Total individuals	584	488
Total biomass (g)	0.118	0.159
Density (no./m^2)	8391	7011
Biomass (g/m^2)	1.690	2.287
Index of diversity	3.32	4.49
Equitability	0.65	0.98

Table 11. Results of benthic macroinvertebrate sampling at Control Station 3 at the Turkey Point Plant, 1982.

ORGANISMS	SUM OF 3 REPLICATES	
	May	October
Class Polychaeta (worms)		
Capitella capitata	24	16
C. jonesi	4	-
Fabricia sp.	16	-
Haploscoloplos sp.	12	4
Hypaniola florida	4	-
Laeonereis culveri	32	20
Marphysa sanguinea	4	8
Syllides sp.	8	-
Tharyx annulosus	-	4
Tubificidae sp.	124	16
Tubificoides sp.	4	-
Class Gastropoda (snails)		
Cylichnella canaliculata	8	-
Mangelia stellata	4	-
Class Pelecypoda (bivalves)		
Macoma constricta	-	4
Polymesoda maritima	12	-
Class Crustacea (tanaids, mysids, amphipods, insects)		
Apseudes sp. A	-	20
Apseudes sp. B	8	28
Hargeria rapax	140	4
Taphromysis bowmani	4	-
Grandidierella bonnieroides	56	60
Chironomidae sp.	8	-
Collembola sp. (insect)	-	4
Phylum Nemertinea (proboscis worms)	8	4
Phylum Chaetognatha (arrow worms)	4	-
Total individuals	484	192
Total biomass (g)	0.113	0.158
Density (no./m^2)	6954	2759
Biomass (g/m^2)	1.621	2.276
Index of diversity	3.17	3.10
Equitability	0.64	0.93

Table 12. Physical data recorded during benthic sampling at the Turkey Point Plant, 1982.

STATION	MONTH	TEMPERATURE (°C) 1982	SALINITY (ppt) 1982	DISSOLVED OXYGEN (ppm) 1982
RC.0	May	27.2	36.0	7.0
	October	28.1	38.0	4.4
RC.1	May	26.0	36.0	7.8
	October	29.0	38.0	3.9
E3.2	May	27.8	36.0	7.2
	October	28.9	38.0	4.8
RF.3	May	28.0	36.0	6.4
	October	29.2	38.0	3.5
WF.2	May	28.5	36.0	5.9
	October	32.0	38.0	4.5
W18.2	May	28.0	36.0	6.3
	October	31.8	38.0	4.9
W6.2	May	30.1	36.0	7.6
	October	31.7	38.0	4.7
F.1	May	34.5	36.0	6.2
	October	37.1	38.0	5.0
Control 1	May	22.2	15.5	7.3
	October	29.0	19.0	7.3
Control 2	May	22.2	15.5	7.7
	October	27.8	18.0	4.4
Control 3	May	22.9	17.5	5.7
	October	28.0	17.0	2.6

Table 13. Comparison of mean macroinvertebrate density, biomass and diversity at the Turkey Point Canal and Control Stations, 1982.

PARAMETER	STATION	MAY	OCTOBER	ANNUAL
Density	Canal	3613	4727	4170
(no./m^2)	Control	7126	7529	7328
Biomass	Canal	2.16	5.04	3.60
(g/m^2)	Control	1.71	1.92	1.80
Diversity	Canal	3.11	2.43	2.77
	Control	3.04	3.09	3.07

Table 14. Annual means of density, biomass, diversity, and physical data for the macroinvertebrate station groups at the Turkey Point Plant, 1982.

STATION GROUP	DENSITY (no./m^2)	DIVERSITY	BIOMASS (g/m^2)	TEMPERATURE (°C)	SALINITY (°/••)	DISSOLVED OXYGEN (ppm)
Control (C-1,C-2,C-3)	7328	3.07	1.811	25.35	17.08	5.83
East (RC.0,RC.1,RF.3,E3.2)	6638	3.54	5.964	28.03	37.00	5.63
West (WF.2,W6.2,W18.2)	2194	2.41	1.555	30.38	37.00	5.65
Discharge (F.1)	230	0.75	0.291	35.80	37.00	5.60

Table 15. Correlation coefficients of density, diversity and biomass vs. temperature, salinity and dissolved oxygen for benthic macroinvertebrates at the Turkey Point Canal Stations, 1982.

PARAMETERS	MONTH	TEMPERATURE (°C)	SALINITY (ppt)	DISSOLVED OXYGEN (ppm)
Density ($no./m^2$)	May	-0.68	0.00	0.68
	October	-0.28	0.00	-0.73
Diversity	May	-0.61	0.00	0.84*
	October	-0.85*	0.00	-0.84*
Biomass (g/m^2)	May	-0.57	0.00	0.78
	October	-0.31	0.00	-0.84*

*Statistically significant correlation at the P=0.05 levels.

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

Introduction

This study documents the recovery of the marine flora in the Grand Canal Discharge Area. Grand Canal discharged into Biscayne Bay from 1967 to 1973. Discharge perturbations were a result of thermal, scouring, and turbidity 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 macroalgae. A combination of aerial and plane table surveys, *in situ* density determinations, and *in situ* transect surveys constituted the study.

Method 1 - Aerial and Plane Table Surveys

The revegetation of the affected Grand Canal Discharge Area was assessed using aerial photographs taken from an altitude of 2000 feet. The scale of the photograph was determined by measuring known reference points on Turtle Point. Tracings of the different floral populations were made from the photographs. A plane table survey was made using a Keuffel and Esser paragon conventional expedition alidade and a fiberglass Philadelphia rod to determine the affected area (Figure 2) and compare it to the baseline data of Thorhaug (Bader and Roessler, 1972).

Method 2 - Quadrat Stations

Quantitative measurements of seagrass and algal densities were made by counting and identifying the vegetation at six permanent stations of one square meter each (Figures 3 and 4).

Method 3 - Transects

Three east-west transects and two north-south transects, represented by dotted lines in Figures 3 and 4, were surveyed to determine the different floral zones in the affected area. Relative abundance, sediment depths, general conditions, and macroalgae present were also determined during this survey. The surveys primarily served to "ground truth" the aerial photographs.

Results

June 1982

The analysis of the aerial photograph and transect survey indicated four community zones in the previously affected area (Figure 2). Listed in order from west to east was a macroalgal dominant zone consisting mainly of *Caulerpa sp.*, a *Thalassia testudinum* and *Halodule wrightii* mixed dominance zone, a *H. wrightii* and macroalgae mixed dominance zone consisting of *Caulerpa sp.* and *Laurencia sp.*, and a *T. testudinum* dominant zone.

The results of the quadrat density analysis are summarized in Table 1. *Halodule wrightii* was the dominate seagrass at

Stations X-1, X-2, X-2N, and X-2S. *Thalassia testudinum* was dominant at Stations X-3 and X-4. These results corresponded roughly to the seagrass zones determined from the transect survey and the aerial photograph.

November 1982

The November transect survey and aerial photograph analysis indicated three marine floral communities. Listed in order from west to east were zone of macroalgal dominance, a *T. testudinum* and *H. wrightii* mixed dominance zone, and a *T. testudinum* zone.

The results of the November quadrat analysis are summarized in Table 2. *Halodule wrightii* was dominant at Stations X-2, X-2N and X-2S. *Thalassia testudinum* was the dominant seagrass at Stations X-1, X-3, and X-4. The results corresponded roughly to the transect survey and aerial photograph data.

Annual

The alidade analysis revealed a total affected area of 0.62 acres (Figure 4) as compared to 0.21 acres for 1981. The survey of the affected area roughly corresponded to the velocity scarp (canal drop off) visible in the aerial photographs.

Discussion

June 1982

The benthic area around the canal drop off was composed of rocks and two to three inches of fine, easily disturbed sediments. This area supported a macroalgal zone made up of species of Caulerpa, Penicillus, and Halimeda.

The sediment from Station X-1 to Station X-3 was twelve inches thick and composed of packed calcium carbonate particles, Thalassia and mangrove leaf litter, and animal remains (crustacean cuticle, molluscan shells, etc.). This area supported a patchy Thalassia/Halodule mixed dominance zone with species of Laurencia, Pencillus, and Sargassum present.

The sediment from Stations X-3 to X-4 was sixteen inches or greater and was of the same composition as listed above. This area supported a Thalassia dominant zone with Syringodium filiforme present but sparse. Species of Sargassum, Laurencia, Rhipocephalus, Halimeda, and Pencillus, were also present.

The sediment characteristics at Stations X-2N, and X-2S were of the same depth and composition as Stations X-3 to X-4 and supported a H. wrightii and macroalgal mixed dominance zone. This zone was composed of species of Acetabularia, Pencillus, Rhipocephalus, Halimeda, and sparse Halodule.

November 1982

The sediment characteristics of the study area were the same as described for the June 1982 analysis.

The area in the vicinity of X-1 was dominated by Caulerpa prolifera although H. wrightii and T. testudinum were present as were species of Acetabuleria and Bataphora.

The area between Station X-1 and Station X-2 showed a transition from macroalgal dominance to a Thalassia/Halodule dominant zone. Species of Acetabularia, Halimeda, and Penicillus were also present.

Thalassia was the dominant seagrass from Station X-2 to Station X-4 with species of Sargassum,Acetabularia, Laurencia, Penicillus, and Halimeda present. Syringodum filiforme was present but sparse at Station X-4.

The areas around Stations X-2N and X-2S were sparsely vegetated by a Thalassia/Halodule mixed dominance community with species of Acetabularia, Batophora, Pencillus, Laurencia, Halimeda, Sargassum, and Caulerpa present.

Thorhaug (Bader & Roessler, 1972) reported that areas of decreased sediment depth were unable to sustain large populations of T. testudinum due to its extensive root and rhizome system, but major macroalgae

flourished under these conditions. This might explain the dense macroalgal populations and lack of seagrasses at the immediate mouth of the Grand Canal Discharge.

The increase of 0.41 acres of affected area over last year's survey is not significant when compared to the originally damaged area of 23 acres. The area directly in front of the canal will fluctuate with changing environmental conditions such as temperature, salinity, turbidity, or water velocities due to wind forces. The fine sediments of decreased depth in this area will not support a stable population of seagrasses when combined with conditions of environmental stress.

In general, all stations exhibited a seasonal fluctuation of grass and macroalgal densities with lower densities occurring during the summer months. The densities at all stations except X-1 appeared essentially the same as those found in the baseline studies (Bader & Roessler, 1982). However, they were not directly comparable since the units of enumeration used in these studies differed. The present study uses fasicles (sheathes 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 and macroalgal community very similar to the community described in baseline studies (Bader & Roessler, 1972). The nonrecovered area

(0.62 acres) at the mouth of the former discharge canal will continue to recover at a slow rate and will not support a seagrass community of densities similar to adjacent areas until a stable sediment base becomes established.

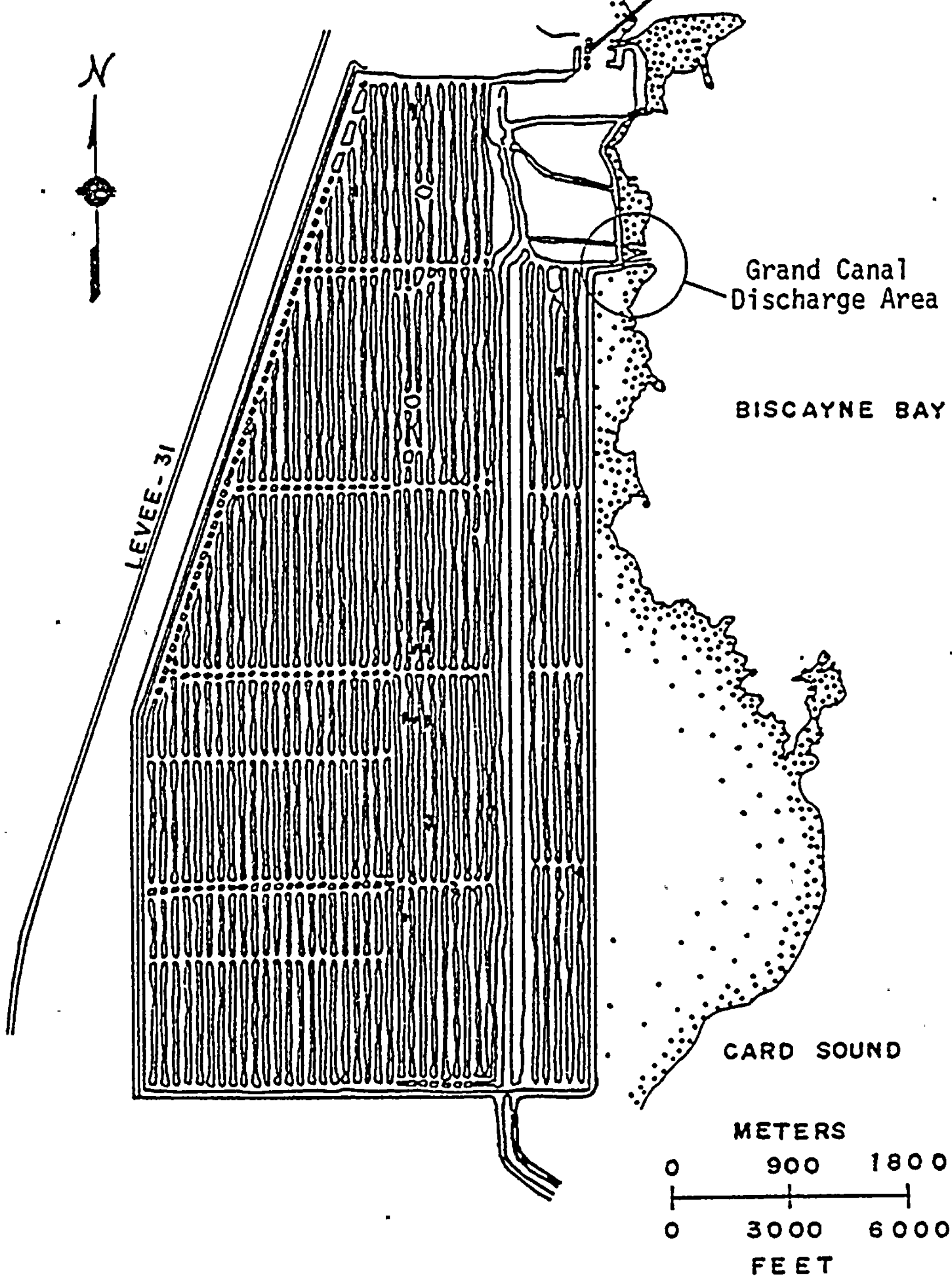


Figure 1. Location of Turkey Point Power Plant Grand Canal Discharge, closed in February, 1973.

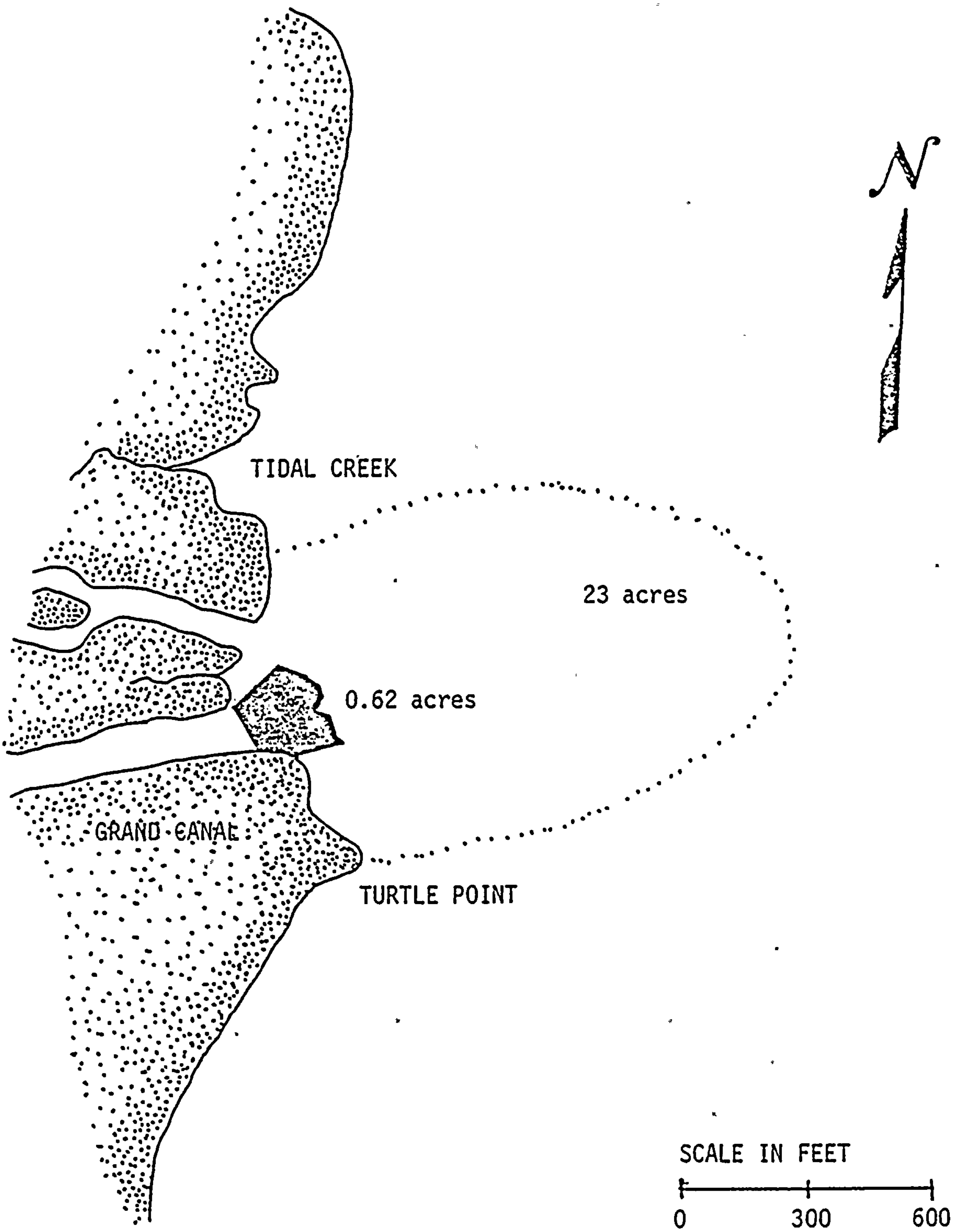


Figure 2. Comparison of plane table surveys of previously affected Turkey Point Power Plant Grand Canal Discharge Area after Thorhaug, October 1971 (dotted line) and Florida Power & Light, June 1982. (blackened area).

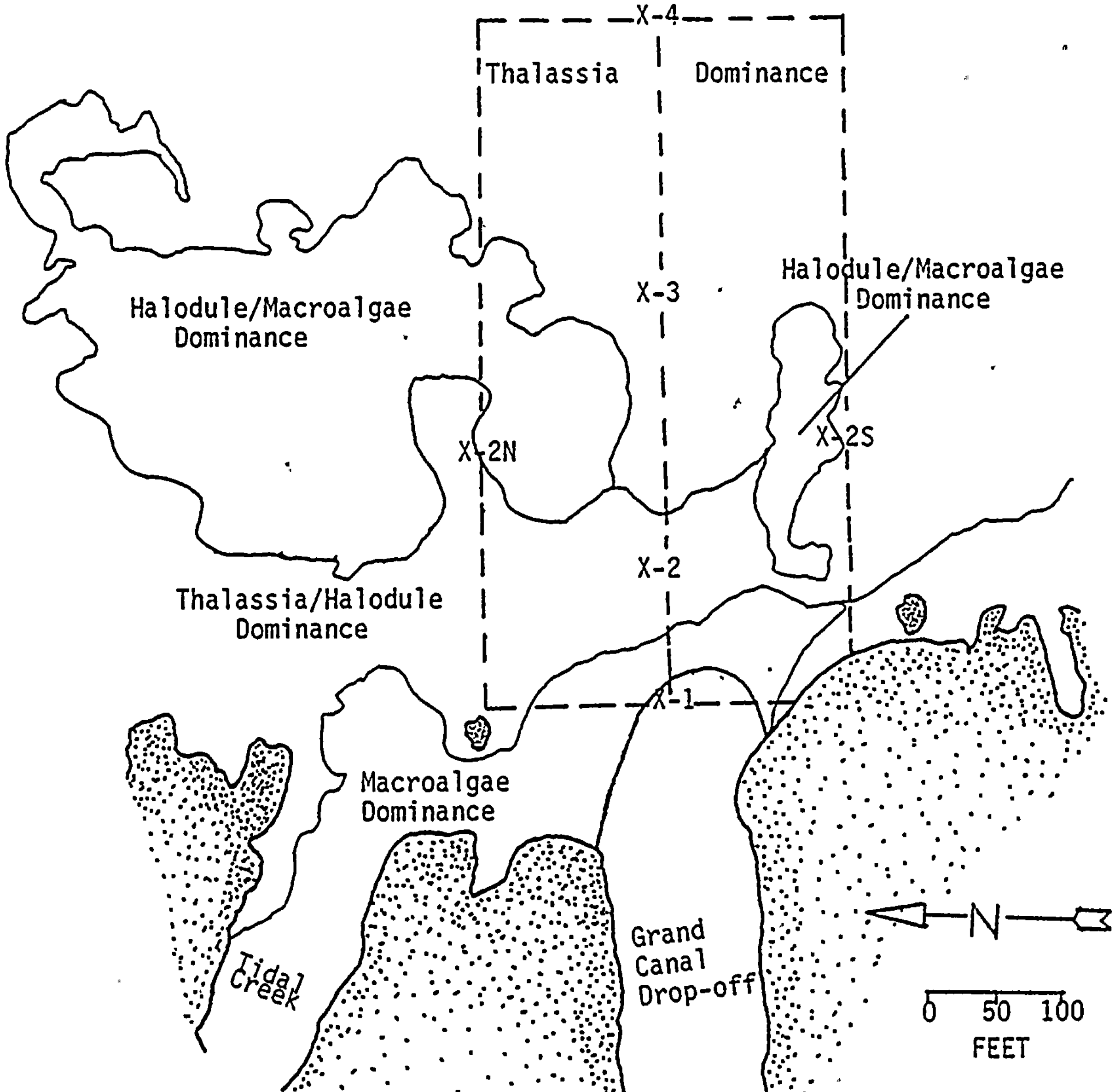


Figure 3. Tracing of Aerial Photograph of previously affected area at Turkey Point Power Plant, Grand Canal Discharge, June, 1982.

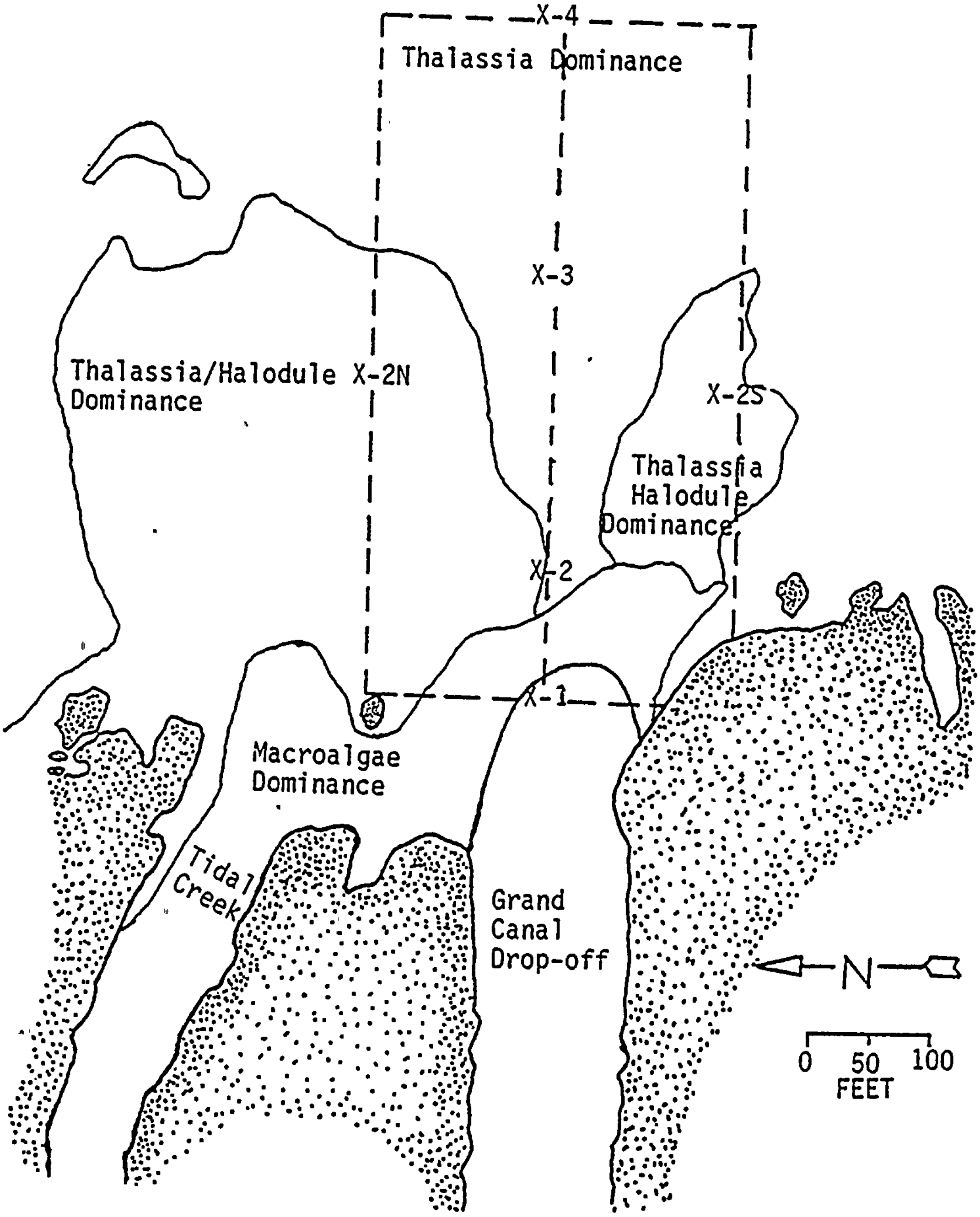


Figure 4. Tracing of Aerial Photograph of previously affected area at Turkey Point Power Plant, Grand Canal Discharge, November 1982.

Table 1. Quadrat Study of the marine flora at the Turkey Point Plant Grand Canal Discharge, June 1982.

FLORA	QUADRATS					
	X-1	X-2	X-3	X-4	X-2N	X-2S
ANGIOSPERMS:						
Halodule wrightii[a]	284	444	308	180	492	564
Thalassia testudinum[a]	88	124	448	612	116	64
Syringodium filiforme[a]	---	---	---	64	---	---
CHLOROPHYTA:						
Acetabularia sp.	---	-[b]	-[b]	-[b]	-[b]	-[b]
Anadyomene stellata	---	---	---	---	---	---
Avrainvillea nigricans[c]	---	---	---	---	---	---
Batophora oerstedi	---	---	-[b]	---	---	---
Caulerpa sp.	-[d]	---	---	---	-[b]	---
Halimeda sp.	-[b]	---	-[b]	---	---	-[b]
Penicillus sp.	---	---	-[b]	---	---	---
Rhipocephalus sp.	---	---	---	---	---	-[b]
Udotea sp.	---	---	---	---	---	---
PHAEOPHYTA:						
Dictyota sp.[c]	---	---	---	---	---	---
RHODOPHYTA:						
Digenia sp.[c]	---	---	-[b]	-[b]	-[b]	-[b]
Laurencia sp.	---	-[b]	-[b]	---	---	-[b]
OTHERS:						
Rhizophora mangle[c]	---	---	---	---	---	---

[a]Number of fasicles/m^2.
[b]Present
[c]Present in previous years
[d]Dominant

Table 2. Quadrat Study of the marine flora at the Turkey Point Plant Grand Canal Discharge, November 1982.

FLORA	QUADRATS					
	X-1	X-2	X-3	X-4	X-2N	X-2S
ANGIOSPERMS:						
Halodule wrightii[a]	---	288	48	16	688	992
Thalassia testudinum[a]	68	84	512	528	212	112
Syringodium filiforme[a]	---	---	44	48	---	---
CHLOROPHYTA:						
Acetabularia sp.	---	-[b]	---	---	-[b]	-[b]
Anadyomene stellata[c]	---	---	---	---	---	-[b]
Avrainvillea nigricans[c]	---	---	---	---	---	---
Batophora oerstedi	---	---	---	---	---	-[b]
Caulerpa sp.	-[d]	---	---	---	---	-[b]
Halimeda sp.	---	---	---	---	-[b]	-[b]
Penicillus sp.[c]	---	---	---	---	-[b]	-[b]
Rhipocephalus sp.[c]	---	---	---	---	---	---
PHAEOPHYTA:						
Dictyota sp.[c]	---	---	---	---	---	---
RHODOPHYTA:						
Digenia sp.[c]	---	---	---	---	---	---
Laurencia sp.[c]	---	---	---	---	-[b]	-[b]
OTHERS:						
Rhizophora mangle[c]	---	---	---	---	---	---

[a] Number of fasicles/m^2.
[b] Present
[c] Present in previous years
[d] Dominant

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

Introduction

Grasses and macrophyton can have potentially detrimental effects on the thermal and hydraulic efficiency of the Turkey Point Cooling Canal System, hereafter referred to as the canal system. This study qualitatively assesses the diversity and extent of seagrasses and macroalgae within the canal system in order to monitor changes in populations which might affect power plant operations.

Materials and Methods

Identification of seagrasses and macrophyton was made during an annual survey and periodically in conjunction with other monitoring programs in the canal system.

Results

Forty-six species in 30 genera of seagrasses and macroalgae were identified in the canal system during 1982 (Table 1) as compared to 41 species in 1981, fifteen in 1980, and 11 reported during the baseline study (Bader and Roessler, 1972). Populations of these marine plants were scattered throughout the canal system with the most dense assemblages in the southwest corner and the eastern canals (Figure 1).

Discussion

Various Rhodophyta (Red), Chlorophyta (Green), and Phaeophyta (Brown) algae continued to be found along the rocky shoreline of most canals (Table 1). The only plants that appeared to be able to adapt to the thermal conditions of the first three sections (Figure 1) were Batophora orstedii, Acetabulbaria crenulata, A. farlowii, Acanthophora spicifera, Halimeda spp., and Polysiphona sp. Species of the red algae Dasya grew predominantly in the winter months on rocks and seemed to be associated with lotic environments. Laurencia spp., Centroceros sp., Polysiphonia sp., and Cladophora spp., were observed in lentic areas of the canals.

The fucale Sargassum filipendula was observed in the eastern return canals as reported previously. Although this plant is typified by long flowing strands bouyed to the surface by bladders, the low population densities do not affect the flow characteristics of the return canals.

The Chlorophyta were well represented in the canal system with substantial growth on a variety of substrates. Algae of the order Siphonales have delicately fibrous bases adapted to growth on soft bottoms (Taylor 1960). These algae grew successfully in the fine sediment base of the canals and were represented by species of Avrainvillea, Derbesia, Penicillus, Rhipocephalus, and Udotea. These algae seemed to be limited to the cooler waters of section five and the

eastern return canals. Stunted species of Halimeda seemed to be the only Siphonales found in the first three sections.

The Rhodophyta are well established throughout the canal systems. The dominant red alga seems to be Laurencia sp., which forms large dense mats in the southern sections and eastern return canals.

All five genera of marine phanerogams found in the tropics were observed in the canal system in 1982. The seagrasses Thalassia testudinum, Syringodium filiforme, and Halophila englemanni were observed only in the northernmost sections of the eastern return canals. This is most likely due to thermal and sediment base requirements of these angiosperms. These seagrasses showed no increase in density or range since last year and posed no immediate threat to hydraulic conditions in the canal system.

Ruppia maritima continued to be the seagrass of primary importance in the canal system although densities are reduced from last year (FPL, 1979-1982). It is no longer confined to the southwest canals in section five and was observed in very heavy concentrations in the eastern return canals and in the southern end of section four. This grass grew to lengths of four to eight feet in flowing strands and seasonally became encrusted with heavy epiphytic growth. The length

of the grass and the epiphytic encrustations combined to severely impede water flow in the affected canals.

Halodule wrightii was particularly well represented by dense stands on both the east and west sides of the canal system. Due to the finite growth habit of its fascicles, this species was thought to be of little consequence in restricting water movement. However, in dense populations, this plant's rhizomes, which are normally attached to the substrate by holdfasts, overlapped each other in such a way that the holdfasts did not penetrate or reach the substrate. This resulted in long floating strands that obstructed water flow in a manner similar to R maritima. Halodule wrightii dominates the canal system in the winter and R. maritima dominates the canal system in the summer.

Nineteen genera of seagrasses and macroalgae were identified in the canal system that were not reported in the baseline study (Bader & Roessler, 1972; Table 1). The apparently large increase of macroalgal species over previous years reflected an increased effort to collect and identify rarely occurring or less visible specimens and to identify to species those genera found in the baseline report. The baseline report does not seem to be representative of the present floral community of either the canal system or Biscayne Bay/ Card Sound.

Conclusions

The growth habits, densities, and morphologies of the macroalgae are such that they do not threaten flow characteristics in the canal system. Ruppia. maritima and H. wrightii continue to dominate the southwest corner of the canal system on alternating seasonal cycles. They will continue to spread into the cooler portions of the canal system until an effective method is found to control them. The continuing spread and concentration of these seagrasses will increasingly reduce thermal and hydraulic efficiency of the canal system.

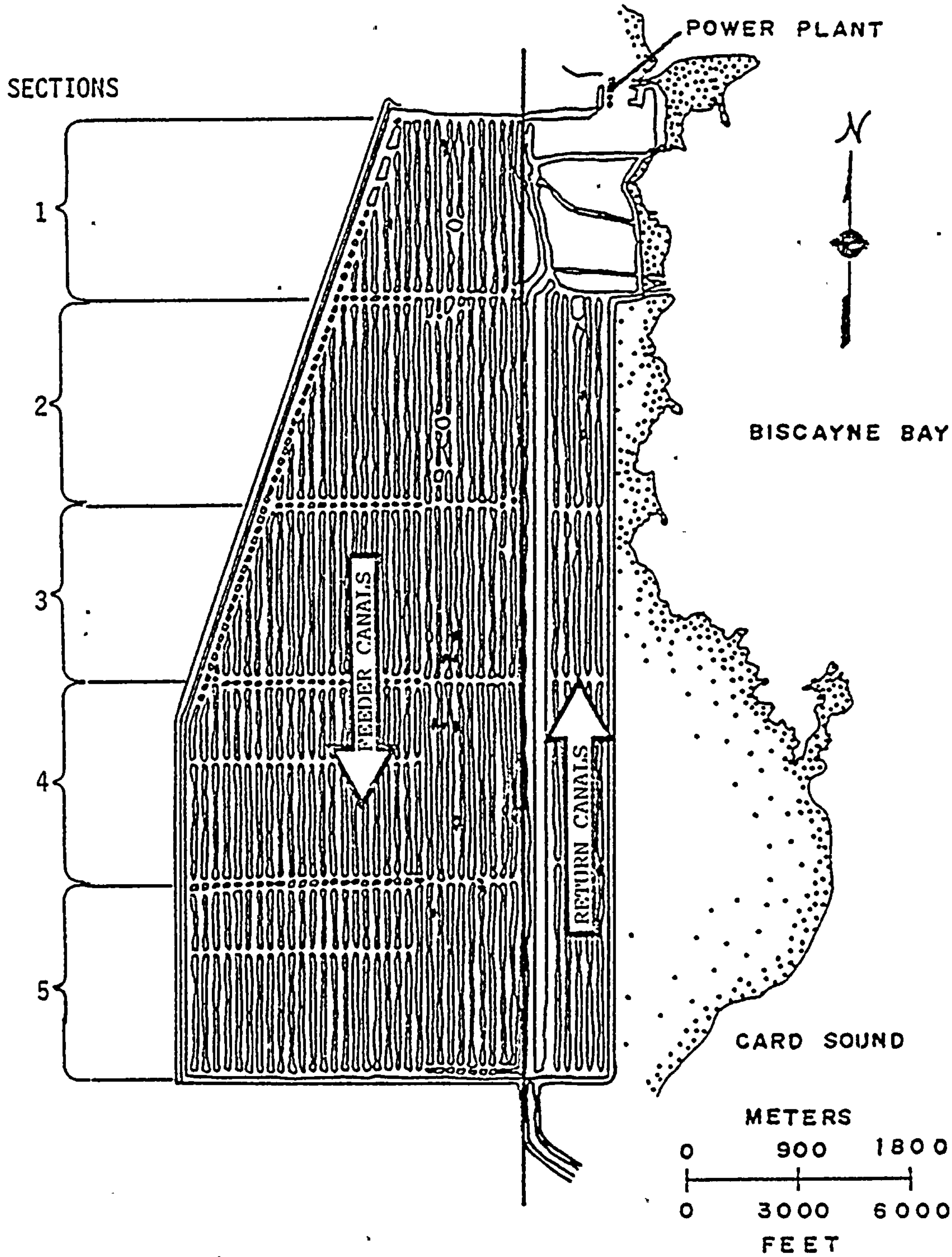


Figure 1. Grasses and macrophyton orientation in the Turkey Point Cooling Canal System, 1982.

Table 1. Comparison of macrophyton and seagrasses identified during the baseline study with those in the Turkey Point Cooling Canal system, 1980-1982.

SCIENTIFIC NAME	BASELINE[a,c] 1972	1980	1981	1982
ANGIOSPERMS				
Halodule wrightii[b]	X	X	X	X
Halophila englemanni	---	X	X	X
Ruppia maritima	---	X	X	X
Syringodium filiforme	---	X	X	X
Thalassia testudinum	X	X	X	X
CHLOROPHYTA				
Acetabularia sp.	X	---	---	---
A. crenulata	---	X	X	X
A. farlowii	---	---	---	X
Batophora oerstedi	X	X	X	X
Caulerpa spp.	X	X	-[c]	---
C. lanuginosa	---	---	X	X
C. mexicana	---	---	X	X
C. prolifera	---	---	X	X
Cladophora crispula	---	---	X	X
Cladophoropsis membranacea	---	---	X	X
Derbesia vaucheriaeformis	---	---	X	X
Enteromorpha sp.	---	---	X	X
Halimeda sp.	---	---	-[c]	---
H. incrassata	X	---	X	X
H. tuna	---	X	X	X
Penicillus spp.	---	X	-[c]	---
P. capitatus	X	---	X	X
P. dumetosus	---	---	X	X
P. lamourouxii	---	---	X	X
Rhipocephalus phoenix	X	X	X	X

Table 1. (Cont'd) Comparison of macrophyton and seagrasses identified during the baseline study with those in the Turkey Point Cooling Canal System, 1980-1982.

SCIENTIFIC NAME	BASELINE[a,c] 1972	1980	1981	1982
CHLOROPHYTA (Cont'd)				
Udotea conglutinata	---	---	X	X
U. flabellum	X	---	X	X
PHAEOPHYTA				
Dictyota sp.	---	---	---	X
Sargassum sp.	---	X	-[c]	---
S. filipendula	---	---	X	X
RHODOPHYTA				
Acanthophora muscoides	---	---	X	X
A. spicifera	---	---	X	X
Centroceras clavulatum	---	---	X	X
Champia parvula	---	---	---	X
Dasya sp.	---	---	X	X
D. pedicillata	---	---	X	X
Digenia simplex	---	---	X	X
Jania rubens	---	---	X	X
Laurencia spp.	X	X	-[c]	---
L. intricata	---	---	X	X
L. papillosa	---	---	X	X
L. poitei	X	---	X	X
Lophosiphonia saccorhiza	---	---	X	X
Polysiphonia subtilissima	---	---	X	X
Spyridia filamentosa	---	---	X	X

[a]Bader & Roessler, 1972
[b]Formerly *Diplanthera wrightii*
[c]Refer to paragraph eight of discussion

6. Groundwater Program (ETS 4.1.1.2)

Florida Power and Light Company has submitted summaries of the monitoring data required by the Turkey Point Environmental Technical Specifications to the NRC for ten years. At the present time, FPL and the South Florida Water Management District are in discussions, the result of which could significantly alter the groundwater monitoring program. Once these discussions are complete, a summary report will be submitted reflecting any program revision.

B. TERRESTRIAL ENVIRONMENT

1. Revegetation of Cooling Canal Banks (ETS 4.2.1)

a. Natural Revegetation

Introduction

This study measures the density of the floristic species and their rate of recolonization on the spoil berms created by constructing the cooling canals.

Materials and Methods

Data were gathered semiannually (May and November) from six stations located within the Turkey Point Cooling Canal System (Figure 1). One 10 meter by 10 meter quadrat was permanently staked out at each station on the canal system spoil berms. One 10 meter by 2 meter quadrat, which was established along the shoreline at each of the aforementioned stations, was monitored to estimate *Rhizophora mangle* growth and reinvasion rates. Tabulated data were presented as number of individuals per quadrat for two species *Casuarina equisetifolia* and *Conocarpus erectus*. Only individuals greater than 3 feet (*C.equisetifolia*) or greater than 1 foot (*C. erectus*) were reported.

Results

Changes in the number of individuals of all species observed at the six stations since 1977 are listed in Tables 1-6.

Rhizophora mangle growth and reinvasion rates are presented in Table 7. The common and scientific names of all species identified since the start of the natural revegetation program in 1975 can be found in Table 8.

Discussion

Land elevation is one of the primary factors which determines the composition and distribution of plant communities. The present site of the cooling canal system was originally dominated by saline mangrove swamps, brackish grasslands and hammock communities. The higher elevation caused by berm construction has allowed sufficient edaphic changes to permit non-mangrove communities to progressively invade the spoil berms of the cooling canal system. Soil type historically has been an overt factor determining vegetation density. The peat and muck of old tidal creeks and hammock areas were dominated by C. equisetifolia and C. erectus, while the marl barrens were vegetated by Distichilis spicata and Cladium jamaicensis.

A vegetation control program has been underway for over three years. This program was designed to control vegetation over 3 feet in height which inhibits wind flow across the water surface thereby reducing cooling canal efficiency. The decrease in the large tree species has had a dramatic affect on most small species. Noticable increases in D. spicata, Andropogon glomeratus, Solanum donianum, Aster tenuifolius, and numerous other species have been observed since

1980. The increases in previously declining species can be attributed primarily to the vegetation control program which employed herbicide combinations selective for woody species of the canopy. In areas of larger woody species where airboat or aerial applications were utilized, little or no herbicide reached the ground. The larger species in these areas died while the smaller understory plants were relatively unaffected. The small plants, previously shaded by the larger species, received increased light and nutrient resources and have proliferated accordingly.

Casuarina equisetifolia and Schinus terebinthifolius are two of the primary target species of the vegetation control program. Both of these trees are undesirable exotic species which have invaded and out competed the indigenous vegetation throughout much of South Florida including the plant site area. At three of the six stations the C. equisetifolia populations substantially decreased during 1982. Overall, C. equisetifolia for the six stations showed a 94 percent decrease from the 1979 population level.

Conocarpus erectus was present at five of the six stations. The adult population decreased at all stations due to the vegetation control program. Seedlings were too numerous to count at Stations 505N, 323S, and 105S.

Changes in the adult R. mangle population occurred at two of the six shoreline quadrats (Table 7). Rhizophorous mangle at Station 408M increased by one adult while this species at Station 505N decreased by three adults. The adult population remained unchanged at the other four stations.

The R. mangle seedling population of Station 204N increased considerably since 1981. The populations at Stations 408M and 505N increased slightly while all others remained unchanged.

Distichilis spicata remained the primary ground cover on the western berms and was found throughout the system. This grass grew well even on marl soils and should serve as excellent erosion protection for the berms. Increases in the species occurred at stations where C. equisetifolia was absent.

Although C. jamaicensis occurred at only 3 of 6 stations, it was still considered an important ground cover and erosion inhibitor because of its observed system wide distribution.

Comparison with available pre-operational vegetation data was 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).

Conclusions

The increased elevations resulting from berm construction have allowed upland species to invade the western areas of the canal system. Soil type continues to be the apparent factor determining vegetation density. Casuarina equisetifolia and C. erectus dominate the peat and muck soils of the old tidal creeks and hammock areas, while D. Spicata and C. jamaicensis, dominate the marl barrens. The vegetation control program has been effective in substantially decreasing the dominance of C. equisetifolia which in turn has allowed for greater species diversity. The increased revegetation rates of D. Spicata, C. jamaicensis and other small understory species are expected to continue as long as a vegetation control program is in use. Rhizophora mangle showed no evidence of reinvading the shoreline margin of the spoil berms.

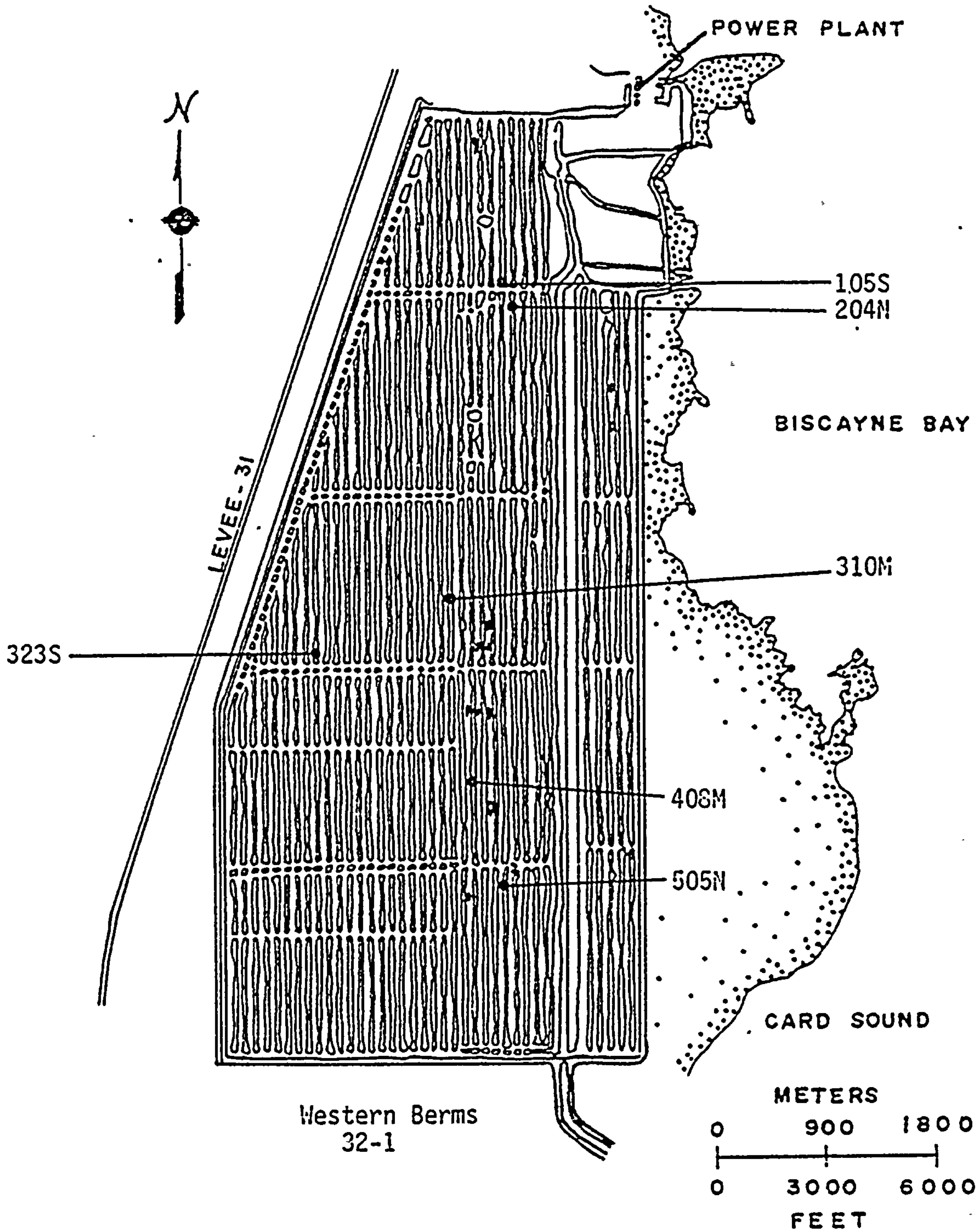


Figure 1. Natural revegetation stations at the Turkey Point Cooling Canal System, 1982.

Table 1. Number of individuals per 10 x 10m revegetation quadrat at Station 105S in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Rhizophora mangle	5	4	7	7	7	7	7	7	7	7	7	7	7	7	4	3	2
Laguncularia racemosa	6	5	7	8	8	8	8	8	8	8	10	10	10	7	7	8	5
Conocarpus erectus	4	4	4	4	4	4	4	4	4	4	4	4	4	4	9	2	3
Distichilis spicata[a]	9	9	18	15	20	22	30	35	35	35	46	40	35	70	80	95	100
Juncus roemerianus	19	30	47	30	33	25	15	5	5	5	6	5	4	2	2	3	3
Solanum donianum						1	1	2	2	2	15	14	20	10	14	17	43
Erechtites hieracifolia								2	2	2	0	0	0	0	0	0	0
Baccharis halimifolia								1	3	3	3	4	4	12	12	11	15
Eupatorium capillifolium								3	3	3	2	2	0	84	27	20	18
Schinus terebinthifolius											2	3	0	1	1	1	0
Andropogon glomeratus											1	1	3	1	6	19	26
Mikania scandens											1	3	1	9	_[b]	_[b]	_[b]
Casuarina equisetifolia													1	2	1	1	1
Borrichia frutescens														3	0	0	0
Melothria pendula															1	4	10
Ficus citrifolia																	1

[a]Denotes coverage in m^2.
[b]Too numerous to count.

Table 2. Number of individuals per 10 x 10m revegetation quadrat at Station 204N in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Baccharis halimifolia	0	11	18	23	42	35	40	40	50	50	13	8	0	1	1	1	0
Conocarpus erectus	2	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
Casuarina equisetifolia	10	13	31	31	32	30	30	36	37	40	37	38	24	9	8	1	1
Acrostichum danaeifolium	2	3	4	4	5	5	5	2	2	2	0	0	0	0	0	0	0
Eupatorium capillifolium	0	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0
Borrichia frutescens	21	43	43	45	4	0	0	0	0	0	0	0	0	0	0	0	0
Rhabdadenia biflora	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	-[b]	0
Sonchus oleraceus	0	1	0	0	5	0	0	0	0	0	0	0	1	0	0	0	0
Solanum nigrescens	2	1	0	0	3	3	3	0	0	0	0	0	0	0	0	0	0
Solanum donianum	1	4	1	1	10[a]	10[a]	10[a]	2	2	2	2	1	9	29	32	35	23
Chamaesyce mesembryanthemifolia	1	0	0	6	4	1	0	1	2	2	0	0	0	0	0	0	0
Pluchea rosea		29	25	40	50	20	0	0	0	0	0	0	0	0	0	2	0
Sarcostemma clausa			1	1	1	2	3	10[a]	15[a]	15[a]	90[a]	90[a]	2	1	0	0	b
Mikania scandens			2	2	2	25[a]	50[a]	50[a]	40[a]	40[a]	3	0	95[a]	87[a]	95[a]	95[a]	95[a]
Physalis angulata				1	1	0	0	0	0	0	1	0	0	0	1	1	2
Thelysteris normalis				1	1	4	3	2	2	2	0	0	0	0	0	0	0
Aster tenuifolius					3	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Number of individuals per 10 x 10m revegetation quadrat at Station 204N in the
(Cont'd) Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Phytolacca rigida					4	5	7	9	1	1	5	3	0	0	0	0	0
Erechtites hieracifolia					5	30	25	0	0	0	0	0	3	0	0	0	0
Schinus terebinthifolius								1	1	1	1	0	0	0	0	0	0
Melothria pendula											3	6	50[a]	50[a]	35[a]	50[a]	70[a]
Lantana camara											1	2	1	0	1	1	1
Passiflora suberosa											1	1	1	0	1	0	0

[a]Denotes coverage in m^2.
[b]Too numerous to count.

Table 3. Number of individuals per 10 x 10m revegetation quadrat at Station 310N in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Rhizophora mangle	9	8	10	11	12	13	13	13	13	13	10	10	6	0	0	0	0
Casuarina equisetifolia	37	39	42	44	46	48	43	43	43	45	45	58	25	19	8	2	0
Cladium jamaicensis	620	600	9[a]	12[a]	14[a]	15[a]	14[a]	15[a]	15[a]	15[a]	13[a]	15[a]	35	41	16	21	16
Distichlis spicata	4	4	8	8	12	12	12	10	9	9	1	1	8	8	8	7	8
Baccharis halomifolia	0	0	1	2	2	2	2	2	2	2	1	1	0	4	0	2	0
Conocarpus erectus	4	6	5	6	8	8	8	8	8	8	1	2	1	1	1	0	0
Rhabdadenia biflora	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	0
Laguncularia racemosa	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
Acrostichum danaeifolium	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Pteris vittata	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	24	20
Schinus terebinthifolius		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum donianum								2	2	2	0	0	0	2	1	0	0
Sporobolus virginicus[a]											6	0	0	0	0	0	0
Aster tenuifolius											1	0	0	1	1	0	0
Mikania scandens													12	20	5	13	2
Andropogon glomeratus														1	1	3	2
Thelysteros normales																	1

[a]Denotes coverage in m^2.

Table 4. Number of individuals per 10 x 10m revegetation quadrat at Station 323S in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Conocarpus erectus	18	19	18	19	22	23	23	24	24	24	20	26	20	20	30	13	8
Casuarina equisetifolia	12	18	17	18	19	19	19	19	19	33	37	55	65	65	23	11	10
Cladium jamaicensis	376	-[b]	-[b]	35[a]	35[a]	50[a]	65[a]	65[a]	65[a]	65[a]	65[a]	65[a]	65[a]	65[a]	25[a]	15[a]	116[a]
Juncus roemerianus	82	102	74	65	32	39	20	14	14	14	0	0	0	0	0	0	0
Solanum doniaum	40	9[a]	38	61	73	89	89	104	107	163	160	149	169	-[b]	-[b]	87	-[b]
Ipomoea sagittata	0	11	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pluchea rosea	0	57	3	8	5	0	2	0	0	0	0	0	0	0	0	0	3
Eupatorium capillifolium	6	0	4	9	8	8	8	0	0	0	0	0	0	0	0	2	1
Aster tenuifolius	8	19	0	0	5	0	0	0	0	0	0	0	0	0	0	0	4
Sabatia stellaris	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schinus terebinthifolia	1	1	1	1	2	2	2	1	1	1	1	2	1	3	0	1	2
Acrostichum danaeifolium	18	13	1	3	3	3	3	3	3	3	3	4	3	2	2	1	5
Baccharis helimifolia	20	17	15	19	24	20	22	22	22	23	4	3	1	1	0	4	1
Passiflora suberosa	1	1	1	1	1	1	1	4	4	2	4	3	3	0	1	17	11
Andropogon glomeratus	1	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0
Trema floridana			1	1	0	0	0	1	1	0	0	0	0	0	0	0	0
Mikania scandens											5	0	1	0	1	10	10
Borrichia frutescens											1	0	0	0	0	0	0

Table 4. (Cont'd) Number of individuals per 10 x 10m revegetation quadrat at Station 323S in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Celtis laevigata																1	4
Pteris vittata																	4
Thelypteris normalis																	1

[a] Denotes coverage in m^2.
[b] Too numerous to count.

Table 5. Number of individuals per 10 x 10m revegetation quadrat at Station 408M in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Conocarpus erectus	5	8	7	7	7	7	7	7	7	7	12	8	3	2	2	2	1
Casuarina equisetifolia	32	85	79	130	139	140	140	140	145	150	155	162	11	3	3	9	7
Cladium jamaicensis	3	16	10	11	14	13	12	12	12	12	10	7	5	5	6	7	33
Distichilis spicata[a]	2	4	5	5	9	9	9	9	9	9	9	9	12	12	12	6	1
Sabatia stellaris	0	1	1	1	1	0	4	0	0	0	0	4	1	21	0	0	0
Pteris vittata	33	47	40	42	50	40	30	20	18	16	4	0	32	-[b]	85	-[b]	-[b]
Thelysteris normalis	9	6	7	6	8	7	4	4	4	4	2	9	24	14	12	18	12
Baccharis halimifolia	1	2	1	1	3	3	3	0	0	0	0	3	5	5	4	3	5
Solanum donianum	2	0	2	1	1	1	1	1	0	0	0	0	0	57	37	48	54
Acrostichum danaeifolium	6	5	0	2	2	2	2	2	2	2	0	0	40	26	11	10	12
Sonchus oleraceus	1	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
Eupatorium capillifolium				3	3	4	6	4	6	6	0	0	11	-[b]	-[b]	-[b]	-[b]
Andropogon glomeratus				8	6	0	14	50	50	50	2[a]	1[a]	8	-[b]	-[b]	-[b]	-[b]
Pluchea rosea				2	2	1	1	1	1	1	0	0	43	10	0	0	0
Salix caroliniana													3	1	1	0	0
Aster tenuifolius													1	0	3	1	0
Vallesia antillana													1	0	0	0	0
Trema floridana														7	6	6	6

Table 5. (Cont'd) Number of individuals per 10 x 10m revegetation quadrat at Station 408M in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Mikania scandens														8	8	24	13

[a]Denotes coverage in m^2.
[b]Too numerous to count.

Table 6. Number of individuals per 10 x 10m revegetation quadrat at Station 505N in the Turkey Point Cooling Canal System, 1977-1982.

SCIENTIFIC NAME	1977				1978				1979			1980		1981		1982	
	Jan.	Apr.	Jul.	Oct.	Jan.	Apr.	Jul.	Oct.	Jan.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Conocarpus erectus	5	5	5	5	5	4	4	4	4	4	4	4	4	4	6	6	4
Borrichia frutescens	5	5	5	5	7	8	12	13	13	13	40	38	47	128	82	-[b]	-[b]
Distichilis spicata	5	3	5	1	2	2	2	2	2	2	4	6	10	25	16	25	50
Casuarina equisetifolia									1	1	1	0	0	0	2	6	8
Aster tenuifolius											39	84	120	-[b]	-[b]	-[b]	32
Baccharis halimifolia											3	1	8	3	3	11	13
Andropogon glomeratus												1	1	10	23	36	50
Sabattia stellaris														1	0	-[b]	0
Mikania scandens														10	7	6	11
Rhabdadenia biflora														1	1	1	0
Schinus terebinthifolius																1	2
Pteris vittata																1	0
Ficus citrifolia																	4
Solanum donianum																	1

[a] Denotes coverage in m^2.
[b] Too numerous to count.

Table 7. Number of *Rhizophora mangle* per 2 x 10m quadrat at stations in the Turkey Point Cooling Canal System, 1979-1982.

STATIONS	1979		1980		1981		1982	
	MAY	NOV.	MAY	NOV.	MAY	NOV.	MAY	NOV.
105S								
Mature[b]	2	2	2	2	2	2	2	2
Seedlings[c]	7	4	3	3	0	0	0	0
204N								
Mature	1	1	1	1	0	0	0	0
Seedlings	12	16	14	7	5	3	106	47
310N								
Mature	2	2	2	2	2	2	2	2
Seedlings	7	0	0	0	1	0	0	0
323S								
Mature	0	0	0	0	0	0	0	0
Seedlings	0	0	0	0	0	0	0	0
408M								
Mature	10	10	14	7	6	3	4	4
Seedlings	48	53	27	2	0	4	8	6
505N								
Mature	-[a]	7	14	15	16	15	15	12
Seedlings	-[a]	11	5	4	0	0	1	2

[a] No data taken
[b] Adults, woody trunk and prop roots, greater than 1 foot in height.
[c] No prop roots, green radicle, less than 1 foot in height.

Table 8. Historical list of species identified in the Turkey Point Natural Revegetation Program, 1975-1982.

SCIENTIFIC NAME	COMMON NAME
Acrostichum danaeifolium	Leather Fern (Mangrove Fern)
Andropogon glomeratus	Beard Grass
Aster tenuifolius	Saltmarsh Aster
Baccharis halimifolia	Saltbush (Groundsel)
Borrichia frutescens	Sea Oxeye (Oxeye Daisy, Sea Daisies)
Casuarina equisetifolia	Australian Pine
Celtis laevigata	Hackberry (Sugarberry)
Chamaesyce mesembryanthemifolia	Spurge
Cladium jamaicensis	Sawgrass
Conocarpus erectus	Buttonwood
Distichilis spicata	Saltgrass
Echites sp.	Devil's Potatoe
Eleocharis sp.	Club Rush (Spike Rush)
Erechtites hieracifolia	Fireweed (Burnweed)
Eupatorium capillifolium	Dog Fennel
Ficus citrifolia	Wild Banyan Tree
Fuirena sp.	Umbrella Grass
Ipomoea sagittata	Glades Morning Glory
Juncus roemerianus	Black Rush (Needle Rush)
Laguncularia racemosa	White Mangrove
Lantana camara	Lantana
Melanthera aspera	Rohrb
Melothria pendula	Creeping Cucumber
Mikania scandens	Climbing Hempweed (Hempvine)
Passiflora suberosa	Corky-stemmed Passion Flower
Physalis angulata	Ground Cherries
Phytolacca rigida	Pokeweed (Inkberry)
Pluchea rosea	Marsh Fleabane

Table 8. (Cont'd) Historical list of species identified in the Turkey Point Natural Revegetation Program, 1975-1982.

SCIENTIFIC NAME	COMMON NAME
Pteris vittata	Brake Fern
Rhabdadenia biflora	Mangrove Rubber Vine
Rhizophora mangle	Red Mangrove
Sabatia stellaris	Marsh Pink
Salix caroliniana	Coastal Plains Willow
Sarcostemma clausa	White Vine
Schinus terebinthifolius	Brazilian Pepper
Sesuvium portulacastrum	Sea Purslane
Sida rubromarginata	Mallow Family
Solanum donianum	Blodgett's Potatoe
Solanum nigrescens	Black-Nightshade
Solidago stricta	Golden Rod
Sonchus oleraceus	Sow Thistle
Sporobolus virginicus	Virginia Dropseed
Thelypteris normalis	Schmidel
Trema floridana	Florida Trema (Nettle Tree)
Vallesia antillana	Oleander

Nomenclature according to Long & Lakela, 1971.

b. Soil Chemistry (ETS 4.2.1.1)

Introduction

This program monitors selected chemical parameters and their changes over time for three elevations of the spoil banks (berms) in the Turkey Point Cooling Canal System.

Materials and Methods

Samples were collected semiannually (wet and dry seasons) at 53 sites that represented all major soil types and vegetation densities through out the canal system (Figure 1). Samples were taken at each site from three berm levels at a depth of 12 inches using a JMC Backsaver Coring Device. They were placed in "Whirl Paks" for transportation to the laboratory. Samples were separated and mixed to form composite samples representing the various soil and vegetation types by elevations (Table 1). East side samples were mixed according to elevation only i.e. "ET" equals all east side top elevations.

Composite samples were analyzed for pH, nitrogen, phosphorus, 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. Nitrogen was determined using the Brucine Method. Phosphorus was determined using the Stannous Chloride Method. Chloride was determined using a silver nitrate titration. Conductivity was determined using a modified

Wheatstone Bridge. All analytical methods were according to A.P.H.A., 1975. The resulting data were analyzed statistically using the P7D Program of U.C.L.A. Biomedical Program, Series P.

Results

Data for all sample types for May (dry season) and November (wet season) are listed in Tables 1 and 2. The ranges of the parameter values and the sample types having the highest values can be found in Table 3.

Discussion

The pH exhibited significant variance (α=0.01) within successive years and sample types. It was lowest at stations with organic substrates and at middle elevations. The high pH values were found in the clay substrates, areas with grass vegetation, and low elevations. The average pH for all western samples (WT,WM,and WL) was 7.89 for both May and November. The highest value occurred during May in sample 4 WT and during November in Samples 5WL, 6WL, 8WL, and 9WL (Table 3). The pH values were more alkaline than the range cited as optimal for plant growth (Hartmann & Kester, 1975).

Nitrogen values also exhibited highly significant variance (α=0.01) within sample types. Values ranged from 7.0 - 180.0 mg/kg. This was similar to the 1981 range of 2.0 - 180 mg/kg (FPL, 1981). Historically, nitrogen values were increasing until 1980. In 1980

average nitrogen value dropped by two-thirds. Since 1981 there has been a slow recovery trend.

Phosphorus concentrations in soils declined from 1975 through 1979. In 1980, concentrations increased markedly. Average values for 1982 were the highest recorded. Phosphorus values exhibited a highly significant difference ($\alpha=0.01$) by year but no significant difference by sample type. The yearly variations are apparent in the following ranges 0.1-8.0 mg/kg, 1982; 0.1-10.0 mg/kg, 1981 and 0.1-6.0 mg/kg, 1980. Soil phosphorus concentrations were generally higher at middle elevations. The highest recorded phosphorus value occurred during November in Samples 1 WM and EL (Table 3). Although the 1982 values were high for the study area, relative to other areas of Florida they are very low. Phosphorus values in this area are thought to remain low due to the very high calcium levels (Black, 1968).

During 1982 potassium values correlated well with both chloride and conductivity values having correlation coefficients (r) of 0.83 and 0.95 respectively. However, the historical correlations (using all data points 1975-1982) were only fair between potassium and chloride (r=0.83) and between potassium and conductivity (r=0.74). The highest potassium value was noted in November in Sample 1WL (Table 3). The levels of potassium for the berms were within the historical ranges for this geographic area (Black, 1968).

Calcium concentrations exhibited highly significant variance ($\alpha=0.01$) within successive years and sample types. In May the highest value was observed in Sample 2WM while in November the highest value was noted in 6WM and 1WL (Table 3).

Chloride concentrations showed significant variance by year ($\alpha=0.05$), but no significant difference by sample type. Generally, the higher chloride levels were observed at the lowest elevations (Tables 1 and 2) which were in contact with the water.

Conductivity followed chloride concentrations very closely in terms of yearly and sample type comparisons. Again the general pattern was for higher conductivities at the lowest elevations.

Conclusions

The pH, chloride and conductivity values vary significantly from year to year (FPL, 1975-1982). When the vegetation control program was initiated in 1979, mean nitrogen values dropped considerably, but are now slowly recovering. Average phosphorus values gradually decreased from 1975 to 1979. In 1980 a marked increase in phosphorus was noticed

vary significantly by sample type. Generally, the values for all parameters except phosphorus decreased during the wet season and increased in the dry season.

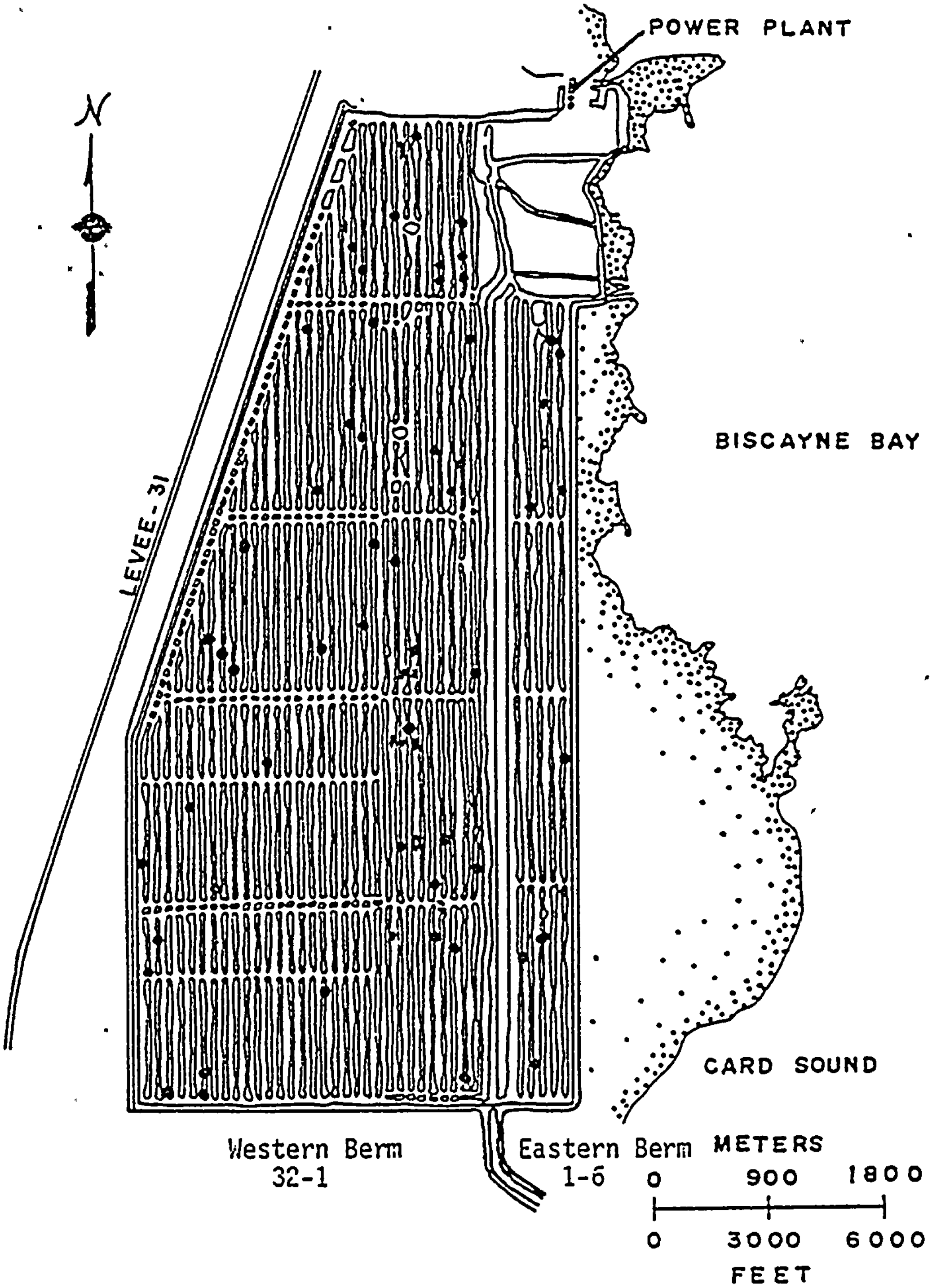


Figure 1. Soil Chemistry samples sites (•) in the Turkey Point Cooling Canal System, 1982.

Table 1. Chemical summary of soils for Turkey Point Cooling Canal System berms during May 1982.

SAMPLE[a] TYPES		pH	NO_3[b]	P[b]	K[b]	Ca[b]	Cl[b]	Cond.[c]
1	WT	7.6	85	0.5	13	850	1100	187
	WM	7.8	140	3.0	25	800	2450	153
	WL	7.7	100	<0.1	164	1000	5500	450
2	WT	7.8	125	<0.1	15	1000	1000	143
	WM	7.7	145	2.0	37	1100	2200	178
	WL	7.7	38	<0.1	103	550	4400	360
3	WT	7.9	115	<0.1	107	650	3750	360
	WM	7.9	49	4.0	120	1000	5250	360
	WL	7.8	24	<0.1	348	750	9500	900
4	WT	8.0	180	0.5	170	1050	4500	500
	WM	7.9	115	0.2	155	700	7000	430
	WL	7.9	49	<0.1	220	500	8000	750
5	WT	8.1	105	<0.1	45	500	2500	200
	WM	7.9	110	2.0	95	1000	4500	260
	WL	8.0	16	1.0	210	750	7000	680
6	WT	7.7	115	1.0	15	700	3500	130
	WM	7.8	115	1.0	27	600	2600	200
	WL	7.9	7	1.0	332	750	10 000	700
7	WT	7.9	39	<0.1	8	400	3000	120
	WM	7.9	110	3.0	22	700	2000	160
	WL	8.0	14	0.3	200	500	7500	650
8	WT	8.0	85	<0.1	49	650	1500	230
	WM	7.8	160	4.0	95	800	3600	290
	WL	8.0	15	<0.1	292	850	11 000	630
9	WT	8.0	49	<0.1	30	300	900	125
	WM	8.1	43	1.0	22	250	2000	130
	WL	8.2	12	<0.1	225	550	7000	630
	ET	7.7	50	3.0	35	450	4000	170
	EM	7.7	55	0.5	62	650	10 000	330
	EL	7.6	14	1.0	332	1000	3200	850

[a]1-4, sample type based on composition i.e. black organic, organic, mucky-marl and marl respectively.
5-9, sample type based on vegt. density i.e. none, heavy, medium, light and areas initially covered by grass.
"W" and "E", samples taken on the west and east sides of system respectively.
"T", "M", and "L", samples taken at three levels, top, middle and one foot above water level.
[b]All values in mg/kg.
[c]Conductivity in MHOS X 10^{-5}.

Table 2. Chemical summary of soils for Turkey Point Cooling Canal System berms during November 1982.

SAMPLE[a] TYPES		pH	NO_3[b]	P[b]	K[b]	Ca[b]	Cl[b]	Cond.[c]
1	WT	7.5	130	<0.1	18	600	1400	135
	WM	7.4	170	8.0	60	1100	3600	280
	WL	7.9	82	<0.1	440	1400	11 000	1320
2	WT	7.5	70	<0.1	30	1200	1500	195
	WM	7.3	140	<0.1	18	1100	1150	140
	WL	8.0	16	2.0	180	800	6500	740
3	WT	8.0	98	<0.1	64	300	3500	225
	WM	7.8	32	8.0	98	400	4250	360
	WL	8.1	36	<0.1	260	1300	8000	980
4	WT	8.0	290	<0.1	150	1100	7500	680
	WM	8.0	32	8.0	98	400	4250	360
	WL	8.1	78	4.0	172	1100	7000	660
5	WT	7.9	110	<0.1	34	700	3000	300
	WM	8.0	80	4.0	44	500	3000	190
	WL	8.2	12	<0.1	122	700	5500	440
6	WT	7.7	48	<0.1	22	900	1000	130
	WM	7.8	50	<0.1	12	1400	1500	133
	WL	8.2	27	<0.1	122	700	5000	380
7	WT	7.7	26	<0.1	22	700	700	88
	WM	7.5	110	6.0	60	700	1250	90
	WL	8.2	26	4.0	70	400	3900	300
8	WT	7.8	120	<0.1	60	1100	4000	230
	WM	7.9	110	<0.1	54	600	3200	220
	WL	8.2	16	2.0	164	700	5000	580
9	WT	8.1	14	0.1	10	100	750	57
	WM	8.0	25	<0.1	10	400	750	54
	WL	8.2	4	<0.1	136	700	5500	560
	ET	7.7	54	<0.1	30	1100	1500	260
	EM	7.4	90	<0.1	106	500	2900	280
	EL	7.6	37	8.0	296	1100	8500	770

[a] 1-4, sample type based on composition i.e. black organic, organic, mucky-marl and marl respectively.
5-9, sample type based on vegt. density i.e. none, heavy, medium, light and areas initially covered by grass.
"W" and "E", samples taken on the west and east sides of system respectively.
"T", "M", and "L", samples taken at three levels, top, middle and one foot above water level.
[b] All values in mg/kg.
[c] Conductivity in MHOS X 10^{-5}.

Table 3. The ranges of soil parameter values and the sample type with the highest value for the Turkey Point Cooling Canal System, 1982.

MAY			NOVEMBER		
PARAMETER	RANGE	SAMPLE TYPE WITH HIGHEST VALUE	PARAMETER	RANGE	SAMPLE TYPE WITH HIGHEST VALUE
pH	7.6-8.2	9WL	pH	7.3-8.2	5WL, 6WL, 7WL, 8WL, 9WL
Nitrate[a]	7.0-180	4WT	Nitrate[a]	4.0-290	4WT
Phosphorus[a]	<0.1-4.0	3WM, 8WM	Phosphorus[a]	<0.1-8.0	EL, 1WM, 3WM
Potassium[a]	8-348	3WL	Potassium[a]	10-440	1WL
Calcium[a]	250-1100	2WM	Calcium[a]	100-1400	6WM, 1WL
Chloride[a]	900-11 000	8WL	Chloride[a]	3000-11 000	1WL

[a]Values in mg/kg.

c. Soil Erosion (ETS 4.2.1.1)

Introduction

Soil erosion measurements are made to determine canal bank erosion rates resulting from 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 since it can cause sedimentation in the cooling canals thus reducing the thermal and hydraulic efficiency of the Turkey Point Cooling Canal System.

Material and Methods

Soil erosion measurements were made semiannually at two stations in the canal system (Figure 1). Stations 502N and 530N are both located in the southern part of the canal system. The most common soil type in the canal system is mucky-marl, therefore, both stations were placed in areas with that predominant edaphic characteristic. At each station, four pipes were driven vertically through the berms and into the underlying rock to serve as permanent reference points. A stainless steel "averaging cross" was placed horizontally on each of the pipes. It was aligned to magnetic north and the distance from the tips of the cross to the berm surface was measured. Comparing these measurements over time yields the berm erosion rates.

Results

An average berm erosion rate of 0.023 feet occurred during the dry season and 0.000 feet during the wet season for a total average erosion of 0.023 feet in 1982. Rainfall for the dry season and wet season was 10.43 inches and 17.00 inches respectively (Table 1).

Discussion

In 1982, deposition or little erosion occurred during the wet season while relatively high erosion rates occurred during the dry season. This is a seasonal pattern reversal similar to that which occurred in 1978 and 1979 (Table 1).

Rainfall during 1982 generally occurred in frequent small amounts rather than large amounts over short periods of time. This pattern tends to result in the soils actually developing cohesive characteristics which inhibit erosion. There was a poor correlation between rainfall and soil erosion. It therefore appears that other factors such as wind gustiness, duration of critical wind velocities, soil densities, soil moisture content, rainfall frequency and rainfall intensity act in concert to erode the berms.

No comparison to baseline data can be made since preoperational studies were not performed.

Conclusions

The 1982 cooling canal berm erosion rate does not differ significantly from historical data (1976-1981). The general pattern reversals which occurred in 1978, 1979 and 1982 should not be considered uncommon and were manifestations of changes in the patterns or magnitudes of eroding agents other than rainfall. No increase in erosion rate can be expected to occur other than that due to the intrinsic seasonal fluctuation apparent in the historical data.

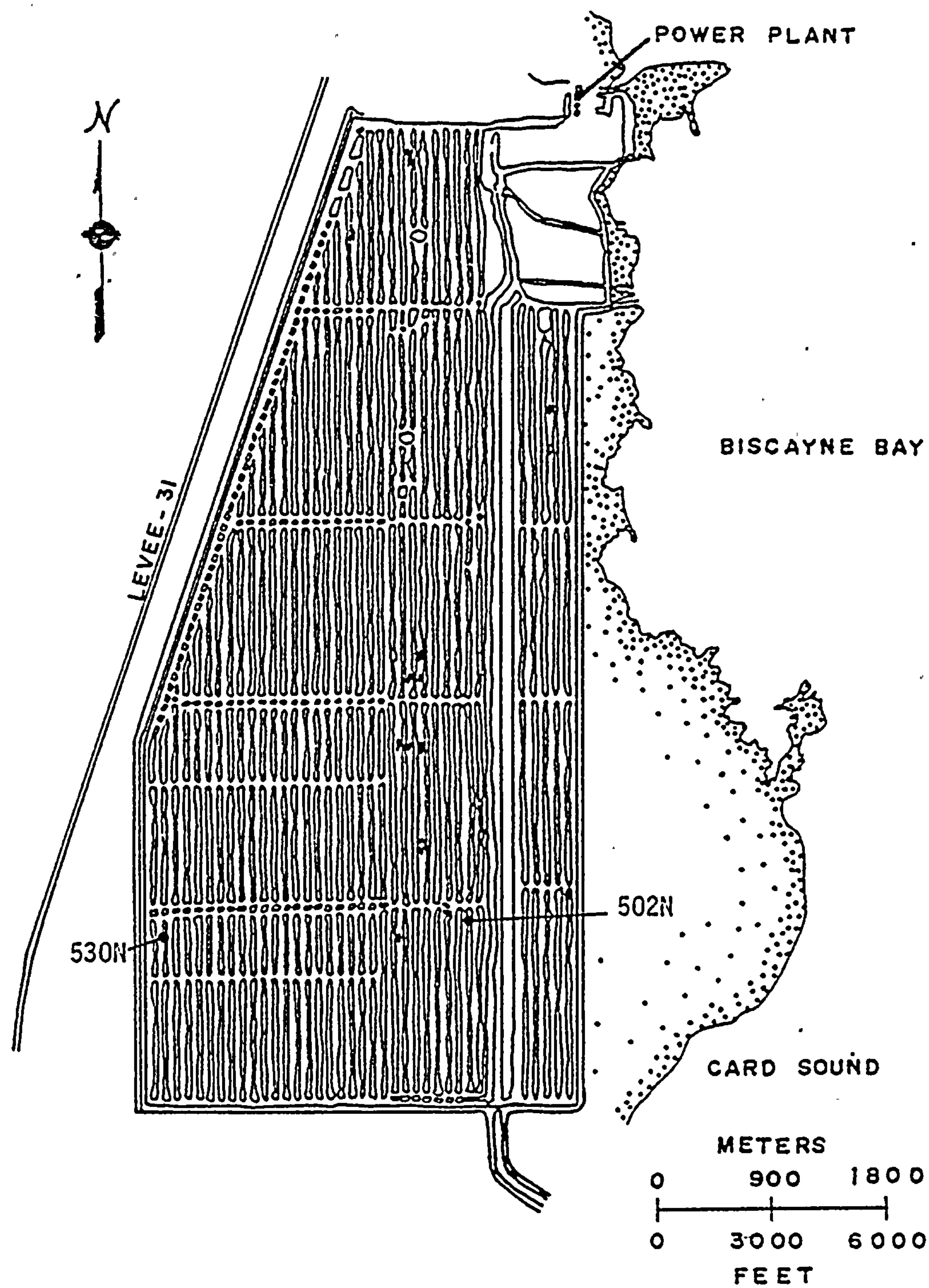


Figure 1. Soil erosion stations at the Turkey Point Cooling Canal System, 1982.

Table 1. Rainfall, erosion and erosion rate in the Turkey Point Cooling Canal System, 1977-1982.

YEAR	QUARTER	RAINFALL (inches)	EROSION (feet[a])	EROSION PER INCH OF RAINFALL [(feet)· 10^{-4}]
1977	1	4.81	+0.001	
	2	22.16	+0.057[b]	
	3	23.56	-0.093[b]	
	4	12.66	-0.016	
	Total	63.19	-0.051	-8.07
1978	1	10.20	-0.008	
	2	12.92	-0.007	
	3	24.42	-0.014	
	4	4.11	-0.018	
	Total	52.65	-0.047	-8.93
1979[c]	1	----	----	
	2	10.62	-0.034	
	3	----	----	
	4	22.75	-0.012	
	Total	33.37	-0.046	-13.78
1980	1	----	----	
	2	12.44	+0.008	
	3	----	----	
	4	30.84	-0.042	
	Total	43.28	-0.034	-7.85
1981	1	----	----	
	2	7.49	-0.010	
	3	----	----	
	4	28.78	-0.017	
	Total	36.27	-0.037	-10.20
1982	1	----	----	
	2	10.43	-0.023	
	3	----	----	
	4	17.00	0.000	
	Total	27.43	-0.023	-8.38

[a]Erosion is denoted by (-), and deposition by (+).
[b]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
[c]The monitoring frequency was changed to semi-annually in 1979.

d. Faunal Survey (ETS 4.2.1.1)

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, 1978b). The study area encompasses 6,800 acres of land utilized for the cooling canal system, selected coastline, associated canals, and 28 acres for plant site (Figure 1).

Materials and Methods

Most faunal estimates were made by visual observations during routine monitoring. Some non-destructive sampling was carried out with captured organisms being released after identification. Mammal abundance was estimated from visual observations, 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

One hundred one avian species (Table 1), 19 reptilian species (Table 2), three amphibian species (Table 2) and seven mammalian species (Table 3) were observed in the study area during 1982. Particularly important among the observed species were the: bald eagle, wood stork, American crocodile, eastern indigo snake, and manatee.

Sixty one avian species, 11 species of reptiles and amphibians and six species of mammals were common to both the surrounding area (ABI, 1978b) and the study area (Tables 4, 5, and 6).

The 1982 population estimate for crocodiles observed in the study area was 18 to 21 individuals. No active nest sites or hatchlings were discovered during 1982.

Discussion

Table 1 is a list of 101 avian species sighted in the study area during 1982. A total of 105 avian species was sighted during 1981. The birds occurred either as permanent residents, regular or casual visitors, or visitors that appeared only during migration.

The common nighthawk and the least tern were common during the months of April through August. As in previous years, these species found the spoil banks a suitable nesting ground. The common starling, the common flicker and the mockingbird were also observed nesting during 1982.

A total of 19 reptiles and three amphibians were observed in the study area (Table 2) as compared to 18 reptiles and five amphibians observed in 1981 and 10 reptiles and one amphibian in 1980. All reptiles and amphibians were considered permanent residents of the study area.

The 1982 crocodile population estimate of 18 to 21 individuals, remained unchanged from the population estimate of 1981.

Nocturnal observations indicated that the marsh rabbit and racoon were quite common. A total of seven species of mammals (Table 3) were identified in 1982, compared to six in 1981 and seven in 1980.

Species lists for the surrounding area (ABI, 1978b) were compared to the list of fauna sighted in the study area (Tables 4, 5, and 6). A total of 76 species of birds, 18 species of reptiles and amphibians, and 10 species of mammals were observed in the surrounding area in 1978 (ABI, 1978b). During 1982, sixty one species of birds, 11 species of reptiles and amphibians, and six species of mammals were common to both areas.

Conclusions

Any changes in the individual or total number of faunal species sighted from 1981-1982 is not considered significant. It is primarily due to the transient nature of avian species and the opportunistic nature of the program.

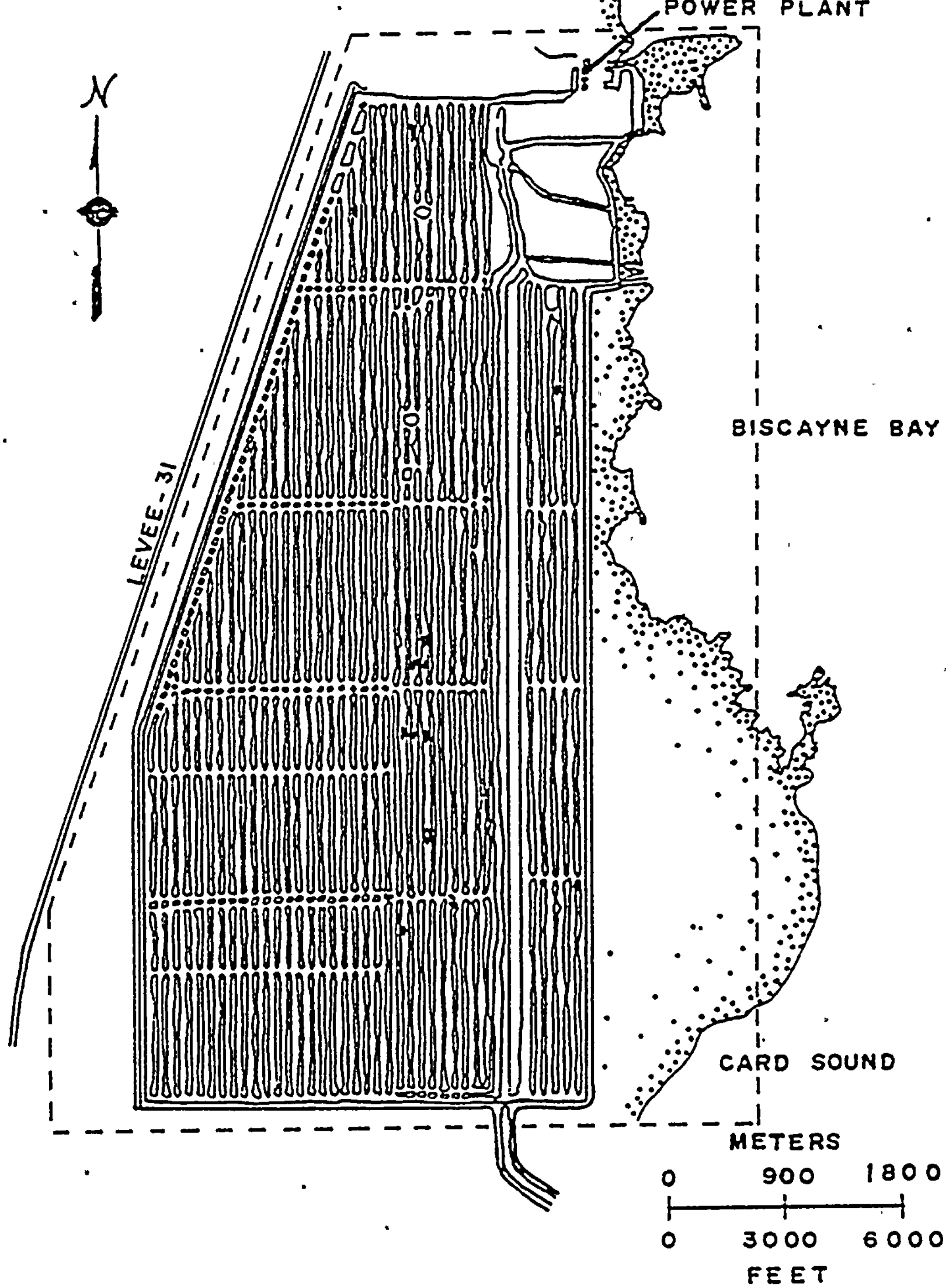


Figure i. Faunal study area (outline) for Turkey Point Cooling Canal System, 1982.

Table 1. A list of birds observed in the Turkey Point Study Area for 1982.

COMMON NAME	SCIENTIFIC NAME[a]	RELATIVE ABUNDANCE[b]	SEASON OF OCCURRENCE
American Bittern	Botaurus lentiginosus	Very Rare	Transient
American Coot	Fulica americana	Uncommon	Permanent
American Kestrel	Falco sparverius	Common	Winter
Anhinga	Anhinga anhinga	Rare	Permanent
Bald Eagle	Haliaeetus leucocephalus	Uncommon	Permanent
Barn Swallow	Hirundo rustica	Uncommon	Winter
Belted Kingfisher	Megaceryle alcyon	Common	Winter
Black-bellied Plover	Pluvialis squatarola	Fairly Common	Winter
Black-crowned Night Heron	Nycticorax nycticorax	Rare	Permanent
Black-necked Stilt	Himantopus mexicanus	Rare	Summer
Black Skimmer	Rynchops niger	Common	Winter
Black Vulture	Coragyps atratus	Fairly Common	Permanent
Black Whiskered Vireo	Vireo altiloquus	Very Rare	Transient
Blue-gray Gnatcatcher	Polioptila caerulea	Rare	Permanent
Blue Jay	Cyanocitta cristata	Rare	Permanent
Blue-winged Teal	Anas discors	Rare	Winter
Boat-tailed Grackle	Quiscalus major	Fairly Common	Permanent
Bonapartes Gull	Larus philadelphia	Very Rare	Winter
Broad-winged Hawk	Buteo platypterus	Very Rare	Summer

Table 1. A list of birds observed in the Turkey Point Study Area for 1982. (Cont'd)

COMMON NAME	SCIENTIFIC NAME[a]	RELATIVE ABUNDANCE[b]	SEASON OF OCCURRENCE
Brown-headed Cowbird	Molothrus ater	Rare	Winter
Brown Pelican	Pelecanus occidentalis	Common	Permanent
Cardinal	Cardinalis cardinalis	Uncommon	Permanent
Caspian Tern	Sterna caspia	Common	Winter
Cat Bird	Dumetella carolinensis	Very Rare	Winter
Cattle Egret	Bubulcus ibis	Common	Permanent
Common Crow	Corvus brachyrhynchos	Uncommon	Permanent
Common Egret	Casmerodius albus	Common	Permanent
Common Flicker	Colaptes auratus	Fairly Common	Permanent
Common Grackle	Quiscalus quiscula	Fairly Common	Permanent
Common Loon	Gavia immer	Uncommon	Winter
Common Nighthawk	Chordeiles minor	Common	Summer
Common Snipe	Capella gallinago	Rare	Winter
Common Starling	Sturnus vulgaris	Common	Permanent
Common Yellowthroat	Geothlypis trichas	Very Rare	Permanent
Double-crested Cormorant	Phalacrocorax auritus	Common	Permanent
Downy Woodpecker	Picoides pubescens	Very Rare	Permanent
Dunlin	Calidris alpina	Uncommon	Winter
Eastern Meadowlark	Sturnella magna	Rare	Permanent

Table 1. A list of birds observed in the Turkey Point Study Area for 1982. (Cont'd)

COMMON NAME	SCIENTIFIC NAME[a]	RELATIVE ABUNDANCE[b]	SEASON OF OCCURRENCE
Eastern Phoebe	Sayornis phoebe	Rare	Winter
Gray Kingbird	Tyrannus dominicensis	Very Rare	Summer
Great Blue Heron	Ardea herodias	Common	Permanent
Great Crested Flycatcher	Myiarchus crinitus	Rare	Permanent
Great White Heron	Ardea occidentalis	Uncommon	Permanent
Green Heron	Butorides striatus	Common	Permanent
Ground Dove	Columbina passerina	Common	Permanent
Herring Gull	Larus argentatus	Uncommon	Winter
Hooded Merganser	Lophodytes cucullatus	Uncommon	Winter
House Sparrow	Passer domesticus	Common	Permanent
Killdeer	Charadrius vociferus	Fairly Common	Winter
Laughing Gull	Larus atricilla	Fairly Common	Permanent
Least Sandpiper	Calidris minutilla	Rare	Winter
Least Tern	Sterna albifrons	Common	Summer
Lesser Yellowlegs	Tringa flavipes	Uncommon	Winter
Little Blue Heron	Florida caerulea	Common	Permanent
Loggerhead Shrike	Lanius ludovicianus	Very Rare	Permanent
Long-billed Dowitcher	Limnodromus scolopaceus	Very Rare	Winter
Louisiana Heron	Hydranassa tricolor	Common	Permanent

Table 1. A list of birds observed in the Turkey Point Study Area for 1982. (Cont'd)

COMMON NAME	SCIENTIFIC NAME[a]	RELATIVE ABUNDANCE[b]	SEASON OF OCCURRENCE
Magnificent Frigatebird	Fregata magnificens	Rare	Permanent
Marsh Hawk	Circus cyaneus	Rare	Winter
Merlin (Pigeon Hawk)	Falco columbarius	Very Rare	Transient
Mockingbird	Mimus polyglottos	Common	Permanent
Mottled Duck	Anas fulvigula	Common	Permanent
Osprey	Pandion haliaetus	Common	Permanent
Palm Warbler	Dendroica palmarum	Fairly Common	Winter
Peregrine Falcon	Falco peregrinus	Rare	Winter
Pied-billed Grebe	Podilymbus podiceps	Common	Winter
Pine Warbler	Dendroica pinus	Uncommon	Permanent
Piping Plover	Charadrius melodus	Rare	Winter
Prairie Warbler	Dendroica discolor	Rare	Permanent
Purple Martin	Progne subis	Rare	Transient
Red-bellied Woodpecker	Melanerpes carolinus	Uncommon	Permanent
Red-brested Merganser	Mergus serrator	Common	Winter
Reddish Egret	Dishromanassa rufescens	Common	Summer
Red-shouldered Hawk	Buteo lineatus	Uncommon	Permanent
Red-tailed Hawk	Buteo jamaicensis	Very Rare	Permanent
Red-winged Blackbird	Agelaius phoeniceus	Common	Permanent

Table 1. A list of birds observed in the Turkey Point Study Area for 1982. (Cont'd)

COMMON NAME	SCIENTIFIC NAME[a]	RELATIVE ABUNDANCE[b]	SEASON OF OCCURRENCE
Ring-billed Gull	*Larus delawarensis*	Common	Winter
Robin	*Turdus migratorius*	Rare	Winter
Rock Dove	*Columba livia*	Uncommon	Permanent
Roseate Spoonbill	*Ajaia ajaja*	Fairly Common	Winter
Royal Tern	*Sterna maxima*	Common	Winter
Ruddy Turnstone	*Arenaria interpres*	Common	Permanent
Savannah Sparrow	*Passerculus sandwichensis*	Very Rare	Winter
Semipalmated Plover	*Charadrius semipalmatus*	Common	Winter
Semipalmated Sandpiper	*Calidris pusilla*	Fairly Common	Transient
Short-billed Dowitcher	*Limnodromus griseus*	Fiarly Common	Winter
Short-tailed Hawk	*Buteo brachyurus*	Very Rare	Permanent
Smooth-billed Ani	*Crotophaga ani*	Rare	Permanent
Snowy Egret	*Egretta thula*	Common	Permanent
Spotted Sandpiper	*Actitis macularia*	Rare	Winter
Swamp Sparrow	*Melospiza georgiana*	Uncommon	Winter
Tree Swallow	*Iridoprocne bicolor*	Uncommon	Winter
Turkey Vulture	*Cathartes aura*	Common	Permanent
Whimbrel	*Numenius phaeopus*	Rare	Winter
White Ibis	*Eudocimus albus*	Common	Permanent

Table 1. A list of birds observed in the Turkey Point Study Area for 1982. (Cont'd)

COMMON NAME	SCIENTIFIC NAME[a]	RELATIVE ABUNDANCE[b]	SEASON OF OCCURRENCE
White Pelican	Pelecanus erythrorhynchos	Very Rare	Winter
Willet	Catoptrophorus semipalmatus	Rare	Winter
Wilson's Plover	Charadrius wilsonia	Uncommon	Permanent
Wood Stork	Mycteria americana	Fairly Common	Winter
Yellow-bellied Sapsucker	Sphyrapicus varius	Very Rare	Winter
Yellow-crowned Night Heron	Nyctanassa violacea	Uncommon	Permanent

[a]Binomial Nomenclature by American Ornithologist Union, 1982.
[b]Very rare = 1 sighting; Rare = 2-5 sightings; Uncommon = 6-20 sightings; Fairly Common = 21-50 sightings; Common = 51 and more sightings.

Table 2. A list of reptiles and amphibians observed in the Turkey Point Study Area for 1982.

COMMON NAME	SCIENTIFIC NAME[a]	PREFERRED HABITAT
Reptiles		
American Alligator	Alligator mississippiensis	Fresh or brackish water
American Crocodile	Crocodylus acutus	Salt or brackish water
Blue-striped Garter Snake	Thamnophis sirtalis similis	Marshes and coastal lowlands
Brown Anole	Anolis sagrei	On ground near shrubs
Corn Snake	Elaphe guttata guttata	Rocky hillsides
Eastern Diamondback Rattlesnake	Crotalus adamanteus	Dry thickets
Eastern Garter Snake	Thamnophis sirtalis sirtalis	Marshes, woodlands and drainage ditches
Eastern Indigo Snake	Drymarchon corais couperi	Near thickets of dense vegetation
Florida Box Turtle	Terrapene carolina bauri	Woodlands
Florida Brown Snake	Storeria dekayi victa	Bogs, marshes and ponds
Florida Mud Turtle	Kinosternon subrubrum steindachneri	Drainage ditches, marshes & other small bodies of water
Florida Red-bellied Turtle	Chrysemys nelsoni	Fresh or brackish water
Florida Softshell Turtle	Trionyx ferox	Fresh water
Green Anole	Anolis carolinensis carolinensis	Shrubs and vines
Indo-pacific Gecko	Hemidactylus garnoti	Associated with man
Mangrove Water Snake	Natrix fasciata compressicauda	Salt or brackish water

Table 2. A list of reptiles and amphibians observed in the Turkey Point Study Area for
(Cont'd) 1982.

COMMON NAME	SCIENTIFIC NAME[a]	PREFERRED HABITAT
Reptiles (Cont'd)		
Peninsula Ribbon Snake	Thamnophis sauritus sackeni	Ponds, bogs and swamps
Snapping Turtle	Chelydra serpentina	Fresh or brackish water
Southeastern Five-lined Skink	Eumeces inexpectatus	On spoil banks
Amphibians		
Green Tree Frog	Hyla cinera	Swamps, borders of lakes and streams
Little Grass Frog	Limnaoedus ocularis	Low vegetation, borders of ponds
Southern Leopard Frog	Rana utricularia	Fresh or brackish water

[a]Binomial nomenclature by Conant, 1975.

Table 3. A list of mammals observed in the Turkey Point Study Area for 1982.

COMMON NAME	SCIENTIFIC NAME[a]	PREFERRED HABITAT
Black Rat	*Rattus rattus*	Associated with man
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 and protected coastal waters
Opossum	*Didelphis marsupialis*	Woodland and along streams
Raccoon	*Procyon lotor*	Along berms

[a]Binomial nomenclature by Burt, et al., 1976.

Table 4. A comparison of the bird species identified in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
American Bittern	X	X	X	X
American Coot	---	X	X	X
American Goldfinch	X	---	---	---
American Kestrel	X	X	X	X
American Redstart	X	---	---	---
Anhinga	X	X	X	X
Bald Eagle	X	X	X	X
Barn Swallow	X	X	---	X
Belted Kingfisher	X	X	X	X
Black-bellied Plover	X	---	X	X
Black-crowned Night.Heron	X	---	X	X
Black Duck	---	---	X	---
Black-necked Stilt	---	X	X	X
Black Scoter	---	---	X	---
Black Skimmer	X	X	X	X
Black Vulture	---	---	X	X
Black-poll Warbler	X	---	---	---
Black-whiskered Vireo	X	---	---	X
Blue-gray Gnatcatcher	X	X	X	X
Blue Jay	X	---	---	X
Blue-winged Teal	---	X	---	X
Boat-tailed Grackle	X	X	X	X
Bobolink	X	---	---	---
Bobwhite	---	X	X	---
Bonapartes Gull	---	---	X	X
Broad-winged Hawk	---	---	---	X
Brown-headed Cowbird	---	---	---	X
Brown Pelican	X	X	X	X

Table 4. (Cont'd) A comparison of the bird species identified in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Cape May Warbler	---	---	X	---
Cardinal	X	X	X	X
Caspian Tern	X	---	X	X
Cat Bird	---	---	X	X
Cattle Egret	X	X	X	X
Cedar Waxwing	X	---	---	---
Chuck-will's Widow	X	---	---	---
Clapper Rail	X	---	X	---
Common Crow	---	X	X	X
Common Egret	X	X	X	X
Common Flicker	X	---	X	X
Common Gallinule	---	---	X	---
Common Grackle	X	X	X	X
Common Loon	---	---	X	X
Common Nighthawk	X	X	X	X
Common Snipe	X	---	X	X
Common Starling	---	X	X	X
Common Tern	---	---	X	---
Common Yellowthroat	X	---	---	X
Double-crested Cormorant	X	X	X	X
Downy Woodpecker	X	---	---	X
Dunlin	---	---	X	X
Eastern Kingbird	---	---	X	---
Eastern Meadowlark	X	---	---	X
Eastern Phoebe	X	---	X	X
Glossy Ibis	X	---	---	---
Gray Kingbird	X	---	X	X
Great Blue Heron	X	X	X	X

Table 4. (Cont'd) A comparison of the bird species identified in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Great Crested Flycatcher	---	---	---	X
Great White Heron	---	X	X	X
Green Heron	X	X	X	X
Ground Dove	---	X	X	X
Gull-billed Tern	---	---	X	---
Herring Gull	X	X	X	X
Hooded Merganser	---	X	X	X
House Sparrow	---	X	X	X
House Wren	X	---	---	---
Killdeer	X	X	X	X
Laughing Gull	X	X	X	X
Least Flycatcher	---	---	X	---
Least Sandpiper	---	X	X	X
Least Tern	X	X	X	X
Lesser Yellowlegs	X	---	X	X
Little Blue Heron	X	X	X	X
Loggerhead Shrike	---	---	---	X
Long-billed Curlew	---	---	X	---
Long-billed Dowitcher	---	---	---	X
Louisana Heron	X	X	X	X
Magnificent Frigatebird	X	X	X	X
Mallard Duck	---	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	---	---	---

Table 4. (Cont'd) A comparison of the bird species identified in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Osprey	X	X	X	X
Painted Bunting	---	X	X	---
Palm Warbler	X	---	X	X
Peregrine Falcon	X	---	---	X
Pied-billed Grebe	X	X	X	X
Pileated Woodpecker	---	---	X	---
Pine Warbler	---	---	---	X
Piping Plover	---	---	X	X
Prairie Warbler	X	---	---	X
Purple Martin	---	---	X	X
Red-bellied Woodpecker	X	---	X	X
Red-breasted Merganser	X	---	X	X
Reddish Egret	X	X	X	X
Red-headed Woodpecker	---	X	---	---
Red Knot	---	---	X	---
Red-shouldered Hawk	X	X	X	X
Red-tailed Hawk	---	---	X	X
Red-winged Blackbird	X	X	X	X
Ring-billed Gull	X	X	X	X
Robin	---	X	X	X
Rock Dove	---	---	X	X
Roseate Spoonbill	X	X	X	X
Royal Tern	X	---	X	X
Ruddy Turnstone	---	X	X	X
Rufous-sided Towhee	---	---	X	---
Sanderling	X	X	X	---
Savannah Sparrow	---	---	---	X
Screech Owl	X	---	---	---

Table 4. (Cont'd) A comparison of the bird species identified in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Scrub Jay	---	---	X	---
Semipalmated Plover	---	X	X	X
Semipalmated Sandpiper	---	---	X	X
Sharp-shinned Hawk	X	---	X	---
Short-billed Dowitcher	---	X	X	X
Short-tailed Hawk	---	---	---	X
Smooth-billed Ani	---	X	---	X
Snowy Egret	X	X	X	X
Solitary Sandpiper	---	---	X	---
Sooty Tern	---	---	X	---
Spotted Sandpiper	---	---	X	X
Summer Tanager	---	---	X	---
Swallow-tailed Kite	---	X	X	---
Swamp Sparrow	---	---	---	X
Tree Swallow	X	X	X	X
Turkey Vulture	X	X	X	X
Whimbrel	---	---	---	X
White-crowned Pigeon	---	---	X	---
White-eyed Vireo	X	X	---	---
White Ibis	X	X	X	X
White Pelican	X	X	X	X
Willet	X	X	X	X
Wilson's Plover	---	---	X	X
Wood Duck	X	---	---	---
Wood Stork	---	X	X	X
Wurdemann's Heron	---	X	---	---
Yellow-bellied Sapsucker	X	---	---	X
Yellow-crowned Night Heron	X	X	X	X

Table 4. (Cont'd) A comparison of the bird species identified in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Yellow-rumped Warbler	X	---	---	---
Yellow-throated Vireo	---	---	X	---
Yellow Warbler	X	---	---	---

[a]ABI, 1978b

Table 5. A comparison of the amphibian and reptilian species in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
American Alligator	X	X	X	X
American Crocodile	X	X	X	X
Atlantic Loggerhead Turtle	---	X	X	---
Bahaman Bark Anole	X	---	---	---
Blue-striped Garter Snake	---	---	---	X
Brown Anole	---	X	X	X
Corn Snake	X	---	X	---
Cuban Tree Frog	X	---	X	---
Eastern Diamondback Rattlesnake	X	X	X	X
Eastern Garter Snake	X	---	X	X
Eastern Indigo Snake	X	X	X	X
Everglades Racer Snake	X	---	---	X
Florida Box Turtle	---	---	---	X
Florida Brown Snake	---	---	---	X
Florida Cricket Frog	X	---	X	---
Florida Mud Turtle	---	---	---	X
Florida Red-bellied Turtle	---	---	X	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	X	X
Indo-pacific Gecko	---	---	---	X
Key West Anole	X	---	---	---
Little Grass Frog	---	---	---	X
Mangrove Water Snake	X	X	X	X
Mediterranean Gecko	---	---	X	X
Mud Snake	---	X	---	---

Table 5. (Cont'd) A comparison of the amphibian and reptilian species in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Peninsula Ribbon Snake	---	X	---	---
Pig Frog	---	---	---	X
Reef Gecko	X	---	---	---
Snapping Turtle	---	---	X	---
Southeastern Five-lined Skink	---	X	X	X
Southern Black Racer	---	---	X	---
Southern Leopard Frog	X	---	X	X
Southern Toad	---	---	X	---
Striped Swamp Snake	---	---	X	---

[a]ABI, 1978b

Table 6. A comparison of the mammalian species in the Turkey Point Study Area, 1980-1982, to those of the Surrounding Area.

COMMON NAME	SURROUNDING AREA[a]	1980	1981	1982
Black Rat	X	X	X	X
Bobcat	X	X	X	---
Cotton Rat	X	---	---	---
Dolphin	X	---	---	---
Domestic Cat	X	X	X	X
Domestic Dog	X	X	---	X
House Mouse	X	---	---	---
Manatee	X	X	X	X
Marsh Rabbit	X	X	X	X
Opossum	---	---	X	X
Raccoon	X	X	X	X
Rice Rat	X	X	---	---
Whitetail Deer	X	---	---	---

[a]ABI, 1978b

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 is conducted to measure nitrite and nitrate levels in soils to the west and south of the Turkey Point Plant Cooling Canal System. These data define soil nitrogen levels in areas of natural vegetation relatively unaffected by the Turkey Point Plant and canals.

Materials and Methods

Soil samples were taken from the midpoint of Transects 1, 3, 5, 7 and 9 (Figure 1). A small core 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, 1980).

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

Results

Nitrite levels in 1982 are similar to levels in 1981 (Table 2). The range of nitrite at different sampling points is 0.18 to 4.17

μg/g dry soil in 1982 (Table 1) as compared with a range of 0.38 to 6.11 μg/g dry soil in 1981 (FPL, 1982). The highest nitrite value is present at a depth of 33 cm in the middle of Transect 7. Nitrate levels range from 0.67 to 61.96 μg/g dry soil in 1982 as compared with a range of 1.56 to 10.93 μg/g dry soil in 1981. Nitrate concentration is highest in the top 3 cm of soil at Transect 1.

Discussion

Most soil nitrogen is found in organic matter that is decomposed by soil microorganisms into ammonium compounds. 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 major soil type found west and south of the Turkey Point cooling canal system is 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 in mineral soils.
Consequently, the nitrite and nitrate values found in the 1982 soil

samples probably reflect this accumulation. As in previous years, nitrite and nitrate values generally are greater at a depth of 33 cm than nearer the surface. The exception is the high nitrate value at 3 cm depth at Transect 1. This may reflect a patch of decomposing organic material which happened to be sampled. Overall, the higher nitrogen concentrations in deeper soils result from nitrate accumulation.

Conclusion

The combination of edaphic characteristics and environmental factors that influence the nitrification process accounts for the variability found in soil nitrite and nitrate concentrations. No evidence suggests that this natural variability is affected by operation of the Turkey Point Plant.

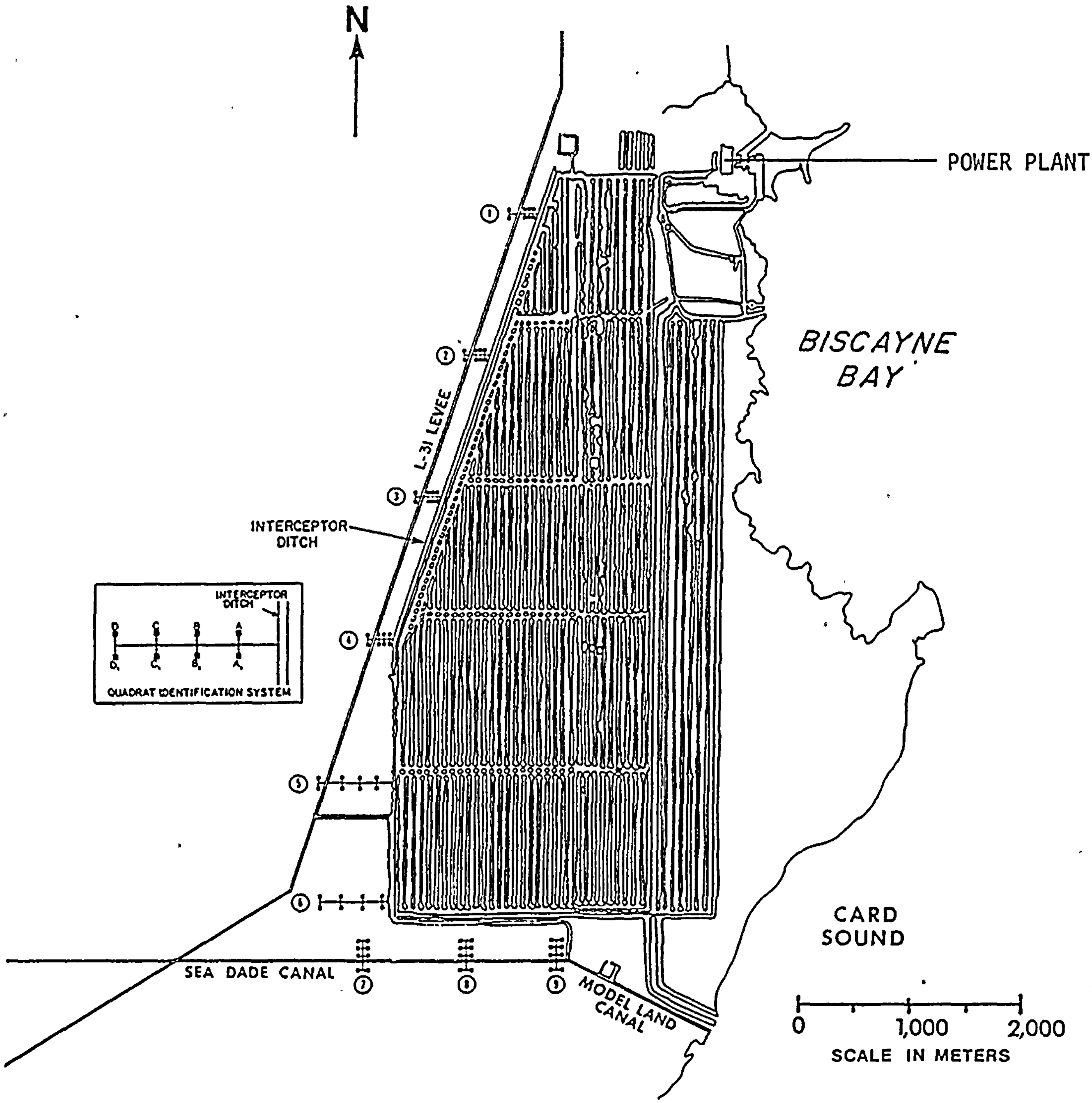


Figure 1. Vegetation transects, Turkey Point Plant, 1982. Soil samples were collected from Transects 1,3,5,7 and 9.

Table 1. Laboratory analysis of 10 soil samples from the Turkey Point Site, 1982.

TRANSECT (number)	SOIL DEPTH (cm)	NITRITE NITROGEN (μg/g dry soil)	NITRATE NITROGEN (μg/g dry soil)
1	3	0.18	61.96
	33	0.91	1.71
3	3	1.18	1.12
	33	2.02	13.60
5	3	1.93	0.67
	33	1.91	4.57
7	3	0.95	0.70
	33	4.17	7.63
9	3	0.70	6.91
	33	0.76	6.24

Table 2. Ranges of soil nitrite and nitrate measured at depths of 3 centimeters and 33 centimeters (in parentheses) at Transects 1, 3, 5, 7 and 9 in the Turkey Point Canal System.

PARAMETER	UNITS	OPERATIONAL STUDIES			
		1979[a]	1980[a]	1981[a]	1982
Nitrite nitrogen	µg/g dry soil	0.16-0.42 (0.16-0.35)	0.61-6.83 (0.31-4.50)	0.51-1.11 (0.38-6.11)	0.18-1.93 (0.76-4.17)
Nitrate nitrogen	µg/g dry soil	<0.01-0.18 (<0.01-0.44)	7.09-103.17 (5.17-61.37)	1.74-3.28 (1.56-10.93)	0.67-61.96 (1.71-13.60)

[a]FPL, 1980-1982

b. Vegetation Study (ETS 4.2.2.3)

Introduction

The salinity regime resulting from land elevation is a major factor that determines the composition and distribution of plant communities along southeast Florida's coast. 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 falls in the area annually, primarily from May through November. During this wet season, groundwater is near the surface. During the dry season (December through April), when groundwater levels are low, infiltration of surface water is greater and freshwater runoff is reduced. The slight slope of the land, approximately 1.8 cm per 100 m, used to cause fresh water from inland regions to drain southeastward into Card Sound (Figure 1).

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 and the Sea Dade and Model Land Canals south of the site. 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 (Figure 1). 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 near 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, needle 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 observed.

Field Methods

Quantitative data have been collected along nine transects once during each dry season since 1975. The 1982 sampling was conducted in late October.

Transects 1 through 6 run east to west perpendicular to and west of the cooling canals (Figure 1). These transects were selected so that three intersect tree islands and three intersect grasslands. Transects 7 through 9 run north-south perpendicular 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 increasing distance from the canal system. At each sampling point, two 5 x 5-m (25-m^2) quadrats were located on oppo-

site sides of the transect line as shown in the insert of 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. For each community sampled this design yields six replicate quadrats for each of the four transect interval distances.

Statistical Methods

The statistical approach used to detect impacts of cooling canal system operation on the vegetation attempts to answer 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 yearsπ

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

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 z as the test criterion (Zar, 1974) 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 (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. Analysis of variance with the F-ratio as the test criterion was used to detect changes in biomass (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 significant effect was detected, then each individual species was 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

Plant Species at Turkey Point

A total of 187 plant species (Table 1) have been observed in the Turkey Point and South Dade studies. Fifteen species were present in all studies and in 1982, 13 species had frequencies greater than or equal to 10 percent. In the 1982 study, 62 species were observed. This value is not significantly different from the average (64 species) for all studies.

Community Composition

Overall community composition is presented as frequency data for each individual species in Table 1. The baseline period 1972-1974 and the five year operational period 1978-1982 are reported here. Frequency data for the most common plant species are presented in Table 2. Common species are defined as those present in 1982 at frequencies greater than 10 percent. Of these 13 common species, eight showed significant differences in frequency in 1982 from 1972-1974.

Biomass

Vegetation volume-density indices by transect for 1982 are presented in Tables 3 through 5. Biomass data from 1982 then were combined with data from the previous four years for species whose frequencies were 10 percent or greater in 1982 (two common species of vines were excluded from biomass analyses because their volume-density could not be measured in the field). These data are presented as an analysis of variance over years and with increasing distance from the canal system (Table 6).

Discussion

Plant Species at Turkey Point

An overall trend of decreasing number of new species observed each year at the Turkey Point site is evident (Figure 3). In a

stable plant community this phenomenon would be expected since a smaller number of the uncommon species would be discovered with each year's sampling effort. In agreement with this phenomenon only one new species was observed in 1982. Exceptions to this trend occurred in 1977 and 1981 because of plant community disturbances, first from a severe freeze and then from a natural fire event.

Community Composition.

The frequency data in Table 1 show the establishment of a stable vegetation community at the study area over the past five years since the freeze of January 1977. The disparity in frequency observations for pre-freeze years as compared to post-freeze years has been thoroughly documented (FPL, 1979-1982) and will not be reexamined in this report. Differences in values for plant operational years as compared to baseline studies have been observed previously and occur again in 1982 data.

Variation for ecologically important plant associations is characterized through the presentation of frequency data for the most common plant species (Table 2). Six species (aster, sawgrass, buttonwood, clubrush, glades morning glory and climbing hempvine) have significantly increased in frequency, and two (salt grass and red mangrove) have significantly decreased since baseline sampling.

It should be noted that the two species with decreasing frequency, red mangrove and salt grass, are those adapted to highly saline environments. The species showing increases in frequency are those with brackish to fresh water affinities. The probable reason for this is the more westward siting of the operational monitoring vegetation transects relative to the initial baseline sampling. This baseline sampling was nearer the coastline and, therefore, in a more saline environment. A different plant community is being sampled at present and variations in community structure are to be expected. In any event, the observed changes in vegetation community composition are not those which would be expected if salinity elevation caused by the canal system were taking place.

During the past seven years in the sampling transects south and west of the canal system, an essentially stable plant community has been observed. Species frequencies measured in 1982 for the most common plants are in agreement with this since no significant differences relative to 1981 frequencies are found and only two species, aster and climbing hempvine, show significant increases relative to the 1975-1980 sampling period. Such variation may be attributable to succession or natural cyclic growth patterns. Leather fern is one species which had previously been found at frequencies greater than 10 percent and in 1982 occurs at only a 6.9 percent frequency level. This is a plant species which was strongly impacted by the January 1977 freeze and is continuing its

drop in frequency, perhaps suffering competition from species which were provided an opportunity for expansion after the freeze event.

Description of the ecological setting and dominant vegetation associations observed during monitoring at Turkey Point would provide a context for the ongoing sampling efforts. To the west of the canal system lies a freshwater to brackish wetland prairie where sawgrass and buttonwood are the dominant plant species. In such open areas, aster, glades morning glory, clubrush and needlerush are very commonly associated species, although they would not be considered as dominants because of their less robust growth form.

In certain saline wetland areas south of the canal system, very dense thickets or somewhat broken growth of red mangrove and buttonwood create a habitat different from the open grass prairies. An important associated species in such areas is white mangrove which occurs in tree and shrub form. Nightshade is a less robust woody species which also occurs in these thickets. Red mangrove favors more saline environments and is found in fewer numbers at inland locations. In areas of elevated salinity (such as south of the Sea Dade and Model Land Canals) the dominance of sawgrass gives way and salt grass is found as the most important grass cover species. Black mangroves (which possess a specific metabolism for crystalized salt excretion) are found exclusively in such areas along with other mangrove species and buttonwoods.

The behavior of salt tolerant species is of particular interest in this study because the expansion of such a species into previously unsuitable brackish or freshwater areas would signal the possible modification of the environmental salinity gradient by the cooling canal system. No such salt tolerant invader species has expanded its range as a result of cooling canal operation in this case.

Hammocks or tree islands are the most vegetatively complex habitats at the Turkey Point site and occur where the wetlands give way to drier areas of differing size and elevation. They are botanically more diverse since they are hospitable environments relative to the sawgrass prairie and mangrove swamp and provide biological niche space to a variety of plant life (Craighead, 1971). In contrast, the wetlands are rigorous habitats in which only a particular assemblage of specifically adapted plant life can succeed. A variety of tree species dominate the hammock sites, including Australian pine, saw palmetto, mahogany, poisonwood and buttonwood. A wide variety of shrubs, vines, ferns and herbaceous plants are found in these areas with both exclusively terrestrial plants and facultative wetland species among them. This ecotone effect contributes to the species richness of these sites.

Biomass

Biomasses of the 11 common species were examined to detect changes occurring over time and changes occurring with distance

from the cooling canal system. If the biomass of a species differed significantly with time or distance, the overall biomass for that year or quadrat was examined. Analysis of variance results for long-term biomass changes from 1978-1982 reveal that none of the 11 most common species occurring at the Turkey Point Plant have significant differences among years (Table 6). This evidence suggests that the cooling canal system has had no significant impact on vegetation biomass over time. Prior to the period 1978-1982, the freeze of January 1977 and differing original baseline study siting had contributed to significant yearly biomass variance.

Biomass of four of the common species showed significant differences with distance from the canal system (Table 6). These species were Australian pine, clubrush, needlerush and red mangrove. Such variance with distance reflects the non-homogenous distribution of each species and may be explained in most cases by environmental or ecological factors.

Australian pine biomass is highest at quadrats adjacent to the canals (Quadrats A and B; Figure 1). The particular quadrats where this elevated growth occurs are hammock areas which provide drier ground substrate required by this species. Australian pine is an exotic species that has established itself in south Florida, being well suited to areas such as disturbed spoil berms and hammock islands. It cannot tolerate wetlands or mangrove communities and is thus found at large biomass on drier hammock sites.

The distribution of clubrush with respect to canal system proximity shows no apparent pattern with highest values recorded at A Quadrats, while C and D Quadrats have notable but somewhat lower biomass values. It should be noted that clubrush occurs most frequently and with greatest biomass along Transect 1, the northernmost sampling area, and that this may simply reflect natural vegetative clumping. Needlerush biomass is highest at Quadrats A and C with its bulk occurring at Transect 8 located south of the canal system, again suggesting a natural clumping phenomenon. Red mangrove is the only one of these four species that displays a consistent gradient of biomass values relative to the cooling canal system. Biomass for this species is highest at the A Quadrats close to the canal system and lower at the distant D Quadrats.

A consistent increase or decrease in biomass with distance from the cooling canal system would indicate an impact on vegetation. No ecologically consistent pattern is evident, however. For example, biomass of salt-tolerant species is not always greater adjacent to the cooling canals, nor is biomass of freshwater species always greater away from the system. Therefore, evidence suggests that no impact on the biomass of vegetation can be attributed to the Turkey Point canals.

Conclusion

A total of 187 plant species have been observed in all of the Turkey Point (FPL, 1976-1982) 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 in the 1982 operational monitoring study was 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 variations.

No canal system impact upon plant biomass was apparent, either in terms of canal proximity effect or cumulative annual effect. The significant quadrat variance in vegetation biomass had no clear pattern that would indicate a cooling canal system impact upon surrounding plant life.

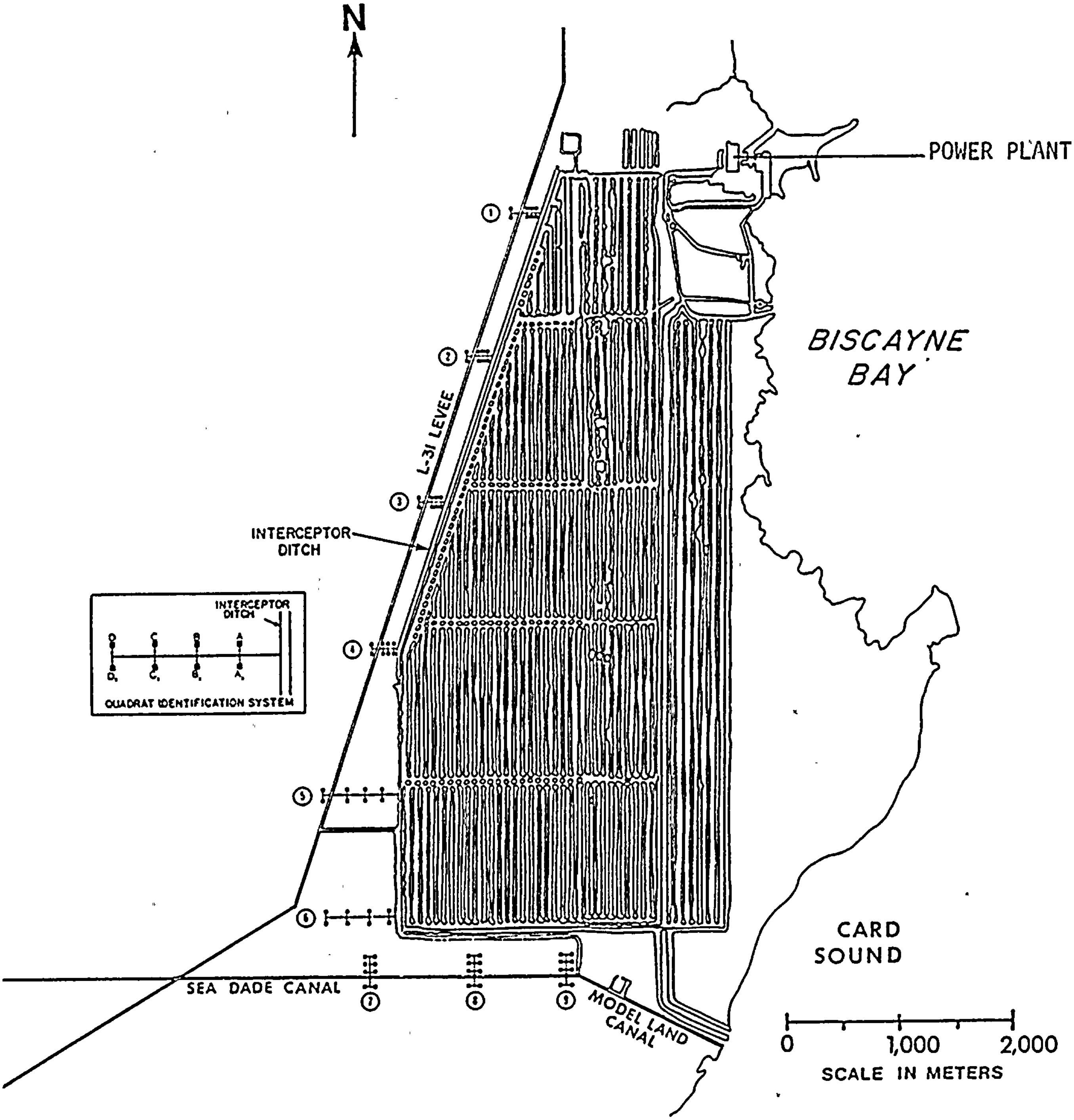


Figure 1. Location of vegetation sampling transects, Turkey Point site, 1982.

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

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

where:

A = Area of sample in meters

N = Number of graminoid samples

H = Average height of grass blades in cm

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

sample values

A = 1.0

N = 240

H = 142.2

R = 1.6; R^2 = 2.56

Cladium Index $= \frac{(240)(142.2)(2.52)}{1.0} = 87,367.68$

Example 2. Woody shrub (*Conocarpus*)

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

where:

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

H = Shrub height in cm

R = Maximum radius of trunk

sample values

N = 1.0

H = 365.8

R = 6.5; R^2 = 42.25

Conocarpus Index = (1.0)(365.8)(42.25) = 15,455.05

Figure 2. Examples of volume-density index calculations of a graminoid and woody plant species, Turkey Point Plant, 1982.

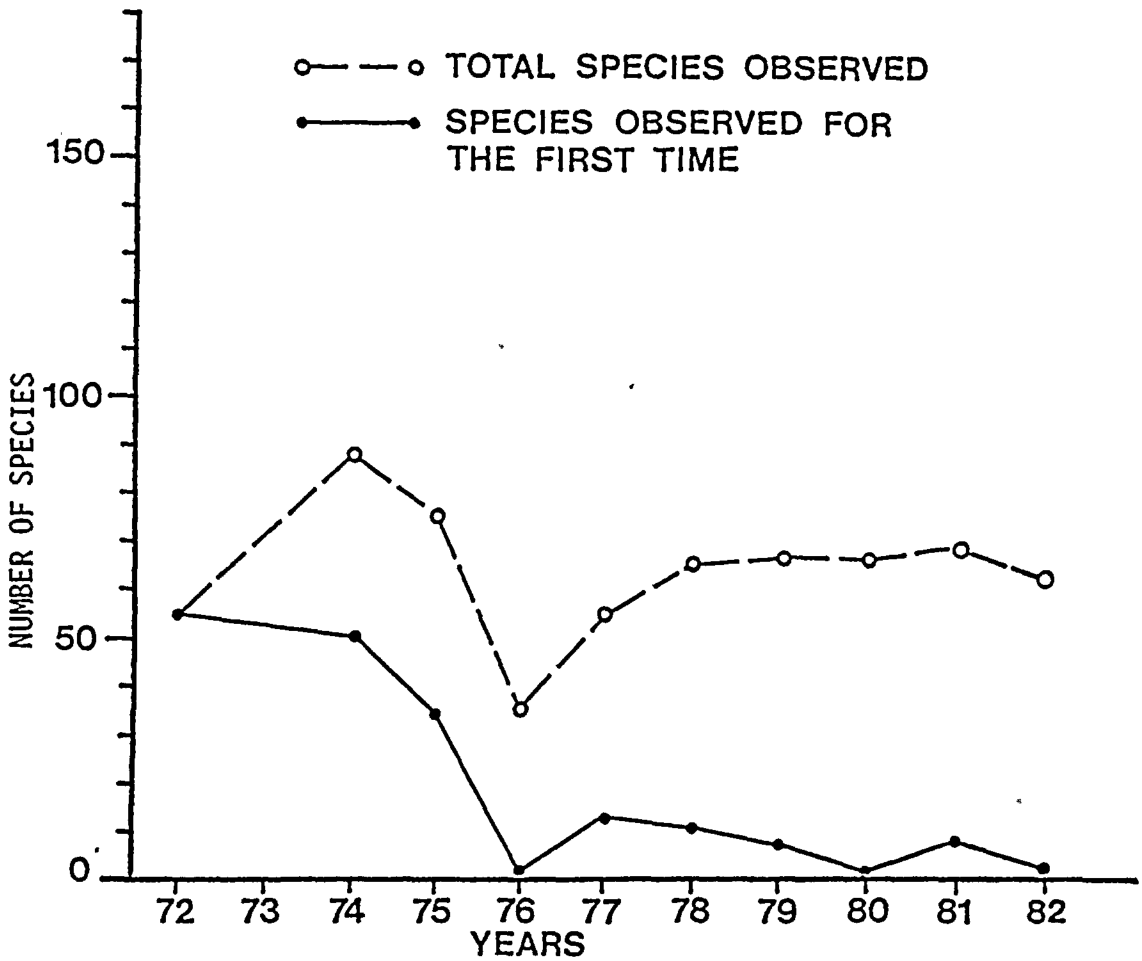


Figure 3. Number of plant species observed, Turkey Point Plant, 1972-1982.

Table 1. Plant species observed and frequency of occurrence at the Turkey Point Plant during baseline and 1978-1982 operational monitoring.

SPECIES	COMMON NAME	FREQUENCY (%) Baseline[a] 1972	1974	Mean 1972 - 1974	Operational[b] 1978	1979	1980	1981	1982	Mean 1978 - 1982
Acrostichum aureum	Leather fern	15.9	10.0	13.0	12.5	11.1	12.5	8.3	6.9	10.3
Agalinis sp.	False foxglove	2.4	-	1.2	-	-	-	-	-	-
Ammania teres	Toothcup	-	-	-	-	-	-	-	2.8	0.5
Annona glabra	Pond apple	3.7	3.3	3.5	-	-	1.4	-	-	0.3
Ardisia escallonoides[c]	Marlberry	-	-	-	-	-	-	-	-	-
Asclepias sp.	Milkweed	3.7	0.5	2.1	-	-	-	-	-	-
Aster sp.	Aster	-	0.5	0.3	29.2	27.8	29.2	30.6	40.3	31.4
Aster tenuifolius v. aphyllus[c]	Aster	-	-	-	-	-	-	-	-	-
Avicennia germinans (Avicennia nitida)	Black mangrove	-	5.2	2.6	-	2.8	2.8	2.8	2.8	2.2
Baccharis sp.	Groundsel, saltbush	-	-	-	4.2	-	1.4	-	-	1.1
B. angustifolia	False willow	1.2	7.1	4.2	5.6	4.2	5.6	4.2	1.4	4.2
B. dioica	Groundsel	-	-	-	-	1.4	-	-	-	0.3
B. glomeruliflora	Groundsel tree	-	-	-	4.2	4.2	2.8	5.6	2.8	3.9
B. halimifolia	Groundsel	12.2	6.2	9.2	2.8	8.3	4.2	1.4	-	3.3
Bacopa monnieri	Water hyssop	-	-	-	-	-	-	-	2.8	0.6
Batis maritima	Saltwort	-	4.3	2.2	-	-	-	-	-	-
Blechnum serrulatum	Blechnum fern	9.8	5.2	7.5	8.3	5.6	9.7	11.1	11.1	9.2
Borrichia arborescens	Sea oxeye daisy	-	1.4	0.7	1.4	-	-	-	-	0.3
B. frutescens	Sea daisy	6.1	16.2	11.2	12.5	9.7	12.5	8.3	9.7	10.5
Bucida spinosa[c]	Spiny bucida	-	-	-	-	-	-	-	-	-
Bulbostylis stenophylla	(no common name)	-	-	-	-	-	-	1.4	-	0.3
Cakile fusiformis[c]	Sea rockets	-	-	-	-	-	-	-	-	-
Calopogon sp.	Grass pink	-	0.5	0.3	-	-	-	-	-	-
Calyptranthes pallens[c]	Pale lidflower	-	-	-	-	-	-	-	-	-
Cassytha filiformis	Love vine, dodder	-	-	-	-	2.8	5.6	1.4	4.2	3.5
Casuarina equisetifolia	Australian pine	12.2	5.7	9.0	12.5	9.7	9.7	11.1	11.1	10.8
Celtis laevigata[c]	Hackberry	-	-	-	-	-	-	-	-	-
Cephalanthus occidentalis	Buttonbush	-	4.8	2.4	-	-	-	-	1.4	0.3
Chamaesyce sp.	Spurge	-	-	-	1.4	-	-	-	-	0.3
Chiococca alba	Snowberry	4.9	5.2	5.1	-	5.6	1.4	4.2	2.8	2.8
Chloris sp.	Finger grass	-	0.5	0.3	-	-	-	-	-	-
Chrysobalanus icaco	Coco palm	1.2	1.9	1.6	4.2	-	-	-	-	0.8
Cladium jamaicensis (Mariscus jamaicensis)	Saw grass	74.4	44.3	59.4	86.1	84.7	83.3	84.7	81.9	84.1
Coccothrinax argentata[c]	Silver palm	-	-	-	-	-	-	-	-	-
Cocos nucifera	Coconut palm	1.2	-	0.6	-	-	-	-	-	-
Colubrina elliptica (Colubrina reclinata)	Nakedwood	2.4	-	1.2	-	-	-	-	-	-
Conocarpus erecta	Buttonwood	65.9	30.5	48.2	77.8	73.6	70.8	69.4	72.2	72.8
Crinum americanum	String lily	-	2.4	1.2	-	-	-	-	-	-
Cuscuta sp.	Dodder	1.2	2.4	1.8	1.4	-	-	-	-	0.3
Cuscuta americana	Dodder	-	0.5	0.3	-	-	-	-	-	-
Cyanchum palustre	Vine milkweed	-	2.4	1.2	-	-	-	-	-	-

Table 1. Plant species observed and frequency of occurrence at the Turkey Point Plant during baseline and 1978-1982 (cont'd). operational monitoring.

SPECIES	COMMON NAME	FREQUENCY (%) Baseline[a] 1972	1974	Mean 1972 - 1974	Operational[b] 1978	1979	1980	1981	1982	Mean 1978 - 1982
CYPERACEAE	Sedge	-	-	-	1.4	-	-	-	-	0.3
Dalbergia amerimnon (Dalbergia brownii)	(no common name)	-	1.4	0.7	-	-	-	-	-	-
D. ecastophyllum[c]	(no common name)	-	-	-	-	-	-	-	-	-
Damifino sp.	(no common name)	-	-	-	-	1.4	1.4	-	-	0.6
Dichromena floridensis	(no common name)	-	-	-	1.4	-	1.4	-	-	0.6
Dipholis salicifolia	Bustic	-	-	-	1.4	1.4	2.8	1.4	2.8	2.0
Distichilis spicata	Salt grass	20.7	49.0	34.9	18.1	19.4	18.0	18.1	18.1	18.3
Eleocharis sp.	Clubrush, spikerush	1.2	1.0	1.1	-	-	-	-	-	-
Eleocharis cellulosa	Clubrush, spikerush	1.2	-	0.6	12.5	13.9	11.1	15.3	16.7	13.9
Eleusine indica	Yard grass	-	1.0	0.5	-	-	-	-	-	-
Encyclia tampensis[c]	Butterfly orchid	-	-	-	-	-	-	-	-	-
Eugenia sp.	(no common name)	-	-	-	-	1.4	-	-	2.8	0.8
E. axillaris	White stopper	2.4	-	1.2	-	-	-	-	-	-
E. confusa	Ironwood	-	-	-	2.8	-	-	-	-	0.6
E. foetida[e]	Stopper	-	-	-	-	-	-	2.8	-	0.6
E. myrtoides	Spanish stopper	2.4	-	1.2	1.4	1.4	4.2	-	-	1.4
Eulophia alta[c]	Wild coco	-	-	-	-	-	-	-	-	-
Eupatorium capillifolium	Dog fennel	-	7.1	3.6	5.6	1.4	-	2.8	-	2.0
Ficus aurea[c]	Strangler fig	-	-	-	-	-	-	-	-	-
F. citrifolia	Wild banyon tree	3.7	3.8	3.8	-	-	-	-	-	-
Fimbristylis sp.[c]	Sedge	-	-	-	-	-	-	-	-	-
Flaveria sp.	(no common name)	-	-	-	-	1.4	1.4	-	-	0.6
Forestiera segregata	Florida privet	-	-	-	-	1.4	1.4	1.4	-	0.8
Fuirena sp.	Umbrella grass	1.2	0.5	0.9	-	-	-	-	-	-
F. scirpoidea	Umbrella grass	1.2	3.3	2.3	-	1.4	-	-	-	0.3
Galium hispidulum[c]	Bedstraw	-	-	-	-	-	-	-	-	-
G. obtusum	Bedstraw	-	-	-	-	1.4	2.8	1.4	1.4	1.4
Habenaria sp.	Orchid	-	-	-	-	-	1.4	1.4	1.4	0.8
Hydrocotyle umbellata	Marsh pennywort	-	3.3	1.7	-	-	-	-	-	-
Hypericum sp.	St. John's wort	-	-	-	6.9	-	2.8	6.9	4.2	4.2
Ilex cassine	Dahoon holly	6.1	5.2	5.7	1.4	1.4	4.2	2.8	5.6	3.1
Ipomoea sp.	Morning glory	2.4	-	1.2	-	-	-	-	-	-
I. sagittata	Glades morning glory	-	4.3	2.2	20.8	1.4	9.7	20.8	15.3	13.6
Jacquemontia curtissii	(no common name)	-	-	-	-	2.8	2.8	4.2	2.8	2.5
J. reclinata	(no common name)	-	-	-	4.2	-	-	-	-	0.8
Juncus roemerianus	Rush	15.9	17.6	16.8	19.4	22.2	19.4	19.4	26.4	21.4
Kosteletzkya virginica	Salt marsh willow	-	0.5	0.3	-	-	-	-	-	-
Lachnanthes caroliniana	Red root	-	0.5	0.3	-	-	-	-	-	-
Laguncularia racemosa	White mangrove	9.8	34.8	22.3	33.3	29.2	29.2	33.3	27.8	30.6
Lantana involucrata	Lantana	-	0.5	0.3	2.8	1.4	1.4	1.4	1.4	1.7
L. microcephala	Lantana	-	-	-	-	1.4	1.4	1.4	1.4	1.1
Lippia nodiflora	Capeweed	-	1.0	0.5	-	-	-	-	-	-
Ludwigia sp.	(no common name)	-	-	-	-	1.4	5.6	4.2	4.2	3.1
L. microcarpa[c]	Water purslane	-	-	-	-	-	-	-	-	-

Table 1. Plant species observed and frequency of occurrence at the Turkey Point Plant during baseline and 1978-1982 (cont'd). operational monitoring.

SPECIES	COMMON NAME	FREQUENCY (%) Baseline[a] 1972	Baseline[a] 1974	Mean 1972 - 1974	Operational[b] 1978	Operational[b] 1979	Operational[b] 1980	Operational[b] 1981	Operational[b] 1982	Mean 1978 - 1982
L. peruviana	Primrose willow	-	1.0	0.5	-	-	-	-	-	-
L. repens	Water purslane	-	-	-	5.6	4.2	4.2	1.4	-	3.1
Lycium carolinianum[c]	Christmas berry	-	-	-	-	-	-	-	-	-
Lythrum alatum	Loosestrife	-	-	-	-	1.4	1.4	6.9	2.8	2.5
Magnolia virginiana	Sweet bay, swamp bay	-	3.8	1.9	1.4	1.4	2.8	-	2.8	1.7
Maytenus phyllanthoides	Molina	-	-	-	-	-	-	2.8	-	0.6
Metopium toxiferum	Poisonwood	4.9	1.9	3.4	8.3	8.3	9.7	8.3	9.7	8.9
Mikania batatifolia	Hemp vine	-	-	-	5.6	-	1.4	-	-	1.4
M. scandens	Climbing hempvine	4.9	4.8	4.9	1.4	1.4	6.9	12.5	12.5	6.9
Myrica cerifera	Wax myrtle	4.9	5.2	5.1	6.9	5.6	6.9	8.3	9.7	7.5
Myrsine guianensis (Rapanea guianensis)	Myrsine	4.9	5.7	5.3	8.3	6.9	8.3	8.3	8.3	8.0
Nectandra coriacea	Lancewood	-	-	-	-	-	-	-	-	-
Nephrolepis biserrata[c]	Boston fern	-	-	-	-	-	-	-	-	-
N. exaltata	Boston fern	-	0.5	0.3	-	-	-	-	-	-
Osmunda cinnamonea	Royal fern	-	0.5	0.3	-	-	-	-	-	-
O. regalis v. spectabilis	Royal fern	-	2.4	1.2	-	-	-	-	-	-
Panicum sp.[c]	Panic grass	-	-	-	-	-	-	-	-	-
Panicum portoricense	Panic grass	-	-	-	-	-	-	1.4	-	0.3
P. dichotomum	Panic grass	-	-	-	-	1.4	-	-	-	0.3
Parthenocissus quinquefolia	Virginia creeper	4.9	4.8	4.9	-	-	-	-	1.4	0.3
Paspalum sp.	(no common name)	-	3.3	1.7	-	-	-	-	-	-
Passiflora suberosa	Corky-stemmed passion flower	-	-	-	1.4	-	-	-	-	0.3
Peltandra virginica	(no common name)	-	2.4	1.2	-	-	-	-	-	-
Penstemon sp.	Beardtongue	-	0.5	0.3	-	-	-	-	-	-
Persea borbonia	Red bay	4.9	-	2.5	1.4	1.4	4.2	6.9	1.4	3.1
P. palustris	Swamp bay	-	3.3	1.7	-	-	-	1.4	-	0.3
Phlebodium sp.	Golden polypody	-	-	-	1.4	1.4	1.4	1.4	1.4	1.4
P. aureum	Golden polypody	4.9	-	2.5	-	-	-	-	-	-
Phyllanthus	(no common name)	-	-	-	-	1.4	1.4	2.8	-	1.1
Pinguicula pumila	Butterwort	-	-	-	1.4	-	1.4	-	-	0.6
Pisonia sp.	Cockspur	-	-	-	-	-	-	-	-	-
P. aculeata	Devil's claw	-	-	-	-	-	-	-	2.8	0.6
P. discolor (Torrubia longifolia)	Blolly, beef tree	1.2	-	0.6	4.2	1.4	2.8	4.2	1.4	2.8
Pithecellobium unguis-cati	Catclaw	1.2	-	0.6	-	-	-	-	-	-
Pluchea purpurascens	Camphorweed	2.4	-	1.2	-	-	-	-	-	-
P. rosea	Marsh fleabane	-	6.2	3.1	1.4	-	-	8.3	5.6	3.1
Polygala sp.	Milkwort	-	0.5	0.3	-	-	-	-	-	-
Polygala cruciata[c]	Milkwort	-	-	-	-	-	-	-	-	-
P. grandiflora	Milkwort	-	1.4	0.7	-	-	-	-	-	-
Polygonum sp.	Knotweed, smartweed	-	1.0	0.5	-	-	-	-	-	-

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Pontederia lanceolata	Pickerelweed	-	0.5	0.3	-	-	-	-	-	-
Proserpinaca sp.	Mermaid weed	-	-	-	4.2	2.8	-	-	-	1.4
P. palustris	Swamp mermaid	-	4.3	2.2	-	1.4	4.2	5.6		2.2
Psilotum nudum	Whisk fern	-	-	-	-	-	-	-	4.2	0.8
Psychotria ligustrifolia	Wild coffee	-	-	-	-	1.4	-	2.8	1.4	1.1
Pteris vittata	Brake fern	-	-	-	-	1.4	1.4	-	-	0.6
Randia aculeata	White indigoberry	-	0.5	0.3	4.2	2.8	2.8	5.6	4.2	3.9
Rhexia sp.	Meadow beauty	1.2	0.5	0.9	-	-	-	-	-	-
R. mariana	Meadow beauty	-	-	-	1.4	1.4	-	-	-	0.6
Rhizophora mangle	Red mangrove	50.0	46.2	48.1	31.9	33.3	37.5	27.8	31.9	32.5
Rhus sp.	Sumac	-	-	-	1.4	-	-	-	2.8	0.8
Rhynchospora sp.[c]	Beak rush	-	-	-	-	-	-	-	-	-
Sabal palmetto	Cabbage palm	13.4	4.3	17.7	9.7	8.3	8.3	6.9	6.9	8.0
Sabatia sp.	Marsh pink	4.9	1.0	3.0	-	-	-	-	-	-
S. grandiflora	Marsh pink	-	-	-	-	1.4	-	1.4	-	0.6
Salicornia virginica (*Salicornia perrenis*)	Perennial glasswort	-	8.6	4.3	2.8	2.8	1.4	2.8	2.8	2.5
Salix caroliniana	Coastal plain willow	-	2.9	1.5	1.4	1.4	1.4	1.4	1.4	1.4
Samolus ebracteatus[c]	Water pimpernel	-	-	-	-	-	-	-	-	-
Sarcostemma clausa[c]	White vine	-	-	-	-	-	-	-	-	-
Schinus terebinthifolius	Brazilian pepper	6.1	5.7	5.9	5.6	6.9	6.9	8.3	8.3	7.2
Schoenus nigricans	(no common name)	-	1.0	0.5	6.9	8.3	8.3	12.5	9.7	9.1
Serenoa repens	Saw palmetto	1.2	1.0	1.1	-	-	-	-	-	-
Sesuvium maritimum[c]	Sea purslane	-	-	-	-	-	-	-	-	-
S. portulacastrum	Sea purslane	1.2	6.2	3.7	-	-	-	-	-	-
Setaria geniculata	Foxtail grass	-	-	-	-	-	-	1.4	-	0.3
Setaria sp.	Foxtail grass	-	0.5	0.3	-	-	-	-	-	-
Smilax sp.	Briar	3.7	-	1.9	-	-	-	-	-	-
S. auriculata[c]	Earleaf briar	-	-	-	-	-	-	-	-	-
S. bona-nox	Green briar	-	0.5	0.3	-	-	-	-	-	-
S. laurifolia	Bamboo vine	-	1.4	0.7	-	-	-	-	-	-
Solanum blodgettii	Nightshade	-	-	-	20.8	18.1	18.1	18.1	18.1	18.6
S. erianthum (*Solanum verbascifolium*)	Potato tree	13.4	8.1	10.8	-	-	-	-	-	-
Solidago microcephala	Goldenrod	-	-	-	1.4	-	-	-	-	0.3
S. tortifolia[c]	Goldenrod	-	-	-	-	-	-	-	-	-
Sophora tomentosa	Necklace pod	-	0.5	0.3	-	-	-	-	-	-
Sporobolus virginicus	Brown dropseed	-	-	-	-	-	-	1.4	1.4	0.6
Stenandrium sp. (*Gerardia* sp.)	(no common name)	1.2	-	0.6	-	-	-	-	-	-
Suriana maritima	Bay cedar	-	0.5	0.3	-	-	-	-	-	-
Swietenia mahagoni	West Indian mahogany	1.2	0.5	0.9	2.8	2.8	2.8	2.8	2.8	2.8
Talinum sp.	Flame flowers	-	-	-	-	-	-	-	-	-
T. paniculatum	Flame flower	-	2.4	1.2	-	1.4	-	-	-	0.3
Thelypteris sp.	(no common name)	1.2	-	0.6	2.8	2.8	2.8	1.4	1.4	2.2

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SPECIES	COMMON NAME	FREQUENCY (%) Baseline[a] 1972	Baseline[a] 1974	Mean 1972 - 1974	Operational[b] 1978	Operational[b] 1979	Operational[b] 1980	Operational[b] 1981	Operational[b] 1982	Mean 1978 - 1982
T. augescens[c]	(no common name)	-	-	-	-	-	-	-	-	-
Tillandsia balbisiana	Air plant	-	0.5	0.3	-	-	-	-	-	-
T. circinata	Air plant	-	-	-	4.2	1.4	2.8	1.4	-	2.0
T. fasciculata[c]	Air plant	-	-	-	-	-	-	-	-	-
T. flexuosa	Twisted air plant	-	-	-	4.2	-	-	-	-	0.8
T. utriculata	Air plant	2.4	-	1.2	-	-	-	-	1.4	0.3
T. valenzuelana	Soft-leaf air plant	-	-	-	-	-	-	-	2.8	0.6
Toxicodendron radicans	Poison ivy	6.1	7.1	6.6	2.8	1.4	2.8	4.2	-	2.2
Trema lamarkiana	West Indian trema	7.3	2.9	5.1	-	-	-	-	-	-
T. micrantha	Florida trema	4.9	2.9	3.9	1.4	1.4	2.8	2.8	1.4	2.0
Typha sp.	Cattail	-	-	-	2.8	2.8	2.8	2.8	2.8	2.8
T. dominginensis	Southern cattail	-	0.5	0.3	-	-	-	-	-	-
Utricularia sp.	Bladderwort	-	-	-	-	-	-	1.4	-	0.3
Vanilla inodora	Scentless vanilla	-	0.5	0.3	-	-	-	-	-	-
Verbena bonariensis	Vervain	-	1.9	1.0	-	-	-	-	-	-
Vitis rotundifolia	Muscadine grass	2.4	5.7	4.1	4.2	2.8	4.2	5.6	2.8	3.9
Vittaria lineata	Shoestring fern	3.7	-	1.9	1.4	-	1.4	1.4	1.4	1.1
Xyris sp.	Yellow-eyed grass	-	-	-	1.4	1.4	2.8	-	-	1.1
X. brevifolia	Yellow-eyed grass	-	-	-	4.2	-	1.4	-	2.8	1.7
Zanthoxylum fagara	Wild lime	-	0.5	0.3	-	-	-	-	-	-
TOTAL NUMBER OF SPECIES OBSERVED ANNUALLY		56	88		66	67	66	67	62	
CUMULATIVE NUMBER OF SPECIES OBSERVED		56	105		167	177	179	186	187	

[a]1972 is Turkey Point site prior to construction of the cooling canal system (ABI, 1978a); 1972 is South Dade site adjacent to the cooling canal system (ABI, 1978b.)

[b]Turkey Point site, annual operational monitoring (FPL, 1979, 1980, 1981, 1982, 1983).

[c]Species found during 1975-1977 (FPL, 1976, 1977, 1978).

[d]New species found in 1982.

Table 2. Comparisons of the 1982 frequency of occurrence of common plant species with species frequencies in previous years at the Turkey Point Plant.

SPECIES	COMMON NAME	1972-1974	1975-1980	1981	1982
Aster sp.	aster	0.3*	19.7*	30.6	40.3
Blechnum serrulatum	blechnum fern	7.5	11.6	11.1	11.1
Casuarina equisetifolia	Australian pine	9.0	11.1	11.1	11.1
Cladium jamaicensis	saw grass	59.4*	83.3	84.7	81.9
Conocarpus erecta	buttonwood	48.2*	74.5	69.4	72.2
Distichilis spicata	salt grass	34.9*	13.9	18.1	18.1
Eleocharis cellulosa	clubrush	0.6*	9.3	15.3	16.7
Ipomoea sagittata	glades morning glory	2.2*	7.6	20.8	15.3
Juncus roemerianus	rush	16.8	18.5	19.4	26.4
Laguncularia racemosa	white mangrove	22.3	31.3	33.3	27.8
Mikania scandens	climbing hempvine	4.9*	1.9*	12.5	12.5
Rhizophora mangle	red mangrove	48.1*	36.3	27.8	31.9
Solanum sp.	nightshade	10.8	18.5	18.1	18.1

*Indicates significant difference from 1982 frequency (z-test, $\alpha \leq 0.05$).

Table 3. Volume-density index of grassland transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
Aster sp.	1	0	0	2	0	0	<1	2	1
	3	0	0	3	2	0	1	0	0
	5	6	0	16	32	5	13	8	1
Cassytha filiformis	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	<1	0	0	0	0	0
Cladium jamaicensis	1	101	955	1,677	0	2,064	1,346	6,007	8,289
	3	7,929	5,692	1,744	2,112	2,805	3,416	4,607	5,225
	5	2,581	5,098	5,020	2,825	1,422	2,242	8,798	6,700
Conocarpus erecta	1	0	3	183	20	44	964	304	51
	3	0	0	179	188	0	142	0	0
	5	264	0	2,246	863	84	0	200	0
Distichilis spicata	1	0	0	0	25	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	612	129	10	67	215	9	47	56
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	16	87
Hypericum sp.	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	<1	0	0	0	0
Ipomoea sagittata	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	<1	0

Table 3. (cont'd) Volume-density index of grassland transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	Quadrats							
		A1	A2	B1	B2	C1	C2	D1	D2
Juncus roemerianus	1	87	81	90	39	48	2	7	4
	3	0	0	0	0	12	22	0	0
	5	0	0	0	0	0	0	0	0
Rhizophora mangle	1	0	0	0	109	0	0	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0
Typha sp.	1	0	0	0	0	655	51	0	0
	3	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0

Table 4. Volume-density index of tree island transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
Acrostichum aureum	2	0	0	0	0	0	0	0	0
	4	0	0	0	14	0	12	0	0
	6	0	0	3,252	0	0	0	0	0
Ammania teres	2	0	<1	0	0	0	3	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Aster sp.	2	5	0	0	0	2	0	0	0
	4	2	0	0	0	0	0	0	1
	6	0	0	0	0	0	0	0	0
Baccharis sp.	2	0	0	5	0	0	0	0	0
	4	0	0	0	0	152	20	0	0
	6	0	0	0	0	0	0	0	0
Bacopa monnieri	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	8	1	0	0
	6	0	0	0	0	0	0	0	0
Blechnum serrulatum	2	0	0	0	0	0	0	0	0
	4	28	0	0	0	535	372	2,484	0
	6	2,500	1,239	0	0	5	106	0	0
Casurina equisetifolia	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	338	6
	6	0	132,300	0	61,396	0	0	22	0
Cephalanthus occidentalis	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	240	0
	6	0	0	0	0	0	0	0	0

Table 4. Volume-density index of tree island transects at the Turkey Point Canal System,
(cont'd) 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
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	3	0	104
Cladium jamaicensis	2	9,180	8,659	4,806	14,070	4,651	21,354	9,430	17,817
	4	1,089	4,126	9,422	22,881	3,637	45,034	10,984	3,434
	6	18,326	9,291	6,341	4,595	1,090	0	5,519	4,940
Conocarpus erecta	2	1,627	43,685	1,793	6,938	10,411	2,599	4,867	11,708
	4	324	1,767	5,931	12,563	926	16,908	3,790	4,086
	6	0	0	4,481	35	0	1,138	4,889	34
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	1	0	12,150
Eugenia 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	325	0	577
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	1	0
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	115	0	0	0

Table 4. (cont'd) Volume-density index of tree island transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS A1	A2	B1	B2	C1	C2	D1	D2
Hypericum sp.	2	0	<1	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Ilex cassine	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	<1	0	383	0
	6	0	4,225	<1	0	0	0	0	0
Ipomoea sagittata	2	<1	<1	0	0	0	0	<1	0
	4	0	0	0	0	<1	0	0	0
	6	0	0	0	0	0	0	0	0
Jacquemontia curtissii	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	1	0
Juncus roemerianus	2	0	0	0	0	0	0	2	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
Laguncularia racemosa	2	60	0	0	395	15,224	8,101	68	0
	4	0	0	0	0	4,180	2,222	0	0
	6	0	0	409	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	200
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	12	0

Table 4. (cont'd) Volume-density index of tree island transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
<u>Ludwigia</u> sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	1	0	2	3
	6	0	0	0	0	0	0	0	0
<u>Magnolia virginiana</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	470	1132	0	0
<u>Metopium toxiferum</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	<1	<1	<1	639	4,653	12,603	36,777
<u>Mikania scandens</u>	2	<1	<1	0	0	0	0	0	0
	4	0	0	0	0	<1	<1	<1	<1
	6	0	0	0	0	0	0	0	<1
<u>Myrica cerifera</u>	2	0	0	0	0	0	0	0	0
	4	0	130	0	0	<1	0	131	0
	6	0	10,252	0	0	112	0	674	1,575
<u>Myrsine guianensis</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	4,894	675	0	0	161	6	4,258	800
<u>Parthenocissus quinquefolia</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	<1	0	0	0	0	0
<u>Persea borbonia</u>	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	<1	0	0	0
	6	0	0	0	0	0	0	0	0

Table 4. Volume-density index of tree island transects at the Turkey Point Canal System,
(cont'd) 1982.

SPECIES	TRANSECT	QUADRATS A1	A2	B1	B2	C1	C2	D1	D2
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	3	0	0	0
Pisonia 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	25	13	0
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	1,494	0	0	0
Pluchea rosea	2	34	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	30	37
	6	0	0	0	0	0	0	15	0
Proserpinaca palustris	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	<1	0	9	38
	6	0	0	0	0	0	0	0	0
Psychotria ligustrifolia	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	21,175	0	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	123	96	79
Rhizophora mangle	2	0	0	0	14,480	20	339	5	0
	4	152	1,980	0	0	0	0	0	0
	6	0	7,655	6	0	0	0	0	0

Table 4. (cont'd) Volume-density index of tree island transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS A1	A2	B1	B2	C1	C2	D1	D2
Rhus sp.	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	<1	0	0	0
	6	0	0	0	0	<1	0	0	0
Sabal palmetto	2	0	0	0	0	0	0	0	0
	4	0	0	0	118,300	192,200	0	0	0
	6	46,288	0	54,150	0	25,270	0	0	0
Salix caroliniana	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	900	0	0	0
	6	0	0	0	0	0	0	0	0
Schinus terebinthifolius	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	2	4	0	0
	6	0	0	680	0	2	231	0	0
Solanum blodgettii	2	0	0	0	0	0	30	0	0
	4	0	14	0	0	284	223	2,944	359
	6	8	0	7,097	0	8	19	50	102
Sporobolus virginicus	2	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	36
	6	0	0	0	0	0	0	0	0
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	34,846	1,158	0	0
Thelypteris sp.	2	0	0	0	0	0	0	0	0
	4	0	0	4	0	0	0	0	0
	6	0	0	0	0	0	0	0	0

Table 4. Volume-density index of tree island transects at the Turkey Point Canal System,
(cont'd) 1982.

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	60	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	1	0	<1
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
Xyris brevifolia	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	355	34

Table 5. Volume-density index of mangrove transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
Acrostichum aureum	7	0	0	0	0	0	0	0	0
	8	0	0	0	318	0	0	0	0
	9	54,546	0	0	0	0	0	0	0
Aster sp.	7	5	3	3	2	<1	2	<1	31
	8	0	0	0	0	<1	0	0	0
	9	0	1	1	0	0	0	0	0
Avicennia germinans	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	261	360
	9	0	0	0	0	0	0	0	0
Borrichia frutescens	7	0	0	0	0	0	0	13	31
	8	0	0	0	0	0	0	1	0
	9	22	0	50	0	15	5	0	0
Cassytha filiformis	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	<1	<1	0	0
	9	0	0	0	0	0	0	0	0
Casurina equisetifolia	7	0	0	0	0	0	0	0	0
	8	6,032	171,875	0	121,275	0	0	0	0
	9	0	0	0	0	0	0	0	0
Cladium jamaicensis	7	5,309	1,595	4,727	3,601	2,184	7,748	0	92
	8	13,730	3,030	5,255	9,288	1,625	4,155	0	0
	9	0	0	0	0	0	0	0	0

Table 5. (cont'd) Volume-density index of mangrove transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
Conocarpus erecta	7	0	1,269	0	3,488	924	1,563	476	408
	8	303	2,332	20,155	3,040	2,091	2,704	0	0
	9	6,300	0	39	0	819	333	0	0
Distichilis spicata	7	0	0	0	<1	0	0	437	148
	8	0	0	0	0	0	0	163	180
	9	0	35	35	2	14	12	47	81
Eleocharis cellulosa	7	0	0	0	0	0	0	52	16
	8	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0
Hypericum sp.	7	0	<1	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0
Ipomoea sagittata	7	0	<1	0	0	<1	<1	0	0
	8	0	<1	<1	0	0	<1	0	0
	9	0	0	0	0	0	0	0	0
Juncus roemerianus	7	0	0	<1	8	4	0	0	0
	8	346	199	17	0	643	0	0	0
	9	0	0	0	0	0	26	0	0
Laguncularia racemosa	7	0	0	0	0	0	0	53	788
	8	0	0	253	6,991	0	6,443	3,484	1,582
	9	101	828	0	0	0	42	1,500	183

Table 5. (cont'd) Volume-density index of mangrove transects at the Turkey Point Canal System, 1982.

SPECIES	TRANSECT	QUADRATS							
		A1	A2	B1	B2	C1	C2	D1	D2
Lythrium alatum	7	0	0	0	0	0	0	0	0
	8	<1	0	0	0	0	<1	0	0
	9	0	0	0	0	0	0	0	0
Mikania scandens	7	0	0	0	0	0	0	0	0
	8	0	0	<1	<1	0	0	0	0
	9	0	0	0	0	0	0	0	0
Rhizophora mangle	7	0	0	0	0	0	0	0	0
	8	0	25	5,211	63	0	1,085	345	1,581
	9	57,671	3,769	4,899	5,350	4,444	10,071	5,556	4,579
Salicornia virginica	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	109	18
	9	0	0	0	0	0	0	0	0
Schinus terebinthifolius	7	0	0	0	0	0	0	0	0
	8	0	0	0	5	0	0	0	0
	9	0	0	0	0	0	0	0	0
Schoenus nigricans	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	194	0	0
	9	0	26	42	19	257	192	0	2
Solanum blodgettii	7	0	0	0	0	0	0	0	0
	8	0	0	50	165	0	0	0	0
	9	0	0	0	0	0	0	0	0

Table 6. Analysis of variance for long-term changes in biomass of common species at the Turkey Point Plant during 1978-1982.

SPECIES	COMMON NAME	F-RATIO	
		YEARS[a]	DISTANCE[b]
Aster sp.	aster	0.77	0.70
Blechnum serrulatum	blechnum fern	0.86	1.96
Casuarina equisetifolia	Australian pine	0.31	5.24*
Cladium jamaicensis	saw grass	1.50	0.47
Conocarpus erecta	buttonwood	1.36	1.34
Distichilis spicata	salt grass	1.56	1.80
Eleocharis cellulosa	clubrush	0.99	2.98*
Juncus roemerianus	rush	1.21	4.70*
Laguncularia racemosa	white mangrove	1.25	0.64
Rhizophora mangle	red mangrove	0.23	4.09*
Solanum blodgettii	nightshade	1.09	0.77

[a]A significant value (*) indicates a change in biomass from 1978 to 1982.

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

3. Annual Aerial Photograph Analyses (ETS 4.2.2.1)

The 1982 Turkey Point study aerial photograph taken in February 1983 shows continued healthy vegetation growth to the east, south and west of the canal system. Since the aerial photograph of last year (taken in November 1982), no change was apparent in the cover and vigor of either mangrove swamps to the east and south of the canal system or the fresh-water saw grass marshes to the west.

Reflectance for most of the canal system spoil banks continued to be low. This results from the herbicide control of the exotic Australian pine which colonizes the canal spoil berms. Those areas of canal bank system which do show healthy vegetative reflectance are remnants of tree island hammocks. These remnants within the canal bank system show up on the aerial photograph as clumps and strips of vegetation similar to those tree island groupings found in undisturbed marsh areas. No significant changes were evident in canal embankment vegetation between 1981 and 1982.

Besides these natural differences within the canal system, no major changes were noted in vegetative growth or cover in the area adjacent to the canal system. In general, neither the growth condition of the saw grass marshes nor the distribution of growing woody vegetation has changed between 1981 and 1982.

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V. CHANGES IN SURVEY PROCEDURES

A. Thermal (ETS 3.1.1)

On July 24, 1982 the Leeds and Northrup Speedometer 250 Temperature Recording Equipment was replaced by Hydrolab 2000 Series Submersible Thermographs.

B. Chemical Concentrations (ETS 3.1.2)

The Perkin-Elmer Model 306 Atomic Absorption Spectrophotometer used to analyze for copper and zinc was replaced in March 1982 with a Perkin-Elmer Model 5000 Atomic Absorption Spectrophotometer.

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

A. AMERICAN CROCODILES POPULATION STUDY

There was a continuing study of the American Crocodile, *Crocodylus acutus* at the Turkey Point Power Plant Site-Annual Report, January 1983.

B. HEAVY METALS BIOACCUMULATION STUDIES

A report entitled "Metal Concentrations in Fish and Snails from the Turkey Point Cooling Canal System" was completed in September 1982 .

C. AQUATIC WEED CONTROL

In 1982 an experimental aquatic herbicide program was carried out in the southwestern part of the cooling canal system. Since the herbicide treatment program was experimental, treatment of affected areas was confined to a number of one acre test plots and did not noticeably affect the total population of seagrasses within the canal system.

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

No Violations of the ETS occurred during 1982 at the Turkey Point Plant relative to the cooling canal system operation.

VIII. UNUSUAL EVENTS, CHANGES TO ETS, PERMITS OR CERTIFICATES (ETS 5.0)

A. A National Pollutant Discharge Elimination System (NPDES) Permit Application filed April 3, 1980 was amended April 28, 1981. Final permit not issued as of December 31, 1982.

B. An Industrial Wastewater Treatment System Permit, IO-13-57079, was issued by the Florida Department of Environmental Regulation for the Turkey Point Plant on October 15, 1982.

VIII. UNUSUAL EVENTS, CHANGES TO ETS, PERMITS OR CERTIFICATES (ETS 5.0)

A National Pollutant Discharge Elimination System (NPDES) Permit Application filed April 3, 1980 was amended April 28, 1981.

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