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O'REILLY,J.P. Region 2, Atlanta, Office of the Director

SUBJECT: Forwards "Annual Nonradiological Monitoring Rept,1979," Vols 1,2 & 3.Vol 1 summarizes abiotic monitoring for 1979 & Vols 2 & 3 discuss biotic monitoring.
(see Enviro. rpts 8004040434,0443 & 0448)

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FLORIDA POWER & LIGHT COMPANY

March 28, 1980
L-80-106

Mr. James P. O'Reilly, Director, Region II
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

Re: St. Lucie Unit 1
Docket No. 50-335
Non-Radiological Environmental Monitoring Report No. 4

In accordance with Appendix B, Section 5.6.1.a of the St. Lucie Environmental Technical Specifications and Regulatory Guide 10.1, Florida Power & Light Company submits herewith two (2) copies of Non-Radiological Environmental Monitoring Report No. 4.

This report consists of three volumes. Volume I summarizes the abiotic monitoring for 1979. Volumes II and III discuss biotic monitoring.

Yours very truly,

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU/TCG/ah

Enclosures

cc: Director, Office of Inspection & Enforcement (1)
Director, Office of Nuclear Reactor Regulation (17)
Harold F. Reis, Esquire (w/o enclosure)

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8004040425

Florida Power & Light Company

St. Lucie Plant

Annual Non-Radiological

Monitoring Report

1979

Volume I

ABIOTIC Monitoring

#8004040425

TABLE OF CONTENTS

EXECUTIVE SUMMARY

VOLUME 1

Introduction

This document is the fourth consecutive annual report on abiotic monitoring at the Florida Power & Light Company St. Lucie Plant. It is Volume I of three volumes submitted in accordance with the St. Lucie Unit No. 1 Environmental Technical Specifications, Appendix B, Section 5.6.1.a. The report covers the period from January 1, 1979 through December 31, 1979.

Thermal

Four thermal limitations are required by the Environmental Technical Specifications (ETS): 1) discharge canal maximum release temperature (111°F); 2) maximum temperature rise across the condenser (26°F); 3) maximum temperature within the zone of mixing (93°F) and 4) maximum surface temperature rise over ambient within the zone of mixing (5.5°F).

Analysis of the thermal data as specified in the preceding paragraph showed that the only ETS violation which occurred during 1979 was for "maximum surface temperature rise over ambient within the zone of mixing." The length of time for which the temperatures were in excess of the ETS limitation were relatively brief.

An assessment of the thermal effects on the offshore marine environment caused by the operation of the St. Lucie plant is presented in Volumes II and III of the Annual Report. No significant adverse environmental impact could be attributed to plant operations during 1979.

Chemical

Chemical monitoring was conducted during 1979 in the discharge canal at the St. Lucie Plant for dissolved oxygen, pH, salinity, heavy metals and total residual chlorine. Dissolved oxygen and heavy metals were also monitored in the intake canal.

Dissolved oxygen was not significantly depleted in the condenser cooling water during plant passage.

Total residual chlorine values were well below ETS limits for the entire year.

Heavy metal concentrations were generally within the expected ranges with only a few random instances of concentrations above minimum detection limits of the instruments used in analysis. Additionally, no adverse environmental impacts are believed to have occurred from the presence of the noted chemicals.

The pH values were within the normal ranges of nearshore oceanic waters.

A. INTRODUCTION

In 1970, Florida Power & Light Company (FPL) was issued a construction permit by the United States Atomic Energy Commission (now Nuclear Regulatory Commission) for the construction of Unit No. 1 of the St. Lucie Plant, and 810-megawatt nuclear-powered electric generating station on Hutchinson Island in St. Lucie County, Florida.

Unit No. 1 was placed on-line in March 1976. Plant operation was intermittent in 1976, but was base loaded throughout 1977, 1978 and 1979, except for repair and refueling outages. The condenser cooling water is provided by a once-through circulating water system which consists of intake and discharge pipes in the ocean linked by canals to the plant. Cooling water is drawn from the Atlantic Ocean through an intake structure located 365 m (1,200 ft) offshore. The intake structure is covered with a concrete velocity cap, the top of which is approximately 2.4 m (8 ft) below the water surface. From the intake point, water is drawn into the intake canal through a pipe buried under the dunes and ocean bottom. The 90 m (300 ft) wide canal carries the cooling water about 1,500 m (5,000 ft) to the plant intake structure where pumps provide a design flow of 33,400 liters/sec. (530,000 gpm). The cooling water then moves through the intake screens, passes through the plant and is released into the discharge canal.

The temperature rise of the water passing through the condensers is limited to 26^{o}F (14.3^{o}C). After leaving the plant, the heated water passes through a 60 m (200 ft) wide discharge canal before entering a pipe buried under the dune and the ocean floor. The water is carried about 365 m (1,200 ft) offshore and discharged through a Y-port nozzle located approximately 9 m (30 ft) below the water surface. The discharge pipe is located 730 m (2,400 ft) north of the intake pipe.

The purpose of chemical and thermal limitations and monitoring is to provide a reasonable assurance that the aquatic ecosystem in the area of the thermal plume will be subjected to no unacceptable environmental impact. It is also desirable to maintain the quality of receiving body of water so that human uses of the water are protected, and so that local aquatic biota do not suffer adversely from exposure to any chemical discharges.

This document provides a report of the abiotic monitoring programs for the period from January 1, 1979 through December 31, 1979. Also included herein are discussions of various reports and studies (Sections D, E and G) prepared or performed during 1979 which are required by the ETS. Submitted simultaneously with this volume (Non-Radiological Environmental Monitoring Report, Volume I, 1979) are two other volumes (Non-Radiological Environmental Monitoring Report, Volumes II and III), which describe the biotic monitoring carried out during 1979. Together, these three volumes satisfy the requirements of St. Lucie Unit No. 1 Environmental Technical Specifications, Appendix B, Section 5.6.1.a.

B. THERMAL (ETS 3.1.A.5)

Introduction

Four thermal limitations are prescribed by the St. Lucie Unit 1 Environmental Technical Specifications (ETS): 1) discharge canal maximum release temperature (111°F or 44°C); 2) maximum temperature rise across the condenser (26°F or 14.3°C); 3) maximum temperature within the zone of mixing (93°F or 34°C); and 4) maximum surface temperature rise over ambient within the zone of mixing (5.5°F or 3.1°C).

Data were collected for item (1) using a temperature sensor located near the discharge canal terminus. The output from the sensor is recorded continuously on a strip chart located in a structure near the sensor. Data for item (2) are obtained from a series of RTD sensors located in the intake and discharge water lines. Output is transmitted to the reactor control room where it is logged hourly.

Items (3) and (4) are monitored using self-contained continuous recording thermographs located near the ocean intake and at the predicted location of the discharge surface plume maximum temperature.

MAXIMUM DISCHARGE CANAL WATER TEMPERATURE

The maximum discharge canal water temperature was determined and tabulated (Table B-1) for each day that the plant was operating during 1979. As can be seen in the tabulation, no single canal temperature was dominant for the entire reporting period.

The variation in ambient inlet water temperature coupled with fluctuations in power plant thermal output are responsible for

the relatively wide fluctuations of discharge canal temperatures.

Figure B-1 graphically illustrates the varied maximum discharge canal temperatures observed during 1979 and compares them with observed values during 1978. The maximum discharge canal release temperature limit of 111^{o}F was not exceeded during 1979.

<u>MAXIMUM CONDENSER TEMPERATURE RISE</u> (Condenser ΔT)

ETS 2.1.2 states:

> "Under normal full power operation, the temperature rise across the condenser shall not exceed 26^{o} F or 14.3^{o} C. Under the following conditions, the condenser temperature rise shall not exceed 35^{o} F or 20^{o} C for greater than a 72-hour period: 1) Condenser and/or circulating water pump maintenance; 2) Throttling circulating water pumps to minimize use of chlorine; 3) Fouling of circulating water system."

Table B-2 shows a tabulation of condenser ΔT values for 1979. Figure B-2 is a comparison of 1978 and 1979 data. Review of Figure B-2 shows that the plant operated near the design temperature rise the majority of the time. All reported values which exceeded the 26^{o} F limitation were the result of one or more of the stated conditions. Only one temperature was reported above the 35^{o} F limitation; it occurred for less than the 72-hour required limit, and thus was not in violation of the Environmental Technical Specifications.

<u>MAXIMUM TEMPERATURE WITHIN THE ZONE OF MIXING</u>

Table B-3 summarizes the maximum daily surface temperatures reported within the ocean discharge zone of mixing during 1979.

The maximum temperature observed in the zone of mixing during 1979 was 92^{o}F. Thus, all temperatures measured in the ocean mixing zone were within the 93^{o}F ETS limitation.

As in previous years, 100% retrieval of surface plume temperature data was not achieved due to suspected vandalism as well as exposure to an extremely harsh environment. These factors resulted in loss of data as reported in Section G, Reportable Occurrences, of this report.

Figure B-3 shows a comparison of ocean mixing zone maximum temperatures for 1978 and 1979. It can be seen that temperature ranges and frequencies for the two years are similar.

MAXIMUM SURFACE TEMPERATURE RISE - ZONE OF MIXING (ΔT)

Daily surface temperature rises above ambient in the ocean zone of mixing are summarized in Table B-4. As has been the case with other data obtained from the thermographs, 100% data retrieval was not possible for the 1979 reporting period. These factors resulted in the loss of data as reported in Section G, Reportable Occurrences, of this report.

Some time periods were observed when the discharge zone of mixing temperature was less than the ocean intake area temperature resulting in negative ΔT values. This was believed to be caused by time delay in passage of water through the plant, variations in ocean surface temperatures and surface currents.

Figure B-4 compares 1978 and 1979 data and illustrates the variations which occurred in measuring temperatures under the stated conditions.

TABLE B-1

ST. LUCIE PLANT
MAXIMUM DISCHARGE CANAL TEMPERATURE
TEMPERATURE DURATION

Number of Days	Maximum Temperature (°F)	% of Operating Days	Accumulated % of Operating Days
1	111	0.4	0.4
0	110	0	0.4
2	109	0.7	1.0
10	108	3.5	4.5
15	107	5.2	9.7
12	106	4.2	13.8
8	105	2.8	16.6
18	104	6.2	22.8
8	103	2.8	25.6
20	102	6.9	32.5
11	101	3.8	36.3
18	100	6.2	42.6
8	99	2.8	45.3
16	98	5.5	50.8
15	97	5.2	56.1
19	96	6.6	62.6
12	95	4.2	66.8
20	94	6.9	73.7
15	93	5.2	78.9
17	92	5.9	84.8
3	91	1.0	85.8
14	90	4.8	90.7
3	89	1.0	91.7
2	88	0.7	92.4
2	87	0.7	93.1
2	86	0.7	93.8
2	85	0.7	94.5
2	84	0.7	95.2
0	83	0	95.2
1	82	0.4	95.5
1	81	0.4	95.8
7	80	2.4	98.3
0	79	0	98.3
0	78	0	98.3
0	77	0	98.3
1	76	0.4	98.6
0	75	0	98.6
0	74	0	98.6
0	73	0	98.6
1	72	0.4	99.0
1	71	0.4	99.3
0	70	0	99.3
2	69	0.7	100.0

TABLE B-2

ST. LUCIE PLANT
MAXIMUM CONDENSER Δ T
TEMPERATURE DURATION TABLE

Number of Days	Maximum ΔT (^{o}F)	% Of Operation Days	Accumulated % Of Operating Days
1	36*	0.4	0.4
0	35	0	0.4
0	34	0	0.4
0	33	0	0.4
1	32	0.4	0.7
0	31	0	0.7
3	30	1.1	1.8
1	29	0.4	2.2
6	28	2.2	4.3
4	27	1.4	5.8
9	26	3.3	9.1
14	25	5.1	14.1
116	24	42.0	56.2
72	23	26.1	82.2
35	22	12.7	94.9
1	21	0.4	95.3
3	20	1.1	96.4
1	19	0.4	96.7
0	18	0	96.7
1	17	0.4	97.1
1	16	0.4	97.5
1	15	0.4	97.8
1	14	0.4	98.2
0	13	0	98.2
1	12	0.4	98.6
1	11	0.4	98.9
1	10	0.4	99.3
0	9	0	99.3
1	8	0.4	99.6
1	7	0.4	100.0

* Two circulating water pumps off for maintenance. 72 hour ETS limitation of 35^{o} F was not exceeded.

TABLE B-3

ST. LUCIE PLANT
ZONE OF MIXING MAXIMUM TEMPERATURE
TEMPERATURE DURATION CURVE

Number of Days	Maximum Temperature (°F)	% of Total Days of Data Collection	Accumulated % of Days of Data Collection
2	92	0.9	0.9
2	91	0.9	1.8
4	90	1.8	3.6
6	89	2.7	6.4
14	88	6.4	12.7
7	87	3.2	15.9
16	86	7.3	23.2
14	85	6.4	29.5
23	84	10.5	40.0
9	83	4.1	44.1
17	82	7.7	51.8
10	81	4.5	56.4
11	80	5.0	61.4
11	79	5.0	66.4
2	78	0.9	67.3
3	77	1.4	68.6
5	76	2.3	70.9
9	75	4.1	75.0
11	74	5.0	80.0
11	73	5.0	85.0
10	72	4.5	89.5
5	71	2.3	91.8
9	70	4.1	95.9
4	69	1.8	97.7
3	68	1.4	99.1
2	67	0.9	100.0

TABLE B-4

ST. LUCIE PLANT
ZONE OF MIXING MAXIMUM SURFACE TEMPERATURE RISE
TEMPERATURE DURATION CURVE

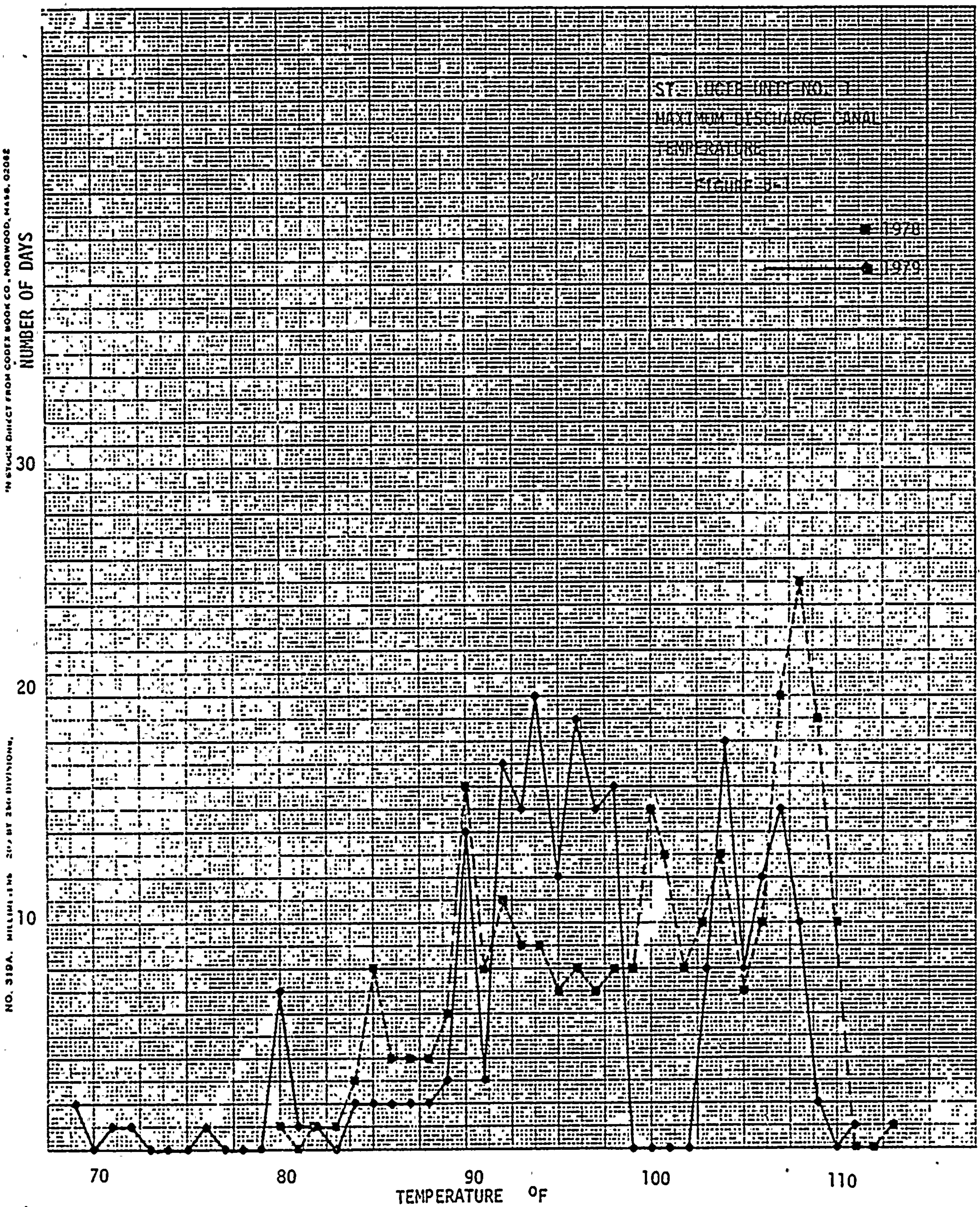
Number Of Days	Maximum ΔT (°F)	% Of Total Days Of Data Collection	Accumulated % Of Days Of Data Collection
2	8.1*	1.3	1.3
0	5.5	0	1.3
1	5.4	0.6	1.9
0	5.3	0	1.9
4	5.2	2.5	4.4
0	5.1	0	4.4
1	5.0	0.6	5.1
0	4.9	0	5.1
4	4.8	2.5	7.6
0	4.7	0	7.6
0	4.6	0	7.6
5	4.5	3.2	10.8
0	4.4	0	10.8
5	4.3	3.2	13.9
0	4.2	0	13.9
5	4.1	3.2	17.1
3	4.0	1.9	19.0
6	3.9	3.8	22.8
0	3.8	0	22.8
0	3.7	0	22.8
8	3.6	5.1	27.8
1	3.5	0.6	28.5
18	3.4	11.4	39.9
0	3.3	0	39.9
7	3.2	4.4	44.3
5	3.1	3.2	47.5
3	3.0	1.9	49.4
0	2.9	0	49.4
0	2.8	0	49.4
7	2.7	4.4	53.8
3	2.6	1.9	55.7
10	2.5	6.3	62.0
0	2.4	0	62.0
0	2.3	0	62.0
5	2.2	3.2	65.2
1	2.1	0.6	65.8
0	2.0	0	65.8
0	1.9	0	65.8
3	1.8	1.9	67.7
2	1.7	1.3	69.0
4	1.6	2.5	71.5
0	1.5	0	71.5
6	1.4	3.8	75.3

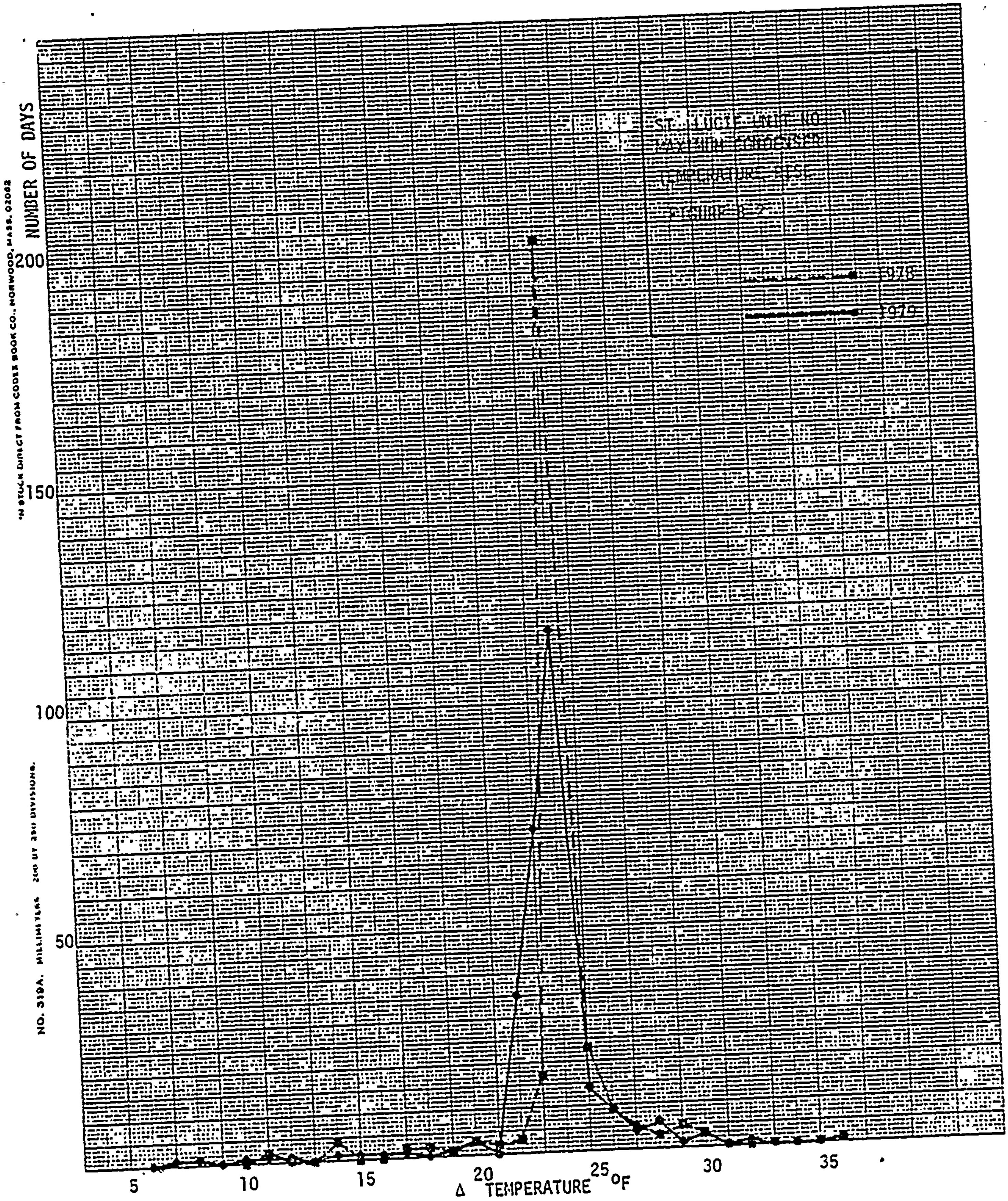
TABLE B-4

ST. LÚCIE PLANT (Cont.)
ZONE OF MIXING MAXIMUM SURFACE TEMPERATURE RISE
TEMPERATURE DURATION CURVE

Number Of Days	Maximum Δ T (°F)	% Of Total Days Of Date Collection	Accumulated % Of Days Of Data Collection
1	1.3	0.6	75.9
0	1.2	0	75.9
0	1.1	0	75.9
0	1.0	0	75.9
0	0.9	0	75.9
0	0.8	0	75.9
0	0.7	0	75.9
0	0.6	0	75.9
8	0.5	5.1	81.0
0	0.4	0	81.0
0	0.3	0	81.0
0	0.2	0	81.0
0	0.1	0	81.0
0	0	0	81.0
30	< 0	19.0	100.0

* Two Out-Of-Specification, ΔT values, were reported in February, 1979. A subsequent, more intensive analysis of the raw data and evaluation of the thermograph instruments' history indicated a high probability that these Δ T's are the result of an instrument malfunction not detected on the initial inspection of data. The recalculated values are fully explained in Section G. of this report.


ST. LUCIE UNIT NO. 1
MAXIMUM DISCHARGE CANAL
TEMPERATURE
FIGURE B-1
1978
1979
NUMBER OF DAYS
30
20
10
70
80
90
100
110
TEMPERATURE °F


ST. LUCIE UNIT NO. 1
MAXIMUM CONDENSER
TEMPERATURE RISE
FIGURE B-2
1978
1979
NUMBER OF DAYS
200
150
100
50
5
10
15
20
25
30
35
Δ TEMPERATURE °F
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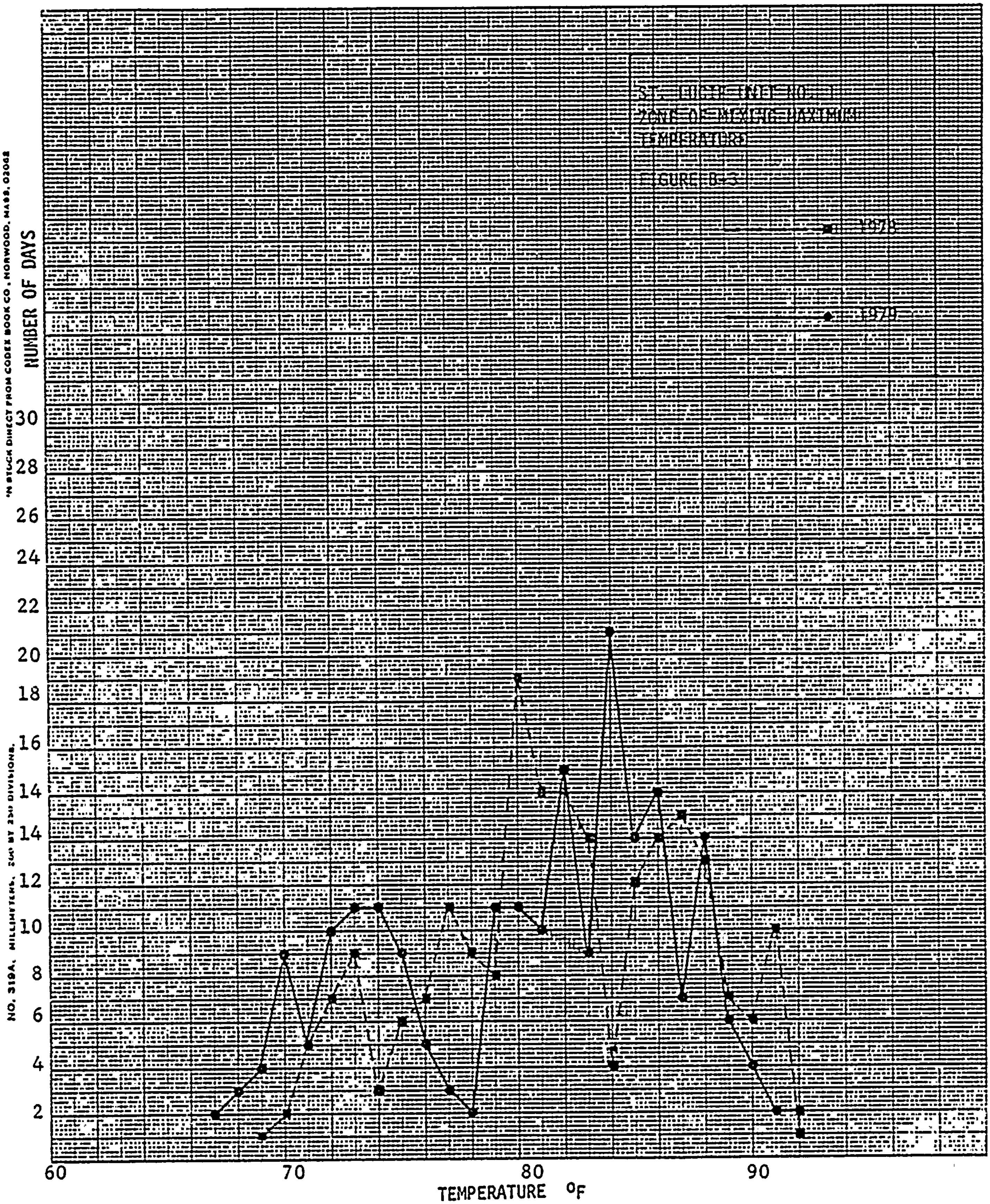
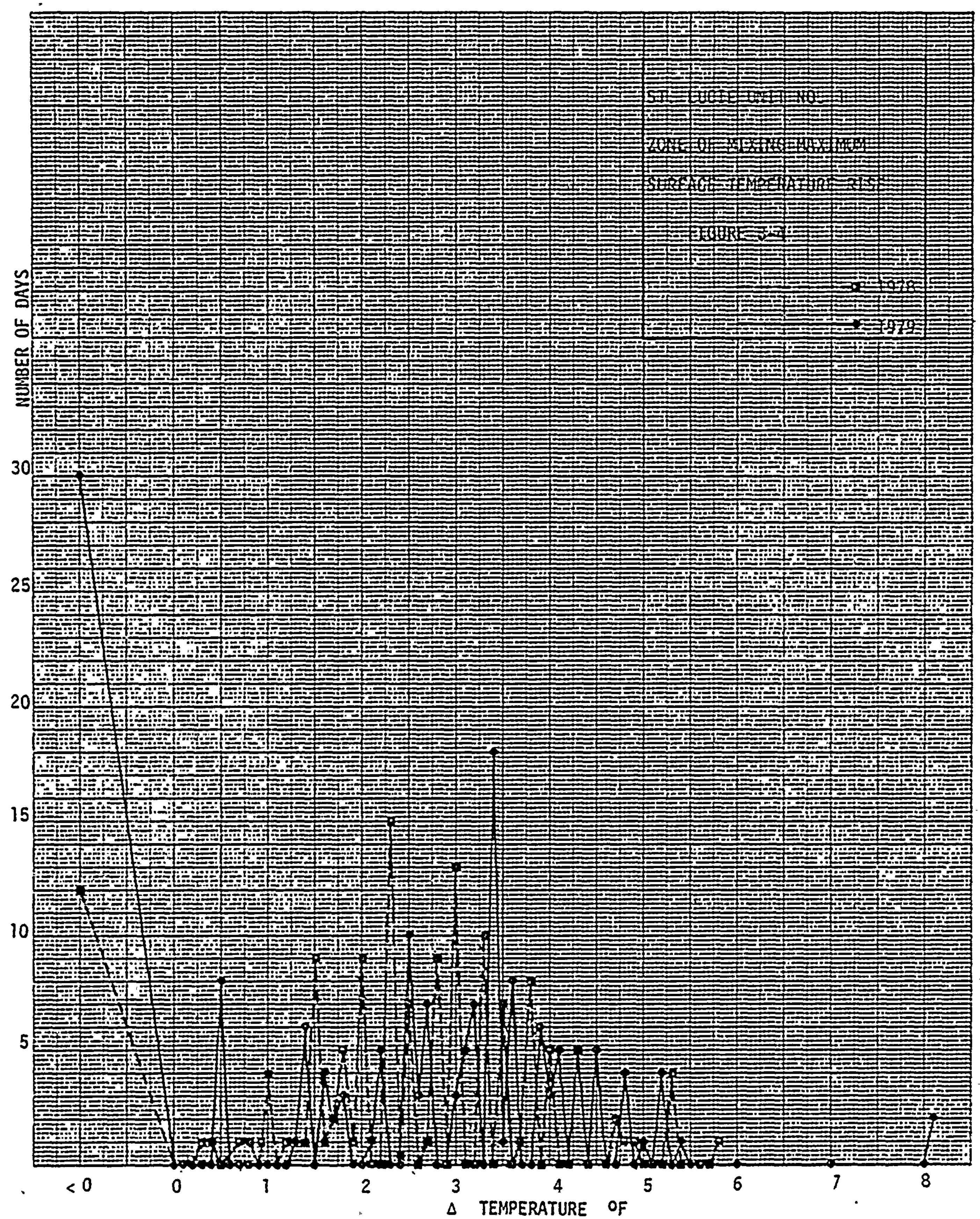
IN STOCK DIRECT FROM CODEX BOOK CO., NORWOOD, MASS. 02062


ST. LUCIE UNIT NO. 1
ZONE OF MIXING MAXIMUM
TEMPERATURES
FIGURE B-3
1978
1979
NUMBER OF DAYS
30
28
26
24
22
20
18
16
14
14
12
10
8
6
4
2
60
70
80
90
TEMPERATURE °F


ST. LUCIE UNIT NO. 1
ZONE OF MIXING MAXIMUM
SURFACE TEMPERATURE RISE
1978
1979
NUMBER OF DAYS
30
25
20
15
10
5
< 0
0
1
2
3
4
5
6
7
8
Δ TEMPERATURE °F

C. CHEMICAL (ETS 3.1.A.1 through 3.1.A.4)

INTRODUCTION

Tables C-1 and C-2 summarize the chemical monitoring program for 1979 associated with the operation of the cooling water system at the St. Lucie Plant. Dissolved oxygen (D.O.), pH, salinity, heavy metals and total residual chlorine (T.R.C.) were monitored in the discharge canal. Dissolved oxygen and heavy metals were also measured in the intake canal.

TOTAL RESIDUAL CHLORINE (ETS 3.1.A.1)

During 1979 total residual chlorine levels ranged from below the instrument maufacturer's specified analytical detection limit of 0.01 ppm to a high of 0.03 ppm. All reported values were well below the ETS limit of 0.1 mg/L at the terminus of the discharge canal. Due to the very low residual chlorine values it is believed that no adverse environmental impact occurred as a result of chlorination at the St. Lucie Plant.

Section D. of this report describes the St. Lucie Plant's Minimum Effective Chlorine Usage Program as required by the ETS.

HEAVY METALS (ETS 3.1.A.2)

The purpose of heavy metals monitoring was to detect any measurable concentrations above ambient seawater levels which could be attributed to cooling water passage through the plant.

Table C-2 shows the intake and discharge canal heavy metals concentrations measured during 1979. Values for arsenic, chromium, copper, lead and mercury show no measurable increase in concentration after plant cooling system passage.

Values obtained for nickel showed an increase in nickel concentration of 0.03 mg/L for the samples obtained in April. No specific conclusions could be drawn from this data, since this is the only time that nickel was observed above detectable levels in intake or discharge canal water for 1978 and 1979.

Relatively small amounts of zinc were detected in some intake and discharge water samples during 1979. Table C-2 illustrates a rather random occurrence of zinc during the sampling. All values are near minimum detection limit, except for the November discharge sample for which no explanation was apparent.

Iron was routinely found in all intake and discharge canal samples in relatively low concentrations. The only value of potential interest was an elevated September discharge sample, for which no explanation could be offered.

None of the heavy metal concentrations observed during 1979 are believed to have resulted in any adverse environmental impact to the nearshore ecosystem at the St. Lucie Plant site.

pH (ETS 3.1.A.3)

The purpose of pH monitoring in the discharge canal was to insure that the pH of once-through cooling system water was not being altered by plant passage when compared to the generally accepted pH levels for nearshore marine waters. The pH for the 1979 samples ranged from 8.1 to a 8.4, thus the pH is stable and within the normal range of these waters.

DISSOLVED OXYGEN (ETS 3.1.A.4)

Dissolved oxygen was monitored in the intake and discharge canals to determine the effect of plant cooling water system passage. As can be seen in Figure C-1, dissolved oxygen concentrations are generally unaffected by plant passage. The very slight depletion occurring between intake and discharge waters is not unexpected due to the heating of water during passage through the plant condensers. No adverse environmental impact was believed to have occurred from the minimal dissolved oxygen depletion observed during 1979.

SALINITY

Salinity monitoring was required only through January 23, 1979, since it was deleted from the ETS by Amendment 29 to Operating License DPR-67 on that date. Salinity data gathered between January 1, 1979 and January 23, 1979, as tabulated in Table C-1, ranged from a low of 33.7 o/oo to a high of 35.5 o/oo and revealed no values considered unusual for nearshore marine environments.

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1

Month JANUARY 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]	SALINITY[2]	T.R.C.[3]	
1			8.2		35.5		
2			8.2		34.2		
3	6.5		8.2	6.2	34.4	.01	
4			8.1		34.5		
5			8.1		34.5		
6			8.1		34.2		
7			8.1		34.1		
8			8.1		35.0		
9	6.6		8.1	6.3	35.2	.02	
10			8.1		33.8		
11			8.1		34.0		
12			8.1		33.9		
13			8.1		34.0		
14			8.2		34.0		
15			8.2		34.0		
16	6.9		8.2	6.7	33.7	.01	
17			8.2		33.8		
18			8.2		33.8		
19			8.2		33.7		
20			8.2		34.0		
21			8.2		34.0		
22			8.2		34.0		
23	6.5		8.2	7.5	35.0	0.1	
24			8.2				
25			8.2				
26			8.2				
27			8.2				
28			8.2				
29			8.2				
30	7.0		8.2	7.3			
31			8.2			.00	

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Salinity in ppt. (Deleted from ETS effective January 24, 1979)
[3]Total Residual Chlorine in ppm.

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month FEBRUARY 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.2				
2			8.2				
3			8.2				
4			8.2				
5			8.2				
6	6.7		8.2	6.5			
7			8.2			<.01	
8			8.2				
9			8.2				
10			8.2				
11			8.2				
12			8.2				
13	7.2		8.2	7.28		<.01	
14			8.2				
15			8.2				
16			8.2				
17			8.2				
18			8.2				
19			8.2				
20	7.18		8.2	7.30		<.01	
21			8.2				
22			8.2				
23			8.2				
24			8.2				
25			8.2				
26			8.2				
27	6.55		8.2	6.37		<.01	
28			8.2				
29							
30							
31							

NOTES:
[1] Dissolved Oxygen in ppm.
[2] Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month MARCH 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.2				
2			8.2				
3			8.2				
4			8.2				
5			8.2				
6	6.7		8.2	6.6			
7			8.2			<.01	
8			8.1				
9			8.2				
10			8.2				
11			8.2				
12			8.2				Did not chlorinate
13	6.6		8.2	6.4			3/12 - 3/16
14			8.2				
15			8.2				
16			8.2				
17			8.2				
18			8.2				
19			8.1			<.01	
20			8.1				
21	6.7		8.2	6.6			
22			8.2				
23			8.1			.01	
24			8.2				
25			8.2				
26			8.2			0.015	
27	6.6		8.2	6.4			
28			8.2				
29			8.2			<.01	
30			8.1				
31			8.1				

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month APRIL 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.2				Refueling -
2			8.2				No chlorination
3	6.4		8.2	6.4			
4			8.2				
5			8.2				
6			8.2				
7			8.2				
8			8.2				
9			8.2				
10			8.2				
11	9.0		8.3	9.0			
12			8.3				
13			8.3				
14			8.3				
15			8.3				
16			8.3				
17	6.4		8.3	6.4			
18			8.3				
19			8.3				
20			8.3				
21			8.3				
22			8.3				
23			8.3				
24	6.4		8.3	6.5			
25			8.3				
26			8.3				
27			8.3				
28			8.3				
29			8.3				
30			8.2				
31							

NOTES:
[1] Dissolved Oxygen in ppm.
[2] Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month MAY 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1	6.5		8.2	6.5			Refueling -
2			8.2				No chlorination
3			8.3				
4			8.2				
5			8.2				
6			8.2				
7			8.2				
8	6.5		8.2	6.5			
9			8.2				
10			8.2				
11			8.2				
12			8.2				
13			8.2				
14			8.2				
15	6.6		8.2	6.6			
16			8.2				
17			8.2				
18			8.2				
19			8.2				
20			8.2				
21			8.2				
22			8.2				
23	6.2		8.3	6.2			
24			8.3				
25			8.3				
26			8.3				
27			8.3				
28			8.3				
29	6.4		8.3	6.4			
30			8.4				
31			8.3				

NOTES:
[1] Dissolved Oxygen in ppm.
[2] Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month JUNE 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.3				
2			8.4				
3			8.2				
4			8.2				
5			8.2				
6	6.4		8.2	6.49			Refueling
7			8.2				No chlorination
8			8.2				
9			8.2				
10			8.2				
11			8.2				
12			8.2			.03	
13	6.0		8.2	5.6			
14			8.2				
15			8.2				
16			8.2				
17	6.2		8.2				
18			8.2				
19			8.2	5.70			
20			8.3				
21			8.2			.03	
22			8.3				
23			8.2				
24			8.3				
25			8.2				
26	6.0		8.2	6.22			
27			8.3			.03	
28			8.2				
29			8.3				
30			8.2				
31			8.3				

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month JULY 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.3				
2			8.2				
3	5.80		8.2	5.60			
4			8.2				
5			8.2			<.01	
6			8.2				
7			8.2				
8			8.2				
9			8.2				
10	6.20		8.2	5.70			
11			8.2			.03	
12			8.2				
13			8.2				
14			8.2				
15			8.2				
16			8.2				
17	5.80		8.2	5.50		.02	
18			8.2				
19			8.2				
20			8.2				
21			8.2				
22			8.2				
23			8.2				
24	7.20		8.1	6.80		.02	
25			8.2				
26			8.1				
27			8.2				
28			8.1				
29			8.1				
30			8.1				
31	7.20		8.2	6.70			

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month AUGUST 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.2				
2			8.2			.01	
3			8.2				
4			8.2				
5			8.2				
6			8.2				
7	5.9		8.2	5.6		.02	
8			8.2				
9			8.2				
10			8.2				
11			8.2				
12			8.2				
13			8.2				
14	6.6		8.2	6.2			
15			8.2			.01	
16			8.2				
17			8.2				
18			8.2				
19			8.2				
20			8.2				
21	5.9		8.1	5.8			
22			8.2			0.02	
23			8.2				
24			8.2				
25			8.2				
26			8.2				
27			8.2				
28	5.8		8.2	5.2		0.01	
29			8.1				
30			8.2				
31			8.2				

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month SEPTEMBER 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.2				
2			8.2				
3							
4			8.2				
5			8.2				
6	5.5		8.1	5.2		.01	
7			8.1				
8			8.1				
9			8.1				
10			8.1				
11	7.2		8.1	6.6			
12			8.1			.02	
13			8.1				
14			8.1				
15			8.1				
16			8.1				
17			8.1				
18	6.9		8.1	6.4		.01	
19			8.1			.01	
20			8.1				
21			8.1				
22			8.1				
23			8.1				
24			8.1				
25	6.8		8.2	6.9			Did not chlorinate
26			8.1				9/22-9/30
27			8.1				
28			8.1				
29			8.1				
30			8.1				
31							

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month OCTOBER 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.1				
2			8.2				
3	5.9		8.2	5.9		.02	
4			8.2				
5			8.2				
6			8.2				
7			8.2				
8			8.2			.02	
9	6.0		8.2	6.0			
10			8.2				
11			8.2				
12			8.1				
13			8.1				
14			8.2				
15			8.1				Did not chlorinate
16	6.0		8.1	6.0			10/15-10/23
17			8.1				
18			8.1				
19			8.1				
20			8.1				
21			8.1				
22			8.1				
23	5.8		8.1	5.8			
24			8.1			.02	
25			8.1				
26			8.1				
27			8.1				
28			8.1				
29			8.1				
30	6.2		8.1	6.1		.03	
31			8.1				

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month NOVEMBER 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.1				
2			8.2				
3			8.2				
4			8.2				
5			8.2				
6	6.6		8.2	6.6			
7			8.2			.02	
8			8.2				
9			8.2				
10			8.2				
11			8.2				
12			8.1				
13	6.2		8.2	6.2			
14			8.1				
15			8.1				
16			8.2			.01	
17			8.1				
18			8.2				
19			8.2				
20	6.4		8.1	6.3		.02	
21			8.1				
22			8.1				
23			8.1				
24			8.1				
25			8.1				
26			8.1				
27	6.7		8.1	6.6			
28			8.2			.02	
29			8.2				
30			8.2				
31							

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
CHEMICAL PARAMETERS
TABLE C-1 (Cont.)

Month DECEMBER 1979

DAY	INTAKE		DISCHARGE				REMARKS
	D.O.[1]		pH	D.O.[1]		T.R.C.[2]	
1			8.2				
2			8.2				
3			8.2				
4	5.8		8.2	6.0			
5			8.2			.02	
6			8.2				
7			8.2				
8			8.2				
9			8.2				
10			8.2				
11	5.7		8.2	5.6		.01	
12			8.1				
13			8.1				
14			8.1				
15			8.1				
16			8.1				
17			8.1				
18	6.1		8.1	5.9		.01	
19			8.1				
20			8.1				
21			8.1				
22			8.1				
23			8.1				
24			8.1				
25			8.1				
26	6.1		8.1	6.0		.02	
27			8.2				
28			8.2				
29			8.2				
30			8.2				
31			8.2				

NOTES:
[1]Dissolved Oxygen in ppm.
[2]Total Residual Chlorine in ppm

ST. LUCIE PLANT UNIT NO. 1
HEAVY METALS

TABLE C-2

A. INTAKE

YEAR 1979

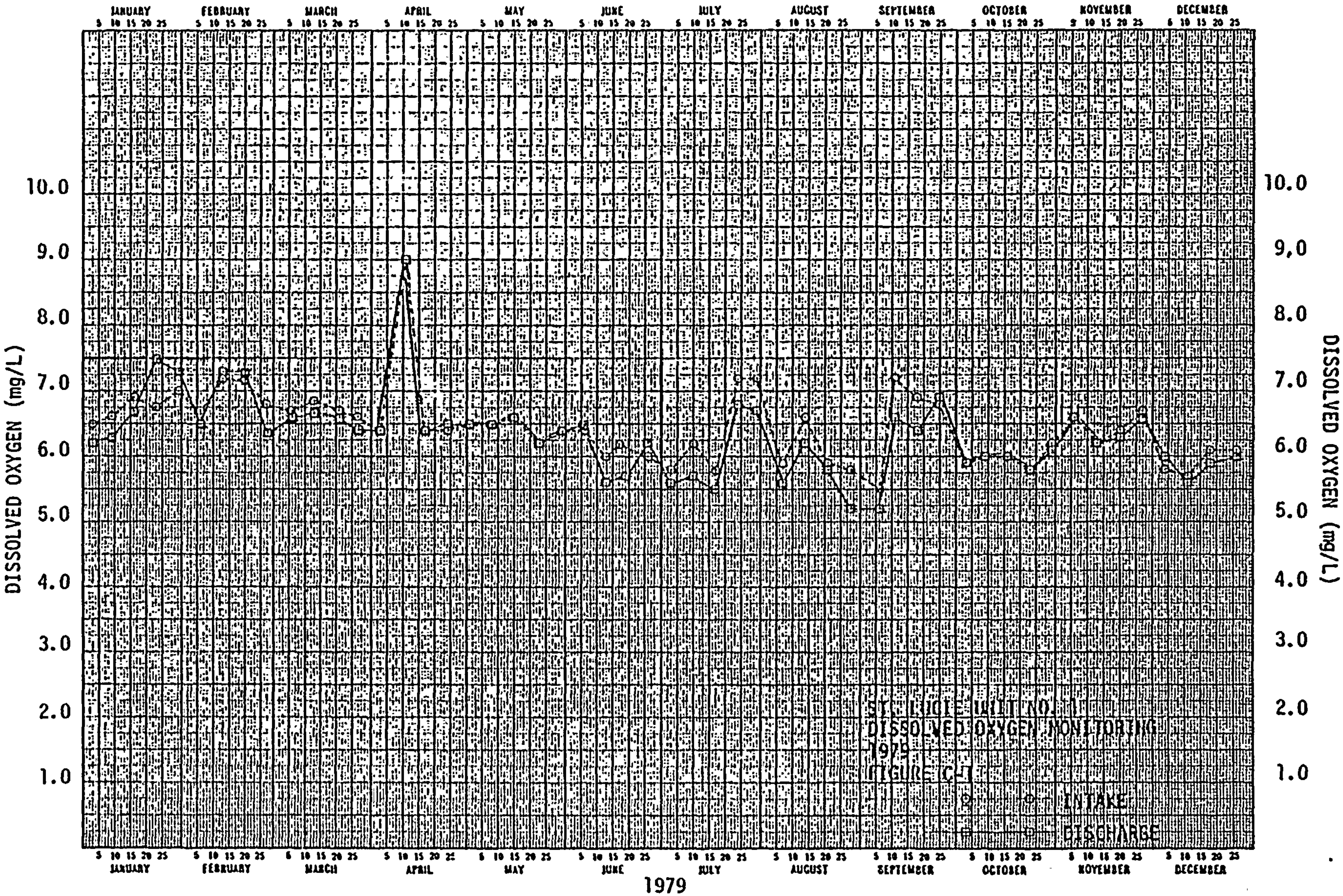
	ARSENIC[1]	CHROMIUM[2]	COPPER[2]	IRON[2]	LEAD[2]	MERCURY[2]	NICKEL[2]	ZINC[2]
JAN.	<0.002	< .02	< .02	.32	< .05	< .0002	< .02	< .02
FEB.	<0.002	< .02	< .02	.34	< .05	< .0002	< .02	< .02
MAR.	<0.002	< .02	< .02	.14	< .05	< .0002	< .02	.03
APR.	<0.002	< .02	< .02	.42	< .05	< .0002	.12	.02
MAY	<0.002	< .02	< .02	.18	< .05	< .0002	< .02	< .02
JUNE	*	< .02	< .02	.05	< .05	< .0002	< .02	< .02
JULY	<0.002	< .02	< .02	.08	< .05	< .0002	< .02	.03
AUG.	<0.002	< .02	< .02	.06	< .05	< .0002	< .02	.02
SEPT.	<0.002	< .02	< .02	.05	< .05	< .0002	< .02	< .02
OCT.	<0.002	< .02	< .02	.26	< .05	< .0002	< .02	< .02
NOV.	<0.002	< .02	< .02	.33	< .05	< .0002	< .02	< .02
DEC.	<0.002	< .02	< .02	.35	< .05	< .0002	< .02	.04

B. DISCHARGE

	ARSENIC[1]	CHROMIUM[2]	COPPER[2]	IRON[2]	LEAD[2]	MERCURY[2]	NICKEL[2]	ZINC[2]
JAN.	<0.002	< .02	< .02	.21	< .05	< .0002	< .02	< .02
FEB.	<0.002	< .02	< .02	.08	< .05	< .0002	< .02	< .02
MAR.	<0.002	< .02	< .02	.12	< .05	< .0002	< .02	< .03
APRIL	<0.002	< .02	< .02	.25	< .05	< .0002	.15	.02
MAY	<0.002	< .02	< .02	.05	< .05	< .0002	< .02	< .02
JUNE	*	< .02	< .02	.06	< .05	< .0002	< .02	< .02
JULY	<0.002	< .02	< .02	.07	< .05	< .0002	< .02	.03
AUG.	<0.002	< .02	< .02	.05	< .05	< .0002	< .02	.02
SEPT.	<0.002	< .02	< .02	1.40	< .05	< .0002	< .02	.04
OCT.	<0.002	< .02	< .02	.24	< .05	< .0002	< .02	< .02
NOV.	<0.002	< .02	< .02	.30	< .05	< .0002	< .02	.10
DEC.	<0.002	< .02	< .02	.26	< .05	< .0002	< .02	.05

NOTE: 1 Results in PPM
2 Results in mg/L

*Samples lost


JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
DISSOLVED OXYGEN (mg/L)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
ST. LUCIE UNIT NO. 1
DISSOLVED OXYGEN MONITORING
1979
FIGURE C-1
INTAKE
DISCHARGE
1979

D. MINIMUM EFFECTIVE CHLORINE USAGE STUDY PROGRESS REPORT (ETS 4.2)

A chlorine solution is added to the seawater passing through the plant ahead of the plant intake structure for biofouling control. The chlorinated seawater subsequently passes through the main condensers and component cooling water heat exchangers and finally into the discharge canal.

During 1977 and 1978 data were obtained in an attempt to relate condenser efficiency to chlorine injection rates. It was determined that they were apparently unrelated. Additionally, observations of the level of biofouling were carried out on the component cooling water heat exchangers, where efficiency testing was impractical. Visual observations of the condenser inlet water boxes, during 1978, after utilizing varying chlorine injection rates, indicated that an injection rate sufficient to yield a 1.5 ppm free residual chlorine concentration at the outlet waterbox was necessary for biofouling control. As of the end of 1978 plant personnel were unable to inspect the condition of the component cooling water heat exchangers in order to assess the effect of these chlorine injection rates. As stated in the 1978 Annual Report, initial estimates of required chlorine usage were too low and injection rates were, therefore raised in late 1978. The chlorine injection rates remained at the higher levels until inspections during the April and May 1979 refueling outage.

Starting the July 1979, the chlorine injection rates were decreased based on testing, which revealed that a lower chlorine injection rate than previously used would obtain the same levels

of free residual chlorine at the condenser outlet waterboxes, which had previously been shown to be effective. It was believed that the installation of titanium alloy condenser tubes during the refueling outage was somehow related to this phenomenon. Inspection of the component cooling water heat exchangers during the 1979 refueling outage indicated that no increase in the level of biofouling had occurred. Although no inspection of the heat exchangers has been performed since the post-refueling outage chlorine injection rate reduction, it is believed that the component cooling water heat exchangers have not experienced biofouling problems. Observations of chlorine effectiveness will continue to be made with an ultimate goal of optimization of heat exchanger surface cleanliness and chlorine residuals at the lowest possible levels of discharge.

Total residual chlroine levels are reported in Section C of this report. As can be seen in Table C-1 the residuals have been consistently below the ETS limit of 0.1 ppm at the terminus of the discharge canal. Table D-1 shows the monthly chlorine injection rates used in 1979. It is believed that no adverse environmental impact has resulted from the use of chlorine at the St. Lucie Plant.

TABLE D - 1

ST LUCIE UNIT NO. 1
CHLORINE INJECTION RATES
1979

Months	Cl_2 Injection Rate (lbs/hr)	Total Number of Days/Month Chlorination Occurred
January	167	30
February	167	27
March	167	27
April	Refueling	0
May	Refueling	0
June	167 & 104	22
July	104, 125 & 146	30
August	125	31
September	125 & 146	19
October	146	20
November	146	25
December	146	31

NOTE: Chlorination was performed on one waterbox once per day for 1.5 hours at the above listed injection rates.

E. ADDITIONAL BIOTIC RESULTS

Some sea turtle entrapment in the intake canal has occurred during the monitoring period from January 1, 1979 through December 31, 1979. A large mesh turtle net placed in the intake canal is used to capture the entrapped turtles. A total of 164 turtles were caught, tagged and released unharmed to the ocean. Loggerhead turtles accounted for 162 of the number and two green turtles comprised the balance.

In addition to the number of turtles noted above, some mortality of sea turtles has been noted in the intake canal with 13 loggerheads and one green being recovered. With the exception of three accidental deaths directly associated with netting, the cause of death for the remainder of the turtles (11) was unknown.

F. CHANGES TO THE ENVIRONMENTAL TECHNICAL SPECIFICATIONS

During 1979, the Nuclear Regulatory Commission (NRC) issued Amendment No. 29 to Operating License No. DPR-67 on January 24, 1979. This amendment consisted of changes to the Environmental Technical Specifications in response to FP&L's requests dated August 1, 1977; October 27, 1977; August 29, 1978; and September 29, 1978. The amendment revised Appendix B Administrative Controls to reflect individual title changes and department name changes; deleted salinity, primary coolant activity, and fish impingement monitoring requirements; included Centigrade temperature equivalents in addition to Fahrenheit, wherever specified; and authorized a 2°F increase in the allowable condenser cooling water temperature rise.

By its letters dated April 12 and September 10, 1979, FP&L has requested that deletion of thermal and chemical limits and monitoring requirements on the basis of ALAB-515 (Yellow Creek). As of December 31, 1979, the NRC had not yet approved this request.

G. REPORTABLE OCCURRENCES

The following Reportable Occurence Reports were filed with NRC's Region II office of Inspection and Enforcement during 1979.

R.O. NUMBER	DATE OF R.O.	TITLE
335-B-79-01	1-5-79	Ocean Intake Area - Recording Thermographs
335-B-79-02*	3-14-79	Zone of Mixing - Surface Temperature Rise
335-B-79-03	8-15-79	Ocean Discharge Area - Recording Thermographs
335-B-79-04	11-13-79	Ocean Intake Area - Recording Thermographs
335-B-79-05	12-10-79	Ocean Discharge Area - Recording Thermographs

* R. O. 335-B-79-02 reported two out-of specification values for February 26 and 27, 1979 of 8.5°F and 6.7°F respectively. A subsequent, more intensive analysis of the raw data revealed that these values were actually 8.1°F for February 26 and 8.1°F for February 27. Evaluation of thermograph instruments' history indicated a high probability that these temperatures were the result of instrument malfunction not detected on the initial inspection of data. The corrected temperatures were not believed to have caused any adverse environmental impact.

AB-244

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT

ANNUAL NON-RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

VOLUME II

BIOTIC MONITORING

1979

APPLIED BIOLOGY, INC.
ATLANTA, GEORGIA

February 1980

BIOTIC MONITORING

TABLE OF CONTENTS

TABLE OF CONVERSION FACTORS FOR METRIC UNITS

To convert	Multiply by	To obtain
centigrade (degrees)	(°C x 1.8) + 32	fahrenheit (degrees)
centigrade (degrees)	°C + 273.18	kelvin (degrees)
centimeters (cm)	3.937×10^{-1}	inches
centimeters (cm)	3.281×10^{-2}	feet
centimeters/second (cm/sec)	3.281×10^{-2}	feet per second
cubic meters	1.0×10^{6}	cubic centimeters
cubic meters	3.531×10^{1}	cubic feet
cubic centimeters (cm^3)	1.0×10^{-3}	liters
foot-candle	1.0764×10^{1}	lumen/sq. meter (lux)
grams (g)	2.205×10^{-3}	pounds
grams (g)	3.527×10^{-2}	ounces (avoirdupois)
kilograms (kg)	1.0×10^{3}	grams
kilograms (kg)	2.2046	pounds
kilograms (kg)	3.5274×10^{1}	ounces (avoirdupois)
kilometers (km)	6.214×10^{-1}	miles (statute)
kilometers (km)	1.0×10^{6}	millimeters
liters (l)	1.0×10^{3}	cubic centimeters (cm^3)
liters (l)	2.642×10^{-1}	gallons (U.S. liquid)
meters (m)	3.281	feet
meters (m)	3.937×10^{1}	inches
meters (m)	1.094	yards
microns (μ)	1.0×10^{-6}	meters
milligrams (mg)	1.0×10^{-3}	grams
milligrams/liter (mg/l)	1.0	parts per million
milliliters (ml)	1.0×10^{-3}	liters (U.S. liquid)
millimeters (mm)	3.937×10^{-2}	inches
millimeters (mm)	3.281×10^{-3}	feet
square centimeters (cm^2)	1.550×10^{-1}	square inches
square meters (m^2)	1.076×10^{1}	square feet
square millimeters (mm^2)	1.55×10^{3}	square inches

EXECUTIVE SUMMARY

INTRODUCTION

This document is the fourth consecutive annual report on biotic monitoring at the Florida Power & Light Company St. Lucie Plant. These reports have been prepared in response to the Nuclear Regulatory Commission's Environmental Technical Specifications found in Appendix B to Operating License No. DPR-67 for St. Lucie Plant Unit No. 1. The objective of the specifications, and of the study, is to assess the effects of plant construction and operation on the major biotic communities in the nearshore marine environment.

FISH AND SHELLFISH

Potential nearshore effects are mainly associated with the entrapment of fish and shellfish into the intake canal, which may be subsequently followed by their impingement or entrainment. However, no large accumulation of fishes was indicated in the intake canal. In addition, the numbers of fish and shellfish impinged and ichthyoplankton entrained were low, and thus the plant intake is not considered to have any significant impact on offshore populations.

The thermal discharge plume is the plant effect of primary potential concern offshore. No detrimental effects of this plume on fishes, including the commercially important migratory species, could be discerned from the distribution and abundance of the fishes collected at the offshore stations. Differences in the species composition and abun-

dance of the fish communities, both between stations and between study years, were not attributed to plant operation, but rather to natural events.

MACROINVERTEBRATES

The benthic community structure has exhibited extensive seasonal variations, apparently unrelated to plant activity, over the past 4 years. Composition by major taxonomic group has exhibited little change over this time. Although the dominant macroinvertebrate species in the benthic grab samples have fluctuated in abundance from year to year, no statistically significant reductions in the number of individuals or number of species have been observed.

Trawl samples showed a statistically significant reduction in the number of taxa collected at several stations. These reductions are considered to be natural changes in community composition. If the plant was affecting the offshore benthic community, differences in the number of taxa collected at the control and discharge stations would have been greater than the studies indicated.

PHYTOPLANKTON

Variations in phytoplankton seasonal cycles were typical of natural annual variation and, during the 4-year monitoring period, the offshore distribution and seasonal occurrence of major species did not indicate effects due to power plant operation. Data suggested, however, that plant operation altered phytoplankton composition at the discharge during

certain seasons by decreasing or enhancing the densities of certain taxa. Plant effect on standing crop and relative abundance of phytoplankton was limited to the discharge canal and to the surface at the offshore discharge.

ZOOPLANKTON

The offshore zooplankton composition has not changed substantially over the 4 years of study. Zooplankton densities, however, have been shown to be greater at the offshore discharge station than at other offshore stations. It has been suggested that, because this greater density at the offshore discharge station was associated with a plant-related increase in phytoplankton density at the same location, the plant has had an indirect effect on the offshore zooplankton. A direct effect of plant entrainment was shown by a decrease in the number of zooplankton in the discharge canal as compared to the number in the intake canal.

MACROPHYTES

Attached macrophytic growth at all stations in the study area was limited primarily by the lack of suitable substrates; thus, the importance of this biotic community as a contributor to primary productivity was minimal. Seasonal trends in algal diversity were noted, but no plant related effects were observed.

WATER QUALITY

No statistically significant differences were found between measurements made at the offshore stations for selected physical parameters,

with the exception of turbidity. Turbidity was significantly higher at the discharge and control stations. These stations are near the shore where the wave action is greatest. Concentrations of nutrients in the nearshore environment adjacent to the plant were dispersed homogeneously, but varied with time of the year. No differences were found when stations near the plant were compared with the control station, and analysis of nutrient concentrations indicated that plant operation had no statistically significant effect on the selected nutrients measured in this study.

TURTLES

During 1979, it was calculated that 4676 nests occurred on Hutchinson Island. This total nest estimate is consistent with previous years' totals. As in previous years, a gradient of nesting was identified with the heaviest nesting on the southern end of the island. Nesting on Area 4 (plant site) during 1979 was not influenced by the plant.

No statistically significant alteration of spatial or temporal distribution of nesting has occurred during the years of power plant operation.

CONCLUSION

An assessment of the effects of St. Lucie Plant construction and operation indicated low impact on the major biotic communities in the nearshore marine environment.

A. INTRODUCTION

BACKGROUND

This document has been prepared in response to the Nuclear Regulatory Commission's Environmental Technical Specifications found in Appendix B to Operating License No. DPR-67, which is for Unit No. 1 of Florida Power & Light Company's St. Lucie Plant.

In 1970, the United States Atomic Energy Commission (now Nuclear Regulatory Commission) issued construction Permit No. CPPR-74 to the Florida Power & Light Company (FPL). This permit allowed construction of Unit No. 1 of the St. Lucie Plant, an 810-MW nuclear-powered electric generating station, on Hutchinson Island in St. Lucie County, Florida. Unit No. 1 was placed on-line in March 1976. Plant operation was intermittent in 1976 but was continuous throughout 1977, 1978, and 1979 except for repair and refueling outages. Repair outages were brief, typically lasting no more than a few days. The refueling outage occurred from 1 April 1979 through 1 June 1979.

The St. Lucie Plant presently generates electricity with one 810-MW pressurized water reactor. A once-through circulating water system, which consists of submerged intake and discharge pipes linked by canals to the plant, provides the condenser cooling water. A vertical intake structure located 365 m offshore draws cooling water from the Atlantic Ocean. The top of the intake structure consists of a concrete velocity cap which is approximately 2.4 m below the surface. A pipe buried under the dunes transmits water from the intake point into the intake canal.

The 90-m-wide canal carries the cooling water about 1500 m to the plant intake structure, where pumps provide a flow of 33,400 l/sec. The water moves through the intake screens, passes through the plant condensers, and is released into the discharge canal.

The temperature rise of the water passing through the condensers is permitted to 26°F (14.4°C). After leaving the plant, the heated water passes through a 60-m-wide discharge canal before entering a pipe buried under a dune and the ocean floor. The water is carried about 365 m offshore and discharged through a Y-shaped pipe 5 m below the water surface. The discharge pipe is located 730 m north of the intake.

The Florida Department of Natural Resources Marine Research Laboratory, in conjunction with FPL, conducted preoperational baseline environmental studies of the marine environment adjacent to the St. Lucie Plant from September 1971 to July 1974. FPL contracted with Applied Biology, Inc. (ABI), in 1975 to conduct the operational phase of the ecological monitoring program at the St. Lucie Plant. A sampling program was designed in accordance with the Nuclear Regulatory Commission's Environmental Technical Specifications for St. Lucie Unit No. 1. Preliminary studies on fish populations in the plant's cooling water canals began in December 1975; the complete sampling program started in March 1976. ABI submitted results of the 1976, 1977, and 1978 studies to FPL in separate annual reports.

This report compares data generated during the present study with results of the baseline study and the 1976, 1977, and 1978 operational studies in order to assess the effects of plant construction and operation on the major biotic communities in the nearshore marine environment.

AREA DESCRIPTION

The St. Lucie Plant is located on a 457.3-ha site on Hutchinson Island, approximately midway between Ft. Pierce and St. Lucie Inlets on Florida's lower east coast (Figures A-1 and A-2). The island is bounded on the east by the Atlantic Ocean and on the west by the Indian River, a shallow lagoonal estuary.

The Indian River, linked by tidal flushing to the Atlantic Ocean via Ft. Pierce and St. Lucie Inlets as well as to Lake Okeechobee via the St. Lucie River and Canal, is an integral part of the ecosystem in this area.

Hutchinson Island extends 37.5 km between inlets and reaches its maximum width of 1.8 km at the plant site. Elevations approach 5 m atop dunes bordering the beach, then decrease to sea level in the mangrove swamps that are common on much of the western side. Island vegetation is typical of southeast Florida coastal areas: dense stands of Australian pine, palmetto, sea grape, and Spanish bayonet inhabit the higher elevations, and mangroves abound in the lower elevations and swamps. County mosquito control practices have extensively altered large portions of the interior mangrove communities over past decades. Controlled flooding has killed numerous mangrove stands, including some on the plant site.

Offshore coquinoid rock formations parallel much of the island's ocean shoreline and provide suitable substrate for intertidal accumulations of worm reefs. Colonial marine worms form the stony-looking worm reefs out of sand and mucus. A relatively extensive worm reef community lies approximately 0.5 km south of the intake pipeline. Relic worm reef formations protrude through present-day beaches along much of the island's southern end.

The ocean bottom offshore of the plant site consists entirely of sand and shell sediments with no reef obstructions or rock outcroppings. The unstable substrate limits the establishment of rooted macrophytes or attached benthic communities.

The Florida Current, which parallels the continental shelf margin, begins to diverge from the coastline at West Palm Beach. At Hutchinson Island, this current is approximately 33 km offshore. Oceanic water associated with the current's western boundary, however, periodically meanders over the inner shelf, especially during summer months.

SAMPLING DESIGN

The proposed configurations of the thermal plume provided by FPL and also the locations of dominant macrohabitats established during the preoperational survey determined station locations. Maps within the respective sections of this report depict the stations used in each phase of the present study.

A description of the offshore stations is given in Table A-1. Stations 1, 2, and 3 were selected to be perpendicular to the beach on a transect coinciding with the postulated slack current thermal plume configuration. Additional offshore stations (4 and 5) were established to the south and north, respectively, of Station 2. A control station (Station 0) was established south of the plant discharge.

Three beach seine stations were located near shore, at points north of the discharge (Station 6), south of the intake (Station 8), and midway between these two points (Station 7). Six additional stations were established in the plant intake canal (Stations 11, 13, 14, and 15) and discharge canal (Stations 12 and 16).

Systematic sampling was continued in 1979 according to the outline in Table A-2. To increase the efficiency of some portions of the study, minor changes were made in the sampling design. These changes are discussed in the appropriate sections of this report.

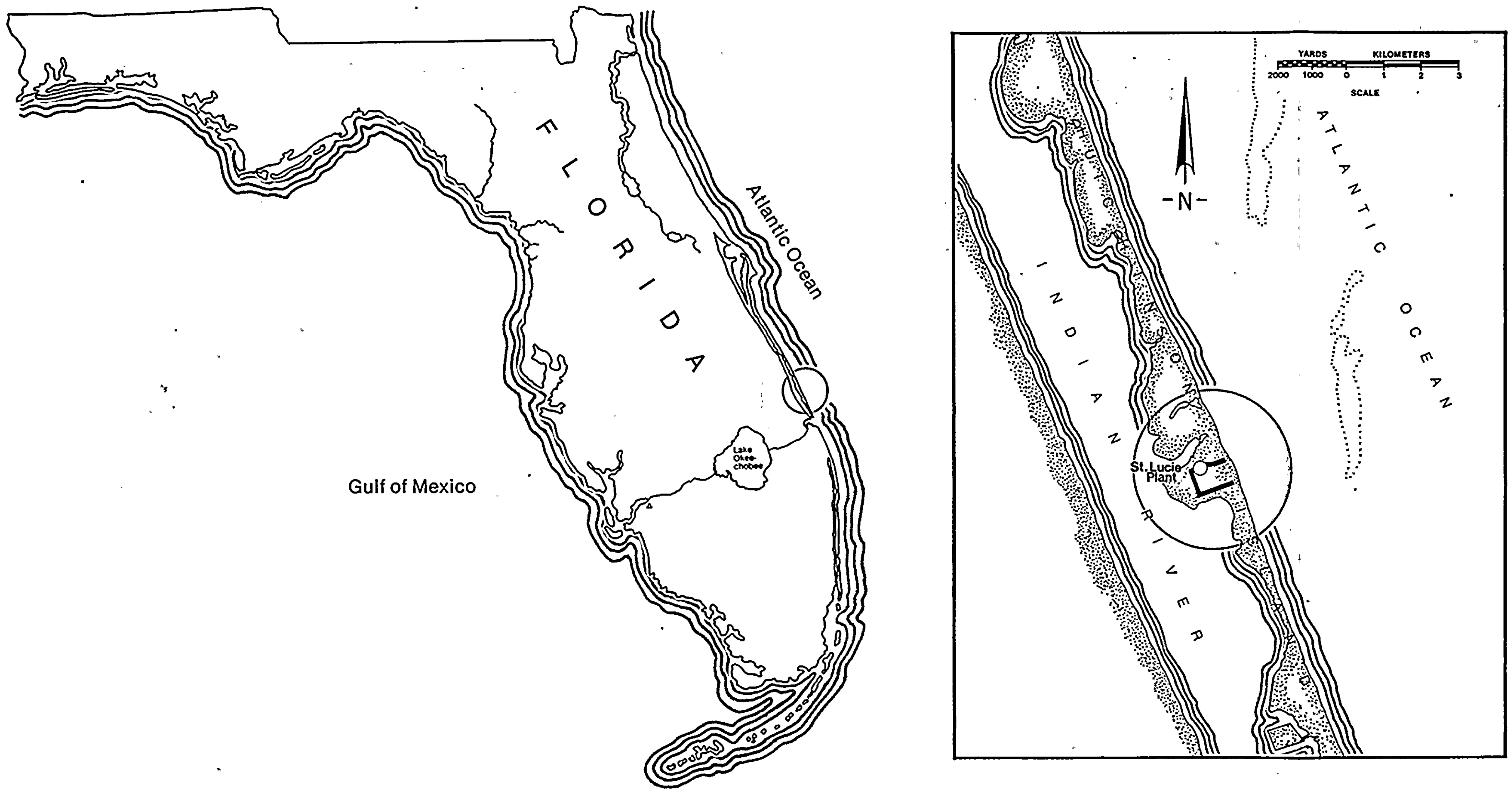


Figure A-1. Location of St. Lucie Plant.

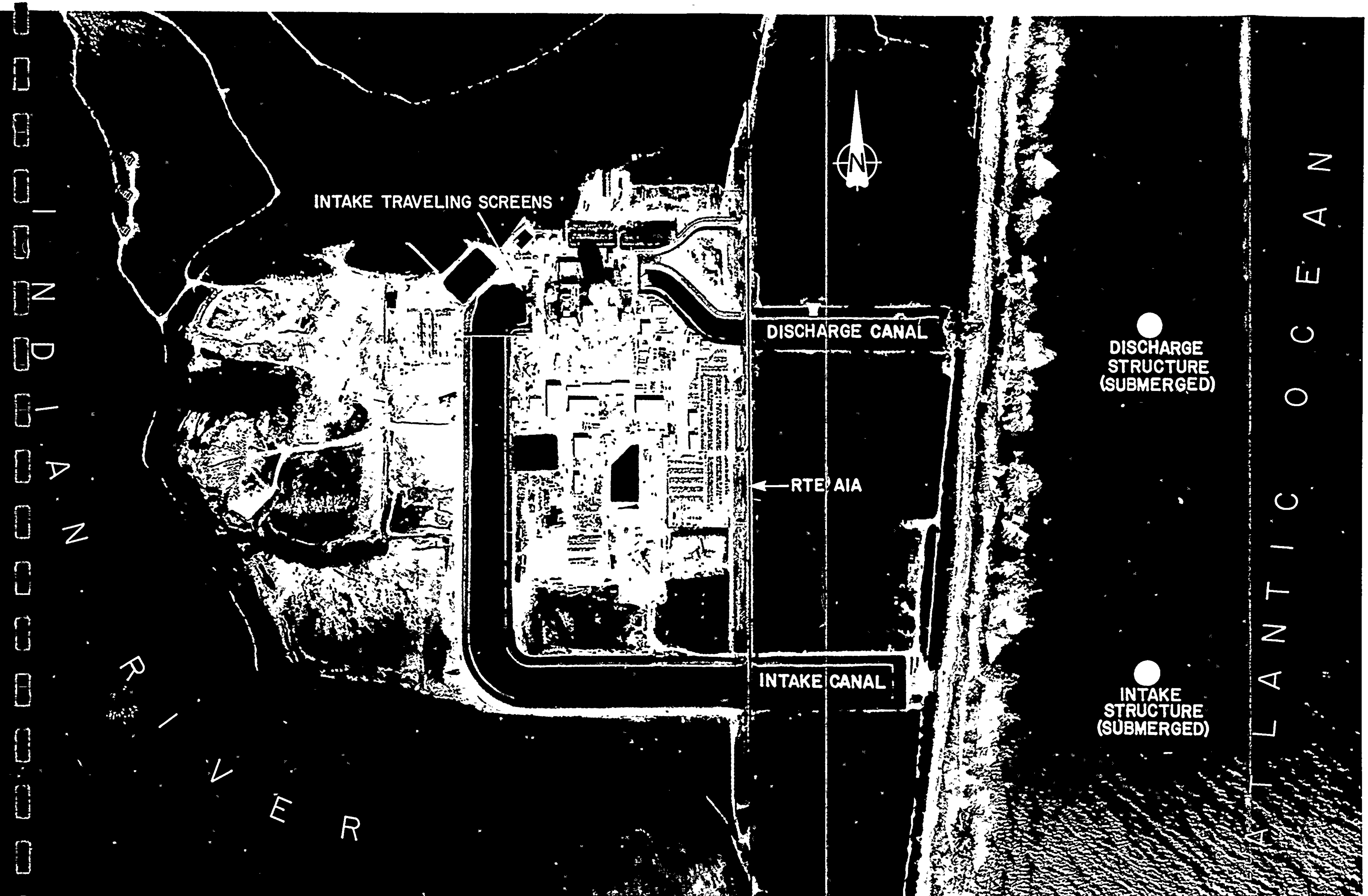


Figure A-2. St. Lucie Plant area photograph.

TABLE A-1

DESCRIPTION OF OFFSHORE STATIONS
ST. LUCIE PLANT
1976-1979

Station	Latitude-Longitude	Geographic location	Mean sampling depth (m)	Substrate
0 (control)	27°19.1'N 80°13.2'W	4.7 km south of plant discharge, on beach terrace	8.2	Fine gray sand
1	27°21.1'N 80°14.1'W	0.5 km offshore, at seaward margin of beach terrace	7.6	Gray, hard-packed fine sand
2	27°21.4'N 80°13.3'W	1.5 km east-northeast of Station 1 in offshore trough, approximately midway between beach terrace and offshore shoal	11.3	Shell hash
3	27°21.7'N 80°12.4'W	3 km from Station 1, on coincident compass heading, atop Pierce Shoal	7.6	Medium sand with few large shell particles
4	27°20.6'N 80°12.8'W	1.6 km south-southeast of Station 2 and 0.6 km west of southernmost tip of Pierce Shoal, in offshore trough	11.3	Shell hash
5	27°22.9'N 80°14.0'W	2.2 km north-northeast of Station 2 and 2.1 km east of beach, in offshore trough	11.3	Shell hash

TABLE A-2

BIOLOGICAL AND PHYSICAL SAMPLING SCHEDULE (NUMBER SAMPLES/STATION)
ST. LUCIE PLANT
1976-1979

Section	Offshore									Intake				Discharge		Sampling frequency
	0	1	2	3	4	5	6	7	8	11	13	14	15	12	16	
Adult fish-beach seine							3	3	3							monthly
Adult fish-gill net	1	1	1	1	1	1					1S		1S		1S	monthly
											1B	1B	1B		1B	monthly
Adult fish-otter trawl	1	1	1	1	1	1										monthly
Aquatic macrophytes	2	2	2	2	2	2										quarterly
Benthos-trawl	1	1	1	1	1	1										monthly (with adult fish)
Benthos-grab	4	4	4	4	4	4										quarterly
Ichthyoplankton (fish eggs and larvae)	2	2	2	2	2	2				2				2		twice monthly
Phytoplankton and chlorophyll	2S	2S	2S	2S	2S	2S				2S				2		monthly
	2B	2B	2B	2B	2B	2B				2B						monthly
Thermograph monitoring										Continuous				Continuous		monthly
Water quality and nutrients	2S	2S	2S	2S	2S	2S				2S				2		monthly
	2M	2M	2M	2M	2M	2M										monthly
	2B	2B	2B	2B	2B	2B				2B						monthly
Zooplankton	2S	2S	2S	2S	2S	2S				20						monthly
	2B	2B	2B	2B	2B	2B								20		monthly

S = surface sample.
M = mid-depth sample.
B = bottom sample.
0 = oblique tow.

B. FISH AND SHELLFISH

Environmental Technical Specifications (3.1.B.c., 4.1 and 4.2)[a]

INTRODUCTION

Fishes distribute themselves within the aquatic ecosystem according to their biological limitations and needs. A consequence of this distribution has been the development of fish communities or assemblages which depend on the physical conditions and resources of an area. The aquatic faunal communities off Hutchinson Island are unique because they are transitional between temperate northern faunas and tropical southern faunas. Natural variations in physical conditions, such as seasonal temperature changes or fluctuations in the Florida Current's proximity to the island's coastline, could cause variations in the composition or abundance of fishes in this area. Similarly, although on a much more localized scale, operations of the St. Lucie Plant could affect these fish assemblages.

This study, a continuation of the study initiated by Applied Biology, Inc. (ABI), in December 1975, was to further examine the composition and abundance of fishes in the vicinity of the St. Lucie Plant and to evaluate the habitat, distribution, and life history of these

[a]These specifications are delineated under each appropriate section of this report.

fishes. Data obtained were to be used in conjunction with data from environmental monitoring (ABI, 1977-1979a) and the baseline study (Futch and Dwinnell, 1977) to determine whether plant operation had any significant effect on the fishes in this area.

The evaluation of the potential effects of plant operation on local fish communities required studies of both canal and offshore areas. Samples were taken by gill netting in the intake and discharge canals. Offshore samples were taken by gill netting, trawling, and beach seining. In analyzing canal samples, the emphasis was on the impact of fishes becoming entrapped in the intake canal. In analyzing offshore samples, the emphasis was on possible effects of the offshore thermal discharge upon sport and migratory fishes of commercial importance. In addition, canal and inshore ichthyoplankton sampling was conducted to evaluate thermal discharge and entrainment effects, respectively, on fish eggs and larvae.

Prior to a discussion of specific sampling techniques and results, a brief overview of fish communities is given. This overview leads into a generalized account of fish habitats and trophic interrelationships (the food chain) in the vicinity offshore of Hutchinson Island.

Fish Communities

The most comprehensive list of fishes in the vicinity of the St. Lucie Plant was recently compiled by Gilmore (1977), based on extensive

collections and literature review by the Harbor Branch Foundation.[a] Regarding this fish fauna, Gilmore stated:

> The richness of this fauna appears to be directly affected by water temperature moderation and recruitment via the Florida Current, moderate inshore salinities, and the transitional zoogeographic setting of the study area. The Indian River region encompasses several biotopes, all of which affect the distribution and composition of the local fish fauna. The study area is broad (latitude 27°00'-29°00'N) and includes nearly all of the aquatic fish communities in east Florida... The fish distribution is further complicated by its transitional nature, as the warm-temperate Carolinian and the tropical Caribbean fish faunas overlap considerably here; 28% of the fish fauna is considered tropical, 22% are warm-temperate, and 50% are eurythermic tropicals and continential species having a wide distribution both north and south of this region.
>
> These [tropical] fishes originated in the Caribbean faunal province and apparently came into the region via the Florida Current. Warm-temperate Carolinian fishes are more commonly found in the open bottom continental shelf biotope... Distribution of the Carolinian species must be explained by adult migration, with some aid from larval fishes transported via southbound counter-currents of the Florida Current and other inshore water mass movements.

The Harbor Branch Foundation studies established that at least 654 species of fishes occurred in the Indian River lagoon, its tributaries, and the adjacent Atlantic Ocean continental shelf at depths of less than 200 m, and predicted that at least 50 more species might eventually be collected or identified from this area (Gilmore, 1977; R.G. Gilmore, per-

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[a]The Harbor Branch Foundation, Inc., is a nonprofit corporation with programs aimed primarily at oceanographic engineering and marine science research. Its complex of research facilities is located on the Indian River just north of Ft. Pierce, Florida. R.G. Gilmore is Fisheries Biologist at the Harbor Branch Foundation.

sonal communication). Probably less than 40 percent of the fish species in the Indian River and adjacent areas were characteristic of the surf communication), the three oceanic habitats within the influence of normal St. Lucie Plant operations. The majority of the species were from the rich grass flats within the Indian River lagoon, from around inlets and inshore reefs which provide cover, and from the offshore reefs. These preferred habitats were either of limited extent, such as worm reefs, or beyond the influence of normal St. Lucie Plant operations.

The fish fauna offshore of the St. Lucie Plant was studied by the Florida Department of Natural Resources (DNR) between September 1971 and August 1974 and has been under study by ABI since December 1975.

A total of 75 fish species was found during the baseline study conducted by the Florida DNR (Futch and Dwinell, 1977). These fishes were collected by trawl (42-hour effort) and beach seine (9-hour effort) and were, for the most part, the more common species in the area. ABI personnel have collected or observed 264 fish species in the vicinity of the plant. These species were tabulated in the 1977 annual report (ABI,

1978) and a subsequent addendum (Table B-1; ABI, 1979a). Only seven additional species[a] were found by ABI in 1979.

Only three species[b] found during the baseline study have not been collected by ABI and, considering the intensity of collections during the last 4 years, they must be considered very uncommon. All species which are common in the area have probably been found. Future additions to the species list will include the rarer forms such as transients through the area, strays from deeper offshore waters, and tropical forms carried inshore by eddies from the Florida Current.

Fish Habitats

Three relatively distinct oceanic habitats are within the influence of normal St. Lucie Plant operations: the surf zone, the open bottom, and the neritic zone.

The surf zone is characterized by water turbulence and shifting sand substrate. In addition to the turbulence, a major limitation on this habitat's fish diversity is the lack of bottom cover. Only one worm reef

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[a]Southern stingray (Dasyatis americana), tarpon snook (Centropomus pectinatus), bigeye (Priacanthus arenatus), red snapper (Lutjanus campechanus), Atlantic threadfin (Polydactylus octonemus), spottail flounder (Bothus sp.), and smallmouth flounder (Etropus microstomus).

[b]Clearnose skate (Raja eglanteria), freckled driftfish (Psenes cyanophyrys), and spotted driftfish (Ariomma regulus).

occurs in the vicinity of the plant, and it provides minimal cover for fish in the surf zone. Little or no attached macroscopic vegetation grows in the zone, with the exception of that found on the worm reef.

Fishes capable of thriving in this turbulent area are limited to a few taxa. Characteristically, these are the bottom-feeding carnivores: drum (sand drum and kingfish), threadfin, and pompano that feed on burrowing invertebrates, such as sand fleas and coquinas. Transient fishes, such as herrings, anchovies, jacks, Spanish mackerel, and bluefish, occasionally occur in the surf zone. Some of these, particularly herring and anchovy, often occur in large numbers.

The open bottom in deeper water beyond the surf zone consists of a relatively homogeneous shell hash substrate which, like the surf zone, lacks vegetation or other cover that could provide food and shelter for fishes. Dominant fishes are the flatfishes, cusk-eels, and searobins. These forms have adapted to living in or on the ocean bottom. The burying behavior and protective coloration of the flatfish, the burrowing nature of the cusk-eel, and the hard spiny exterior of the searobin help protect these generally small bottom-dwellers against predators. Other common species occurring on or just over the bottom are sand perch, grunt, mojarra, and lizardfish.

The neritic zone refers to the open water coastal area beyond the surf zone and above the open bottom. The vast majority of the fishes found in the vicinity of the St. Lucie Plant during this study were

either residing in, or passing through, the neritic zone. Herrings and anchovies, sharks, mackerels, bluefish, and jacks are characteristic. Many fishes found in this zone are of sport or commercial importance, such as mackerels and bluefish which make extensive north-south seasonal migrations. In order to spawn, other taxa, such as mullet, menhaden, and certain drum, migrate seasonally from the Indian River lagoon out into neritic waters. In addition, the Florida Current provides continual recruitment of tropical forms from south Florida and the Caribbean into the Hutchinson Island area.

Trophic Interrelationships: The Food Chain

The lack of macroscopic vegetation in the open water area offshore of the St. Lucie Plant, in sharp contrast with the extensive grass flats in the adjacent Indian River lagoon, results in a food chain based almost entirely on microscopic algae (phytoplankton). Phytoplankton use solar energy and dissolved nutrients to produce organic material by means of photosynthesis and become a primary source of food to aquatic animal life.

The primary consumers of phytoplankton are the multitudes of zooplankton, which are also microscopic or semi-microscopic in size. Some larval fishes also feed on microalgae (Lebour, 1924) and a few adult fishes, such as menhaden, feed partly on diatoms and dinoflagellates (Bigelow, 1925).

It is extremely difficult to measure relative volumes of plants and animals in the sea, although the mass of plant material produced daily must be considerable to support the zooplankton. In turn, the zooplankton accomplish two important ends: first, the utilization of the primary food; second, the transformation of this primary food into animal substance large enough to be caught and utilized by carnivorous forms (Sverdrup et al., 1942).

The plankton feeders either pick the individual zooplankters from the water or use some type of screening device through which water passes while small organisms are retained as food. Depending on the fineness of the screening device, phytoplankton and detritus may also be retained and ingested. Differences between these two feeding methods are based primarily on relative selectivity. Many of the copepods (within the zooplankton), barnacles, mussels, clams, and sponges indiscriminately filter plankton from the water. On the other hand, certain copepods, arrow worms, and ctenophores are active predators which seize zooplankters (and larval fishes) that drift within their reach. Among the planktivorous fishes are the herrings and anchovies, which select individual zooplankters or filter indiscriminately with the aid of gill rakers. These fishes generally occur in great abundance and form the link between the zooplankton and the larger predators. The larger predators, such as the sharks, mackerels, bluefish, and jacks, are the fishes most familiar to man.

An equally vital group of organisms within the oceanic food chain consists of the detritus feeders, browsers, and scavengers. Although these forms may be separately defined, they all feed more or less indiscriminately upon living or dead organic matter and herein are discussed as a group. The majority of the benthic invertebrates are found in this assemblage: polychaetes, echinoderms, gastropods, and several crustaceans including crabs, shrimp, amphipods, and isopods. Many of the fishes, in turn, are "bottom-feeders" that prey on these benthic forms (and each other) both in the surf zone and over the open bottom. The more common fishes in this category are the flatfish, searobins, cusk-eels, lizardfish, pompanos, and drums.

As this discussion implies, the aquatic flora and fauna offshore of Hutchinson Island are intricately interrelated. Additional, and often more specific, trophic interrelationships will be discussed in this report.

IMPINGEMENT

Environmental Technical Specification (4.2)

> Intake screen washings shall be examined for a consecutive twenty-four hour period, twice a week whenever the Unit 1 circulating water pumps are operating. The collected washings shall be analyzed for the species present, number of each individual species caught, total biomass of each species, and the average size of the individuals caught.

On 24 January 1979, the Nuclear Regulatory Commission issued a technical specification change (Amendment No. 29) which deleted Section 4.2, Impingement of Aquatic Organisms, of Appendix B to Operating License No. DPR-67 for the St. Lucie Plant. Data collected prior to the termination of impingement sampling were submitted to FPL as document AB-198 (ABI, 1979b).

Those data covered seven 24-hour impingement samplings taken during the period 1 January through 23 January 1979 (Tables B-2 through B-8). During the seven sampling periods, fish impingement ranged from 82 to 952 individuals per day; the mean equaled 412 individuals. Fishes commonly found were herrings and anchovies, mojarras, jacks, grunts, flatfish, cusk-eels and searobins. Fishes of sport or commercial importance, such as snappers and croakers, accounted for 2.8 percent of all fishes collected. Shellfishes of sport and commercial importance were shrimp which had a mean of 739 individuals per day; blue crab which had a mean of 102 individuals per day; and spiny lobster which was represented by only 1 individual during all seven periods.

The mean numbers of fish, shrimp, and blue crabs found during January 1979 were higher than those found in January 1977 and January 1978. This does not mean, however, that numbers would have been higher for the entire year. The taxa of fish and shellfish found in the samples, and the low number of sport and commercial fishes, were similar to previous years. As pointed out previously (ABI, 1979a), when compared to commercial landings that indicate the abundance of fish and shellfish

off Hutchinson Island, the amount impinged was low and not considered to have any significant impact on offshore populations.

CANAL GILL NETS

Materials and Methods

Monthly gill net collections were taken at Stations 13, 14, and 15 in the intake canal (Figure B-1) to determine whether fishes were accumulating in the intake canal because of entrapment at the intake velocity cap. Sampling at Station 16 in the discharge canal was conducted only when the circulating water pumps were off for an extended period of time, which might allow fishes to enter the canal through the offshore discharge and establish populations.

The gill nets measured 61 m long by 3 m wide and were constructed of 76-mm stretch mesh. At each station, a net was set on the bottom and completely spanned the canal.

Sampling duration was two consecutive 24-hour periods at each station during each month. After each 24-hour period, fishes and shellfishes were removed from the nets and analyzed. Specimens were identified to species, counted, measured to the nearest millimeter, and weighed to the nearest gram. Standard length, the distance from the tip of the snout to the base of the tail, was measured for most fishes. Disk width was measured for rays. Carapace (shell) length was measured for shrimp and lobsters; carapace width was recorded for crabs. The taxonomic nomenclature for fishes is in accordance with Bailey et al. (1970), except for the few changes made in more recent literature.

To facilitate station, monthly, or yearly data comparisons, the species data were often summarized by category or taxon in the text and tables. Categories or taxa are groups of closely related fishes, that is, fishes of the same species, genus, or family.

Results and Discussion

Discharge canal gill netting was conducted during April, May, and part of June when the circulating water pumps were off. A total of five net sets were made during that time. For all sets, only two fish (a croaker and a catfish), one shrimp, and four blue crabs were collected. This low catch indicates that very few fishes and shellfishes enter the discharge canal when the circulating pumps are off and hence, a considerable amount of time would be required for populations to become established. Thus, only a few individuals would be subjected to potential thermal effects in the discharge canal once the plant resumed normal operation.

The balance of this section concerns gill netting studies in the intake canal where a total of 661 fishes was collected during the 24 daily sampling periods conducted in 1979 (Tables B-1 and B-9). Total fish biomass recorded was 373.3 kg; however, this weight included fragments (partially eaten fish) and the undamaged weight would have been somewhat greater. A total of 173 shellfishes, weighing 45.7 kg was also found during the intake canal gill netting (Table B-1).

The total number of fishes collected each month varied considerably and no trend was apparent in the numbers from month to month (Table B-9). The variation meant that fishes were not accumulating in the intake canal. The absence of any build-up in fish populations is also evident once the rate of capture was plotted over the last 4 years (Figure B-2). The catch rate through most of 1977 was usually less than 10 fish per net per day. Peaks of abundance in late 1977 and early 1978 caused the rate to rise. Subsequently, the catch rate declined in mid-1978 and remained low through 1979. The peaks of abundance were primarily caused by influxes of blue runners and crevalle jacks. The reasons for the relatively high numbers of these fishes entering the intake on limited occasions are not known. However, the fact that a build-up of fishes has not occurred in the intake canal can be attributed to predation, sampling, or other mortality factors.

The lane snapper was the most abundant species found in the intake canal. It accounted for 21.3 percent of the total number of fishes collected during 1979 (Table B-1). The sheepshead was the species having the highest total weight. Based on taxa, porgies[a] made up 26.0 percent of the total number of fishes found, followed in lesser amounts by snappers, grunts, and jacks (Table B-9). Blue crabs were the predominant shellfish (Table B-1).

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[a]The porgies include sheepshead, pinfish and silver porgy.

Several of the fishes, as well as the shellfishes, collected in the intake canal are considered of sport or commercial importance. These include snappers, sheepshead, crevalle jack, spot, mackerels, croakers (drum), mullet, snook, and Florida pompano. Although entrapped fishes are lost to sport or commercial interests, the impact of the loss is considered to be negligible because both the number and weight of fishes entrapped (as measured by canal gill netting data) were low (Table B-1). Further, the negligibility of impact is particularly evident when the biomass of fishes entrapped (Table B-1) is contrasted to the biomass of fishes in the commercial landings (Table B-10). Of additional importance is the fact that few Spanish mackerel, king mackerel, or bluefish, the primary commercial fishes in St. Lucie and Martin Counties (Table B-10), have been collected in the intake canal.[a] It appears that these fishes who pass Hutchinson Island during seasonal migrations are generally able to avoid entrapment at the offshore inlet of the intake.

In addition to the wide variations in rates of capture over the past 4 years (Figure B-2), considerable variation exists in the taxa represented (Table B-11). For example, the percentage composition of croakers and mullet has generally declined while that of snappers and porgies has generally increased. These differences are attributed to natural yearly variations in fish population composition, to the chance occurrence of

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[a]Five Spanish mackerel, 8 king mackerel, and 16 bluefish during the past 4 years.

schooling fishes, and to variations in the total yearly sample sizes from which the percentage compositions of the taxa are calculated. For all fishes during the 4 years combined, grunts, snappers, and jacks each accounted for about 17 percent of the gill net catch from the intake canal, followed by porgies, mullet, croakers, spadefish, and searobins (Figure B-3). These taxa are all common offshore Hutchinson Island and, as would be expected, were the fishes commonly found in the intake canal.

In contrast to the number of fishes collected during offshore studies, the number entrapped in the intake canal was relatively low. Low entrapment numbers are attributed to the velocity cap at the offshore inlet of the intake pipe. The velocity cap maximizes a horizontal direction of water flow into the intake. Whereas fishes may become entrapped by a downward flow, they are more likely to detect and avoid the horizontal one (Clark and Brownell, 1973).

OFFSHORE GILL NETS

Environmental Technical Specification (3.1.B.c.)[a]

> Nektonic Organisms - Samples will be collected monthly by trawling, seining or other suitable method. Types and numbers of organisms present will be determined, including species of migratory fish of commercial and sports fisheries value such as bluefish and mackerel.

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[a]This specification is also applicable to the trawling and beach seining sections of this report.

Materials and Methods

Monthly gill net collections were made at each of six offshore stations. Stations 1 through 5 were in the vicinity of the plant and Station 0, the control, was located to the south (Figure B-4). The offshore gill net measured 183 m in length by 3.7 m in depth and was made up of five 36.6-m panels sewn end-to-end. The mesh size of the panels varied, measuring 64, 74, 84, 97, and 117 mm in respective stretch lengths. The net was set on the bottom perpendicular to shore and was fished for 30 minutes at each station.

Specimens collected by offshore gill netting were analyzed by the same methods described under "Canal Gill Nets: Materials and Methods." Two-way analyses of variance were applied to the data to determine whether differences occurred between stations. When significant differences occurred, Tukey's HSD (honestly significant difference) comparison was used to identify relationships between the means.

Results and Discussion

A total of 1610 fishes was collected by offshore gill netting at Stations 0 through 5 during the 12 months sampled in 1979 (Table B-12). The total weight of these fishes was 951.3 kg. Two spiny lobsters were the only shellfishes found. The largest total number of fishes collected during 1979 was 658 at Station 1, near the point of discharge, followed by 410 at Station 0, the control (Table B-13). The annual catch at the other stations ranged from 90 to 189 individuals. Statistically, the

mean number of fishes found near the discharge was significantly (α=0.05) higher than that found at the control, while the mean number of fishes found at both the discharge and control stations was higher than that found at each of the other stations. Fifty percent of the total catch was collected during the months of January (20.6 percent) and December (29.4 percent) in 1979.

During each of the 4 years, the largest percentage of fishes collected by offshore gill netting at Stations 0 through 5 was found at either Station 0 or Station 1, which are located closest to shore (Figure B-5). For the 4 years combined, the percentage of fishes collected at each of these two stations was similar: 29.7 percent at Station 0, the control, and 37.5 percent at Station 1, in the discharge vicinity. Statistically, there was no significant difference in the mean numbers of fishes found between Stations 0 and 1; Station 0 had significantly (α=0.05) more fish than Stations 3 and 4, and Station 1 had more fish than Stations 2 through 5.

Differences between the number of fishes collected at the various stations were attributed to chance and distance from the shore. With respect to chance, the taxa involved were mostly highly mobile, often migratory schooling species, and the data obtained during offshore gill netting probably reflected their chance occurrence. With respect to distance from the shore, forage species are probably most abundant near shore and would attract the larger predators to the nearshore discharge and control locations. Additionally, bottom relief provided by the

discharge pipe, warmer water, or turbulence at this latter station could attract the forage fishes and, in turn, the larger predators.

Atlantic bumper, Spanish mackerel, crevalle jack, and bluefish were the predominant species found in 1979 with each accounting for about 14 to 15 percent of the total fishes collected (Table B-12). Based on biomass, bluefish were the predominant species with 21.4 percent of the total.

Migratory species of sport and commercial fisheries value found during offshore gill netting were Spanish mackerel, king mackerel, and bluefish.

Spanish mackerel made up 14.8 percent of the fishes collected (Table B-12). Most were found in November and December, their time of southward migration (Table B-13). The Spanish mackerel migrates north in the spring, spawns during the summer months in the northern part of its range (north of Cape Canaveral on the Atlantic coast), and migrates south in the autumn (Wollam, 1970). These fishes generally move near shore, as evidenced both by commercial fishing operations and by their greater abundance at Stations 0 and 1 in ABI collections. Commercial landings in 1976 in St. Lucie and Martin Counties totaled almost 3.1 million kg which represented 70.8 percent of the entire Florida east coast landings (Table B-10).

Only 12 king mackerel were found (Table B-12). All were taken in the autumn and they were not concentrated at any particular station. The king mackerel's seasonal migratory habits duplicate those of the Spanish mackerel although the former's movements occur farther offshore. In addition to its commercial importance (Table B-10), the king mackerel is the most prominent marine fish in the Florida sport fishery (Beaumariage, 1973).

Bluefish made up 13.7 percent of the fishes collected (Table B-12). The majority (72 percent) of the bluefish were found at the discharge location (Station 1) in January (Table B-13). As previously discussed, they may have been attracted to the discharge area, or simply to a nearshore location. Bluefish occur off the St. Lucie area in the winter and, like Spanish mackerel, are generally found near shore. They move north during spring and summer (Beaumariage, 1969) and spawn in offshore waters north of Florida in early summer (Deuel et al., 1966). Their northward movement along the Florida coast is probably part of a spawning migration by that part of the population that extends its winter range into south Florida waters (Moe, 1972). This species also is important in sport and commercial fishing. A total of 363,000 kg was commercially landed in St. Lucie and Martin Counties in 1976 (Table B-10).

A few other fishes having sport and/or commercial importance were found during offshore gill netting. They included menhaden, spot and other croakers, Florida pompano, sheepshead, and certain of the sharks and barracuda (Table B-12). As shown by the gill netting results, a high

diversity of the larger pelagic fishes occurs offshore of Hutchinson Island.

Five species made up about 60 to 85 percent of the total number of fishes collected by offshore gill netting during each of the 4 years (Table B-14). The large variations in percentage of total composition for any particular species between years are attributed primarily to the chance occurrence of the taxa involved. Natural fluctuations in abundance, however, would also alter species' relative abundance. For example, during 1977 the percentage composition (33.3 percent) for Spanish mackerel was higher than that found during the other 3 years (Table B-14). Commercial mackerel fishermen were also considerably more active in 1977 than during the other years. This would indicate a larger catch, although landings data are not yet available. This yearly variation in the occurrence of a migratory species could be attributed to year-class success, water temperature and current pattern differences, nearshore versus offshore movement, or other factors. Similarly, the annual decrease in the total number of fishes found over the first 3 study years, followed by a resurgence in number during 1979, may reflect natural yearly variations, may represent a sampling artifact (sampling was conducted only once per month and results may not be representative for the month), or may simply be coincidental. Considering the large size of the study area and the highly mobile, often migratory, habits of the fishes involved, it is doubtful whether variations in species occurrence or percentage composition could be attributed to any plant-related effect.

TRAWL

Materials and Methods

Monthly trawl samples were taken at each of offshore Stations 0 through 5 (Figure B-4). One 15-minute tow was made at each station with a 5-m semi-balloon bottom trawl of 12.7-mm stretch mesh in the bag and 6.4-mm stretch mesh in the cod end. Towing speed was 2 to 3 knots at each station. To reduce net avoidance by the fishes, all trawling was conducted at night.

Fishes collected by trawling were analyzed by the same methods described under "Inshore (Canal) Gill Nets: Materials and Methods." Two-way analyses of variance were applied to the data to determine whether differences occurred between stations. When significant differences occurred, Tukey's HSD comparison was used to identify relationships between the means.

Macroinvertebrate samples were obtained concomitant with the fish samples, and are discussed in Section C.

Results and Discussion

A total of 3251 fishes weighing 65.2 kg was collected by trawling during the 12 months sampled in 1979 (Table B-15). The number of fishes collected per month ranged from 20 to 1131 (Table B-16); the majority (56 percent) were found in the autumn months of October and November. Although more fishes were found at control Station 0 than at any of the other stations in 1979, the differences between stations were not statistically significant (α=0.05).

The percentage composition by number of fishes collected trawling at the six different stations has varied considerably over the 4 years sampled (Figure B-6); as a general trend, more fishes were collected each year at the nearshore Stations 0 and 1, and at Station 5 north of the plant than at the other areas. For the 4 years combined, the most fishes (26.3 percent of the total) have been collected at Station 1, in the discharge vicinity. The only significant (α=0.05) difference over the 4 years was that Station 1 had a higher mean number of fishes collected than either Stations 3 or 4. There were no significant differences in other station comparisons.

The total number of fishes collected has increased during each of the last 4 years (Table B-17). Whether this trend is real or coincidental is unknown. However, any plant-related causative factors seem highly unlikely considering the size of the study area. (NOTE: the number of fishes collected during the baseline study [Table B-17] should not be directly compared to those collected in the environmental monitoring studies because stations, sampling frequency, and methodology differed.)

Anchovies, accounting for 41.6 percent of the total, were the predominant fishes collected by trawling in 1979 (Table B-16). Searobins and scorpionfish shared a distant second place in abundance at 12.0 percent. Based on biomass, pigfish (a member of the grunt family) accounted for 29.1 percent of the fishes collected (Table B-15). This species made up only 4.3 percent (141 individuals) of the total fishes; for the most part, the fishes collected by trawl were the smaller species and juve-

niles which could not avoid being captured as readily as the larger, faster swimming individuals.

The percentage composition, or relative abundance, of the taxa collected during trawling has varied between the baseline study and subsequent environmental monitoring studies as well as during the different study years of environmental monitoring (Table B-17). These differences are attributed to natural yearly variations in fish population composition, to the chance occurrence of schooling fishes, and to variations in the total sample sizes from which the percentage compositions of the taxa are calculated. Because no consistent trends are apparent for any particular taxon over the years, it is doubtful that percentage composition differences are related to plant operations.

BEACH SEINE

Materials and Methods

Beach seining was conducted each month at each of three stations: Station 6 north of the discharge, Station 7 between the discharge and intake adjacent to the plant, and Station 8 south of the intake (Figure B-4).

The seine was 30.5 m in length by 1.8 m in depth, with a stretch mesh size of 25 mm. It was heavily weighted along the bottom and had extra flotation along the top to maintain a hanging position under surf conditions. The rolled net was carried out to a depth of approximately 1.2 m, deployed parallel to shore, and then pulled onto the beach with

the ends perpendicular to shore. Three replicate seine hauls were made at each station during each sampling period.

Specimens collected by seining were analyzed by the same methods described under "Canal Gill Nets: Materials and Methods." Two-way analyses of variance were applied to the data to determine whether differences occurred between stations.

Results and Discussion

A total of 629 fishes weighing 21.0 kg was collected by beach seining during the 12 months sampled (Table B-18). Twenty-nine speckled crabs, a noncommercial species, and three blue crabs were also collected. The majority (52 percent) of the fishes collected in 1979 was found during July (Table B-19). The largest catch of 281 was found at Station 6 north of the discharge followed by 238 at Station 8 south of the intake, and 110 at Station 7 adjacent to the plant. Differences between stations in the mean numbers of individuals collected were not statistically significant.

During the last 4 years, the percentage composition by number of fishes collected at each station was quite variable, although, for the 4 years combined, the most fish (45.0 percent) were found at Station 6 while 27.1 and 27.9 percent were found at Stations 7 and 8, respectively (Figure B-7). Differences between stations in mean numbers of fishes collected were not statistically significant. The higher abundance to the north may have been a sampling artifact resulting from a more rapid

transit of the net and the concomitant escape of fewer fish, or it may have been caused by some presently unknown factor. At any rate, it is doubtful that the thermal plume would have a limiting influence on fish abundance to the south because the prevailing water currents are to the north in the summer, when most of the fishes were collected. (NOTE: the number of fishes collected during the baseline study [Table B-20] should not be directly compared to those from subsequent environmental monitoring studies because sampling frequency and methodology differed).

Scaled sardines (35.9 percent of the total) and sand drum (26.7 percent) were the predominant fishes collected by beach seining in 1979 (Table B-18). Florida pompano (14.5 percent) and Atlantic bumper (13.5 percent) were predominant based on weight. Although several of the species collected during beach seining are considered of sport or commercial value, the only species of major economic value was the Florida pompano. Pompano occurred during 10 of the 12 months sampled in 1979 but were never found in large numbers at any one time or place (Table B-19). During the last 4 years of study, 55 pompano have been found north of the plant, 52 adjacent to the plant and 26 south of the plant. The importance, if any, of fewer pompano being found to the south is unknown.

Based on the numbers of individuals collected by beach seining, anchovies, herrings, and sand drum have been the predominant taxa collected during baseline and environmental studies at the St. Lucie Plant (Table B-20). Most of the differences in relative abundance shown in Table B-20 are attributed to the chance occurrences of schooling spe-

cies in the catch. To illustrate, the herring found at Station 6 in July 1976 accounted for 40 percent of all fishes collected by beach seining in 1976, while the anchovies, which were so abundant during the baseline study, were almost all found on only two occasions. It is doubtful if these occurrences or percentage compositions of the taxa were related to any plant-induced effects.

ICHTHYOPLANKTON

Environmental Technical Specification (4.1)

> Samples shall be collected from the intake and discharge canals and a control station at monthly intervals when the unit is in operation to identify the organisms involved, and to attempt to quantify how many of each organism are potentially affected. Biomass measurements, numbers of eggs collected, and numbers and identification of larvae - to the level of major taxonomic groups, if possible - shall be performed. Present "state-of-the-art" information shall be used to attempt to quantify the mortality of the organisms due to entrainment. This program shall determine the seasonal abundance of fish eggs and larvae.

Materials and Methods

Ichthyoplankton Sampling and Analysis

Sampling of ichthyoplankton was conducted offshore at Stations 0 through 5, at Station 11 in the intake canal, and at Station 12 in the discharge canal (Figure B-4). Ichthyoplankton samples were also collected at an additional offshore station (Station OI) which was established directly over the offshore intake structure specifically for ichthyoplankton sampling. Samples were collected twice a month during

the daytime with paired 20-cm diameter, 505-μ mesh bongo nets (Figure B-8). At each of Stations 0 through 5, nets were towed just below the surface at 3.5 to 4.0 knots for 15 minutes. Mid-depth samples were taken at Station OI in the same manner in order to sample that parcel of water being drawn into the intake pipe. At Stations 11 and 12, however, 15-minute step-oblique tows were taken in order to effectively sample the canal ichthyoplankton population drawn in from offshore waters, and circulated through the plant. A digital flowmeter (General Oceanics Model 2030) mounted in the mouth of each net enabled calculation of the volume of water filtered. Water volume, in cubic meters, through the net was calculated by:

$$\text{Volume} = AVT$$

where: A = Area of the mouth of the net, in square meters;
V = Velocity of current, in meters per second;
T = Time, in seconds.

Ichthyoplankton samples were taken during the day. All specimens retained in the cod end collecting bucket were washed into jars, preserved in 5 percent formalin solution in the field, and returned to the laboratory for microscopic analysis. Water temperature, dissolved oxygen, salinity, and turbidity were recorded at the time and location of each sample.

Eggs were counted and their diameters were measured. Eggs were not identified to taxon because of the lack of specific egg descriptions in the scientific literature. Larval fishes were identified to the lowest

practicable taxon, counted, and their total length was measured to the nearest tenth of a millimeter. Identification of larval fishes was facilitated by photographing larvae and arranging the photographs in a developmental series from identifiable large forms to increasingly smaller and earlier stages (Figure B-9).

Statistical Analysis

Statistical analyses were performed according to procedures of the Statistical Analysis System (SAS; Helwig and Counsil, 1979):

1. The General Linear Models (GLM) Procedure was employed to give the regression approach to analysis of variance by using class variables to determine over-all station effects. Examples of the individual variables and model used are shown in Table B-21.

2. Relationships between eggs and larval densities (dependent variables) and environmental variables, that is, the independent variables salinity, water temperature, turbidity, and dissolved oxygen, were determined by calculating correlation coefficients (r), their approximate probability, and the number of observations through the Correlation (CORR) Procedure.

3. The Stepwise (STEPWISE) Procedure was used to determine the model with the largest r^2 value that relates egg or larval densities to the environmental variables (r^2 is the proportion of the variation in the dependent variable which is explained by the independent variable). During previous studies (ABI, 1977, 1978, 1979a) numbers of fish eggs and larvae varied considerably over time. This temporal variation can potentially mask or further complicate analyses of any existing relationships with environmental variables. Therefore, in order to obtain a more accurate model using the Stepwise Procedure, an additional variable representing this temporal variation was first included into the model before inclusion of any environmental variable. This variable is equal to

$$\text{cosine}\left[\frac{2\pi}{365 \text{ days}} \times \text{Elapsed time (days)}\right]$$

4. Multiple linear regression analysis was used to determine if a significant over-all trend in egg or larval densities occurred from 1976 through 1979. This was accomplished by regressing the dependent variables egg and larval density with the independent variable representing seasonal variation, which is equal to

$$\text{sine}\left[\frac{2\pi}{365\text{ days}} \times \text{Elapsed time (days)}\right]$$

Because of unequal error variance and skewed distributions, log transformations were made on the dependent variable (number of eggs or larvae per cubic meter) before the GLM, CORR, STEPWISE, or multiple linear regression procedures were employed.

Unless otherwise stated, references to mean numbers of ichthyoplankton in the sections of this report refer to geometric means. These were utilized instead of arithmetic means because of the skewed distribution of ichthyoplankton densities. Geometric means were calculated by taking the antilog of the mean of the logged values.

Analyses or comparisons made over the entire study year included data collected from 1 December 1978 through 13 December 1979. Collections were grouped for seasonal analysis as follows: winter samples were from 1 December 1978 through 19 March 1979 and include samples collected during December 1979, spring samples from 20 March through 20 June 1979, summer samples from 21 June through 22 September 1979, and fall samples from 23 September through 30 November 1979.

Percentage Loss Due to Entrainment

The method used to evaluate entrainment is based on a technique developed by Goodyear (1977), which was originally applied to the analysis of entrainment in riverine habitats; it has been adapted for this study because the current flow offshore of the St. Lucie Plant is analo-

gous to a riverine situation. The calculation to determine entrainment loss is the following:

$$\text{Percentage loss} = \frac{\frac{mC_p}{C_r} \times Q_p}{Q_r} \times 100$$

where: m = Mortality rate of entrained organisms (assumed to be 100 percent, making m = 1.0);

C_p = Geometric mean concentration of organisms per cubic meter in the intake canal (Station 11);

C_r = Geometric mean concentration of organisms per cubic meter (based on surface tows only) in offshore areas (Stations 0 through 5);

Q_p = Water flow, in cubic meters per second, through the plant intake, based on maximum recorded daily value;

Q_r = Water flow, in cubic meters per second, past the plant.

More conservative estimates were made by assuming that the average concentration of organisms entering the power plant intake is equal to the average concentration of organisms offshore. When this is done, the value of mC_p/C_r equals 1, and the percentage loss estimates are calculated strictly on a percentage volume basis.

Results and Discussion

Approximately 390 samples were collected and analyzed during the period from 1 December 1978 through 13 December 1979. The results of each sample analysis include the number of individuals within each taxon, length ranges, the total numbers of eggs and larvae per cubic meter, and total water volume filtered.

Offshore Stations: Eggs

Fish eggs were collected during every sampling period. Densities averaged 3.744/m^3 during the study year and ranged from 0.000 to 3192.710 eggs/m^3 per individual sample. Egg densities were highest in May (Figure B-10). The erratic occurrence of eggs during 1978 reflects the wide variations in spawning seasons of the different fish species in the offshore area (Table B-22).

During the 1979 study year, significantly (α=0.05) higher egg densities were found at Stations 2 and 4 than at Stations 1 and 0 (Tables B-23 and B-24). During 1977 and 1978, no over-all significant differences had occurred between the offshore stations (ABI, 1978, 1979a), suggesting that the differences observed during 1979 are probably due to natural year-to-year variation. When egg distributions were analyzed by season, no significant differences between stations were found (Table B-25).

When physical parameters were correlated with egg density, only turbidity proved significant (Table B-26). This correlation, however, explained little (r^2=0.11 or 11 percent) of the variation in egg densities. The correlation between egg densities and turbidity was probably coincidental, rather than cause and effect.

The model developed for egg density, based on stepwise regression analysis, included turbidity and water temperature as independent variables (Table B-27). Since the r^2 value was low (0.22), however, the

model explained very little of the variation in egg densities and consequently had low predictive value.

Offshore Stations: Larvae

Fish larvae were also collected during every sampling period. Densities averaged 0.304/m^3 during the study year and ranged from 0.000 to 7.189 larvae/m^3 per individual sample. Larval densities were highest in the summer and lowest in the autumn (Figure B-10). When comparisons were made over the entire study year, no significant (α=0.05) differences in larval densities were found between offshore Stations 0 through 5 (Table B-23). A seasonal analysis, however, showed significant differences between the offshore stations occurring during the spring, summer, and autumn (Table B-28). The significant (α=0.05) findings of this analysis are threefold: 1) spring larval densities were higher at Station 1 than at Stations 2, 3, 4, or 5, and Station 0 had higher densities than Stations 2, 3, or 4 (Table B-29); 2) summer larval densities were higher at Station 3 than at all other offshore stations (Table B-30); 3) and autumn larval densities were higher at Station 1 than at all other offshore stations (Table B-31). During spring 1978, larval densities were also significantly higher at Station 1 than at the other offshore stations (ABI, 1979a). The higher larval densities observed at Station 1 may have been related to the higher food densities (phytoplankton and zooplankton) also found in that area. However, no significant differences were detected between the offshore stations by season during 1977 (ABI, 1978), and the observed differences in larval densities between stations during 1978 and 1979 may be natural year-to-year variations.

When physical parameters were correlated with larval densities, only the negative correlation with turbidity proved significant (Table B-26). As with egg densities, the correlation between larval densities and turbidity was probably coincidental, rather than cause and effect.

The model developed for larval density, based on stepwise regression analysis, included turbidity and water temperature as independent variables (Table B-32). With a low r^2 value of 0.12, however, the model explained very little of the variation in larval densities and thus had low predictive value.

Offshore Stations: Larval Fish Taxa Represented

The larval fishes most abundant during all seasons were herrings and anchovies (Clupeiformes), which made up 71.5 percent of all larvae collected (Table B-23). High densities of larval clupeiforms occurred in May, June, and July, and some were generally found throughout the year (Figure B-11). Eight species of herrings and seven species of anchovies were found as adults in the plant area. The eggs and larvae of at least two herring taxa, the menhaden and Atlantic thread herring, occurred in the samples. Although menhaden spawn from December through March, gravid (ripe) menhaden were collected in the St. Lucie area only in January and February (Table B-22). The Atlantic thread herring spawns through most of the year (Richards et al., 1974; Houde, 1977). Little is known of the spawning habits of the anchovies found, except for the bay anchovy which is an estuarine or nearshore spawner. Anchovy larvae were common in the autumn ichthyoplankton collections. Although certain clupeiforms, such

as menhaden, are commercially important, they are among the most abundant of all fishes; it is unlikely that the St. Lucie Plant is significantly affecting them.

Eighteen species of jack (Carangidae) have been collected in the plant area, four of which (blue runner, Atlantic bumper, bigeye scad, and Atlantic moonfish) have been found in ripe condition (Table B-22). However, other species of jack in ripe condition were probably not collected due to their uncommon occurrence in the area. Jacks (Carangidae) accounted for 7.6 percent of all larvae collected (Table B-33) and were found from late January through October. The highest density occurred during the summer (Figure B-12). The relative abundance of jacks varied between seasons and was highest during the summer (Table B-33). The predominant larval jack species were Atlantic bumper and palometa. Jack larvae occur farther offshore where spawning takes place and, because development proceeds rapidly, generally only the juveniles and later stages reach coastal waters (Berry, 1959).

Of the 17 species of drum (Sciaenidae) recorded at the St. Lucie area, 13 were taken as ripe adults (Table B-22). Maximum larval density was recorded during the winter, although drum larvae were found throughout the year (Figure B-13). Larval drum made up 4.1 percent of all larvae collected from the offshore stations (Table B-33). The relative abundance of this group varied between seasons and was appreciably higher during the autumn and winter. Spot and Atlantic croaker predominated, but other taxa (red and sand drum, silver perch, seatrout

and kingfish) were also collected. These results are similar to the findings of Powles and Stender (1976), who sampled larval fish populations from Cape Canaveral, Florida, to Cape Fear, North Carolina. Spot and Atlantic croaker spawn in the winter in offshore waters. Their larvae approach the coast as they grow (Fahay, 1975) and then use estuaries as nursery areas. Kingfish (Menticirrhus spp.) spawn offshore and use shallow surf zone habitats when young. Seatrout spawn in estuaries or shallow coastal waters, depending on the species, and use a variety of habitats for growth. For example, juvenile silver seatrout (<80-mm TL) were commonly found during impingement sampling during 1978 (ABI, 1979a) and were found in abundance during the October 1979 trawl samples. The St. Lucie Plant area apparently is used to some extent as a reproductive and/or nursery area by these sciaenids because both larvae and juveniles have been collected in the area.

Larvae of flatfishes (Bothidae and Soleidae), plectognaths, sea basses (Serranidae), mojarras (Gerreidae), blennies (Blenniidae and Clinidae), gobies (Gobiidae), and stargazers (Dactyloscopidae) also frequently occurred in samples taken offshore the St. Lucie Plant (Figures B-14 through B-20). These are not considered to be economically important taxa, although several of these families are utilized as forage fishes.

It should be noted that several important species, such as snook and bluefish, were not found. Snook (Centropomidae) are important sport fish in the adjacent Indian River lagoon. Larval snook were neither encoun-

tered nor expected in our collections because snook typically spawn in brackish areas (Marshall, 1958; Volpe, 1959; Springer and Woodburn, 1960). Bluefish (Pomatomidae) are important sport and commercial fish which migrate through the offshore St. Lucie area. The study area is south of their spawning grounds (Deuel et al., 1966).

Occasional king and Spanish mackerel were found in the St. Lucie ichthyoplankton collections. Spanish mackerel (Scombridae) have been found in ripe condition in St. Lucie waters from April through June (Table B-22). While spawning may occur in the vicinity of the power plant, the major spawning area of Spanish mackerel appears to be off the Carolinas, with a disjunct spawning population in the Gulf of Mexico (Wollam, 1970). Deuel et al. (1966) reported king mackerel larvae offshore from Florida's east coast.

Offshore Stations: Egg and Larvae Study Comparisons

Eggs - Fish eggs were found in waters offshore the St. Lucie Plant year-round during each study year; maximum densities generally occurred during the spring or summer of each year (Figure B-21). The majority of these eggs were probably clupeiforms, based on the relative composition of the fish larvae found. A significant increasing trend in egg densities was found during the period from 1976 through 1979 (Table B-34). However, this increase was very small and its biological significance is questionable. This trend is probably due to natural causes and not to operation of the St. Lucie Plant.

Correlations between egg density and physical parameters were not consistent from one year to the next except for a positive correlation with dissolved oxygen during 1976, 1977, and 1978. The reason for the positive correlation between egg density and dissolved oxygen is not apparent, but is probably coincidental because dissolved oxygen was not a limiting factor during these years. These correlations between egg densities and physical parameters, although statistically significant, generally do not explain the over-all variations in egg densities found during 1976 through 1979. This is probably due to the great complexity of the biological system and to the many variables affecting egg distribution and abundance.

Larvae - Fish larvae were also found throughout the year in waters offshore of the St. Lucie Plant during each study year. High larval densities generally occurred during the spring and summer (Figure B-21). No significant trend in larval densities was observed during the period from 1976 through 1979 (Table B-34). The majority of the larvae found during these years were herrings and anchovies (Clupeiformes). Blennies, gobies, mojarras, drums, and jacks also commonly occurred in samples collected during all years. In general, the composition of the larval populations in the St. Lucie Plant area has not changed appreciably over this time.

Neither the correlations between larval densities and physical parameters nor the regression models were consistent from one year to the next; neither did they explain larval density variations. In general,

attempts at single or multiple variable analyses with ichthyoplankton abundance or occurrence have not been very successful (Parsons and Takahashi, 1973). In a review of the effects of abiotic factors such as salinity and water temperature on marine ichthyoplankton, Lillelund (1965) concluded that abiotic factors had only an indirect effect; he also concluded that over-all effects were complex and probably associated with biotic factors such as spawning success and predation.

Offshore Stations: Baseline Versus Operational Year Comparisons

Collections specifically for ichthyoplankton were not made during the baseline (1971-1973) study. Thus, comparisons were made between the baseline and operational study years using fish eggs and larvae collected during baseline and operational zooplankton sampling. Mean (arithmetic) ichthyoplankton density increased from 39.0/m^3 during the baseline study to 123.5/m^3 during the 1978 operational study, and then decreased to 85.9/m^3 during the present study year (Table B-35). The percentage ichthyoplankton, that is the percent of total zooplankton collected for a given study year made up of fish eggs and larvae, increased from 0.6 percent during the baseline study to 6.4 percent during the present study year. The cause of the above trends in mean density and percentage ichthyoplankton are not known. However, it appears from this limited amount of data that the operation of the St. Lucie Plant has not reduced offshore ichthyoplankton populations.

Inshore Stations: Eggs and Larvae

The average densities of fish eggs at Stations 11 (intake canal) and 12 (discharge canal) during this study were 0.831 and 0.193 eggs/m^3, respectively. The average densities of larvae at the intake and discharge canals were 0.030 and 0.019 larvae/m^3, respectively. Significantly higher egg densities were found at Station 11 than at Station 12 (Tables B-36 and B-37). No significant (α=0.05) difference was found for larval densities between the intake and discharge canals (Table B-36). In general, Station 12 consistently had lower egg and larval densities than Station 11 during 1977 through 1979. Apparently egg and larval mortality occurs during passage through the plant.

The average densities of eggs and larvae at the intake were comparatively lower than the averages reported for offshore stations (3.744 eggs/m^3 and 0.304 larvae/m^3, respectively). These differences also occurred during 1977 and 1978 (ABI, 1978, 1979a).

Possible explanations for the lower concentrations of eggs and larvae recorded in the intake canal compared to the surface densities at offshore stations are that 1) the intake pipe is drawing cooling water from a relatively depauperate depth not representative of surface offshore areas and that 2) mortality may be occurring during passage through the pipe or predation in the intake canal.

Statistical comparisons were made between egg and larval densities found at the offshore intake Stations 1 (surface) and OI (mid-depth), and

at the intake canal (Station 11). No significant (α=0.05) differences in either egg or larval densities were found between Stations 1 and OI (Tables B-38 through B-40). Furthermore, mean densities by taxon and relative abundance varied little between these stations (Table B-41). Thus the area close to the offshore intake is not a depauperate one and is representative of offshore waters in the vicinity of the plant.

Both egg and larval densities were significantly higher at Stations 1 and OI than at Station 11 (Tables B-38 through B-40). Although this trend was consistent for each taxon collected, these differences are primarily due to the large decrease in numbers of clupeiformes in the intake canal (Table B-41). Except for flatfishes, which were relatively more abundant in the intake canal than in the offshore intake area, the relative abundance changed very little between offshore intake and intake canal areas. The lower larval densities in the intake canal were probable due to mortality from both mechanical injuries incurred during passage through the intake pipe and predation. Mortalities due to mechanical injury are suspected because most of the larval fishes collected from the intake canal were physically damaged. Predation is also suspected because the inside surface of the intake pipe is encrusted with barnacles and because schools of fishes, such as silver porgies, sergeant majors and jacks, were regularly observed aggregating where the water from the intake pipe first enters the intake canal. Both barnacles and fish probably feed heavily on larval fishes during their passage through the pipe and as they enter the canal.

Inshore Stations: Entrainment

In order to put the impact of entrainment into perspective with ichthyoplankton populations in offshore waters, it was necessary to define an offshore boundary for the region from which ichthyoplankton are potentially drawn. For this assessment of entrainment impact, the offshore boundary is located at Station 3. Fish egg and larval populations beyond this boundary are assumed to be unaffected by plant operation. The distance between the imaginary offshore boundary and the shoreline is approximately 3500 m, with an average depth of 9.2 m for a calculated cross-sectional area of 32,200 m^2. The near-surface ichthyoplankton tows represented populations to an approximate depth of only 3 m. Because stratification of ichthyoplankton could lead to erroneous population estimates, an additional calculation producing a cross-sectional area of 10,500 m^2 was therefore made based on the 3-m depth. The average current velocity in this region, with a prevailing direction to the north, is approximately 0.17 m/sec (Envirosphere, 1977; Worth and Hollinger, 1977). Current velocity multiplied by each of the cross-sectional areas provides figures for the volume of water per second flowing past the plant: 5474 m^3/sec assuming an area of 32,200 m^2 and 1785 m^3/sec assuming an area of 10,500 m^2.

Using the above volume figures and the technique proposed by Goodyear (1977) outlined in this section's "Materials and Methods," it is then possible to estimate the percentage of fish eggs and larvae entrained as they drift past the plant. The percentage loss estimates for 1976 through 1979 for fish eggs or larvae was usually less than 1

percent of the offshore egg and larval populations (Table B-35). This occurred whether or not the average egg or larval densities in the intake canal were assumed to be equal to the average egg or larval densities in the defined offshore areas ($mC_p/C_r \neq 1$, or = 1); this was also the case whether the cross-sectional area was assumed to be 32,200 m^2 or 10,500 m^2 (Table B-42). A worst case of 1.8 percent loss was calculated. The percentage loss estimates for eggs and larvae were not considered to be a significant proportion of the ichthyoplankton occurring in the vicinity of the plant. Therefore, entrainment of ichthyoplankton at the St. Lucie Plant was not considered to be of environmental concern.

SUMMARY

The fish communities offshore of the St. Lucie Plant were transitional assemblages of temperate and tropical forms. Habitats within the influence of normal St. Lucie Plant operations included the surf zone, the open bottom and the neritic zone. The number of fish species found in these habitats is relatively low compared to the number of species from the Indian River lagoon, grass flats, from around inlets and inshore reefs which provide cover, and from the offshore reefs. Those habitats were either of limited extent or beyond the influence of normal plant operations.

Fish and shellfish were sampled in the plant's intake and discharge canals and at oceanic stations. Sampling was conducted by gill netting, trawling, and beach seining for the relatively large forms and by plankton netting for the small fish eggs and larvae.

Gill netting in the intake canal provided data which showed that fishes were not accumulating there. When compared to the numbers of fishes collected during offshore studies, the number entrapped in the intake canal appeared to be relatively low. This was attributed to the velocity cap at the offshore inlet of the intake pipe which enabled fishes to avoid the intake. Of particular importance is the fact that very few migratory fishes of sport and commercial importance have been entrapped in the intake over the past 4 years of study.

Discharge canal gill netting was conducted during 3 months when the circulating water pumps were off. A very low catch indicated that a considerable amount of time would be required for fish and shellfish populations to become established there. Thus, only a few individuals would be subjected to potential thermal effects in the discharge canal once the plant resumed normal operation.

The discharge and control stations yielded consistently more fishes during 4 years of gill netting and trawling than the offshore stations. Differences between stations were attributed to the chance occurrence of highly mobile schooling species and to station location in relation to distance from shore. No detrimental effects of the offshore thermal plume on fishes, including the commercially important migratory species, could be discerned from the distribution and number of fishes collected. Similarly, none of the differences in what species of fishes were represented and their relative percentage composition, during the baseline study and environmental monitoring, could be attributed to plant operation.

The majority of fishes collected by beach seining were found during the summer of each year, and the largest percentage of the total catch was found north of the plant. Although the reason for the higher abundance to the north was not clear, no plant-induced effects were demonstrated.

Ichthyoplankton were generally abundant during the spring and summer of each year. The most common larval fish taxon was clupeiform, a group of primarily forage species which are abundant in the St. Lucie area. Differences in ichthyoplantkon densities between offshore stations were attributed to natural year-to-year and seasonal variations in fish populations, not to plant operation. Comparisons between baseline and operational study years indicate that operation of the St. Lucie Plant has not reduced ichthyoplankton populations in the vicinity of the plant.

The average densities of ichthyoplankton found in the intake canal were lower than those found at the offshore stations. The ichthyoplankton entrained were considered to be an insignificant proportion of the ichthyoplankton populations occurring in the vicinity of the St. Lucie Plant, and therefore, not considered to be of environmental concern.

Changes in the composition and relative abundance of the fish communities and differences, also, in their spatial and temporal distribution during the last 4 years were not attributed to any plant-related

effects. The impact of the St. Lucie Plant's operation on the populations of fish and shellfish offshore of Hutchinson Island was considered negligible.

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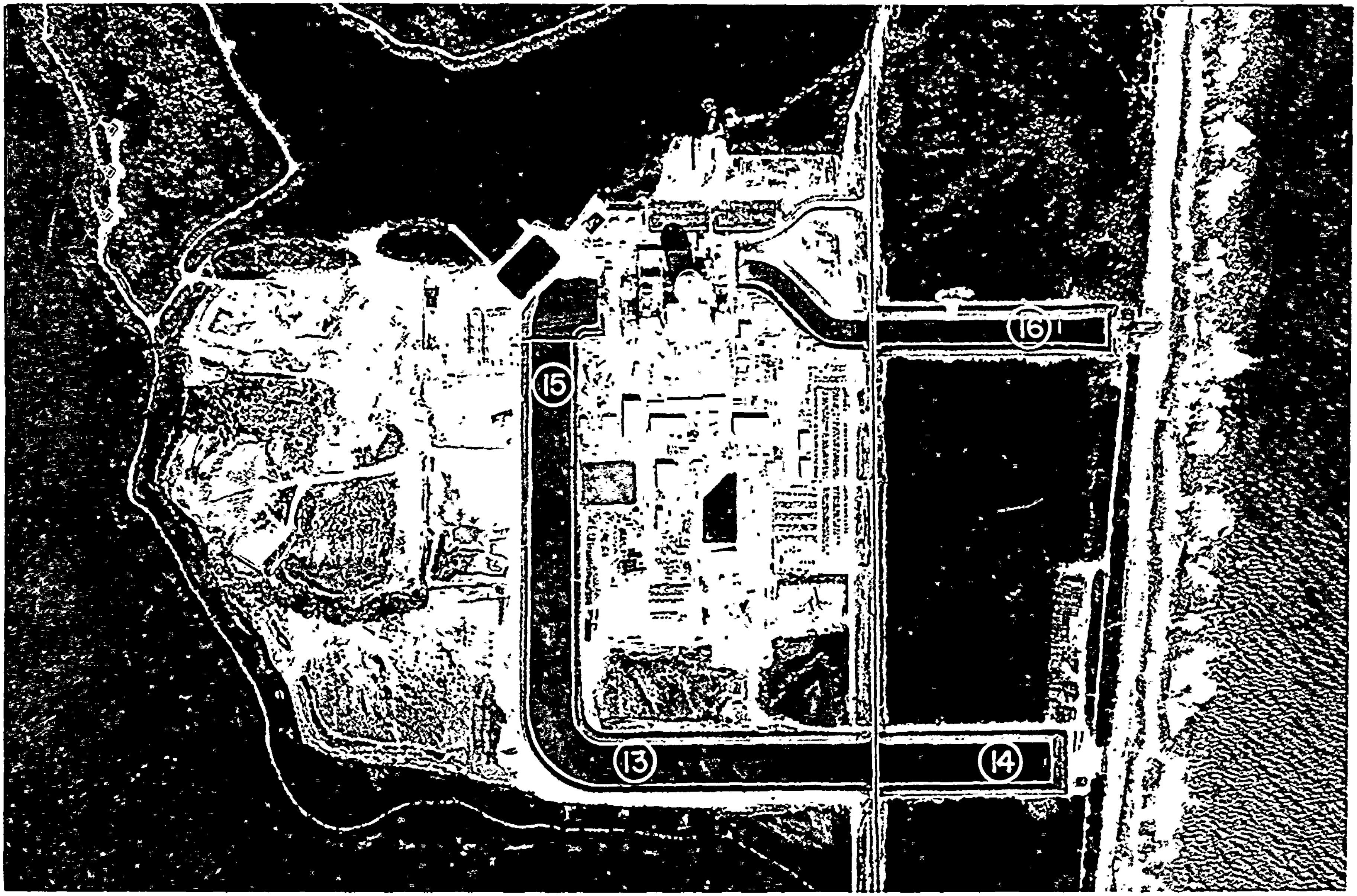

Figure B-1. Canal gill net stations, St. Lucie Plant, 1979.

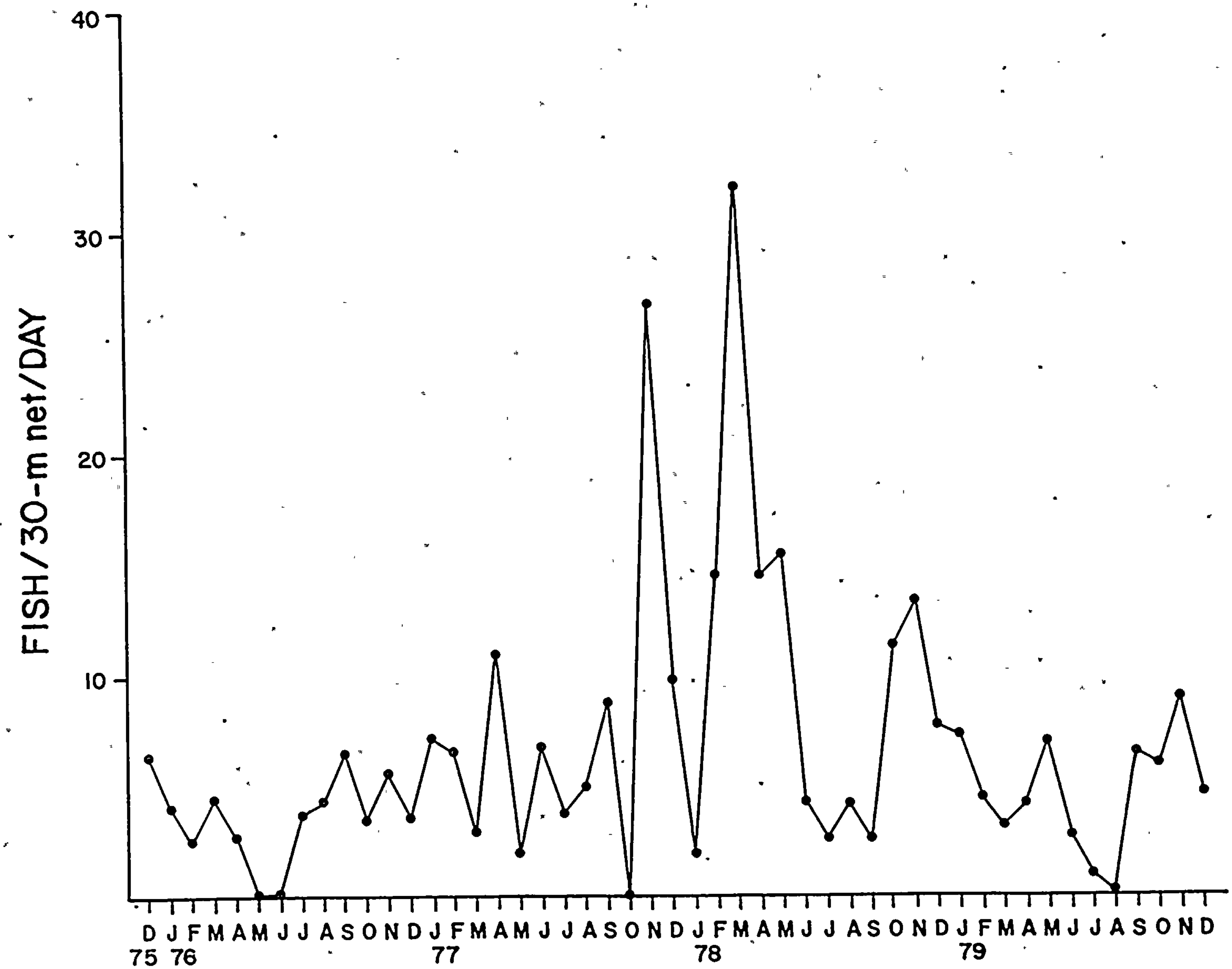

Figure B-2. Number of fishes collected by gill nets at intake canal Stations 13, 14, and 15, St. Lucie Plant, December 1975 - December 1979.

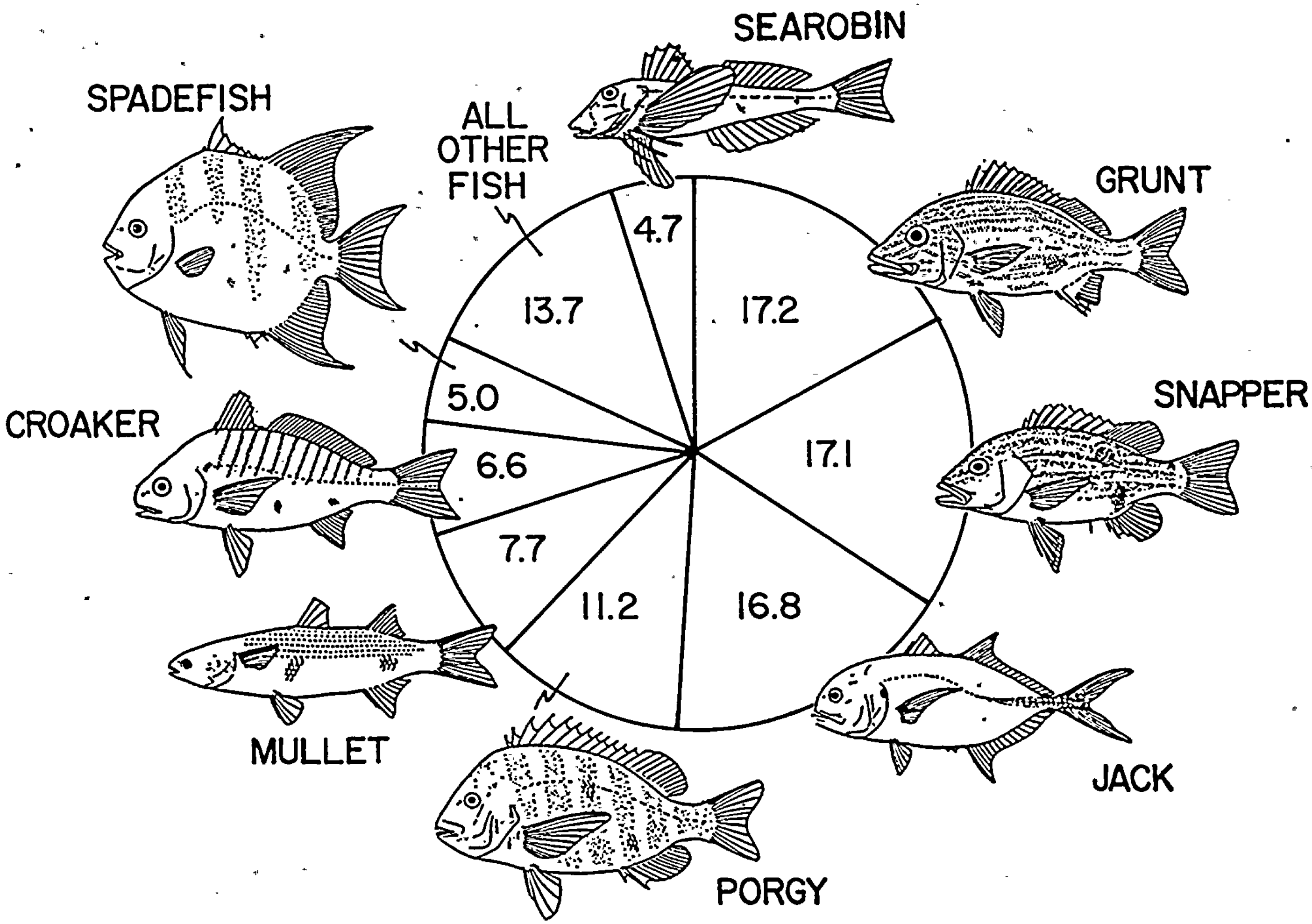

Figure B-3. Percentage composition by number of fishes collected by gill nets at intake canal Stations 13, 14, and 15, St. Lucie Plant, 1976-1979.

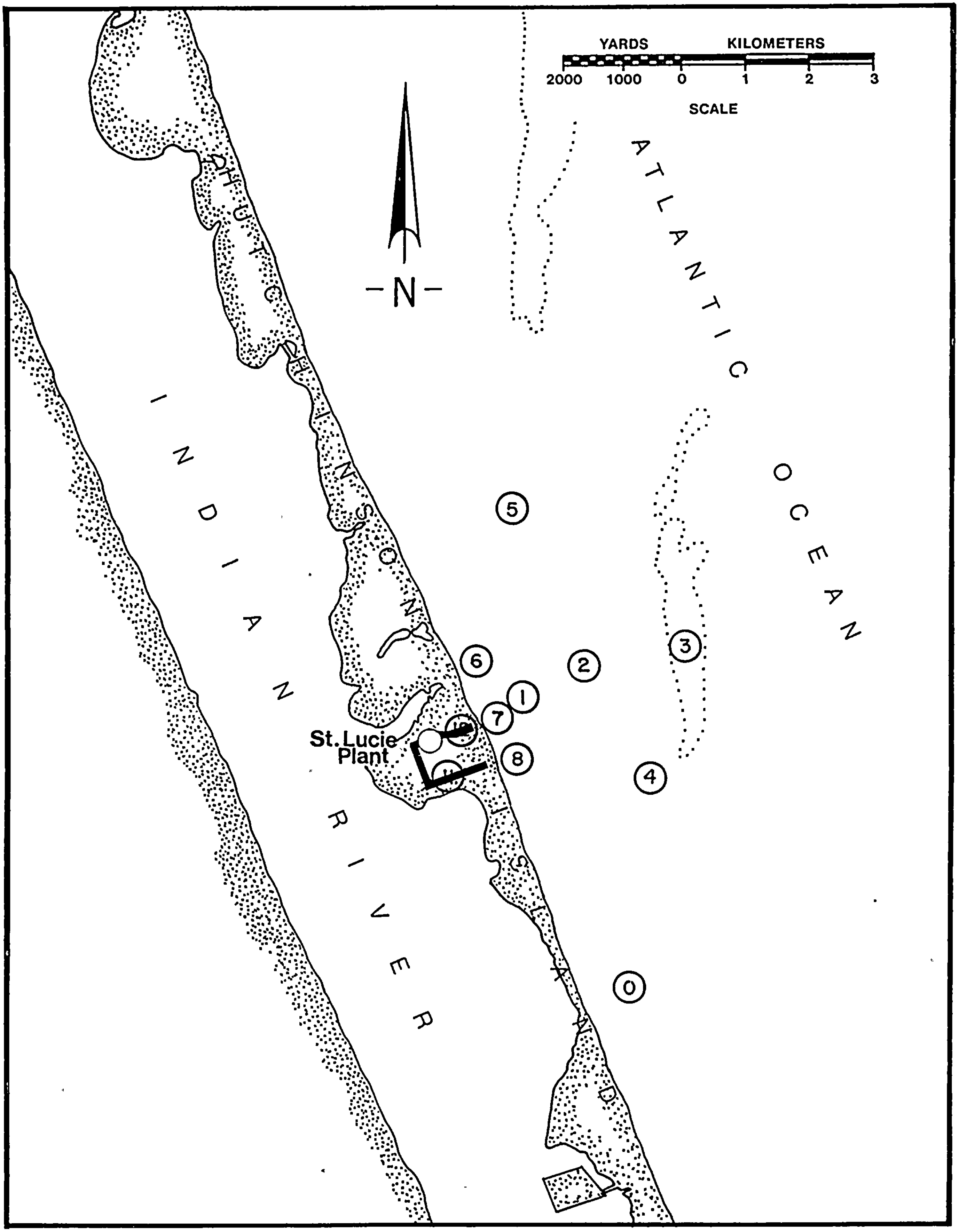

Figure B-4. Locations of fish sampling stations, 1979.

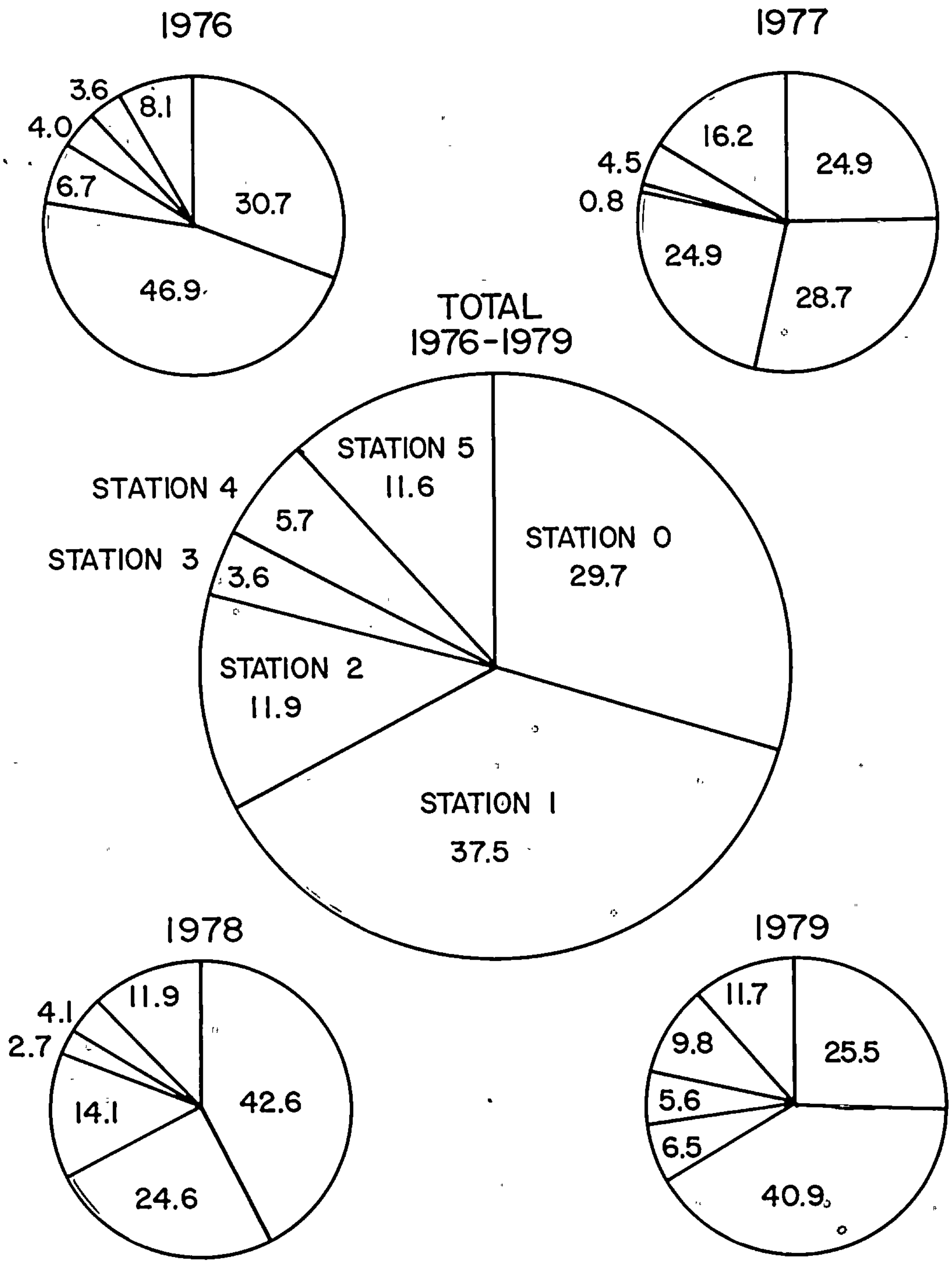

Figure B-5. Percentage composition by number of fishes collected at Stations 0 through 5 by gill nets each year and for all 4 years combined, St. Lucie Plant, 1976-1979.

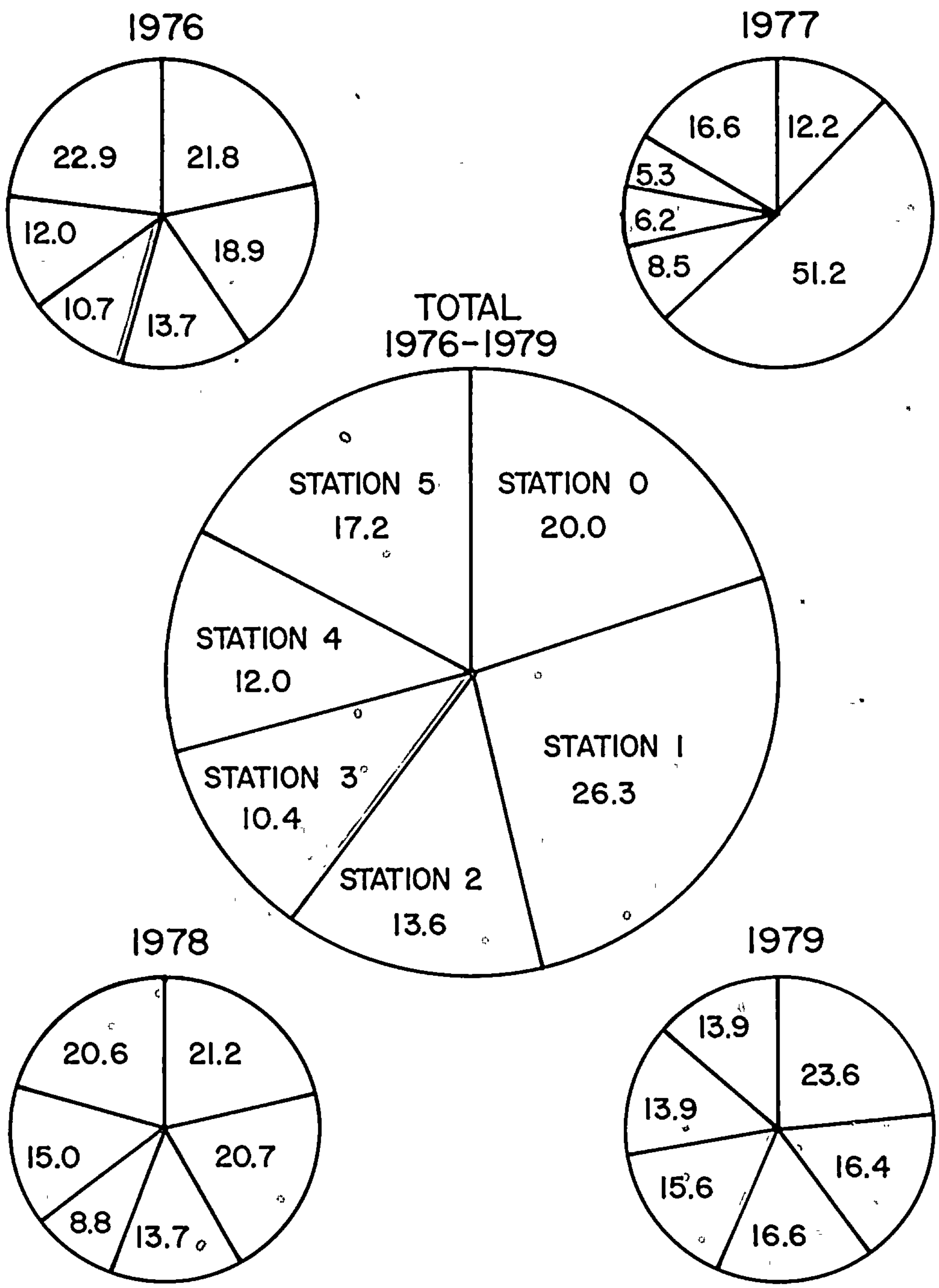

Figure B-6. Percentage composition by number of fishes collected by trawl at Stations 0 through 5 each year and for all 4 years combined, St. Lucie Plant, 1976-1979.

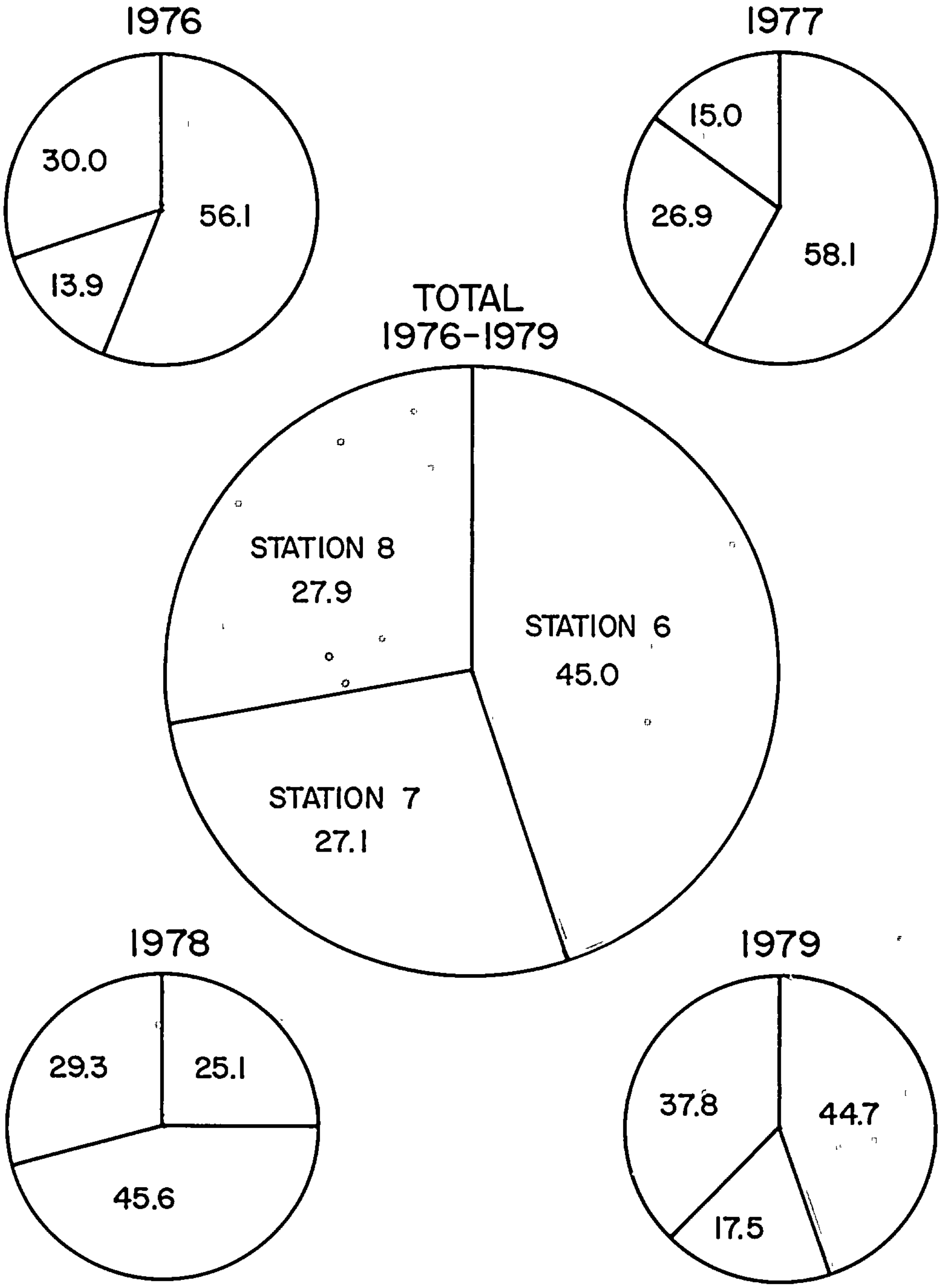

Figure B-7. Percentage composition by number of fishes collected by beach seine at Stations 6, 7, and 8 each year and for all 4 years combined, St. Lucie Plant, 1976-1979.

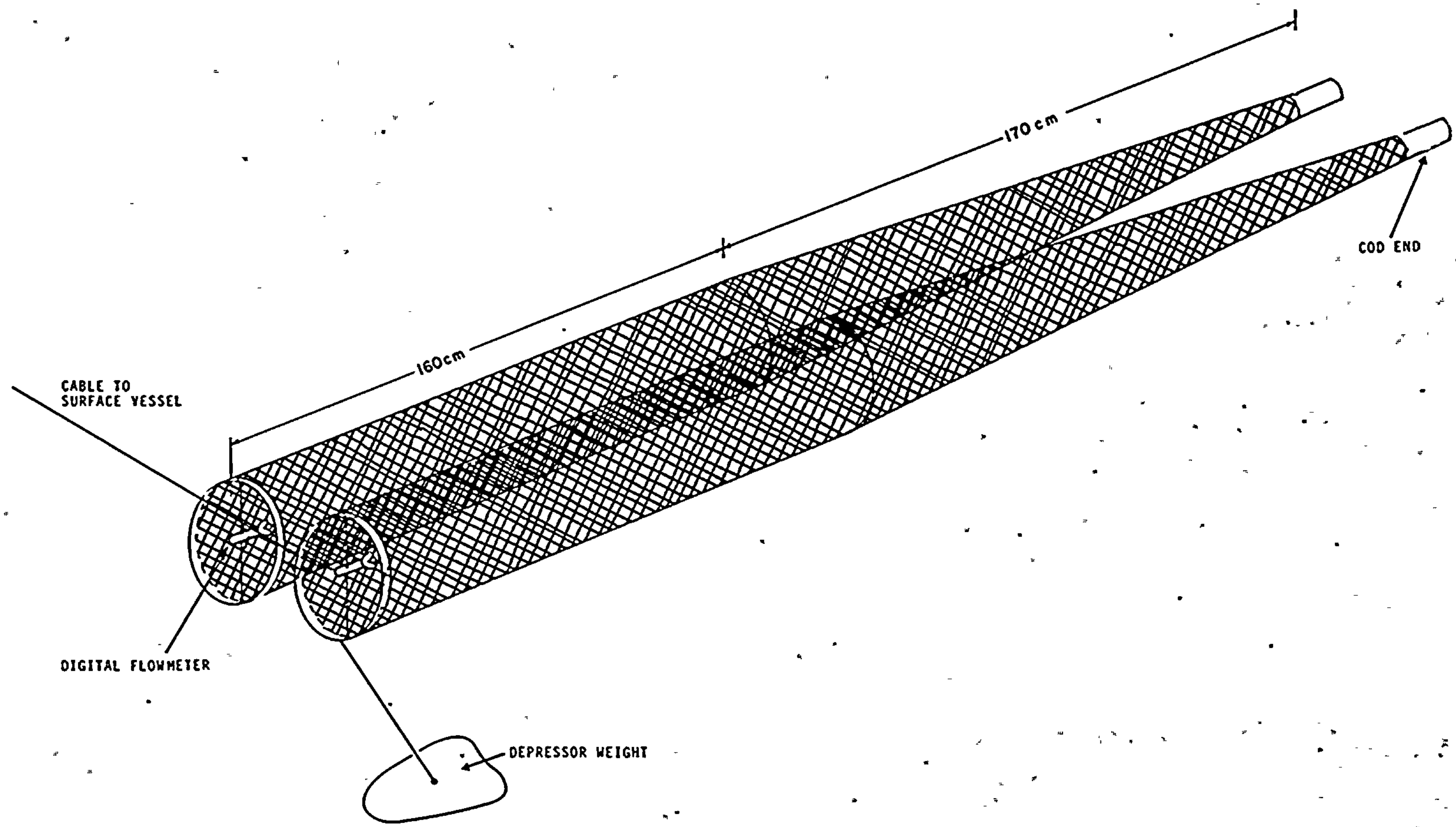

Figure B-8. Diagrammatic view of bongo nets used for collecting larval fish and shellfish.

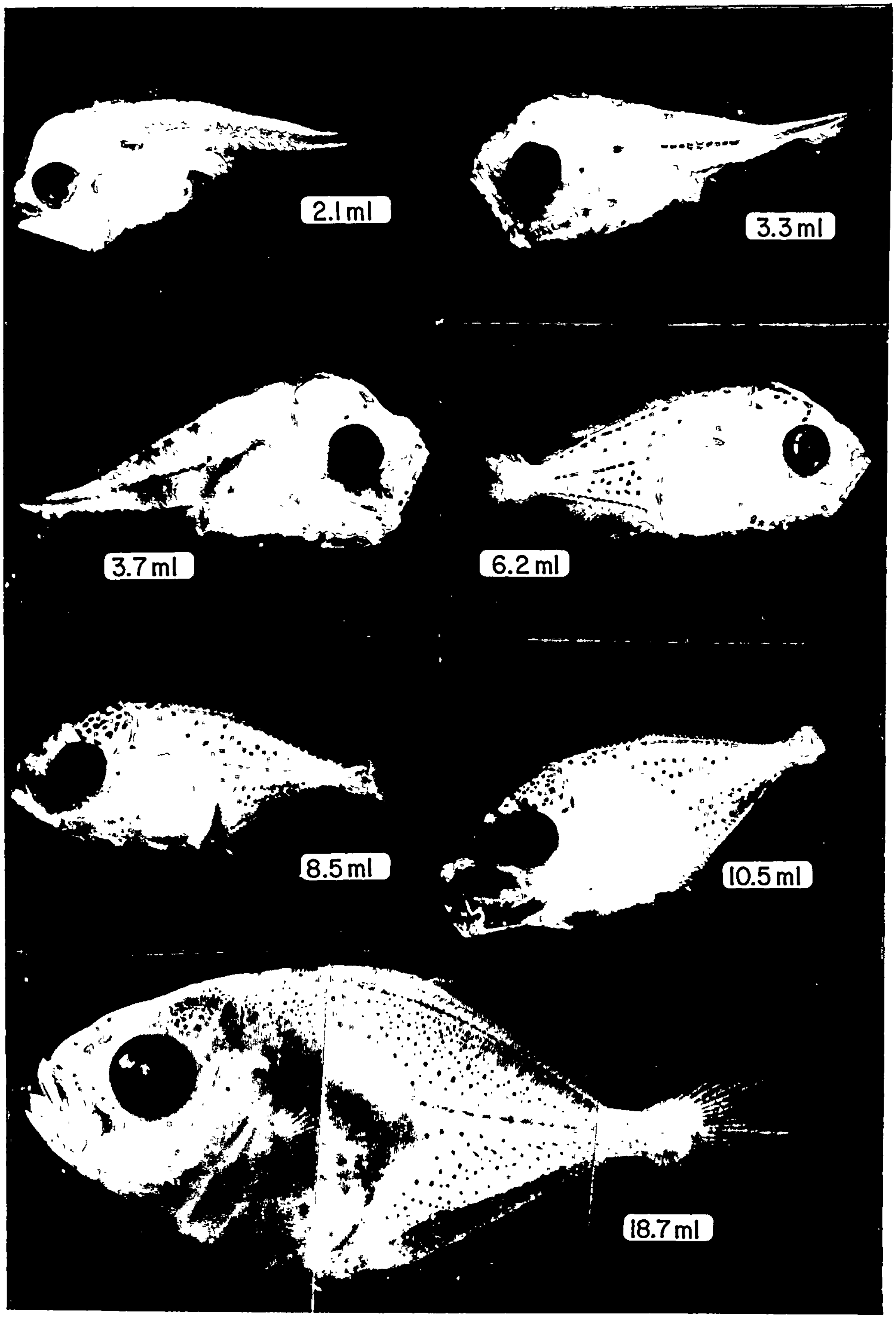

Figure B-9. Development of the Atlantic bumper--an example of the use of photomicroscopy for the identification of larval fishes.

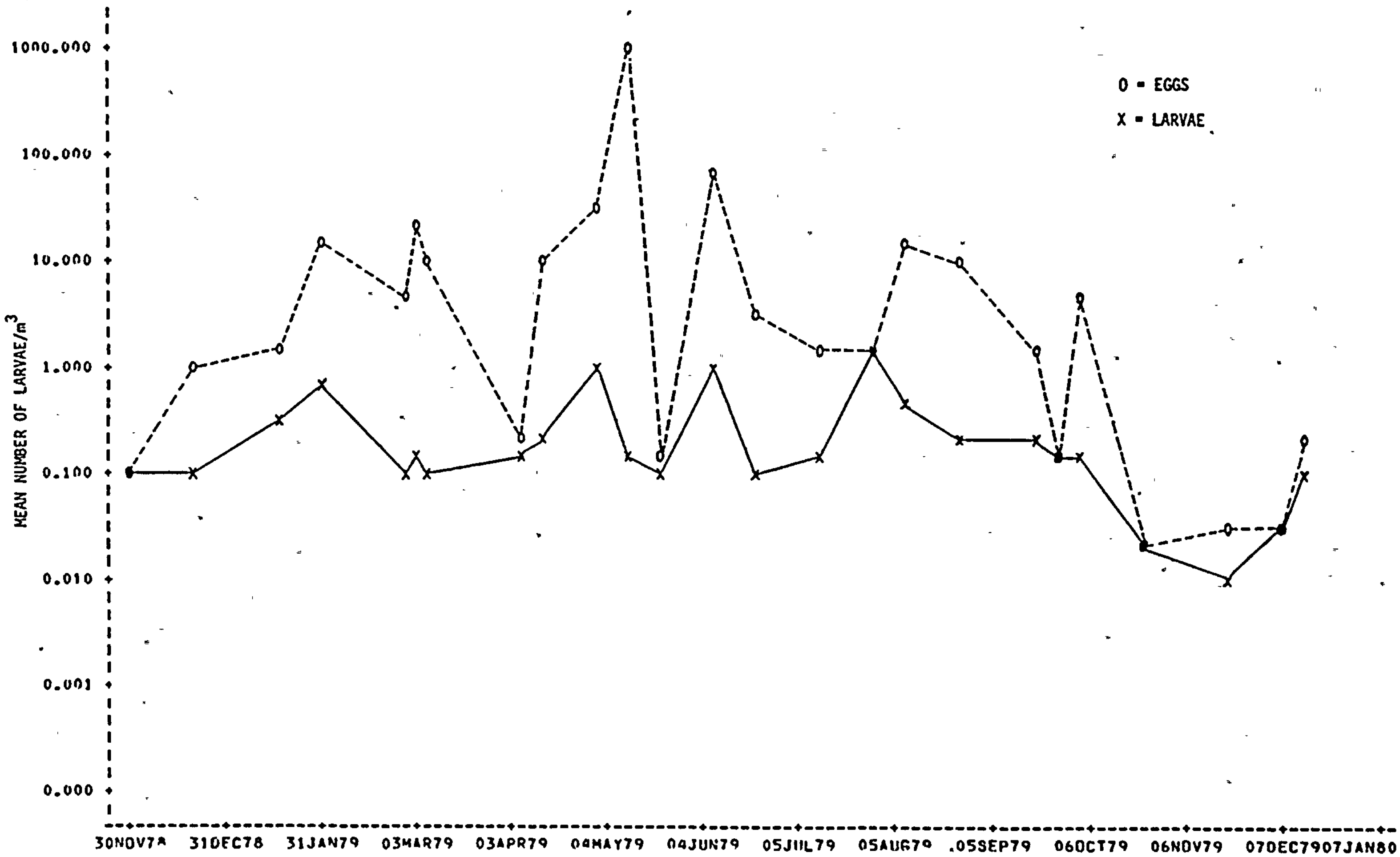

Figure B-10. Mean total densities of fish eggs and larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

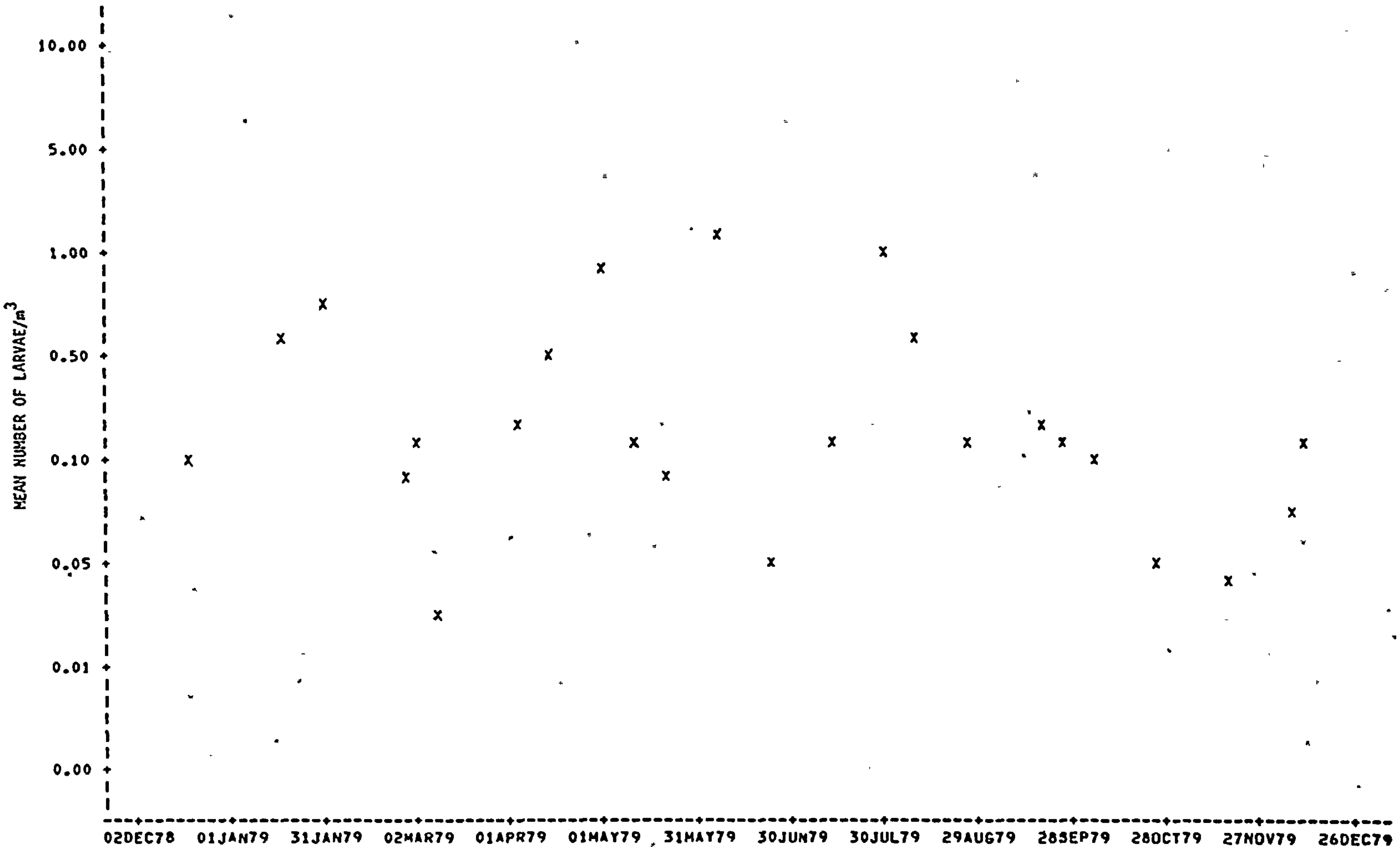

Figure B-11. Mean density of clupeiform larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

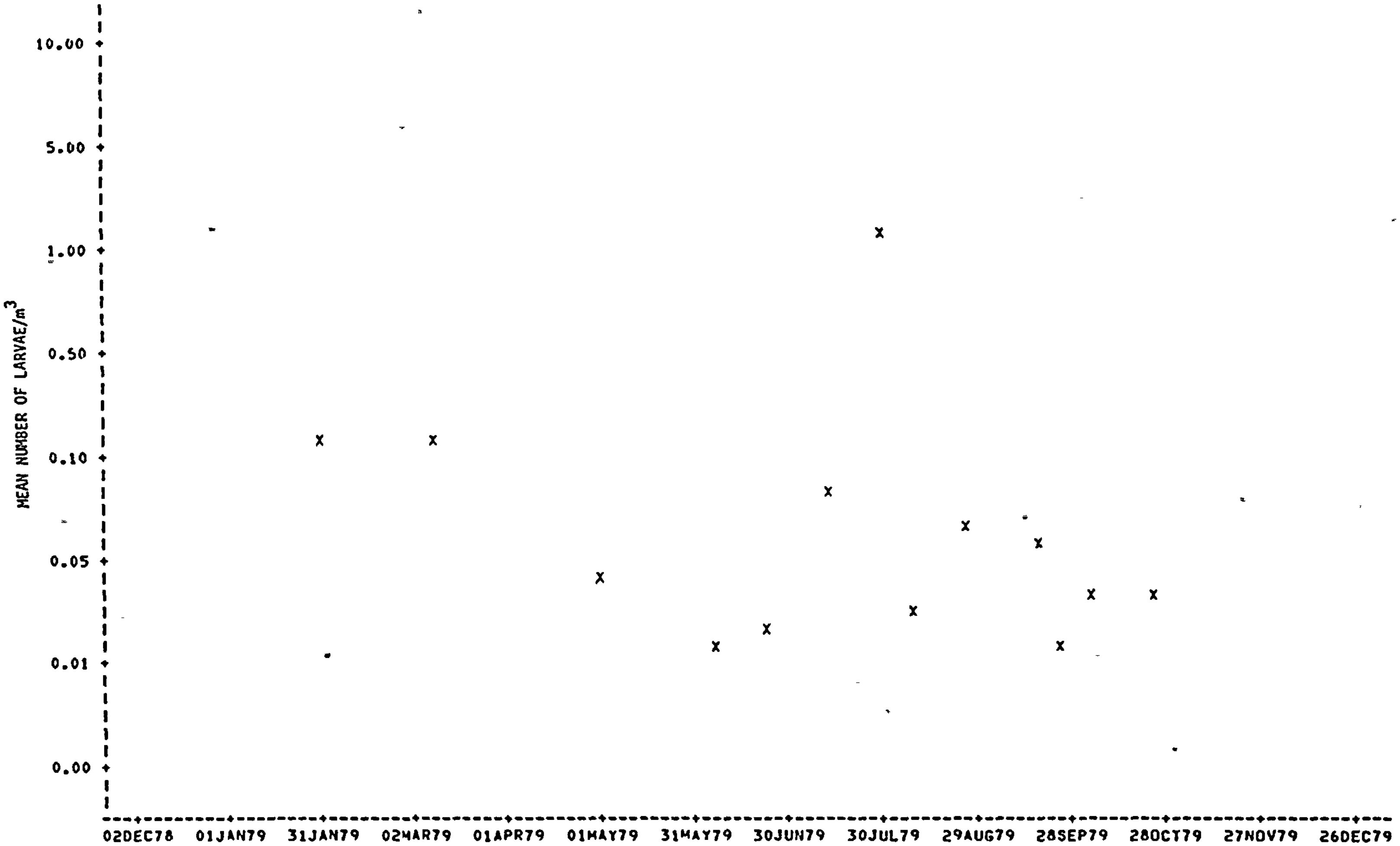

Figure B-12. Mean density of Carangidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

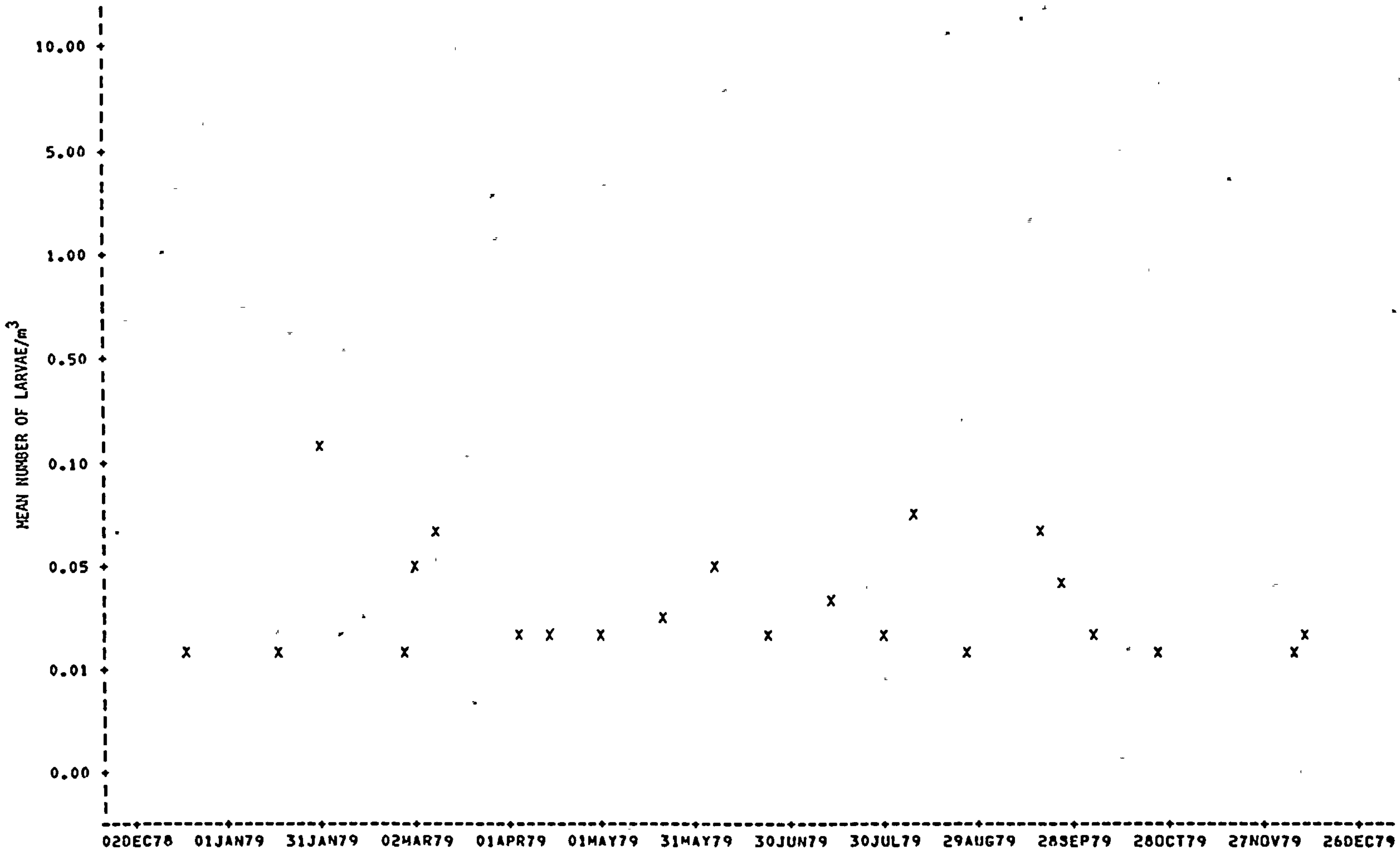

Figure B-13. Mean density of Sciaenidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

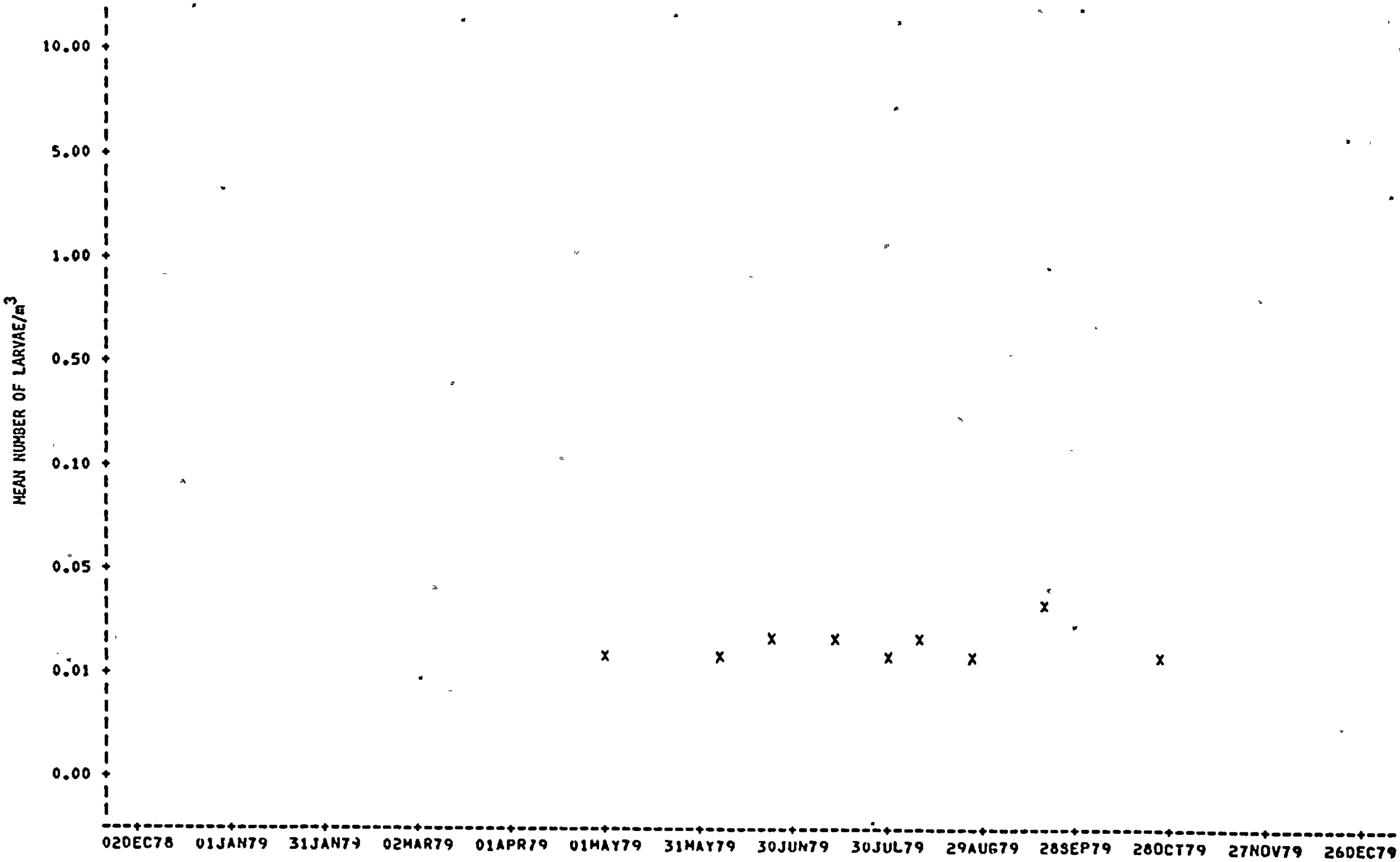

Figure B-14. Mean density of flatfish larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

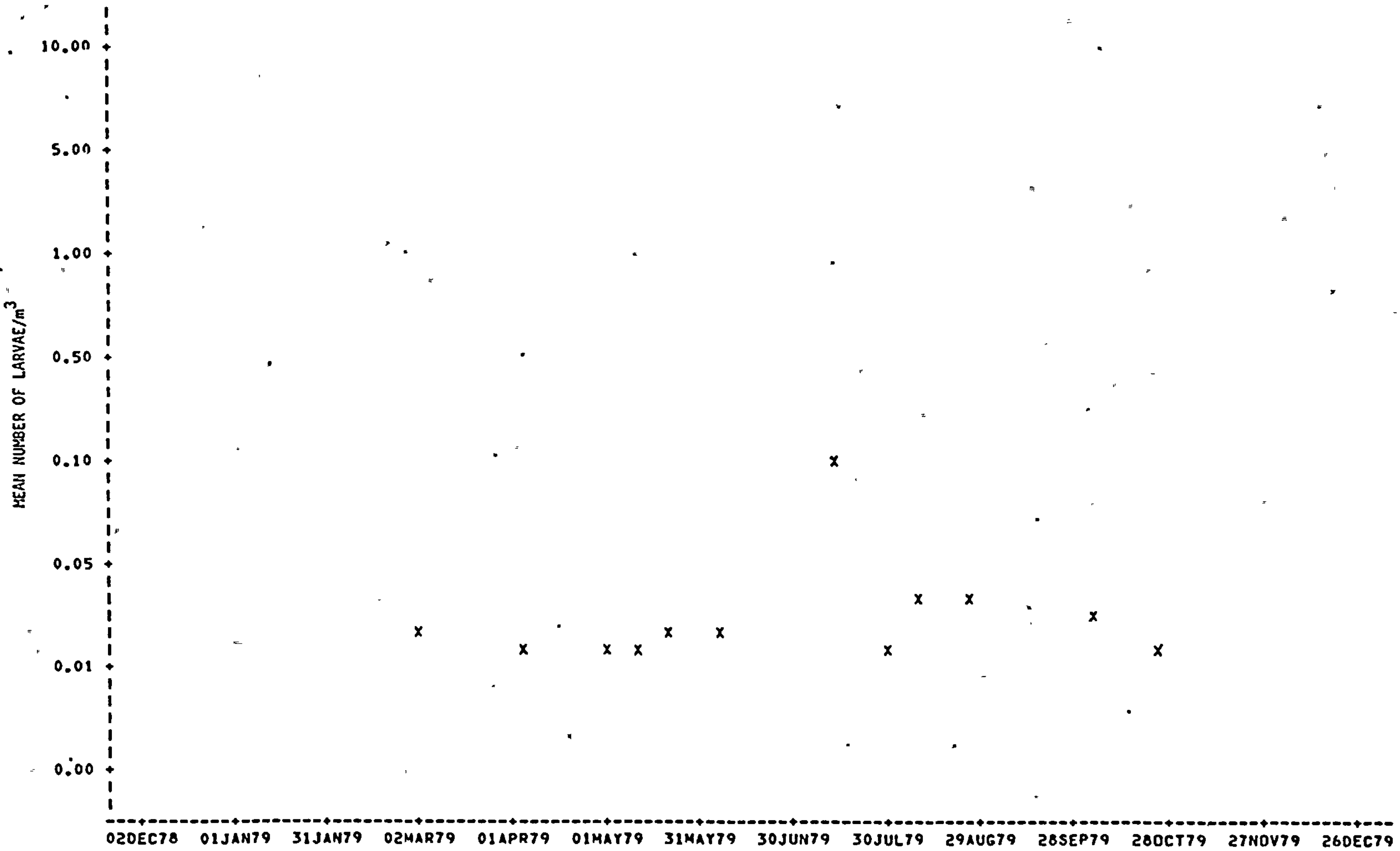

Figure B-15. Mean density of plectognath larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

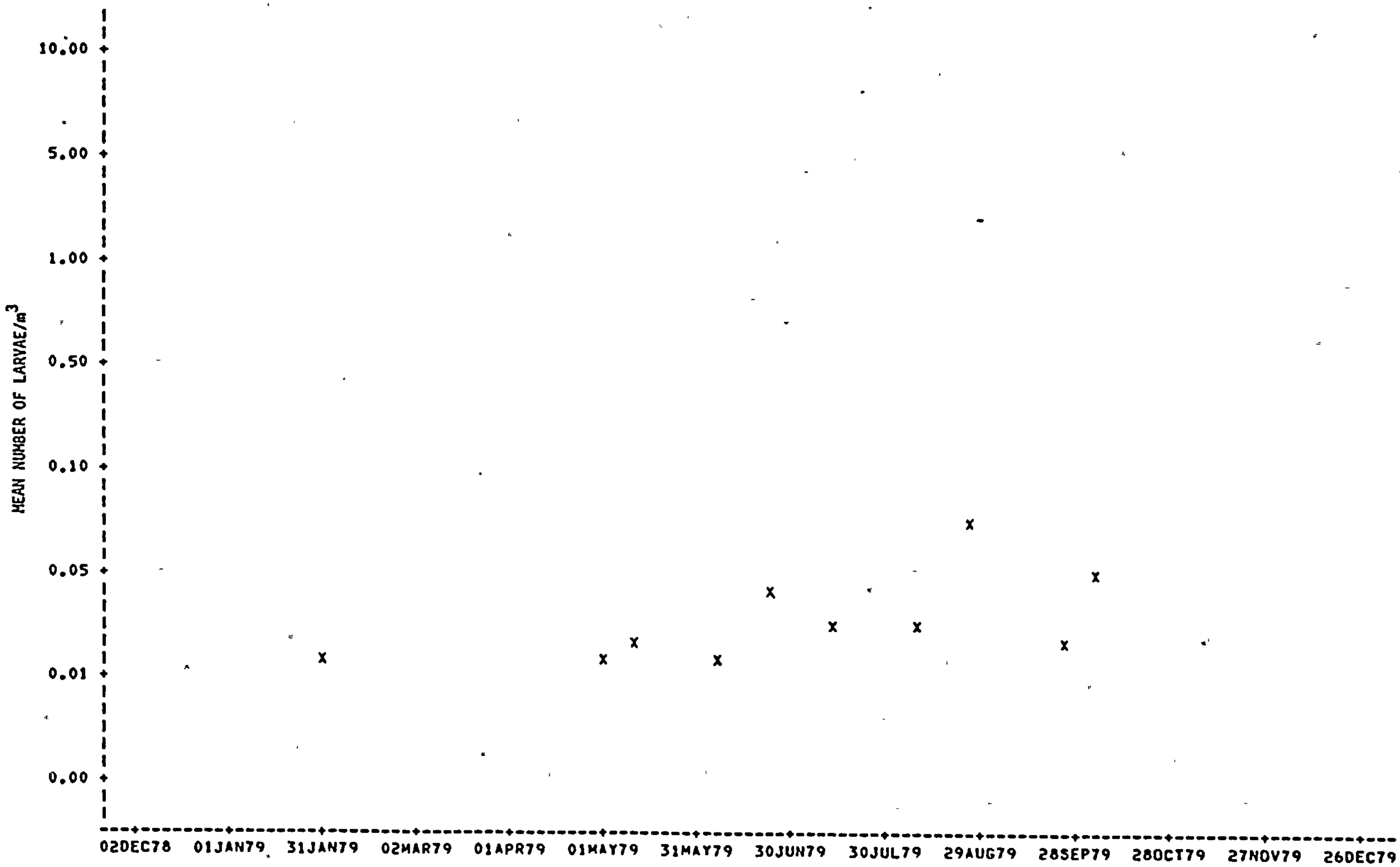

Figure B-16. Mean density of Serranidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

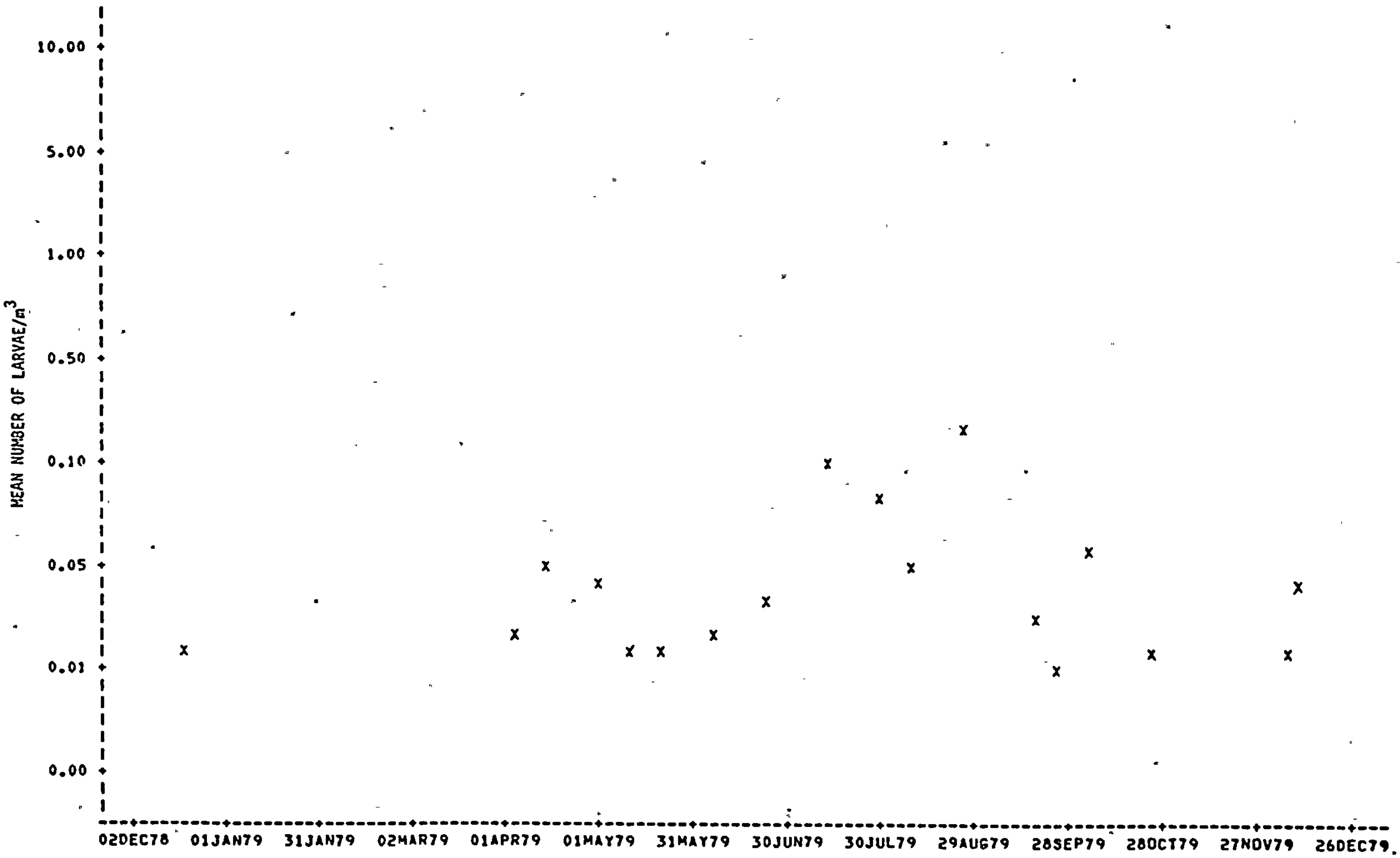

Figure B-17. Mean density of Gerreidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

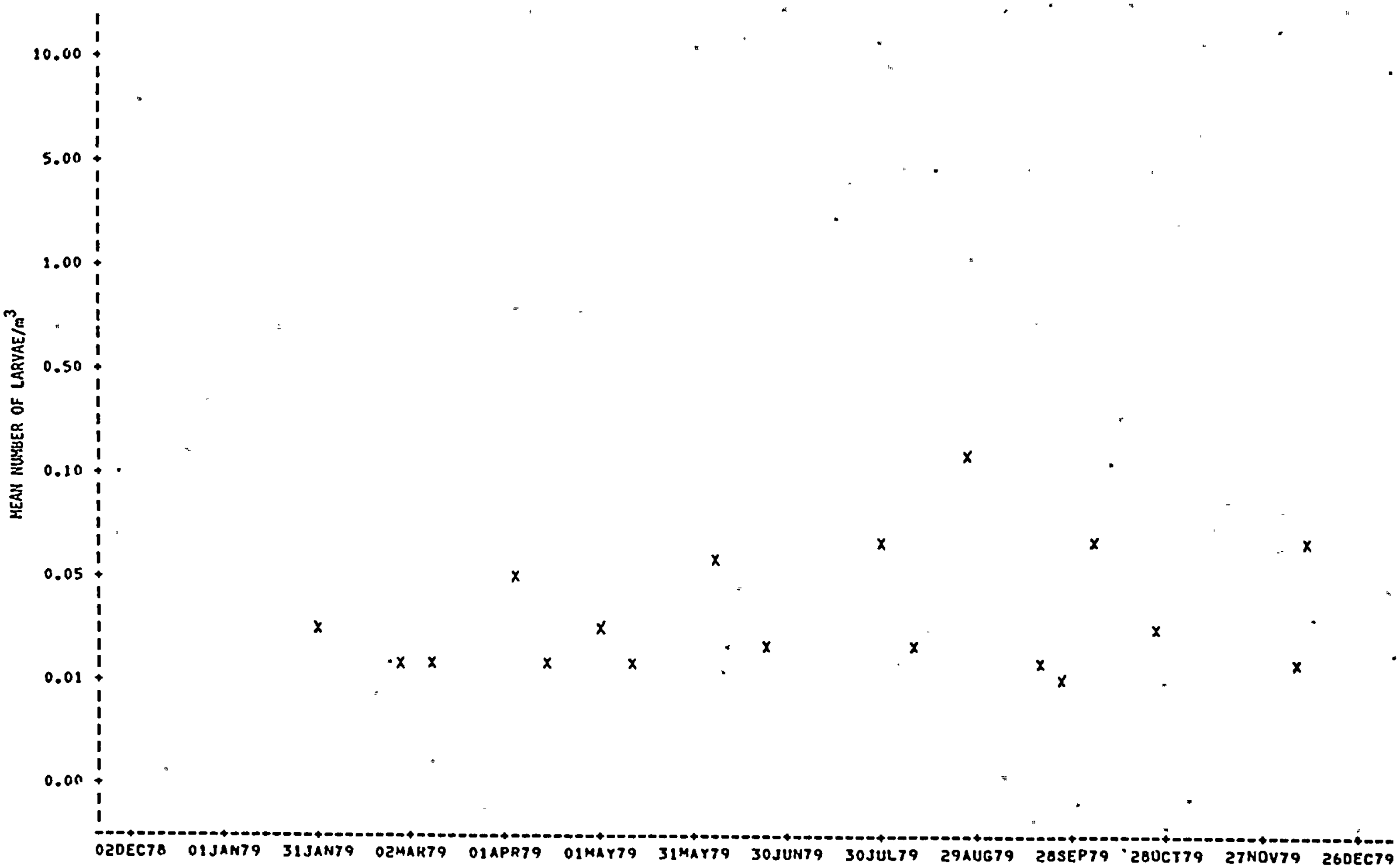

Figure B-18. Mean density of Blenniidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

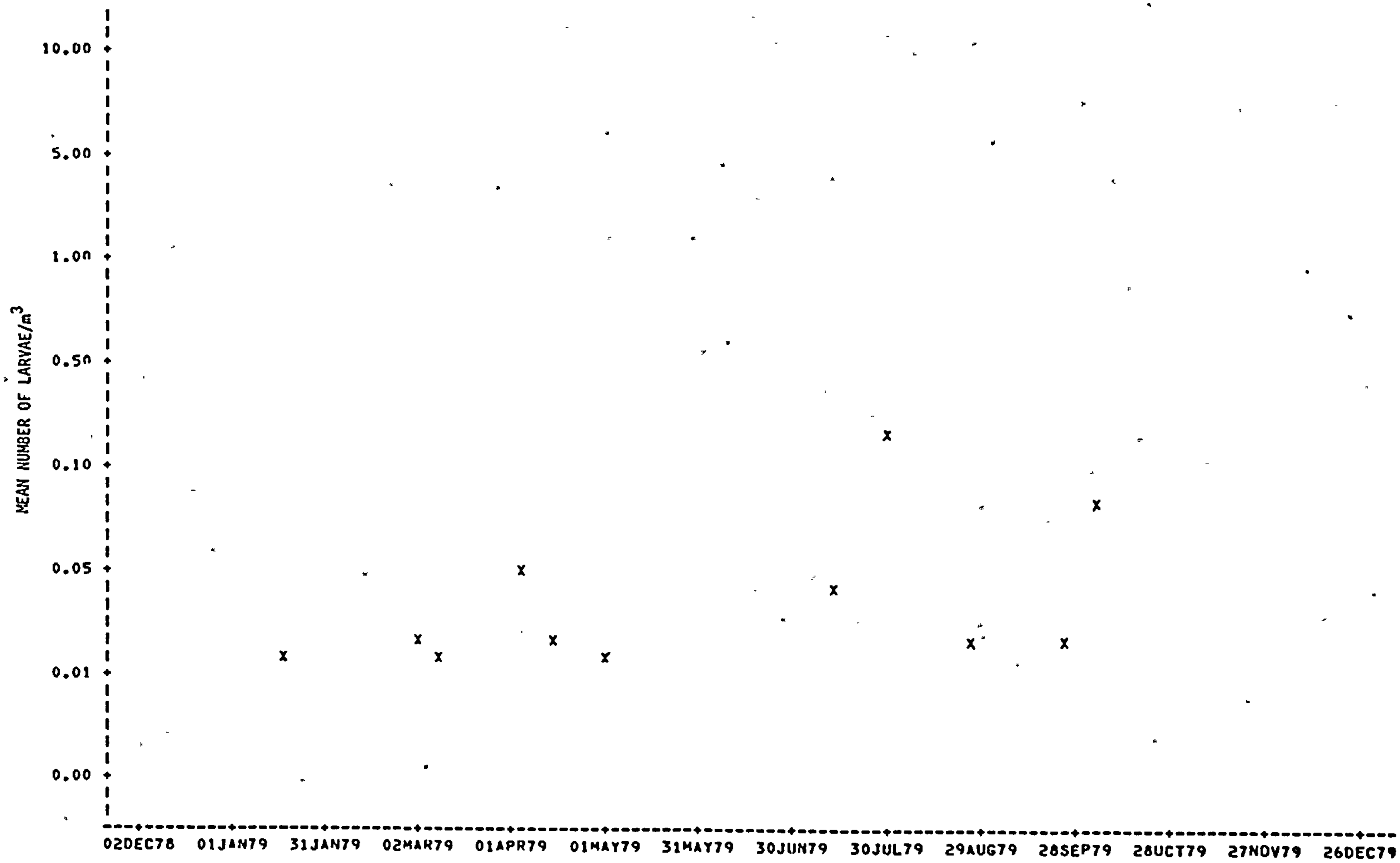

Figure B-19. Mean density of Gobiidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

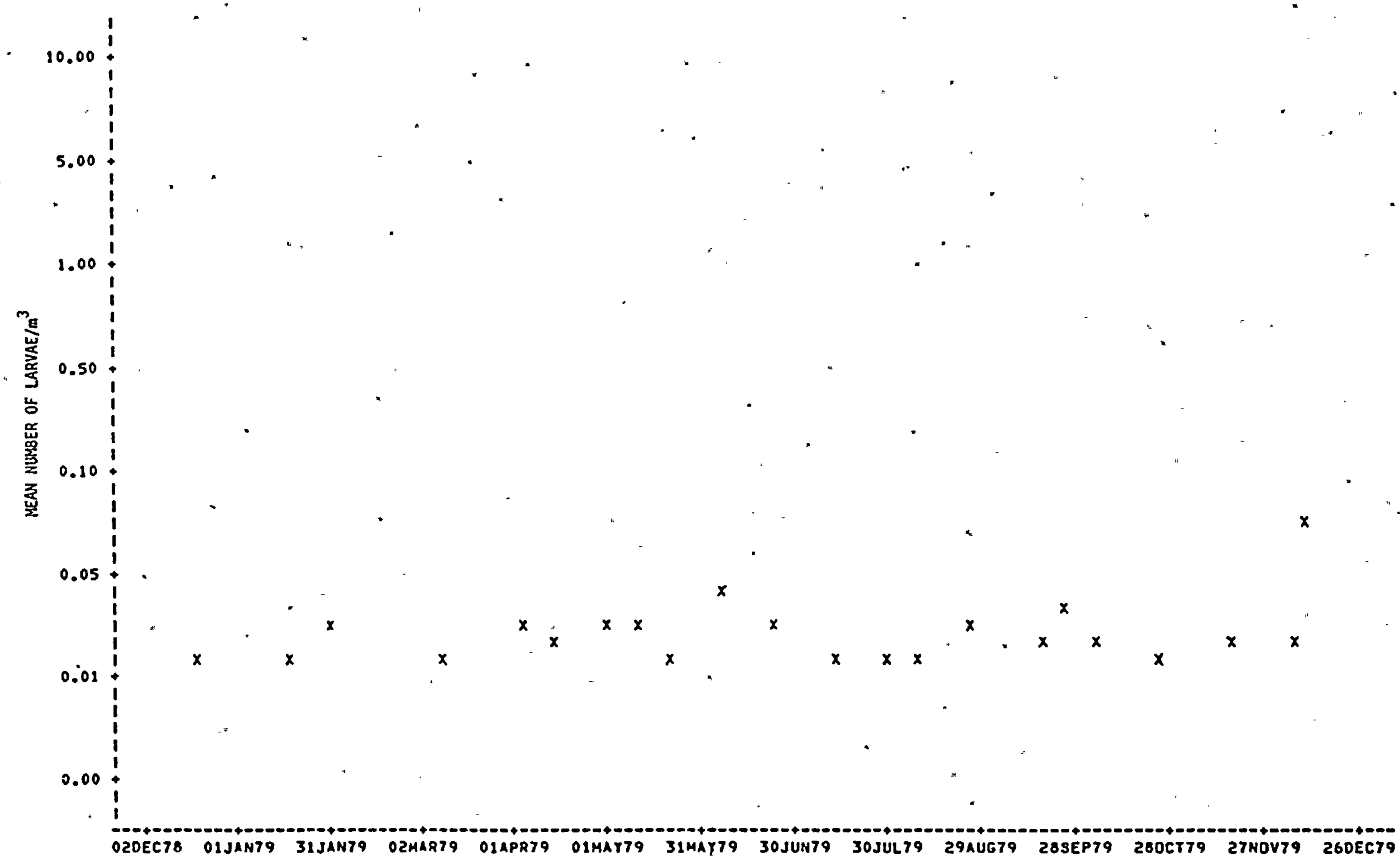

Figure B-20. Mean density of Dactyloscopidae larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

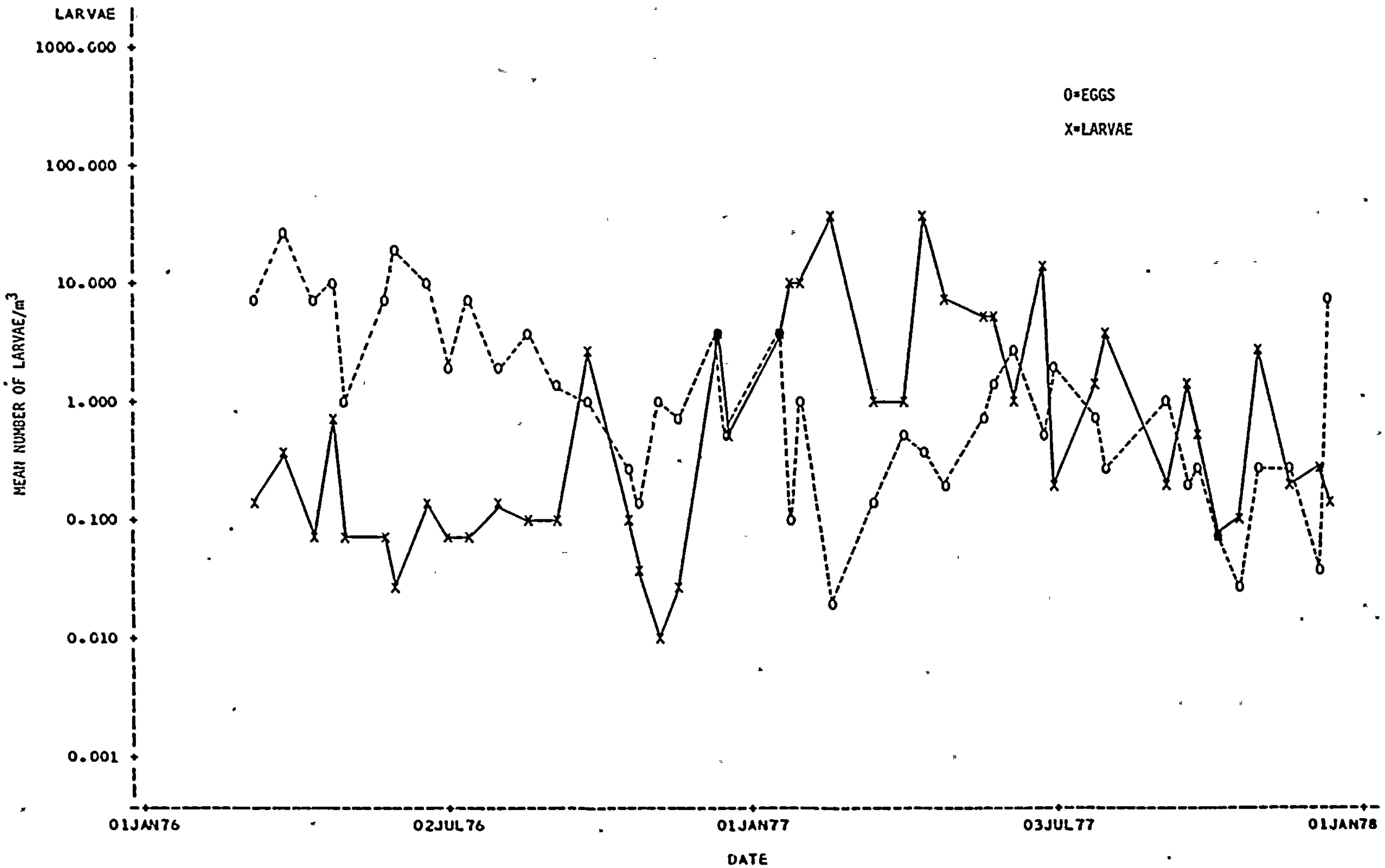

Figure B-21. Mean densities of fish eggs and larvae at Stations 0 through 5, St. Lucie Plant, December 1978 - December 1979.

TABLE B-1

NUMBER, SIZE, AND PERCENTAGE COMPOSITION OF SHELLFISHES AND FISHES
COLLECTED BY GILL NETTING AT CANAL STATIONS
ST. LUCIE PLANT
1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition: Number of individuals	Percentage composition: Total weight
blue crab	148	101-188	28,449	85.6	62.3
spiny lobster	21	56-120	16,286	12.1	35.7
stone crab	4	77-106	937	2.3	2.0
Total	173	-	45672	100.0	100.0
lane snapper	141	92-327	47,089[a]	21.3	12.6
sheepshead	71	139-453	81,508	10.7	21.8
silver porgy	53	123-240	9044[a]	8.0	2.4
pinfish	45	149-247	10,273[a]	6.8	2.8
sailors choice	32	126-273	13,118	4.8	3.5
porkfish	25	133-260	4431[a]	3.8	1.2
crevalle jack	24	167-425	13,572[a]	3.6	3.6
sea catfish	17	156-291	5302	2.6	1.4
striped mojarra	17	135-241	2712[a]	2.6	0.7
spot	16	172-250	3140[a]	2.4	0.8
pigfish	15	135-302	4538[a]	2.3	1.2
great barracuda	13	462-1076	36,039[a]	2.0	9.7
horse-eye jack	12	132-249	2483[a]	1.8	0.7
Atlantic bumper	12	114-212	741	1.8	0.2
white grunt	11	181-245	3212[a]	1.7	0.9
black margate	10	165-423	8613[a]	1.5	2.3
spotted scorpionfish	10	130-216	4161	1.5	1.1
Atlantic spadefish	8	128-321	4478	1.2	1.2
king mackerel	8	346-491	4147[a]	1.2	1.1
blue runner	8	156-308	3014	1.2	0.8
blackwing searobin	8	122-224	744[a]	1.2	0.2
gray snapper	6	250-465	4158[a]	0.9	1.1
spotfin mojarra	6	89-127	230	0.9	<0.1
nurse shark	5	879-1410	43,975	0.8	11.8
black drum	5	202-577	13,701	0.8	3.7
southern flounder	4	317-612	11,084	0.6	3.0
white mullet	4	269-336	2183	0.6	0.6
Spanish mackerel	4	328-388	1784	0.6	0.5
bighead searobin	4	196-241	1130	0.6	0.3
yellow jack	4	177-284	1054	0.6	0.3
tomtate	4	82-192	477	0.6	0.1
Florida pompano	4	145-165	461	0.6	0.1
mutton snapper	4	216-260	292[a]	0.6	<0.1
Atlantic moonfish	4	104-152	139	0.6	<0.1
bullnose ray	3	360-385	1975	0.5	0.5
Atlantic croaker	3	244-348	1757	0.5	0.5
snook	2	358-438	2226	0.3	0.6
yellowfin mojarra	2	273-297	1359	0.3	0.4
striped mullet	2	300	1000	0.3	0.3
sea bream	2	213-248	905	0.3	0.2
tarpon snook	2	334-407	582[a]	0.3	0.2
cero	2	320-335	430[a]	0.3	0.1
cubbyu	2	136-198	292	0.3	<0.1
mojarra	2	230-290	-[a]	0.3	-
bluntnose stingray	1	411	3325	<0.2	0.9
southern stingray	1	502	3225	<0.2	0.9

TABLE B-1
(continued)
NUMBER, SIZE, AND PERCENTAGE COMPOSITION OF SHELLFISHES AND FISHES
COLLECTED BY GILL NETTING AT INSHORE (CANAL) STATIONS
ST. LUCIE PLANT
1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition Number of individuals	Total weight
scalloped hammerhead	1	836	2650	<0.2	0.7
smooth butterfly ray	1	544	1750	<0.2	0.5
Atlantic guitarfish	1	737	1450	<0.2	0.4
red grouper	1	338	1116	<0.2	0.3
ladyfish	1	450	1020	<0.2	0.3
smooth dogfish	1	657	791	<0.2	0.2
lookdown	1	269	705	<0.2	0.2
silver seatrout	1	290	490	<0.2	0.1
cobia	1	338	437	<0.2	0.1
southern stargazer	1	214	415	<0.2	0.1
southern kingfish	1	268	406	<0.2	0.1
sand drum	1	253	350	<0.2	<0.1
greater soapfish	1	197	301	<0.2	<0.1
gulf flounder	1	230	284	<0.2	<0.1
whitebone porgy	1	192	258	<0.2	<0.1
red snapper	1	200	248	<0.2	<0.1
bigeye	1	175	187	<0.2	<0.1
searobin	1	197	156	<0.2	<0.1
dusky flounder	1	193	133	<0.2	<0.1
scaled sardine	1	115	34	<0.2	<0.1
Atlantic thread herring	1	102	25	<0.2	<0.1
silver jenny	1	85	21	<0.2	<0.1
kingfish	1	274	-[a]	<0.2	<0.1
Total	661	-	373,330	100.0	100.0

[a] Includes 1 to 5 fragments.

TABLE B-2

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
1-2 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
silver jenny	29	71-92	406
spotfin mojarra	2	53-62	7
pygmy sea bass	28	32-53	44
belted sandfish	1	49	4
Atlantic bumper	27	34-152	341
Atlantic moonfish	2	25-27	2
bar jack	1	145	48
barbfish	21	29-159	400
spotted scorpionfish	5	144-182	1132
spotted whiff	17	69-145	384
flounder (*B. robinsi*)	2	60-66	14
southern flounder	2	299-400	2040
bay whiff	1	107	24
blackwing searobin	15	41-203	430
leopard searobin	12	133-171	520
bighead searobin	7	31-76	38
northern searobin	1	37	1
hairy blenny	14	71-115	284
seaweed blenny	1	46	2
oyster blenny	1	46	3
Cuban anchovy	13	35-60	9
striped anchovy	4	77-108	38
longnose anchovy	4	43-70	6
anchovy	4	50-70	7
bay anchovy	3	52-77	5
jawfish	12	52-67	44
blackcheek tonguefish	12	52-139	173
offshore tonguefish	2	71-105	15
spotted fin tonguefish	1	113	17
bank cusk-eel	11	124-233	716
spotted soapfish	10	52-97	92
greater soapfish	1	102	26
sand drum	10	41-101	34
striped croaker	9	56-87	57
southern kingfish	2	48-64	5
silver seatrout	2	84-91	22

TABLE B-2
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
1-2 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
high hat	1	75	11
gulf kingfish	1	164	72
silver perch	1	114	33
tomtate	9	43-69	44
sailors choice	3	56-58	16
white grunt	1	87	8
lined sole	9	47-93	206
naked sole	4	100-133	186
bandtail puffer	8	43-92	87
planehead filefish	8	26-65	47
Atlantic midshipman	7	62-185	351
leopard toadfish	1	144	91
palespotted eel	7	292-360	274
shrimp eel	2	250-311	59
sooty eel	2	607-609	109
Atlantic thread herring	7	46-80	44
scaled sardine	7	87-111	129
Spanish sardine	6	72-86	40
bull pipefish	6	248-286	64
chain pipefish	5	103-296	40
lined seahorse	1	66	1
southern stargazer	6	53-173	810
goby	3	78-84	13
Seminole goby	1	44	1
surgeonfish (<u>Acanthurus</u> sp.)	3	19-26	2
doctorfish	1	199	316
Atlantic cutlassfish	3	162-171	5
sea catfish	2	142-159	110
scrawled cowfish	2	167-191	347
lesser electric ray	2	117-121	67
twospot cardinalfish	2	48-56	8
dusky cardinalfish	2	47-48	7
tripletail	2	82-104	54
inshore lizardfish	2	124-139	38
Atlantic spadefish	1	64	20
blackedge moray	1	241	20

TABLE B-2
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
1-2 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
bandtooth conger	1	214	18
bullnose ray	1	364	626
hogfish	1	134	98
shrimp	417	8-50	2026
blue crab	131	11-140	1489
blue crab (Callinectes sp.)	60	20-43	120

TABLE B-3

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
4-5 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
bank cusk-eel	124	145-262	7777
blotched cusk-eel	47	83-263	2432
naked sole	89	92-132	4154
lined sole	13	53-99	364
spotted whiff	78	51-144	2243
dusky flounder	20	71-214	2292
bay whiff	7	76-105	102
fringed flounder	3	79-123	59
southern flounder	2	308-419	2630
eyed flounder	2	42-72	11
gulf flounder	1	229	279
flounder (Citharichthys sp.)	1	60	4
flounder (B. robinsi)	1	117	40
silver jenny	72	68-119	1173
hairy blenny	66	54-172	1364
seaweed blenny	1	47	2
molly miller	1	64	8
blackcheek tonguefish	57	53-159	1347
offshore tonguefish	11	81-133	195
spottedfin tonguefish	1	108	16
leopard searobin	42	114-171	1846
striped searobin	6	101-168	523
blackwing searobin	6	122-204	527
bighead searobin	6	47-209	333
northern searobin	1	107	20
tomtate	25	45-87	172
sailors choice	5	33-74	32
inshore lizardfish	21	129-286	2598
shrimp eel	19	283-444	1039
palespotted eel	12	282-444	390
sooty eel	2	621-644	161
barbfish	16	41-176	1520
spotted scorpionfish	8	144-197	2164
smoothhead scorpionfish	4	57-103	63
Cuban anchovy	15	38-63	17
striped anchovy	8	64-82	53

TABLE B-3.
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
4-5 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
bigeye anchovy	1	73	5
pygmy seabass	12	35-47	15
black seabass	6	63-96	55
rock seabass	1	46	2
belted sandfish	1	46	2
Atlantic bumper	10	32-117	122
Atlantic moonfish	1	26	1
southern stargazer	9	35-198	1071
scaled sardine	9	63-107	155
Spanish sardine	8	70-80	36
Atlantic thread herring	5	58-102	48
cocoa damselfish	8	43-80	101
beaugregory	1	59	12
sergeant major	1	54	10
greater soapfish	7	74-139	382
spotted soapfish	5	53-77	39
Atlantic midshipman	6	47-135	190
scrawled cowfish	5	70-158	712
southern puffer	5	63-157	265
bandtail puffer	4	47-74	25
lesser electric ray	5	110-126	156
high hat	4	73-84	47
silver perch	4	87-144	135
striped croaker	2	69-119	46
southern kingfish	2	61-68	8
silver seatrout	2	75-103	28
chain pipefish	4	146-307	19
bull pipefish	2	264-267	19
lined seahorse	1	87	11
sea catfish	3	133-158	139
blackedge moray	3	246-281	98
dusky cardinalfish	2	43-45	7
twospot cardinalfish	1	53	6
silver porgy	2	71-108	32
whitebone porgy	1	171	216
Atlantic spadefish	2	35-66	17

TABLE B-3
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
4-5 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
slender pike eel	1	326	58
bluntnose stingray	1	232	642
lane snapper	1	76	12
northern sennet	1	43	1
bonnethead	1	493	564
doctorfish	1	37	2
tripletail	1	162	140
Atlantic guitarfish	1	398	266
gray triggerfish	1	142	93
jawfish	1	68	8
dusky jawfish	1	48	3
slippery dick	1	63	4
parrotfish (*Scarus* sp.)	1	46	2
parrotfish (*Sparisoma* sp.)	1	68	8
shrimp	879	7-43	2150
blue crab	122	30-150	1483
blue crab (*Callinectes* sp.)	85	21-45	147

TABLE B-4

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
8-9 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
silver jenny	57	49-105	818
spotfin mojarra	3	97-120	92
Atlantic bumper	50	66-206	944
blue runner	1	157	78
naked sole	52	100-146	2525
lined sole	6	58-94	128
tomtate	26	46-104	440
sailors choice	2	65-68	14
pigfish	6	132-158	401
scaled sardine	22	56-110	373
Atlantic thread herring	5	71-94	45
Spanish sardine	7	66-99	36
bank cusk-eel	20	151-257	1094
blotched cusk-eel	3	183-207	172
silver seatrout	20	29-39	20
silver perch	11	108-134	396
striped croaker	5	67-75	37
reef croaker	1	80	11
sand drum	7	36-135	101
gulf kingfish	4	46-169	89
kingfish	1	31	1
spot	2	152-157	161
high hat	1	78	11
star drum	2	63-76	18
hairy blenny	17	48-104	250
Cuban anchovy	16	37-50	11
striped anchovy	6	70-89	33
blackwing searobin	7	72-149	538
bighead searobin	2	44-71	13
leopard searobin	1	132	30
striped searobin	4	159-210	530
blackcheek tonguefish	10	42-145	155
offshore tonguefish	3	57-137	37
tonguefish	1	50	2
Atlantic spadefish	10	42-77	125
pale spotted eel	8	270-305	155
shrimp eel	3	293-470	216
bandtooth conger	1	225	15
Atlantic cutlassfish	6	137-185	15

TABLE B-4
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
8-9 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
barbfish	3	152-189	554
spotted scorpionfish	2	68-206	407
smoothhead scorpionfish	1	53	6
southern puffer	6	54-137	179
bandtail puffer	2	81-84	32
pinfish	4	135-139	305
silver porgy	1	64	10
spotted whiff	6	44-130	97
smallmouth flounder	1	72	9
fringed flounder	1	100	21
flounder (B. robinsi)	1	71	9
lookdown	5	29-115	115
Atlantic moonfish	1	26	1
Atlantic midshipman	3	87-174	65
blackedge moray	1	305	47
lesser electric ray	2	67-169	577
bullnose ray	1	351	505
rock sea bass	1	101	26
black sea bass	1	93	22
belted sandfish	1	43	2
greater soapfish	1	148	86
surgeonfish	2	25-27	2
french angelfish	1	226	746
grey angelfish	1	176	294
planehead filefish	1	175	165
striped burrfish	1	137	227
inshore lizardfish	1	179	48
barbu	1	150	68
lane snapper	2	61-83	20
flamefish	1	63	8
lined seahorse	1	94	4
hogfish	1	147	137
bay anchovy	1	51	2
shrimp	1479	8-38	3813
blue crab	36	26-168	1220
blue crab (Callinectes sp.)	36	21-40	57

TABLE B-5

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
11-12 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
naked sole	89	91-134	3177
lined sole	17	40-89	364
silver jenny	88	46-131	1407
spotfin mojarra	6	44-126	79
Atlantic bumper	49	35-156	738
Atlantic moonfish	4	22-90	34
lookdown	3	23-42	56
crevalle jack	2	34-287	627
leatherjacket	2	58-89	9
bar jack	1	166	75
scaled sardine	48	67-117	987
Spanish sardine	14	70-116	78
Atlantic thread herring	9	80-91	77
bank cusk-eel	47	104-240	2759
blotched cusk-eel	10	84-234	347
cusk-eel	1	85	5
hairy blenny	44	57-111	751
oyster blenny	1	43	2
spotted whiff	22	52-148	712
fringed flounder	4	82-106	64
dusky flounder	4	87-195	286
ocellated flounder	3	34-149	73
smallmouth flounder	2	72-79	17
southern flounder	1	365	fragment
flounder	1	205	140
bighead searobin	19	27-241	546
leopard searobin	10	106-167	384
blackwing searobin	7	65-122	135
northern searobin	1	47	2
tomtate	19	40-93	257
pigfish	8	117-143	400
sailors choice	5	60-74	45
blackcheek tonguefish	12	57-134	260
offshore tonguefish	3	122-139	95
tonguefish	1	47	2
barbfish	13	33-168	506
spotted scorpionfish	8	101-214	1633
southern puffer	12	45-152	286
bandtail puffer	4	55-87	53

TABLE B-5
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
11-12 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
inshore lizardfish	11	120-262	1568
shrimp eel	8	272-377	302
palespotted eel	4	269-357	123
Atlantic croaker	8	30-49	9
silver perch	4	115-141	174
gulf kingfish	3	43-137	123
spot	2	160-198	234
striped croaker	2	58-69	10
star drum	2	75-96	34
banded drum	1	36	1
high hat	1	80	11
southern kingfish	1	59	3
pinfish	7	101-136	281
Atlantic spadefish	7	46-109	187
chain pipefish	6	121-227	17
bluntnose stingray	5	177-217	1807
Atlantic stingray	1	138	2
striped anchovy	5	69-94	39
Cuban anchovy	4	35-57	5
bigeye anchovy	3	64-70	103
sea catfish	4	160-234	374
scrawled cowfish	4	86-181	573
black sea bass	4	58-112	70
pygmy sea bass	3	39-42	5
sand perch	2	94-99	37
sand perch	2	57-65	10
dwarf sand perch	1	104	24
rock sea bass	1	109	29
belted sandfish	1	44	3
spotted soapfish	3	67-72	26
greater soapfish	1	142	87
leopard toadfish	3	50-137	112
Atlantic midshipman	3	58-91	25
toadfish (<u>Opsanus</u> sp.)	1	126	fragment
lesser electric ray	3	111-193	188
bullnose ray	2	339-368	1175
smooth butterfly ray	1	382	625
twospot cardinalfish	2	60-68	14
bronze cardinalfish	1	32	1
doctorfish	2	120-129	151

TABLE B-5
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
11-12 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
surgeonfish	1	25	1
gray triggerfish	1	107	32
planehead filefish	1	33	2
orange filefish	1	392	784
unicorn filefish	1	352	651
French angelfish	1	233	fragment
blue angelfish	1	241	fragment
cocoa damselfish	1	60	2
blackedge moray	1	504	297
sooty eel	1	756	56
polka-dot batfish	1	221	375
tripletail	1	77	15
lane snapper	1	53	5
yellowtail snapper	1	84	13
hogfish	1	109	42
striped burrfish	1	175	222
yellowhead jawfish	1	59	4
shrimp	1782	6-39	3957
bluecrab	105	31-179	4479
bluecrab (_Callinectes_ sp.)	55	17-36	88
lobster (_Panulirus_ sp.)	1	9	1

TABLE B-6

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
15-16 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
silver jenny	21	62-98	282
spotfin mojarra	5	72-110	75
Atlantic croaker	7	31-40	6
silver seatrout	6	33-42	7
spot	1	157	111
bank cusk-eel	6	121-196	633
hairy blenny	6	55-88	80
palehead blenny	1	61	6
seaweed blenny	1	46	3
tomtate	6	40-139	108
pigfish	1	151	108
Atlantic bumper	5	66-106	54
Atlantic moonfish	1	61	5
jack (<u>Caranx</u> sp.)	1	34	1
scaled sardine	5	92-109	108
Atlantic thread herring	3	82-95	33
blackwing searobin	5	62-113	79
leopard searobin	3	111-155	92
bighead searobin	1	63	7
scrawled cowfish	4	134-160	640
lesser electric ray	4	121-318	661
Cuban anchovy	3	32-40	2
longnose anchovy	1	42	1
striped anchovy	1	87	8
bigeye anchovy	1	73	5
barbfish	3	161-194	539
blackcheek tonguefish	3	59-109	32
spotted whiff	2	82-122	53
Atlantic midshipman	2	85-193	151
inshore lizardfish	2	131-200	50
palespotted eel	2	289-350	55
pinfish	2	100-102	77
silver porgy	1	67	10
chain pipefish	1	181	2
bull pipefish	1	268	12
bluntnose stingray	1	207	377
Atlantic spadefish	1	104	fragment
dusky cardinalfish	1	48	3
southern stargazer	1	158	173
butterfish	1	91	45
planehead filefish	1	27	1

TABLE B-6
(continued)
RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
15-16 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
orange filefish	1	402	1004
polka-dot batfish	1	189	279
blackedge moray	1	261	28
spotted soapfish	1	61	7
silver perch	1	118	36
southern puffer	1	79	19
frillfin goby	1	51	3
shrimp	161	9-24	612
blue crab	24	22-159	1179
blue crab (*Callinectes* sp.)	4	18-34	7

TABLE B-7

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
18-19 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
silver jenny	14	49-92	156
spotfin mojarra	2	66-80	22
Atlantic bumper	10	72-142	155
lookdown	1	77	20
naked sole	10	94-143	348
lined sole	1	55	10
hairy blenny	9	67-101	114
seaweed blenny	2	63-65	17
Atlantic thread herring	4	82-99	39
Spanish sardine	2	75-77	13
silver seatrout	4	39-45	6
spot	2	139-184	318
sand drum	2	42-43	3
Atlantic croaker	1	37	1
striped croaker	1	71	10
silver perch	1	114	33
high hat	1	71	8
star drum	1	86	17
Cuban anchovy	3	36-45	2
bay anchovy	1	50	1
spotted whiff	3	90-132	83
offshore tonguefish	3	80-110	26
blackcheek tonguefish	1	78	6
Atlantic cutlassfish	2	152-187	5
Atlantic spadefish	2	54-61	30
sea catfish	1	97	15
bank cusk-eel	1	184	48
inshore lizardfish	1	83	5
chain pipefish	1	172	2
lined seahorse	1	125	19
bandtail puffer	1	68	10
southern puffer	1	129	76
bighead searobin	1	30	1
leopard searobin	1	189	104
shrimp	363	8-32	1170
blue crab	21	44-165	2176
blue crab (Callinectes sp.)	3	27-37	6

TABLE B-8

RESULTS OF IMPINGEMENT SAMPLING
ST. LUCIE PLANT
22-23 JANUARY 1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)
Atlantic cutlassfish	17	180-235	85
hairy blenny	12	77-107	195
striped anchovy	7	70-104	53
Cuban anchovy	4	37-44	3
naked sole	5	106-133	248
silver jenny	4	75-82	50
Atlantic bumper	3	94-97	39
lookdown	1	134	74
leatherjacket	1	93	7
tomtate	2	62-77	16
sailors choice	2	43-51	25
French grunt	1	45	2
Atlantic thread herring	2	70-79	13
Spanish sardine	1	96	9
scaled sardine	1	84	10
lane snapper	2	46-72	12
lined seahorse	2	291	24
silver porgy	2	72-81	30
star drum	2	74-75	20
silver seatrout	2	159	31
bank cusk-eel	1	205	71
spotted whiff	1	78	9
bay whiff	1	96	20
palespotted eel	1	242	10
smoothhead scorpionfish	1	99	42
southern puffer	1	91	35
sergeant major	1	78	21
butterfish	1	124	77
bighead searobin	1	82	15
shrimp	93	7-42	507
blue crab	19	41-180	1567
blue crab (<u>Callinectes</u> sp.)	12	23-39	30

TABLE B-9

NUMBER OF FISHES COLLECTED BY GILL NETTING[a] AT CANAL STATIONS
ST. LUCIE PLANT
1979

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug[a]	Sep	Oct	Nov	Dec	Total by taxon	Percentage composition
porgy	36	14	20	8	14	8	1		11	16	31	13	172	26.0
snapper	8	11	3	14	34	4	3	1	21	20	25	7	151	22.9
grunt	9	5	2	5	14	6			11	13	26	5	96	14.5
jack	7	5	6	5	8	1	2		6	9	12	9	70	10.6
mojarra	1		5	1	2		2		1	10	5	1	28	4.2
croaker	5	3		1	1	5	2		2		1	7	27	4.1
scorpionfish; searobin	3	1		2	5				1		3	8	23	3.5
catfish	5	3	1	3	1	3			2		1	1	20	3.0
shark, ray		8		4	1			1					14	2.1
mullet	2	2		2									6	0.9
spadefish	1		1	1	2				1				6	0.9
other fish	10	1		4	2	6	2		9	4	4	6	48	7.3
Total	87	53	38	50	84	33	12	2	65	72	108	57	661	100.0

[a]Six 24-hour net sets per month.

[b]Strong intake currents reduced efficiency of the nets during August.

TABLE B-10

COMMERCIAL FISHERY LANDINGS[a] FOR ST. LUCIE COUNTY
MARTIN COUNTY, AND THE FLORIDA EAST COAST
1976

	Commercial catch (lb)		
Species[b]	St. Lucie County	Martin County	Florida East Coast
amberjack	35,042	4,884	66,091
blue runner	23,799	31,319	67,398
bluefish	277,128	522,613	1,379,814
catfish, sea	0	12,442	45,301
crevalle jack	9,109	34,705	96,596
croaker	2,352	45,223	78,471
dolphin	13,297	285	26,759
drum, black	9,995	35,196	120,837
goatfish	1,320	78,590	96,121
groupers and scamp	72,597	5,726	747,154
herring, thread	0	57,529	57,529
jewfish	5,824	15,786	53,247
king mackerel	2,411,793	95,708	4,820,890
king whiting (kingfish)	6,049	23,771	768,403
menhaden	37,070	16,834	10,131,313
mullet, black (striped)	139,614	225,488	1,930,091
mullet, silver (white)	41,070	14,683	296,495
pompano	97,084	82,494	444,264
sand perch (mojarra)	8,472	104,370	125,663
sea trout, spotted	23,253	10,211	531,707
sheepshead	16,142	100,773	231,875
snapper, mangrove	21,587	3,811	88,941
snapper, red	26,129	2,358	487,900
Spanish mackerel	3,608,391	3,177,067	9,588,569
Spanish sardine	0	16,045	16,175
spot	68,617	36,324	533,881
tilefish	107,875	2,964	151,404
unclassified, food	49,596	27,995	257,980
unclassified, misc.	713	112,798	225,247
other fish[c]	64,002	128,143	2,755,008
Total	7,177,920	4,935,439	36,221,124

[a]NOAA (1978) is the most recent source available for commercial landings statistics.

[b]Species in which over 10,000 lb were landed in either St. Lucie or Martin Counties.

[c]Species in which less than 10,000 lb were landed in both St. Lucie and Martin Counties.

TABLE B-11

NUMBER AND PERCENTAGE COMPOSITION OF FISHES COLLECTED
BY GILL NETTING AT INTAKE CANAL STATIONS DURING ENVIRONMENTAL MONITORING
ST. LUCIE PLANT
1976 - 1979

Taxon	1976[a] Number of fishes	1976[a] Percentage composition	1977[b] Number of fishes	1977[b] Percentage composition	1978[c] Number of fishes	1978[c] Percentage composition	1979[d] Number of fishes	1979[d] Percentage composition
croaker	111	25.0	23	5.7	33	2.3	27	4.1
mullet	90	20.3	28	7.0	103	7.1	6	0.9
grunt	63	14.2	41	10.2	309	21.2	96	14.5
snapper	62	14.0	49	12.2	244	16.7	151	22.9
jack	37	8.3	56	14.0	336	23.1	70	10.6
scorpionfish, searobin	16	3.6	8	2.0	92	6.3	23	3.5
porgy	11	2.5	47	11.7	103	7.1	172	26.0
mojarra	10	2.3	3	0.8	18	1.2	28	4.2
spadefish	2	0.4	84	21.0	57	3.9	6	0.9
shark, ray	2	0.4	34	8.5	23	1.6	14	2.1
catfish	0	0.0	1	0.2	64	4.4	20	3.0
other fish	40	9.0	27	6.7	73	5.1	48	7.3
Total	444	100.0	401	100.0	1455	100.0	661	100.0

[a]Total of 5670 m of net fished.

[b]Total of 3292 m of net fished.

[c]Total of 4267 m of net fished.

[d]Total of 4389 m of net fished.

TABLE B-12

NUMBER, SIZE, AND PERCENTAGE COMPOSITION OF SHELLFISHES AND FISHES
COLLECTED BY OFFSHORE GILL NETTING
ST. LUCIE PLANT
1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition Number of individuals	Percentage composition Total weight
spiny lobster	2	71-78	740	-	-
Atlantic bumper	247	111-211	19,762	15.3	2.1
Spanish mackerel	238	259-575	162,717	14.8	17.1
crevalle jacks	222	150-380	103,479	13.8	10.9
bluefish	221	230-499	203,445	13.7	21.4
spot	158	150-229	26,022	9.8	2.7
Atlantic sharpnose shark	89	450[a]-800	98,873	5.5	10.4
blue runner	77	190-357	36,263	4.8	3.8
Atlantic croaker	47	170-211	7197	2.9	0.8
yellowfin menhaden	40	146-292	13,281	2.5	1.4
scalloped hammerhead	33	762-900[a]	92,200	2.0	9.7
bonnethead	33	502-702[a]	24,282	2.0	2.6
menhaden	25	218-251	8001	1.6	0.8
Florida pompano	17	184-297	4846	1.1	0.5
Atlantic menhaden	16	221-278	5086	1.0	0.5
gafftopsail catfish	15	259-392	12,256	0.9	1.3
king mackerel	12	333-628	9533	0.7	1.0
sea catfish	12	220-325	5134	0.7	0.5
weakfish	11	238-305	3539	0.7	0.4
blacktip shark	10	740-3800[a]	34,950	0.6	3.7
little tunny	8	330-657	21,166	0.5	2.2
banded rudderfish	8	310-363	6576	0.5	0.7
butterfish	8	153-169	914	0.5	<0.1
banded drum	8	137-155	842	0.5	<0.1
southern kingfish	5	249-300	1815	0.3	0.2
silver seatrout	5	205-240	1044	0.3	0.1
pigfish	5	150-192	561	0.3	<0.1
Atlantic thread herring	5	150-165	413	0.3	<0.1
northern kingfish	4	254-301	1550	0.2	0.2
leatherjacket	3	211-254	443	0.2	<0.1
northern searobin	3	149-203	264	0.2	<0.1
finetooth shark	2	1257-1440	30,200	0.1	3.2
sharksucker	2	289-726	3925	0.1	0.4
sheepshead	2	263-287	1399	0.1	0.1
sand drum	2	220-227	465	0.1	<0.1
bigeye scad	2	206	408	0.1	<0.1
Atlantic moonfish	2	136-167	203	0.1	<0.1
great barracuda	1	785	600	<0.1	0.5
shark (Carcharhinus sp.)	1	556	742	<0.1	<0.1
smooth dogfish	1	630	740	<0.1	<0.1
guaguanche	1	419	628	<0.1	<0.1
horse-eye jack	1	242	330	<0.1	<0.1
whitebone porgy	1	198	322	<0.1	<0.1
Atlantic cutlassfish	1	770	289	<0.1	<0.1
lane snapper	1	189	204	<0.1	<0.1
unicorn filefish	1	207	156	<0.1	<0.1
snakefish	1	179	107	<0.1	<0.1
harvestfish	1	101	60	<0.1	<0.1
Spanish sardine	1	158	57	<0.1	<0.1
eyed flounder	1	92	17	<0.1	<0.1
Total	1610	-	951,306	100.0	100.0

[a]Total length.

TABLE B-13

NUMBER OF FISHES COLLECTED BY OFFSHORE GILL NETTING[a]
ST. LUCIE PLANT
1979

	19 JAN						15 FEB						9 MAR					
Taxon	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Atlantic bumper	-	-	-	-	4	-	-	4	-	-	-	-	-	-	-	-	-	-
blue runner	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
crevalle jack	1	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
other jacks	1	1	1	-	1	-	12	-	-	-	-	-	-	-	-	-	-	-
Spanish mackerel	3	6	2	-	10	3	3	5	-	-	-	-	-	-	-	-	-	-
bluefish	2	159	4	-	16	6	8	2	-	-	-	-	-	-	-	-	-	-
shark	14	13	1	-	2	-	16	31	-	-	2	-	-	1	1	-	-	-
menhaden	-	1	13	-	11	12	13	-	-	-	-	-	-	-	-	-	-	-
croaker	1	4	3	-	28	4	4	2	-	-	1	-	-	-	1	-	-	-
other fish	-	-	-	-	2	-	-	10	-	-	-	-	-	1	1	-	-	-
Total	22	185	25	0	74	25	56	56	0	0	3	0	0	2	3	0	0	1

	16 APR						22 MAY						26 JUN					
Taxon	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Atlantic bumper	-	-	-	-	-	-	12	10	-	-	2	-	9	1	-	-	-	-
blue runner	2	-	1	-	-	-	2	3	1	-	-	2	4	5	1	-	1	4
crevalle jack	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
other jacks	-	-	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Spanish mackerel	12	1	6	-	-	3	-	1	-	1	1	-	-	-	-	1	1	-
bluefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
shark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
menhaden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
croaker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
other fish	-	-	1	-	-	-	-	1	-	2	2	1	-	-	-	-	-	-
Total	14	1	13	0	0	3	15	15	1	3	5	3	13	6	1	1	2	4

[a]One 30-minute set per station per month.

TABLE B-13
(continued)
NUMBER OF FISHES COLLECTED BY OFFSHORE GILL NETTING[a]
ST. LUCIE PLANT
1979

	30 JUL						14 AUG						25 SEP					
Taxon	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Atlantic bumper	-	-	-	-	-	-	-	37	-	-	-	1	1	1	3	5	6	1
blue runner	-	9	2	-	-	1	-	6	-	-	-	1	-	-	-	-	-	-
crevalle jack	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
other jacks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spanish mackerel	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
bluefish	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2	3
shark	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
menhaden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
croaker	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-
other fish	1	-	-	-	-	2	-	1	-	2	-	1	1	2	2	-	1	3
Total	1	9	2	0	2	3	0	44	0	2	0	3	7	4	5	5	9	7

	23 OCT						9 NOV						12 DEC					
Taxon	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Atlantic bumper	-	11	3	-	5	12	22	-	2	44	-	36	-	15	-	-	-	-
blue runner	-	3	13	-	-	12	-	-	-	-	-	-	-	-	2	-	-	-
crevalle jack	-	5	1	-	1	15	4	-	-	2	-	4	-	185	-	-	-	-
other jacks	1	1	-	-	-	1	-	2	-	2	-	-	-	1	-	-	-	3
Spanish mackerel	-	5	15	1	-	8	12	2	8	24	-	20	22	60	-	-	-	-
bluefish	-	4	1	-	1	4	-	-	-	2	-	1	-	4	-	-	-	-
shark	2	9	1	-	-	8	-	-	-	-	2	3	4	-	4	2	48	4
menhaden	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-
croaker	8	2	-	-	1	-	70	4	-	-	-	-	104	1	-	-	-	-
other fish	25	6	3	-	3	2	-	14	2	2	-	4	2	2	-	-	2	3
Total	36	46	37	1	11	62	108	22	12	76	2	68	138	268	6	2	50	10

[a]One 30-minute set per station per month.

TABLE B-13

(continued)

NUMBER OF FISHES COLLECTED BY OFFSHORE GILL NETTING[a]

ST. LUCIE PLANT

1979

Taxon	Total by Station 0	1	2	3	4	5	Total by taxon	Percentage Composition
Atlantic bumper	44	79	8	49	17	50	247	15.3
blue runner	8	27	20	0	1	21	77	4.8
crevalle jack	6	192	2	2	1	19	222	13.8
other jacks	15	5	6	2	1	4	33	2.1
Spanish mackerel	54	80	31	27	12	34	238	14.8
bluefish	11	170	5	2	19	14	221	13.7
shark	36	54	7	2	55	15	169	10.5
menhaden	19	1	13	0	11	12	56	3.5
croaker	188	13	4	0	31	4	240	14.9
other fish	29	37	9	6	10	16	107	6.6
Total	410	658	105	90	158	189	1610	100.0

[a]One 30-minute set per station per month.

TABLE B-14

NUMBER AND PERCENTAGE COMPOSITION OF FISHES COLLECTED BY OFFSHORE GILL NETTING DURING ENVIRONMENTAL MONITORING[a]
ST. LUCIE PLANT
1976 - 1979

Taxon	1976[b]		1977[c]		1978[c]		1979[c]	
	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition
Atlantic bumper	557	32.2	211	17.2	482	55.1	247	15.3
crevalle jack	327	18.9	5	0.4	46	5.3	222	13.8
blue runner	273	15.7	71	5.8	91	10.4	77	4.8
Spanish mackerel	179	10.3	407	33.3	61	7.0	238	14.8
bluefish	91	5.2	331	27.1	12	1.4	221	13.7
other fish	307	17.7	198	16.2	182	20.8	605	37.6
Total	1734	100.0	1223	100.0	874	100.0	1610	100.0

[a]Offshore gill netting was not employed during the baseline study.

[b]Total of 60 gill net sets during environmental monitoring by ABI.

[c]Total of 72 gill net sets during environmental monitoring by ABI.

TABLE B-15

NUMBER, SIZE, AND PERCENTAGE COMPOSITION OF FISHES
COLLECTED BY TRAWLING
ST. LUCIE PLANT
1979

Species	Number of fishes	Range of standard lengths (mm)	Total weight (g)	Percentage composition: Number of fishes	Percentage composition: Total weight
Cuban anchovy	1109	26-61	527	34.1	0.8
searobin	214	8-26	34	6.6	<0.1
anchovy	176	15-36	41	5.4	<0.1
silver seatrout	157	20-239	469	4.8	0.7
seatrout	155	9-24	19	4.8	<0.1
pigfish	141	29-230	19,001	4.3	29.1
leopard searobin	126	36-195	4887	3.9	7.5
bank cusk-eel	124	83-265	7113	3.8	10.9
longnose anchovy	67	29-39	28	2.1	<0.1
Atlantic bumper	46	9-41	13	1.4	<0.1
sand perch	39	13-134	244	1.2	<0.1
flounder	38	10-36	24	1.2	<0.1
sand drum	37	12-192	1555	1.1	2.4
Seminole goby	37	15-33	22	1.1	<0.1
sea catfish	31	151-271	4241	1.0	6.5
blotched cusk-eel	29	87-236	1358	0.9	2.1
banded drum	28	10-172	427	0.9	0.7
flounder (B. robinsi)	28	18-117	202	0.9	0.3
inshore lizardfish	27	31-364	1865	0.8	2.9
spotted whiff	26	75-135	445	0.8	0.7
lane snapper	25	17-194	419	0.8	0.6
Atlantic spadefish	24	11-140	2009	0.7	3.1
tomtate	24	18-170	1362	0.7	2.1
eyed flounder	23	23-130	383	0.7	0.6
twospot cardinalfish	22	11-22	8	0.7	<0.1
blackwing searobin	21	64-169	895	0.6	1.4
silver jenny	21	67-108	421	0.6	0.6
Atlantic midshipman	21	22-140	124	0.6	0.2
dusky flounder	20	40-291	1214	0.6	1.9
southern kingfish	14	133-195	1120	0.4	1.7
blackcheek tonguefish	13	37-152	684	0.4	1.0
dwarf sand perch	13	27-68	35	0.4	<0.1
kingfish	13	9-32	4	0.4	<0.1
bay whiff	12	27-121	86	0.4	0.1
cusk-eel	12	40-69	14	0.4	<0.1
spot	11	152-188	1133	0.3	1.7
mojarra	11	13-26	5	0.3	<0.1
grunt	11	13-19	4	0.3	<0.1
spottedfin tonguefish	10	65-145	184	0.3	0.3
drum	10	10-26	5	0.3	<0.1
Atlantic cutlassfish	10	69-100	3	0.3	<0.1
northern searobin	9	46-123	107	0.3	0.2
silver perch	8	78-160	464	0.2	0.7
smoothhead scorpionfish	8	58-113	196	0.2	0.3
planehead filefish	8	13-48	23	0.2	<0.1
shrimp eel	7	323-650	900	0.2	1.4
bighead searobin	7	22-223	829	0.2	1.3
sheepshead	6	180-231	1870	0.2	2.9
gray snapper	6	180-225	1458	0.2	2.2
striped croaker	6	103-192	668	0.2	1.0
gray triggerfish	6	52-192	511	0.2	0.8
naked sole	6	107-151	271	0.2	0.4
snakefish	6	68-151	154	0.2	0.2
lesser electric ray	5	103-247	893	0.2	1.4
barfish	5	50-165	209	0.2	0.3
spotfin mojarra	5	28-65	13	0.2	<0.1
pinfish	4	115-155	347	0.1	0.5

TABLE B-15
(continued)
NUMBER, SIZE, AND PERCENTAGE COMPOSITION OF FISHES
COLLECTED BY TRAWLING
ST. LUCIE PLANT
1979

Species	Number of fishes	Range of standard lengths (mm)	Total weight (g)	Percentage composition Number of fishes	Percentage composition Total weight
rock sea bass	4	42-152	178	0.1	0.3
lined sole	4	42-110	139	0.1	0.2
fringed flounder	3	78-99	40	<0.1	<0.1
lizardfish	3	14-37	3	<0.1	<0.1
gulf flounder	2	211-233	410	<0.1	0.6
scrawled cowfish	2	25-242	390	<0.1	0.6
porkfish	2	165-180	317	<0.1	0.5
Irish pompano	2	140-150	186	<0.1	0.3
gafftopsail catfish	2	167-168	163	<0.1	0.2
blackedge moray	2	173-337	105	<0.1	0.2
bandtail puffer	2	12-101	35	<0.1	0.2
spottail flounder	2	15-74	10	<0.1	0.2
bigeye stargazer	2	47-56	4	<0.1	0.2
bronze cardinalfish	2	17-27	2	<0.1	0.2
puffer	2	10	1	<0.1	<0.1
bluntnose stingray	1	248	564	<0.1	0.9
weakfish	1	247	276	<0.1	0.4
mutton snapper	1	203	254	<0.1	0.4
black drum	1	187	176	<0.1	0.3
sharksucker	1	302	128	<0.1	0.2
Atlantic croaker	1	183	118	<0.1	0.2
striped searobin	1	150	89	<0.1	0.1
palespotted eel	1	316	28	<0.1	<0.1
offshore tonguefish	1	127	19	<0.1	<0.1
bull pipefish	1	280	13	<0.1	<0.1
bandtooth conger	1	206	12	<0.1	<0.1
king mackerel	1	88	7	<0.1	<0.1
star drum	1	45	2	<0.1	<0.1
Atlantic thread herring	1	35	1	<0.1	<0.1
bigeye anchovy	1	46	1	<0.1	<0.1
belted sandfish	1	12	1	<0.1	<0.1
Atlantic moonfish	1	30	1	<0.1	<0.1
seaboard goby	1	20	1	<0.1	<0.1
whiff	1	26	1	<0.1	<0.1
orange filefish	1	35	1	<0.1	<0.1
unidentified fishes	117	9-38	10	3.6	<0.1
Total	3251	-	65,226	100.0	100.0

TABLE B-16

NUMBER OF FISHES COLLECTED BY TRAWLING[a]
ST. LUCIE PLANT
1979

Taxon	30 JAN						28 FEB						MAR (5 APR)					
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
anchovy	1	-	-	1	-	-	5	-	1	1	-	4	-	-	-	-	-	-
searobin,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
scorpionfish	1	2	-	1	10	1	3	4	16	2	11	13	-	-	1	-	1	2
seatrout	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-
flatfish[a]	1	4	-	3	2	3	2	4	6	1	5	2	2	-	-	2	-	2
grunt	-	1	-	1	6	10	3	4	20	2	7	42	1	3	-	-	-	-
cusk-eel	1	15	2	3	2	2	-	3	14	-	2	8	-	-	-	-	-	1
croaker[b]	5	4	-	1	2	-	-	1	5	-	2	7	1	-	-	-	-	1
sand perch	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
mojarra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
lizardfish	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-
other fish	-	2	-	-	5	1	4	4	5	-	1	7	-	1	2	-	-	-
Total	10	28	2	10	27	17	17	20	69	6	31	84	4	4	3	2	1	6

Taxon	17 APR						14 MAY						7 JUN					
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
anchovy	-	2	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
searobin,																		
scorpionfish	63	104	7	1	-	2	3	1	-	2	1	2	-	-	1	-	-	1
seatrout	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
flatfish[a]	-	-	4	4	3	-	1	1	1	1	3	1	-	2	4	1	1	3
grunt	2	1	1	-	-	-	1	10	-	-	-	-	3	1	-	-	6	1
cusk-eel	1	5	1	-	-	-	-	-	-	-	1	1	-	2	-	-	-	-
croaker[b]	3	2	-	-	-	1	-	3	-	-	-	-	15	2	-	-	1	-
sand perch	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-
mojarra	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-
lizardfish	-	-	1	-	1	-	1	-	1	1	1	1	-	-	1	2	-	-
other fish	2	2	1	1	2	2	8	6	2	1	1	-	79	14	-	-	31	2
Total	71	116	17	6	6	6	14	21	4	6	7	5	108	23	7	3	39	7

[a]One 15-minute trawl per station per month.

TABLE B-16
(continued)
NUMBER OF FISHES COLLECTED BY TRAWLING[a]
ST. LUCIE PLANT
1979

Taxon	30 JUL 0	1	2	3	4	5	23 AUG 0	1	2	3	4	5	29 SEP 0	1	2	3	4	5
anchovy	1	-	-	-	-	-	-	-	-	-	-	-	5	17	1	1	1	17
searobin, scorpionfish	-	2	4	2	4	3	-	-	-	3	-	1	2	-	17	1	19	7
seatrout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
flatfish[a]	-	2	7	5	2	5	5	4	3	19	4	2	3	-	11	-	17	4
grunt	-	6	4	-	-	5	-	-	-	-	-	1	-	4	2	-	8	3
cusk-eel	-	2	2	1	3	2	-	1	1	3	-	-	5	1	11	-	12	3
croaker[b]	-	-	-	-	-	1	1	-	-	-	-	-	3	5	-	-	-	-
sand perch	1	1	3	-	1	4	1	14	16	-	2	-	-	-	2	-	-	1
mojarra	-	4	1	-	-	-	2	1	7	-	-	1	2	-	-	1	3	2
lizardfish	1	1	1	1	3	2	-	-	1	1	-	1	-	-	-	4	-	-
other fish	-	1	1	-	7	3	3	8	11	7	3	-	18	29	7	1	9	3
Total	3	19	23	9	20	25	12	28	39	33	9	5	37	58	51	8	69	40

Taxon	23 OCT 0	1	2	3	4	5	11 NOV 0	1	2	3	4	5	12 DEC 0	1	2	3	4	5
anchovy	47	31	16	17	16	21	150	40	187	369	197	140	18	5	6	18	1	13
searobin, scorpionfish	4	-	15	1	4	3	1	1	4	5	3	-	18	6	2	1	1	1
seatrout	169	61	42	-	-	38	-	-	-	-	-	-	-	-	-	-	-	-
flatfish[a]	1	4	5	-	4	2	1	1	-	-	-	1	4	3	-	-	-	1
grunt	-	-	5	-	-	6	-	6	-	-	-	-	1	-	-	-	-	1
cusk-eel	5	5	16	-	3	14	-	1	1	1	-	-	6	2	-	-	-	-
croaker[b]	31	8	2	-	1	-	-	2	-	-	-	-	7	11	1	-	-	-
sand perch	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
mojarra	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	2
lizardfish	-	-	1	1	2	-	-	-	1	1	1	-	-	-	-	1	-	-
other fish	21	20	19	1	4	9	2	5	-	3	4	1	4	5	2	4	1	3
Total	278	129	121	20	34	94	155	57	193	379	205	142	58	32	11	24	3	21

[a]One 15-minute trawl per station per month.

TABLE B-16
(continued)
NUMBER OF FISHES COLLECTED BY TRAWLING[a]
ST. LUCIE PLANT
1979

Taxon	Total by station 0	1	2	3	4	5	Total by taxon	Percentage composition
anchovy	227	95	213	408	215	195	1353	41.6
searobin, scorpionfish	95	120	67	19	54	36	391	12.0
seatrout	169	61	43	0	0	40	313	9.6
flatfish[b]	20	25	41	36	41	26	189	5.8
grunt	11	36	32	3	27	69	178	5.5
cusk-eel	18	37	48	8	23	31	165	5.1
croaker[c]	66	38	8	1	6	10	129	4.0
sand perch	3	17	22	0	4	6	52	1.6
mojarra	15	8	8	1	3	4	39	1.2
lizardfish	2	1	8	12	10	4	37	1.1
other fish	141	97	50	18	68	31	405	12.5
Total	767	535	540	506	451	452	3251	100.0

[a]One 15-minute trawl per station per month.

[b]Flounder, sole, tonguefish.

[c]Other than seatrout.

TABLE B-17

NUMBER AND PERCENTAGE COMPOSITION OF FISHES COLLECTED
BY TRAWLING DURING THE BASELINE STUDY AND ENVIRONMENTAL MONITORING
ST. LUCIE PLANT
1971-1974 AND 1976-1979

Taxon	1971-1974[a]		1976[b]		1977[c]		1978[c]		1979[c]	
	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition
jack	38	13.9	0	0.0	1	0.0	3	0.1	47	1.5
flatfish[d]	35	12.8	129	19.7	220	10.7	302	12.0	189	5.8
croaker[e]	35	12.8	13	2.0	250	12.2	114	4.5	129	4.0
searobin, scorpionfish	34	12.4	129	19.7	170	8.3	293	11.7	391	12.0
anchovy	28	10.3	18	2.7	22	1.1	459	18.3	1353	41.6
porgy	14	5.1	2	0.3	0	0.0	4	0.2	10	0.3
lizardfish	13	4.8	9	1.4	45	2.2	47	1.9	37	1.1
cusk-eel	12	4.4	72	11.0	47	2.3	202	8.0	165	5.1
grunt	11	4.0	61	9.3	178	8.7	263	10.5	178	5.5
catfish	10	3.7	18	2.7	10	0.5	69	2.7	33	1.0
mojarra	6	2.2	26	4.0	139	6.8	83	3.3	39	1.2
sand perch	4	1.5	86	13.1	141	6.9	61	2.4	52	1.6
seatrout	2	0.7	0	0.0	606	29.6	176	7.0	313	9.6
other fish	31	11.4	93	14.1	219	10.7	437	17.4	315	9.7
Total	273	100.0	656	100.0	2048	100.0	2513	100.0	3251	100.0

[a]Total of 132 trawl tows during the baseline study; data from Futch and Dwinell (1977).

[b]Total of 60 trawl tows during environmental monitoring by ABI.

[c]Total of 72 trawl tows during environmental monitoring by ABI.

[d]Flounder, sole, tonguefish

[e]Other than seatrout.

TABLE B-18

NUMBER, SIZE, AND PERCENTAGE COMPOSITION OF SHELLFISHES AND FISHES
COLLECTED BY BEACH SEINING
ST. LUCIE PLANT
1979

Species	Number of individuals	Range of standard lengths (mm)	Total weight (g)	Percentage composition: Number of individuals	Percentage composition: Total weight
speckled crab	29	40-139	2516	-	-
blue crab	3	151-161	593	-	-
scaled sardine	226	36-143	1209	35.9	5.7
sand drum	168	30-180	2051	26.7	9.7
gulf kingfish	49	52-220	1543	7.8	7.3
Florida pompano	47	50-179	3060	7.5	14.5
Atlantic bumper	30	155-194	2841	4.8	13.5
lookdown	20	112-206	2060	3.2	9.8
spot	15	114-223	1496	2.4	7.1
leatherjacket	13	110-218	573	2.1	2.7
ladyfish	7	51-141	256	1.1	1.2
palometa	7	56-151	37	1.1	0.2
Atlantic thread herring	7	202-393	1639	1.1	7.8
permit	5	60-99	74	0.8	0.4
crevalle jack	5	171-331	2018	0.8	9.6
spotfin mojarra	4	157-254	616	0.6	2.9
southern kingfish	4	138-164	438	0.6	2.1
striped mojarra	6	25-72	38	1.0	0.2
white mullet	3	66-72	30	0.5	0.1
silver jenny	4	107-261	410	0.6	1.9
jack (*Trachinotus* sp.)	2	21-22	2	0.3	<0.1
kingfish	2	23-26	1	0.3	<0.1
menhaden	1	244	320	<0.2	1.5
silver porgy	1	165	219	<0.2	1.0
Atlantic threadfin	1	159	97	<0.2	0.5
barbu	1	73	7	<0.2	<0.1
striped anchovy	1	56	3	<0.2	<0.1
Total	629	-	21,038	100.0	100.0

TABLE B-19

NUMBER OF FISHES COLLECTED BY BEACH SEINING[a]
ST. LUCIE PLANT
1979

	26 JAN			26 FEB			22 MAR			27 APR			23 MAY			27 JUN		
Taxon	6	7	8	6	7	8	6	7	8	6	7	8	6	7	8	6	7	8
herring	2	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–
sand drum	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–
kingfish	1	–	1	–	1	–	1	–	1	–	2	–	–	–	–	1	–	–
jack[b]	2	–	–	–	1	–	1	1	–	–	2	1	3	–	–	–	–	–
Florida pompano	7	–	–	–	–	–	2	–	–	–	–	–	1	–	–	1	–	–
Atlantic bumper	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
spot	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
mojarra	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–
other fish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	13	0	1	1	2	0	5	1	1	0	4	1	8	0	–[c]	3	1	0

	6 JUL			23 AUG			24 SEP			3 OCT			NOV (7 DEC)[d]			13 DEC		
Taxon	6	7	8	6	7	8	6	7	8	6	7	8	6	7	8	6	7	8
herring	173	48	7	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–
sand drum	14	2	56	6	–	–	–	–	1	3	10	58	–	–	16	–	–	–
kingfish	3	2	5	10	–	2	4	–	1	3	4	6	–	2	4	–	–	1
jack[b]	–	–	2	–	–	2	3	6	24	–	–	1	–	2	–	2	–	–
Florida pompano	4	1	–	2	–	1	2	7	1	5	–	–	3	3	4	1	1	1
Atlantic bumper	–	–	–	–	–	–	2	1	26	–	–	–	–	–	–	–	–	–
spot	6	–	–	–	3	2	–	–	–	–	–	2	–	–	–	–	–	–
mojarra	1	–	1	–	–	–	–	2	2	–	2	2	–	–	–	–	–	–
other fish	1	–	–	–	1	1	–	3	3	1	–	1	–	2	–	2	–	–
Total	202	53	71	18	4	8	11	19	60	12	16	70	3	9	24	5	1	2

TABLE B-19
(continued)
NUMBER OF FISHES COLLECTED BY BEACH SEINING[a]
ST. LUCIE PLANT
1979

	Total by station			Total by taxon	Percentage composition
	6	7	8		
herring	177	48	9	234	37.2
sand drum	25	12	131	168	26.7
kingfish	23	11	21	55	8.7
jack[b]	11	12	30	53	8.4
Florida pompano	28	12	7	47	7.5
Atlantic bumper	3	1	26	30	4.8
spot	7	4	4	15	2.4
mojarra	3	4	5	12	1.9
other fish	4	6	5	15	2.4
Total	281	110	238	629	100.0

[a]Combination of three replicates per station per month.

[b]Other than Florida pompano and Atlantic bumper.

[c]Not sampled; exposed rocks.

[d]Delayed due to inclement weather.

TABLE B-20

NUMBER AND PERCENTAGE COMPOSITION OF FISHES COLLECTED
BY BEACH SEINING DURING THE BASELINE STUDY AND ENVIRONMENTAL MONITORING
ST. LUCIE PLANT
1971-1973 AND 1976-1979

Taxon	1971-1973[a]		1976[b]		1977[c]		1978[c]		1979[c]	
	Number of fishes	Percentage composition[d]	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition	Number of fishes	Percentage composition
anchovy	11540	89.5(0.0)	159	13.1	60	7.3	0	0.0	1	0.2
herring	580	4.5(42.8)	510	42.1	171	20.9	340	28.3	234	37.2
sand drum	360	2.8(26.5)	105	8.7	173	21.1	194	16.1	168	26.7
kingfish	121	0.9(8.9)	108	8.9	172	21.0	172	14.3	55	8.7
jack[e]	96	0.7(7.1)	73	6.0	42	5.1	23	1.9	53	8.4
spot	59	0.5(4.4)	101	8.3	0	0.0	147	12.2	15	2.4
Florida pompano	59	0.5(4.4)	43	3.6	22	2.7	27	2.2	47	7.5
Atlantic bumper	43	0.3(3.2)	28	2.3	44	5.4	1	0.1	30	4.8
mojarra	6	0.1(0.4)	8	0.7	81	9.9	280	23.3	12	1.9
other fish	31	0.2(2.3)	76	6.3	54	6.6	19	1.6	14	2.2
Total	12894	100.0 100.0	1211	100.0	819	100.0	1203	100.0	629	100.0

[a]Total of 108 beach seine hauls during the baseline study; data from Futch and Dwinell (1977).

[b]Total of 90 beach seine hauls during environmental monitoring by ABI.

[c]Total of 108 beach seine hauls during environmental monitoring by ABI.

[d]Percentage in parenthesis is composition exclusive of anchovy.

[e]Other than Florida pompano and Atlantic bumper.

TABLE B-21

EXAMPLES OF THE INDIVIDUAL VARIABLES, CLASS VARIABLES AND MODEL WITH THE GENERAL LINEAR MODELS PROCEDURE
ST. LUCIE PLANT
1979

INDIVIDUAL VARIABLES			CLASS VARIABLES	
			Station	
			1	2
(Y_1) Density	$(X_{1,2})$ Station	(X_0) Intercept	X_{i1}	X_{i2}
Y_{i1}	1	1	1	0
Y_{i1}	2	1	0	1

MODEL

For station effects:

$$Y_i = B_0X_0 + B_1X_{i1} + B_2X_{i2} + \Sigma_i$$

where: B is the respective slope
Σ_i is the error term.

TABLE B-22

OCCURRENCE OF GRAVID FISH IN THE VICINITY OF THE
ST. LUCIE PLANT
JANUARY 1976-DECEMBER 1979

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ladyfish	-	-	-	-	-	-	-	-	x	x	-	-
sooty eel	x	-	-	-	-	-	-	-	-	-	-	-
shrimp eel	-	x	-	x	-	-	-	-	-	-	-	x
palespotted eel	x	-	-	-	-	-	-	-	-	-	-	-
menhaden	x	x	-	-	-	x	-	-	-	-	-	-
yellowfin menhaden	x	-	-	-	-	-	-	-	-	-	-	-
Atlantic menhaden	x	-	-	-	-	-	-	-	-	-	-	-
Spanish sardine	-	-	-	-	-	x	-	x	-	-	-	-
Atlantic thread herring	-	-	-	-	x	-	-	-	-	-	-	-
Cuban anchovy	-	x	-	-	-	-	-	-	-	-	-	-
lizardfish	x	-	-	-	-	-	-	-	-	-	-	-
sea catfish	-	-	-	-	-	x	-	-	-	-	-	-
gafftopsail catfish	-	-	x	-	-	-	-	-	-	-	-	-
Atlantic midshipman	-	x	-	-	-	-	-	-	-	-	-	-
blotched cusk-eel	x	-	-	-	-	-	-	-	-	-	-	-
bank cusk-eel	x	x	-	x	-	-	-	-	-	-	-	-
seahorse	-	x	-	-	-	-	-	-	-	-	-	-
bull pipefish	x	-	-	-	-	-	-	-	-	-	-	-

TABLE B-22
(continued)
OCCURRENCE OF GRAVID FISH IN THE VICINITY OF THE
ST. LUCIE PLANT
JANUARY 1976-DECEMBER 1979

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
rock sea bass	x	x	x	-	-	-	-	-	-	-	-	-
sand perch	-	-	x	-	-	-	-	-	-	-	-	-
bluefish	x	-	x	-	x	-	-	-	x	x	-	-
blue runner	-	-	-	-	x	x	x	x	-	-	-	-
Atlantic bumper	-	-	x	x	x	x	x	x	x	-	-	-
bigeye scad	-	-	-	-	-	-	-	-	-	-	x	-
scad	-	-	-	-	-	x	-	-	-	x	-	-
Atlantic moonfish	-	-	-	-	-	-	-	-	-	-	x	-
lane snapper	-	-	-	x	-	x	x	-	-	-	-	-
striped mojarra	-	-	-	-	x	x	-	-	-	-	-	-
yellowfin mojarra	-	-	-	-	-	-	-	-	-	x	-	-
black margate	-	-	x	x	-	-	-	-	-	-	-	-
porkfish	-	x	-	-	x	-	-	-	-	-	-	-
tomtate	-	-	-	-	-	x	-	-	-	-	-	-
sailors choice	-	-	-	-	x	-	-	-	-	-	-	-
white grunt	-	-	-	-	x	x	-	-	-	-	-	-
pigfish	x	x	x	x	x	-	-	-	-	-	-	x
sheepshead	x	x	x	-	-	-	-	-	-	-	-	-

TABLE B-22
(continued)
OCCURRENCE OF GRAVID FISH IN THE VICINITY OF THE
ST. LUCIE PLANT
JANUARY 1976-DECEMBER 1979

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
striped mullet	x	x	-	-	-	-	-	-	-	-	x	x
white mullet	x	-	x	x	x	x	x	x	x	x	-	x
great barracuda	-	-	-	-	-	-	-	x	-	-	-	-
guaguanche	-	-	-	-	-	-	x	-	-	-	-	-
dusky jawfish	-	-	-	-	-	-	-	-	-	-	-	x
hairy blenny	-	x	-	-	-	-	-	-	-	-	-	-
checkered blenny	-	x	-	-	-	-	-	-	-	-	-	-
seaweed blenny	-	x	-	-	-	-	-	-	x	-	-	-
oyster blenny	x	x	-	-	-	x	x	-	-	-	-	-
barred blenny	-	-	-	-	-	-	-	x	-	-	-	-
orangespotted blenny	x	x	-	-	-	-	-	-	-	-	-	-
Atlantic cutlassfish	-	-	-	-	x	-	-	-	-	x	-	-
frigate mackerel	-	-	-	-	x	-	x	-	-	-	-	-
little tunny	-	-	-	-	-	-	x	-	-	-	-	-
Spanish mackerel	-	-	-	x	x	x	-	-	-	-	-	-
butterfish	-	x	-	-	-	-	-	-	-	-	-	-
striped searobin	x	-	-	-	-	-	-	-	-	-	-	-
blackwing searobin	-	x	x	x	x	-	-	x	-	-	-	-

TABLE B-22
(continued)
OCCURRENCE OF GRAVID FISH IN THE VICINITY OF THE
ST. LUCIE PLANT
JANUARY 1976-DECEMBER 1979

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
leopard searobin	x	x	-	-	x	-	-	-	-	-	x	x
bighead searobin	x	-	-	-	-	-	-	-	-	-	-	-
spotted whiff	-	-	-	x	-	-	-	-	-	-	-	-
southern flounder	x	-	-	-	-	-	-	-	-	-	-	-
dusky flounder	-	-	-	-	-	-	x	-	-	-	-	-
naked sole	x	-	-	-	-	-	-	-	-	-	-	-
southern puffer	-	x	-	-	-	-	-	-	-	-	-	-

TABLE B-23

ANALYSIS OF VARIANCE:
COMPARISON OF EGG AND LARVAL DENSITIES AT STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

EGGS

Source	DF	Sum of squares	Mean square	
Model	5	36.56348947	7.31269789	
Error	293	690.98757096	2.35831935	
Corrected total	298	727.55106042		
Source	DF	Type I SS	F value	PF > F
Station	5	36.56348947	3.10	0.0097*

LARVAE

Source	DF	Sum of squares	Mean square	
Model	5	1.05607391	0.21121478	
Error	293	33.82199837	0.11543344	
Corrected total	298	34.87807228		
Source	DF	Type I SS	F value	PF > F
Station	5	1.05607391	1.83	0.1059

*Significant.

TABLE B-24

DUNCAN'S MULTIPLE-RANGE TEST:
DENSITY OF EGGS AT STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=293 MS=2.35832

Grouping		Geometric mean	N	Station
	A	6.583	50	2
	A	5.265	50	4
B	A	4.666	50	3
B	A	3.609	49	5
B		2.062	50	1
B		2.001	50	0

TABLE B-25

ANALYSIS OF VARIANCE:
DENSITY OF EGGS AT STATIONS 0 THROUGH 5 BY SEASON
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

Season	Source	DF	Sum of squares	Mean square	
Winter	Model	5	15.18222090	3.03644418	
	Error	101	157.11169737	1.55556136	
	Corrected total	106	172.29391827		
	Source	DF	Type I SS	F value	PR > F
	Station	5	15.18222090	1.95	0.0914
Season	Source	DF	Sum of squares	Mean square	
Spring	Model	5	20.22078581	4.04415716	
	Error	66	311.19398419	4.71506037	
	Corrected total	71	331.41477000		
	Source	DF	Type I SS	F value	PR > F
	Station	5	20.22078581	0.86	0.5158
Season	Source	DF	Sum of squares	Mean square	
Summer	Model	5	7.90998926	1.58199785	
	Error	66	60.76438372	0.92067248	
	Corrected total	71	68.67437299		
	Source	DF	Type I SS	F value	PR > F
	Station	5	7.90998926	1.72	0.1417
Season	Source	DF	Sum of squares	Mean square	
Autumn	Model	5	1.72453958	0.34490792	
	Error	42	30.53449697	0.72701183	
	Corrected total	47	32.25903655		
	Source	DF	Type I SS	F value	PR > F
	Station	5	1.72453958	0.47	0.7932

TABLE B-26

CORRELATION COEFFICIENTS BETWEEN DENSITIES OF EGGS AND LARVAE AND FOUR PHYSICAL PARAMETERS
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

	Eggs	Larvae	Salinity	Turbidity	Dissolved oxygen	Temperature
Eggs	1.00000[a]	0.20864	0.08943	0.32437	0.02947	-0.06145
	0.0000[b]	0.0003*	0.1228	0.0001*	0.6228	0.2928
	299[c]	299	299	299	281	295
Larvae		1.00000	0.01606	-0.23213	-0.08487	0.03713
		0.0000	0.7821	0.0001*	0.1559	0.5253
		299	299	299	281	295
Salinity			1.00000	-0.06230	-0.27300	0.13950
			0.0000	0.2829	0.0001*	0.0165*
			299	299	281	295
Turbidity				1.00000	0.19630	-0.48910
				0.0000	0.0009*	0.0001*
				299	281	295
Dissolved oxygen					1.00000	-0.25973
					0.0000	0.0001*
					281	281
Temperature						1.00000
						0.0000
						295

*Significant.

[a]Correlation coefficients.

[b]Probability.

[c]Number of observations.

TABLE B-27

SEASONALLY ADJUSTED ICHTHYOPLANKTON STEPWISE REGRESSION ANALYSIS
STEPWISE REGRESSION PROCEDURE FOR DEPENDENT VARIABLE EGGS
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

STEP 1 VARIABLE TURBITY ENTERED R SQUARE = 0.19389311

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	1	117.95675930	117.95675930	67.11	0.0001*
ERROR	279	490.40297472	1.75771676		
TOTAL	280	608.35973401			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	0.03454076				
TURBIDITY	0.02155855	0.00263168	117.95675930	67.11	0.0001*

STEP 2 VARIABLE TEMPERATURE ENTERED R SQUARE = 0.21733327

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	2	132.21680957	66.10840478	38.60	0.0001*
ERROR	278	476.14292445	1.71274433		
TOTAL	280	608.35973401			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	0.02608141				
TURBIDITY	0.01724665	0.00299693	56.72150680	33.12	0.0001*
TEMPERATURE	-0.11786397	0.04084763	14.26005027	8.33	0.0042*

STEP 3 VARIABLE SALINITY ENTERED R SQUARE = 0.22072902

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	3	134.28264726	44.76088242	26.15	0.0001*
ERROR	277	474.07708675	1.71146963		
TOTAL	280	608.35973401			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	0.03180070				
SALINITY	-0.12111679	0.11024042	2.06583769	1.21	0.2729
TURBIDITY	0.01718370	0.00299637	56.28758358	32.89	0.0001*
TEMPERATURE	-0.11821562	0.04083368	14.34438498	8.38	0.0041*

STEP 4 VARIABLE SALINITY REMOVED R SQUARE = 0.21733327

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	2	132.21680957	66.10840478	38.60	0.0001*
ERROR	278	476.14292445	1.71274433		
TOTAL	280	608.35973401			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	0.02608141				
TURBIDITY	0.01724665	0.00299693	56.72150680	33.12	0.0001*
TEMPERATURE	-0.11786397	0.04084763	14.26005027	8.33	0.0041*

*Significant.

NO OTHER VARIABLES MET THE 0.5000 SIGNIFICANCE LEVEL FOR ENTRY INTO THE MODEL.

TABLE B-28

ANALYSIS OF VARIANCE:
DENSITY OF LARVAE AT STATIONS 0 THROUGH 5 BY SEASON
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

Season	Source	DF	Sum of squares	Mean square
Winter	Model	5	0.19909052	0.03981810
	Error	101	5.83899975	0.05781188
	Corrected total	106	6.03809027	

Source	DF	Type I SS	F value	PR > F
Station	5	0.19909052	0.69	0.6354

Season	Source	DF	Sum of squares	Mean square
Spring	Model	5	4.41492609	0.88298522
	Error	66	8.74144572	0.13244615
	Corrected total	71	13.15637180	

Source	DF	Type I SS	F value	PR > F
Station	5	4.41492609	6.67	0.0001*

Season	Source	DF	Sum of squares	Mean square
Summer	Model	5	2.34252671	0.46850534
	Error	66	9.04421546	0.13703357
	Corrected total	71	11.38674218	

Source	DF	Type I SS	F value	PR > F
Station	5	2.34252671	3.42	0.0084*

Season	Source	DF	Sum of squares	Mean square
Autumn	Model	5	0.36324289	0.07264858
	Error	42	0.83244984	0.01982023
	Corrected total	47	1.19569274	

Source	DF	Type I SS	F value	PR > F
Station	5	0.36324289	3.67	0.0077*

*Significant.

TABLE B-29

DUNCAN'S MULTIPLE-RANGE TEST:
SPRING DENSITY OF LARVAE AT STATIONS 0 THROUGH 5
ST. LUCIE PLANT
20 MARCH 1979 - 20 JUNE 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=66 MS=0.132446

Grouping		Geometric mean	N	Station
	A	1.221	12	1
B	A	0.743	12	0
B	C	0.329	12	5
	C	0.206	12	3
	C	0.164	12	2
	C	0.122	12	4

TABLE B-30

DUNCAN'S MULTIPLE-RANGE TEST:
SUMMER DENSITY OF LARVAE AT STATIONS 0 THROUGH 5
ST. LUCIE PLANT
21 JUNE 1979 - 22 SEPTEMBER 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=66 MS=0.137034

Grouping	Geometric mean	N	Station
A	1.147	12	3
B	0.511	12	4
B	0.425	12	0
B	0.356	12	2
B	0.277	12	1
B	0.260	12	5

TABLE B-31

DUNCAN'S MULTIPLE-RANGE TEST:
AUTUMN DENSITY OF LARVAE AT STATIONS 0 THROUGH 5
ST. LUCIE PLANT
23 SEPTEMBER 1979 - 30 NOVEMBER 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=42 MS=0.0198202

Grouping	Geometric mean	N	Station
A	0.363	8	1
B	0.124	8	5
B	0.088	8	2
B	0.073	8	4
B	0.072	8	3
B	0.066	8	0

TABLE B-32

SEASONALLY ADJUSTED ICHTHYOPLANKTON STEPWISE ANALYSIS
STEPWISE REGRESSION PROCEDURE FOR DEPENDENT VARIABLE LARVAE
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

STEP 1 VARIABLE TURBIDITY ENTERED R SQUARE = 0.03729846

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	1	0.95805966	0.95805966	10.81	0.0011*
ERROR	279	24.72824757	0.08863171		
TOTAL	280	25.68630723			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	-0.00987401				
TURBIDITY	-0.00194292	0.00059095	0.95805966	10.81	0.0011*

STEP 2 VARIABLE TEMPERATURE ENTERED R SQUARE = 0.12546598

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	2	3.22275760	1.61137880	19.94	0.0001*
ERROR	278	22.46354963	0.08080414		
TOTAL	280	25.68630723			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	-0.01324519				
TURBIDITY	-0.00366127	0.00065095	2.55624043	31.64	0.0001*
TEMPERATURE	-0.04697055	0.00887232	2.26469794	28.03	0.0001*

STEP 3 VARIABLE SALINITY ENTERED R SQUARE = 0.13462090

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	3	3.45791382	1.15263794	14.36	0.0001*
ERROR	277	22.22839341	0.08024691		
TOTAL	280	25.68630723			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	-0.01131556				
SALINITY	-0.04086340	0.02387099	0.23515621	2.93	0.0880
TURBIDITY	-0.00368251	0.00064882	2.58503926	32.21	0.0001*
TEMPERATURE	-0.04708920	0.00884195	2.27601315	28.36	0.0001*

STEP 4 VARIABLE DISSOLVED OXYGEN ENTERED R SQUARE = 0.13727590

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	4	3.52611102	0.88152775	10.98	0.0001*
ERROR	276	22.16019622	0.08029057		
TOTAL	280	25.68630723			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	-0.01116514				
SALINITY	-0.04591966	0.02449966	0.28206006	3.51	0.0619
TURBIDITY	-0.00362525	0.00065196	2.48251428	30.92	0.0001*
DISSOLVED OXYGEN	-0.01551510	0.01683463	0.06819720	0.85	0.3575
TEMPERATURE	-0.04785947	0.00888376	2.33027366	29.02	0.0001*

TABLE B-32
(continued)
SEASONALLY ADJUSTED ICHTHYOPLANKTON STEPWISE ANALYSIS
STEPWISE REGRESSION PROCEDURE FOR DEPENDENT VARIABLE LARVAE
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

STEP 5 VARIABLE DISSOLVED OXYGEN REMOVED R SQUARE = 0.13462090

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	3	3.45791382	1.15263794	14.36	0.0001*
ERROR	277	22.22839341	0.08024691		
TOTAL	280	25.68630723			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	-0.01131556				
SALINITY	-0.04086340	0.02387099	0.23515621	2.93	0.0880
TURBIDITY	-0.00368251	0.00064882	2.58503926	32.21	0.0001*
TEMPERATURE	-0.04708920	0.00884195	2.27601315	28.36	0.0001*

*Significant.

NO OTHER VARIABLES MET THE 0.5000 SIGNIFICANCE LEVEL FOR ENTRY INTO THE MODEL.

TABLE B-33

PERCENTAGE COMPOSITION OF LARVAL FISH TAXA BY SEASON
STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

	Season				
Taxon	Winter	Spring	Summer	Autumn	Over-all composition
Clupeiformes	78.2	88.4	56.5	37.7	71.5
Gobiesocidae	0.0	0.0	0.1	0.0	0.0
Atherinidae	0.0	0.0	0.0	0.0	0.0
Serranidae	0.1	0.3	1.0	4.4	0.7
Carangidae	1.4	0.8	18.3	5.9	7.6
Gerreidae	0.3	2.0	8.5	7.1	4.3
Sciaenidae	10.9	0.9	2.1	9.8	4.1
Dactyloscopidae	3.2	1.4	1.1	4.2	1.9
Blenniidae	1.8	1.5	3.7	9.8	2.8
Gobiidae	0.3	0.4	1.7	6.9	1.2
Scorpaenidae	0.1	0.0	0.0	1.0	0.0
Flatfishes	0.1	0.1	0.9	1.1	0.4
Plectognaths	0.1	0.6	1.3	1.5	0.8
All others	3.8	3.4	4.8	10.6	4.4

TABLE B-34

MULTIPLE REGRESSION ANALYSIS
ELAPSED TIME EFFECTS ON DEPENDENT VARIABLES RESIDUAL EGG DENSITY AND
RESIDUAL LARVAE DENSITY
ST. LUCIE PLANT
10 MARCH 1976 - 13 DECEMBER 1979

DEPENDENT VARIABLE: RESIDUAL EGG DENSITY R-SQUARE = 0.175071

Source	DF	SUM OF SQUARES	MEAN SQUARE
Model	2	23.49463629	11.74731815
Error	90	110.70583783	1.23006486
Corrected total	92	134.20047413	

Source	DF	TYPE I SS	F VALUE	PR > F
Seasonal adjustment	1	17.80484518	14.47	0.0003*
Elapsed time	1	5.68979111	4.63	0.0342*

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STANDARD ERROR OF ESTIMATE
Intercept	0.82618544	3.35	0.0012*	0.24679270
Seasonal adjustment	0.62290906	3.94	0.0002*	0.15799398
Elapsed time	0.00063463	2.15	0.0342*	0.00029508

DEPENDENT VARIABLE: RESIDUAL LARVAE DENSITY R-SQUARE = 0.078778

Source	DF	SUM OF SQUARES	MEAN SQUARE
Model	2	3.90325749	1.95162875
Error	87	45.64461267	0.52465072
Corrected total	89	49.54787017	

Source	DF	TYPE I SS	F VALUE	PR > F
Seasonal adjustment	1	2.52954388	4.82	0.0308*
Elapsed time	1	1.37371362	2.62	0.1098

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STANDARD ERROR OF ESTIMATE
Intercept	0.81082288	4.91	0.0001*	0.16502868
Seasonal adjustment	0.21235435	2.03	0.0454*	0.10458209
Elapsed time	-0.00031833	-1.62	0.1093	0.00019673

*Significant.

TABLE B-35

MEAN DENSITY[a] OF ICHTHYOPLANKTON AND PERCENTAGE ICHTHYOPLANKTON FOR BASELINE AND OPERATIONAL MONITORING STUDY YEARS
ST. LUCIE PLANT
1971-1973 and 1976-1979

Study year	Mean density (number/m^3)	Percentage ichthyoplankton[b]
Baseline 1971-73	39.0[c]	0.6
Operational 1976	62.6	2.6
Operational 1977	105.6	3.0
Operational 1978	123.5	3.4
Operational 1979	85.9	6.4

[a]Arithmetic means are based on ichthyoplankton collected during zooplankton sampling.

[b]Percent of total zooplankton collected for a given study year made up of fish eggs and larvae.

[c]As reported in Walker et al. (1979).

TABLE B-36

ANALYSIS OF VARIANCE:
COMPARISON OF EGG AND LARVAL DENSITIES AT STATIONS 11 AND 12
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

EGGS

Source	DF	Sum of squares	Mean square
Model	1	4.59339919	4.59339919
Error	98	38.19698822	0.38976519
Corrected total	99	42.79038741	

Source	DF	Type I SS	F value	PR > F
Station	1	4.59339919	11.79	0.0009*

LARVAE

Source	DF	Sum of squares	Mean square
Model	1	0.00283260	0.00283260
Error	98	0.39255891	0.00400570
Corrected total	99	0.39539151	

Source	DF	Type I SS	F value	PR > F
Station	1	0.00283260	0.71	0.4024

*Significant.

TABLE B-37

DUNCAN'S MULTIPLE-RANGE TEST:
DENSITY OF EGGS AT STATIONS 11 AND 12
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=98 MS=0.389765

Grouping	Geometric mean	N	Station
A	0.831	50	11
B	0.193	50	12

TABLE B-38

ANALYSIS OF VARIANCE:
COMPARISON OF EGG AND LARVAL DENSITIES AT STATIONS 1, OI, AND 11
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

EGGS

Source	DF	Sum of squares	Mean square
Model	2	7.43687440	3.71843720
Error	147	148.40711651	1.00957222
Corrected total	149	155.84399091	

Source	DF	Type I SS	F value	PR > F
Station	2	7.43687440	3.68	0.0275*

LARVAE

Source	DF	Sum of squares	Mean square
Model	2	3.38969628	1.69484814
Error	147	21.19936481	0.14421473
Corrected total	149	24.58926108	

Source	DF	Type I SS	F value	PR > F
Station	2	3.38969628	11.75	0.0001*

*Significant.

TABLE B-39

DUNCAN'S MULTIPLE-RANGE TEST:
DENSITY OF EGGS AT STATIONS 1, 0I, AND 11
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=147 MS=1.00957

Grouping	Geometric mean	N	Station
A	2.062	50	1
A	1.772	50	0I
B	0.831	50	11

TABLE B-40

DUNCAN'S MULTIPLE-RANGE TEST:
DENSITY OF LARVAE AT STATIONS 1, 0I, AND 11
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT

Alpha Level=0.05 DF=147 MS=0.144215

Grouping	Geometric mean	N	Station
A	0.418	50	1
A	0.416	50	0I
B	0.030	50	11

TABLE B-41

DIFFERENCES IN LARVAL DENSITIES
AND PERCENTAGE COMPOSITION BETWEEN SAMPLES TAKEN
AT OFFSHORE STATIONS 1 AND OI AND THE INTAKE CANAL STATION 11
ST. LUCIE PLANT
DECEMBER 1978 - DECEMBER 1979

	Density (no./1000 m^3)			Relative abundance (%)		
Taxon	Station 1	Station OI	Station 11	Station 1	Station OI	Station 11
Clupeiformes	1344	1307	19	84.6	82.9	61.3
Gobiesocidae	0	0	0	0.0	0.0	0.0
Atherinidae	1	0	0	0.1	0.0	0.0
Serranidae	4	4	0	0.7	0.6	0.0
Carangidae	5	4	1	0.8	0.6	1.3
Gerreidae	11	5	0	1.9	0.7	0.0
Sciaenidae	16	23	1	2.7	3.1	2.6
Dactyloscopidae	3	1	0	0.6	0.1	0.0
Blenniidae	12	9	1	2.0	1.2	2.6
Gobiidae	12	24	0	2.1	3.6	0.0
Scorpaenidae	1	3	0	0.1	0.4	0.0
Flatfishes	3	21	6	0.5	0.3	20.4
Plectognaths	3	3	1	0.4	0.4	1.3
All other larvae	20	25	3	3.4	3.4	10.5

TABLE B-42

PERCENTAGE LOSS ESTIMATES OF ICHTHYOPLANKTON ENTRAINMENT BASED ON
PLANT OPERATING AND ICHTHYOPLANKTON SAMPLING STATISTICS
ST. LUCIE PLANT
1976-1979

Year	Category	Variables[a]					Percentage loss (mean depth=9.2m)		Percentage loss (mean depth=3.0m)	
		C_r	C_p	Q_r	Q_p	m	$\frac{mC_p}{C_r} \neq 1$	$\frac{mC_p}{C_r} = 1$	$\frac{mC_p}{C_r} \neq 1$	$\frac{mC_p}{C_r} = 1$
1976	eggs	3.848	1.259	5474[1785]	32.36	1.0	0.19	0.59	0.59	1.81
	larvae	0.205	0.041	5474[1785]	32.36	1.0	1.07	0.59	3.29	1.81
1977	eggs	0.429	0.366	5474[1785]	32.36	1.0	0.50	0.59	1.55	1.81
	larvae	1.345	0.028	5474[1785]	32.36	1.0	0.01	0.59	0.04	1.81
1978[b]	eggs	2.709	1.503	5474[1785]	32.36	1.0	0.40	0.59	1.23	1.81
	larvae	0.421	0.087	5474[1785]	32.36	1.0	0.15	0.59	0.47	1.81
1979[c]	eggs	3.744	0.831	5474[1785]	32.36	1.0	0.13	0.59	0.40	1.81
	larvae	0.304	0.030	5474[1785]	32.36	1.0	0.06	0.59	0.18	1.81

[a] C_r = geometric mean concentration of organisms per cubic meter (based on surface tows only) in offshore areas (Stations 0 through 5).

C_p = geometric mean concentration of organisms per cubic meter in the intake canal (Station 11).

Q_r = flow in cubic meters per second past the plant, based on a cross-sectional area of 32,200 m^2; numbers in brackets are based on a cross-sectional area of 10,500 m^2.

Q_p = water flow in cubic meters per second through the plant intake, based on maximum recorded daily value.

m = mortality rate of entrained organisms (assumed to be 100%, making m = 1.0).

[b] Mean numbers of eggs or larvae per cubic meter are calculated from data collected from 14 December 1977 through 29 November 1978.

[c] Mean numbers of eggs or larvae per cubic meter are calculated from data collected from 1 December through 13 December 1979.

C. MACROINVERTEBRATES

Environmental Technical Specification (Section 3.1.B.a)

> Benthic Organisms - Benthic organisms will be collected quarterly and inventoried as to type and abundance of major taxonomic groups present.

INTRODUCTION

Benthic macroinvertebrates are organisms that spend a large part of their life cycles within or on submerged substrates such as pilings, pipes, rocks, or bottom sediments. Their preferences toward habitat and hydrological conditions vary and, thus, they tend to group themselves into relatively distinct communities. Because macroinvertebrates have limited mobility and relatively long life spans, community characteristics tend to reflect prevailing environmental conditions (EPA, 1973).

Benthic assemblages are sensitive to environmental stress, and fluctuations in community composition may be an indication of changing water quality (Holland et al., 1973). Benthic macroinvertebrate communities are therefore useful in assessing environmental perturbation.

The present study documents continued sampling of benthic macroinvertebrate communities in the vicinity of the St. Lucie Plant, with emphasis on potential operational effects on community structure. Data gathered during 1979 augments data collected by ABI in 1976 (ABI, 1977) when the plant was operating intermittently and that data collected

during 1977 and 1978 (ABI, 1978, 1979), a period of full plant operation. Where possible, post-operational data are compared with available baseline information generated during plant construction (1971-1974). Composite data characterize the benthic communities residing in the study area, document changes in community structure over time, and compare communities potentially affected by thermal effluents with those temporally or spatially removed from the discharge plume.

MATERIALS AND METHODS

As during the past 3 years, six permanent offshore stations were sampled in 1979 (Figure A-1, Table A-1). Stations 1 through 5 correspond to locations sampled during baseline studies conducted from 1971 to 1974 (Gallagher and Hollinger, 1977). The sixth, Station 0, which is located 4.3 km south of the plant discharge (Station 1), has served as a control since 1976. This station was moved slightly inshore after 1976 to a substrate more like that encountered in the discharge area. Because this relocation drastically changed the type of fauna collected, data from 1976 are often omitted from discussion in this report.

Benthic Grab Sampling

Samples of the smaller, less motile infaunal and epifaunal macroinvertebrates were taken at each of the six offshore stations quarterly using a Shipek grab sampler. Four replicate samples were taken at each sampling location. Three of these were used for community analyses and the fourth was used for substrate analysis. As each replicate was collected, sample depth within the grab bucket was measured to the

nearest millimeter. These data were used to determine whether changes in macroinvertebrate community composition were due to changes in sampling efficiency of the Shipek grab.

All samples were preserved in a 10-percent buffered formalin-seawater solution and stained with rose bengal dye. In the laboratory, three replicate samples to be used for community analysis were washed through a No. 25 sieve to remove fine sediment and particulate matter. This screen size and procedure were used to conform with sampling methodology employed during baseline studies (Gallagher and Hollinger, 1977). Material retained on the sieve was hand-sorted under low magnification and the organisms were removed, counted, and identified to the lowest practicable taxon. All identified organisms (exclusive of mollusc shells) were dried at 105°C for 4 hours and their ash free dry-weight biomass was determined (EPA, 1973).

Substratum Analysis

The substratum material of the fourth replicate was dried, dissaggregated, and placed in a graduated nest of nine sieves (mesh widths of 16, 8, 4, 2, 1, 0.5, 0.25, 0.125, and 0.063 mm, respectively). The nest was shaken for 15 minutes on a Tyler Ro-Tap sieve shaker after which the nest was analyzed for particle size class distribution, mean particle diameter, and sorting coefficient (standard deviation of mean particle size; Folk, 1966).

Trawl Sampling

Trawl sampling for larger, more motile benthic macroinvertebrates was conducted in conjunction with the fish sampling program (see Section B. Fish and Shellfish). Using a 4.9-m semi-balloon otter trawl, one 15-minute tow was made at each of the six offshore stations every month. Tows were made at night to reduce net avoidance by the organisms. The samples were preserved in a 10-percent buffered formalin-seawater solution, labeled, and transported to the on-site laboratory for sorting and identification to the lowest practicable taxon.

Temperature

Bottom water temperatures were recorded at the time of each sampling and averaged to provide monthly means. The data were then used to correlate annual oceanic temperature cycles with seasonal variations in community characteristics.

RESULTS AND DISCUSSION

Substratum - Background

The composition and distribution of marine benthic communities are affected by many physical characteristics of their environment. Consistent patterns of water temperature, salinity, and ocean currents within an area potentially allow the colonization of relatively large bottom areas by a similar array of faunal elements. Within these large areas, however, sharp distinctions in community structure occur that are related to substratum type. Hard substrata, such as coral reefs, rock outcroppings, wrecks and pilings, support a distinct and varied community

of cryptic (worms, arthropods), boring (bivalve molluscs) and epifaunal species.

A pertinent example of hard substrata is the large amount of dead mollusc shells that forms a major component of the nearshore substrata occurring adjacent to the St. Lucie Plant. These substrata support a very diverse benthic community composed both of infaunal and hard substratum elements. Soft substrata, exemplified by the homogeneous quartz and biogenic sands found at some of the sampling stations, generally support a much less diverse infaunal community having a lower biomass (Abele, 1974).

Substratum - Findings

Based on physical characteristics of the sediment, the study area is divided into three zones (Gallagher, 1977; ABI 1977, 1978):

1. Beach terrace (Stations 0 and 1),
2. Offshore trough (Stations 2, 4 and 5),
3. Offshore bar-Pierce Shoal (Station 3).

In 1979, beach terrace sediments, both at the control station (0) and the discharge (Station 1), were found to be composed predominately of fine and very fine, moderately well-sorted gray quartz sands (Table C-1). Broken mollusc shells make up the large (pebble, granule) size fractions at these stations. Sediment at Station 0 has remained fairly consistent since the St. Lucie Plant began full operation. Sediment at the plant discharge (Station 1) has essentially remained unchanged since the base-

line study (Gallagher, 1977) with the exception of an unusually coarse grain size class distribution in September 1979. Wind-, wave-, and current-generated sediment transport associated with the passage of Hurricane David during September may have produced this atypical sediment distribution. The sediment at Station 1 assumed a more typical distribution in November 1979.

Offshore trough sediments are composed almost entirely of dead mollusc shells in various stages of decomposition and fragmentation. Mean particle sizes of these poorly to extremely poorly sorted sediments (Table C-1) are unchanged from those noted during previous years (ABI, 1978, 1979).

The substratum at Pierce Shoal (Station 3) is well sorted and is predominantly comprised of medium and fine calcareous sand (Table C-1). This substratum has remained relatively stable through time because it probably results from a consistent pattern of hydrological processes. In winter, storms selectively transport medium and fine sands to the shoal crest. The reverse of this process occurs during fair weather, when fine sand particles are winnowed from the shoal crest by wave action (Duane et al., 1972).

Seasonal Variation of Faunal Densities in Benthic Grab Samples

Marine benthic macroinvertebrates often exhibit marked seasonal fluctuations in community abundance. These patterns are generally associated with annual reproductive rhythms and larval recruitment of consti-

tuent species in conjunction with cyclical environmental variables. Temperature, in particular, is known to affect annual reproductive patterns in marine invertebrates (Giese and Pearse, 1974; Sastry, 1975), and thus, periods of larval recruitment are linked with yearly oceanic temperature cycles. Heated discharges from power plants can disrupt seasonal patterns of abundance by altering local thermal regimes (Warinner and Brehmer, 1966). Consequently, abundances of benthic organisms in the vicinity of the St. Lucie Plant were examined to determine whether any aberrant seasonal trends were evident.

Through 4 years of sampling, densities of benthic organisms have varied considerably between quarters. At most stations, seasonal patterns are seldom repetitive, and annual trends among stations vary dramatically (Figures C-1 and C-2; Table C-2). During previous years, Station 3 had displayed the most consistent pattern of seasonal density. Late summer recruitment of large numbers of the dominant organism, _Crassinella duplinana_ (Mollusca), was most responsible for high density levels observed during the third quarter of each year. Although _Crassinella_ remained the dominant organism at Station 3 in 1979, its numbers declined steadily throughout the year, and the annual pattern observed for 1976-1978 was absent.

Station 4 also displayed a repetitive pattern of high abundances during the third quarter of each year. Unlike Station 3, however, where population increases are primarily the result of increases by only one or two dominant species, changes in density at Station 4 were the result of

cumulative changes in a larger number of taxa. At all stations, a highly significant correlation existed between number of taxa and density (Table C-3).

The lack of recurrent seasonal patterns of abundance at most stations is not uncommon in shallow coastal systems along the southeastern coast of the United States. Frankenberg (1971) found that densities of benthic macroinvertebrates off Georgia are similarly represented by population peaks which do not repeat themselves precisely each year. Causes of temporal and spatial variability have been attributed to patchy larval settlement, to differences in longevity and predation intensity, and to seasonal migration patterns (Frankenberg and Leiper, 1977).

During 1979, seasonal abundances at Stations 0 and 1 were similar, except during September when unusually large numbers of macroinvertebrates were collected at Station 1 (Figure C-2). This is probably attributable to hurricane-influenced substrate changes observed at that time. When all 3 years (1977-1979) are compared with the Wilcoxon paired sample test (P=0.05), there is no significant difference in macroinvertebrate densities between the control and discharge stations. This suggests that changes due to plant operation have not occurred.

Diversity and Equitability

Diversity ($\bar{d}$) and equitability (e) indices relate, respectively, to the number of taxa in a sample (Lloyd et al., 1968) and to the apportionment of individuals among the taxa present (Lloyd and Ghelardi, 1964).

Diversity in nonstressed environments is theoretically higher than in similar systems experiencing some form of physical stress (EPA, 1973). Thus, if thermal effluent from the power plant was creating a physical stress on benthic communities, a decrease in diversity might be expected.

During all 4 years of plant operation, diversity values have been relatively high and well above the levels proposed by the Environmental Protection Agency (EPA, 1973) as being indicative of healthy (nonstressed) environments (Table C-2). Diversity values have fluctuated seasonally during the 4 years of plant monitoring, but as with density, no consistent seasonal patterns are apparent (Figures C-1 and C-2). The repetitive pattern observed at Station 3 from 1976-1978 (ABI, 1979) was disrupted in 1979 by atypical population changes of the dominant species.

Equitability values are highest when all species present are represented by similar numbers of individuals. During 1979, equitability values at trough stations (Stations 2, 4 and 5) were lower than at other stations illustrating the disproportionate influence of dominant taxa in the shell hash environment (Table C-2). As with diversity, seasonal patterns of equitability varied among stations and were nonrepetitive.

Diversity values at Stations 0 and 1 have remained relatively constant during post-operational years, deviating substantially from one another only during the fourth quarter of 1979 (Figure C-2). During that quarter, very few individuals and taxa were collected at Station 0, and diversity dropped to its lowest observed level. The Wilcoxon paired

sample test (P=0.05) detected no significant differences in quarterly diversity values between these stations when all 3 years of post-operational data (1977-1979) were examined. Thus, in the area of immediate discharge, there is little indication that changes in diversity patterns have occurred since the plant has been in full operation.

Biomass

Biomass is affected by both the absolute size and number of organisms present in a sample. With the exception of Station 4, total annual biomass during 1979 differed only slightly among stations, even though densities varied substantially (Table C-2). This is due primarily to the small size of many dominant species collected at stations having highest densities (Stations 2, 4, and 5). High biomass values at Station 4 are attributable to the periodic collection of relatively large echinoderms at that station. The presence of disproportionately large individuals detracts from the ability to relate biomass with other community parameters. Thus, it is not surprising that from 1976-1979, biomass and density of organisms were significantly correlated only at one station (Station 5, Table C-3).

Biomass values were generally higher at Station 1 than Station 0 during 1979 (Table C-3). However, the Wilcoxon paired sample test (P=0.05) showed no significant difference in biomass between stations during the last 3 years of full plant operation (1977-1979).

The Physical Environment as a Determinant of Community Structure

Benthic community structure is influenced by both abiotic and biotic factors. Among the physical factors affecting community parameters, temperature and substrate are probably the most important. Substrate variability in the vicinity of the St. Lucie Plant produces three distinct faunal assemblages (ABI, 1978). These assemblages have maintained their distinctiveness over time, though measured parameters varied seasonally within the assemblages. The influence of sediment composition on abundance is illustrated at Station 1 where, in September 1979, mean grain size increased noticeably due to the presence of an unusually large number of shell fragments in the sample (Table C-1). This shift toward large grain size increased sediment heterogeneity, and a concomitant increase in both number of taxa and individuals was observed (Table C-2; Figure C-2). Generally, however, within-habitat sediment composition has been relatively stable throughout the period of study, varying little between years or seasons. This suggests that other components of the physical environment most likely were responsible for observed fluctuations in community parameters.

In certain areas where temperature and salinity are relatively stable, turbulence from storms or strong currents has been reported to be the primary factor controlling community characteristics (Lie and Kisker, 1970; Boesch, 1972). In the vicinity of the St. Lucie Plant, wave-induced turbulence is a common component of the physical environment and may account for the dynamic nature of the benthic communities found there. For example, the sediment change during September at Station 1

may have resulted from turbulence associated with the passing of Hurricane David earlier in the month.

In most environments, temperature is an obvious causative agent for observed community dynamics because of its seasonal variability and known influence on biological activities. The number of taxa at Stations 2 and 4 and the densities at Stations 2, 3, and 4 were positively correlated with water temperature (Table C-3). The lack of correlations at other stations suggests that factors other than temperature are more important in determining the numbers and types of organisms present. Alternatively, relationships between bottom water temperature and benthic community parameters are masked by undetermined biological or physical disturbances.

Though densities in 1979 did not appear to respond to oceanic temperature cycles as they had in previous years (Figure C-3), water temperature and density were correlated when all stations were combined (Table C-3). Thus, most populations generally experienced greatest density increase during the summer. Because number of taxa and density were highly correlated, summer was also the period when the largest number of new taxa were introduced into the area.

Mean bottom water temperatures at Stations 0 and 1 were compared to determine whether heated discharges from the St. Lucie Plant produced substantially different thermal regimes at the two stations (Figure C-4). Noticeable differences were observed only during summer months when mean

monthly water temperatures at Station 1 rose approximately 1 degree above those at Station 0. However, summer temperatures at Station 1 never exceeded 30°C, and thus were well below those levels demonstrated to be detrimental to benthic communities elswhere in Florida (Bader and Roessler, 1972; Virnstein, 1972; Blake et al., 1976). When the data for all 3 post-operational years were combined, neither number of taxa nor density of organisms were found to differ significantly between these stations (Wilcoxon paired sample test; P=0.05). Thus, within-habitat comparisons provide no evidence to suggest that thermal effluents from continued plant operation have adversely affected the number of individuals or taxa residing near the discharge.

Plant Effects on Benthic Fauna Collected by Grabs: 1976-1979

The structure of the benthic communities in the vicinity of the St. Lucie Plant is part of a dynamic system, dependent on variables not necessarily related to plant activities. Seasonal variability within the community is not necessarily indicative of long-term instability. It is rather a reflection of the physical processes normally found in dynamic nearshore areas. Researchers have found that seasonally dynamic systems are often quite stable on a long-term basis (Livingston, 1976).

Both number of taxa and density of organisms were analyzed to determine whether these community parameters varied among all 4 years of post-operational study. Each station was treated separately to test for significant differences. Grab efficiency, defined here as depth of penetration and therefore the size of the sample, was also tested to

determine whether differences in number of taxa or number of individuals collected were due to differences in the amount of substrate sampled. All tests were made with the Kruskal-Wallis nonparametric statistic (P=0.05; Sokal and Rohlf, 1969) and a variation of the SNK test (P=0.05; Zar, 1974).

No significant differences in grab efficiency were detected among stations between 1978 and 1979 (Table C-4). Therefore, any significant changes in community parameters are not attributable to varying sample sizes. However, significant decreases in the number of taxa occurred between 1978 and 1979 at Stations 2, 4, and 5, stations which had significant increases in the previous 3 years. Because no decreases in the number of taxa were determined between 1976 (a year of intermittent operation) and 1979, a natural cyclic change within the benthic community is indicated.

Number of individuals decreased from 1978 to 1979 only at Stations 0 and 5. The decrease at Station 0 was apparently due to natural variation. The decrease observed between 1976 and 1979 was due to relocation after the first year of sampling. The decrease in number of individuals at Station 5 between 1978 and 1979 is also most likely due to natural variation in that the over-all trend of both number of individuals and number of taxa have been toward either no differences or increases since full plant operation.

Mann-Whitney U-tests (P=0.05; Elliot, 1971) were applied to grab data at Stations 0 and 1 to ascertain whether significant differences existed between the stations. By the use of this test, changes in benthic community composition and abundance as a result of plant activities would be apparent. In 1979, grab efficiency was significantly greater at Station 1 than at the control. This may be a result of the varying substrate type collected at Station 1, resulting in greater grab penetration and a larger sample. However, no significant differences in either the number of taxa or the abundance of organisms between the two stations existed during 1979.

Comparison of Benthic Grab Diversity by Year

Rarefaction is a method used to graphically compare benthic diversity between two or more samples (Sanders, 1968). The technique estimates, from the total sample, the number of taxa expected to occur in samples containing fewer numbers of individuals. Low diversity, a possible indication of physical stress, is characterized by gently sloping curves. As the slope of the curve increases, a greater number of taxa per unit number of individuals is expected (i.e., higher diversity).

Data for four quarters were combined and diversity for 1976-1979 was compared at each station (Figure C-5). Rarefaction diversity for all stations showed fairly consistent patterns over the entire course of plant monitoring, indicating that dramatic changes in community structure have not occurred. Station 3 appears to be most stable over time, while trough stations (Stations 2, 4, and 5) exhibit greater fluctuations. In

some cases, rarefaction curves indicated lower diversity in 1979 than in 1976, a year of intermittent plant operation. However, the fluctuation in rarefaction diversity among all years suggests that this decrease is a natural pheonomenon rather than part of a steady trend of decreasing benthic diversity. The lack of consistent increases or decreases in rarefaction diversity between years again reflects the dynamic nature of benthic communities in the study area.

During previous years, rarefaction indicated that diversity at Station 1 was slightly greater than at Station 0 (ABI, 1978, 1979). A similar divergence in rarefaction curves was found during 1979 (Figure C-5). This finding coupled with the very consistent nature of the rarefaction curves at Station 1 suggest that thermal effluent from the power plant is having no adverse effect on benthic diversity.

Dominant Benthic Grab Phyla

Environmental perturbation can effect a change in the percentage composition of major groups comprising benthic macroinvertebrate communities (Rosenberg, 1976). As the St. Lucie Plant became fully operational during 1976, no major shifts in taxonomic groups were observed (ABI, 1978). Continued plant operations have had no appreciable effect on community composition, as percentages of major groups remained relatively constant during post-operational years (Figure C-6).

Annelids continued to dominate the fauna at all but Station 3 during 1979, contributing at least 50 percent of the total number of individuals

collected. Molluscs predominated at Station 3 due to the large contributions by one or two dominant species (ABI, 1979).

Between 1978 and 1979, only a few changes in community composition by major group were observed. At Stations 2 and 4, the relative number of sipunculids increased, while the contribution by molluscs and arthropods decreased. At Station 3, the relative abundance of molluscs decreased substantially in 1979, as the dominant organism, Crassinella, did not attain population peaks observed during previous years (ABI, 1979). As a result, the relative contribution of arthropods and ceph-lochordates at that station increased.

During 1978, faunal composition at Stations 0 and 1 were very similar (ABI, 1979) and, with small changes, this similarity was again observed in 1979. Annelids increased in abundance during 1979, while most other groups experienced small declines (Figure C-6). When all post-operational years are examined, the faunal composition by major groups at Stations 0 and 1 appear to be quite stable, and slight differences between years can best be explained in terms of natural phenomena (ABI, 1979). The similarity between community structure at the discharge and control stations indicates plant operations have had little effect on the relative abundances of major groups.

The percentage contribution to biomass by major groups during 1979 differed substantially from the relative abundance (Figure C-7). At shell-hash Stations 2, 4, and 5, annelids, which had contributed up to 70

percent of the numbers of individuals, accounted for only 10 to 18 percent of the biomass. This reflects the relatively small sizes of the dominant polychaetes and oligochaetes collected at these stations. A combination of molluscs and cephalochordates produced the majority of biomass. The contribution by cephalochordates is particularly notable in view of their very low abundances. These organisms have been large contributors to biomass in other systems as well (Bloom et al., 1972).

Corresponding to their large contribution to total abundance, molluscs dominated the biomass at Station 3 (Figure C-7). Annelids and arthropods, which collectively accounted for about 33 percent of the total abundance, provided only 7 percent of the biomass.

Stations 0 and 1 differed little in community composition, but exhibited markedly different biomass structure (Figure C-7). The contribution to biomass by major groups at Station 0 paralleled the relative contributions to total abundance. This was not the case at Station 1 where molluscs accounted for 90 percent of the biomass and only 10 percent of the total fauna. This was attributable to the relatively large size of two species which ranked in the top 10 dominants at that station. As previously mentioned, biomass did not differ significantly between these stations during 3 years of plant operation. Thus, discharge and control stations were similar in both total community biomass and faunal composition; only variability in size of the component organisms differed.

Patterns of Dominant Benthic Grab Taxa

McCloskey's index (1970) was used to characterize patterns of dominance over 4 years of plant monitoring at St. Lucie. This method reflects both abundance and frequency of occurrence of each taxon. A rank "score" is computed for the 10 most abundant taxa every quarter, and the sum of scores produces a dominance value for the year. The 10 top-ranked taxa for each station each year were determined in this manner, with a total of 77 taxa being classified as dominants at one time or another since 1976 (Table C-5). Annelids accounted for over half of the dominant taxa (41 species), while arthropods and molluscs were represented by 13 and 14 taxa, respectively. Echinoderms and minor phyla made up the nine remaining taxa.

Station 4 has been the most stable offshore station through the 4 years of sampling, with four of the same taxa ranked as dominants. Among the 10 top-ranked species each year, Stations 0 and 1 shared 5 dominants in 1977, 4 in 1978, and 3 in 1979.

The apparent lack of continuity between dominant taxa collected through the 4 years of sampling indicates that, although the relative composition of the major groups remained constant (Figure C-6), the dominant components of these groups exhibited a great deal of variation. For the 3 years that Station 0 was located on the beach terrace (1977-1979), only three of the top-ranked taxa were shared. It appears, therefore, that this variation is normal and is not attributable to plant operations.

Interstation Comparisons

Benthic community data for 1976 through 1978 have been compared to determine the degree of faunal similarity between stations (ABI, 1979). Analyses indicated that there are distinct communities on each of the three major substrate types sampled. These assemblages are represented by Stations 0 and 1 on the beach terrace, Stations 2, 4 and 5 in the shelly substrates, and Station 3 on Pierce Shoal. Similarities between groups of stations within a substrate type has been shown to be more stable spatially than temporally (ABI, 1978). Therefore, separate comparisons were made between stations for each year in order to indicate any local alterations in community structure.

The Morisita (1959) index of community similarity (Cλ) was used to make interstation comparisons for 1979. This index is based on the abundances of shared taxa between stations, total abundances in each sample, and respective diversities. Cλ represents the degree of faunal similarity between stations, with a value of 1.0 expected for two samples taken from the same community.

A trellis diagram based on these analyses indicates that Station 3 continued to be the least similar to any of the offshore stations (Figure C-8). High similarities in 1979 were again observed among Stations 2, 4, and 5, with Stations 2 and 4 having the same similarity value during all 4 years. Stations 4 and 5 increased in faunal similarity during 1979, approaching a level near that of 1976. Similarities between Stations 0 and 1 varied little from 1977 through 1979 (range = 0.44 to 0.57).

Sediment heterogeneity, shifting dominance and fluctuating diversity have been proposed to account for minor changes in faunal similarity from year to year (ABI, 1979). Thus far, these changes in station groupings are considered to be insignificant, therefore suggesting negligible plant-induced perturbations at the station localities.

Analysis of Trophic Types

Two modes of feeding have been found to predominate in most benthic communities. Deposit feeding organisms generally feed on organic material in the sediment, and suspension feeding organisms utilize material suspended in the water column (Sanders, 1958; McCloskey, 1970). Although other modes of feeding are present (e.g., carnivory and herbivory), deposit and suspension feeders dominate the numbers of individuals at all stations in the vicinity of the St. Lucie Plant (ABI, 1978).

Because of the preponderance of deposit and suspension feeding organisms in previous years, the ratios among these groups were calculated and comparisons made between all 4 years of plant monitoring. Predominance of one mode over another has been shown to be indicative of surrounding substrate and water conditions (Sanders, 1958; Levinton, 1972). Changes in ratios between years of monitoring might therefore indicate changing conditions related to plant operations. Due to the distinct alignment of faunal assemblages with substrate compositon (beach terrace, offshore trough, and Pierce Shoal), assemblages were treated separately.

Data for trough Stations 2, 4, and 5 were combined, and quarterly deposit/suspension feeder ratios for each year were compared with the Kruskal-Wallis and SNK statistics (P=0.05). During 1976, both feeding types were approximately equal in numbers. In 1977, the ratio of deposit to suspension feeders increased significantly to the highest levels for the 4 years of sampling. Ratios determined for 1978 and 1979 decreased significantly from 1977, but they remained greater than 1976. Therefore, these ratios appear to be changing as a result of natural variation rather than continued plant operation during the last 3 years.

At Station 3, on Pierce Shoal, ratios for all 4 years were not significantly different from one another, indicating little change in the trophic structure of the community in that area. Suspension feeders, primarily bivalve molluscs, dominated the fauna throughout the sampling program.

When applied to quarterly ratios for 1977 through 1979, the Wilcoxon paired sample test (P=0.05) indicated that deposit/suspension feeder ratios did not differ significantly between Stations 0 and 1. Most ratios at both stations were well above 1, indicating a preponderance of deposit feeding organisms on the beach terrace. Using the Kruskal-Wallis test (P=0.05), no significant differences were found in ratios at the discharge station (Station 1) through all 4 years of sampling (1976-1979). The stability of the trophic structure at Stations 1 and 0 suggest that plant operation has not disrupted the dominant trophic regime of the benthic community near the discharge.

Comparisons with Baseline Benthic Grab Studies

Benthic baseline studies, conducted from 1971 through 1973 at five of the six present offshore stations were compared with combined post-operational data for 1977 through 1979. To date, the only published information available described lancelet distributions (Futch and Dwinell, 1977) and the ecological aspects of arthropod assemblages in the vicinity of the St. Lucie Plant (Camp et al., 1977). An unpublished manuscript (Martin, in press) describes the echinoderm fauna of this area. Other unpublished reports are not in a form which would lend the data to statistical comparison.

The Mann-Whitney U-test (P=0.05) which was applied to the published data indicates that no significant differences in lancelet density was found following the start of plant operations except at Station 2 where significant increases were observed (Table C-6). Arthropod densities were significantly greater at Stations 1, 2, and 5 during post-operational studies with no significant changes at Stations 3 and 4. Diversities were also significantly greater at three stations during post-operational years, with Stations 3 and 5 exhibiting no change. Significant increases in echinoderm densities were noted at Stations 2 and 5 following the beginning of full plant operation. Echinoderm densities at other stations did not change significantly between baseline and post-operational studies. These data clearly indicate no reductions in the above mentioned constituents of the benthic community following plant construction and full operation. The causes for increases are unknown, but the extensive nature of this phenomenon suggests that the

increases were probably part of long-term community dynamics rather than due to localized plant influences.

Benthic Trawl Collections

During 46 months (March 1976 through December 1979) of otter trawl collections at the six benthic stations, 34,277 macroinvertebrates comprising 266 taxa were identified. During 1979, 10,510 individuals (118 taxa) were collected. Collections from Station 1 produced the highest number of taxa--54; Station 3 produced the least--36 (Figure C-9).

Seasonal Variation: Trawl Species Richness

As in previous years, seasonal patterns of species richness (Figures C-10 through C-15) varied among stations during 1979. In general, species richness was relatively high during late summer-early autumn. Station 1 was the only exception, with relatively few taxa being collected during that period.

Though bottom water temperatures were slightly higher at Station 1 than at the control station from July through November 1979, no significant correlation between bottom water temperatures and species richness at Station 1 was indicated by the Spearman rank correlation (Siegel, 1956; P=0.05). In addition, the results of the Mann-Whitney U-test (P=0.05) indicated no significant difference between the number of taxa collected at Station 1 and the control station. Therefore, no significant effect of power plant discharge on species richness at Station 1 was indicated during 1979.

When seasonal patterns of species richness were compared between 1978 and 1979, species richness was noted to be generally lower and less variable during 1979. Because this phenomenon was widespread (occurring at the control and most other stations), it was apparently a result of natural processes not related to power plant discharge.

Benthic Trawl Species Richness from Year to Year

Pooled species richness data (Figure C-9) indicate that fewer taxa were collected in 1979 than in any previous year at every station, except Station 3. Total number of taxa collected at Station 3 remained relatively constant from year to year.

The number of taxa decreased at all stations between 1978 and 1979 with the greatest decrease occurring at Station 0 and the least at Station 3. The substantial decrease in species richness at Station 0 probably reflects a natural over-all decrease in taxa in the study area as well as the lack of large quantities of drift algae, which were probably responsible for the significant increase in species richness at Station 0 between 1977 and 1978 (ABI, 1979).

When compared to 1978 data using the Mann-Whitney U-test, significantly fewer taxa were collected during 1979 at Stations 0, 2, 4, and 5, but no difference was indicated between years at Stations 1 or 3. Neither results of these tests nor observed fluctuations in species richness are indicative of detrimental effects due to power plant operations.

Trawl Abundance Data

During 1979, macroinvertebrates were most abundant from trawl collections at Stations 0 and 1 (Figure C-16) primarily due to large numbers of two shrimp species, Acetes americanus and Trachypenaeus sp. The difference in total numbers of individuals between Stations 0 and 1 in 1979 was primarily due to the extremely high number of A. americanus collected in December at Station 0. The small size of this species, however, may not allow effective sampling by the trawl. Elimination of Acetes from abundance data resulted in total abundances of 1765 individuals at Station 0 and 2106 individuals at Station 1. These abundances are quite similar, considering the semi-quantitative nature of trawl collections, and are not indicative of power plant influence.

Considerable variations in abundances were noted at most stations between years. These variations are probably a result of normal fluctuations in densities of dominant taxa, as well as the semi-quantitative nature of the trawl. Comparisons between years indicate a continuous increase in the number of individuals over the past 3 years at Station 0 and over the past 4 years at Station 1. Thus, there is no apparent detrimental effect of power plant discharge on abundances of macroinvertebrates at trawl stations.

Commercially Important Species

Six species of commercially important shellfish were included among the macroinvertebrates collected during 1979 (Table C-7). All were collected in relatively low numbers. As in the previous 3 years, the

most abundant (39 specimens) of these was the pink shrimp Penaeus duorarum followed by the brown shrimp Penaeus aztecus (25 specimens), the blue crab Callinectes sapidus (8 specimens), the rock shrimp Sicynoia brevirostris (5 specimens), and the pink spotted shrimp Penaeus brasiliensis (3 specimens). As in previous years, unidentifiable juvenile shrimp of the genus Penaeus (13 specimens) were present in 1979 samples. Stone crab Menippe mercenaria has been collected only once during past monitoring programs.

Though abundances of Penaeus duorarum and Sicyonia brevirostris decreased between 1978 and 1979, Penaeus aztecus and Callinectes sapidus increased in numbers between 1978 and 1979. Fluctuations in abundance and distribution of commercially important species do not appear to be related to power plant discharge.

Trawl Collections of Trachypenaeus constrictus

As in previous years, the penaeid shrimp Trachypenaeus constrictus was collected in large numbers during 1979. This species occasionally occurs in commercial catches of bait shrimp but is usually of minor commercial importance.

Though abundances of this species have fluctuated between years at all stations, T. constrictus has been consistently collected in great numbers at Stations 0 and 1 (Figure C-17). The results of the Wilcoxon paired sample test (P=0.05) indicated no significant difference between Station 1 and Station 0 abundances during 1979 or any of the previous 3

years. Therefore, the power plant discharge has no significant effect on abundances of T. constrictus at Station 1.

Monthly abundance data for T. constrictus indicated that, during 1979, maximum abundance occurred during January at Station 1 and during December at Station 0 (Figure C-18). Differences between the numbers of T. constrictus collected at these stations probably indicated natural differences in the spatial and temporal distribution of this species, as well as the semi-quantitative aspect of the trawl as a sampling device. Nevertheless, abundance patterns at Stations 1 and 0 appear quite similar when compared over the entire 4-year period indicating little, if any, effect from power plant discharge.

Dominant Taxa Collected by Trawls

Dominant species captured by the trawl at each of the six offshore stations were determined by using the biological index value of McCloskey (1970). To facilitate comparisons with 1976 data, which were collected from March through December, values for January and February were excluded from 1977, 1978, and 1979 ranking calculations.

With the exception of Trachypenaeus, dominant species in trawl collections continued to show a high degree of replacement from year to year (Table C-8). The most noticeable change in dominance occurred in 1979 at Station 4 where a considerable decrease in the dominance of the sand dollar Mellita quinquiesperforata was noted. The great variability in dominant species is probably indicative of natural changes in community structure.

Trawl Diversity

Dominance-diversity curves (Whittaker, 1965) depend solely on the abundance of each species in a sample. A high degree of dominance (i.e., low diversity) is indicated by a steeply sloping curve while a gently sloping curve indicates a more equitable distribution of species abundances (i.e., high diversity).

Dominance-diversity curves for 1979 produced station relationships that differed in several respects from those of previous years (Figures C-19 through C-24). The most conspicuous differences were decreases in diversity at Stations 0 and 5 and a decrease in the dominance of the top-ranked species at Station 4.

Decreases in diversity at Stations 0 and 5 are apparently due to the natural decreases in species richness and do not indicate detrimental effects from the power plant discharge. Decreased dominance at Station 4 in 1979 resulted from a reduction in the number of Mellita quinquiesperforata collected at that station.

Compared to previous years, Station 3 was slightly more diverse in 1979 while Station 2 was slightly less diverse. Dominance-diversity curves indicate little change in diversity at Station 1 during the last 3 years (1977-1979) and little difference between Station 1 and the control station during 1979. Therefore, power plant operation has no apparent detrimental effect on diversity of larger epibenthic invertebrates in the vicinity of the discharge.

Trawl Station Similarity

The Morisita index of community similarity (Cλ; Morisita, 1959) was used to compare trawl stations during each year (Figure C-25). In general, similarities between Station 4 and the other trawl stations were higher in 1979 than in previous years. This increased similarity probably reflects the considerable decrease in the *Mellita quinquiesperforata* population at that station. As previously mentioned, fluctuations in the *Mellita* population at Station 4 do not apear to be related to power plant operation.

Similarity between Stations 0 and 1 increased slightly between 1978 and 1979 but remained considerably lower than in 1977. The presence of an extremely high number of *Acetes americanus* in the December 1979 trawl collection at Station 0 appears to be responsible for the relatively low similarity between Stations 0 and 1. As discussed previously, *Acetes americanus* may not be effectively sampled by the trawl. When the Morisita index was recalculated excluding *Acetes*, similarity between Stations 0 and 1 was extremely high (Cλ=0.99) in 1979. The extremely high similarity between Stations 0 and 1 (excluding *Acetes*) is indicative of little, if any, power plant effect on the epibenthic macroinvertebrate community in the vicinity of the discharge.

Comparisons with Baseline Trawl Data

A monthly otter trawl program was conducted at night in the vicinity of the discharge prior to plant start-up (September 1973 - August 1974; Camp et al., 1977). Although that program is not identical to present

studies (e.g., tow times were longer and the trawl was of a slightly different design), the data are representative of the larger, more motile crustacean component of the benthos and are reasonably comparable with post-operational data (1976-1979).

At the discharge (Station 1), the total number of individuals, number of taxa, and number of taxa identified to species level increased from baseline to follow-up studies (Table C-9). Although these observations could very well be attributable to differences in methodology, the number of species shared between the two studies, an average of 66 percent, is considerably high. This value is well within the normal variability of species shared between years of follow-up samplings (approximately 50 percent). It appears, therefore, that the larger crustacean component of the benthic community has changed little in the vicinity of the discharge since plant start-up.

During baseline studies, only one species of echinoderm was collected in night trawls at Station 1 (Table C-9). Though higher numbers of species were collected during 3 post-operational years, only one species was again collected in 1979. Echinoderms were apparently a minor component of the benthos at Station 1 before and after power plant start-up. No detrimental effects due to plant operation are indicated by these data.

SUMMARY

Quarterly grab and monthly trawl sampling for benthic macroinvertebrates was continued at six offshore stations in the vicinity of the St. Lucie Plant (Figure A-1). Data from 1979 is presented and compared with 1976, 1977, and 1978 information. Data from 1976 represents a period of intermittent plant operation, while 1977-1979 data essentially represents full plant operation. Baseline comparisons, using preoperational data, were made where possible.

Percentage composition of the larger sediment grain size fractions increased somewhat at Station 1 during September 1979 and was the only major change in sediment data collected in 1979. Wind, waves and currents generated by Hurricane David possibly could have produced this atypical sediment distribution in the vicinity of the discharge.

Grab data continued to show extensive seasonal variations in benthic community structure during 1979. Again, the number of taxa collected showed a significant correlation with density in the study area. Density trends for all stations generally tended to be directly associated throughout the study with mean bottom water temperature, although few significant correlations were determined. No significant differences were determined in quarterly benthic community parameters between discharge and control stations during 3 years of full plant operation.

Macroinvertebrate abundance by major taxonomic group in grab collections exhibited little change from 1976 through 1979. It was shown,

however, that biomass could vary greatly in relative composition by group.

Although the dominant species fluctuated from year to year at all stations, these changes were attributed to natural dynamics of nearshore communities. The portion of top-ranked species shared by discharge and control stations decreased only slightly from 1977 through 1979. A more drastic reduction would be expected if the discharge area were significantly stressed.

No significant reductions in number of individuals or number of species collected by grab sampling were observed from 1976-1978 (excluding Station 0). However, some reductions occurred between 1978 and 1979. The over-all trend throughout the sampling program indicated that these reductions are due to natural variability.

Both rarefaction diversities and community similarities calculated from benthic grab data for 1979 showed little change when compared to previous years. The discharge station had slightly greater diversity than the control in 1979, and community similarity between the two areas was consistent with those observed during previous years. Comparison of full operational data (1977-1979) with published preoperational data from the study area showed no significant reductions in diversity.

Trawl sampling of macroinvertebrates in 1979 indicated that commercially important shellfish continued to be represented by very small

populations. Shrimp of the genus *Trachypenaeus*, of little commercial importance, remained dominant at both the discharge and control stations. No significant differences were noted between numbers of *Trachypenaeus constrictus* collected at discharge and control stations.

Significant reductions in the number of benthic trawl taxa collected were noted at Stations 0, 2, 4 and 5 between 1978 and 1979. These reductions appear to reflect natural changes in community structure, however, because no significant difference between number of taxa collected at discharge and control stations occurred in 1979. Furthermore, trawl diversity was similar at these two stations.

Comparison of post-operational trawl data with baseline data on trawl crustaceans indicated little change in the vicinity of the discharge since power plant start-up.

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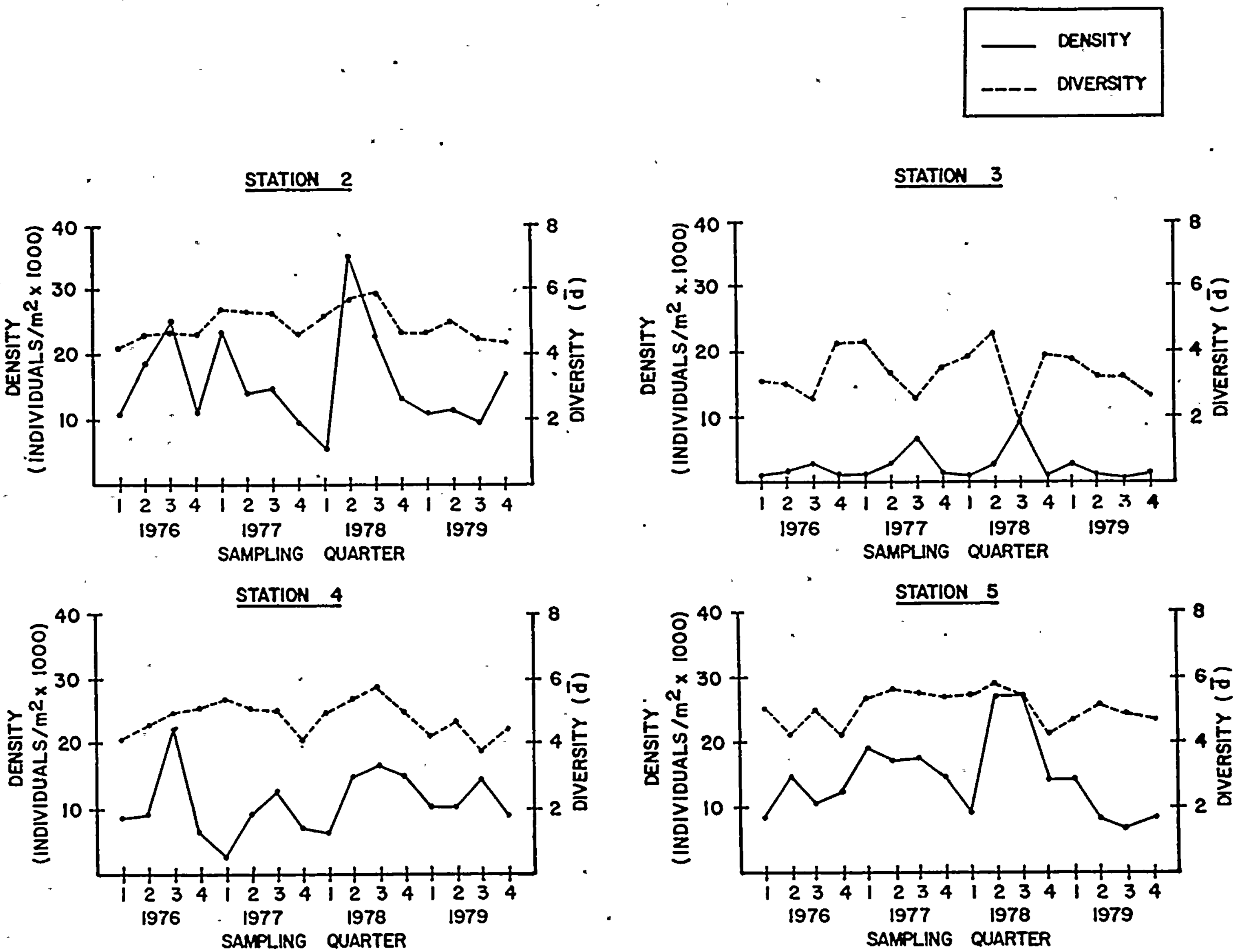

Figure C-1. Density and diversity of benthic macroinvertebrates collected by Shipek grab at Stations 2, 3, 4, and 5, St. Lucie Plant, 1976-1979.

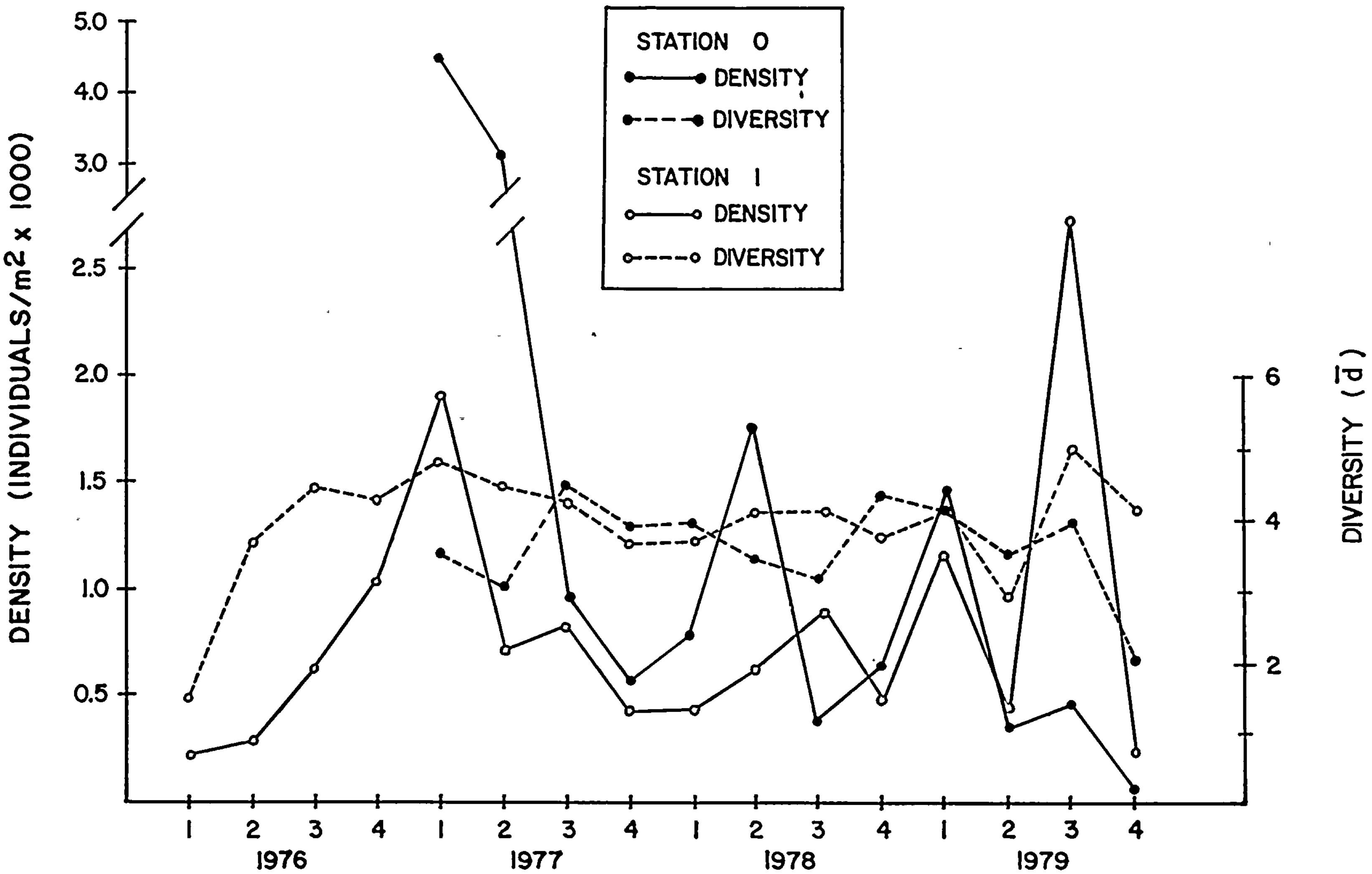

Figure C-2. Density and diversity of benthic macroninvertebrates collected by Shipek grab at Stations 0 and 1, St. Lucie Plant, 1976-1979. (Station 0 was relocated in March 1977 - prior data are not included.)

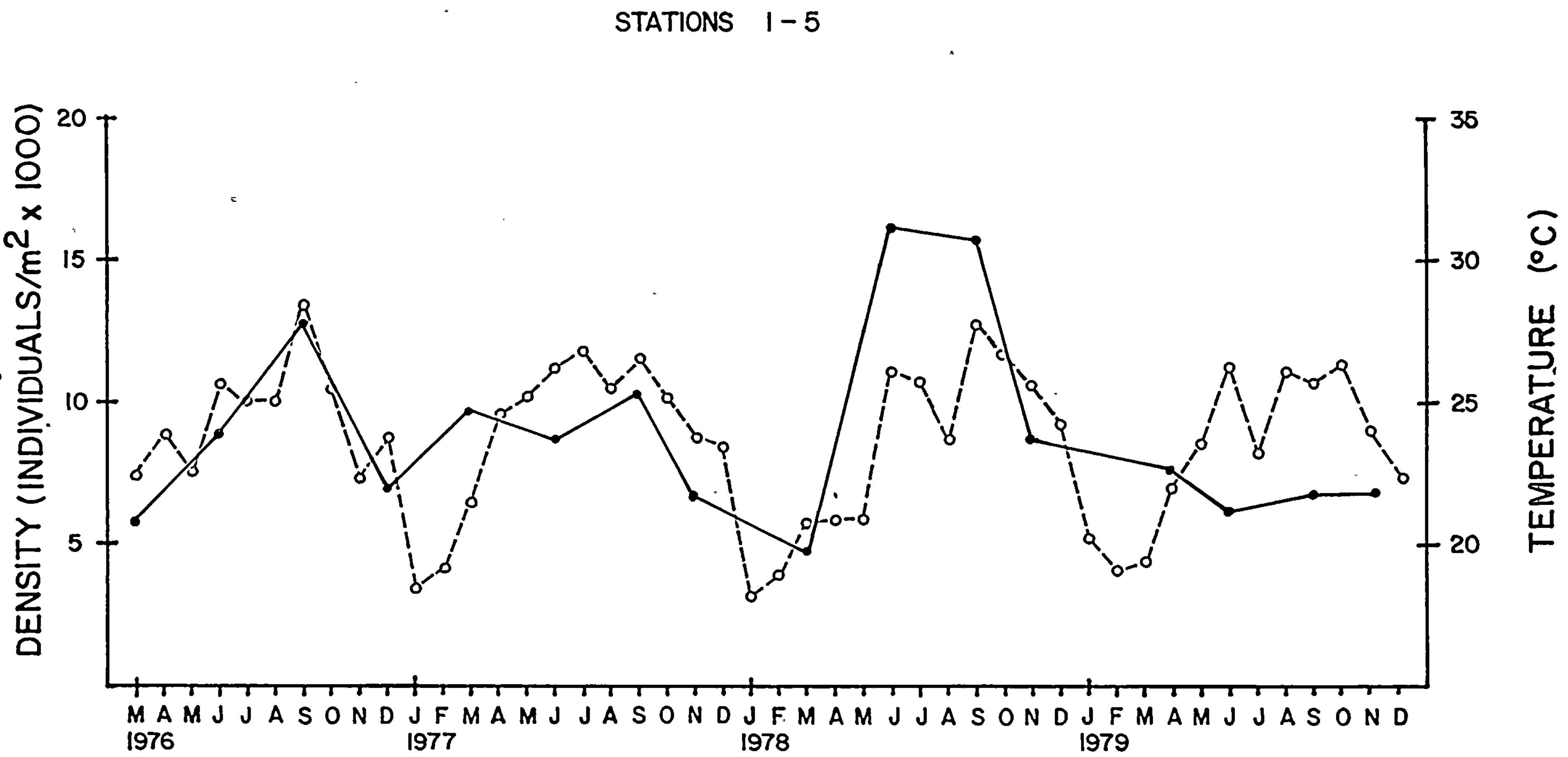

Figure C-3. Mean bottom water temperature and mean density of benthic macroinvertebrates collected by Shipek grab at Stations 1 through 5, St. Lucie Plant, March 1976-December 1979.

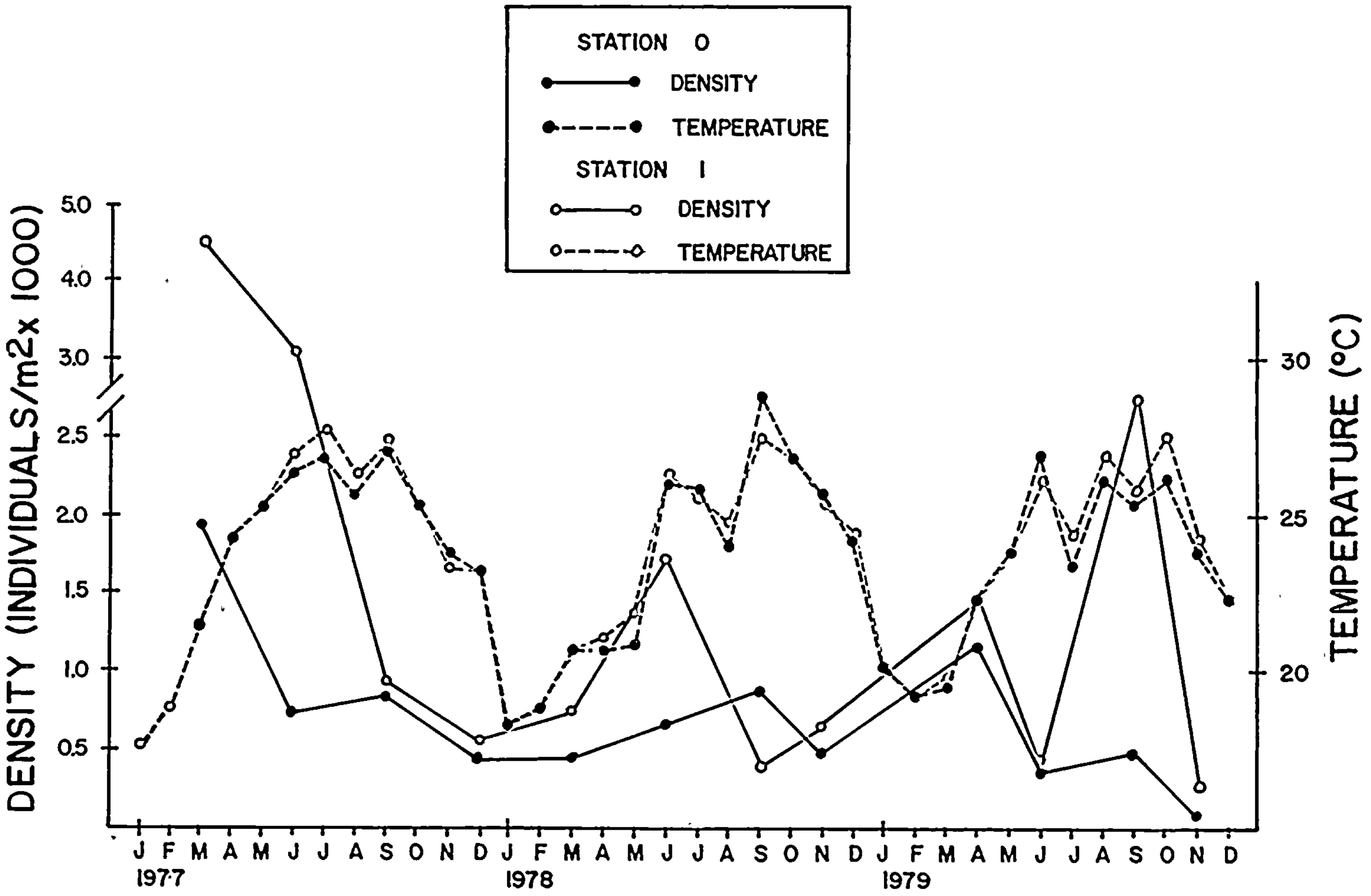

Figure C-4. Mean monthly bottom water temperature and mean monthly density of benthic macroinvertebrates collected by Shipek grab at Stations 0 and 1, St. Lucie Plant, 1977-1979.

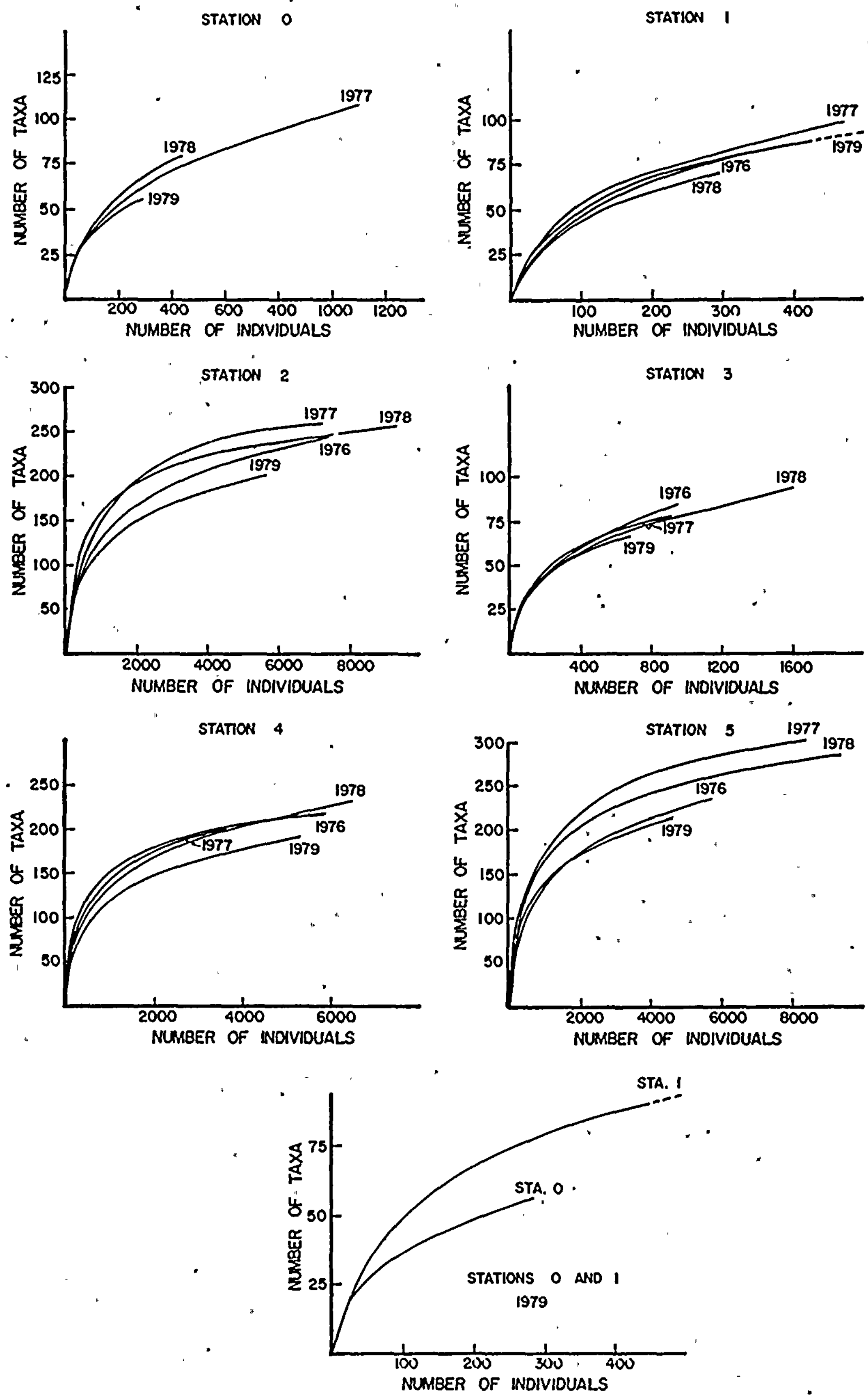

Figure C-5. Rarefaction curve for offshore grab sampling stations indicating number of expected taxa for various population levels of benthic macroinvertebrates, St. Lucie Plant, 1976-1979.

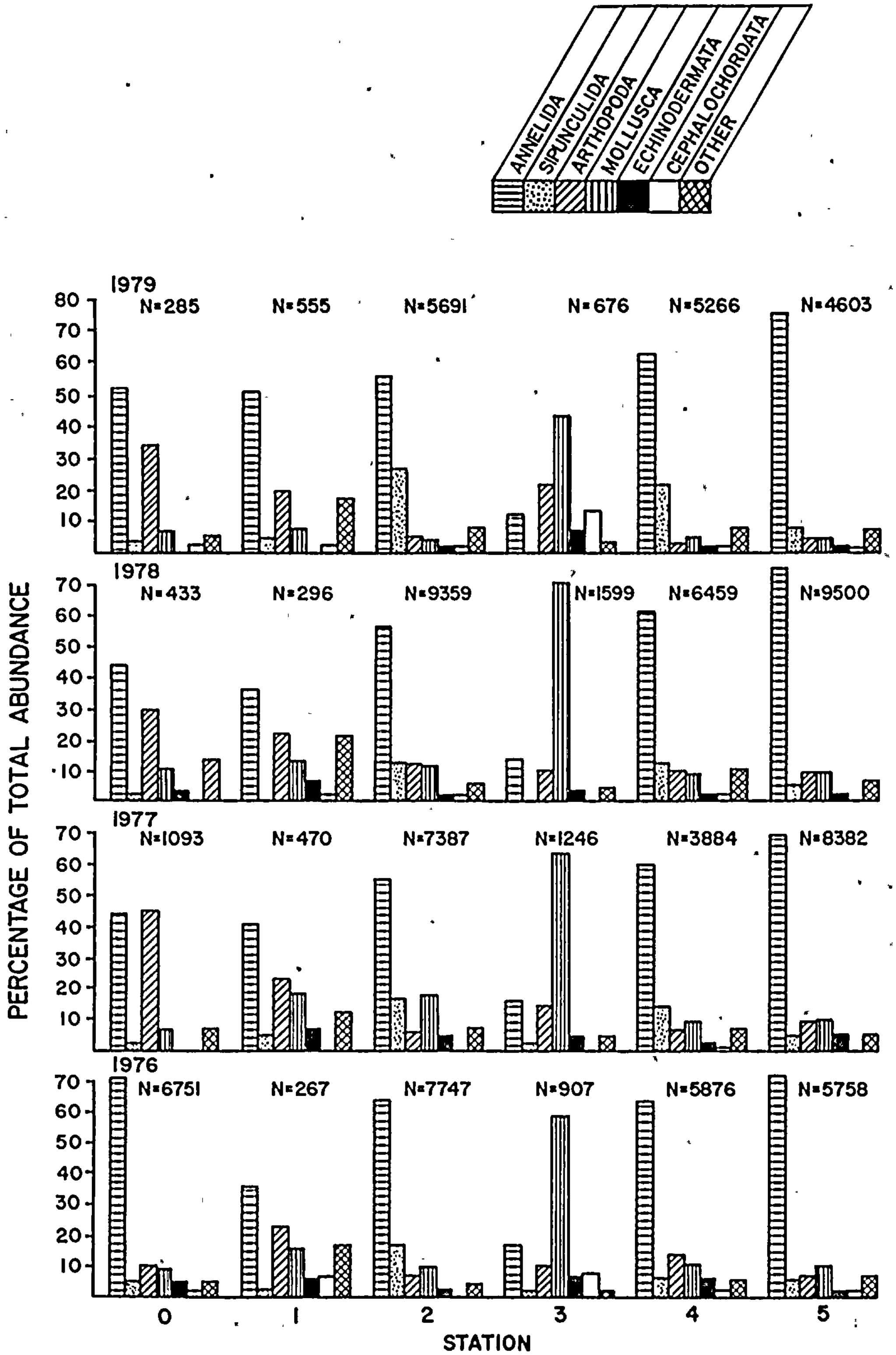

Figure C-6. Distribution by group of benthic macroinvertebrates collected by Shipek grab, St. Lucie Plant, 1974-1979. Note: N = number of observations.

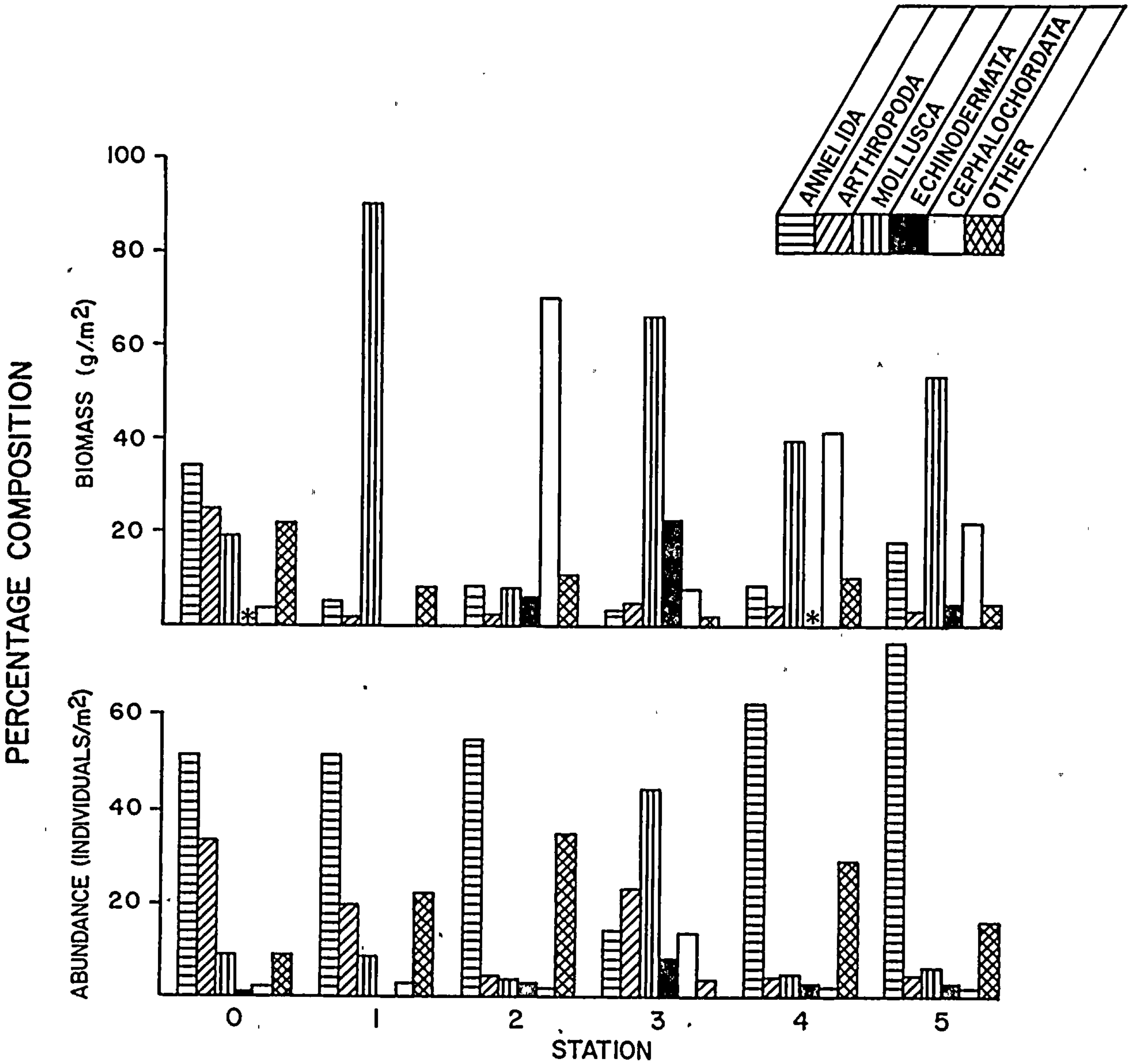

Figure C-7. Percentage contribution to total abundance and biomass by major taxa of benthic macroinvertebrates collected by Shipek grab, St. Lucie Plant, 1979.

Note: *Echinodermata excluded from calculations due to presence of extremely large specimen.

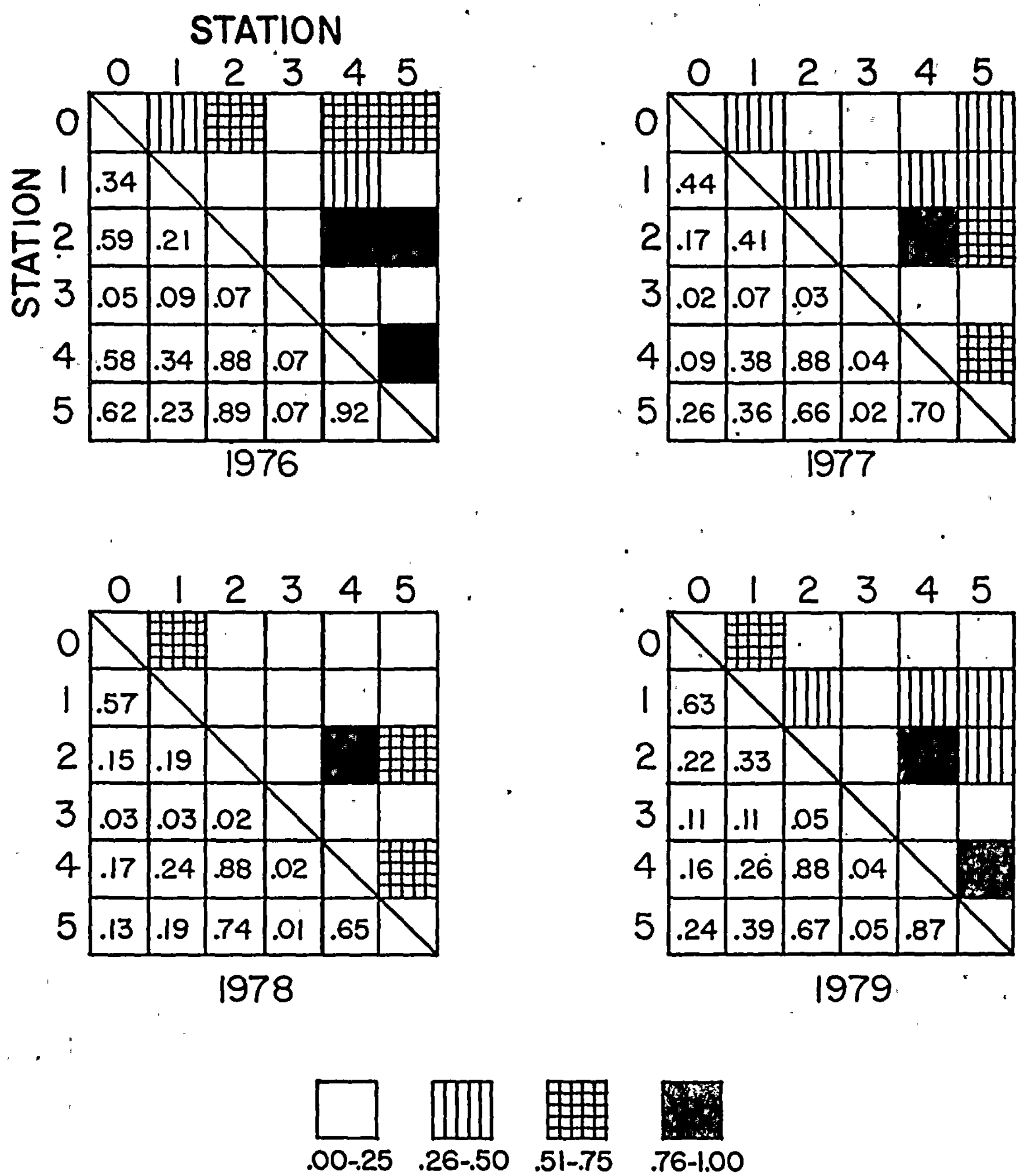

Figure C-8. Morisita indices of similarity between offshore stations based on Shipek grab data (all quarters combined for each year), St. Lucie Plant, 1976-1979.

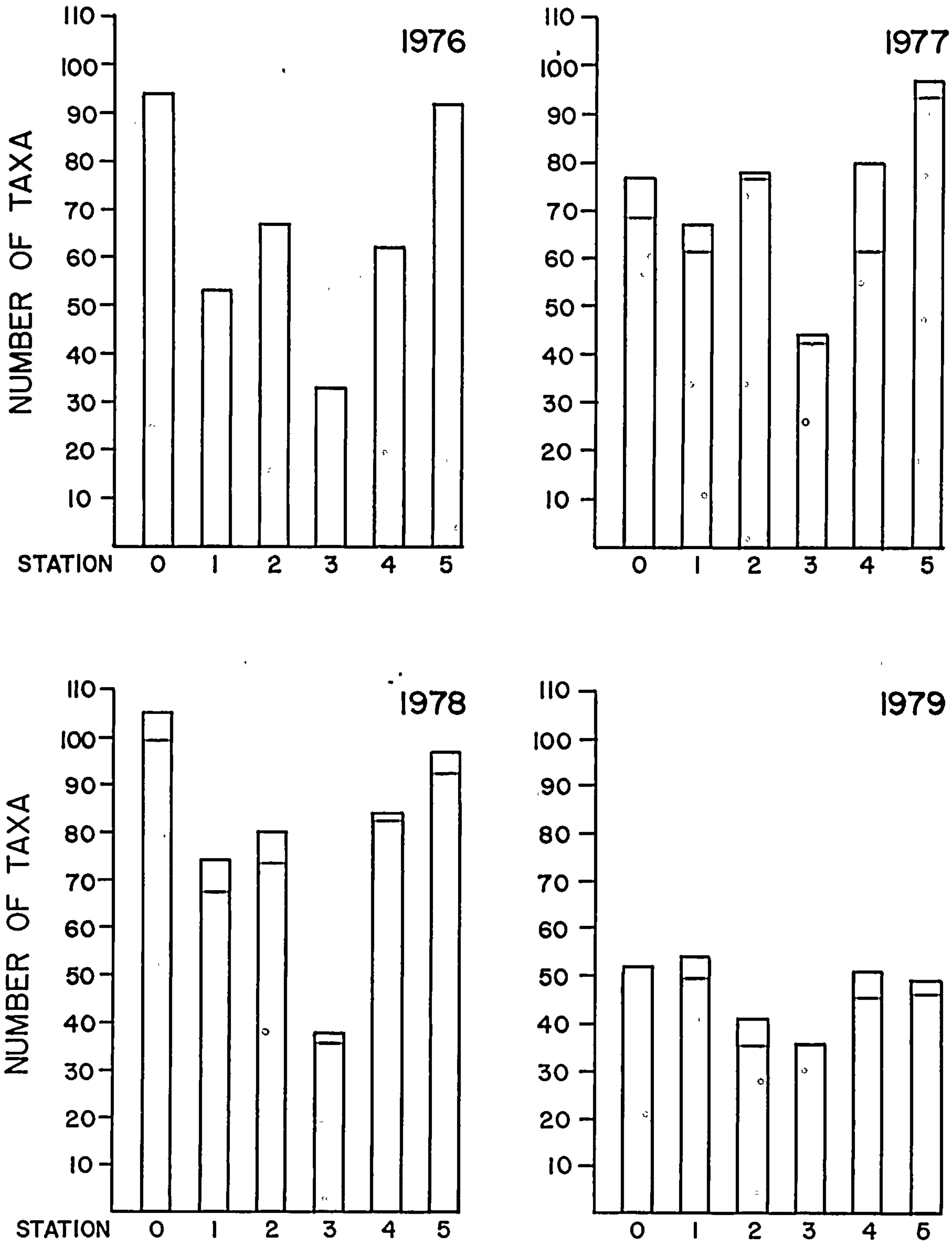

Figure C-9. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at each offshore station, St. Lucie Plant, March through December 1976 and all months of 1977, 1978, and 1979.

Note: March through December 1977, 1978, and 1979 are shaded for comparison with 1976.

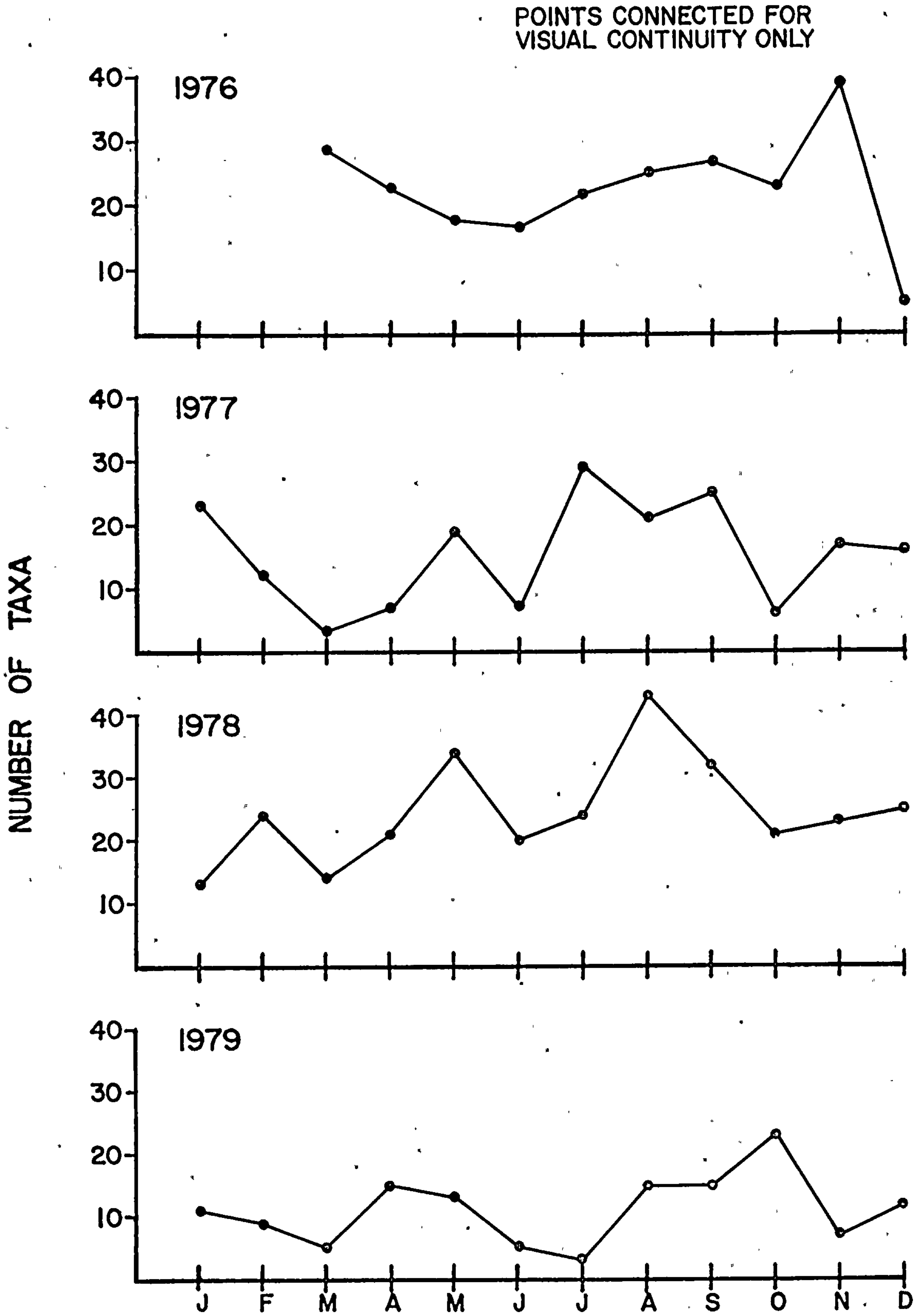

Figure C-10. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at Station 0, St. Lucie Plant, March 1976 - December 1979.

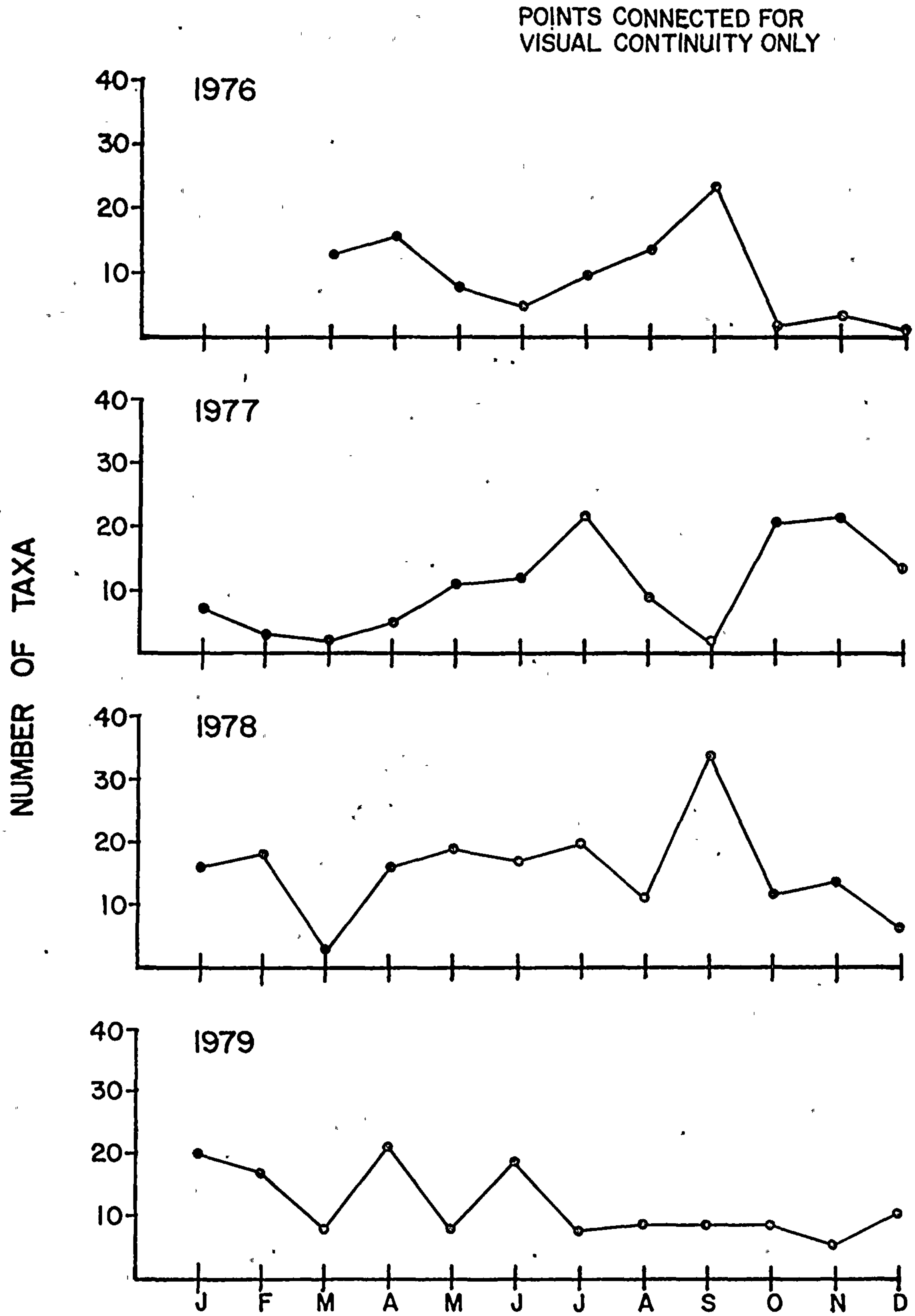

Figure C-11. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at Station 1, St. Lucie Plant, March 1976 - December 1979.

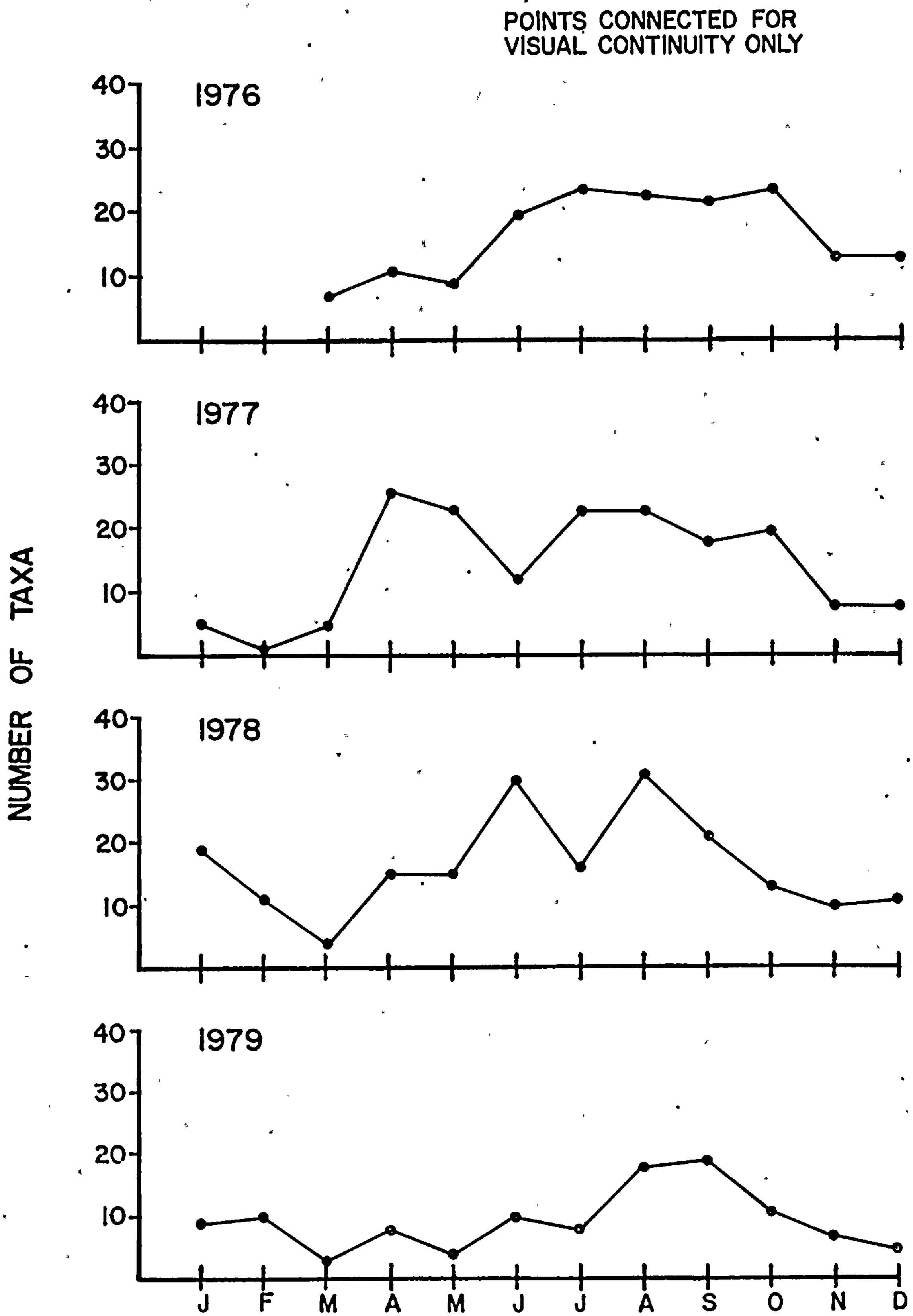

Figure C-12. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at Station 2, St. Lucie Plant, March 1976 - December 1979.

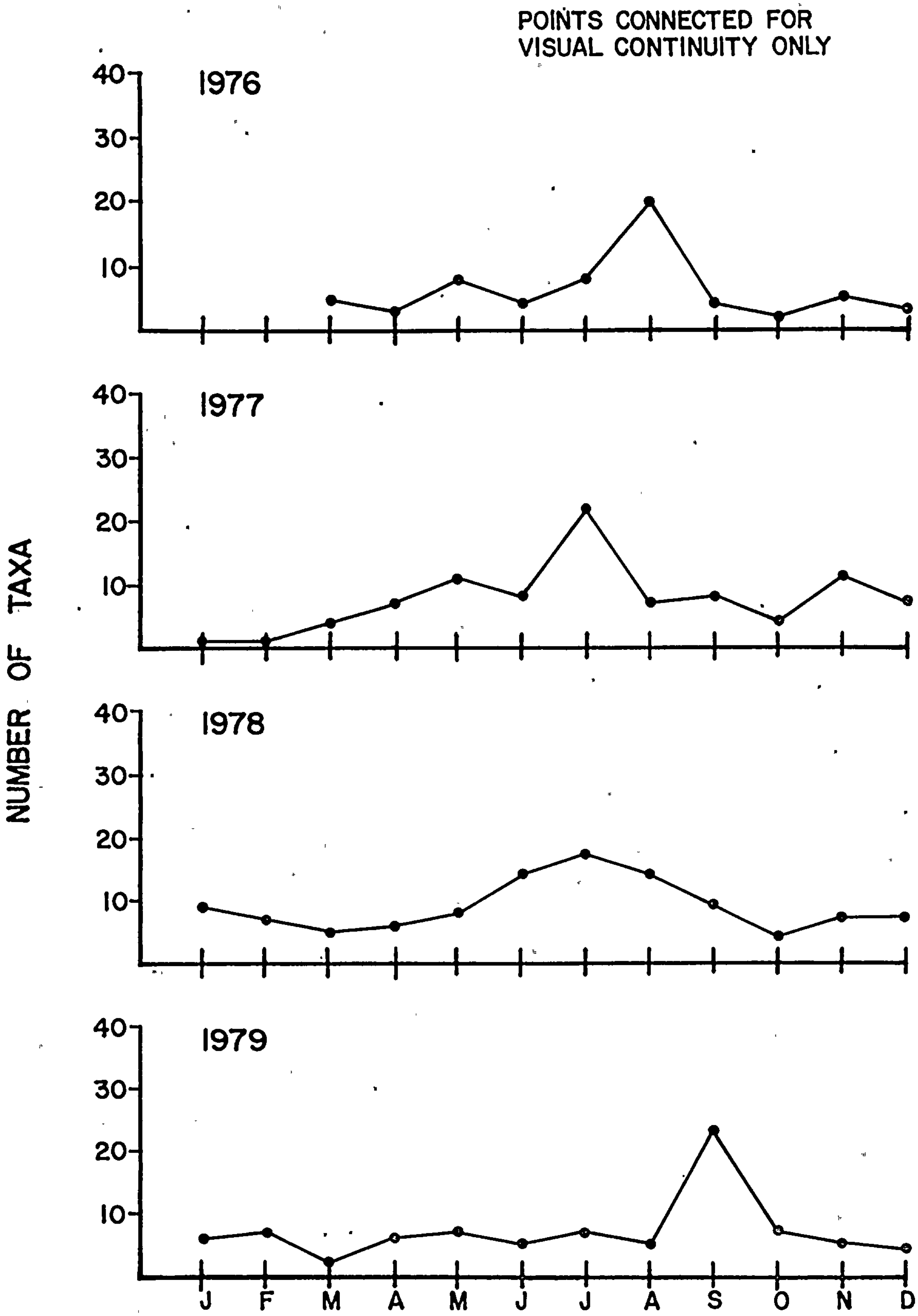

Figure C-13. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at Station 3, St. Lucie Plant, March 1976 - December 1979.

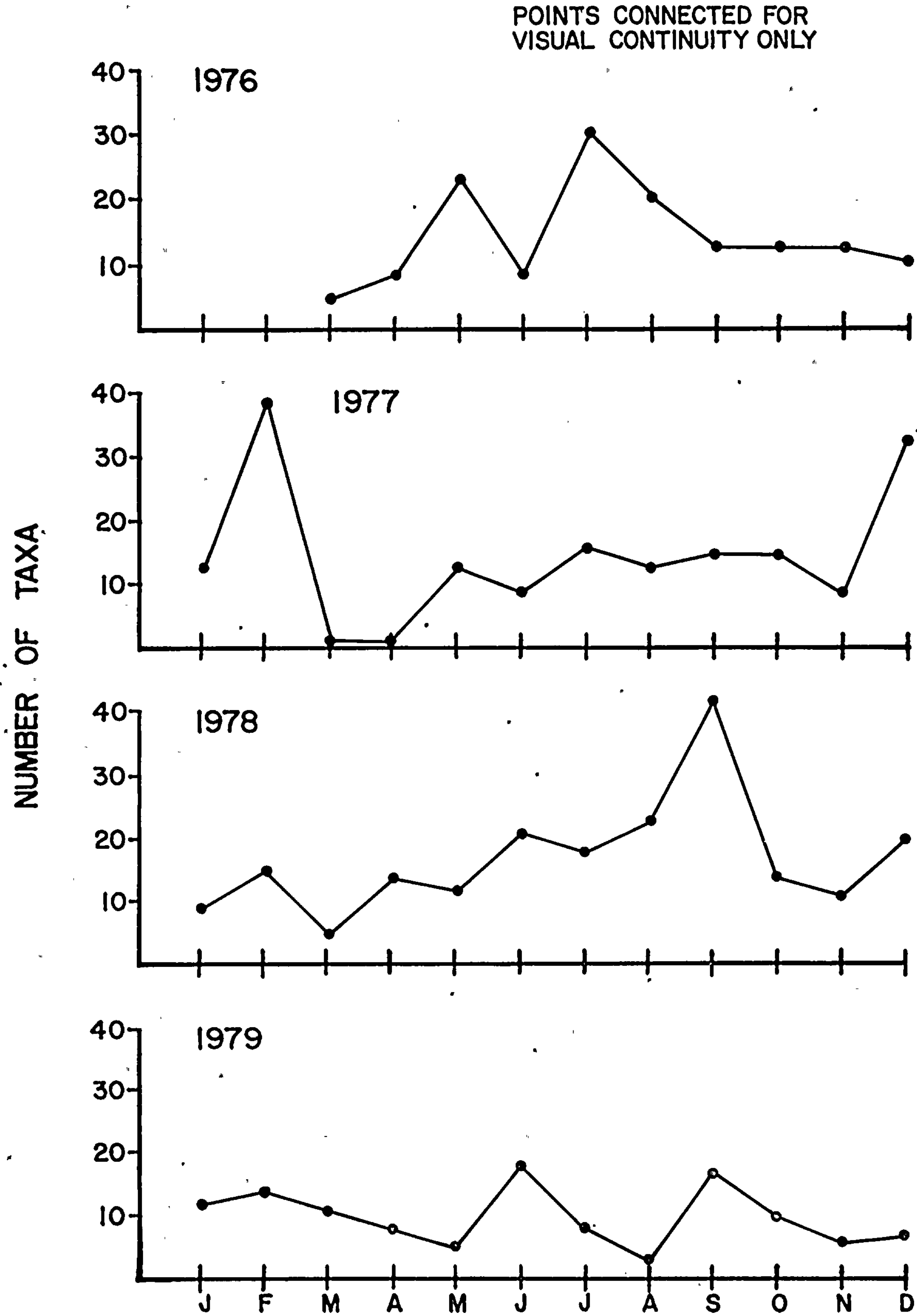

Figure C-14. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at Station 4, St. Lucie Plant, March 1976 - December 1979.

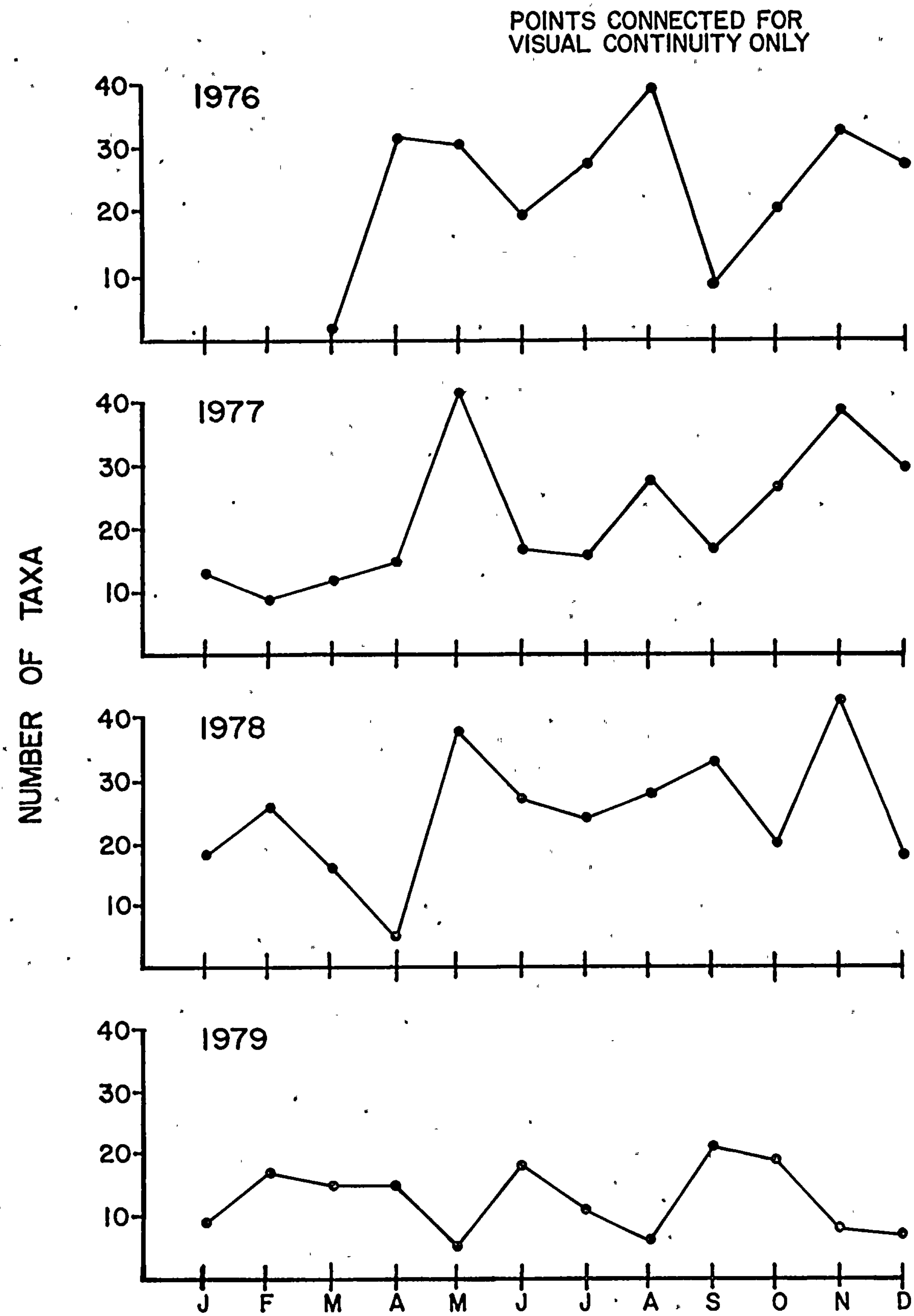

Figure C-15. Total number of benthic macroinvertebrate taxa collected by monthly otter trawl at Station 5, St. Lucie Plant, March 1976 - December 1979.

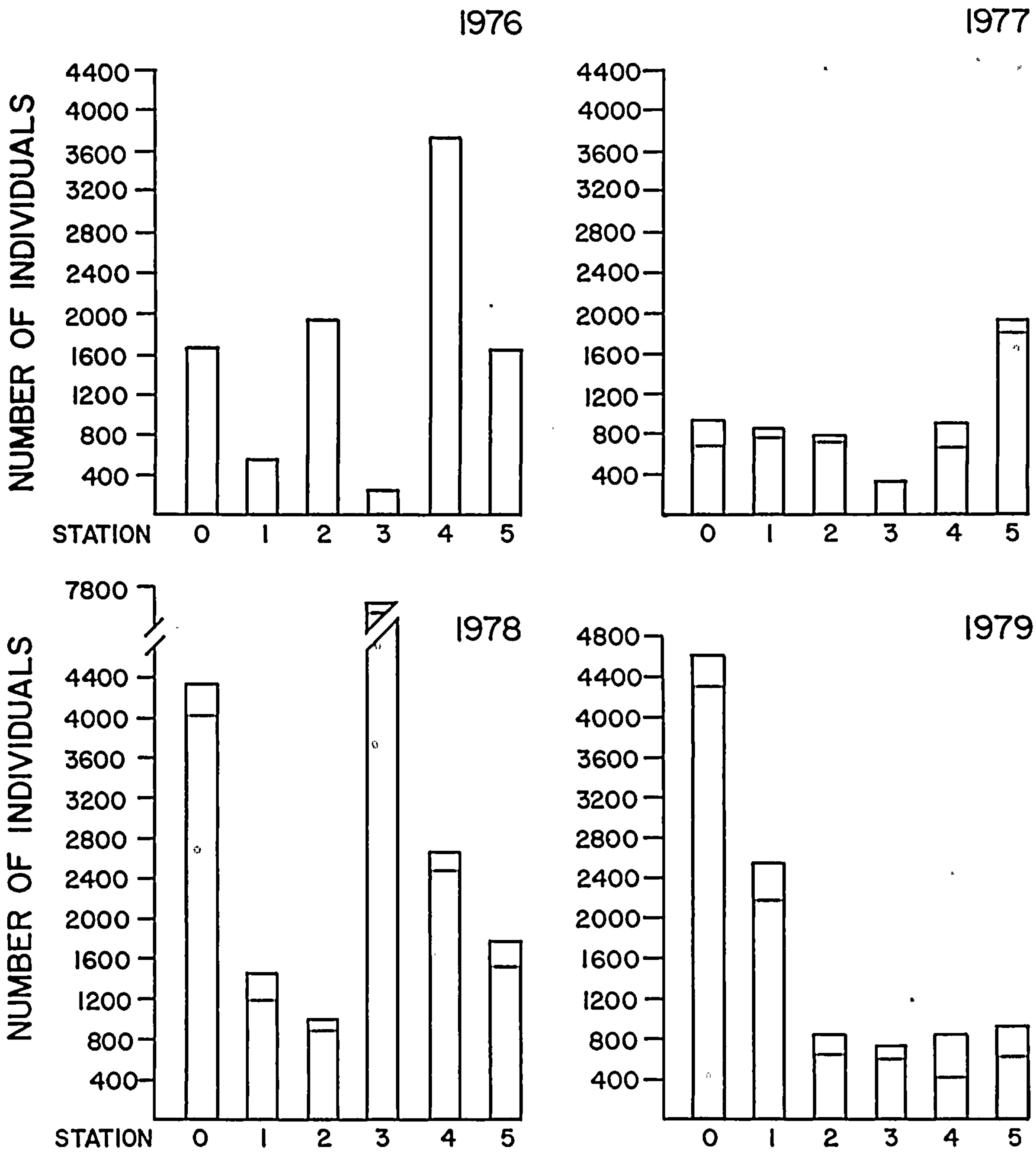

Figure C-16. Total number of benthic macroinvertebrates collected by otter trawl at each offshore station, St. Lucie Plant, March through December 1976 and all months of 1977, 1978, and 1979.

Note: March through December 1977, 1978, and 1979 are shaded for comparison with 1976.

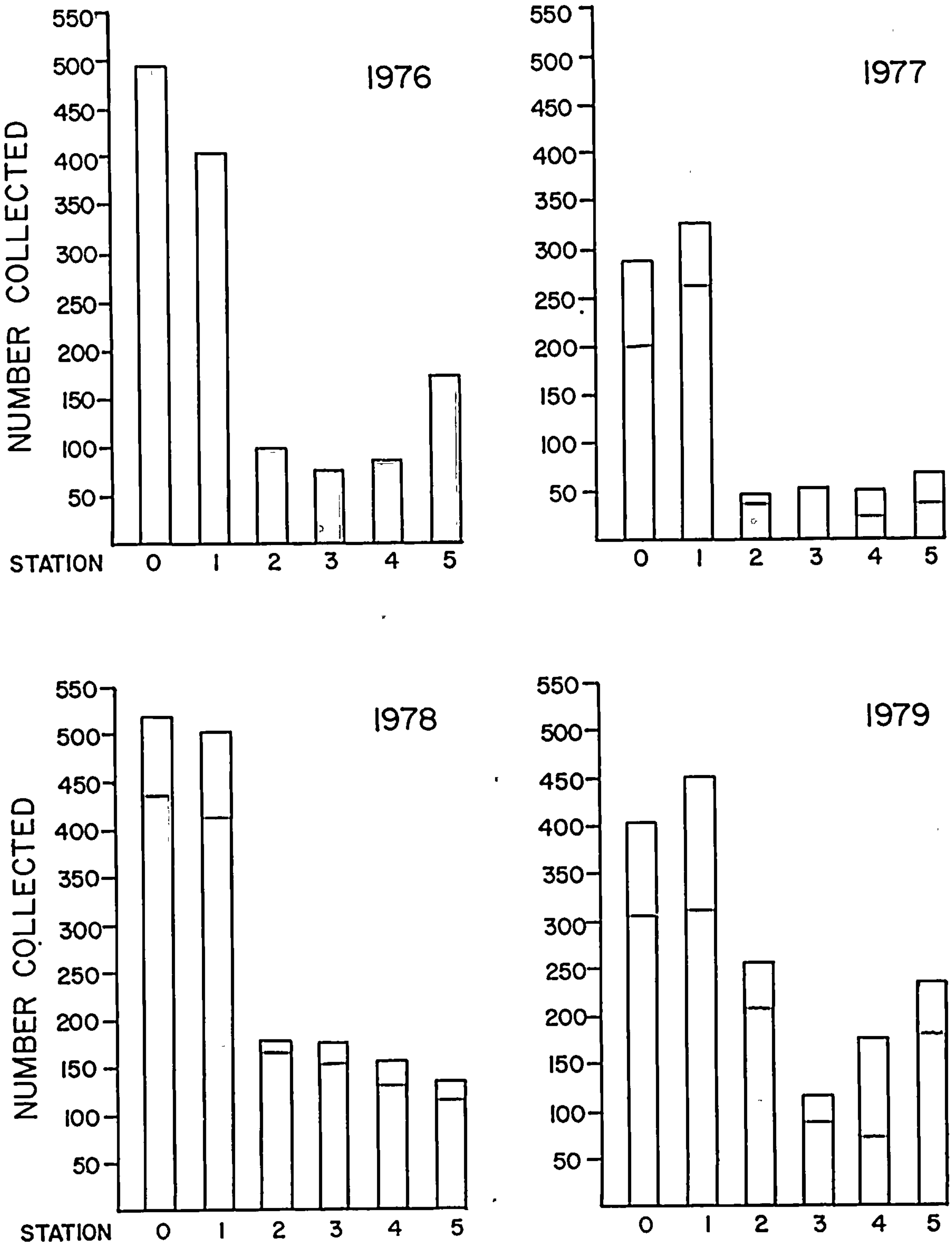

Figure C-17. Abundance of <u>Trachypenaeus constrictus</u> in trawl collections for all months combined, March through December 1976 and all months of 1977, 1978, and 1979, St. Lucie Plant.

Note: March through December 1977, 1978, and 1979 are shaded for comparison with 1976.

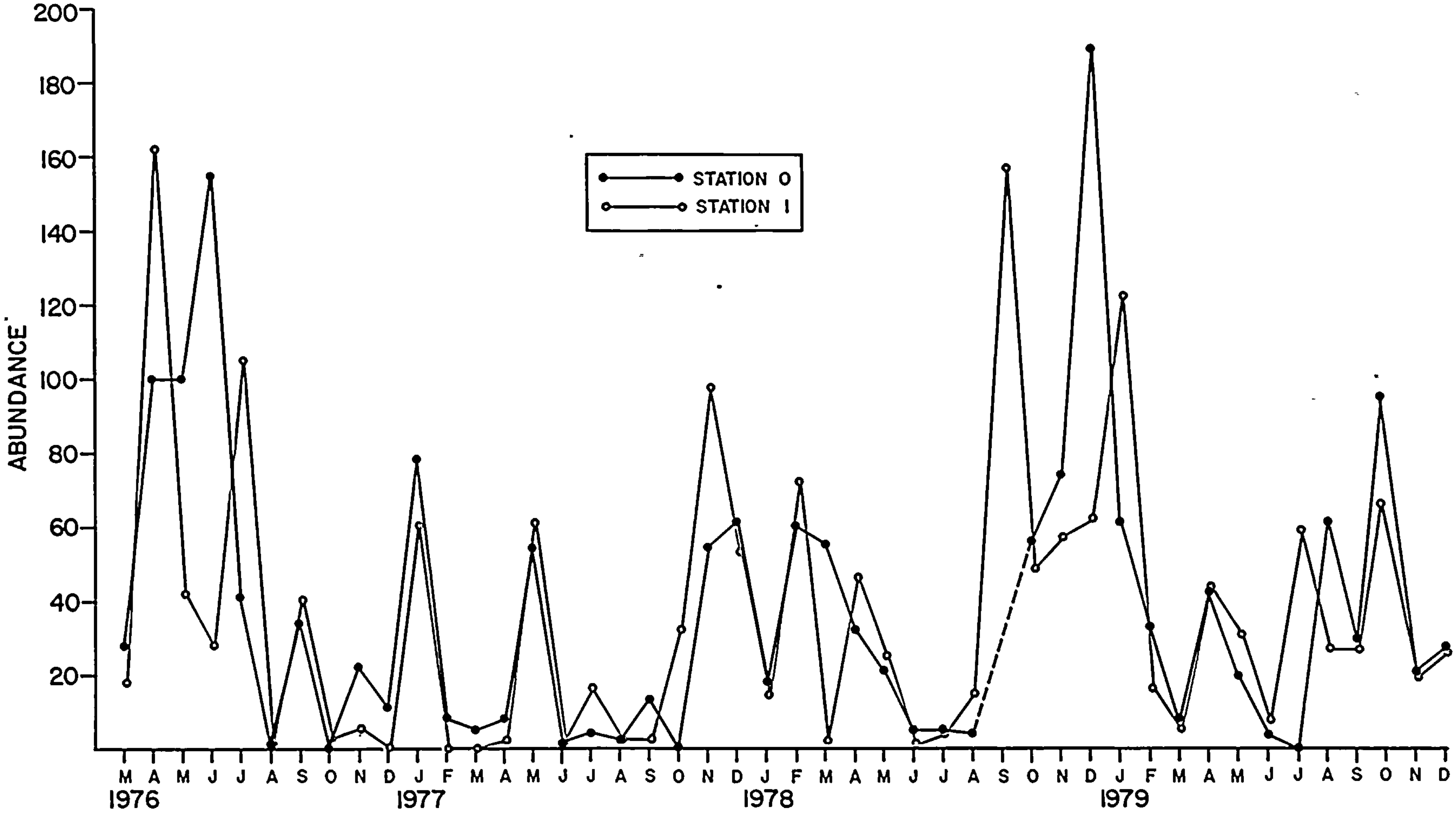

Figure C-18. Monthly abundance of Trachypenaeus constrictus in trawl collections at Stations 0 and 1, St. Lucie Plant, March 1976 - December 1979.

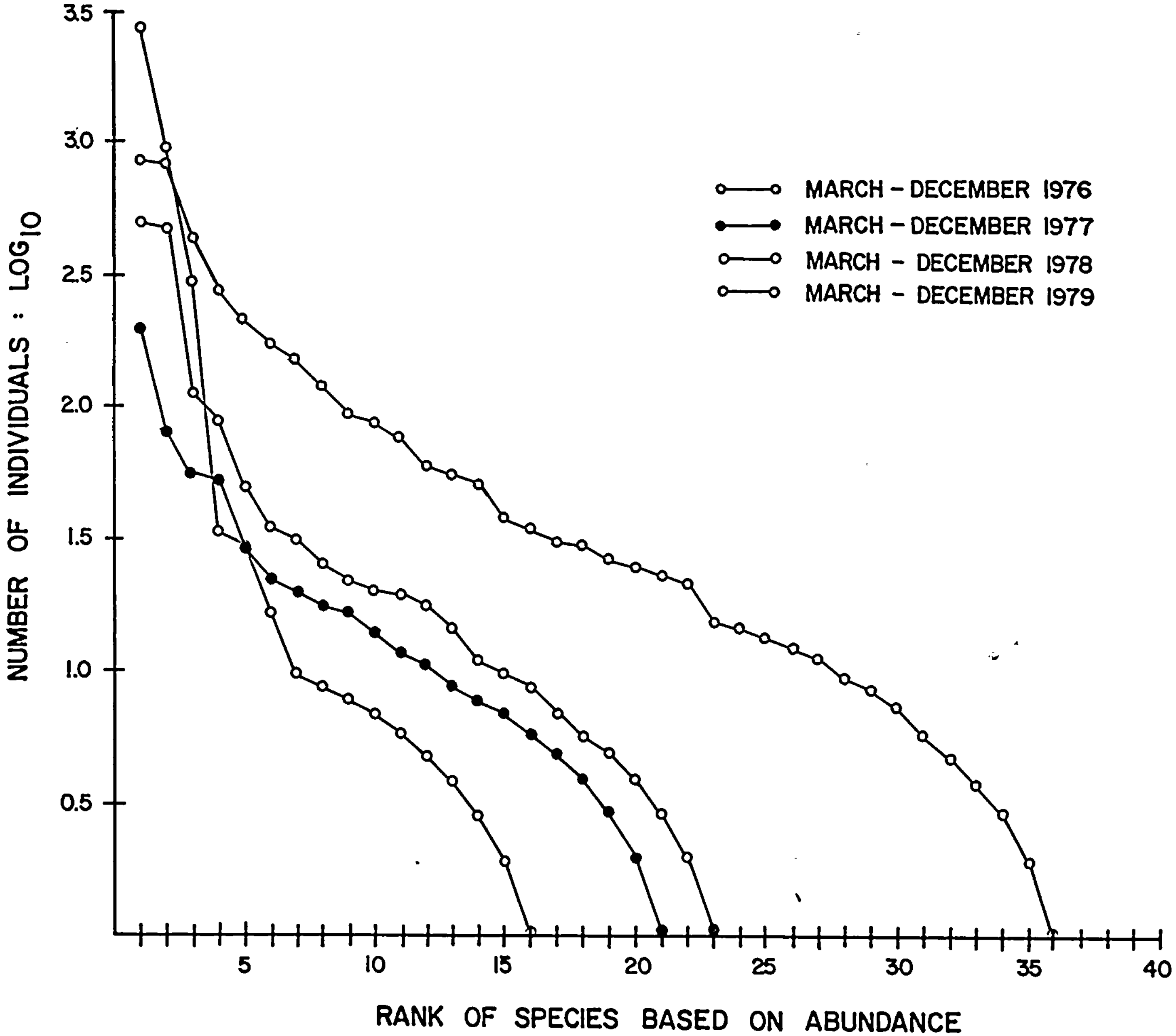

Figure C-19. Dominance-diversity curves for trawl collections at Station 0, St. Lucie Plant, 1976-1979.

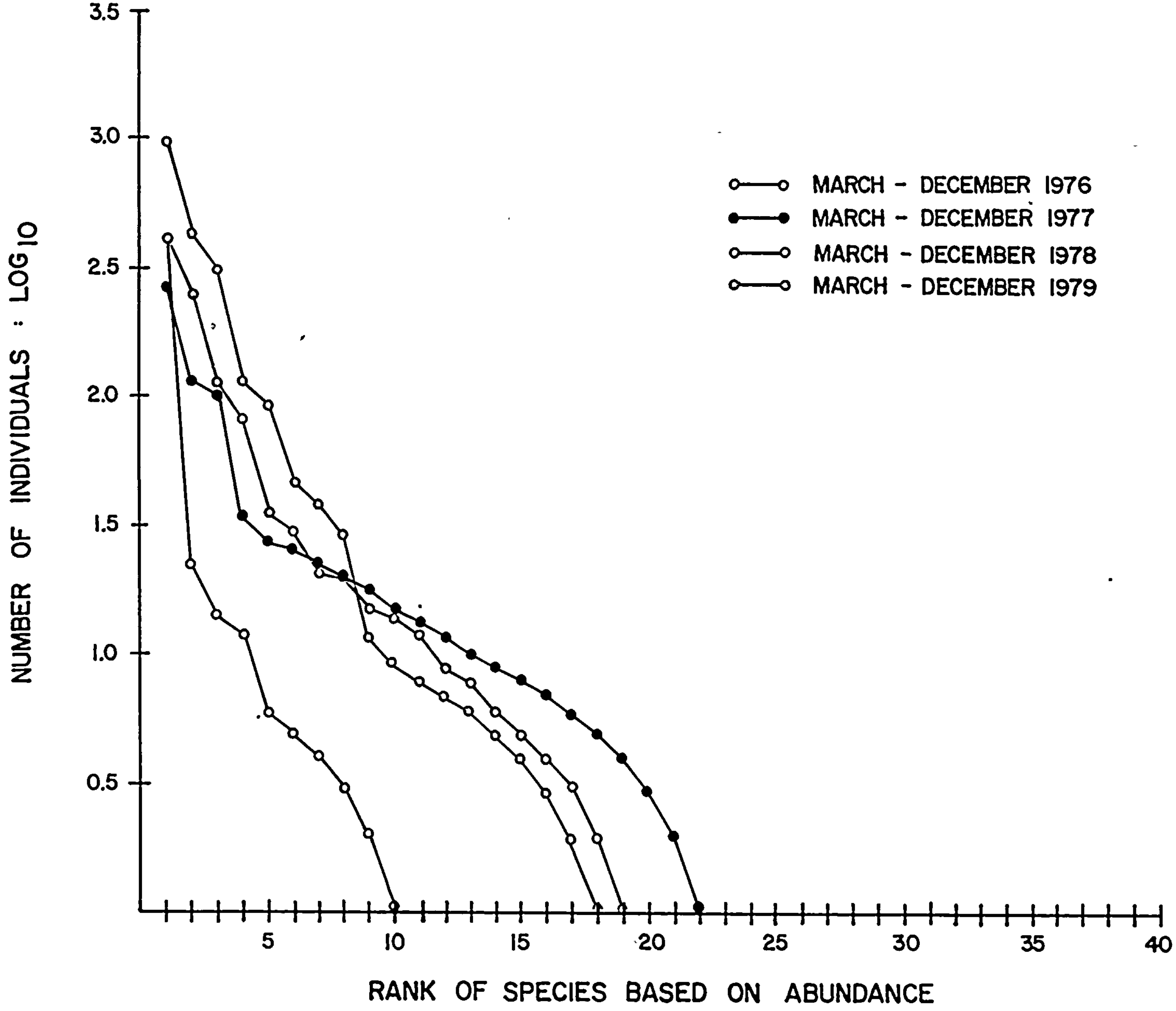

Figure C-20. Dominance-diversity curves for trawl collections at Station 1, St. Lucie Plant, 1976-1979.

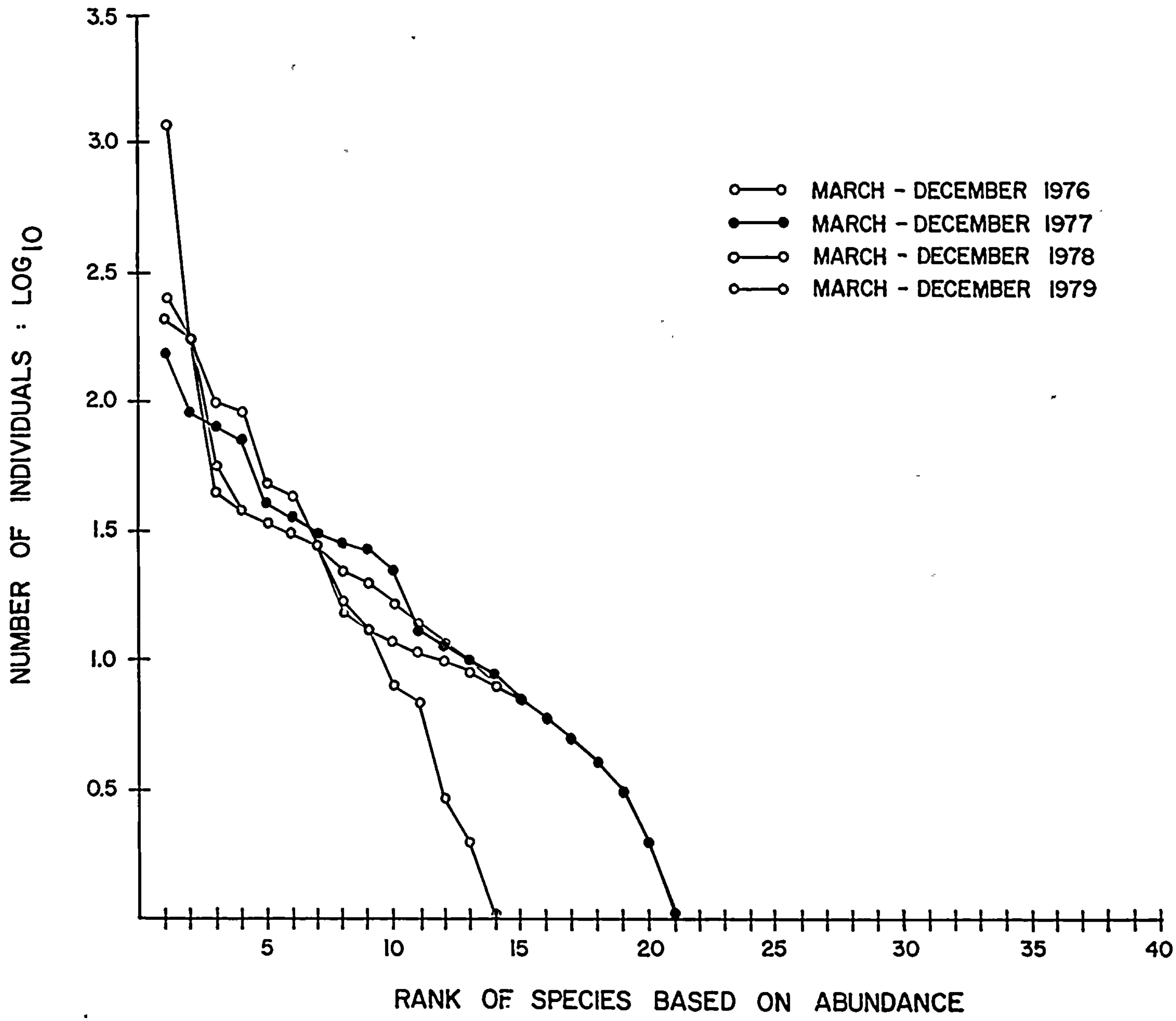

Figure C-21. Dominance-diversity curves for trawl collections at Station 2, St. Lucie Plant, 1976-1979.

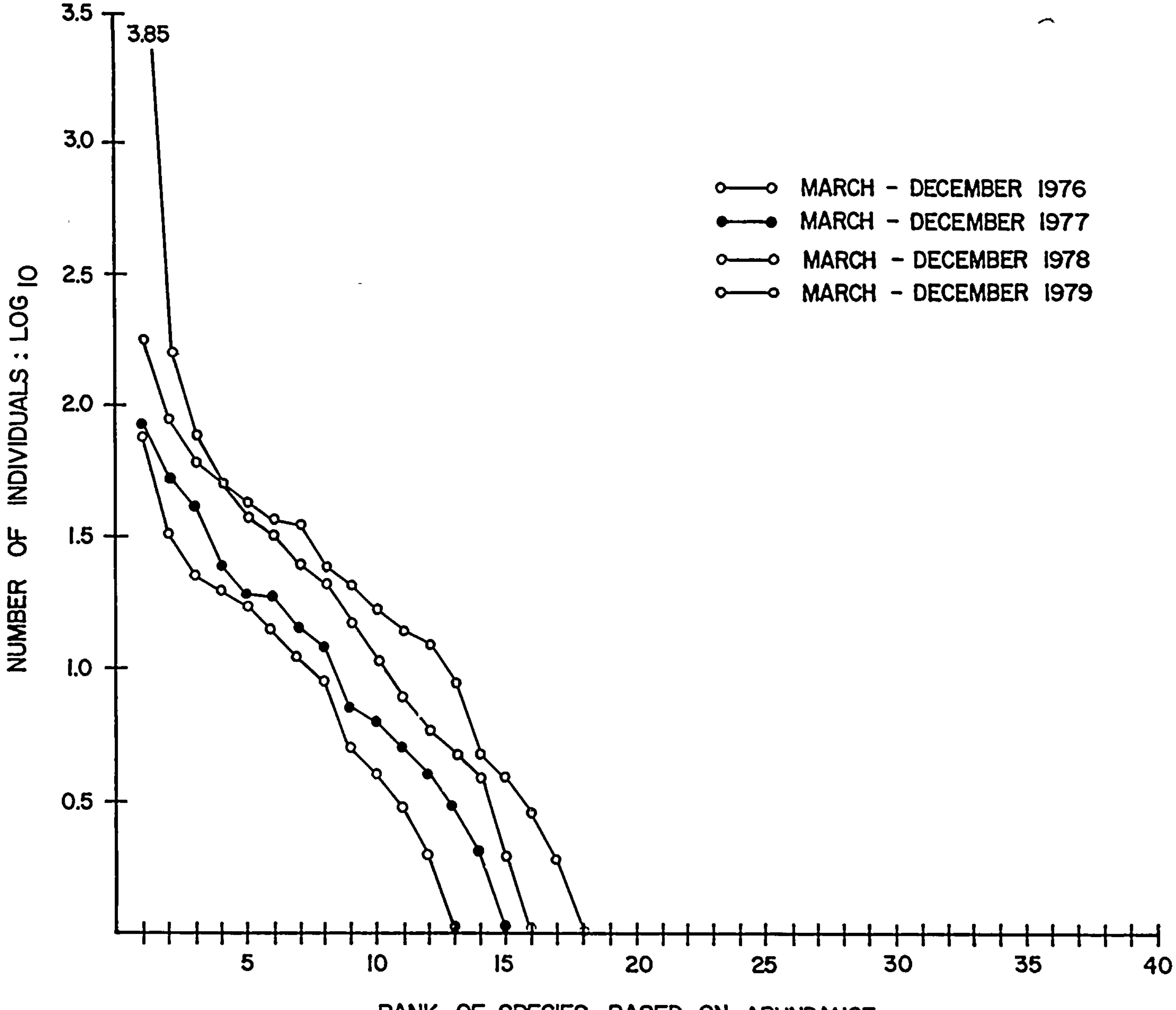

Figure C-22. Dominance-diversity curves for trawl collections at Station 3, St. Lucie Plant, 1976-1979.

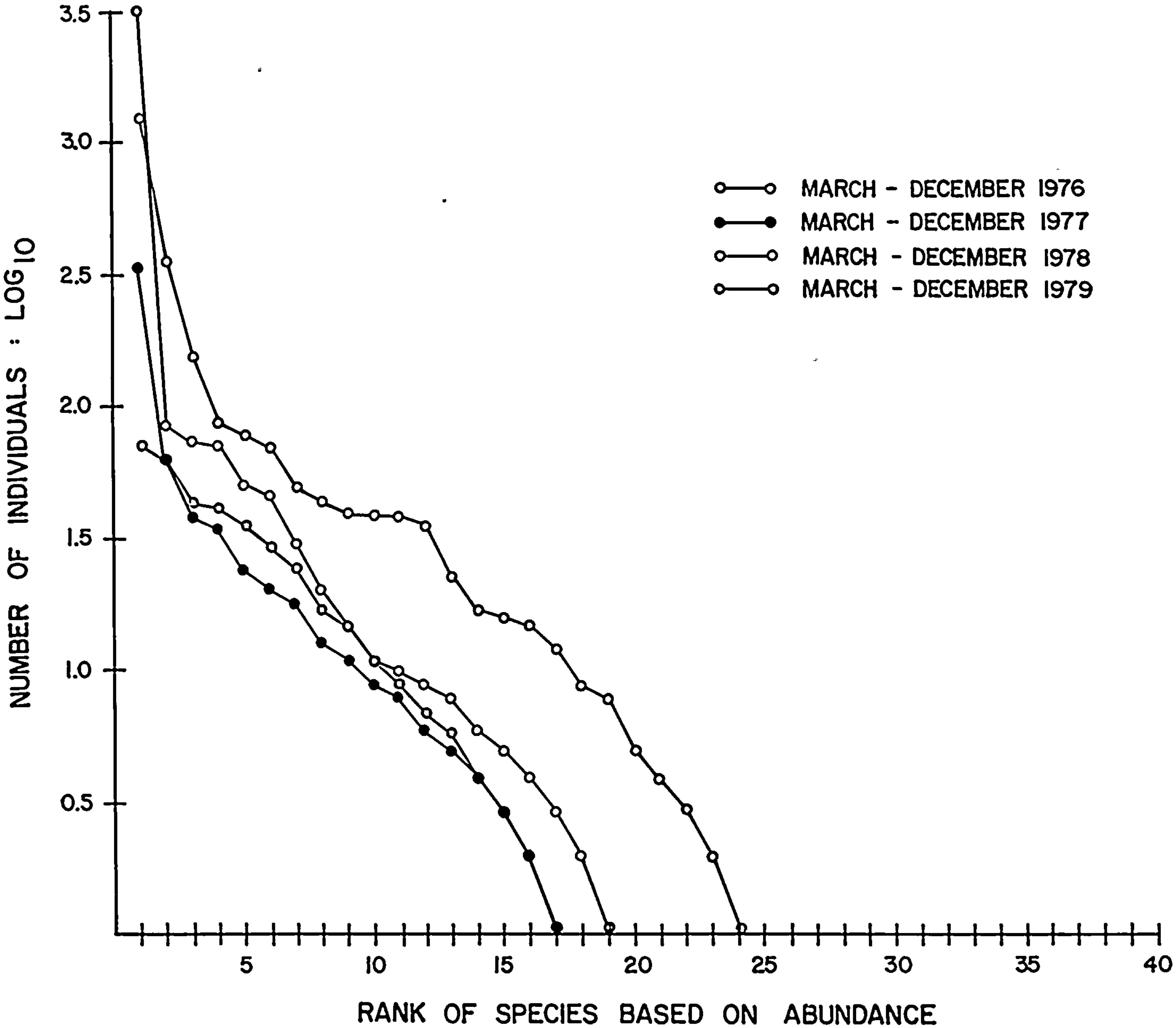

Figure C-23. Dominance-diversity curves for trawl collections at Station 4, St. Lucie Plant, 1976-1979.

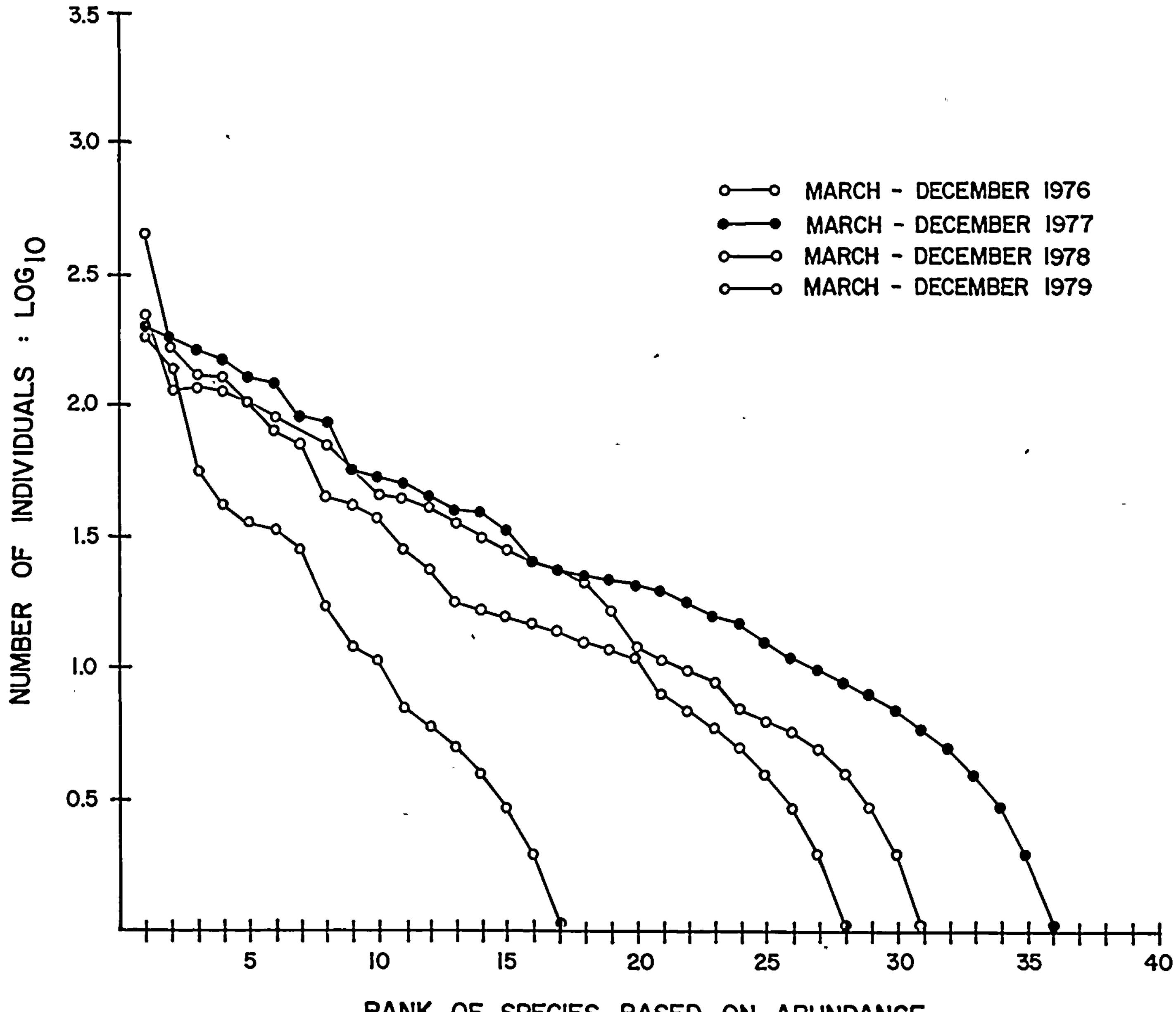

Figure C-24. Dominance-diversity curves for trawl collections at Station 5, St. Lucie Plant, 1976-1979.

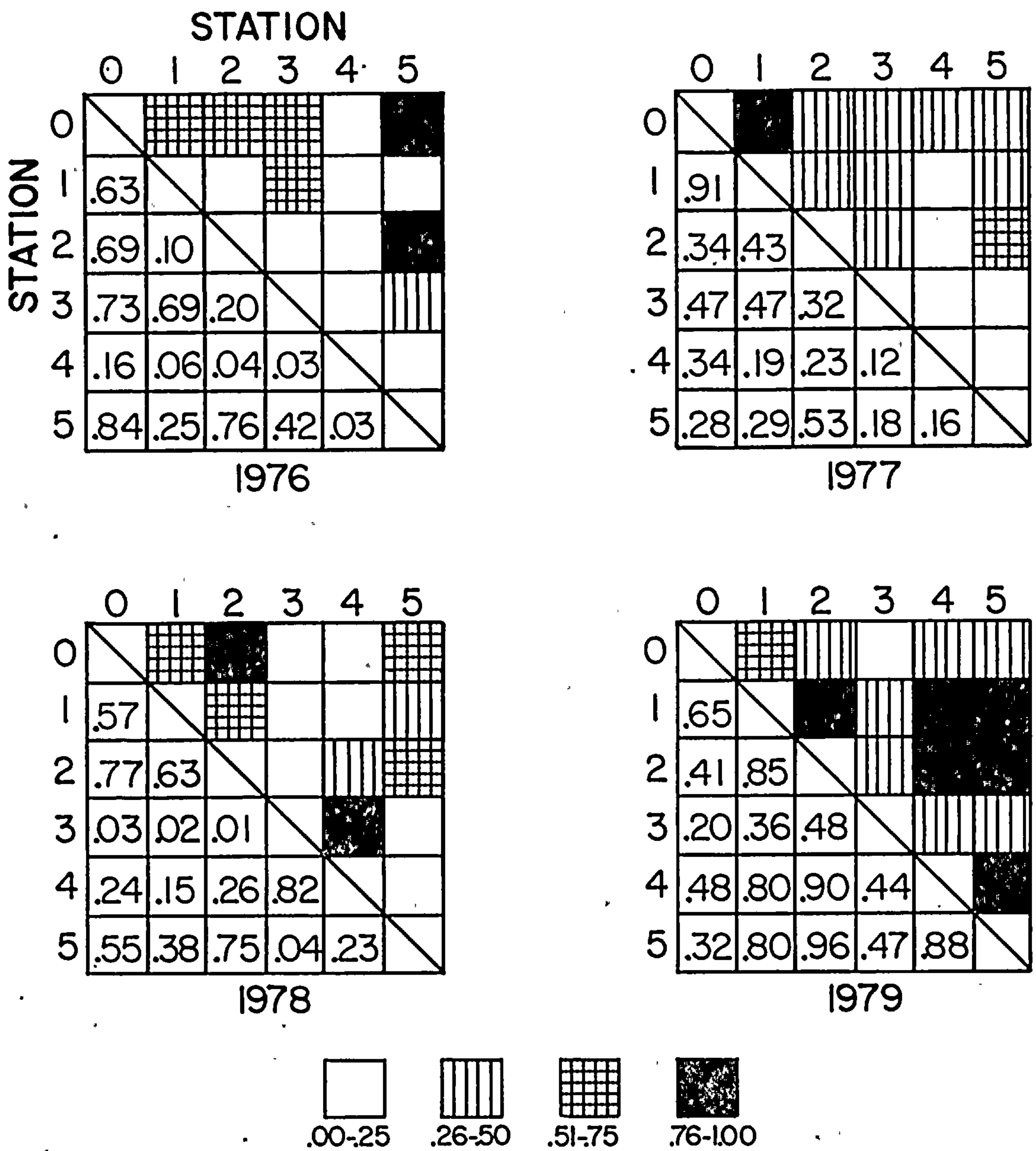

Figure C-25. Morisita indices of similarity between offshore stations based on trawl data (all months combined for each year), St. Lucie Plant, 1976-1979.

TABLE C-1

SEDIMENT SIZE ANALYSIS (PERCENTAGE BY WEIGHT) AT BENTHIC STATIONS
ST. LUCIE PLANT
1979

Station	Qtr	Pebble <-4 (>16)	Pebble -3 (16-8)	Pebble -2 (8-4)	Granule -1 4-2	Very coarse sand 0 2-1	Coarse sand 1 1-0.500	Medium sand 2 0.500-0.250	Fine sand 3 0.250-0.125	Very fine sand 4 0.125-0.063	Silt and clay >4 <0.063	Mean diameter (Ø)	Sorting coefficient (Ø)
0	1	0.0	2.1	1.5	3.2	4.5	4.3	0.3	24.3	53.2	6.5	2.6	3.0
	2	0.0	0.0	0.1	0.6	0.6	0.4	0.2	12.1	76.9	9.1	3.4	0.5
	3	0.0	0.0	0.4	0.9	1.1	0.9	1.6	70.3	24.3	0.4	2.6	0.7
	4	0.0	0.0	0.2	0.7	1.0	1.7	0.2	65.8	21.4	9.2	2.8	0.8
1	1	0.0	0.0	0.5	0.9	0.9	0.4	0.3	23.4	62.9	10.6	3.2	1.3
	2	0.0	0.8	1.6	1.7	3.3	4.8	8.1	51.1	22.7	5.8	2.4	2.0
	3	0.0	2.2	3.6	4.9	5.5	5.9	18.2	42.0	16.5	1.2	1.7	3.0
	4	0.0	0.0	0.4	0.5	1.9	1.1	0.9	64.7	24.1	6.8	2.8	0.8
2	1	0.0	0.7	3.6	7.2	18.1	25.2	12.3	32.5	0.3	0.1	0.8	2.2
	2	1.3	1.8	1.8	3.9	21.0	23.1	11.6	34.7	0.6	0.2	0.9	2.6
	3	0.2	1.7	2.5	2.8	14.2	27.0	36.3	13.2	1.9	0.2	0.8	1.8
	4	0.0	5.7	9.2	11.5	35.2	21.3	0.1	15.0	0.8	1.2	-0.2	2.9
3	1	0.0	0.0	0.0	0.1	0.4	1.8	11.1	85.8	0.6	0.1	2.3	0.2
	2	0.0	0.0	0.0	0.2	0.9	4.3	3.1	91.1	0.3	0.1	2.4	0.3
	3	0.0	0.0	0.3	0.2	0.7	3.7	33.5	61.2	0.6	0.1	2.1	0.4
	4	0.0	0.0	0.0	0.1	2.0	5.2	0.4	91.0	0.1	0.3	2.3	0.4
4	1	ND[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	0.0	0.7	2.1	7.3	24.9	31.0	10.2	23.3	0.4	0.1	0.6	1.9
	3	0.0	1.5	3.3	7.1	18.1	26.0	31.6	11.2	1.0	0.2	0.6	1.9
	4	0.0	7.1	3.6	6.2	26.1	27.6	0.2	28.9	0.1	0.3	0.3	3.1
5	1	0.0	0.5	1.5	2.5	8.9	19.7	34.4	31.4	0.8	0.4	1.3	1.5
	2	0.2	2.0	4.4	5.7	18.6	25.5	4.0	38.0	1.3	0.3	0.8	2.8
	3	0.4	7.5	6.5	9.7	18.2	24.2	23.2	6.6	2.8	1.0	0.1	3.2
	4	0.0	15.4	7.6	9.2	21.2	20.4	0.2	23.5	0.2	2.5	-0.2	4.6

Note: Brackets surround consistently higher (>10%) percentage groups.

[a]ND= No data.

TABLE C-2

BENTHIC GRAB MACROINVERTEBRATE AND STATISTICAL DATA BY STATION AND QUARTER
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
1979

Parameter	Qtr	Station 0	1	2	3	4	5	Mean	Mean (excluding Sta 0)
No. of taxa	1	31	32	101	40	93	117	69.0	76.6
	2	18	19	108	32	117	108	67.0	76.8
	3	21	65	111	26	115	113	75.2	86.0
	4	4	21	105	18	73	84	50.8	60.2
	Total	56	97	202	67	194	212	138.0	154.4
	Mean	19	34	106	29	99	105	--	--
Density (individuals/m^2)	1	1458	1175	10,462	2407	10,571	14,694	6,783	7,848
	2	375	450	10,846	1508	10,404	8,163	5,291	6,274
	3	475	2741	9,471	825	14,411	7,172	5,849	6,924
	4	67	258	16,627	891	8,480	8,313	5,773	6,914
	Total	2375	4624	47,406	5631	43,866	38,342	23,707	27,974
	Mean	594	1156	11,852	1407	10,966	9,585		
Mean number of individuals per sample	1	58±23	47±6	419±50	96±14	423±28	588±139	--	--
	2	15±4	18±4	434±239	60±14	416±214	234±124	--	--
	3	19±6	110±42	379±58	33±30	577±162	287±73	--	--
	4	3±2	10±2	665±323	9±5	339±67	333±196	--	--
	Total[a]	285	555	5691	676	5266	4603		
Biomass (g/m^2)	1	0.339	0.761	5.191	3.986	317.142	3.252	55.112	66.066
	2	0.176	0.601	10.329	13.564	3.567	14.051	7.048	8.422
	3	16.988	2.550	5.446	0.928	133.658	3.099	27.112	29.136
	4	0.060	25.288	4.234	0.195	17.348	2.360	8.248	9.885
	Total	17.563	29.200	25.200	18.673	471.715	22.762	--	--
	Mean	4.391	7.300	6.300	4.668	117.929	5.691	--	--
Diversity ($\bar{d}$)	1	4.049	3.973	4.785	3.760	4.303	4.747	4.283	4.329
	2	3.562	2.859	5.089	3.207	4.724	5.265	4.118	4.229
	3	3.975	5.023	4.391	3.236	3.733	4.987	4.224	4.274
	4	2.000	4.196	4.285	2.740	4.398	4.802	3.737	4.084
	$\bar{d}$/year	4.832	5.429	4.979	4.087	4.694	5.418	--	--
	Mean[b]	3.397	4.013	4.638	3.236	4.290	4.950	--	--
Equitability (e)	1	0.774	0.727	0.406	0.500	0.312	0.342	0.510	0.457
	2	0.944	0.526	0.472	0.406	0.333	0.537	0.536	0.455
	3	1.095	0.754	0.279	0.500	0.165	0.416	0.535	0.423
	4	1.250	1.286	0.276	0.500	0.425	0.494	0.705	0.596
	e/year	0.768	0.670	0.235	0.373	0.201	0.302	--	--
	Mean	1.016	0.823	0.358	0.477	0.309	0.447	--	--

[a]Total number of individuals collected at each station for the year.

[b]Diversity ($\bar{d}$) values between 3 and 4 generally indicate unpolluted waters (EPA, 1973).

TABLE C-3

SPEARMAN RANK CORRELATIONS (RS) FOR VARIOUS COMBINATIONS OF NUMBER OF TAXA, DENSITY AND BOTTOM WATER TEMPERATURE
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
1976 - 1979

Station	Taxa vs. temperature	Density vs. temperature	Density vs. biomass	Taxa vs. density
0 (n = 12)	NS[a]	NS	NS	**
1 (n = 16)	NS	NS	NS	**
2 (n = 16)	**	*	NS	**
3 (n = 16)	NS	*	NS	**
4 (n = 16)	**	**	NS	**
5 (n = 16)	NS	NS	**	**
All (excluding 0; n = 16)	*	*	NS	**

[a]NS = not significant.

*Significant correlation (P = 0.05).

**Highly significant correlation (P = 0.01).

TABLE C-4

KRUSKAL-WALLIS AND SNK COMPARISONS OF GRAB REPLICATE DATA
ST. LUCIE PLANT
1976-1979

Parameter	Year	Station 0	1	2	3	4	5
Grab efficiency	1976-77	decrease*	decrease*	NS[a]	NS	NS	decrease*
	1977-78	decrease*	NS	NS	NS	NS	increase*
	1978-79	NS	NS	NS	NS	NS	NS
	1976-78	decrease*	decrease*	NS	NS	NS	decrease*
	1976-79	decrease*	decrease*	NS	NS	NS	decrease*
Number of taxa	1976-77	decrease*	NS	increase*	NS	NS	increase*
	1977-78	decrease*	NS	NS	NS	increase*	NS
	1978-79	NS	NS	decrease*	NS	decrease*	decrease*
	1976-78	decrease*	NS	increase*	NS	increase*	increase*
	1976-79	decrease*	NS	NS	NS	NS	NS
Number of individuals	1976-77	decrease*	NS	NS	NS	NS	increase*
	1977-78	decrease*	NS	NS	NS	NS	NS
	1978-79	decrease*	NS	NS	NS	NS	decrease*
	1976-78	decrease*	NS	NS	NS	NS	increase*
	1976-79	decrease*	NS	NS	NS	NS	decrease*

[a]NS = not significant.

*Significant at P = 0.05.

TABLE C-5

TEN TOP-RANKED[a] DOMINANT TAXA OF BENTHIC MACROINVERTEBRATES FROM GRAB SAMPLES AT SIX OFFSHORE STATIONS
ST. LUCIE PLANT
1976 - 1979

	STATION AND YEAR																							
	0				1				2				3				4				5			
Taxa	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	10	5	-	-	-	-	-	-	7	6	-	-	-	-
NEMERTINA	10	1	1	1	1	1	1	1	4	2	2	3		4	3	10	8	3	2	3	5	3	2	4
ANNELIDA																								
Apoprionospio dayi	-	-	-	-	-	8	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Armandia agilis	-	5	7	3	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Axiothella mucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-
Brania wellfleetensis	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	5	-	-	-	-	-	-	-	-
Eunice vittata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-
Exogone dispar	2	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	4	3	-
Filogranula sp. A	1	-	-	-	-	-	-	-	1	4	3	2	10	-	-	-	1	2	3	2	1	1	1	1
Goniada littorea	-	8	-	9	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Goniadides carolinae	3	-	-	-	-	7	-	8	6	5	-	-	-	-	-	-	6	4	8	4	2	-	-	2
Grania macrochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	5	-	-	-	-	-	-
Hemipodus roseus	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Heterodrilus arenicolus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-
Loimia medusa	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lumbrineris cruzensis	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macrochaeta sp.	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	10	-	-	-	-	-	-
Mediomastus californiensis	-	2	-	-	-	10	-	-	10	9	-	-	-	-	-	-	-	-	-	-	-	2	8	10
Nephtys cf. incisa	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oligochaeta spp.	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	7	-	-	-	4	-	7	-
Onuphis eremita oculata	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapionosyllis longicirrata	-	-	-	-	-	-	-	-	-	-	5	9	-	10	10	6	-	-	-	-	-	-	-	-
Poecilochaetus johnsoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-
Polycirrus eximius	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygordius sp.	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prionospio cristata	6	-	-	5	3	-	-	10	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Protodorvillea kefersteini	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-
Protodrilus sp.	-	-	-	-	-	-	-	-	-	-	-	6	-	7	5	-	-	-	-	-	-	-	-	-
Pseudovermilia sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-
Sabellaria vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-
Scolelepis texana	-	-	9	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaerosyllis sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	8	-	5	-	-
Sphaerosyllis spp.	-	-	-	-	-	-	-	-	3	-	6	7	-	-	-	-	-	-	5	-	6	-	4	9
Spio pettiboneae	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spiophanes bombyx	-	-	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spirorbis sp.	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	3	-	-	-	-	-	-	-
Syllis (Haplosyllis) spongicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-
Tharyx marioni	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tharyx sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-
Tubificid sp. C	-	-	-	-	-	-	-	-	-	-	7	4	-	-	-	-	-	-	4	7	-	-	-	7
Tubificid sp. E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-
Tubificoides sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-
Vermiliopsis sp. A	4	-	-	-	-	-	-	-	5	-	-	10	-	-	-	-	-	-	6	5	-	-	6	-

TABLE C-5
(continued)
TEN TOP-RANKED[a] DOMINANT TAXA OF BENTHIC MACROINVERTEBRATES
FROM GRAB SAMPLES AT SIX OFFSHORE STATIONS
ST. LUCIE PLANT
1976 - 1979

	STATION AND YEAR																							
	0				1				2				3				4				5			
Taxa	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979
MOLLUSCA																								
Caecum cooperi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
C. strigosum	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crassinella duplinana	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-
C. lunulata	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
Crepidula fornicata	-	-	-	-	-	-	-	-	9	7	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Dentalium calanus	-	-	-	-	-	-	-	-	-	-	-	-	5	3	4	-	-	-	-	-	-	-	-	-
Glycymeris spectralis	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	4	-	-	-	-	-	-	-	-
Ischnochiton hartmeyeri	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I. papillosus	-	-	-	-	-	-	-	-	-	3	4	-	-	-	-	-	-	6	-	10	-	-	-	-
Macoma brevifrons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-
Oliva sayana	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Olivella floralia	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Semele nuculoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-
Tellina iris	-	-	2	-	4	2	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODA																								
Balanus trigonus	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-
B. venustus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
Cyclaspus pustula ?	-	9	-	-	-	6	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. varians	-	3	-	7	-	5	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-
Eurydice littoralis	-	-	-	-	7	-	-	-	-	-	-	-	8	8	7	-	-	-	-	-	-	-	-	-
Melita sp. A	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Microcerberus sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-
Oxyurostylis smithi	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudoplatyishnopus sp. A	-	6	3	6	5	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protohaustorius sp. A	-	-	-	-	-	-	-	-	-	-	-	-	7	6	-	-	-	-	-	-	-	-	-	-
Synchelidium americanum	-	7	4	-	-	9	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichophoxus sp. A	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	2	-	-	-	-	-	-	-	-
Trichophoxus sp. B	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIPUNCULIDA	5	-	8	-	2	4	-	3	2	1	1	1	-	-	-	-	2	1	1	1	3	6	5	3
PHORONIDA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-
ECHINODERMATA																								
Amphiodia pulchella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
Clypeasteroida	-	-	-	-	-	-	-	-	-	-	-	-	6	9	9	9	-	-	-	-	-	-	-	-
Mellitidae sp.	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiuroidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	8
CEPHALOCHORDATA																								
Branchiostoma caribaeum	-	-	-	-	6	-	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-

[a]Ranked according to McCloskey (1970) biological index values.

TABLE C-6

MANN-WHITNEY U-TEST COMPARISONS BETWEEN GRAB DATA
ST. LUCIE PLANT
1971 - 1973[a] AND 1977 - 1979

Parameter	Station 1	2	3	4	5
Lancelet density (no./m^2)	NS[b]	increase*	NS	NS	NS
Arthropod density (no./m^2)	increase*	increase*	NS	NS	increase*
Arthropod diversity ($\bar{d}$)	increase*	increase*	NS	increase*	NS
Echinoderm density (no./m^2)	NS	increase*	NS	NS	increase*

[a]Futch and Dwinell, 1977; Camp et al., 1977; Martin, in press.

[b]NS = Not significant.

*Significant at P = 0.05.

TABLE C-7

COMMERCIALLY IMPORTANT SPECIES OF MACROINVERTEBRATES
CAPTURED BY TRAWL COLLECTIONS
ST. LUCIE PLANT
1976 - 1979

Species	Year	Number captured	Station
Callinectes sapidus	1976	2	0,1
	1977	2	1
	1978	1	1
	1979	8	0,1,2
Menippe mercenaria	1976	1	0
	1977	0	-
	1978	0	-
	1979	0	-
Penaeus aztecus	1976	0	-
	1977	12	0,1,5
	1978	2	1
	1979	25	0,1,2,4,5
Penaeus brasiliensis	1976	3	0,5
	1977	2	0,2
	1978	2	1,5
	1979	3	1,2,5
Penaeus duorarum	1976	43	0,4,5
	1977	57	all
	1978	97	0,1,2,4,5
	1979	38	0,1,2,4,5
Penaeus sp.	1976	11	0,1
	1977	15	0,1
	1978	11	1,2,5
	1979	13	1,2,5
Sicyonia brevirostris	1976	21	0,2,3,5
	1977	35	0,2,3,4,5
	1978	67	all
	1979	5	2,5

TABLE C-8

FIVE TOP-RANKED[a] DOMINANT TAXA OF BENTHIC INVERTEBRATES
FROM TRAWL SAMPLES AT SIX OFFSHORE STATIONS
ST. LUCIE PLANT
1976-1979

Station	Species	1976	1977	1978	1979
0	Trachypenaeus constrictus	1	1	1	2
	Crepidula fornicata	2	-	-	-
	Mellita quinquiesperforata	3	2	-	-
	Anomia simplex	3	-	-	-
	Portunus spinimanus	4	-	-	-
	Trachypenaeus sp.[b]	-	3	2	1
	Turbo castanea	-	4	-	-
	Loligo plei	-	5	-	-
	Leptochela serratorbita	-	-	5	5
	Periclimenes longicaudatus	-	-	3	-
	Processa hemphilli	-	-	4	4
	Acetes americanus	-	-	-	3
1	Trachypenaeus constrictus	1	1	1	2
	Sicyonia dorsalis	2	-	-	-
	Leptochela serratorbita	3	4	4	5
	Mellita quinquiesperforata	4	-	-	-
	Squilla neglecta	5	-	-	-
	Periclimenes longicaudatus	-	2	3	-
	Loligo plei	-	3	-	-
	Trachypenaeus sp.[b]	-	5	2	1
	Portunus spinimanus	-	-	5	-
	Processa hemphilli	-	-	-	3
	Acetes americanus	-	-	-	4
2	Crepidula fornicata	1	3	-	-
	Trachypenaeus constrictus	2	2	1	1
	Anomia simplex	3	-	-	-
	Portunus spinimanus	4	5	3	4
	Processa hemphilli	5	-	5	-
	Periclimenes longicaudatus	-	1	2	4
	Loligo plei	-	4	-	-
	Trachypenaeus sp.[b]	-	-	4	2
	Portunus gibbesii	-	-	-	3
3	Trachypenaeus constrictus	1	1	1	1
	Trachypeneopsis mobilispinis	2	2	3	3
	Portunus anceps	3	-	-	-
	Leptochela serratorbita	4	4	-	-
	Encope michelini	5	-	-	-

TABLE C-8
(continued)
FIVE TOP-RANKED[a] DOMINANT TAXA OF BENTHIC INVERTEBRATES
FROM TRAWL SAMPLES AT SIX OFFSHORE STATIONS
ST. LUCIE PLANT
1976-1979

Station	Species	1976	1977	1978	1979
3 (cont'd)	*Periclimenes longicaudatus*	-	3	5	4
	Processa sp. A	-	5	2	5
	Mellita quinquiesperforata	-	-	4	-
	Trachypenaeus sp.[b]	-	-	-	2
4	*Mellita quinquiesperforata*	1	1	1	-
	Trachypenaeus constrictus	2	5	3	1
	Chaetopleura apiculata	3	-	-	-
	Portunus spinimanus	4	-	5	-
	Anomia simplex	5	-	-	-
	Periclimenes longicaudatus	-	2	2	4
	Turbo castanea	-	3	-	-
	Loligo plei	-	4	-	-
	Processa hemphilli	-	-	5	-
	Metapenaeopsis goodei	-	-	4	-
	Trachypenaeus sp.[b]	-	-	-	2
	Acetes americanus	-	-	-	3
	Portunus gibbesii	-	-	-	5
5	*Crepidula fornicata*	1	-	-	-
	Trachypenaeus constrictus	2	-	1	1
	Turbo castanea	3	2	-	-
	Anomia simplex	4	-	-	-
	Portunus spinimanus	5	-	3	-
	Lytechinus variegatus	-	1	2	3
	Chaetopleura apiculata	-	3	-	-
	Arbacia punctulata	-	4	-	-
	Chione grus	-	5	-	-
	Periclimenes longicaudatus	-	-	4	4
	Metapenaeopsis goodei	-	-	5	-
	Trachypenaeus sp.[b]	-	-	-	2
	Processa hemphilli	-	-	-	5

[a]Ranked according to McCloskey (1970) biological index values.

[b]*Trachypenaeus* sp. are probably juvenile specimens of *Trachypenaeus constrictus* but positive identification to species is not possible.

TABLE C-9

COMPARISON OF CRUSTACEANS AND ECHINODERMS COLLECTED BY OTHER TRAWLS DURING BASELINE[a] (1973-1974) AND FOLLOW-UP STUDIES (1976-1979)
STATION 1
ST. LUCIE PLANT

Arthropods	Baseline 1973-74	1976	1977	1978	1979
Total number of individuals	201	509	763	1377	2374
Total number of taxa	26	32	41	54	36
Number identified to species	17	26	34	42	24
Number shared with baseline	-	8	13	12	12
Echinoderms					
Total number of individuals	3	21	7	20	1
Total number of taxa	1	5	5	8	1
Number identified to species	1	5	5	7	1
Number shared with baseline	-	1	0	1	0

[a]Camp et al., 1977; Martin, in press.

AB-244

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ST. LUCIE PLANT

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BIOTIC MONITORING

TABLE OF CONTENTS

D. PHYTOPLANKTON

Environmental Technical Specification (3.1.B.b)

> Plankton - Plankton samples will be collected monthly. Both zooplankton and phytoplankton species will be identified as to kind and abundance. Chlorophyll "a" analysis will be performed as a measure of primary productivity.

INTRODUCTION

The purposes of the phytoplankton study at the St. Lucie Plant are 1) to monitor changes in phytoplankton density, relative abundance, pigment levels, and productivity and 2) to examine the relationships between these variables and power plant operation with regard to physical and chemical parameters.

Phytoplankton consists of the chlorophyll-bearing algae which drift passively or have limited means of locomotion and are, therefore, carried largely by waves and currents in aquatic environments. Phytoplankters, along with macrophytes which are important contributors only in shallow water (Reid, 1961), form the basis of the aquatic food chain using solar energy to convert inorganic nutrients into protoplasm by means of photosynthesis. Phytoplankters are consumed by zooplankters and other filter feeders which, in turn, provide food for larger carnivores. Thus, phytoplankton abundance and composition in aquatic ecosystems ultimately determine the quantity and quality of various larger organisms which depend on phytoplankters for food.

Physical and chemical factors which influence phytoplankton standing crop and productivity include water temperature, light, nutrient availability, salinity, and current. Because major groups of algae vary both in temperature tolerance ranges and in temperature ranges for optimum growth (Patrick, 1969), thermal additions from power plants may affect the composition as well as the density of entrained phytoplankton. Alterations of phytoplankton species composition, diversity, and population succession have been attributed to power plant thermal addition in various studies (Carpenter, 1973; Patrick, 1974; Briand, 1975). Extensive changes in phytoplankton composition may disrupt food chain relationships and affect the diversity and condition of consumer forms because various phytoplankton groups differ in their relative food value.

Investigators have found that adverse environmental factors in addition to increased water temperature create a combined impact on the phytoplankton community which may be greater than that of either parameter alone (Grayum, 1971; Fisher and Wurster, 1973; Griffiths, 1973; Thomas and Dodson, 1974; Fox and Moyer, 1975; Flemer and Sherk, 1977; Roberts, 1977). Even when water temperatures are not high enough to cause death, these synergistic effects may profoundly disturb phytoplankton productivity, species composition, and physiology; this may directly or indirectly lead to impact at higher trophic levels.

Recent studies have addressed the combined effects of thermal addition and chlorination on phytoplankton standing crop and productivity. Mixed phytoplankton cultures taken from the intake and discharge canals

of a coastal power plant indicated substantial growth recovery potential of entrained phytoplankton (Goldman and Quinby, 1979). In another coastal power plant study, however, phytoplankton nitrate reductase (enzyme) activity was depressed as a result of entrainment and showed no sign of recovery following a 24-hour incubation period (Peck and Warren, 1978). One hundred percent mortality of entrained phytoplankton was observed at total residual chlorine concentrations of greater than 1.0 part per million in a power plant study in Connecticut (Gentile et al., 1976). Variability among these results as well as among those previously cited show that power plant effects are difficult to generalize; they must be assessed on the basis of individual plant location and operational characteristics. Factors commonly associated with coastal power plants, which include the proportionately small percentage of available water entrained, complete dissipation of chlorine in seawater, and rapid return of cooling water to ambient temperature, minimize the impact of entrainment on phytoplankton (Goldman and Quinby, 1979).

MATERIALS AND METHODS

Phytoplankton Analysis

Monthly phytoplankton samples were collected from surface and bottom levels of the water column at six offshore stations (Stations 0 through 5) and in the intake canal (Station 11; Figure D-1). After November 1976, only the surface level was sampled in the discharge canal (Station 12). Replicate 1-l whole-water samples were collected at each station with a pump designed to minimize damage to the phytoplankters (Figure D-2). Each 1-l water sample was preserved in the field with 5 percent

buffered formalin and returned to the laboratory. The preserved samples were allowed to settle for a minimum period of 4 hours per centimeter of height of sample before concentration (EPA, 1973). Whole-water samples were used in conjunction with the sedimentation technique for qualitative analyses and quantitative estimates of standing crop.

Microscopic analysis was performed by the Utermohl (1958) technique with inverted compound microscopes equipped with calibrated ocular micrometers. Identifications and counts were made after the sample concentrates had settled a minimum of 4 hours in counting chambers. Through the use of random field counts, phytoplankton species were enumerated (Littleford et al., 1940; APHA, 1971; EPA, 1973) in two identically prepared counting chambers per replicate sample. A minimum of one-half the entire counting chamber was examined to enumerate large and relatively scarce phytoplankters. Statistical analyses (hierarchical design analysis of variance) were used to determine the examined volume of sample concentrate necessary to ensure 90 percent accuracy in counts at the 95 percent confidence interval.

All phytoplankters, except some green and blue-green algae, were counted individually. Filamentous green and blue-green algae were measured in 100μ standard lengths, with each length representing one counting unit. Colonial forms exclusive of diatoms were counted, with each colony representing one counting unit. An average number of individuals per colony was specified where possible. Cells per liter (N) were calculated by:

$$N = \frac{\frac{V_s}{V_c} C}{V_i}$$

where: C = Units counted;

V_s = Volume of sample concentrate, in milliliters;

V_c = Counted concentrate volume; determined by multiplying the aliquot volume, in milliliters, by the proportion of the counting chamber which was examined;

V_i = Initial sample volume, in liters.

As part of the ABI quality assurance program, a minimum of two individuals verified both qualitative analyses and counts for each group of monthly samples. Analysis of variance was used to determine significant differences between counts. If discrepancies were greater than 10 percent or if significant differences existed between operators at the 95-percent confidence level, counts were repeated. Qualitative verifications of new species were performed on each sample as new species were encountered. All samples were retained in the Applied Biology laboratory as permanent references.

Samples for water chemistry were collected and physical measurements and weather observations were made concurrently with phytoplankton collections at each station. These data, which are presented in Section G of this report, were examined as potential factors influencing phytoplankton populations.

Pigment Analysis

Replicate water samples for pigment determinations were collected monthly concurrently with phytoplankton samples. Samples were pumped from specified surface and bottom depths at each station, stored in 25-l polyethylene containers, and transported to the on-site laboratory as quickly as possible to minimize chlorophyll degradation.

Samples were processed according to the method of Strickland and Parsons (1972) and the recommendations of UNESCO (1966). Samples were filtered on the day of collection through Whatman GFC filters; these were folded in half with the filtered particulates on the inside, immediately frozen under darkened conditions, and shipped frozen in light-proof containers to the Atlanta laboratory for extraction and analysis.

Filters from replicate samples were extracted by grinding in a 90 percent aqueous solution of acetone. The volume of the extract was measured and extinction values were read with a spectrophotometer at a slit width of 1.0 nanometer (nm), using 1-cm cuvettes.

Chlorophyll-a, -b, and -c concentrations were determined from readings at 665, 645, and 630 nm, respectively. Carotenoid concentration was determined from extinction at 480 nm. The amount of nonactive chlorophyll-a, in terms of the quantity of phaeopigments present, was estimated from extinction at 665 nm 1 minute after acidification with 50-percent HCl. All extinctions were corrected by subtracting the turbidity reading at 750 nm. Excessive turbidity readings were reduced by

additional centrifugation. Results were obtained from the equations of Strickland and Parsons (1972), and chlorophyll and phaeopigment values were expressed in milligrams per cubic meter. Carotenoid values were expressed in millispecified pigment units per cubic meter (m-SPU/m^3).

Statistical Procedures

For statistical analysis, phytoplankton density data were transformed to $\log_n$ (density/liter + 1) to reduce the effect of non-homogeneous variation and skewness in density data, and geometrical means were calculated. The single discharge canal value was compared to the average of surface and bottom intake canal values. The Statistical Analysis System (SAS; Barr et al., 1976) was used in all analyses. The General Linear Models (GLM) Procedure, which provides the regression approach to analysis of variance, was the method used to examine interstation and annual variation in phytoplankton density and various pigments for 1979 and for monitoring data over all 4 years. Examples of individual variables, class variables, and models used are shown in Table D-1. Duncan's multiple range tests were used to determine which means were significantly different. The relationships between phytoplankton parameters (density and pigments) and selected physical and chemical variables were examined through simple correlations utilizing the Correlation (CORR) Procedure and stepwise regression utilizing the maximum R^2 technique. To eliminate seasonality from the data, variables were either sine or cosine adjusted. The residual variation in each variable, after seasonal variation had been removed, was then used in regression analyses. The 0.05 level of significance was employed in all statistical comparisons, unless otherwise noted.

December 1979 phytoplankton abundance, percentage composition, and pigment data were included in this report; however, because of the length of time between phytoplankton sample collection and completion of species analysis, statistical treatments did not include this last month's data. December data will be statistically analyzed in the 1980 Annual Non-Radiological Environmental Monitoring Report.

RESULTS AND DISCUSSION

Phytoplankton Density

Total phytoplankton densities in 1979 ranged from 38,512 x 10^3 cells per liter to 265 x 10^3 cells per liter at offshore Stations 0 through 5 and from 30,199 x 10^3 to 809 x 10^3 cells per liter at Stations 11 and 12, (the intake and discharge canals, respectively; Tables D-2 through D-13). Densities in the intake and discharge canals and at Station 1 were generally higher than at offshore Stations 0 and 2 through 5 in 1979 and in all previous monitoring studies (Figures D-3 through D-5). Densities at Station 0 in 1979 and 1978 were also frequently higher than at Stations 2 through 5. Lowest densities occurred most often at Station 3 as in all previous years. Contrary to the results of previous studies, densities at offshore bottom stations were not consistently higher than corresponding surface densities in 1979. Higher surface densities, higher bottom densities, and nearly equal surface and bottom densities occurred with similar frequency.

Annual mean phytoplankton densities both in the intake and discharge canals and at offshore stations were generally similar in 1979 and 1976

and were higher than in 1977 and 1978 (Figures D-3 through D-5). Annual variation in mean densities was similar at all stations. A bimodal pattern of seasonal variation in total phytoplankton density resulted from spring maxima, summer reductions, and secondary autumn increases at the offshore stations (Figure D-6) and in the intake and discharge canals in 1976, 1978, and 1979, whereas a unimodal pattern was observed in 1977. The variation in mean densities and seasonal abundance was typical of natural variation observed in the St. Lucie area (Youngbluth et al., 1976) and did not provide evidence of St. Lucie Plant impact.

Phytoplankton Community Composition

In 1979, diatoms were the most abundant phytoplankton group at all stations. Diatoms are the dominant phytoplankters in East Coast neritic waters (Smayda, 1957; Patten et al. 1963; Carpenter, 1971; Mulford and Norcross, 1971; Marshall, 1976). Diatom relative abundance ranged from 7 to 95 percent, (Tables D-2 through D-13) and diatoms were dominant on most sampling dates (Figures D-7 through D-17).

The relative abundance of unidentified phytoflagellates ranged from 4 to 57 percent. This group sometimes achieves secondary importance (Smayda, 1957; Youngbluth et al., 1976) and was occasionally dominant or codominant with diatoms in 1979.

Phytoplankton composition was similar in 1977, 1978, and 1979 and in each of these years, representation of non-diatom groups was greater than in 1976. As in previous studies, variation in offshore phytoplankton

composition during 1979 was seasonally influenced and did not reflect plant impact.

Seasonal Occurrence of Species

The seasonal composition of dominant phytoplankton species in 1979 was similar to that in previous years (Table D-14). Skeletonema costatum and Nitzschia delicatissima continued to be the most abundant phytoplankters. Seasonal variations in the abundance of dominant phytoplankton species were either bimodal or unimodal. Many of these species were present in low density or were not observed during the warmer months (June through September), or during the cooler months (December through February). The only consistent long-term seasonal patterns were the exclusion of species from certain seasons; Asterionella japonica never occurred as a dominant in summer or autumn, and Nitzschia closterium, Prasinophyte sp. 1, Thalassionema nitzschioides, and Tropidoneis lepidoptera were excluded as major species from either or both of the spring and summer periods. Numbers of dominant species and variation in the seasonal occurrence of dominant species has remained similar during all operational monitoring. This similarity indicated that neither major shifts in species composition nor alteration of natural, annual succession has resulted from St. Lucie Plant cooling water discharge.

Statistical Evaluation of Offshore Phytoplankton Data

As in previous years, both surface and bottom annual mean phytoplankton densities at Station 1 were higher than at all other offshore stations (Figures D-4 and D-5). Surface densities at Stations 0 and 1

were significantly higher than those at other offshore stations (Table D-15). At the bottom, densities at Station 1 were significantly higher than at Stations 2, 3, and 4 and densities at Station 0 were significantly higher than at Stations 3 and 4 (Table D-16). In general, increased densities of various taxa contributed proportionately to the increased density at Station 1 and no qualitative shift in phytoplankton composition was attributable to plant operation.

The persistence of significantly higher densities on the surface and bottom at Station 1 in 1978 and 1979 and over 4 years of pooled data cannot be adequately explained by natural variation alone (Tables D-17 and D-18). Although the occasional occurrence of significantly higher densities at Station 0 may indicate a natural influence of nearshore proximity on phytoplankton density, the consistently higher annual mean densities observed at Station 1 indicate enhanced phytoplankton densities in the immediate area of the offshore discharge.

The means of offshore surface and bottom phytoplankton densities in 1979 were not significantly different from those in 1976 (Tables D-17 and D-18). In the 1978 annual report (ABI, 1979), plant effects were considered to be a possible factor in the significant reduction of 1977 and 1978 annual phytoplankton densities at surface and bottom below the respective 1976 densities. However, the similarity of 1979 and 1976 annual means indicated that those differences were within a range of natural variation and that widespread plant impact has not occurred offshore during the 4 years of monitoring.

At offshore surface stations, total phytoplankton density for 1979 showed a significant negative correlation with temperature and a significant positive correlation with dissolved oxygen (Table D-19). At the bottom, there were significant negative correlations with several variables (Table D-20). Multiple regression of phytoplankton densities with temperature and ammonia at the surface and with temperature, ammonia, and phosphate at the bottom, accounted for 22 and 34 percent, respectively, of the residual variation in phytoplankton density after seasonal adjustment (Table D-21). As in previous studies, temperature was the most important single variable which influenced offshore phytoplankton density.

Entrainment and Temperature Relationships

Total phytoplankton densities in the intake canal (Station 11) ranged from 638 x 10^3 to 24,435 x 10^3 cells per liter and, in the discharge canal (Station 12) from 500 x 10^3 to 18,683 x10^3 cells per liter. Values of ΔT (change in measured water temperature between intake and discharge canals) ranged from 0.8°C to 13.5°C (Table D-22).

Reductions in total phytoplankton density between the intake and discharge canals occurred on all but three sampling dates in 1979. As in previous studies, there was no consistent relationship between percentage change in phytoplankton density and ΔT. Pressure changes, acceleration, shear, abrasion, and chlorination have been well documented as factors other than temperature which can contribute to power plant impact from entrainment (Marcy et al., 1978; Morgan and Carpenter, 1978). All or any

combination of these factors may interact with temperature increment in determining net entrainment effects. Also, environmental differences between the canals may result in differential phytoplankton growth during periods of reduced circulation.

Since the beginning of sustained St. Lucie Plant operation in December 1976, phytoplankton densities have been reduced between the intake and the discharge canal on 86 percent of all sampling dates. However, as observed in 1978, the much lower incidence of density reductions between the discharge canal and Station 1 (37 percent), and the persistence of higher densities at Station 1 than at other offshore stations indicated no chronic density decreases offshore due to plant operation.

Statistical Evaluation of Canal Phytoplankton Data

Phytoplankton density in the discharge canal (Station 12) was not significantly lower than in the intake canal (Station 11) in 1979 (Table D-23). However, over the 4 years of pooled monitoring data, densities in the discharge canal were significantly lower (α=0.1; Table D-24). Trends of reduced density between the intake and discharge canals were observed for certain major phytoplankton groups in 1979, but these differences were generally not statistically significant. Correlation of phytoplankton density in the canals with physicochemical parameters showed a significant negative correlation with temperature and significant positive correlations with dissolved oxygen and ammonia (Table D-25). The negative correlation of density with temperature may have

reflected adverse plant impact due to thermal addition in the discharge canal.

Seasonally Recurrent Density Changes and Plant Effect

As in previous studies, several major phytoplankton groups exhibited seasonal trends of density increase or decrease between the intake and discharge canals, and between the discharge canal and Station 1. These trends were considered to reflect variable plant effect on phytoplankton composition and abundance in response to seasonal factors such as changing ambient water temperature and natural species succession. Over the 4 years of operational monitoring, diatom densities were generally reduced between the intake (Station 11) and discharge (Station 12) canals (Figure D-18). These reductions were most consistently observed during spring (March, April, and May). Seasonal trends of reduced densities between the intake and discharge canals were also apparent for prasinophytes during the autumn (September, October, and November); for dinoflagellates during the winter (December, January, and February); for unidentified phytoflagellates during the summer (June, July, and August) and winter; and for cryptophytes in all seasons, except spring (Figures D-18 and D-19). No trends in cryptophyte density changes between the discharge canal and Station 1 were apparent, while the most consistent seasonal trends for diatoms and prasinophytes were increased densities during the autumn. Prasinophyte densities also increased between the discharge canal and Station 1 in summer.

During some months, entrainment losses in major groups, including unidentified phytoflagellates, cryptophytes, dinoflagellates, and prasinophytes, caused an increase in diatom relative abundance. However, this change in the discharge canal phytoplankton composition was not reflected at Station 1 where composition was generally within the variability observed at other offshore surface stations.

Pigment Analysis and Primary Productivity

Because chlorophyll-a is the primary photosynthetic pigment found in all phytoplankton species, it is widely used as an index of phytoplankton standing crop. In the St. Lucie area, chlorophyll-a provides a very good estimate of standing crop, because this pigment has generally exhibited a significant positive correlation with phytoplankton density during all 4 years of operational monitoring.

Distribution of Offshore Chlorophyll-a

During 1979, chlorophyll-a at offshore surface stations ranged from 0.24 to 8.03 mg/m^3 and bottom chlorophyll-a values ranged from 0.35 to 13.55 mg/m^3 (Table D-26). Surface chlorophyll-a values continued to be slightly lower than bottom values as observed in all prior monitoring (ABI, 1977, 1978, 1979; Worth and Hollinger, 1977; Figure D-20). Offshore chlorophyll-a levels in 1979 were within the range of annual means observed during previous operational monitoring. As with phytoplankton density, chlorophyll-a levels in 1979 were more similar to 1976 levels than to those observed in 1977 and 1978 (Tables D-27 and D-28).

The bimodal seasonal pattern in chlorophyll-a corresponded to that observed for phytoplankton during 1979. Chlorophyll-a levels in the spring (March, April and May) decreased in the summer months and increased again from August through November (Figure D-20). At both surface and bottom stations during 1979, chlorophyll-a maxima occurred in November at Stations 0 and 1 and during the spring at Stations 2 through 5. Higher chlorophyll-a levels in the late autumn months have been observed during all previous monitoring.

Relationship Between Offshore Chlorophyll-a Levels and Physicochemical Parameters

Chlorophyll-a levels exhibited significant correlations with temperature, salinity, phosphate, and nitrite at offshore stations although the correlation coefficients were not high (Tables D-19 and D-20). The trend of decreasing chlorophyll-a with increasing water temperature was strongest in the spring and autumn and probably reflected the seasonality in chlorophyll-a distribution rather than plant effect. For the variables examined, the best surface and bottom regression models accounted for 30 and 27 percent, respectively, of the residual variation in chlorophyll-a after seasonal adjustment. No single independent variable was important in both models of residual variation (Table D-29). The relationships between chlorophyll-a and physicochemical parameters observed at offshore stations were not indicative of adverse plant impact.

Interstation Comparisons of Offshore Chlorophyll-a Levels

Chlorophyll-*a* at Station 1 remained consistently, although not significantly, higher than that observed at other offshore stations (Tables D-30 and D-31). Pooled data from all 4 years of operational monitoring exhibited significantly higher chlorophyll-*a* levels at Station 1 than at Stations 3 and 4 at the surface and significantly higher chlorophyll-*a* at Stations 0 and 1 than at Station 3 at the bottom (Tables D-27 and D-28). Results of the 1978 monitoring study suggested that chlorophyll-*a* levels at Station 1 were becoming more similar to those generally observed at other offshore stations and the inclusion of the 1979 data support this trend, although standing crop at Station 1 continues to be higher.

Seasonal and Interstation Distribution of Chlorophyll-a in the Canals

In 1979, chlorophyll-*a* levels continued to be higher in the canals than offshore and higher in the intake canal than in the discharge canal (Figure D-21; Table D-26). Seasonal and annual trends in chlorophyll-*a* levels in the canals continued to correspond to those observed at offshore stations. Although not significant in 1979, comparison of pooled data indicated significantly lower (α=0.1) chlorophyll-*a* in the discharge canal (Tables D-32 and D-33). There was also a significant negative correlation between chlorophyll-*a* and temperature in the canals. Seasonally, this relationship was strongest during the summer months. As observed for phytoplankton density, reduced standing crop in the discharge canal indicated adverse impact due to plant entrainment. Even with this reduction, however, chlorophyll-*a* levels in the discharge canal

continued to be higher than the levels observed offshore, and water high in chlorophyll-a continues to be discharged at Station 1.

Offshore Phaeopigment Levels

Phaeopigment levels continued to be higher on the bottom than at the surface for offshore stations (Figure D-22). Phaeopigments result from the breakdown of chlorophyll, thus higher concentrations with increasing depth is an expected occurrence because dying or dead phytoplankters more readily sink out of the water column. There were no significant interstation differences in offshore phaeopigment levels in 1979 (Tables D-34 and D-35). Over all years of operational monitoring, surface phaeopigment levels at Station 1 were significantly higher than at Stations 2 and 5 (Tables D-36 and D-37). Higher phaeopigment levels in the immediate area of the offshore discharge may result from a limited plant operational effect and could be derived from several sources or a combination of sources, that is, 1) discharge of water high in phaeopigments; 2) normal breakdown of the large phytoplankton standing crop at Station 1; 3) thermal death of certain phytoplankton taxa resulting in subsequent chlorophyll degradation; or 4) increased feeding by herbivores because of the large standing crop in the area.

Annual offshore phaeopigment levels did not continue to decrease in 1979 as they had from 1976 through 1978. Changes in observed phaeopigment levels continued to generally correspond to changes in chlorophyll-a concentration. After seasonal adjustment, the best regression model accounted for only 8 percent of the residual variation

in surface phaeopigment (Table D-38). Seasonal adjustment did not significantly improve the regression model for bottom phaeopigment and the variables examined accounted for less than 24 percent of the total variation at this depth.

Phaeopigment Levels in the Canals

There were no significant differences in phaeopigment levels between the canals (Tables D-39 and D-40). Phaeopigment levels in the intake canal continued to be higher than in the discharge canal during 1979 and did not correspond to the finding of reduced phytoplankton density and chlorophyll-a between the intake and discharge canals.

Gross Primary Productivity

Gross primary productivity was calculated from active chlorophyll-a and light data, using the total curve of Ryther and Yentsch (1957) for photosynthetic rate with an assimilation rate of 3.7 grams of carbon per hour per gram (g C/hr/g) of chlorophyll. The bimodal seasonal pattern in productivity during 1979 generally corresponded to that observed for chlorophyll-a (Figure D-23). Productivity ranged from 0.09 to 1.91 grams of carbon per square meter per day (g $C/m^2/day$) with values lowest in the summer (June, July, and August) and highest in March (April 6 sampling date; Table D-41). There were no significant differences in productivity between offshore stations (Table D-42).

Comparisons Between Baseline and Operational Monitoring Data

Baseline collections were bi-monthly during the first 12-month period (September 1971 through August 1972) and monthly during the second "period" (September 1972 through August 1973). The complete year of monthly baseline chlorophyll-a data, (Walker and Steidinger, 1979) designated 1973 in statistical tables, was pooled with the monthly operational data for statistical comparison.

The annual variability in chlorophyll-a at offshore stations was generally comparable between baseline and operational monitoring (Figure D-20). The trend of higher surface chlorophyll-a at Station 1 during operational monitoring was also observed in baseline data and mean chlorophyll-a was significantly higher at Station 1 than at Stations 2 through 5 (Table D-43). For bottom stations, the inclusion of baseline data with operational data resulted in significant differences similar to those obtained for operational data alone (Table D-44). The comparison of baseline and operational data indicated that long-term or widespread impact on offshore standing crop has not resulted from plant operation.

SUMMARY

Seasonal variation of total phytoplankton densities and chlorophyll-a was bimodal in 1979, as in 1976 and 1978. The similarity of the 1976 and 1979 annual mean densities and chlorophyll-a both offshore and in the canals indicated that no long-term change in phytoplankton abundance has resulted from St. Lucie Plant operation. As in previous studies, phytoplankton densities and chlorophyll-a levels were higher in

the intake and discharge canals and offshore at Stations 0 and 1 (Figure D-1). The significantly higher phytoplankton standing crop at Station 1 as compared to other offshore stations was attributable partly to plant effect. However, natural causes were also a factor as reflected in elevated phytoplankton densities at Station 0, the control station.

Phytoplankton composition in 1979 was generally similar to that observed in 1977 and 1978 with diatoms being the dominant taxonomic group. Non-diatom species were relatively more abundant in each of these three years than in 1976. The diatoms _Skeletonema_ _costatum_ and _Nitzschia delicatissima_ were the most abundant species, as in previous studies. The composition and seasonal distribution of major phytoplankton species did not show changes between years which could be attributed to plant impact. Although higher densities of some taxonomic groups occurred at Station 1, phytoplankton composition at this station remained within the range of natural variation observed between other offshore stations.

The reduction in phytoplankton density between the intake and discharge canals during 1979 was a direct result of entrainment. Factors other than just temperature increases apparently caused this reduction because there was no consistent relationship between percentage change in phytoplankton density and ΔT. Chlorophyll-_a_ reductions were also observed between the intake and discharge canals; however, levels in the discharge canal continued to be higher than those offshore and water high in chlorophyll-_a_ continues to be discharged at Station 1.

Seasonal reductions of unidentified phytoflagellates, cryptophytes, and prasinophytes between the intake and discharge canals contributed to greater diatom dominance in the discharge canal. No shift in composition was observed at Station 1 as compared to the other offshore stations, although apparent plant-related elevation of diatom and prasinophyte densities between the discharge canal and Station 1 contributed to over-all density increases at this station.

Currently available data suggest that the increased phytoplankton density and chlorophyll-a concentration at Station 1 are attributable to power plant operation. However, plant effects on standing crop continue to be limited to the discharge canal and to Station 1. There were no significant interstation differences in primary productivity offshore and comparison of baseline and operational data indicated that long-term or widespread impact on offshore standing crop has not resulted from St. Lucie Plant operation.

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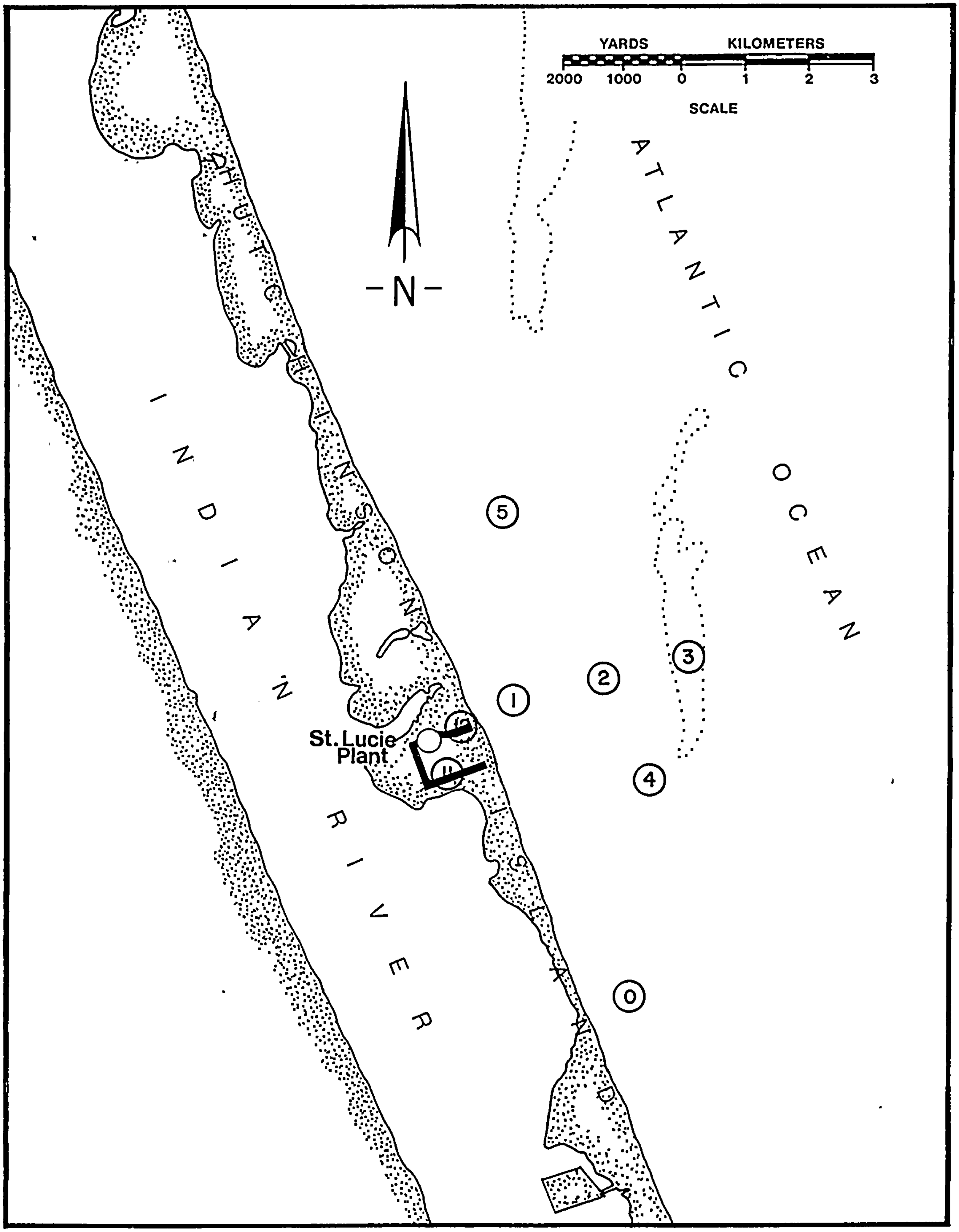


Figure D-1. Locations of phytoplankton sampling stations, 1979.

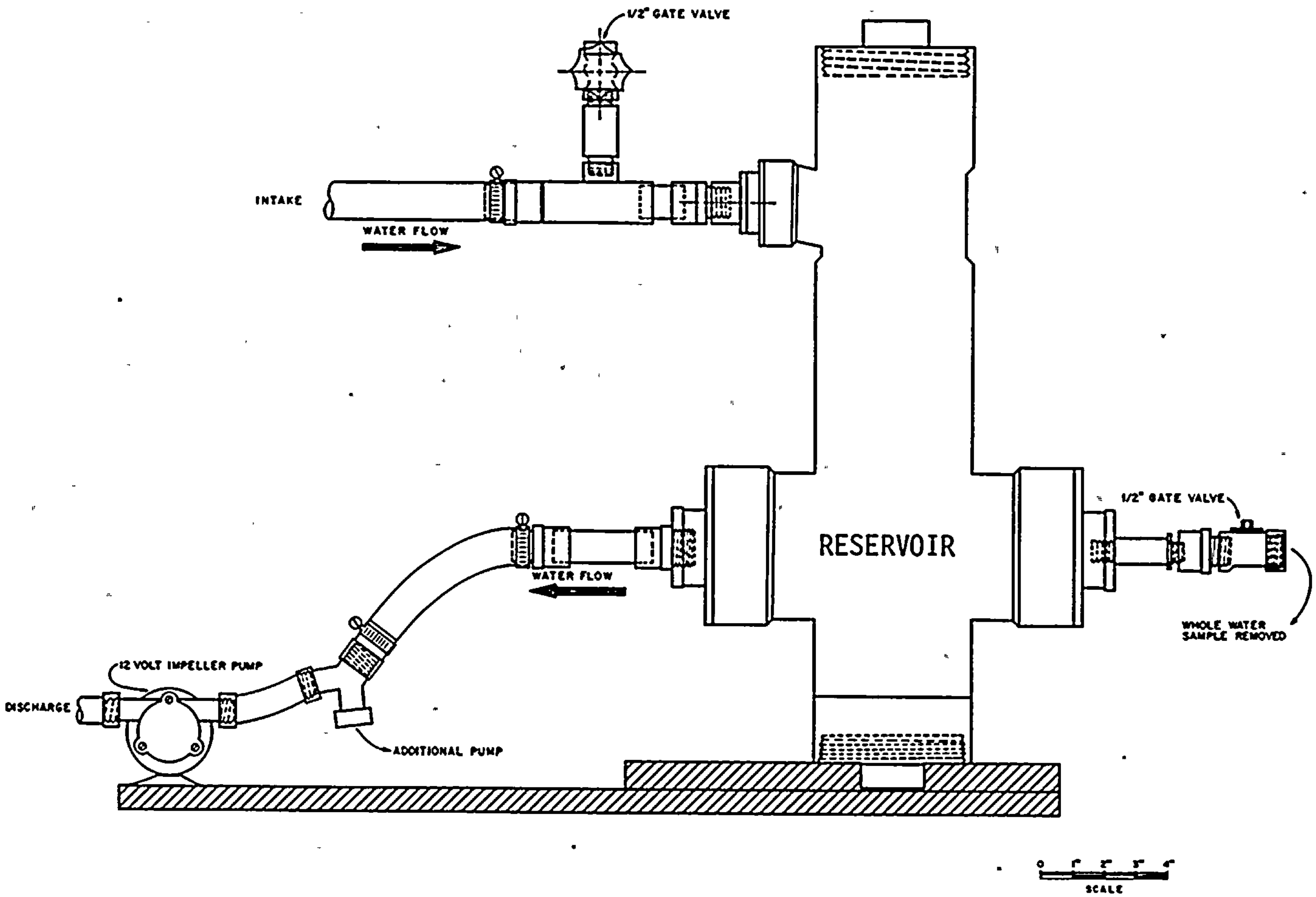


Figure D-2. Pump design for whole water sample collections, St. Lucie Plant.

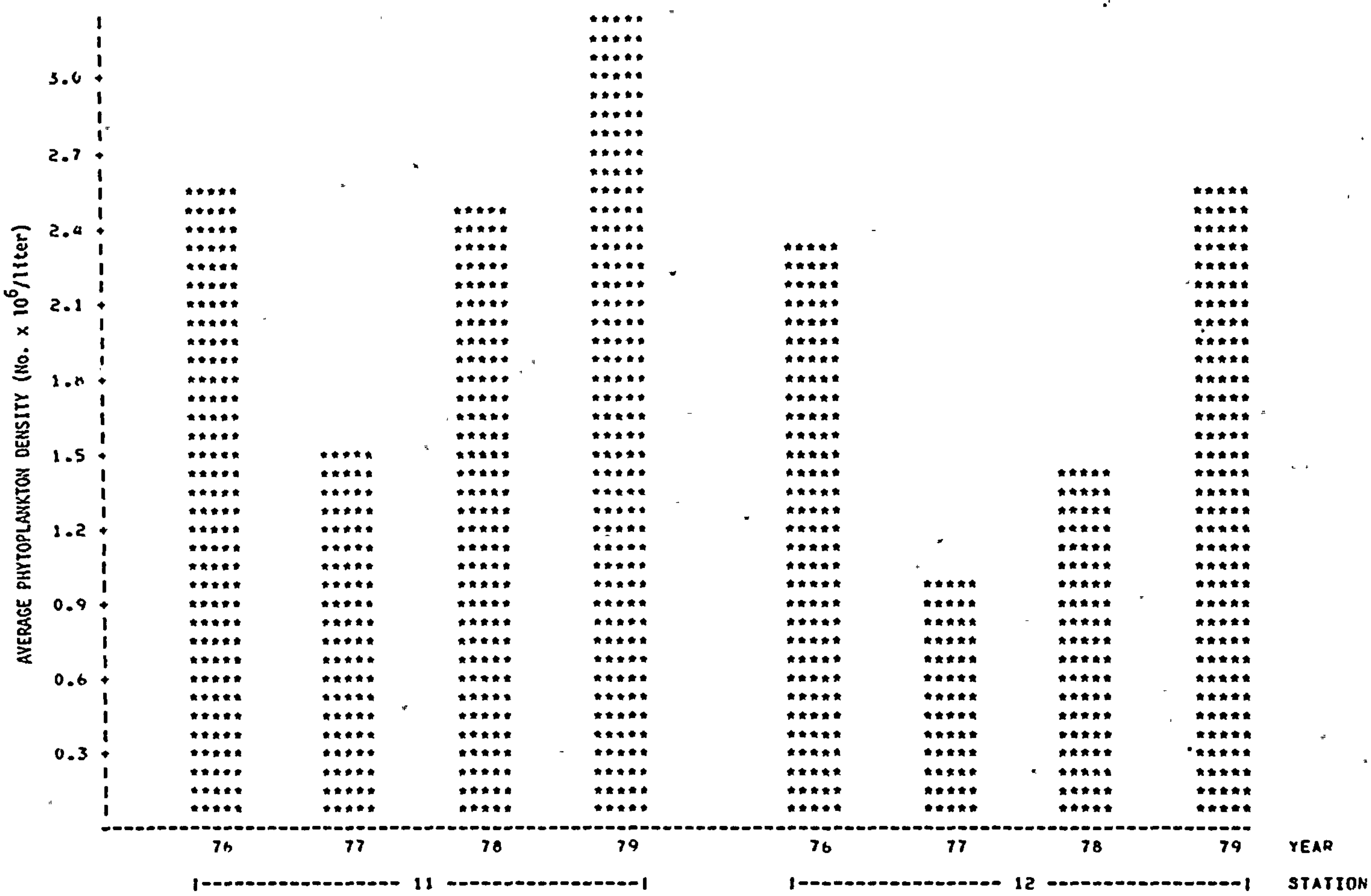


Figure D-3. Comparison of annual mean density of phytoplankton at the intake (Station 11) and the discharge (Station 12) canal, St. Lucie Plant, March 1976-October 1979.

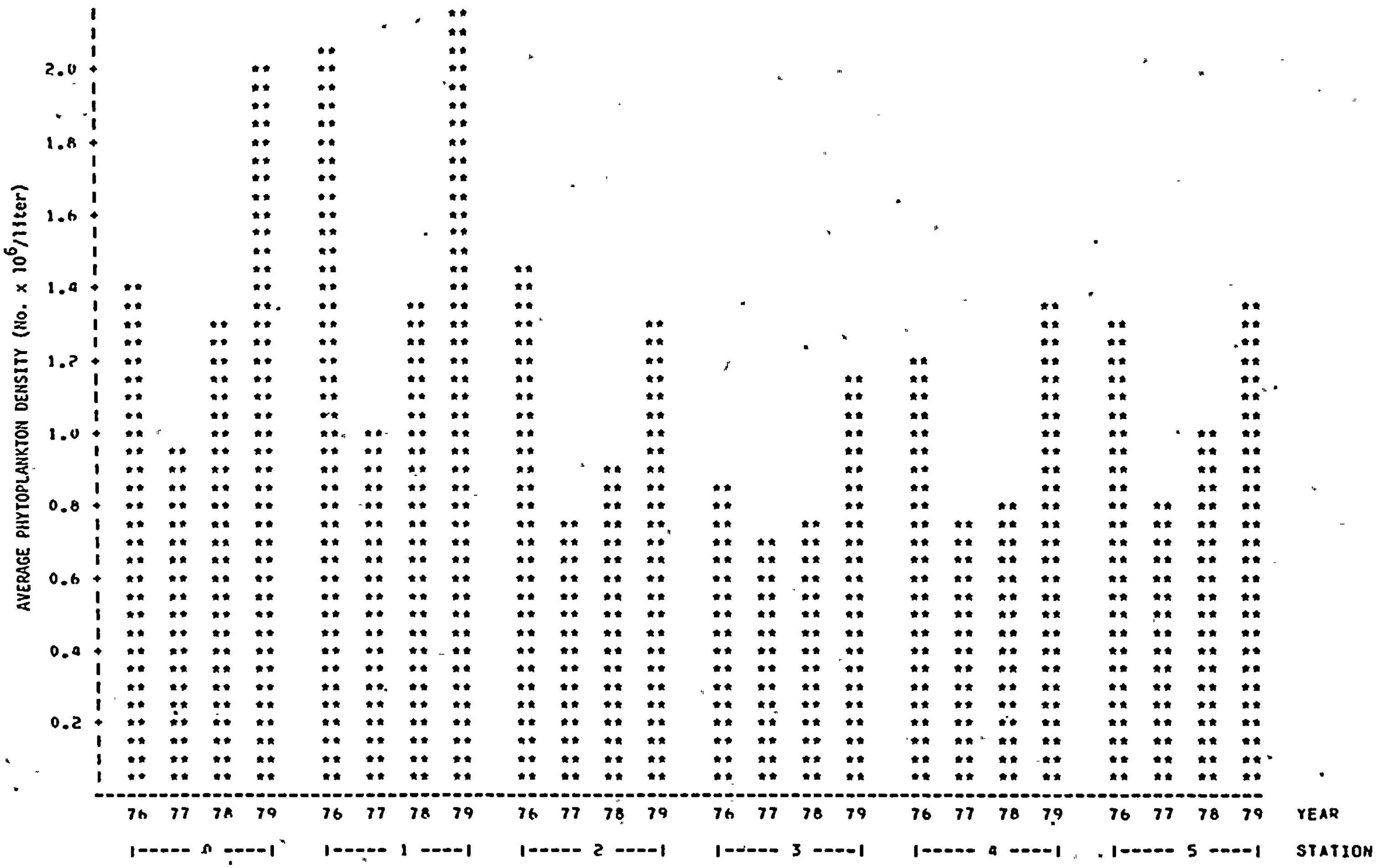


Figure D-4. Comparison of annual mean density of phytoplankton at the surface at Stations 0 through 5, St. Lucie Plant, March 1976-October 1979.

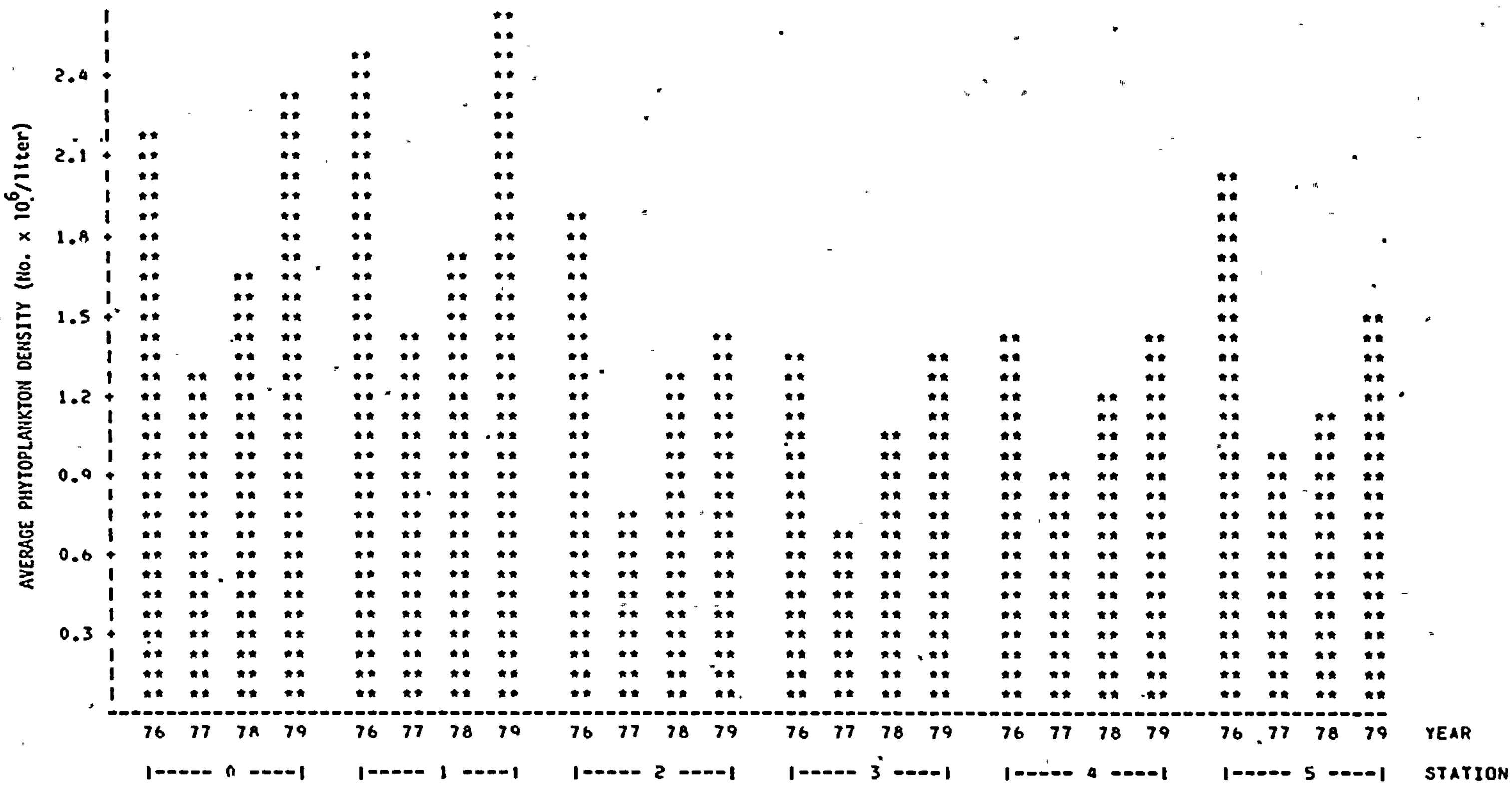


Figure D-5. Comparison of annual mean density of phytoplankton at the bottom at Stations 0 through 5, St. Lucie Plant, March 1976-October 1979.

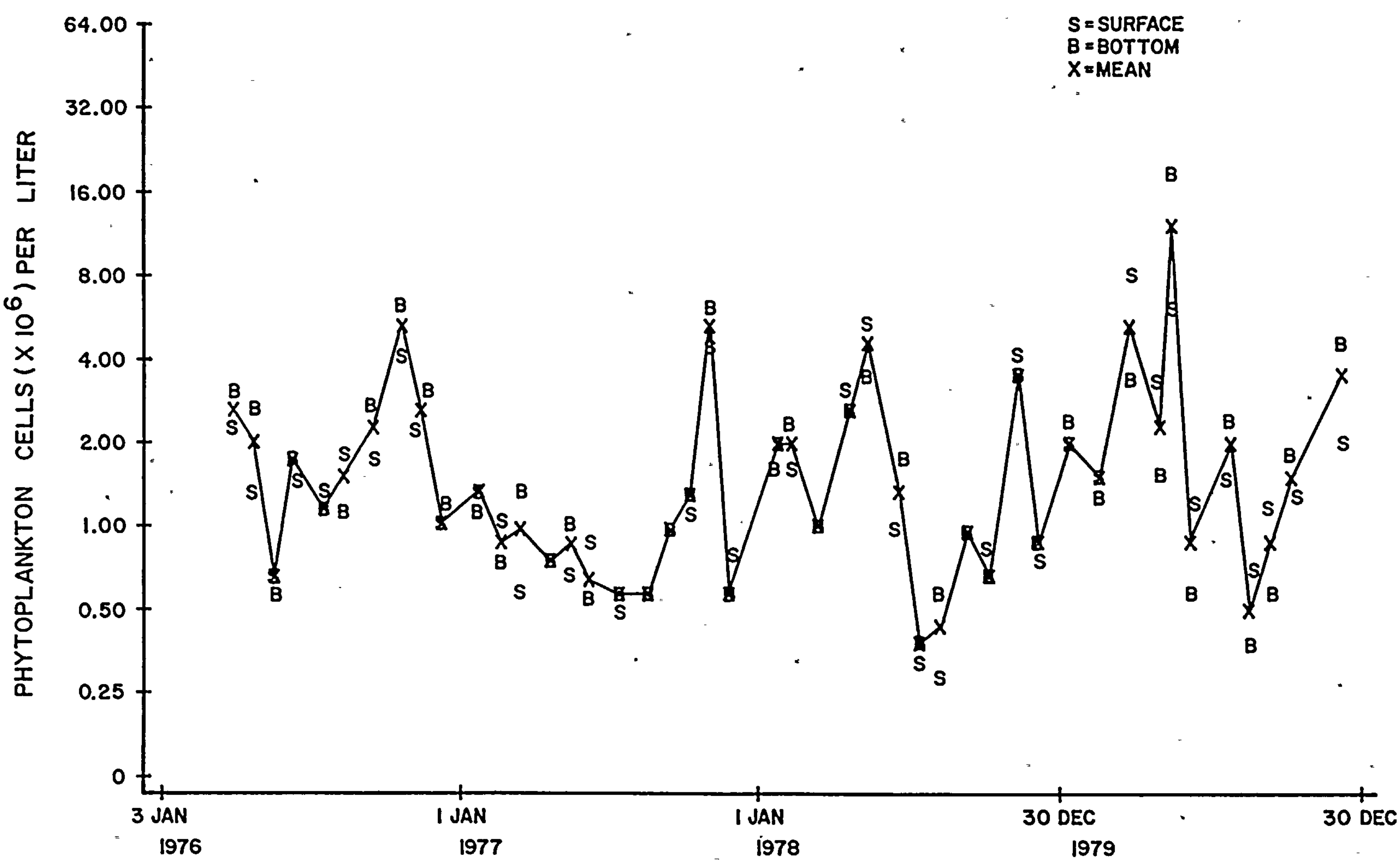
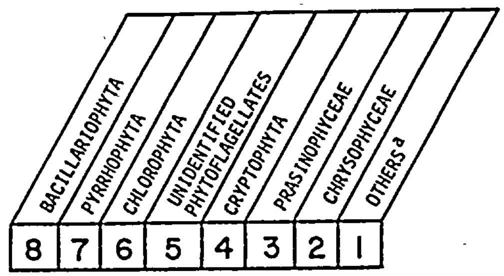


Figure D-6. The mean of the average monthly surface and bottom phytoplankton densities at Stations 0 through 5, St. Lucie Plant, March 1976 - October 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

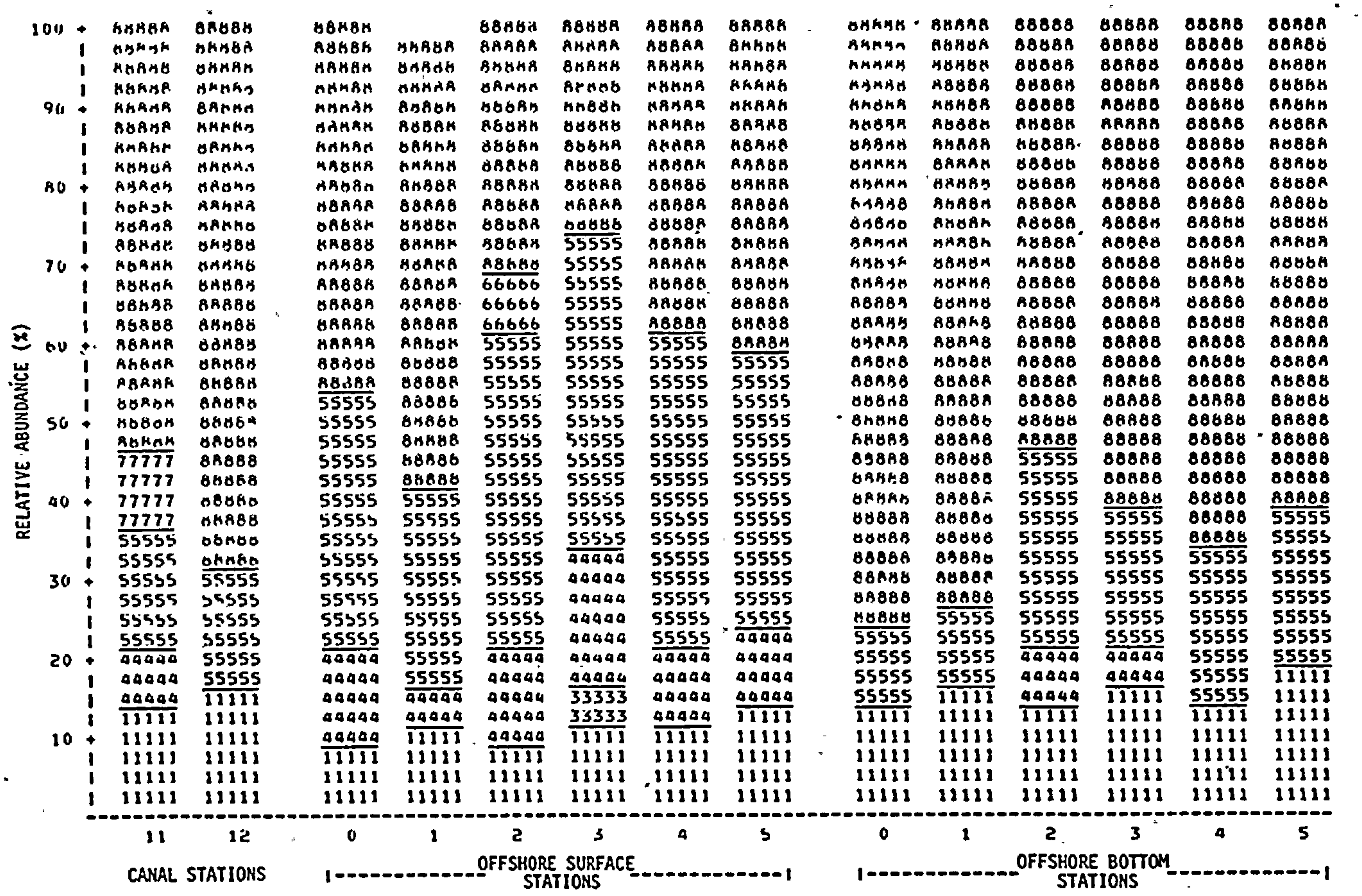
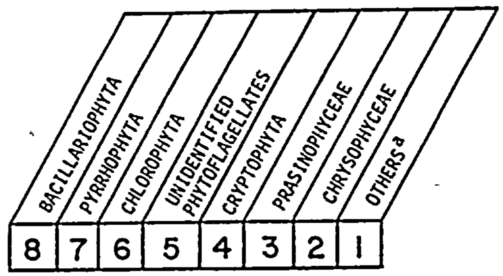


Figure D-7. Phytoplankton percentage composition, St. Lucie Plant, 17 January 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

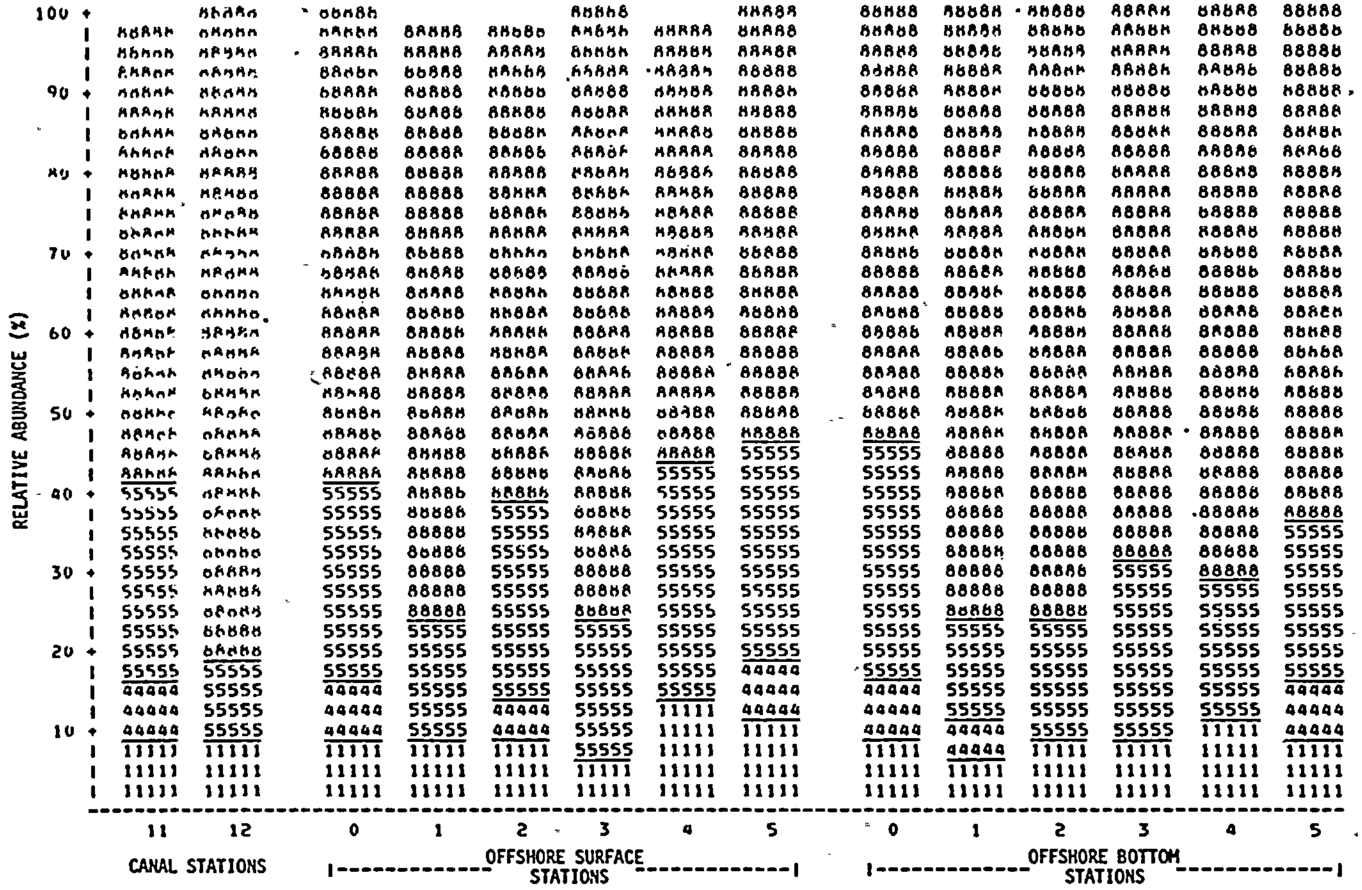
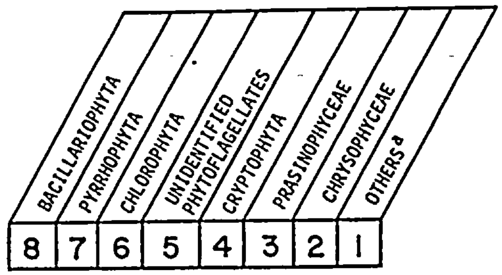


Figure D-8. Phytoplankton percentage composition, St. Lucie Plant, 13 February 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

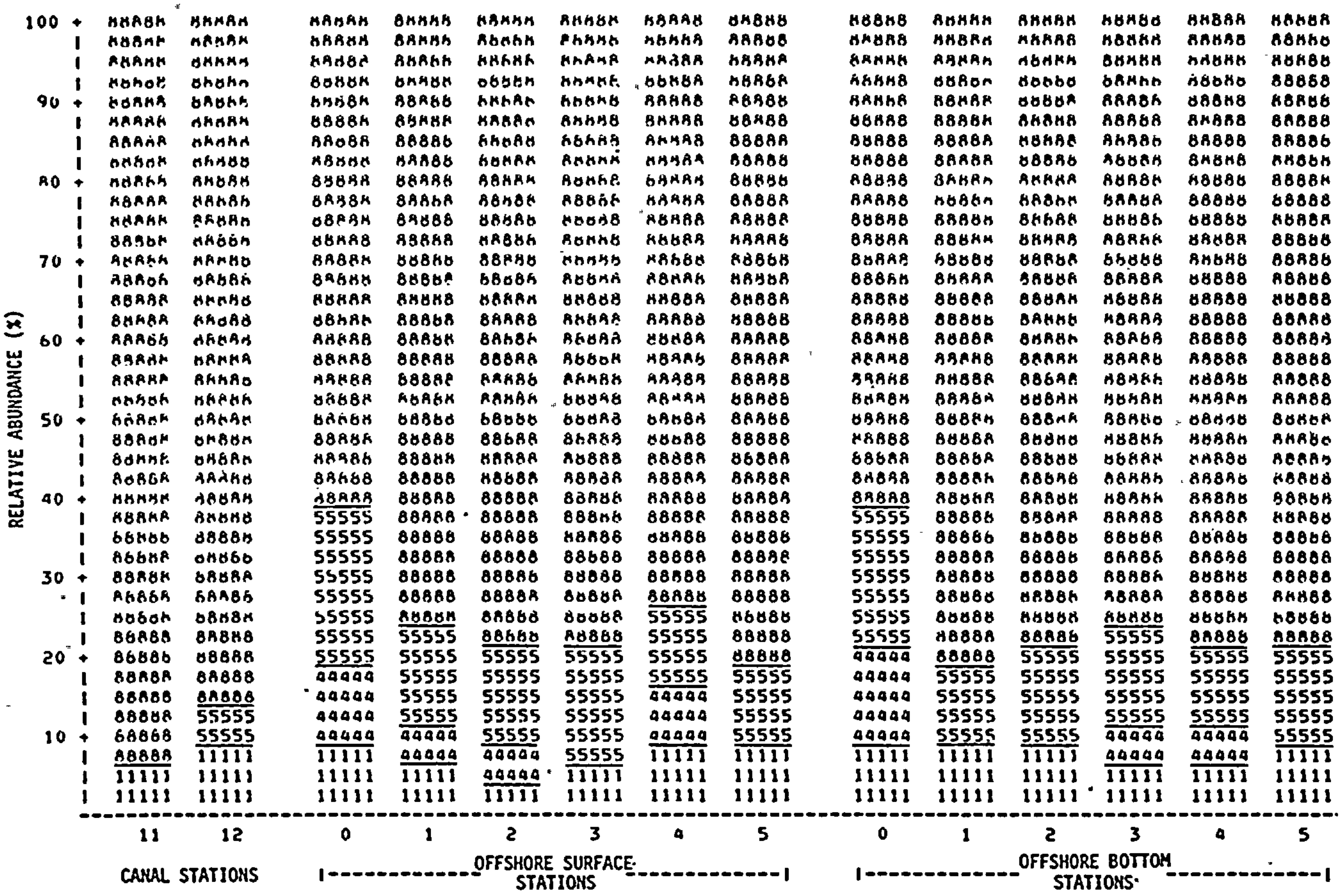
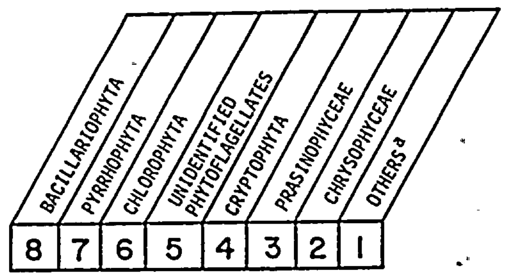


Figure D-9. Phytoplankton percentage composition, St. Lucie Plant, 6 April 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

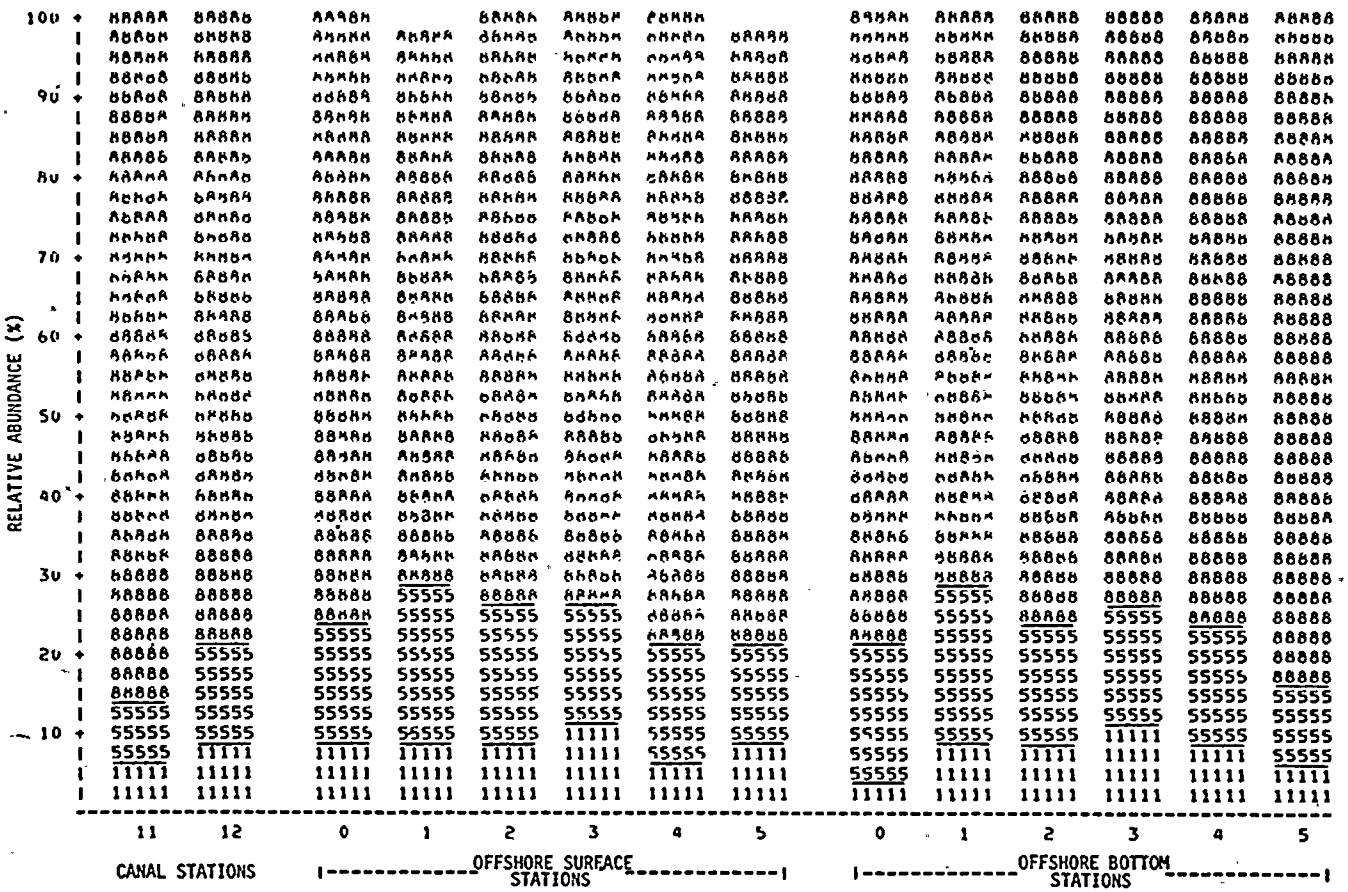
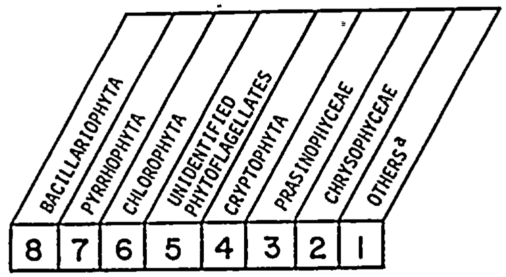


Figure D-10. Phytoplankton percentage composition, St. Lucie Plant, 27 April 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

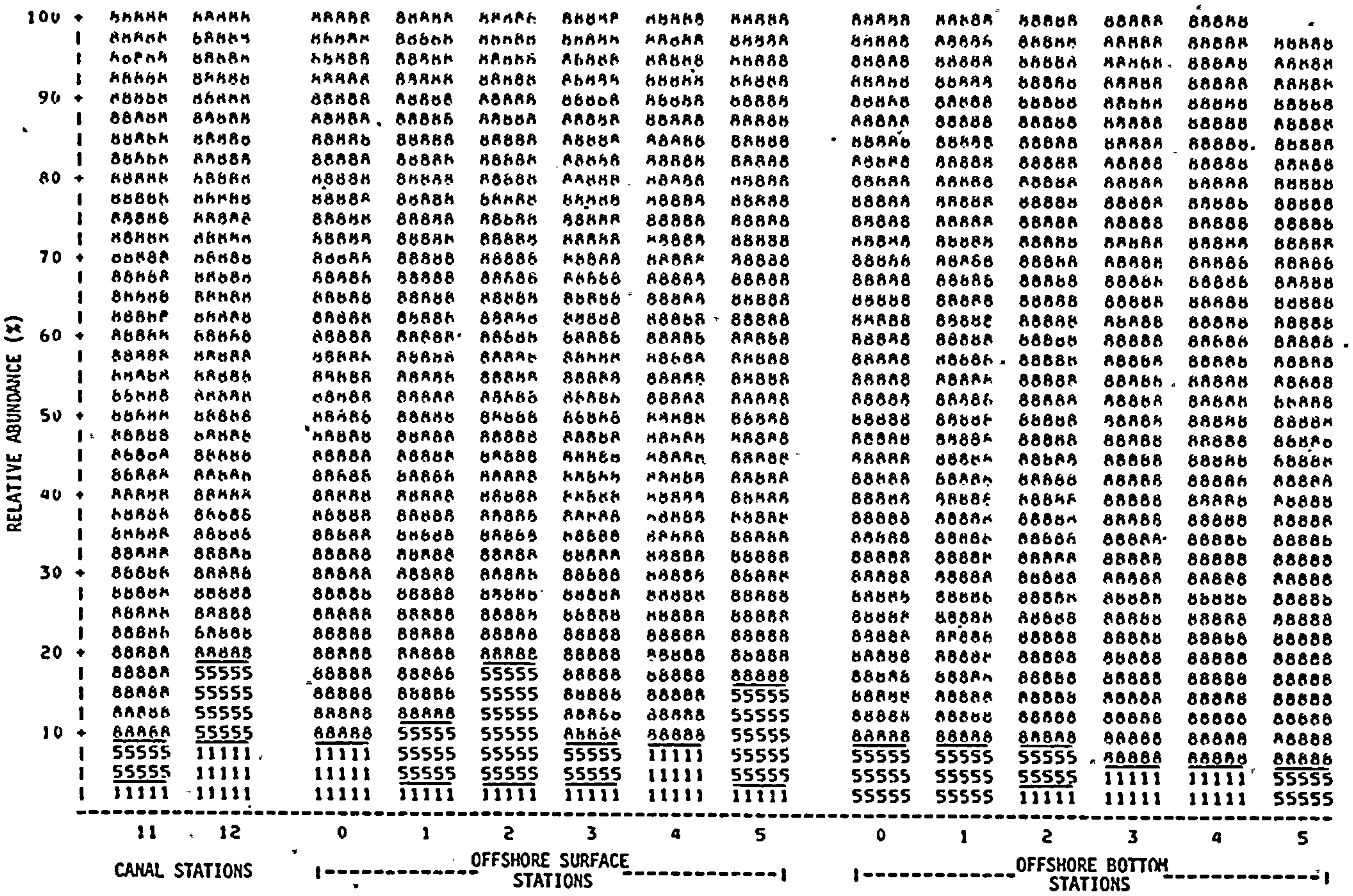
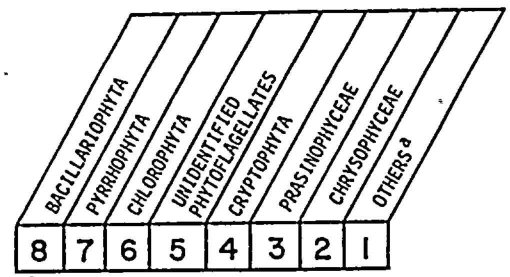


Figure D-11. Phytoplankton percentage composition, St. Lucie Plant, 15 May 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

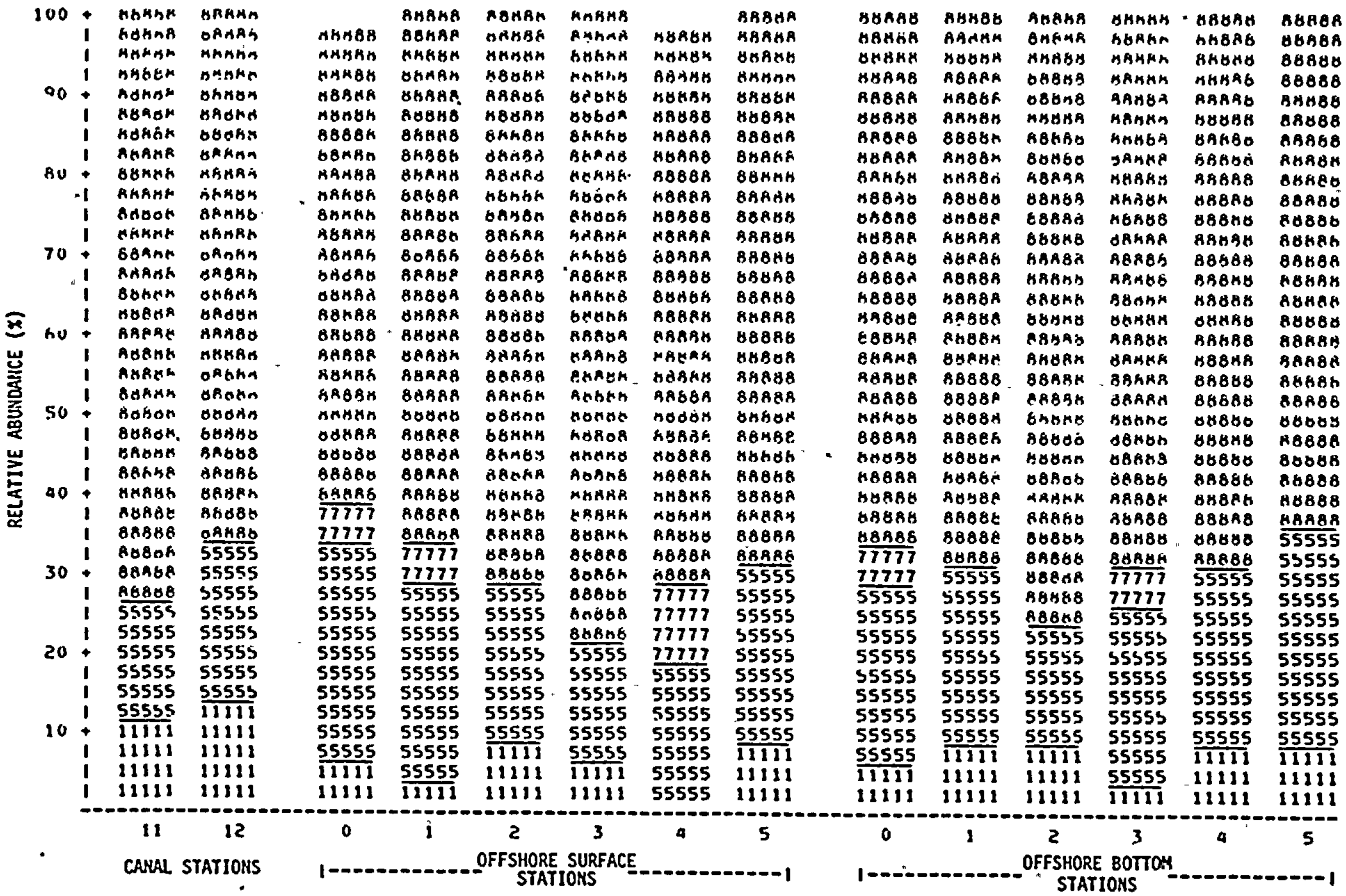
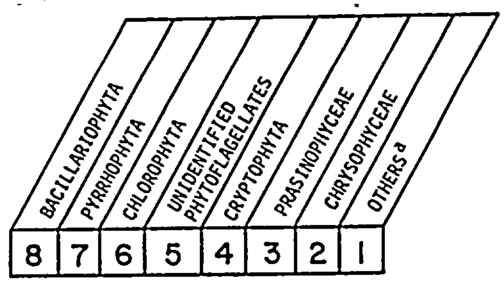


Figure D-12. Phytoplankton percentage composition, St. Lucie Plant, 12 June 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

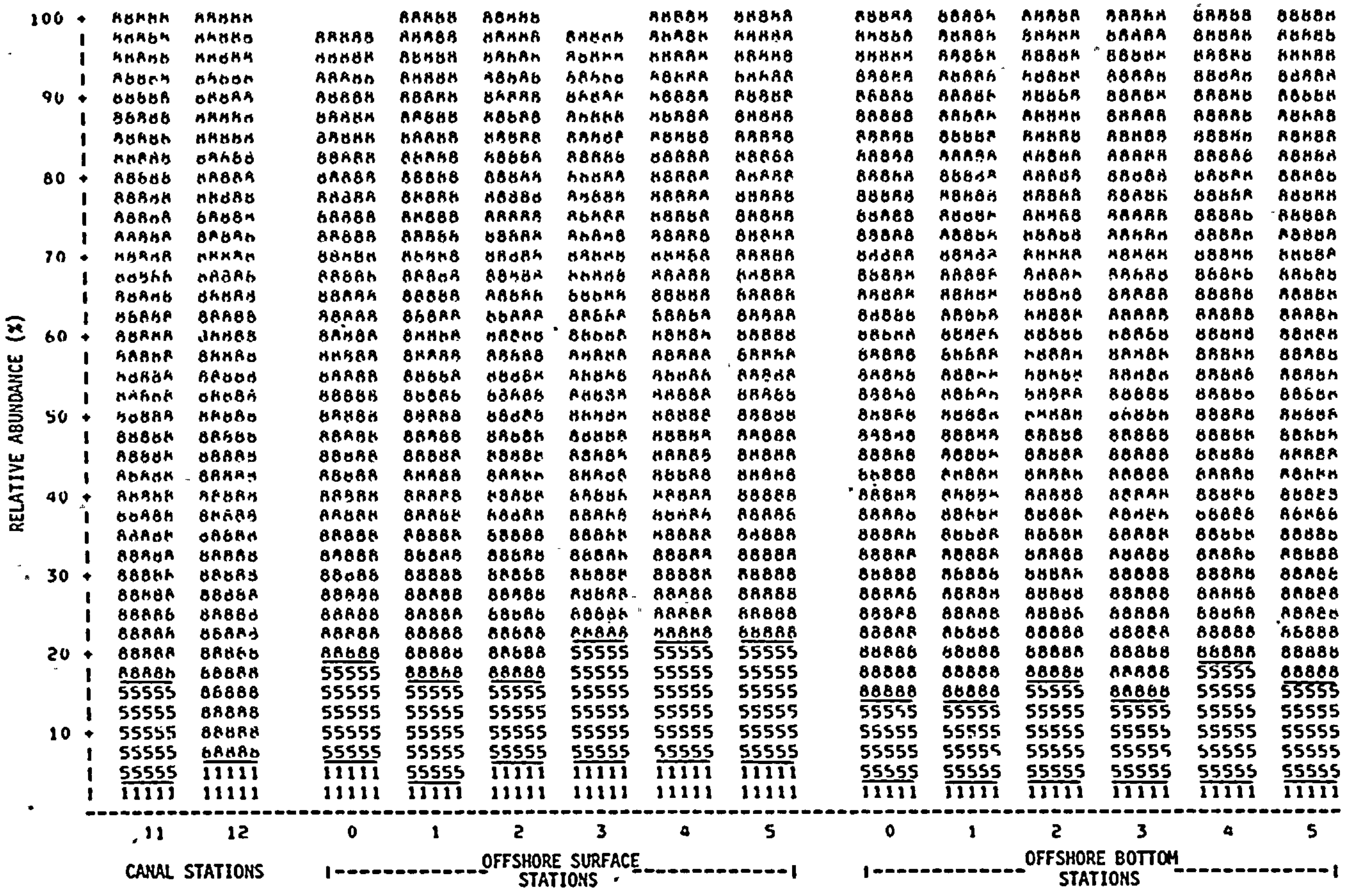
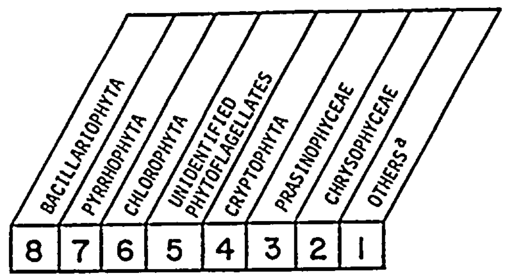


Figure D-13. Phytoplankton percentage composition, St. Lucie Plant, 26 July 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

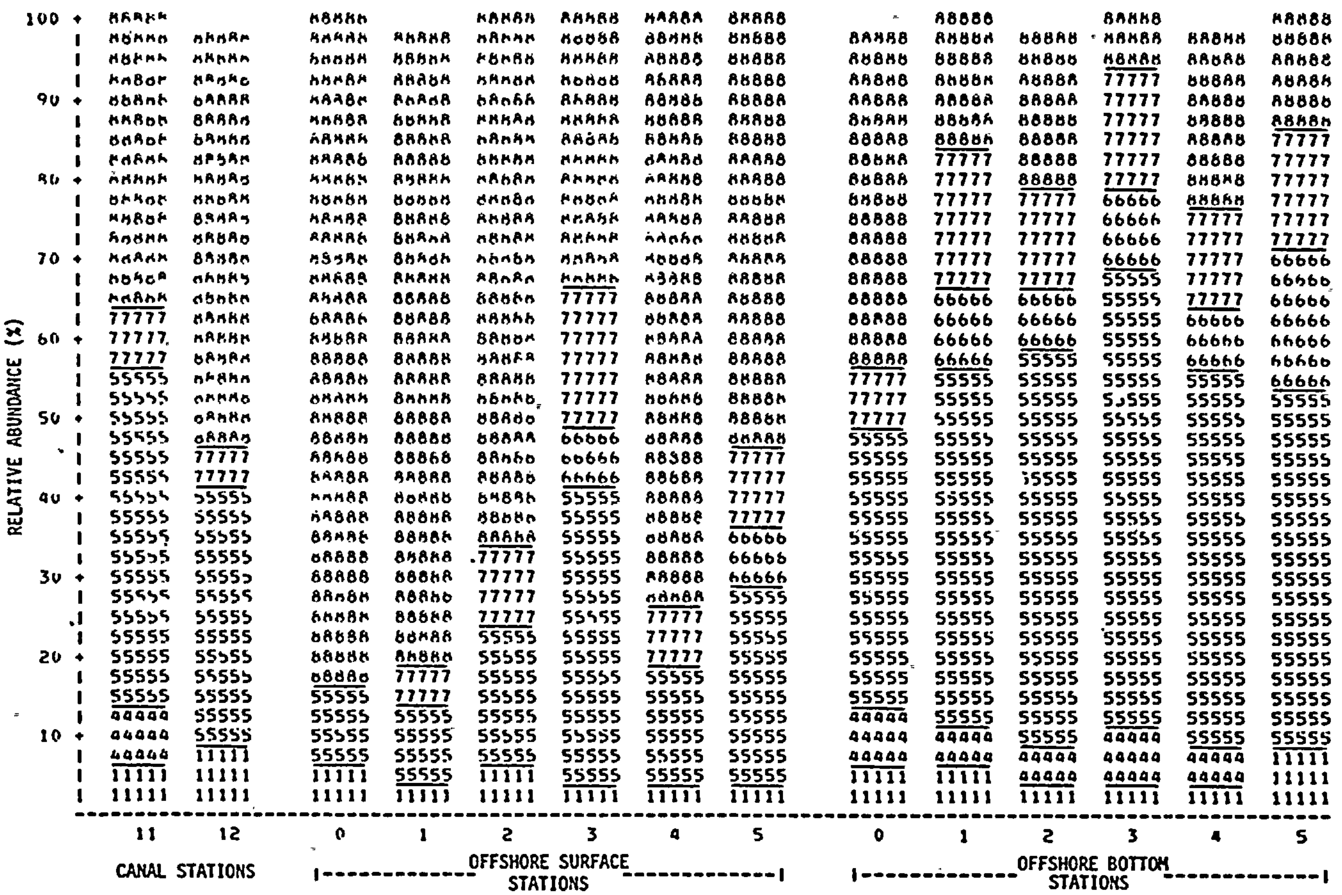
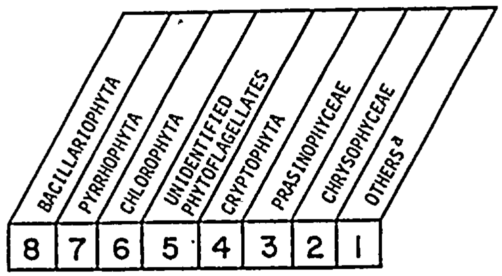


Figure D-14. Phytoplankton percentage composition, St. Lucie Plant, 21 August 1979.



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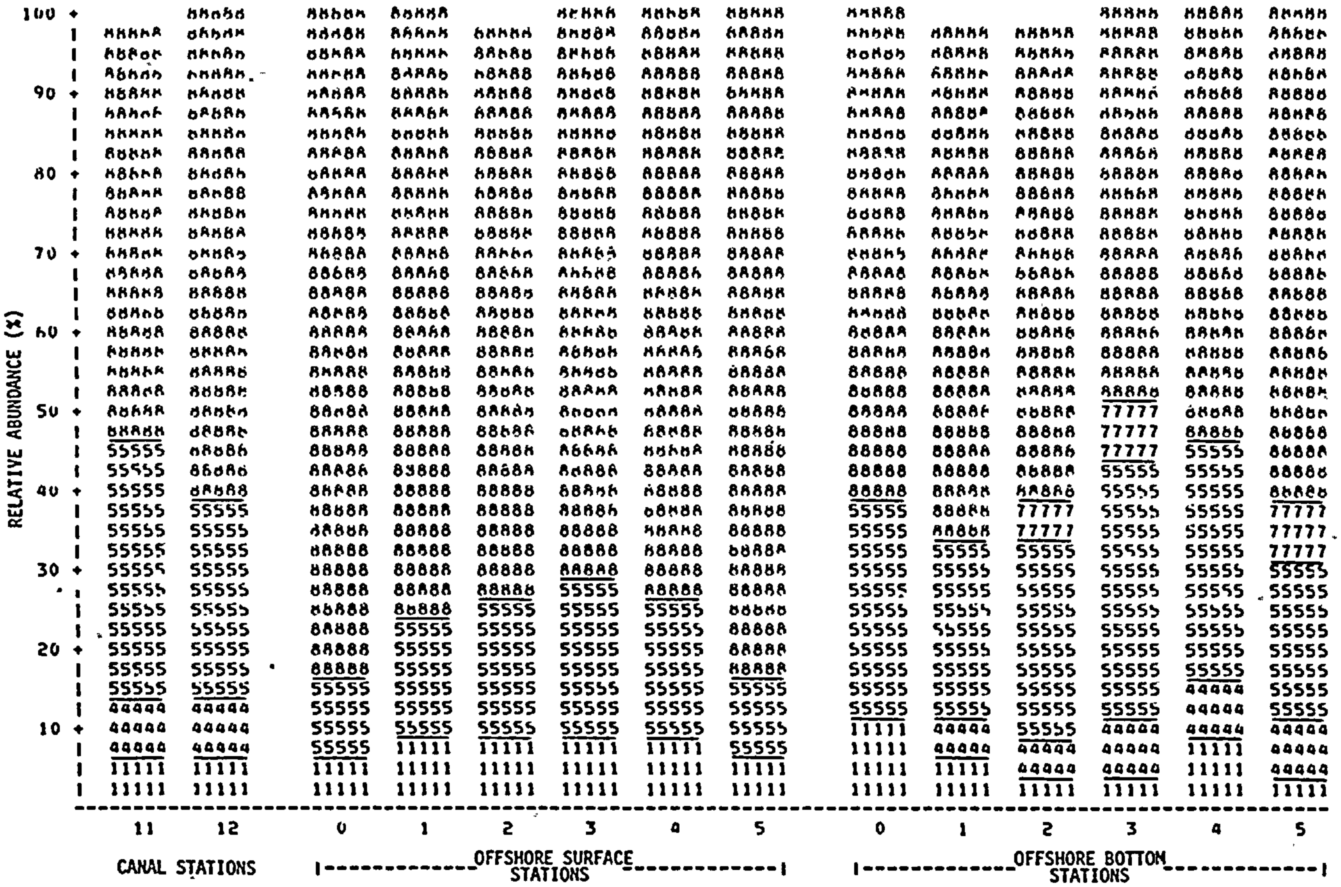
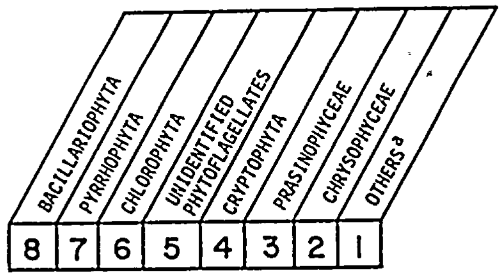


Figure D-15. Phytoplankton percentage composition, St. Lucie Plant, 7 September 1979.



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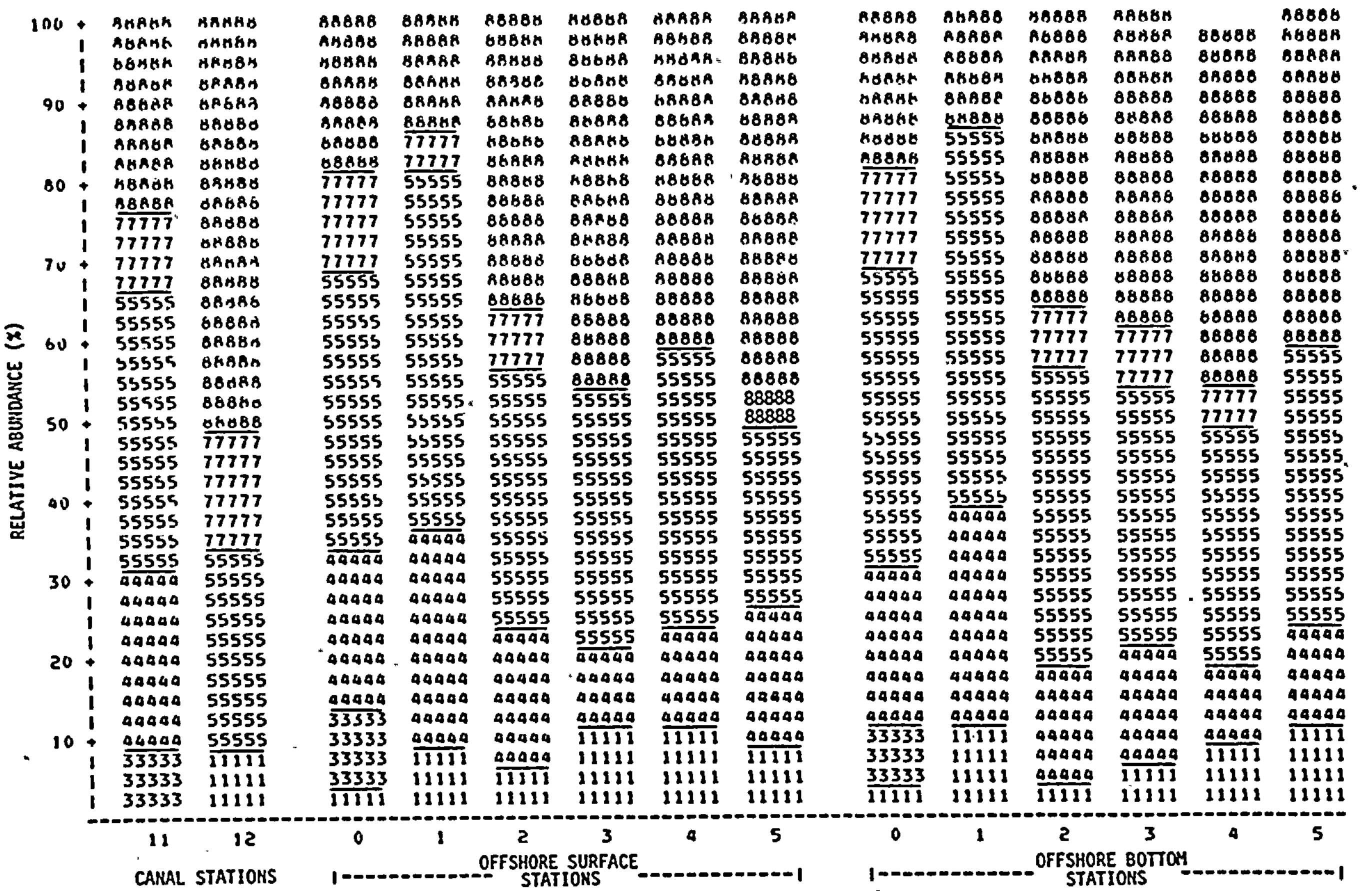
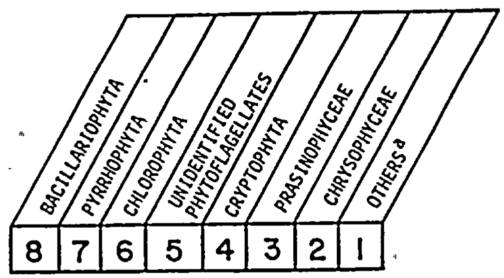


Figure D-16. Phytoplankton percentage composition, St. Lucie Plant, 2 October 1979.



[a]Any group representing <5% of the total density was included in the OTHERS category.

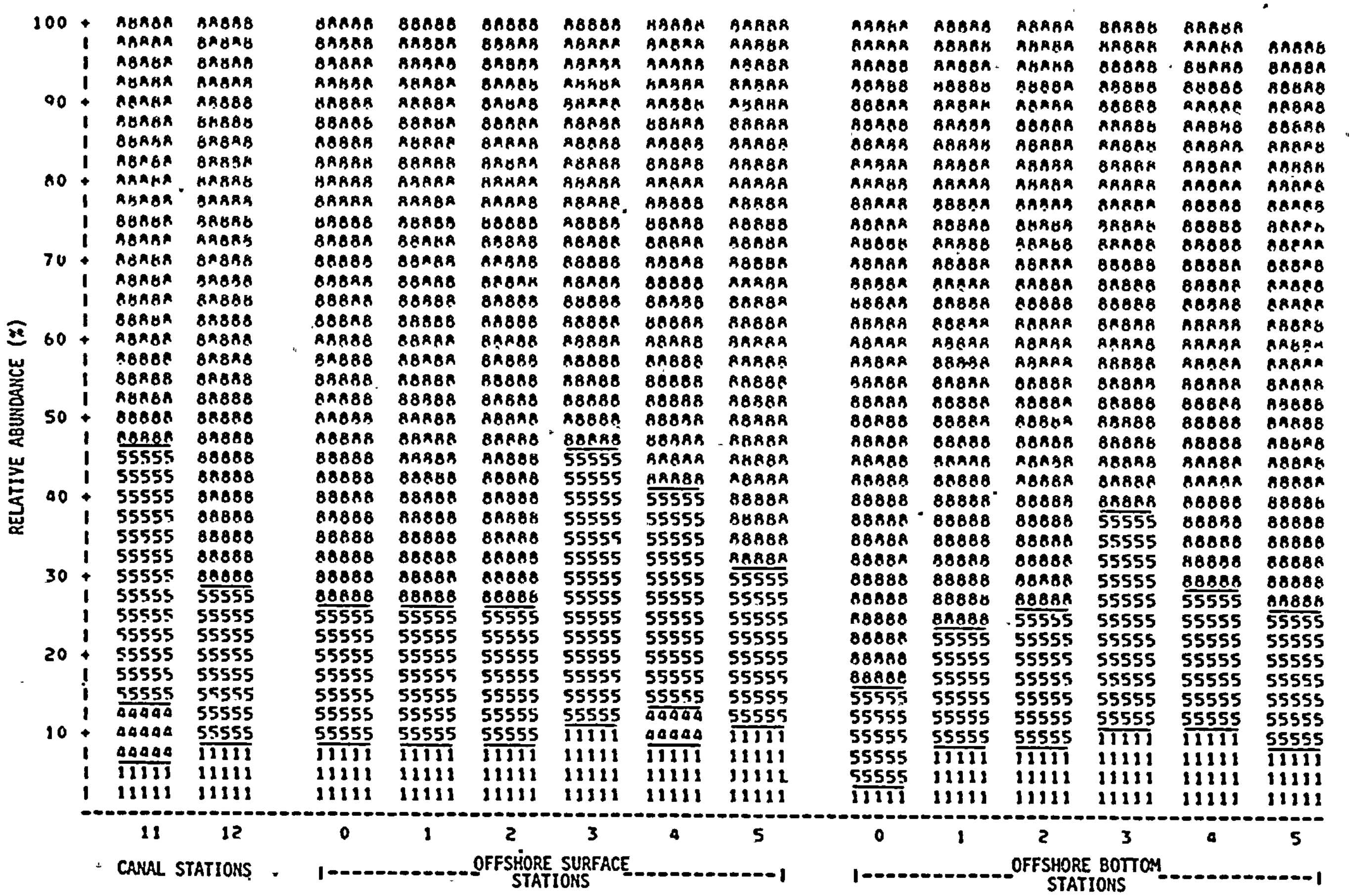


Figure D-17. Phytoplankton percentage composition, St. Lucie Plant, 30 October 1979.

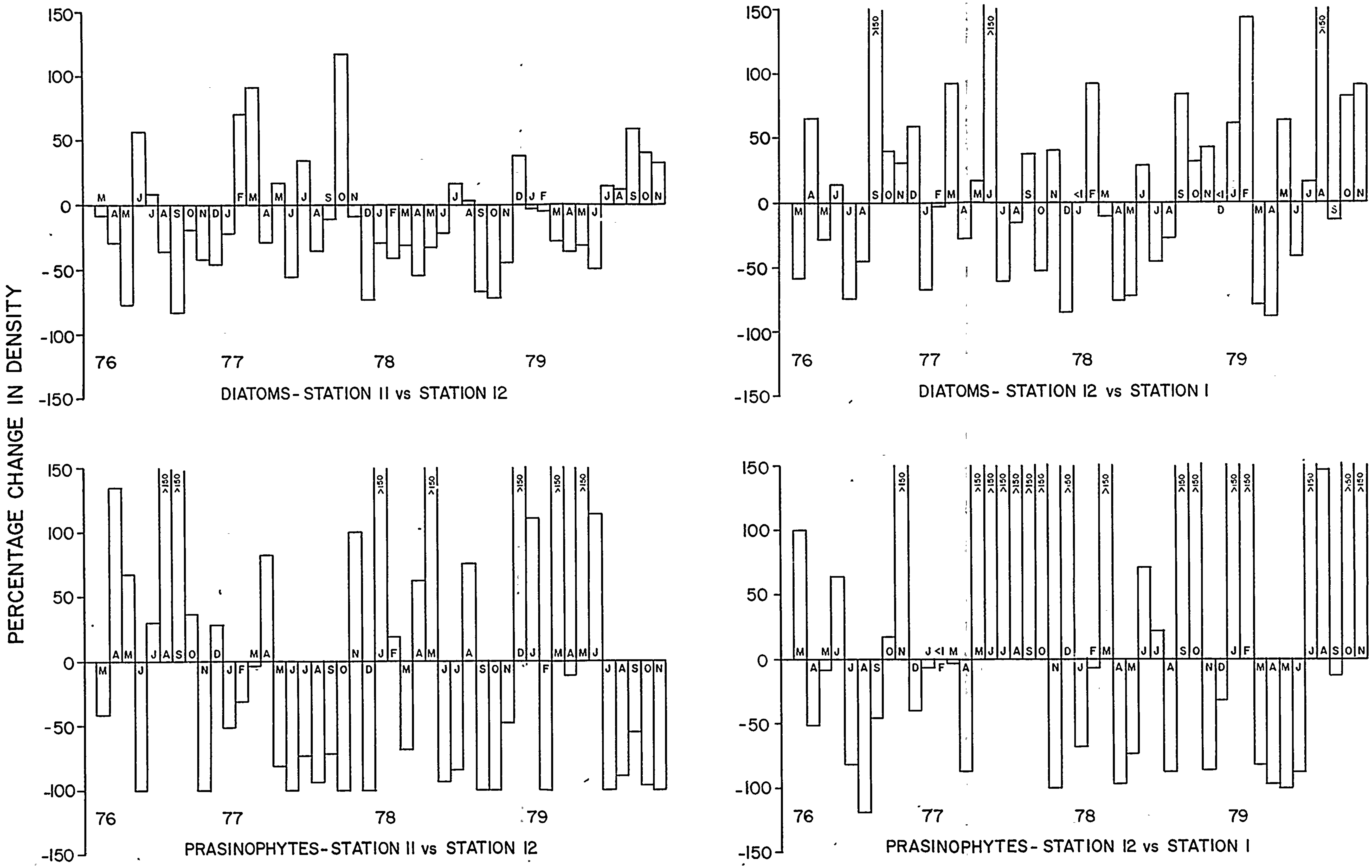


Figure D-18. Changes in densities of diatoms and prasinophytes between intake (Station 11 average) and discharge (Station 12) canals as well as between the discharge canal and Station 1, St. Lucie Plant, March 1976 - November 1979.

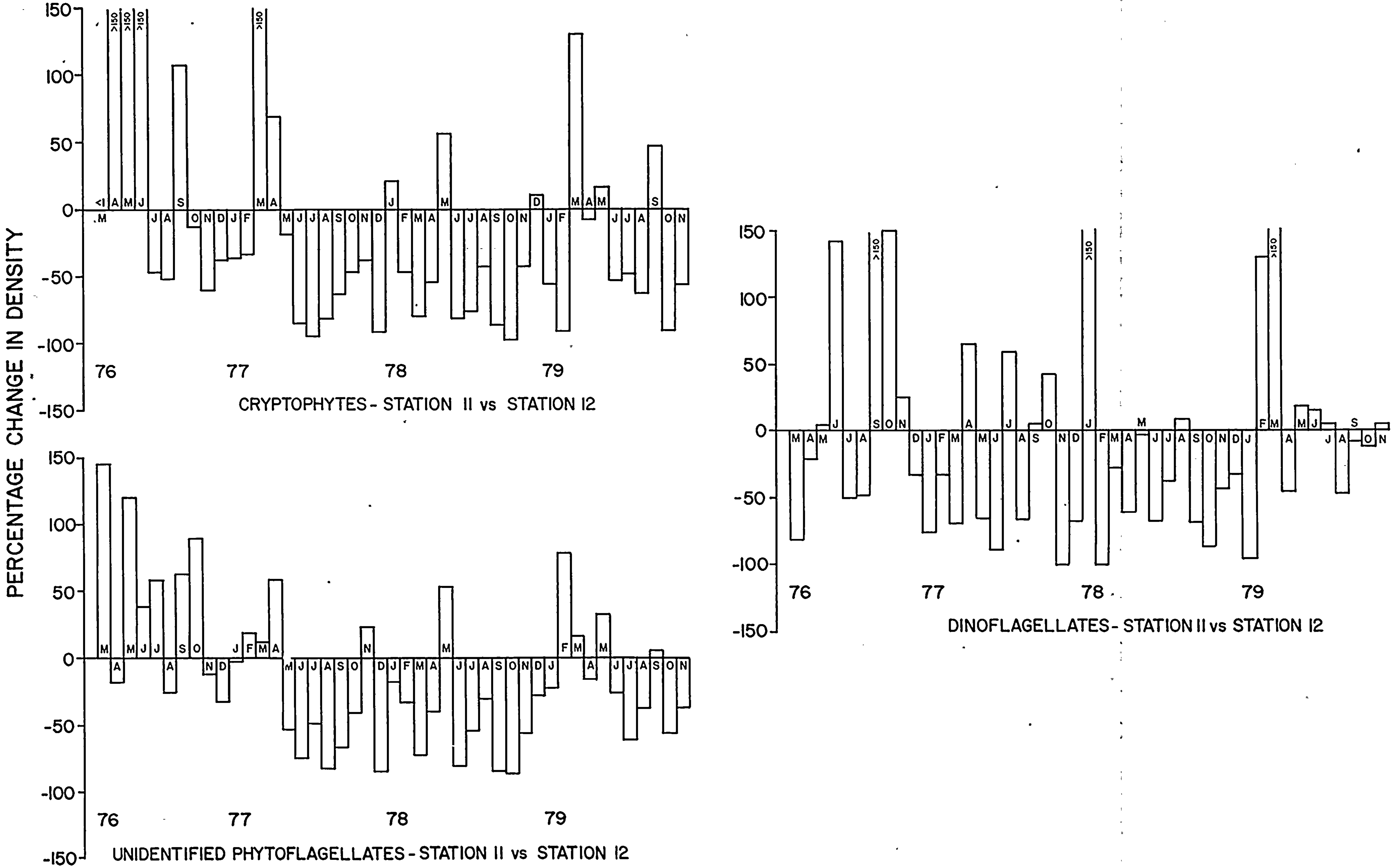


Figure D-19. Changes in densities of cryptophytes, unidentified phytoflagellates, and dinoflagellates between intake (Station 11 average) and discharge (Station 12) canals, St. Lucie Plant, 1976 - 1979.

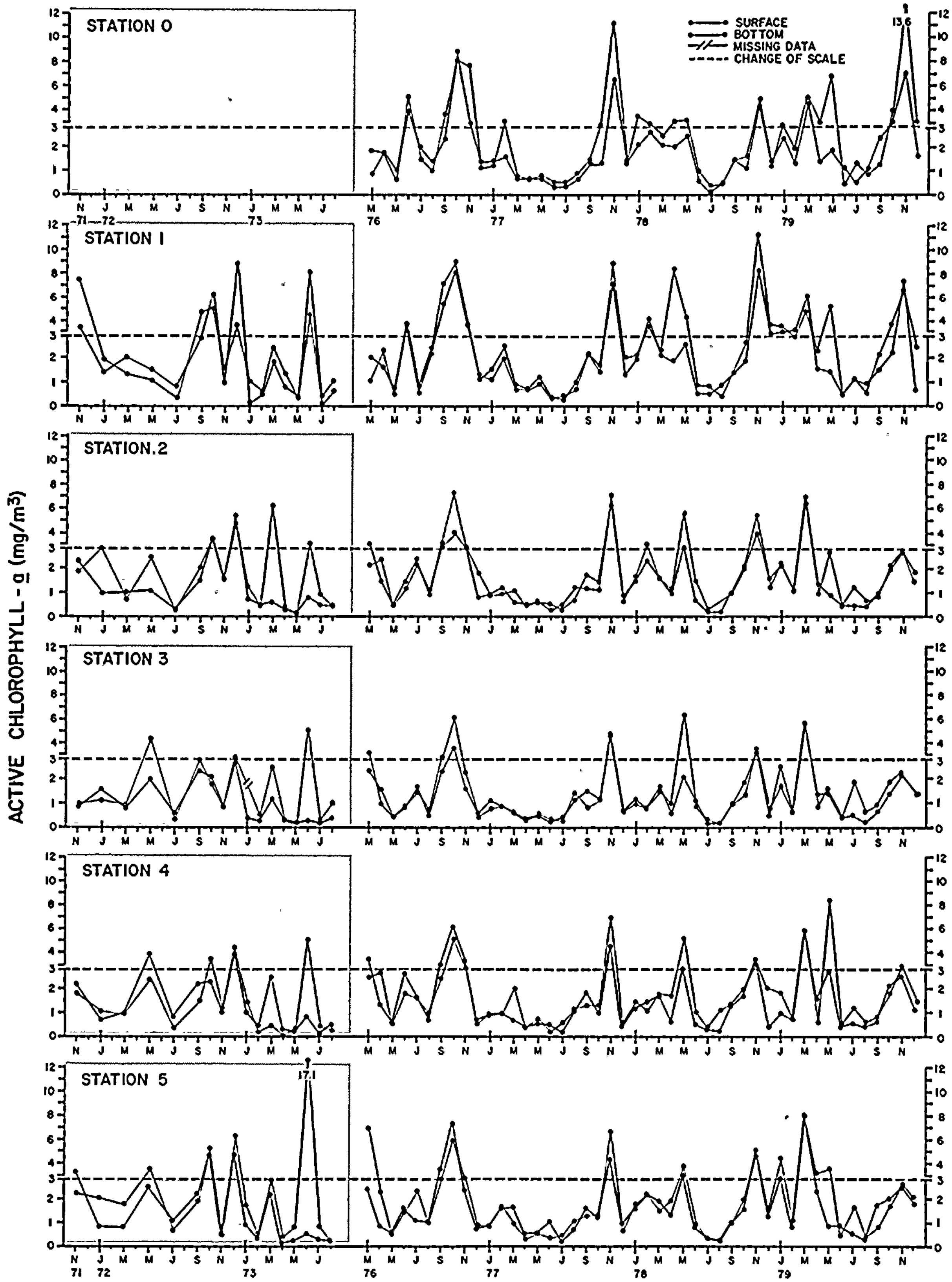


Figure D-20. Active chlorophyll-a at Stations 0 through 5, St. Lucie Plant, November 1971 - December 1979.

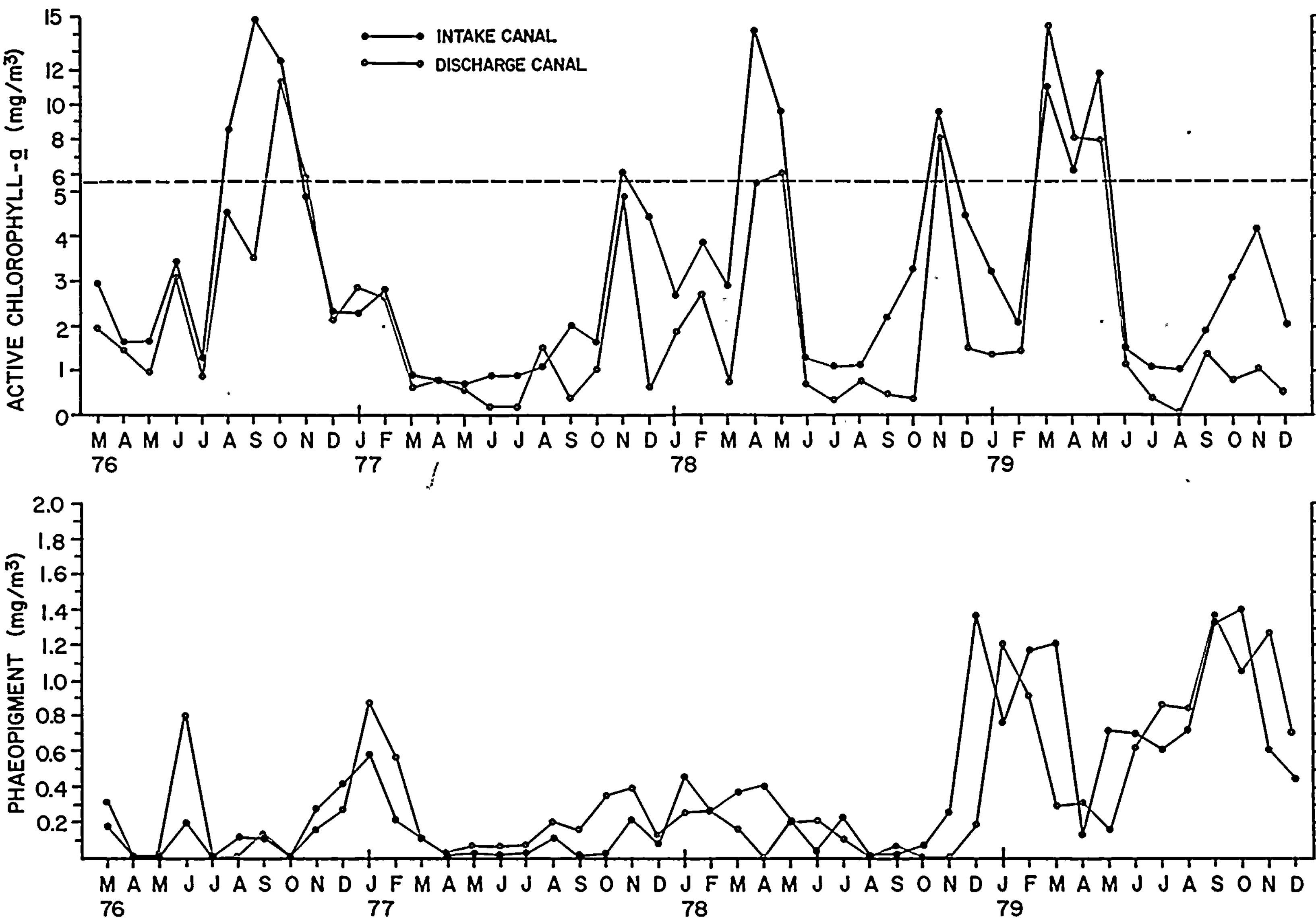


Figure D-21. Active chlorophyll-a and phaeopigment concentrations in the intake (Station 11) and discharge (Station 12) canals, St. Lucie Plant, March 1976 - December 1979.

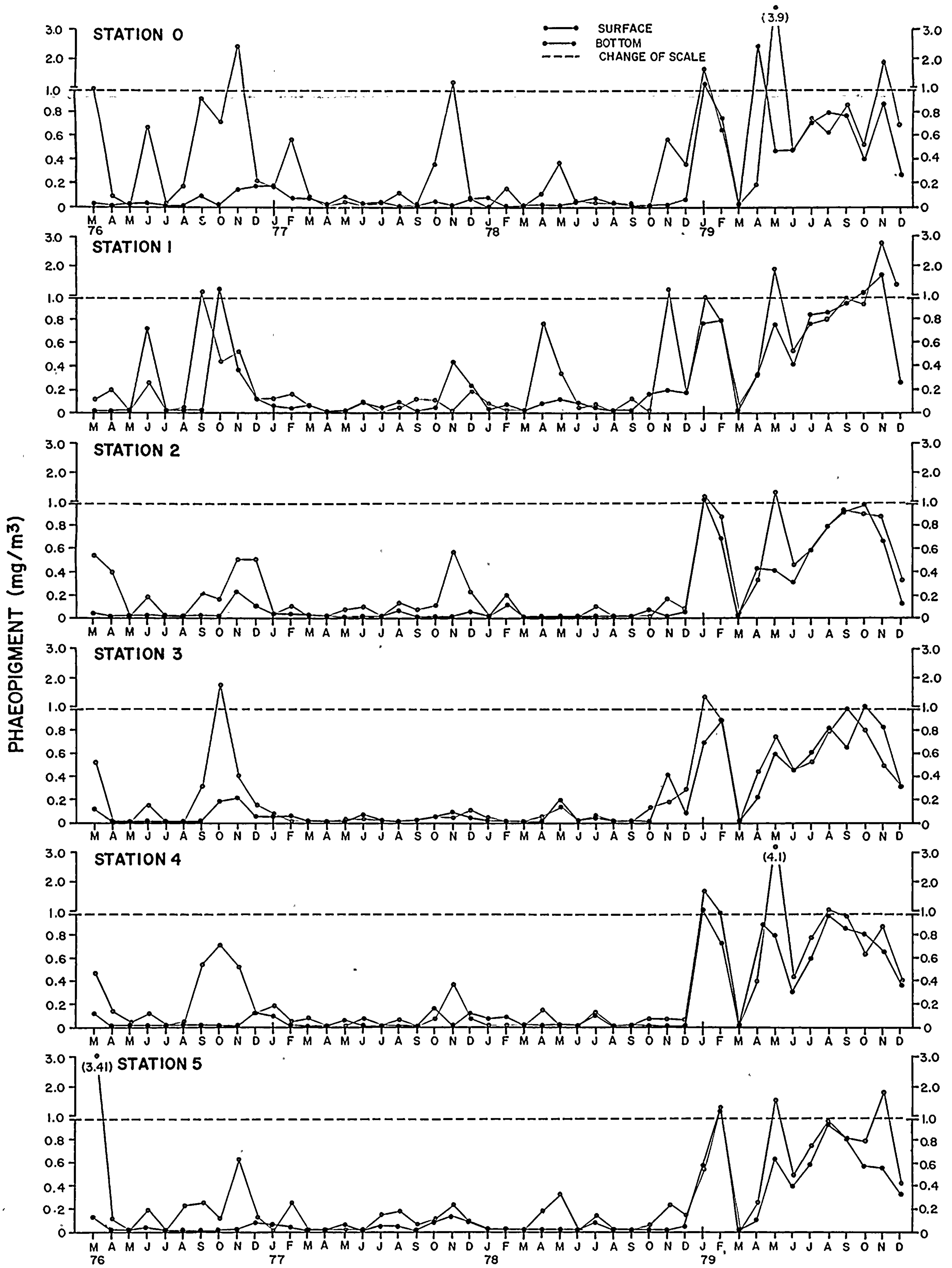


Figure D-22. Phaeopigment concentration at Stations 0 through 5, St. Lucie Plant, March 1976 - December 1979.

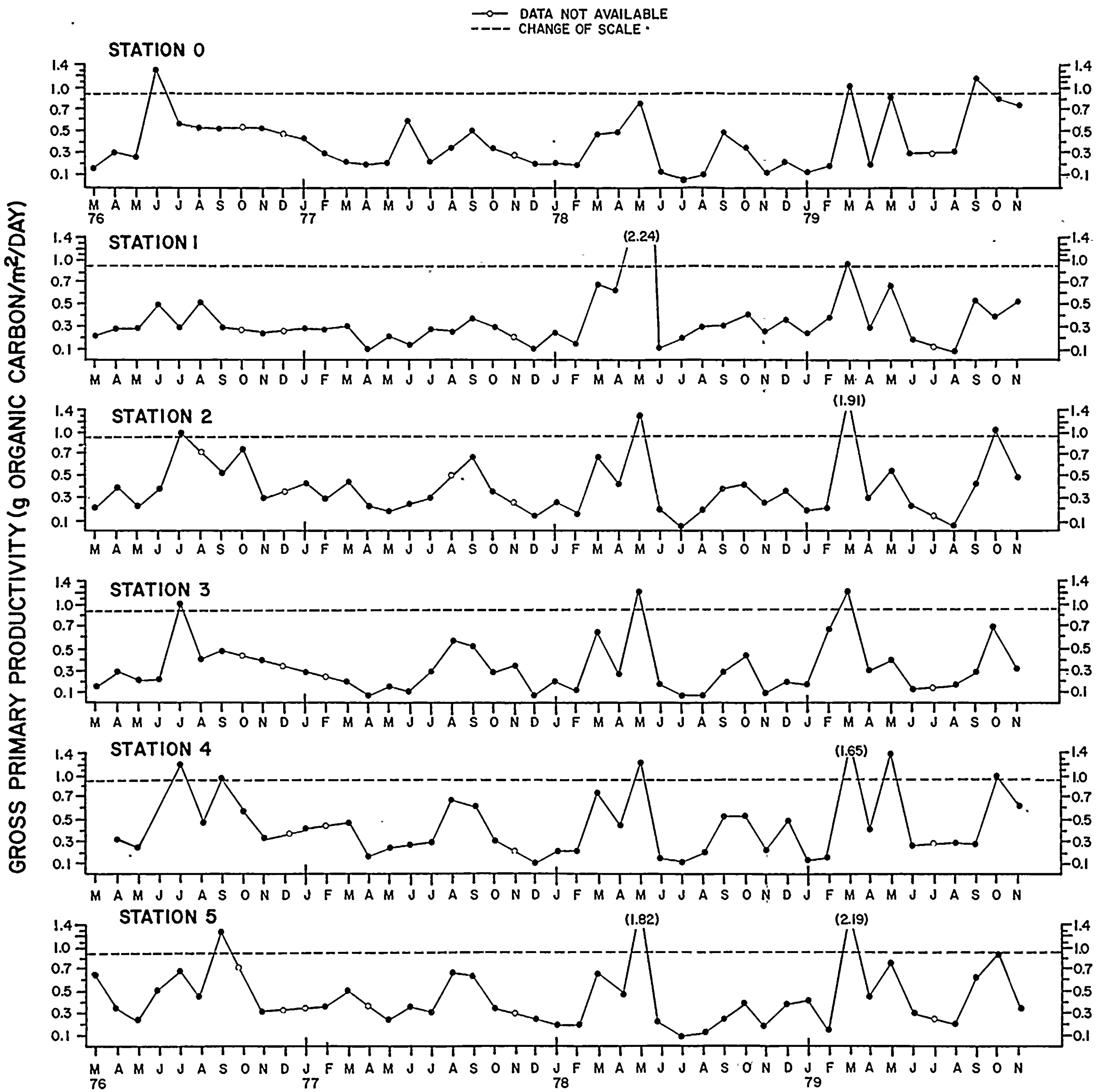


Figure D-23. Gross primary productivity of phytoplankton, St. Lucie Plant, March 1976 - November 1979.

TABLE D-1

EXAMPLES OF THE INDIVIDUAL VARIABLES, CLASS VARIABLES AND MODELS USED WITH THE GENERAL LINEAR MODELS PROCEDURE
ST. LUCIE PLANT
1979

INDIVIDUAL VARIABLES			
(Y_1) Density	($X_{1,2}$) Station	($X_{3,4}$) Year	(X_0) Intercept
Yi_1	1	A	1
Yi_1	1	B	1
Yi_1	2	A	1
Yi_1	2	B	1

CLASS VARIABLES			
Station		Year	
1	2	A	B
X_{i1}	X_{i2}	X_{i3}	X_{i4}
1	0	1	0
1	0	0	1
0	1	1	0
0	1	0	1

MODELS

For station and year effects:

$$Y_i = B_0X_0 + B_1X_{i1} + B_2X_{i2} + B_3X_{i3} + B_yX_{i4} + \Sigma_i$$

For station effects:

$$Y_i = B_0X_0 + B_1X_{i1} + B_2X_{i2} + \Sigma_i$$

where: B is the respective slope
Σ_i is the error term

TABLE D-2

PHYTOPLANKTON DENSITY AND PERCENTAGE COMPOSITION * **
ST. LUCIE PLANT
17 JANUARY 1979

STATION AND DEPTH ***

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
BACILLARIOPHYTA	1034846 (62)	1218575 (51)	1126711 (56)	1091292 (70)	1160234 (49)	2558220 (77)	1754299 (58)	2841280 (77)	660581 (32)	1342186 (56)	420166 (27)	605058 (64)	856390 (40)	1536356 (68)	856823 (42)	839324 (65)
PYRRHOPHYTA (DINOFLAGELLATES)	341029 (20)	44799 (2)	192914 (11)	9408 (1)	61689 (3)	29658 (1)	73256 (2)	17795 (<1)	17203 (1)	37631 (2)	62202 (4)	20761 (2)	71179 (3)	11863 (1)	66063 (3)	14846 (1)
CHLOROPHYTA (GREEN ALGAE)	47038 (3)	80637 (3)	63838 (3)	70558 (5)	26099 (1)	66731 (2)	46267 (2)	41521 (1)	141062 (7)	81533 (3)	26890 (2)	19278 (2)	37814 (2)	35590 (2)	24023 (1)	17795 (1)
CYANOPHYTA (BLUE-GREEN ALGAE)	10584 (1)	.a ( )	5292 (1)	. ( )	2373 (<1)	. ( )	3856 (<1)	17795 (<1)	12386 (1)	5272 (<1)	. ( )	4449 (<1)	6673 (<1)	8304 (<1)	2002 (<1)	. ( )
EUGLENOPHYTA (EUGLENOIDS)	. ( )	. ( )	. ( )	. ( )	11863 (<1)	. ( )	15422 (1)	. ( )	3441 (<1)	. ( )	5042 (<1)	. ( )	6673 (<1)	. ( )	8008 (<1)	. ( )
CRYPTOPHYTA (CRYPTOPHYTES)	141115 (8)	179194 (8)	160155 (8)	70558 (5)	272855 (11)	14829 (<1)	161933 (5)	94906 (3)	275242 (13)	200697 (8)	277303 (18)	48936 (5)	238006 (11)	59316 (3)	206198 (10)	44487 (3)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	5880 (<1)	. ( )	2940 (<1)	. ( )	11863 (<1)	. ( )	7711 (<1)	5932 (<1)	3441 (<1)	. ( )	11764 (1)	4449 (<1)	11122 (1)	. ( )	8008 (<1)	5932 (<1)
PRASINOPHYCEAE (PRASINOPHYTES)	. ( )	8960 (<1)	4480 (<1)	9408 (1)	42708 (2)	7415 (<1)	26989 (1)	. ( )	72251 (3)	31359 (1)	89073 (6)	1483 (<1)	62282 (3)	5932 (<1)	78075 (4)	. ( )
UNIDENTIFIED PHYTOFLAGELLATES	. ( )	573421 (24)	286711 (24)	221081 (14)	766365 (32)	355897 (11)	794244 (26)	344034 (9)	846370 (41)	583277 (24)	631915 (40)	154222 (16)	845259 (39)	450803 (20)	732703 (36)	246162 (19)
OTHERS	99957 (6)	268791 (11)	184374 (9)	89373 (6)	28472 (1)	281752 (9)	154222 (5)	344034 (9)	44727 (2)	131708 (5)	47058 (3)	80077 (9)	31141 (1)	136427 (6)	58056 (3)	130496 (10)
TOTAL PHYTOPLANKTON	1680449	2374378	2027413	1561677	2384520	3314501	3038198	3707296	2076702	2414663	1571414	938712	2166540	2244592	2039959	1299041

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

a ( ) = NOT OBSERVED.

TABLE D-3

PHYTOPLANKTON DENSITY* AND PERCENTAGE COMPOSITION**
ST. LUCIE PLANT
13 FEBRUARY 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
	STATION AND DEPTH***															
BACILLARIOPHYTA	1312918 (58)	993452 (57)	1153185 (57)	1097564 (84)	722175 (60)	125459 (57)	2650714 (76)	2159851 (78)	904770 (61)	1183670 (78)	1587322 (78)	1596199 (72)	717958 (56)	713277 (73)	772297 (54)	905462 (65)
PYRRHOPHYTA (DINOFLAGELLATES)	20906 (1)	3763 (<1)	12335 (1)	28223 (2)	14829 (1)	4806 (2)	59316 (2)	26692 (1)	38570 (3)	16715 (1)	24913 (1)	28938 (1)	45313 (4)	14651 (2)	30844 (2)	25633 (2)
CHLOROPHYTA (GREEN ALGAE)	58537 (3)	41394 (2)	49965 (2)	40767 (3)	5932 (<1)	1602 (1)	51902 (1)	22244 (1)	12852 (1)	17993 (1)	8897 (<1)	11567 (1)	12355 (1)	5169 (1)	26099 (2)	32031 (2)
CYANOPHYTA (BLUE-GREEN ALGAE)	( )[a]	( )	( )	6272 (<1)	( )	( )	( )	( )	( )	( )	1780 (<1)	( )	( )	771 (<1)	( )	( )
EUGLENOPHYTA (EUGLENOIDS)	4181 (<1)	( )	2091 (<1)	( )	( )	( )	7415 (<1)	( )	5141 (<1)	1285 (<1)	( )	( )	( )	( )	2373 (<1)	1068 (<1)
CRYPTOPHYTA (CRYPTOPHYTES)	221603 (10)	127945 (7)	174774 (9)	15679 (1)	75628 (6)	15659 (7)	122340 (4)	151256 (5)	74541 (5)	34700 (2)	39149 (2)	75183 (3)	63146 (5)	42411 (4)	121005 (8)	95025 (7)
XANTHOPHYTA (XANTHOPHYTES)	( )	( )	( )	3136 (<1)	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	4181 (<1)	11289 (1)	7735 (<1)	( )	7415 (1)	712 (<1)	11122 (<1)	4449 (<1)	6426 (<1)	3856 (<1)	5339 (<1)	3856 (<1)	4118 (<1)	2313 (<1)	9491 (1)	4271 (<1)
PRASINOPHYCEAE (PRASINOPHYTES)	41812 (2)	30105 (2)	35958 (2)	( )	23726 (2)	2491 (1)	14829 (<1)	17795 (1)	16707 (1)	3856 (<1)	3559 (<1)	9639 (<1)	24709 (2)	6940 (1)	36776 (3)	8542 (1)
UNIDENTIFIED PHYTOFLAGELLATES	539374 (24)	496726 (28)	518050 (26)	116028 (9)	309927 (26)	63884 (29)	526431 (15)	355897 (13)	377844 (25)	233904 (15)	350559 (17)	478089 (22)	395351 (31)	169644 (17)	402164 (28)	284006 (21)
OTHERS	62718 (3)	45157 (3)	53937 (3)	( )	38556 (3)	4093 (2)	33365 (1)	44487 (2)	47552 (3)	30844 (2)	24913 (1)	19278 (1)	15100 (1)	16193 (2)	34403 (2)	27760 (2)
TOTAL PHYTOPLANKTON	2266231	1749831	2008031	1307669	1198187	218705	3477433	2782671	1484403	1526821	2046429	2222748	1278051	972370	1435452	1383796

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED.

TABLE D-4

PHYTOPLANKTON DENSITY AND PERCENTAGE COMPOSITION * **
ST. LUCIE PLANT
6 APRIL 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
BACILLARIOPHYTA	17535937 (94)	28477083 (94)	23006510 (94)	16245202 (87)	2004591 (63)	2026478 (64)	3459588 (78)	3493131 (81)	5208200 (81)	3147063 (82)	2470659 (80)	2106912 (78)	2558892 (75)	3074442 (80)	3121936 (82)	2912662 (81)
PYRRHOPHYTA (DINOFLAGELLATES)	75262 (<1)	56446 (<1)	65854 (<1)	248363 (1)	82746 (3)	106769 (3)	117980 (3)	69400 (2)	96107 (1)	42716 (1)	74749 (2)	46775 (2)	41394 (1)	41402 (1)	51269 (1)	42708 (1)
CHLOROPHYTA (GREEN ALGAE)	45157 (<1)	84669 (<1)	64913 (<1)	112892 (1)	58723 (2)	36301 (1)	34700 (1)	23133 (1)	43241 (1)	24023 (1)	21354 (1)	38640 (1)	135471 (4)	94077 (2)	38437 (1)	34166 (1)
CYANOPHYTA (BLUE-GREEN ALGAE)	7526 (<1)	.[a] ( )	3763 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	2669 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )
EUGLENOPHYTA (EUGLENOIDS)	7526 (<1)	. ( )	3763 (<1)	22578 (<1)	. ( )	. ( )	3470 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	3763 (<1)	. ( )	2135 (<1)	2135 (<1)
CRYPTOPHYTA (CRYPTOPHYTES)	278468 (1)	338677 (1)	308572 (1)	711221 (4)	330984 (10)	360880 (11)	249840 (6)	205308 (5)	326714 (5)	168161 (4)	. ( )	138292 (5)	233311 (7)	233311 (6)	136665 (4)	138800 (4)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	15052 (<1)	28223 (<1)	21638 (<1)	. ( )	2669 (<1)	6406 (<1)	. ( )	. ( )	. ( )	8008 (<1)	2135 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )
PRASINOPHYCEAE (PRASINOPHYTES)	120418 (1)	84669 (<1)	102544 (<1)	349966 (2)	64061 (2)	79009 (3)	58990 (1)	37592 (1)	14414 (<1)	21354 (1)	44843 (1)	55944 (2)	63972 (2)	41394 (1)	36301 (1)	36301 (1)
UNIDENTIFIED PHYTOFLAGELLATES	587040 (3)	1128923 (4)	857982 (3)	993452 (5)	624600 (20)	535981 (17)	520500 (12)	465558 (11)	763933 (12)	437754 (11)	461243 (15)	323358 (12)	376308 (11)	349956 (9)	399317 (11)	450566 (12)
OTHERS	. ( )	. ( )	. ( )	. ( )	2669 (<1)	. ( )	3470 (<1)	2892 (<1)	. ( )	2669 (<1)	. ( )	2034 (<1)	3763 (<1)	. ( )	2135 (<1)	. ( )
TOTAL PHYTOPLANKTON	18672387	30198691	24435539	18683676	3171044	3151825	4448537	4297014	6452609	3854417	3074983	2712954	3416874	3834592	3788196	3617338

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED.

TABLE D-5

PHYTOPLANKTON DENSITY AND PERCENTAGE COMPOSITION[*] [**]
ST. LUCIE PLANT
27 APRIL 1979

STATION AND DEPTH[***]

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
BACILLARIOPHYTA	12182351 (86)	7700868 (87)	9941614 (86)	6278962 (81)	1247024 (79)	2535768 (81)	761547 (71)	1421689 (73)	639903 (75)	628522 (78)	814706 (76)	1179724 (76)	690915 (80)	590077 (79)	2087782 (79)	1676466 (85)
PYRRHOPHYTA (DINOFLAGELLATES)	170897 (1)	26879 (<1)	99888 (1)	53758 (1)	48441 (3)	20751 (1)	20820 (2)	33635 (2)	14244 (2)	21362 (3)	22584 (2)	31986 (2)	26578 (3)	28476 (4)	59168 (2)	21374 (1)
CHLOROPHYTA (GREEN ALGAE)	32031 (<1)	94077 (1)	63054 (1)	75261 (1)	12455 (1)	11863 (<1)	12011 (1)	7909 (<1)	7118 (1)	9253 (1)	22578 (2)	3763 (<1)	2491 (<1)	7830 (1)	8453 (<1)	7118 (<1)
CYANOPHYTA (BLUE-GREEN ALGAE)	( )[a]	( )	( )	10752 (<1)	( )	( )	( )	( )	( )	925 (<1)	1882 (<1)	( )	( )	712 (<1)	( )	1780 (<1)
EUGLENOPHYTA (EUGLENOIDS)	10677 (<1)	( )	5338 (<1)	( )	( )	( )	( )	( )	712 (<1)	( )	( )	( )	( )	( )	( )	( )
CRYPTOPHYTA (CRYPTOPHYTES)	437754 (3)	147835 (2)	292794 (2)	268791 (3)	26297 (2)	17795 (1)	48847 (5)	83043 (4)	35590 (4)	15659 (2)	48920 (5)	75262 (5)	12456 (1)	8542 (1)	98613 (4)	44487 (2)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	( )	( )	( )	( )	2768 (<1)	( )	1602 (<1)	( )	1424 (<1)	( )	( )	( )	( )	( )	( )	( )
PRASINOPHYCEAE (PRASINOPHYTES)	138800 (1)	53758 (1)	96279 (1)	86013 (1)	4152 (<1)	( )	3203 (<1)	1977 (<1)	4271 (1)	3559 (<1)	3763 (<1)	7526 (<1)	830 (<1)	2135 (<1)	16905 (1)	1780 (<1)
UNIDENTIFIED PHYTOFLAGELLATES	1174461 (8)	833253 (9)	1003857 (9)	946145 (12)	220063 (14)	536812 (17)	221813 (21)	391487 (20)	140935 (17)	118158 (15)	155168 (15)	235192 (15)	124564 (14)	108905 (15)	346555 (13)	190405 (10)
OTHERS	( )	13440 (<1)	6720 (<1)	10752 (<1)	8304 (1)	23727 (1)	3203 (<1)	13840 (1)	3559 (<1)	13524 (2)	3763 (<1)	18815 (1)	5813 (1)	4271 (1)	36628 (1)	37369 (2)
TOTAL PHYTOPLANKTON	14146980	8870109	11508545	7730434	1569506	3146725	1073046	1953580	847755	810963	1074364	1552269	863649	750947	2654104	1980778

[*] VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

[**] PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

[***] S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a] ( ) = NOT OBSERVED.

TABLE D-6

PHYTOPLANKTON DENSITY* AND PERCENTAGE COMPOSITION**
ST. LUCIE PLANT
15 MAY 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
	STATION AND DEPTH***															
BACILLARIOPHYTA	1220365 (91)	11126163 (92)	11664911 (92)	7958907 (83)	3627135 (93)	23398462 (93)	12954015 (90)	17962419 (92)	2436472 (84)	7535234 (93)	2617090 (93)	9545163 (94)	5361414 (94)	36515087 (95)	2067763 (85)	21078013 (93)
PYRRHOPHYTA (DINOFLAGELLATES)	124182 (1)	100349 (1)	112265 (1)	131708 (1)	36311 (1)	133461 (1)	117408 (1)	25087 (<1)	34166 (1)	58065 (1)	41106 (1)	88110 (1)	73422 (1)	256246 (1)	48046 (2)	97872 (<1)
CHLOROPHYTA (GREEN ALGAE)	.[a] ( )	. ( )	. ( )	112892 (1)	9075 (<1)	21354 (<1)	26091 (<1)	. ( )	21354 (1)	16015 (<1)	5872 (<1)	16015 (<1)	14681 (<1)	53385 (<1)	19574 (1)	26692 (<1)
CYANOPHYTA (BLUE-GREEN ALGAE)	. ( )	13798 (<1)	6899 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )
EUGLENOPHYTA (EUGLENOIDS)	11289 (<1)	. ( )	5645 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	8008 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )
CRYPTOPHYTA (CRYPTOPHYTES)	146760 (1)	112892 (1)	129826 (1)	150523 (2)	33276 (1)	42708 (<1)	78272 (1)	62718 (<1)	2135 (<1)	8008 (<1)	11745 (<1)	. ( )	46978 (1)	106769 (<1)	5338 (<1)	26692 (<1)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	. ( )	25087 (<1)	12544 (<1)	. ( )	. ( )	. ( )	26091 (<1)	. ( )	2135 (<1)	12012 (<1)	. ( )	8008 (<1)	. ( )	. ( )	1780 (<1)	. ( )
PRASINOPHYCEAE (PRASINOPHYTES)	101603 (1)	62718 (1)	82161 (1)	235192 (2)	3025 (<1)	5338 (<1)	. ( )	50174 (<1)	2135 (<1)	4004 (<1)	1957 (<1)	24023 (<1)	5872 (<1)	. ( )	1780 (<1)	8897 (<1)
UNIDENTIFIED PHYTOFLAGELLATES	835403 (6)	614636 (5)	725019 (6)	959585 (10)	184533 (5)	1692291 (7)	1213216 (8)	1417426 (7)	399317 (14)	448430 (6)	148765 (5)	416400 (4)	226084 (4)	1558830 (4)	302513 (12)	1352409 (6)
OTHERS	. ( )	12544 (<1)	6272 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	1957 (<1)	8008 (<1)	2936 (<1)	21354 (<1)	. ( )	35590 (<1)
TOTAL PHYTOPLANKTON	13422895	12068187	12745541	9548807	3893356	25293615	14415093	19517824	2897714	8099776	2828493	10105727	5731387	38511671	2446794	22626166

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED.

TABLE D-7

PHYTOPLANKTON DENSITY[*] AND PERCENTAGE COMPOSITION[**]
ST. LUCIE PLANT
12 JUNE 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
BACILLARIOPHYTA	590534 (56)	3555108 (80)	2073321 (68)	981536 (67)	1045383 (61)	573497 (67)	569838 (69)	405606 (70)	820788 (74)	472075 (79)	596974 (82)	239426 (69)	559645 (75)	373799 (71)	731542 (69)	656264 (66)
PYRRHOPHYTA (DINOFLAGELLATES)	48920 (5)	79025 (2)	63972 (3)	72126 (5)	106119 (6)	47415 (6)	43007 (5)	27417 (5)	43383 (4)	17546 (3)	22585 (3)	20700 (6)	33943 (59)	18399 (3)	47737 (5)	32255 (3)
CHLOROPHYTA (GREEN ALGAE)	20966 (2)	45157 (1)	33061 (2)	9408 (1)	2258 (<1)	2258 (<1)	1344 (<1)	.a ( )	10010 (1)	5338 (1)	. ( )	. ( )	. ( )	1672 (<1)	2580 (<1)	2481 (<1)
CYANOPHYTA (BLUE-GREEN ALGAE)	. ( )	51930 (1)	25965 (1)	3763 (<1)	. ( )	452 (<1)	806 (<1)	1613 (<1)	3337 (<1)	458 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )
EUGLENOPHYTA (EUGLENOIDS)	1747 (<1)	. ( )	874 (<1)	. ( )	6773 (<1)	. ( )	. ( )	. ( )	1112 (<1)	. ( )	903 (<1)	941 (<1)	828 (<1)	836 (<1)	. ( )	1241 (<1)
CRYPTOPHYTA (CRYPTOPHYTES)	45426 (4)	146760 (3)	96093 (4)	43903 (3)	33868 (2)	28223 (3)	10752 (1)	8870 (2)	7785 (1)	9914 (2)	9031 (1)	6585 (2)	7451 (1)	8362 (2)	24514 (2)	24811 (2)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	1747 (<1)	11289 (<1)	6518 (<1)	3136 (<1)	. ( )	1129 (<1)	. ( )	. ( )	. ( )	763 (<1)	. ( )	. ( )	. ( )	. ( )	1290 (<1)	1241 (<1)
PRASINOPHYCEAE (PRASINOPHYTES)	20966 (2)	11289 (<1)	16127 (1)	34495 (2)	24836 (1)	14676 (2)	4032 (<1)	6451 (1)	2224 (<1)	1525 (<1)	. ( )	1411 (<1)	. ( )	1672 (<1)	3871 (<1)	7443 (1)
UNIDENTIFIED PHYTOFLAGELLATES	312739 (30)	541883 (12)	427311 (21)	310454 (21)	480921 (28)	190788 (22)	200249 (24)	124988 (22)	214650 (19)	87703 (15)	102055 (14)	77143 (22)	145706 (19)	121255 (23)	243847 (23)	265483 (27)
OTHERS	3494 (<1)	11289 (<1)	7392 (<1)	12544 (1)	6774 (<1)	2258 (<1)	1344 (<1)	1613 (<1)	3337 (<1)	2288 (<1)	. ( )	470 (<1)	828 (<1)	3345 (1)	5161 (<1)	1241 (<1)
TOTAL PHYTOPLANKTON	1046538	4454730	2750634	1471363	1706931	860695	831371	576557	1106626	597611	731550	346677	748401	529341	1060543	992459

STATION AND DEPTH[***]

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

a(.) = NOT OBSERVED.

TABLE D-8

PHYTOPLANKTON DENSITY[*] AND PERCENTAGE COMPOSITION[**]
ST. LUCIE PLANT
26 JULY 1979

STATION AND DEPTH[***]

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
BACILLARIOPHYTA	1763852 (89)	1934261 (81)	1849057 (85)	2104313 (94)	1297542 (81)	2263536 (88)	2449788 (87)	2455732 (89)	703790 (85)	1592640 (85)	886237 (78)	2909490 (89)	790092 (80)	1692307 (83)	1012180 (80)	1891926 (85)
PYRRHOPHYTA (DINOFLAGELLATES)	13596 (1)	15062 (1)	14329 (1)	15052 (1)	71179 (4)	21364 (1)	3763 (<1)	8008 (<1)	32034 (4)	28482 (2)	47453 (4)	40038 (1)	26344 (3)	40068 (2)	35882 (3)	24043 (1)
CHLOROPHYTA (GREEN ALGAE)	.[a] ( )	15052 (1)	7526 (1)	3010 (<1)	1483 (<1)	8008 (<1)	7526 (<1)	8008 (<1)	2669 (<1)	3559 (<1)	7118 (1)	5338 (<1)	5694 (1)	5339 (<1)	6406 (1)	12012 (1)
CYANOPHYTA (BLUE-GREEN ALGAE)	8153 (<1)	. ( )	4077 (<1)	. ( )	. ( )	1602 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )
EUGLENOPHYTA (EUGLENOIDS)	. ( )	3763 (<1)	1882 (<1)	. ( )	. ( )	2669 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	2002 (<1)
CRYPTOPHYTA (CRYPTOPHYTES)	. ( )	11289 (<1)	5645 (<1)	3010 (<1)	8897 (1)	18685 (1)	11289 (<1)	26692 (1)	3559 (<1)	10677 (1)	10677 (1)	8008 (<1)	2135 (<1)	8008 (<1)	8969 (1)	14013 (1)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	. ( )	. ( )	. ( )	. ( )	4449 (<1)	. ( )	. ( )	. ( )	2669 (<1)	. ( )	3559 (<1)	. ( )	2847 (<1)	. ( )	1281 (<1)	4004 (<1)
PRASINOPHYCEAE (PRASINOPHYTES)	2718 (<1)	3763 (<1)	3240 (<1)	. ( )	. ( )	. ( )	11289 (<1)	8008 (<1)	5338 (1)	. ( )	1186 (<1)	2669 (<1)	712 (<1)	2669 (<1)	5125 (<1)	. ( )
UNIDENTIFIED PHYTOFLAGELLATES	195680 (10)	387597 (16)	291638 (13)	111387 (5)	219470 (14)	245569 (10)	327388 (12)	248238 (9)	82746 (10)	233113 (12)	183880 (16)	314969 (10)	158730 (16)	293615 (14)	198591 (16)	274263 (12)
OTHERS	. ( )	3763 (<1)	1882 (<1)	3010 (<1)	2966 (<1)	2669 (<1)	3763 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	5338 (<1)	. ( )	. ( )
TOTAL PHYTOPLANKTON	1983999	2374551	2179275	2239783	1605986	2564102	2814806	2754686	832806	1868470	1140111	3280513	986555	2047344	1268434	2222263

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a](.) = NOT OBSERVED.

TABLE D-9

PHYTOPLANKTON DENSITY[*] AND PERCENTAGE COMPOSITION[**]
ST. LUCIE PLANT
21 AUGUST 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
	STATION AND DEPTH[***]															
BACILLARIOPHYTA	173913 (37)	303364 (37)	238638 (37)	267889 (54)	1114104 (85)	290613 (41)	856230 (81)	103440 (18)	406179 (69)	95121 (20)	111805 (37)	21952 (7)	585597 (75)	71243 (23)	191300 (55)	46430 (18)
PYRRHOPHYTA (DINOFLAGELLATES)	40529 (9)	66427 (8)	53478 (8)	27646 (6)	39037 (3)	59316 (8)	54025 (5)	95265 (17)	62152 (11)	56590 (12)	50537 (17)	48049 (16)	58723 (8)	40928 (13)	38558 (11)	39617 (15)
CHLOROPHYTA (GREEN ALGAE)	6537 (1)	18321 (2)	12429 (2)	13346 (3)	8008 (1)	26692 (4)	12919 (1)	56113 (10)	14191 (2)	40928 (9)	23433 (8)	28768 (9)	15605 (2)	23430 (8)	26198 (8)	44275 (17)
CYANOPHYTA (BLUE-GREEN ALGAE)	654 (<1)	1019 (<1)	836 (<1)	5815 (1)	.[a] ( )	. ( )	1292 (<1)	457 (<1)	979 (<1)	819 (<1)	. ( )	415 (<1)	246 (<1)	386 (<1)	717 (<1)	466 (<1)
EUGLENOPHYTA (EUGLENOIDS)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	411 (<1)	297 (<1)	. ( )	212 (<1)
CRYPTOPHYTA (CRYPTOPHYTES)	30723 (7)	64274 (8)	47499 (7)	17159 (3)	4004 (<1)	54571 (8)	11157 (1)	30666 (5)	3915 (1)	28116 (6)	7340 (2)	23726 (8)	3285 (<1)	18388 (6)	2966 (1)	9533 (4)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	654 (<1)	. ( )	327 (<1)	953 (<1)	3003 (<1)	1186 (<1)	4698 (<1)	9135 (2)	1468 (<1)	7474 (2)	847 (<1)	1779 (1)	1643 (<1)	3856 (1)	2472 (1)	3601 (1)
PRASINOPHYCEAE (PRASINOPHYTES)	9152 (2)	25509 (3)	17330 (3)	1907 (<1)	8008 (1)	9491 (1)	4698 (<1)	15007 (3)	489 (<1)	6762 (1)	. ( )	6228 (2)	411 (<1)	2373 (1)	494 (<1)	2542 (1)
UNIDENTIFIED PHYTOFLAGELLATES	206566 (44)	329589 (41)	268077 (42)	163967 (33)	130125 (10)	254467 (36)	113923 (11)	262296 (46)	101297 (17)	238807 (50)	110670 (36)	175873 (57)	115393 (15)	147104 (47)	84278 (24)	117361 (44)
OTHERS	. ( )	728 (<1)	364 (<1)	1907 (<1)	. ( )	5932 (1)	. ( )	3262 (1)	. ( )	2135 (<1)	565 (<1)	297 (<1)	821 (<1)	2966 (1)	247 (<1)	1059 (<1)
TOTAL PHYTOPLANKTON	468726	809231	638979	500589	1306289	702267	1058942	575642	590671	476751	305198	307088	782135	310969	347231	265098

[*] VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

[**] PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

[***] S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED.

TABLE D-10

PHYTOPLANKTON DENSITY* AND PERCENTAGE COMPOSITION**
ST. LUCIE PLANT
7 SEPTEMBER 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
	STATION AND DEPTH***															
BACILLARIOPHYTA	457593 (45)	889793 (59)	673693 (52)	1067691 (62)	1747995 (84)	679146 (64)	916084 (76)	681454 (66)	508541 (73)	258253 (61)	570918 (73)	216509 (53)	539188 (76)	346469 (55)	756574 (86)	226008 (62)
PYRRHOPHYTA (DINOFLAGELLATES)	45758 (4)	42263 (3)	44011 (4)	40038 (2)	26341 (1)	27417 (3)	36704 (3)	36035 (3)	26692 (4)	25027 (6)	22837 (3)	26396 (6)	20210 (3)	31498 (5)	12812 (1)	25209 (7)
CHLOROPHYTA (GREEN ALGAE)	12711 (1)	6673 (<1)	9692 (1)	23356 (1)	.a ( )	6451 (1)	6606 (1)	9509 (1)	4805 (1)	3003 (1)	10440 (1)	6821 (2)	8389 (1)	11745 (2)	4484 (1)	6228 (2)
CYANOPHYTA (BLUE-GREEN ALGAE)	. ( )	. ( )	. ( )	334 (<1)	. ( )	. ( )	. ( )	1602 (<1)	534 (<1)	. ( )	652 (<1)	297 (<1)	. ( )	. ( )	. ( )	. ( )
EUGLENOPHYTA (EUGLENOIDS)	. ( )	. ( )	. ( )	. ( )	. ( )	1613 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	1186 (<1)	. ( )	. ( )	. ( )	. ( )
CRYPTOPHYTA (CRYPTOPHYTES)	96601 (9)	91199 (6)	93900 (8)	136798 (8)	77143 (4)	53221 (5)	46244 (4)	57655 (6)	20820 (3)	26025 (6)	14354 (2)	26989 (7)	14871 (2)	49114 (8)	16656 (2)	24913 (7)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	501 (<1)	. ( )	297 (<1)	. ( )	. ( )	. ( )	. ( )
PRASINOPHYCEAE (PRASINOPHYTES)	7626 (1)	22244 (1)	14935 (1)	6673 (<1)	20697 (1)	4838 (<1)	9542 (1)	9609 (1)	4271 (1)	5505 (1)	. ( )	3262 (1)	2669 (<1)	2669 (<1)	1281 (<1)	3559 (1)
UNIDENTIFIED PHYTOFLAGELLATES	396571 (39)	442647 (30)	419609 (34)	440423 (26)	210732 (10)	291907 (27)	179839 (15)	240231 (23)	129724 (19)	106102 (25)	160510 (21)	129013 (31)	125835 (18)	190583 (30)	91608 (10)	75925 (21)
OTHERS	. ( )	2224 (<1)	1112 (<1)	. ( )	. ( )	. ( )	1468 (<1)	1602 (<1)	. ( )	1001 (<1)	652 (<1)	. ( )	. ( )	. ( )	. ( )	2966 (1)
TOTAL PHYTOPLANKTON	1016860	1497043	1256952	1715313	2082909	1064593	1196488	1037795	695387	425416	780364	410769	711163	632078	883416	364808

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

a( ) = NOT OBSERVED.

TABLE D-11

PHYTOPLANKTON DENSITY* AND PERCENTAGE COMPOSITION**
ST. LUCIE PLANT
2 OCTOBER 1979

STATION AND DEPTH***

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
BACILLARIOPHYTA	241470 (24)	370287 (24)	305878 (24)	428092 (54)	310912 (19)	350203 (19)	778525 (15)	777306 (16)	354807 (38)	438543 (40)	360905 (46)	578659 (42)	403276 (43)	412130 (46)	450499 (51)	474313 (44)
PYRRHOPHYTA (DINOFLAGELLATES)	114983 (12)	144502 (9)	129742 (10)	115602 (15)	211670 (13)	228495 (13)	298064 (6)	226351 (5)	61170 (7)	72074 (7)	31197 (4)	98190 (7)	44376 (5)	46982 (5)	34405 (4)	46254 (4)
CHLOROPHYTA (GREEN ALGAE)	11498 (1)	14450 (1)	12974 (1)	21675 (3)	32618 (2)	34165 (2)	80077 (2)	64061 (1)	20798 (2)	14236 (1)	24468 (3)	20972 (2)	24913 (3)	32031 (4)	7526 (1)	29007 (3)
CYANOPHYTA (BLUE-GREEN ALGAE)	1045 (<1)	( )[a]	523 (<1)	3071 (<1)	833 (<1)	2135 (<1)	1780 (<1)	( )	1223 (<1)	( )	( )	( )	156 (<1)	2829 (<1)	645 (<1)	1568 (<1)
EUGLENOPHYTA (EUGLENOIDS)	( )	( )	( )	( )	1388 (<1)	( )	( )	12812 (<1)	612 (<1)	1779 (<1)	( )	( )	( )	( )	1075 (<1)	( )
CRYPTOPHYTA (CRYPTOPHYTES)	235192 (24)	335968 (22)	285580 (23)	27094 (3)	349082 (21)	379030 (21)	1441384 (28)	1264147 (26)	168829 (18)	153036 (14)	87473 (11)	196379 (14)	114443 (12)	85415 (10)	145147 (16)	124652 (12)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	( )	( )	( )	( )	694 (<1)	1068 (<1)	8897 (<1)	4271 (<1)	( )	1779 (<1)	( )	953 (<1)	( )	534 (<1)	( )	( )
PRASINOPHYCEAE (PRASINOPHYTES)	73171 (7)	113795 (7)	93483 (7)	3613 (<1)	144352 (9)	146274 (8)	235782 (5)	222080 (5)	16516 (2)	15126 (1)	13457 (2)	30505 (2)	14014 (1)	36301 (4)	13977 (2)	16463 (2)
UNIDENTIFIED PHYTOFLAGELLATES	313590 (32)	578009 (37)	445799 (34)	191465 (24)	594758 (36)	657698 (37)	2273293 (44)	2233611 (46)	298509 (32)	403054 (37)	261807 (34)	452816 (33)	338658 (36)	278134 (31)	234386 (26)	380228 (35)
OTHERS	3136 (<1)	( )	1568 (<1)	1806 (<1)	694 (<1)	( )	4449 (<1)	( )	( )	890 (<1)	( )	( )	( )	( )	1075 (<1)	784 (<1)
TOTAL PHYTOPLANKTON	994085	1557011	1275548	792418	1647000	1799070	5122250	4804639	922463	1100617	779307	1378475	939836	894356	888736	1073269

* VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

** PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

*** S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED.

TABLE D-12

PHYTOPLANKTON DENSITY AND PERCENTAGE COMPOSITION[*] [**]
ST. LUCIE PLANT
30 OCTOBER 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
	STATION AND DEPTH[***]															
BACILLARIOPHYTA	1916714 (58)	2738795 (56)	2327754 (57)	3075515 (74)	2598309 (75)	18050487 (84)	316565 (75)	3612189 (76)	865525 (74)	1281037 (75)	645208 (54)	960411 (62)	872213 (60)	775010 (72)	870057 (70)	1123541 (73)
PYRRHOPHYTA (DINOFLAGELLATES)	110384 (3)	52265 (1)	81324 (2)	85610 (2)	85415 (2)	59316 (<1)	10796 (3)	94376 (2)	42925 (4)	60490 (4)	48931 (4)	47621 (3)	53207 (4)	42801 (4)	52050 (4)	54827 (4)
CHLOROPHYTA (GREEN ALGAE)	5017 (<1)	41812 (1)	23415 (1)	52683 (1)	.[a] ( )	. ( )	385 (<1)	20019 (<1)	3844 (<1)	7931 (<1)	18345 (2)	18527 (1)	6940 (<1)	4627 (<1)	1652 (<1)	3915 (<1)
CYANOPHYTA (BLUE-GREEN ALGAE)	2007 (<1)	15680 (<1)	8843 (<1)	19756 (<1)	14592 (<1)	. ( )	308 (<1)	. ( )	3203 (<1)	3569 (<1)	. ( )	2070 (<1)	4164 (<1)	925 (<1)	1487 (<1)	979 (<1)
EUGLENOPHYTA (EUGLENOIDS)	. ( )	. ( )	. ( )	. ( )	. ( )	. ( )	386 (<1)	. ( )	. ( )	. ( )	3058 (<1)	. ( )	. ( )	. ( )	. ( )	979 (<1)
CRYPTOPHYTA (CRYPTOPHYTES)	165575 (5)	365855 (8)	265715 (6)	111952 (3)	124564 (4)	433008 (2)	16193 (4)	177313 (4)	33312 (3)	49571 (3)	51978 (4)	76579 (5)	82123 (6)	35857 (3)	47919 (4)	60680 (4)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	5017 (<1)	. ( )	2509 (<1)	. ( )	. ( )	. ( )	386 (<1)	5720 (<1)	641 (<1)	2974 (<1)	. ( )	. ( )	2313 (<1)	2313 (<1)	. ( )	1957 (<1)
PRASINOPHYCEAE (PRASINOPHYTES)	15052 (<1)	83624 (2)	49338 (1)	. ( )	14236 (<1)	. ( )	4241 (1)	37179 (1)	5125 (<1)	991 (<1)	9173 (1)	24836 (2)	16193 (1)	17350 (2)	18176 (1)	2936 (<1)
UNIDENTIFIED PHYTOFLAGELLATES	1068714 (32)	1547043 (32)	1307878 (32)	810002 (19)	590789 (17)	2817520 (13)	72099 (17)	737851 (16)	208200 (18)	303377 (18)	409705 (35)	418078 (27)	394423 (27)	198947 (18)	254467 (20)	288722 (19)
OTHERS	. ( )	10453 (<1)	5227 (<1)	13171 (<1)	14236 (<1)	41521 (<1)	1928 (<1)	48518 (1)	2562 (<1)	2974 (<1)	. ( )	. ( )	10410 (1)	1157 (<1)	3305 (<1)	4894 (<1)
TOTAL PHYTOPLANKTON	3288480	4855525	4072003	4168689	3442141	21401852	423287	4733265	1165337	1712915	1185397	1548222	1441987	1078986	1249113	1543530

[*] VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

[**] PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

[***] S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED.

TABLE D- 13

PHYTOPLANKTON DENSITY AND PERCENTAGE COMPOSITION[*] [**]
ST. LUCIE PLANT
28 NOVEMBER 1979

TAXON	11 S	11 B	11 AVG.	12 S	0 S	0 B	1 S	1 B	2 S	2 B	3 S	3 B	4 S	4 B	5 S	5 B
	STATION AND DEPTH[***]															
BACILLARIOPHYTA	1895716 (69)	216660 (72)	1056188 (71)	2163836 (79)	693052 (62)	6569603 (77)	1962409 (68)	1716879 (71)	288014 (35)	1307130 (76)	215870 (36)	2647310 (77)	206936 (27)	542813 (69)	584293 (59)	856638 (69)
PYRRHOPHYTA (DINOFLAGELLATES)	42335 (2)	5376 (2)	23855 (2)	56446 (2)	25872 (2)	88974 (1)	32255 (1)	50184 (2)	43724 (5)	19278 (1)	24636 (4)	40063 (1)	23834 (3)	14251 (2)	16237 (2)	22803 (2)
CHLOROPHYTA (GREEN ALGAE)	14112 (1)	538 (<1)	7325 (<1)	5272 (<1)	4957 (<1)	. ( )	32255 (1)	28671 (1)	11104 (1)	3856 (<1)	5186 (1)	13346 (<1)	3737 (<1)	6228 (1)	7687 (1)	6940 (1)
CYANOPHYTA (BLUE-GREEN ALGAE)	.[a] ( )	1344 (<1)	672 (<1)	18815 (1)	991 (<1)	. ( )	26879 (1)	7168 (<1)	4303 (1)	5783 (<1)	4343 (1)	4894 (<1)	2102 (<1)	. ( )	1110 (<1)	. ( )
EUGLENOPHYTA (EUGLENOIDS)	. ( )	. ( )	. ( )	6272 (<1)	991 (<1)	. ( )	. ( )	. ( )	. ( )	. ( )	2593 (<1)	. ( )	1868 (<1)	. ( )	. ( )	. ( )
CRYPTOPHYTA (CRYPTOPHYTES)	216377 (8)	22578 (8)	119478 (8)	75262 (3)	71383 (5)	177949 (2)	215033 (7)	175610 (7)	77728 (9)	53978 (3)	71955 (12)	66731 (2)	107436 (14)	43597 (6)	69186 (7)	63451 (5)
CHRYSOPHYCEAE (YELLOW-BROWN ALGAE AND SILICOFLAGELLATES)	4704 (<1)	. ( )	2352 (<1)	. ( )	991 (<1)	. ( )	. ( )	3584 (<1)	4858 (1)	. ( )	3889 (1)	4449 (<1)	4204 (1)	890 (<1)	854 (<1)	3966 (<1)
PRASINOPHYCEAE (PRASINOPHYTES)	. ( )	2150 (1)	1075 (<1)	. ( )	21811 (2)	. ( )	21503 (1)	7168 (<1)	39558 (5)	7711 (<1)	27874 (5)	. ( )	46244 (6)	890 (<1)	17083 (2)	5949 (<1)
UNIDENTIFIED PHYTOFLAGELLATES	564462 (21)	50533 (17)	307497 (19)	426482 (15)	282557 (25)	1408760 (17)	564461 (20)	394227 (16)	345612 (42)	291094 (18)	241146 (40)	591679 (17)	357343 (47)	162823 (21)	286996 (29)	257771 (21)
OTHERS	9408 (<1)	. ( )	4704 (<1)	. ( )	23794 (2)	237265 (3)	26879 (1)	39423 (2)	7634 (1)	25061 (2)	5186 (1)	57833 (2)	8875 (1)	16905 (2)	10250 (1)	25777 (2)
TOTAL PHYTOPLANKTON	2747113	299179	1523146	2753385	1126401	8482551	2881675	2422913	822535	1713891	602678	3426305	762581	788397	993697	1253295

[*] VALUES ARE EXPRESSED AS CELLS PER LITER AND REPRESENT THE MEAN OF THREE REPLICATES.

[**] PERCENTAGE VALUES ARE GIVEN IN PARENTHESES

[***] S=SURFACE; B=BOTTOM; AVG.=THE AVERAGE OF STATION 11 S AND B VALUES.

[a]( ) = NOT OBSERVED

TABLE D-14

SEASONAL[a] OCCURRENCE OF MAJOR PHYTOPLANKTON SPECIES
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

1976

Winter	Spring	Summer	Autumn
	Asterionella japonica	Nitzschia delicatissima	Nitzschia closterium
	Leptocylindrus danicus	Skeletonema costatum	Skeletonema costatum
	Nitzschia delicatissima	Thalassiosira sp. 1	Thalassiosira sp. 1
	Skeletonema costatum	Chlorophyte sp. 1	Prasinophyte sp. 1
	Chlorophyte sp. 1		

1977

Winter	Spring	Summer	Autumn
Nitzschia closterium	Asterionella japonica	Chlorophyte sp. 1	Nitzschia closterium
Skeletonema costatum	Leptocylindrus danicus		N. delicatissima
Chlorophyte sp. 1	Chlorophyte sp. 1		Skeletonema costatum
Prasinophyte sp. 1			Thalassiosira sp. 1
			Thalassionema nitzschioides
			Tropidoneis lepidoptera

TABLE D-14
(continued)
SEASONAL[a] OCCURRENCE OF MAJOR PHYTOPLANKTON SPECIES
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

1978

Winter	Spring	Summer	Autumn
Asterionella japonica	Asterionella japonica	Leptocylindrus danicus	Leptocylindrus danicus
Nitzschia delicatissima	Nitzschia closterium	Nitzschia delicatissima	Nitzschia closterium
Skeletonema costatum	N. delicatissima	Skeletonema costatum	N. delicatissima
	Skeletonema costatum		Skeletonema costatum
	Thalassionema nitzschioides		Thalassiosira sp. 1
	Chlorophyte sp. 1		Thalassionema nitzschioides
			Tropidoneis lepidoptera
			Chlorophyte sp. 1
			Prasinophyte sp. 1

1979

Winter	Spring	Summer	Autumn
Asterionella japonica	Leptocylindrus danicus	Leptocylindrus danicus	Nitzschia closterium
Nitzschia closterium	Nitzschia closterium	Nitzschia delicatissima	N. delicatissima
Skeletonema costatum	N. delicatissima	Rhizosolenia stolterfothii	Leptocylindrus danicus
Thalassiosira sp. 1	Skeletonema costatum	Skeletonema costatum	Skeletonema costatum
Tropidoneis lepidoptera	Thalassionema nitzschioides		Thalassiosira sp. 1
	Thalassiosira sp. 1		
	Chlorophyte sp. 1		

[a]Winter = December (of preceding year), January and February.

Spring = March, April, May.

Summer = June, July, August.

Autumn = September, October, November.

TABLE D-15

STATISTICAL COMPARISON OF TOTAL PHYTOPLANKTON DENSITY
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square
Model	5	12.94531067	2.58906213
Error	209	102.59794173	0.49089924
Corrected total	214	115.54325240	

Source	DF	Type I SS	F value	PR > F
Station	5	12.94531067	5.27	0.0002

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=209 MS=0.490899

GROUPING	MEAN	N	STATION
A	14.532400	36	1
A	14.468734	36	0
B	14.068496	36	5
B	14.065866	36	4
B	14.039303	36	2
B	13.847990	35	3

[a]Means with the same letter are not significantly different.

TABLE D-16

STATISTICAL COMPARISON OF TOTAL PHYTOPLANKTON DENSITY
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square
Model	5	16.47070597	3.29414119
Error	208	253.99865825	1.22114740
Corrected total	213	270.46936421	

Source	DF	Type I SS	F value	PR > F
Station	5	16.47070597	2.70	0.0218

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=208 MS=1.22115

GROUPING			MEAN	N	STATION
	A		14.704598	36	1
B	A		14.641334	36	0
B	A	C	14.188633	36	5
B		C	14.115034	35	2
		C	14.058031	35	4
		C	14.025721	36	3

[a]Means with the same letter are not significantly different.

TABLE D-17

STATISTICAL COMPARISON OF TOTAL PHYTOPLANKTON DENSITY
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	28.76289748	1.25056076
Error	246	147.79059696	0.60077478
Corrected total	269	176.55349444	

Source	DF	Type I SS	F value	PR > F
Year	3	16.33919146	9.07	0.0001
Station	5	10.66129229	3.55	0.0042
Station x Year	15	1.76241373	0.20	0.9995

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=246 MS=0.600775

GROUPING	MEAN	N	STATION
A	14.237177	45	1
B A	14.116186	45	0
B C	13.892352	45	5
B C	13.862140	45	2
B C	13.789382	45	4
C	13.643011	45	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=246 MS=0.600775

GROUPING	MEAN	N	YEAR
A	14.234651	66	79
A	14.102640	60	76
B	13.797779	72	78
B	13.614246	72	77

[a]Means with the same letter are not significantly different.

TABLE D-18

STATISTICAL COMPARISON OF TOTAL PHYTOPLANKTON DENSITY
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	33.03815209	1.43644140
Error	246	201.42393263	0.81879647
Corrected total	269	234.46208472	

Source	DF	Type I SS	F value	PR > F
Year	3	17.42366379	7.09	0.0002
Station	5	13.72485518	3.35	0.0061
Station x Year	15	1.88963312	0.15	1.0000

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=246 MS=0.818796

GROUPING	MEAN	N	STATION
A	14.495863	45	1
B A	14.404814	45	0
B C	14.089892	45	5
B C	14.013752	45	2
B C	13.999840	45	4
C	13.874690	45	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=246 MS=0.818796

GROUPING	MEAN	N	YEAR
A	14.433692	60	76
B A	14.351700	66	79
B C	14.079842	72	78
C	13.785638	72	77

[a]Means with the same letter are not significantly different.

TABLE D-19

CORRELATIONS OF PHYTOPLANKTON DENSITIES, CHLOROPHYLLS-a, -b AND -c, PHAEOPIGMENTS AND CAROTENOIDS VERSUS CHEMICAL AND PHYSICAL PARAMETERS. OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

Parameter	Temperature	Salinity	Dissolved oxygen	Nitrate	Nitrite	Ammonia	Phosphate	Silicate
Density	-0.56656[a]	-0.18320	0.48999	0.06013	-0.04877	0.15122	-0.02039	-0.10857
	0.0001[b]	0.1235	0.0001	0.6159	0.6841	0.2048	0.8650	0.3640
	72[c]	72	66	72	72	72	72	72
Chlorophyll-a	-0.37191	-0.33395	-0.06257	0.10966	0.26012	0.03800	-0.33558	0.02796
	0.0013	0.0041	0.6177	0.3591	0.0273	0.7513	0.0040	0.8157
	72	72	66	72	72	72	72	72
Chlorophyll-b	0.32135	-0.18283	-0.51314	-0.16888	0.17066	-0.50322	-0.46527	-0.02477
	0.0059	0.1242	0.0001	0.1561	0.1518	0.0001	0.0001	0.8364
	72	72	66	72	72	72	72	72
Chlorophyll-c	-0.00788	-0.36834	-0.41969	-0.03856	0.18857	-0.32523	-0.49206	-0.06217
	0.9476	0.0015	0.0005	0.7478	0.1127	0.0053	0.0001	0.6039
	72	72	66	72	72	72	72	72
Phaeopigments	0.02978	-0.26845	-0.13363	0.06149	-0.14187	-0.06781	0.02143	-0.13390
	0.8039	0.0226	0.2848	0.6079	0.2345	0.5714	0.8582	0.2621
	72	72	66	72	72	72	72	72
Carotenoids	-0.40845	-0.46519	-0.13752	0.25467	0.19624	0.10702	-0.33983	-0.00268
	0.0004	0.0001	0.2708	0.0309	0.0985	0.3709	0.0035	0.9822
	72	72	66	72	72	72	72	72

[a]Correlation coefficient.

[b]Probability of a greater R value for the null hypothesis.

[c]Number of observations (n).

TABLE D-20

CORRELATIONS OF PHYTOPLANKTON DENSITIES, CHLOROPHYLLS-a, -b AND -c, PHAEOPIGMENTS AND CAROTENOIDS VERSUS CHEMICAL AND PHYSICAL PARAMETERS OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

Parameter	Temperature	Salinity	Dissolved oxygen	Nitrate	Nitrite	Ammonia	Phosphate	Silicate
Density	-0.43750[a] 0.0001[b] 72[c]	-0.32609 0.0052 72	0.29944 0.0146 66	-0.20754 0.0802 72	-0.11078 0.3542 72	0.00354 0.9765 72	-0.25201 0.0327 72	-0.26638 0.0237 72
Chlorophyll-a	-0.25260 0.0323 72	-0.41432 0.0003 72	-0.01923 0.8782 66	-0.13599 0.2547 72	0.01747 0.8842 72	-0.02581 0.8296 72	-0.39794 0.0005 72	-0.17330 0.1455 72
Chlorophyll-b	0.28174 0.0165 72	-0.20391 0.0858 72	-0.37160 0.0021 66	0.05043 0.6740 72	0.11030 0.3563 72	-0.44819 0.0001 72	-0.52697 0.0001 72	-0.00248 0.9835 72
Chlorophyll-c	-0.01610 0.8932 72	-0.40714 0.0004 72	-0.24190 0.0504 66	-0.01880 0.8755 72	0.01016 0.9325 72	-0.30106 0.0102 72	-0.56968 0.0001 72	-0.12287 0.3038 72
Phaeopigments	-0.16231 0.1731 72	-0.33675 0.0038 72	0.01760 0.8884 66	0.08025 0.5028 72	-0.20323 0.0869 72	-0.20044 0.0914 72	-0.16210 0.1737 72	-0.11764 0.3250 72
Carotenoids	-0.25732 0.0291 72	-0.47309 0.0001 72	-0.08452 0.4999 66	-0.05233 0.6624 72	0.00836 0.9445 72	-0.00685 0.9544 72	-0.42892 0.0002 72	-0.15756 0.1862 72

[a]Correlation coefficient.

[b]Probability of a greater R value for the null hypothesis.

[c]Number of observations (n).

TABLE D-21

PHYTOPLANKTON STEPWISE ANALYSIS[a]
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

SURFACE

R square = 0.22151630

	DF	Sum of squares	Mean square	F	PROB>F
Regression	2	6.42469556	3.21234778	9.82	0.0002
Error	69	22.57856794	0.32722562		
Total	71	29.00326350			

	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
R Temperature[b]	-0.13123682	0.03254336	5.32149692	16.26	0.0001
R Ammonia	-5.86070124	2.04030609	2.69995059	8.25	0.0054

BOTTOM

R square = 0.33811460

	DF	Sum of squares	Mean square	F	PROB>F
Regression	3	26.17239996	8.72413332	11.58	0.0001
Error	68	51.23449186	0.75344841		
Total	71	77.40689182			

	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
R Temperature	-0.18242435	0.04885984	10.50304049	13.94	0.0004
R Ammonia	-8.30239808	2.60196303	7.67111306	10.18	0.0021
R Phosphate	-68.96478756	21.92883135	7.45207730	9.89	0.0025

[a]The last step to include only significant type II sums of squares was selected as the best model.

[b]The prefix R indicates residual variance for each variable after seasonal adjustment.

TABLE D-22

COMPARISON OF INTAKE (STATION 11) AND DISCHARGE (STATION 12) PHYTOPLANKTON
ST. LUCIE PLANT
JANUARY 1979 - NOVEMBER 1979

Date	Temperature in °F (°C)		ΔT (°C)	Intake[a] (cells/liter)	Discharge (cells/liter)	Change in cell count[b] (%)
	Intake[a]	Discharge				
17 Jan	69.4 (20.8)	92.3 (33.5)	22.9 (12.7)	2,027,413	1,561,677	-23.0
13 Feb	65.5 (18.6)	87.6 (30.9)	22.1 (12.3)	2,008,031	1,307,670	-34.9
6 Apr	70.5 (21.4)	73.4 (23.0)	2.9 (1.6)	24,435,540	18,683,676	-23.5
27 Apr	74.8 (23.8)	76.3 (24.6)	1.5 (0.8)	11,508,545	7,730,434	-32.8
15 May	74.3 (23.5)	77.2 (25.1)	2.9 (1.6)	12,745,541	9,548,808	-25.1
12 Jun	77.7 (25.4)	91.8 (33.2)	14.1 (7.8)	2,750,634	1,471,363	-46.5
26 Jul	75.0 (23.9)	99.3 (37.4)	24.3 (13.5)	2,179,276	2,239,783	+2.8
21 Aug	78.8 (26.0)	99.5 (37.5)	20.7 (11.5)	638,979	500,589	-21.7
7 Sep	72.0 (22.2)	94.6 (34.8)	22.6 (12.6)	1,256,952	1,715,313	+36.5
2 Oct	80.8 (27.1)	94.6 (34.8)	13.8 (7.7)	1,275,548	792,418	-37.9
30 Oct	76.3 (24.6)	98.6 (37.0)	22.3 (12.4)	4,072,003	4,168,689	+2.4

[a] Average of surface and bottom values.

[b] Change in cell count = $\frac{\text{Discharge count} - \text{Intake count}}{\text{Intake count}} \times 100$

TABLE D-23

STATISTICAL COMPARISON OF TOTAL PHYTOPLANKTON DENSITY
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square	
Model	1	0.25576742	0.25576742	
Error	22	27.02887031	1.22858501	
Corrected total	23	27.28463773		
Source	DF	Type I SS	F value	PR > F
Station	1	0.25576742	0.21	0.6527

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=22 MS=1.22859

GROUPING	MEAN	N	STATION
A	14.877602	12	11
A	14.671137	12	12

[a]Means with the same letter are not significantly different.

TABLE D-24

STATISTICAL COMPARISON OF TOTAL PHYTOPLANKTON DENSITY
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	7	13.49271304	1.92753043
Error	82	70.72824787	0.86253961
Corrected total	89	84.22096091	

Source	DF	Type I SS	F value	PR > F
Station	1	2.70421437	3.14	0.0803
Year	3	10.04279253	3.88	0.0120
Station x Year	3	0.74570614	0.29	0.8350

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=82 MS=0.86254

GROUPING	MEAN	N	STATION
A	14.657820	45	11
A	14.311140	45	12

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=82 MS=0.86254

GROUPING	MEAN	N	YEAR
A	14.860317	22	79
A	14.716584	20	76
A B	14.438430	24	78
B	13.992593	24	77

[a]Means with the same letter are not significantly different.

TABLE D-25

CORRELATIONS OF PHYTOPLANKTON DENSITIES, CHLOROPHYLLS-a, -b AND -c, PHAEOPIGMENTS AND CAROTENOIDS VERSUS CHEMICAL AND PHYSICAL PARAMETERS
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

Parameter	Temperature	Salinity	Dissolved oxygen	Nitrate	Nitrite	Ammonia	Phosphate	Silicate
Density	-0.47815[a]	-0.11751	0.51806	-0.28236	-0.30188	0.46686	-0.23454	0.01730
	0.0181[b]	0.6025	0.0135	0.1813	0.1517	0.0214	0.2700	0.9361
	24[c]	22	22	24	24	24	24	24
Chlorophyll-a	-0.54638	0.03476	0.57568	-0.26367	-0.19544	0.51991	-0.16586	0.07402
	0.0058	0.8780	0.0051	0.2132	0.3601	0.0092	0.4386	0.7310
	24	22	22	24	24	24	24	24
Chlorophyll-b	0.26164	-0.34194	-0.66247	0.35600	0.16333	-0.33613	-0.12998	-0.06276
	0.2168	0.1193	0.0008	0.0877	0.4457	0.1083	0.5449	0.7708
	24	22	22	24	24	24	24	24
Chlorophyll-c	-0.56233	-0.03574	0.42173	-0.17919	-0.21907	0.43164	-0.23361	0.08158
	0.0043	0.8745	0.0506	0.4022	0.3037	0.0352	0.2719	0.7047
	24	22	22	24	24	24	24	24
Phaeopigments	0.12827	0.07867	-0.38353	0.35576	0.20561	-0.37504	-0.04426	0.44572
	0.5503	0.7279	0.0781	0.0880	0.3351	0.0709	0.8373	0.0290
	24	22	22	24	24	24	24	24
Carotenoids	-0.60808	0.04889	0.47971	-0.25190	-0.20845	0.44131	-0.13254	0.03787
	0.0016	0.8290	0.0239	0.2351	0.3283	0.0309	0.5370	0.8605
	24	22	22	24	24	24	24	24

[a]Correlation coefficient.

[b]Probability of a greater R value for the null hypothesis.

[c]Number of observations (n).

TABLE D-26

ACTIVE CHLOROPHYLL-a AND PHAEOPIGMENTS[a]
ST. LUCIE PLANT
1979

Date	Station	Chlorophyll-a (mg/m^3) S	B	A	Phaeopigment (mg/m^3) S	B	A
17 JAN	0	2.34	2.83	2.59	1.07	1.65	1.36
	1	3.06	3.29	3.18	0.76	0.98	0.87
	2	2.06	2.29	2.17	1.06	1.25	1.16
	3	2.53	1.69	2.11	0.71	1.29	1.00
	4	1.80	0.96	1.38	1.06	1.73	1.39
	5	2.85	4.51	3.68	0.58	0.55	0.57
	11	2.88	3.77	3.33	0.79	0.74	0.76
	12	1.36	-	1.36	1.21	-	1.21
13 FEB	0	1.25	2.00	1.63	0.75	0.66	0.71
	1	3.35	2.80	3.07	0.78	0.75	0.77
	2	1.18	1.16	1.17	0.70	0.84	0.77
	3	0.66	0.70	0.68	0.90	0.87	0.88
	4	0.75	0.73	0.74	0.74	0.97	0.85
	5	0.80	1.12	0.96	1.22	1.34	1.28
	11	2.21	2.14	2.17	0.90	1.45	1.17
	12	1.48	-	1.48	0.93	-	0.93

(Column group heading: Pigment and Depth[b])

[a]Phaeopigment = Phaeophytin-a plus phaeophorbide-a.

[b]S = Surface; B = Bottom; A = Average. S and B values represent mean of duplicate determinations.

TABLE D-26
(continued)
ACTIVE CHLOROPHYLL-a AND PHAEOPIGMENTS[a]
ST. LUCIE PLANT
1979

		Pigment and Depth[b]					
		Chlorophyll-a (mg/m^3)			Phaeopigment (mg/m^3)		
Date	Station	S	B	A	S	B	A
6 APR	0	4.62	5.01	4.82	ND[c]	ND	ND
	1	6.10	4.80	5.45	ND	0.06	0.03
	2	6.52	7.01	6.76	ND	ND	ND
	3	5.57	5.35	5.46	ND	ND	ND
	4	5.90	6.13	6.01	ND	0.04	0.02
	5	8.03	7.57	7.80	ND	ND	ND
	11	9.79	12.30	11.04	1.74	0.68	1.21
	12	14.49	-	14.49	0.30	-	0.30
27 APR	0	1.42	3.06	2.24	2.42	0.21	1.32
	1	1.60	2.63	2.12	0.31	0.35	0.33
	2	1.36	1.04	1.20	0.43	0.33	0.38
	3	1.32	0.87	1.09	0.22	0.44	0.33
	4	1.61	0.68	1.15	0.90	0.40	0.65
	5	2.30	3.39	2.84	0.11	0.26	0.18
	11	5.77	6.68	6.23	0.20	0.08	0.14
	12	8.23	-	8.23	0.34	-	0.34

[a]Phaeopigment = Phaeophytin-a plus phaeophorbide-a.

[b]S = Surface; B = Bottom; A = Average. S and B values represent mean of duplicate determinations.

[c]ND = Not detected.

TABLE D-26
(continued)
ACTIVE CHLOROPHYLL-a AND PHAEOPIGMENTS[a]
ST. LUCIE PLANT
1979

		Pigment and Depth[b]					
		Chlorophyll-a (mg/m^3)			Phaeopigment (mg/m^3)		
Date	Station	S	B	A	S	B	A
15 MAY	0	1.84	6.79	4.31	0.52	3.90	2.21
	1	1.37	5.38	3.37	0.75	1.85	1.30
	2	0.91	2.71	1.81	0.42	1.31	0.87
	3	1.33	1.55	1.44	0.60	0.73	0.67
	4	2.73	8.40	5.56	0.80	4.10	2.45
	5	0.94	3.65	2.30	0.63	1.63	1.13
	11	17.90	5.66	11.78	ND[c]	1.44	0.72
	12	8.01	-	8.01	0.17	-	0.17
12 JUN	0	1.14	0.46	0.80	0.49	0.46	0.47
	1	0.55	0.55	0.55	0.41	0.54	0.47
	2	0.52	0.56	0.54	0.31	0.47	0.39
	3	0.36	0.35	0.36	0.46	0.47	0.46
	4	0.43	0.51	0.47	0.32	0.41	0.36
	5	0.76	0.61	0.68	0.40	0.49	0.44
	11	1.14	1.82	1.48	0.52	0.90	0.71
	12	1.06	-	1.06	0.64	-	0.64

[a]Phaeopigment = Phaeophytin-a plus phaeophorbide-a.

[b]S = Surface; B = Bottom; A = Average. S and B values represent mean of duplicate determinations.

[c]ND = Not detected.

TABLE D-26
(continued)
ACTIVE CHLOROPHYLL-a AND PHAEOPIGMENTS[a]
ST. LUCIE PLANT
1979

		Pigment and Depth[b]					
		Chlorophyll-a (mg/m^3)			Phaeopigment (mg/m^3)		
Date	Station	S	B	A	S	B	A
26 JUL	0	0.61	1.29	0.95	0.71	0.75	0.73
	1	1.16	1.17	1.16	0.83	0.76	0.80
	2	0.49	1.27	0.88	0.59	0.60	0.59
	3	0.51	1.87	1.19	0.61	0.54	0.58
	4	0.55	1.24	0.90	0.61	0.78	0.69
	5	0.55	1.66	1.10	0.59	0.76	0.67
	11	1.15	1.20	1.17	0.67	0.55	0.61
	12	0.42	-	0.42	0.88	-	0.88
21 AUG	0	1.12	0.83	0.98	0.80	0.62	0.71
	1	0.64	0.79	0.72	0.87	0.80	0.83
	2	0.44	0.68	0.56	0.79	0.80	0.80
	3	0.24	0.67	0.45	0.82	0.80	0.81
	4	0.43	0.60	0.51	0.97	1.04	1.00
	5	0.34	0.43	0.38	0.94	0.97	0.95
	11	1.02	1.13	1.07	0.67	0.76	0.72
	12	0.11	-	0.11	0.86	-	0.86

[a]Phaeopigment = Phaeophytin-a plus phaeophorbide-a.

[b]S = Surface; B = Bottom; A = Average. S and B values represent mean of duplicate determinations.

TABLE D-26
(continued)
ACTIVE CHLOROPHYLL-a AND PHAEOPIGMENTS[a]
ST. LUCIE PLANT
1979

		Pigment and Depth[b]					
		Chlorophyll-a (mg/m^3)			Phaeopigment (mg/m^3)		
Date	Station	S	B	A	S	B	A
7 SEP	0	2.41	1.32	1.87	0.78	0.86	0.82
	1	2.22	1.64	1.93	0.94	0.97	0.96
	2	1.00	0.92	0.96	0.93	0.93	0.93
	3	0.68	0.88	0.78	0.66	0.97	0.81
	4	0.62	0.82	0.72	0.86	0.96	0.91
	5	1.70	0.94	1.32	0.82	0.81	0.82
	11	1.92	1.88	1.90	1.42	1.26	1.34
	12	1.47	-	1.47	1.39	-	1.39
2 OCT	0	3.10	3.99	3.55	0.42	0.51	0.47
	1	3.78	2.30	3.04	1.08	0.92	1.00
	2	2.03	2.15	2.09	0.96	0.90	0.93
	3	1.35	1.91	1.63	1.05	0.80	0.93
	4	2.10	1.87	1.99	0.82	0.64	0.73
	5	1.98	1.88	1.93	0.59	0.79	0.69
	11	2.80	3.55	3.18	0.71	2.11	1.41
	12	0.84	-	0.84	1.06	-	1.06

[a]Phaeopigment = Phaeophytin-a plus phaeophorbide-a.

[b]S = Surface; B = Bottom; A = Average. S and B values represent mean of duplicate determinations.

TABLE D-26
(continued)
ACTIVE CHLOROPHYLL-a AND PHAEOPIGMENTS[a]
ST. LUCIE PLANT
1979

		Pigment and Depth[b]					
		Chlorophyll-a (mg/m^3)			Phaeopigment (mg/m^3)		
Date	Station	S	B	A	S	B	A
30 OCT	0	6.99	13.55	10.27	0.86	1.93	1.39
	1	6.62	7.40	7.01	1.70	2.80	2.25
	2	2.70[c]	2.79	2.74	0.67[c]	0.84	0.75
	3	2.22	2.43	2.33	0.83	0.51	0.67
	4	2.50	2.99	2.74	0.68	0.88	0.78
	5	2.48	2.68	2.58	0.57	1.77	1.17
	11	4.14	4.27	4.21	0.70	0.54	0.62
	12	1.09	-	1.09	1.29	-	1.29
28 NOV	0	1.73	3.24	2.48	0.25	0.70	0.48
	1	2.63	1.26	1.94	0.27	1.15	0.71
	2	1.93	1.28	1.61	0.14	0.31	0.23
	3	1.35	1.49	1.42	0.32	0.38	0.35
	4	1.12	1.26	1.19	0.37	0.40	0.39
	5	1.74	2.26	2.00	0.33	0.42	0.37
	11	2.42	1.85	2.13	0.46	0.47	0.46
	12	0.71	-	0.71	0.71	-	0.71

[a]Phaeopigment = Phaeophytin-a plus phaeophorbide-a.

[b]S = Surface; B = Bottom; A = Average. S and B values represent mean of duplicate determinations.

[c]Singe determination.

TABLE D-27

STATISTICAL COMPARISON OF CHLOROPHYLL-a
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	85.70657367	3.72637277
Error	246	700.25142818	2.84655052
Corrected total	269	785.95800185	

Source	DF	Type I SS	F value	PR > F
Year	3	43.44804392	5.09	0.0021
Station	5	36.49475296	2.56	0.0276
Station x Year	15	5.76377678	0.13	1.0000

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=246 MS=2.84655

GROUPING	MEAN	N	STATION
A	2.512889	45	1
B A	2.054444	45	0
B A	1.776222	45	5
B A	1.765556	45	2
B	1.621333	45	4
B	1.335111	45	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=246 MS=2.84655

GROUPING	MEAN	N	YEAR
A	2.403500	60	76
B A	2.051818	66	79
B C	1.725833	72	78
C	1.306389	72	77

[a]Means with the same letter are not significantly different.

TABLE D-28

STATISTICAL COMPARISON OF CHLOROPHYLL-a
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	131.16433288	5.70279708
Error	246	1089.29281379	4.42801957
Corrected total	269	1220.45714667	

Source	DF	Type I SS	F value	PR > F
Year	3	47.56691134	3.58	0.0145
Station	5	62.01206222	2.80	0.0176
Station x Year	15	21.58535932	0.32	0.9922

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=246 MS=4.42802

GROUPING	MEAN	N	STATION
A	2.810889	45	1
A	2.805333	45	0
B A	2.122444	45	5
B A	1.902222	45	4
B A	1.858444	45	2
B	1.543333	45	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=246 MS=4.42802

GROUPING	MEAN	N	YEAR
A	2.548500	60	76
A	2.546970	66	79
B A	2.164306	72	78
B	1.528889	72	77

[a]Means with the same letter are not significantly different.

TABLE D-29

CHLOROPHYLL-a STEPWISE ANALYSIS[a]
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

SURFACE

R square = 0.29799296

	DF	Sum of squares	Mean square	F	PROB>F
Regression	3	55.50357986	18.50119329	9.62	0.0001
Error	68	130.75444136	1.92285943		
Total	71	186.25802122			

	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
R Temperature[b]	-0.38430722	0.08095048	43.33769299	22.54	0.0001
R Dissolved Oxygen	-0.68465114	0.19565270	23.54585676	12.25	0.0008
R Nitrite	704.16608263	168.07829546	33.75005400	17.55	0.0001

BOTTOM

R square = 0.27346375

	DF	Sum of squares	Mean square	F	PROB>F
Regression	2	104.48904334	52.24452167	12.99	0.0001
Error	69	277.60563450	4.02327007		
Total	71	382.09467785			

	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
R Phosphate	-171.71112666	54.31204764	40.21459583	10.00	0.0023
R Salinity	-1.24192513	0.53864872	21.38743731	5.32	0.0241

[a]The last step to include only significant type II sums of squares was selected as the best model.

[b]The prefix R indicates residual variance for each variable after seasonal adjustment.

TABLE D-30

STATISTICAL COMPARISON OF CHLOROPHYLL-a
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square	
Model	5	14.06202361	2.81240472	
Error	66	207.34404167	3.14157639	
Corrected total	71	221.40606528		
Source	DF	Type I SS	F value	PR > F
Station	5	14.06202361	0.90	0.4909

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=3.14158

GROUPING	MEAN	N	STATION
A	2.787500	12	1
A	2.355000	12	0
A	2.005000	12	5
A	1.784167	12	4
A	1.735000	12	2
A	1.442500	12	3

[a]Means with the same letter are not significantly different.

TABLE D-31

STATISTICAL COMPARISON OF CHLOROPHYLL-a
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square
Model	5	30.73391250	6.14678250
Error	66	363.30467500	5.50461629
Corrected total	71	394.03858750	

Source	DF	Type I SS	F value	PR > F
Station	5	30.73391250	1.12	0.3603

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=5.50462

GROUPING	MEAN	N	STATION
A	3.535833	12	0
A	3.048333	12	1
A	2.501667	12	5
A	2.196667	12	4
A	1.980833	12	2
A	1.589167	12	3

[a]Means with the same letter are not significantly different.

TABLE D-32

STATISTICAL COMPARISON OF CHLOROPHYLL-a
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square
Model	1	5.96505104	5.96505104
Error	22	365.49132292	16.61324195
Corrected total	23	371.45637396	

Source	DF	Type I SS	F value	PR > F
Station	1	5.96505104	0.36	0.5552

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=22 MS=16.6132

GROUPING	MEAN	N	STATION
A	4.337083	12	11
A	3.340000	12	12

[a]Means with the same letter are not significantly different.

TABLE D-33

STATISTICAL COMPARISON OF CHLOROPHYLL-*a*
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	7	148.55966620	21.22280946
Error	82	1004.58927519	12.25108872
Corrected total	89	1153.14894139	

Source	DF	Type I SS	F value	PR > F
Year	3	96.50805198	2.63	0.0550
Station	1	41.12108028	3.36	0.0706
Station x Year	3	10.93053395	0.30	0.8286

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=82 MS=12.2511

GROUPING	MEAN	N	STATION
A	4.085333	45	11
A	2.733444	45	12

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=82 MS=12.2511

GROUPING	MEAN	N	YEAR
A	4.544500	20	76
B A	3.914545	22	79
B A	3.632500	24	78
B	1.777292	24	77

[a]Means with the same letter are not significantly different.

TABLE D-34

STATISTICAL COMPARISON OF PHAEOPIGMENT
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square
Model	5	0.39305694	0.07861139
Error	66	11.76577500	0.17826932
Corrected total	71	12.15883194	

Source	DF	Type I SS	F value	PR > F
Station	5	0.39305694	0.44	0.8198

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=0.178269

GROUPING	MEAN	N	STATION
A	0.740000	12	0
A	0.715833	12	1
A	0.646667	12	4
A	0.578333	12	3
A	0.577500	12	2
A	0.542500	12	5

[a]Means with the same letter are not significantly different.

TABLE D-35

STATISTICAL COMPARISON OF PHAEOPIGMENT
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares		Mean square
Model	5	1.39564028		0.27912806
Error	66	38.35622500		0.58115492
Corrected total	71	39.75186528		
Source	DF	Type I SS	F value	PR > F
Station	5	1.39564028	0.48	0.7915

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=0.581155

GROUPING	MEAN	N	STATION
A	1.000833	12	4
A	0.992500	12	0
A	0.911667	12	1
A	0.792500	12	5
A	0.695833	12	2
A	0.642500	12	3

[a]Means with the same letter are not significantly different.

TABLE D-36

STATISTICAL COMPARISON OF PHAEOPIGMENT
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	20.51234286	0.89184099
Error	246	11.96727788	0.04864747
Corrected total	269	32.47962074	

Source	DF	Type I SS	F value	PR > F
Year	3	19.65433549	134.67	0.0001
Station	5	0.44444741	1.83	0.1070
Station x Year	15	0.41355997	0.57	0.8988

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=246 MS=0.0486475

GROUPING	MEAN	N	STATION
A	0.291333	45	1
B A	0.228667	45	0
B A	0.200889	45	4
B A	0.195333	45	3
B	0.180444	45	2
B	0.168222	45	5

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=246 MS=0.0486475

GROUPING	MEAN	N	YEAR
A	0.684545	66	79
B	0.080333	60	76
B	0.054722	72	77
B	0.041389	72	78

[a]Means with the same letter are not significantly different.

TABLE D-37

STATISTICAL COMPARISON OF PHAEOPIGMENT
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	31.94858008	1.38906870
Error	246	58.68898288	0.23857310
Corrected total	269	90.63756296	

Source	DF	Type I SS	F value	PR > F
Year	3	28.25471168	39.48	0.0001
Station	5	1.58371852	1.33	0.2521
Station x Year	15	2.11014989	0.59	0.8821

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=246 MS=0.238573

GROUPING	MEAN	N	STATION
A	0.500667	45	0
A	0.400667	45	5
A	0.393111	45	1
A	0.364889	45	4
A	0.287556	45	2
A	0.270889	45	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=246 MS=0.238573

GROUPING	MEAN	N	YEAR
A	0.899091	66	79
B	0.408833	60	76
C	0.112917	72	77
C	0.108333	72	78

[a]Means with the same letter are not significantly different.

TABLE D-38

PHAEOPIGMENT STEPWISE ANALYSIS[a]
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

SURFACE

R square = 0.07881100

	DF	Sum of squares	Mean square	F	PROB>F
Regression	1	0.88547836	0.88547836	5.99	0.0169
Error	70	10.34998809	0.14785697		
Total	71	11.23546645			

	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
R Salinity[b]	-0.17781363	0.07266027	0.88547836	5.99	0.0169

BOTTOM

R square = 0.23414273

	DF	Sum of squares	Mean square	F	PROB>F
Regression	3	9.30761035	3.10253678	6.93	0.0004
Error	68	30.44425492	0.44770963		
Total	71	39.75186528			

	B value	Standard error	Type II SS	F	PROB>F
Intercept	19.84064393				
Temperature	-0.08547664	0.03462506	2.72841396	6.09	0.0161
Ammonia	-5.45660027	1.73882755	4.40887406	9.85	0.0025
Salinity	-0.47183159	0.16601959	3.61619449	8.08	0.0059

[a]The last step to include only significant type II sums of squares was selected as the best model.

[b]The prefix R indicates residual variance for each variable after seasonal adjustment.

TABLE D-39

STATISTICAL COMPARISON OF PHAEOPIGMENT
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
DECEMBER 1978 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of Squares	Mean square	
Model	1	0.09690104	0.09690104	
Error	22	3.80269792	0.17284991	
Corrected total	23	3.89959896		
Source	DF	Type I SS	F value	PR > F
Station	1	0.09690104	0.56	0.4619

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=22 MS=0.17285

GROUPING	MEAN	N	STATION
A	0.899583	12	11
A	0.772500	12	12

[a]Means with the same letter are not significantly different.

TABLE D-40

STATISTICAL COMPARISON OF PHAEOPIGMENT
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
MARCH 1976 - NOVEMBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	7	7.56127275	1.08018182
Error	82	6.14468530	0.07493519
Corrected total	89	13.70595806	

Source	DF	Type I SS	F value	PR > F
Year	3	7.30655419	32.50	0.0001
Station	1	0.01950694	0.26	0.6113
Station x Year	3	0.23521162	1.05	0.3775

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=82 MS=0.0749352

GROUPING	MEAN	N	STATION
A	0.356444	45	11
A	0.327000	45	12

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=82 MS=.0749352

GROUPING	MEAN	N	YEAR
A	0.840227	22	79
B	0.223750	24	78
B	0.161250	24	77
B	0.151500	20	76

[a]Means with the same letter are not significantly different.

TABLE D-41

GROSS PRIMARY PRODUCTIVITY (P)[a], EXTINCTION COEFFICIENT PER METER (k) AND SURFACE RADIATION (g-cal/cm^2/day)
ST. LUCIE PLANT
JANUARY-NOVEMBER 1979

	Station and parameter												
	0		1		2		3		4		5		Surface
Date	P	k	P	k	P	k	P	k	P	k	P	k	radiation
17 Jan	0.17	1.03	0.24	0.88	0.20	0.72	0.18	0.78	0.14	0.67	0.41	0.61	333
13 Feb	0.21	0.59	0.39	0.60	0.23	0.39	0.66	0.08	0.16	0.36	0.16	0.46	420
6 Apr	1.05	0.39	0.90	0.51	1.91	0.30	1.23	0.37	1.65	0.31	2.19	0.30	521
27 Apr	0.24	0.82	0.29	0.65	0.30	0.35	0.28	0.34	0.41	0.25	0.45	0.57	570
15 May	0.85	0.49	0.68	0.47	0.56	0.31	0.40	0.35	1.37	0.39	0.77	0.29	654
12 Jun	0.30	0.24	0.21	0.24	0.26	0.19	0.14	0.23	0.27	0.16	0.28	0.22	602
26 Jul[b]													577
21 Aug	0.33	0.27	0.09	0.70	0.08	0.63	0.18	0.22	0.29	0.16	0.21	0.16	596
7 Sep	1.16	0.14	0.53	0.33	0.42	0.21	0.26	0.26	0.29	0.22	0.61	0.19	586
2 Oct	0.84	0.35	0.39	0.64	1.02	0.17	0.67	0.20	1.00	0.17	0.90	0.18	511
30 Oct	0.75	0.92	0.52	0.91	0.50	0.37	0.33	0.48	0.61	0.30	0.34	0.51	339

[a]P = grams of organic carbon produced per square meter per day.

[b]Insufficient data for calculation because of instrument failure during sampling.

TABLE D-42

ANALYSIS OF VARIANCE FOR GROSS PRIMARY PRODUCTIVITY
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT

JANUARY-NOVEMBER 1979[a]

Source	Degrees of freedom	Sum of squares	Mean square	F
Stations	5	0.42168	0.08434	1.39
Months	9	8.58684	0.95409	15.70*
Error	45	2.73402	0.06076	
Total	59	11.74254		

MARCH 1976-NOVEMBER 1979[b]

Source	Degrees of freedom	Sum of squares	Mean square	F
Stations	5	0.76457	0.15291	1.24
Error	230	28.41363	0.12354	
Total	235	29.17820		

[a]July 1979 results were not available because of instrument failure during sampling.

[b]The following dates are not included in the analysis because data were not available at one or more stations: March, August, and October 1976; January, February, April, August, and December 1977; and July 1979.

*Significant at α=0.05.

TABLE D-43

STATISTICAL COMPARISON OF BASELINE AND OPERATIONAL CHLOROPHYLL-*a*
SURFACE STATIONS 1 THROUGH 5
ST. LUCIE PLANT
1973 AND 1976 THROUGH 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	24	97.64411787	4.06850491
Error	260	764.46383652	2.94024553
Corrected total	284	862.10795439	

Source	DF	Type I SS	F value	PR > F
Year	4	36.46897987	3.10	0.0162
Station	4	53.66076842	4.56	0.0014
Year x Station	16	7.51436958	0.16	1.0000

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=260 MS=2.94025

GROUPING	MEAN	N	STATION
A	2.552281	57	1
B	1.693509	57	5
B	1.674561	57	2
B	1.546667	57	4
B	1.252281	57	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=260 MS=2.94025

GROUPING	MEAN	N	YEAR
A	2.348200	50	76
A B	1.974182	55	79
A B	1.700833	60	78
B	1.525000	60	73
B	1.291000	60	77

[a]Means with the same letter are not significantly different.

TABLE D-44

STATISTICAL COMPARISON OF BASELINE AND
OPERATIONAL CHLOROPHYLL-a
BOTTOM STATIONS 1 THROUGH 5
ST. LUCIE PLANT
1973 AND 1976 THROUGH 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	24	110.25051997	4.59377167
Error	259	1146.02181242	4.42479464
Corrected total	283	1256.27233239	

Source	DF	Type I SS	F value	PR > F
Year	4	35.59912670	2.01	0.0933
Station	4	47.16666190	2.66	0.0330
Year x Station	16	27.48473136	0.39	0.9845

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=259 MS=4.42479

GROUPING	MEAN	N	STATION
A	2.698070	57	1
A B	2.361579	57	5
A B	1.911053	57	2
B	1.833333	57	4
B	1.547321	56	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=259 MS=4.42479

GROUPING	MEAN	N	YEAR
A	2.389400	50	76
A	2.308545	55	79
A B	2.166102	59	73
A B	2.162833	60	78
B	1.407833	60	77

[a]Means with the same letter are not significantly different.

E. ZOOPLANKTON

Environmental Technical Specification (3.1.B.b)

> Plankton - Plankton samples will be collected monthly. Both zooplankton and phytoplankton species will be identified as to kind and abundance. Chlorophyll "a" analysis will be performed as a measure of primary productivity.

INTRODUCTION

Zooplankters are aquatic invertebrates that have limited mobility or passively drift with water currents. Ecologically, zooplankton represents the second trophic level in an aquatic food chain and can be divided into two main groups: 1) holoplankters, which spend their entire life cycle in the water column, and 2) meroplankters, which consist predominantly of larvae of benthic macroinvertebrates, who are temporary members of the zooplankton community. Zooplankton are an integral part of the total marine environment found near the St. Lucie Plant because zooplankters are the major consumers of primary producers, such as phytoplankton, and in turn provide an important food source for larger macroinvertebrates and fishes. Zooplankton community composition and density reflect the influences of temperature, salinity, food availability, and various other physicochemical parameters. Zooplankton populations of a nearshore environment such as that at the St. Lucie Plant are likely to vary considerably in both space and time.

General Effects of Power Plant Operation

Because of their size and limited mobility, zooplankton are easily entrained and subjected to the effects of power plant operation. Perturbations to the zooplankton community may occur as a result of entrainment in 1) power plant condenser cooling waters and 2) thermally elevated plant discharge waters.

The effects of plant entrainment on zooplankters may include lethal or sublethal exposure to rapid thermal elevation, mechanical stresses, and biocides, such as chlorine. These factors can act separately or synergistically with various other physicochemical parameters in causing stress to an organism. Pertinent studies on the effects of power plant entrainment on zooplankton have demonstrated impaired swimming and feeding capabilities, lowered resistance to predation, and increased susceptibility to disease (Mihursky and Kennedy, 1967; Coutant, 1970; Davies et al., 1976; Polgar et al., 1976). Mortality of entrained zooplankton may range from 15 to 100 percent and appears to be site specific, depending on species and environmental conditions (Marcy et al., 1978).

The nearshore zooplankton, which potentially include the larval stages of the vast majority of local benthic communities, are subject to plant entrainment. These meroplanktonic groups include larvae of echinoderms, molluscs, barnacles and decapod crustaceans (shrimp and crabs). The impact of entrainment mortality of these larvae upon adult populations is important because most benthic invertebrates have slow

generation time and limited spawning periods. Power plant entrainment of these meroplankters could result in a decrease in abundance of recruitable larvae in the waters adjacent to the power plant (Enright, 1978). Holoplanktonic organisms, such as copepods, appendicularians and chaetognaths have rapid generation times, and thus, potential losses attributable to plant passage would be minimized by recruitment from offshore communities.

The effects of entrainment on zooplankton in thermal effluent discharges are difficult to assess because the duration and extent of exposure is dependent on the response of the individual as well as on the movement and mixing of water masses. The dissipation of waste heat into receiving waters is a function of its assimilative capacity. An open coastal environment, such as that found at the St. Lucie Plant, most likely provides rapid dissipation of waste heat over relatively short distance and time. Thermal plume entrainment effects are therefore likely to be negligible.

Effects of Other Environmental Components

Physical factors which potentially influence zooplankton distribution include salinity, dissolved oxygen, and temperature. The interaction of zooplankton with these physical components and other biological elements of the ecosystem may result in uneven zooplankton distribution (i.e., patchiness). Patchiness compounds the difficulty of estimating power plant influence on zooplankton densities and species composition.

This section examines the composition and density of the zooplankton community during the 1979 monitoring period at the St. Lucie Plant. The 1979 data were compared to those of previous operational phase studies (1976-1978) and to baseline data (1972-1973) to evaluate the potential effects of power plant operation.

MATERIALS AND METHODS

Duplicate zooplankton samples were collected monthly at six offshore locations (Stations 0 through 5) and in the intake and discharge canals (Stations 11 and 12, respectively; Figure E-1). Collections were made with 0.5-m, 202μ-mesh plankton nets equipped with flowmeters to record the volume of seawater filtered. Discrete offshore samples were collected from surface and bottom depths by making horizontal tows for 5-minute intervals at speeds of 0.5 to 2 knots. Intake and discharge samples were collected by 10 minute step-oblique tows, by fishing the nets at spaced intervals from the bottom to the surface. Zooplankton samples were preserved immediately after collection in a 5-percent formalin solution buffered to pH 7-8 with sodium borate.

For qualitative and quantitative analysis, zooplankton samples were split with a Folsom plankton splitter and diluted to a workable volume. Three replicate 1-ml aliquots were withdrawn with a Stempel pipette and placed in grided counting trays for examination. Zooplankters were identified to the lowest practicable taxon.

Zooplankters per cubic meter were calculated by multiplying the number of organisms in the subsample by appropriate dilution factors, and then dividing by the volume of water filtered in cubic meters. The volume of water filtered was calculated by:

$$V = \pi(r^2)l$$

where: V = Volume of water filtered, in cubic meters;

r = Radius of net at the mouth, in meters;

l = Distance the net is towed, in meters.

Whole zooplankton samples were retained as vouchers in a permanent collection.

Zooplankton biomass for each station and depth was determined by the ash-free dry weight method (EPA, 1973). Results of these determinations were expressed as milligrams of ash-free dry weight per cubic meter of water sampled.

The designation of damaged zooplankton was based on observation of major structural impairment to any zooplankter. This category was differentiated in attempting to estimate mortality resulting from plant operation by comparing the number of damaged zooplankters between stations. Mean percent damaged for offshore stations between January and September 1979 ranged from 2.96 to 7.32 and was not expected to exceed 10.84 (α=0.05). Intake and discharge mean percent damaged during this period was 2.09 and 1.47, respectively. Literature estimates of net damage to zooplankters often exceed 10 percent and vary according to spe-

cies and collection method. Because of the relatively small percentage of damaged zooplankters observed at St. Lucie during the 1979 collections, discussion of damaged zooplankton will not be presented.

Statistical Procedures

For statistical analysis, zooplankton density data were transformed to $\log_n$ (number/m^3 + 1), in order to reduce the effect of nonhomogeneous variation and skewness in these data. Geometric means were also calculated. The Statistical Analysis System (SAS; Barr et al., 1976) was used in all statistical analyses. The General Linear Models (GLM) Procedure, which provides the regression approach to analysis of variance, was used to examine interstation and annual variation in zooplankton density and biomass for 1979 and for all previous operational monitoring (March 1976 through November 1978) and baseline studies (1972 through 1973). Examples of the individual variables, class variables, and models used are shown in Table E-1. Duncan's multiple range tests were used to determine which means were significantly different. The relationships between zooplankton density and biomass and selected variables were examined by means of simple correlations, using the Correlation (CORR) Procedure, and stepwise regression, using the maximum R^2 technique. To eliminate seasonality from the data, variables were sine or cosine adjusted. The residual for each parameter, after seasonal variation had been removed, was then used in regression analysis to determine whether significant relationships between variables existed. The 0.05 level of significance was used in all statistical comparisons. Because of the lag between collection of zooplankton samples and comple-

tion of sample analyses, statistical analyses included data collected through November 1979. The December data will be statistically analyzed in the 1980 annual non-radiological report.

RESULTS AND DISCUSSION

Community Composition

Zooplankton composition during 1979 was similar to that observed during previous operational phase monitoring at the St. Lucie Plant (ABI, 1977-1979). Generally, the zooplankton community was characterized by neritic (nearshore) holoplanktonic species. Copepods, as in previous study periods, were the dominant component of the community, comprising 70 percent of the annual mean zooplankton density at the offshore stations (Figure E-2). *Paracalanus aculeatus* was the dominant copepod species and was observed during each sampling period at all stations. *Paracalanus* was also the most frequently observed zooplankter in baseline and prior operational phase studies at the St. Lucie Plant.

Other holoplankters which were major contributors to the zooplankton community in 1979 include the copepods *Acartia tonsa*, *Temora turbinata*, *Oithona* sp., and *Euterpina acutifrons*; the sergestid shrimp *Lucifer* sp.; the appendicularian *Oikopleura* sp.; and chaetognaths. Cladoceran and ostracod species occurred infrequently and were numerically abundant only during brief periods.

The meroplankton community observed during 1979 collections consisted largely of barnacle, mollusc, echinoderm, and decapod larvae. The

decapods included penaeidean, craidean, and thalassinid shrimps as well as anomuran and brachyuran crabs. Brachyuran crabs were the major contributors to the decapod population in 1979. Meroplanktonic stages of commercially important decapod species included the stone crab Menippe mercenaria; the Cuban stone crab Menippe nodifrons; the blue crab Callinectes sp.; and the bait shrimp Trachypenaeus constrictus. These commercially important decapod species have been identified in previous collections at the St. Lucie Plant.

Density Trends

During 1979, average zooplankton densities offshore ranged from 638/m^3 in November to 6678/m^3 in July (Figure E-2). Peak zooplankton abundance of 14,157/m^3 occurred at Station 1 surface in August, while the lowest recorded density for any station was 65/m^3 at Station 2 bottom in April (Tables E-2 through E-13). These offshore densities were consistent with previous collections at the St. Lucie Plant (Figure E-3); they fall within the range of recorded densities for other Florida waters (Grice, 1957; Owre and Foyo, 1967; Reeve, 1970; ABI, 1979).

Zooplankton densities in the canals were highest in June with 13,772 and 7175 zooplankters/m^3 at Stations 11 and 12, respectively. Minimal zooplankton abundance occurred in February for the intake station (294/m^3) and in March for the discharge station (76/m^3). Annual mean zooplankton density for the intake canal was higher in 1979 than in any previous monitoring period at the St. Lucie Plant while that of Station 12 was greater than those for 1977 and 1978 (Figure E-4). However, as in

previous studies, zooplankton densities in the canals were consistently less than those observed offshore (Figures E-4 through E-6).

Seasonal zooplankton abundance during 1979 was similar to that during previous operational monitoring periods at the St. Lucie Plant (Figure E-3). Peak zooplankton densities were usually observed in the warmer summer months with variable autumn and winter-spring periods of abundance. Fluctuations in zooplankton densities in 1979 were generally consistent with variations in biomass (Table E-14). Zooplankton seasonality is influenced by various physicochemical parameters. Most zooplankters are opportunistic organisms, having rapid reproductive and maturation rates that allow them to quickly take advantage of favorable environmental conditions. Seasonal and annual fluctuations in zooplankton density, composition, and biomass are normal occurrences and reflect the response of zooplankters to temporal and spacial variations in the environment.

Differences in zooplankton densities between surface and bottom depths in 1979 often varied among stations and between sampling dates. However, 72 percent of the time, the average surface density was greater than the average bottom density. This trend was not consistent with the previous operational monitoring data where bottom zooplankton densities were generally greater than surface densities.

Canal Station Comparison

Zooplankton community composition at the canal stations was dominated by barnacle nauplii and copepods during most of year. Peak zooplankton densities observed in June were the result of high copepod abundance (Table E-6). The copepods _Acartia tonsa_ and _Paracalanus aculeatus_ together accounted for nearly 74 percent of the total 13,772 zooplankters/m^3 at Station 11 during this period. Similar species composition was also observed at Station 12, although total zooplankton density between the intake and discharge canals showed a 48 percent decrease on this date (Table E-15). Other copepod species that were frequently observed in the canals include _Euterpina acutifrons_ and _Temora turbinata_. Copepod densities were greatest in the months of June and July and generally lowest during winter and spring periods. Over-all, copepod densities showed an annual mean decrease of 39 percent between intake and discharge canals during 1979.

Barnacle nauplii were collected at the intake and discharge stations throughout the year, with highest densities occurring in April. Barnacle nauplii comprised 24 and 34 percent of the total annual mean zooplankton density at Stations 11 and 12, respectively, in 1979. The spawning of resident populations of barnacles in the canals most likely was responsible for fluctuations in total zooplankton abundance between stations and sampling dates. Barnacle nauplii, like most zooplankters, exhibit seasonal peaks in density when environmental conditions are optimal for reproduction and growth. Patel and Crisp (1960) studied the breeding habits of four tropical species of cirripedes and found optimum embryo

production between 22° and 25°C. Water temperatures in the canals during March and April collection periods provided favorable reproductive conditions for barnacle species (Table E-15).

Larval decapods and molluscs exhibited similar peak abundance periods during summer months. Decapod densities were greatest in June and July (Tables E-7 and E-8, respectively) and were composed largely of pinnotherid (pea) crabs. As with other zooplankton groups observed in the canals, Station 11 annual mean decapod densities were greater than those at Station 12. Larvae of the blue crab Callinectes was the only commercially important decapod species collected in the canals during 1979.

There were no significant differences in total zooplankton density or biomass between the intake and discharge canals in 1979 or in over-all (1976-1979) data comparisons (Tables E-16 through E-19). Also, no significant variability of individual groups that were important constituents of the zooplankton community (i.e., copepods, barnacle nauplii, brachyuran crabs, or sergestid shrimps) were observed between canals in 1979. No significant annual variation was noted, although 1979 annual mean densities were generally greater than those of prior monitoring years (Figure E-4). Zooplankton densities and biomass showed similar peak periods of occurrence and were significantly correlated to each other at the canal stations during 1979 (Table E-20).

Zooplankton species live within a temperature range where growth and reproduction are optimal, and they have upper and lower thermal limits past which they cannot survive. Temperatures above 35°C approach maximum lethality for all plankton (Storr, 1974). During summer months, tropical and subtropical zooplankton species, such as those found at St. Lucie, may be sensitive to thermal addition because discharge water temperatures often approach or exceed upper thermal limits of many zooplankters (Naylor, 1965; Drost-Hansen, 1969; Bader et al., 1970; Reeve and Cosper, 1970; Gonzales, 1974). Discharge temperatures measured during sampling at the St. Lucie Plant were 35°C or greater in the 6-month period of July through December 1979 (Table E-15). Reductions in zooplankton density between the intake and discharge canals occurred in 75 percent of the collections made during 1979. Reductions were also observed in 60, 58, and 75 percent of the collections during 1976, 1977, and 1978, respectively (ABI, 1979).

Although no significant variation existed in total zooplankton densities between canals, an annual 42 percent reduction in abundance occurred between the intake and discharge stations in 1979. The effect of plant entrainment on zooplankton is shown by density reductions in total zooplankton abundance as well as individual holoplanktonic and meroplanktonic groups between canals.

<u>Offshore Station Comparisons</u>

In July, total zooplankton densities were highest for the year with an average offshore density of 6678/m^3. Fluctuations in total zooplankton abundance were generally attributable to variation in total copepod

density (Figure E-2). Copepods constituted 70 percent of the total annual mean zooplankton density at offshore stations during 1979. Total copepod densities at St. Lucie were highest in the summer months with decreasing abundance through winter (Figure E-3). The most frequently observed copepod genera included *Paracalanus*, *Acartia*, *Temora*, *Oithona*, *Labidocera*, and *Euterpina*. *Paracalanus aculeatus* was the dominant zooplankton taxon collected offshore, occurring in every sample. Annually, *Paracalanus* accounted for over 40 percent of the total offshore copepod community. *Paracalanus* is a common inhabitant of Florida waters and occurs in both oceanic and neritic habitats.

Acartia tonsa (previously identified as *A. bermudensis*) was the second most frequently occurring copepod species and was often co-dominant with *Paracalanus*. Youngbluth et al. (1976) found *A. tonsa* to be the dominant copepod species collected in the Indian River, while Grice (1957) observed this species 4 miles seaward of the Ft. Pierce inlet during summer and winter collection periods. *A. tonsa* is an eurythermal and euryhaline copepod species found from the Gulf of St. Lawrence to the Gulf of Mexico and is the dominant copepod species in many semi-enclosed waters (Deevey, 1960). Species of *Acartia* and *Paracalanus* have demonstrated many similarities, both in occurrence and time of greatest abundance in Florida waters (Reeve, 1964).

Larvaceans were second to copepods in total zooplankton abundance. *Oikopleura* spp. comprised 4.4 percent of the total zooplankton density observed in 1979. This genus was present year-round, occurring in over

93 percent of the zooplankton collections at St. Lucie. Peak Oikopleura densities were recorded between May and August. The larval stages of crabs and shrimp were also collected throughout the year at the offshore stations. Decapod abundance displayed a bimodal pattern with greatest densities occurring in March and August. Pinnotherid (pea) crabs and portunid (swimming) crabs were the major constituents of the decapod community in 1979. Decapod densities at Station 1 were greater than those at any other station and surface densities were generally greater than those at the bottom. The larval stages of the commercially important blue crab and stone crab occurred infrequently and were not a numerically important part of the total decapod community observed at St. Lucie. Decapods accounted for only 2 percent of the total annual mean zooplankton abundance at offshore stations.

Seasonally, other zooplankton groups were characterized by absence or low abundance during most of the year with relatively high densities for brief periods. The ostracod Conchoecia elegans and molluscan larvae were exemplary of this seasonal trend of occurrence (Figure E-2). Seasonal fluctuations in zooplankton densities and biomass are normal occurrences (Figure E-3). Zooplankters respond to temporal variations in environmental conditions through changes in community composition and abundance. Total zooplankton densities in 1979 were significantly correlated with biomass and salinity at surface and bottom depths (Tables E-21 and E-22, respectively). Residual stepwise regression analysis for zooplankton densities showed a significant relationship with the variable salinity at offshore surface stations. Salinity accounted for 9.2 per-

cent of the non-seasonal variation in zooplankton abundance (Table E-23). No other significant relationships for total density or biomass were observed with the variables examined (Table E-24).

Mean zooplankton densities and biomass were generally greater at Station 1 than at other offshore locations with signficantly greater total zooplankton abundance at Station 1 surface than at Stations 0, 2, and 4 during 1979 (Tables E-25 through E-28). Variations in copepod and decapod densities were not significantly different between stations but they exhibited similar increased abundance at Station 1. Increased zooplankton density and biomass in the vicinity of Station 1 during 1979 suggests the influence of power plant operation. However, zooplankton composition between stations and depths were consistent within sampling dates.

Results of annual interstation comparisons (1976-1979) were similar to those observed in the previous study periods. Surface zooplankton densities in 1979, 1978, and 1977 were significantly greater than those observed in 1976 while bottom zooplankton densities in 1977 and 1978 were significantly greater than those in 1976 and 1979. No significant differences in bottom zooplankton densities or biomass between stations were found (Tables E-29 and E-30, respectively). However, significant variation in surface densities between stations occurred. Surface zooplankton densities at Station 1 were significantly greater than those at all other surface stations during the 1976-1979 study period (Table E-31). Variations in zooplankton biomass at the surface indicated simi-

lar results (Table E-32). These data suggest an apparent long term influence on zooplankton abundance in the vicinity of the immediate discharge area as a result of St. Lucie Plant operations.

The observed increase in total zooplankton abundance and biomass at Station 1 surface most likely is in response to the higher food availability in the area. Total phytoplankton density during operational monitoring has consistently been greater at Station 1 surface than at other offshore locations (Section D. Phytoplankton). The zooplankton community at St. Lucie is composed largely of herbaceous copepods and although it is unlikely that resident populations of these organisms are found offshore, zooplankters could emigrate into the vicinity of Station 1 to graze on high surface phytoplankton densities. Studies on the relationships between zooplankton and phytoplankton demonstrate that stations with increased phytoplankton abundance generally have high zooplankton abundance. No adverse plant effects on the offshore zooplankton community at St. Lucie were indicated during 1979 or for pooled data (1976-1979).

Baseline Versus Operational Study Comparisons

Baseline zooplankton collections were bimonthly during the first year (September 1971 through August 1972) and monthly the second year (September 1972 through August 1973; Walker et al., 1979). The monthly 1972-1973 zooplankton data were statistically compared to operational phase data (March 1976 through November 1979) to evaluate yearly and interstation differences in zooplankton density.

Interstation and seasonal trends in total zooplankton densities were variable between and within baseline and operational studies. Over-all, similar peak zooplankton densities occurred during the warmer summer months, with variable winter/spring periods of production (Figures E-3 and E-7).

Zooplankton species collected during baseline monitoring did not differ greatly from those collected during subsequent operational monitoring. Holoplanktonic species dominated the zooplankton community during most of the year. Adult copepods were the most abundant zooplankton group with the calanoid Paracalanus being the dominant taxon recorded. Paracalanus was observed in all of the baseline and operational zooplankton collections at the St. Lucie Plant. Other numerically important copepod genera that were frequently observed during both studies include Acartia, Temora, Oithona, Labidocera and Euterpina.

Seasonally, other holoplanktonic and meroplanktonic species occurred infrequently and in low densities during most of the year, becoming numerically abundant in the plankton only during brief periods. Zooplankters that followed this seasonal trend of occurrence during all years of monitoring at St. Lucie include the larvacean Oikopleura; gastropod, pelecypod, and echinoderm larvae; the cladoceran Evadne; the ostracod Conchoecia; and barnacle nauplii. These organisms were often responsible for large fluctuations in total zooplankton densities between stations and between years.

Comparisons of baseline and operational data indicated that zooplankton densities during 1973 and 1977 were significantly greater than those observed in 1976 and 1979 (Table E-33). Annual mean zooplankton densities between stations over all years (1973-1979) exhibited no significant variation. However, during baseline monitoring, zooplankton abundance was greatest at Station 5, while densities during operational periods have consistently been higher at Station 1.

Annual and station differences in total zooplankton densities were generally the result of fluctuations in abundance of various holoplanktonic and meroplanktonic groups (i.e., copepods, larvaceans, and mollusc and echinoderm larvae). The trend of increased zooplankton abundance at Station 1 from baseline monitoring and during subsequent operational studies, again suggests an indirect influence of St. Lucie Plant operations on the zooplankton community in the immediate discharge area. Zooplankton community composition, however, has varied little between years. No detrimental effects of power plant operations on the nearshore zooplankton community of St. Lucie were indicated.

<u>SUMMARY</u>

The zooplankton community in 1979 was characterized by neritic holoplanktonic species. Copepods, as in prior monitoring periods, were the dominant component of the community, comprising 70 percent of the annual mean zooplankton density at the offshore stations. Zooplankton densities in 1979 ranged from a low of 65/m^3 at Station 2 (Figure E-1) bottom in April to 14,158/m^3 at Station 1 surface in August. Seasonal

peaks in density fluctuated between years but generally occurred during the summer months with variable autumn and winter-spring periods of abundance. Zooplankton community composition however has varied little between study periods at the St. Lucie Plant.

Variations in zooplankton density and biomass between the canal stations in 1979 or for pooled (1976-1979) data demonstrated no significant plant entrainment effects. However, pertubations to the zooplankton community were apparent as indicated by an annual 42 percent reduction in total zooplankton abundance between Stations 11, the intake canal, and 12, the discharge canal, during 1979. Zooplankton densities in the intake canal have consistently been greater than those of the discharge canal during all operational monitoring years.

Mean zooplankton densities and biomass were generally greater at Station 1 than at other offshore stations during 1979. These findings, combined with baseline (1972-1973) and pooled (1976-1979) results, suggest an indirect effect of St. Lucie plant operations on the nearshore zooplankton community. Significant increases in zooplankton densities and biomass were observed at the immediate discharge area in comparison to various other offshore locations. Increased zooplankton abundance in the vicinity of Station 1 appears to be in response to high food availability (i.e., high phytoplankton density). However, increased densities have not resulted in altered zooplankton community composition. No adverse plant-related effects were apparent offshore.

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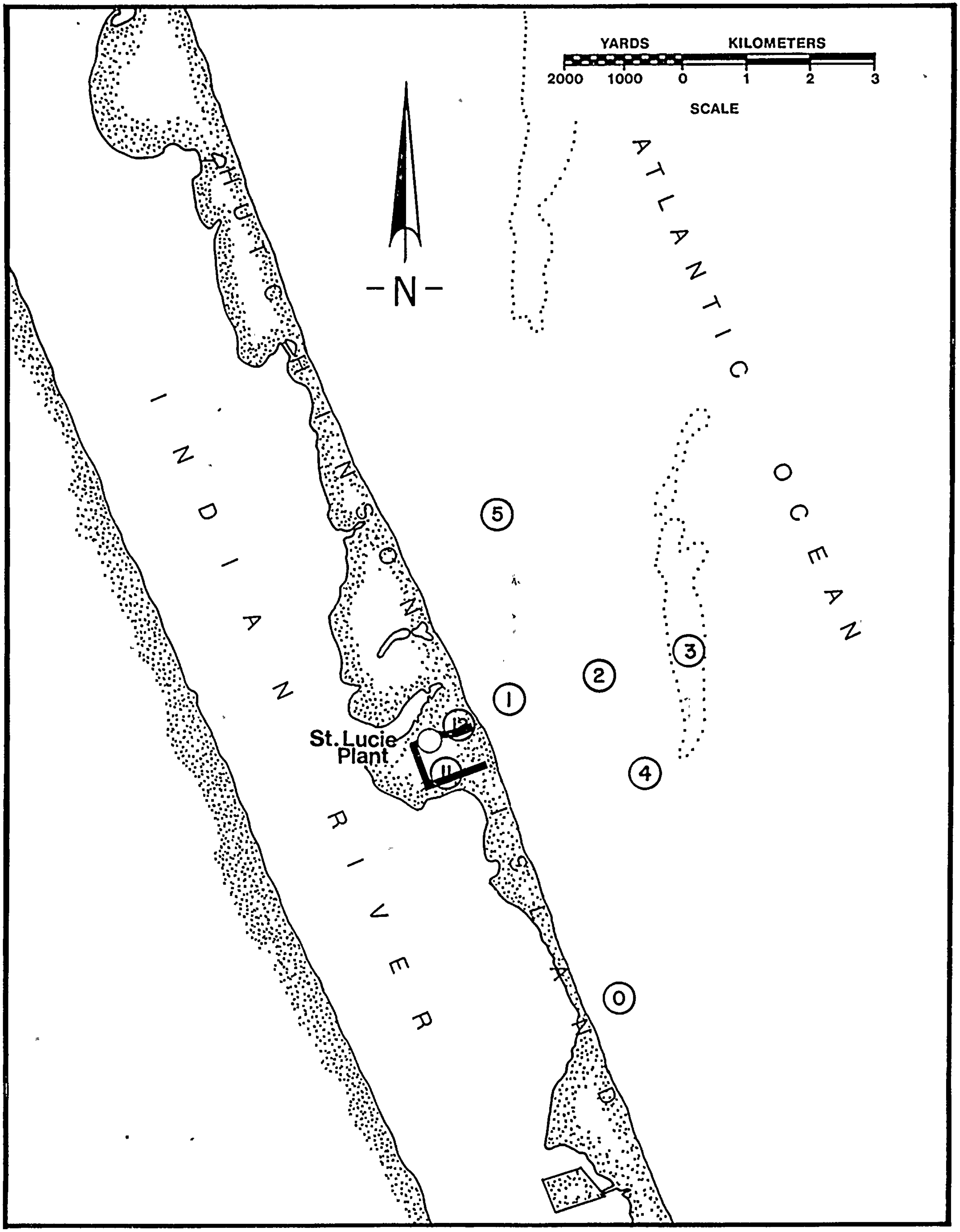

Figure E-1. Locations of zooplankton sampling stations, 1979.

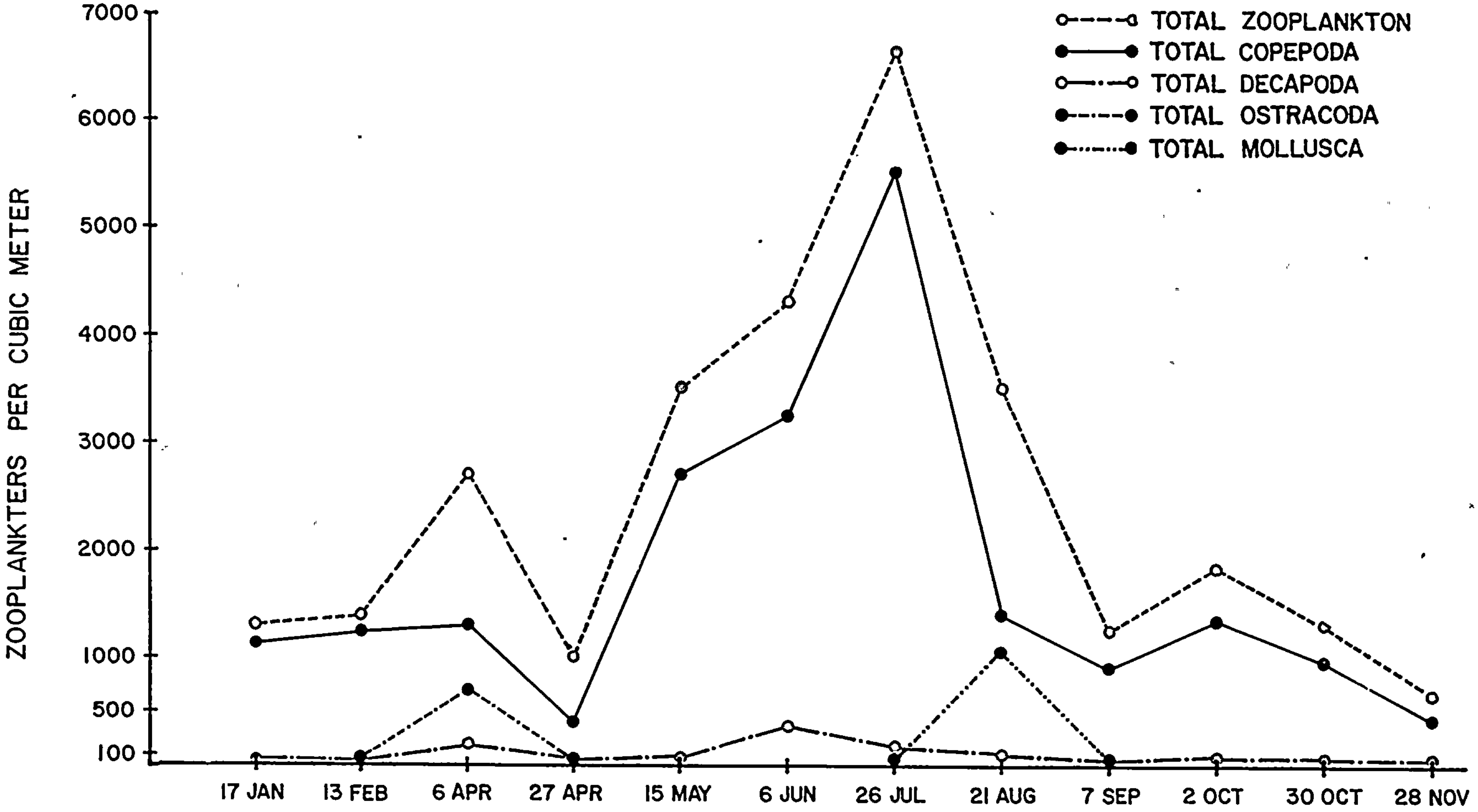

Figure E-2. Average densities of major zooplankton groups at Stations 0 through 5, St. Lucie Plant, 1979.

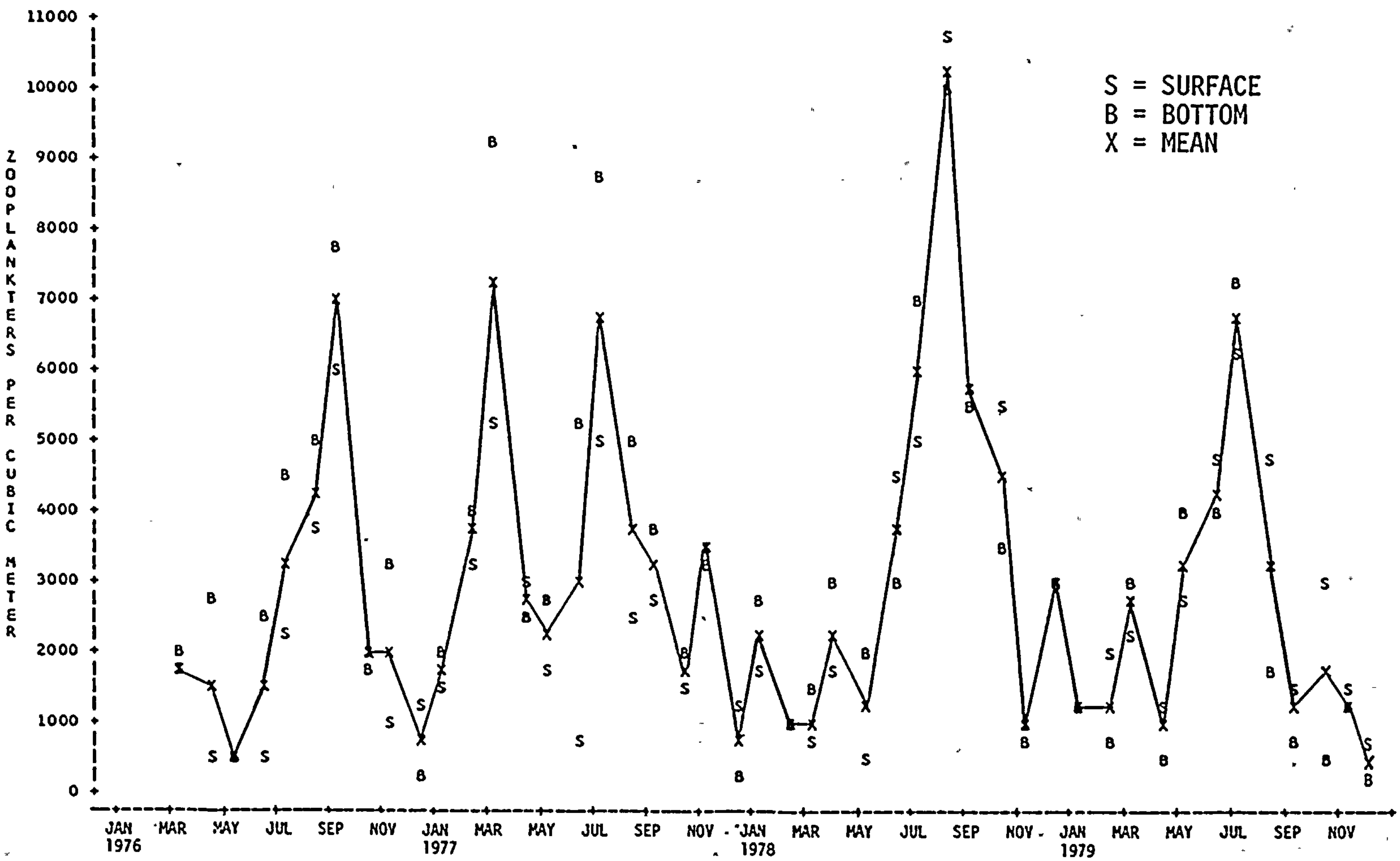

Figure E-3. The mean of the average monthly surface and bottom zooplankton densities at Stations 0 through 5, St. Lucie Plant, March 1976-November 1979.

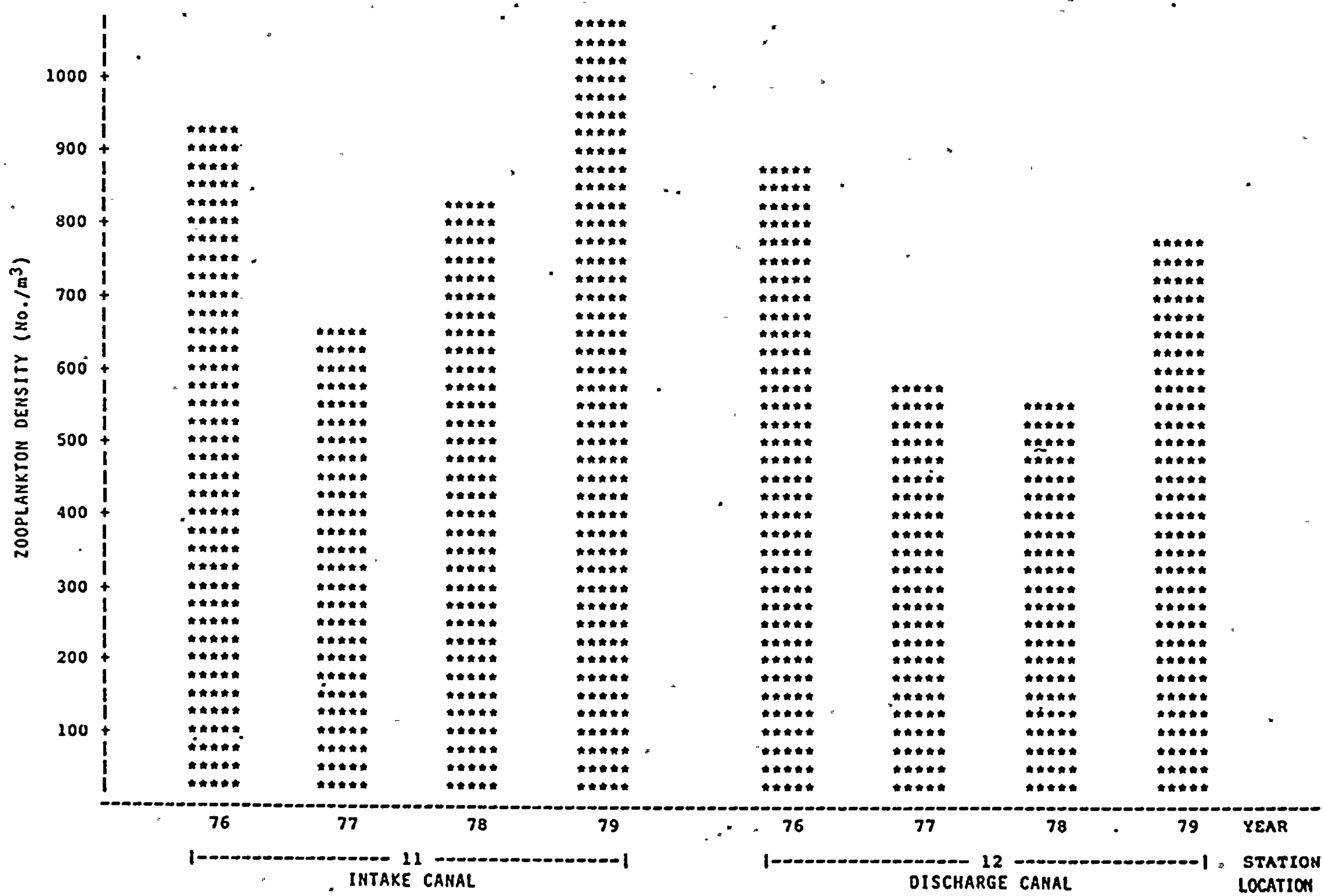

Figure E-4. Annual mean density of zooplankton at Stations 11 and 12, St. Lucie Plant, March 1976 - October 1979.

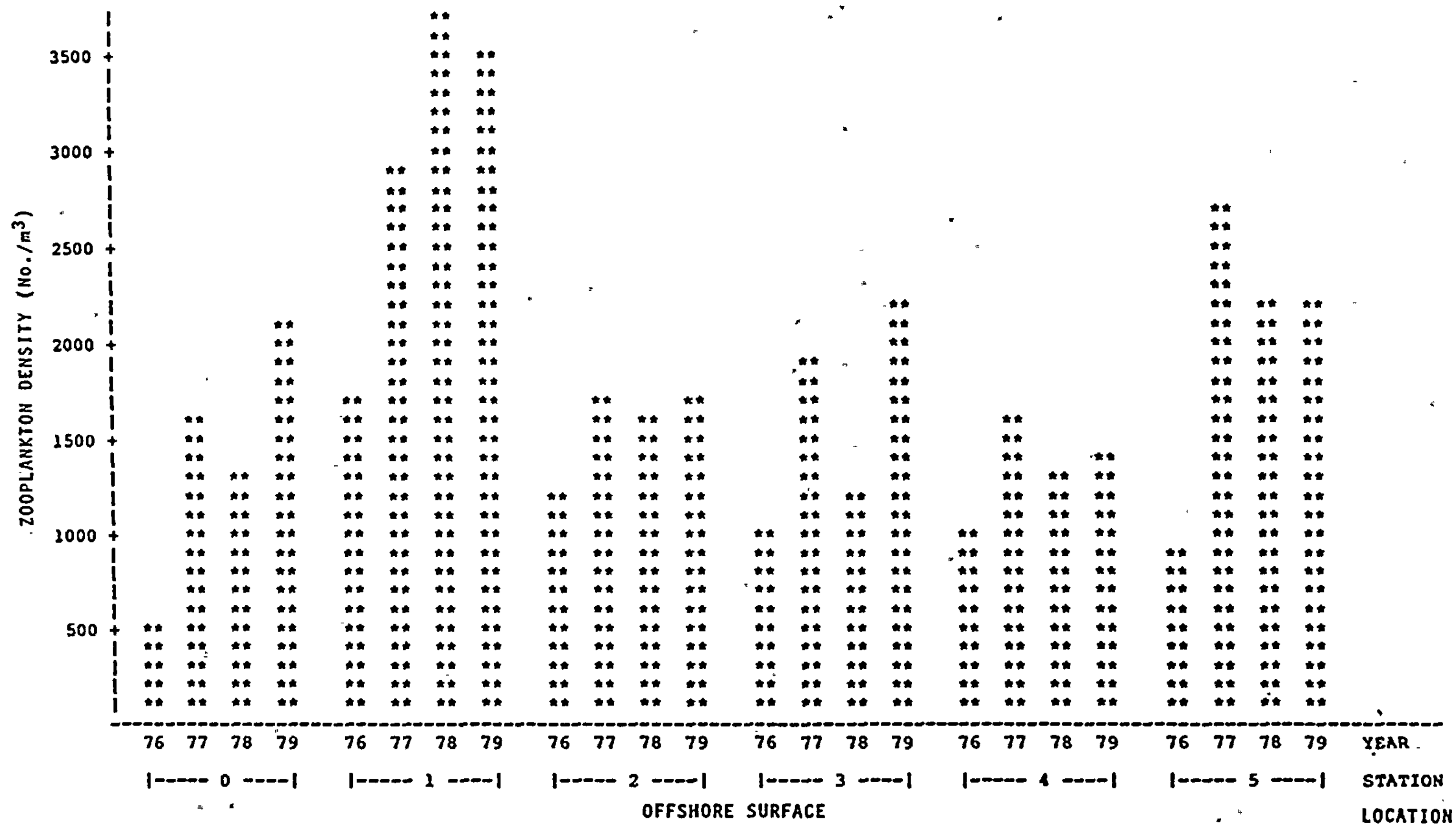

Figure E-5. Annual mean density of zooplankton at Stations 0 through 5, St. Lucie Plant, March 1976 - October 1979.

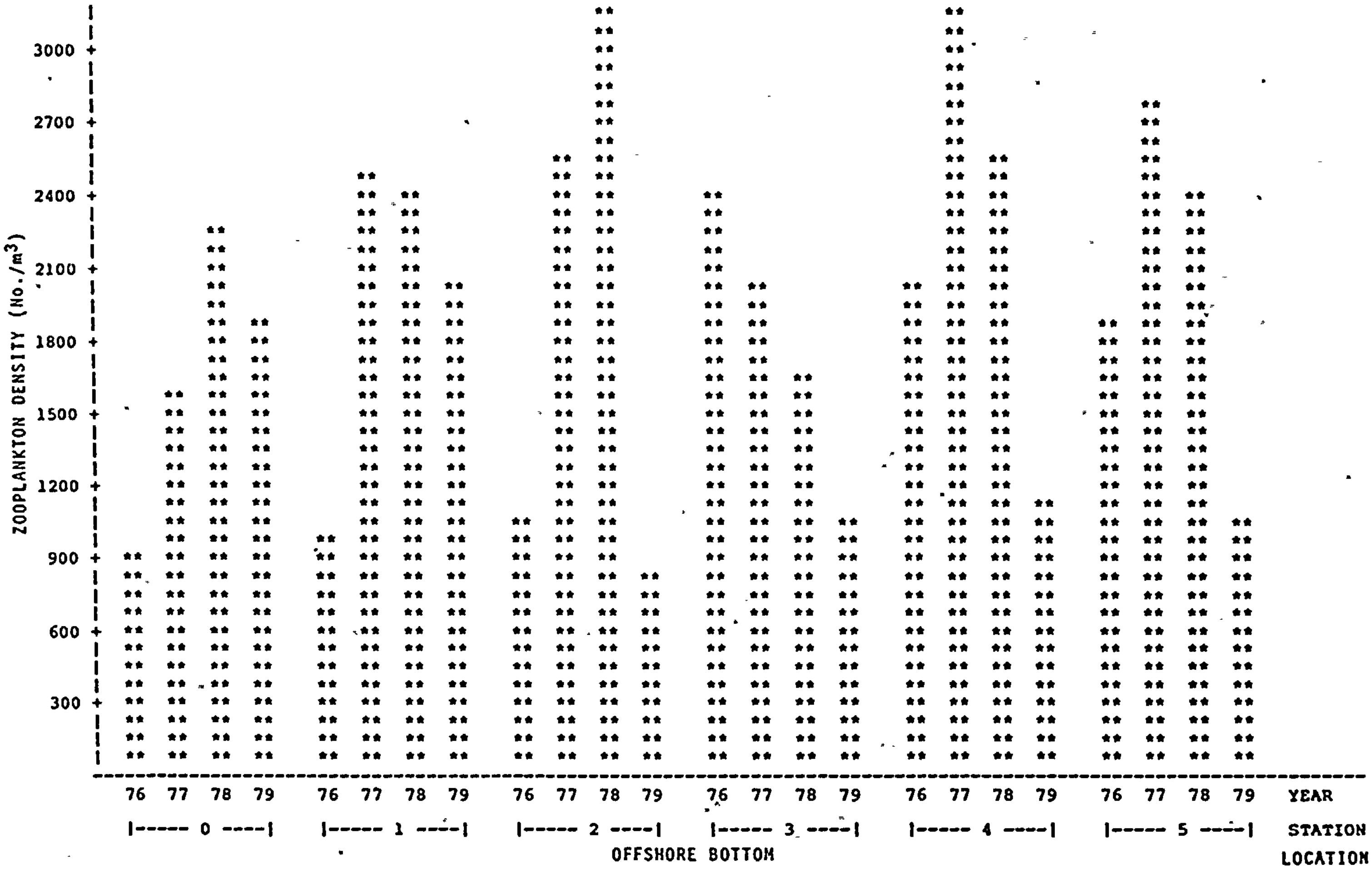

Figure E-6. Annual mean density of zooplankton at Stations 0 though 5, St. Lucie Plant, March 1976 - October 1979.

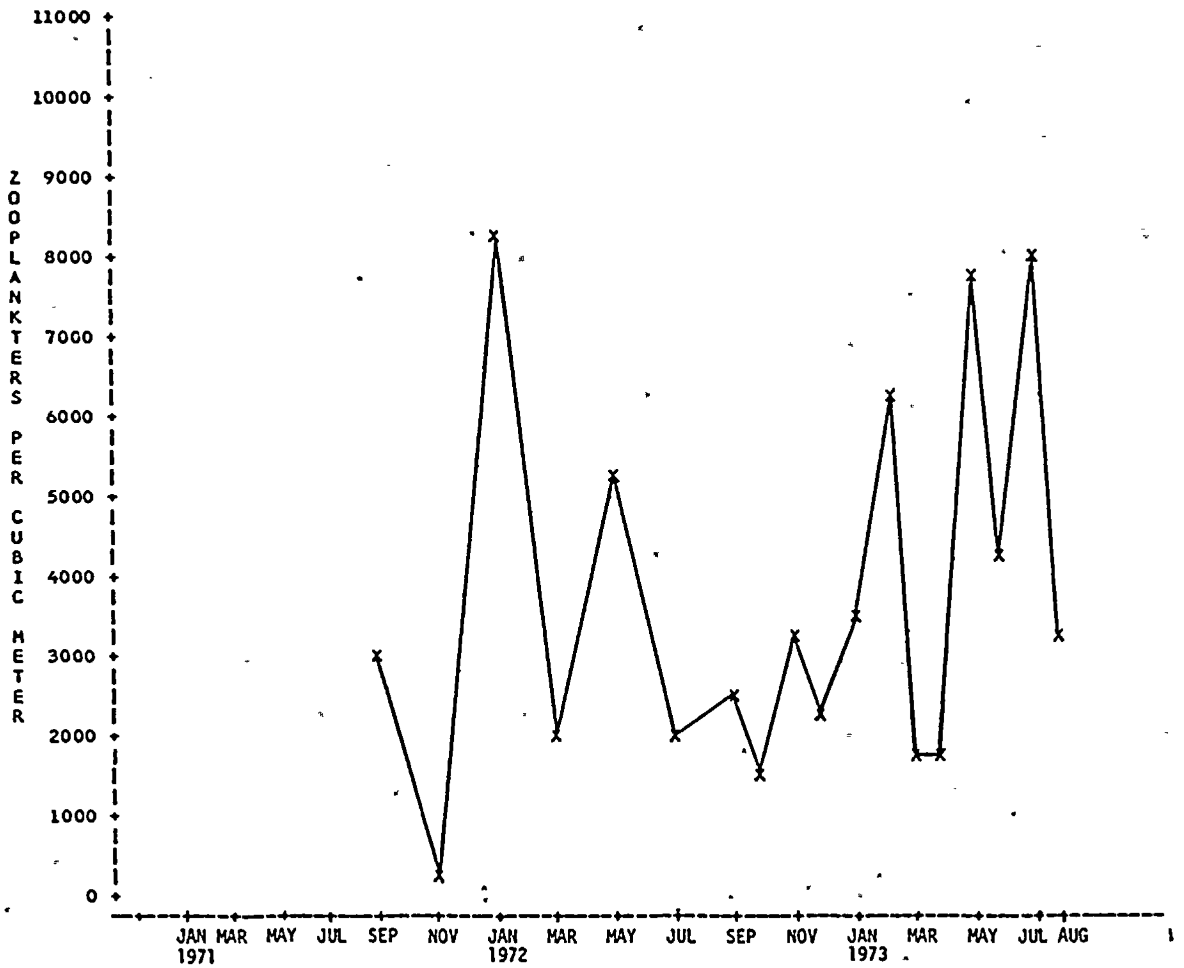

Figure E-7. Average density of zooplankton at Stations 1 through 5 during baseline monitoring, St. Lucie Plant, September 1971 - August 1973.

TABLE E-1

EXAMPLES OF THE INDIVIDUAL VARIABLES, CLASS VARIABLES AND MODELS USED WITH THE GENERAL LINEAR MODELS PROCEDURE
ST. LUCIE PLANT
1979

INDIVIDUAL VARIABLES

(Y_1) Density	($X_{1,2}$) Station	($X_{3,4}$) Year	(X_0) Intercept
Yi_1	1	A	1
Yi_1	1	B	1
Yi_1	2	A	1
Yi_1	2	B	1

CLASS VARIABLES

Station		Year	
1	2	A	B
X_{i1}	X_{i2}	X_{i3}	X_{i4}
1	0	1	0
1	0	0	1
0	1	1	0
0	1	0	1

MODELS

For station and year effects:

$$Y_i = B_0X_0 + B_1X_{i1} + B_2X_{i2} + B_3X_{i3} + B_yX_{i4} + \Sigma_i$$

For station effects:

$$Y_i = B_0X_0 + B_1X_{i1} + B_2X_{i2} + \Sigma_i$$

where: B is the respective slope
Σ_i is the error term

TABLE E-2

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
17 JANUARY 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	O	O	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	0.0	0.0	2.6 (<1)	0.0	0.0	0.0	0.0	0.0	1.1 (<1)	0.0	0.0	0.2 (<1)	0.0	0.0
Mollusca	0.0	3.1 (1)	7.8 (1)	21.6 (1)	94.4 (3)	106.7 (4)	11.1 (1)	4.8 (1)	0.0	1.0 (<1)	2.3 (<1)	1.1 (1)	9.2 (1)	10.2 (1)
Polychaeta	0.0	0.0	2.6 (<1)	8.6 (<1)	5.9 (<1)	0.0	3.7 (<1)	0.0	0.0	0.0	0.0	0.2 (<1)	3.7 (<1)	0.0
Crustacea nauplii	0.0	0.0	0.0	0.0	0.0	0.0	2.5 (<1)	0.0	0.0	0.0	0.0	0.0	14.7 (2)	0.0
cladocera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	0.0	0.0	0.0	0.0	0.0	0.0	1.2 (<1)	0.0	0.0	0.0	2.3 (<1)	0.2 (<1)	0.0	0.0
copepoda	206.8 (21)	101.7 (20)	957.8 (87)	2495.1 (94)	2791.9 (91)	2789.7 (91)	899.6 (82)	257.8 (77)	405.7 (63)	367.8 (76)	1032.0 (82)	80.9 (82)	689.4 (71)	889.9 (92)
cirripedia (barnacle) nauplii	783.5 (78)	371.6 (73)	10.4 (1)	0.0	17.7 (1)	5.6 (<1)	25.8 (2)	0.0	12.1 (2)	3.1 (1)	4.7 (<1)	0.4 (<1)	25.7 (3)	0.0
decapoda	4.0 (<1)	0.0	10.4 (1)	60.6 (2)	23.6 (1)	44.8 (2)	66.6 (6)	5.6 (2)	27.5 (4)	17.7 (4)	44.3 (4)	5.0 (5)	102.6 (11)	22.0 (2)
others	2.0 (<1)	16.9 (3)	5.2 (1)	0.0	23.6 (1)	5.6 (<1)	0.0	0.0	3.3 (1)	1.0 (<1)	0.0	0.0	0.0	0.0
Chaetognatha	0.0	1.5 (<1)	0.0	25.9 (1)	5.9 (<1)	67.3 (2)	4.9 (1)	1.6 (1)	6.6 (1)	3.1 (1)	9.3 (1)	0.2 (<1)	11.0 (1)	3.4 (<1)
Echinodermata	0.0	1.5 (<1)	0.0	0.0	0.0	0.0	1.2 (<1)	2.4 (1)	0.0	0.0	0.0	0.0	0.0	0.0
Chordata urochordata	0.0	1.5 (<1)	0.0	4.3 (<1)	0.0	0.0	4.9 (1)	1.6 (1)	0.0	0.0	2.3 (<1)	0.2 (<1)	3.7 (<1)	11.9 (1)
fish (eggs and larvae)	0.0	0.0	2.6 (<1)	0.0	11.8 (<1)	5.6 (<1)	2.5 (<1)	0.8 (<1)	4.4 (1)	1.0 (<1)	2.3 (<1)	0.0	3.6 (<1)	1.7 (<1)
Eggs	5.9 (1)	13.9 (3)	106.7 (10)	34.6 (1)	100.3 (3)	44.9 (2)	75.1 (7)	58.0 (17)	185.7 (29)	86.7 (18)	153.7 (12)	9.9 (10)	113.7 (12)	22.0 (2)
Miscellaneous	0.0	1.5 (<1)	0.0	0.0	5.9 (<1)	0.0	0.0	0.8 (<1)	0.0	0.0	0.0	0.4 (<1)	0.0	1.7 (<1)
SUBTOTAL UNDAMAGED	1002.2	513.2	1106.1	2650.7	3081.0	3070.2	1099.1	333.4	646.4	481.4	1253.2	98.7	977.3	962.8
SUBTOTAL DAMAGED	2.0 (<1)	1.5 (<1)	33.8 (3)	82.1 (3)	41.3 (1)	50.5 (2)	19.7 (2)	17.5 (5)	28.7 (4)	11.4 (2)	23.3 (2)	3.6 (4)	16.5 (2)	10.2 (1)
TOTAL UNDAMAGED + DAMAGED	1004.2	514.7	1139.9	2732.8	3122.3	3120.7	1188.8	350.9	675.1	492.8	1276.5	102.3	993.8	973.0

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]O = Oblique; S = Surface; B = Bottom.

TABLE E-3

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
13 FEBRUARY 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	12.6 (13)	0.0	0.0	6.6 (<1)	0.4 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	0.0	0.0	0.0	0.0	2.2 (<1)	0.4 (<1)	0.0	0.0	18.6 (<1)	0.0	0.0	2.0 (<1)	0.0	3.6 (1)
Mollusca	5.6 (2)	1.4 (1)	0.0	1.7 (1)	26.3 (1)	1.1 (1)	2.6 (<1)	9.2 (1)	43.3 (1)	14.2 (1)	0.0	8.0 (1)	18.0 (1)	1.2 (<1)
Polychaeta	5.6 (2)	0.2 (<1)	0.0	0.0	122.6 (6)	2.1 (1)	0.0	5.5 (1)	0.0	0.0	0.9 (<1)	2.0 (<1)	0.0	2.4 (<1)
Crustacea nauplii	0.0	0.2 (<1)	2.6 (1)	1.1 (<1)	26.3 (1)	0.0	0.0	0.0	0.0	3.5 (<1)	1.8 (1)	12.0 (1)	9.0 (<1)	0.0
cladocera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	0.6 (<1)	0.2 (<1)	0.0	0.6 (<1)	2.2 (<1)	0.0	5.2 (<1)	9.2 (1)	68.1 (2)	24.8 (1)	0.0	10.0 (1)	4.5 (<1)	13.1 (3)
copepoda	40.3 (14)	25.8 (26)	448.5 (85)	272.0 (86)	1696.8 (80)	136.2 (82)	1167.1 (92)	927.3 (90)	4012.6 (94)	1686.2 (92)	339.3 (89)	957.5 (81)	2571.5 (95)	444.8 (83)
cirripedia (barnacle) nauplii	217.0 (74)	47.9 (48)	1.3 (<1)	3.3 (1)	89.8 (4)	8.2 (5)	0.0	0.0	12.4 (<1)	14.2 (1)	0.0	97.9 (8)	9.0 (<1)	26.1 (5)
decapoda	4.0 (1)	0.7 (<1)	3.9 (1)	6.3 (2)	4.4 (<1)	0.4 (<1)	18.2 (1)	23.8 (2)	18.6 (<1)	53.0 (3)	7.2 (2)	30.0 (3)	9.0 (<1)	9.6 (2)
others	1.1 (<1)	1.4 (1)	0.0	0.0	4.4 (<1)	2.3 (1)	0.0	0.0	0.0	7.0 (<1)	0.0	2.0 (<1)	0.0	1.2 (<1)
Chaetognatha	0.0	0.0	2.6 (1)	1.1 (<1)	4.4 (<1)	0.4 (<1)	5.2 (<1)	3.7 (<1)	18.6 (<1)	7.1 (<1)	0.9 (<1)	0.0	4.5 (<1)	0.0
Echinodermata	0.0	0.0	3.9 (1)	0.0	2.2 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chordata urochordata	5.7 (2)	0.0	6.5 (1)	9.9 (3)	109.5 (5)	3.2 (2)	0.0	5.5 (1)	12.4 (<1)	7.1 (<1)	2.7 (1)	16.0 (1)	13.5 (1)	5.9 (1)
fish (eggs and larvae)	0.6 (<1)	0.5 (<1)	7.8 (1)	5.5 (2)	0.0	0.7 (<1)	33.9 (3)	14.7 (1)	24.8 (1)	3.5 (<1)	4.5 (1)	0.0	0.0	2.4 (<1)
Eggs	12.5 (4)	9.7 (10)	48.7 (9)	14.9 (5)	26.3 (1)	11.0 (7)	31.3 (3)	33.0 (3)	55.8 (1)	21.3 (1)	25.3 (7)	46.0 (4)	63.0 (2)	23.7 (4)
Miscellaneous	0.6 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	293.6	100.6	525.8	316.4	2124.0	166.4	1263.5	1031.9	4285.2	1841.9	382.6	1183.4	2702.0	534.0
SUBTOTAL DAMAGED	5.1 (2)	2.6 (3)	5.3 (1)	9.9 (3)	43.8 (2)	12.5 (7)	13.0 (1)	32.9 (3)	55.8 (1)	21.3 (1)	6.3 (2)	20.0 (2)	54.0 (2)	14.3 (3)
TOTAL UNDAMAGED + DAMAGED	298.7	103.2	531.1	326.3	2167.8	178.9	1276.5	1064.8	4341.0	1863.2	388.9	1203.4	2756.0	548.3

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-4

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
6 APRIL 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	48.6 (64)	7.4 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	0.0	0.8 (1)	29.6 (<1)	14.0 (<1)	14.2 (<1)	5.8 (<1)	16.8 (<1)	12.8 (<1)	8.6 (<1)	4.8 (<1)	4.9 (<1)	36.4 (<1)	4.1 (<1)	35.1 (<1)
Mollusca	5.4 (1)	3.1 (4)	133.5 (3)	56.4 (2)	17.0 (1)	19.0 (2)	37.2 (2)	42.7 (2)	8.6 (<1)	29.1 (2)	34.6 (2)	63.7 (1)	40.8 (2)	87.6 (2)
Polychaeta	20.7 (5)	0.0	14.8 (<1)	14.1 (<1)	5.7 (<1)	1.5 (<1)	3.4 (<1)	4.3 (<1)	2.9 (<1)	2.4 (<1)	0.0	9.1 (<1)	4.1 (<1)	8.8 (<1)
Crustacea nauplii	10.1 (2)	0.0	22.2 (<1)	7.0 (<1)	17.1 (1)	0.0	3.4 (<1)	0.0	14.3 (<1)	4.9 (<1)	2.5 (<1)	9.1 (<1)	20.4 (<1)	8.8 (<1)
cladocera	0.0	0.0	0.0	7.0 (<1)	2.8 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	1.2 (<1)	0.1 (<1)	541.4 (13)	732.3 (26)	62.6 (4)	90.4 (11)	20.3 (1)	755.9 (30)	22.8 (1)	43.6 (3)	9.9 (<1)	2949.8 (54)	183.8 (8)	2705.4 (49)
copepoda	62.8 (15)	11.7 (15)	2202.6 (52)	1366.1 (48)	857.1 (51)	399.8 (48)	1147.8 (61)	1161.7 (46)	1323.4 (73)	980.5 (65)	988.0 (62)	1702.5 (31)	1515.1 (62)	1646.0 (30)
cirripedia (barnacle) nauplii	188.2 (45)	7.5 (10)	111.2 (3)	14.1 (<1)	37.0 (2)	11.7 (1)	47.2 (3)	17.1 (<1)	20.0 (1)	21.8 (1)	7.4 (<1)	18.2 (<1)	77.6 (3)	70.0 (1)
decapoda	23.1 (6)	1.1 (1)	348.3 (8)	309.8 (11)	85.4 (5)	45.4 (5)	97.9 (5)	183.7 (7)	105.8 (6)	128.3 (9)	71.9 (5)	364.1 (7)	143.0 (6)	315.4 (6)
others	0.0	0.0	14.8 (<1)	0.0	0.0	5.9 (<1)	0.0	0.0	0.0	14.5 (<1)	5.0 (<1)	9.1 (<1)	4.1 (<1)	8.8 (<1)
Chaetognatha	0.0	0.0	133.5 (3)	42.3 (2)	14.2 (<1)	10.2 (1)	13.5 (<1)	4.3 (<1)	5.7 (<1)	31.5 (2)	37.1 (2)	36.4 (<1)	24.5 (1)	78.8 (1)
Echinodermata	0.6 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	4.3 (<1)	0.0	0.0	0.0	0.0	0.0	0.0
Chordata urochordata	50.3 (12)	0.0	363.4 (9)	147.9 (5)	227.8 (14)	113.8 (14)	226.2 (12)	94.0 (4)	71.3 (4)	104.1 (7)	200.6 (13)	118.4 (2)	187.8 (8)	210.1 (4)
fish (eggs and larvae)	15.4 (4)	0.0	7.4 (<1)	28.2 (1)	48.4 (3)	27.7 (3)	23.6 (1)	0.0	8.6 (<1)	2.4 (<1)	19.8 (1)	18.2 (<1)	106.3 (4)	157.7 (3)
Eggs	42.0 (10)	3.2 (4)	304.0 (7)	105.6 (4)	293.3 (17)	99.2 (12)	236.3 (13)	213.5 (9)	211.1 (12)	142.8 (10)	222.9 (14)	154.8 (3)	151.1 (6)	166.3 (3)
Miscellaneous	1.2 (<1)	0.1 (<1)	0.0	0.0	0.0	0.0	3.4 (<1)	8.5 (<1)	11.4 (<1)	0.0	2.5 (<1)	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	421.0	76.2	4234.1	2844.8	1682.6	830.4	1877.0	2502.8	1814.5	1510.7	1607.1	5489.8	2462.7	5498.8
SUBTOTAL DAMAGED	32.6 (8)	1.8 (2)	296.5 (7)	204.1 (7)	105.3 (6)	65.6 (8)	101.4 (5)	89.5 (4)	34.3 (2)	55.5 (4)	69.4 (4)	209.3 (4)	183.9 (7)	332.8 (6)
TOTAL UNDAMAGED + DAMAGED	453.6	78.0	4530.6	3048.9	1787.9	896.0	1978.4	2592.3	1848.8	1566.2	1676.5	5699.1	2646.6	5831.6

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-5

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
27 APRIL 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	6.8 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8 (<1)	0.0	0.0
Coelenterata	0.0	0.0	2.0 (<1)	8.5 (<1)	6.8 (<1)	7.8 (1)	0.0	0.5 (<1)	1.8 (<1)	3.6 (<1)	2.7 (<1)	0.0	0.0	1.9 (<1)
Mollusca	142.6 (3)	116.0 (2)	2.0 (<1)	7.3 (<1)	17.0 (1)	10.5 (2)	64.2 (4)	0.9 (1)	40.0 (3)	11.0 (1)	4.0 (<1)	4.0 (1)	35.2 (2)	7.6 (1.1)
Polychaeta	106.9 (3)	20.5 (<1)	2.0 (<1)	1.2 (<1)	15.3 (1)	3.9 (<1)	11.7 (<1)	0.9 (1)	1.8 (<1)	3.6 (<1)	2.4 (<1)	2.4 (<1)	3.9 (<1)	0.0
Crustacea nauplii	11.9 (<1)	0.0	7.0 (<1)	46.5 (5)	20.4 (2)	9.2 (1)	11.7 (<1)	0.2 (<1)	1.8 (<1)	3.7 (<1)	1.3 (<1)	2.4 (<1)	15.6 (<1)	1.9 (<1)
cladocera	0.0	0.0	3.0 (<1)	9.8 (1)	3.4 (<1)	2.6 (<1)	11.7 (<1)	0.9 (1)	3.6 (<1)	5.4 (<1)	2.7 (<1)	2.4 (<1)	3.9 (<1)	11.4 (2)
ostracoda	0.0	0.0	0.0	11.0 (1)	5.1 (<1)	0.0	0.0	0.0	0.0	1.8 (<1)	0.0	2.4 (<1)	0.0	0.0
copepoda	499.0 (12)	641.5 (12)	236.2 (28)	515.3 (57)	651.2 (51)	436.0 (60)	668.1 (39)	29.6 (46)	463.6 (34)	495.2 (52)	206.9 (20)	163.1 (51)	759.4 (38)	343.8 (49)
cirripedia (barnacle) nauplii	2821.7 (67)	4538.4 (85)	2.0 (<1)	7.4 (<1)	64.6 (5)	57.8 (8)	8.8 (<1)	0.2 (<1)	3.7 (<1)	113.0 (12)	1.3 (<1)	3.2 (1)	19.6 (1)	13.2 (2)
decapoda	53.3 (1)	20.4 (<1)	37.9 (5)	28.1 (3)	10.2 (<1)	26.2 (4)	5.8 (<1)	1.6 (3)	3.6 (<1)	94.7 (10)	2.6 (<1)	46.4 (15)	58.7 (3)	126.7 (18)
others	0.0	0.0	1.0 (<1)	1.2 (<1)	0.0	0.0	0.0	0.0	0.0	32.8 (4)	1.3 (<1)	0.0	0.0	0.0
Chaetognatha	0.0	0.0	8.0 (<1)	6.1 (<1)	6.8 (<1)	2.6 (<1)	17.5 (1)	0.5 (<1)	18.2 (1)	14.5 (2)	6.7 (<1)	9.6 (3)	31.3 (2)	7.6 (1)
Echinodermata	0.0	0.0	2.0 (<1)	20.8 (2)	5.1 (<1)	1.3 (<1)	8.8 (<1)	0.0	5.5 (<1)	1.8 (<1)	1.3 (<1)	4.8 (2)	7.8 (<1)	0.0
Chordata urochordata	439.6 (11)	6.8 (<1)	27.9 (3)	20.8 (2)	81.6 (6)	40.7 (6)	90.4 (5)	2.6 (4)	101.9 (8)	56.4 (6)	25.5 (3)	14.4 (5)	62.7 (3)	58.6 (8)
fish (eggs and larvae)	5.9 (<1)	0.0	74.8 (9)	25.8 (3)	5.1 (<1)	1.3 (<1)	253.8 (15)	14.2 (22)	134.5 (10)	1.8 (<1)	178.7 (17)	12.0 (4)	156.6 (8)	34.0 (5)
Eggs	106.9 (3)	20.5 (<1)	443.5 (52)	198.3 (22)	387.6 (30)	123.4 (17)	560.2 (33)	12.4 (19)	563.6 (42)	101.9 (11)	593.7 (58)	45.6 (14)	837.7 (42)	86.9 (13)
Miscellaneous	0.0	0.0	0.0	2.4 (<1)	1.7 (<1)	0.0	5.8 (<1)	0.2 (<1)	5.5 (<1)	3.6 (<1)	2.7 (<1)	6.4 (2)	0.0	3.8 (<1)
SUBTOTAL UNDAMAGED	4187.8	5370.9	849.3	910.5	1281.9	723.3	1718.5	64.7	1349.1	944.8	1031.4	319.9	1992.4	697.4
SUBTOTAL DAMAGED	100.8 (2)	27.3 (1)	13.0 (2)	13.4 (1)	40.8 (3)	18.4 (3)	32.1 (2)	6.5 (10)	23.6 (2)	112.8 (12)	29.5 (3)	48.0 (15)	42.9 (2)	47.4 (7)
TOTAL UNDAMAGED + DAMAGED	4288.6	5398.2	862.3	923.9	1322.7	741.7	1750.6	71.2	1372.7	1057.6	1060.9	367.9	2035.3	744.8

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-6

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
15 MAY 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	5.9 (<1)	2.7 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	3.9 (<1)	0.9 (<1)	6.5 (<1)	34.1 (<1)	9.0 (<1)	0.0	0.0	8.3 (<1)	0.0	10.3 (<1)	1.8 (<1)	10.1 (<1)	12.7 (<1)	0.0
Mollusca	4.0 (<1)	8.1 (1)	6.5 (<1)	113.6 (2)	13.4 (<1)	0.0	0.0	4.2 (<1)	11.5 (<1)	7.7 (<1)	1.8 (<1)	0.0	6.3 (<1)	5.6 (<1)
Polychaeta	9.8 (<1)	0.0	0.0	68.1 (<1)	4.5 (<1)	0.0	0.0	0.0	0.0	0.0	1.8 (<1)	0.0	6.3 (<1)	0.0
Crustacea nauplii	17.7 (2)	0.0	0.0	45.4 (<1)	0.0	0.0	0.0	45.9 (2)	0.0	17.9 (1)	0.0	60.8 (<1)	0.0	22.3 (<1)
cladocera	0.0	0.0	0.0	11.4 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	0.0	0.0	0.0	34.1 (<1)	4.5 (<1)	0.0	0.0	20.9 (<1)	0.0	7.7 (<1)	1.8 (<1)	40.5 (<1)	0.0	695.7 (20)
copepoda	528.7 (48)	89.0 (15)	3363.5 (89)	5950.4 (82)	2198.1 (81)	1755.9 (78)	2711.9 (87)	2475.5 (81)	1703.8 (79)	1359.6 (74)	906.3 (86)	5147.7 (78)	2655.5 (86)	2376.4 (70)
cirripedia (barnacle) nauplii	316.4 (29)	471.1 (82)	0.0	0.0	0.0	0.0	21.9 (<1)	20.8 (<1)	0.0	2.6 (<1)	1.8 (<1)	50.7 (<1)	0.0	0.0
decapoda	27.6 (3)	1.8 (<1)	19.5 (<1)	284.0 (4)	44.6 (2)	22.0 (1)	27.4 (<1)	154.5 (5)	3.8 (<1)	12.9 (<1)	7.1 (<1)	1023.4 (16)	6.3 (<1)	100.2 (3)
others	0.0	0.0	0.0	56.8 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.1 (<1)	0.0	0.0
Chaetognatha	0.0	0.0	19.5 (<1)	0.0	8.9 (<1)	4.4 (<1)	0.0	0.0	3.8 (<1)	0.0	0.0	0.0	6.3 (<1)	0.0
Echinodermata	5.9 (<1)	0.0	0.0	193.0 (3)	22.3 (<1)	0.0	0.0	87.7 (3)	0.0	5.1 (<1)	0.0	81.1 (1)	0.0	11.1 (<1)
Chordata urochordata	90.4 (8)	0.0	208.2 (6)	454.3 (6)	178.3 (7)	61.8 (3)	32.8 (1)	192.0 (6)	206.3 (10)	388.4 (21)	69.2 (7)	141.9 (2)	164.4 (5)	89.1 (3)
fish (eggs and larvae)	9.8 (<1)	0.9 (<1)	84.6 (2)	0.0	142.7 (5)	326.4 (15)	262.5 (8)	0.0	141.3 (7)	5.1 (<1)	23.1 (2)	0.0	145.4 (5)	33.4 (1)
Eggs	76.6 (7)	3.6 (<1)	84.6 (2)	11.4 (<1)	89.2 (3)	88.2 (4)	71.1 (2)	41.7 (1)	76.4 (4)	17.9 (1)	37.2 (4)	30.4 (<1)	82.2 (3)	50.1 (2)
Miscellaneous	5.9 (<1)	0.0	0.0	22.7 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	1102.6	578.1	3792.9	7279.3	2715.5	2258.7	3127.6	3051.5	2146.9	1835.2	1051.9	6596.7	3085.4	3383.9
SUBTOTAL DAMAGED	15.7 (1)	4.5 (1)	143.2 (4)	522.4 (7)	209.6 (8)	88.2 (4)	93.0 (3)	100.2 (3)	110.8 (5)	163.5 (9)	63.9 (6)	101.3 (2)	101.2 (3)	78.0 (2)
TOTAL UNDAMAGED + DAMAGED	1118.3	582.6	3936.1	7801.7	2925.1	2346.9	3220.6	3151.7	2257.7	1998.7	1115.8	6698.0	3186.6	3461.9

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-7

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
12 JUNE 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	31.4 (<1)	4.7 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1 (<1)	0.0
Coelenterata	39.2 (<1)	83.7 (1)	7.0 (<1)	44.3 (1)	37.1 (<1)	44.1 (1)	3.3 (<1)	0.0	11.7 (<1)	9.8 (<1)	4.7 (<1)	19.9 (1)	22.1 (1)	21.2 (<1)
Mollusca	2723.0 (20)	1453.8 (20)	67.6 (5)	33.2 (1)	1242.3 (11)	617.0 (8)	122.0 (6)	56.0 (2)	351.8 (5)	29.3 (1)	18.7 (<1)	23.9 (1)	337.2 (10)	191.1 (4)
Polychaeta	0.0	41.9 (<1)	2.3 (<1)	0.0	0.0	44.1 (1)	0.0	0.0	0.0	4.9 (<1)	0.0	4.0 (<1)	0.0	7.1 (<1)
Crustacea nauplii	98.0 (1)	31.4 (<1)	0.0	0.0	37.1 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1 (<1)	7.1 (<1)
cladocera	19.6 (<1)	0.0	0.0	0.0	0.0	0.0	39.6 (2)	7.0 (<1)	0.0	0.0	4.7 (<1)	8.0 (<1)	132.7 (4)	7.1 (<1)
ostracoda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
copepoda	10461.2 (76)	4989.2 (70)	1012.9 (75)	2781.6 (70)	9567.5 (82)	6290.8 (80)	1526.7 (77)	1722.5 (66)	5382.7 (79)	1951.7 (66)	2413.7 (88)	1751.1 (75)	2382.8 (73)	2377.4 (55)
cirripedia (barnacle) nauplii	58.8 (<1)	94.1 (1)	0.0	44.3 (1)	37.0 (<1)	33.1 (<1)	0.0	42.0 (2)	0.0	4.9 (<1)	4.7 (<1)	4.0 (<1)	0.0	28.3 (1)
decapoda	235.1 (2)	167.6 (2)	130.6 (10)	554.0 (14)	129.7 (1)	396.8 (5)	82.4 (4)	357.0 (14)	375.2 (6)	312.4 (11)	51.4 (2)	187.6 (8)	27.6 (1)	1507.4 (35)
others	19.6 (<1)	0.0	2.3 (<1)	0.0	0.0	0.0	0.0	7.0 (<1)	0.0	9.8 (<1)	0.0	0.0	0.0	0.0
Chaetognatha	0.0	10.5 (<1)	37.3 (3)	22.2 (1)	37.1 (<1)	55.1 (1)	3.3 (<1)	21.0 (1)	82.1 (1)	14.6 (<1)	14.0 (1)	8.0 (<1)	0.0	7.1 (<1)
Echinodermata	0.0	0.0	0.0	0.0	0.0	11.0 (<1)	0.0	0.0	0.0	0.0	0.0	8.0 (<1)	0.0	0.0
Chordata urochordata	78.4 (<1)	198.7 (3)	37.3 (3)	443.3 (11)	482.1 (4)	308.5 (4)	148.4 (7)	329.1 (13)	527.7 (8)	527.0 (18)	182.1 (7)	295.2 (13)	237.7 (7)	127.4 (3)
fish (eggs and larvae)	0.0	0.0	11.7 (1)	22.1 (1)	92.7 (1)	0.0	13.2 (1)	49.0 (2)	0.0	68.4 (2)	4.7 (<1)	12.0 (1)	83.0 (3)	0.0
Eggs	39.2 (<1)	73.2 (1)	32.7 (2)	44.3 (1)	18.5 (<1)	33.1 (<1)	49.5 (2)	0.0	58.6 (1)	39.0 (1)	51.3 (2)	12.0 (1)	11.1 (<1)	35.4 (1)
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	13772.1	7175.5	1346.4	3989.3	11681.1	7833.6	1988.4	2590.6	6789.8	2971.8	2750.0	2333.7	3256.4	4316.6
SUBTOTAL DAMAGED	137.1 (1)	167.4 (2)	39.7 (3)	432.2 (11)	259.6 (2)	495.8 (6)	89.0 (4)	231.1 (9)	691.9 (10)	283.0 (10)	60.7 (2)	103.7 (4)	88.5 (3)	141.7 (3)
TOTAL UNDAMAGED + DAMAGED	13909.2	7342.9	1386.1	4421.5	11940.7	8329.4	2077.4	2821.7	7481.7	3254.8	2810.7	2437.4	3344.9	4458.3

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-8

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
26 JULY 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	4.3 (<1)	4.3 (<1)	0.0	0.0	6.7 (<1)	0.0	6.7 (<1)	0.0	0.0	0.0	20.9 (<1)	0.0	0.0	0.0
Coelenterata	13.0 (<1)	8.6 (<1)	23.0 (<1)	10.6 (<1)	6.7 (<1)	13.7 (<1)	0.0	0.0	0.0	0.0	10.4 (<1)	16.7 (<1)	12.8 (<1)	10.0 (<1)
Mollusca	177.5 (7)	25.9 (<1)	34.4 (<1)	42.4 (<1)	101.2 (3)	54.9 (<1)	0.0	29.7 (<1)	23.3 (<1)	38.4 (<1)	20.9 (<1)	16.7 (<1)	0.0	19.9 (<1)
Polychaeta	64.9 (3)	25.8 (<1)	23.0 (<1)	0.0	81.0 (2)	27.5 (<1)	13.4 (<1)	29.7 (<1)	0.0	102.3 (1)	10.4 (<1)	50.1 (<1)	0.0	10.0 (<1)
Crustacea nauplii	116.9 (5)	129.4 (5)	0.0	0.0	33.7 (<1)	96.1 (1)	0.0	9.9 (<1)	0.0	25.6 (<1)	0.0	183.7 (2)	0.0	29.9 (<1)
cladocera	91.0 (4)	8.6 (<1)	34.4 (<1)	10.6 (<1)	74.2 (2)	192.1 (2)	53.5 (2)	128.5 (2)	116.6 (2)	524.2 (7)	135.6 (2)	484.2 (5)	433.5 (5)	69.7 (1)
ostracoda	0.0	0.0	0.0	0.0	0.0	13.7 (<1)	0.0	0.0	0.0	25.6 (<1)	0.0	0.0	0.0	10.0 (<1)
copepoda	796.4 (31)	1483.9 (52)	5762.9 (84)	6218.7 (85)	2773.5 (73)	6286.3 (76)	3144.4 (90)	4240.7 (81)	6728.7 (90)	6341.6 (82)	5589.1 (84)	7246.4 (78)	7345.1 (82)	4138.7 (83)
cirripedia (barnacle) nauplii	675.2 (26)	509.0 (18)	11.5 (<1)	10.6 (<1)	20.2 (<1)	41.2 (<1)	0.0	9.9 (<1)	0.0	12.8 (<1)	0.0	0.0	0.0	19.9 (<1)
decapoda	138.6 (5)	142.3 (5)	126.2 (2)	201.4 (3)	209.1 (6)	521.5 (6)	20.1 (<1)	306.6 (6)	11.7 (<1)	217.6 (3)	0.0	267.2 (3)	12.8 (<1)	219.4 (4)
others	4.3 (<1)	0.0	0.0	21.2 (<1)	6.7 (<1)	13.7 (<1)	0.0	0.0	0.0	0.0	10.4 (<1)	16.7 (<1)	0.0	10.0 (<1)
Chaetognatha	13.0 (<1)	0.0	34.4 (<1)	74.1 (1)	20.2 (<1)	27.5 (<1)	13.4 (<1)	29.7 (<1)	23.3 (<1)	25.6 (<1)	0.0	33.4 (<1)	76.5 (<1)	19.9 (<1)
Echinodermata	51.9 (2)	4.3 (<1)	34.4 (<1)	211.9 (3)	6.7 (<1)	27.5 (<1)	0.0	118.6 (2)	0.0	25.6 (<1)	41.7 (<1)	150.3 (2)	0.0	149.6 (3)
Chordata urochordata	26.0 (1)	0.0	218.1 (3)	286.1 (4)	135.0 (4)	439.2 (5)	46.8 (1)	177.9 (3)	46.7 (<1)	281.3 (4)	260.7 (4)	500.9 (5)	25.5 (<1)	159.6 (3)
fish (eggs and larvae)	0.0	0.0	103.3 (2)	0.0	47.2 (1)	0.0	113.8 (3)	69.2 (1)	279.9 (4)	51.2 (<1)	187.7 (3)	33.4 (<1)	803.4 (9)	10.0 (<1)
Eggs	398.2 (16)	500.4 (18)	459.2 (7)	264.9 (4)	303.7 (8)	507.8 (6)	66.9 (2)	108.7 (2)	209.9 (4)	76.7 (1)	323.2 (5)	333.9 (4)	216.8 (2)	139.6 (3)
Miscellaneous	4.3 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4 (<1)	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	2575.5	2842.5	6864.8	7352.5	3825.8	8262.7	3479.0	5259.1	7440.1	7748.5	6621.4	9333.6	8926.4	5016.2
SUBTOTAL DAMAGED	125.5 (5)	73.2 (3)	183.7 (3)	190.8 (3)	67.3 (2)	288.1 (3)	100.4 (3)	454.9 (8)	128.3 (2)	281.4 (4)	146.0 (2)	250.5 (3)	204.1 (2)	229.5 (4)
TOTAL UNDAMAGED + DAMAGED	2701.0	2915.7	7048.5	7543.3	3893.1	8550.8	3579.4	5714.0	7568.4	8029.9	6767.4	9584.1	9130.5	5245.7

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-9

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
21 AUGUST 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	3.1 (<1)	15.8 (<1)	0.0	17.5 (<1)	5.7 (<1)	8.1 (<1)	0.0	0.0	0.0	6.1 (<1)	0.0	5.6 (<1)	7.6 (<1)
Coelenterata	0.0	0.0	213.7 (4)	56.1 (2)	17.5 (<1)	5.7 (<1)	20.2 (1)	27.2 (2)	3.3 (<1)	7.4 (1)	12.1 (<1)	47.7 (3)	11.2 (<1)	60.5 (4)
Mollusca	4597.1 (96)	221.4 (51)	822.8 (16)	601.4 (21)	8907.5 (63)	974.8 (31)	238.7 (12)	128.7 (10)	270.2 (15)	81.0 (11)	88.3 (5)	157.2 (9)	683.8 (21)	103.3 (7)
Polychaeta	0.0	0.0	7.9 (<1)	9.9 (<1)	0.0	11.4 (<1)	0.0	2.5 (<1)	3.3 (<1)	0.0	0.0	0.0	0.0	0.0
Crustacea nauplii	1.4 (<1)	3.1 (1)	23.7 (<1)	3.3 (<1)	17.5 (<1)	22.8 (<1)	0.0	7.4 (<1)	0.0	1.9 (<1)	0.0	0.0	33.6 (1)	0.0
cladocera	0.0	1.5 (<1)	182.0 (4)	112.4 (4)	140.0 (1)	45.6 (1)	271.1 (14)	442.6 (36)	309.7 (18)	90.4 (12)	109.7 (7)	583.9 (34)	448.4 (14)	357.8 (24)
ostracoda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
copepoda	62.0 (1)	104.9 (24)	3624.1 (72)	845.8 (29)	4165.0 (29)	1618.9 (51)	1238.3 (62)	363.5 (29)	675.4 (38)	352.2 (48)	959.8 (57)	583.9 (34)	1793.6 (54)	665.4 (45)
cirripedia (barnacle) nauplii	7.1 (<1)	81.2 (19)	0.0	13.2 (<1)	17.5 (<1)	11.4 (<1)	0.0	2.5 (<1)	0.0	0.0	0.0	11.2 (<1)	0.0	7.6 (<1)
decapoda	16.8 (<1)	8.5 (2)	15.8 (<1)	270.8 (9)	595.0 (4)	313.5 (10)	36.4 (2)	131.0 (11)	72.5 (4)	143.0 (19)	30.5 (2)	218.8 (13)	100.8 (3)	156.2 (11)
others	1.4 (<1)	2.3 (<1)	0.0	3.3 (<1)	17.5 (<1)	5.7 (<1)	0.0	9.9 (<1)	0.0	11.3 (2)	3.0 (<1)	2.8 (<1)	0.0	5.0 (<1)
Chaetognatha	1.4 (<1)	0.0	87.0 (2)	85.9 (3)	122.5 (<1)	74.1 (2)	129.5 (7)	64.3 (5)	168.0 (10)	30.1 (4)	158.4 (9)	61.7 (4)	112.1 (3)	55.4 (4)
Echinodermata	0.0	0.0	7.9 (<1)	720.3 (25)	17.5 (<1)	17.1 (<1)	0.0	2.5 (<1)	0.0	0.0	0.0	5.6 (<1)	5.6 (<1)	10.1 (<1)
Chordata urochordata	1.4 (<1)	1.5 (<1)	31.6 (<1)	181.7 (6)	122.5 (<1)	28.5 (<1)	44.5 (2)	47.0 (4)	253.7 (14)	11.3 (2)	323.0 (19)	44.9 (3)	61.6 (2)	42.8 (3)
fish (eggs and larvae)	0.0	0.0	31.6 (<1)	0.0	0.0	0.0	0.0	0.0	3.3 (<1)	7.5 (1)	0.0	0.0	50.4 (2)	0.0
Eggs	0.0	2.3 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	3.3 (<1)	0.0	0.0	0.0	0.0	0.0
Miscellaneous	83.2 (2)	2.3 (<1)	7.9 (<1)	0.0	0.0	11.4 (<1)	0.0	7.5 (<1)	0.0	0.0	0.0	2.8 (<1)	0.0	5.0 (<1)
SUBTOTAL UNDAMAGED	4771.8	432.1	5071.8	2904.1	14157.5	3146.6	1986.8	1236.6	1762.7	736.1	1690.9	1720.5	3306.7	1476.7
SUBTOTAL DAMAGED	4.2 (<1)	1.6 (<1)	87.0 (2)	122.1 (4)	192.5 (1)	51.3 (2)	84.9 (4)	113.8 (8)	66.0 (4)	114.7 (14)	94.4 (5)	137.3 (7)	218.6 (6)	93.2 (6)
TOTAL UNDAMAGED + DAMAGED	4776.0	433.7	5158.8	3026.2	14350.0	3197.9	2071.7	1350.4	1828.7	850.8	1785.3	1857.8	3525.3	1569.9

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-10

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
7 SEPTEMBER 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.0	2.9 (<1)	0.0	0.0	22.8 (<1)	0.0	0.0	0.0	1.2 (<1)	0.2 (<1)	0.0	0.0	0.0	0.0
Coelenterata	0.0	0.0	0.0	1.7 (<1)	30.4 (<1)	0.0	1.9 (<1)	0.0	2.5 (<1)	0.0	9.7 (2)	2.8 (<1)	4.2 (<1)	2.8 (<1)
Mollusca	144.0 (7)	45.4 (4)	2.3 (<1)	22.2 (2)	99.0 (2)	6.0 (<1)	7.5 (1)	4.1 (2)	9.9 (1)	2.0 (1)	5.8 (1)	7.4 (1)	14.6 (<1)	7.5 (2)
Polychaeta	27.6 (1)	7.3 (<1)	9.1 (<1)	22.2 (2)	83.7 (2)	60.4 (2)	18.9 (3)	1.2 (<1)	29.7 (4)	0.2 (<1)	31.9 (7)	2.8 (<1)	18.8 (1)	3.8 (<1)
Crustacea nauplii	9.2 (<1)	5.9 (<1)	0.0	0.0	38.1 (<1)	18.1 (<1)	3.8 (<1)	0.6 (<1)	7.4 (<1)	0.7 (<1)	2.9 (<1)	2.8 (<1)	2.1 (<1)	1.9 (<1)
cladocera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	0.0	0.0	0.0	1.7 (<1)	0.0	6.0 (<1)	0.0	5.2 (2)	2.5 (<1)	1.5 (1)	0.0	3.7 (<1)	0.0	0.0
copepoda	1230.9 (57)	640.9 (62)	1116.2 (85)	723.6 (79)	3587.1 (75)	2330.6 (81)	259.7 (45)	125.7 (48)	524.4 (61)	79.9 (51)	196.0 (41)	311.4 (53)	1370.5 (82)	209.0 (50)
cirripedia (barnacle) nauplii	468.5 (22)	92.4 (9)	0.0	22.2 (2)	342.7 (7)	96.6 (3)	0.0	7.0 (3)	0.0	1.0 (<1)	1.9 (<1)	11.2 (2)	4.2 (<1)	9.5 (2)
decapoda	76.7 (4)	85.1 (8)	4.6 (<1)	42.7 (5)	190.3 (4)	229.3 (8)	39.7 (7)	16.3 (6)	65.7 (8)	8.2 (5)	25.2 (5)	41.8 (7)	54.4 (3)	39.6 (10)
others	3.1 (<1)	5.9 (<1)	0.0	1.7 (<1)	7.6 (<1)	12.1 (<1)	0.0	0.0	0.0	0.0	0.0	1.8 (<1)	2.1 (<1)	0.0
Chaetognatha	0.0	1.5 (<1)	9.1 (<1)	5.1 (<1)	15.2 (<1)	24.1 (<1)	2.8 (<1)	3.5 (1)	3.7 (<1)	0.7 (<1)	2.9 (<1)	3.7 (<1)	2.1 (<1)	2.8 (<1)
Echinodermata	0.0	3.0 (<1)	2.3 (<1)	0.0	0.0	6.0 (<1)	5.7 (1)	0.6 (<1)	3.7 (<1)	0.5 (<1)	5.8 (1)	0.9 (<1)	2.1 (<1)	0.9 (<1)
Chordata urochordata	24.5 (1)	1.5 (<1)	11.4 (<1)	8.5 (<1)	76.1 (2)	12.1 (<1)	96.3 (17)	16.8 (6)	23.6 (3)	9.0 (6)	50.2 (11)	19.6 (3)	18.8 (1)	22.8 (6)
fish (eggs and larvae)	0.0	0.0	20.4 (2)	1.7 (<1)	45.6 (1)	0.0	50.0 (9)	1.7 (<1)	26.0 (3)	0.5 (<1)	17.4 (4)	4.7 (<1)	14.6 (<1)	6.6 (2)
Eggs	196.0 (9)	149.6 (14)	142.9 (11)	61.4 (7)	243.7 (5)	84.5 (3)	95.4 (16)	81.1 (31)	151.2 (18)	51.0 (33)	126.5 (27)	172.9 (29)	173.4 (10)	108.3 (26)
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.9 (<1)	0.0	3.7 (<1)	0.2 (<1)	1.0 (<1)	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	2180.5	1041.4	1318.3	914.7	4782.3	2885.8	582.6	263.8	855.2	155.6	477.2	587.5	1681.9	415.5
SUBTOTAL DAMAGED	6.2 (<1)	5.9 (<1)	29.4 (2)	17.0 (2)	106.5 (2)	108.6 (4)	63.1 (10)	14.6 (5)	35.9 (4)	16.9 (10)	46.5 (9)	15.8 (3)	14.7 (<1)	21.7 (5)
TOTAL UNDAMAGED + DAMAGED	2186.7	1047.3	1347.7	931.7	4888.8	2994.4	645.7	278.4	891.1	172.5	523.7	603.3	1696.6	437.2

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-11

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
2 OCTOBER 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	2.5 (<1)	1.2 (<1)	0.0	0.0	0.0	15.2 (<1)	4.2 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	0.0	0.0	0.0	1.7 (<1)	15.0 (<1)	12.1 (<1)	0.0	4.7 (1)	0.0	9.3 (2)	4.3 (<1)	2.6 (1)	0.0	1.0 (<1)
Mollusca	72.3 (19)	46.5 (6)	17.5 (<1)	22.5 (3)	240.2 (6)	124.3 (8)	4.2 (<1)	19.4 (4)	12.1 (<1)	9.4 (2)	4.3 (<1)	5.2 (3)	5.5 (<1)	12.0 (6)
Polychaeta	0.0	0.0	0.0	0.0	5.0 (<1)	0.0	8.5 (<1)	0.0	0.0	1.3 (<1)	0.0	0.4 (<1)	0.0	0.0
Crustacea nauplii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1 (<1)	0.0	1.3 (<1)	0.0	0.0	0.0	0.0
cladocera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
copepoda	182.1 (47)	353.3 (47)	2233.0 (69)	191.8 (27)	3026.5 (73)	976.4 (61)	2272.4 (87)	103.9 (24)	4019.9 (79)	253.1 (47)	2215.0 (87)	63.4 (32)	652.7 (75)	92.7 (45)
cirripedia (barnacle) nauplii	5.9 (2)	26.7 (4)	0.0	0.0	40.0 (1)	21.2 (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
decapoda	1.6 (<1)	3.5 (<1)	10.5 (<1)	67.5 (10)	110.0 (3)	145.6 (9)	12.7 (<1)	47.2 (11)	36.3 (<1)	79.8 (15)	4.3 (<1)	9.8 (5)	19.6 (2)	19.3 (9)
others	1.7 (<1)	8.2 (1)	0.0	1.7 (<1)	10.0 (<1)	18.2 (1)	0.0	2.3 (<1)	0.0	2.6 (<1)	0.0	0.0	1.1 (<1)	2.3 (1)
Chaetognatha	1.7 (<1)	0.0	48.8 (2)	8.7 (1)	25.0 (<1)	18.2 (1)	0.0	3.9 (<1)	42.4 (<1)	8.0 (2)	21.6 (<1)	4.3 (2)	6.5 (<1)	2.4 (1)
Echinodermata	0.8 (<1)	0.0	0.0	0.0	40.0 (1)	12.1 (<1)	0.0	2.3 (<1)	0.0	0.0	0.0	0.0	0.0	0.0
urochordata	0.8 (<1)	1.2 (<1)	3.5 (<1)	3.4 (<1)	0.0	12.1 (<1)	0.0	7.0 (2)	205.9 (4)	54.3 (10)	4.3 (<1)	4.3 (2)	3.3 (<1)	2.9 (1)
fish (eggs and larvae)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1 (<1)	1.3 (<1)	0.0	0.4 (<1)	0.0	0.0
Eggs	122.3 (31)	302.2 (41)	910.7 (28)	411.3 (58)	625.3 (15)	242.6 (15)	313.1 (12)	247.3 (56)	750.7 (15)	115.3 (22)	307.1 (12)	105.6 (54)	181.7 (21)	75.8 (36)
Miscellaneous	0.0	2.3 (<1)	0.0	0.0	10.0 (<1)	3.0 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	391.7	745.1	3224.0	708.6	4147.0	1601.0	2615.1	441.1	5073.4	535.7	2560.9	196.0	870.4	208.4
SUBTOTAL DAMAGED	13.3 (3)	4.7 (<1)	52.3 (2)	22.4 (3)	35.0 (<1)	36.3 (2)	38.1 (1)	14.1 (3)	151.4 (3)	31.9 (6)	17.4 (<1)	13.8 (7)	13.1 (2)	15.9 (7)
TOTAL UNDAMAGED + DAMAGED	405.0	749.8	3276.3	731.0	4182.0	1637.3	2653.2	455.2	5224.8	567.6	2578.3	209.8	883.5	224.3

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-12

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
30 OCTOBER 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	Ø	Ø	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	1.3 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	1.3 (<1)	0.0	4.0 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	1.2 (<1)	0.0	0.0	0.0	0.0
Mollusca	8.3 (<1)	1.1 (<1)	8.1 (<1)	4.6 (<1)	30.1 (1)	53.8 (1)	2.8 (<1)	3.0 (1)	11.8 (1)	15.7 (3)	2.7 (<1)	2.8 (<1)	3.7 (<1)	1.3 (1)
Polychaeta	4.5 (<1)	0.0	44.4 (2)	2.3 (<1)	11.3 (<1)	0.0	46.5 (5)	0.6 (<1)	4.4 (<1)	0.0	4.0 (<1)	0.0	36.0 (4)	0.4 (<1)
Crustacea nauplii	18.0 (<1)	2.3 (<1)	319.2 (12)	4.6 (<1)	37.6 (2)	20.2 (<1)	139.4 (14)	4.2 (2)	0.0	0.0	66.1 (7)	7.5 (2)	186.0 (22)	0.0
cladocera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6 (<1)	0.9 (<1)	0.0	0.0
ostracoda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
copepoda	228.6 (8)	194.8 (32)	1770.0 (67)	1205.9 (88)	1843.0 (84)	4026.0 (92)	429.2 (41)	156.8 (61)	463.2 (54)	249.1 (42)	602.6 (64)	344.4 (68)	213.4 (25)	89.6 (70)
cirripedia (barnacle) nauplii	2474.9 (89)	398.8 (65)	32.3 (1)	16.2 (1)	135.4 (6)	6.7 (<1)	10.9 (1)	6.0 (2)	13.3 (2)	12.1 (2)	9.2 (1)	12.3 (2)	2.5 (<1)	0.9 (<1)
decapoda	20.5 (<1)	7.9 (1)	28.2 (1)	34.6 (3)	33.9 (2)	67.3 (2)	28.6 (3)	23.6 (9)	114.8 (13)	106.7 (18)	31.8 (3)	35.7 (7)	14.8 (2)	11.5 (9)
others	3.2 (<1)	4.6 (<1)	0.0	4.6 (<1)	3.8 (<1)	13.5 (<1)	0.0	0.0	0.0	1.2 (<1)	0.0	0.0	0.0	0.4 (<1)
Chaetognatha	10.3 (<1)	0.0	173.7 (7)	60.1 (4)	56.4 (3)	154.9 (4)	73.8 (7)	17.5 (7)	22.1 (3)	21.9 (4)	62.1 (7)	34.8 (7)	49.6 (6)	3.1 (2)
Echinodermata	0.0	0.0	28.3 (1)	4.6 (<1)	0.0	0.0	49.2 (5)	9.0 (4)	155.9 (18)	128.8 (22)	26.4 (3)	8.4 (2)	81.8 (10)	6.7 (5)
urochordata	5.1 (<1)	5.7 (<1)	194.0 (7)	11.5 (<1)	33.9 (2)	26.9 (<1)	221.5 (21)	13.3 (5)	25.0 (3)	19.4 (3)	103.1 (11)	26.4 (5)	236.9 (28)	1.3 (1)
fish (eggs and larvae)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5 (<1)	0.0	0.0	0.0	0.0	0.0
Eggs	1.3 (<1)	1.1 (<1)	20.2 (<1)	16.2 (1)	11.3 (<1)	13.5 (<1)	28.7 (3)	23.6 (9)	44.1 (5)	30.4 (5)	22.5 (2)	33.0 (7)	14.9 (2)	13.8 (11)
Miscellaneous	2.6 (<1)	0.0	4.0 (<1)	0.0	3.8 (<1)	13.5 (<1)	5.5 (<1)	0.6 (<1)	1.5 (<1)	1.2 (<1)	0.0	0.9 (<1)	0.0	0.0
SUBTOTAL UNDAMAGED	2779.9	616.3	2626.4	1365.2	2200.5	4396.3	1036.1	258.2	857.6	587.7	937.1	507.1	839.6	129.0
SUBTOTAL DAMAGED	7.6 (<1)	14.8 (2)	36.3 (1)	25.4 (2)	86.5 (4)	94.2 (2)	24.7 (2)	5.4 (2)	13.3 (2)	4.8 (1)	17.2 (2)	17.8 (3)	13.6 (2)	4.4 (3)
TOTAL UNDAMAGED + DAMAGED	2787.5	631.1	2662.7	1390.6	2287.0	4490.5	1060.8	263.6	870.9	592.5	954.3	524.9	853.2	133.4

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]Ø = Oblique; S = Surface; B = Bottom.

TABLE E-13

DENSITY[a] AND PERCENTAGE COMPOSITION[b] OF MAJOR ZOOPLANKTON TAXA
ST. LUCIE PLANT
28 NOVEMBER 1979

	Station and depth[c]													
	11	12	0		1		2		3		4		5	
Taxon	O	O	S	B	S	B	S	B	S	B	S	B	S	B
UNDAMAGED														
Protozoa	0.7 (<1)	0.6 (<1)	0.5 (<1)	0.0	3.0 (<1)	1.2 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coelenterata	0.0	0.0	2.7 (1)	1.2 (<1)	0.0	1.2 (<1)	2.8 (2)	0.8 (<1)	0.9 (<1)	0.0	3.0 (2)	4.8 (<1)	1.9 (<1)	0.8 (<1)
Mollusca	3.7 (<1)	0.2 (<1)	0.0	2.4 (<1)	3.0 (<1)	4.7 (<1)	0.0	0.4 (<1)	0.0	0.0	0.0	0.7 (<1)	0.0	0.0
Polychaeta	3.0 (<1)	0.4 (<1)	1.1 (<1)	13.8 (4)	45.2 (1)	10.4 (1)	8.3 (5)	0.4 (<1)	5.2 (<1)	0.6 (<1)	14.9 (8)	9.0 (2)	9.1 (2)	0.8 (<1)
Crustacea nauplii	0.0	0.0	0.0	1.8 (<1)	0.0	3.5 (<1)	9.9 (5)	1.2 (<1)	32.3 (5)	1.3 (<1)	4.3 (2)	4.8 (<1)	9.6 (2)	1.2 (<1)
cladocera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ostracoda	0.7 (<1)	0.0	1.1 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
copepoda	142.3 (25)	151.5 (72)	290.8 (71)	257.0 (80)	2438.8 (78)	727.0 (76)	58.4 (32)	105.4 (37)	243.8 (38)	201.1 (65)	61.7 (32)	230.8 (39)	127.8 (33)	162.2 (71)
cirripedia (barnacle) nauplii	403.8 (71)	47.4 (23)	6.0 (2)	3.6 (1)	69.3 (2)	26.6 (3)	1.2 (<1)	3.2 (1)	9.6 (2)	5.8 (2)	2.3 (1)	6.2 (1)	11.9 (3)	6.6 (3)
decapoda	5.2 (<1)	1.2 (<1)	4.2 (1)	10.2 (3)	42.1 (1)	15.0 (2)	2.4 (1)	13.2 (5)	16.6 (3)	20.5 (7)	1.6 (<1)	12.5 (2)	2.9 (<1)	10.6 (5)
others	4.5 (<1)	5.5 (3)	0.0	0.0	3.0 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.7 (<1)	0.0	0.0
Chaetognatha	0.0	0.0	1.6 (<1)	1.8 (<1)	9.0 (<1)	1.2 (<1)	1.2 (<1)	0.4 (<1)	5.2 (<1)	0.6 (<1)	0.3 (<1)	2.8 (<1)	3.8 (<1)	0.8 (<1)
Echinodermata	0.0	0.0	9.3 (2)	3.6 (1)	352.3 (11)	91.2 (10)	38.9 (21)	129.1 (45)	211.5 (33)	16.7 (5)	30.2 (16)	236.4 (40)	139.2 (35)	26.1 (11)
Chordata urochordata	0.0	0.8 (<1)	20.0 (5)	7.2 (2)	138.5 (4)	33.5 (4)	7.5 (4)	5.9 (2)	33.3 (5)	5.2 (2)	15.9 (8)	28.4 (5)	61.5 (16)	10.5 (5)
fish (eggs and larvae)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eggs	1.5 (<1)	0.0	73.7 (18)	20.4 (6)	30.1 (<1)	40.4 (4)	52.8 (29)	28.1 (10)	76.1 (12)	56.6 (18)	59.7 (31)	56.7 (10)	24.8 (6)	10.5 (5)
Miscellaneous	0.0	2.1 (1)	1.1 (<1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTAL UNDAMAGED	565.4	209.7	412.1	323.0	3134.3	955.9	183.4	288.1	634.5	308.4	193.9	593.8	392.5	230.1
SUBTOTAL DAMAGED	5.1 (<1)	4.2 (2)	6.5 (2)	2.4 (<1)	42.1 (1)	8.1 (<1)	2.0 (1)	2.0 (<1)	3.5 (<1)	3.2 (1)	1.6 (<1)	4.2 (<1)	1.5 (<1)	6.7 (3)
TOTAL UNDAMAGED + DAMAGED	570.5	213.9	418.6	325.4	3176.4	964.0	185.4	290.1	638.0	311.6	195.5	598.0	394.0	236.8

[a]Density is expressed in number of zooplankters per cubic meter.

[b]Number in parentheses is percentage composition expressed in percent.

[c]O = Oblique; S = Surface; B = Bottom.

TABLE E-14

ZOOPLANKTON BIOMASS ANALYSIS
ST. LUCIE PLANT
1979

	Station and depth[a]																			
	11	12	0			1			2			3			4			5		
Date	Ø	Ø	S	B	$\overline{X}$	S	B	$\overline{X}$	S	B	$\overline{X}$	S	B	$\overline{X}$	S	B	$\overline{X}$	S	B	$\overline{X}$
17 JAN	0.56	2.59	6.06	4.33	5.20	19.01	44.82	31.92	3.22	1.73	2.48	3.55	1.22	2.39	5.13	7.40	6.27	1.45	1.77	1.61
13 FEB	0.29	0.67	2.66	3.74	3.20	7.95	2.73	5.34	2.98	4.52	3.75	11.41	3.51	7.46	1.25	3.90	2.58	5.01	3.26	4.14
6 APR	4.20	1.18	21.17	30.48	25.83	10.83	3.35	7.09	14.29	31.79	23.04	10.30	10.10	10.20	17.93	105.93	61.93	15.76	34.99	25.38
27 APR	10.69	35.34	2.74	3.23	2.99	4.01	4.98	4.50	5.11	5.97	5.54	5.21	7.17	6.19	4.06	11.84	7.95	6.10	9.24	7.67
15 MAY	2.87	1.28	48.20	28.17	38.19	27.21	57.78	42.50	58.23	22.36	40.30	36.51	2.80	19.66	36.19	22.52	29.36	46.74	20.16	33.45
12 JUN	31.53	35.69	18.11	40.43	29.27	57.02	24.78	40.90	22.98	11.71	17.35	103.38	19.32	61.35	23.38	17.00	20.19	41.14	18.62	29.88
26 JUL	8.24	14.05	58.29	36.20	47.25	22.03	36.05	29.04	35.37	39.39	37.38	59.70	69.31	64.51	64.10	17.55	40.83	27.39	34.43	30.91
21 AUG	4.05	--[b]	41.46	60.94	51.20	51.30	46.13	48.71	11.58	49.25	30.41	9.48	26.57	18.02	7.26	29.13	18.19	15.81	28.75	22.28
7 SEP	2.96	3.07	15.38	15.53	15.46	17.85	12.23	15.04	6.35	5.63	5.99	8.51	2.70	5.61	2.85	7.00	4.93	6.79	4.24	5.52
2 OCT	8.27	6.11	20.98	15.35	18.17	20.45	36.74	28.60	39.12	7.12	23.12	45.46	21.81	33.64	10.35	8.34	9.35	4.13	9.39	6.76
30 OCT	5.43	2.15	12.26	3.66	7.96	12.88	14.27	13.58	2.47	1.47	1.97	3.75	1.36	2.56	3.08	2.30	2.69	2.37	2.86	2.62
28 NOV	0.69	1.20	0.69	2.28	1.49	7.59	4.31	5.95	0.65	0.21	0.43	0.77	1.09	0.93	3.07	0.97	2.02	0.77	0.21	0.49

[a]Ø = Oblique tow; S = Surface; B = Bottom; $\overline{X}$ = Mean value.

[b]Not analyzed.

TABLE E-15

COMPARISON OF ZOOPLANKTON DENSITY AND TEMPERATURE IN THE INTAKE (STATION 11) AND DISCHARGE (STATIONS 12) CANALS
ST. LUCIE PLANT
1979

Date	Temperature (°C) Intake	Discharge	ΔT(°C)	Intake(no./m^3)	Discharge(no./m^3)	Percentage change(%)[a]
17 JAN	21.0	33.7	+12.7	1002.2	513.2	-48.8
13 FEB	18.7	30.9	+12.2	293.6	100.6	-65.7
6 APR	21.4	22.5	+ 1.1	421.0	76.2	-81.9[b]
27 APR	25.1	25.6	+ 0.5	4187.8	5370.9	+28.3[b]
15 MAY	25.2	27.2	+ 2.0	1102.6	578.1	-47.5[b]
6 JUN	26.1	32.2	+ 6.1	13,772.1	7175.5	-47.6[b]
26 JUL	24.9	38.8	+13.9	2575.5	2842.5	+10.4
21 AUG	27.3	37.0	+ 9.7	4771.8	432.1	-90.9
7 SEP	23.5	35.1	+11.6	2180.5	1041.4	-52.2
2 OCT	27.7	35.0	+ 7.3	391.7	745.1	+90.2
30 OCT	24.7	37.5	+12.8	2779.9	616.3	-77.8
28 NOV	24.9	36.2	+11.3	565.4	209.7	-62.9

[a]Percentage change = $\frac{\text{Discharge - Intake}}{\text{Intake}} \times 100$

[b]Plant down or in limited operational capacity only.

TABLE E-16

STATISTICAL COMPARISON OF TOTAL ZOOPLANKTON DENSITY
CANAL STATIONS 11 AND 12.
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of squares	Mean square
Model	1	2.64003669	2.64003669
Error	22	39.72216939	1.805555315
Corrected total	23	42.36220608	

Source	DF	Type I SS	F value	PR > F
Station	1	2.64003669	1.46	0.2394

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=22 MS=1.80555

GROUPING	MEAN	N	STATION
A	7.227751	12	11
A	6.564422	12	12

[a]Means with the same letter are not significantly different.

TABLE E-17

STATISTICAL COMPARISON OF TOTAL ZOOPLANKTON DENSITY
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
26 MARCH 1976 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	7	4.74706871	0.67815267
Error	83	126.08128555	1.51905163
Corrected total	90	130.82835426	

Source	DF	Type I SS	F value	PR > F
Year	3	2.96171180	0.65	0.5890
Station	1	1.34606736	0.89	0.3493
Year x Station	3	0.43928955	0.10	0.9569

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=83 MS=1.51905

GROUPING	MEAN	N	STATION
A	6.747327	46	11
A	6.499782	45	12

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=83 MS=1.51905

GROUPING	MEAN	N	YEAR
A	6.821883	23	79
A	6.801512	20	76
A	6.500613	24	78
A	6.413290	24	77

[a]Means with the same letter are not significantly different.

TABLE E-18

STATISTICAL COMPARISON OF ZOOPLANKTON BIOMASS
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS

Source	DF	Sum of Squares	Mean square
Model	1	0.14650379	0.14650379
Error	19	22.44909488	1.18153131
Corrected total	20	22.59559868	

Source	DF	Type I SS	F value	PR > F
Station	1	0.14650379	0.12	0.7286

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=19 MS=1.18153

GROUPING	MEAN	N	STATION
A	1.745942	10	12
A	1.578702	11	11

[a]Means with the same letter are not significantly different.

TABLE E-19

STATISTICAL COMPARISON OF ZOOPLANKTON BIOMASS
CANAL STATIONS 11 AND 12
ST. LUCIE PLANT
26 MARCH 1976 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square	
Model	7	5.10818973	0.72974139	
Error	78	50.92156837	0.65284062	
Corrected total	85	56.02975810		
Source	**DF**	**Type I SS**	**F value**	**PR > F**
Year	3	1.93711544	0.99	0.4037
Station	1	1.25344383	1.92	0.1698
Year x Station	3	1.91763047	0.98	0.4084

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=78 MS=0.652841

GROUPING	MEAN	N	STATION
A	1.655314	42	12
A	1.417483	44	11

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=78 MS=0.652841

GROUPING	MEAN	N	YEAR
A	1.776554	19	79
A	1.573162	24	77
A	1.445654	19	76
A	1.371441	24	78

[a]Means with the same letter are not significantly different.

TABLE E-20

CORRELATIONS OF ZOOPLANKTON DENSITY AND VARIOUS PARAMETERS
CANAL STATIONS 11 AND 12
ST LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

	Parameters				
	Biomass	Chlorophyll-a	Temperature	Salinity	Dissolved oxygen
Density	0.71226[a]	-0.24553	-0.04448	-0.04853	0.50504
	0.0001[b]	0.2475	0.8365	0.8302	0.0165
	23[c]	24	24	22	22
Biomass	1.00000	-0.08687	0.06342	0.21920	-0.27880
	0.0000	0.6935	0.7737	0.3397	0.2090
	23	23	23	21	22

[a]Correlation coefficient.

[b]Probability of a greater R value for the null hypothesis.

[c]Number of observations (n).

TABLE E-21

CORRELATIONS OF ZOOPLANKTON DENSITY AND VARIOUS PARAMETERS
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

	Parameters				
	Biomass	Chlorophyll-a	Temperature	Salinity	Dissolved oxygen
Density	0.74321[a]	-0.11650	0.18829	0.45561	0.11975
	0.0001[b]	0.3298	0.1132	0.0001	0.3499
	72[c]	72	72	72	63
Biomass	1.00000	-0.27523	0.21566	0.37392	0.18257
	0.0000	0.0193	0.0689	0.0012	0.1521
	72	72	72	72	63

[a]Correlation coefficient.

[b]Probability of a greater R value for the null hypothesis.

[c]Number of observation (n).

TABLE E-22

CORRELATIONS OF ZOOPLANKTON DENSITY AND VARIOUS PHYSICAL PARAMETERS
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

	Parameters				
	Biomass	Chlorophyll-a	Temperature	Salinity	Dissolved oxygen
Density	0.60226[a] 0.0001[b] 72[c]	0.19060 0.1088 72	0.01400 0.9078 71	0.27143 0.0211 72	0.10213 0.4296 62
Biomass	1.00000 0.0000 72	0.06178 0.6062 72	0.10357 0.3901 71	0.30373 0.0095 72	0.14372 0.2651 62

[a]Correlation coefficient.

[b]Probability of a greater R value for the null hypothesis.

[c]Number of observations (n).

TABLE E-23

STEPWISE ANALYSIS OF ZOOPLANKTON DENSITY
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

SURFACE

Variable RSA[a]		R square = 0.10997843		C(P) = 0.29148235	
	DF	Sum of squares	Mean square	F	PROB>F
Regression	1	4.08128001	4.08128001	8.65	0.0044
Error	70	33.02854354	0.47183634		
Total	71	37.10982355			
	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
RSA	0.42929349	0.14596603	4.08128001	8.65	

BOTTOM

Variable RSA		R square = 0.02229676		C(P) = 1.49878285	
	DF	Sum of squares	Mean square	F	PROB>F
Regression	1	1.92745114	1.92745114	1.60	0.2106
Error	70	84.51790961	1.20739871		
Total	71	86.44536075			
	B value	Standard error	Type II SS	F	PROB>F
Intercept	0.00000000				
RSA	0.34938813	0.27652972	1.92745114	1.60	0.2106

[a]The prefix R indicates residual variance for each variable after seasonal (cosine) adjustment.

TABLE E-24

STEPWISE ANALYSIS OF ZOOPLANKTON BIOMASS
OFFSHORE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

SURFACE

Variable RSA[a]		R square = 0.04027460			C(P) = 0.86498091
	DF	Sum of squares	Mean square	F	PROB>F
Regression	1	995.51109745	995.51109745	2.94	0.0910
Error	70	23722.57819099	338.89397416		
Total	71	24718.08928844			
	B value	Standard error	Type II SS	F	PROB>F
Intercept	-0.00000000				
RSA	6.70469704	3.91190256	995.51109745	2.94	0.0910

BOTTOM

Variable RSA		R square = 0.04929968			C(P) = 0.39348799
	DF	Sum of squares	Mean square	F	PROB>F
Regression	1	1229.15629038	1229.15629038	3.63	0.0609
Error	70	23703.18200611	338.61688580		
Total	71	24932.33829649			
	B value	Standard error	Type II SS	F	PROB>F
Intercept	-0.00000000				
RSA	8.82307574	4.63095711	1229.15629038	3.63	0.0609

[a]The prefix R indicates residual variance for each variable after seasonal (cosine) adjustment.

TABLE E-25

STATISTICAL COMPARISON OF TOTAL ZOOPLANKTON DENSITY
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATION

Source	DF	Sum of squares	Mean square
Model	5	6.90160773	1.38032155
Error	66	37.02394914	0.56096893
Corrected total	71	43.92555688	

Source	DF	Type I SS	F value	PR > F
Station	5	6.90160773	2.46	0.0415

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=0.560969

GROUPING		MEAN	N	STATION
	A	8.175259	12	1
B	A	7.766297	12	3
B	A	7.736061	12	5
B	A	7.592722	12	0
B		7.471477	12	2
B		7.156893	12	4

[a]Means with the same letter are not significantly different.

TABLE E-26

STATISTICAL COMPARISON OF ZOOPLANKTON BIOMASS
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATION

Source	DF	Sum of squares	Mean square
Model	5	4.75196967	0.95039393
Error	66	62.89382322	0.95293672
Corrected total	71	67.64579289	

Source	DF	Type I SS	F value	PR > F
Station	5	4.75196967	1.00	0.4271

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=0.952937

GROUPING	MEAN	N	STATION
A	2.951444	12	1
A	2.916422	12	3
A	2.748999	12	0
A	2.512990	12	2
A	2.486965	12	5
A	2.226284	12	4

[a]Means with the same letter are not significantly different.

TABLE E-27

STATISTICAL COMPARISON OF TOTAL ZOOPLANKTON DENSITY
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATION

Source	DF	Sum of squares	Mean square
Model	5	7.28744701	1.45748940
Error	66	96.29429361	1.45900445
Corrected total	71	103.58174062	

Source	DF	Type I SS	F value	PR > F
Station	5	7.28744701	1.00	0.4261

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=1.459

GROUPING	MEAN	N	STATION
A	7.713551	12	1
A	7.544031	12	0
A	7.089731	12	5
A	7.046428	12	4
A	7.009197	12	3
A	6.808760	12	2

[a]Means with the same letter are not significantly different.

TABLE E-28

STATISTICAL COMPARISON OF ZOOPLANKTON BIOMASS
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
6 DECEMBER 1978 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATION

Source	DF	Sum of squares	Mean square	
Model	5	3.27173063	0.65434613	
Error	66	68.81555728	1.04265996	
Corrected total	71	72.08728791		
Source	DF	Type I SS	F value	PR > F
Station	5	3.27173063	0.63	0.6816

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=66 MS=1.04266

GROUPING	MEAN	N	STATION
A	2.980318	12	1
A	2.801940	12	0
A	2.650604	12	4
A	2.513896	12	5
A	2.507147	12	2
A	2.327740	12	3

[a]Means with the same letter are not significantly different.

TABLE E-29

STATISTICAL COMPARISON OF TOTAL ZOOPLANKTON DENSITY
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
26 MARCH 1976 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	45.51008007	1.97869913
Error	245	356.35341861	1.45450375
Corrected total	268	401.86349868	

Source	DF	Type I SS	F value	PR > F
Year	3	22.43473658	5.14	0.0020
Station	5	2.48714216	0.34	0.8873
Year x Station	15	20.58820133	0.94	0.5166

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=245 MS=1.4545

GROUPING	MEAN	N	STATION
A	7.651925	45	4
A	7.577252	45	5
A	7.548433	45	1
A	7.441822	45	3
A	7.430375	44	2
A	7.377242	45	0

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=245 MS=1.4545

GROUPING	MEAN	N	YEAR
A	7.774633	72	77
A	7.767121	72	78
B	7.264528	59	76
B	7.138992	66	79

[a]Means with the same letter are not significantly different.

TABLE E-30

STATISTICAL COMPARISON OF ZOOPLANKTON BIOMASS
OFFSHORE BOTTOM STATIONS 0 THROUGH 5
ST. LUCIE PLANT
26 MARCH 1976 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square	
Model	23	25.52136919	1.10962475	
Error	242	240.55750785	0.99403929	
Corrected total	265	266.07887704		
Source	DF	Type I SS	F value	PR > F
Year	3	10.26445475	3.44	0.0174
Station	5	3.94163581	0.79	0.5575
Year x Station	15	11.31527863	0.76	0.7231

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=242 MS=0.994039

GROUPING	MEAN	N	STATION
A	2.847634	44	1
A	2.841809	44	2
A	2.812998	44	3
A	2.781932	45	5
A	2.701597	44	4
A	2.498979	45	0

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=242 MS=0.994039

GROUPING	MEAN	N	YEAR
A	2.955960	72	78
A	2.904353	69	77
B	2.547611	66	79
B	2.529607	59	76

[a]Means with the same letter are not significantly different.

TABLE E-31

STATISTICAL COMPARISON OF TOTAL ZOOPLANKTON DENSITY
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
26 MARCH 1976 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	50.05876166	2.17646790
Error	245	241.82961215	0.98705964
Corrected total	268	291.88837381	

Source	DF	Type I SS	F value	PR > F
Year	3	22.42213192	7.57	0.0001
Station	5	20.31745722	4.12	0.0014
Year x Station	15	7.31917252	0.49	0.9423

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=245 MS=0.98706

GROUPING	MEAN	N	STATION
A	7.984257	44	1
B	7.538809	45	5
B	7.341464	45	2
B	7.297671	45	3
B	7.192560	45	4
B	7.162586	45	0

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=245 MS=0.98706

GROUPING	MEAN	N	YEAR
A	7.639367	66	79
A	7.611940	72	77
A	7.451159	72	78
B	6.890763	59	76

[a]Means with the same letter are not significantly different.

TABLE E-32

STATISTICAL COMPARISON OF ZOOPLANKTON BIOMASS
OFFSHORE SURFACE STATIONS 0 THROUGH 5
ST. LUCIE PLANT
26 MARCH 1976 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	23	39.01983959	1.69651476
Error	243	211.25740380	0.86937203
Corrected total	266	250.27724338	

Source	DF	Type I SS	F value	PR > F
Year	3	17.50513774	6.71	0.0003
Station	5	13.78351902	3.17	0.0087
Year x Station	15	7.73118283	0.59	0.8797

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=243 MS=0.869372

GROUPING	MEAN	N	STATION
A	2.892627	44	1
B A	2.552257	44	5
B	2.468737	45	3
B	2.292747	45	2
B	2.237449	45	0
B	2.229660	44	4

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=243 MS=0.869372

GROUPING	MEAN	N	YEAR
A	2.650482	71	77
A	2.624327	66	79
A	2.447683	72	78
B	1.982912	58	76

[a]Means with the same letter are not significantly different.

TABLE E-33

STATISTICAL COMPARISON OF ZOOPLANKTON DENSITIES
BASELINE VERSUS OPERATIONAL MONITORING DATA
OFFSHORE STATIONS 1 THROUGH 5
ST. LUCIE PLANT
SEPTEMBER 1972 - 30 OCTOBER 1979

ANALYSIS OF VARIANCE: STATIONS X YEARS

Source	DF	Sum of squares	Mean square
Model	24	25.03319115	1.04304963
Error	259	205.17546001	0.79218324
Corrected total	283	230.20865116	

Source	DF	Type I SS	F value	PR > F
Year	4	12.41331220	3.92	0.0042
Station	4	5.14179872	1.62	0.1689
Year x Station	16	7.47808023	0.59	0.8905

DUNCAN'S MULTIPLE RANGE TEST: STATIONS[a]

Alpha level=0.05 DF=259 MS=0.792183

GROUPING	MEAN	N	STATION
A	7.891032	56	1
A	7.865217	57	5
A	7.669806	57	2
A	7.659679	57	4
A	7.538195	57	3

DUNCAN'S MULTIPLE RANGE TEST: YEARS[a]

Alpha level=0.05 DF=259 MS=0.792183

GROUPING	MEAN	N	YEAR
A	7.936587	59	73
A	7.915617	60	77
B A	7.783362	60	78
B	7.492076	55	79
B	7.428227	50	76

[a]Means with the same letter are not significantly different.

F. AQUATIC MACROPHYTES

Environmental Technical Specification (Section 3.1.B.d.)

> Macrophytes - Macroscopic aquatic vegetation will be collected quarterly and identified as to species and abundance.

INTRODUCTION

The purpose of the offshore macrophyte study is to determine whether operation of the St. Lucie Plant is affecting the species compostion and abundance of the macrophyte community of the area. The term "aquatic macrophytes" refers to aquatic plants, including seagrasses and seaweeds or algae, large enough to be seen with the unaided eye. Attached benthic macrophytes are good indicators of environmental change because they cannot avoid environmental stresses as more mobile species can. Therefore changes in environmental conditions can result in alteration of the species composition and abundance of the benthic macrophyte community.

The distribution of aquatic macrophytes is limited by substrate, temperature and light. An unstable bottom, such as sand or mud, is generally unsuitable for attachment of macrophytes except in quiet bays and estuaries where agitation by wind and waves is slight. In areas exposed to these forces, detached, or drift, algae are usually washed upon the beach or swept out of the photic zone (Eiseman et al., 1974). Along the east coast of Florida, marine macrophytes are found on rock outcroppings, worm reefs, shell rubble, and artificial substrates.

Most marine plants are found from the intertidal zone to a depth of 30 to 40 m. Beyond this depth, the light-absorbing properties of seawater reduce the availability of light to levels below that needed for photosynthesis. Light penetration is also attenuated by turbidity and plankton which decrease the transparency of water. One group of algae, however, has adapted to low light levels; red algae have been dredged from depths of 170 m in clear, tropical waters (McConnaughey, 1970).

Temperature controls the growth and distribution of marine macrophytes directly by influencing the rate of photosynthesis and respiration and indirectly by affecting the level of dissolved oxygen in the water. Consequently, many marine plants tolerate only a narrow temperature range (Dawson, 1966). Marine plants in subtropical and tropical areas are particularly vulnerable to temperature changes because normal water temperatures are usually high and do not vary greatly over the course of a year (Steidinger and Van Breedveld, 1971).

MATERIALS AND METHODS

Aquatic macrophytes were collected quarterly at each of six offshore stations during 1979 (Figure F-1). Each sample was collected by towing a box-type dredge (46 cm X 46 cm X 25 cm) along the ocean bottom for 5 minutes. The speed of each tow was recorded and used to compute the surface area sampled. The area sampled at all stations in 1979 was approximately 190 m2. Duplicate samples were collected at each station and preserved in a solution of 5 percent buffered formalin-seawater.

Attached macrophytes were scraped from shell and rock surfaces and the preserved samples were sorted in the laboratory. The algae were identified to the lowest practicable taxon and the number of species per unit area of sample substrate was determined. Representative material was retained for voucher specimens and species lists were prepared for each sample. Where apparent, the presence of the most abundant or dominant species was noted. The presence of reproductive structures was determined by microscopic examination.

RESULTS AND DISCUSSION

A total of 60 taxa of marine algae were collected in 1979. Of this number, 38 (63.3 percent) were red algae (Rhodophyta), 12 (20 percent) were brown algae (Phaeophyta), and 9 (15 percent) were green algae (Chlorophyta). One species of blue-green algae (Cyanophyta), was collected.

Species composition for each station during each collection period is given in Table F-1. Only one taxa, Gracilaria sp., was collected during all four sampling trips. Thirteen taxa were found only during June and 27 were found only during September. Three additional species of algae were collected only during November.

As noted in 1978, drift algae was the main contributor to increased algal diversity and abundance in the 1979 summer and fall samples. The abundance of drift algae was most obvious at Station 0, the control station to the south, where the fine, gray sand substrate is unsuitable for algal attachment, but where the shallow depth apparently allows the drift algae carried inshore by prevailing winds and currents to collect. Drift algae were less abundant at Stations 1 through 5. Station 1, at the discharge, is about the same depth as Station 0 but the stronger currents at Station 1, at the discharge, may prevent drift algae from accumulating. Attached algae were collected only at Stations 2 and 4 and were generally small individual plants or fragments found on pieces of rock and shell. The year's data indicate that the biomass of attached algae was insignificant when compared to that of drift algae.

Fifty of the 60 species collected in 1979 were found at Station 0. Of the 50 species, 98 percent were collected in June and September and consisted of drift algae only. The smallest amount of algae collected for the year was found at Station 3. In March, macrophytes were found only at Station 4. No significant differences in algal abundance or diversity between stations were found in September except for the absence of any algae at Stations 2 and 3. No general trend in the occurrence or abundance of a species between stations was observed, although dominant species were noted at two stations. Large, unattached mats of Ceramium were collected in all replicates at Stations 0 and 1 in June. Hypnea sp., Halymenia sp., and Codium spp. were abundant at Station 0 in September. Otherwise, most of the algae was represented by small fragments of plants. Reproductive algae were collected in June and September.

Algal diversity and abundance reflected the seasonal trend characteristic of Hutchinson Island's location in a subtropical zone (Phillips, 1961). Tropical and subtropical marine plants display greatest species diversity and abundance in summer and early fall. In 1979, algal diversity and abundance were greatest in September (42 species) and June (29 species) and lowest in November (7 species) and March (6 species). This trend was observed in the previous 3 years' collections of macrophytes at St. Lucie (ABI, 1977, 1978, 1979). As previously reported, this seasonal trend is unrelated to power plant operation. No baseline data is available on the macrophyte community.

SUMMARY

The lack of suitable substrate for algal attachment and growth at all stations limits the occurrence of macrophytes in the study area. The substrates in the study area are either shell hash or fine sand with very little hard surfaces suitable for algal attachment. The importance of this community as primary producers in the study area, therefore, is limited.

Differences in the number of algal taxa between stations and between sampling periods were evident. Algal diversity and abundance were greatest in June and September and at Station 0 (Figure F-1) during these months. This trend reflects the seasonality of the drift algal community and the tendency of drift algae to collect on the beach terrace. Attached algae were found only at Stations 2 and 4 during the year. No effects of power plant operation on the macrophyte community were noted.

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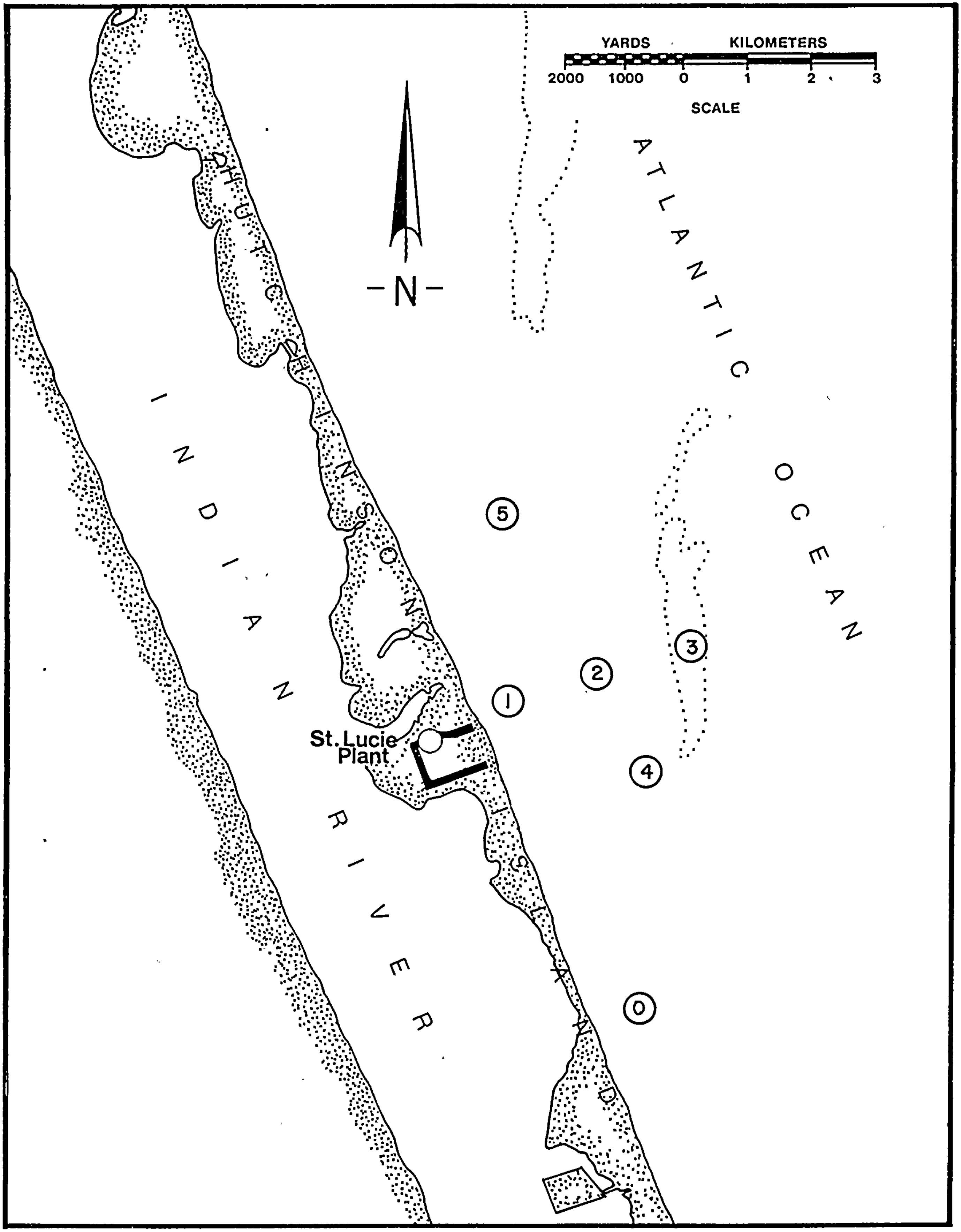

Figure F-1. Locations of macrophyte sampling stations, 1979.

TABLE F-1

MACROPHYTE SPECIES COLLECTED AT OFFSHORE STATIONS
ST. LUCIE PLANT
1979

Species	March						June						September						November					
Station:	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
CYANOPHYTA (blue-green algae)																								
Microcoleus lyngbyaceous											X													
CHLOROPHYTA (green algae)																								
Caulerpa microphysa													X											
C. racemosa v. *macrophysa*													X	X										
Cladophora fascicularis							X		X		X													
Cladophora sp.									X															
Codium isthomocladum													X	X		X								
C. taylori													X											
Codium sp.									X															
Ernodesmis verticillata													X					X						
Ulva lactuca													X											
PHAEOPHYTA (brown algae)																								
Dictyopteris plagiogramme													X											
D. justii													X											
Dictyota cervicornis													X					X						
D. dichotoma									X				X											
Dictyota sp.					X		X		X		X				X			X						
Ectocarpus sp.							X																	
Giffordia sp.							X		X															
Sargassum sp.							X	X	X		X		X						X					
Spatoglossum schroederi																		X						
Sphacelaria furcigera															X				X					
Sphacelaria sp.															X									
Stypopodium zonale													X											
RHODOPHYTA (red algae)																								
Agardhinula brownea													X											
Amphiroa brasiliana																								X
Antithamnion elegans													X											
Botryocladia occidentalis																								X
Bryothamnion seaforthii																			X	X				X

TABLE F-1
(continued)
MACROPHYTE SPECIES COLLECTED AT OFFSHORE STATIONS
ST. LUCIE PLANT
1979

	March						June						September						November					
Species Station:	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
RHODOPHYTA (continued)																								
Centroceras clavulatum													X											
Ceramium fastiagatum f. flaccida							X	X			X							X						
Ceramium sp.									X				X	X				X						
Champia parvula													X	X				X						
Champia sp.														X										
Chondria littoralis					X				X															
Chondria sp.							X		X		X													
Cryptarachne sp.													X		X		X							
Dasya sp.					X		X	X	X		X													
Gracilaria foliifera					X				X		X		X		X									X
G. mammillaris													X											
G. verrucosa									X						X	X								
Gracilaria sp.					X		X						X		X									X
Grinnellia americana							X		X															
Halymenia agardhii													X	X										
H. vinaceae													X					X						
Halymenia sp.								X					X	X	X		X	X						
Hypnea cervicornis							X	X																
H. musciformis							X						X					X						
H. volubilis													X											
Hypnea sp.							X						X	X				X						
Jania sp.							X				X													
Kallymenia limminghii													X					X						
Polysiphonia denudata							X																	
P. subtilissima							X	X																
Polysiphonia sp.					X							X	X											

TABLE F-1
(continued)
MACROPHYTE SPECIES COLLECTED AT OFFSHORE STATIONS
ST. LUCIE PLANT
1979

	March						June						September						November					
Species / Station:	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
RHODOPHYTA (continued)																								
Scinaia complanata									X				X											
Solieria tenera									X				X					X						
Spermothamnion sp.													X	X				X						
Spyridia aculeata													X		X									
Tiffaniella gorgoneum													X											
Titanophora incrustans													X											
Wurdemannia miniata							X																	

G. WATER QUALITY

INTRODUCTION

Environmental Technical Specification (Section 3.1.B.e.)

> Water Quality - Analysis will be made on water samples taken at bottom, mid-depth and surface levels at the same time as the biotic samples are collected. Parameters studied will be temperature, salinity, dissolved oxygen content and turbidity. Water samples for selected nutrient analysis will be collected at the time of plankton sampling.

This study was designed to monitor selected physical and chemical parameters of the waters offshore of the St. Lucie Plant and within the intake and discharge canals immediately adjacent to the plant. The purpose of monitoring these parameters was to 1) determine if selected physical and chemical parameters of the water discharged by the plant were significantly different from offshore waters, 2) provide a more unified view of the offshore habitat than would be obtained from sampling only the biotic components of the area, and 3) enable examination of the relationships between the abiotic and biotic components of the aquatic environment.

PHYSICAL PARAMETERS

Materials and Methods

Physical oceanographic parameters measured at designated offshore stations (0 through 5; Figure G-1) at surface, middle and bottom depths were water temperature, salinity, dissolved oxygen, turbidity and light

transmittance (Table G-1). Water current direction and velocity, wind direction and velocity, and general weather conditions were also determined at the offshore stations. Parameters measured within the intake and discharge canals (Stations 11 and 12) were temperature, salinity, dissolved oxygen and turbidity. These were measured at surface and bottom depths in the intake canal and at the surface in the discharge canal. Physical parameters were measured monthly for all stations, at the same time that sampling for phytoplankton and chemical parameters (nutrients) was being conducted.

Water Temperature

Water temperature was measured *in situ* with a Yellow Springs Instrument Co. (YSI) Model 33 salinity-conductivity-temperature meter with an accuracy of ±0.1°C. Data were recorded in degrees Celsius.

Salinity

Salinity was measured in the field with a YSI Model 33 salinity-conductivity-temperature meter or in the laboratory with an American Optical refractometer (Model 10419 Goldberg; temperature compensating). Both instruments were precalibrated using stock solutions containing known sea-salt concentrations. Data were recorded in parts per thousand.

Dissolved oxygen

Dissolved oxygen was measured *in situ* with either a YSI Model 54 or 51B oxygen meter. These meters were precalibrated by using readings taken from oxygen saturated seawater. Data were recorded in milligrams per liter.

Turbidity

Turbidity was measured with a Hellige turbidimeter. Turbidity was measured as a function of light attenuation over a fixed path length, as recommended by the EPA (1974). Conventional units of turbidity were based upon FTU (Formazine Turbidity Units).

Light Transmittance

Light transmittance (luminosity) was measured at the offshore stations with an Interocean Marine Illuminance Meter Model 510. Incident solar radiation at the surface and at various depths was recorded as luminosity in foot candles.

Other Physical Parameters

Other physical parameters were measured when considered pertinent to the ecological investigations. Water current velocity was measured at offshore stations with a General Oceanics Model 2030 digital flowmeter lowered from the surface to a depth of 0.5 m. Surface currents were recorded in centimeters per second. Water current direction was determined by comparing water position of the flowmeter to a magnetic marine compass. Wind direction and velocity were recorded according to Marine Forecast reports issued by the National Oceanographic and Atmospheric Administration (NOAA), U.S. Weather Bureau. Other weather conditions were expressed as clear, partly cloudy, rainy, or by similar descriptors. Data on water currents and weather conditions, as well as those obtained on tidal cycles and lunar phases, are maintained in the laboratory and are not included in this report.

Two-way analysis of variance (ANOVA) was used to determine if water temperature, salinity, dissolved oxygen and turbidity were significantly (α=0.05) different at the offshore stations and depths. When significant differences occurred, Duncan's Multiple Range Test was used to determine which stations or depths differed from the others.

Results and Discussion

Water Temperature

Water temperature is of prime importance in the marine environment because it acts 1) directly upon the physiological processes of the biota and 2) indirectly through its influence on solubility of gases and solids, water viscosity and density distribution. Throughout the oceans there are temperature barriers controlled by latitude, water depth and general circulation, which segregate faunas into geographical regions (Sverdrup et al., 1942).

Organisms within a particular geographical region are generally adapted to prevailing temperature conditions and may be adversely affected if temperatures shift too far or too rapidly. For example, massive mortalities of fishes have occurred in Florida during unusually cold winters (Snelson and Bradley, 1978). Organisms can be similarly affected by unusually warm conditions; this is pertinent to the present study, since the St. Lucie Plant discharges water offshore at temperatures generally higher than the receiving waters.

Water temperatures measured during 1979 at the stations offshore of the St. Lucie Plant ranged from 17.9° to 29.2°C, in the intake canal from 18.6° to 27.2°C, and in the discharge canal from 23.0° to 37.5°C (Table G-2). Temperatures in the discharge canal were often high enough (>32°C) to approach or exceed what are considered to be upper tolerance limits for much of the local (indigenous) fauna. Nevertheless, these high temperatures were not found at the offshore discharge (Station 1) because of rapid temperature dilution at the discharge diffuser.

Analysis of variance indicated no significant (α=0.05) differences among the six offshore stations at either surface, middle or bottom depths. As expected, variations between months were significant because of seasonal temperature differences (Figure G-2). A general decrease in temperature with depth was also observed. This vertical temperature stratification was especially noticeable in the summer months.

Salinity

Salinity, or the salt content of the water, is the chief factor which makes marine life distinct from other faunal assemblages. Because of the salt, the ocean provides a medium which is 1) similar to salt concentrations in internal body fluids, and thus limits the necessity of salt regulatory mechanisms, and 2) of high density, which is important to swimming forms and to those which depend entirely on the water to support their weight. As is the case with temperature limits, animals in the sea are also bound by salinity limits. Animals which are sensitive to relatively small salinity changes are particularly characteristic of

deep water and the open sea, where salinity ranges only from 34 to 36 ppt. Those which have a high degree of tolerance are characteristic of the coastal regions and estuaries, where wide salinity variations may occur.

The salinities measured at the St. Lucie Plant, both offshore and in the canals, were in a narrow range between 32.3 and 37.5 ppt (Table G-2). This salinity range is more characteristic of the open sea than of a nearshore location. This is probably a result of the plant being located relatively far from sources of less saline waters such as Indian River inlets and extensive land areas where runoff from rainfall could occur. No significant differences in salinity were indicated at the various stations or depths.

Oxygen

Oxygen is indispensable for the maintenance of life processes in all organisms, with the notable exception of anaerobic bacteria. Oxygen is available for the normal metabolic activities of aquatic organisms only when it is in solution in a free state. Free oxygen is comparable to carbon dioxide (necessary for photosynthesis) in being one of the two most important dissolved gases in the sea. Oxygen is seldom a determining factor in the distribution and abundance of most marine life however, since it is generally well supplied throughout the oceans. The saturation level of dissolved oxygen in sea water is temperature dependent and, for conditions at St. Lucie, would range from 8.1 mg/l at 15°C to 6.1 mg/l at 30°C.

Dissolved oxygen values ranged from 4.3 to 9.8 mg/l at the offshore stations (Table G-2), and differences between these stations and depths were not significant. Measurements in the intake canal ranged from 5.2 to 9.5 mg/l. Dissolved oxygen concentrations were about the same in the discharge canal (5.1 to 9.4 mg/l) as offshore, even though temperatures were higher, because of the added effect of water turbulence. Dissolved oxygen concentrations at all stations exceeded the minimum requirements of the indigenous aquatic biota.

Turbidity

Turbidity, which affects the clarity of seawater, is the presence of suspended matter in the water column. It is often quite variable in shallow coastal waters, where wind or tidal currents can stir up bottom sediments and where runoff from the land can add additional materials. Turbidity may be a direct limiting factor to certain animals, such as filter feeders which strain food from the water. It is more often an indirect limiting factor, however, because it restricts light penetration through the water column and, in this way, limits growth and reproduction of phytoplankton in the deeper waters where light would otherwise penetrate.

Turbidity measurements at the six offshore stations ranged from 0.0 to 14.2 FTU (Table G-2). The turbidity at Stations 0 and 1 was significantly higher than at Stations 2 through 5. Stations 0 and 1 are closer to shore than the other stations and, therefore, are subject to wave action that stirs up bottom sediments. These factors also explain why

turbidity levels were significantly higher at the bottom than at mid-depth or surface. Measurements in the intake canal ranged from 0.3 to 5.1 FTU. Turbidities were similar in the discharge canal (0.7 to 5.2 FTU).

Light

Light in the sea directly affects chemical reactions associated with the metabolism of organisms, and its greatest importance is as an energy source for the photosynthetic processes of plants upon which all animals depend for their nourishment. Considering this tremendous importance, it is noteworthy that light sufficient for photosynthesis extends from the surface only to a depth of about 80 m.

Light transmittance measured at the six offshore stations ranged from 0.8 to 1640 foot candles. This considerable variation reflected such light-influencing factors as turbidity in the water, wave action, cloud cover, time of day, season and depth. With the exception of the expected decreased light with increased depth, no consistent patterns of light transmittance were apparent at the offshore stations. It is doubtful if light reduction would ever exclude photosynthetic processes offshore of Hutchinson Island, since the waters are so shallow.

CHEMICAL PARAMETERS

Materials and Methods

Chemical parameters (nutrients) measured during the study were ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, silicates, orthophosphate and total organic carbon. These nutrients were measured from samples collected monthly at offshore Stations 0 through 5, intake canal Station 11 and discharge canal Station 12 (Figure G-1; Table G-1). Offshore samples were taken from surface, middle and bottom depths; intake canal samples from surface and bottom depths; and discharge canal samples from the surface. Subsurface samples were obtained either by pumping or with a Niskin bottle; surface samples were obtained directly. Water samples to be analyzed for ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, reactive silica, and orthophosphate were passed through 0.45μ membrane filters, placed in acid-washed polyethylene bottles, and frozen. Water samples to be analyzed for total organic carbon were spiked with 5 ml of concentrated sulfuric acid. All samples for chemical analysis were shipped to the laboratory on the day of collection.

Methods of analysis used to measure these selected nutrients (Table G-3) appear in either Strickland and Parsons (1972) or the American Public Health Association manual (APHA, 1976). Each chemical parameter was independently compared over the entire year by a two-way analysis of variance. Offshore Stations 0 through 5 were statistically compared, in order to detect significant differences both between stations and for surface, middle, and bottom depths. Nutrient concentrations measured in the intake and discharge canals (Stations 11 and 12) were statistically

compared to control Station 0, to determine differences between the canals and offshore. Statistical procedures used in the following discussion of chemical parameters were performed at the 0.05 level of significance.

Results and Discussion

Nutrients such as the forms of inorganic nitrogen, silicates, phosphates and total organic carbon are essential for the growth of phytoplankton populations (Yentsch, 1962). Since phytoplankton provides the basis for the oceanic food chain, upon which all higher forms subsist either directly or indirectly, the inclusion of nutrients is particularly relevant to any marine biological study.

The distribution of nutrients in the marine environment is a function of diffusion, currents and biological turnover. High concentrations of nutrients are spatially limited and usually associated with upwelling (Spencer, 1975), a river-ocean interface (Steffansson and Richardson, 1963), or ocean waste disposal outfalls (EPA, 1971). Concentrations in nearshore localities are generally considered homogeneous, because of turbulence induced by winds or currents (Bowden, 1970). However, runoff from the land can have substantial effects on nutrient concentration.

Nitrogen

Nitrogen, an essential constituent of living matter, is found within organic compounds both in organisms and in particulate and dissolved organic material. It occurs within seawater as ammonia (NH_3-N), nitrate

(NO_3-N) and nitrite (NO_2-N) in various organic compounds and as free dissolved nitrogen gas. Only the first three nitrogen forms have been measured extensively in the environmental monitoring studies.

These inorganic nitrogen compounds show a wide range of concentration values in the sea and are generally present in low concentrations. Additional variability is due to turnover rates, when these compounds are utilized by aquatic organisms. In coastal areas, rivers and water runoff from the land can have substantial influence on the concentrations of these nutrients.

Concentrations measured at the stations offshore of the St. Lucie Plant during 1979 ranged from <0.01 to 0.23 mg/l for ammonia nitrogen, <0.001 to 0.113 mg/l for nitrate nitrogen, and <0.001 to 0.005 mg/l for nitrite nitrogen (Table G-4). These concentrations were generally similar to those reported in earlier studies at St. Lucie (Table G-5). No significant differences that could be related to plant operation were found in ammonia and nitrate concentrations at the offshore stations. No significant differences in ammonia and nitrate concentrations were detected between the intake canal, discharge canal and offshore control Station 0. Nitrite concentrations were significantly higher at Station 5 than at Stations 0, 1, and 2. This difference does not appear to be related to St. Lucie Plant operations because the increased concentrations are not near the discharge.

Based on average concentrations at the six offshore stations over the 1979 study year, ammonia values steadily diminished during the year from the peak values observed in January (Figure G-3). Nitrate and nitrite were highest during the fall and winter (Figures G-4 and G-5). Neither the concentration values of these nitrogen compounds nor their variations by season were considered unusual.

Silicon

Silicon has been studied extensively because it is utilized by diatoms (the predominant phytoplankters offshore of St. Lucie). Silicate-silicon (SiO_2-Si) concentrations measured during 1979 at the stations offshore of the St. Lucie Plant ranged from <0.02 to 0.41 mg/l (Table G-4). No significant differences were found in silicon concentrations when the offshore stations were compared by depth, but Station 5 had higher values than offshore Stations 0, 2, 3, and 4. The reason for this difference is not known, but plant operation was not the cause. Significantly higher silica concentration would have also been observed at Stations 1 through 4 if this difference was plant related.

Based on the time of year sampled, the highest silica concentrations were found during the fall (Figure G-6). Silicate values were usually higher in the intake (not significantly) and discharge (significantly) canals than offshore. There was no significant difference in silica concentrations between intake and discharge canals. This could have been related to high diatom concentrations (Section D. Phytoplankton, Tables D-2 through D-13), since silicates result from diatom shell dissolution,

or to the higher turbulence in the canals which stirs up higher amounts of filtrable SiO_2 from the bottom.

Phosphorus

Phosphorus is present in sea water almost solely in the form of various types of phosphate and is an essential constituent of living organisms. In addition to the nitrogen and silicon compounds, phosphate-phosphorus has been considered one of the substances that may limit production of plant life (Sverdrup et al., 1942). Orthophosphate (PO_4-P) concentrations measured during 1979 at stations offshore of the St. Lucie Plant ranged from <0.01 to 0.02 mg/l (Table G-4). These values were slightly lower than those in canal stations where phosphate values ranged from <0.01 to 0.06. However, no significant statistical differences were found comparing Station 0 and canal phosphate values.

Total Organic Carbon

Total organic carbon (TOC) is the sum of the suspended organic carbon and the dissolved organic carbon in the water. It thus includes carbon in detritus and within living organisms, such as the phytoplankton, and that which is in the water and available for use by organisms. Because different water masses can vary considerably in their levels of organic production, TOC levels can also show considerable variation. Stations offshore of the St. Lucie Plant during 1979 had TOC concentrations of from 1 to 14 mg/l (Table G-4). No significant differences were found in TOC concentrations between offshore station locations, but surface values were higher than at bottom and mid-depth levels. TOC con-

centrations offshore were not very variable over the year, although spring values were generally higher than others (Figure G-7). Canal stations' TOC values were in the same general range of 1 to 5 mg/l as offshore stations. No significant differences in TOC concentrations were detected between the intake canal, discharge canal and offshore control Station 0.

Comparison of 1979 Chemistry Data to 1976-1978 Monitoring and 1972-1973 Baseline Data

Ranges of nutrient concentrations recorded at offshore Stations 0 through 5 at the St. Lucie Plant are listed in Table G-5 as well as ranges of nutrient concentrations found during the baseline study (Worth and Hollinger, 1977) at offshore Stations 1 through 5. The baseline study, which was performed from February 1972 to August 1973, monitored the same nutrients as the current study with the exception of TOC. Combined (depth and stations) nutrient values for the 1976-1979 monitoring study and the 1972-1973 baseline study are shown in Figures G-8 through G-12. Within the limits of the analytical methods used, orthophosphate values did not vary appreciably during the 1976-1979 monitoring study and are not discussed in this report.

Ammonia concentrations measured from 1976 through 1979 were generally in the same range but these values were higher than those in the baseline study (Table G-5). Mean ammonia values (Figure G-8) also showed the same pattern of higher values during operational monitoring periods. Analyses of the data from 1976 through 1979 (ABI, 1977, 1978, 1979) showed that there was no significant difference in ammonia values between the control Station 0 and Stations 1 through 5.

Presently, there is no explanation for the lower ammonia values reported in the baseline study, but comparisons between control and other stations show that operation of the St. Lucie Plant is not the cause of the difference.

Nitrate concentrations monitored during operational monitoring and baseline studies were generally in the same ranges except in 1976 when nitrate values were much higher (Table G-5). Mean nitrate values showed the same characteristics during this period (Figure G-9). The exceptionally high values in 1976 were probably caused by preservation techniques that have since been shown to be inadequate.

Nitrite concentrations and mean values were similar during each year of operational monitoring but these values were slightly lower than those measured during the baseline study (Table G-5; Figure G-10). Analysis of the 1976 through 1979 data (ABI, 1977, 1978, 1979) showed that there was no significant difference in nitrite values between the control Station 0 and Stations 1 through 5. This shows that St. Lucie Plant operation is not the cause of observed differences in nitrate concentrations between operational monitoring and baseline studies.

Silica concentrations and mean concentrations were similar in the baseline and operational studies except in 1976 when values were much higher (Table G-5; Figure G-11). The high values recorded in 1976 are probably erroneous due to error in methodology. If the 1976 data are deleted, a seasonal pattern of high silica concentrations in the fall can be seen.

Orthophosphate concentrations were similar during operational monitoring with most of the values below the detection limit of 0.01 ppm PO_4-P (Table G-5). These values were considerably below the highest concentration reported during the baseline study (>1.40 mg/l; Table G-5). Reasons for the high concentration during the baseline study are not known, although it was apparently not related to runoff from the land during heavy rains (Worth and Hollinger, 1977) which is the usual cause of high phosphate concentrations.

Total organic carbon concentrations at the offshore stations have shown a downward trend from 1976 to 1979 (Table G-5). Mean TOC values observed during this period exhibited the same pattern (Figure G-12). Still, seasonal variations were obvious with spring TOC values generally higher than in other seasons. The reasons for the decline in offshore TOC concentrations are not apparent. It should be noted that phytoplankton and zooplankton standing crop did not decline during this period (Sections D. Phytoplankton and E. Zooplankton). TOC concentrations were not measured during the baseline study.

SUMMARY

No significant differences in temperature, salinity, or dissolved oxygen were found among the six offshore sampling stations. Turbidity was significantly higher at the discharge and control stations. The increase in turbidity at both near-shore stations suggests that wave action and possibly surface runoff are contributory factors.

Nutrients in the nearshore environment adjacent to the plant were dispersed homogeneously but varied with the time of year. No differences were found when stations near the plant were compared with the control station, and analysis of nutrient concentrations indicated that plant operation had no significant effects on the selected nutrients measured in this study. The yearly range in nutrient concentrations offshore of the St. Lucie Plant was generally similar with data collected in previous studies.

These physical and chemical measurements provided a more unified view of the offshore habitat than would have been obtained by sampling only the biotic components, and enabled examination of the relationships between the abiotic and biotic components of the aquatic environment offshore of the St. Lucie Plant. Offshore plant effects related to these selected physical and chemical parameters were apparently minimal.

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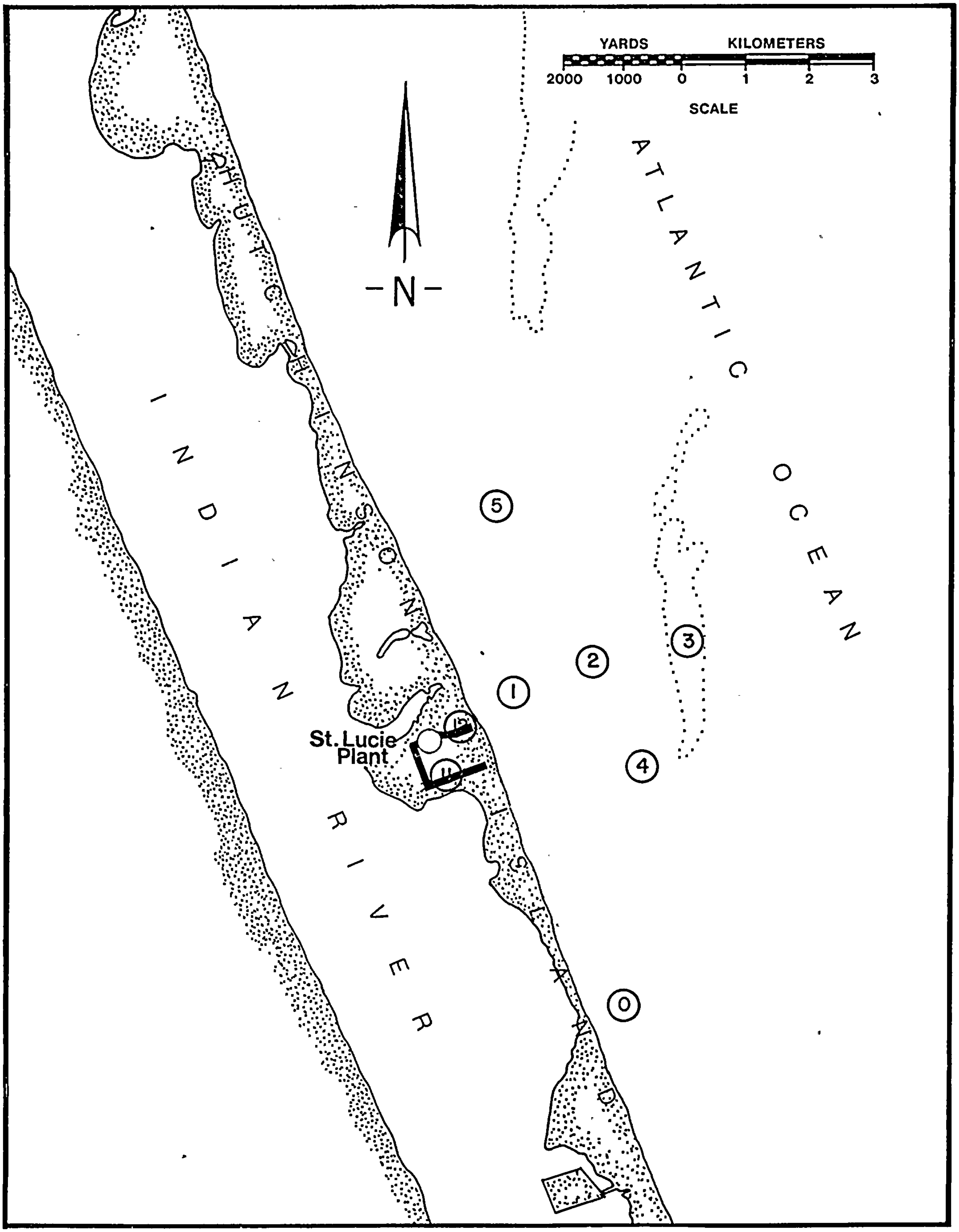

Figure G-1. Locations of water quality sampling stations, 1979.

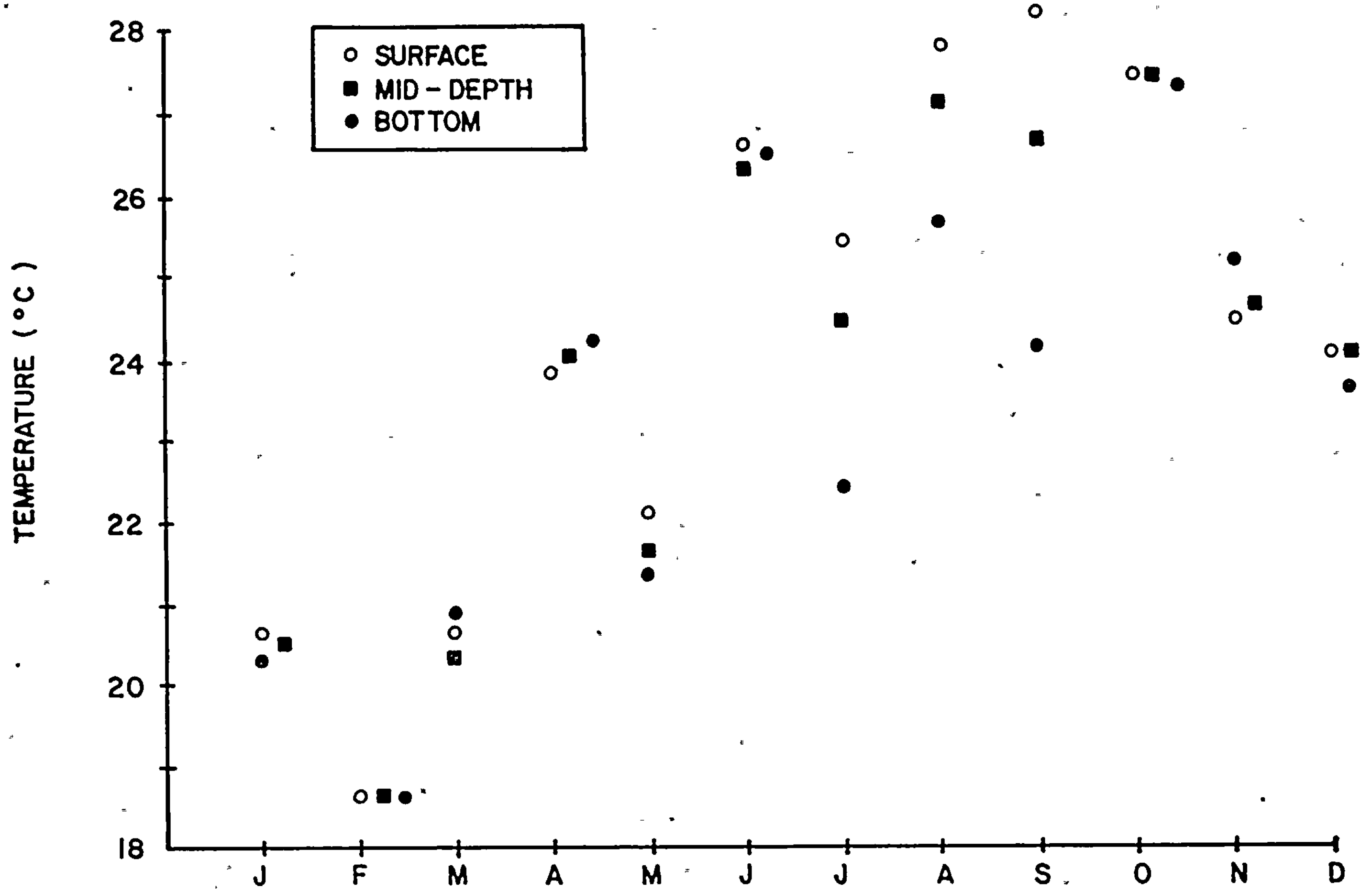

Figure G-2. Mean water temperatures (°C) for offshore Stations 0 through 5 combined, St. Lucie Plant, 1979.

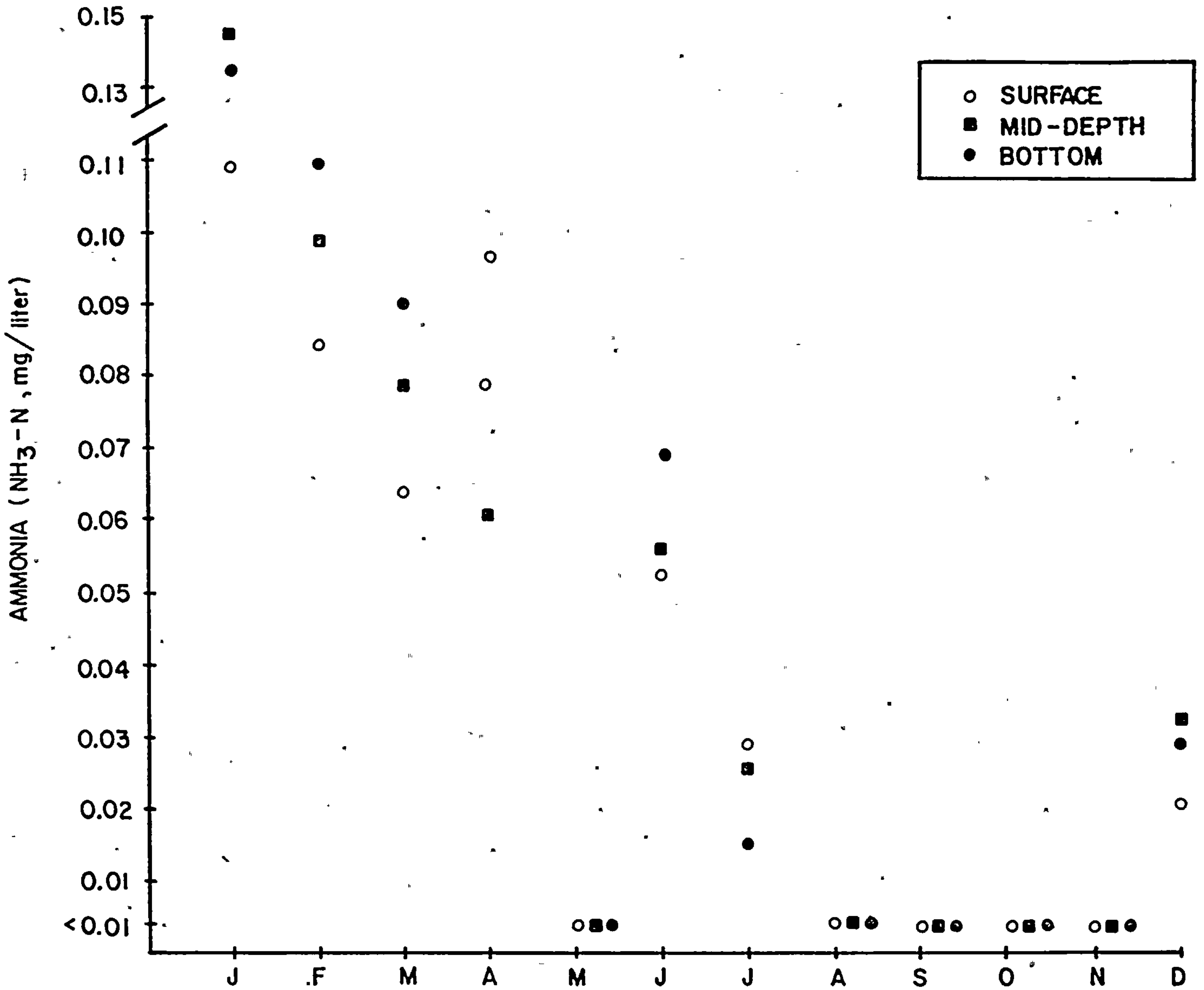

Figure G-3. Mean ammonia values for offshore Stations 0 through 5 combined, St. Lucie Plant, 1979.

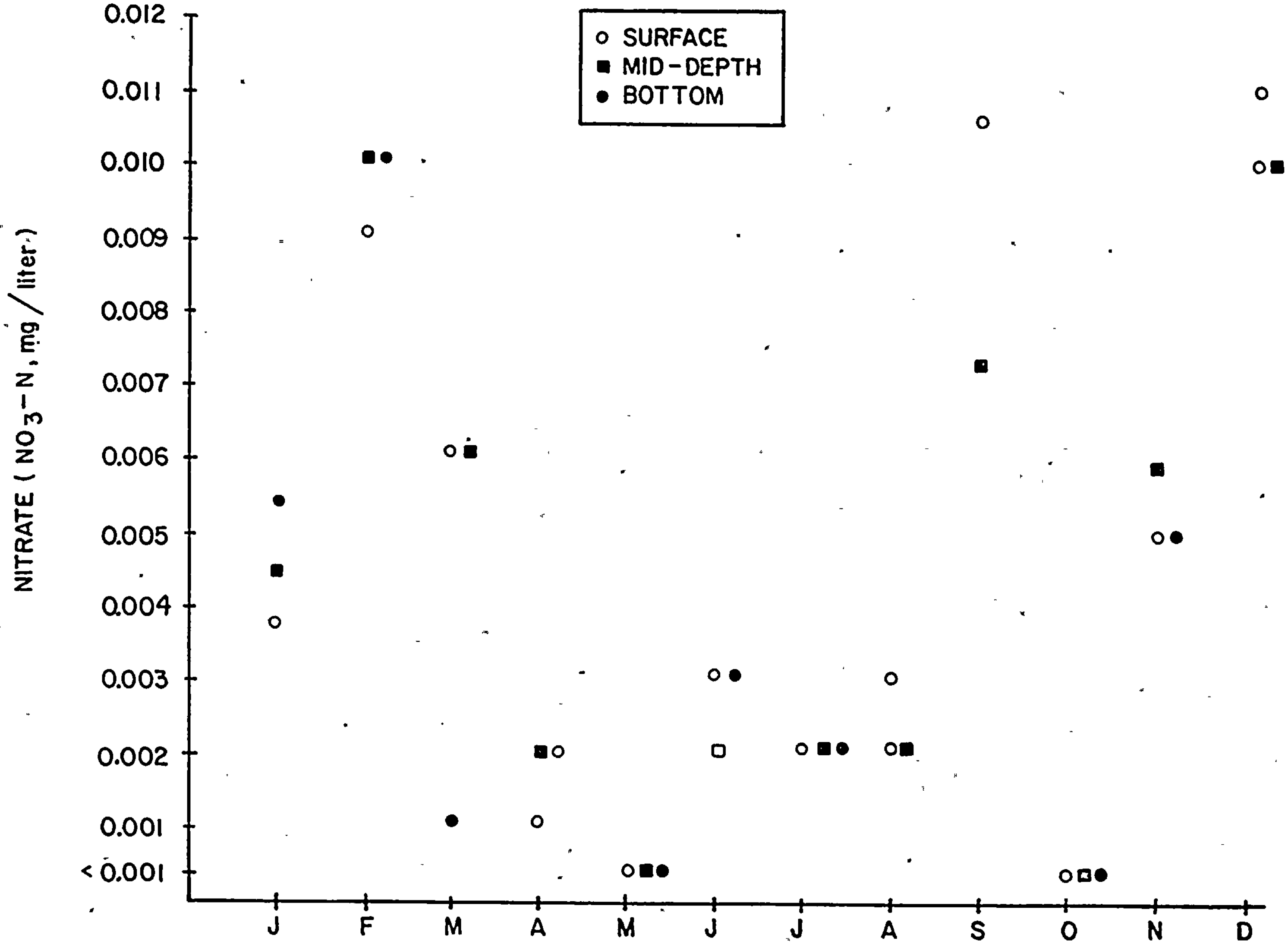

Figure G-4. Mean nitrate values for offshore Stations 0 through 5 combined, St. Lucie Plant, 1979.

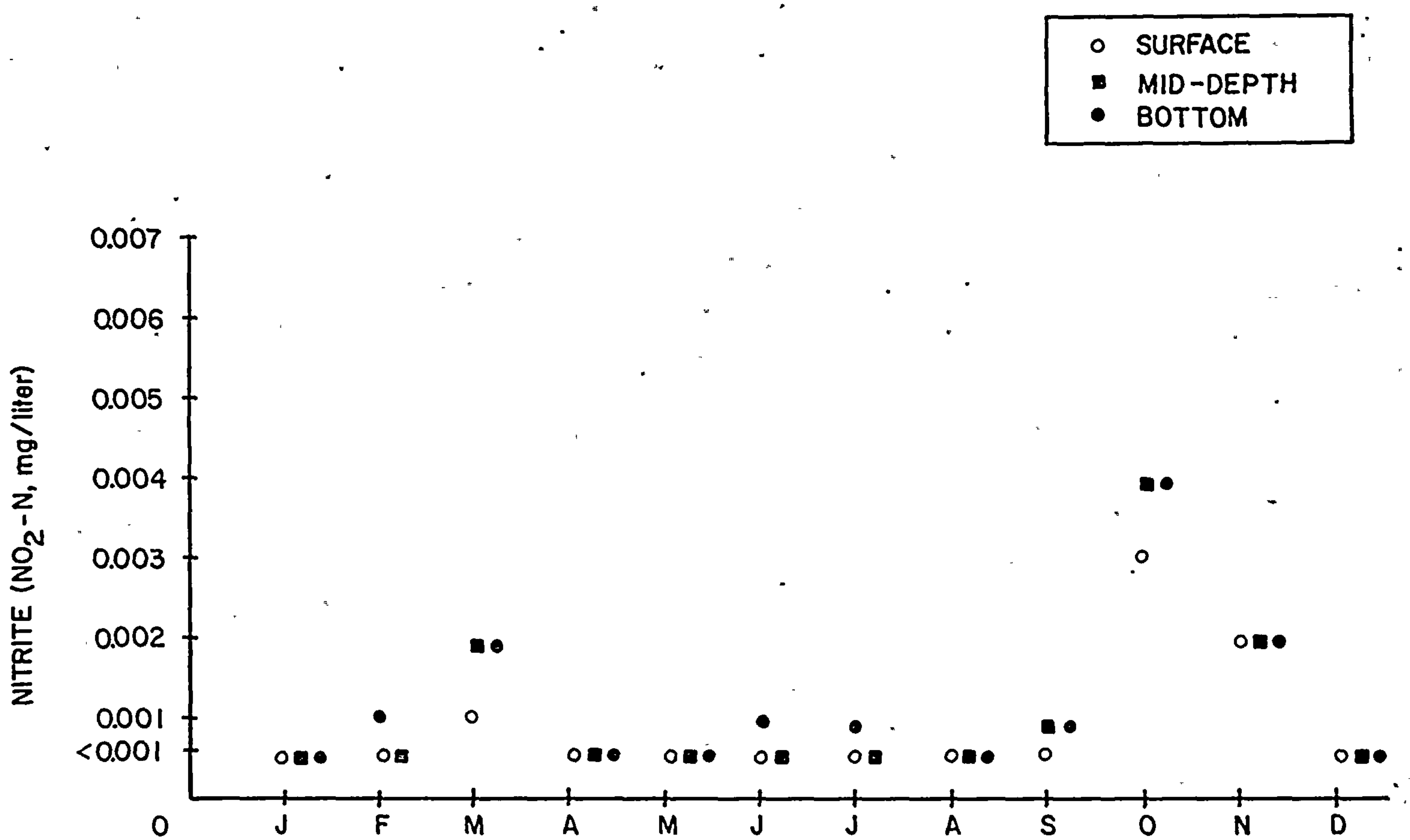

Figure G-5. Mean nitrite values for offshore Stations 0 through 5 combined, St. Lucie Plant, 1979.

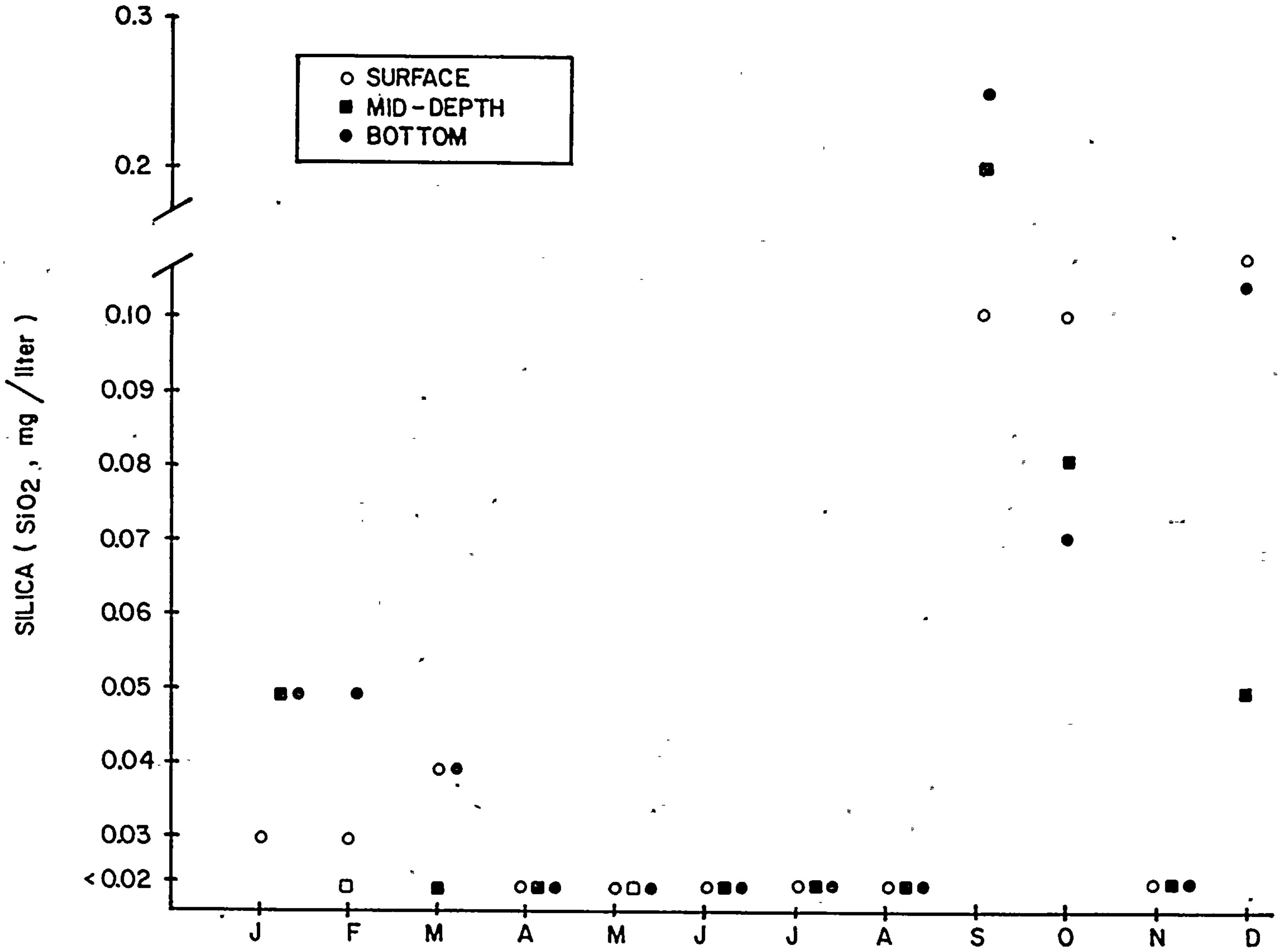

Figure G-6. Mean silica values for offshore Stations 0 through 5 combined, St. Lucie Plant, 1979.

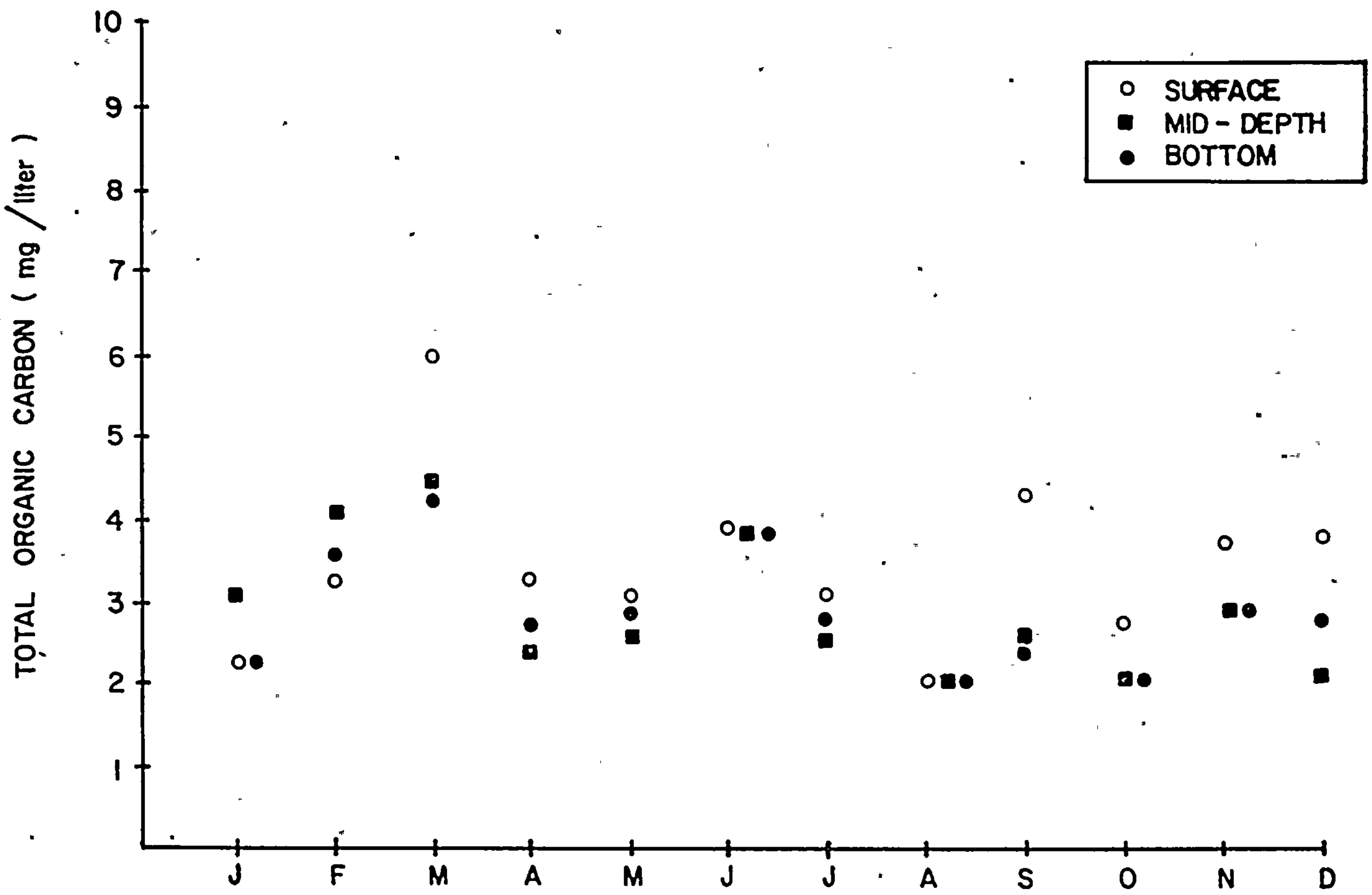

Figure G-7. Mean total organic carbon values for offshore Stations 0 through 5 combined, St. Lucie Plant, 1979.

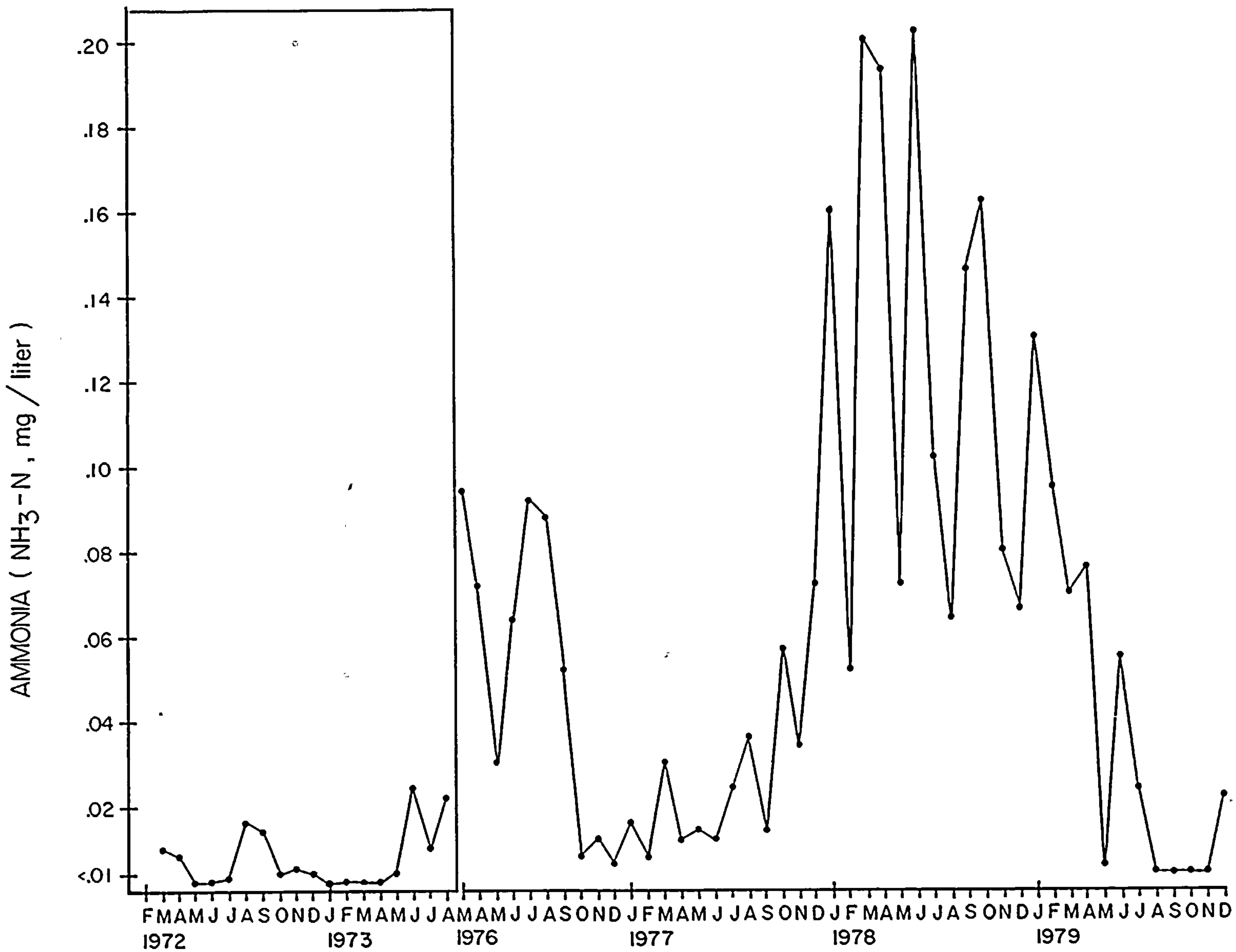

Figure G-8. Mean ammonia values for 1972-1973 baseline study (Stations 1 through 5 combined) and 1976-1979 operational study (Stations 0 through 5 combined), St. Lucie Plant.

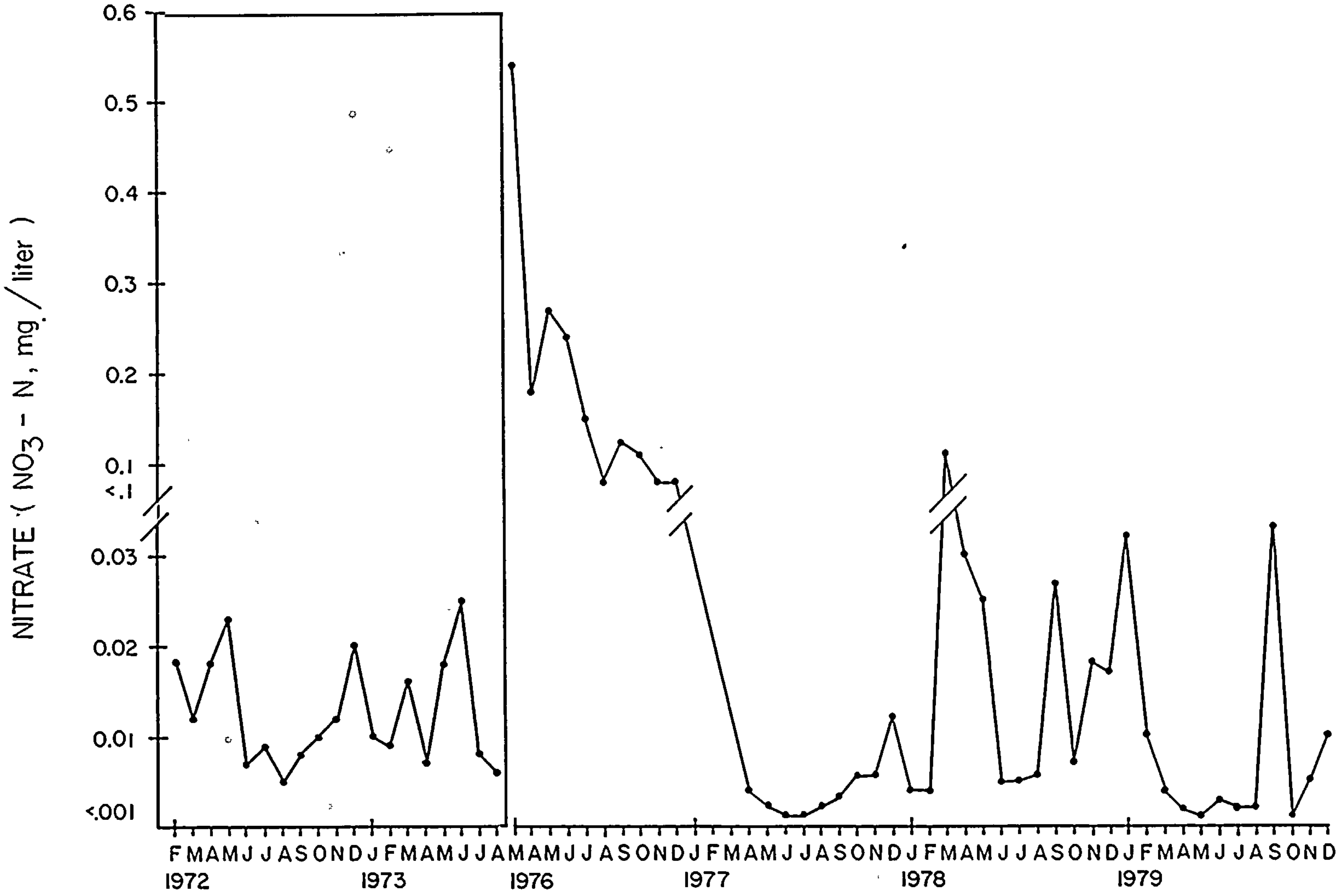

Figure G-9. Mean nitrate values for 1972-1973 baseline study (Stations 1 through 5 combined) and 1976-1979 operational study (Stations 0 through 5 combined), St. Lucie Plant.

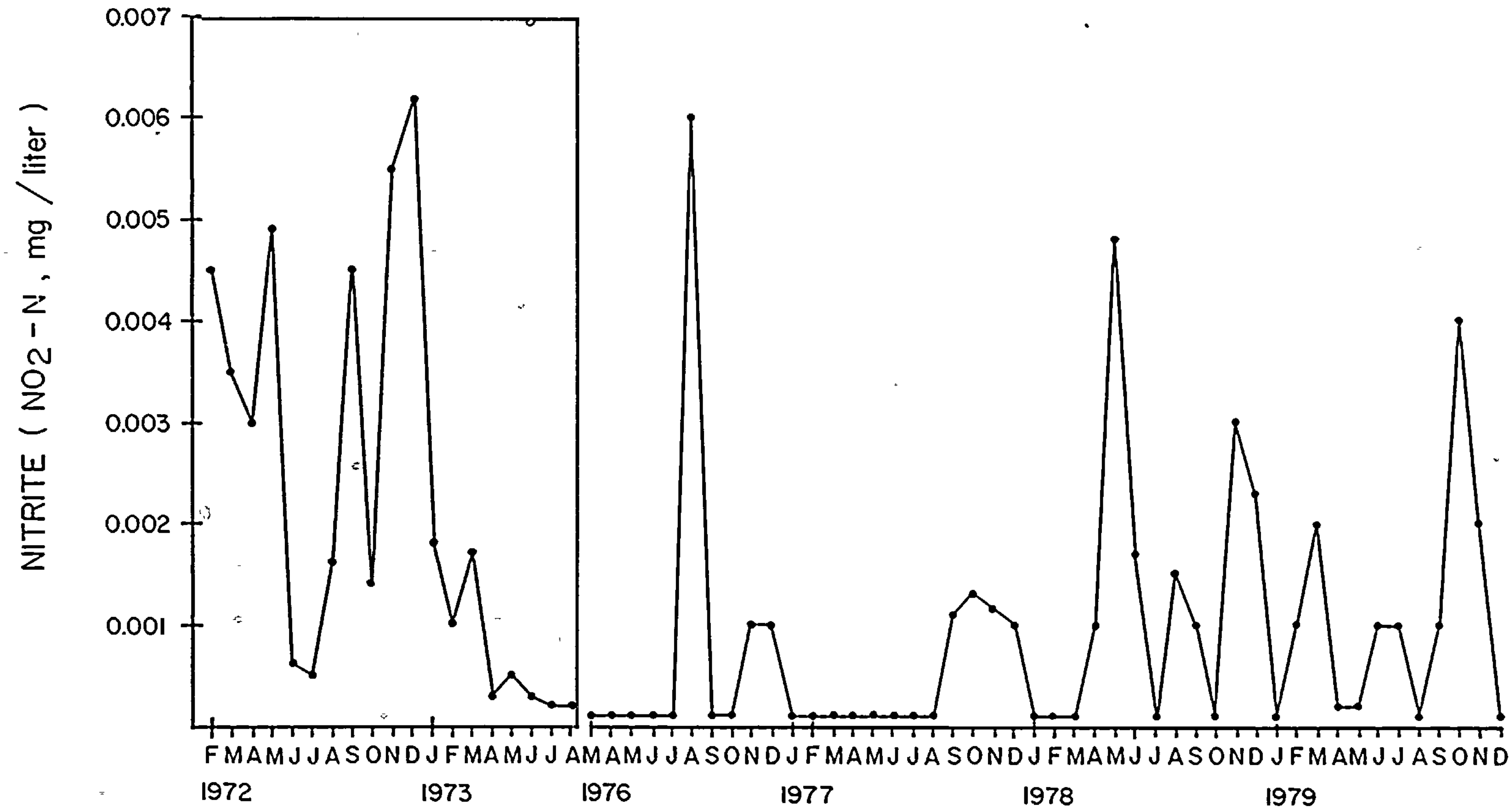

Figure G-10. Mean nitrite values for 1972-1973 baseline study (Stations 1 through 5 combined) and 1976-1979 operational study (Stations 0 through 5 combined), St. Lucie Plant.

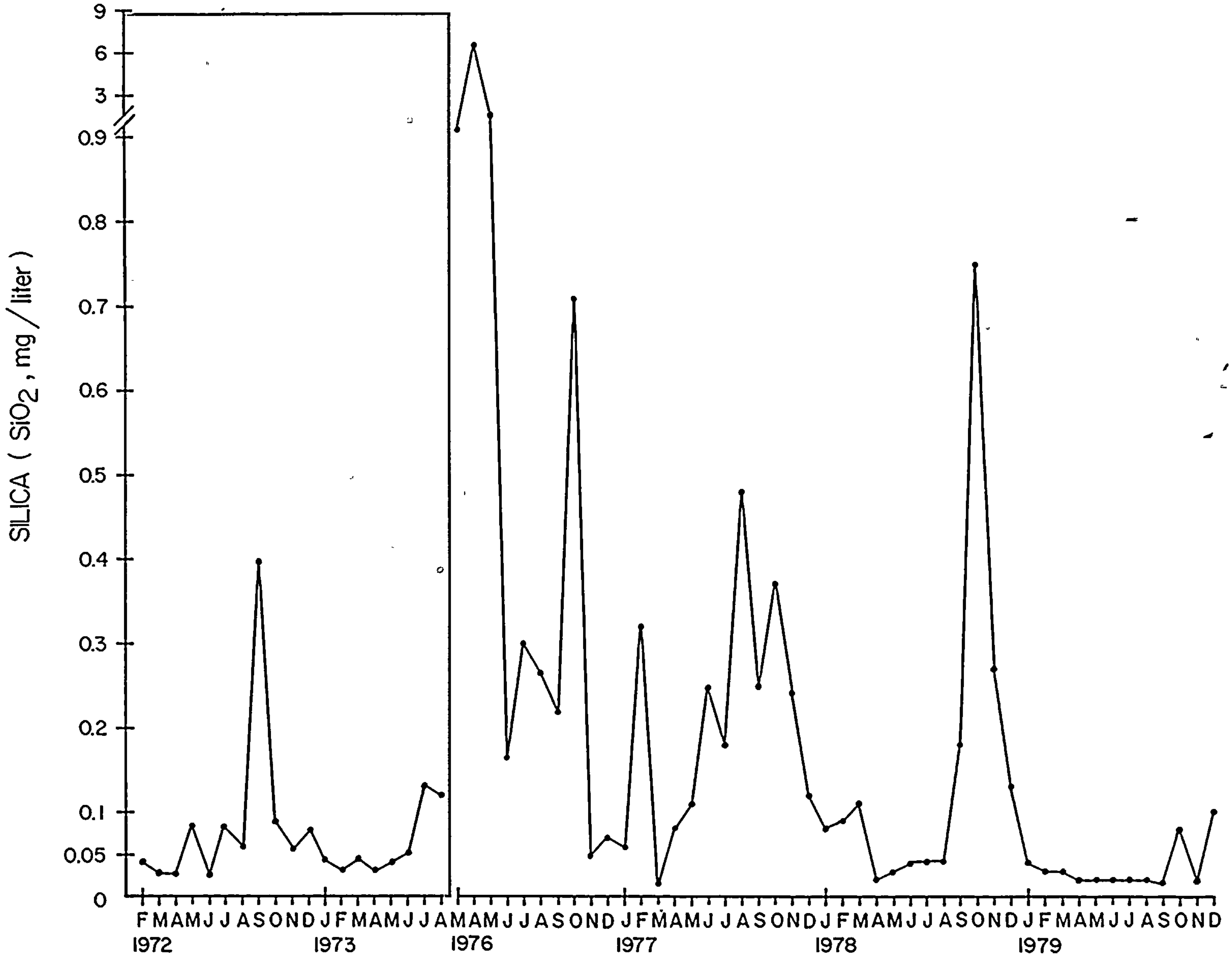

Figure G-11. Mean silica values for 1972-1973 baseline study (Stations 1 through 5 combined) and 1976-1979 operational study (Stations 0 through 5 combined), St. Lucie Plant.

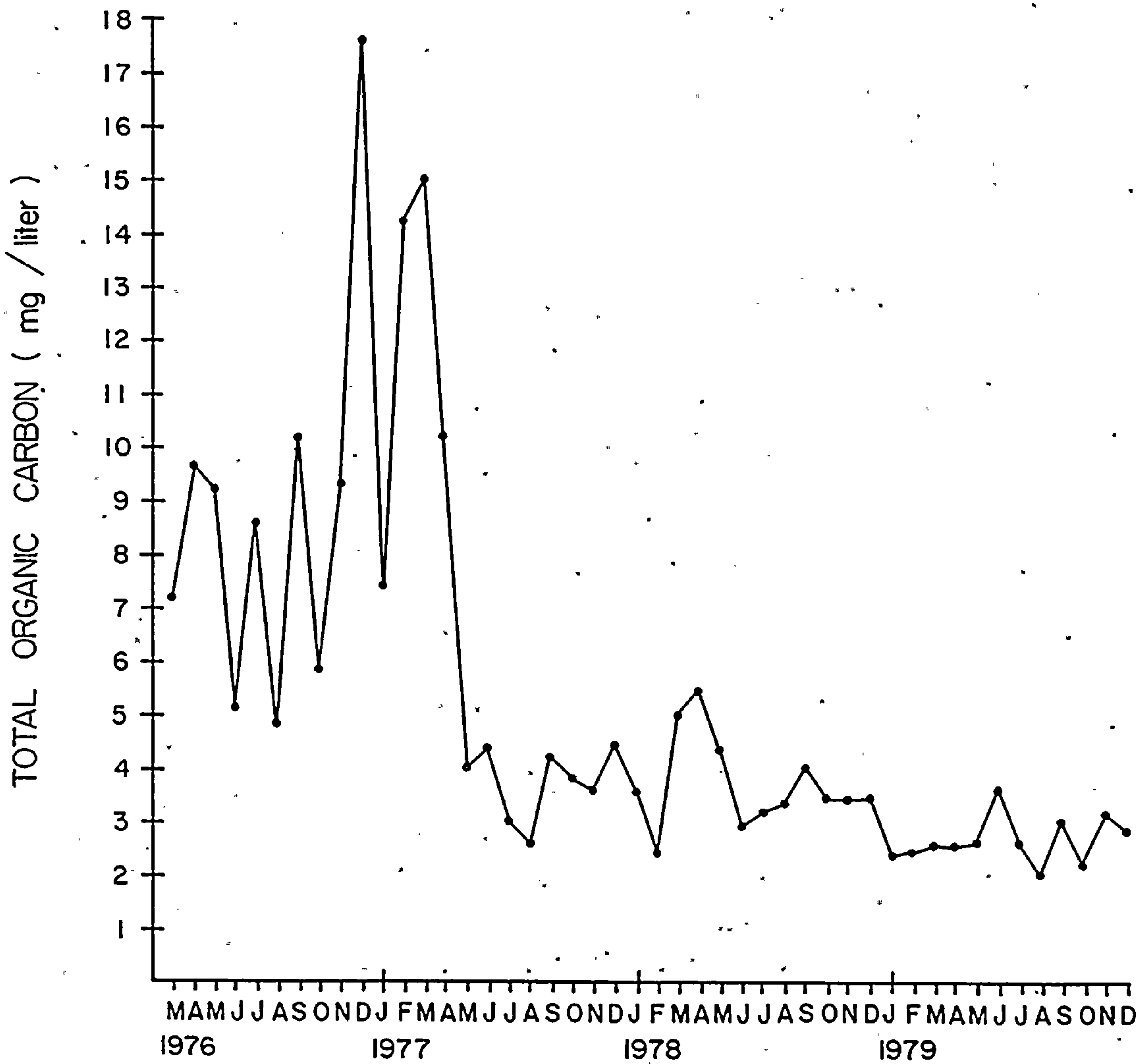

Figure G-12. Mean total organic carbon values for offshore Stations 0 through 5 combined, St. Lucie Plant, 1976-1979.

TABLE G-1

PHYSICAL/CHEMICAL PARAMETERS MEASURED FOR EACH STATION
ST. LUCIE PLANT
1979

Parameter	Station 0	1	2	3	4	5	11	12	Offshore intake	Offshore discharge
Water temperature (continuous)									x	x
Water temperature (in situ)	x	x	x	x	x	x	x	x		
Salinity	x	x	x	x	x	x	x	x		
Dissolved oxygen	x	x	x	x	x	x	x	x		
Turbidity	x	x	x	x	x	x	x	x		
Light transmittance	x	x	x	x	x	x				
Current direction and velocity[a]	x	x	x	x	x	x				
Wind direction, velocity, cloud cover[a]	x	x	x	x	x	x	x	x		
Tidal cycle, lunar phases[a]	x	x	x	x	x	x	x	x		
Ammonia nitrogen	x	x	x	x	x	x	x	x		
Nitrate nitrogen	x	x	x	x	x	x	x	x		
Nitrite nitrogen	x	x	x	x	x	x	x	x		
Silicates	x	x	x	x	x	x	x	x		
Orthophosphate	x	x	x	x	x	x	x	x		
Total organic carbon	x	x	x	x	x	x	x	x		

[a]Data records are maintained in the laboratory and are not included in this report.

TABLE G-2

RANGES OF SELECTED PHYSICAL PARAMETERS RECORDED AT OFFSHORE AND INSHORE (CANAL) STATIONS
ST. LUCIE PLANT
1979

Station and depth[a]		Temperature (°C)	Salinity (ppt)	Dissolved oxygen (mg/l)	Turbidity (FTU)
offshore					
0	S	18.2-28.5	34.5-36.7	4.7-8.6	0.2- 2.8
	M	18.1-27.4	34.5-36.6	4.6-8.3	0.0- 2.4
	B	18.1-27.4	34.5-36.6	4.4-7.7	0.3-14.2
1	S	18.7-28.2	34.5-36.1	4.5-8.6	0.2- 4.3
	M	18.7-27.2	34.5-36.7	4.4-8.4	0.2- 4.9
	B	18.6-27.3	33.4-36.1	4.3-7.9	0.2- 7.2
2	S	18.2-28.0	34.5-36.1	4.7-8.6	0.3- 2.0
	M	18.3-27.8	34.5-36.6	4.7-8.8	0.2- 3.0
	B	17.9-27.3	34.5-36.1	4.4-7.8	0.3- 3.2
3	S	18.8-28.8	34.5-36.1	4.8-8.6	0.9- 1.5
	M	18.8-28.3	34.5-36.1	5.6-8.7	0.2- 2.0
	B	18.9-27.2	34.5-36.1	4.8-8.3	0.3- 2.5
4	S	18.4-29.2	34.5-37.2	4.8-8.5	0.2- 2.0
	M	18.5-27.4	34.5-36.1	4.8-8.2	0.3- 2.6
	B	18.6-27.4	35.0-35.5	4.5-7.7	0.3- 2.7
5	S	18.1-28.3	34.5-36.1	4.6-9.1	0.3- 2.0
	M	18.2-27.3	34.5-36.1	4.6-9.4	0.3- 2.7
	B	18.2-27.5	35.0-36.1	4.3-9.8	0.5- 4.0
inshore					
11	S	18.7-27.2	32.3-35.5	5.6-9.5	0.3- 2.6
	M	18.6-27.0	33.4-35.5	5.2-7.5	0.9- 5.1
12	B	23.0-37.5	34.5-37.5	5.1-9.4	0.7- 5.2

[a]S = Surface; M = Middle; B = Bottom.

TABLE G-3

METHODS OF ANALYSIS USED TO MEASURE SELECTED CHEMICAL PARAMETERS
ST. LUCIE PLANT
1979

Parameter	Method	Reference
Ammonia nitrogen (NH_3-N)	Indophenol	Strickland and Parsons, 1972, p. 87
Nitrate nitrogen (NO_3-N)	Cadmium reduction	APHA, 1976, p. 423
Nitrite nitrogen (NO_2-N)	Diazotization	APHA, 1976, p. 434
Silicates (SiO_2-Si)	Heteropoly blue	APHA, 1976, p. 490
Orthophosphate (PO_4-P)	Ascorbic acid	APHA, 1976, p. 481
Total organic carbon (TOC)	Combustion-infrared	APHA, 1976, p. 532

TABLE G-4

RANGES OF SELECTED CHEMICAL PARAMETERS (NUTRIENTS)
RECORDED AT OFFSHORE AND INSHORE (CANAL) STATIONS
ST. LUCIE PLANT
1979

Station and depth[a]		NH_3-N (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	SiO_2-Si (mg/l)	PO_4-P (mg/l)	TOC (mg/l)
offshore							
0	S	<0.01-0.09	<0.001-0.054	<0.001-0.003	<0.02-0.10	<0.01-0.01	2-4
	M	<0.01-0.23	<0.001-0.084	<0.001-0.002	<0.02-0.24	<0.01-0.01	2-6
	B	<0.01-0.19	<0.001-0.096	<0.001-0.003	<0.02-0.26	<0.01-0.01	2-6
1	S	<0.01-0.14	<0.001-0.040	<0.001-0.002	<0.02-0.16	<0.01-0.01	2-4
	M	<0.01-0.13	<0.001-0.084	<0.001-0.004	<0.02-0.26	<0.01-0.01	2-6
	B	<0.01-0.14	<0.001-0.090	<0.001-0.005	<0.02-0.25	<0.01-0.01	2-4
2	S	<0.01-0.08	<0.001-0.038	<0.001-0.004	<0.02-0.10	<0.01-0.02	2-6
	M	<0.01-0.14	<0.001-0.056	<0.001-0.002	<0.02-0.16	<0.01-0.01	1-4
	B	<0.01-0.12	<0.001-0.106	<0.001-0.004	<0.02-0.26	<0.01-0.01	2-6
3	S	<0.01-0.14	<0.001-0.038	<0.001-0.003	<0.02-0.10	<0.01-0.01	2-4
	M	<0.01-0.12	<0.001-0.036	<0.001-0.004	<0.02-0.14	<0.01-0.01	1-6
	B	<0.01-0.18	<0.001-0.068	<0.001-0.004	<0.02-0.19	<0.01-0.01	2-3
4	S	<0.01-0.14	<0.001-0.031	<0.001-0.004	<0.02-0.07	<0.01-0.01	2-10
	M	<0.01-0.21	<0.001-0.069	<0.001-0.004	<0.02-0.20	<0.01-0.01	2-4
	B	<0.01-0.19	<0.001-0.094	<0.001-0.004	<0.02-0.25	<0.01-0.01	2-6

TABLE G-4
(continued)
RANGES OF SELECTED CHEMICAL PARAMETERS (NUTRIENTS)
RECORDED AT OFFSHORE AND INSHORE (CANAL) STATIONS
ST. LUCIE PLANT
1979

Station and depth[a]		NH_3-N (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	SiO_2-Si (mg/l)	PO_4-P (mg/l)	TOC (mg/l)
5	S	<0.01-0.06	<0.001-0.026	<0.001-0.004	<0.02-0.41	<0.01-0.01	2-14
	M	<0.01-0.08	<0.001-0.100	<0.001-0.005	<0.02-0.29	<0.01-0.01	2-5
	B	<0.01-0.17	<0.001-0.113	<0.001-0.005	<0.02-0.29	<0.01-0.01	2-3
11	S	<0.01-0.06	<0.001-0.102	<0.001-0.005	<0.02-0.36	<0.01-0.04	2-5
	B	<0.01-0.04	<0.001-0.108	<0.001-0.006	<0.02-0.40	<0.01-0.06	1-5
12	S	<0.01-0.12	<0.001-0.106	<0.001-0.006	<0.02-0.42	<0.01-0.02	1-4

[a]S = Surface; M = Middle; B = Bottom.

TABLE G-5

RANGES OF NUTRIENT CONCENTRATIONS (mg/liter) RECORDED AT OFFSHORE STATIONS
ST. LUCIE PLANT
1972-1979

Parameter	Feb 1972-Aug 1973 (Worth and Hollinger, 1977)	Mar-Dec 1976 (ABI, 1977)	Jan-Dec 1977 (ABI, 1978)	Jan-Dec 1978 (ABI, 1979)	Jan-Dec 1979 (ABI, present study)
NH_3-N	<0.01 - 0.07	<0.01 - 0.34	<0.01 - 0.12	0.02 - 0.35	<0.01 - 0.23
NO_3-N	<0.001 - 0.075	<0.10 - 0.58	<0.001 - 0.024	<0.001 - 0.211	<0.001 - 0.113
NO_2-N	<0.001 - 0.022	<0.001 - 0.007	<0.001 - 0.002	<0.001 - 0.013	<0.001 - 0.005
SiO_2-Si	0.03 - 0.90	<0.02 - 13.70	<0.02 - 0.61	<0.02 - 0.99	<0.01 - 0.41
PO_4-P	<0.01 - >1.40	<0.01 - 0.14	<0.01 - 0.07	<0.01 - 0.02	<0.01 - 0.02
TOC	not available	3 - 36	1 - 25	1 - 23	1 - 14

H. TURTLES

Environmental Technical Specification (Section 3.1.B.f.)

> Migratory Sea Turtles - The species, numbers, and nesting characteristics of sea turtles that migrate in from the sea and nest along the east coast of Florida will be determined on the FPL shoreline property and selected adjacent control areas in 1975 and 1977. A study shall be conducted to determine the effects of the discharge thermal plume on turtle nesting patterns and turtle hatchling migration. In addition, control studies on temperature stress, hatching, and rearing factors will be conducted using turtle eggs from displaced nests.

INTRODUCTION

Hutchinson Island, Florida, is an important nesting area for Atlantic loggerhead turtles (*Caretta caretta*; Gallagher et al., 1972). Each year, from about May to September, female loggerhead turtles emerge from the water and crawl up on the beach at night to nest. Each female deposits approximately 120 eggs in a 60-cm-deep nest hole and the eggs hatch 50 to 70 days later. The hatchling turtles dig out of the sand-covered nest, usually at night, and crawl rapidly across the beach into the sea. The rest of their lives is spent in the sea except for the periodic nesting on the beach by mature females. After nesting, adult turtles may disperse along migratory routes or remain at sea in the vicinity of the nesting area.

In addition to the loggerhead turtles, Hutchinson Island supports limited nesting of Atlantic green turtles (*Chelonia mydas*) and leatherback turtles (*Dermochelys coriacea*; Gallagher et al., 1972). All marine turtles in Florida are protected by the Federal government and by Florida

statutes. The Federal government classifies the leatherback turtle as an endangered species, the green turtle as endangered in Florida (threatened throughout the remainder of its range) and the loggerhead turtle as a threatened species. Maintaining the vitality of the Hutchinson Island rookery is of importance in view of the declining world populations of marine turtles caused by coastal development and fishing pressure (IUCN, 1969, 1971; NMFS, 1978).

In 1970, FPL received a construction permit for an 810-MW nuclear-powered electric generating station on Hutchinson Island. It has been of concern to FPL that the construction and subsequent operation of this plant would not adversely affect the turtle populations offshore of the island. As a result of this concern, FPL, in conjunction with the Florida Department of Natural Resources, surveyed the nesting sea turtle populations of Hutchinson Island in 1971. Since that time FPL has surveyed turtle nesting activity every other year (1973, 1975, 1977, and 1979). This report documents the results of this ongoing study through 1979 and discusses the observed spatial and temporal trends in turtle nesting density and behavior. Because loggerheads dominate the nesting populations, discussions are based on this species unless otherwise noted.

MATERIALS AND METHODS

Nine 1.25-km-long segments of beach established as sample areas by Gallagher et al. (1972) have been used throughout the 5 years of study (Figure H-1). The total length of the sample areas was 11.25 km which

comprises 31 percent of the 36.3-km long island. The nine sample areas were approximately equidistant from each other along the island and were typical of nearby beach habitats. Accordingly, it was assumed that the nine sample areas were representative of the entire island and that turtle activity within these areas reflected activity on the entire island.

The number and distribution of turtle nests on Hutchinson Island for the 1979 survey was determined by counting the number of loggerhead turtle nests in Areas 1 through 9. Nest counts were made by observers patrolling the beach on small off-road motorcycles, Monday through Friday from 15 May through 30 August. All nests located were numbered, dated, and marked with an identifying stake to assist observers in keeping accurate counts and to monitor nest predation by raccoons.

In addition, as in previous study years, the entire beach from Area 1 south through Area 9 was routinely surveyed for evidence of green and leatherback turtle nests. Each nest location was recorded and these data were transmitted to the Florida Department of Natural Resources as part of a cooperative study on these less frequently occurring species.

To collect data on 1979 turtle populations and nesting behavior, a tagging/recapture program was begun on 23 May and continued through 17 August 1979. Tagging was conducted south of Area 4 in 1971, 1973, and 1975, and from Area 2 through 7 in 1977 and 1979. This study was done at night when the female turtles crawl onto the beach to nest. About 19 km

of beach (Areas 2 through 7, Figure H-2) were surveyed five to seven nights per week from approximately 9:00 PM until 4:00 AM. Each of three observers patrolled a 6.4-km region in as short a time as half an hour.

The site at which each turtle emerged from the sea to nest was recorded. Once a turtle had begun to deposit eggs or was seen returning to the sea, an identification tag (Monel self-piercing, National Band and Tag Co., No. 4-1005, size No. 49) was affixed to the posterior proximal margin of the right foreflipper. Straight-line measurements of carapace length (from precentral lamina to the notch between postcentral laminae) and maximum width were made using specially designed calipers. Turtles were not weighed because of the difficulty in placing specimens, which can weigh in excess of 100 kg, on scales. The presence of marine parasites as well as any obvious physical injuries to the turtle were noted.

Often a turtle will crawl up on the beach and begin nest excavation but will return to the sea without depositing eggs. Although such false crawls are natural phenomena, extraneous light, sound, movement or other factors may increase their likelihood. The presence of biologists in the turtle rookery areas at night may have affected turtle behavior by increasing the number of false crawls, but the effect would have been constant throughout the survey areas. In addition, care was taken not to disturb turtles prior to nesting to reduce the likelihood of a nesting crawl becoming a false crawl.

The data derived from this ongoing study include daytime nest counts, raccoon predation of nests, and nighttime tag and recapture studies. The intensity and efficiency of the daytime nest count and predation study remained relatively constant over the entire study period. However, the nighttime tagging studies in 1971 and 1973 were affected by variables such as study effort intensity, numbers of available observers, and study efficiency (differing modes of transportation). Accordingly, comparisons between each of the study years should be interpreted with caution.

RESULTS AND DISCUSSION

Number and Distribution of Nests

During the five nesting periods studied, a considerable year-to-year variation in nest density occurred in each study area (Figure H-3). Regardless of year, however, the spatial distribution of turtle nests formed a gradient with the lowest densities being found on the northern portion of the island. Linear regression analysis of variance of nest density with respect to location describes the gradient of nesting during each year. The linear regression equations were derived as:

$$Y = a + bx$$

Year	Equation	Coefficient of Determination, (r^2)
1971	Y = 70.03 + 7.39X	0.74
1973	Y = 110.24 + 2.53X	0.61
1975	Y = 67.20 + 8.29X	0.59
1977	Y = 33.17 + 5.91X	0.74
1979	Y = 16.00 + 12.22X	0.96

where Y = the number of nests,
a = the Y intercept,
b = the slope of the regression line,
X = miles from Ft. Pierce inlet.

The only study year in which the nesting density was fairly uniform along the island (b=2.53) was 1973. This distribution was associated with beach accretion in Areas 1 through 3 during that year (Worth and Smith, 1976). The nesting density gradient was most marked (b=12.22) in 1979 when early season storms eroded considerable portions of Areas 1 through 3. Historically, the northern portion of Hutchinson Island has been subject to heavy storm erosion which has reduced the beach at times to a minimum of 3 m from the water to the primary dune. In addition, wave action frequently forms cliff-like ledges that prevent turtles from crawling to the upper beach which they prefer for nesting. The similarity between the gradients of beach stability and nest numbers indicates that relative beach stability can influence the nesting preferences of turtles. This behavioral trait may account for much of the annual variation in nesting between sample areas (Worth and Smith, 1976).

The influence of the St. Lucie Plant on nest distribution was evaluated by comparing the observed nesting density in each sample area with the number of nests predicted by the regression line calculations. Except for 1975, when construction activity on the beach was greatest, nest density at Area 4 (plant site) deviated from the expected value by less than 14 percent. The 1975 decline in nesting at Area 4 was attributed to the construction of the St. Lucie Plant offshore intake and discharge systems. During construction, nesting dropped to 50 percent of the expected number. At this time, construction crews were operating on a 24-hour schedule using drag lines and other heavy equipment and strong lights. Additionally, the cofferdam used to construct the discharge pipe extended 350 m perpendicular from shore and presented a barrier to turtles swimming close in along the shore to select a nesting site. It is reasonable to presume that this barrier made Area 4 less desirable as a nesting beach. In 1977 and 1979, however, nesting activity in Area 4 returned to the general pattern observed during the other study years.

The total number of nests produced in all sample areas has remained fairly stable during the 5 study years except for 1977 when the number of nests produced was only 66 percent of the average of the other years (Table H-1). However, the similarity of the slope values in the regression equations shows that nest distribution in the nine areas in 1977 was similar to that observed in 1971 and 1975. The similarity of the distribution and number of nests between years indicates that construction activities and the operation of the St. Lucie Plant has not affected long-term nest production on the island.

The total number of nests produced on Hutchinson Island was calculated by extrapolating from the total number of nests in all sample areas. Thus, in 1979, the 1449 nests observed along the 11.25 km of the 36.3-km beach extrapolate to 4676 nests on all of Hutchinson Island.

In past years, various methods have been used to estimate the total nest production on the island (Table H-1). Gallagher et al. (1972) used a conservative weighted estimate to arrive at the number of nests on the

southernmost 31 km of beach in 1971. The northern 5 km of beach were not included in the 1971 survey because a beach dredge and fill project prevented access. A similar but less conservative method was applied to 1973 nesting data by Worth and Smith (1976). To allow comparison of total nesting trends, data from past surveys were recalculated using the method applied to 1979 data. Total nesting estimates for the entire island are presented in Table H-1. An estimate of over 4000 nests on the island appears to be fairly consistent since 1971.

Nesting Behavior

Nesting Success

As discussed previously, turtles may crawl up on the beach but return to the sea without digging a nest or depositing eggs. The causes of these false crawls are not clearly understood, but their frequency may reflect the over-all suitability of a beach for nesting. Beach suitability depends on characteristics such as sand texture, beach stability, primary dune vegetation, beach slope, lighting, and human activity. The frequency of false crawls, therefore, can provide an index of the sensitivity of nesting turtles to changes in environmental variables which could be affected by island development and power plant operation. The index derived from false crawl data used in this report has been termed "nesting success" and is defined as:

$$\text{nesting success} = \frac{\text{number of nests} \times 100}{\text{number of nests} + \text{number of false crawls}}$$

Nesting success varied with both area and month during each survey year (false crawls were not recorded in 1971), but no consistent pattern in these variations was noted (Figures H-4 and H-5). Over-all nesting success declined each year from a maximum of 70 in 1973 to a minimum of 52 in 1979. These observed decreases were not significant (Kruskal-Wallis test, $P \leq 0.05$; Zar, 1974) except for the large decline observed between 1973 and 1975. This decrease may have reflected increased sampling effort in 1975, so this data should be interpreted with caution. Nesting success data show that power plant operation had little effect on turtle nesting success. Two observations support this contention: 1) the largest decline in nesting success occurred from 1973 to 1975, prior to plant operation, and 2) the spatial variation in nesting success was not related to power plant proximity. If plant operation was a factor, the lowest nesting success would be expected in Area 4. However, in both 1977 and 1979, Area 4 had a mean nesting success (53 in 1977; 51 in 1979) equal to or only slightly below the over-all success.

In 1975, construction activities apparently reduced the nesting suitability of portions of the beach near the plant as indicated by low nesting success in Area 4 (51 percent, the minimum for the year) relative to over-all nesting success (58 percent). Low nesting success may have contributed to the low ratio of observed to expected nest numbers for the area, but beach avoidance was apparently the primary cause of the reduction in Area 4 nesting. The effects of power plant construction were localized and short term because in subsequent years nest numbers and nesting success in Area 4 were near expected values.

The most important factor affecting nesting success appears to be short-term changes in beach characteristics resulting from natural causes such as storm-induced beach erosion. For example, a tropical depression which occurred offshore of Hutchinson Island during 11-17 June 1979 produced abnormally high tides and rough seas and caused beach flooding and erosion particularly in Areas 1, 2, and 5 (D. Worth, personal communication). During the storm, and for several weeks after, nesting success was very low in the affected areas.

Long-term effects on nesting success may be caused by increased beachfront development and increased nighttime pedestrian traffic on the beach. A slight long-term decline in nesting success has been observed between 1975 and 1979 (1971 and 1973 data cannot be compared with confidence with these latter years). Presently, it is not possible to determine whether this decline reflects commercial development of the beach or a reduction in the quality of the nesting beach as a result of extensive beach erosion.

The slight long-term decline in nesting success has not yet had an observable effect on the total number of nests produced. However, it should be noted that a decline in nesting success implies an increase in effort expended per nest. There may be a threshold of effort per nest beyond which the total number of nests produced will decline. At this point, turtle populations would be adversely affected.

Timing of Nesting

Nesting in the nine sample areas usually occurred from May through August. However, in 1975, nests were first observed in April, and in 1971 and 1973 nests were observed into September (Figure H-6). The onset of nesting occurred in the spring when ocean temperatures increased to 23° or 24°C. Nesting activity increased with ocean temperature to a maximum in June (except in 1973 when the maximum occurred in July), and then declined so that nesting activity was very low or absent in September.

To determine whether plant operation was affecting the timing of nesting, the nesting patterns for preoperational years (1971, 1973, 1975) and for operational years (1977, 1979) were determined from pooled data (Figure H-7) and statistically compared (Kolmogorov-Smirnov goodness of fit, $p \leq 0.05$; Zar, 1974). This analysis indicated that there has been no significant alteration of the temporal distribution of nesting during the years of plant operation.

Renesting Behavior

Green and loggerhead turtles frequently produce more than one nest per summer. The distance between successive nests is termed the renesting distance while the time between deposition of successive nests is the renesting interval. For green turtles, the renesting distance can be quite small (Carr, 1972), a behavior termed site-specific nesting. Although loggerhead turtle nesting behavior is not as site-specific as green turtles (Caldwell et al., 1959; Worth and Smith, 1976), changes in

the mean renesting distance could indicate an alteration of nesting behavior. Consequently, the renesting distance of loggerheads at Hutchinson Island was examined by analyzing information from the turtle tagging program.

The renesting distance for undisturbed female loggerhead turtles ranged from less than 0.1 km to 15.9 km. Average renesting distances were calculated from pooled observations for each study year and statistically compared (Student-Newman-Keuls Test, $p \leq 0.05$; Zar, 1974). There were no significant differences between mean renesting distances before plant operation (1975, 4.6 km) and during plant operation (1977, 4.6 km; 1979, 5.0 km; Table H-2). Power plant environmental effects such as heated water discharge are most pronounced in the immediate vicinity of the plant (Area 4). For this reason, the 1979 distribution of renesting distances for turtles observed nesting at least once in Area 4 was compared to that of turtles that were never observed nesting in Area 4 (Figure H-8). This analysis indicates no significant difference between the two groups (Kolmogorov-Smirnov goodness of fit, $p \leq 0.05$; Zar, 1974).

The renesting interval of loggerhead turtles is generally 14 days, but wide geographical and individual variations occur (Caldwell, 1962; Hughes et al., 1967). The renesting interval may also vary according to environmental conditions. For example, as water temperature increases during the summer, the renesting interval may decrease (Hughes and Brent, 1972). The apparent sensitivity of the renesting interval to environmen-

tal temperature makes it an important component of the nesting behavior in evaluations of plant thermal effects. As with renesting distance, information on the renesting interval was provided by the turtle tagging program.

The renesting interval prior to plant operation (1975) ranged from 11 to 19 days with a mean of 13.9 days. During plant operation (1977 and 1979), the renesting interval ranged from 11 to 20 days with means of 13.8 and 14.1 days in 1977 and 1979, respectively. Analysis of variance indicates no significant differences between the means for 1975, 1977, and 1979 (Table H-3).

Operation of the St. Lucie Plant has not significantly affected the renesting distance or renesting interval of loggerhead turtles on Hutchinson Island.

Population Estimates

Population estimates for nesting female loggerhead turtles were derived from the calculated total nest production divided by the estimated number of nests produced by each female. The accuracy of this methodology depends on the degree to which the nine sample areas are representative of the entire island and the accuracy of the estimate of the mean number of nests produced per female per season.

The number of nests produced by individual females during the 5 study years has ranged from one to nine nests. Several authors have

suggested that four to five nests per female might generally be expected (Hughes, 1974; Kaufman, 1975; Worth and Smith, 1976). This figure is supported by the 14 day internesting period observed for recaptured turtles. However, on Hutchinson Island, approximately 55 percent of the population observed on the beach are seen only once during a season and the remainder of the turtles generally are recaptured less than four times. A comparison of the numbers of nests produced by tagged turtles during 1975, 1977 and 1979 study years (Table H-4) suggests that one turtle visits the Hutchinson Island tagging beach for every two nests produced. The implied nesting frequency of two per season can be reconciled with the 14 day internesting period only by assuming that the balance of the nests laid by tagged turtles are deposited outside the study area.

Estimates of turtle populations in previus years can be obtained by dividing the calculated total number of nests by the estimated number of nests per female (2). Using this method, the number of nesting female turtles in 1979 is calculated to be 2338. Likewise, it was estimated that 2291 females nested on Hutchinson Island in 1971, 2036 in 1973, 2404 in 1975, and 1505 in 1977. Previous estimates of nesting females calculated on the basis of higher renesting frequencies tended to underestimate the turtle population. Upper and lower limits of population estimates were calculated for all study years using the corresponding upper and lower limits for total nest estimates each year (Figure H-9). These values indicate that the populations are fairly stable with approximately 2000 females nesting on Hutchinson Island each year.

Annual fluctuations in nesting marine turtle populations are common. These fluctuations have been attributed to environmental factors affecting food supply and reproductive potential, variation in individual reproductive cycles, and variation in population fecundity due to changes in age structure (Hughes, 1974; Carr et al., 1978).

Predation

The raccoon, Procyon lotor, is a significant predator of turtle eggs. Raccoons typically forage along the beach at night digging up nests and consuming the eggs. During the years of study, nest predation varied widely from year to year. Presumably predation rates reflect fluctuations in the size of the raccoon population.

Raccoon predation in the nine sample areas destroyed 28 percent of the nests in 1971, 43.6 percent in 1973 (study maximum), and 20.8 percent in 1975 (Figure H-10). Predation rose to 38.5 percent in 1977, but declined to 8.8 percent (study minimum) in 1979. In 1979, the percentage of total nests destroyed by predation was significantly lower than in all previous survey years. This low predation rate coincided with high nest density. However, no significant correlation ($P \leq 0.05$) was found between nest abundance and predation within the study areas. When the numbers of nests destroyed in each area are compared over the 5 study years, a general decline in nest predation is seen.

A decline in turtle nest predation probably reflects a reduction in raccoon populations. While no data are available to document reduced raccoon populations, the decline in predation in the relatively undisturbed Areas 1 through 3 indicates some factor, besides disturbance due to beach development, is working to reduce raccoon activity.

Green and Leatherback Turtles

The green and leatherback turtles nest on Hutchinson Island but less commonly than the loggerhead. Since 1971, the number of green turtle nests has ranged between 5 and 37 per year while leatherback nests were between 1 and 7. Leatherback turtle nesting generally begins in late April or early May while green turtle nesting begins in late June. Since 1971, there has been a gradual shift in the preferred location for nesting on the island (Figure H-11). In the study years between 1971 and 1975, 81.3 percent of the nests of these species were deposited between Areas 6 and 9. In the combined study years 1977 and 1979, the percentage of nests south of Area 6 declined to 24.1 percent of the nests on the island. Since this trend has not been evidenced by loggerhead turtles, it appears that the green and leatherback turtles may be more sensitive to some environmental change that has occurred on the south end of the island.

The number of green turtle nests on the island appears to have declined slightly during the years of study; however, in 1978 (a non-survey year), 62 green turtle nests were located on the island by the Florida Department of Natural Resources (Ross Witham; personal communication).

The size of the endangered Florida population of green turtles has been estimated to be less than 100 adults (NMFS, 1978) with 8 to 13 females nesting on Hutchinson Island (Worth and Smith, 1976). Using an approximation of two nests per female, the 1978 population was 31 females while the survey years between 1971-1979 produced estimated populations of between 3 and 19 females.

SUMMARY

During the five nesting periods studied, there was a considerable variation in nest density in each study area. Nest density formed a gradient along the length of the beach. The lowest densities were observed on the northern portion of the island because of the instability of the nesting beach. Operation of the St. Lucie Plant has not significantly affected over-all nesting density of loggerhead turtles.

In 1975, during construction of the St. Lucie Plant intake and discharge systems, nest density and nesting success was reduced in Area 4 (plant site). However, in 1977 and 1979, there was a return to the general pattern previously observed.

The total number of nests produced on Hutchinson Island was calculated to be 4676 during 1979. An estimate of over 4000 nests produced on the island by approximately 2000 females appears to be fairly consistent since 1971.

No significant alteration of temporal distribution of nesting, renesting behavior, or nesting success has occurred during the years of power plant operation.

Nest predation by the raccoon, <u>Procyon lotor</u>, varied widely. No significant correlation was found between nest abundance and predation within study areas. A general decline in nest predation was observed which may reflect a decline in the raccoon population on Hutchinson Island.

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PERSONAL COMMUNICATION

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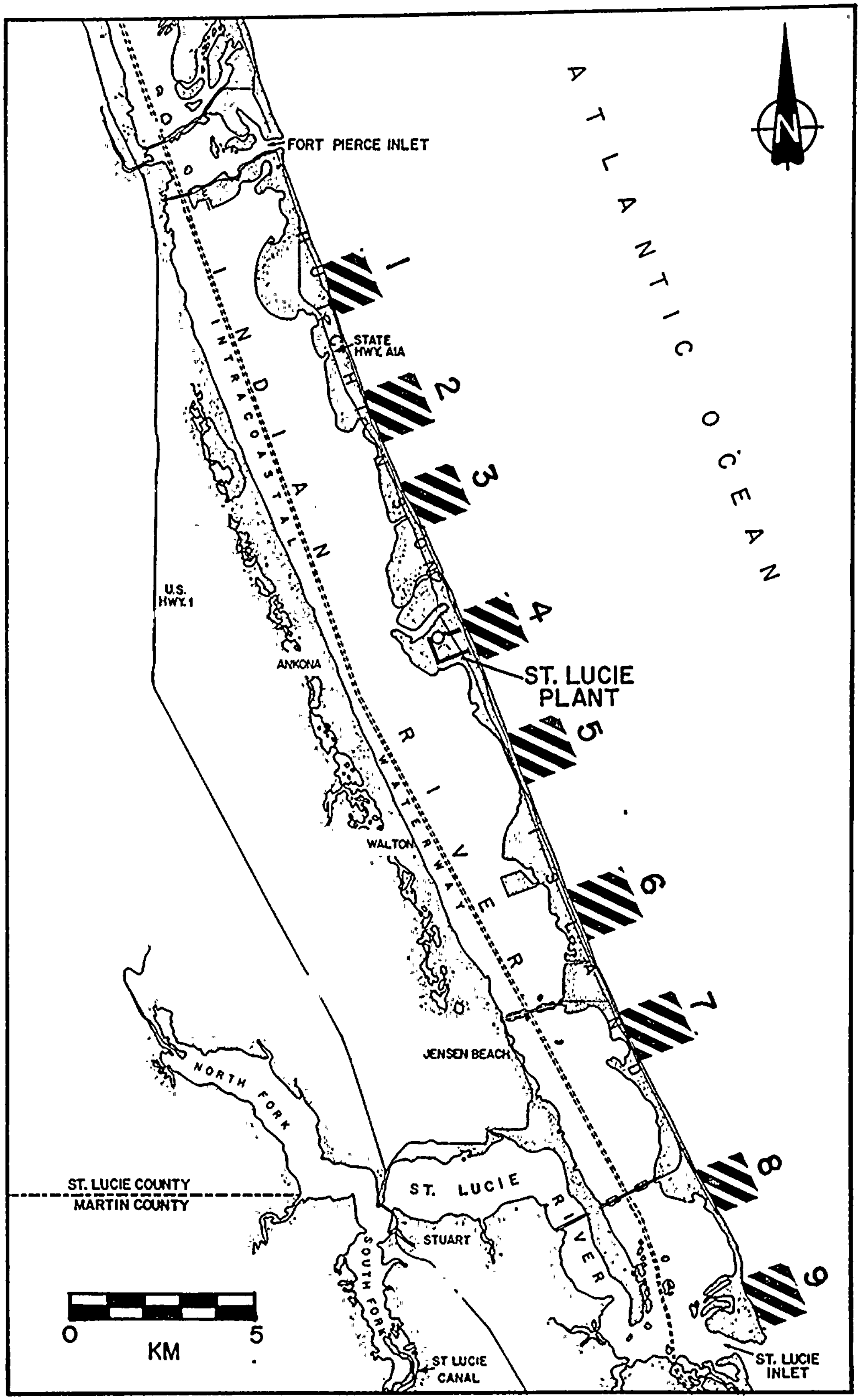

Figure H-1. Locations of turtle nesting areas surveyed, 1979, Hutchinson Island.

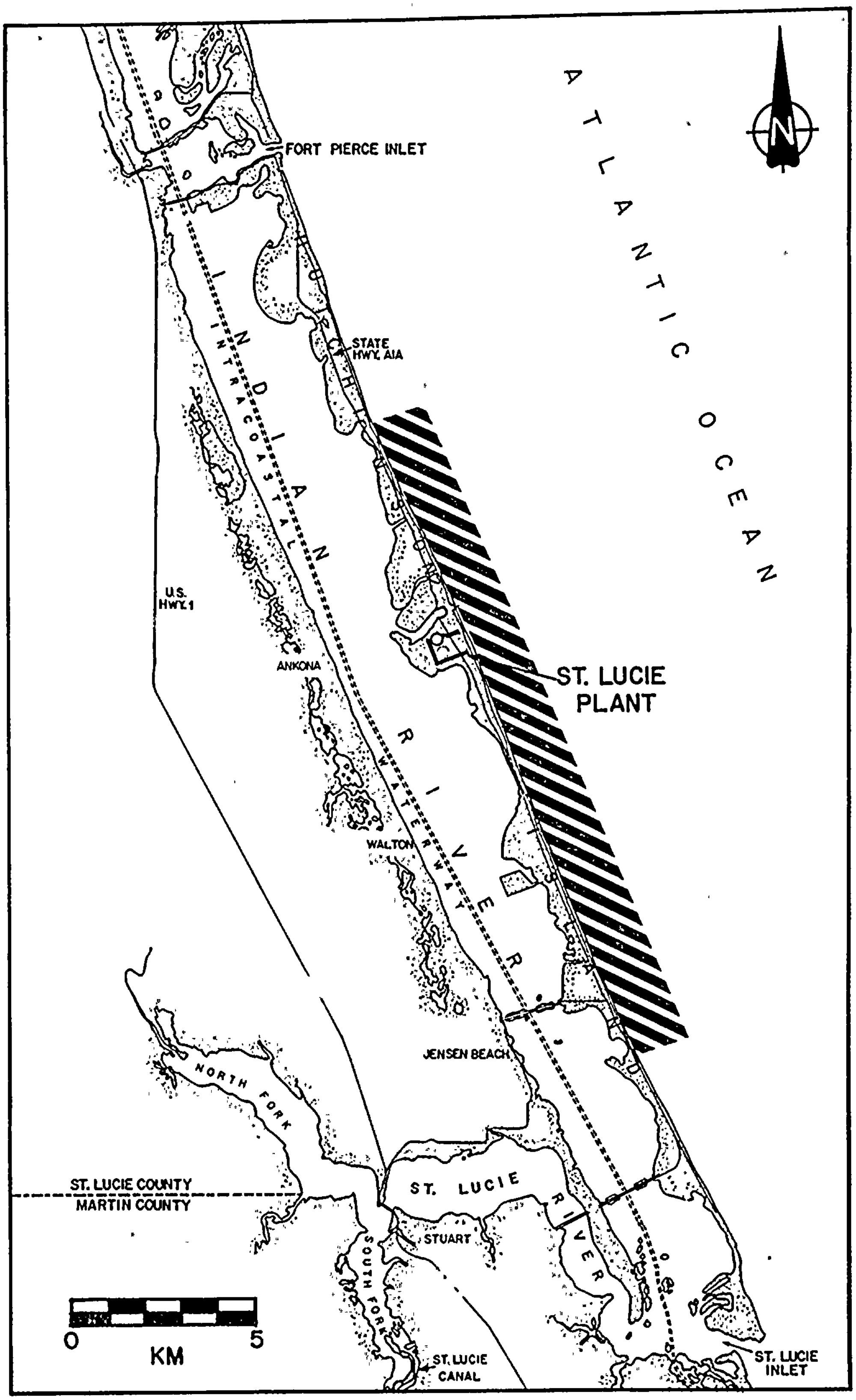

Figure H-2. Locations of turtle tagging areas surveyed, 1977 and 1979, Hutchinson Island.

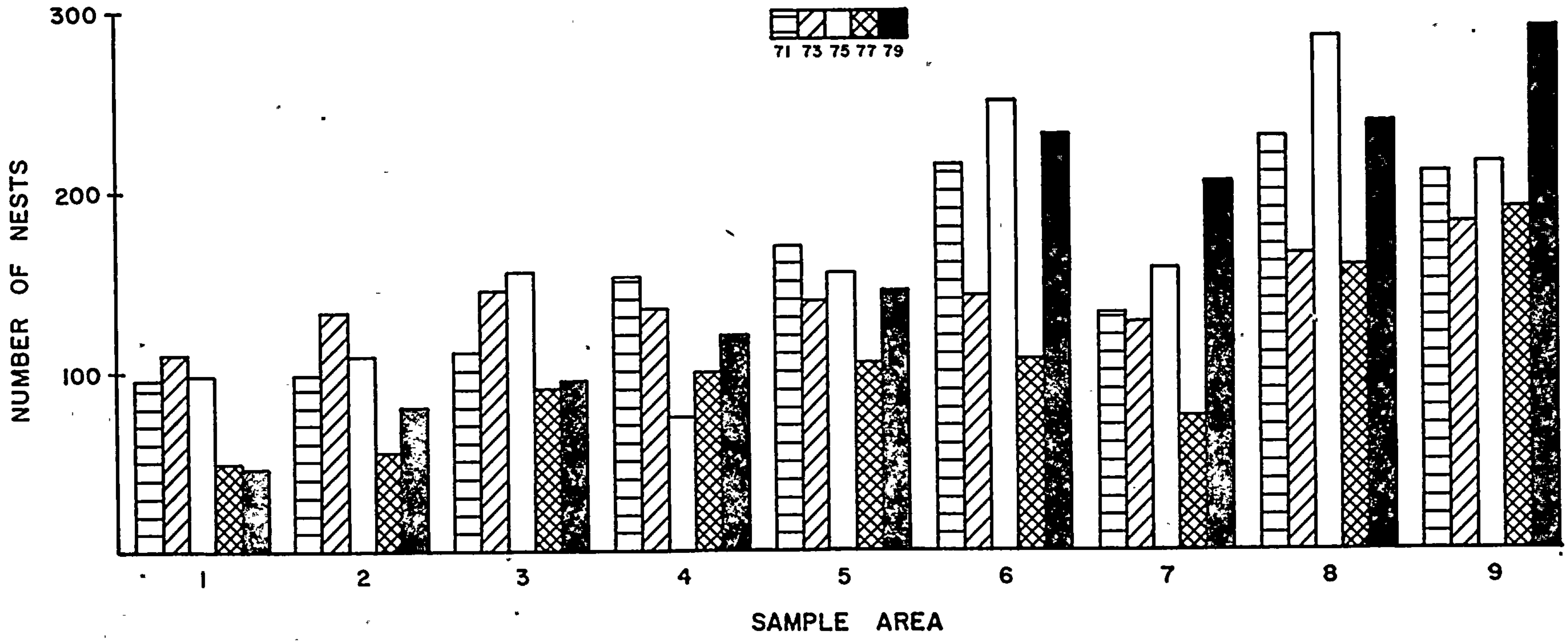

Figure H-3. Number of loggerhead turtle nests in each sample area for each study year, 1971, 1973, 1975, 1977, and 1979, Hutchinson Island.

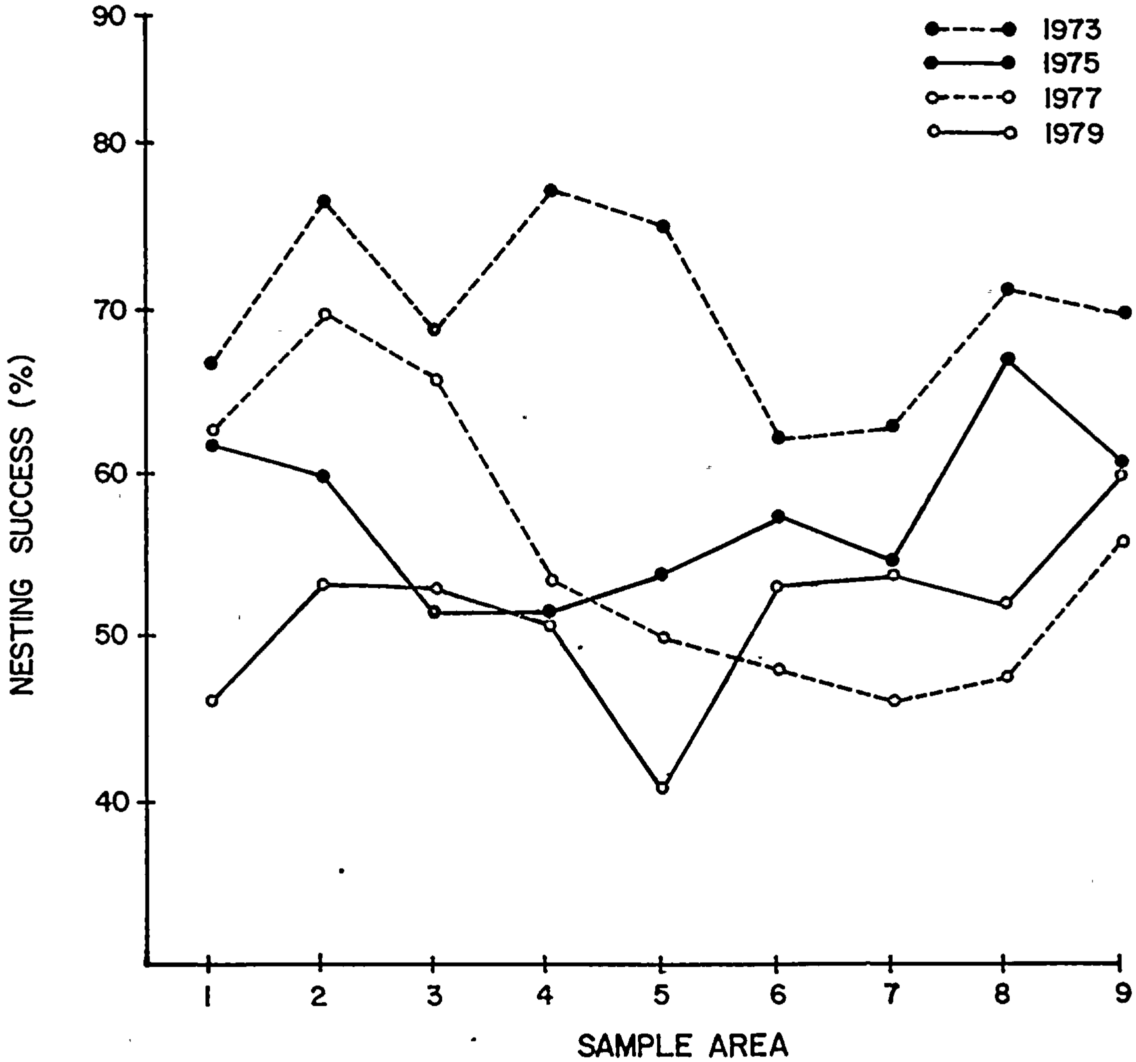

Figure H-4. Loggerhead turtle nesting success by sample area and year, 1973, 1975, 1977, and 1979, Hutchinson Island.

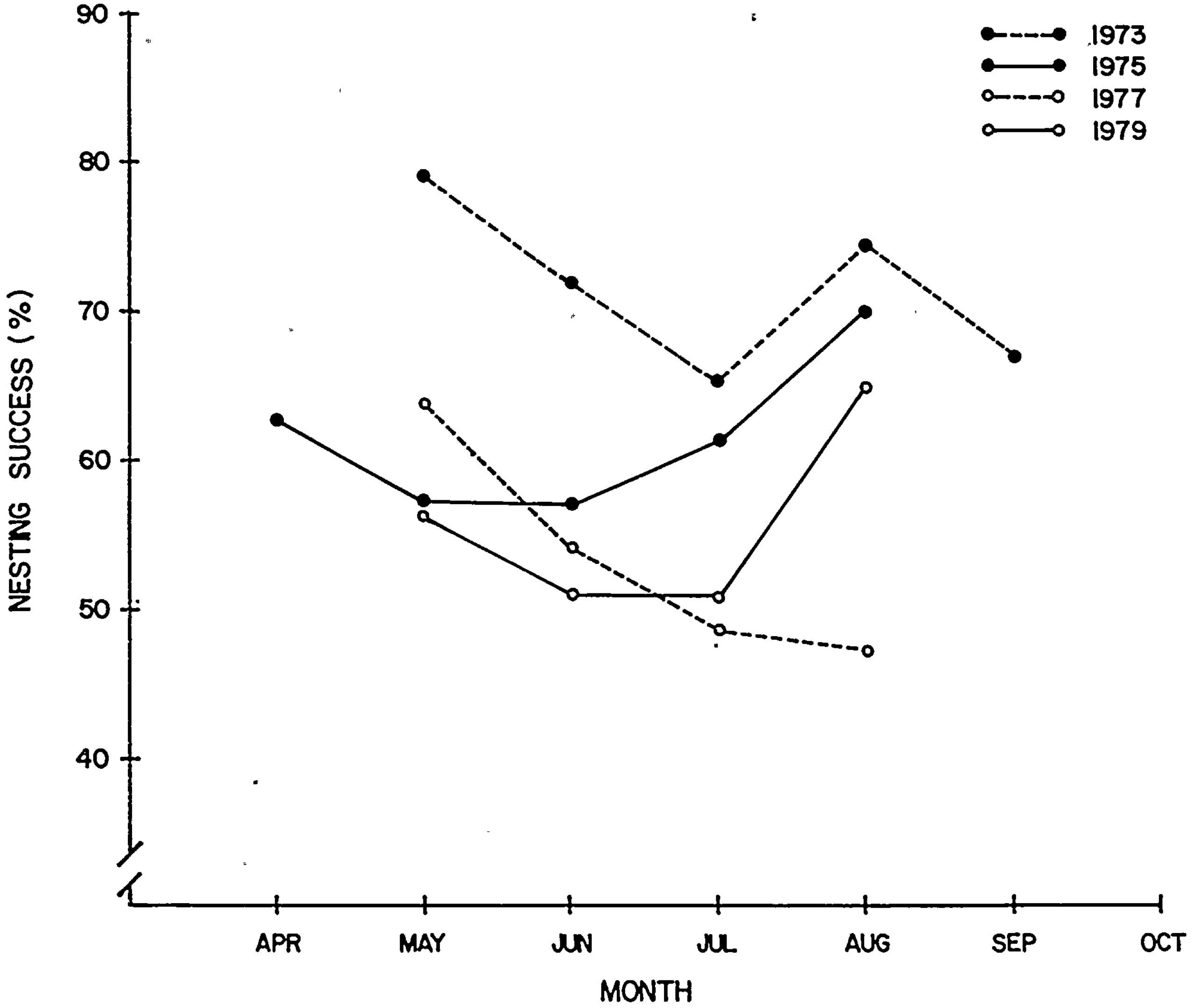

Figure H-5. Loggerhead turtle nesting success by month and year, 1973, 1975, 1977, and 1979, Hutchinson Island.

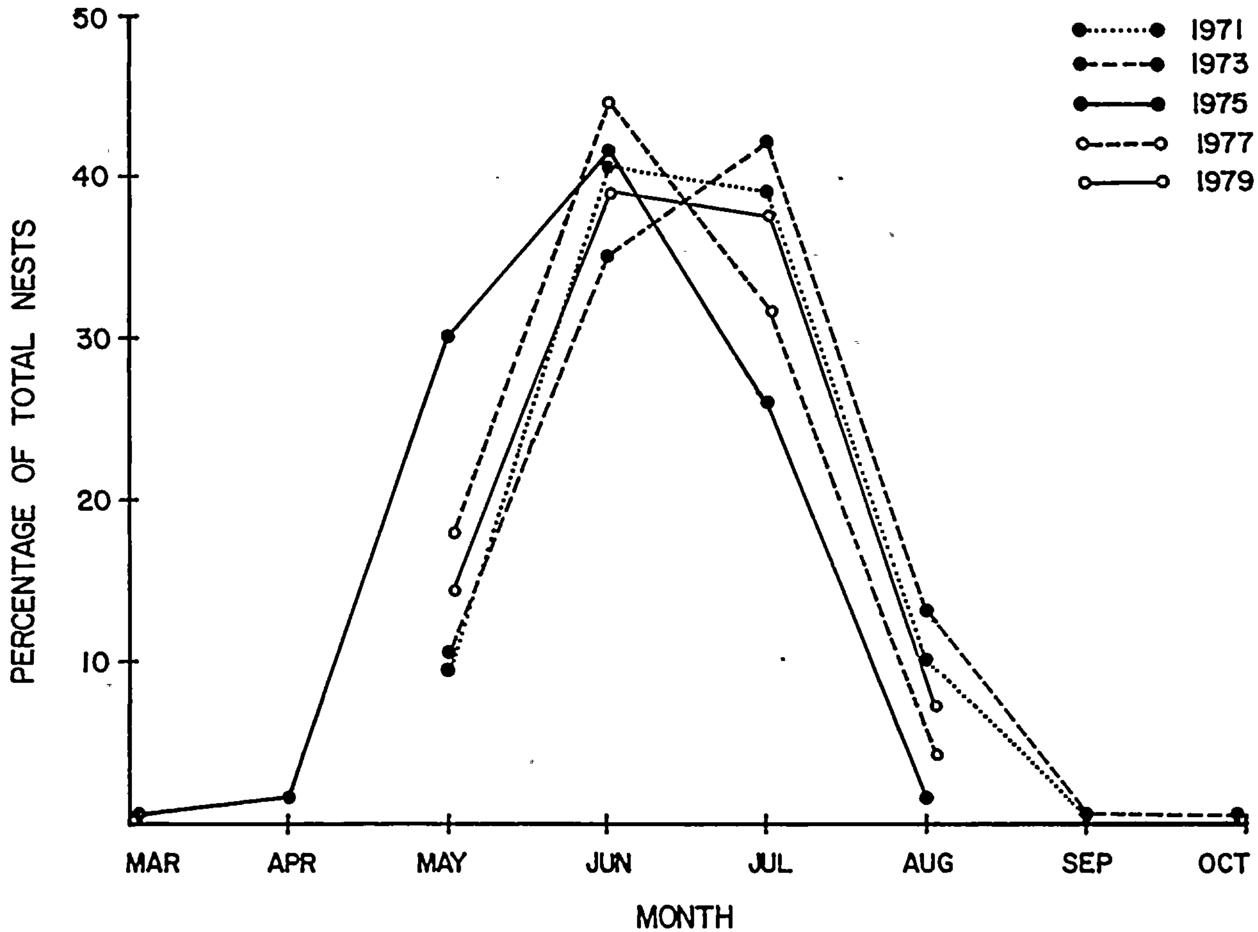

Figure H-6. Comparison of the percentage of the annual total number of loggerhead turtle nests produced each month, 1971, 1973, 1975, 1977, and 1979, Hutchinson Island.

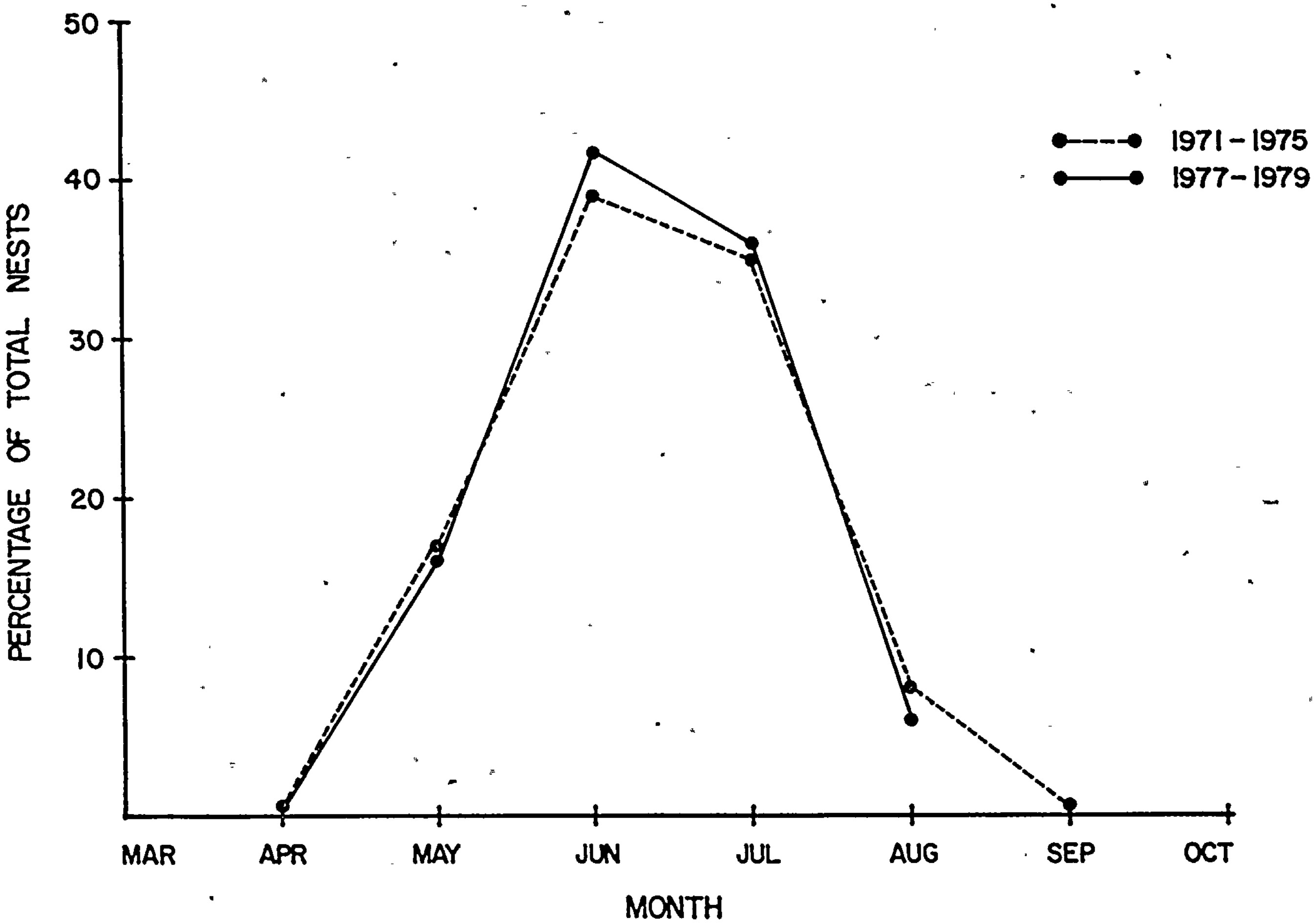

Figure H-7. Comparison of the percentage of the total number of loggerhead turtle nests observed during each month for pooled preoperational years (1971, 1973, 1975) and operational years (1977, 1979), Hutchinson Island.

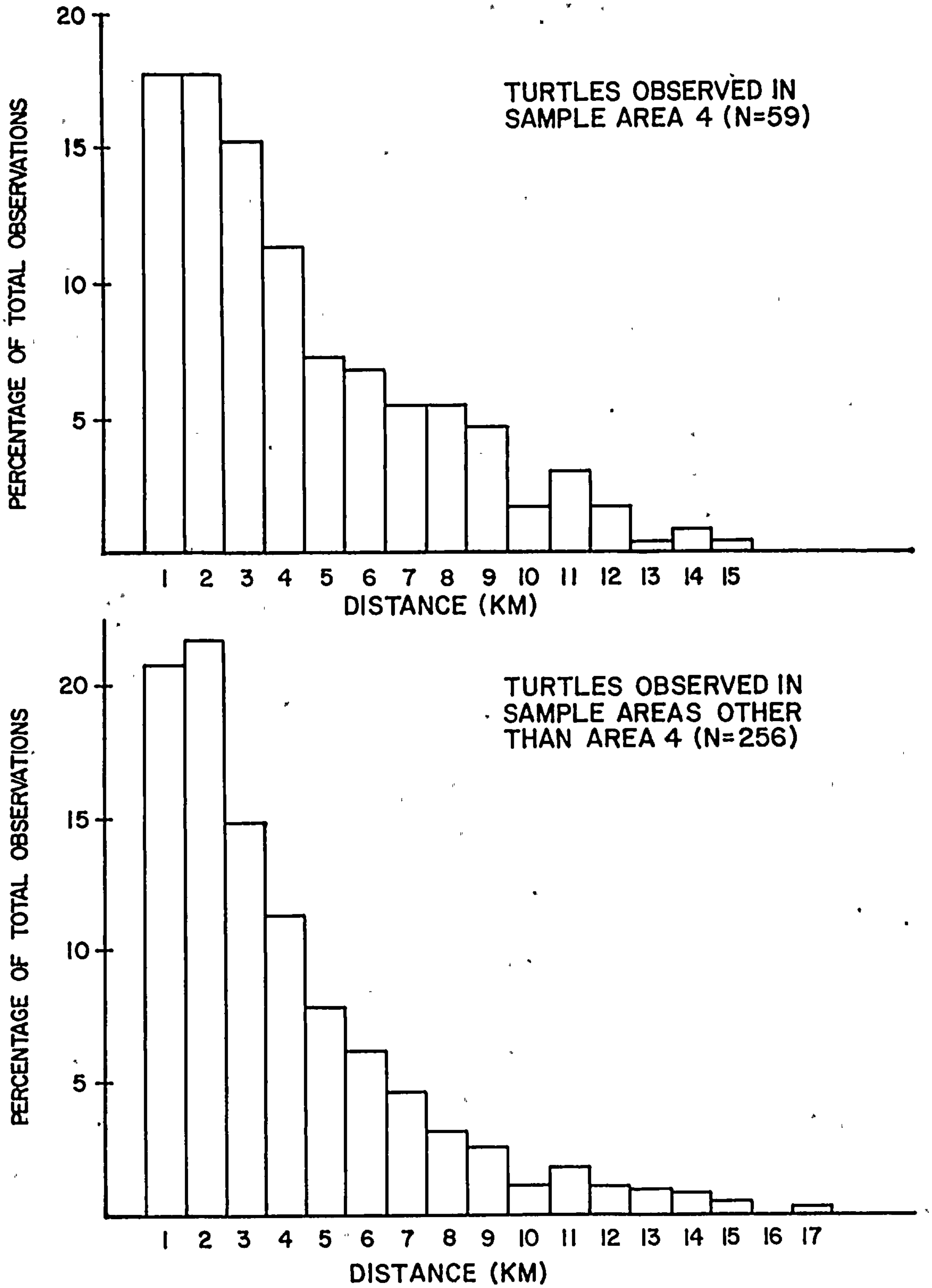

Figure H-8. Comparison of the percentage distribution of the distance between recapture sites of loggerhead turtles observed in sample area 4 and turtles observed in sample areas other than 4, 1979, Hutchinson Island.

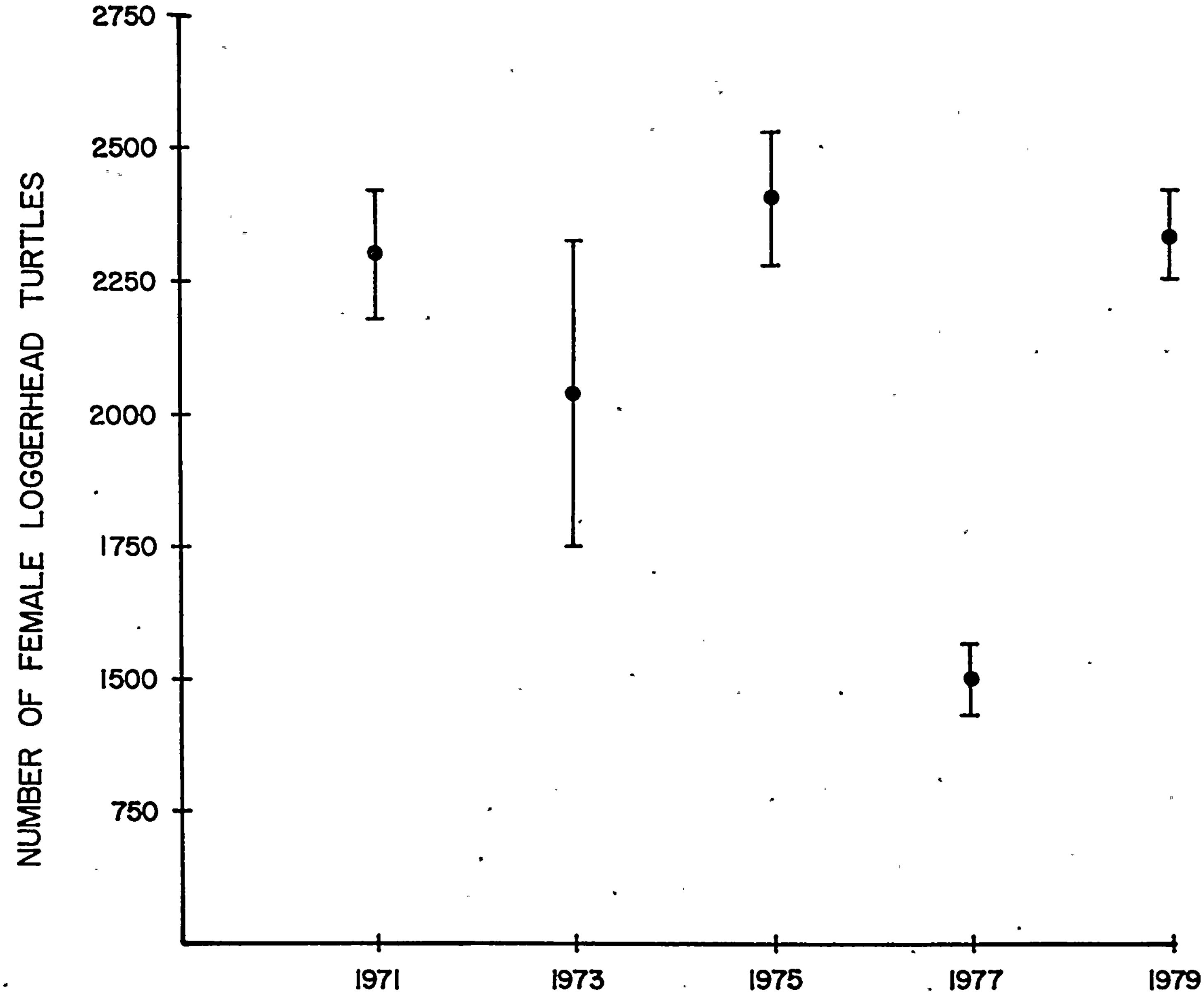

Figure H-9. Estimated number with 95 percent confidence interval of loggerhead turtles nesting, 1971, 1973, 1975, 1977, and 1979, Hutchinson Island.

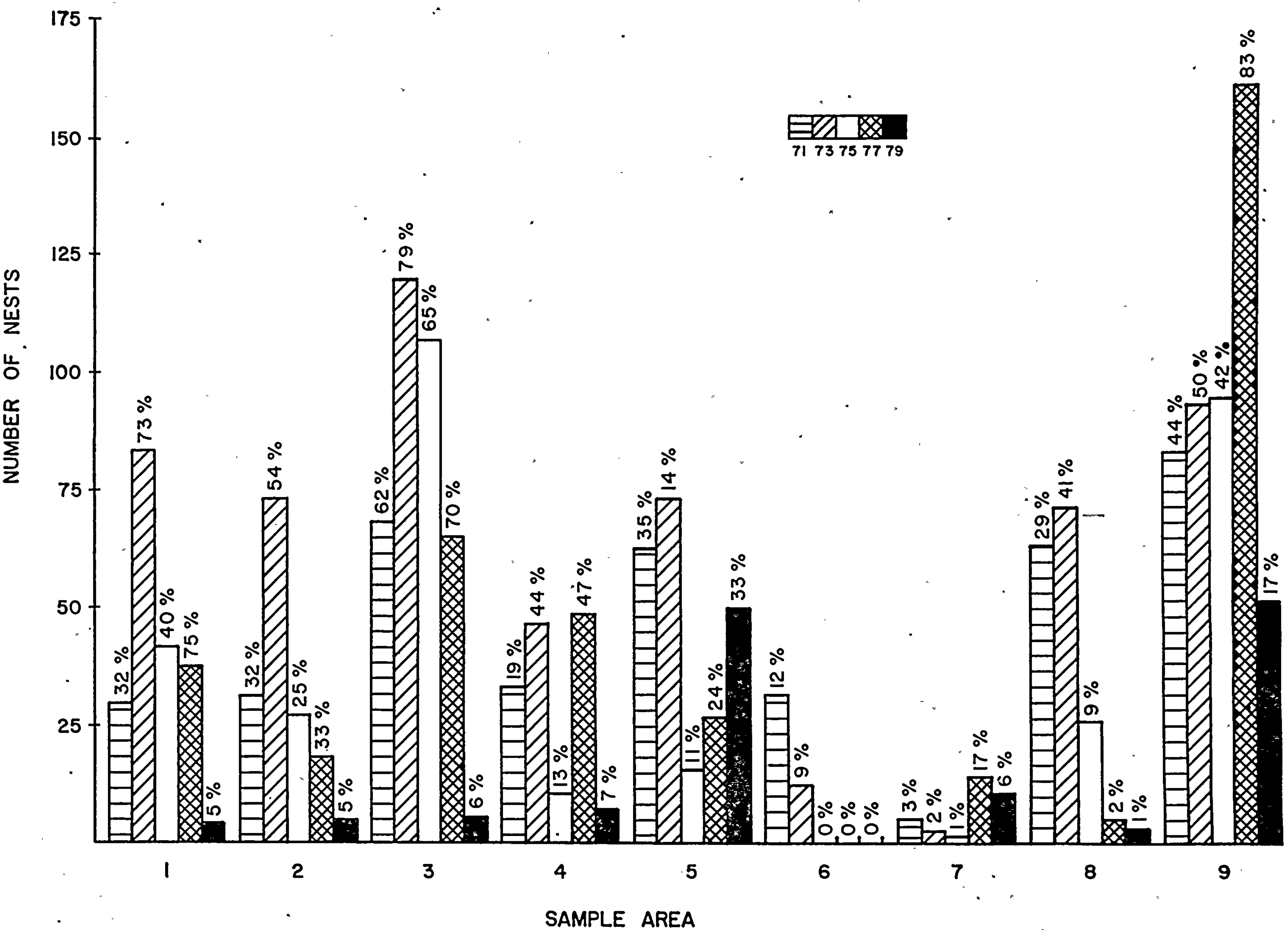

Figure H-10. Number of loggerhead turtle nests and percentage of total loggerhead nests destroyed by raccoons by area and year, 1971, 1973, 1975, 1977, and 1979, Hutchinson Island.

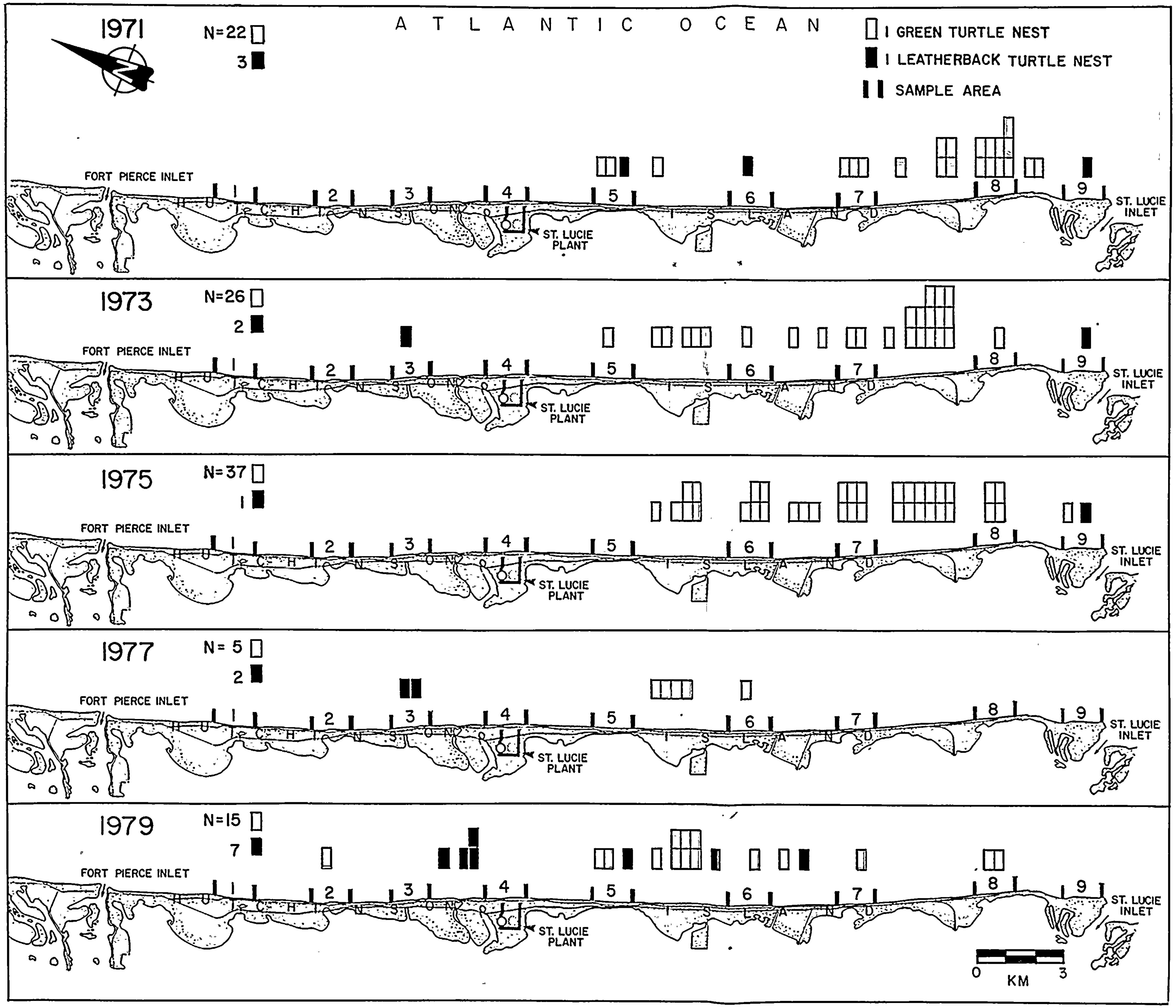

Figure H-11.
Location and number of green and leatherback turtle nests observed during each study year, 1971, 1973, 1975, 1977, and 1979, Hutchinson Island.

TABLE H-1

COMPARISON OF NUMBERS OF TURTLE NESTS ON HUTCHINSON ISLAND
ESTIMATED BY VARIOUS AUTHORS
WITH 95% CONFIDENCE INTERVALS[a] OF THE PRESENT ESTIMATES
ST. LUCIE PLANT
1979

		Estimates for entire island			
Year	Nests counted in 9 areas	Gallagher et al., 1972	Worth and Smith, 1976	ABI, 1978	Present
1971	1420	3350	6067		4582 ± 236
1973	1262		5359		4072 ± 578
1975	1490				4808 ± 245
1977	930			2801[b]	3001 ± 116
1979	1449				4676 ± 152

[a]The confidence intervals ($P \leq 0.05$) were calculated from the residual variance of the mean. The residual variance is obtained by subtracting the regression variance from the total variance.

[b]Erroneously reported as 2108.

TABLE H-2

RENESTING DISTANCE DATA RANGES AND MEANS FOR
LOGGERHEAD TURTLES NESTING ON HUTCHINSON ISLAND
ST. LUCIE PLANT
1971, 1973, 1975, 1977, AND 1979

Parameter	Year 1971	1973	1975	1977	1979
Range, km	0.8-10.4	0.3-15.9	0.1-15.4	0.1-14.8	0.1-15.9
Mean, km	-[a]	-[a]	4.6	4.6	5.0
Standard deviation	-[a]	-[a]	2.8267	2.9932	3.1267
Number	17	30	1013	746	961

[a]Values not calculated because of extremely small sample size.

TABLE H-3

ANALYSIS OF VARIANCE COMPARING OBSERVED LOGGERHEAD RENESTING INTERVALS (days) BETWEEN SUCCESSIVE RENESTING ATTEMPTS
ST. LUCIE PLANT
1975, 1977, AND 1979

Source of variation	Degrees of freedom	Sum of squares	Mean square	F value
Between years	2	10.7510	5.3755	2.2455[a]
Within years	774	1852.8976	2.3939	
Total	776	1863.6486		

[a]Not significant at $P \leq 0.05$.

TABLE H-4

CALCULATED MULTIPLE NESTING FREQUENCY DERIVED FROM
TAG/RECAPTURE DATA
ST. LUCIE PLANT
1975, 1977, and 1979

Year[a]	Number of tagged turtles	Number of known nests by tagged turtles	Ratio number nests/individual
1975	946	1706	1.8
1977	579	1091	1.9
1979	739	1322	1.8

[a]1971 and 1979 recapture data were insufficient to contribute to this analysis.