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ECOLOGICAL MONITORING OF SELECTED PARAMETERS AT THE TURKEY POINT PLANT

ANNUAL REPORT

JANUARY - DECEMBER 1977

Prepared for

FLORIDA POWER & LIGHT COMPANY

MIAMI, FLORIDA

By

APPLIED BIOLOGY, INC.

ATLANTA, GEORGIA

January 1978

CONTENTS[a]

III. ANALYSIS OF ENVIRONMENTAL DATA

A. CHEMICAL (FPL)

B. THERMAL (FPL)

C. FISH AND SHELLFISH C-1
Introduction C-1
Materials and Methods C-1
Results and Discussion C-3
Comparative Studies C-6
Summary C-7
Literature Cited C-9
Figures C-10
Tables C-13

D. BENTHOS D.1-1
1. MACROINVERTEBRATES D.1-1
Introduction D.1-1
Materials and Methods D.1-2
Results and Discussion D.1-5
Conclusions D.1-9
Literature Cited D.1-11
Figures D.1-13
Tables D.1-18

2. MICROBIOLOGY D.2-1
Introduction D.2-1
Materials and Methods D.2-2
Results and Discussion D.2-6
Conclusions D.2-12
Literature Cited D.2-15
Figures D.2-17
Tables D.2-19

E. TERRESTRIAL ENVIRONMENT E-1
Introduction E-1
Materials and Methods E-2
Results and Discussion E-4
Literature Cited E-10
Figures E-11
Tables E-13

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

C. FISH AND SHELLFISH

INTRODUCTION

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

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

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

MATERIALS AND METHODS

Fishes were collected monthly from January through December 1977, the period covered by this report, at the ten stations which were surveyed in 1974 and 1975 (Florida Power & Light Co., 1976). Stations 1 and 8 were relatively deep (6 m) water localities near

the plant intake and discharge, respectively (Figure III.C-1). Stations 2 and 4 were situated between deep (6 m) and shallow (1 m) water areas. Stations 3, 5, 6, and 7 averaged less than 1 m in water depth. Canal width at Stations 1 through 8 was approximately 30 m. Stations 9 and 10 were in a backwater area and a small pond, respectively, off the canal system proper. Water depth at these two stations was less than 0.6 m.

Collections were made by gill net and minnow trap. Each monofilament net was 30.5 m in length by 1.8 m in depth and consisted of three 10-m panels of 51-, 76-, and 102-mm stretch mesh sewn end to end. The minnow traps were of the funnel type and measured 406 mm long by 229 mm in diameter. These traps were constructed of 6.4-mm square galvanized mesh.

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

All specimens collected were identified to species, counted, measured to the nearest millimeter, and weighed to the nearest gram. Fishes were measured from the tip of the snout to the base of the

tail (standard length, SL). Crabs were measured across the shell (carapace width, CW), lobster and shrimp along the carapace and tail. Fish nomenclature was in accordance with Bailey et al. (1970).

RESULTS AND DISCUSSION

Three species of shellfishes and 29 species of fishes were collected during this 12-month sampling period (Table III.C-1). Collections by month and station number are presented in Tables III.C-2 through III.C-13. The number of individuals of each species collected, range of standard lengths, total weight, and the range of water temperatures recorded at each station during sampling are included. The number of individuals and length ranges presented in Tables III.C-2 through III.C-13 are summarized in Table III.C-14, which also summarizes results from the 1975 and 1976 studies.

The killifish family (Cyprinodontidae) comprised 85.4% of the 6596 total fishes collected during the normal sampling regime.[a] The goldspotted killifish (*Floridichthys carpio*) and sheepshead minnow (*Cyprinodon variegatus*) were the predominant species collected with 3392 and 2207 individuals, respectively. The livebearer family (Poeciliidae) made up 11.6% of the total number of fishes collected. The sailfin molly (*Poecilia latipinna*) accounted for 762 of the 765

[a] Additional studies were conducted on 27-29 April 1977 (Table III.C-5B). These data are excluded to maintain consistency in sampling methodology and monthly data comparisons.

livebearers. Fishes other than killifishes and livebearers comprised only 3.0% of the total number of fishes collected.

The goldspotted killifish, sheepshead minnow, and sailfin molly were the only species collected in large enough numbers for meaningful comparison. The goldspotted killifish was the only one of these three species collected on the eastern edge of the canal system (Stations 2, 3 and 4; Figure III.C-2). The sheepshead minnow was the dominant species at Station 5, and the goldspotted killifish was dominant at Stations 6 and 7 on the western side of the canal system. Comparatively few sailfin molly were found at Stations 5 through 7.

Total numbers of goldspotted killifish and sheepshead minnow were similar at the discharge (Station 8; Figure III.C-2). The majority of the sheepshead minnow were collected during the first half of the year, the majority of the goldspotted killifish during the second half. Only two sailfin molly were found at Station 8. Sheepshead minnow were the most abundant of these three species at Stations 9 and 10 combined, the backwater area and small pond, respectively, off the canal system proper. Station 10 was the only location at which the sailfin molly was abundant.

Habitat differences, physiological tolerances and/or competitive abilities have been previously discussed (Applied Biology, Inc., 1977) to account for differences in species dominance at these stations.

Since both juveniles and adults were captured, it may be assumed that reproducing populations of goldspotted killifish, sheepshead minnow, and sailfin molly are established within the canal system.

Other killifishes collected were the marsh killifish (12 individuals), Gulf killifish (13), and rainwater killifish (7). These species are apparently maintaining reproducing populations at Stations 9 and 10. Visual observations indicate that the pike killifish (*Belonesox belizanus*) is established in the vicinity of Stations 9 and 10. This is an exotic (introduced) species which has been established in south Dade County since 1957 (Courtenay et al., 1974).

The crested goby also appears to be established in the canal system. Fifty-three individuals, including juveniles, were collected during this sampling period (Table III.C-14). Numerous redfin needlefish were observed during this 12 month sampling period and are considered established in the canal system, based on the presence of both adults and juveniles.

Gulf toadfish, tidewater silverside, silver jenny and pinfish were found more commonly than in the previous year, although still in low numbers (Table III.C-14). Juveniles as well as adults were found for these species, but the low levels of abundance would indicate only a marginal possibility of prolonged presence in the system.

The remainder of the fishes collected were represented by adult individuals only. These include the ladyfish, bonefish, sea catfish, hardhead silverside, snook, crevalle jack, snappers, mojarras (with the exception of silver jenny), grunts, fat sleeper, and barracuda (Table III.C-14). The shellfishes were also represented by adult individuals only.

The number of fishes collected per gill net per 24-hr sample period (catch per unit effort) has steadily decreased over the 37 months sampled to date (Figure III.C-3). Concomitant with the decrease in the larger fishes, and corresponding predatory pressure, has been an increase in the small forage species as represented by the killifishes. Fishes and shellfishes represented only by adult forms which mature and die may be expected to disappear from the canal system unless recruitment occurs from outside. Yearly populations of forage species are expected to stabilize in the system, although at what abundance level is still unknown. Seasonal variations will continue to be great within each year.

COMPARATIVE STUDIES

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

(1970) in the immediate vicinity of the plant. This work was done primarily with gill nets and traps in tidal creeks, and resulted in the collection of 51 species of fishes. Pinfish, mojarras, snappers, and mullet were the fishes most commonly found. Blue crabs and shrimp were the common shellfishes. Applied Biology has collected or observed approximately 40 species of fishes since studies were initiated after the closing of the canal system to Biscayne Bay.

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

SUMMARY

The Turkey Point cooling canals are a closed system containing a decreasingly diverse assemblage of fishes and shellfishes. Reproducing populations, as evidenced by the occurrence of both juveniles and adults, are confined primarily to the killifish and livebearer families of fishes. The goldspotted killifish and the sheepshead

minnow are the dominant fishes, based on the number of individuals collected. The majority of fish and shellfish species may be expected to disappear from the canal system as natural attrition occurs.

LITERATURE CITED

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

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

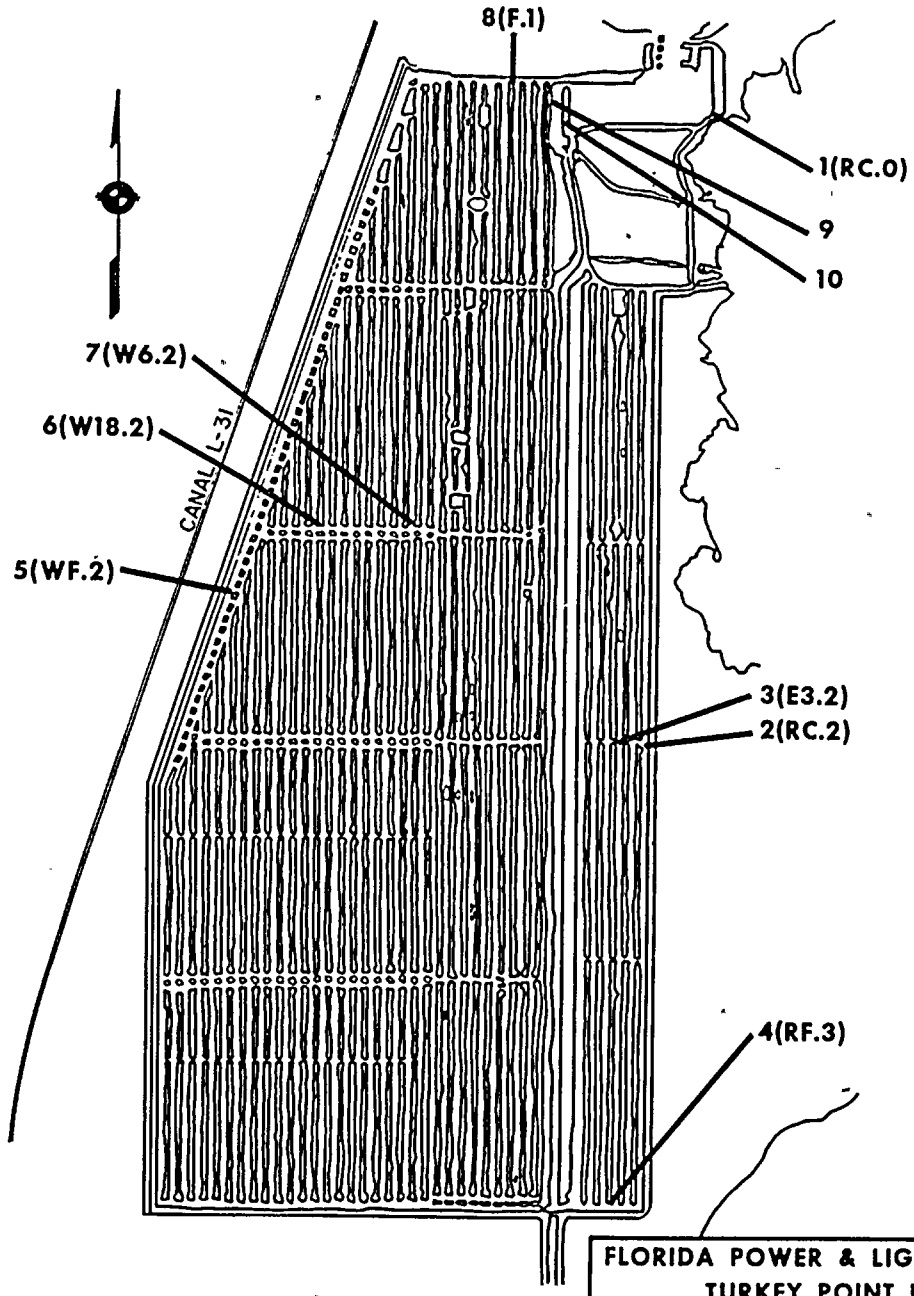
Bailey, R.M., J.E. Fitch, E.S. Herald, E.A. Lachner, C.C. Lindsey, C.R. Robins and W.B. Scott. 1970. A list of common and scientific names of fishes from the United States and Canada, 3rd ed. Amer. Fish. Soc., Spec. Publ. 6. 150 pp.

Courtenay, W.R., Jr., H.F. Sahlman, W.W. Miley II, and D.J. Herrema. 1974. Exotic fishes in fresh and brackish waters of Florida. Biol. Conservation 6(4):292-302.

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

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

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



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

FISH AND SHELLFISH
SAMPLING STATIONS

(FPL Station Numbers)

APPLIED BIOLOGY, INC.
Figure III.C-1

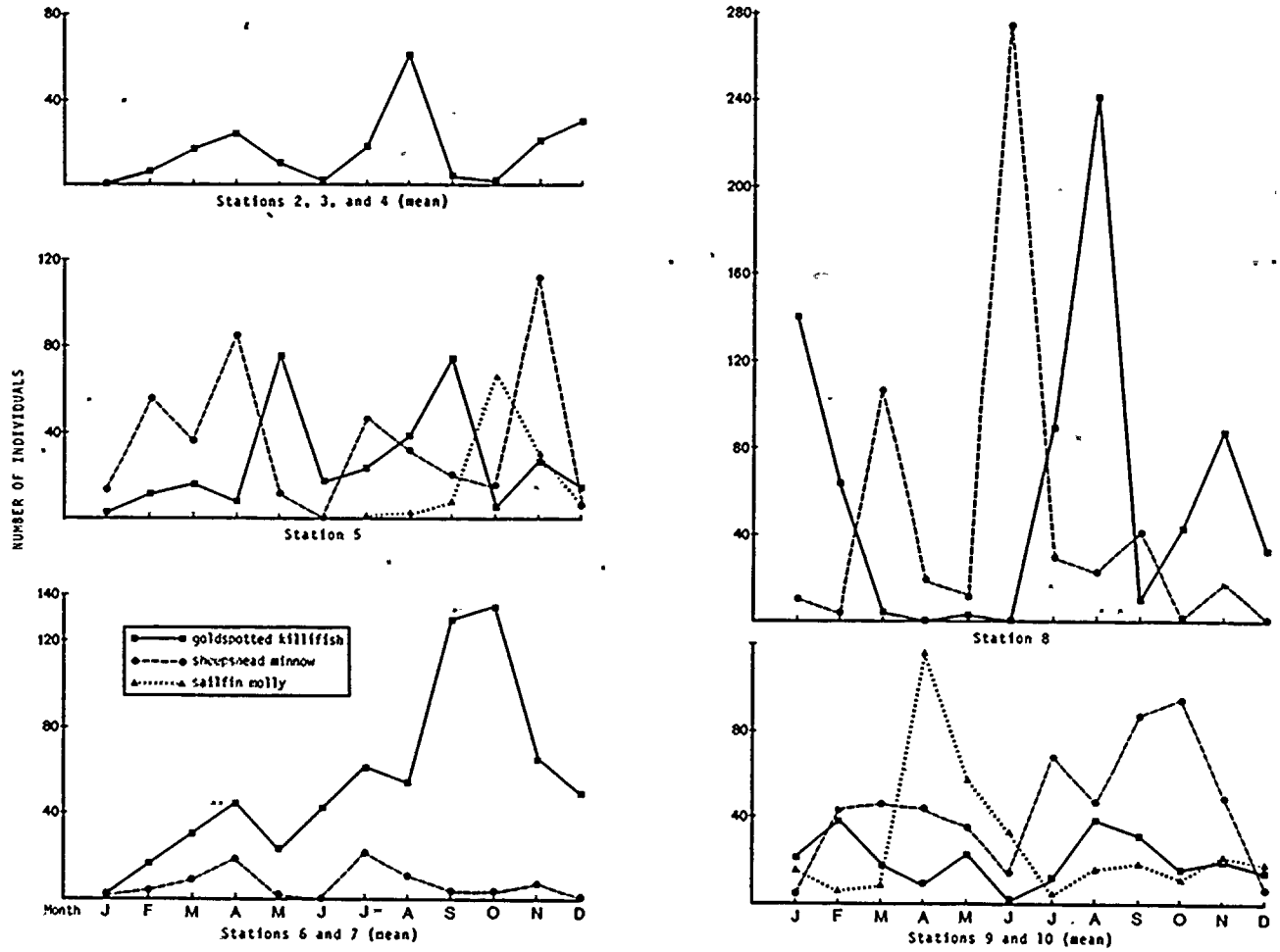


Figure III.C-2. Number of goldspotted killifish, sheepshead minnow, and sailfin molly collected at Stations 2 through 10, Turkey Point cooling canals, 1977.

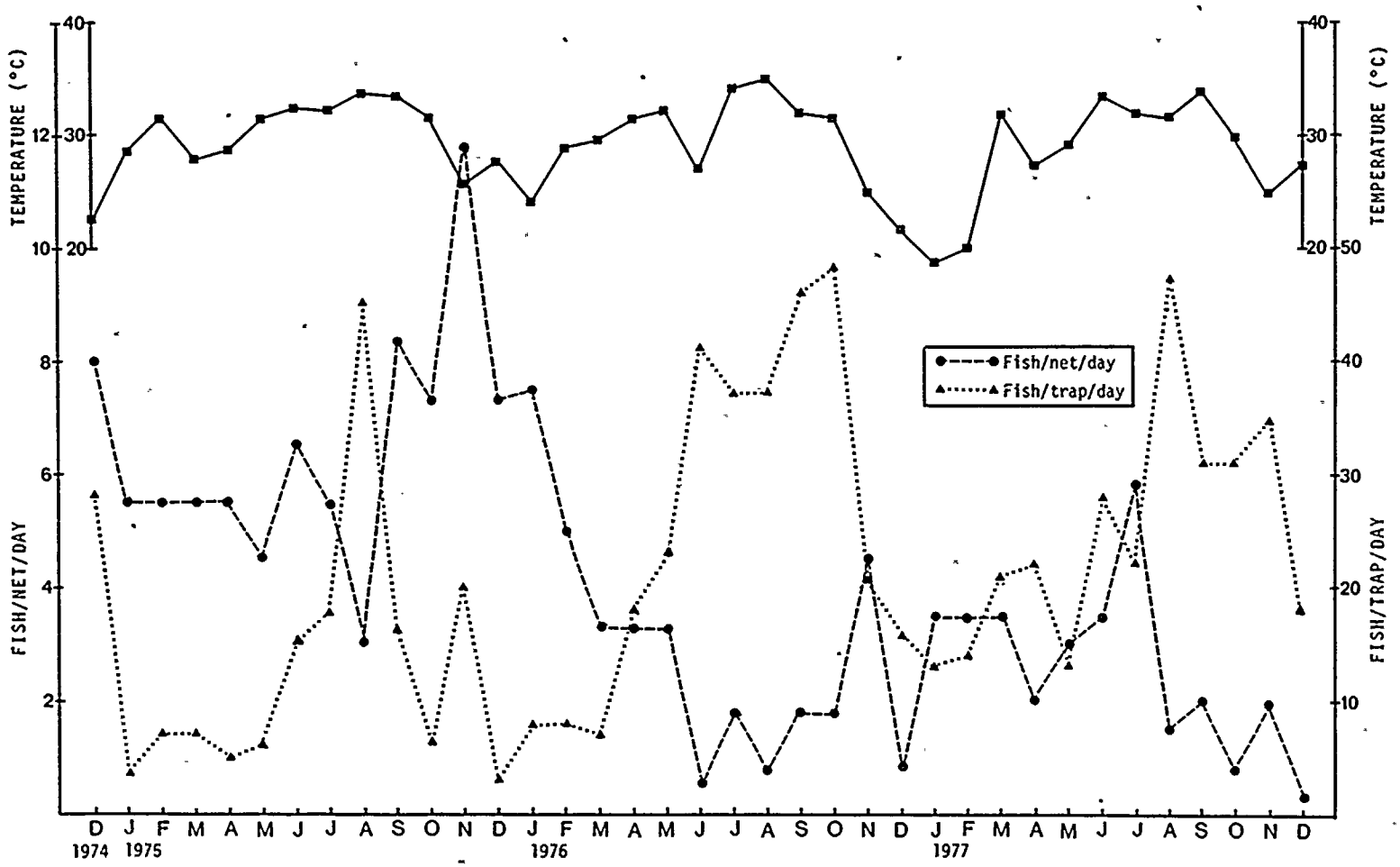


Figure III.C-3. Fish per gill net per day, fish per minnow trap per day, and mean maximum temperature recorded at Stations 1 through 8, Turkey Point cooling canals, December 1974-December 1977.

TABLE III.C-1

SCIENTIFIC AND COMMON NAMES OF SHELLFISHES AND FISHES COLLECTED WITHIN THE TURKEY POINT COOLING CANAL SYSTEM 1977

Penaeus sp.	edible shrimp
Panulirus argus	spiny lobster
Callinectes sapidus	blue crab
Elops saurus	ladyfish
Albula vulpes	bonefish
Strongylura marina	Atlantic needlefish
Arius felis	sea catfish
Opsanus beta	Gulf toadfish
Cyprinodon variegatus	sheepshead minnow
Floridichthys carpio	goldspotted killifish
Fundulus confluentus	marsh killifish
Fundulus grandis	Gulf killifish
Lucania parva	rainwater killifish
Belonesox belizanus	pike killifish
Poecilia latipinna	sailfin molly
Atherinomorus stipes[a]	hardhead-silverside
Menidia beryllina	tidewater silverside
Centropomus undecimalis	snook
Caranx hippos	crevalle jack
Lutjanus apodus	schoolmaster
Lutjanus griseus	gray snapper
Diapterus plumieri	striped mojarra
Eucinostomus argenteus	spotfin mojarra
Eucinostomus gula	silver jenny
Gerres cinereus	yellowfin mojarra
Haemulon parrai	sailors choice
Haemulon sciurus	bluestriped grunt
Archosargus probatocephalus	sheepshead
Lagodon rhomboides	pinfish
Sphyraena barracuda	great barracuda
Dormitator maculatus	fat sleeper
Lophogobius cyprinoides	crested goby

[a]Observational record only.

TABLE III.C-2

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 JANUARY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	nothing collected	-	-	-	16.0-17.0
2	shrimp	1	124	22	14.0-16.0
	yellowfin mojarra	4	161-213	862	
	gray snapper	1	264	544	
	goldspotted killifish	2	30-31	2	
3	Gulf toadfish	1	53	4	11.0-13.0
4	blue crab	1	121	116	14.5-15.5
	bonefish	5	255-454	4994	
	great barracuda	1	505	1108	
	yellowfin mojarra	1	177	157	
	silver jenny	1	111	40	
5	sheepshead minnow	13	22-34	12	19.0
	goldspotted killifish	3	28-43	6	

TABLE III.C-2
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 JANUARY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
6	goldspotted killifish	5	28-38	7	19.0
	sheepshead minnow	3	24-26	2	
7	nothing collected	-	-	-	18.5-19.0
8	shrimp	1	128	25	21.5-23.5
	blue crab	1	129	145	
	bonefish	1	fragment	fragment	
	goldspotted killifish	140	22-39	128	
	sheepshead minnow	10	18-32	7	
9	goldspotted killifish	39	23-55	76	18.0-23.0
	sheepshead minnow	6	28-34	8	
	sailfin molly	3	28-40	5	
10	sailfin molly	27	28-40	38	13.0-16.0
	sheepshead minnow	5	21-36	6	
	goldspotted killifish	4	34-37	7	

TABLE III.C-2
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 JANUARY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10 (cont.)	rainwater killifish	2	23-26	1	
	pike killifish	1	57	3	

TABLE III.C-3

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
17-18 FEBRUARY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	silver jenny	3	98-113	121	16.0-19.0
2	blue crab	1	168	191	16.0-18.5
	bonefish	2	380-391	2002	
	great barracuda	1	516	1188	
	silver jenny	1	115	47	
	goldspotted killifish	19	26-46	34	
	Gulf toadfish	2	89-104	40	
3	goldspotted killifish	2	27-35	2	12.0-13.5
4	blue crab	3	151-161	594	16.0-17.0
	yellowfin mojarra	5	178-217	1109	
	bluestriped grunt	1	236	451	
5	sheepshead minnow	56	20-31	38	20.5-21.5
	goldspotted killifish	11	25-35	13	

TABLE III.C-3
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
17-18 FEBRUARY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
6	goldspotted killifish	17	23-37	17	20.0-20.5
	sheepshead minnow	4	20-24	2	
7	goldspotted killifish	14	24-41	22	20.0
	sheepshead minnow	5	19-23	2	
8	blue crab	3	103-145	452	26.0-30.0
	silver jenny	1	117	45	
	goldspotted killifish	65	24-40	59	
	sheepshead minnow	4	22-24	2	
9	goldspotted killifish	75	23-40	80	26.0
	sheepshead minnow	9	21-32	8	
	sailfin molly	9	29-41	14	
10	sheepshead minnow	78	22-41	131	18.0-19.0
	sailfin molly	3	26-35	3	

TABLE III.C-3
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
17-18 FEBRUARY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10 (cont.)	goldspotted killifish	2	35-37	4	
	Gulf killifish	1	53	5	
	marsh killifish	1	32	1	

TABLE III.C-4

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
14-15 MARCH 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	blue crab	1	142	174	29.0-29.5
	schoolmaster	3	198-244	1084	
	yellowfin mojarra	2	178-198	374	
2	gray snapper	1	291	596	29.0-30.0
	goldspotted killifish	30	24-39	30	
3	goldspotted killifish	20	24-45	28	27.0-28.0
4	blue crab	5	130-148	878	27.0-28.0
	yellowfin mojarra	4	170-246	1131	
	gray snapper	1	280	601	
	schoolmaster	1	ca. 200	fragment	
	goldspotted killifish	2	25-34	2	
5	sheepshead minnow	36	22-32	25	31.0-33.5
	goldspotted killifish	16	25-42	21	
6	goldspotted killifish	49	25-45	82	30.0-34.0
	sheepshead minnow	10	24-28	6	
7	goldspotted killifish	11	22-36	14	30.5-32.5
	sheepshead minnow	9	18-28	5	
	rainwater killifish	1	30	1	

TABLE III.C-4
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
14-15 MARCH 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
8	silver jenny	2	83-103	56	37.5-38.0
	sheepshead minnow	107	22-31	72	
	goldspotted killifish	4	27-37	6	
	sailfin molly	1	26	1	
9	goldspotted killifish	20	27-35	25	35.0-35.5
	sheepshead minnow	14	25-46	34	
	sailfin molly	2	36-40	5	
10	sheepshead minnow	78	26-42	131	31.0-31.5
	goldspotted killifish	17	34-50	45	
	sailfin molly	15	28-42	22	
	crested goby	6	37-48	15	

TABLE III.C-5

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
27-28 APRIL 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	bluestriped grunt	1	224	397	26.5-27.5
	schoolmaster	1	231	403	
2	blue crab	1	158	230	26.0-28.0
	bonefish	1	391	1005	
	silver jenny	1	116	46	
	goldspotted killifish	8	19-49	14	
3	goldspotted killifish	20	22-46	28	24.0-27.0
4	blue crab	1	153	215	24.5-26.0
	yellowfin mojarra	3	200-224	1058	
	goldspotted killifish	45	25-34	43	
	tidewater silverside	1	38	1	
5	sheepshead minnow	85	19-36	67	24.5-27.0
	goldspotted killifish	8	23-48	12	

TABLE III.C-5
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
27-28 APRIL 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
6	sheepshead minnow	31	19-30	18	24.0-27.0
	goldspotted killifish	4	28-45	6	
7	goldspotted killifish	85	20-44	100	24.0-27.0
	sheepshead minnow	5	20-25	3	
	sailfin molly	1	38	2	
8	blue crab	6	140-155	940	29.0
	shrimp	1	112	11	
	spotfin mojarra	1	122	56	
	sheepshead minnow	19	17-26	11	
	sailfin molly	1	30	1	
9	sheepshead minnow	86	22-38	68	30.0-31.0
	goldspotted killifish	17	24-39	17	
	Gulf killifish	2	43-49	4	
		1	81	13	
	sailfin molly	1	40	1	

TABLE III.C-5
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
27-28 APRIL 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10	sailfin molly	223	29-58	470	25.0-29.5
	crested goby	4	32-54	9	
	sheepshead minnow	3	35-39	6	
	rainwater killifish	2	20-24	1	
	goldspotted killifish	1	42	3	

TABLE III.C-5B

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
MISCELLANEOUS COLLECTIONS[a]
27-29 APRIL 1977

Species	Number of individuals	Range of standard lengths (mm)
blue crab	8	140-153
shrimp	9	100-120
spotfin mojarra	29	69-130
silver jenny	14	62-107
mojarra[b]	111	62-87
yellowfin mojarra	7	140-188
redfin needlefish	15[c]	243-287[d]
gray snapper	2	195-210
schoolmaster	2	205-242
ladyfish	1	328
pinfish	1	165
Gulf toadfish	1	160
hardhead silverside	20[e]	60-80[e]

[a] Nine sets with 48.8 x 1.8 m (160 x 6 ft) gill nets of 13, 19, 25 and 38-mm square mesh (1/2, 3/4, 1 and 1-1/2 in).

[b] Mixture of spotfin mojarra and silver jenny.

[c] Includes 3 ripe females.

[d] Numerous individuals (35-240 mm SL) observed.

[e] Estimated, observational record.

TABLE III.C-6

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
19-20 MAY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1.	nothing collected	-	-	-	26.0-29.0
2	schoolmaster	1	264	640	26.0-28.5
	goldspotted killifish	14	25-46	21	
3	goldspotted killifish	7	23-42	14	24.5-27.0
4	blue crab	6	140-155	940	27.5-28.0
	yellowfin mojarra	8	170-231	2244	
	snook	1	294	401	
	schoolmaster	1	263	680	
	goldspotted killifish	7	26-43	11	
5	goldspotted killifish	75	25-43	97	29.0
	sheepshead minnow	11	23-29	9	
6	goldspotted killifish	20	28-47	39	29.0
	sheepshead minnow	1	22	1	
7	goldspotted killifish	25	27-43	40	28.5-29.0

TABLE III.C-6
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
19-20 MAY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
8	blue crab	5	124-157	760	33.0
	striped mojarra	1	237	708	
	sheepshead minnow	12	20-26	7	
	goldspotted killifish	3	23-42	5	
9	sheepshead minnow	49	21-42	49	30.0-30.5
	goldspotted killifish	44	24-49	53	
	sailfin molly	4	33-46	8	
	Gulf killifish	1	64	8	
10	sailfin molly	111	27-54	213	27.0-28.5
	sheepshead minnow	20	27-41	39	
	marsh killifish	9	44-53	20	
	goldspotted killifish	2	35-46	8	
	Gulf killifish	1	57	5	
	crested goby	2	45-51	7	
	fat sleeper	1	66	7	

TABLE III.C-7

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
6-17 JUNE 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	blue crab	1	151	219	31.5-33.0
	bluestriped grunt	1	217	341	
	schoolmaster	1	232	368	
	geay snapper	1	264	417	
2	blue crab	2	152-156	477	31.5-34.0
	great barracuda	1	1020	ca. 7700	
	bonefish	1	407	1028	
	crested goby	2	51-72	15	
	goldspotted killifish	1	42	4	
	Gulf toadfish	1	98	19	
3	goldspotted killifish	4 4	23-29 23-29	6 6	31.0-32.0 31.0-32.0
4	blue crab	3	140-176	910	30.5-31.0
	yellowfin mojarra	6	219-246	2143	
	striped mojarra	1	259	447	
	gray snapper	1	345	1117	
	bonefish	1	164	72	

TABLE III.C-7
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
16-17 JUNE 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
4 (cont.)	crested goby	2	59-62	12	30.5-31.0
	goldspotted killifish	1	33	2	
5	goldspotted killifish	17	23-33	22	31.0
6	goldspotted killifish	75	26-38	127	31.5-33.0
7	goldspotted killifish	8	26-34	14	32.5-33.0
8	sheepshead minnow	276	22-40	228	37.0-40.0
9	sheepshead minnow	22	23-39	33	30.0-35.0
	goldspotted killifish	1	42	3	
10	sailfin molly	69	29-69	182	32.0-35.5
	crested goby	5	40-64	16	

TABLE III.C-7
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
16-17 JUNE 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10 (cont.)	sheepshead minnow	4	38-43	11	
	pike killifish	1	89	10	
	goldspotted killifish	1	42	2	
	marsh killifish	1	52	4	

TABLE III.C-8

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
18-19 JULY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	spiny lobster	1	251	549	30.0-32.0
2	yellowfin mojarra	14	148-229	3200	31.0-32.0
	silver jenny	1	128	48	
	gray snapper	2	201-227	480	
	goldspotted killifish	7	23-44	10	
3	goldspotted killifish	46	21-32	33	30.0-31.0
4	yellowfin mojarra	2	230-236	780	30.0-30.5
	silver jenny	1	103	37	
	gray snapper	1	332	fragment	
	crested goby	2	50-57	8	
5	sheepshead minnow	46	19-32	42	30.0-31.0
	goldspotted killifish	23	27-40	33	
	sailfin molly	1	22	1	
	crested goby	1	55	4	

TABLE III.C-8
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
18-19 JULY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10	sheepshead minnow	101	25-43	173	33.5
	sailfin molly	5	37-48	8	
	goldspotted killifish	2	30-52	8	
	crested goby	5	45-69	25	

TABLE III.C-8
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
18-19 JULY 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
6	goldspotted killifish	38	27-45	68	31.0-32.0
	sheepshead minnow	24	18-29	13	
7	goldspotted killifish	85	21-38	86	30.5-31.0
	sheepshead minnow	18	20-26	10	
8	blue crab	1	90	61	35.0-36.5
		1	166	386	
	silver jenny	2	114-117	64	
	goldspotted killifish	91	22-43	100	
	sheepshead minnow	30	21-40	22	
9	sheepshead minnow	36	30-45	62	31.0-37.0
	goldspotted killifish	21	32-45	36	
	sailfin molly	5	37-42	12	
	Gulf killifish	2	67-70	19	
	pinfish	1	61	8	

TABLE III.C-9

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
29-30 AUGUST 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	nothing collected	-	-	-	30.0-30.5
2	yellowfin mojarra	2	200-203	516	29.0-30.5
	goldspotted killifish	4	22-33	4	
	crested goby	1	67	8	
3	goldspotted killifish	139	23-41	113	28.5-29.0
	tidewater silverside	1	44	2	
4	yellowfin mojarra	1	202	247	30.0
	silver jenny	1	126	59	
	sea catfish	1	279	371	
	goldspotted killifish	36	22-33	26	
5	goldspotted killifish	38	23-39	41	30.5-31.0
	sheepshead minnow	32	23-33	37	
	sailfin molly	2	30-32	2	
	crested goby	1	72	9	
	Gulf killifish	1	43	3	

TABLE III.C-9
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
29-30 AUGUST 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
6	goldspotted killifish	41	24-42	45	31.5-32.0
	sheepshead minnow	5	24-28	4	
7	goldspotted killifish	67	23-39	56	31.0-31.5
	sheepshead minnow	16	22-30	10	
	tidewater silverside	2	37-39	2	
8	yellowfin mojarra	1	ca.210	fragment	37.0-38.0
	goldspotted killifish	242	24-43	227	
	sheepshead minnow	23	22-31	18	
9	sheepshead minnow	91	22-47	148	34.0-36.0
	goldspotted killifish	75	23-42	80	
10	sailfin molly	33	33-51	68	29.5-33.0
	goldspotted killifish	3	31-54	11	
	crested goby	3	40-62	11	
	sheepshead minnow	2	33-34	3	
	Gulf killifish	1	71	8	

TABLE III.C-10

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
26-27 SEPTEMBER 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	spiny lobster	1	112	1260	31.0-32.0
	sheepshead	1	367	1982	
	schoolmaster	1	255	480	
2	yellowfin mojarra	2	ca 200-210	fragments	32.0-32.5
	spotfin mojarra	1	97	25	
	goldspotted killifish	7	28-32	7	
3	goldspotted killifish	3	24-29	3	31.0-31.5
	Gulf toadfish	2	31-79	11	
4	blue crab	1	157	242	32.0
	yellowfin mojarra	1	213	225	
	gray snapper	1	216	fragment	
	sea catfish	1	407	1064	
	goldspotted killifish	3	24-26	2	
	crested goby	3	52-57	13	

TABLE III.C-10
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
26-27 SEPTEMBER 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
5	goldspotted killifish	74	23-47	98	33.0-33.5
	sheepshead minnow	19	23-34	18	
	sailfin molly	7	25-33	5	
	marsh killifish	1	41	2	
6	goldspotted killifish	71	23-45	78	34.0-35.0
	sheepshead minnow	1	24	1	
	rainwater killifish	1	27	1	
7	goldspotted killifish	187	24-42	155	33.5-34.5
	sheepshead minnow	6	25-28	5	
8	sheepshead minnow	41	24-34	24	40.0
	goldspotted killifish	10	22-31	7	
9	sheepshead minnow	167	24-47	176	37.0-38.0
	goldspotted killifish	65	24-43	60	
	sailfin molly	1	29	1	

TABLE III.C-10
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
26-27 SEPTEMBER 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
10	sailfin molly	38	37-56	106	30.0-35.0
	sheepshead minnow	8	35-40	17	
	crested goby	1	44	2	
	Gulf killifish	1	86	15	

TABLE III.C-11

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 OCTOBER 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
1	yellowfin mojarra	2	196-229	575	28.0-28.5
2	blue crab	1	160	271	28.5-29.0
	goldspotted killifish	5	22-32	4	
	rainwater killifish	1	28	1	
3	goldspotted killifish	1	31	1	25.0-28.0
4	Gulf toadfish	1	176	111	27.0-28.5
	crested goby	11	43-60	38	
5	sailfin molly	74	24-39	61	28.5-30.0
	sheepshead minnow	14	24-37	16	
	goldspotted killifish	5	24-41	6	
	crested goby	1	81	13	
6	goldspotted killifish	203	22-40	203	29.0-30.5
	sheepshead minnow	4	23-29	3	

TABLE III.C-11
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
20-21 OCTOBER 1977

Station number	Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Range of water temperatures (°C)
7	goldspotted killifish	68	24-45	74	28.0-30.0
	sheepshead minnow	2	24-26	1	
8	goldspotted killifish	42	22-32	28	34.5-35.0
	sheepshead minnow	1	24	1	
9	sheepshead minnow	134	17-39	106	33.5-34.0
	goldspotted killifish	28	23-43	37	
	sailfin molly	6	31-40	10	
10	sheepshead minnow	57	28-43	97	29.0-30.0
	sailfin molly	19	38-52	52	
	goldspotted killifish	5	35-50	15	
	Gulf killifish	1	64	9	

TABLE III.C-12

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
14-15 NOVEMBER 1977

Station number	Species	Number of individuals	Range of standard length (mm)	Total weight (g)	Range of water temperatures (°C)
1	bluestriped grunt	1	210	315	22.5-23.5
2	pinfish	3	104-121	376	23.5-24.5
	sailors choice	1	321	777	
	yellowfin mojarra	1	150	171	
	great barracuda	1	434	434	
	crested goby	1	54	5	
3	goldspotted killifish	10	27-33	10	20.5-22.0
4	blue crab	1	152	254	22.0-23.0
	crevalle jack	1	452	1960	
	goldspotted killifish	50	24-36	51	
	crested goby	1	27	1	
	tidewater silverside	1	40	1	
5	sheepshead minnow	109	22-36	100	24.5
	sailfin molly	29	23-40	27	
	goldspotted killifish	27	26-45	35	
	tidewater silverside	3	42-44	4	

TABLE III.C-12
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
14-15 NOVEMBER 1977

Station number	Species	Number of individuals	Range of standard length (mm)	Total weight (g)	Range of water temperatures (°C)
6	goldspotted killifish	39	25-41	41	24.5-25.5
	sheepshead minnow	6	22-32	4	
	sailfin molly	1	29	1	
7	goldspotted killifish	93	22-44	85	23.5-25.5
	sheepshead minnow	8	16-28	5	
8	blue crab	1	158	241	28.5-30.5
	goldspotted killifish	88	23-39	71	
	sheepshead minnow	18	21-29	11	
9	sheepshead minnow	87	22-36	69	25.5-27.0
	goldspotted killifish	39	22-41	38	
	sailfin molly	2	39-45	4	
	crested goby	1	69	11	
10	sailfin molly	43	30-60	155	21.0-25.5
	sheepshead minnow	11	32-38	25	
	goldspotted killifish	2	40-41	6	

TABLE III.C-12
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
14-15 NOVEMBER 1977

Station number	Species	Number of individuals	Range of standard length (mm)	Total weight (g)	Range of water temperatures (°C)
10 (cont.)	Gulf killifish	1	85	22	
	pike killifish	1	84	9	

TABLE III.C-13

FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
1-2 DECEMBER 1977

Station number	Species	Number of individuals	Range of standard length (mm)	Total weight (g)	Range of water temperatures (°C)
1	nothing collected	-	-	-	26.5
2	schoolmaster	1	226	342	26.0-27.0
	goldspotted killifish	33	25-38	42	
	crested goby	1	57	7	
	Gulf toadfish	1	72	10	
3	goldspotted killifish	42	22-34	38	25.5-26.0
4	goldspotted killifish	12	22-34	12	25.0-25.5
5	goldspotted killifish	15	27-41	10	26.0-26.5
	sheepshead minnow	8	25-30	8	
	sailfin molly	7	24-31	5	
6	goldspotted killifish	42	23-41	45	26.5
	sheepshead minnow	2	23-27	1	

TABLE III.C-13.
(continued)
FISH AND SHELLFISH SURVEY
TURKEY POINT COOLING CANALS
1-2 DECEMBER 1977

Station number	Species	Number of individuals	Range of standard length (mm)	Total weight (g)	Range of water temperatures (°C)
7	goldspotted killifish	57	26-37	51	26.5-27.5
	sheepshead minnow	1	22	1	
8	blue crab	1	122	172	32.0-33.0
	goldspotted killifish	33	24-30	24	
	sheepshead minnow	1	21	1	
9	nothing collected[a]	-	-	-	27.5-30.5
10	sailfin molly	19	36-51	58	29.5-32.5
	goldspotted killifish	15	40-43	47	
	sheepshead minnow	7	35-38	16	
	crested goby	3	48-52	13	

[a]Dredging in area.

TABLE III.C-14

NUMBER OF INDIVIDUALS AND RANGE OF STANDARD LENGTHS OF SHELLFISHES AND FISHES COLLECTED WITHIN THE TURKEY POINT COOLING CANAL SYSTEM DECEMBER 1974-DECEMBER 1977

		December 1974 - December 1975		January 1976 - December 1976		January 1977 - December 1977	
Scientific Name	Common name	Number of Individuals	Range of Standard Lengths (mm)	Number of Individuals	Range of Standard Lengths (mm)	Number of Individuals	Range of Standard Lengths (mm)
Limulus polyphemus	horseshoe crab	1	290	1	240	-	-
Penaeus sp.	edible shrimp	2	55-86	3	70-108	3	112-128
Panulirus argus	spiny lobster	16	200-331	5	250-320	[illegible]	112-251
Menippe mercenaria	stone crab	70	26-112	18	36-112		
Callinectes sapidus	blue crab	57	47-192	3	46-160	47	90-176
Family Elopidae-tarpons							
Elops saurus	ladyfish	4	482-495	2	509[a]	1[b]	328
Family Albulidae-bonefishes							
Albula vulpes	bonefish	9	194-415	8	219-432	11	164-454
Family Belonidae							
Strongylura marina	Atlantic needlefish	-	-	1	50		
Strongylura notata	redfin needlefish	-	-	-	-	numerous[b]	35-287
Family Ariidae-sea catfishes							
Arius felis	sea catfish	18	179-375	-	-	2	371-407
Family Batrachoididae-toadfishes							
Opsanus beta	Gulf toadfish	-	-	1	104	8	31-176
Family Cyprinodontidae-killifishes							
Cyprinodon variegatus	sheepshead minnow	358	10-44	2181	18-51	2207	16-47
Floridichthys carpio	goldspotted killifish	1949	12-47	3351	18-62	3392	19-55
Fundulus confluentus	marsh killifish	-	-	5	37-55	12	32-53
Fundulus grandis	Gulf killifish	-	-	10	45-93	13	43-86
Lucania parva	rainwater killifish	18	16-33	2	26-29	7	20-30
Family Poeciliidae-livebearers							
Belonesox belizanus	pike killifish	2	99-101	2	55-107	3	57-89
Poecilia latipinna	sailfin molly	111	19-62	341	20-74	762	22-69
Family Atherinidae-silversides							
Atherinomorus stipes	hardhead silverside	17	26-45	-	-	ca. 20[b]	ca. 60-80
Menidia beryllina	tidewater silverside	15	23-46	3	42-52	8	37-41
Family Syngnathidae-pipefishes							
Syngnathus sp.	pipefish	2	51-73	-	-	-	-
Hippocampus erectus	lined seahorse	-	-	1	80	-	-
Family Centropomidae-snooks							
Centropomus undecimalis	snook	-	-	-	-	1	294
Family Echeneidae-remoras							
Echeneis naucrates	sharksucker	-	-	1	458	-	-

TABLE III.C-14
(continued)
NUMBER OF INDIVIDUALS AND RANGE OF STANDARD LENGTHS OF SHELLFISHES AND FISHES COLLECTED WITHIN THE TURKEY POINT COOLING CANAL SYSTEM
DECEMBER 1974-DECEMBER 1977

Scientific Name	Common name	December 1974 - December 1975		January 1976 - December 1976		February 1977 - December 1977	
		Number of Individuals	Range of Standard Lengths (mm)	Number of Individuals	Range of Standard Lengths (mm)	Number of Individuals	Range of Standard Lengths (mm)
Family Carangidae-jacks							
Caranx crysos	blue runner	1	380	-	-	-	-
Caranx hippos	crevalle jack	1	370	-	-	1	452
Selene vomer	lookdown	2	268	-	-	-	-
Trachinotus falcatus	permit	-	-	1	385	-	-
Family Lutjanidae-snappers							
Lutjanus apodus	schoolmaster	9	209-240	8	174-370	10	198-264
Lutjanus griseus	gray snapper	28	164-336	16	178-444	9	201-345
Family Gerreidae-mojarras							
Diapterus plumieri	striped mojarra	3	158-427	3	140-241	1	237
Eucinostomus argenteus	spotfin mojarra	8	31-115	3	29-123	3	97-259
Eucinostomus gula	silver jenny	4	115-121	1	113	14	40-128
Gerres cinereus	yellowfin mojarra	68	105-300	55	155-256	59	150-246
Family Sciaenidae-drums							
Menticirrhus littoralis	Gulf kingfish	1	fragment	-	-	-	-
Family Ephippidae-spadefishes							
Chaetodipterus faber	Atlantic spadefish	3	140-296	3	280-359	-	-
Family Mugilidae-mullets							
Mugil cephalus	striped mullet	7	230-368	13	300-574	-	-
Family Pomadasyidae-grunts							
Haemulon parrai	sailors choice	17	197-278	11	234-295	1	321
Haemulon sciurus	bluestriped grunt	31	186-267	9	199-267	4	210-236
Family Sparidae-porgies							
Archosargus probatocephalus	sheepshead	-	-	-	-	1	367
Lagodon rhomboides	pinfish	-	-	1	131	4	61-121
Family Sphyraenidae-barracudas							
Sphyraena barracuda	great barracuda	12	365-557	3	457-522	4	434-1020
Family Eleotridae-sleepers							
Dormitator maculatus	fat sleeper	-	-	-	-	1	66
Family Gobiidae-gobies							
Gobionellus sp.	goby	2	17-19	-	-	-	-
Lophogobius cyprinoides	crested goby	15	31-61	27	25-71	53	27-81
Microgobius microlepis	banner goby	1	40	-	-	-	-
Family Tetraodontidae-puffers							
Sphoeroides testudineus	checkered puffer	1	28	-	-	-	-

[a]No length on one individual (fragment).

[b]Collected or observed during sampling additional to the normal program.

D. BENTHOS

1. MACROINVERTEBRATES

Introduction

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

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

Materials and Methods

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

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

Three replicate grab samples were taken in April and October of 1977 at each of eight sampling stations (Figure III.D.1-1). Replication is necessary for valid statistical analysis because of variation in distribution patterns of benthic fauna (EPA, 1973). Sampling at Station RC.0 was hindered by the fact that the substratum was very rocky, thus allowing the grab to shut without enclosing a sample. No reliable data could be obtained at this station.

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

The Shannon-Weaver Index of Diversity and the equitability component were also computed from the data. Diversity indices are an additional tool for measuring the quality of the environment and the effect of induced stress on the structure of a community of macroinvertebrates. Their use is based on the generally observed phenomenon that undisturbed environments support communities having relatively few species with large numbers of individuals and large numbers of species represented by only a few individuals. Many forms of stress tend to reduce diversity by making the environment unsuitable for some species or by giving other species a competitive advantage.

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

The Shannon-Weaver index of diversity ($\overline{d}$) (Lloyd, Zar, and Karr, 1968) calculates mean diversity and is recommended by the EPA (1973):

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

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

To evaluate the component of diversity due to the distribution of individuals among the species (equitability), the calculated $\overline{d}$ is compared with a hypothetical maximum $\overline{d}$ based on a model distribution frequently observed in nature, i.e., one with a few abundant species and increasing numbers of species represented by only a few individuals (MacArthur, 1957). Sample data are not expected to conform to the MacArthur model, since it is only being used as a measure against which the distribution of abundances is compared. Equitability values may range from zero to one except in rare cases where the distribution in the sample is more equitable than that in the MacArthur model.

Equitability is computed by:

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

where: s = number of taxa in the sample

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

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

Results and Discussion

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

Density of benthic macroinvertebrates was dependent on station location and ranged from 560 individuals/m^2 at Station RF.3 (October) to 5603/m^2 at Stations F.1 (April) and RC.2 (October). In 1977, the mean density of all stations combined was 3064 individuals/m^2. Mean density in October (2436/m^2) was the second lowest ever reported from the canals (Figure III.D.1-2). The lowest density occurred in November 1976 (2212/m^2). Populations were dominated by molluscs at Stations RC.2 (April) and F.1 (April and October) and by polychaete worms at the other stations. Molluscs and polychaete worms were nearly equally abundant at Station W18.2 in both sampling periods.

In April, a mean biomass of 6.776 g/m^2 was recorded, while in October mean biomass was 1.784 g/m^2. These values are the highest and lowest values respectively, ever recorded in the Turkey Point canals. Over the past three years, a pattern of biomass fluctuation has emerged in which biomass tends to increase in spring and decrease in fall (Figure III.D.1-3).

Most responsible for the wide variation in biomass was the black horn shell *Batillaria minima*. This small snail comprised 95% of the molluscs found in April and 96% of the molluscs found in October. Density of *Batillaria* in April was so great that molluscs numerically dominated the fauna in April despite the fact that they were found at only three stations (RC.2, W18.2, F.1).

In October, *Batillaria* was found only at Stations W18.2 and F.1 and was not of sufficient density to outnumber the polychaete worms. Except for April 1977, polychaetes have dominated the Turkey Point fauna in terms of number of species and individuals.

Mean diversity at the Turkey Point sampling stations in October was the lowest in three years of sampling (1.27; Figure III.D.1-4). The steady decline in mean diversity since November 1976 is a reflection of the appearance of large numbers of *Batillaria minima* and the gradual disappearance of many mollusc and crustacean species that had previously occurred in small numbers. The increase of *Batillaria* represents a major shift in community composition and may be attributable to the fact that benthic animals are known to congretate in widely spaced "patches".

A total of 28 species were collected in April 1977, one less than in November 1976. Fifteen of these species had eight individuals or less, while five species had from 11 to 23 individuals. The ostracod *Cylindroleberis* was moderately abundant (142 individuals). Combined, these 21 species comprised only 15.5% of the total macroinvertebrates collected. Therefore, the bulk of the benthic individuals (84.5%) was distributed among only seven species, which included the snail *Batillaria* and six of the nine polychaete worm species.

Distribution of the species was similar in October when only 17 species were collected, the least number ever found in the canals. Nine of these species had less than nine individuals each while three species had between 11 and 17 individuals. Again, *Cylindroleberis mariae* was moderately abundant (79 individuals). *Batillaria* and three worm species comprised 85.7% of benthic macroinvertebrates collected in October (Figure III.D.1-5).

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

While several species were present in the canal system, the numerically important species were very limited. All were burrowing, sedentary species which are detritus or filter feeders. The bottom substratum was composed of fibrous peat and mud mixed with

shell debris, a type of substratum to which the most abundant species are well adapted.

No specific ecological information on tolerances or habitat preferences for *Batillaria* is known. Polychaete worms are known to tolerate wider variances in environmental conditions than most other animals. Several studies have shown polychaetes to be among the only animals capable of surviving the effects of thermal outfalls (Markowski, 1960; Warinner and Brehmer, 1965 and 1966). Studies in southern California have reported polychaetes surviving heavily polluted areas with restricted circulation (Reish, 1956 and 1959). Bandy et al. (1965) reported that polychaetes outnumbered other groups eight to one at an ocean sewage outfall. Polychaetes thus appear best suited for life in an area of elevated temperature, restricted circulation, and highly organic substratum like the Turkey Point canal system.

Conclusions

When compared to the data collected in 1975 and 1976, the general trends exhibited by the Turkey Point benthic macroinvertebrate community during 1977 were decreased density and biomass coupled with a significant decrease in diversity. As in previous years, polychaete worms were very abundant, but the snail *Batillaria minima* displaced polychaetes as the most abundant organism in April. The benthic macroinvertebrate community has several species which

occur in small numbers, but only those burrowing, sedentary, detritus or filter-feeding species better adapted to living in the thick, fibrous peat substratum may be expected to occur in significant number. In general, the community is poorly balanced and subject to wide qualitative and biomass variation (as evidenced by the sudden appearance of many *Batillaria*).

LITERATURE CITED

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

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

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

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

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

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

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

MacArthur, R. H. 1957. On the relative abundance of bird species. Proc. Nat. Acad. Sci. Washington, D.C. 43:293-295.

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

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

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

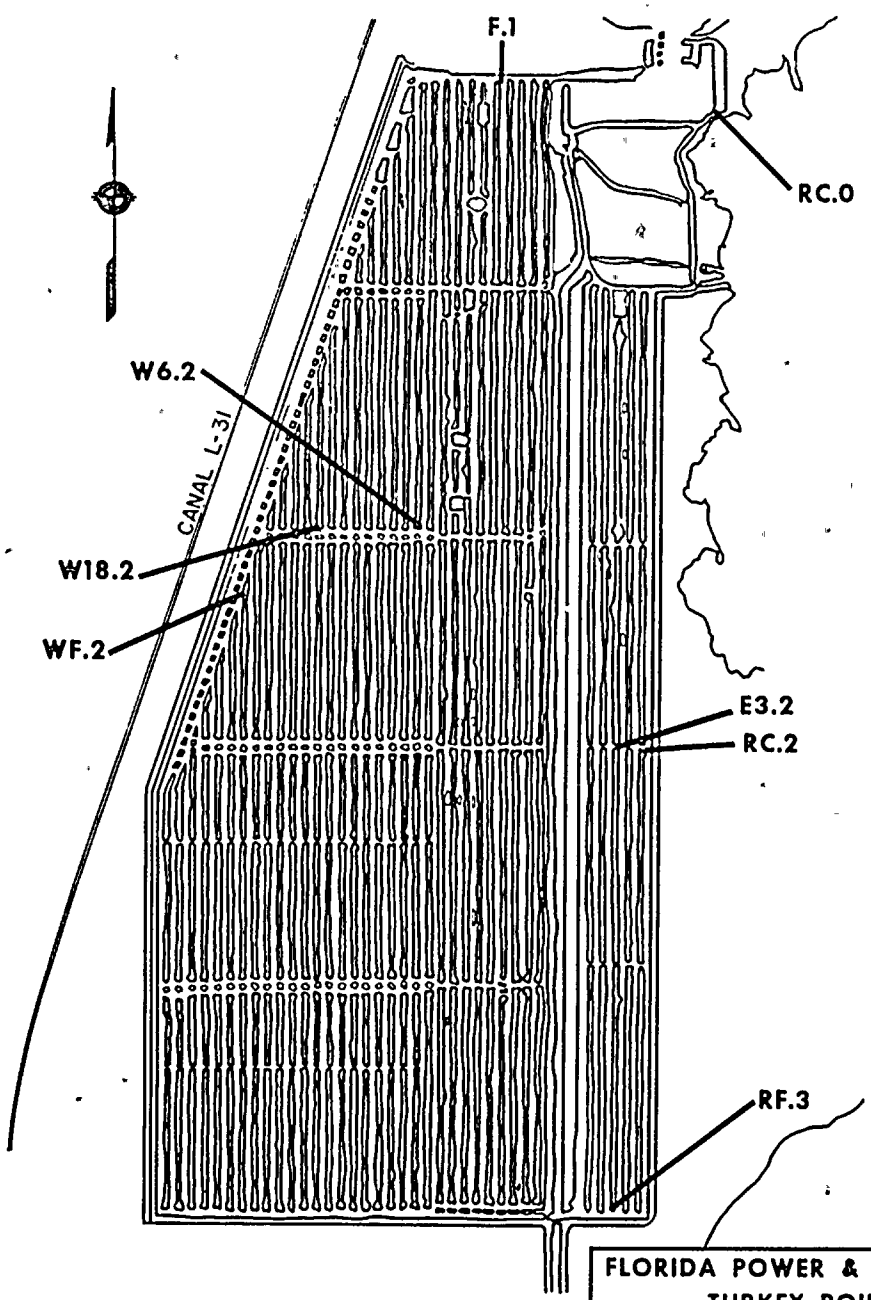
_____. 1959. An ecological study of pollution in Los Angles - Long Beach Harbors, California. Allan Hancock Occ. Paper 22. 119 pp.

LITERATURE CITED (continued)

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

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

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



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

MACROBENTHOS SAMPLING
STATION LOCATIONS

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

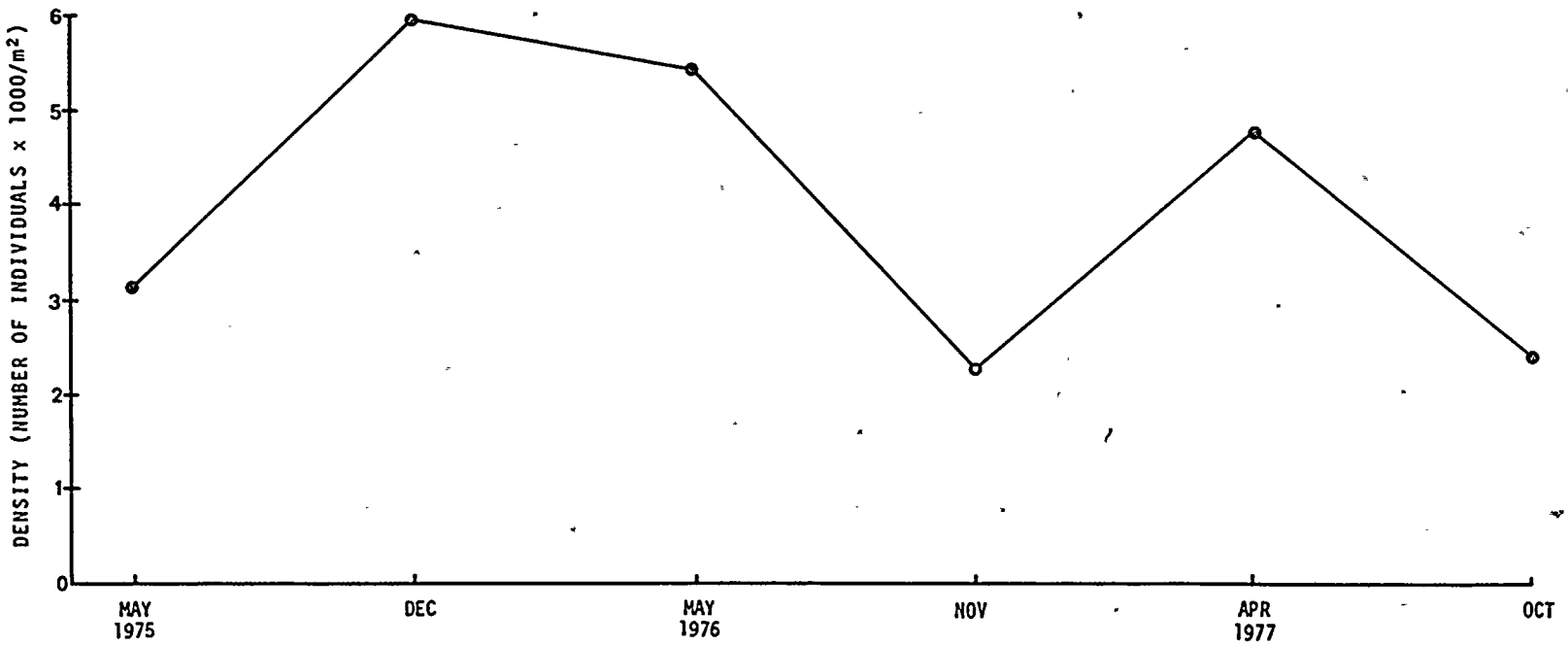


Figure III.D.1-2. Mean number of individuals per square meter, Turkey Point Plant, May 1975-October 1977.

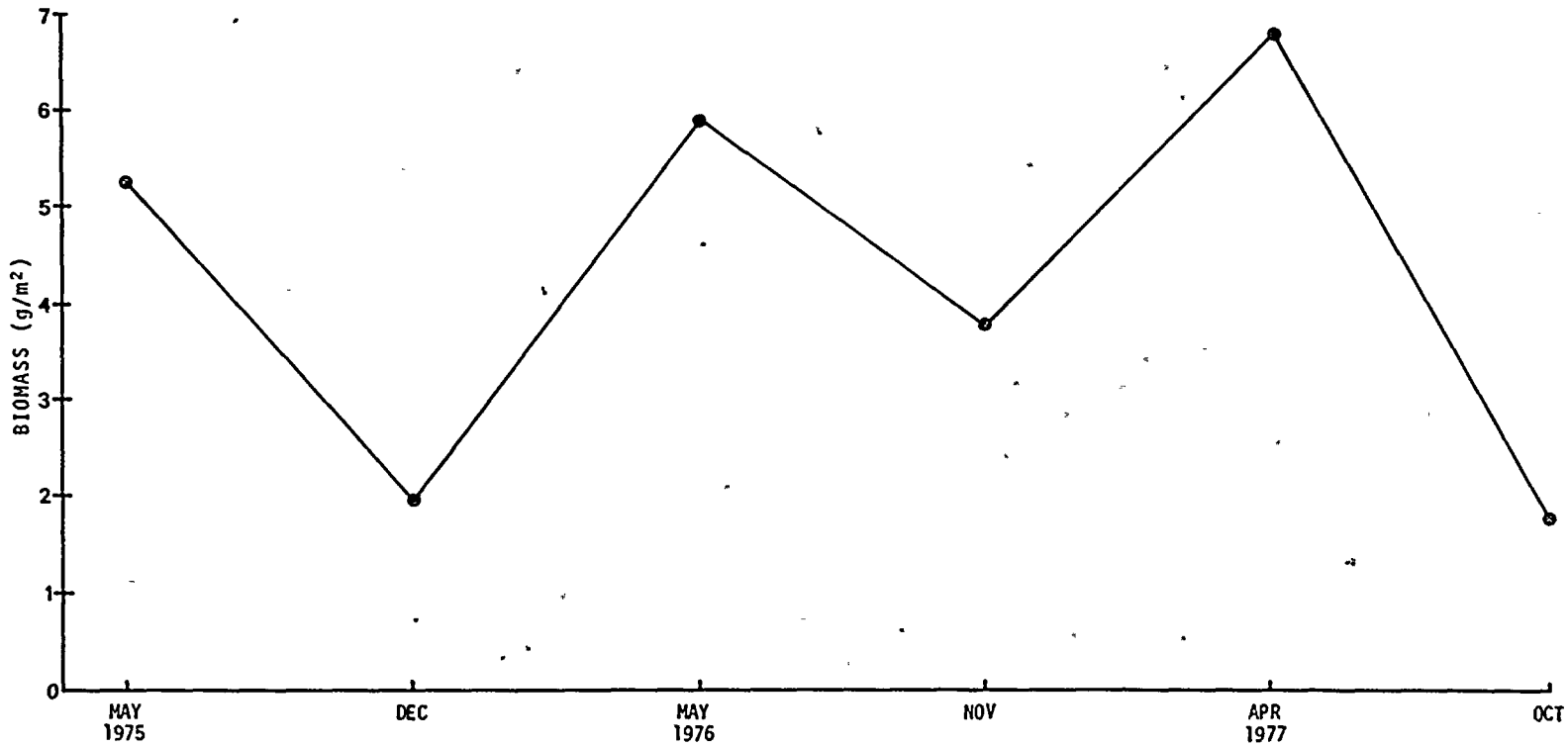


Figure III.D.1-3. Mean biomass per square meter, Turkey Point Plant, May 1975-October 1977.

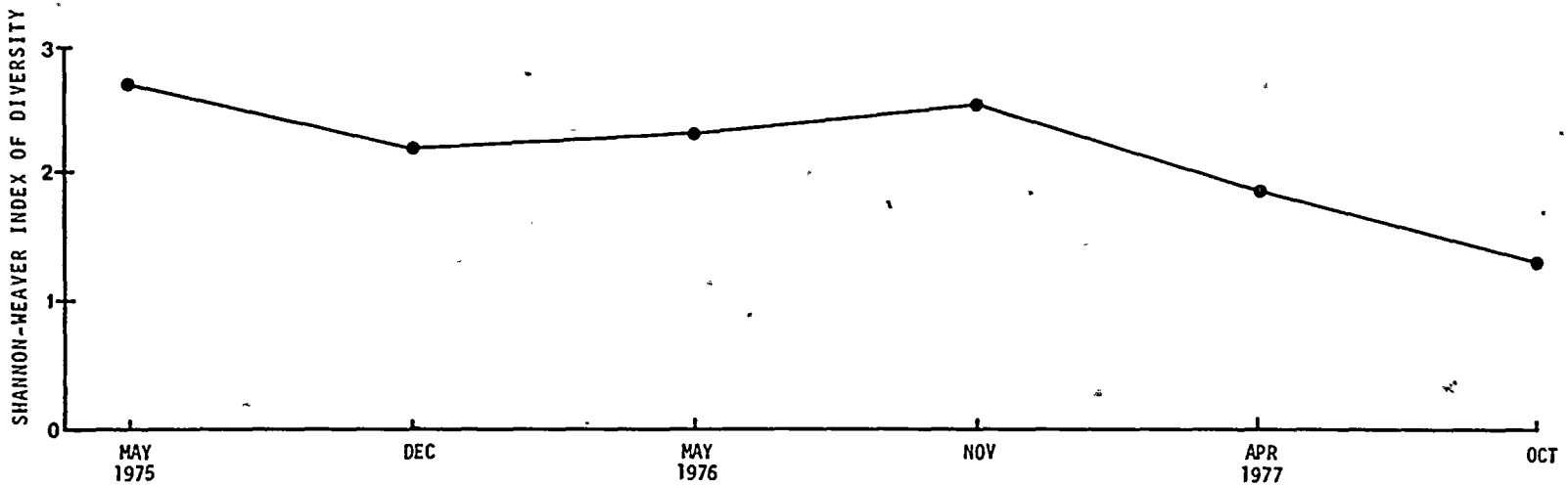


Figure III.D.1-4. Mean diversity at the Turkey Point Plant, May 1975-October 1977.

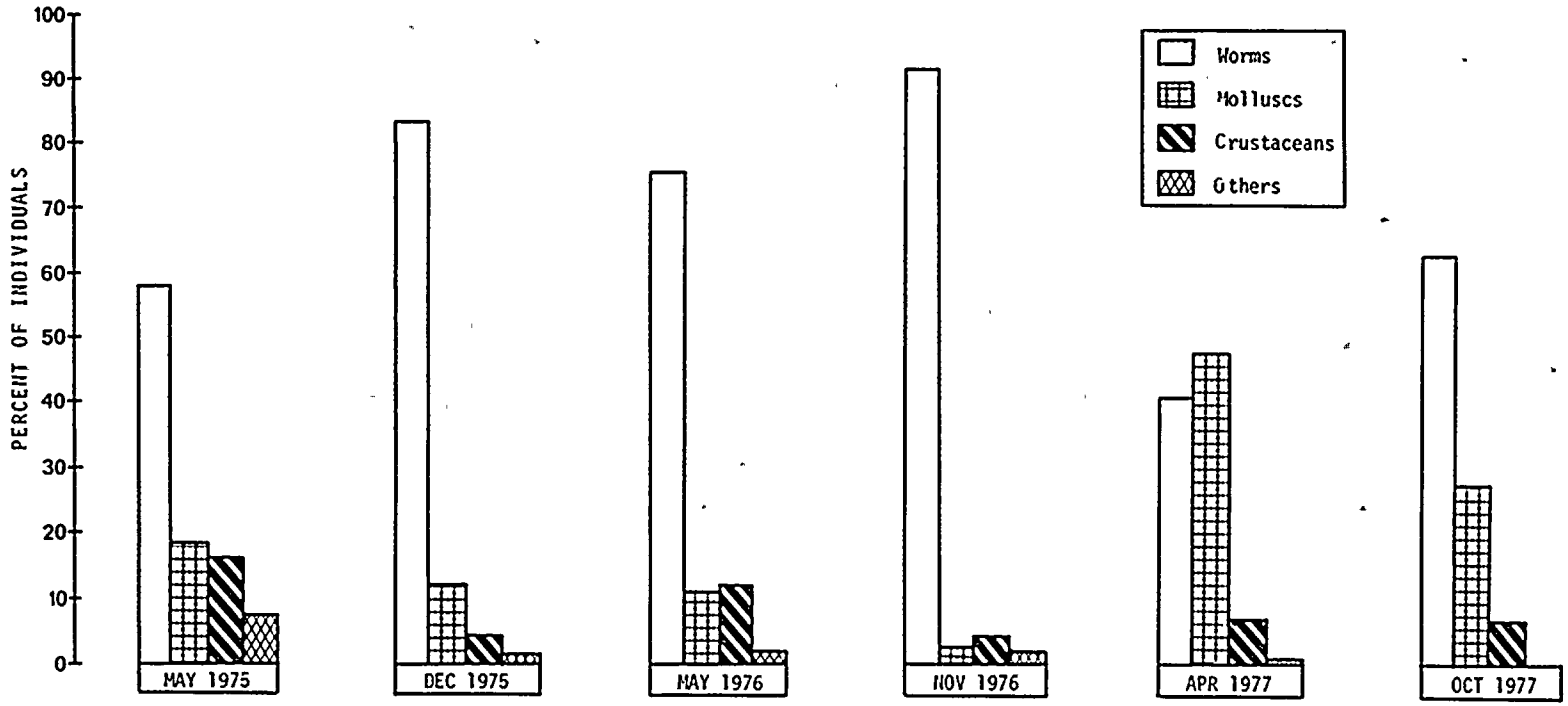


Figure III.D.1-5. Structure of benthic macroinvertebrate community at the Turkey Point Plant, May 1975-October 1977.

TABLE III.D.1-1

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION RC.2
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	November
Class Polychaeta			
worms	*Autolytus brevicirrata*	3	61
	Cirriformia filigera	-	5
	Dorvillea sociabilis	5	9
	Nereis succinea	21	3
	Pista cristata	20	4
	Platynereis dumerilii	-	6
	Sabellaria floridensis	2	6
Class Gastropoda			
snails	*Batillaria minima*	330	-
	Crepidula fornicata	5	-
Class Pelecypoda			
bivalves	*Astarte nana*	-	2
	Chione grus	-	5
	Gouldia cerina	-	5
Class Crustacea			
shrimp	*Palaemonetes* sp. larvae	-	2
Class Pycnogonida			
sea spiders	*Anoplodactylus lentus*	2	-
Class Ophiuroidea			
brittle stars	*Amphipholis squamata*	-	1
Total Individuals		388	109
Total Biomass (g)		1.319	0.448
Density (No./m^2)		5575	1566
Biomass (g/m^2)		18.951	6.437
Index of Diversity		0.94	2.43
Equitability		0.28	0.61

TABLE III.D.1-2

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION E3.2
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	October
Class Polychaeta			
worms	*Autolytus brevicirrata*	102	86
	Dorvillea sociabilis	5	-
	Marphysa sanguinea	2	-
	Nereis succinea	2	-
	Pista cristata	24	6
	Platynereis dumerilii	36	-
	Podarke obscura	49	-
Class Pelecypoda			
bivalves	*Astarte nana*	1	-
	Gouldia cerina	5	-
Class Crustacea			
ostracods	*Cylindroleberis mariae*	66	69
	Sarsiella americana	2	-
cumaceans	*Cyclaspis varians*	4	-
isopods	*Cilicaea caudata*	4	-
amphipods	*Elasmopus rapax*	7	4
	Microdeutopus gryllotalpa	11	-
mysids	*Mysidopsis bigelowi*	4	-
shrimp	*Alpheus armillatus*	6	-
	Palaemonetes sp. larvae	-	13
Total Individuals		328	178
Total Biomass (g)		0.267	0.027
Density (No./m^2)		4713	2557
Biomass (g/m^2)		3.836	0.388
Index of Diversity		2.97	1.60
Equitability		0.65	0.77

TABLE III.D.1-3

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION RF.3
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	Sum of 3 Replicates October
Class Polychaeta			
worms	*Autolytus brevicirrata*	55	-
	Glycera americana	-	3
	Pista cristata	10	-
	Platynereis dumerilii	14	-
	Podarke obscura	11	-
	Polydora ligni	21	-
Class Pelecypoda			
bivalves	*Gouldia cerina*	9	-
	Lyonsia floridana	4	-
Class Crustacea			
ostracods	*Cylindroleberis mariae*	76	10
amphipods	*Elasmopus rapax*	6	-
	Hemiaegina minuta	2	-
	Lysianopsis alba	2	-
shrimp	*Palaemonetes* sp.	2	-
Phylum Echiurida			
echiuroid worms	*Thalassema hartmani*	2	-
Class Ophiuroidea			
brittle stars	*Amphipholis squamata*	4	-
Total Individuals		224	13
Total Biomass (g)		0.086	0.002
Density (No./m^2)		3218	560
Biomass (g/m^2)		1.236	0.029
Index of Diversity		2.82	0.78
Equitability		0.71	0.98

TABLE III.D.1-4

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION WF.2
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	Sum of 3 Replicates October
Class Polychaeta			
worms	*Autolytus brevicirrata*	-	69
	Nereis succinea	17	3
	Platynereis dumerilii	11	-
	Polydora ligni	55	-
Phylum Echiurida			
echiuroid worms	*Thalassema hartmani*	6	-
Total Individuals		89	72
Total Biomass (g)		0.010	0.005
Density (No./m^2)		1279	1034
Biomass (g/m^2)		0.144	0.072
Index of Diversity		1.52	0.25
Equitability		0.91	0.65

TABLE III.D.1-5

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION W18.2
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	Sum of 3 Replicates October
Class Polychaeta			
worms	*Autolytus brevicirrata*	68	16
	Nereis succinea	-	98
	Pista cristata	8	-
	Platynereis dumerilii	21	65
	Podarke obscura	-	6
	Polydora ligni	46	-
Class Gastropoda			
snails	*Batillaria minima*	102	154
Class Pelecypoda			
bivalves	*Lyonsia floridana*	9	-
Class Crustacea			
amphipods	*Elasmopus rapax*	10	-
Total Individuals		264	339
Total Biomass (g)		0.361	0.150
Density (No./m^2)		3793	4871
Biomass (g/m^2)		5.187	2.155
Index of Diversity		2.26	1.80
Equitability		0.92	0.90

TABLE III.D.1-6

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION W6.2
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	Sum of 3 Replicates October
Class Polychaeta			
worms	*Autolytus brevicirrata*	46	31
	Glycera americana	-	12
	Marphysa sanguinea	2	-
	Nereis succinea	6	138
	Pista cristata	7	-
	Platynereis dumerilii	5	93
	Polydora ligni	37	-
	Sabellaria floridensis	4	-
Class Pelecypoda			
bivalves	*Lyonsia floridana*	3	-
Class Crustacea			
shrimp	*Alpheus armillatus*	2	-
Phylum Echiurida			
echiuroid worms	*Thalassema hartmani*	4	-
Total Individuals		116	274
Total Biomass (g)		0.034	0.094
Density (No./m^2)		1667	3937
Biomass (g/m^2)		0.489	1.351
Index of Diversity		2.39	1.58
Equitability		0.81	0.95

TABLE III.D.1-7

RESULTS OF BENTHIC MACROINVERTEBRATE SAMPLING
STATION F.1
TURKEY POINT PLANT
1977

Species		Sum of 3 Replicates April	Sum of 3 Replicates October
Class Polychaeta			
worms	*Autolytus brevicirrata*	-	4
	Glycera americana	-	2
	Podarke obscura	-	5
Class Gastropoda			
snails	*Batillaria minima*	384	165
Class Crustacea			
mysids	*Mysidopsis bigelowi*	2	-
Phylum Echiurida			
echiuroid worms	*Thalassema hartmani*	4	-
Total Individuals		390	176
Total Biomass (g)		1.224	0.143
Density (No./m^2)		5603	2529
Biomass (g/m^2)		17.586	2.055
Index of Diversity		0.13	0.43
Equitability		0.39	0.38

TABLE III. D.1-8

SALINITY, TEMPERATURE, AND DISSOLVED OXYGEN CONCENTRATION RECORDED
DURING BENTHIC MACROINVERTEBRATE SAMPLING
TURKEY POINT PLANT
1977

	Station RC.0			Station RC.2			Station E3.2			Station RF.3		
Month	°/oo	°C	D.O.(ppm)	°/oo	°C	D.O.(ppm)	°/oo	°C	D.O.(ppm)	°/oo	°C	D.O.(ppm)
January	37.2	17.1	9.7	36.6	15.6	10.0	37.2	11.1	11.1	36.6	14.5	10.3
February	37.7	19.1	9.3	37.7	18.6	9.4	37.2	13.7	10.5	37.2	17.0	9.7
March	37.7	29.5	7.7	38.2	29.0	7.8	38.2	27.1	8.1	38.2	26.9	8.1
April	42.5	26.3	8.2	42.5	25.8	8.3	42.5	23.9	8.5	42.0	24.4	8.5
May	35.0	26.2	8.2	35.0	26.1	8.2	35.0	24.4	8.5	35.0	27.9	7.9
June	37.2	33.1	7.3	37.2	33.9	7.2	37.2	31.8	7.4	37.2	30.4	7.6
July	39.9	30.1	7.7	37.2	31.0	7.5	37.7	30.0	7.7	39.9	29.9	7.7
August	40.4	30.2	7.7	40.4	30.2	7.6	40.4	29.1	7.8	40.9	30.0	7.7
September	37.2	32.0	7.4	37.2	32.3	7.4	37.2	31.1	7.5	37.2	31.9	7.4
October	41.5	27.8	8.0	41.5	28.7	7.8	42.0	25.0	8.4	41.5	26.9	8.1
November	39.5	22.4	8.8	38.7	23.4	8.6	39.1	20.6	9.1	39.5	22.8	8.7
December	36.3	26.3	8.2	36.1	25.8	8.2	36.0	25.6	8.3	36.3	25.1	8.4

TABLE III. D.1-8
(continued)
SALINITY, TEMPERATURE, AND DISSOLVED OXYGEN CONCENTRATION RECORDED
DURING BENTHIC MACROINVERTEBRATE SAMPLING
TURKEY POINT PLANT
1977

Month	Station WF.2			Station W18.2			Station W6.2			Station F.1		
	°/oo	°C	D.O.(ppm)	°/oo	°C	D.O.(ppm)	°/oo	°C	D.O.(ppm)	°/oo	°C	D.O.(ppm)
January	36.6	19.2	9.3	36.6	19.1	9.3	36.6	18.5	9.4	36.1	23.4	8.6
February	37.2	20.4	9.1	37.7	20.1	9.1	37.7	19.9	9.2	37.2	30.1	7.7
March	38.2	33.5	7.2	38.2	33.9	7.2	38.2	32.3	7.4	37.7	37.4	6.8
April	42.5	24.6	8.4	42.0	24.2	8.5	42.5	24.1	8.5	42.5	29.0	7.8
May	35.0	29.0	7.8	35.0	28.9	7.8	35.0	28.7	8.0	35.0	33.0	7.3
June	36.6	31.2	7.5	36.1	33.0	7.3	37.2	33.1	7.3	36.6	39.9	6.5
July	37.7	30.9	7.5	37.7	32.0	7.4	37.2	31.2	7.5	39.9	35.2	7.1
August	40.9	30.8	7.6	40.9	32.2	7.4	40.9	31.2	7.5	40.9	36.9	6.8
September	37.2	33.2	7.3	37.2	34.2	7.1	37.2	33.6	7.2	37.2	39.8	6.5
October	42.0	28.3	7.9	41.5	28.0	7.9	41.5	28.1	7.9	41.5	34.4	7.0
November	39.4	24.4	8.5	39.5	24.7	8.4	39.5	23.4	8.6	39.2	28.7	7.8
December	36.0	26.0	8.2	35.6	26.4	8.1	35.9	26.3	8.2	35.0	32.1	7.4

2. MICROBIOLOGY

Introduction

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

This study had three primary objectives. The first was to estimate the total number of heterotrophic bacteria present in the sediments of the canal system. Secondly, a representative sample of the bacterial isolates was characterized and grouped taxonomically to determine the diversity of the bacterial population present. The third objective involved testing isolates for their ability to utilize various substrates. These substrates included representative members from the three major classes of organic macromolecules (protein, carbohydrate, lipid) which are probably present in the canal system due to the death and lysis of larger organisms. Other smaller organic substrates as well as inorganic molecules involved in the nitrogen cycle were also tested for substrate utilization.

Materials and Methods

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

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

Estimation of the number of sulfate-reducing bacteria -- A known weight of each sediment sample was placed in a dilution bottle containing 99 ml of 3% NaCl and shaken. A 1.0-ml aliquot was withdrawn and added to 9.0 ml of API sulfate-reducing agar which was kept in a liquid state at 45°C. Appropriate serial dilutions were then made with liquid API sulfate-reducing agar. After rapid solidification of the agar, the

tubes were incubated at 25°C for 2 weeks and checked at intervals for the formation of black colonies which indicate sulfate-reducing bacteria. The results are reported as the number of sulfate-reducing bacteria per gram of wet weight sediment.

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

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

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

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

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

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

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

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

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

Standard analytical methods (Table III.D.2-2) were used to perform the preceding chemical analyses. Prior to May 1977 analysis of the chemical parameters sulfate, sulfite, and sulfide was performed by Dunn Laboratories. After April all chemical analyses were performed by Applied Biology, Inc.

The pH of sediment samples diluted 1:3 with distilled water was measured with a standard Corning pH meter (Model 10). Samples

for salinity determinations were transported to the laboratory and measured with a refractometer. Values of conductivity for each station were measured with a YSI Model 33 salinity-conductivity-temperature meter as well as calculated from salinity and temperature measurements according to tables published in *Marine Chemistry* (Horne, 1969).

Results and Discussion

Table III.D.2-3 shows the distribution of heterotrophic bacteria per gram of wet weight soil at the 11 sampling stations as estimated by the MPN analysis using TSB/YE/SW as a growth medium. Mean values are given for the three stations in the bay as well as for the eight stations within the canal system on a monthly and 12-month basis. The 12-month average bacterial count for the canal stations was approximately threefold greater than the mean value for Biscayne Bay. Table III.D.2-4 shows a similar distribution of heterotrophic bacteria when estimated by the MPN method using distilled water instead of artificial seawater to prepare the growth medium (TSB/YE/DW). A comparison of the 12-month averages between bay and canal stations indicates that differences in the number of heterotrophic bacteria between the two locations are similar with either medium. Figure III.D.2-2 graphically illustrates these relationships. With growth media prepared with either artificial seawater or distilled water, bacterial counts are higher in the canal sediments than in the Biscayne Bay sediments. Bacterial counts are also significantly higher when estimated using artificial seawater rather than distilled water in the growth medium.

This indicates that marine bacteria are the predominate type of organism present in both the canal and Biscayne Bay sediments.

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

Table III.D.2-5 shows the distribution of sulfate-reducing bacteria per gram of wet weight soil at the 11 sampling stations. No significant difference was observed in numbers of sulfate-reducing bacteria between the overall average of the canal stations and the average for the Biscayne Bay stations.

The bacterial isolates selected for taxonomic identification were characterized according to the procedures listed in the Materials and Methods section. Table III.D.2-6 shows a distribution of the isolates divided into four groups. Organisms which were found to be gram negative rods were grouped according to a scheme put forth by Shewan (1963). Group I, which contains species of *Pseudomonas*, *Aeromonas*, *Vibrio*, and *Xanthomonas*, are characterized as oxidase positive, gram negative motile rods. Group II are gram negative, non-motile rods that are non-pigmented; these are either *Achromobacter* or *Alcaligenes*. Group III contain *Flavobacter* and *Cytophaga* which are gram negative, non-motile rods that are pigmented, and Group IV are gram positive rods.

Group I, which contains the mobile gram negative rods, and Group IV, which contains the gram positive rods, are the predominate groups in both the canal and Biscayne Bay sediments. Based on the preceding taxonomic groupings, the distribution of bacterial types in the canal sediments is very similar to that in the Biscayne Bay sediments.

The substrate utilization tests indicated that the bacterial isolates were capable of degrading a wide range of organic substrates. The monthly and 12-month average percentages of bacterial isolates from the canal and Biscayne Bay stations capable of utilizing the substrates tested are presented in Tables III.D.2-7 through III.D.2-11.

Table III.D.2-7 lists the monthly percentage of bacterial isolates capable of hydrolyzing casein, a common milk protein. Proteins are hydrolyzed to polypeptides and then further degraded to amino acids, which then can be deaminated to produce ammonia and various organic acids. The organic acids can be used as substrates for other bacteria as either building blocks for growth or as energy sources in oxidation or fermentation reactions. The ammonia can enter the nitrogen cycle and be oxidized to produce nitrites and nitrates by the nifrifying bacteria *Nitrobacter* and *Nitrosomonas*. These two genera are strict aerobes and chemoautotrophic, so they cannot be isolated on the heterotrophic media used in this study. The results of the test which measured the ammonification of peptone (Table III.D.2-7) indicated that approximately 40% of the bacterial isolates were capable of producing ammonia from peptone and hence could start the process by which protein nitrogen becomes mineralized to nitrates.

Carbohydrates are a complex group of compounds which include such diverse macromolecules as cellulose, starch, and chitin. Table III.D.2-8 lists the percentages of bacterial isolates capable of hydrolyzing chitin, which is a polymer of N-acetyl-glucosamine. The breakdown of chitin also shunts ammonia into the nitrogen cycle and provides simple sugars as substrates for a number of reaction possibilities. Starch, which is a macromolecule used almost universally as an energy storage product, was degraded by 58.0% of the canal isolates and 60.2% of the bay isolates (Table III.D.2-8).

Cellobiose is the repeating disaccharide unit of cellulose. Like cellulose it contains the B(1-4) glycosidic linkage which makes cellulose resistant to digestion by most organisms. Table III.D.2-8 lists the percentages of canal and bay isolates capable of fermenting cellobiose.

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

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

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

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

The results of the chemical analyses of the Turkey Point canal system from January 1977 through December 1977 are given in Tables III.D.2-12 through III.D.2-19.

The pH's of the canal and Biscayne Bay sediments for 1977 appear in Table III.D.2-20. As expected, they are in the narrow range usually encountered in the strongly buffered seawater environment.

The results of salinity and temperature measurements are given in Tables III.D.2-21 and III.D.2-22, respectively. The values for salinity are higher in the canal system than in the bay with significant seasonal variations probably due to rainfall conditions. Conductivity values are presented in Table III.D.2-23. Because conductivity is a function of both ionic concentration and temperature, the highest conductivity values are found at the warmest stations in the canal system.

Conclusions

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

There was no increase in either the numbers of sulfate-reducing bacteria or concentration of sulfide in the canal system as compared to the Biscayne Bay control stations. An increase in sulfate-reducing bacteria and subsequent hydrogen sulfide production could be damaging to other biological processes, but no evidence of such increases was found.

During the January through December 1977 time period, concentrated sulfuric acid and concentrated sodium hydroxide were added to Lake Warren at a rate approaching 100,000 pounds per month. Hydrated lime was also added at an average rate of 25,000 pounds per month. Although these chemicals are either very alkaline or acidic in pH, when added in a balanced fashion, as described above, the overall pH of Lake Warren was not affected; it remained in the normal range expected of seawater. This is documented both by pH data on the water column taken daily in Lake Warren and the sediment pH data collected monthly by Applied Biology at eight stations within the cooling canal system. The pH in both instances remained very close to 8.0, which is considered normal for seawater.

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

A similar calculation was made concerning the effect of all

discharged chemicals on the salinity of the canal water. Again, the effect was found to be very small.

Chemical analyses performed by Applied Biology, Inc., from January through December 1977 indicated that the soluble sulfate ion concentration and the salinity of the cooling canal system were approximately 24% higher than adjacent Biscayne Bay sampling stations. This large differential is due in part to freshwater runoff into Biscayne Bay which reduces salinity and sulfate concentrations to values below those of normal seawater. The average yearly salinity of the eight sampling stations inside the Turkey Point canal system was 38.3, which is only about 10% higher than normal seawater salinities of approximately 35.0. This 10% increase is probably attributable to evaporation processes occurring in a closed water system that serves to concentrate ions already present in the source water.

LITERATURE CITED

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

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

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

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

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

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

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

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

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

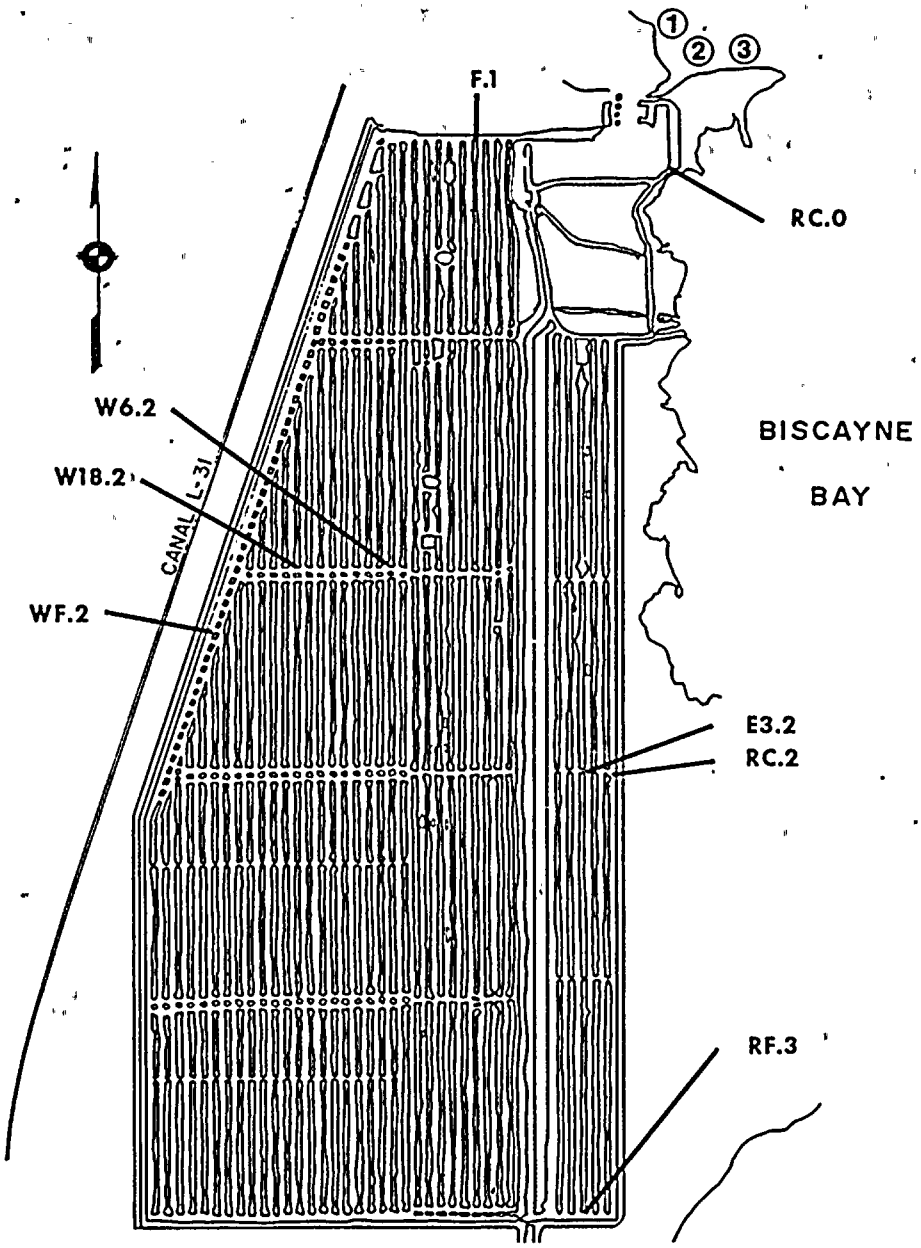
Strickland, J. D., and T. R. Parsons. 1972. A practical handbook of seawater analysis. Fish Res. Bd. Canad. Ottawa, Bulletin No. 167. 310 pp.

ADDITIONAL SOURCES

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

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

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



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

MICROBIOLOGY
SAMPLING STATIONS

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

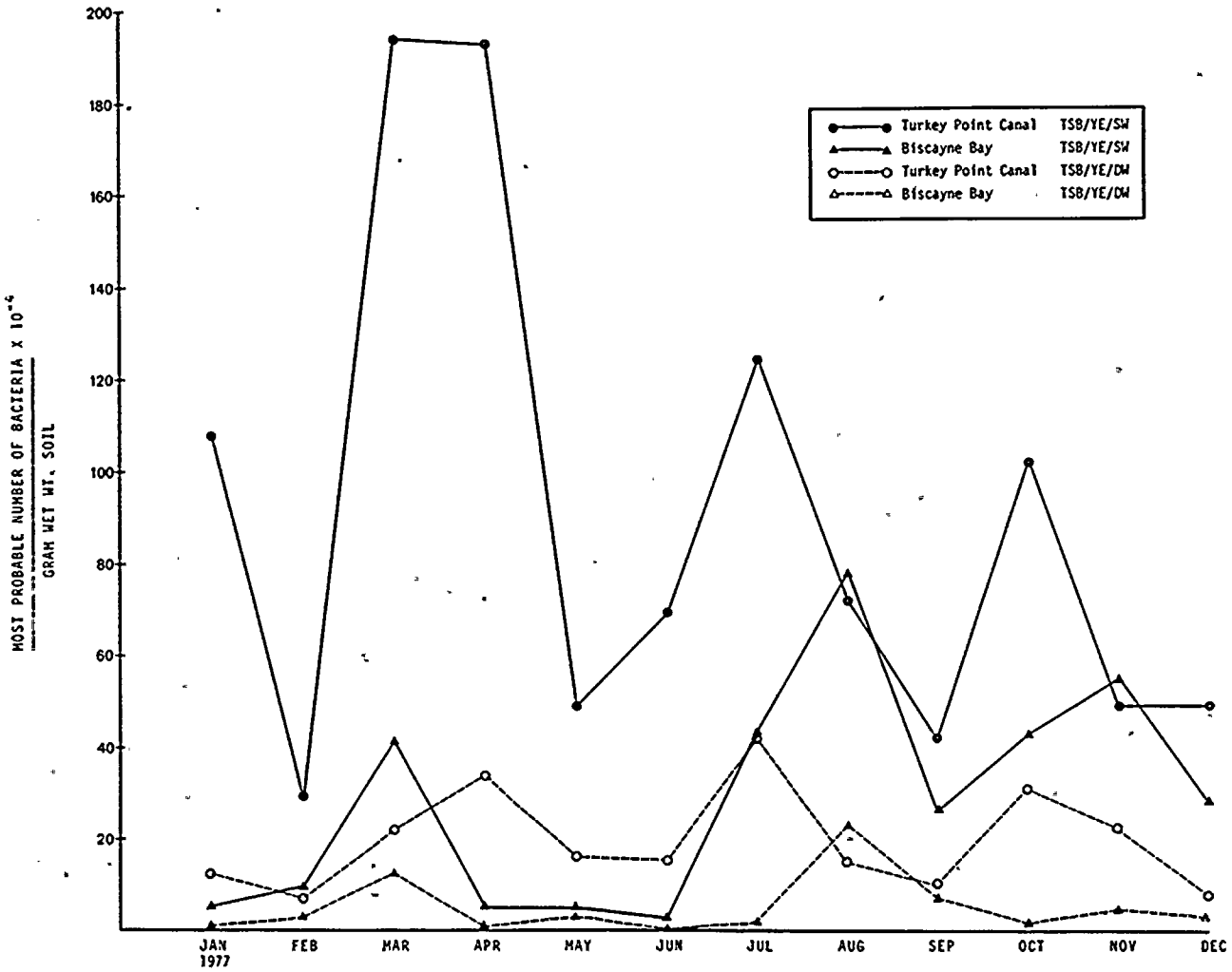


Figure III.D.2-2. Comparison of 1977 bacterial counts between Turkey Point canal and Biscayne Bay sediments with two types of media.

TABLE III.D.2-1

TESTS FOR DETERMINATION OF SUBSTRATE UTILIZATION
TURKEY POINT PLANT

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

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

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

TABLE III.D.2-2

METHODS FOR CHEMICAL ANALYSIS OF SOIL AND WATER
TURKEY POINT PLANT

Parameter	Method	Reference
Ammonia-nitrogen	spectrophotometric (phenol-hypochlorite)	Strickland and Parsons, 1972, p. 87
Nitrate-nitrogen	(1) spectrophotometric (Brucine) (2) cadmium reduction[a]	APHA, 1976, p. 427 APHA, 1976, p. 423
Nitrite-nitrogen	spectrophotometric (diazotization)	APHA, 1976, p. 434
Orthophosphate	spectrophotometric (ascorbic acid)	APHA, 1976, p. 481
Sulfate	tubidimetric (barium sulfate)	APHA, 1976, p. 493
Sulfite	titrimetric (iodide-iodate)	APHA, 1976, p. 509
sulfide	spectrophotometric (p-phenylenediamine)	Strickland and Parsons, 1972, p. 41

[a] This method used after March 1977.

TABLE III.D.2-3

MOST PROBABLE NUMBER OF BACTERIA ($x10^{-4}$) PER GRAM OF WET WEIGHT SOIL
GROWTH MEDIUM-TSB/YE/SW
TURKEY POINT PLANT
JANUARY-DECEMBER
1977

	Station location and number												
	Biscayne Bay				Turkey Point Canal System								
Month	1	2	3	Mean	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0	Mean
JAN	7.05	6.82	2.27	5.38	436	224	80.0	3.19	8.11	17.9	85.1	8.11	107.8
FEB	6.94	7.96	12.5	9.13	29.4	8.96	4.34	21.4	8.60	37.5	97.8	31.9	30.0
MAR	37.5	14.3	73.0	41.6	212	76.7	7.68	203	461	444	82.1	85.2	196.4
APR	3.65	6.62	3.48	4.58	90.2	16.9	18.2	18.2	220	470	522	211	195.8
MAY	4.04	2.34	7.17	4.52	220	41.2	4.70	30.0	37.5	24.5	16.6	18.6	49.1
JUN	3.04	0.579	3.54	2.38	17.2	43.6	8.60	46.2	88.5	83.6	47.1	220	69.4
JUL	5.65	61.3	64.8	43.9	40.0	39.3	254	172	75.4	16.0	23.8	375	124
AUG	153	68.7	14.1	78.6	25.0	115	70.7	196	79.3	7.05	70.8	7.17	71.4
SEP	60.5	6.42	12.4	26.4	76.7	41.3	93.9	73.0	8.78	6.94	16.3	16.3	41.7
OCT	32.9	32.9	65.7	43.8	76.6	79.3	37.5	38.1	76.7	74.2	429	4.11	102
NOV	69.7	64.8	30.4	55.0	78.0	79.3	40.0	41.3	41.4	42.1	40.7	26.3	48.8
DEC	63.8	14.3	5.89	28.0	186	36.2	3.77	42.1	38.1	15.2	36.9	33.3	48.9
12-month Average	37.3	23.9	24.6	28.6	124	66.8	60.0	73.7	95.1	103	122.5	86.4	90.4

TABLE III.D.2-4

MOST PROBABLE NUMBER OF BACTERIA ($x10^{-4}$) PER GRAM OF WET WEIGHT SOIL
GROWTH MEDIUM-TSB/YE/DW
TURKEY POINT PLANT
JANUARY- DECEMBER
1977

	Station location and number												
	Biscayne Bay				Turkey Point Canal System								
Month	1	2	3	Mean	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0	Mean
JAN	1.47	2.22	1.36	1.68	43.6	18.9	48.0	3.19	17.5	1.73	1.66	8.11	12.3
FEB	3.71	1.67	2.33	2.57	4.51	4.79	8.11	16.6	1.80	4.11	4.89	8.29	6.63
MAR	14.5	14.4	14.8	14.6	4.40	40.0	7.70	85.1	17.9	2.70	4.10	17.2	22.4
APR	0.476	0.462	0.454	0.464	14.7	1.64	4.50	18.2	15.0	2.94	239	4.42	33.7
MAY	4.04	2.34	3.54	3.31	17.9	8.43	4.69	18.6	5.75	1.84	4.11	3.00	8.04
JUN	0.434	0.434	0.461	0.443	4.26	7.82	18.6	18.6	17.9	1.64	4.51	44.4	14.7
JUL	0.579	0.533	6.06	2.39	7.17	24.5	186	71.9	3.77	1.55	3.65	37.5	42.0
AUG	63.9	2.24	3.48	23.2	15.5	36.9	6.62	42.9	7.41	2.46	3.23	3.50	14.8
SEP	12.2	1.34	5.73	6.42	7.17	7.68	8.78	38.1	1.84	6.94	7.54	6.84	10.6
OCT	1.23	2.05	0.571	1.28	3.83	1.55	14.5	175	40.0	3.71	7.68	4.11	31.3
NOV	3.48	3.23	6.23	4.31	7.28	16.0	40.0	79.3	16.0	7.54	7.28	7.54	22.6
DEC	3.19	6.62	0.548	3.45	0.678	7.41	7.05	16.3	3.65	3.77	14.3	1.04	7.94
12-month average	9.10	3.13	3.80	5.34	10.9	14.6	29.6	48.6	6.06	3.41	25.1	12.1	19.7

TABLE III.D.2-5

NUMBER OF SULFATE-REDUCING BACTERIA PER GRAM
OF WET WEIGHT SOIL
TURKEY POINT PLANT
JANUARY- DECEMBER
1977

	Station location and number												
	Biscayne Bay				Turkey Point Canal System								
Month	1	2	3	Mean	F.1	W6.2	W18.2	WF.2	RF.3	E3.2	RC.2	RC.0	Mean
JAN	180	952	758	630	909	1020	200	<23	113	961	93	943	532
FEB	806	93	83	327	196	105	94	<18	1000	8928	1064	1064	1558
MAR	781	77	95	317	962	83	89	<19	961	2777	892	926	838
APR	793	77	758	543	980	91	98	98	100	980	1087	9615	1631
MAY	88	781	77	315	961	980	98	100	125	1020	902	1000	648
JUN	725	7246	769	2913	130	91	961	96	961	9090	9800	926	2756
JULY	7246	67	70	2461	83	82	847	78	82	86	79	781	265
AUG	694	7463	76	2744	<17	77	77	89	862	82	769	833	350
SEP	66	746	67	293	83	86	102	79	102	806	175	88	190
OCT	685	685	714	695	8333	86	78	7936	833	161	893	89	2301
NOV	76	70	72	73	85	86	83	86	172	877	85	88	195
DEC	69	69	685	274	85	862	82	88	79	820	769	69	357
12-month Average	736	1526	421	965	1068	304	234	726	449	2212	1383	1868	969

TABLE III.D.2-6

TAXONOMIC GROUPING OF BACTERIAL ISOLATES
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Percentage Distribution By Month											
	Jan		Feb		Mar		Apr		May		June	
	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay
Group I pseudomonas aeromonas vibrio xanthomonas	45.8	33.0	54.2	22.2	62.5	77.8	33.3	22.2	54.2	22.2	33.3	11.1
Group II achromobacter alcaligenes	0	0	4.2	0	4.2	0	4.2	0	4.2	11.1	0	0
Group III flavobacter cytophaga	0	0	4.1	44.5	0	0	16.6	44.5	4.2	22.2	16.7	44.5
Group IV gram positive rods	54.2	66.7	37.5	33.3	33.3	22.2	45.8	33.3	41.7	44.4	50.0	44.4

TABLE III.D.2-6
(continued)
TAXONOMIC GROUPING OF BACTERIAL ISOLATES
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Percentage Distribution By Month												12-month average	
	JUL		AUG		SEP		OCT		NOV		DEC			
	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal	Bay
Group I pseudomonas aeromonas vibrio xanthomonas	16.6	77.8	25.0	33.0	0	22.2	16.7	22.2	12.5	0	4.2	0	29.8	28.6
Group II achromobacter alcaligenes	20.8	11.1	8.3	0	8.3	0	12.5	11.1	0	0	4.2	0	5.6	2.8
Group III flavobacter cytophaga	0	0	0	0	0	0	0	22.2	0	0	0	0	3.5	14.9
Group IV gram positive rods	62.6	11.1	66.7	66.7	91.7	77.8	70.8	44.4	87.5	100	91.6	100	61.1	53.7

TABLE III.D.2-7

PROTEIN UTILIZATION
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Ammonification of peptone		Hydrolysis of casein	
	Bay	Canal	Bay	Canal
JAN	33.3	50.0	55.6	62.5
FEB	44.4	37.5	66.7	50.0
MAR	55.6	45.8	66.7	54.2
APR	11.1	37.5	22.2	50.0
MAY	44.4	54.2	44.4	66.7
JUN	11.1	29.2	22.2	50.0
JUL	77.8	41.7	77.8	41.7
AUG	77.8	66.7	77.8	66.7
SEP	44.4	58.3	77.8	66.7
OCT	66.7	50.0	66.7	66.7
NOV	11.1	25.0	100	87.5
DEC	11.1	16.7	77.8	91.7
12-month average	40.7	42.7	63.0	62.9

TABLE III.D.2-8

CARBOHYDRATE UTILIZATION
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Starch hydrolysis		Chitin hydrolysis		Cellobiose fermentation	
	Bay	Canal	Bay	Canal	Bay	Canal
JAN	55.6	70.8	22.2	37.5	22.2	25.0
FEB	66.7	66.7	33.3	25.0	22.2	29.2
MAR	66.7	70.8	55.6	41.7	44.4	29.2
APR	22.2	29.2	22.2	25.0	11.1	20.8
MAY	55.6	50.0	33.3	33.3	55.6	33.3
JUN	44.4	37.5	0.0	29.2	33.3	33.3
JUL	66.7	45.8	66.7	29.2	77.8	16.7
AUG	100	70.8	22.2	16.7	77.8	29.2
SEP	44.4	79.2	11.1	0.0	0.0	12.5
OCT	55.6	41.7	11.1	8.4	55.6	20.8
NOV	66.7	62.5	0.0	12.5	11.1	8.3
DEC	77.8	70.8	0.0	4.3	44.4	12.5
12-month average	60.2	58.0	23.2	22.0	38.0	22.6

TABLE III.D.2-9

CARBOHYDRATE FERMENTATION
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Glucose		Saccharose		Mannitol		Lactose	
Month	Bay	Canal	Bay	Canal	Bay	Canal	Bay	Canal
JAN	77.8	87.5	66.7	79.2	77.8	66.7	0.0	0.0
FEB	66.7	66.7	66.7	58.3	33.3	41.7	22.2	4.2
MAR	88.9	75.0	88.9	58.3	77.8	50.0	0.0	4.2
APR	55.6	58.3	55.6	41.7	55.6	33.3	22.2	4.2
MAY	55.6	54.2	55.6	50.0	44.4	33.3	0.0	20.8
JUN	44.4	41.7	33.3	25.0	44.4	29.2	0.0	0.0
JUL	100	45.8	77.8	25.0	88.9	8.3	0.0	0.0
AUG	100	83.3	88.9	45.8	88.9	54.2	11.1	0.0
SEP	77.8	91.7	55.6	75.0	55.6	58.3	0.0	4.2
OCT	55.6	66.7	55.6	45.8	55.6	41.7	11.1	0.0
NOV	88.9	58.3	88.9	37.5	88.9	20.8	11.1	0.0
DEC	100	86.8	100	54.1	100	66.7	0.0	4.2
12-month average	75.9	68.0	69.5	50.0	67.6	42.0	5.6	3.5

TABLE III.D.2-10

LIPID UTILIZATION
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Lipid Hydrolysis	
	Bay	Canal
JAN	33.3	41.7
FEB	55.6	29.2
MAR	77.8	50.0
APR	22.2	25.0
MAY	66.6	37.5
JUN	33.3	37.5
JUL	44.4	16.7
AUG	55.6	58.3
SEP	55.6	29.2
OCT	22.2	12.5
NOV	22.2	37.5
DEC	22.2	45.8
12-month average	42.6	35.2

TABLE III.D.2-11

NITRATE METABOLISM
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Reduction of nitrates	
	Bay	Canal
JAN	22.2	33.3
FEB	22.2	41.7
MAR	55.6	50.0
APR	22.2	70.8
MAY	44.4	58.3
JUN	0.0	45.8
JUL	44.4	33.3
AUG	33.3	25.0
SEP	33.3	20.8
OCT	33.3	62.5
NOV	0.0	33.3
DEC	0.0	16.7
12-month average	25.9	40.9

TABLE III.D.2-12

ANALYSIS OF SOLUBLE AMMONIA (ppm)
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	0.06	0.56	0.11	0.04	0.09	0.12	0.13	0.11	0.11
FEB	<0.01	0.038	0.03	0.02	0.02	0.05	0.05	0.16	0.06
MAR	0.04	0.07	0.06	0.04	0.04	0.03	0.02	0.07	0.07
APR	<0.01	0.02	0.01	0.02	0.03	0.02	0.02	0.02	0.01
MAY	0.03	0.07	0.05	0.04	0.03	0.05	0.04	0.07	0.04
JUN	0.39	0.48	0.63	0.37	0.57	0.55	0.23	0.81	0.34
JUL	0.36	0.54	0.49	0.41	0.43	0.17	0.83	0.35	0.50
AUG	0.30	0.30	0.27	0.36	0.21	0.32	0.31	0.09	0.08
SEP	0.52	0.53	0.37	0.34	0.31	0.44	0.27	0.98	0.81
OCT	0.27	0.29	0.43	0.21	0.29	0.38	0.27	0.52	0.57
NOV	0.69	0.30	0.49	0.40	0.70	0.25	0.64	0.91	0.60
DEC	0.25	0.41	0.13	0.38	0.42	0.51	0.32	0.45	0.67

TABLE III.D.2-13

ANALYSIS OF SOLUBLE NITRATE (ppm)
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	0.05	0.25	0.19	0.25	0.29	0.23	0.23	0.22	0.22
FEB	0.04	0.30	0.46	0.27	0.39	0.27	0.20	0.23	0.25
MAR	0.08	0.17	0.19	0.14	0.25	0.19	0.24	0.20	0.23
APR	0.007	0.034	0.036	0.020	0.042	0.030	0.014	0.026	0.032
MAY	0.240	0.288	0.296	0.256	0.243	0.292	0.263	0.270	0.304
JUN	0.075	0.180	0.122	0.160	0.118	0.146	0.180	0.238	0.150
JUL	0.091	0.139	0.160	0.109	0.097	0.080	0.087	0.135	0.138
AUG	0.080	0.100	0.075	0.079	0.089	0.077	0.083	0.072	0.083
SEP	0.131	0.062	0.061	0.076	0.095	0.095	0.081	0.101	0.090
OCT	0.152	0.131	0.093	0.134	0.104	0.112	0.119	0.142	0.062
NOV	0.091	0.106	0.193	0.109	0.086	0.119	0.076	0.097	0.093
DEC	0.021	0.265	0.262	0.228	0.192	0.235	0.236	0.164	0.201

TABLE III.D.2-14

ANALYSIS OF SOLUBLE NITRATE (ppm)
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.001	0.010	0.008	0.006	0.006	0.006	0.008	0.006	0.004
FEB	0.003	0.008	0.014	0.011	0.009	0:009	0.007	0.008	0.008
MAR	0.001	0.007	0.006	0.007	0.007	0.007	0.007	0.008	0.008
APR	<0.001	0.002	0.003	0.002	0.004	0.003	0.002	0.003	0.002
MAY	0.010	0.011	0.011	0.011	0.012	0.013	0.017	0.016	0.011
JUN	0.001	0.005	0.005	0.005	0.004	0.005	0.002	0.012	0.007
JUL	0.001	0.004	0.005	0.003	0.005	0.002	<0.001	0.006	0.005
AUG	0.003	0.004	0.004	0.003	0.004	0.003	0.004	0.004	0.003
SEP	0.007	0.004	0.005	0.006	0.006	0.006	0.007	0.005	0.004
OCT	0.007	0.006	0.007	0.006	0.007	0.004	0.004	0.007	0.004
NOV	0.006	0.006	0.004	0.007	0.006	0.005	0.007	0.003	0.009
DEC	0.001	0.008	0.008	0.010	<0.001	0.008	0.020	0.001	0.010

TABLE III.D.2-15

ANALYSIS OF SOLUBLE ORTHOPHOSPHATE (ppm)

TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	0.04	0.09	0.02	<0.01	0.09	0.02	<0.01	0.12	0.09
FEB	0.04	0.02	0.04	0.02	0.03	0.01	0.01	0.01	0.01
MAR	0.02	0.02	0.01	0.02	0.04	0.01	0.01	0.03	0.02
APR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MAY	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
JUN	<0.01	<0.01	<0.01	<0.01	0.03	0.03	<0.01	0.13	0.02
JUL	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
AUG	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	<0.01
SEP	<0.01	0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.02	0.02
OCT	<0.01	0.04	0.01	0.04	<0.01	0.04	0.02	0.02	0.03
NOV	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01
DEC	<0.01	0.02	<0.01	<0.01	0.01	0.03	<0.01	0.01	0.02

TABLE III.D.2-16

ANALYSIS OF SOLUBLE SULFATE (ppm)
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	2437	2980	2890	2920	2800	3030	2950	2970	3010
FEB	2040	2600	2790	2810	2710	2790	2680	2580	2800
MAR	2590	2890	3047	3023	3060	2984	3062	3018	3089
APR	3448	3527	3664	3356	3390	3476	3818	3647	3545
MAY	733	2930	2980	2850	2850	2930	2800	2750	2980
JUN	2567	2800	3050	2850	3000	3000	2850	2850	3000
JUL	2733	3075	2950	2950	2950	3150	2950	2950	3100
AUG	2250	3030	2900	3050	3140	2850	2920	2910	3120
SEP	1255	2700	2750	2690	2800	2750	2700	2510	2690
OCT	1933	3400	3400	3500	3400	3500	3400	3400	3400
NOV	1823	3220	2100	3140	3280	3240	3230	3150	3100
DEC	2000	2800	2800	2900	2900	2900	2800	2800	2800

TABLE III.D.2-17

ANALYSIS OF SOLUBLE SULFITE (ppm)
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
FEB	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
APR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAY	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
JUN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
JUL	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
AUG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SEP	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
OCT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NOV	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DEC	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

TABLE III.D.2-18

ANALYSIS OF SOLUBLE SULFIDE (ppm)
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
FEB	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
APR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05
MAY	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	<0.05
JUN	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
JUL	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05
AUG	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SEP	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
OCT	<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
DEC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

TABLE III.D.2-19

ANALYSIS OF INSOLUBLE SULFIDES (μg/g wet wt. soil).
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

Month	Mean of 3 controls	Station							
		F.1	W18.2	W6.2	WF.2	RF.3	E3.2	RC.2	RC.0
JAN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
FEB	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
APR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MAY	2.41	0.46	1.55	<0.05	<0.05	0.68	1.06	13.94	2.56
JUN	2.87	1.65	8.77	2.55	2.86	3.20	0.44	10.30	0.31
JUL	5.6	5.6	11.6	22.9	29.5	31.5	25.9	0.71	14.2
AUG	1.0	0.8	45.9	5.3	2.1	0.8	<0.1	0.4	1.1
SEP	1.2	0.3	9.1	3.2	3.5	0.3	3.7	2.7	0.2
OCT	2.1	1.1	0.4	0.4	5.3	1.4	2.7	13.3	2.7
NOV	4.6	2.2	25.0	8.4	5.0	3.6	4.7	17.2	1.2
DEC	0.8	0.1	<0.1	6.5	2.7	0.2	0.2	46.0	0.5

TABLE III.D.2-20

pH OF TURKEY POINT CANAL AND BISCAYNE BAY SEDIMENTS
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Station location and number										
	Biscayne Bay				Turkey Point Canal System						
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.2	E3.2	RC.2	RC.0
MAY	8.3	8.4	8.3	7.9	8.3	8.3	8.2	7.9	8.0	8.1	7.9
JUN	8.3	8.3	8.3	7.7	8.1	8.2	8.0	8.0	8.1	7.7	7.8
JUL	8.7	8.7	8.5	8.1	8.5	8.1	8.2	8.4	7.9	8.3	7.8
AUG	8.0	8.0	8.1	7.6	8.1	8.1	7.9	7.8	8.0	7.7	7.9
SEP	8.2	8.1	8.4	7.6	8.0	8.0	8.0	7.9	7.8	7.7	7.5
OCT	8.3	8.4	8.3	7.8	8.1	8.1	8.0	7.7	7.9	7.8	7.5
NOV	8.3	8.2	8.2	7.9	8.0	7.9	8.1	7.8	8.1	7.7	7.4
DEC	8.3	8.1	8.1	7.8	8.1	8.0	8.1	7.7	8.0	8.0	7.4

TABLE III.D.2- 21

SALINITY (°/₀₀) AT STATIONS IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Station location and number										
	Biscayne Bay				Turkey Point Canal System						
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.2	E3.2	RC.2	RC.0
JAN	30.15	30.15	30.15	36.08	36.62	36.62	36.62	36.62	37.16	36.62	37.16
FEB	29.62	29.62	26.92	37.16	37.69	37.69	37.16	37.16	37.16	37.69	37.69
MAR	32.31	32.31	32.85	37.69	38.23	38.23	38.23	38.23	38.23	38.23	37.69
APR	30.69	30.69	30.69	54.54	42.54	42.00	42.54	42.00	42.54	42.54	42.54
MAY	26.92	26.92	26.92	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
JUN	33.39	33.39	33.39	36.62	37.16	36.08	36.62	37.16	37.16	37.16	37.16
JUL	35.54	35.54	35.54	39.85	37.16	37.69	37.69	39.85	37.69	37.16	39.85
AUG	a	a	a	40.92	40.92	40.92	40.92	40.92	40.38	40.38	40.38
SEP	30.69	30.69	30.69	37.16	37.16	37.16	37.16	37.16	37.16	37.16	37.16
OCT	23.69	23.69	23.69	41.46	41.46	41.46	42.00	41.46	42.00	41.46	41.46
NOV	25.0	25.0	24.9	39.2	39.5	39.5	39.4	39.5	39.1	38.7	39.5
DEC	28.5	28.5	28.2	35.0	35.9	35.6	36.0	36.3	36.0	36.1	36.3

[a]Sample lost in transit.

TABLE III.D.2-22

TEMPERATURE (°C) AT STATIONS IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Station location and number										
	Biscayne Bay				Turkey Point Canal System						
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.2	E3.2	RC.2	RC.0
JAN	19.1	19.1	19.9	23.4	18.5	19.1	19.2	14.5	11.1	15.6	17.1
FEB	21.0	21.0	21.0	30.1	19.9	20.1	20.4	17.0	13.7	18.6	19.1
MAR	28.0	28.0	28.3	37.4	32.3	33.9	33.5	26.9	27.1	29.0	29.5
APR	26.5	26.5	26.5	29.0	24.1	24.2	24.6	24.4	23.9	25.8	26.3
MAY	28.7	28.7	28.7	33.0	28.7	28.9	29.0	27.9	24.4	26.1	26.2
JUN	32.5	32.5	32.5	39.9	33.1	33.0	31.2	30.4	31.8	33.9	33.1
JUL	33.0	32.7	32.5	35.2	31.2	32.0	30.9	29.9	30.0	31.0	30.1
AUG	29.7	29.7	29.7	36.9	31.2	32.2	30.8	30.0	29.1	30.2	30.2
SEP	30.0	30.0	30.0	39.8	33.6	34.2	33.2	31.9	31.1	32.3	32.0
OCT	28.0	28.0	28.1	34.4	28.1	28.8	28.3	26.9	25.0	27.8	27.8
NOV	22.5	22.5	22.3	28.7	23.4	24.7	24.4	22.8	20.6	23.4	22.4
DEC	22.5	22.5	22.3	32.1	26.3	26.4	26.0	25.1	25.6	25.8	26.3

TABLE III.D.2-23

SPECIFIC CONDUCTIVITY ($ohm^{-1}cm^{-1}$ x 1000) AT STATIONS IN TURKEY POINT CANALS AND BISCAYNE BAY
TURKEY POINT PLANT
JANUARY-DECEMBER 1977

	Station location and number										
	Biscayne Bay				Turkey Point Canal System						
Month	1	2	3	F.1	W6.2	W18.2	WF.2	RF.2	E3.2	RC.2	RC.0
JAN	41.0	41.0	41.0	53.0	48.0	48.7	48.7	44.0	41.0	45.2	47.0
FEB	42.0	42.0	42.0	62.0	51.0	51.5	51.5	43.0	44.5	49.5	50.1
MAR	52.5	52.5	52.5	69.5	65.5	67.0	66.5	59.0	60.5	62.0	62.0
APR	48.5	48.5	48.5	80.0	62.0	61.5	62.0	61.5	62.0	64.0	64.5
MAY	44.5	44.5	44.5	61.5	57.3	57.5	57.5	56.0	52.5	54.3	53.5
JUN	58.5	58.5	58.5	70.5	64.5	63.0	62.8	61.7	63.4	65.4	64.5
JUL	62.0	62.8	62.5	71.0	62.5	64.5	63.5	65.0	62.3	62.5	65.0
AUG	a	a	a	71.3	68.0	68.5	67.8	67.0	65.5	67.0	66.5
SEP	52.0	52.0	52.0	71.5	63.4	63.6	63.0	62.5	62.0	62.6	62.5
OCT	39.0	39.0	39.0	73.5	66.0	66.5	65.5	64.0	62.5	66.0	65.0
NOV	37.5	37.5	37.5	64.0	57.5	58.8	58.5	57.0	53.5	56.5	56.5
DEC	42.5	42.5	42.5	61.5	56.0	55.5	56.0	55.0	55.4	55.7	56.5

[a]Could not be calculated because samples were lost in transit.

E. TERRESTRIAL ENVIRONMENT

INTRODUCTION

The purpose of this study was to determine the status of the plant communities adjacent to the Turkey Point cooling canal system. Potential effects of the cooling canal system on the local flora were examined.

Surface water in the Turkey Point area drains in a southeasterly direction through the littoral mangrove communities into Biscayne Bay. Interruption of this runoff by the canal system could result in the alteration of plant communities to the west and south of the canal system.

The cooling canal system contains saline water which could potentially flow from within the system into surrounding habitats. The introduction of warm saline water into an area could select for euryhaline species and result in an increase in the number and diversity of salt-tolerant forms.

An important method of evaluating changes in a habitat is to monitor the number and diversity of plant species found there. Plant communities are good indicators of habitat alterations because plants are immobile and cannot avoid environmental alterations. Habitat

changes can, therefore, be detected by long-term monitoring of the relative abundance and density of plant species.

Many data points are required to adequately define the vegetation density and composition of an area. To meet this need, a sampling program was devised to maintain adequate statistical power and reduce the impact of normal fluctuations present in biological populations. This sampling program was begun in 1974, modified in 1975, and continued in 1976 and 1977.

MATERIALS AND METHODS

Nine transect lines were established so that six transects ran east-west adjacent to the western border of the canal system and three transects ran north-south adjacent to the southern border of the canal system (Figure III.E-1). The transect lines were then divided into quadrats. Eight quadrats, 5 x 5 m (25 m^2), were delineated so that four quadrats lay north (or west) of the transect and four lay south (or east). Thus 72 quadrats were laid out encompassing a sample area of 1800 m^2.

The two principal plant communities west of the canal system were tree islands (woody species) and grasslands (graminoid species). Because the woody species appeared in clusters surrounded by graminoids, random assignment of transects would not serve to delineate species differences within these two diverse habitats. Assignment of

quadrats along each transect, however, had to be random to prevent sample bias. Accordingly, each transect line was specifically selected to be representative of an area so that the first and last quadrats were selected as being either woody or graminoid. The remaining quadrat locations were a fixed distance from the predetermined quadrats and were thus random in relation to the habitat between the two points.

In order that meaningful comparisons might be made between woody and graminoid habitats, an index was employed which quantified the height, diameter, and density of all species sampled. Indices which allow comparisons between habitats are commonly used in botanical surveys. Sample index calculations for the index derived for this study can be seen in Figure III.E-2. In each quadrat, the data collected resulted in a volume-density index for each dominant plant species. A plant volume measurement was taken and summed within each quadrat. Quadrats located opposite each other along the transects were averaged into four quadrat means and used in analysis of variance.

The borrow canal L-31 lies just west of the Turkey Point canal system. Because much of the vegetation being sampled lay between an active drainage canal and the Turkey Point canal system, suitable control quadrats had to be located outside the influence of both systems. To prevent potential confounding effects of the South Florida Flood Control District system, control quadrats for all east-west transects were located west of the L-31 canal.

The statistical design was a completely randomized factorial analysis which examined the volume-density variables of two factors: variance between transects, and variance between quadrats within each transect. Interaction effects between quadrats and transects were also examined. The assumptions for random factorial analyses that were met included the following:

a. A random assignment of plant species existed within each quadrat.

b. Homogeneity of variance existed within each quadrat.

Soil samples from each transect were analyzed for nitrates and nitrites and the results are presented in Table III.E-1.

RESULTS AND DISCUSSION

The Turkey Point cooling canal system lies in several vegetation zones which are characterized by saw grass and salt-tolerant grasses such as black rush and salt grass. Tree islands, comprised principally of mangrove species and buttonwoods, form discrete habitats which differ from the surrounding grasslands. The trees and shrubs of the tree islands are significantly taller and denser in biomass, and therefore require separate analytical techniques.

Plant Species at Turkey Point

Fifty-six (56) species of plants were recorded from Turkey Point. The vegetation included highly salt-tolerant species such as

the black and red mangrove, and salt-intolerant varieties such as dog fennel and morning glory (Table III.E-2).

The transition from freshwater prairie to the saline mangrove zone occurred in a west to east direction so that all of the western transects were located in a similar freshwater area. The presence of red and white mangroves and buttonwood in the experimental area indicated that this area had probably been subject to periodic tidal flooding before the construction of Central and Southern Florida Flood Control District's levee and borrow canal L31-E.

Transects 2, 4, and 6 passed through tree islands and therefore were characterized as woody transects. The tree island flora varied with elevation but were generally characterized by cabbage palm, wax myrtle, holly, and nightshade. Buttonwood was found throughout the study area. This species, generally found in coastal areas, is tolerant of freshwater. Sawgrass was found around the tree islands and was taller than sawgrass growing in glades areas. The amount of tree cover increased from north to south along the western transects. Transect 6, at the southern end of the study area, contained well-developed high tree hammocks. Several species in these hammocks are generally intolerant of standing water.

Transects 1, 3 and 5 were largely grasslands characterized by sawgrass, salt grass, spikerush, salt rush, and cattails. Various forms of tree islands and low shrub associations were scattered throughout these grasslands.

Transects 7, 8, and 9 were located along the southern end of the canal system. Transect 7 was in a transition zone from fresh to saline water. This zone contained Australian pine in higher elevations. Most of the area contained wet tree islands with white mangrove and buttonwood. This area is apparently wetter or more saline than in previous years, as indicated by a number of dead cabbage palm stumps. Cabbage palms are unable to tolerate standing water or saltwater inundation for extended periods of time. Transects 8 and 9 are located in a saline zone and the dominant species of the area are scrub mangrove, black rush, salt grass, and islands of large mangrove trees.

Vegetation density-volume ratios by species, transect number, and quadrat number (Tables III.E-3 through III.E-11) indicated differences in species community make-up. Variation in the number and type of species showed no consistent pattern.

Analysis of density-volume ratios (Table III.E-12) for grassland transects 1, 3, and 5 demonstrated no significant differences between quadrats or between transects. No interaction between the variables (quadrats x transects) was observed.

Woody transects 2, 4, and 6 (Table III.E-13) showed much the same trends. No significant differences were observed for density-volume data between transects, between quadrats, and quadrats x transect interactions.

The variability of the vegetation density-volume index west of the Turkey Point cooling system was slight. Variations in biological populations are normal. Analysis of variance did not reveal significant differences in vegetative densities in plant communiites west of the Turkey Point cooling canal system. The absence of differences in the western transects suggests that the cooling system has a negligible effect on the western plant communities.

Southern transects (7, 8, and 9; Table III E-14) demonstrated differences within transects.

Tukey's pairwise comparison test (Snedecor, 1966) was used to determine where differences in transects occurred:

$$D = Q\alpha, df\sqrt{\frac{MSE}{N}}$$

where: D = Highest Significant Difference

$Q\alpha$, df = 3.77 for 3 treatments and 12 degrees of freedom

MSE = mean square error

N = 8

Tukey's analysis revealed a significant difference between transects 7 and 9 (Table III.E-14). The region south of the Turkey Point cooling system experienced dredge and fill activity during the construction of the Model Land Company canal. Therefore, alteration of vegetative patterns was anticipated. Additionally, the southern boundary of the canal system passes through three major vegetation zones which are dominated by mangroves, black rush and salt grass, and saw grass, respectively. The cooling canal system is in no way responsible for vegetative distribution patterns which lie between it and the Model Land Canal.

Long-Term Analyses

Quadrat and transect data for 1975, 1976, and 1977 showed good agreement and validate the conclusions presented in reports from previous years. These conclusions, briefly stated, are that no detectable shift in vegetation density has been observed in the areas west and south of the canal cooling system. Also, no shifts in dominant vegetative species have been observed for those same areas. Table III.E-16 shows the similarity of the 1975-1977 data from the southern transects 7, 8, and 9. Spoil banks created by Model Land Canal construction have encouraged the invasion of the Australian pine, a fast-growing exotic species. These woody plants add disproportionately to the survey data.

An examination of the density-volume indices over three years for the woody transects 2, 4, and 6 shows little variation between transects and between quadrats (Table III.E-17). These data support the position that the cooling canals have a negligible effect upon the tree islands which lie to the west of the canal system.

Grassland data (Table III.E-18) were less consistent from year to year, as compared with the woody and southern transect data. Patchy distributions were observed and reported in 1975. These uneven density-volume data were attributed to:

a. The decrease of black rush and red mangrove populations with distance south of Transect 1, and

b. The greater density-volume index of saw grass east of borrow canal L-31 as compared with quadrats located west of L-31.

Examination of the grassland areas in subsequent years (1976 and 1977) has demonstrated that the 1975 data reflected irregular and patchy distribution of vegetation. A probable cause for the reduction of species density-volume ratios observed in 1977 was a killing frost of January 21, 1977. This frost damaged and killed many young red mangroves and buttonwoods which were not counted in the December 1977 survey. Absence of mangrove and buttonwoods would remove a heavily weighted component from calculation. As of this writing, no perturbation of the grasslands west of the canal system has been demonstrated.

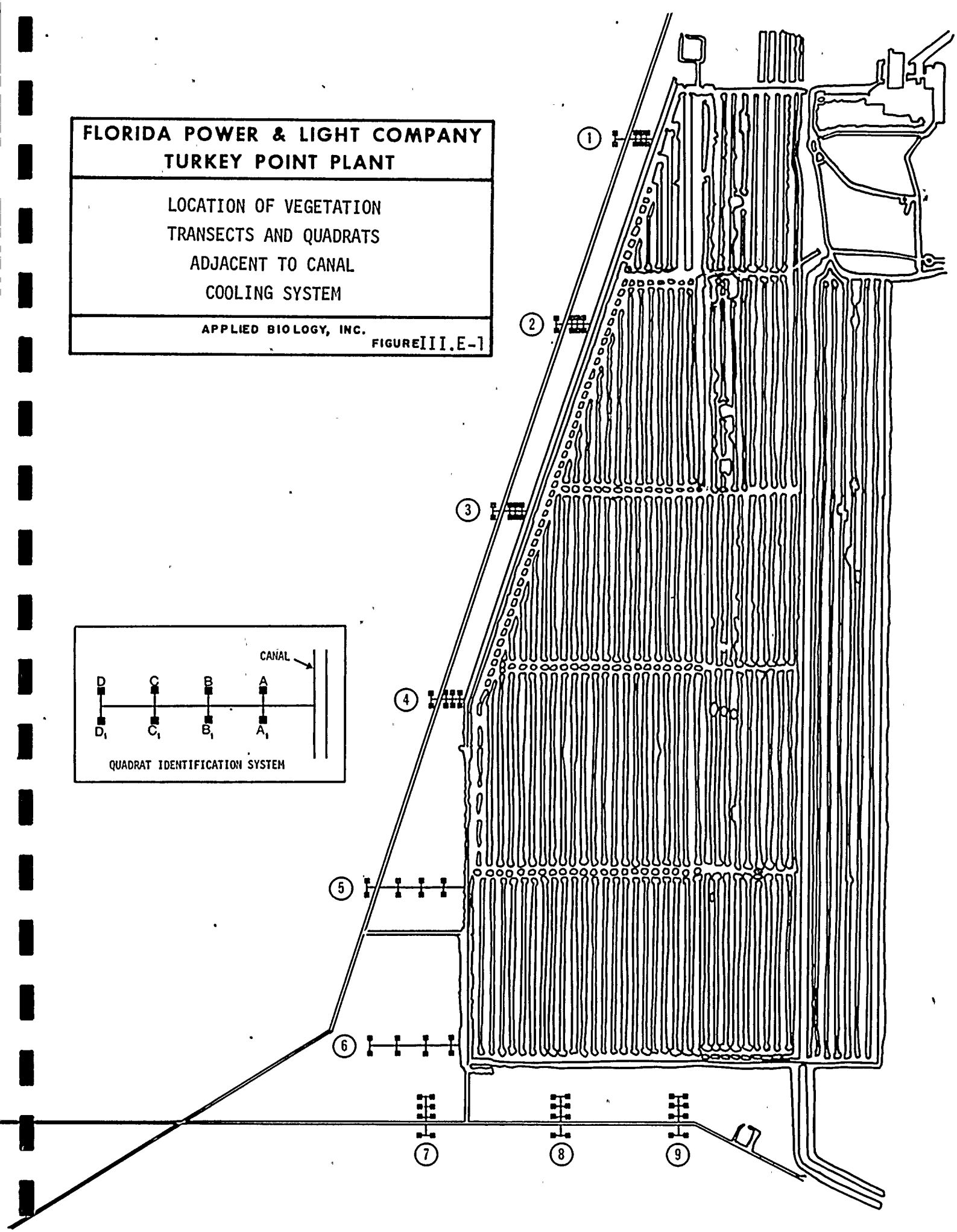
LITERATURE CITED

Snedecor, G.W. 1966. Statistical Methods. Iowa State Univ. Press, Ames, Iowa. 534 pp.

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT

LOCATION OF VEGETATION
TRANSECTS AND QUADRATS
ADJACENT TO CANAL
COOLING SYSTEM

APPLIED BIOLOGY, INC.
FIGURE III.E-1



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

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

where:

A = Area of sample in meters

N = Number of graminoid samples

H = Height of grass blades in cm

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

sample values

A = 1.0

N = 240

H = 142.2

R = 1.59

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

Example 2. Woody shrub (*Conocarpus*)

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

where:

N = Number of shrubs of same dimensions

H = Shrub height in cm

R = Maximum radius of trunk

sample values

N = 1.0

H = 365.8

R = 6.45^2

Conocarpus Index $= (1.0)(365.8)(6.45\ ) = 15{,}218.19$

Figure III.E- 2. Examples of volume-density index calculations of a graminoid and wood plant series.

TABLE III.E-1

ANALYSIS OF SOIL SAMPLES TAKEN DURING
TURKEY POINT VEGETATION SURVEY, 1977

Transect[a]		Nitrate (μg/g dry soil)	Nitrite (μg/g dry soil)
1	Surface	4.16	0.17
	12" Depth	1.17	0.05
2	Surface	3.14	0.11
	12" Depth	0.37	0.03
3	Surface	4.05	0.14
	12" Depth	2.39	0.13
4	Surface	2.85	0.08
	12" Depth	2.64	0.33
5	Surface	0.33	0.02
	12" Depth	0.30	0.03
6	Surface	5.26	0.23
	12" Depth	1.87	0.09
7	Surface	0.52	0.03
	12" Depth	6.80	0.22
8	Surface	10.32	0.41
	12" Depth	10.97	0.56
9	Surface	0.37	0.06
	12" Depth	0.30	0.03

TABLE III.E-2

PLANT SPECIES FOUND IN SAMPLING QUADRATS
TURKEY POINT, 1977

Scientific Name	Common Name
Acrostichum aureum	Leather Fern
Ardisia escallonoides	Marlberry
Aster sp.	Aster
Avicennia germinans	Black Mangrove
Baccharis sp.	Groundsel
Blechnum serrulatum	Swamp Fern
Borrichia fructescens	Sea Daisy
Cakile fusiformis	Sea Rocket
Casuarina equisetifolia	Australian Pine
Cephalanthus occidentalis	Buttonbush
Chiococca alba	Snowberry
Cladium jamaicensis	Saw Grass
Conocarpus erecta	Buttonwood
Cyperaceae	Sedge Family
Dipholis salicifolia	Willow Bustic
Distichilis spicata	Salt Grass
Eleocharis cellulosa	Spikerush
Eugenia axillarix	White Sopper
Eupatropium capillifolium	Dog Fennel
Fimbristylis sp.	Sedge
Forestiera segregata	Florida Privet
Fuirena scirpoidea	Umbrella Grass
Hypericum sp.	St. John's Wort
Ilex cassine	Dahoon
Ipomoea saggittata	Glades Morning Glory
Jacquemontia curtissii	
Juncus roemerianus	Salt Rush
Laguncularia racemosa	White Mangrove
Lantana involucrata	Bush Lantana
Magnolia virginiana	Sweet Bay
Metopium toxiferum	Poisonwood
Mikania scandens	Climbing Hempweed
Myrica cerifera	Wax Myrtle
Myrsine guianensis	Myrsine
Passiflora subserosa	Corky-stemmed Passionflower
Persea borbonia	Red Bay
Pinguicula pumila	Butterwort
Pisonia sp.	Cockspur
Pluchea purpurascens	Camphorweed
Polygala cruciata	Milkwort

TABLE III.E-2
(continued)
PLANT SPECIES FOUND IN SAMPLING QUADRATS
TURKEY POINT, 1977

Scientific Name	Common Name
Proserpinaca sp.	Mermaid Weed
Randia aculeata	White Indigo Berry
Rhizophora mangle	Red Mangrove
Sabal palmetto	Cabbage Palm
Sabatia grandiflora	Marsh Pink
Salicornia virginica	Perrenial Glasswort
Samolus ebracteatus	Water Pimpernel
Schinus terebinthifolius	Brazilian Pepper Tree
Schoenus nigricans	
Solanum blodgettii	Nightshade
Solidago tortifolia	Goldenrod
Swietienia mahogani	Mahogany
Talium sp.	Flame flower
Tillandsia circinata	Air Plant
Tillandsia flexuosa	Twisted Air Plant
Typha sp.	Cattail

TABLE III.E-3

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 1
1977

Species	Quadrat 1A1	1A2	1B1	1B2	1C1	1C2	1D1	1D2	Totals
Aster sp.			66			6	2	1	75
Cladium jamaicensis		142	185		379	286	1,111	800	2,903
Conocarpus erecta		26,195	3,592		960	10,309	505	603	42,164
Distichilis spicata		present		87					87
Eleocharis cellulosa	271	3,576	5	261	21	2	10	18	4,164
Juncus roemerianus	129	101	61	103	374	12		23	803
Typha sp.					present				
TOTALS	400	30,014	3,909	451	1,734	10,615	1,628	1,445	49,796

TABLE III.E-4

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 2
1977

Species	Quadrat								
	2A1	2A2	2B1	2B2	2C1	2C2	2D1	2D2	Totals
Cladium jamaicensis	2,698	8,089	2,437	3,617	6,751	5,870	912	2,049	32,423
Conocarpus erecta	2,510	65,072	1,139	3,195	5,254	2,816	2,090	8,392	90,468
Juncus roemerianus							41		41
Laguncularia racemosa	339	36	221	1,009	1,429	1,824	810		5,668
Rhizophora mangle	1,089	2,072	196	1,995		290	268	142	6,052
Solanum blodgettii						53			53
Tillandsia circinata		present		present					
Tillandsia flexuosa		present		present					
TOTALS	6,636	75,269	3,993	9,816	13,434	10,853	4,121	10,583	134,705

TABLE III.E-5

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 3
1977

Species	Quadrat								
	3A1	3A2	3B1	3B2	3C1	3C2	3D1	3D2	Totals
Aster sp.			17	15		12			44
Cladium jamaicensis	862	1,114	496	799	879	570	1,545	724	6,989
Conocarpus erecta			753	990		210			1,953
Hypericum sp.			present			present			
Ipomea saggittata			present						
Juncus roemerianus					50	60			110
Mikania scandens						present			
TOTALS	862	1,114	1,266	1,804	929	852	1,545	724	9,096

TABLE III.E-6

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 4
1977

Species	Quadrat								
	4A1	4A2	4B1	4B2	4C1	4C2	4D1	4D2	Totals
Acrostichum aureum				46					46
Aster sp.								37	37
Baccharis sp.					47	432	181		660
Blechnum serrulatum					1,307	59			1,366
Cladium jamaicensis	619	508	1,867	11,722	882	1,338	5,262	540	22,738
Conocarpus erecta	5,697	1,570	21,491	5,739	1,602	22,429	1,070	5	59,603
Eupatropium capillifolium								2	2
Ipomoea saggittata							present	present	
Juncus roemerianus		6							6
Laguncularia racemosa					25,729	274			26,003
Myrsine guianensis						4			4

TABLE III.E-6
(continued)
DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE
TURKEY POINT CANAL SYSTEM
TANSECT 4
1977

Species	Quadrat								
	4A1	4A2	4B1	4B2	4C1	4C2	4D1	4D2	Totals
Persea borbonia							271		271
Proserpinaca sp.						present			
Rhizophora mangle		1,239							1,239
Sabal palmetto			127,400		202,300		89,600		419,300
Schinus terebinthifolius			present		4				4
Solanum blodgettii		505	6		3,619	63	178		4,371
TOTALS	6,316	3,828	150,764	17,507	235,490	24,599	96,562	584	535,450

TABLE III.E-7

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 5
1977

Species	Quadrat								
	5A1	5A2	5B1	5B2	5C1	5C2	5D1	5D2	Totals
Aster sp.	1		9	7	7	2	1	1	28
Baccharis sp.			present	present					
Cladium jamaicensis	746	1,338	524	581	923	890	1,790	1,710	8,502
Conocarpus erecta	114		1,242	3,621	270	1	644		5,892
Eleocharis cellulosa								83	83
Ipomoea saggittata							present		
TOTALS	861	1,338	1,775	4,209	1,200	893	2,435	1,794	14,505

TABLE III.E-8

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 6
1977

Species	Quadrat								
	6A1	6A2	6B1	6B2	6C1	6C2	6D1	6D2	Totals
Acrostichum aureum		24	4,338						4,362
Ardisia escallonoides							63	339	402
Baccharis sp.						10	5		15
Blechnum serrulatum	822	41				111			974
Casuarina equisetifolia		128,672		282,426		1			411,099
Cephalanthus occidentalis								29	29
Chiococca alba		present				present	present		
Cladium jamaicensis	5,861	2,082	5,133	1,392	899	456	2,267	4,098	22,188
Conocarpus erecta		289	4,276	1,450		695		19	6,729
Cyperaceae							1		1
Dipholis salicifolia						64,016	1,455	10,412	75,883

TABLE III.E-8
(continued)
DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE
TURKEY POINT CANAL SYSTEM
TRANSECT 6
1977

Species	Quadrat								
	6A1	6A2	6B1	6B2	6C1	6C2	6D1	6D2	Totals
Eugenia axillaris						900			900
Fimbristylis sp.							47		47
Forestiera segregata							5	1,824	1,829
Fuirena scirpoidea							118		118
Hypericum sp.							1		1
Ilex cassine		919						1	920
Jacquemontia curtissii							present	present	
Lantana involucrata								86	86
Laguncularia racemosa			11,499						11,499
Magnolia virginiana					300	1			301
Metopium taxiferum		present	1		1,709	186	6,059	58,830	66,785

TABLE III.E-8
(continued)
DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE
TURKEY POINT CANAL SYSTEM
TRANSECT 6
1977

Species	Quadrat								
	6A1	6A2	6B1	6B2	6C1	6C2	6D1	6D2	Totals
Myrica cerifera	1	10,442			52		200	230	10,925
Myrsine guianensis	1,454	261			1,069				2,784
Passiflora subserosa								present	
Persea borbonia					303	1,880			2,183
Pinguicula pumila							1		1
Pisonia sp.					11,560	51			11,611
Polygala cruciata							9		9
Randia aculeata						204			204
Rhizophora mangle		6,510							6,510
Sabatia grandiflora							1		1
Sabal palmetto	90,000		36,125		27,075				153,200

TABLE III.E-8
(continued)
DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE
TURKEY POINT CANAL SYSTEM
TRANSECT 6
1977

Species	Quadrat								
	6A1	6A2	6B1	6B2	6C1	6C2	6D1	6D2	Totals
Samolus ebracteatus							9		9
Schinus terebithifolius			718		14	2,984			3,716
Solanum blodgettii	2	625	306		586	756	18	111	2,404
Solidago tortifolia							82		82
Swietienia mahogani					74,023	445,672			519,695
TOTALS	98,140	149,865	62,396	285,268	117,590	517,923	10,341	75,979	1,317,502

TABLE III.E-9

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 7
1977

Species	Quadrat								
	7A1	7A2	7B1	7B2	7C1	7C2	7D1	7D2	Totals
Aster sp.	1	present			2	1		2	6
Baccharis sp.	1								1
Borrichia fructescens							33	118	152
Cakile fusiformis	3								3
Cladium jamaicensis	3,820	3,270	1,950	2,007	14,420	1,715			27,182
Conocarpus erecta	7,302		6,729		1,540	1,319	1,119	2,306	20,315
Distichilis spicata							181	11,487	11,668
Fimbristylis sp.	present								
Hypericum sp.	present								
Ipomea saggittata	present					present			
Laguncularia racemosa							8	207	215
TOTALS	11,127	3,270	8,679	2,007	15,962	3,035	1,341	14,120	59,539

TABLE III.E-10

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 8
1977

Species	Quadrat								
	8A1	8A2	8B1	8B2	8C1	8C2	8D1	8D2	Totals
Acrostichum aureum				726					726
Avicennia germinans							7	338	345
Borrichia fructescens							17	11	28
Casuarina equistifolia	6,863	85,738		31,850					124,451
Cladium jamaicensis	659	1,830	3,929	3,512	632	1,264			11,826
Conocarpus erecta		385	15,652	4,860	6,148	7,553		21	34,619
Distichilis spicata							196	279	475
Hypericum sp.	present								
Juncus roemerianus	368	162	328		183		1		1,042
Laguncularia racemosa				8,519		3,876	816	2,778	15,989
Rhizophora mangle			5,107			234	26	170	5,537

TABLE III.E-10
(continued)
DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE
TURKEY POINT CANAL SYSTEM
TRANSECT 8
1977

Species	Quadrat								
	8A1	8A2	8B1	8B2	8C1	8C2	8D1	8D2	Totals
Salicornia virginica							14		14
Solanum blodgettii				261					261
Schoenus nigricans						74			74
Talinum sp.	181								181
TOTALS	8,071	88,115	25,016	49,728	6,963	13,001	1,077	3,597	195,568

TABLE III.E-11

DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE TURKEY POINT CANAL SYSTEM
TRANSECT 9
1977

Species	Quadrat								
	9A1	9A2	9B1	9B2	9C1	9C2	9D1	9D2	Totals
Acrostichum aureum	5,000								5,000
Ardisia escallonoides							60		60
Aster sp.		4			present				4
Avicennia germinans								1	1
Borrichia fructescens	98		10		4		11	1	124
Cladium jamaicensis					144				144
Conocarpus erecta		2			1,304	19			1,325
Distichilis spicata		17	9	123	7	5	269	62	492
Juncus roemerianus						4			4
Laguncularia racemosa	5,375	72	86	159	79		359	1,113	7,243

TABLE III.E-11
(continued)
DENSITY-VOLUME INDEX OF VEGETATIONAL QUADRATS ADJACENT TO THE
TURKEY POINT CANAL SYSTEM
TRANSECT 9
1977

Species	Quadrat								
	9A1	9A2	9B1	9B2	9C1	9C2	9D1	9D2	Totals
Rhizophora mangle	68,918	3,759	16,530	23,020	6,497	65,124	6,243	4,304	194,395
Schoenus nigricans			277	49	342	76			744
TOTALS	79,391	3,854	16,912	23,351	8,377	65,228	6,942	5,481	209,536

TABLE III.E-12

ANALYSIS OF GRASSLAND TRANSECTS 1, 3, AND 5
TURKEY POINT PLANT
1977[a]

Factor Level	Degrees of Freedom	Sum of Squares	Mean Squares	Calculated F	$F_{.05}$
Quadrats	3	$.1583 \times 10^9$	$.5278 \times 10^8$	1.33	3.49
Transects	2	$.4729 \times 10^8$	$.2364 \times 10^8$	0.59	3.88
Quadrats x Transects	6	$.1742 \times 10^9$	$.2904 \times 10^8$	0.73	3.00
Error	12	$.4761 \times 10^9$	$.3968 \times 10^8$		

[a]Based on 4 quadrats with 2 replicates per quadrat.

TABLE III.E-13

ANALYSIS OF WOODY TRANSECTS 2, 4, AND 6
TURKEY POINT PLANT
1977[a]

Factor Level	Degrees of Freedom	Sum of Squares	Mean Squares	Calculated F	$F_{.05}$
Quadrats	3	$.1995 \times 10^{11}$	$.6653 \times 10^{10}$	0.34	3.49
Transects	2	$.1265 \times 10^{11}$	$.6325 \times 10^{10}$	0.32	3.88
Quadrats x Transects	6	$.6840 \times 10^{11}$	$.1140 \times 10^{11}$	0.58	3.00
Error	12	$.2343 \times 10^{12}$	$.1953 \times 10^{11}$		

[a]Based on 4 quadrats with 2 replicates per quadrat.

TABLE III.E-14

ANALYSIS OF SOUTHERN TRANSECTS 7, 8, AND 9
TURKEY POINT PLANT
1977[a]

Factor level	Degrees of freedom	Sum of squares	Mean square	Calculated F	$F_{.05}$
Quadrats	3	$.1217 \times 10^{10}$	$.4059 \times 10^{9}$	1.32	3.49
Transects	2	$.2685 \times 10^{10}$	$.1342 \times 10^{10}$	4.40[b]	3.88
Quadrats x Transects	6	$.6825 \times 10^{10}$	$.1137 \times 10^{10}$	3.72[b]	3.00
Error	12	$.3666 \times 10^{10}$	$.3055 \times 10^{9}$		

[a]Based on 4 quadrats with 2 replicates per quadrat.
[b]Significant at .05 level.

TABLE III.E-15

TUKEY'S PAIRWISE COMPARISON OF SOUTHERN TRANSECTS

Transects	Tukey's minimum value	Transect number	Transect means	Transect comparison	Difference
Southern	D = 19,033	7	6,215	7, 8	13,530
		8	19,745	7, 9	25,904[a]
		9	32,119	8, 9	12,374

[a]Transect 8 is significantly different from 7 and 9.

TABLE III.E-16

THREE-YEAR COMPARISON OF SOUTHERN TRANSECTS 7,8 AND 9
TURKEY POINT PLANT
1977

Factor level	Degrees of freedom	Calculated F for year		
		1975	1976	1977
Quadrats	3	48.83[a]	10.32[a]	1.32
Transects	2	37.59[a]	13.56[a]	4.40[a]
Quadrats x Transects	6	25.58[a]	6.35[a]	3.72[a]
Error	12			

[a]Significant at F = .05.

TABLE III.E-17

THREE-YEAR COMPARISON OF WOODY TRANSECTS 2, 4, AND 6
TURKEY POINT PLANT
1977

Factor Level	Degrees of freedom	Calculated F for year		
		1975	1976	1977
Quadrats	3	2.65	0.51	0.34
Transects	2	0.26	0.42	0.32
Quadrats x Transects	6	4.05[a]	1.65	0.58
Error	12			

[a]Significant at F = .05.

TABLE III.E-18

THREE-YEAR COMPARISON OF GRASSLAND TRANSECTS 1, 3, AND 5
TURKEY POINT PLANT
1977

Factor level	Degrees of freedom	Calculated F for year		
		1975	1976	1977
Quadrats	3	25.72[a]	1.77	1.33
Transects	2	30.69[a]	4.53[a]	0.59
Quadrats x Transects	6	24.29[a]	1.26	0.73
Error	12			

[a]Significant at F = .05.