

1.0 Non Radiological Monitoring Program Table of Contents

7903220265

VIRGINIA ELECTRIC AND POWER COMPANY  
SURRY POWER STATION UNITS 1 and 2

NONRADIOLOGICAL ENVIRONMENTAL  
OPERATING REPORT FOR 1978

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1.0 Non-Radiological Monitoring Program - Table of Contents

2.0 Thermal & Physical Characteristics

3.0 Biological

Appendix A - Ecological Study of the Tidal Segment of the James River  
Encompassing Hog Point

## 1.1 MODIFICATION OF TECHNICAL SPECIFICATIONS

The Virginia Electric and Power Company was notified in November, 1978 that its request for modification of the Non-Radiological Environmental Monitoring Program had been granted. This will be the last report under the original Technical Specifications.



## 2.0 NON-RADIOLOGICAL MONITORING PROGRAM - THERMAL AND PHYSICAL CHARACTERISTICS

The Non-radiological Monitoring Program - Thermal and Physical Characteristics applies to the monitoring of the temperature-salinity distribution in the ten (10) mile segment of the James River centered at Hog Island. The objective of the program is to determine the relationship between the thermal discharge and the physical-chemical characteristics of the water mass within the ten (10) mile tidal segment of the James River and the effects of the operation of the Surry Power Station on the physical and chemical variables of the James River Estuary.

## 2.1 TEMPERATURE AND SALINITY MONITORING

### Summary

Temperatures are monitored continuously at points in the James River at thirteen (13) stations (Figure 2.1.1-1) of the tidal segment encompassing Hog Point. Near surface and bottom temperatures are recorded as indicated on the figure.

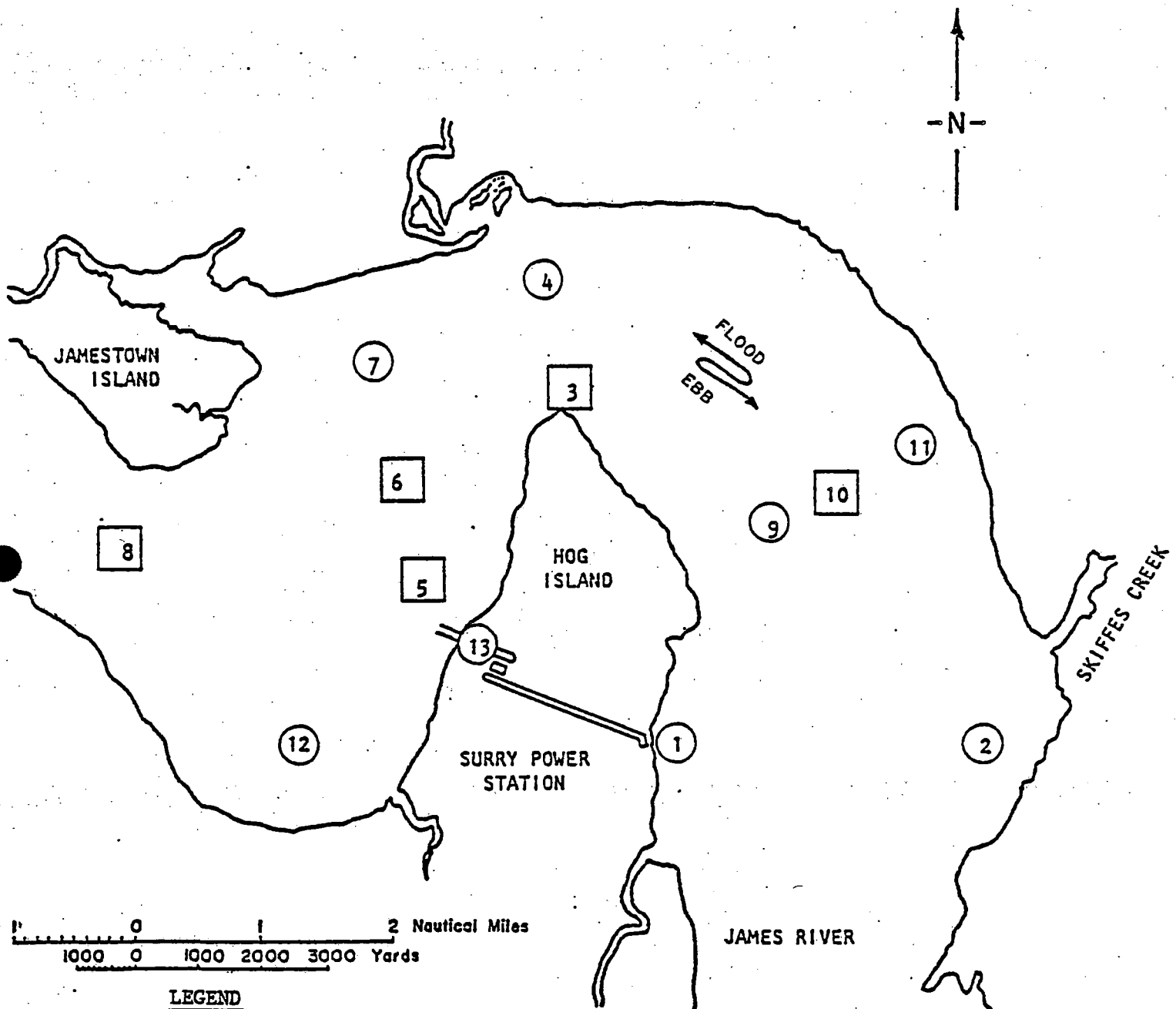
Salinity is continuously monitored at the station intakes.

### Results

The results of the temperature and salinity monitoring programs are summarized in Sections 2.1.1, 2.1.2, and 2.1.3.

#### 2.1.1 TEMPERATURE AND SALINITY MONITORING STATIONS IN THE JAMES RIVER

Tables 2.1.1-1 and 2.1.1-2 summarize results of the temperature and salinity monitoring program in the James River. The monthly means of the daily highs, lows, and means are reported for each month of the reporting period.

TEMPERATURE MONITORING STATIONSSURRY POWER STATIONLEGEND

- |                        |            |
|------------------------|------------|
| 1. Station Intakes     | - SE21NT   |
| 2. Deepwater Shoals    | - SE1TAT   |
| 3. Hog Point - South   | - SC2TCT,B |
| 4. Hog Point - North   | - SC1TBT   |
| 5. Cobham Bay - South  | - SB3TFT,B |
| 6. Cobham Bay - Middle | - SB2TET,B |
| 7. Cobham Bay - North  | - SB1TDT   |
| 8. Jamestown Island    | - SA1TGT   |
| 9. Transect 3          | - SA2BAT   |
| 10. Transect 3         | - SD2BDT,B |
| 11. Transect 3         | - SD1BCT   |
| 12. Lower Cobham Bay   | - SD3BBT   |
| 13. Station Discharge  | - SA3GRT   |

- Near Surface Temperature  
 □ Near Surface and Bottom Temperature

Figure 2.1.1-2

# TEMPERATURE AND SALINITY MONITORING STATIONS

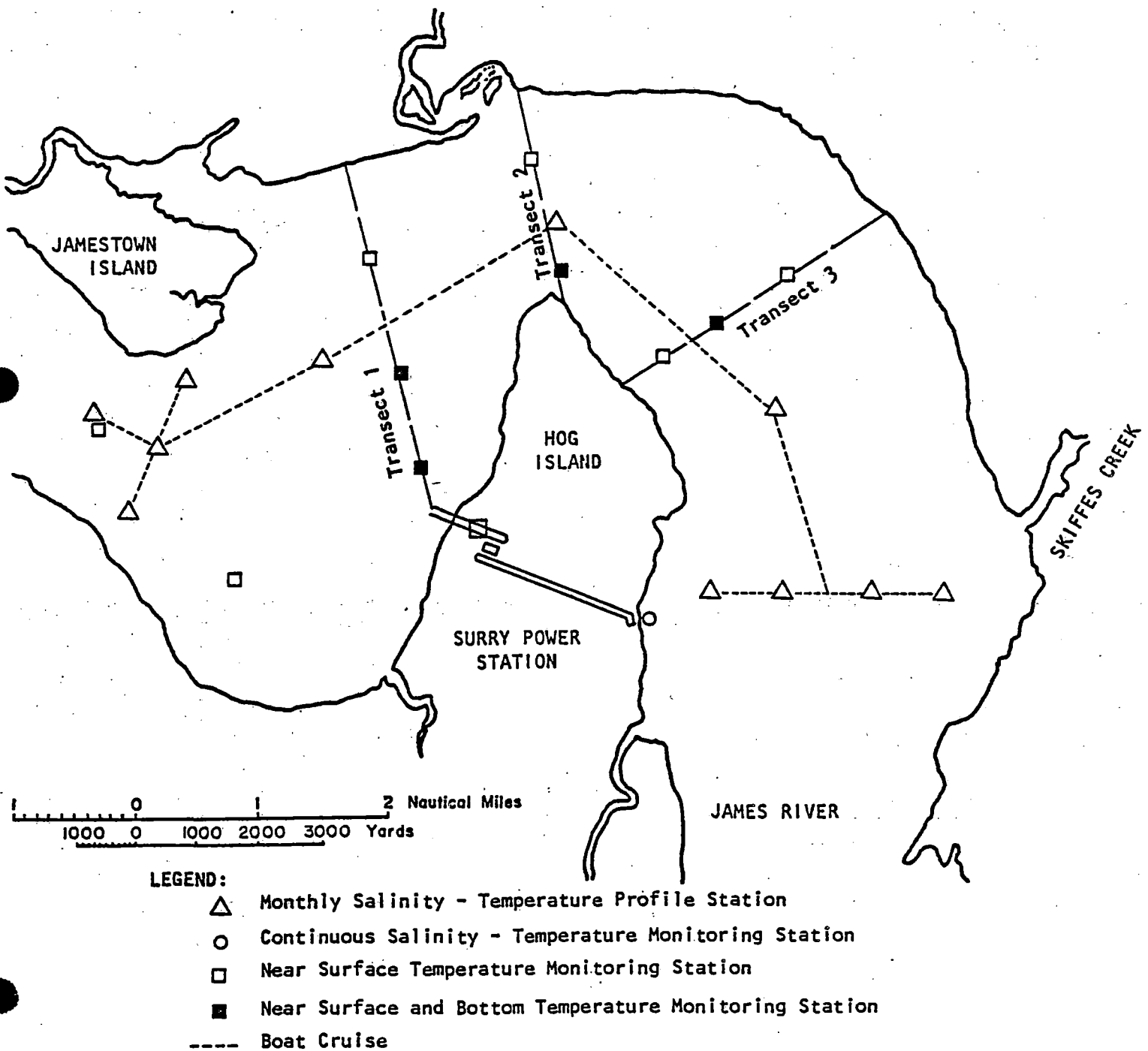


TABLE 2.1.1-1

JAMES RIVER TEMPERATURE DATA  
VALUES ARE MEANS OF DAILY HIGH, MEAN, AND LOW VALUES  
ANNUAL REPORT FOR 1978

MONTH=1

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
1	HIGH	.	5.4	12.5	2.9	3.3	4.6	5.8	5.7	3.8	7.7	7.9	3.8	4.1	3.3	6.4	2.9	4.6
1	MEAN	.	3.4	11.7	2.3	2.2	3.4	3.4	3.3	3.1	5.1	5.4	3.2	3.3	2.6	4.0	2.3	3.8
1	LOW	.	2.3	10.8	1.7	1.5	2.7	1.9	1.8	2.4	3.4	3.9	2.7	2.9	2.2	2.5	1.7	2.9

MONTH=2

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
2	HIGH	.	3.3	12.2	2.3	3.1	3.3	5.7	6.3	2.4	5.4	.	2.2	2.4	2.4	5.5	1.7	3.1
2	MEAN	.	1.7	10.8	1.8	1.9	2.0	2.8	3.4	1.8	3.1	.	1.7	1.8	1.8	3.0	1.2	2.3
2	LOW	.	1.0	9.9	1.3	1.2	1.3	1.2	1.7	1.4	1.7	.	1.2	1.3	1.4	1.8	0.7	1.6

MONTH=3

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
3	HIGH	12.2	8.2	16.5	7.0	8.2	8.1	10.5	10.1	7.5	10.6	13.6	7.4	4.6	8.8	10.1	7.1	8.6
3	MEAN	11.9	6.9	15.1	6.4	7.1	7.0	7.7	7.9	6.9	8.5	11.7	6.8	4.0	8.2	8.1	6.2	7.3
3	LOW	11.6	5.9	14.2	5.8	6.4	6.3	6.0	6.3	6.4	7.1	10.5	6.3	3.4	7.8	7.0	5.6	6.2

MONTH=4

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
4	HIGH	15.3	15.9	22.7	14.8	15.7	15.5	17.3	16.8	15.4	17.6	17.1	15.4	.	15.3	16.9	14.9	16.2
4	MEAN	14.6	14.7	21.5	14.2	15.0	14.9	15.3	15.5	14.8	15.9	15.5	14.9	.	14.7	15.6	13.9	14.8
4	LOW	14.1	13.7	20.6	13.6	14.3	14.2	14.0	14.5	14.3	14.8	14.4	14.3	.	14.2	14.6	13.2	13.6

MONTH=5

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
5	HIGH	19.0	19.6	25.6	19.3	19.3	19.2	21.4	19.6	19.2	21.1	20.5	19.0	.	18.4	20.3	19.3	20.6
5	MEAN	18.4	18.4	24.3	18.6	18.8	18.6	20.1	18.9	18.6	19.6	19.3	18.6	.	17.9	19.4	18.4	18.9
5	LOW	18.0	17.7	23.2	18.1	18.2	18.2	19.2	18.1	18.1	18.7	18.4	18.2	.	17.5	18.6	17.6	17.7

MONTH=6

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
6	HIGH	26.1	26.8	32.9	26.1	24.8	26.0	28.1	26.6	26.2	28.1	27.7	26.1	26.5	26.1	27.0	26.2	27.2
6	MEAN	25.5	25.5	31.5	25.5	24.3	25.5	26.0	25.6	25.6	26.5	26.0	25.5	25.9	25.5	25.9	25.1	25.4
6	LOW	25.1	24.6	30.4	25.0	23.8	25.1	25.0	24.8	25.1	25.3	25.0	25.1	25.4	25.0	25.0	24.2	23.9

2.1.1-4

TABLE 2.1.1-1

JAMES RIVER TEMPERATURE DATA  
VALUES ARE MEANS OF DAILY HIGH, MEAN, AND LOW VALUES  
ANNUAL REPORT FOR 1978

MONTH=7																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
7	HIGH	28.0	28.3	33.9	27.6	.	27.8	29.9	28.4	28.3	29.7	29.5	28.1	28.1	27.7	28.8	28.1	29.1
7	MEAN	27.4	27.2	32.5	27.0	.	27.4	28.2	27.5	27.6	28.1	27.8	27.5	27.5	27.1	27.7	27.2	27.4
7	LOW	27.0	26.4	31.4	26.6	.	27.0	27.2	26.8	27.1	27.0	26.9	27.0	27.0	26.7	26.9	26.5	26.0
MONTH=8																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
8	HIGH	29.6	30.5	38.4	29.8	30.1	29.8	32.1	30.8	29.9	32.7	32.1	29.7	29.7	29.4	31.3	29.5	30.0
8	MEAN	28.9	28.9	37.1	29.2	29.5	29.2	30.1	29.6	29.3	30.5	30.0	29.2	29.1	28.8	29.9	28.7	28.5
8	LOW	28.5	28.1	36.0	28.7	29.0	28.7	28.9	28.7	28.9	29.0	28.7	28.8	28.6	28.4	28.9	28.0	27.3
MONTH=9																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
9	HIGH	26.9	27.4	35.8	27.4	27.1	26.9	29.3	27.8	27.0	29.4	29.0	27.0	26.8	26.7	28.2	26.4	26.8
9	MEAN	26.2	26.1	34.5	26.8	26.5	26.4	26.9	26.8	26.5	27.4	26.9	26.5	26.2	26.2	26.8	25.8	25.4
9	LOW	25.8	25.3	33.3	26.2	26.0	25.9	25.7	26.0	26.0	26.0	25.7	26.1	25.8	25.7	25.9	25.2	24.2
MONTH=10																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
10	HIGH	19.4	19.3	27.7	19.8	21.2	19.7	21.7	21.0	19.7	21.9	21.9	19.4	19.4	19.4	21.0	19.1	19.0
10	MEAN	18.8	18.4	26.7	19.3	20.8	19.0	19.4	19.6	19.3	20.0	19.7	18.9	19.0	19.0	19.5	18.5	17.9
10	LOW	18.4	17.6	25.9	18.9	20.3	18.5	18.2	18.7	18.8	18.8	18.5	18.6	18.6	18.6	18.6	17.9	16.8
MONTH=11																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
11	HIGH	15.8	15.8	24.6	15.9	.	16.1	18.8	18.0	16.1	18.9	18.7	15.9	16.1	15.6	17.9	15.1	14.7
11	MEAN	15.1	14.9	23.7	15.5	.	15.3	16.4	16.4	15.7	16.6	16.3	15.4	15.6	15.2	15.9	14.7	14.1
11	LOW	14.7	14.2	22.9	15.1	.	14.8	14.9	15.2	15.2	15.2	14.9	15.0	15.2	14.7	14.9	14.3	13.4
MONTH=12																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
12	HIGH	12.1	12.0	15.9	.	.	12.6	14.9	15.3	12.1	15.6	15.4	12.2	12.7	12.4	15.4	12.3	9.5
12	MEAN	11.3	11.2	14.8	.	.	11.9	12.7	13.2	11.7	13.5	13.3	11.9	12.1	11.9	13.2	11.4	8.8
12	LOW	10.9	10.6	13.7	.	.	11.3	11.1	11.9	11.4	12.1	11.9	11.6	11.7	11.5	11.9	10.6	8.0

TABLE 2.1.1-2  
JAMES RIVER SALINITY DATA  
VALUES (IN 0/00) WERE COMPUTED FROM DAILY MEAN VALUES

YEAR	MONTH	MAXIMUM	MEAN	MINIMUM
78	1	1.0	0.9	0.8
78	2	2.2	2.0	1.8
78	3	1.4	1.2	1.0
78	4	1.4	1.1	0.9
78	5	0.6	0.5	0.4
78	6	2.4	2.1	1.9
78	7	5.9	5.6	5.3
78	8	5.2	4.9	4.6
78	9	8.0	7.7	7.4
78	10	9.0	8.7	8.4
78	11	10.6	10.4	10.1
78	12	7.1	6.8	6.5



## 2.1.2 INTAKE CANAL MONITORING STATION

Table 2.1.2-1 summarizes the data recorded at the intake canal temperature monitoring station as column SE2INT. Temperatures from other river stations are given for comparison (Figure 2.1.1-1 gives stations locations). Values shown are monthly means of daily highs, lows, and means in degrees Celsius.

TABLE 2.1.2-1

JAMES RIVER TEMPERATURE DATA  
VALUES ARE MEANS OF DAILY HIGH, MEAN, AND LOW VALUES  
ANNUAL REPORT FOR 1978

MONTH=1

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
1	HIGH	.	5.4	12.5	2.9	3.3	4.6	5.8	5.7	3.8	7.7	7.9	3.8	4.1	3.3	6.4	2.9	4.6
1	MEAN	.	3.4	11.7	2.3	2.2	3.4	3.4	3.3	3.1	5.1	5.4	3.2	3.3	2.6	4.0	2.3	3.8
1	LOW	.	2.3	10.8	1.7	1.5	2.7	1.9	1.8	2.4	3.4	3.9	2.7	2.9	2.2	2.5	1.7	2.9

MONTH=2

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
2	HIGH	.	3.3	12.2	2.3	3.1	3.3	5.7	6.3	2.4	5.4	.	2.2	2.4	2.4	5.5	1.7	3.1
2	MEAN	.	1.7	10.8	1.8	1.9	2.0	2.8	3.4	1.8	3.1	.	1.7	1.8	1.8	3.0	1.2	2.3
2	LOW	.	1.0	9.9	1.3	1.2	1.3	1.2	1.7	1.4	1.7	.	1.2	1.3	1.4	1.8	0.7	1.6

MONTH=3

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
3	HIGH	12.2	8.2	16.5	7.0	8.2	8.1	10.5	10.1	7.5	10.6	13.6	7.4	4.6	8.8	10.1	7.1	8.6
3	MEAN	11.9	6.9	15.1	6.4	7.1	7.0	7.7	7.9	6.9	8.5	11.7	6.8	4.0	8.2	8.1	6.2	7.3
3	LOW	11.6	5.9	14.2	5.8	6.4	6.3	6.0	6.3	6.4	7.1	10.5	6.3	3.4	7.8	7.0	5.6	6.2

MONTH=4

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
4	HIGH	15.3	15.9	22.7	14.8	15.7	15.5	17.3	16.8	15.4	17.6	17.1	15.4	.	15.3	16.9	14.9	16.2
4	MEAN	14.6	14.7	21.5	14.2	15.0	14.9	15.3	15.5	14.8	15.9	15.5	14.9	.	14.7	15.6	13.9	14.8
4	LOW	14.1	13.7	20.6	13.6	14.3	14.2	14.0	14.5	14.3	14.8	14.4	14.3	.	14.2	14.6	13.2	13.6

MONTH=5

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
5	HIGH	19.0	19.6	25.6	19.3	19.3	19.2	21.4	19.6	19.2	21.1	20.5	19.0	.	18.4	20.3	19.3	20.6
5	MEAN	18.4	18.4	24.3	18.6	18.8	18.6	20.1	18.9	18.6	19.6	19.3	18.6	.	17.9	19.4	18.4	18.9
5	LOW	18.0	17.7	23.2	18.1	18.2	18.2	19.2	18.1	18.1	18.7	18.4	18.2	.	17.5	18.6	17.6	17.7

MONTH=6

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
6	HIGH	26.1	26.8	32.9	26.1	24.8	26.0	28.1	26.6	26.2	28.1	27.7	26.1	26.5	26.1	27.0	26.2	27.2
6	MEAN	25.5	25.5	31.5	25.5	24.3	25.5	26.0	25.6	25.6	26.5	26.0	25.5	25.9	25.5	25.9	25.1	25.4
6	LOW	25.1	24.6	30.4	25.0	23.8	25.1	25.0	24.8	25.1	25.3	25.0	25.1	25.4	25.0	25.0	24.2	23.9

TABLE 2.1.2-1

JAMES RIVER TEMPERATURE DATA  
VALUES ARE MEANS OF DAILY HIGH, MEAN, AND LOW VALUES  
ANNUAL REPORT FOR 1978

MONTH=7

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
7	HIGH	28.0	28.3	33.9	27.6	.	27.8	29.9	28.4	28.3	29.7	29.5	28.1	28.1	27.7	28.8	28.1	29.1
7	MEAN	27.4	27.2	32.5	27.0	.	27.4	28.2	27.5	27.6	28.1	27.8	27.5	27.5	27.1	27.7	27.2	27.4
7	LOW	27.0	26.4	31.4	26.6	.	27.0	27.2	26.8	27.1	27.0	26.9	27.0	27.0	26.7	26.9	26.5	26.0

MONTH=8

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
8	HIGH	29.6	30.5	38.4	29.8	30.1	29.8	32.1	30.8	29.9	32.7	32.1	29.7	29.7	29.4	31.3	29.5	30.0
8	MEAN	28.9	28.9	37.1	29.2	29.5	29.2	30.1	29.6	29.3	30.5	30.0	29.2	29.1	28.8	29.9	28.7	28.5
8	LOW	28.5	28.1	36.0	28.7	29.0	28.7	28.9	28.7	28.9	29.0	28.7	28.8	28.6	28.4	28.9	28.0	27.3

MONTH=9

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
9	HIGH	26.9	27.4	35.8	27.4	27.1	26.9	29.3	27.8	27.0	29.4	29.0	27.0	26.8	26.7	28.2	26.4	26.8
9	MEAN	26.2	26.1	34.5	26.8	26.5	26.4	26.9	26.8	26.5	27.4	26.9	26.5	26.2	26.2	26.8	25.8	25.4
9	LOW	25.8	25.3	33.3	26.2	26.0	25.9	25.7	26.0	26.0	26.0	25.7	26.1	25.8	25.7	25.9	25.2	24.2

MONTH=10

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
10	HIGH	19.4	19.3	27.7	19.8	21.2	19.7	21.7	21.0	19.7	21.9	21.9	19.4	19.4	19.4	21.0	19.1	19.0
10	MEAN	18.8	18.4	26.7	19.3	20.8	19.0	19.4	19.6	19.3	20.0	19.7	18.9	19.0	19.0	19.5	18.5	17.9
10	LOW	18.4	17.6	25.9	18.9	20.3	18.5	18.2	18.7	18.8	18.8	18.5	18.6	18.6	18.6	18.6	17.9	16.8

MONTH=11

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
11	HIGH	15.8	15.8	24.6	15.9	.	16.1	18.8	18.0	16.1	18.9	18.7	15.9	16.1	15.6	17.9	15.1	14.7
11	MEAN	15.1	14.9	23.7	15.5	.	15.3	16.4	16.4	15.7	16.6	16.3	15.4	15.6	15.2	15.9	14.7	14.1
11	LOW	14.7	14.2	22.9	15.1	.	14.8	14.9	15.2	15.2	15.2	14.9	15.0	15.2	14.7	14.9	14.3	13.4

MONTH=12

MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
12	HIGH	12.1	12.0	15.9	.	.	12.6	14.9	15.3	12.1	15.6	15.4	12.2	12.7	12.4	15.4	12.3	9.5
12	MEAN	11.3	11.2	14.8	.	.	11.9	12.7	13.2	11.7	13.5	13.3	11.9	12.1	11.9	13.2	11.4	8.8
12	LOW	10.9	10.6	13.7	.	.	11.3	11.1	11.9	11.4	12.1	11.9	11.6	11.7	11.5	11.9	10.6	8.0

### 2.1.3 DISCHARGE CANAL MONITORING STATION

Table 2.1.3-1 summarizes the data recorded at the discharge canal temperature monitoring station as column SA3GRT. Temperatures from other river stations are given for comparison (Figure 2.1.1-1 gives station locations). Temperatures shown are monthly means of daily highs, lows, and means in degrees Celsius.

TABLE 2.1.3-1

JAMES RIVER TEMPERATURE DATA  
VALUES ARE MEANS OF DAILY HIGH, MEAN, AND LOW VALUES  
ANNUAL REPORT FOR 1978

MONTH=1																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
1	HIGH	.	5.4	12.5	2.9	3.3	4.6	5.8	5.7	3.8	7.7	7.9	3.8	4.1	3.3	6.4	2.9	4.6
1	MEAN	.	3.4	11.7	2.3	2.2	3.4	3.4	3.3	3.1	5.1	5.4	3.2	3.3	2.6	4.0	2.3	3.8
1	LOW	.	2.3	10.8	1.7	1.5	2.7	1.9	1.8	2.4	3.4	3.9	2.7	2.9	2.2	2.5	1.7	2.9
MONTH=2																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
2	HIGH	.	3.3	12.2	2.3	3.1	3.3	5.7	6.3	2.4	5.4	.	2.2	2.4	2.4	5.5	1.7	3.1
2	MEAN	.	1.7	10.8	1.8	1.9	2.0	2.8	3.4	1.8	3.1	.	1.7	1.8	1.8	3.0	1.2	2.3
2	LOW	.	1.0	9.9	1.3	1.2	1.3	1.2	1.7	1.4	1.7	.	1.2	1.3	1.4	1.8	0.7	1.6
MONTH=3																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
3	HIGH	12.2	8.2	16.5	7.0	8.2	8.1	10.5	10.1	7.5	10.6	13.6	7.4	4.6	8.8	10.1	7.1	8.6
3	MEAN	11.9	6.9	15.1	6.4	7.1	7.0	7.7	7.9	6.9	8.5	11.7	6.8	4.0	8.2	8.1	6.2	7.3
3	LOW	11.6	5.9	14.2	5.8	6.4	6.3	6.0	6.3	6.4	7.1	10.5	6.3	3.4	7.8	7.0	5.6	6.2
MONTH=4																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
4	HIGH	15.3	15.9	22.7	14.8	15.7	15.5	17.3	16.8	15.4	17.6	17.1	15.4	.	15.3	16.9	14.9	16.2
4	MEAN	14.6	14.7	21.5	14.2	15.0	14.9	15.3	15.5	14.8	15.9	15.5	14.9	.	14.7	15.6	13.9	14.8
4	LOW	14.1	13.7	20.6	13.6	14.3	14.2	14.0	14.5	14.3	14.8	14.4	14.3	.	14.2	14.6	13.2	13.6
MONTH=5																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
5	HIGH	19.0	19.6	25.6	19.3	19.3	19.2	21.4	19.6	19.2	21.1	20.5	19.0	.	18.4	20.3	19.3	20.6
5	MEAN	18.4	18.4	24.3	18.6	18.8	18.6	20.1	18.9	18.6	19.6	19.3	18.6	.	17.9	19.4	18.4	18.9
5	LOW	18.0	17.7	23.2	18.1	18.2	18.2	19.2	18.1	18.1	18.7	18.4	18.2	.	17.5	18.6	17.6	17.7
MONTH=6																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
6	HIGH	26.1	26.8	32.9	26.1	24.8	26.0	28.1	26.6	26.2	28.1	27.7	26.1	26.5	26.1	27.0	26.2	27.2
6	MEAN	25.5	25.5	31.5	25.5	24.3	25.5	26.0	25.6	25.6	26.5	26.0	25.5	25.9	25.5	25.9	25.1	25.4
6	LOW	25.1	24.6	30.4	25.0	23.8	25.1	25.0	24.8	25.1	25.3	25.0	25.1	25.4	25.0	25.0	24.2	23.9

2.1.3-2

TABLE 2.1.3-1

JAMES RIVER TEMPERATURE DATA  
VALUES ARE MEANS OF DAILY HIGH, MEAN, AND LOW VALUES  
ANNUAL REPORT FOR 1978

MONTH=7																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
7	HIGH	28.0	28.3	33.9	27.6	.	27.8	29.9	28.4	28.3	29.7	29.5	28.1	28.1	27.7	28.8	28.1	29.1
7	MEAN	27.4	27.2	32.5	27.0	.	27.4	28.2	27.5	27.6	28.1	27.8	27.5	27.5	27.1	27.7	27.2	27.4
7	LOW	27.0	26.4	31.4	26.6	.	27.0	27.2	26.8	27.1	27.0	26.9	27.0	27.0	26.7	26.9	26.5	26.0
MONTH=8																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
8	HIGH	29.6	30.5	38.4	29.8	30.1	29.8	32.1	30.8	29.9	32.7	32.1	29.7	29.7	29.4	31.3	29.5	30.0
8	MEAN	28.9	28.9	37.1	29.2	29.5	29.2	30.1	29.6	29.3	30.5	30.0	29.2	29.1	28.8	29.9	28.7	28.5
8	LOW	28.5	28.1	36.0	28.7	29.0	28.7	28.9	28.7	28.9	29.0	28.7	28.8	28.6	28.4	28.9	28.0	27.3
MONTH=9																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
9	HIGH	26.9	27.4	35.8	27.4	27.1	26.9	29.3	27.8	27.0	29.4	29.0	27.0	26.8	26.7	28.2	26.4	26.8
9	MEAN	26.2	26.1	34.5	26.8	26.5	26.4	26.9	26.8	26.5	27.4	26.9	26.5	26.2	26.2	26.8	25.8	25.4
9	LOW	25.8	25.3	33.3	26.2	26.0	25.9	25.7	26.0	26.0	26.0	25.7	26.1	25.8	25.7	25.9	25.2	24.2
MONTH=10																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
10	HIGH	19.4	19.3	27.7	19.8	21.2	19.7	21.7	21.0	19.7	21.9	21.9	19.4	19.4	19.4	21.0	19.1	19.0
10	MEAN	18.8	18.4	26.7	19.3	20.8	19.0	19.4	19.6	19.3	20.0	19.7	18.9	19.0	19.0	19.5	18.5	17.9
10	LOW	18.4	17.6	25.9	18.9	20.3	18.5	18.2	18.7	18.8	18.8	18.5	18.6	18.6	18.6	18.6	17.9	16.8
MONTH=11																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
11	HIGH	15.8	15.8	24.6	15.9	.	16.1	18.8	18.0	16.1	18.9	18.7	15.9	16.1	15.6	17.9	15.1	14.7
11	MEAN	15.1	14.9	23.7	15.5	.	15.3	16.4	16.4	15.7	16.6	16.3	15.4	15.6	15.2	15.9	14.7	14.1
11	LOW	14.7	14.2	22.9	15.1	.	14.8	14.9	15.2	15.2	15.2	14.9	15.0	15.2	14.7	14.9	14.3	13.4
MONTH=12																		
MONTH	TYPE	SA1TGT	SA2BAT	SA3GRT	SB1TDT	SB2TET	SB2TEB	SB3TFT	SB3TFB	SC1TBT	SC2TCT	SC2TCB	SD1BDT	SD2BCT	SD2BCB	SD3BBT	SE1TAT	SE2INT
12	HIGH	12.1	12.0	15.9	.	.	12.6	14.9	15.3	12.1	15.6	15.4	12.2	12.7	12.4	15.4	12.3	9.5
12	MEAN	11.3	11.2	14.8	.	.	11.9	12.7	13.2	11.7	13.5	13.3	11.9	12.1	11.9	13.2	11.4	8.8
12	LOW	10.9	10.6	13.7	.	.	11.3	11.1	11.9	11.4	12.1	11.9	11.6	11.7	11.5	11.9	10.6	8.0

## 2.2 SALINITY AND TEMPERATURE SPECIAL SURVEYS

### Summary

The salinity and temperature monitoring program encompasses the segment of the James River Estuary which extends from the southern shore of Jamestown Island to below the intake of the Surry Power Station. The horizontal and vertical salinity and temperature of this tidal segment is determined at monthly intervals as follows: Cruises are conducted at slack before flood tide. A four (4) station transect, which is between the intake structure and Skiffes Creek, is sampled from surface to bottom at two (2) meter intervals. A second transect is made near the upper limits of the segment, the exact location of which is based on the salinity regime of the system. The approximate locations of the sampling stations and the cruise route are shown on T.S. Figure 2.2-1.

### Results

Monthly temperature and salinity surveys were conducted at eleven (11) sampling stations as shown in Figure 2.2-1. Data obtained from these surveys are summarized in graphical form in Figures 2.2-2 through 2.2-13.

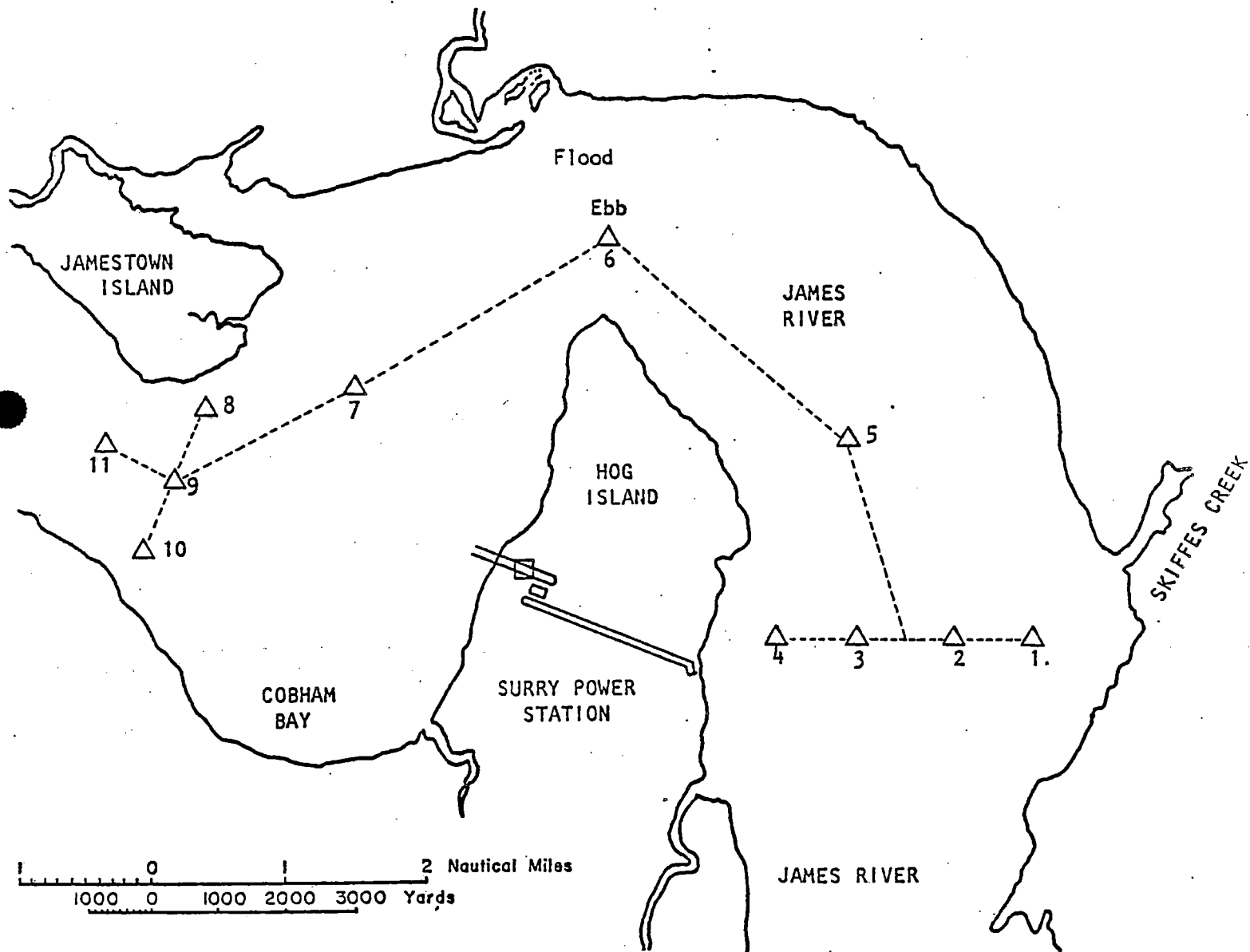
### Conclusions

The salinity in this segment of the river varied between 0 and 11.0 parts per thousand (ppt) during the reporting period. There is no measurable difference in salinity occurring as a result of the diversion of water through the cooling system. Therefore, it is concluded that the operation of the station had no significant effect on the salinity structure of the James River.

Temperature readings taken in conjunction with the salinity surveys are also presented.

Figure 2.2-1

SURRY  
POWER STATION

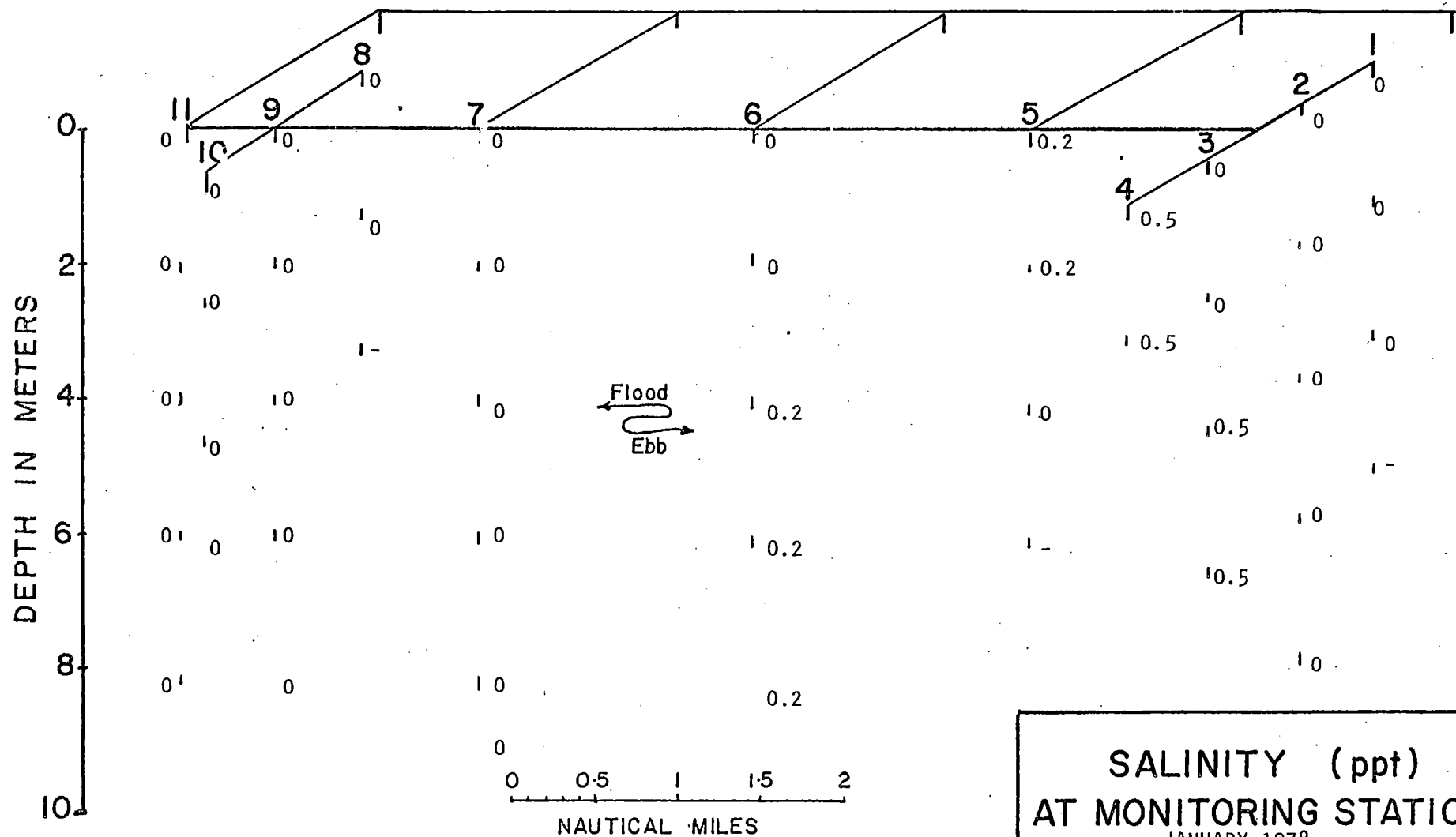


△ Sampling Stations



# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK



SALINITY (ppt)  
AT MONITORING STATIONS  
JANUARY 1978

Figure 2.2-2

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

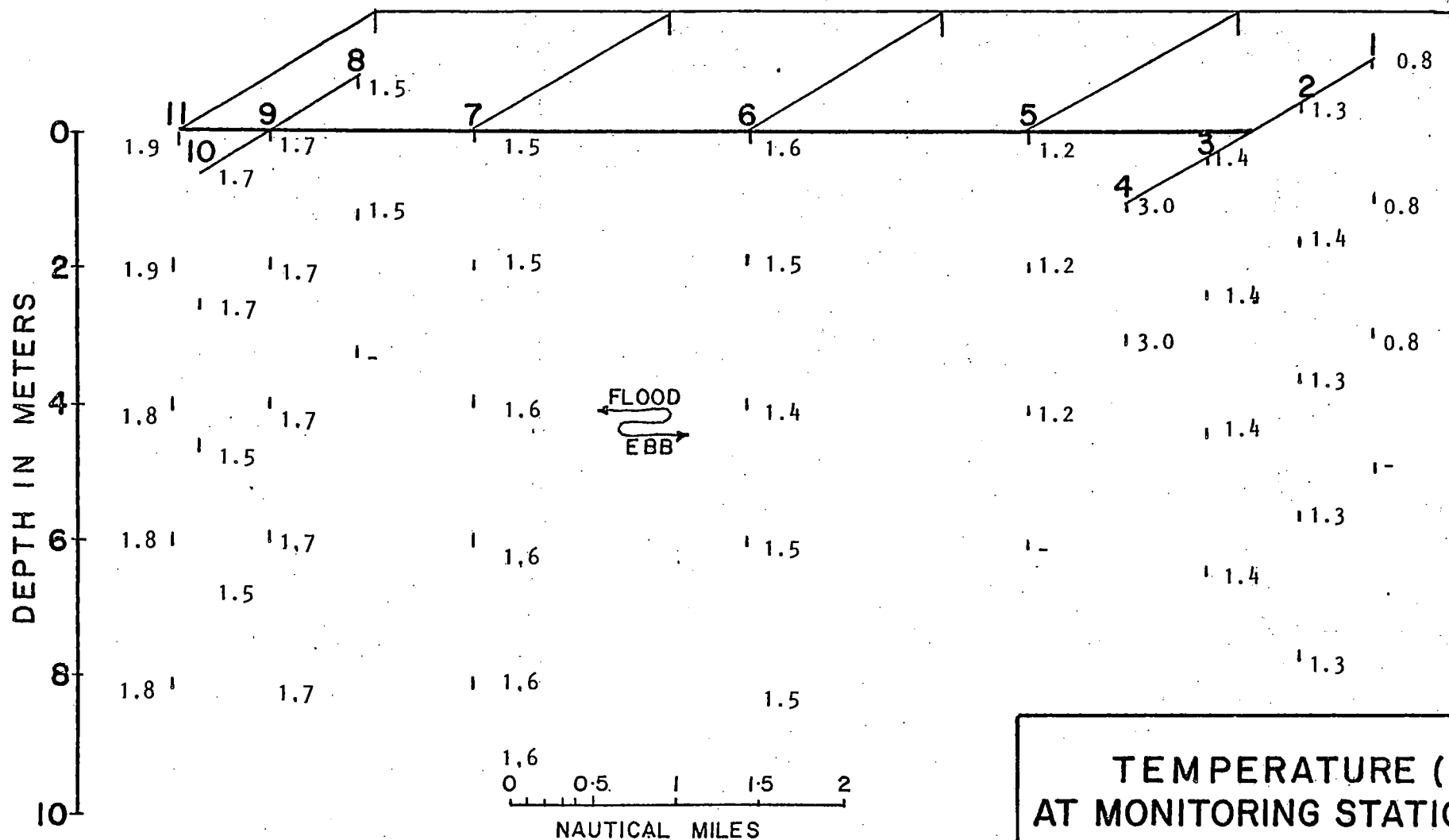


Figure 2,2-3

TEMPERATURE (°C)  
AT MONITORING STATIONS

JANUARY 1978

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

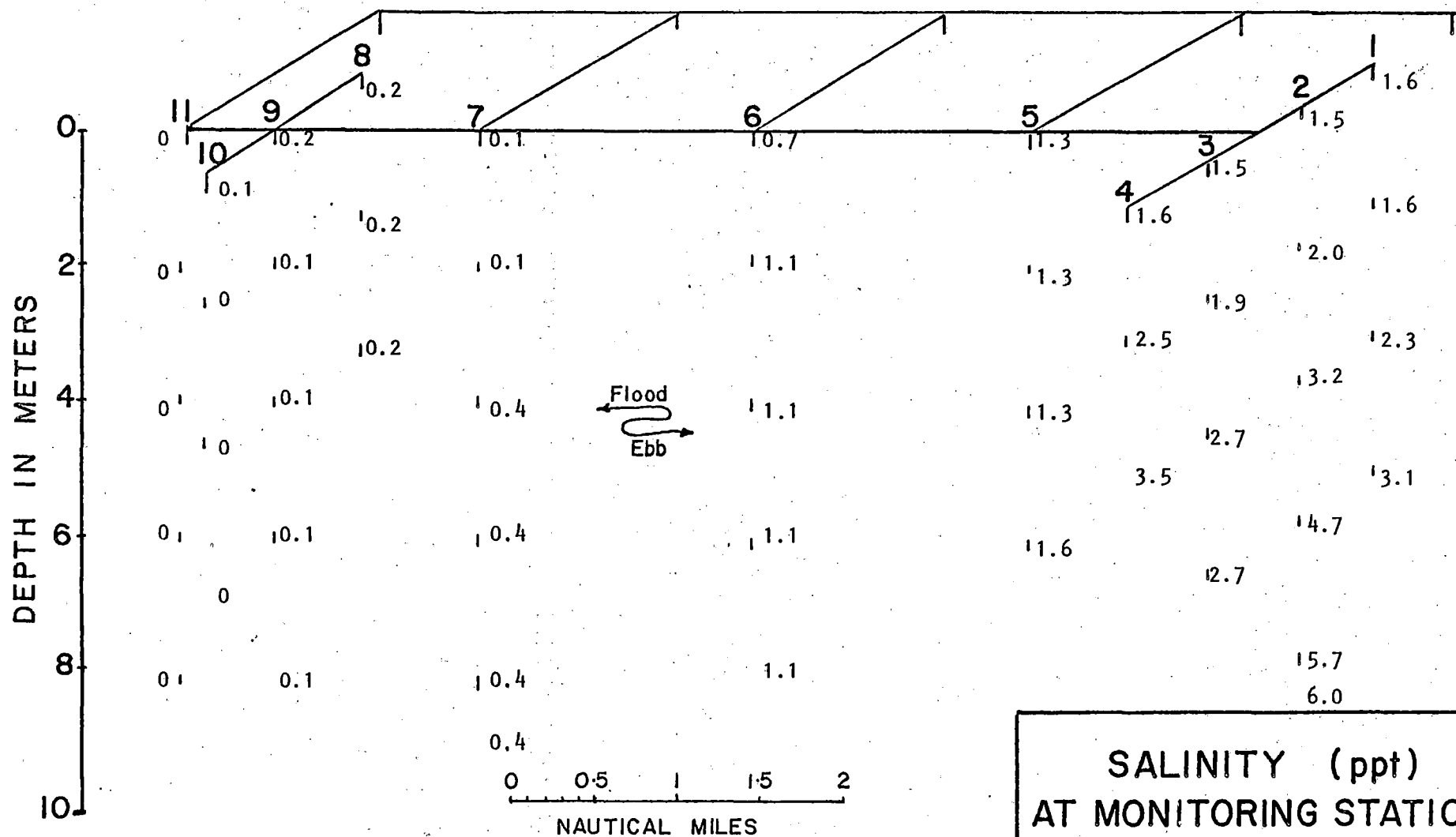


Figure 2.2-4



# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

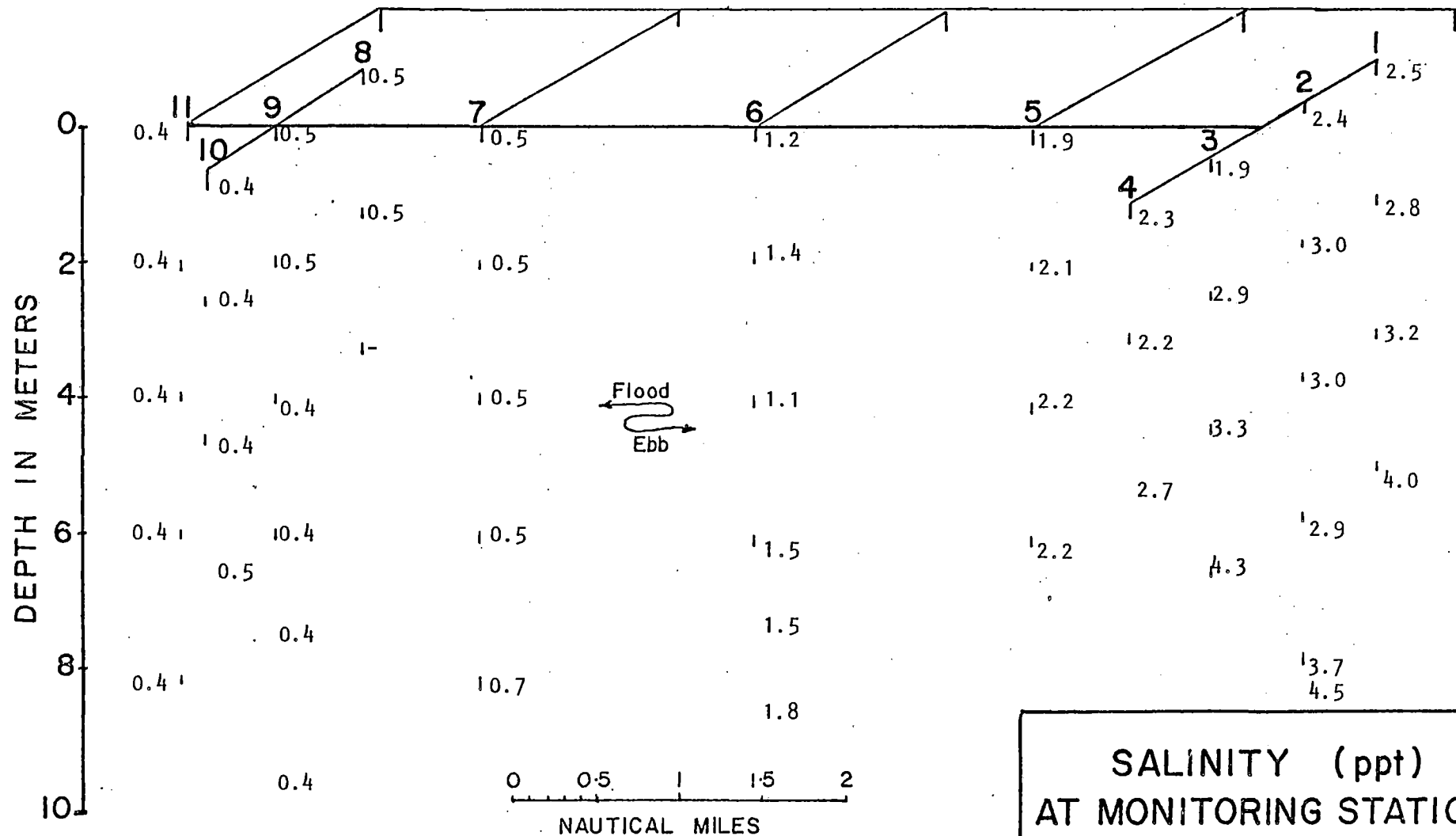


Figure 2,2-6

SALINITY (ppt)  
AT MONITORING STATIONS

MARCH 1978

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

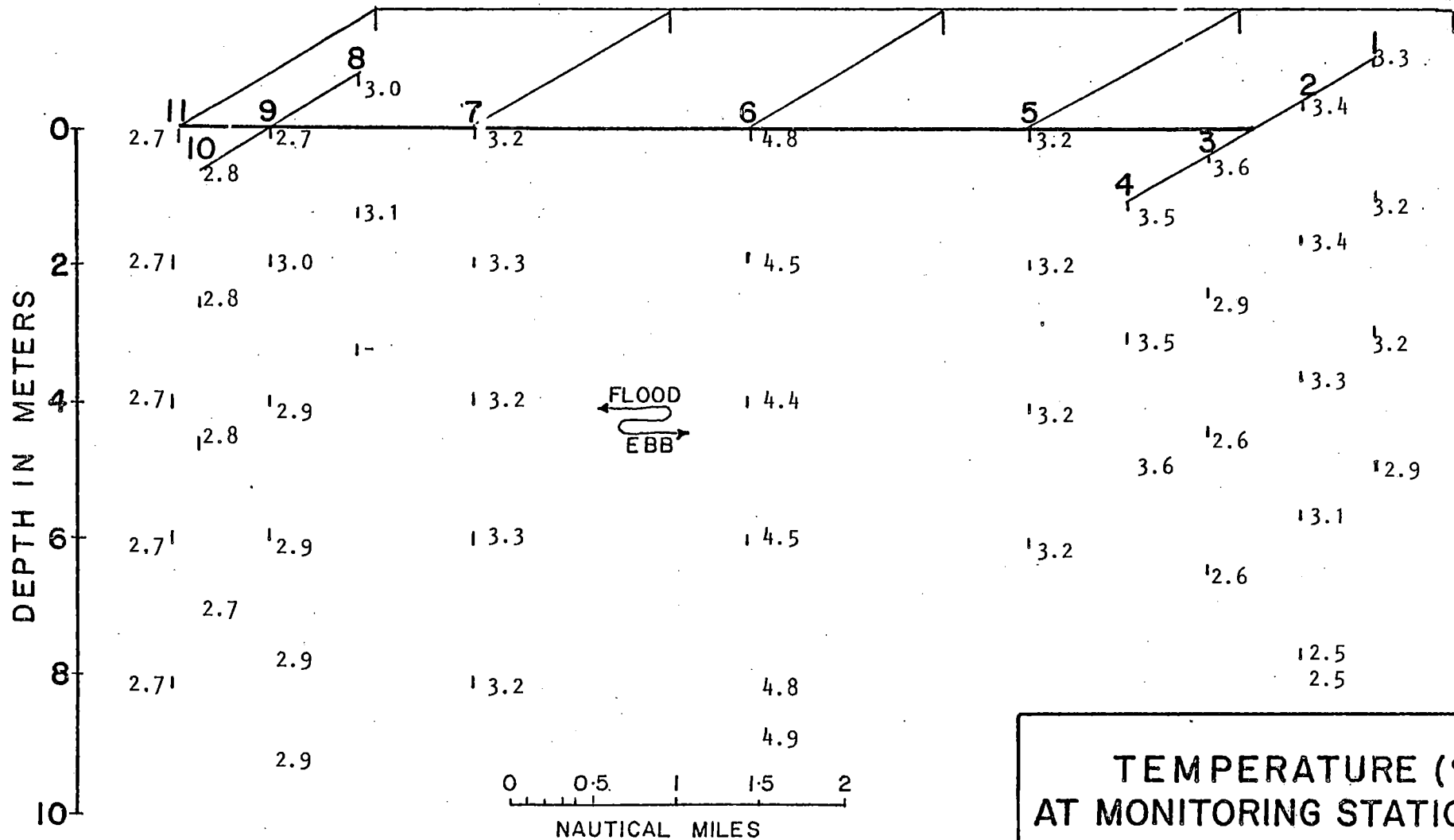


Figure 2.2-7

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

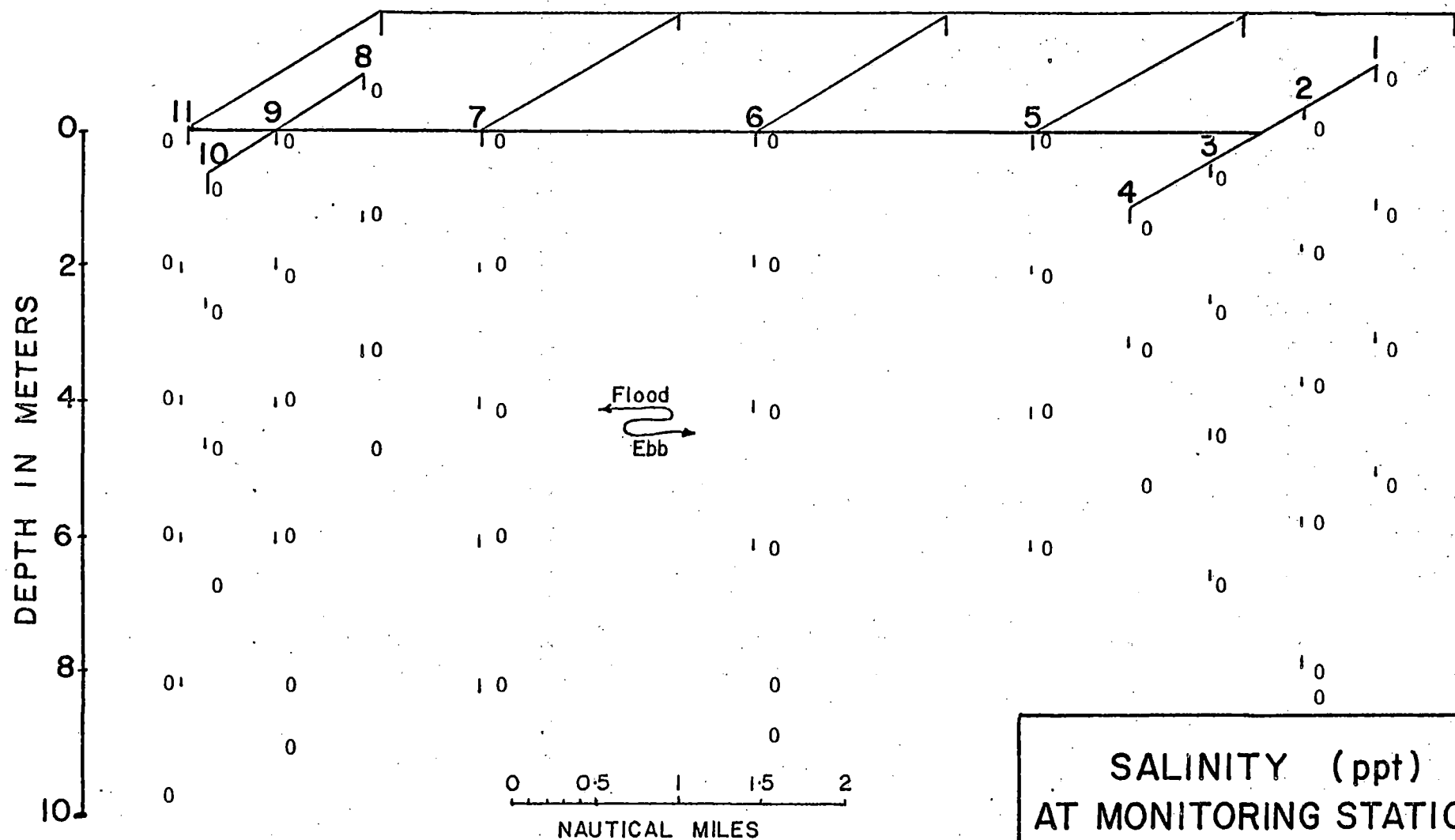


Figure 2.2-8

SALINITY (ppt)  
AT MONITORING STATIONS  
APRIL 1978

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

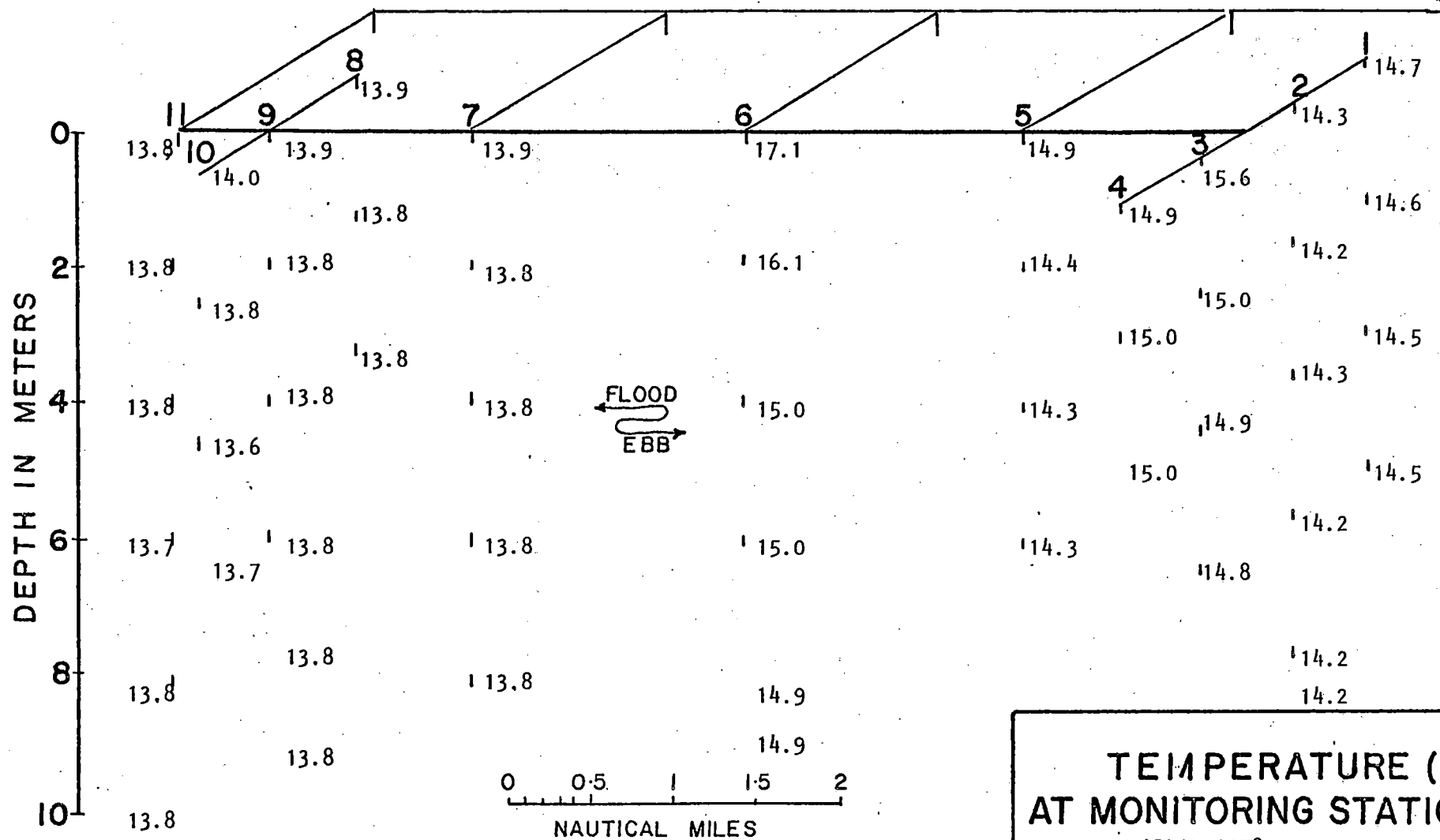


Figure 2.2-9





# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

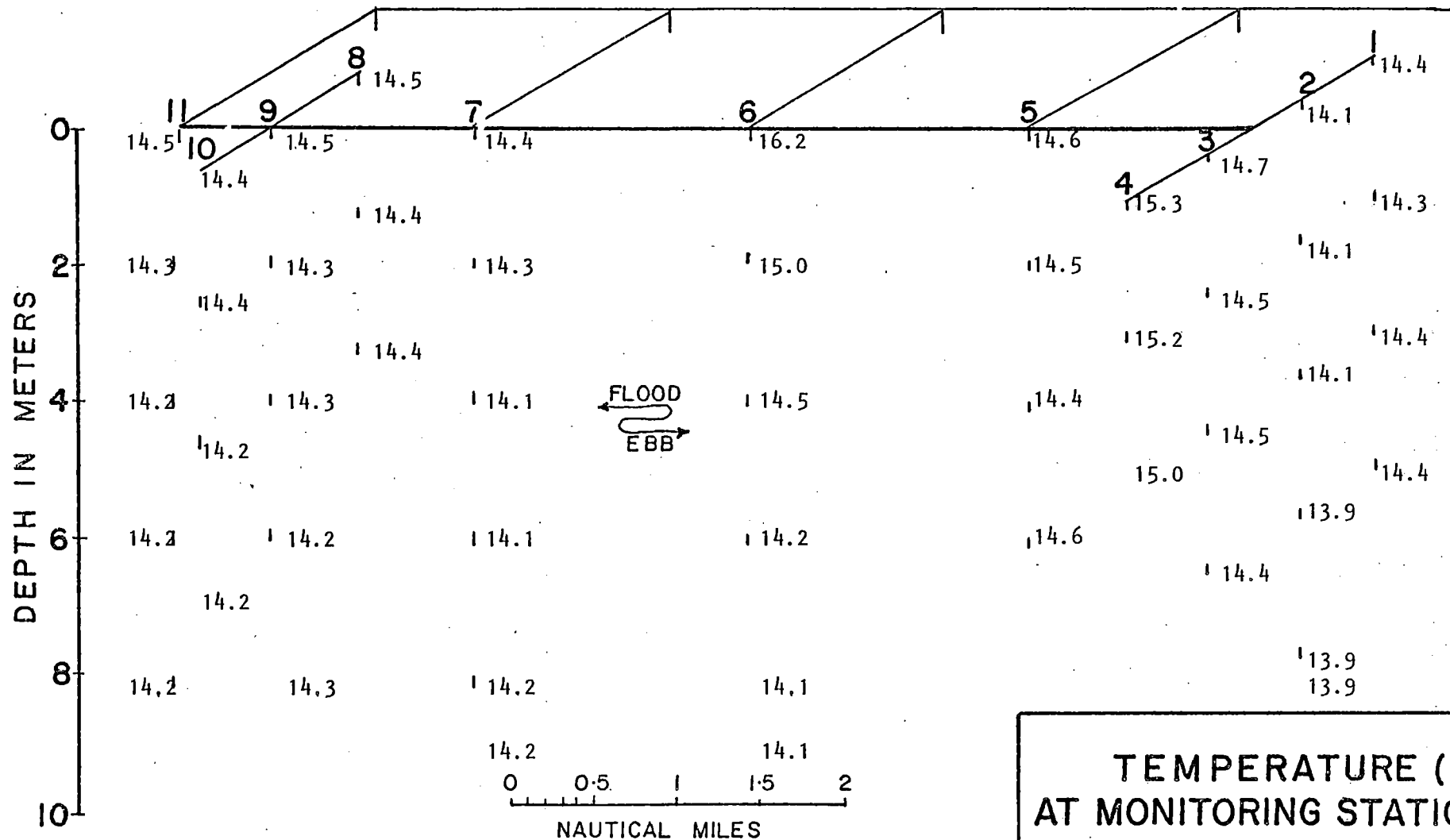


Figure 2.2-11

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

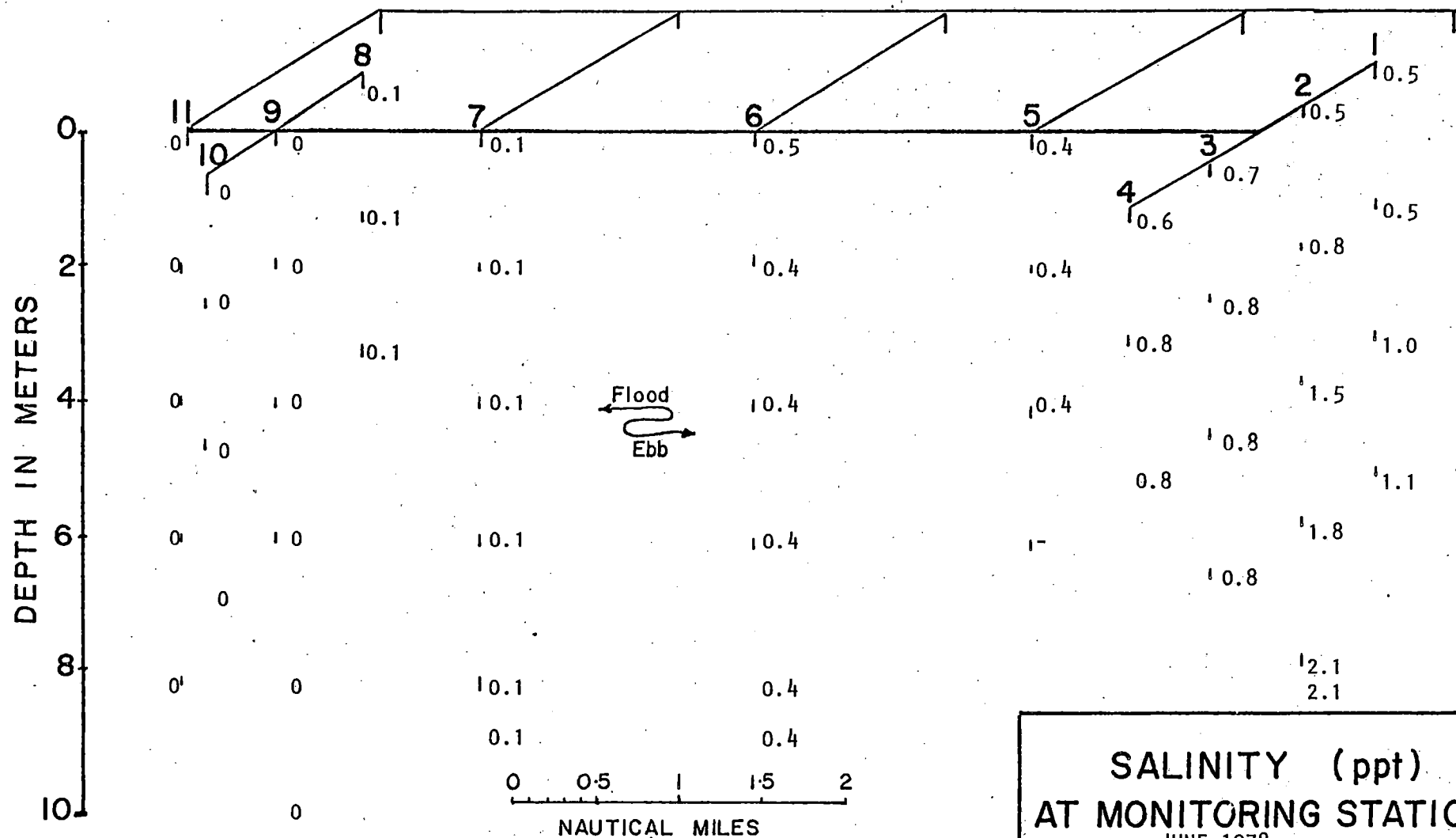


Figure 2.2-12



# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

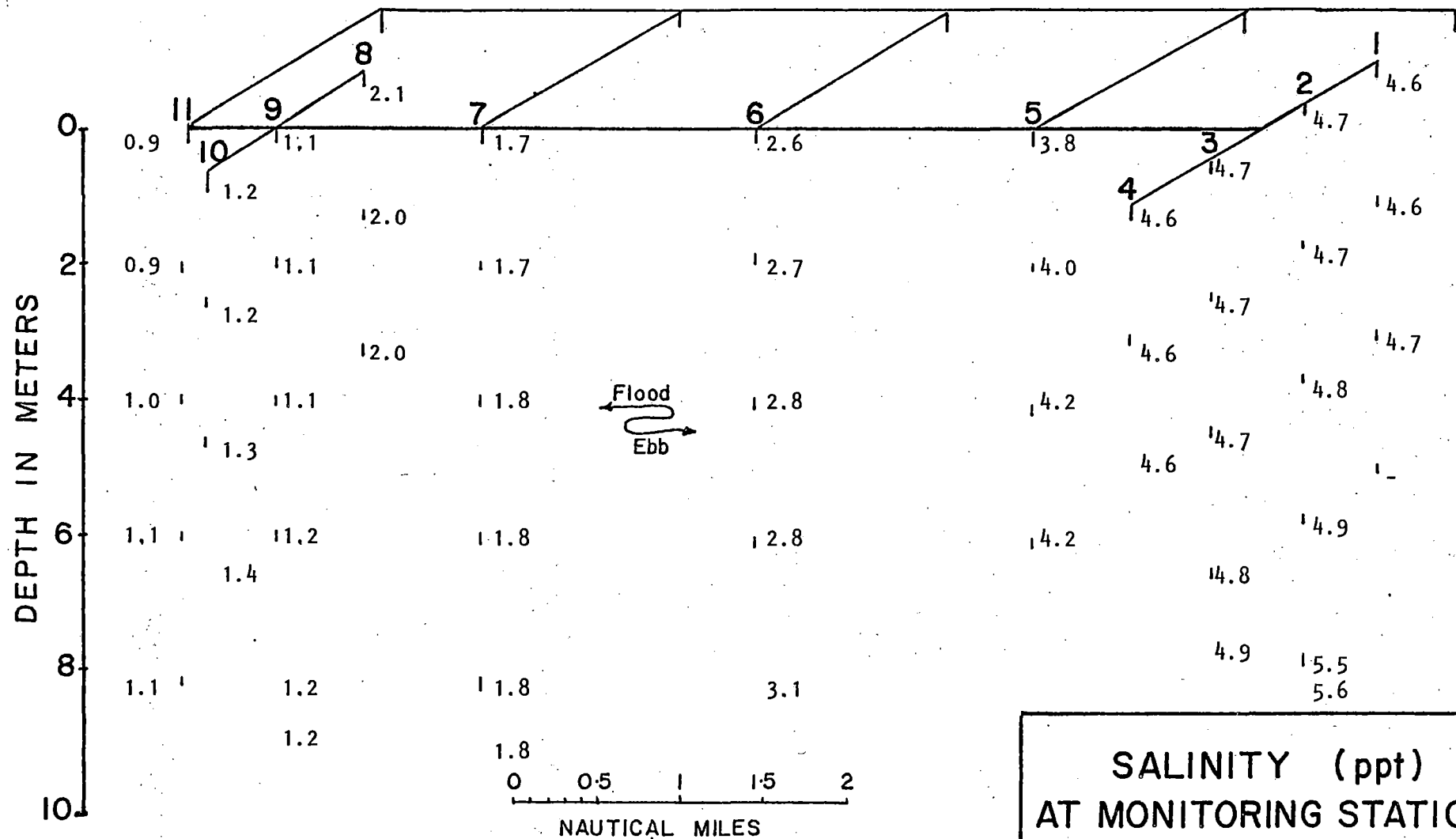


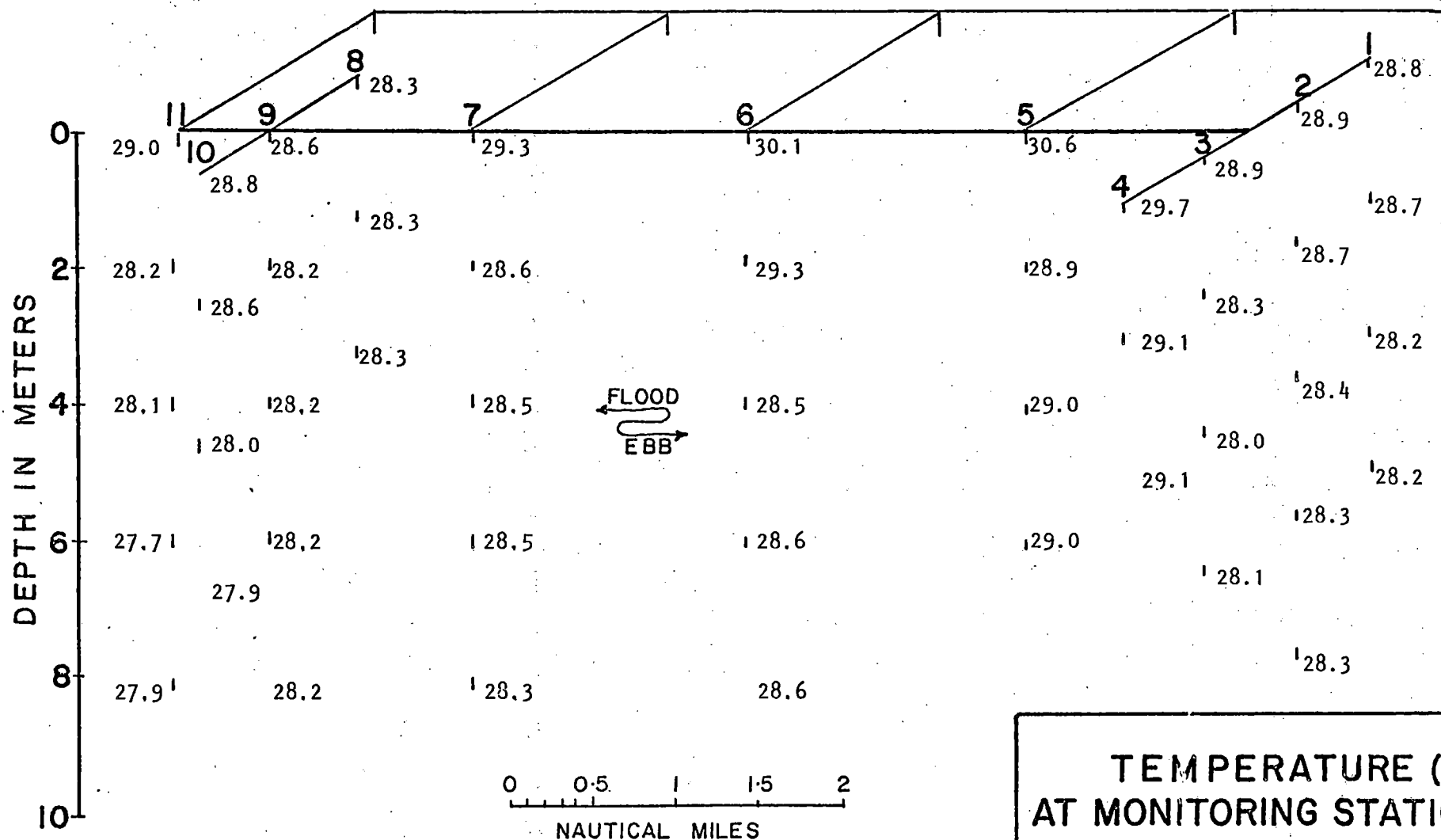
Figure 2.2-14





# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK



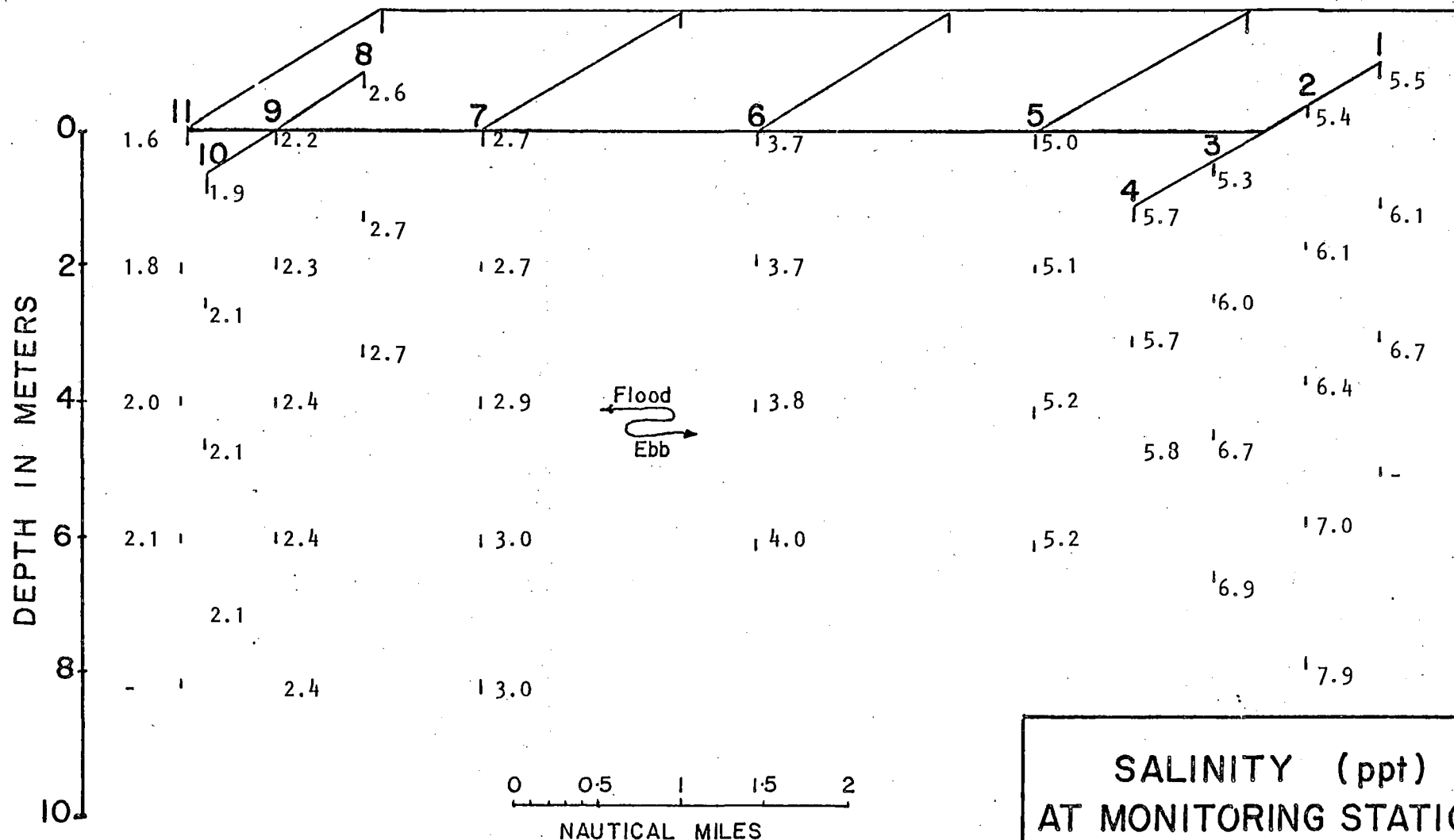
TEMPERATURE (°C)  
AT MONITORING STATIONS  
AUGUST 1978

Figure 2.2-17



# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

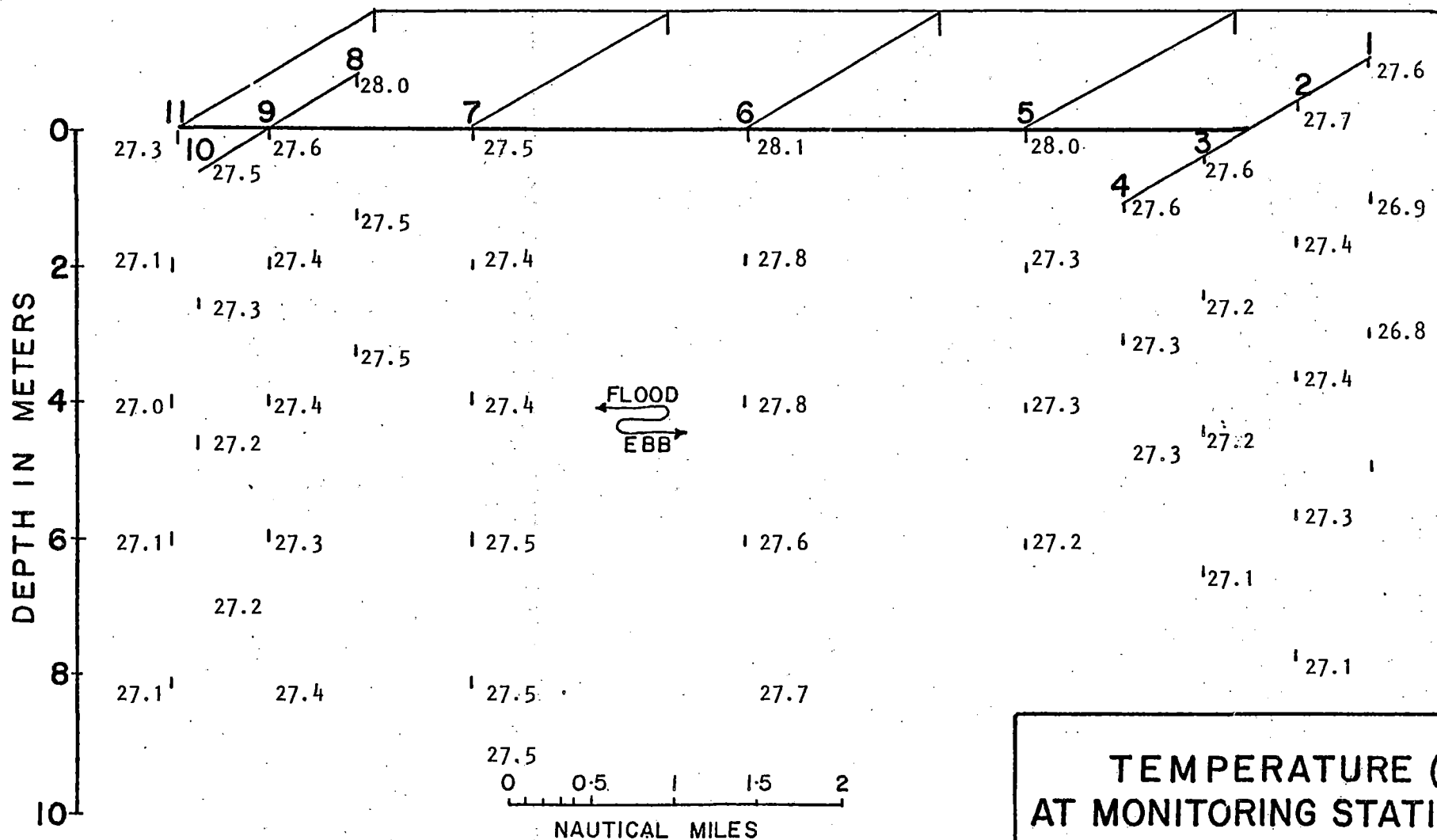


SALINITY (ppt)  
AT MONITORING STATIONS  
SEPTEMBER 1978

Figure 2.2-18

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK



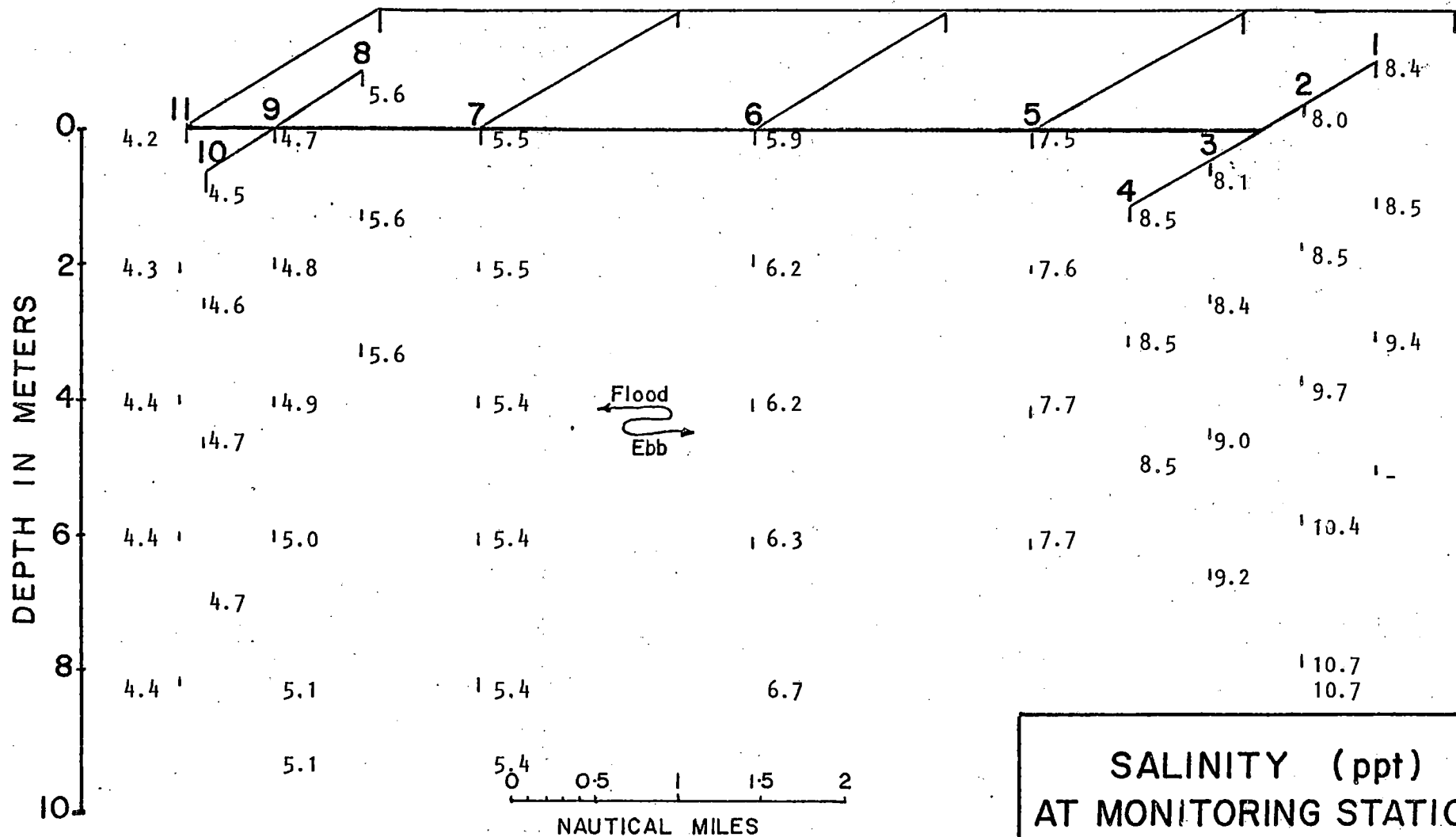
TEMPERATURE (°C)  
AT MONITORING STATIONS

SEPTEMBER 1978

Figure 2.2-19

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK



SALINITY (ppt)  
AT MONITORING STATIONS  
OCTOBER 1978

Figure 2.2-20

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

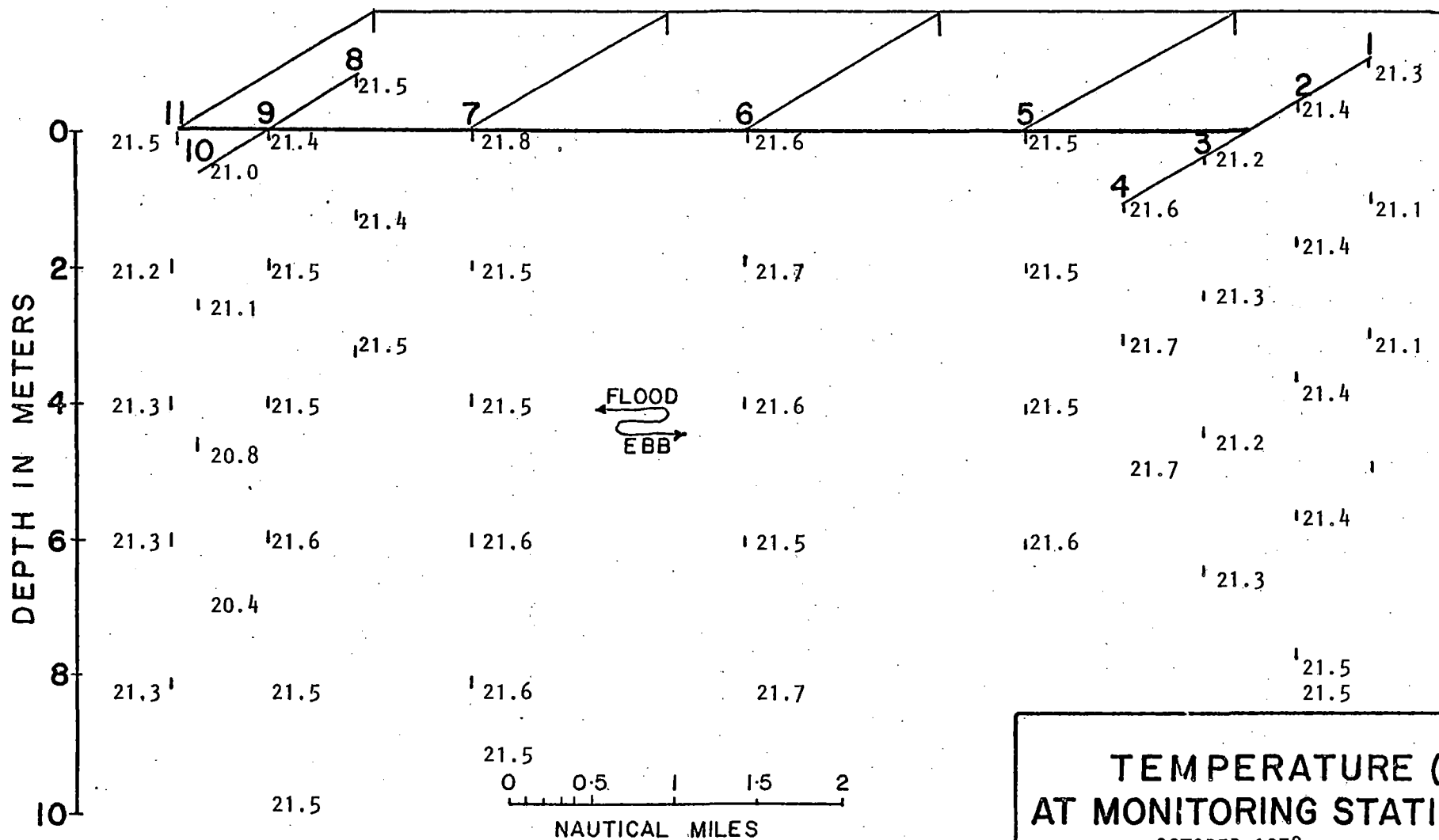


Figure 2.2-21

TEMPERATURE (°C)  
AT MONITORING STATIONS  
OCTOBER 1978

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

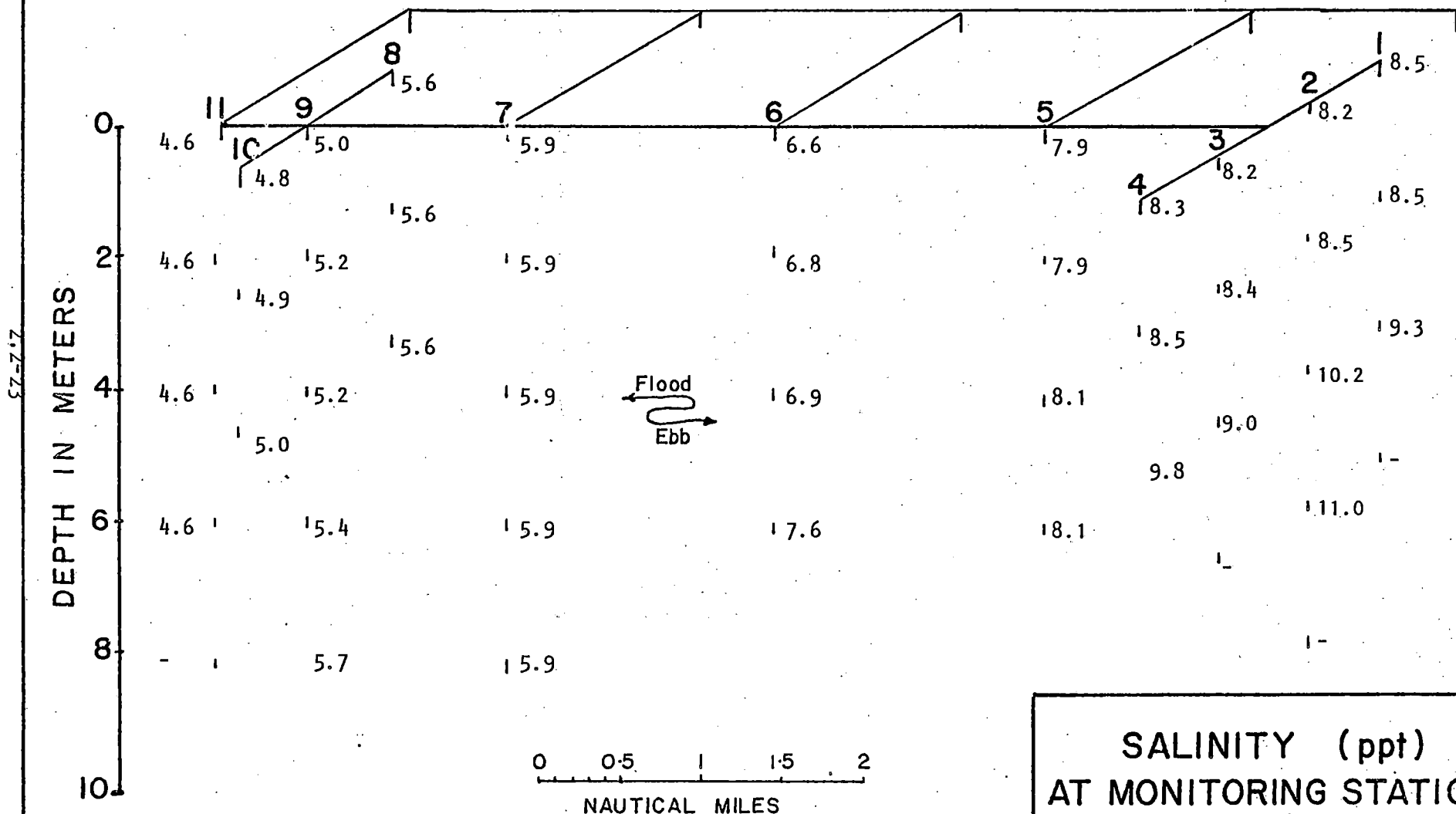
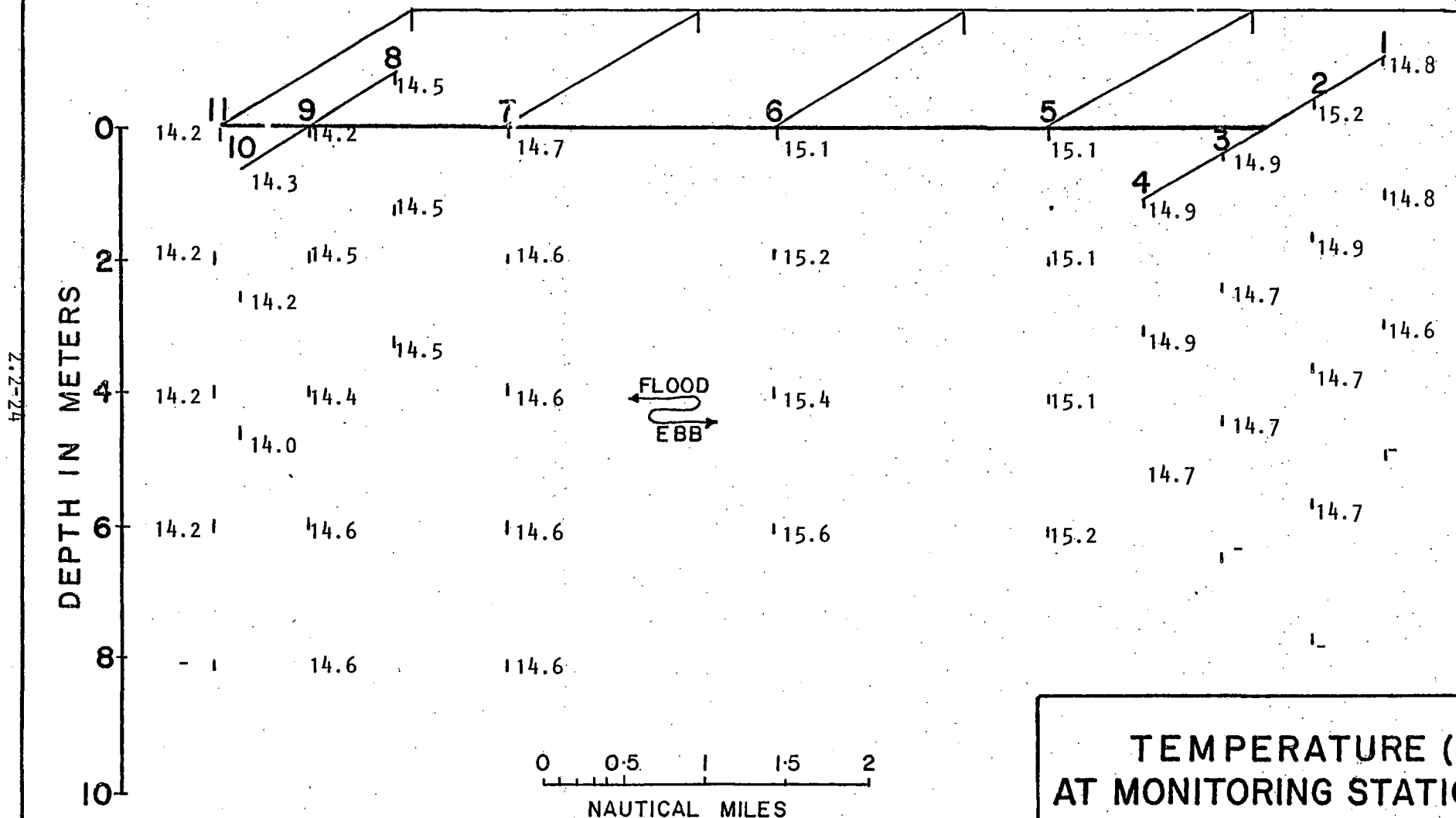


Figure 2.2-22

SALINITY (ppt)  
AT MONITORING STATIONS  
NOVEMBER 1978

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK



TEMPERATURE (°C)  
AT MONITORING STATIONS  
NOVEMBER 1978

Figure 2.2-23

# JAMES RIVER

JAMESTOWN ISLAND TO SKIFFES CREEK

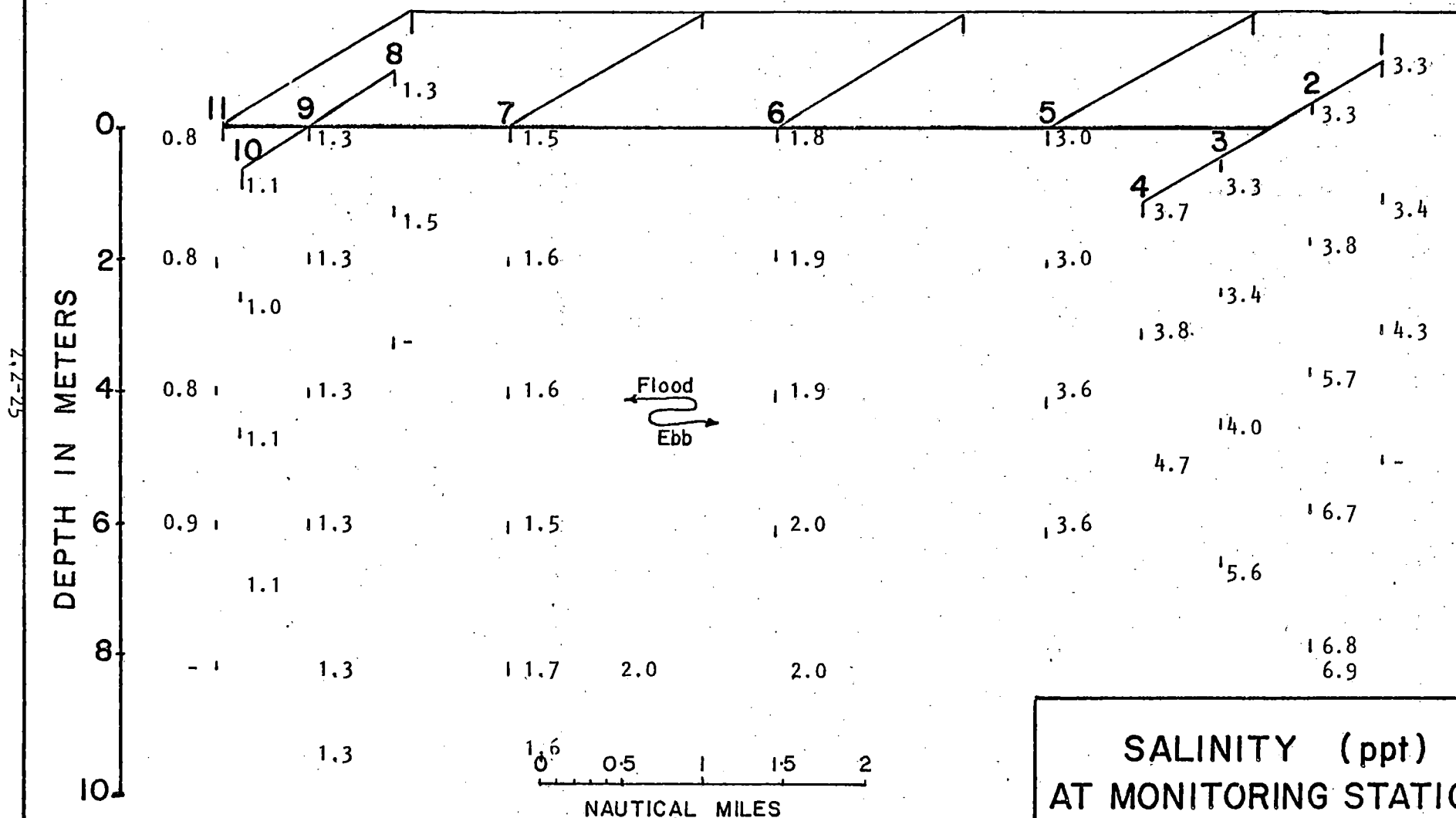
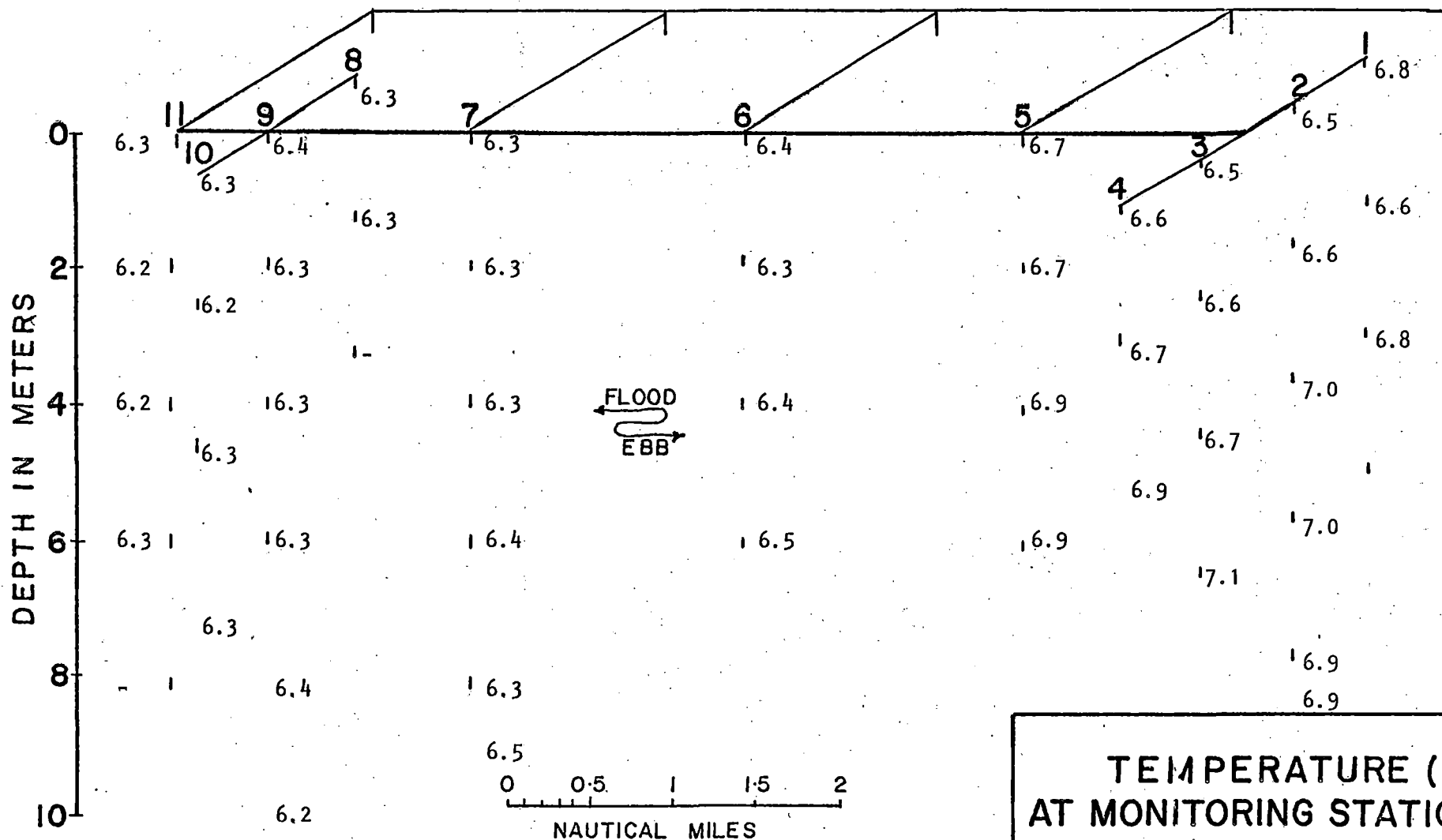


Figure 2.2-24

**SALINITY (ppt)**  
**AT MONITORING STATIONS**  
DECEMBER 1978

JAMES RIVER

# JAMESTOWN ISLAND TO SKIFFES CREEK



## TEMPERATURE (°C) AT MONITORING STATIONS

DECEMBER 1978

Figure 2.2-25



## 2.3 FRESHWATER DISCHARGE OF THE JAMES RIVER AT RICHMOND AND HOG ISLAND

The daily freshwater discharge of the James River and the James River and Kanawha Canal gages at Richmond have been combined and tabulated in Table 2.3-1. The calculated freshwater flow at Hog Island is also tabulated in Table 2.3-1.

The freshwater flow of the James River at Hog Island has been calculated using the flow at Richmond and the relative drainage area of the James River above and below Richmond to Hog Island. The area above Richmond is 6757 square miles and the area from Richmond to Hog Island is 2760 square miles.

Therefore:

$$B = A \times \frac{(6757 + 2760)}{6757}$$

Where: B = Flow at Hog Island

A = Flow at Richmond

The time of flow from Richmond to Hog Island is variable, being dependent upon the flow at Richmond.

TABLE 2.3.1

## FRESHWATER DISCHARGE OF THE JAMES RIVER AT RICHMOND AND HOG ISLAND

JANUARY - DECEMBER, 1978

DATE	JAMES RIVER DISCHARGE AT RICHMOND C.F.S.	CALCULATED JAMES RIVER DISCHARGE AT HOG POINT C.F.S.
JANUARY 1, 1978	6520	9183
JANUARY 2, 1978	6370	8972
JANUARY 3, 1978	6090	8578
JANUARY 4, 1978	5560	7831
JANUARY 5, 1978	5542	7806
JANUARY 6, 1978	5274	7428
JANUARY 7, 1978	5422	7637
JANUARY 8, 1978	5780	8141
JANUARY 9, 1978	23380	32930
JANUARY 10, 1978	43980	61945
JANUARY 11, 1978	30340	42733
JANUARY 12, 1978	20940	29493
JANUARY 13, 1978	14940	21043
JANUARY 14, 1978	14922	21017
JANUARY 15, 1978	17360	24451
JANUARY 16, 1978	14022	19750
JANUARY 17, 1978	11022	15524
JANUARY 18, 1978	16880	23775
JANUARY 19, 1978	19360	27268
JANUARY 20, 1978	16360	23043
JANUARY 21, 1978	13560	19099
JANUARY 22, 1978	10700	15071
JANUARY 23, 1978	8860	12479
JANUARY 24, 1978	7720	10873
JANUARY 25, 1978	9030	12718
JANUARY 26, 1978	50920	71719
JANUARY 27, 1978	98100	138171
JANUARY 28, 1978	76440	107663
JANUARY 29, 1978	27590	38860
JANUARY 30, 1978	26372	37144
JANUARY 31, 1978	18840	26536

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER		CALCULATED	
	DISCHARGE AT RICHMOND		JAMES RIVER	
	C.F.S.		DISCHARGE AT HOG POINT	
	C.F.S.		C.F.S.	
FEBRUARY 1, 1978	15440		21747	
FEBRUARY 2, 1978	13140		18507	
FEBRUARY 3, 1978	11040		15550	
FEBRUARY 4, 1978	9902		13947	
FEBRUARY 5, 1978	9002		12679	
FEBRUARY 6, 1978	7992		11256	
FEBRUARY 7, 1978	7682		10820	
FEBRUARY 8, 1978	6642		9355	
FEBRUARY 9, 1978	6352		8947	
FEBRUARY 10, 1978	6352		8947	
FEBRUARY 11, 1978	6212		8749	
FEBRUARY 12, 1978	6072		8552	
FEBRUARY 13, 1978	5942		8369	
FEBRUARY 14, 1978	5664		7978	
FEBRUARY 15, 1978	5720		8056	**
FEBRUARY 16, 1978	5580		7859	**
FEBRUARY 17, 1978	5860		8254	**
FEBRUARY 18, 1978	5580		7859	**
FEBRUARY 19, 1978	5720		8056	**
FEBRUARY 20, 1978	5580		7859	**
FEBRUARY 21, 1978	5580		7859	**
FEBRUARY 22, 1978	5720		8056	**
FEBRUARY 23, 1978	5860		8254	**
FEBRUARY 24, 1978	6010		8465	**
FEBRUARY 25, 1978	5580		7859	**
FEBRUARY 26, 1978	5720		8056	**
FEBRUARY 27, 1978	6450		9085	**
FEBRUARY 28, 1978	7230		10183	**

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION OF KANAWAH CANAL GAGE.

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER	CALCULATED	
	DISCHARGE AT RICHMOND C.F.S.	JAMES RIVER DISCHARGE AT HOG POINT C.F.S.	
MARCH 1, 1978	7400	10423	**
MARCH 2, 1978	7070	9958	**
MARCH 3, 1978	6910	9733	**
MARCH 4, 1978	6790	9564	**
MARCH 5, 1978	6300	8873	**
MARCH 6, 1978	6160	8676	**
MARCH 7, 1978	5720	8056	**
MARCH 8, 1978	5860	8254	**
MARCH 9, 1978	5720	8056	**
MARCH 10, 1978	8980	12648	**
MARCH 11, 1978	29700	41832	**
MARCH 12, 1978	33600	47325	**
MARCH 13, 1978	33000	46480	**
MARCH 14, 1978	30300	42677	**
MARCH 15, 1978	35000	49296	**
MARCH 16, 1978	50800	71550	**
MARCH 17, 1978	55200	77748	**
MARCH 18, 1978	33600	47325	**
MARCH 19, 1978	22600	31831	**
MARCH 20, 1978	17400	24507	**
MARCH 21, 1978	15000	21127	**
MARCH 22, 1978	13500	19014	**
MARCH 23, 1978	13500	19014	**
MARCH 24, 1978	13100	18451	**
MARCH 25, 1978	12200	17183	**
MARCH 26, 1978	12600	17747	**
MARCH 27, 1978	29100	40986	**
MARCH 28, 1978	57000	80283	**
MARCH 29, 1978	52600	74086	**
MARCH 30, 1978	28500	40141	**
MARCH 31, 1978	21000	29578	**

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION  
OF KANAWAH CANAL GAGE.

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER	CALCULATED	
	DISCHARGE AT RICHMOND C.F.S.	JAMES RIVER DISCHARGE AT HOG POINT C.F.S.	
APRIL 1, 1978	16900	23803	**
APRIL 2, 1978	14500	20423	**
APRIL 3, 1978	12600	17747	**
APRIL 4, 1978	11300	15916	**
APRIL 5, 1978	10100	14226	**
APRIL 6, 1978	9550	13451	**
APRIL 7, 1978	8610	12127	**
APRIL 8, 1978	8250	11620	**
APRIL 9, 1978	7730	10887	**
APRIL 10, 1978	7230	10183	**
APRIL 11, 1978	7070	9958	**
APRIL 12, 1978	6600	9296	**
APRIL 13, 1978	6450	9085	**
APRIL 14, 1978	6160	8676	**
APRIL 15, 1978	5860	8254	**
APRIL 16, 1978	5720	8056	**
APRIL 17, 1978	5430	7648	**
APRIL 18, 1978	5290	7451	**
APRIL 19, 1978	5430	7648	**
APRIL 20, 1978	6600	9296	**
APRIL 21, 1978	6010	8465	**
APRIL 22, 1978	5430	7648	**
APRIL 23, 1978	5290	7451	**
APRIL 24, 1978	5150	7254	**
APRIL 25, 1978	5010	7056	**
APRIL 26, 1978	6450	9085	**
APRIL 27, 1978	37070	52212	**
APRIL 28, 1978	66600	93804	**
APRIL 29, 1978	50000	70424	**
APRIL 30, 1978	24800	34930	**

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION OF KANAWAH CANAL GAGE.

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER DISCHARGE AT RICHMOND C.F.S.	CALCULATED JAMES RIVER DISCHARGE AT HOG POINT C.F.S.	
MAY 1, 1978	17900	25212	**
MAY 2, 1978	14500	20423	**
MAY 3, 1978	12200	17183	**
MAY 4, 1978	11800	16620	**
MAY 5, 1978	29100	40986	**
MAY 6, 1978	27800	39155	**
MAY 7, 1978	17900	25212	**
MAY 8, 1978	15400	21690	**
MAY 9, 1978	19400	27324	**
MAY 10, 1978	24300	34226	**
MAY 11, 1978	22000	30986	**
MAY 12, 1978	16900	23803	**
MAY 13, 1978	14440	20338	
MAY 14, 1978	19880	28000	
MAY 15, 1978	44180	62226	
MAY 16, 1978	36000	50705	
MAY 17, 1978	30100	42395	
MAY 18, 1978	25060	35296	
MAY 19, 1978	21380	30113	
MAY 20, 1978	18420	25944	
MAY 21, 1978	15500	21831	
MAY 22, 1978	13180	18564	
MAY 23, 1978	11480	16169	
MAY 24, 1978	10340	14564	
MAY 25, 1978	9610	13535	
MAY 26, 1978	9060	12761	
MAY 27, 1978	8230	11592	
MAY 28, 1978	7910	11141	
MAY 29, 1978	7280	10254	
MAY 30, 1978	6850	9648	
MAY 31, 1978	6700	9437	

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION OF KANAWAH CANAL GAGE.

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER	CALCULATED
	DISCHARGE AT RICHMOND C.F.S.	JAMES RIVER DISCHARGE AT HOG POINT C.F.S.
JUNE 1, 1978	6700	9437
JUNE 2, 1978	6990	9845
JUNE 3, 1978	7300	10282
JUNE 4, 1978	7600	10704
JUNE 5, 1978	6990	9845
JUNE 6, 1978	6110	8606
JUNE 7, 1978	5820	8197
JUNE 8, 1978	5690	8014
JUNE 9, 1978	5422	7637
JUNE 10, 1978	5422	7637
JUNE 11, 1978	5162	7271
JUNE 12, 1978	4774	6724
JUNE 13, 1978	4644	6541
JUNE 14, 1978	4644	6541
JUNE 15, 1978	4774	6724
JUNE 16, 1978	4386	6178
JUNE 17, 1978	4156	5854
JUNE 18, 1978	4108	5786
JUNE 19, 1978	3988	5617
JUNE 20, 1978	4126	5811
JUNE 21, 1978	4792	6749
JUNE 22, 1978	5460	7690
JUNE 23, 1978	5460	7690
JUNE 24, 1978	5310	7479
JUNE 25, 1978	4404	6203
JUNE 26, 1978	3986	5614
JUNE 27, 1978	4086	5755
JUNE 28, 1978	5860	8254
JUNE 29, 1978	6390	9000
JUNE 30, 1978	5042	7102

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER DISCHARGE AT RICHMOND C.F.S.	CALCULATED JAMES RIVER DISCHARGE AT HOG POINT C.F.S.
JULY 1, 1978	4256	5994
JULY 2, 1978	4026	5671
JULY 3, 1978	3688	5194
JULY 4, 1978	3280	4620
JULY 5, 1978	3606	5079
JULY 6, 1978	4274	6020
JULY 7, 1978	4226	5952
JULY 8, 1978	3608	5082
JULY 9, 1978	3756	5290
JULY 10, 1978	4810	6775
JULY 11, 1978	4524	6372
JULY 12, 1978	3856	5431
JULY 13, 1978	3756	5290
JULY 14, 1978	3418	4814
JULY 15, 1978	3418	4814
JULY 16, 1978	3488	4913
JULY 17, 1978	3786	5332
JULY 18, 1978	4144	5837
JULY 19, 1978	4056	5713
JULY 20, 1978	3826	5389
JULY 21, 1978	3608	5082
JULY 22, 1978	3090	4352
JULY 23, 1978	2832	3989
JULY 24, 1978	2692	3792
JULY 25, 1978	2812	3961
JULY 26, 1978	4162	5862
JULY 27, 1978	4542	6397
JULY 28, 1978	3906	5501
JULY 29, 1978	3230	4549
JULY 30, 1978	3248	4575
JULY 31, 1978	3090	4352



TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER	CALCULATED
	DISCHARGE AT RICHMOND C.F.S.	JAMES RIVER DISCHARGE AT HOG POINT C.F.S.
AUGUST 1, 1978	2990	4211
AUGUST 2, 1978	3366	4741
AUGUST 3, 1978	4174	5879
AUGUST 4, 1978	4960	6986
AUGUST 5, 1978	5330	7507
AUGUST 6, 1978	5730	8071
AUGUST 7, 1978	5580	7859
AUGUST 8, 1978	4792	6749
AUGUST 9, 1978	5200	7324
AUGUST 10, 1978	5180	7296
AUGUST 11, 1978	4644	6541
AUGUST 12, 1978	6000	8451
AUGUST 13, 1978	5560	7831
AUGUST 14, 1978	4792	6749
AUGUST 15, 1978	4626	6516
AUGUST 16, 1978	4120	5803
AUGUST 17, 1978	4370	6155
AUGUST 18, 1978	4184	5893
AUGUST 19, 1978	3568	5025
AUGUST 20, 1978	3280	4620
AUGUST 21, 1978	2632	3707
AUGUST 22, 1978	2392	3369
AUGUST 23, 1978	2302	3242
AUGUST 24, 1978	2194	3090
AUGUST 25, 1978	2122	2989
AUGUST 26, 1978	2422	3411
AUGUST 27, 1978	2014	2837
AUGUST 28, 1978	2052	2890
AUGUST 29, 1978	3544	4992
AUGUST 30, 1978	4088	5758
AUGUST 31, 1978	3128	4406

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION  
OF KANAWAH CANAL GAGE.

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER	CALCULATED
	DISCHARGE AT RICHMOND C.F.S.	JAMES RIVER DISCHARGE AT HOG POINT C.F.S.
SEPTEMBER 1, 1978	3456	4868
SEPTEMBER 2, 1978	3944	5555
SEPTEMBER 3, 1978	3986	5614
SEPTEMBER 4, 1978	3568	5025
SEPTEMBER 5, 1978	2990	4211
SEPTEMBER 6, 1978	832	1172
SEPTEMBER 7, 1978	832	1172
SEPTEMBER 8, 1978	814	1146
SEPTEMBER 9, 1978	1994	2808
SEPTEMBER 10, 1978	1924	2710
SEPTEMBER 11, 1978	1854	2611
SEPTEMBER 12, 1978	1814	2555
SEPTEMBER 13, 1978	1814	2555
SEPTEMBER 14, 1978	1814	2555
SEPTEMBER 15, 1978	1792	2524
SEPTEMBER 16, 1978	1769	2492
SEPTEMBER 17, 1978	1746	2459
SEPTEMBER 18, 1978	1724	2428
SEPTEMBER 19, 1978	1638	2307
SEPTEMBER 20, 1978	1594	2245
SEPTEMBER 21, 1978	1551	2185
SEPTEMBER 22, 1978	1551	2185
SEPTEMBER 23, 1978	1679	2365
SEPTEMBER 24, 1978	1852	2608
SEPTEMBER 25, 1978	2122	2989
SEPTEMBER 26, 1978	1924	2710
SEPTEMBER 27, 1978	1769	2492
SEPTEMBER 28, 1978	1656	2332
SEPTEMBER 29, 1978	1531	2156
SEPTEMBER 30, 1978	1451	2044

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\*\*\* CALCULATION BASED ON KANAWAH CANAL FLOW ONLY DUE TO MALFUNCTION  
OF JAMES RIVER GAGE

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER DISCHARGE AT RICHMOND C.F.S.	CALCULATED JAMES RIVER DISCHARGE AT HOG POINT C.F.S.
OCTOBER 1, 1978	1471	2072
OCTOBER 2, 1978	1451	2044
OCTOBER 3, 1978	1351	1903
OCTOBER 4, 1978	1391	1959
OCTOBER 5, 1978	1415	1993
OCTOBER 6, 1978	1471	2072
OCTOBER 7, 1978	1589	2238
OCTOBER 8, 1978	2032	2862
OCTOBER 9, 1978	1854	2611
OCTOBER 10, 1978	1571	2213
OCTOBER 11, 1978	1476	2079
OCTOBER 12, 1978	1384	1949
OCTOBER 13, 1978	1522	2144
OCTOBER 14, 1978	1471	2072
OCTOBER 15, 1978	1471	2072
OCTOBER 16, 1978	1347	1897
OCTOBER 17, 1978	1459	2055
OCTOBER 18, 1978	1692	2383
OCTOBER 19, 1978	1746	2459
OCTOBER 20, 1978	1746	2459
OCTOBER 21, 1978	1679	2365
OCTOBER 22, 1978	1724	2428
OCTOBER 23, 1978	1769	2492
OCTOBER 24, 1978	1511	2128
OCTOBER 25, 1978	1471	2072
OCTOBER 26, 1978	1431	2016
OCTOBER 27, 1978	1471	2072
OCTOBER 28, 1978	1531	2156
OCTOBER 29, 1978	1511	2128
OCTOBER 30, 1978	1531	2156
OCTOBER 31, 1978	1531	2156

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER DISCHARGE AT RICHMOND C.F.S.	CALCULATED JAMES RIVER DISCHARGE AT HOG POINT C.F.S.	
NOVEMBER 1, 1978	1511	2128	
NOVEMBER 2, 1978	1491	2100	
NOVEMBER 3, 1978	1746	2459	
NOVEMBER 4, 1978	1702	2397	
NOVEMBER 5, 1978	1679	2365	
NOVEMBER 6, 1978	1661	2339	
NOVEMBER 7, 1978	1571	2213	
NOVEMBER 8, 1978	1594	2245	
NOVEMBER 9, 1978	1724	2428	
NOVEMBER 10, 1978	1724	2428	
NOVEMBER 11, 1978	1746	2459	
NOVEMBER 12, 1978	1769	2492	
NOVEMBER 13, 1978	1746	2459	
NOVEMBER 14, 1978	1702	2397	
NOVEMBER 15, 1978	1616	2276	
NOVEMBER 16, 1978	1679	2365	
NOVEMBER 17, 1978	1884	2654	
NOVEMBER 18, 1978	1992	2806	
NOVEMBER 19, 1978	2460	3465	
NOVEMBER 20, 1978	3162	4454	
NOVEMBER 21, 1978	1960	2761	**
NOVEMBER 22, 1978	1630	2296	**
NOVEMBER 23, 1978	1340	1887	**
NOVEMBER 24, 1978	1340	1887	**
NOVEMBER 25, 1978	1250	1761	**
NOVEMBER 26, 1978	1220	1718	**
NOVEMBER 27, 1978	1320	1859	**
NOVEMBER 28, 1978	1430	2014	**
NOVEMBER 29, 1978	1660	2338	**
NOVEMBER 30, 1978	3266	4600	

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION  
OF KANAWAH CANAL GAGE.

TABLE 2.3.1 (CONT'D)

DATE	JAMES RIVER DISCHARGE AT RICHMOND C.F.S.	CALCULATED JAMES RIVER DISCHARGE AT HOG POINT C.F.S.	
DECEMBER 1, 1978	3366	4741	
DECEMBER 2, 1978	3436	4840	
DECEMBER 3, 1978	3406	4797	
DECEMBER 4, 1978	3348	4716	
DECEMBER 5, 1978	3404	4794	
DECEMBER 6, 1978	4310	6071	
DECEMBER 7, 1978	5180	7296	
DECEMBER 8, 1978	4542	6397	
DECEMBER 9, 1978	4680	6592	
DECEMBER 10, 1978	5350	7535	
DECEMBER 11, 1978	6010	8465	**
DECEMBER 12, 1978	5860	8254	**
DECEMBER 13, 1978	7560	10648	
DECEMBER 14, 1978	6230	8775	
DECEMBER 15, 1978	5292	6155	
DECEMBER 16, 1978	4662	6566	
DECEMBER 17, 1978	4102	5778	
DECEMBER 18, 1978	3100	4366	**
DECEMBER 19, 1978	3200	4507	**
DECEMBER 20, 1978	3070	4324	**
DECEMBER 21, 1978	2970	4183	**
DECEMBER 22, 1978	3248	4575	
DECEMBER 23, 1978	2988	4209	
DECEMBER 24, 1978	2888	4068	
DECEMBER 25, 1978	3824	5386	
DECEMBER 26, 1978	6720	9465	
DECEMBER 27, 1978	6700	9437	
DECEMBER 28, 1978	7010	9873	
DECEMBER 29, 1978	7010	9873	
DECEMBER 30, 1978	5560	7831	
DECEMBER 31, 1978	5042	7102	

\*\* CALCULATION BASED ON JAMES RIVER FLOW ONLY DUE TO MALFUNCTION OF KANAWAH CANAL GAGE.

### 3.1 PLANKTON

#### Summary

Water samples for plankton analyses are collected at each of six (6) stations as indicated in Figure 3.1-1. Samples are also collected in the intake and discharge canals. Phytoplankton samples are taken monthly and are analyzed quantitatively in terms of sample volume to determine both the dominant genera of the community and the chlorophyll "a" content. Zooplankton samples are analyzed quantitatively in terms of sample volume to determine generic composition, life history stage and, where possible, species. The sampling interval is approximately monthly, taking into consideration life-history information about important species in the area which have planktonic stages in their life histories.

#### Results

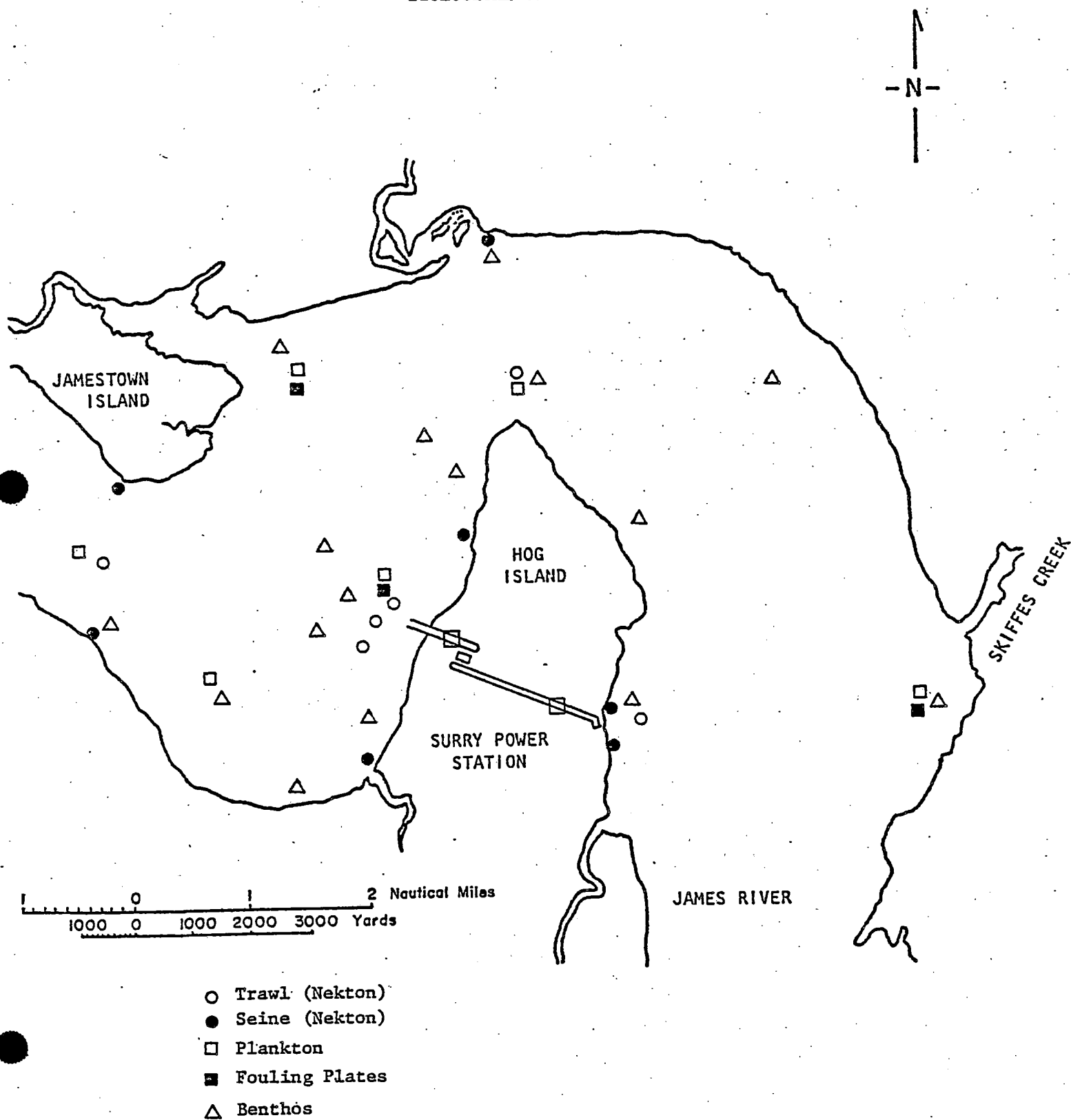
The results of this survey are contained in the report prepared by the Virginia Institute of Marine Science entitled "Ecological Study of the Tidal Segment of the James River Encompassing Hog Point, 1978 Final Technical Report" dated February, 1979 which is appended to this section as Appendix 3.0.

#### Conclusions

Please refer to the referenced report.

Figure 3.1-1

BIOLOGICAL SAMPLE STATIONS



### 3.2 ATTACHED BENTHIC COMMUNITY

#### Summary

Fouling plates made of 125 x 75 asbestos boards are suspended 1 meter above the bottom at the instrument tower locations shown in Figure 3.1-1 and are used to obtain samples. Two vertical and two horizontal plates are suspended at each indicated location. One of each pair is removed and replaced at bimonthly intervals; the other part is left in place for one year before being removed and replaced. The benthic communities attached to the plates are analyzed for species composition and diversity.

#### Results

The results of this survey are contained in the report prepared by the Virginia Institute of Marine Science entitled "Ecological Study of the Tidal Segment of the James River Encompassing Hog Point, 1978 Final Technical Report" dated February, 1979 which is appended to this section as Appendix 3.0.

#### Conclusions

Please refer to the referenced report.



### 3.3 EPIBENTHOS

#### Summary

Replicate benthic grab samples are collected at the stations shown in Figure 3.1.1. Collection is made on a quarterly basis, except during June, July, and August when they are made monthly. Population characteristics such as species composition, diversity, evenness, redundancy, and richness are determined. The data are analyzed to detect changes in specific components of the epibenthic community including the brackish water clam Rangia cuneata and blue crab Callinectes sapidus.

#### Results

The results of this survey are contained in the report prepared by the Virginia Institute of Marine Science entitled "Ecological Study of the Tidal Segment of the James River Encompassing Hog Point, 1978 Final Technical Report" dated February, 1979 which is appended to this report as Appendix 3.0.

#### Conclusions

Please refer to the referenced report.

### 3.4 NEKTON

Fisheries investigations will be reported separately as results from monthly surveys, from special seine surveys, from ichthyoplankton entrainment study, and from thermal plume entrainment study.

#### 3.4.1 MONTHLY SURVEYS

Monthly surveys employing beach seines and otter trawls have been conducted since May, 1970. Six years of data were analyzed and reported in the Semiannual Operating Report, July 1, 1975 through December 31, 1975 as a comparison of pre- and postoperative conditions. Data through August, 1976 have been analyzed and included in a report entitled "The Effects of Surry Power Station Operations on Fishes of the Oligohaline Zone, James River, Virginia."

Data for January-December, 1978 are presented as Tables 3.4.1-1 through 3.4.1-7. The cumulative account of the number of species, diversity, evenness, and richness by year by season is presented as Figure 3.4.1-1.

In all of the cases the following formulae were used:

Diversity --  $H'$  (Shannon-Wiener formula)

$$H' = - \sum_{i=1}^S \left( \frac{N_i}{N} \log_2 \frac{N_i}{N} \right)$$

Evenness --  $J$

$$J = H' / \log_2 S$$

Richness --  $D$

$$D = (S-1) / \log_2 N$$

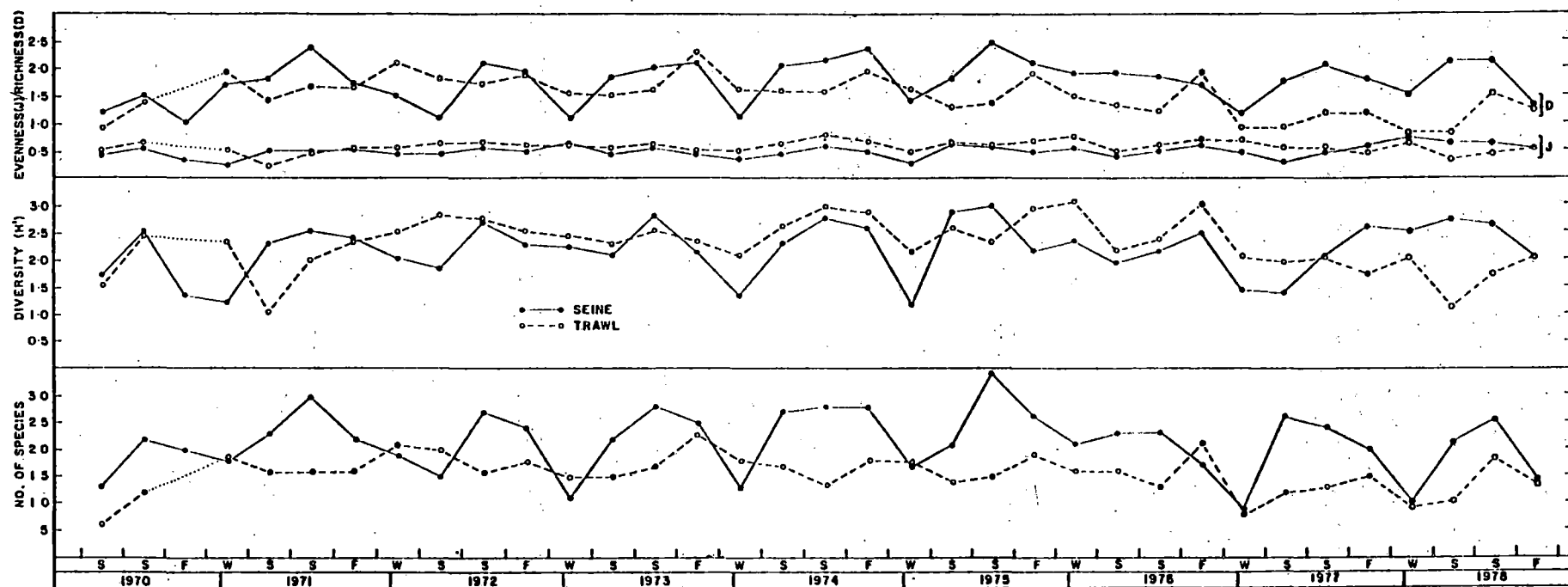
where

$N$  = total number of fish

$N_i$  = number of fish in a sample

$S$  = number of species

$i$  = sample number



COMPOSITE OF NUMBERS OF SPECIES, DIVERSITY ( $H'$ ), EVENNESS (J), AND RICHNESS (D)  
BY SEASON FOR SEINE AND TRAWL SAMPLES - SURRY POWER STATION

TABLE 3.4.1-1-- DIVERSITY ( $H'$ ), EVENESS ( $J$ ), ANDRICHNESS ( $D$ ): COMPOSITES BY SEASON

	<u>SEINE</u>			<u>TRAWL</u>		
	<u><math>H'</math></u>	<u><math>J</math></u>	<u><math>D</math></u>	<u><math>H'</math></u>	<u><math>J</math></u>	<u><math>D</math></u>
WINTER 1977	2.4630	0.7414	1.5115	1.9593	0.6181	0.7753
SPRING 1978	2.6870	0.6117	2.1275	1.0853	0.3267	0.8309
SUMMER 1978	2.5593	0.5511	2.0853	1.6885	0.4049	1.5298
FALL 1978	1.9949	0.5240	1.2881	2.0087	0.5428	1.1890

TABLE 3.4.1-2 -- DIVERSTIY (H') FOR SEINE DATE -- SURRY

DATE	STATION							
	INTAKE SOUTH	INTAKE NORTH	HOG POINT WEST	CHIPOAKES CREEK	GOOSE HILL	JAMESTOWN ISLAND	COLLEGE CREEK	COMPOSITE
1-78	0.0000	0.0000	1.6764	0.8454	.	1.5850	0.9183	2.2547
2-78	1.0000	.	1.7925	1.5000	.	1.0000	.	2.5216
3-78	1.0842	1.0949	0.0000	2.1181	1.4238	0.6988	1.1863	2.5549
4-78	1.5197	1.2389	0.9183	0.0000	1.5850	1.0714	0.8842	1.7297
5-78	2.0000	3.0333	2.1800	1.2075	2.2359	0.7295	2.2167	1.6649
6-78	0.7699	0.7728	2.2783	1.5519	1.6288	0.7778	1.5428	1.5379
7-78	1.5360	0.7669	1.7791	1.6620	2.0588	2.1877	2.3899	2.6924
8-78	0.7046	2.2758	2.4540	2.5281	1.8685	2.5152	2.2199	3.2575
9-78	0.4251	2.0252	2.5334	2.6145	1.3585	0.9792	1.0423	1.9949
12-78	0.1231	0.3912	0.0000	1.2403	0.0710	1.3548	0.2352	0.6219

3.4.1-4

TABLE 3.4.1-3 -- DIVERSTIY (H') FOR TRAWL DATE -- SURRY

DATE	STATION						
	HOG POINT	INTAKE	DISCHARGE NORTH	DISCHARGE MIDDLE	DISCHARGE SOUTH	GOOSE HILL	COMPOSITE
1-78	1.1326	1.3713	1.8979	1.5887	1.4207	0.5917	1.9681
2-78	1.2516	1.2635	1.3288	1.6313	1.5292	0.5665	1.6208
3-78	0.2543	0.5913	1.5686	1.4511	0.8796	0.5700	1.0406
4-78	0.1914	0.2223	0.7004	0.8550	0.4167	1.5339	0.7212
5-78	0.6998	0.8707	1.9657	1.5892	1.6106	1.9131	1.7577
6-78	1.4009	2.1194	0.2833	1.0978	1.7181	2.1266	1.5188
7-78	1.4514	1.6683	1.2733	1.2949	0.6951	1.9691	1.3915
8-78	2.1021	2.2929	1.5026	2.0887	1.5361	1.5962	2.0550
9-78	1.7611	2.5497	1.4329	1.6011	1.7015	1.6459	2.0087
12-78	0.9581	2.0461	2.2876	2.1367	2.5811	0.4808	1.7296

3.4.1-5

TABLE 3.4.1-4 -- EVENNESS (J) FOR SEINE DATA -- SURRY

STATION								
DATE	INTAKE SOUTH	INTAKE NORTH	HOG POINT WEST	CHIPOAKES CREEK	GOOSE HILL	JAMESTOWN ISLAND	COLLEGE CREEK	COMPOSITE
1-78	0.0000	0.0000	0.8382	0.8454	.	1.0000	0.9183	0.8031
2-78	1.0000	.	0.8962	0.9464	.	1.0000	.	0.8982
3-78	0.4194	0.6908	0.0000	0.9122	0.7119	0.3494	0.5931	0.6710
4-78	0.7599	0.7817	0.9183	0.0000	1.0000.	0.6760	0.5579	0.6161
5-78	1.0000	0.9131	0.8434	0.6038	0.9630	0.2301	0.6673	0.4261
6-78	0.2978	0.2753	0.8814	0.4896	0.5802	0.2593	0.5968	0.3762
7-78	0.6615	0.3834	0.5613	0.6429	0.8867	0.6103	0.9245	0.7072
8-78	0.7046	0.6578	0.7742	0.7610	0.6656	0.8959	0.8588	0.7669
9-78	0.1645	0.7835	0.9024	0.8248	0.8571	0.3788	0.5212	0.5240
12-78	0.1231	0.3912	0.0000	0.5342	0.0710	0.6774	0.2352	0.2406

3.4.1-6

TABLE 3.4.1-5 -- EVENNESS (J) FOR TRAWL DATA -- SURRY

## STATION

DATE	HOG POINT	INTAKE	DISCHARGE NORTH	DISCHARGE MIDDLE	DISCHARGE SOUTH	GOOSE HILL	COMPOSITE
1-78	0.7146	0.6857	0.8174	0.6146	0.7104	0.5917	0.6560
2-78	0.7897	0.7972	0.5140	0.6311	0.5916	0.5665	0.5403
3-78	0.2543	0.3731	0.6068	0.5614	0.5550	0.2850	0.3707
4-78	0.1914	0.1111	0.3016	0.4275	0.1794	0.5934	0.2790
5-78	0.4416	0.5493	0.7604	0.6148	0.8053	0.7401	0.5859
6-78	0.7005	0.9128	0.1417	0.5489	0.6646	0.9159	0.4572
7-78	0.5170	0.8342	0.4536	0.4316	0.2193	0.7618	0.3881
8-78	0.7007	0.7643	0.4740	0.6962	0.5120	0.5686	0.5028
9-78	0.7585	0.9082	0.7165	0.5703	0.5672	0.4758	0.5428
12-78	0.3413	0.7288	0.8149	0.7122	0.8143	0.2071	0.4824

3.4.1-7



TABLE 3.4.1-6 -- RICHNESS (D) FOR SEINE DATA -- SURRY

DATE	STATION							
	INTAKE SOUTH	INTAKE NORTH	HOG POINT WEST	CHIPOAKES CREEK	GOOSE HILL	JAMESTOWN ISLAND	COLLEGE CREEK	COMPOSITE
1-78	1.0000	1.0000	0.6175	0.2891	.	1.2619	0.6309	1.0743
2-78	1.0000	.	1.1606	1.0000	.	1.0000	.	1.5759
3-78	0.8688	0.5253	1.0000	1.1563	0.7500	0.6382	0.7500	1.8288
4-78	0.7340	0.5405	0.6309	0.0000	1.2619	0.3509	0.4628	0.8831
5-78	1.5000	1.9380	1.2500	0.8368	1.4248	0.9745	1.4837	1.6022
6-78	0.8158	0.8628	0.8572	1.0835	1.0286	0.6905	0.7417	1.4900
7-78	0.6117	0.5372	1.1288	0.9460	1.2619	1.2414	1.2798	1.3468
8-78	0.1800	1.3466	1.6468	1.5639	1.1894	1.1433	1.0292	2.0807
9-78	0.5685	0.8365	1.3264	1.6148	0.3709	0.5649	0.6309	1.2881
12-78	0.1450	0.2702	0.0000	0.6483	0.1456	0.6000	0.2127	0.5817

3.4.1-8

TABLE 3.4.1-7 -- RICHNESS (D) FOR TRAWL DATA -- SURRY

DATE	STATION						
	HOG POINT	INTAKE	DISCHARGE NORTH	DISCHARGE MIDDLE	DISCHARGE SOUTH	GOOSE HILL	COMPOSITE
1-78	0.3459	0.6309	0.4990	0.6837	0.5495	0.3562	0.7687
2-78	0.7737	0.3899	0.5782	0.7087	0.7055	0.2560	0.7365
3-78	0.1295	0.2896	0.6837	0.7252	0.2901	0.5166	0.6240
4-78	0.1966	0.4173	0.5213	0.3896	0.5456	0.8333	0.5168
5-78	0.4076	0.3686	1.0000	0.8333	0.7879	0.9460	0.8981
6-78	0.5079	0.8152	0.4118	0.6055	0.9002	1.0000	1.0702
7-78	1.0426	0.4644	0.7168	1.0153	0.8680	0.8500	1.0697
8-78	1.2221	1.2822	1.0633	1.0810	0.9608	0.8992	1.7214
9-78	0.6504	0.9464	0.6727	0.7967	0.9314	1.0985	1.1890
12-78	0.7371	0.7835	1.1606	0.9354	1.3838	0.4786	1.0913

3.4.1-9

### 3.4.2 POPULATION ESTIMATES

Several fish species inhabit the waters of the James River around Hog Island at certain stages in their life cycle during certain times of the year. In an effort to estimate numbers of fish inhabiting the shore zone waters during times of expected high population density in an area from the intake structure to the discharge groin, three sample stations (Hog Point-West, Hog Point-North, Hog Point-East) were sampled (Figure 3.4.2-1). Data are reported as Table 3.4.2-1.

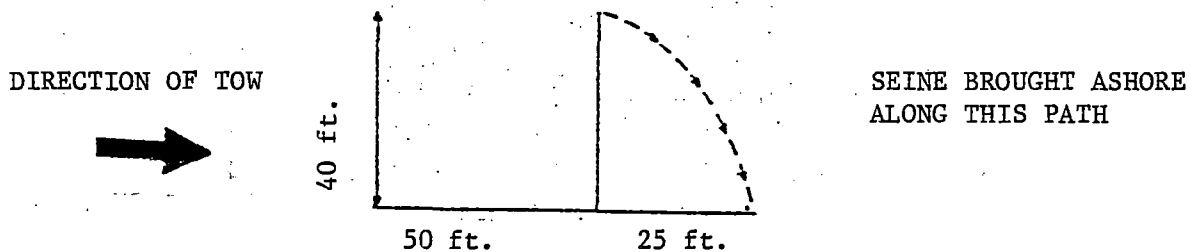
In order for population estimates to approach total populations of a species within a given area in any reliable manner, certain assumptions have to be made: (1) Fish are uniformly distributed throughout the area from the shoreline to 40 feet out from the shoreline; (2) Catch efficiency of a haul seine is about fifty percent; and (3) Sample station habitats, and therefore the entire multiplicity of shoreline habitats, are similar and equal in their ability to attract and support young fish.

That these assumptions do not hold true, especially in the oligohaline reaches of tidal estuaries, is shown by the high degree of variability between and within species, between and within stations, and between replicates of a station. However, to fulfill the requirements of this section of the Surry Technical Specifications, the following methodology was used in an attempt to estimate populations.

The shoreline between the discharge and intake is about 30,000 feet long and provides 400 possible 75-foot sampling stations. Sample values for all species have been projected to reflect the numbers of fish occupying a 40-foot wide strip along this shore on the given sample days.

A fifty-foot haul seine having 1/4 inch bar mesh netting was used to sample a premeasured 75-foot stretch of beach. A replicate sample was taken within minutes of the first sample.

A sample consisted of stretching the seine perpendicular to the shore, hauling it 50 feet and then having the offshore man bring his end ashore in an arc about 25 feet further along the beach as shown below.

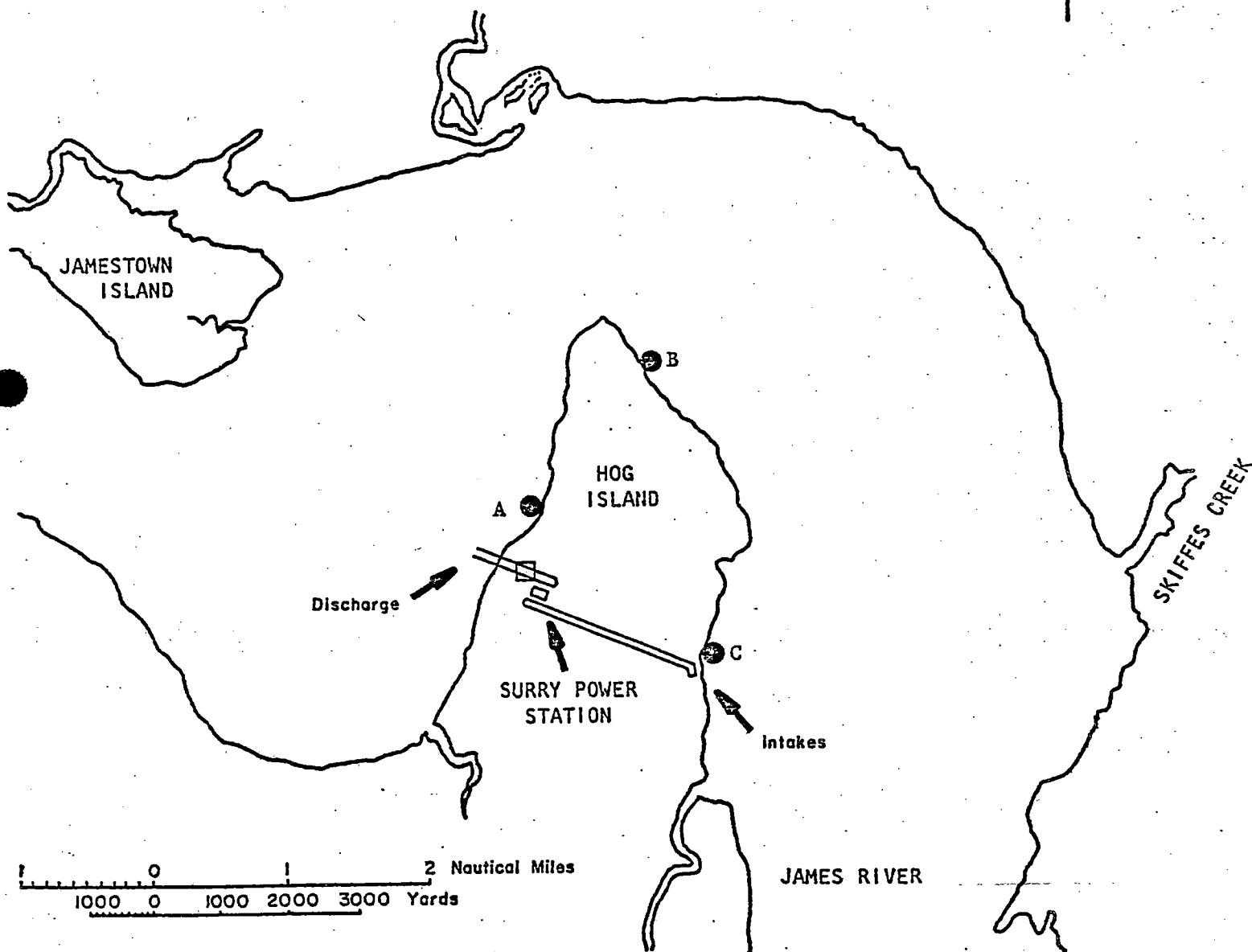
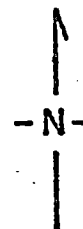


Hence, a small portion of the sample unit (about 8-10%) is not covered. The population estimates do not include an expansion for this unsampled area and thus should consistently underestimate the population values by a small amount.

It should be pointed out that all of the species sampled, within the size ranges taken, are schooling species except for possibly spottail shiner, golden shiner, channel catfish, and white perch. Schooling will also cause large variances to be associated with population estimates.

Figure 3.4.2-1

SURRY  
POWER STATION



A—Hog Point-West  
B—Hog Point-North  
C—Hog Point-East

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=ALOSA AESTIVALIS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780323	2	6	133.3	84.328	J
780504	1	6	66.7	66.659	J
780907	1	6	66.7	66.659	J
781012	1	10	66.7	51.634	J
781013	9	6	600.0	409.880	J

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=ANCHOA MITCHILLI

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780421	45	6	3000.2	1864.05	J/A
780504	35	6	2333.5	802.78	J/A
780602	1	6	66.7	66.66	A
780706	4	6	266.7	168.66	A
780727	11	6	733.4	733.34	J/A
780803	5	6	333.3	261.62	A
780822	1	6	66.7	66.66	A
780907	13	6	866.7	578.89	PL/J
781011	19	14	542.9	349.84	J/A
781012	51	10	2040.0	1014.47	J/A
781013	52	6	3466.8	2092.96	J/A

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=ANGUILLA ROSTRATA -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780330	1	6	66.7	66.6591	J

3.4.2-6



TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=BREVOORTIA TYRANNUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780421	23	6	1533	1080	L
780504	2	6	133	84	L
780602	3051	6	203410	156618	L/J
780706	42	6	2800	2800	J
780727	72	6	4800	3207	J/A
780803	4592	6	306149	302300	J
780822	15	6	1000	771	J
780907	15	6	1000	683	J
781011	3	14	86	62	J
781012	12	10	480	341	J
781013	126	6	8400	8320	J

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=CYPRINUS CARPIO -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780330	2	6	133.3	84.328	A
780602	5	6	333.3	261.620	J
780907	1	6	66.7	66.659	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=DDROSOMA CEPEDIANUM

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780323	3	6	200.0	200.001	A
780330	4	6	266.7	84.328	J/A
780727	3	6	200.0	200.001	A
780803	5	6	333.3	261.620	J
780907	18	6	1200.1	677.252	J
781011	2	14	57.1	57.143	J
781012	4	10	160.0	160.000	J

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=FUNDULUS DIAPHANUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780616	6	6	400	103.28	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=FUNDULUS HETEROCLITUS

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780323	30	6	2000.1	946.58	J/A
780330	17	6	1133.4	747.74	J/A
780421	4	6	266.7	266.67	J/A
780504	15	6	1000.1	683.13	J/A
780602	15	6	1000.1	728.47	J/A
780616	36	6	2400.1	957.78	J/A
780706	29	6	1933.4	1698.37	A
780727	13	6	866.7	392.15	A
780822	6	6	400.0	252.98	J
780907	1	6	66.7	66.66	A
781011	82	14	2342.9	1212.29	J/A
781012	7	10	280.0	280.00	J/A

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=ICTALURUS NEBULOSUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780803	2	6	133.3	84.3278	J

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=ICTALURUS PUNCTATUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780421	1	6	66.7	66.6591	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=LEIDOSTOMUS XANTHURUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780421	4	6	266.7	84.33	J
780504	2	6	133.3	84.33	J
780602	71	6	4733.6	1320.27	J
780616	9	6	600.0	458.99	J
780706	10	6	666.7	304.05	J
780727	51	6	3400.2	1481.45	J
780803	14	6	933.4	552.97	J
780822	7	6	466.7	240.37	J
780907	59	6	3933.5	1888.69	J
781011	202	14	5771.4	1592.13	J
781012	197	10	13134.0	7111.64	J
781013	16	6	1066.7	910.19	J



TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=LEPOMIS GIBBOSUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780727	1	6	66.7	66.6591	J
781012	1	10	66.7	51.6337	J
781013	1	6	66.7	66.6591	J

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=MEMBRAS MARTINICA

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780602	5	6	333.3	261.620	A
780706	2	6	133.3	84.328	A
780727	4	6	266.7	133.334	A
780803	1	6	66.7	66.659	A
780907	1	6	66.7	66.659	A
781011	5	14	142.9	142.857	J/A
781012	1	10	66.7	51.634	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=MENIDIA BERYLLINA

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780323	6	6	400.0	178.89	A
780330	15	6	1000.1	422.69	J/A
780421	11	6	733.4	510.34	J/A
780504	11	6	733.4	530.83	J/A
780602	9	6	600.0	322.49	A
780616	6	6	400.0	326.60	A
780706	2	6	133.3	133.33	A
780727	8	6	533.4	533.34	J/A
780803	2	6	133.3	133.33	A
780907	5	6	333.3	261.62	J
781011	136	14	3885.7	2276.08	J/A
781012	26	10	1040.0	400.89	J/A
781013	19	6	1266.7	747.74	J/A
781102	23	6	1533.4	443.22	J/A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=MENIDIA MENIDIA

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780504	2	6	133.3	84.33	A
780616	15	6	1000.1	651.16	J
780706	34	6	2266.8	1250.78	J/A
780727	105	6	7000.4	2983.97	J/A
780803	27	6	1800.1	524.09	A
780822	11	6	733.4	578.89	A
780907	78	6	5200.3	1642.77	A
781011	427	14	12200.0	4537.85	A
781012	231	10	9240.0	3748.28	A
781013	34	6	2266.8	480.74	A
781102	114	6	7600.4	3088.05	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=MICROPOGON UNDULATUS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780907	2	6	133.3	133.334	J

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE.

SP=MORONE AMERICANA

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780330	3	6	200.0	136.627	J
780421	4	6	266.7	168.656	J
780504	2	6	133.3	84.328	J
780602	7	6	466.7	217.052	A
780706	13	6	866.7	316.931	J
780727	3	6	200.0	89.443	J
780803	2	6	133.3	84.328	J
780822	6	6	400.0	103.280	J/A
780907	23	6	1533.4	656.593	J/A
781011	58	14	1657.1	765.012	J/A
781012	12	10	480.0	271.948	J/A
781013	9	6	600.0	409.880	J/A
781102	9	6	600.0	524.089	J/A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=MORONE SAXATILIS

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780504	3	6	200.0	136.627	J
780602	9	6	600.0	382.972	J
780616	23	6	1533.4	578.890	J
780706	5	6	333.3	261.620	J
780727	2	6	133.3	84.328	J
780803	6	6	400.0	326.600	J
780822	1	6	66.7	66.659	J
780907	5	6	333.3	160.555	J
781011	3	14	85.7	45.522	J
781012	5	10	200.0	89.443	J
781013	1	6	66.7	66.659	J

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=MUGIL CEPHALUS

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780421	16	6	1066.7	1066.67	J
780727	6	6	400.0	273.25	J
780803	2	6	133.3	84.33	J/A
781012	1	10	66.7	51.63	A
781102	3	6	200.0	200.00	A



TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=NOTEMIGONUS CRYSOLEUCAS -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780330	2	6	133.3	133.334	J/A
780504	1	6	66.7	66.659	J
780602	2	6	133.3	84.328	A
780907	2	6	133.3	133.334	A
781013	1	6	66.7	66.659	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=NOTROPIS HUDSONIUS

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780323	1	6	66.7	66.659	A
780330	1	6	66.7	66.659	A
780421	1	6	66.7	66.659	A
780616	2	6	133.3	133.334	J
780706	1	6	66.7	66.659	J
780727	7	6	466.7	299.631	J
780803	4	6	266.7	197.766	J
780907	6	6	400.0	400.002	J
781011	6	14	171.4	69.082	J/A
781012	3	10	120.0	85.375	A
781013	1	6	66.7	66.659	A

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

SP=PERCA FLAVESCENS

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780602	4	6	266.7	133.334	J
781013	1	6	66.7	66.659	J

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=POMATOMUS SALTATRIX -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780706	3	6	200.0	136.627	J
780727	4	6	266.7	133.334	J
780803	2	6	133.3	133.334	J
780822	3	6	200.0	89.443	J
781012	1	10	66.7	51.634	J

TABLE 3.4.2-1  
 POPULATION ESTIMATES AROUND HOG POINT  
 STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

----- SP=STRONGYLURA MARINA -----

DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
780822	1	6	66.7	66.659	A
781012	3	10	120.0	85.375	A
781102	2	6	133.3	133.334	A

TABLE 3.4.2-1  
POPULATION ESTIMATES AROUND HOG POINT.  
STD EST IS THE STANDARD DEVIATION OF THE ESTIMATE

---

SP=TRINECTES MACULATUS					
DATE	TOTAL	SAMPLES	EST	STD EST	STAGE
781102	1	6	66.7	66.6591	A

3.5.1 THERMAL PLUME ENTRAINMENT OF ICHTHYOPLANKTON

Please refer to the following report by the Virginia  
Institute of Marine Science for preliminary results and conclusions.

3.5.1 Thermal Plume Entrainment of Ichthyoplankton

Section II b.

THERMAL PLUME ENTRAINMENT OF ICHTHYOPLANKTON  
AT VEPCO NUCLEAR POWER STATION

by

John V. Merriner

A. Deane Estes

and

Robert K. Dias



TABLE OF CONTENTS	PAGE
LIST OF TABLES . . . . .	iii
LIST OF FIGURES. . . . .	v
ACKNOWLEDGMENTS. . . . .	vii
LIST OF PROJECT PERSONNEL. . . . .	viii
INTRODUCTION . . . . .	1
METHODS AND MATERIALS. . . . .	3
Statistical Methods . . . . .	5
RESULTS AND DISCUSSION . . . . .	9
Seasonal Trends in Species Composition and Abundance. . . . .	9
Hydrographic Data . . . . .	13
Statistical Results . . . . .	14
Summary of Regression Analysis. . . . .	20
CONCLUSIONS. . . . .	23
LITERATURE CITED . . . . .	27

# LIST OF TABLES

Table		Page
1	Ichthyoplankton sampling schedule for plant and plume entrainment studies at VEPCO Surry Nuclear Power Plant (January through December 1978) . . .	48
2	Dependent ( $Y_i$ ) and independent ( $X_j$ ) variables for statistical analysis (standardized catch is number collected per 100 cubic meters of water strained per collection). . . . .	49
3	Number of species captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978. . . . .	51
4	Average number ( $100 \text{ m}^3$ ) of fish and fish eggs <u>per sample</u> captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	53
5	Species and calculated number of fish per $100 \text{ m}^3$ captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978. . . . .	56
6	Species and calculated number of fish eggs per $100 \text{ m}^3$ captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	82
7	Salinity ( $^{\circ}/_{\text{oo}}$ ) at VEPCO Surry Nuclear Power Plant during plume entrainment stations in 1978 (D = Day; N = Night). . . . .	101
8	Water temperature (C) at VEPCO Surry Nuclear Power Plant during plume entrainment stations in 1978 (D = Day; N = Night) . . . . .	104
9	Dissolved oxygen (mg/l) at VEPCO Surry Nuclear Power Plant during plume entrainment stations in 1978 (D = Day; N = Night) . . . . .	107
10	Descriptive statistics of dependent ( $Y_i$ ) and independent ( $X_j$ ) variables. . . . .	110
11	Summary statistics for final stepwise regression equations . . . . .	112

Table

Page

12	Standardized partial regression coefficients with ranks of relative importance in parentheses . . .	113
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# LIST OF FIGURES

Figure		Page
1	0.5 meter paired net apparatus with rope bridle and lead weight . . . . .	29
2	James River in vicinity of Surry Nuclear Power Station showing plume entrainment sampling locations . . . . .	30
3	Number of fish species captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	31
4	Number of fish species captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	32
5	Number of fish species captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	33
6	Number of egg species captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	34
7	Number of egg species captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	35
8	Number of egg species captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	36
9	Average number of fish per sample (100 m <sup>3</sup> ) captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	37
10	Average number of fish per sample (100 m <sup>3</sup> ) captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	38
11	Average number of fish per (100 m <sup>3</sup> ) captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	40

Figure		Page
12	Average number of eggs per sample (100 m <sup>3</sup> ) captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . .	42
13	Average number of eggs per sample (100 m <sup>3</sup> ) captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . .	43
14	Average number of eggs per sample (100 m <sup>3</sup> ) captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978. . .	45
15	Ranges of salinity (‰) in ambient river water during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	46
16	Ranges of water temperature (C) during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	47

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## INTRODUCTION

Thermal plume ichthyoplankton sampling was initiated at VEPCO Surry Nuclear Power Plant in August 1975 by the Ichthyology Department of Virginia Institute of Marine Science. Objectives of this study were to assess the kinds and amounts of ichthyoplankton being entrained from the waters of Cobham Bay, James River by the thermal effluent from the facility.

Heated effluent from the Surry facility travels through the discharge canal where some cooling occurs. The canal is constricted at the discharge point to increase water velocity as it enters the river. In achieving this, considerable turbulence is created, promoting faster mixing, thus reducing the area of thermal impact to the immediate vicinity of the discharge point. Most ichthyoplankton are pelagic and unable to effectively negotiate water currents. As Cobham Bay water mixes with the thermal effluent, ichthyofauna therein are entrained and carried along with the thermal plume.

VEPCO Surry is located near the freshwater to marine transition zone of the James River, thus the ichthyofauna varies considerably as salinity fluctuates with seasonal and short-term weather patterns affecting the James River discharge. Eighty-four fish species representing 38 families have been reported from the vicinity of Hog Island (White, 1976); species reported ranged from strictly



freshwater to polyhaline forms. Many species are represented only as juvenile and adult life stages. As such, they are capable of negotiating the currents in the thermal plume and are not subject to entrainment. Other species utilize the area as spawning areas (engraulids, gobiids), nursery areas (sciaenids, Brevoortia), and as migration route (Alosa, Morone, Anguilla). Many freshwater and several anadromous species spawn upriver from Hog Island; however, in years that salinities are depressed during spawning times, spawning may occur near Hog Island. Larvae and postlarvae of these species might then occur near VEPCO Surry and be subject to entrainment.

Species lists and abundance of ichthyoplankton captured in and near the thermal plume from VEPCO Surry are presented along with ranges of salinity, dissolved oxygen, and temperature during sampling visits. Species composition, trends of abundance, statistical analyses of the data set (1978), and entrainment impact upon the ichthyofauna near Hog Island are discussed.

Sampling visits for plant and thermal plume ichthyoplankton entrainment from January through December 1978 are presented in Table 1. Sampling intensity for plume entrainment reflects anticipated periods of greatest spawning activity (April, May) and periods of critical water temperature elevations ( $\Delta T$ ) i.e., August.

## METHODS AND MATERIALS

Thermal plume ichthyoplankton sampling employed the use of a 0.5 meter paired net apparatus (Fig. 1) equipped with conical Nitex nets (505  $\mu$  mesh) and General Oceanics Digital Flowmeters (Model 2030). The unit was selected as the best sampling gear for the plume study after reviewing gear evaluation studies conducted for the plant entrainment sampling program (Merriner and Estes, 1975). Flowmeters were periodically calibrated in the VIMS flume. For towing, lead weights and a bridle of 0.25 inch braided nylon rope were added to the net apparatus.

Sampling sites (Fig. 2) were: (1) mid-channel in the discharge canal at the roadway bridge; (2) plume area where water temperatures exceed ambient water temperatures by 5 C; and (3) that area of Cobham Bay where ambient water temperatures exist. Two tows each were made in the plume area and ambient river water; one tow was made in the discharge canal. Stepped oblique tows of 5-minute duration were made with bottom, midwater, and surface steps per tow. The nets fished at each depth for approximately 1 minute and 40 seconds. The boat's engine was operated at 900 RPM, except in the discharge canal where the boat was tied to the roadway bridge.

Water temperature, dissolved oxygen, and salinity were taken in the discharge canal, at the end of tow 1, and at the end of tow 3. Data were taken at surface, midwater,

and bottom depths except where water was less than 4 meters deep. For the latter, only surface and bottom data were obtained. Salinity samples were returned to VIMS for analysis with a Beckman RS-7 induction salinometer. Dissolved oxygen samples were fixed in the field for laboratory analysis by the Winkler Titration Method. Water temperature was measured to the nearest degree with a stem thermometer (-35 C to 50 C, 1 C interval). Sea state, weather, turbidity, etc. were recorded at the time of sampling.

Sampling at low slack tide would theoretically locate the plume in the same relative position during sampling visits, except for minor deviations due to meteorological conditions (wind, rain, etc.) that influenced river flow during any given sampling period. This reduced total sampling time and provided relatively constant water depths for sampling. At low slack tide, the plume generally flowed straight out from the discharge canal and then bent slightly upriver (Fig. 2).

Ichthyoplankton samples were preserved with approximately 5% formalin, and returned to VIMS for sorting, enumeration, and identification. Data were tabulated and punched on ADP cards for analysis.

The most useful key for the identification of fish eggs and larvae has been a manual by Lippson and Moran (1974).

Where identification of larvae was dependent upon accurate myomere counts, larvae were cleared and stained (Mook and Wilcox, 1974).

Vessels and operators for sampling stations were provided by VEPCO. Two VIMS project personnel were required to conduct each shift (day; night) of plume sampling.

All calculations and conclusions presented in this report are based on number of organisms per 100 cubic meters of water strained unless otherwise stated.

#### Statistical Methods

Catch data were subjected to statistical analysis (a) to determine the significant spatial and temporal trends in the ichthyoplankton community, (b) to develop regression models which identify the major environmental factors of importance to community structure, and (c) to assess significant patterns in two dominant fish populations (Anchoa mitchilli and Gobiosoma boscii).

Six dependent or response variables ( $Y_i$ ) which reflect overall community structure were included in the analysis; these were total abundance of fish, abundance of fish species, fish species diversity (Shannon index), total abundance of eggs, abundance of egg species, and egg species diversity. The abundance of A. mitchilli fish, A. mitchilli eggs, and G. boscii fish were also included as dependent variables. [NOTE: For simplicity throughout this report, the species abundance and species diversity of the egg

stage are referred to as egg species abundance and egg species diversity, respectively.]

Measures of abundance were computed as  $Y_i = \log_e (C_i + 1)$ , where  $Y_i$  is abundance and  $C_i$  is standardized catch of collection  $i$  (i.e. number captured per 100 cubic meters of water strained per collection). Logarithmic transformation of the catch data was necessary to convert discrete variables to continuous form and to remove heterogeneity and non-normality from the data. Measures of species diversity were not log-transformed and were analyzed in their original scale.

Nine independent variables ( $X_j$ ) were chosen for analysis: water temperature, salinity, dissolved oxygen and dummy variables for sampling locations (plume and ambient), period and seasons (fall, winter and spring). Table 2 summarizes notation and defines the dependent and independent variables.

Multiple regression was selected as the major method to analyze trends in the response variables for the following reasons:

(a) Complex multivariate relationships exist between the abundance of fish and eggs and environmental variables; as a descriptive tool, multiple regression can give a concise summary of these relationships.

(b) Field survey data are confounded by numerous factors since such surveys are observational in nature

rather than controlled; multiple regression allows for control of some of these confounding factors by the use of "dummy" (categorical) variables. Also, each partial regression coefficient is computed as if the other variables in the equation are held constant, thereby removing their confounding effects.

(c) The ability to accurately predict the effects of environmental change or modification upon living resources is an ultimate goal; multiple regression techniques can be used to develop empirical models with predictive capabilities.

Stepwise regression techniques (Draper and Smith, 1966) were used to develop the "best" regression equation for each  $Y_i$  in the following manner:

(a) The dependent variables were plotted against environmental (independent) variables and the data were transformed where necessary.

(b) Matrices of simple correlation coefficients of dependent and independent variables and selected transformations were computed.

(c) Using the multiple regression model

$$Y_i = B_0 + B_1X_1 + B_2X_2 + \dots + B_pX_p + \epsilon,$$

where  $Y_i$  is abundance or species diversity,  $X_j$  is some function of one of the selected environmental variables, and  $B_j$  is a partial regression coefficient, a stepwise regression was performed to identify those parameters which explain a significant portion of the variation in the model.

(d) For each final regression equation residuals were analyzed to detect possible violations of the basic assumptions that the errors were independent, had zero mean, constant variance and followed a normal distribution.

Computations were made using SPSS version 6.02 (Nie, et. al., 1975). Independent variables were retained in the equations if their partial regression coefficients ( $b_j$ ) could be declared significantly different from zero at  $P < 0.10$ . Equations for the community structure variables ( $Y_1$  through  $Y_6$ , Table 2) were based upon data from January through December 1978. Equations for A. mitchilli and G. bosci ( $Y_7$  through  $Y_9$ ) were based on data from May through October 1978, the time period in which eggs and larvae of these species are known to occur.

## RESULTS AND DISCUSSION

Seasonal Trends in Species Composition and Abundance

Number of species (fish) increased slightly from January through March (Table 3; Fig. 3). Counts then increased two-fold in April and remained high through June though numbers fluctuated slightly. Species counts declined slightly in July and fluctuated at moderate counts (4 to 6) through October. November counts declined slightly, and early-December counts increased but mid-December counts decreased again. The highest species count was recorded during the night station on 31 May and lowest counts were recorded on the day stations of February and mid-March. Species counts at night generally exceeded counts in daylight.

Species counts during daytime in the thermal plume exceeded counts in the discharge canal on all but six sampling visits (Fig. 4). The thermal plume contained species that were not captured in the discharge canal on five of those six visits.

Specific counts during nighttime in the thermal plume exceeded counts in the discharge on all but five sampling visits (Fig. 5). The thermal plume contained species that were not captured in the discharge canal on three of those five visits.

Fish eggs were captured from March through September (Table 3; Fig. 6). Species counts of eggs were low in



March, increased to the highest counts in early-April, and remained high through mid-May. Counts thereafter declined to low numbers and remained low through September.

Species counts of fish eggs during daylight in the plume exceeded counts in the discharge canal on six sampling visits (Fig. 7). Discharge canal counts exceeded thermal plume counts on one occasion. Species counts in the thermal plume at night exceeded counts in the discharge canal on seven sampling visits (Fig. 8). Discharge canal counts exceeded thermal plume counts on two occasions. When counts were the same in the discharge canal and thermal plume, different species were captured in the thermal plume once.

Species counts of fish and fish eggs between the thermal plume and discharge canal indicate some ichthyoplankton entrainment by the thermal plume.

Average number of fish per sample (100 m<sup>3</sup>) was low from January through March (Fig. 9). Concentrations increased in early-April but decreased gradually through the month. Abundance again increased in early-May but dropped during the last sampling visit in May. Concentrations then increased sharply with the influx of naked goby (Gobiosoma bosci) and bay anchovy (Anchoa mitchilli) and remained high throughout the summer months. Abundance then gradually declined through October but stabilized at low concentrations during November and December as postlarval and juvenile croaker entered the area.

Nighttime catch exceeded daytime catch on all but four sampling visits (Fig. 9). During summer months nighttime catches exceeded daytime catches two to three-fold.

Average catch per sample (by site) for both daytime and nighttime sampling revealed no consistent trends in catch at any sampling site (Table 4; Figs. 10 and 11). However, during August, sampling in the discharge canal yielded higher catches than the plume area except during daytime sampling on 22 August.

Catches of fish eggs in 1978 was greatly reduced from those in 1977 (Jordan et. al., 1978). Abundance of fish eggs was low except during early-April and early-May (Fig. 12). Several other sampling runs in June, July, and August yielded moderate concentrations of fish eggs. Highest catch of eggs tended to be in the discharge canal during daytime samples (Fig. 13). During April, highest nighttime catches were made in the plume but before and after April, no trends were evident (Fig. 14).

Bay anchovy and naked goby were the dominant species captured in 1978 plume entrainment samples (Tables 5 and 6). Bay anchovy eggs, larvae and postlarvae were taken from late spring through early fall. Juveniles and adult were taken all year, but they were captured more frequently in winter and early spring. Larval bay anchovy were taken from May through October in concentrations generally less than  $1/m^3$ .

(Table 5). Naked goby larvae and postlarvae were captured from May through October and were the most abundant fishes captured (Table 5). Concentrations of naked goby were usually less than  $2/m^3$  and highest concentrations were  $6/m^3$ .

Spot (Leiostomus xanthurus) and Atlantic croaker (Micropogon undulatus) were captured seasonally (Table 5); spot were captured in springtime samples and croaker were captured during fall samples. Both were usually present in concentrations less than  $1/m^3$  at all sampling sites.

Sciaenids are hatched offshore and thereafter migrate into Atlantic coast estuaries which serve as nursery areas for postlarvae and juveniles. The James River is one such estuary and the area near Hog Point is part of the sciaenid nursery area. These postlarvae and juveniles are subject to entrainment by the thermal plume until they reach a size at which they can effectively overcome the turbulence in the mixing zone.

Atlantic menhaden (Brevoortia tyrannus) were taken in April and May samples as the pre-juveniles entered the estuarine nursery grounds (Table 5). However, densities were less than  $1/m^3$ .

Striped bass (Morone saxatilis) and white perch (Morone americana) larvae and postlarvae were frequently captured in springtime samples (Table 5). Concentrations were less than  $1/m^3$  but more larvae were captured in 1978 than in any previous year. White perch were consistently

taken in the thermal plume and ambient river areas but few were taken in the discharge canal. Striped bass were also captured most often in the thermal plume and ambient river areas. White perch eggs were taken frequently in April and May samples but only a few striped bass eggs were taken.

River herring (Alosa species) and American shad (Alosa sapidissima) eggs and larvae were also taken in greater concentrations than in all previous years (Tables 5 and 6). Generally, their concentrations were less than  $1/m^3$ .

Altantic silverside (Menidia menidia), Tidewater silverside (Menidia beryllina) and rough silverside (Membras martinica) were captured throughout the year (Tables 5 and 6). Eggs, larvae, and juveniles were captured during spring and summer; juveniles and adults were captured in fall and winter.

Other species were occasionally taken but numbers remained low.

#### Hydrographic Data

Salinity, water temperature, and dissolved oxygen data from 1978 plume entrainment samples are presented in Tables 7, 8, and 9 and Figures 15 and 16. Dissolved oxygen data are not depicted in graphic form.

Salinities (Table 7; Fig. 15) remained less than 10/00 during all but two samples from March, through May. Salinity was less than 1.70/00 on those two occasions. Accordingly,

several anadromous and freshwater species were frequently taken as eggs and larvae. Salinities rose slightly in mid-June but remained below 40/00 through August. Salinities rose again in the fall to the highest salinities in early-November.

Water temperature (Table 8; Fig. 16) peaked in August. Plume temperatures exceeded 35 C in August but did not always exceed ambient readings by 5 C. Water samples for the plume area are taken at the end of Tow 1 (Fig. 2) and some mixing occurs prior to this point. The thermal plume sometimes "dives" making exact location of the 5C  $\Delta T$  area difficult.

No oxygen deficiencies (<4 mg/l) were recorded though a plume sample on 8 August recorded oxygen levels <5 mg/l (Table 9).

#### Statistical Results

An examination of simple correlation matrices of potential regression variables in the original and log-transformed scales was made to identify the final equation form of variables. In general, correlations were higher between transformed dependent variables ( $Y_i$ ) and independent variables ( $X_j$ ) in their original scale, except for fish and egg species diversities. Little or no improvement in correlations was found by transforming either species diversity or the independent variables.

Although many simple correlation coefficients ( $r$ ) between the dependent and independent variables were declared highly significant ( $P < 0.001$ ), most correlations were not high (maximum  $r = 0.71$ ). All independent variables except location variables, plume and ambient were significantly correlated ( $P < 0.05$  or better) with six or more of the dependent variables.

Table 10 presents descriptive statistics of the dependent and independent variables. Table 11 summarizes the results of regression analysis. Each final regression equation is discussed separately, then overall patterns are summarized.

In the following discussion, the regression coefficients are partial coefficients which estimate the effects of a particular variable while holding constant or controlling all other variables in the equation. Evaluation of the contribution of a particular independent variable is facilitated by controlling the influence of other variables which otherwise could confound or mask significant relationships.

Total Abundance of Fish ( $Y_1$ ):

Temperature, salinity, period, fall and winter were retained in the final regression equation as significant predictors of fish abundance. The equation for  $Y_1$  was highly significant ( $P < 0.001$ ) and explained three-fourths of the variation in fish abundance ( $R^2 = 0.76$ ).

Temperature and period had positive partial regression coefficients ( $b_j$ 's); i.e. their partial effects on  $Y_1$  (fish abundance) were positive. The remaining independent variables had negative  $b_j$ 's. Within the ranges of values observed, the equation predicts an increasing total abundance of fish with an increasing temperature or decreasing salinity. Fish abundance was significantly higher at night than during the day.

Seasons were included in the analysis as dummy variables to mathematically reduce the unexplained variation in the model and to remove factors which could confound the analysis. After allowing for the effects of other variables in the equation, fall and winter had a significantly lower fish abundance than the reference season (summer). Spring did not differ significantly from summer. Unmeasured seasonal effects (in addition to those accounted for by variables in the equation) tended to decrease fish abundance in fall and winter. Factors which may be reflected in the season variables include time and duration of migrations of parent populations, recruitment, wind direction, currents, fishing efficiency of gear, and other unmeasured factors which vary seasonally.

The location variables (plume and ambient) were included in the analysis to estimate the partial effects of location on fish abundance. Because neither were retained in the equation, no significant differences in fish abundance were

found between plume and ambient river samples and samples from the discharge canal (the reference location). In other words, there was no evidence of significant plume entrainment after removing the effects of other variables in the equation.

#### Abundance of Fish Species ( $Y_2$ ):

The highly significant equation for  $Y_2$  explained two-thirds of the variation in fish species abundance ( $R^2 = 0.69$ ). The partial regression coefficients for temperature, plume, ambient, period and spring were positive; those for salinity and winter were negative. Dissolved oxygen and fall were not retained in the equation for fish species abundance. Holding other variables constant, an increase in temperature or a decrease in salinity will increase the fish species abundance. A significantly higher fish species abundance was found at night. Unmeasured seasonal factors represented by the season winter tended to decrease abundance of fish species in this season; the converse was true for spring. A significantly higher abundance of fish species was found in plume and ambient river samples than in samples from the discharge canal.

#### Fish Species Diversity ( $Y_3$ ):

The highly significant equation for  $Y_3$  explained fifty-five percent of the variation in fish species diversity and retained temperature, dissolved oxygen, plume, ambient, period,



and spring as significant independent variables. Samples at night had a significantly higher fish diversity than day samples. Seasonal factors (in addition those reflected in other variables in the equation) increased the fish diversity in spring. Thermal plume and ambient river samples had a significantly higher fish species diversity than discharge canal samples.

Total Abundance of Eggs ( $Y_4$ ):

Thirty-nine percent of the variation in egg abundance was explained by the equation for  $Y_4$ . The partial effects of spring were positive; those of temperature, ambient, period, fall and winter were negative. Ambient river samples and night samples had a significantly lower egg abundance than did plume, discharge or day samples. Unmeasured seasonal factors in fall and winter tended to decrease egg abundance in these seasons compared to summer; the reverse held for spring. The equation predicts a lower egg abundance at higher temperatures, holding other variables constant.

Abundance of Egg Species ( $Y_5$ ):

Forty-five percent of the variation in egg species abundance was explained by the equation for  $Y_5$ . Temperature, ambient, period, fall and winter had significant negative partial regression coefficients; spring had a significant positive coefficient. The abundance of egg

species will increase as the former variables decrease. A significantly higher egg species abundance was found in spring than in summer, and a significantly lower egg species abundance was found in fall and winter.

Egg Species Diversity ( $Y_6$ ):

Thirty-five percent of the variation in egg diversity was explained by the regression. The partial effects of temperature, plume, ambient, period, fall and winter were negative; that of spring was positive. Egg diversity was significantly higher in spring and significantly lower in fall and winter. Plume and ambient samples had a significantly lower egg species diversity than did discharge canal samples.

Abundance of *Anchoa mitchilli* Fish ( $Y_7$ ):

Sixty-eight percent of the variation in anchovy abundance was explained by the final equation for  $Y_7$ . All independent variables except plume and fall were retained as significant independent variables. Temperature, ambient and period had positive partial effects on anchovy abundance, and salinity, dissolved oxygen and spring had negative effects.

Abundance of *Gobiosoma boscii* Fish ( $Y_8$ ):

Almost one-half of the variation in goby abundance was explained by the final equation for  $Y_8$ . The partial regression coefficients for temperature and period were

positive, and the coefficient for salinity was negative. Other independent variables were not retained as significant predictors of goby abundance.

Abundance of Anchoa mitchilli Eggs ( $Y_9$ ):

Only twenty percent of the variation in anchovy egg abundance was explained by the regression which retained two independent variables. The partial effect of temperature was positive. Ambient river samples had significantly fewer anchovy eggs than the other two sampling locations.

Summary of Regression Analysis:

A nonparametric ranking procedure was developed to assess the relative importance of the independent variables. Direct comparisons of partial regression coefficients ( $b_j$ 's) are not useful since the independent variables were measured in different units. However, comparisons between standardized coefficients (the dependent and independent variables were standardized to have unit variance) can be used to determine the relative effect of each independent variable on the dependent variables. The procedure consisted of ranking the absolute values of the standardized  $b_j$ 's in each equation, summing the individual ranks for each variable across all equations, and ranking these sums to give an overall measure of relative importance. Ties were assigned average ranks, and dummy seasons were not included in the analysis. Table 12 summarizes these data.

Overall, temperature ranked first in relative importance of the independent variables and was retained in all of the regression equations as a significant predictor of fish and egg abundances and diversities. However, the relationship between temperature and the dependent variables was not consistent. For all measures of fish abundance and diversity ( $Y_1$ ,  $Y_2$ ,  $Y_3$ ,  $Y_7$ ,  $Y_8$ ) and anchovy egg abundance ( $Y_9$ ), the relationship was a positive one. As temperature increases, these dependent variables will increase. The converse was true for the relationship between temperature and measures of egg abundance and diversity ( $Y_4$ ,  $Y_5$ ,  $Y_6$ ). Holding other variables constant, the partial effect of temperature on these three dependent variables was negative.

The location variables ambient and plume ranked second and fifth, respectively, in relative importance. Plume samples were not significantly higher in abundance and diversity of fish eggs and larvae than either discharge or ambient river samples. Thus, there was no evidence of significant plume entrainment of ichthyoplankton after removing the effects of other variables.

Period was third in relative importance and was retained in all but one of the equations. Night samples had a higher fish abundance and diversity than day samples. On the other hand, day samples had a higher egg abundance and diversity than night samples.

Salinity was fourth in relative importance and had a negative partial effect on total fish abundance, fish species abundance, anchovy abundance and goby abundance. These dependent variables increased as salinity decreased. Salinity was not a significant variable in the remaining equations.

Dissolved oxygen was the least important independent variable and was retained in only two equations. Fish species diversity and anchovy increased as dissolved oxygen decreased.

## CONCLUSIONS

The ichthyoplankton data set collected in and around the thermal plume from VEPCO Surry Nuclear Power Plant during 1978 revealed no statistically significant entrainment of the Cobham Bay ichthyofauna by the thermal plume. Some entrainment is evidently occurring since samples from the plume (Figs. 4, 5, 7 and 8) often show higher number of species. Size of the individuals present should be considered when comparing species captured. Larger fish can overcome turbulence in the mixing zone and may even select the warmer waters in the plume area during colder months.

We can define the species and quantity of ichthyoplankton in and around the thermal plume from VEPCO Surry Nuclear Power Plant, however, we cannot determine the effects of the thermal plume on the ichthyofauna of Cobham Bay. Natural fluctuations in abundance (which may be one or more orders of magnitude from year to year), sampling variability and biological attributes of the ichthyofauna interact in such a way as to confound interpretation of the data set. Other sources of stress (i.e., organic and inorganic pollutants, siltation, flooding, etc.) also interact to add difficulty to impact assessment. Impact assessment for the VEPCO Surry Nuclear Power Plant must contain an examination of all available data sets (trawl, seine, impingement, and entrainment) and take into consideration all factors affecting the estuarine ecosystem.

Adult fish population trends in the vicinity of the plant site have been monitored since the pre-operational period of the facility. VEPCO data (screen impingement, trawl, and seine) and VIMS trawl data reveal large increases and decreases in relative abundance of some fishes in the vicinity of Hog Point (J. White, personal communication and Bender et al., 1975). Ichthyoplankton studies have only been in progress since August, 1975 and pre-operational data are not available. Thus long term trends indicate relatively stable ichthyoplankton abundances.

Bay anchovy and naked goby were the dominant forms captured in 1978 plume entrainment samples. However, both species prefer higher salinities than those recorded in and around the thermal plume from VEPCO Surry in 1978 for spring (Lippson and Moran, 1974). It is unlikely that the centers of egg and larval abundances for these species are near the Cobham Bay area of the James River. Larval abundances could fluctuate yearly with salinity patterns within the river.

Bay anchovy egg and larval concentrations have been relatively stable during this study. Lower concentrations of anchovy eggs were recorded in 1978, probably due to lower salinities. Adult bay anchovy concentrations have also remained within the bounds of natural fluctuations over the long term [VIMS trawl surveys (Hoagman and Kriete, 1975) and VEPCO data (White, 1976)].

Adult naked goby inhabit oyster communities and other areas where crevices etc. afford shelter. Adults are seldom captured in trawl or seine surveys and it is difficult to obtain a realistic estimate of population levels.

Fishes of commercial importance were not a significant portion (relative to other species captured) of the catch in our samples. Several species (Atlantic croaker, spot, and Atlantic menhaden) utilize the area as nursery grounds while in the postlarval and juvenile stages. These species soon reach a size and swimming speed whereby they can effectively negotiate turbulence created in the mixing zone and no longer be subject to entrainment.

Multiple regression techniques were useful in explaining some of the complex relationships between environmental factors and the abundance and diversity of fish and eggs and in isolating factors which tend to confound the analysis of data from general field surveys. These techniques identified the dominant environmental factors and assessed their relative importance.

The data (species capture at each site) from in and around the thermal plume from VEPCO Surry Nuclear Power Plant indicate that limited entrainment of the Cobham Bay ichthyofauna is occurring. However, adult population levels have remained within the bounds of natural population fluctuations and we have found no evidence that suggests a cause and effect relationship between fluctuations in fish



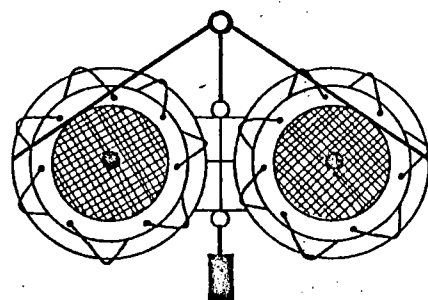
species abundance or fish populations in the Cobham Bay area of the James River and operation of VEPCO Surry Nuclear Power Plant.

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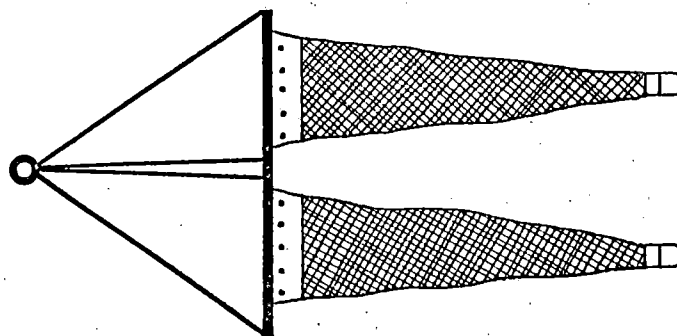
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Figure 1. 0.5 paired-net apparatus with rope bridle and lead weight.

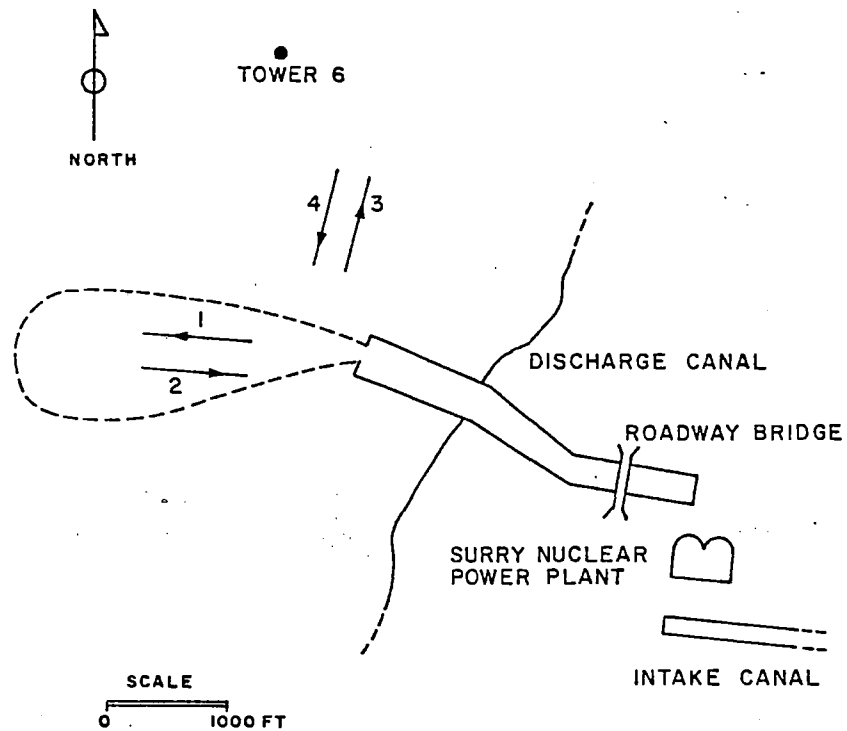


FRONT VIEW



TOP VIEW

Figure 2. James River in vicinity of Surry Nuclear Power Station showing plume entrainment sampling locations.



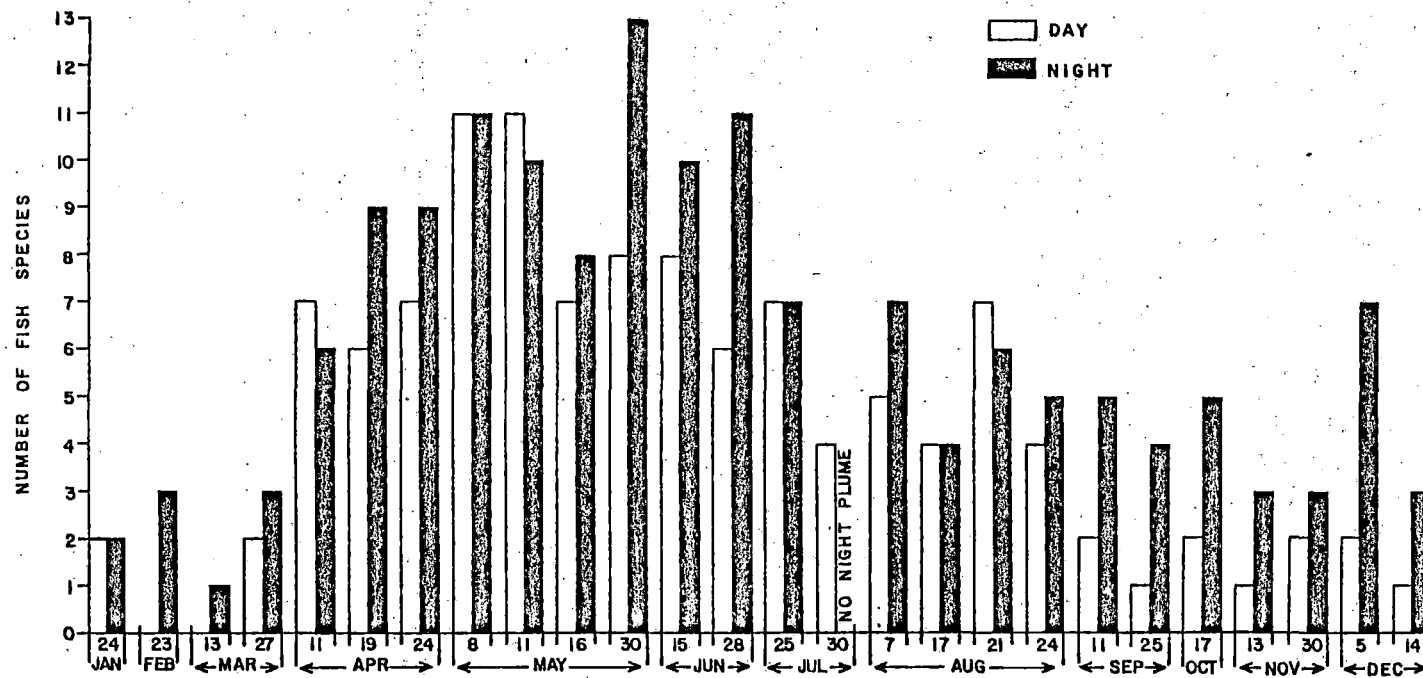


Figure 3. Number of fish species captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

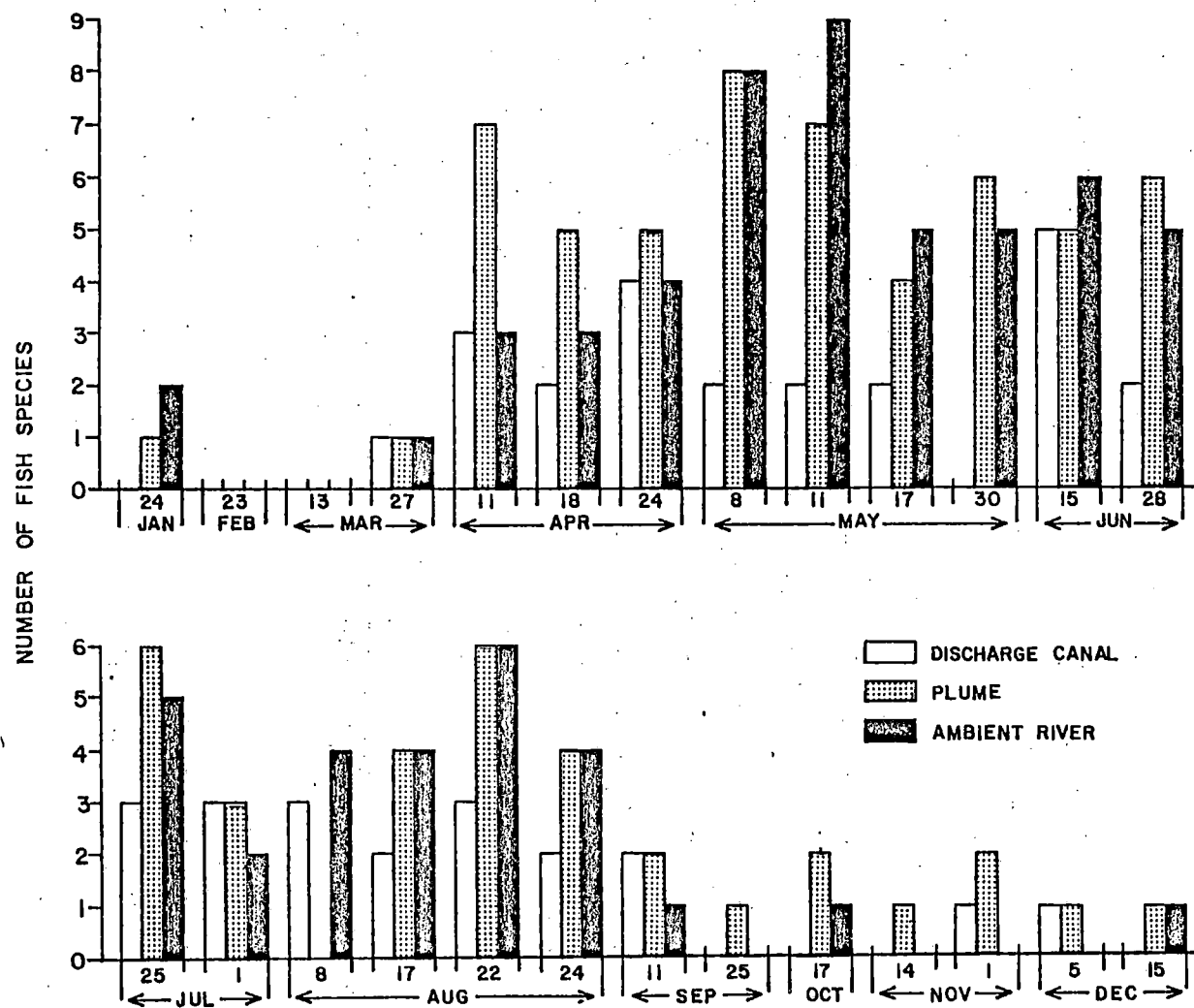


Figure 4. Number of fish species captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

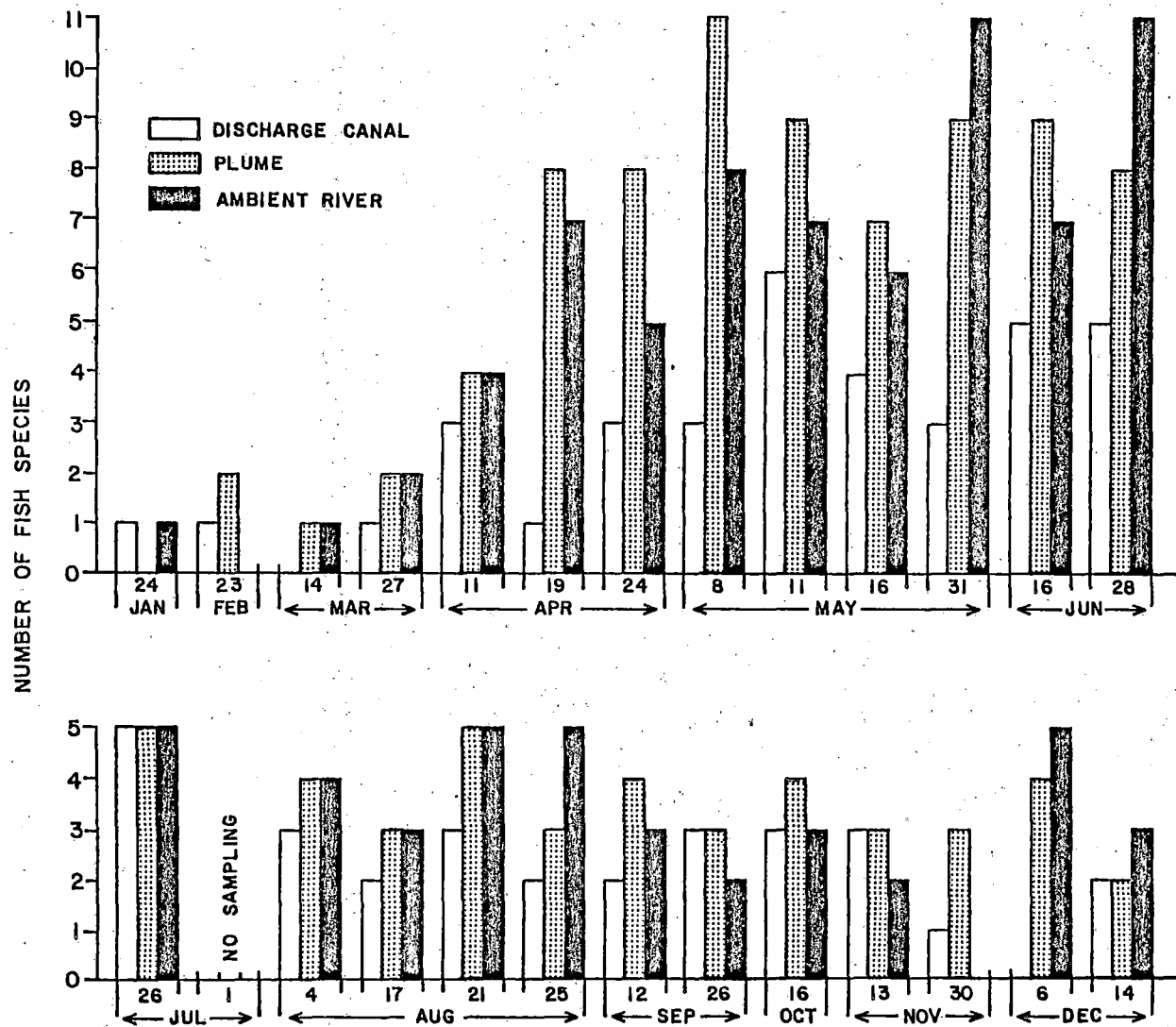


Figure 5. Number of fish species captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.



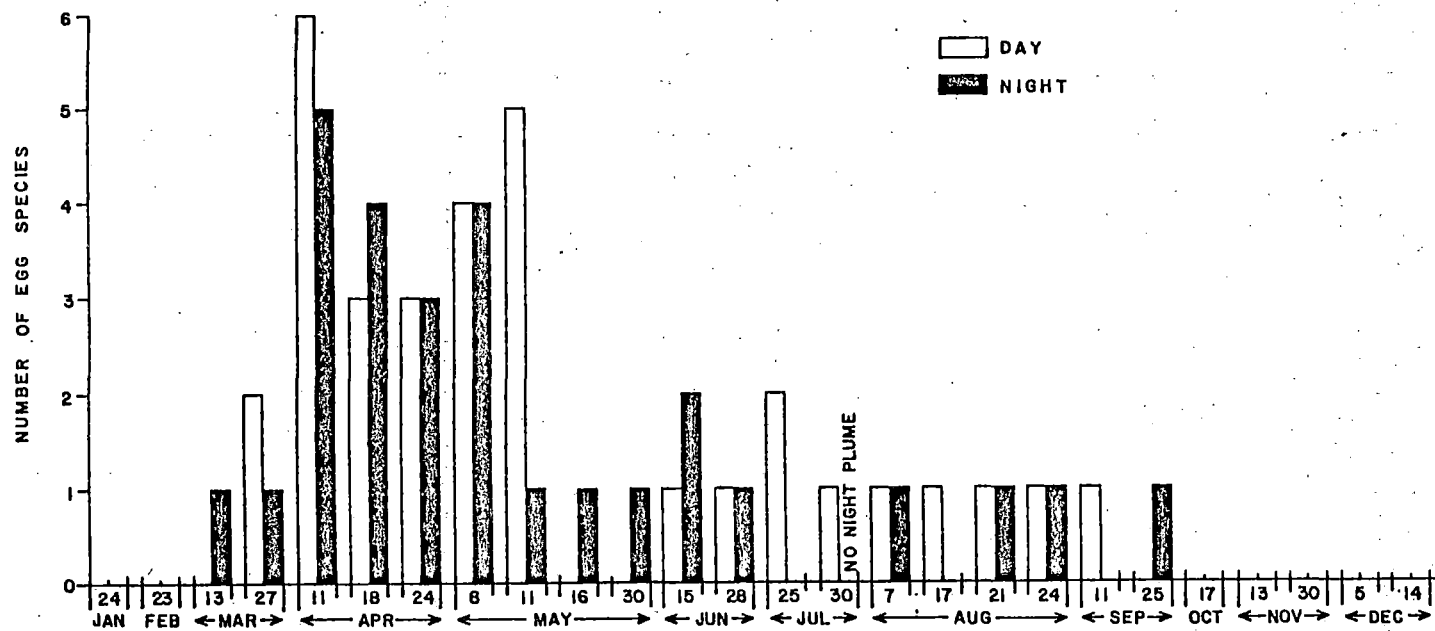


Figure 6. Number of egg species captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

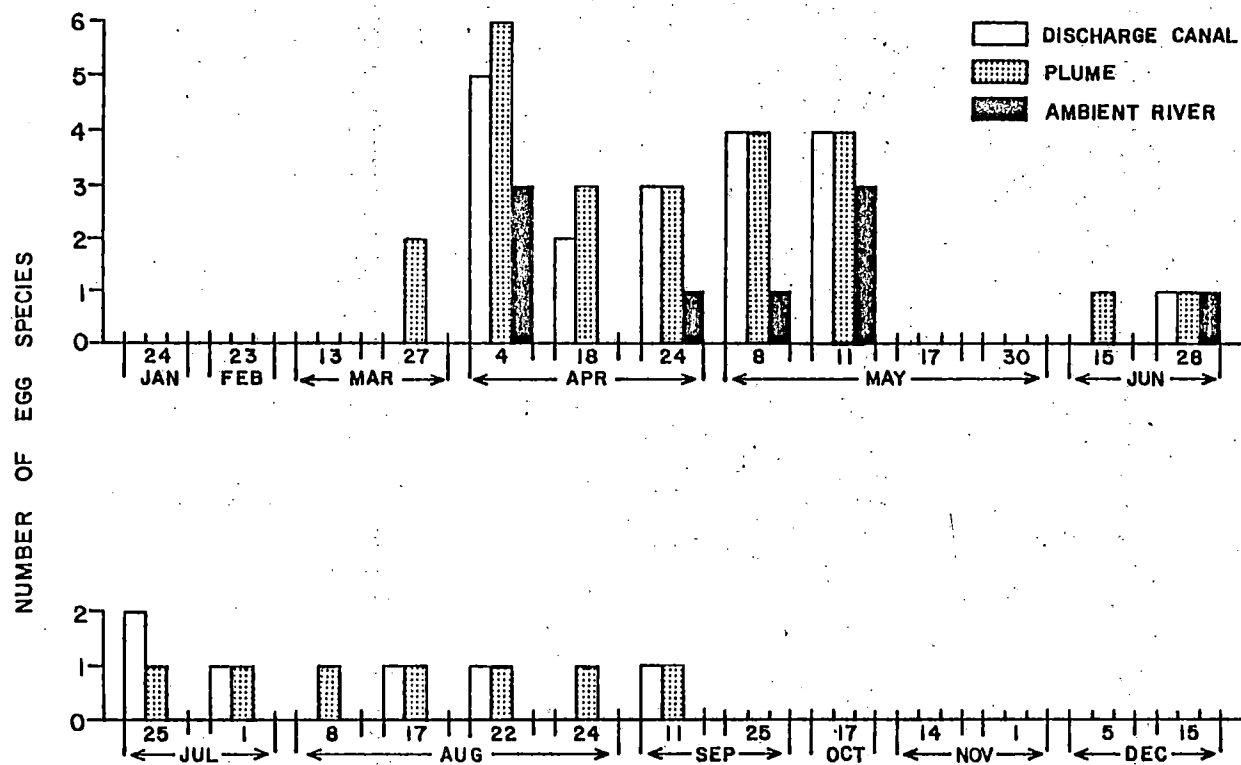


Figure 7. Number of egg species captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

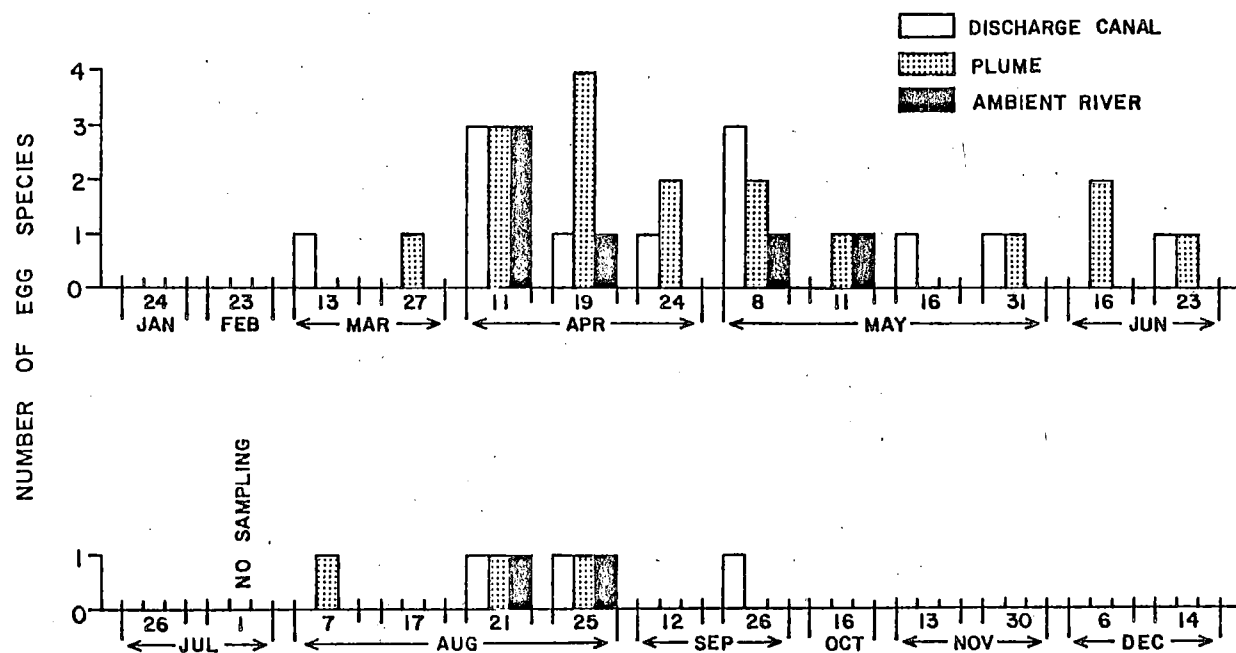


Figure 8. Number of egg species captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

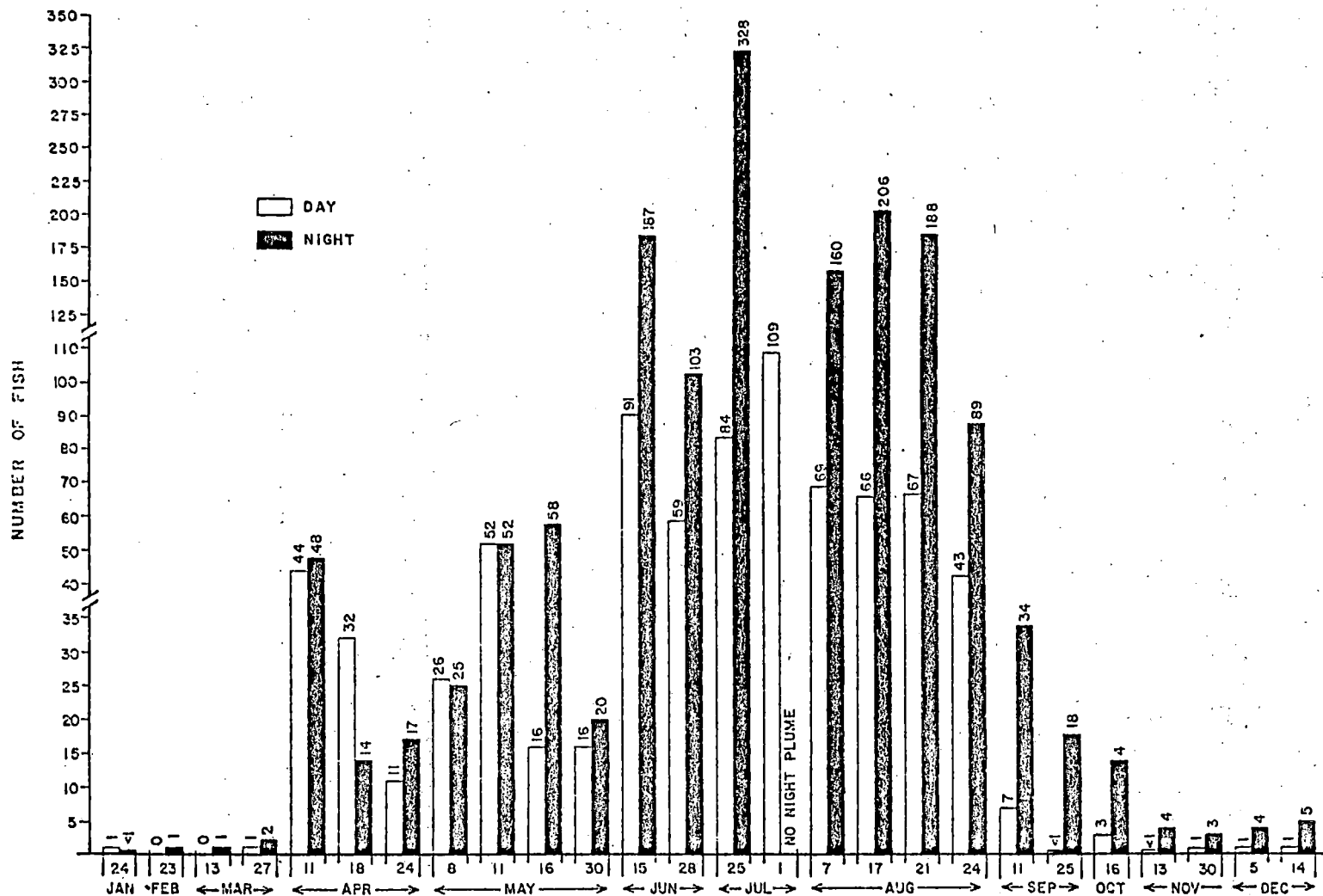


Figure 9. Average number of fish per sample ( $100 \text{ m}^3$ ) captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

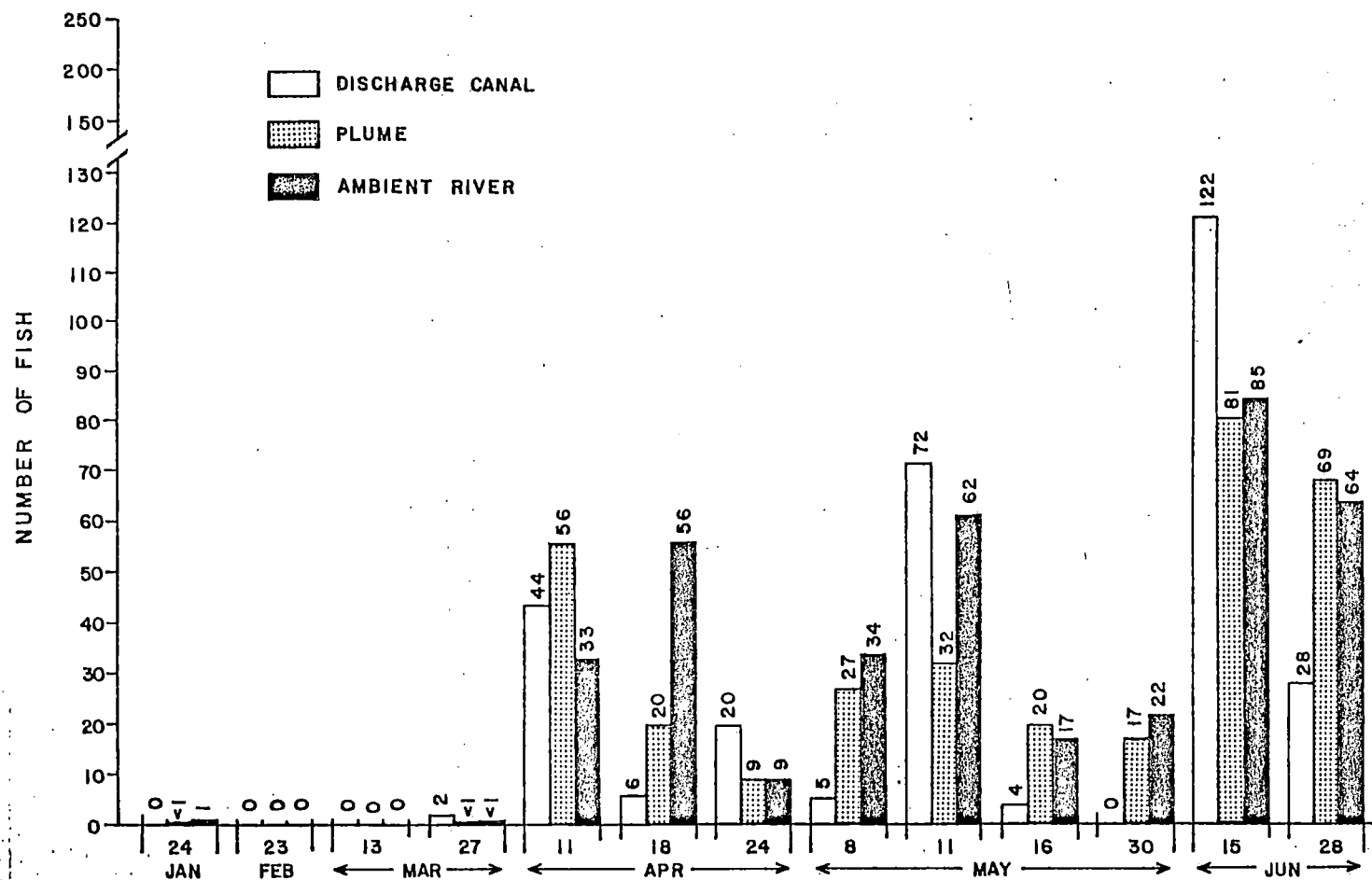


Figure 10. Average number of fish per sample (100 m³) captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

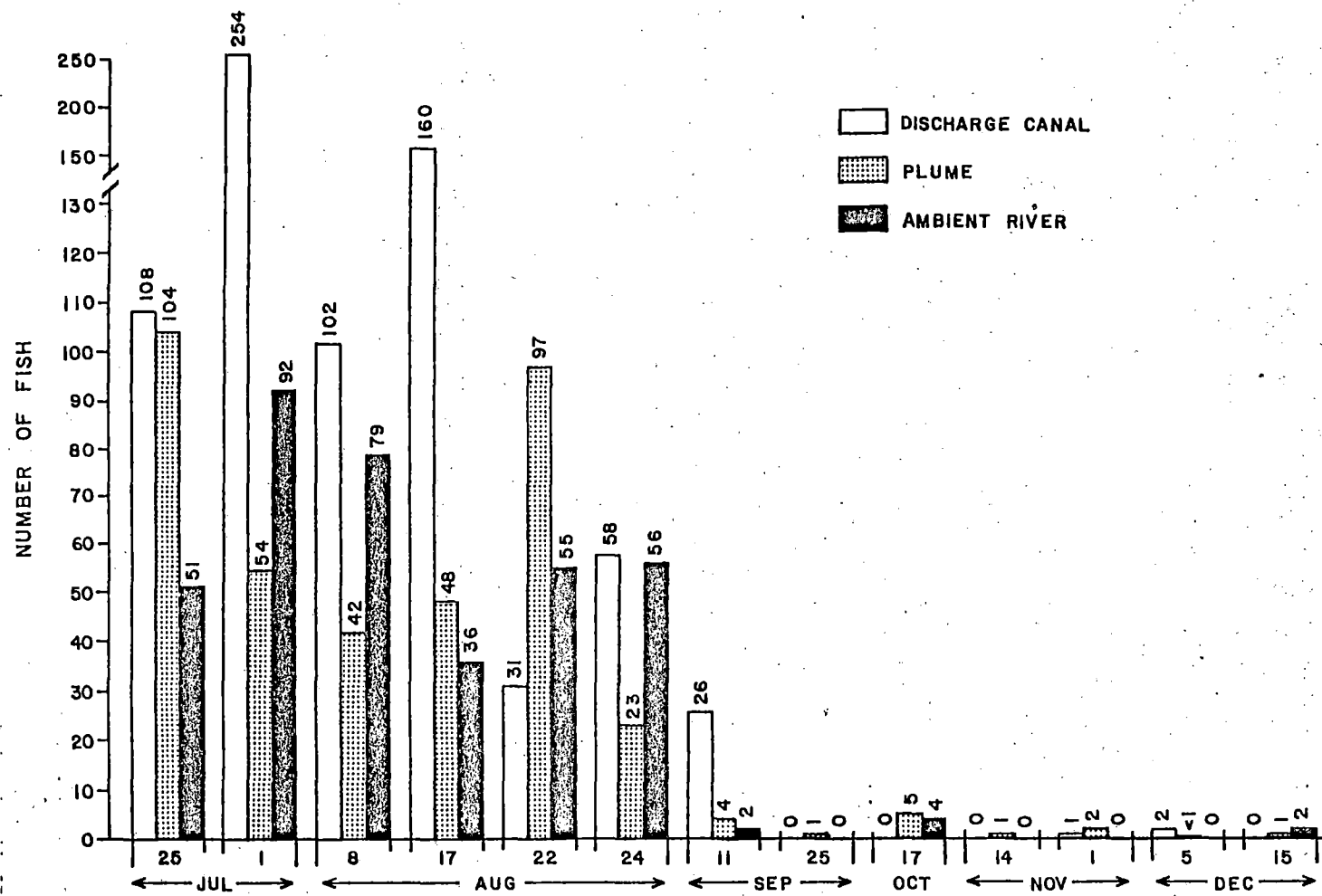


Figure 10. (continued).

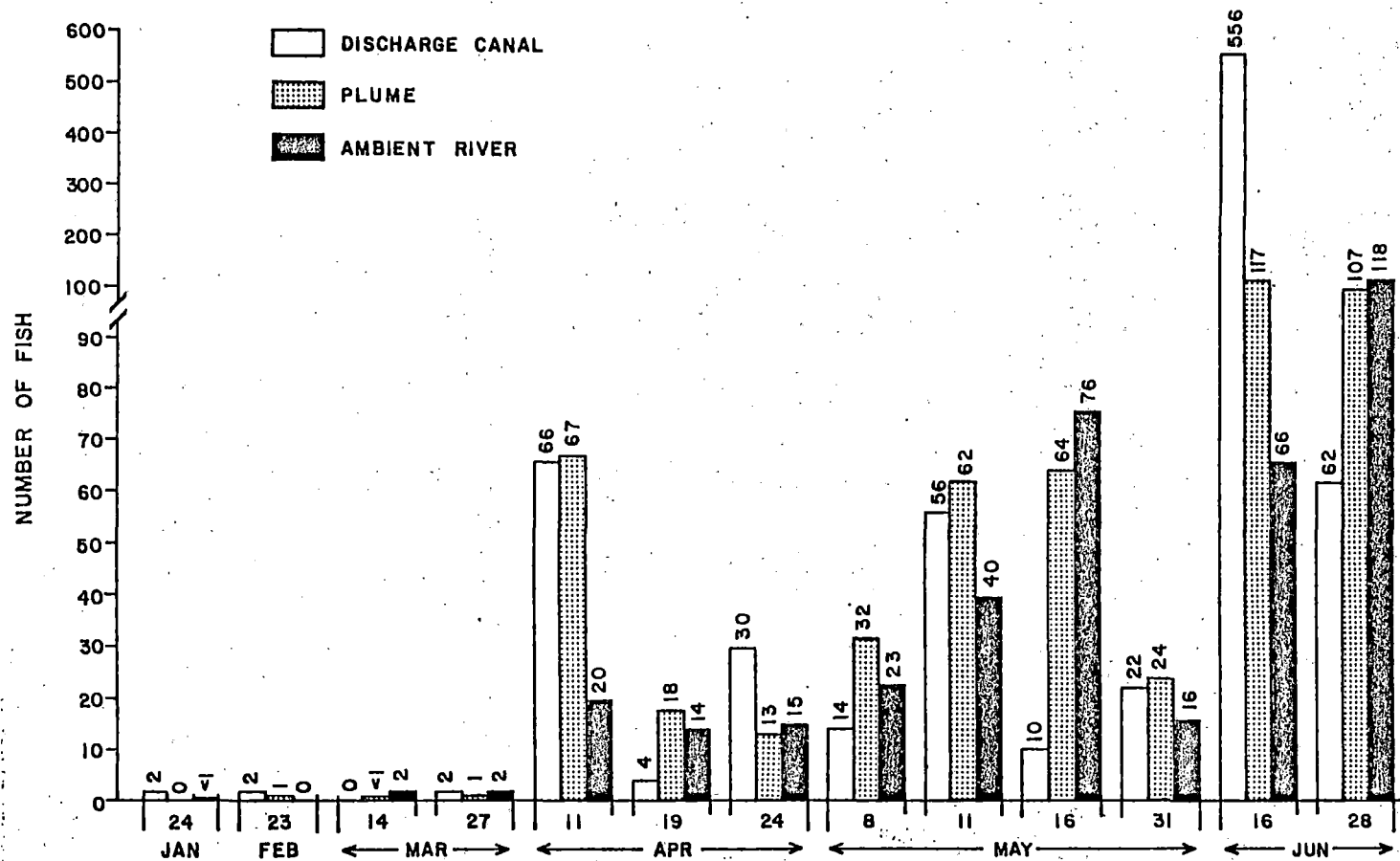


Figure 11. Average number of fish per sample (100 m<sup>3</sup>) captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

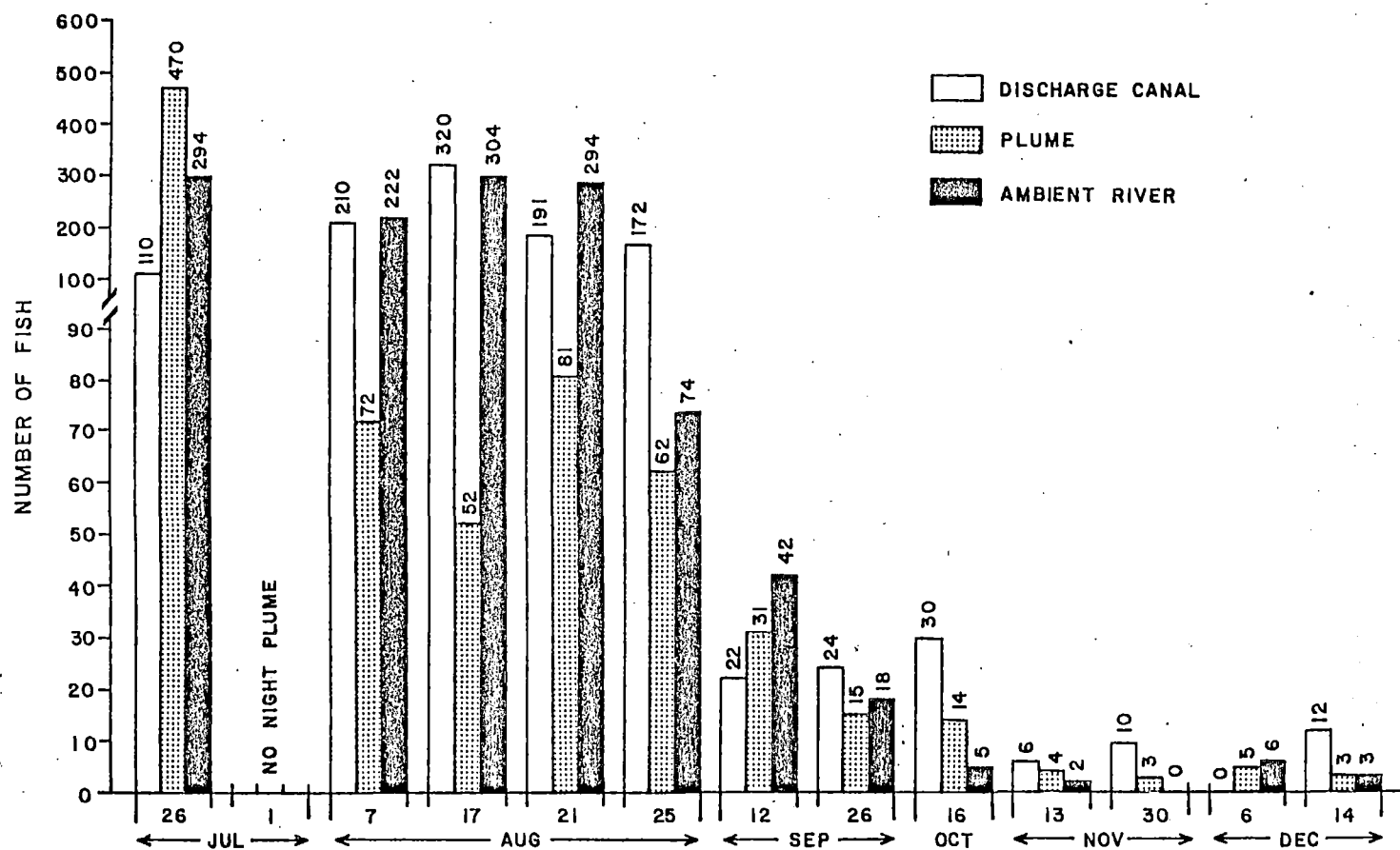


Figure 11. (continued).



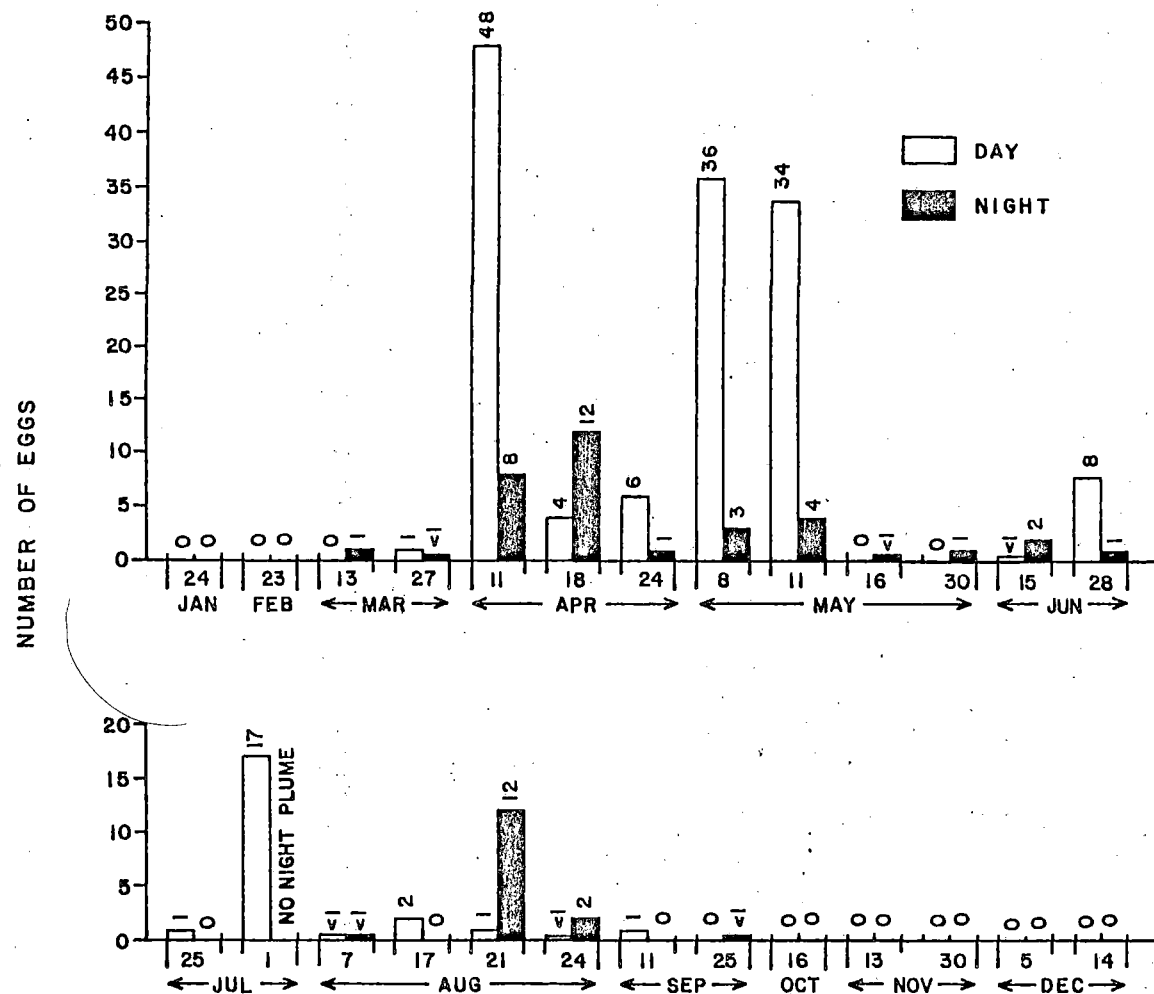


Figure 12. Average number of eggs per sample (100 m³) captured during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

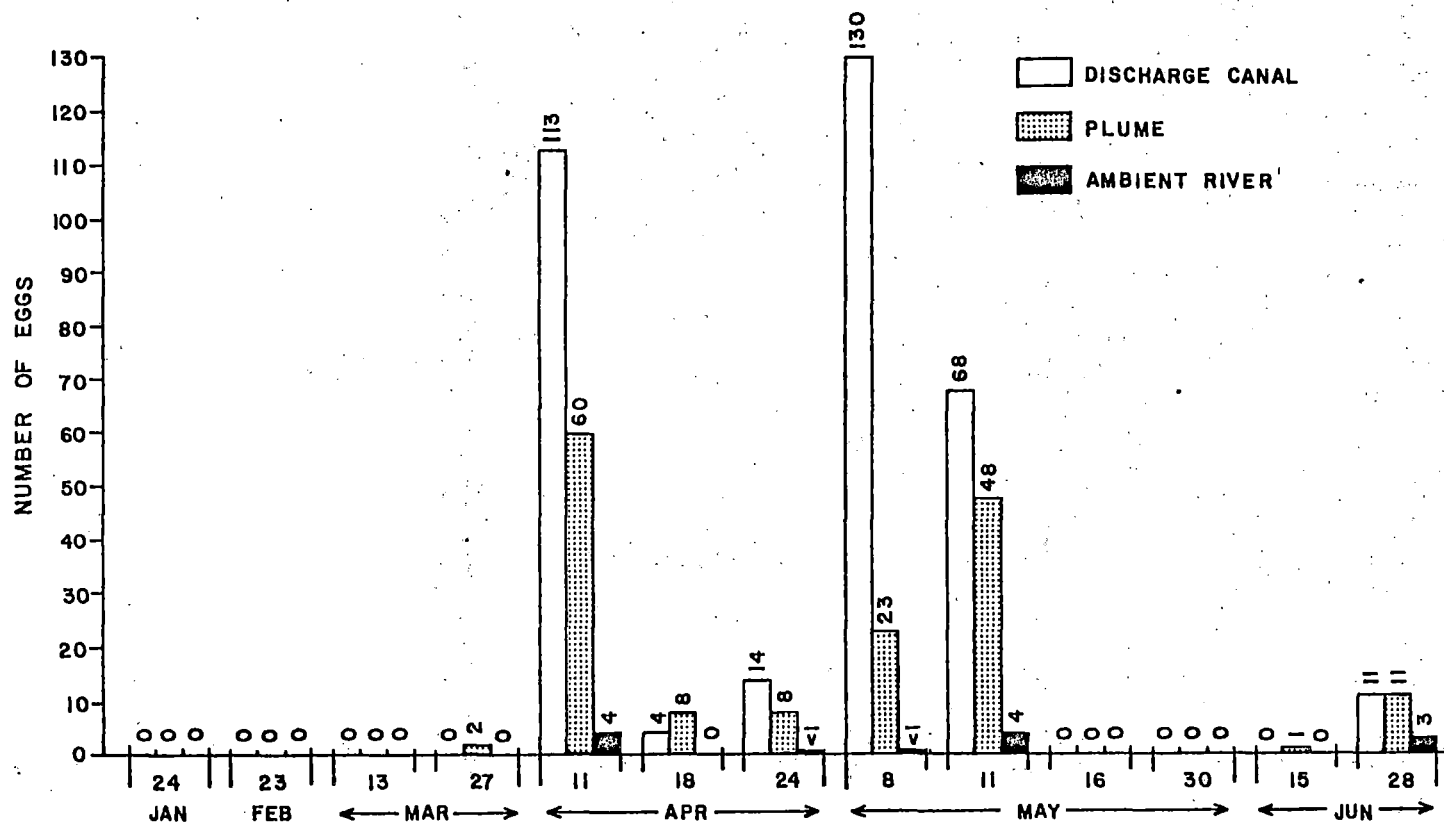


Figure 13. Average number of eggs per sample (100 m³) captured during day-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

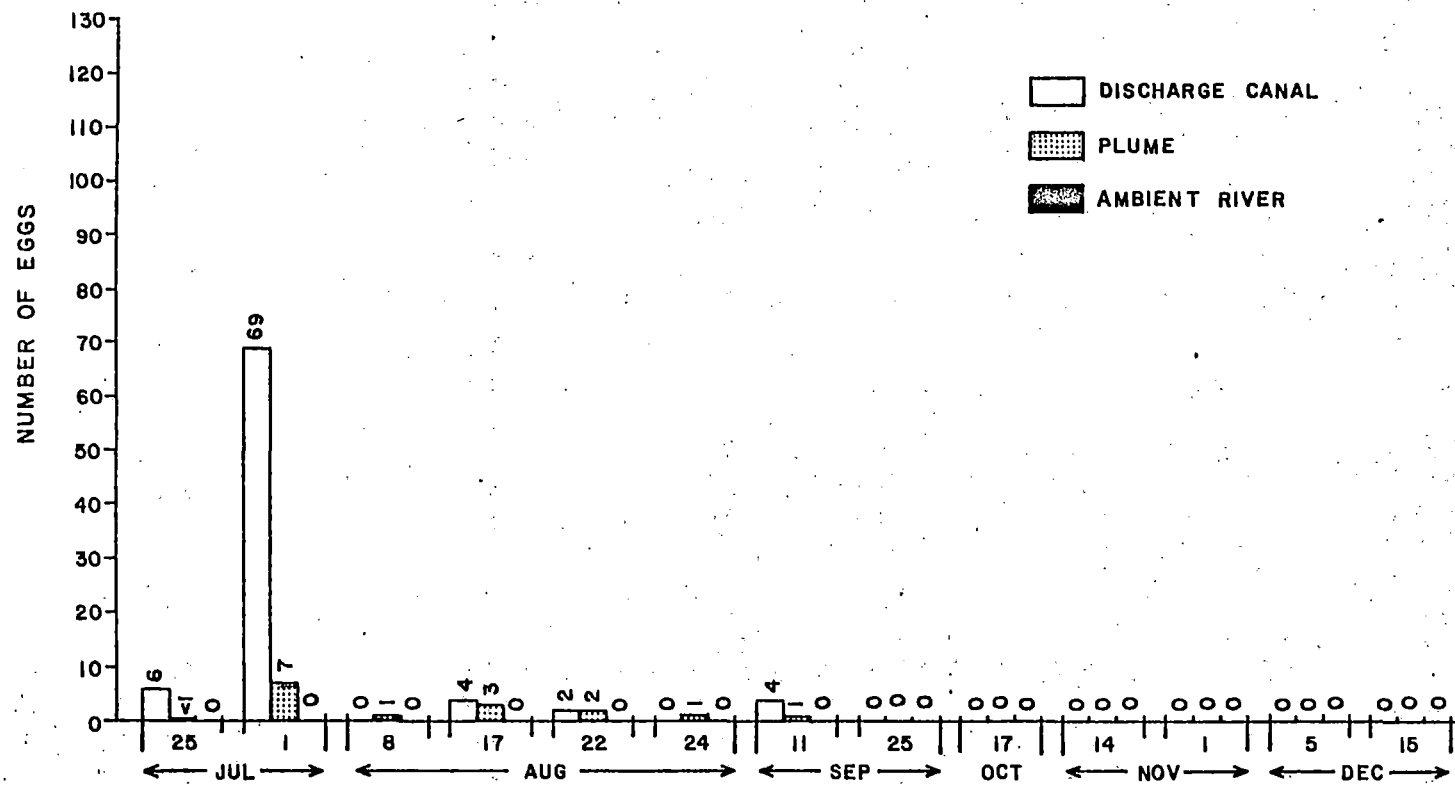


Figure 13. (continued).

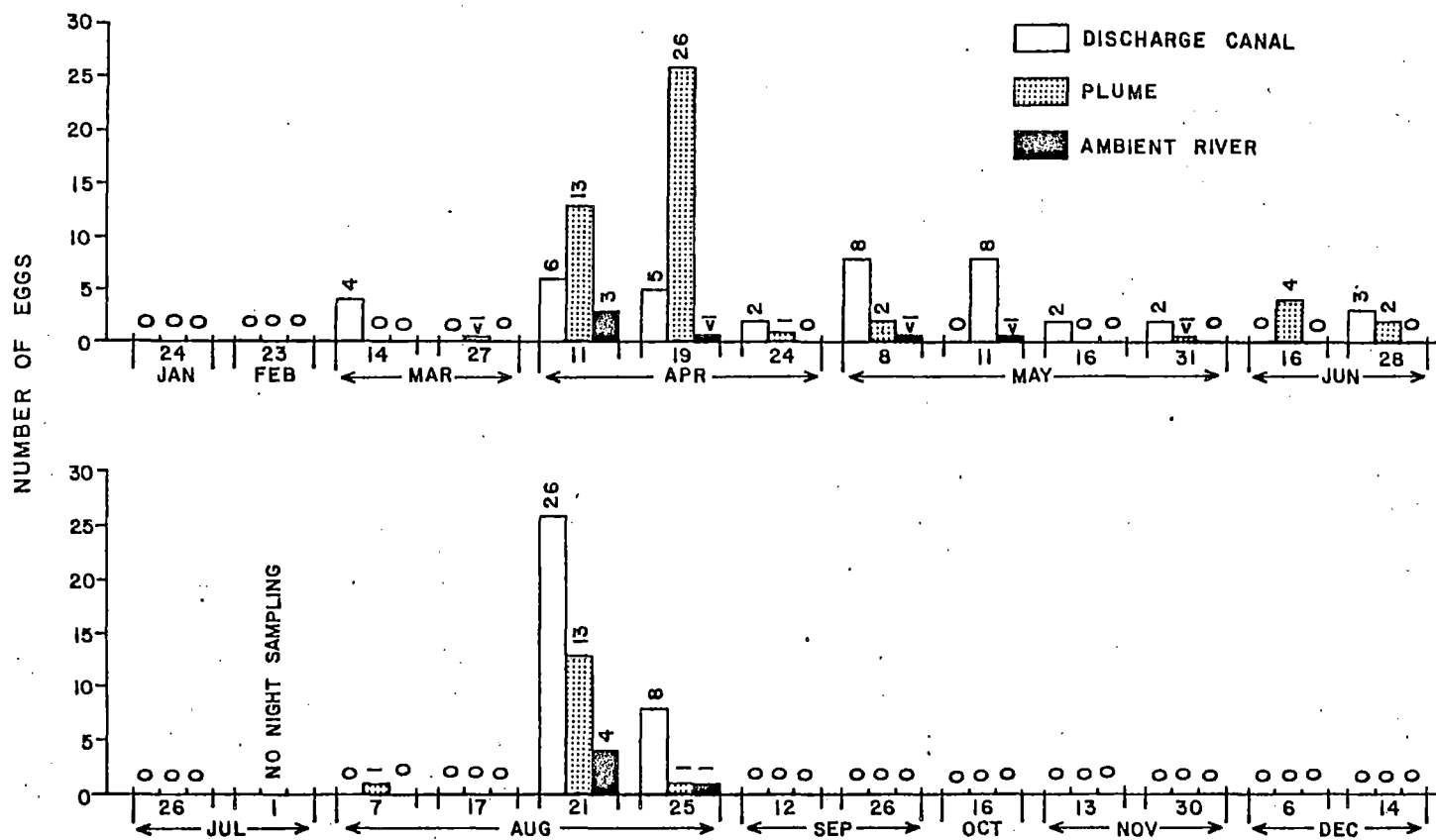


Figure 14. Average number of eggs per sample (100 m³) captured during night-plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

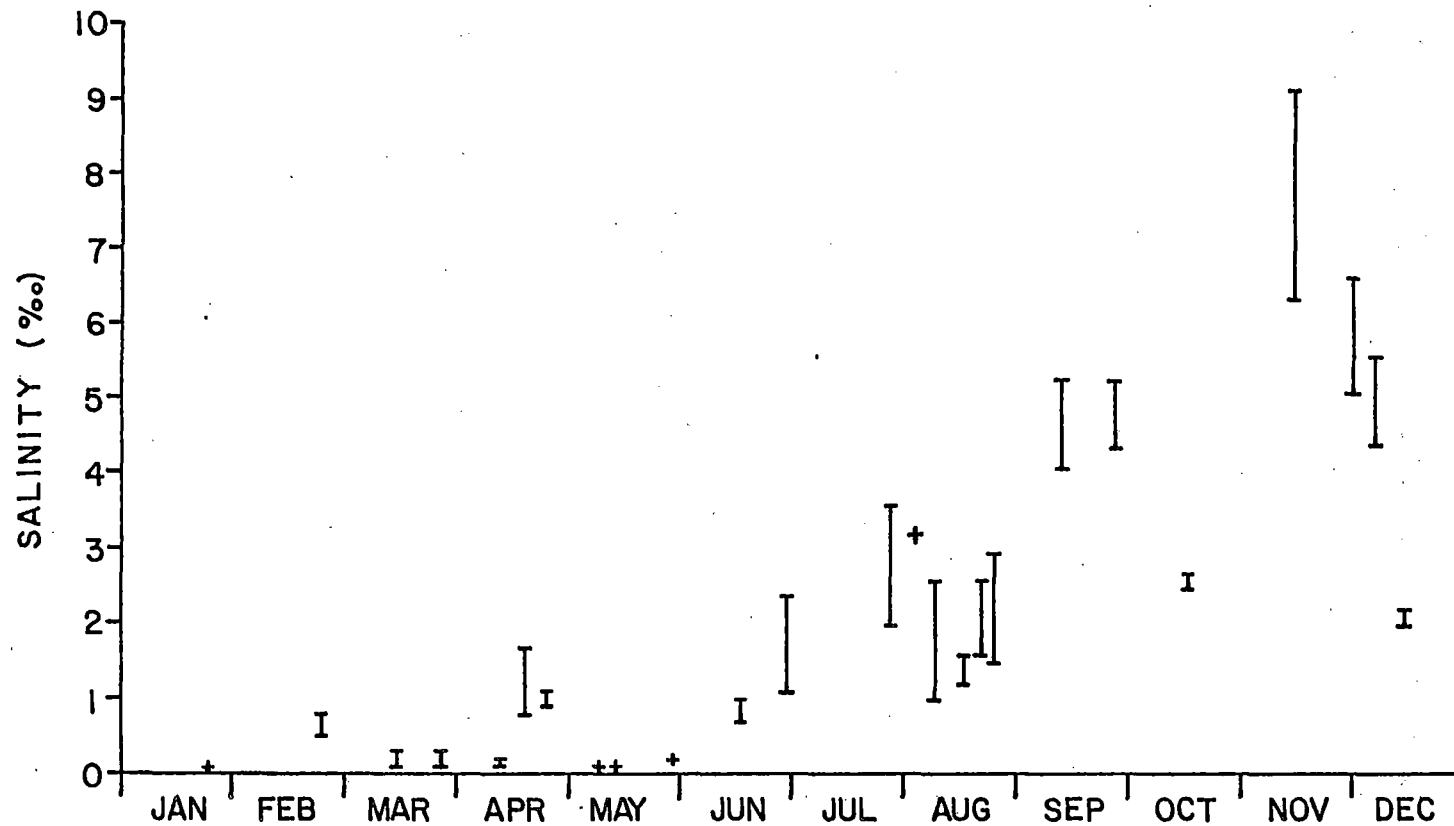


Figure 15. Ranges of salinity (‰) in ambient river water during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

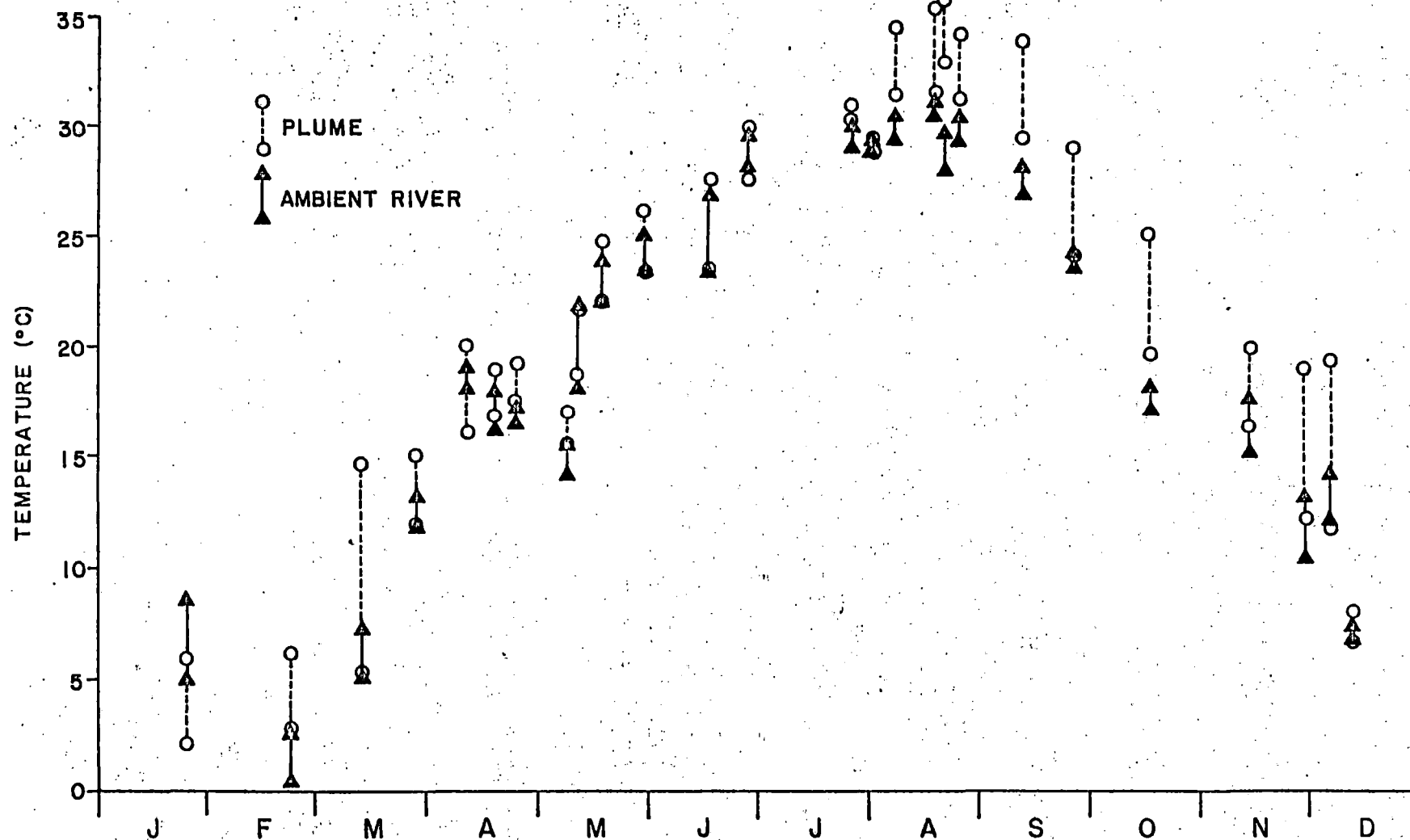


Figure 16. Ranges of water temperature (C) during plume entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

Table 1. Ichthyoplankton sampling schedule for plant and plume entrainment studies at VEPCO Surry Nuclear Power Plant (January through December 1978).

Study	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plant Entrainment	X	X	XX	XXXX	XXXX	XX	X	X	X	X	X	X
Plume Entrainment	X	X	XX	XXXX	XXXX	XX	XX	XXXX	XX	X	XX	XX

Table 2. Dependent ( $Y_i$ ) and independent ( $X_j$ ) variables for statistical analysis (standardized catch is number collected per 100 cubic meters of water strained per collection).

Variable	Definition												
$Y_1$ , Total abundance of fish	$Y_1 = \log_e (C_1 + 1)$ , where $C_1$ = standardized catch of fish												
$Y_2$ , Abundance of fish species	$Y_2 = \log_e (C_2 + 1)$ , where $C_2$ = number of fish species												
$Y_3$ , Fish species diversity	$Y_3 = -\sum p_k \log_e p_k$ , where $p_k = \frac{n_k}{N}$ , $n_k$ = number of fish of the $k^{\text{th}}$ species, and $N$ = total number of fish												
$Y_4$ , Total abundance of eggs	$Y_4 = \log_e (C_4 + 1)$ , where $C_4$ = standardized catch of eggs												
$Y_5$ , Abundance of egg species	$Y_5 = \log_e (C_5 + 1)$ , where $C_5$ = number of egg species												
$Y_6$ , Egg species diversity	$Y_6 = -\sum p_k \log_e p_k$ , where $p_k = \frac{n_k}{N}$ , $n_k$ = number of eggs of the $k^{\text{th}}$ species, and $N$ = total number of eggs												
$Y_7$ , Abundance of <u>A. mitchilli</u> fish	$Y_7 = \log_e (C_7 + 1)$ , where $C_7$ = standardized catch of <u>A. mitchilli</u> fish												
$Y_8$ , Abundance of <u>G. bosci</u> fish	$Y_8 = \log_e (C_8 + 1)$ , where $C_8$ = standardized catch of <u>G. bosci</u> fish												
$Y_9$ , Abundance of <u>A. mitchilli</u> eggs	$Y_9 = \log_e (C_9 + 1)$ , where $C_9$ = standardized catch of <u>A. mitchilli</u> eggs												
<hr/>													
$X_1$ , Water temperature	$^{\circ}\text{C}$												
$X_2$ , Salinity	ppt												
$X_3$ , Dissolved oxygen	mg/l												
$X_4, X_5$ , Location dummy variables	<table><tr><td>Location</td><td><math>X_4</math>, Plume =</td><td><math>X_5</math>, Ambient =</td></tr><tr><td>Discharge</td><td>0</td><td>0</td></tr><tr><td>Plume</td><td>1</td><td>0</td></tr><tr><td>Ambient</td><td>0</td><td>1</td></tr></table>	Location	$X_4$ , Plume =	$X_5$ , Ambient =	Discharge	0	0	Plume	1	0	Ambient	0	1
Location	$X_4$ , Plume =	$X_5$ , Ambient =											
Discharge	0	0											
Plume	1	0											
Ambient	0	1											



Table 2. (continued).

Variable	Definition			
$X_6$ , Period dummy variable	0 = day (5 to 16.9 h EST), 1 = night (17.0 to 4.9 h EST)			
$X_7, X_8, X_9$ , Season dummy variables	Season	$X_7$ , Fall =	$X_8$ , Winter =	$X_9$ , Spring =
	Summer (July, Aug., Sept.)	0	0	0
	Fall (Oct., Nov., Dec.)	1	0	0
	Winter (Jan., Feb., March)	0	1	0
	Spring (April, May, June)	0	0	1

Table 3. Number of species captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978.

DATE	DAY			NIGHT		
	Number of Species			Number of Species		
	FISH	EGGS	BOTH*	FISH	EGGS	BOTH*
Jan. 24-24	2	0	0	2	0	0
Feb. 23-23	0	0	0	3	0	0
Mar. 13-14	0	0	0	1	1	0
Mar. 27-27	2	2	0	3	1	1
Apr. 11-11	7	6	6	6	5	3
Apr. 18-19	6	3	2	9	4	2
Apr. 24-24	7	3	2	9	3	2
May 8-8	11	4	3	11	4	2
May 11-11	11	5	5	10	1	1
May 16-16	7	0	0	8	1	0
May 30-31	8	0	0	13	1	1
June 15-16	8	1	1	10	2	1
June 28-28	6	1	1	11	1	1
July 25-26	7	2	1	7	0	0
Aug. 1(only)	4	1	1	not applicable		
Aug. 7-8	5	1	1	7	1	1
Aug. 17-17	4	1	1	4	0	0
Aug. 21-22	7	1	1	6	1	1
Aug. 24-25	4	1	1	5	1	1
Sep. 11-12	2	1	1	5	0	0
Sep. 25-26	1	0	0	4	1	0

Table 3. (concluded).

DATE	DAY			NIGHT		
	Number of Species			Number of Species		
	FISH	EGGS	BOTH*	FISH	EGGS	BOTH*
Oct. 16-17	2	0	0	5	0	0
Nov. 13-14	1	0	0	3	0	0
Nov. 30-Dec. 1	2	0	0	3	0	0
Dec. 5-6	2	0	0	7	0	0
Dec. 14-15	1	0	0	3	0	0

\* Number of species that occur as both fish and eggs within the same sample.

Table 4. Average number (100 m<sup>3</sup>) of fish and fish eggs per sample captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978.

DATE 1978		<u>DISCHARGE CANAL</u>		<u>PLUME</u>		<u>AMBIENT RIVER</u>	
		Larvae	Eggs	Larvae	Eggs	Larvae	Eggs
24 Jan.	(D)	0	0	<1	0	1	0
24 Jan.	(N)	2	0	0	0	<1	0
23 Feb.	(D)	0	0	0	0	0	0
23 Feb.	(N)	2	0	1	0	0	0
13 March	(D)	0	0	0	0	0	0
14 March	(N)	0	4	<1	0	2	0
27 March	(D)	2	0	<1	2	<1	0
27 March	(N)	2	0	1	<1	2	0
11 April	(D)	44	113	56	60	33	4
11 April	(N)	66	6	67	13	20	3
18 April	(D)	6	4	20	8	56	0
19 April	(N)	4	5	18	26	14	<1
24 April	(D)	20	14	9	8	9	<1
24 April	(N)	30	2	13	1	15	0
8 May	(D)	5	130	27	23	34	<1
8 May	(N)	14	8	32	2	23	<1
11 May	(D)	72	68	32	48	62	4
11 May	(N)	56	0	62	8	40	<1
16 May	(N)	10	2	64	0	76	0
16 May	(D)	4	0	20	0	17	0

Table 4. (continued).

DATE 1978		<u>DISCHARGE CANAL</u> Larvae Eggs		<u>PLUME</u> Larvae Eggs		<u>AMBIENT RIVER</u> Larvae Eggs	
30 May	(D)	0	0	17	0	22	0
31 May	(N)	22	2	24	1	16	0
15 June	(D)	122	0	81	1	85	0
16 June	(N)	556	0	117	4	66	0
28 June	(N)	62	3	107	2	118	0
28 June	(D)	28	11	69	11	64	3
25 July	(D)	108	6	104	<1	51	0
26 July	(N)	110	0	470	0	294	0
1 Aug.	(D)	254	69	54	7	92	0
7 Aug.	(N)	210	0	72	1	222	0
8 Aug.	(D)	102	0	42	1	79	0
17 Aug.	(D)	160	4	48	3	36	0
17 Aug.	(N)	320	0	52	0	304	0
21 Aug.	(N)	191	26	81	13	294	4
22 Aug.	(D)	31	2	97	2	55	0
24 Aug.	(D)	58	0	23	1	56	0
25 Aug.	(N)	172	8	62	1	74	1
11 Sept.	(D)	26	4	4	1	2	0
12 Sept.	(N)	22	0	31	0	42	0
25 Sept.	(D)	0	0	1	0	0	0
26 Sept.	(N)	24	2	15	0	18	0
16 Oct.	(N)	30	0	14	0	5	0
17 Oct.	(D)	0	0	5	0	4	0

Table 4. (concluded).

DATE 1978		<u>DISCHARGE CANAL</u>		<u>PLUME</u>		<u>AMBIENT RIVER</u>	
		Larvae	Eggs	Larvae	Eggs	Larvae	Eggs
13 Nov.	(N)	6	0	4	0	2	0
14 Nov.	(D)	0	0	1	0	0	0
30 Nov.	(N)	10	0	3	0	0	0
1 Dec.	(D)	1	0	2	0	0	0
5 Dec.	(D)	2	0	<1	0	0	0
6 Dec.	(N)	0	0	5	0	6	0
14 Dec.	(N)	12	0	3	0	3	0
15 Dec.	(D)	0	0	1	0	2	0

Table 5. Species and calculated number of fish per 100 m<sup>3</sup> captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978.

JANUARY 24 - 24, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

DAY PLUME

MENIDIA BERYLLINA  
MUGIL CEPHALUS

2

2

3

SPECIES  
LEFT RIGHT

TOW NO. 1  
LEFT RIGHT

TOW NO. 2  
LEFT RIGHT

TOW NO. 3  
LEFT RIGHT

TOW NO. 4  
LEFT RIGHT

56

NIGHT PLUME

ALCSA AESTIVALIS  
MENIDIA BERYLLINA

3

2

Table 5. (continued).

FEBRUARY 23 - 23, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME	NO CATCH AT THIS TIME									

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANGUILLA ROSTRATA					3					
MORONE AMERICANA	3									
TRINECTES MACULATUS						2				



Table 5. (continued).

MARCH 13 - 14, 1978

SPECIES	DISCHARGE CANAL -----		THERMAL PLUME -----		AMBIENT RIVER -----	
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
DAY PLUME	NO CATCH AT THIS TIME					

SPECIES	LEFT RIGHT		TOW NO. 1 LEFT RIGHT		TOW NO. 2 LEFT RIGHT		TOW NO. 3 LEFT RIGHT		TOW NO. 4 LEFT RIGHT	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANGUILLA ROSTRATA				2			2		4	

Table 5. (continued).

MARCH 27 - 27, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANGUILLA ROSTRATA		4								2
FUNDULUS HETEROCLOTUS					2					

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANGUILLA ROSTRATA	5					2	2		2	2
MEGALOTYPIUS BERYLLINA				2						
MORONE AMERICANA							2			

Table 5. (continued).

APRIL 11 - 11, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
DAY PLUME										
ALOSA SAPIDISSIMA				2						
BREVCORTIA TYRANNUS	8	8		3	3	6	1	2		
CYPRINUS CARPIO						2				
DEKOSOMA CEPEDIANUM						2			3	
DEKOSOMA SP.			2							
MORONE AMERICANA	24	46	49	46	52	50	13	35	38	40
MORONE SAXATILIS		3	2		2	2				

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
NIGHT PLUME										
ALOSA SAPIDISSIMA			3		2					
ANGUILLA ROSTRATA			3	3	2	2		2	9	
BREVOORTIA TYRANNUS	7	12								
CYPRINUS CARPIO								2		
MORONE AMERICANA	72	40	29	25	82	67	20	33		12
MORONE SAXATILIS	2			3	30	17			3	

Table 5. (continued).

APRIL 18 - 19, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	TOW NO. 1 RIGHT	TOW NO. 2 LEFT	TOW NO. 2 RIGHT	TOW NO. 3 LEFT	TOW NO. 3 RIGHT	TOW NO. 4 LEFT	TOW NO. 4 RIGHT
DAY PLUME										
ANCHOA MITCHILLI		5								
BREVOORTIA TYRANNUS	3	5	5			2				
CYPRINUS CARPIO			2	2	2	2				
DOPOSOMA CEPEDIANUM			4	2					3	2
MORCNE AMERICANA			13	12	14	7	36	41	51	64
MORCNE SAXATILIS			2		9	2	4	4	9	8

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI			2		5				3	
ANGUILLA ROSTRATA			2			2			3	
BREVOORTIA TYRANNUS		7	2		3				3	8
CYPRINUS CARPIO				2	3	5				3
DOPOSOMA CEPEDIANUM				5					5	
FUNDULUS CONFLUENTUS					3					
MENIDIA BERYLLINA								2		
MORCNE AMERICANA			5	2	13	12	6	12	5	8
MORCNE SAXATILIS				2	3					

Table 5. (continued).

APRIL 24 - 24, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ALCSA PSEUDOHARENGUS						2				
ALCSA SP.		3	4			2	4	4	13	2
ANCHOA MITCHILLI	3		2							
BREVOORTIA TYRANNUS	18	13	10	2	2	4		2		
DOROSOMA CEPEDIANUM	3									
MORONE AMERICANA			2		2	5		4		4
MORONE SAXATILIS									4	

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALCSA SAPIDISSIMA						2				
ALCSA SP.			6	4		4	15	7	6	4
ANCHOA MITCHILLI	20	29		2					2	4
ANGUILLA ROSTRATA		3		4	4					
BREVOORTIA TYRANNUS	3	6	4	4		2	2	2		
LEIOSTOMUS XANTHURUS			6	2						
MEMBRAS MARTINICA							2			
MORONE AMERICANA					2	2	4	2		7
MORONE SAXATILIS			2		2					

Table 5. (continued).

MAY 8 - 8, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ALOSA PSEUDOHARENGUS			2	2	5	2	14		2	26
ALOSA SAPIDISSIMA							2			
ALOSA SP.		5	6	4	18	20	7	11	13	15
BREVOORTIA TYRANNUS			6							2
CYPRINUS CARPIO				2						
DEPESOMA CEPEDIANUM		5								
GOBIOSOMA BOSCHI							2			
LEIOSTOMUS XANTHURUS						2				
MORONE AMERICANA			2	2	3	5	7		6	6
MORONE SAXATILIS			2	6	3	10	10	2		11
NOTROPIS HUDSONIUS					5	2		2		

63

SPECIES	DISCHARGE CANAL		THERMAL PLUME		AMBIENT RIVER		DOWN-STREAM		UP-STREAM	
	LEFT	RIGHT	TOW NO. 1 LEFT	TOW NO. 1 RIGHT	TOW NO. 2 LEFT	TOW NO. 2 RIGHT	TOW NO. 3 LEFT	TOW NO. 3 RIGHT	TOW NO. 4 LEFT	TOW NO. 4 RIGHT
NIGHT PLUME										
ALCSA SP.			4	2		2				9
ANCHGA MITCHILLI			2	2	2	2	2	2		
BREVOORTIA TYRANNUS	5		4	24	4	7	16	17	3	7
DCRCSOMA CEPEDIANUM		4	2		6			4		
DCRCSOMA PETENENSE					2					
DCRCSOMA SP.			4							2
ETHECSTOMA OLMSTEDI			2		2					
LEIOSTOMUS XANTHURUS	10	9	10	2	4	5	9	8		5
MORONE AMERICANA			6		2			4		2
MORONE SAXATILIS			12	2		2			3	
NOTROPIS HUDSONIUS			4			5				
PERCA FLAVESCENS			2							

Table 5. (continued).

MAY 11 - 11, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER				
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	
DAY PLUME											
ALOSA PSEUDCHARENGUS						2			5		
ALCSA SP.	30	93	31	12	18	18	2	75	45	36	29
BREVCORTIA TYRANNUS								2			
CYPRINUS CARPIO			6	4	16	5			2		
DCRCSOMA CEPEDIANUM								5			2
DCRCSOMA PETENENSE										2	
LEIOSTOMUS XANTHURUS						2					
MENIDIA BERYLLINA					2						2
MORONE AMERICANA					2					10	5
MORONE SAXATILIS	4	16	4			5		2		2	14
NOTROPIS HUDSONIUS							6				

64

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
NIGHT PLUME										
ALOSA PSEUDOHARENGUS										
ALOSA SP.	73	9	44	24	70	35	47	34	16	16
ANCHOA MITCHILLI			2			2				
BREVCORTIA TYRANNAUS		3		2	2				5	
CYPRINUS CARPIO			9		5	6		2		
ETHECSTOMA OLIVACEUM	3									
LEIOSTOMUS XANTHURUS	3	9	5		2	2	2	4	2	5
MORONE AMERICANA			2	2					7	7
MORONE SAXATILIS	3		5	2	5	2		2		
NOTROPIS HUDSONIUS	7	3	7	2	7	2	4		7	

Table 5. (continued).

MAY 16 - 17, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
NIGHT PLUME										
ALCSA SP.		3	16	19	72	80	47	46	64	55
ANCHCA MITCHILLI				2	2				2	4
ANGUILLA ROSTRATA		6								
BREVOORTIA TYRANNUS	4		9	13	11	11	9	14	15	29
ICTALURUS PUNCTATUS			2							
LEIOSTOMUS XANTHURUS		6	4						2	2
MORONE AMERICANA				4		2	2	5	2	2
MORONE SAXATILIS			4	4						4

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ALCSA SP.		4	7	11	28	27	17	20	2	19
BREVOORTIA TYRANNUS									2	
CYPRINUS CARPIO									2	
LEIOSTOMUS XANTHURUS						2				
MORONE AMERICANA		4					2			2
MORONE SAXATILIS			2							2
TRINECTES MACULATUS					2					



Table 5. (continued).

MAY 30 - 31, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ALCSA AESTIVALIS				8		4				
ALCSA PSEUDOHARENGUS			6	8	4		11	14	4	2
ALCSA SP.				2	2	2	4	6	6	7
CYPRINUS CARPIO					4					
CCROSOMA CEPEDIANUM			6		4	4	7	4	4	4
GOBIOSOMA BCSOI					2					
MORONE AMERICANA			2	2	4	4	9	6		
MORONE SAXATILIS							2			

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALCSA AESTIVALIS				3			3	3	2	9
ALCSA SP.	4	4	5	5	6			8	4	2
ANCHOA MITCHILLI						3			2	
BREVOORTIA TYRANNUS								3		
CYPRINUS CARPIO						5		3		
CCROSOMA CEPEDIANUM				3				5		
FUNDULUS HETEROCITUS						3				
ICTALURUS PUNCTATUS			2							
LEIOSTOMUS XANTHURUS	16	11	10	10	23	11	5	3		
LEPCOMIS MACROCHIRUS							3			
MENIDIA BERYLLINA		8		3	3			3	2	
MORONE AMERICANA										2
MORONE SAXATILIS										2

Table 5. (continued).

JUNE 15 - 16, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	TOW NO. 1 RIGHT	TOW NO. 2 LEFT	TOW NO. 2 RIGHT	TOW NO. 3 LEFT	TOW NO. 3 RIGHT	TOW NO. 4 LEFT	TOW NO. 4 RIGHT
DAY PLUME										
ALCSA PSEUDOHARENGUS		3								
ALCSA SP.				2			10		6	4
ANCHOA MITCHILLI		3	2	2					2	
DCRESCMA SP.									4	
ELOFS SALPUS	4									
GOBIOSOMA BOSCI	105	123	65	75	53	54	69	54	16	22
MEMBRAS MARTINICA			13	46	2	2	23	2	36	68
MENIDIA BERYLLINA	4	3	2	7			2		4	16
SPECIMEN MANGLED									2	

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	TOW NO. 1 RIGHT	TOW NO. 2 LEFT	TOW NO. 2 RIGHT	TOW NO. 3 LEFT	TOW NO. 3 RIGHT	TOW NO. 4 LEFT	TOW NO. 4 RIGHT
NIGHT PLUME										
ALCSA SP.			5	4	2		2	2	2	
ANCHOA MITCHILLI	14	13	7		2			4		
ANGUILLA ROSTRATA				2						
ATHERINICAE							4		4	
BREVOCPTIA TYRANNUS						2				
GOBIOSOMA BOSCI	609	429	101	135	64	41	34	39	28	8
LEIOSTOMUS XANTHURUS	7		2				10	11	2	2
MEMBRAS MARTINICA	11	3	9	31	22	15		7		26
MENIDIA BERYLLINA	21	6		2	9	7	28	22	24	4
MORONE SAXATILIS					2	4				

Table 5. (continued).

JUNE 28 - 29, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI		3	54	37	48	60	33	41	37	30
ANGUILLA ROSTRATA		3		3			2			
BREVOORTIA TYRANNUS								2		
GOBIOSOMA BCSCI	63	47	43	54	21	40	42	50	37	30
ICTALURUS PUNCTATUS										3
LEIOSTOMUS XANTHURUS	3	3		14	2		2		30	43
MEMBRAS MARTINICA					2			4		
MENIDIA BERYLLINA	3		3	3	2	2			3	3
MORONE AMERICANA			17	17			6	2	27	17
MORONE SAXATILIS			3	3			2	4	7	13
NOTROPIS HUDSONIUS									3	

89

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
DAY PLUME										
ANCHOA MITCHILLI	3	6	12	9	15	5	6	34	25	18
GOBIOSOMA PETENENSE			5	2				2	3	11
GOBIOSOMA BCSCI	9	38	5	7	96	56	26	25	22	21
MEMBRAS MARTINICA					25	3	30	5	5	
MENIDIA BERYLLINA				9	18	5	4	16		3
MORONE AMERICANA					3					

Table 5. (continued).

JULY 25 - 26, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI	32	49	47	48	48	59	55	46	26	57
ATHERINICAE					2					
GOBIOSOMA BOSCI	92	37	19	12	105	18			2	
MEMBRAS MARTINICA		6	3		9	30	2	2		
MENIDIA BERYLLINA						5	7	2	4	
MENIDIA MENIDIA								2		
TRINECTES MACULATUS					9					

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI	46	50	142	130	643	396	150	221	188	216
CYNOSCIUM REGALIS	4									
GOBIOSOMA BOSCI	56	53	142	199	132	86	139	120	45	75
MEMBRAS MARTINICA		3			2			2		5
MENIDIA BERYLLINA	4	3		2		5	4		5	3
MORONE AMERICANA							2			
TRINECTES MACULATUS					2					

Table 5. (continued).

AUGUST 1 - 1, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHCA MITCHILLI	128	123	20	30	27	53	65	83	74	92
FUNDULUS MAJALIS					5					
GOBIOSOMA BOSCI	107	144	7	12	27	36	10	11	14	19
MEMBRAS MARTINICA	6									

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

NIGHT PLUME      NIGHT SAMPLING ABORTED

Table 5. (continued).

AUGUST 7 - 8, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
NIGHT PLUME										
ALOSA AESTIVALIS	3									
ANCHGA MITCHILLI	86	103	39	50	57	43	123	170	166	119
GOBIOSOMA BOSCI	131	96	25	20	19	30	82	88	73	64
ICTALURUS NEBULOSUS			2							
MEMBRAS MARTINICA					2					
MENIDIA MENIDIA										2
TRINECTES MACULATUS										2

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI	46	29	14	10	16	20	76	52	127	52
ATHERINIDAE									2	
GOBIOSOMA BOSCI	63	63	28	39	11	19	4			
MEMBRAS MARTINICA	2	2					2			
MENIDIA MENIDIA			6	2	1					

Table 5. (continued).

AUGUST 17 - 17, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI	40	28	9	2	9	19	44	20	17	22
GOBIOSCMA BOSCI	142	110	48	57	24	22	2	11	2	9
MEMBRAS MARTINICA					2		4			4
MENIDIA BERYLLINA						2		11		

SPECIES										
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI	248	146	20	11	10	22	206	195	169	273
GOBIOSCMA BOSCI	130	117	23	30	38	50	117	135	54	60
MENIDIA MENIDIA									5	
MORONE AMERICANA			2							

Table 5. (continued).

AUGUST 21 - 22, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI	23	52	30	40	21	29	141	230	216	248
GOBIOSOMA BOSCI	150	154	42	60	34	39	56	61	36	46
MEMBRAS MARTINICA				7	4	4	17	24	18	23
MENIDIA BERYLLINA		3	7	2	2		24	13	3	18
MORCNE AMERICANA					2					
TRINECTES MACULATUS										3

SPECIES										
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI	10	8	16	26	68	58	46	36	55	34
ATHERINIDAE							2			
GOBIOSOMA BOSCI	23	18	84	66	11	20	2			
LEIOSTOMUS XANTHURUS				2						
MEMBRAS MARTINICA					23	2	28		10	4
MENIDIA BERYLLINA	3		3		7			2		
TRINECTES MACULATUS				2				2		



Table 5. (continued).

AUGUST 24 - 25, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
DAY PLUME										
ANCHOA MITCHILLI	28	26	24	27	8	10	27	43	52	53
GOBIOSOMA BOSCI	35	26		2	6	6		2		
MEMBRAS MARTINICA				8			16		6	
MENIDIA BERYLLINA						2	10	2	9	4

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI	34	61	34	23	39	46	52	72	23	51
GOBIOSOMA BOSCI	109	141	28	25	13	40	23	33	14	23
MEMBRAS MARTINICA							2			
MENIDIA BERYLLINA					2					
MORONE AMERICANA								2		

Table 5. (continued).

SEPTEMBER 11 - 12, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHCA MITCHILLI	16	27	2	7		3	2	2		3
GOBIOSOMA BOSCI	3	5				3				

SPECIES	LEFT		TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHCA MITCHILLI	18	22	15	16	30	33	32	33	26	40
GOBIOSOMA BOSCI		5	4	7	12	2	10	15	2	7
MEMBRAS MARTINICA						2				
MENIDIA MENIDIA								3		
MICROGGBIUS THALASSINUS				2						

Table 5. (continued).

SEPTEMBER 25 - 26, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI					2	2				

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI	19	19	10	20	8	9	21	20	7	24
GOBIOSOMA BGSCI	3			5	4	2				
MICROGOCBIUS THALASSINUS	3									
MICROPOGON UNDULATUS	3	3	3						2	

Table 5. (continued).

OCTOBER 16 - 17 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALCSA AESTIVALIS	3									
ANCHOA MITCHILLI	20	10	3	6	7	10	7			2
GOBIOSOMA BOSCI				3			5	3		
MICROPOGON UNICULATUS	17	10	9	12	2	3			2	
SYNGNATHUS FUSCUS				3						

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI			14			3				
MENIDIA MENIDIA				2			7	3	4	

Table 5. (continued).

NOVEMBER 13 - 14, 1978

SPECIES	<u>DISCHARGE</u> <u>CANAL</u>		<u>THERMAL PLUME</u>				<u>AMBIENT RIVER</u>			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALOSA AESTIVALIS		3			2					
ANCHCA MITCHILLI		5	4	2	4	2	4			
MICROPCGN UNDULATUS	5		4				2			

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI				3						

Table 5. (continued).

NOVEMBER 30 - DECEMBER 1, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI				2						
MENIDIA BERYLLINA										3
MICROPOGON UNDULATUS	10	10			5					3

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ELOPS SAURUS										3
MICROPOGON UNDULATUS		2								5

Table 5. (continued).

DECEMBER 5 - 6, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI	2	2								
MICROPOGON UNDULATUS				2						

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALCSA AESTIVALIS							2			
ANCHOA MITCHILLI				2		2	6	2		
GOBIONELLUS BOLEOSOMA			2							
LEIOSTOMUS XANTHURUS										3
MENIDIA BERYLLINA			6						2	
MICROPOGON UNDULATUS				2		7				
MORONE AMERICANA									2	5

Table 5. (continued).

DECEMBER 14 - 15 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI		3						2		2
MENIDIA BERYLLINA			2	2		4	2		3	
MICROPOGON UNDULATUS	6	16	2			2	2		2	

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI					2	2		2	3	3



Table 6. Species and calculated number of fish eggs per 100 m<sup>3</sup> captured in plume entrainment samples at VEPCO Surry Nuclear Power Plant in 1978.

MARCH 13 - 14, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

DAY PLUME      NO CATCH AT THIS TIME

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

NIGHT PLUME

UNIDENTIFIED

9

Table 6. (continued).

MARCH 27 - 27, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
MORONE AMERICANA			2	2		4				
UNIDENTIFIED			2							

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
MORONE AMERICANA			2							

Table 6. (continued).

APRIL 11 - 11, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
DAY PLUME										
ALOSA SAPIDISSIMA	3	3				2				
CYPRINUS CARPIO	87	105	42	26	3	5	4			3
CCRCSOMA CEPEDIANUM		15	5							
CCRCSOMA PETENENSE		3	7							
CCRCSOMA SP.				13	6	3	3	2		3
MORONE AMERICANA		10	42	50	14	20				
MORONE SAXATILIS					2					2

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
NIGHT PLUME										
ALOSA SAPIDISSIMA							2		3	
CYPRINUS CARPIO			8				2	2		
CCRCSOMA CEPEDIANUM	2									
CCRCSOMA SP.		5	3							
MORONE AMERICANA		5	5	36						3

Table 6. (continued).

APRIL 18 - 19, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
CYPRINUS CARPIO					4					
DOROSOMA SP.	5				2					
MORONE AMERICANA	3				7	14			4	

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALOSA SAPIDISSIMA										
CYPRINUS CARPIO			2	2						
DOROSOMA SP.			2	7	10					
MORONE AMERICANA	4	7	27	20	15			2		

Table 6. (continued).

APRIL 24 - 24, 1978

DISCHARGE  
CANAL

THERMAL PLUME

AMBIENT RIVER

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ALCSA SP.	3	5	2							
DCRCSOMA SP.		3	4			2				
MORONE AMERICANA	10	8	12	6	2	5	2			

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ALCSA SAPICISSIMA					2					
DCRCSOMA SP.		3								
MCRONE AMERICANA						2				

Table 6. (continued).

MAY 8 - 8, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
CYPRINUS CARPIO	15	24	41	40		2		2		
OGROSOA SP.	10	14	2							
MORCNE AMERICANA	86	106	4	2						
MORCNE SAXATILIS	5					2				

SPECIES										
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
CYPRINUS CARPIO	5			6		2			2	
OGROSOA SP.	5									
MENIDIA MENIDIA			2							
MORCNE AMERICANA	5									

Table 6. (continued).

MAY 11 - 11, 1978

DISCHARGE  
CANAL

## THERMAL PLUME

## AMBIENT RIVER

SPECIES	DISCHARGE CANAL		TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ALCSA SP.	9	8	4	2	7					
CYPRINUS CARPIO	4	12	46	36	7	11	4	2		5
OCROSTOMA SP.	9	12	8	4	4					
PERIDIA BERYLLINA								2		
MORONE AMERICANA	22	61	17	18	11	16		2		

SPECIES	DISCHARGE CANAL		TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
CYPRINUS CARPIO			7	7	11	8	2			

Table 6. (continued).

MAY 16 - 17, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	RIGHT	TOW NO. 2 LEFT	RIGHT	TOW NO. 3 LEFT	RIGHT	TOW NO. 4 LEFT	RIGHT
NIGHT PLUME										
MENIDIA BERYLLINA		4								
DAY PLUME										
	NO CATCH AT THIS TIME									



Table 6. (continued).

MAY 30 - 31, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME	NO CATCH AT THIS TIME									

SPECIES	LEFT		RIGHT		TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME												
MENIDIA BERYLLINA			4				3					

Table 6. (continued).

JUNE 15 - 16, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME		AMBIENT RIVER	
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
DAY PLUME						
MEMBRAS MARTINICA			2	2		
NIGHT PLUME						
SPECIES	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
MEMBRAS MARTINICA			2	2		
MORCNE AMERICANA			2	9		

Table 6. (continued).

JUNE 28 - 28, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHCA MITCHILLI		6		6						
DAY PLUME										
ANCHOA MITCHILLI	13	9	7	9	3	24			8	5

Table 6. (continued).

JULY 25 - 26, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI		9								2
UNIDENTIFIED		3								

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME NO. CATCH AT THIS TIME										

Table 6. (continued).

AUGUST 1 - 1, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHGA MITCHILLI	71	67	2		12	15				

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

NIGHT PLUME NIGHT SAMPLING ABORTED

Table 6. (continued).

AUGUST 7 - 8, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										

GORISCMA BOSCI

4

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

DAY PLUME

ANCHOA MITCHILLI

3

1

1

Table 6. (continued).

AUGUST 17 - 17, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

DAY PLUME

ANCHOA MITCHILLI	9		7	2	2	2				
------------------	---	--	---	---	---	---	--	--	--	--

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

NIGHT PLUME NO CATCH AT THIS TIME

Table 6. (continued).

AUGUST 21 - 22, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
NIGHT PLUME										
ANCHOA MITCHILLI		52	11	2	18	22	2		5	8

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
DAY PLUME										
ANCHOA MITCHILLI	3		3	2	2					



Table 6. (continued).

AUGUST 24 - 25, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME				AMBIENT RIVER			
	LEFT	RIGHT	TOW NO. 1 LEFT	TOW NO. 1 RIGHT	TOW NO. 2 LEFT	TOW NO. 2 RIGHT	TOW NO. 3 LEFT	TOW NO. 3 RIGHT	TOW NO. 4 LEFT	TOW NO. 4 RIGHT

DAY PLUME

ANCHOA MITCHILLI

4

SPECIES			TOW NO. 1		TOW NO. 2		TOW NO. 3		TOW NO. 4	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

NIGHT PLUME

ANCHOA MITCHILLI

17

2

2

2

2

Table 6. (continued).

SEPTEMBER 11 - 12, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME		AMBIENT RIVER	
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT

DAY PLUME

ANCHOA MITCHILLI	8			3		
------------------	---	--	--	---	--	--

SPECIES	LEFT RIGHT		TOW NO. 1 LEFT RIGHT		TOW NO. 2 LEFT RIGHT		TOW NO. 3 LEFT RIGHT		TOW NO. 4 LEFT RIGHT	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

NIGHT PLUME NO CATCH AT THIS TIME

Table 6. (continued).

SEPTEMBER 25 - 26, 1978

SPECIES	DISCHARGE CANAL		THERMAL PLUME		AMBIENT RIVER	
	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT RIGHT
DAY PLUME	NO CATCH AT THIS TIME					

SPECIES	LEFT	RIGHT	TOW NO. 1 LEFT RIGHT	TOW NO. 2 LEFT RIGHT	TOW NO. 3 LEFT RIGHT	TOW NO. 4 LEFT . RIGHT
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NIGHT PLUME

FUNDULUS DIAPHANUS

3

Table 7. Salinity (‰) at VEPCO Surry Nuclear Power Plant during plume entrainment stations in 1978 (D = Day; N = Night).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
Jan. 24 D	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Jan. 24 N	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Feb. 23 D	2.0	2.0	2.0	1.1	1.2	1.3	0.6	0.8
Feb. 23 N	2.3	2.3	2.3	0.6	0.7	1.5	0.5	0.5
Mar. 13 D	1.0	0.9	1.0	0.8	0.6	0.2	0.1	0.3
Mar. 13 N	0.6	0.6	0.6	0.6	0.6	0.6	0.2	0.2
Mar. 27 D	0.4	0.4	0.4	0.3	0.2	0.1	0.3	0.1
Mar. 27 N	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2
Apr. 11 D	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Apr. 11 N	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2
Apr. 18 D	2.9	2.9	2.8	1.6	2.2	1.7	0.9	0.8
Apr. 19 N	2.6	2.6	2.6	1.1	1.6	1.7	1.7	1.7
Apr. 24 D	2.8	2.8	2.8	2.0	2.0	2.0	1.0	0.9
Apr. 24 N	2.7	2.7	2.7	1.8	1.8	1.8	1.0	1.1
May 8 D	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1
May 8 N	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
May 11 D	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
May 11 N	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
May 16 N	*	*	*	*	*	*	*	*
May 17 D	*	*	*	*	*	*	*	*

Table 7. (continued).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
May 30 D	0.9	0.7	0.7	0.2	0.2	0.1	0.2	0.2
May 31 N	0.7	0.7	0.7	0.5	0.4	0.2	0.2	0.2
Jun. 15 D	2.1	1.7	1.7	1.0	0.6	0.5	0.7	0.8
Jun. 16 N	2.0	2.1	2.0	0.6	0.5	0.5	1.0	0.7
Jun. 28 N	3.5	3.5	3.5	2.6	2.7	2.6	2.4	1.8
Jun. 28 D	3.2	3.2	3.2	1.0	1.2	1.4	1.2	1.1
Jul. 25 D	5.2	5.2	5.2	3.5	3.8	4.2	2.0	3.6
Jul. 26 N	5.8	5.9	5.9	4.2	4.3	4.4	3.2	3.1
Aug. 1 D	6.3	6.1	6.1	2.9	3.7	4.1	3.2	3.2
Aug. 7 N	4.2	4.2	4.2	3.5	2.8	2.8	2.3	2.6
Aug. 8 D	3.6	3.6	3.6	3.1	2.7	2.5	1.0	1.4
Aug. 17 D	4.6	4.6	4.6	2.8	3.1	3.1	1.6	1.6
Aug. 17 N	4.0	4.0	4.0	3.1	1.7	1.9	1.2	1.2
Aug. 21 N	5.1	5.0	5.0	3.8	3.9	3.8	1.8	1.9
Aug. 22 D	5.0	5.1	5.0	5.0	4.6	3.8	1.6	2.6
Aug. 24 D	5.5	5.6	5.6	4.0	4.3	4.3	1.5	2.3
Aug. 25 N	5.9	5.9	5.9	4.6	4.6	4.6	3.0	2.9
Sep. 11 D	8.9	8.2	8.9	7.8	7.5	7.5	4.5	4.7
Sep. 12 N	8.2	8.2	8.2	6.9	7.2	7.2	4.1	5.3

Table 7. (concluded).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
Sep. 25 D	8.5	8.4	8.5	6.5	6.3	6.6	4.4	4.5
Sep. 26 N	8.5	8.4	8.4	5.0	6.1	7.0	5.3	5.2
Oct. 16 N	5.9	6.0	6.0	2.9	5.4	5.4	2.7	2.7
Oct. 17 N	5.3	5.3	5.3	4.3	3.9	4.3	2.6	2.5
Nov. 13 N	11.1	10.9	10.9	9.9	7.5	8.9	7.5	8.4
Nov. 14 D	10.6	10.7	10.7	8.6	9.4	9.7	6.4	9.2
Nov. 30 N	10.2	10.3	10.2	6.0	6.8	9.0	5.1	6.7
Dec. 1 D	8.9	8.9	8.9	8.9	8.0	7.7	5.3	6.2
Dec. 5 D	8.9	8.5	8.5	4.3	5.6	5.7	4.9	5.6
Dec. 6 N	8.1	8.2	8.1	7.7	7.2	7.0	4.4	5.5
Dec. 14 N	4.4	4.1	4.1	2.3	2.6	2.7	2.1	2.0
Dec. 15 D	4.4	4.5	4.5	2.3	2.5	3.5	2.2	2.2

\* Data misplaced by the chemistry lab.

Table 8. Water temperature (C) at VEPCO Surry Nuclear Power Plant during plume entrainment stations in 1978 (D = Day; N = Night).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
Jan. 24 D	11.0	10.2	10.2	2.0	3.0	3.1	5.7	5.1
Jan. 24 N	11.3	11.7	11.8	2.4	5.6	5.8	8.5	6.8
Feb. 23 D	11.4	10.7	10.4	5.3	5.5	6.1	0.3	0.9
Feb. 23 N	11.8	11.0	11.2	2.8	2.8	3.0	2.5	2.4
Mar. 13 D	15.9	15.4	15.3	12.3	10.0	5.4	5.3	5.5
Mar. 13 N	15.6	15.3	15.1	14.5	13.0	11.9	6.5	7.2
Mar. 27 D	16.6	16.2	16.1	13.6	12.8	12.1	13.2	12.0
Mar. 27 N	18.3	18.0	18.1	14.8	14.0	13.8	12.5	12.5
Apr. 11 D	23.5	23.2	23.2	16.8	16.0	16.0	19.0	18.0
Apr. 11 N	23.8	23.4	23.4	20.0	16.0	16.0	18.4	18.4
Apr. 18 D	21.2	20.5	20.2	17.8	18.8	18.0	16.2	*
Apr. 19 N	21.0	20.5	20.5	16.8	17.4	17.5	17.5	17.7
Apr. 24 D	19.2	18.5	18.5	17.7	17.5	17.7	16.5	16.5
Apr. 24 N	21.0	20.5	20.5	19.2	18.8	18.8	17.2	17.3
May 8 D	20.3	19.8	19.2	17.0	16.0	15.5	14.7	14.0
May 8 N	20.5	20.5	20.0	16.5	16.5	16.5	15.5	15.5
May 11 D	22.9	23.0	23.1	21.8	20.5	19.0	22.0	18.0
May 11 N	24.5	23.0	23.0	19.2	18.9	18.8	18.6	18.4
May 16 N	28.5	27.0	27.0	24.5	22.5	22.0	23.5	22.0
May 17 D	28.5	27.5	27.5	24.8	24.3	23.7	23.7	23.7

Table 8. (continued).

DATE			DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
			Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
May	30	D	31.2	30.0	29.0	25.0	24.0	23.5	25.0	24.0
May	31	N	29.2	28.5	27.5	26.0	25.0	24.0	23.5	23.5
Jun.	15	D	31.0	29.8	29.3	27.5	26.3	25.5	26.8	26.3
Jun.	16	N	28.5	28.5	28.0	24.0	23.5	23.5	25.2	23.5
Jun.	28	N	32.6	31.0	29.8	29.0	27.5	29.0	29.0	28.2
Jun.	28	D	35.3	34.0	33.8	29.4	29.5	29.7	29.8	29.4
Jul.	25	D	33.5	33.0	33.0	30.8	30.6	31.2	29.2	30.0
Jul.	26	N	33.0	32.2	32.3	30.2	30.2	30.2	29.5	28.8
Aug.	1	D	32.5	32.2	32.2	28.8	29.3	29.5	29.6	29.1
Aug.	7	N	37.2	36.0	36.2	33.8	31.5	31.5	30.5	30.0
Aug.	8	D	37.1	36.3	36.2	34.5	33.0	31.8	29.2	29.3
Aug.	17	D	37.5	36.5	36.5	33.5	33.0	33.2	31.0	31.0
Aug.	17	N	39.1	38.0	37.8	35.2	31.5	31.5	31.0	30.5
Aug.	21	N	36.0	35.8	35.4	33.0	32.9	32.8	29.0	28.0
Aug.	22	D	36.5	35.5	35.5	35.5	34.2	32.8	29.5	29.5
Aug.	24	D	39.0	38.9	38.4	34.3	32.4	32.6	29.5	30.1
Aug.	25	N	37.2	36.0	35.3	33.2	31.3	31.3	30.4	29.3
Sep.	11	D	36.5	35.5	35.0	33.8	32.5	32.5	28.0	28.0
Sep.	12	N	34.5	33.8	34.0	30.3	29.8	30.0	26.8	27.8



Table 8. (concluded).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
Sep. 25 D	33.5	32.8	33.0	29.0	27.9	28.5	24.3	24.1
Sep. 26 N	31.5	31.0	30.8	24.0	25.0	28.0	24.0	23.5
Oct. 16 N	27.6	27.0	26.5	21.0	24.0	25.0	18.0	18.0
Oct. 17 D	26.0	26.0	25.0	19.5	19.5	21.0	17.5	17.0
Nov. 13 N	23.0	23.0	23.0	20.0	16.3	18.0	16.4	16.4
Nov. 14 D	23.0	22.5	22.5	17.5	19.0	19.5	15.0	17.5
Nov. 30 N	19.9	19.2	20.6	12.0	13.2	16.0	10.8	12.8
Dec. 1 D	19.1	18.8	18.8	19.0	15.5	15.0	10.4	10.5
Dec. 5 D	21.0	21.0	20.6	11.8	14.0	14.2	12.3	13.8
Dec. 6 N	22.0	20.3	21.0	19.2	16.8	15.8	12.0	13.0
Dec. 14 N	14.5	14.0	14.0	8.0	7.0	*	7.5	7.5
Dec. 15 D	13.2	13.0	13.0	7.5	7.5	7.0	7.0	7.0

\* Data not recorded.

Table 9. Dissolved oxygen (mg/l) at VEPCO Surry Nuclear Power Plant during plume entrainment stations in 1978 (D = Day; N = Night).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
Jan. 24 D	13.0	12.1	12.2	12.5	12.1	11.9	11.7	10.1
Jan. 24 N	11.0	11.1	11.1	12.1	11.5	11.4	11.1	11.3
Feb. 23 D	11.7	11.7	11.7	12.1	11.9	11.8	12.1	12.2
Feb. 23 N	12.0	12.0	12.0	11.9	12.1	11.8	12.2	12.0
Mar. 13 D	11.0	11.0	11.0	11.2	11.2	11.3	11.2	11.2
Mar. 13 N	11.3	11.3	11.2	11.1	11.2	11.1	11.2	11.1
Mar. 27 D	9.5	9.5	9.5	9.4	9.6	9.7	9.5	9.8
Mar. 27 N	9.6	9.5	9.3	9.3	9.5	9.3	9.6	9.4
Apr. 11 D	8.5	8.2	8.3	8.8	9.4	9.0	8.5	8.6
Apr. 11 N	9.0	8.6	8.9	8.7	9.2	9.0	8.3	8.4
Apr. 18 D	8.7	8.8	8.8	9.0	8.9	8.8	8.9	9.5
Apr. 19 N	8.4	8.7	8.8	9.0	8.5	8.5	8.6	8.7
Apr. 24 D	8.6	9.0	8.5	8.6	8.3	8.4	8.8	8.6
Apr. 24 N	8.8	8.9	8.5	8.8	8.7	8.8	8.9	9.1
May 8 D	8.7	8.3	8.5	8.4	8.5	7.8	8.0	8.1
May 8 N	8.4	8.4	8.3	8.2	8.1	8.4	8.2	8.4
May 11 D	7.7	7.9	8.2	6.8	7.5	7.6	8.2	8.2
May 11 N	7.8	8.0	8.1	8.2	8.0	7.9	8.0	7.8
May 16 N	*	*	*	*	*	*	*	*
May 17 D	*	*	*	*	*	*	*	*

Table 9. (continued).

DATE		DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
		Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
May	30 D	7.3	7.0	6.9	7.1	7.0	7.0	7.3	6.9
May	31 N	6.5	6.8	7.0	6.7	6.9	6.6	6.9	6.7
Jun.	15 D	6.8	6.8	6.7	7.5	7.4	7.4	7.6	7.5
Jun.	16 N	7.1	6.7	6.4	7.5	7.4	7.4	7.3	7.1
Jun.	28 N	6.7	6.4	8.0	5.8	6.1	5.1	5.3	5.3
Jun.	28 D	7.0	7.0	7.2	7.1	7.1	7.0	7.3	7.1
Jul.	25 D	6.3	6.5	6.5	7.1	7.0	7.0	6.9	6.2
Jul.	26 N	6.3	6.2	6.0	6.7	6.7	6.7	7.0	7.0
Aug.	1 D	6.3	6.5	6.0	6.8	6.4	5.9	6.2	6.2
Aug.	7 N	6.2	6.4	6.1	6.3	6.6	6.4	6.4	6.5
Aug.	8 D	6.4	6.3	6.3	4.1	4.8	5.0	6.7	6.6
Aug.	17 D	5.6	6.1	5.5	5.9	6.0	6.3	6.1	6.2
Aug.	17 N	6.0	5.9	5.5	6.7	6.6	6.1	6.4	6.4
Aug.	21 N	6.2	6.2	6.1	**	6.6	6.5	6.9	6.7
Aug.	22 D	6.3	6.2	6.2	6.2	6.2	6.3	6.6	6.2
Aug.	24 D	6.1	6.3	6.4	6.5	6.5	6.4	6.8	7.2
Aug.	25 N	6.6	5.9	6.3	6.7	6.3	7.0	7.0	7.2
Sep.	11 D	6.5	7.2	7.7	7.3	7.4	7.3	7.5	7.1
Sep.	12 N	6.6	6.4	6.4	6.4	6.4	6.5	6.6	6.7

Table 9. (concluded).

DATE	DISCHARGE CANAL			PLUME			AMBIENT RIVER WATER	
	Surface	Midwater	Bottom	Surface	Midwater	Bottom	Surface	Bottom
Sep. 25 D	6.4	6.4	6.4	6.5	6.7	6.7	7.0	7.1
Sep. 26 N	6.7	6.5	7.0	6.9	6.8	6.2	6.5	6.7
Oct. 16 N	7.4	7.3	7.4	8.6	7.4	7.6	7.7	7.5
Oct. 17 D	7.4	7.5	7.7	7.6	7.7	7.7	***	8.0
Nov. 13 N	7.1	7.8	7.4	7.6	7.7	7.7	7.8	7.6
Nov. 14 D	7.5	7.8	7.4	7.7	7.5	7.6	6.9	6.8
Nov. 30 N	9.4	9.3	9.9	8.7	9.0	8.5	9.1	8.5
Dec. 1 D	8.9	8.8	8.8	6.4	7.1	7.1	7.4	7.3
Dec. 5 D	8.2	8.6	8.5	9.1	8.9	8.9	9.0	6.6
Dec. 6 N	8.2	8.3	8.4	8.3	8.4	8.5	8.9	8.8
Dec. 14 N	9.6	9.6	9.6	10.1	8.8	8.9	9.8	9.4
Dec. 15 D	***	9.4	9.3	9.9	10.2	10.1	10.2	10.2

\* Data misplaced by the chemistry lab.

\*\* Sample bottle not full, so discarded.

\*\*\* Data deleted because anomalous reading.

Table 10. Descriptive statistics of dependent ( $Y_i$ ) and independent ( $X_j$ ) variables.

Variable	January-December 1978 (N = 244)				May-October 1978 (N = 135)			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
$Y_1$ , Total abundance of fish	3.1	2.002	0.0	7.1	-	-	-	-
$Y_2$ , Abundance of fish species	1.1	0.666	0.0	2.5	-	-	-	-
$Y_3$ , Fish species diversity	0.6	0.521	0.0	2.1	-	-	-	-
$Y_4$ , Total abundance of eggs	0.8	1.316	0.0	5.6	-	-	-	-
$Y_5$ , Abundance of egg species	0.3	0.477	0.0	1.8	-	-	-	-
$Y_6$ , Egg species diversity	0.1	0.265	0.0	1.2	-	-	-	-
$Y_7$ , Abundance of <u>A. mitchilli</u> fish	-	-	-	-	2.8	1.982	0.0	6.9
$Y_8$ , Abundance of <u>G. bosci</u> fish	-	-	-	-	2.4	2.167	0.0	6.9
$Y_9$ , Abundance of <u>A. mitchilli</u> eggs	-	-	-	-	0.5	1.032	0.0	4.9
$X_1$ , Temperature	21.2	9.036	1.0	39.0	27.5	5.686	14.0	39.0
$X_2$ , Salinity	2.8	2.718	0.0	11.0	2.8	2.269	0.0	9.0
$X_3$ , Dissolved oxygen	8.0	1.775	0.1	12.5	6.9	0.744	4.7	8.5
$X_4$ , Plume	0.4	0.491	0	1	0.4	0.492	0	1
$X_5$ , Ambient	0.4	0.490	0	1	0.4	0.492	0	1
$X_6$ , Period	0.5	0.501	0	1	0.5	0.502	0	1

Table 10. (continued).

Variable	January-December 1978 (N = 244)				May-October 1978 (N = 135)			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
X <sub>7</sub> , Fall	0.2	0.401	0	1	0.1	0.263	0	1
X <sub>8</sub> , Winter	0.2	0.371	0	1	-	-	-	-
X <sub>9</sub> , Spring	0.3	0.470	0	1	0.4	0.485	0	1

Table 11. Summary statistics for final stepwise regression equations.

Y <sub>i</sub>	Final Equation				b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub>	b <sub>8</sub>	b <sub>9</sub>	b <sub>c</sub>
	R <sup>2</sup>	F <sub>s</sub>	DF	Sig.	Temperature	Salinity	Dissolved Oxygen	Plume	Ambient	Period	Fall	Winter	Spring	Constant
Y <sub>1</sub> , Total abundance of fish	0.76	148	5,238	0.001	0.117***	-0.258***	ns	ns	ns	0.831***	-0.775**	-2.242***	ns	1.512
Y <sub>2</sub> , Abundance of fish species	0.69	76	7,236	0.001	0.029**	-0.073***	ns	0.318***	0.169*	0.310***	ns	-0.567***	0.454***	0.327
Y <sub>3</sub> , Fish species diversity	0.55	48	6,237	0.001	0.014**	ns	-0.037	0.336***	0.242***	0.226***	ns	ns	0.627***	0.032
Y <sub>4</sub> , Total abundance of eggs	0.39	26	6,237	0.001	-0.036*	ns	ns	ns	-0.962***	-0.350**	-1.286***	-1.430***	0.595**	2.410
Y <sub>5</sub> , Abundance of egg species	0.45	32	6,237	0.001	-0.020***	ns	ns	ns	-0.339***	-0.124**	-0.550***	-0.633***	0.232**	1.053
Y <sub>6</sub> , Egg species diversity	0.35	18	7,236	0.001	-0.019***	ns	ns	-0.090*	-0.198***	-0.065*	-0.291***	-0.424***	0.097*	0.737
Y <sub>7</sub> , Abundance of <u>A. mitchilli</u> fish	0.68	46	6,128	0.001	0.148***	-0.246***	-0.395	ns	0.419	1.063***	ns	NA	-2.315***	2.344
Y <sub>8</sub> , Abundance of <u>G. bosci</u> fish	0.49	42	3,131	0.001	0.299***	-0.258***	ns	ns	ns	1.157***	ns	NA	ns	-5.659
Y <sub>9</sub> , Abundance of <u>A. mitchilli</u> eggs	0.20	17	2,131	0.001	0.067***	ns	ns	ns	-0.377*	ns	ns	NA	ns	-1.185

R<sup>2</sup>, Coefficient of multiple determination  
 F<sub>s</sub>, F-statistic for test of significance of regression  
 DF, Degrees of freedom  
 Sig., Significance of regression  
 b<sub>i</sub>, Partial regression coefficient  
 \*, Significant, P<0.05  
 \*\*, Highly significant, P<0.01  
 \*\*\*, Very highly significant, P<0.001  
 ns, Not significant P>0.10  
 NA, Not applicable

Table 12. Standardized partial regression coefficients with ranks of relative importance in parentheses.

$Y_i$	Temperature	Salinity	Dissolved Oxygen	Plume	Ambient	Period
$Y_1$	0.526 (1)	-0.350 (2)	ns (5)	ns (5)	ns (5)	0.208 (3)
$Y_2$	0.393 (1)	-0.298 (2)	ns (6)	0.234 (3)	0.124 (5)	0.233 (4)
$Y_3$	0.246 (2)	ns (6)	-0.126 (5)	0.317 (1)	0.228 (3)	0.217 (4)
$Y_4$	-0.251 (2)	ns (5)	ns (5)	ns (5)	-0.359 (1)	-0.133 (3)
$Y_5$	-0.373 (1)	ns (5)	ns (5)	ns (5)	-0.349 (2)	-0.130 (3)
$Y_6$	-0.650 (1)	ns (5.5)	ns (5.5)	-0.166 (3)	-0.365 (2)	-0.122 (4)
$Y_7$	0.426 (1)	-0.281 (2)	-0.148 (4)	ns (6)	0.104 (5)	0.269 (3)
$Y_8$	0.786 (1)	-0.271 (2)	ns (5)	ns (5)	ns (5)	0.268 (3)
$Y_9$	0.368 (1)	ns (4.5)	ns (4.5)	ns (4.5)	-0.180 (2)	ns (4.5)
Sum of Ranks	11	34	45	37.5	30	31.5
Overall Rank of Relative Importance	1	4	6	5	2	3



3.5.2

ICHTHYOPLANKTON ENTRAINMENT STUDY

Please refer to the following report by the Virginia  
Institute of Marine Science for preliminary results and conclusions.

3.5.2 Ichthyoplankton Entrainment Study

Section II a.

PLANT ENTRAINMENT OF ICHTHYOPLANKTON  
AT THE VEPCO NUCLEAR POWER PLANT

by

John V. Merriner

A. Deane Estes

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TABLE OF CONTENTS	PAGE
LIST OF TABLES . . . . .	iii
LIST OF FIGURES. . . . .	v
ACKNOWLEDGMENTS. . . . .	vi
LIST OF PROJECT PERSONNEL. . . . .	vii
INTRODUCTION . . . . .	1
METHODS AND MATERIALS. . . . .	3
Statistical Methods . . . . .	4
RESULTS AND DISCUSSION . . . . .	8
Seasonal Trends in Species Composition and Abundance. . . . .	8
Hydrographic Data . . . . .	13
Statistical Results . . . . .	14
Summary of Regression Analysis. . . . .	20
CONCLUSIONS. . . . .	24
LITERATURE CITED . . . . .	27

# LIST OF TABLES

Table		Page
1	Ichthyoplankton sampling schedule for plant and plume entrainment studies at VEPCO Surry Nuclear Power Plant (January through December 1978) . . .	37
2	Dependent ( $Y_i$ ) and independent ( $X_i$ ) variables for statistical analysis (standardized catch is number collected per 100 cubic meters of water strained per collection) . . . . .	38
3	Number of species captured during 24-hour stations at VEPCO Surry Nuclear Power Station in 1978 . . . . .	40
4	Species and calculated number of fish per 100 m <sup>3</sup> captured during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978. . . . .	41
5	Species and calculated number of fish eggs per 100 m <sup>3</sup> captured during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978. . . . .	74
6	Average (yearly) number of fish and fish eggs captured per sample (by depth) during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	93
7	Average number per sample of dominant species (fish and fish eggs) captured during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	94
8	Ranges of salinity (‰) during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	95
9	Ranges of water temperature (C) during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	97
10	Ranges of dissolved oxygen (mg/l) during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	99

Table		Page
11	Descriptive statistics of dependent ( $Y_i$ ) and independent ( $X_j$ ) variables . . . . .	101
12	Summary statistics for final stepwise regression equations. . . . .	103
13	Standardized partial regression coefficients with ranks of relative importance in parentheses.	104

# LIST OF FIGURES

Figure		Page
1	Paired net apparatus used at VEPCO Surry Nuclear Power Plant for ichthyoplankton collections . . . . .	29
2	Number of fish species captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	30
3	Number of egg species captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	31
4	Average number of fish per sample (100 m <sup>3</sup> ) captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	32
5	Average number of eggs per sample (100 m <sup>3</sup> ) captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	33
6	Ranges of salinity (‰) at the intake during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	34
7	Ranges of water temperature (C) at the intake during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	35
8	Ranges of dissolved oxygen (mg/l) at the intake during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978 . . . . .	36

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## INTRODUCTION

Ichthyoplankton entrainment sampling at VEPCO Surry Nuclear Power Plant was initiated by the Ichthyology Department of Virginia Institute of Marine Science in April 1975. Objectives of this study were assessment of the kinds and amounts of ichthyoplankton being entrained from the James River near Hog Island and passed through the Surry facility.

VEPCO Surry is located near the fresh-saltwater transition zone of the James River. Depending upon river flow and salinity patterns in the area, ichthyofauna can range from strictly fresh-water species to marine strays. This reach of the estuary serves as spawning grounds (engraulids, gobiids), fish nursery grounds (sciaenids, Brevoortia), and migration route (Anguilla, Morone and Alosa). White (1976) reported 84 species representing 38 families in the vicinity of Hog Island and VEPCO Surry Nuclear Power Plant. Most of these species do not spawn in the vicinity of Hog Island but are found there as juvenile through adult life stages. They are not subject to entrainment.

Many eggs, prolarval, and larval fishes are pelagic, and therefore are transported by water currents. Pelagic fish eggs and larvae are potentially subject to entrainment when present in the waters surrounding the intake structure at VEPCO Surry. Intake pumps have a combined capacity to withdraw 1.68 million gallons of water per minute from the James River. Water velocity at the intake structure trash

bars is approximately 1 foot/second (Applicants Environmental Report), but velocity fields have not been thoroughly mapped at distances away from the trash bars (J. White, personal communication).

Samples through December 1978 have been sorted, identified, enumerated, and stored in vials. Data from these samples have been punched and are stored on ADP cards.

Species lists and abundance of fish eggs, larvae, juveniles, and adults taken in samples from January through December 1978 are presented. Ranges of salinity, dissolved oxygen, and temperature for each 24-hour sampling station are also presented. Species composition, trends of abundance, statistical analyses of the data set (1978), and impact of entrainment upon the ichthyofauna near Hog Island are discussed.

Sampling visits for plant and thermal plume ichthyoplankton entrainment during 1978 are presented in Table 1. Sampling intensity reflects anticipated periods of greatest spawning activity (April, May).

## METHODS AND MATERIALS

Ichthyoplankton entrainment studies at VEPCO Surry Nuclear Power Plant from January through December 1978 employed a 0.5 meter paired net apparatus (Fig. 1) equipped with conical Nitex nets (505  $\mu$  mesh) and General Oceanics Digital Flowmeters (Model 2030). Flowmeters were periodically calibrated in the VIMS flume.

Sampling sites for the 24-hour stations were: (1) intake structure forebay directly in front of the trash bars, and (2) mid-channel in the discharge canal at the roadway bridge. Samples were made at surface, midwater, and bottom depths at sample times of 1000, 1400, 1800, 2200, 0200, and 0600 hours. Tow time at the intake was 10 minutes and at the discharge was 5 minutes. Temperature, salinity, and dissolved oxygen data were recorded for each sample at each sample time.

Tow times at the intake and discharge reflect a compromise between sampling equal water volumes and sampling the same water mass at each site. Time of passage through the facility (intake to discharge) is approximately one hour (J. White, personal communication). Transportation time between sites was approximately 15 minutes and occasionally, sampling in the discharge was delayed.

Dissolved oxygen samples were fixed on station for laboratory analysis by Winkler Titration Method. Salinity samples were returned to VIMS for analysis with a Beckman RS-7

induction salinometer. Water temperature was measured with a stem thermometer (-35 to 50 C, 1 C interval) and recorded in the field sample log. Sea state, weather, tidal stage, turbidity, air temperature, and wind were recorded on the log sheet at the time of sampling.

Samples were preserved in approximately 5% formalin in the field and returned to the lab for sorting, enumeration, and identification. Data are stored on ADP cards. Specimens are retained in vials with 5% buffered formalin for further study or reference.

The manual by Lippson and Moran (1974) has been most useful in identification of specimens. Myomere counts of small larvae were facilitated by clearing and staining (Mook and Wilcox, 1974).

Vessels and operators for 24-hour stations were provided by VEPCO. Two VIMS project personnel were required on each of two 12-hour shifts.

All calculations and conclusions presented in this report are based on number of organisms per 100 cubic meters of water strained unless otherwise stated.

#### Statistical methods

Catch data were subjected to statistical analysis (a) to determine the significant spatial and temporal trends in the ichthyoplanktonic community, (b) to develop regression models which identify the major environmental factors of importance to community structure, and (c) to

assess significant patterns in two dominant fish populations (Anchoa mitchilli and Gobiosoma boscii).

Six dependent or response variables ( $Y_i$ ) which reflect overall community structure were included in the analysis these were total abundance of fish, abundance of fish species, fish species diversity (Shannon index), total abundance of eggs, abundance of egg species, and egg species diversity. The abundance of A. mitchilli eggs, and G. boscii fish were also included as dependent variables.

[NOTE: For simplicity throughout this report, the species abundance and species diversity of the egg stage are referred to as egg species abundance and egg species diversity, respectively.]

Measures of abundance were computed as  $Y_i = \log_e (C_i + 1)$ , where  $Y_i$  is abundance and  $C_i$  is standardized catch of collection  $i$  (i.e., number captured per 100 cubic meters of water strained per collection). Logarithmic transformation of the catch data was necessary to convert discrete variables to continuous form and to remove heterogeneity and non-normality from the data. Measures of species diversity were not log-transformed, but were analyzed in their original scale.

Ten independent variables ( $X_j$ ) were chosen for analysis: sample depth, water temperature, salinity, dissolved oxygen, tide and dummy variables for sampling location, period, and seasons (fall, winter and spring). Table 2 summarizes notation and defines the dependent and independent variables.

Multiple regression was selected as the major method to analyze trends in the response variables for the following reasons:

(a) Complex multivariate relationships exist between the abundance of fish and eggs and environmental variables; as a descriptive tool, multiple regression can give a concise summary of these relationships.

(b) Field survey data are confounded by numerous factors since such surveys are observational in nature rather than controlled; multiple regression allows for control of some of these confounding factors by the use of "dummy" (categorical) variables. Also, each partial regression coefficient is computed as if the other variables in the equation are held constant, thereby removing their confounding effects.

(c) The ability to accurately predict the effects of environmental change or modification upon living resources is an ultimate goal; multiple regression techniques can be used to develop empirical models with predictive capabilities.

Stepwise regression techniques (Draper and Smith, 1966) were used to develop the "best" regression equation for each  $Y_i$  in the following manner:

(a) The dependent variables were plotted against environmental (independent) variables and the data were transformed where necessary.

(b) Matrices of simple correlation coefficients of dependent and independent variables and selected transformations were computed.

(c) Using the multiple regression model

$$Y_i = B_0 + B_1X_1 + B_2X_2 + \dots + B_pX_p + \epsilon$$

where  $Y_i$  is abundance or species diversity,  $X_j$  is some function of one of the selected environmental variables, and  $B_j$  is a partial regression coefficient, a stepwise regression was performed to identify those parameters which explain a significant portion of the variation in the model.

(d) For each final regression equation residuals were analyzed to detect possible violations of the basic assumptions that the errors were independent, had zero mean, constant variance and followed a normal distribution.

Computations were made using SPSS version 6.02 (Nie, et al., 1975). Independent variables were retained in the equations if their partial regression coefficients ( $b_j$ ) could be declared significantly different from zero at  $P < 0.10$ . Equations for the community structure variables ( $Y_1$  through  $Y_6$ , Table 2) were based upon data from January through December 1978. Equations for A. mitchilli and G. bosci ( $Y_7$  through  $Y_9$ ) were based on data from May through October 1978, the time period in which eggs and larvae of these species are known to occur.

## RESULTS AND DISCUSSION

Seasonal trends in species composition and abundance

Number of species (fish) decreased from January to March when lowest numbers were recorded (Table 3; Fig. 2). Number of species increased in April and remained relatively stable through mid-June. A slight decrease was recorded in mid-June and afterward remained stable through September. A decrease was recorded in October and little fluctuation occurred through December. Highest number of species was recorded on 18-19 May.

Fish eggs were taken from January through September (Table 3; Fig. 3). January, February, and March samples each yielded one egg in the discharge canal which remains unidentified at present. Number of species increased through late April when a slight decrease was recorded. Number of species again increased in May and highest numbers were recorded on 18-19 May. Number of species then declined in late May and fluctuated at lower numbers through September. Discharge canal samples consistently captured more species of eggs than intake samples, indicating spawning activity in either the high level intake canal or the discharge canal.

Calculated number of fish per 100 m<sup>3</sup> was less than one fish per 100 m<sup>3</sup> from January through March (Fig. 4). Slight increases were recorded in early April but numbers



fell again in late April and early May. Number of fish again increased in mid-May but fell in late May. Sharp increases were recorded in June and a slight decline was recorded in July. Another increase was recorded in August when highest numbers were reached. A drastic decline was recorded in September and numbers remained very low through December.

Increased fish abundance during mid-April (Fig. 4) was due to catches of larval white perch, Morone americana and striped bass, Morone saxatilis. Again in mid-May, white perch and striped bass contributed to increased abundances (Table 4). Larval river herring, Alosa species also contributed greatly to the increased abundance in May. Peak abundances in summer reflect the spawning activity of bay anchovy, Anchoa mitchilli and naked goby, Gobiosoma boscii.

Abundance of fish eggs (Fig. 5) was relatively low through mid-June when increases were recorded with the onset of bay anchovy spawning. Bay anchovy spawning continued through August but ceased in September (Table 5). Eggs were captured during April and May, with most being captured in the discharge canal. White perch, carp (Cyprinus carpio) and threadfin or gizzard shad (Dorosoma species) comprised the bulk of April and May catches. No eggs were captured past September. Highest abundance of eggs was recorded on 22-23 June (1.561/100 m<sup>3</sup>).

Average catch of fish per sample ( $100 \text{ m}^3$ ; all samples) was constant at the surface, decreased at midwater, and increased at the bottom (Table 6). Average catch per sample was stratified with depth (greatest catch at bottom) at both the intake and discharge.

Average catch of fish eggs per sample ( $100 \text{ m}^3$ ; all samples) increased at the surface and decreased at midwater and bottom (Table 6). Fish eggs were also stratified with depth at both the intake and discharge. The increased catch of eggs in surface discharge waters is presumably due to increased turbulence in the discharge canal.

Bay anchovy and naked goby were the dominant species captured during 1978 as in previous years (Jordan et. al., 1978) (Tables 4, 5 & 7). All life stages of bay anchovy were captured; gobies were primarily the larval and post-larval stages. Eggs, larvae, and postlarvae of both species were commonly taken from April through September. Juvenile and adult anchovies were taken all year. These two species comprised 89.6 percent of the total yearly calculated catch for both fish and eggs [bay anchovy = 66.0% (fish = 7.5%; eggs = 58.5%); naked goby = 23.6%]. From April-September, the period of larval goby and anchovy spawning, bay anchovy comprised 66.0 percent of the total catch (fish = 7.3%; eggs = 58.7%) and naked goby comprised 23.7 percent of the total calculated catch for that time period. Naked goby was the most abundant fish captured reaching concentrations of  $15/\text{m}^3$  on 17 August (Table 4). Bay anchovy

concentrations of  $5/\text{m}^3$  were recorded on 17 August. Bay anchovy eggs were the single most abundant organism captured, reaching concentrations of  $95/\text{m}^3$  in one tow on 22 June (Table 5).

Total yearly calculated catch ( $100 \text{ m}^3$ ) of bay anchovy (fish and eggs) was down by 38 percent from the catch in 1977 (approximately 88,400 versus 143,000). Bay anchovy rose slightly as a percent of total catch over 1977 (66.0% versus 65.5%) while total catch of all fish and eggs decreased (134,000 versus 209,000 or 35.9%) (Jordan et. al., 1978). Average catch (yearly) of bay anchovy per sample ( $100/\text{m}^3$ ) decreased from 107/sample to 63/sample.

Total yearly calculated catch of naked goby decreased by 35.5 percent from 1977 (31,600 versus 49,000). Percentage of total catch rose slightly (23.6% versus 23.0%) (Jordan et. al., 1978) while average catch per sample ( $100 \text{ m}^3$ ) decreased from 36/sample to 22/sample.

Atlantic silverside (Menidia menidia), tidewater silverside (Menidia beryllina) and rough silverside (Membras martinica) were captured in all life stages (Tables 4 and 5). Eggs, larvae, and juveniles were taken in spring and summer ( $<1/\text{m}^3$ ). Only juveniles and adults of these species were taken in fall and winter. The tidewater silverside was the most common species of the silverside group. Silverside eggs are normally

attached to submerged objects, thus eggs in our samples presumably had been dislodged by wave action and water currents.

Striped bass larvae and white perch eggs and larvae were common in April and May samples (Tables 4 and 7). Though concentrations never exceeded  $1/m^3$  both species were more abundant than in 1976 or 1977.

Postlarval and juvenile Atlantic croaker (Micropogon undulatus) and spot (Leiostomus xanthurus) were captured seasonally (Tables 4 and 7). Croaker were captured during fall and early-winter in concentrations of less than  $1/m^3$ . Spot were captured during spring in concentrations of less than  $1/m^3$ . Sciaenids as a group spawn in offshore waters but postlarvae and juveniles move into the estuaries (such as the James) which serve as nursery areas for these species.

Atlantic menhaden (Brevoortia tyrannus) also utilize the James River estuary as a nursery area in the postlarval and juvenile stages. During late winter-early spring, menhaden were captured in concentrations of less than  $1/m^3$  at VEPCO Surry Nuclear Power Plant (Tables 4 and 7).

Carp eggs were taken in low numbers during April and May (Table 5). Carp eggs were taken primarily in the discharge canal indicating a resident population spawning in the high level intake canal or in the discharge canal.

Other species were captured in low abundance (Tables 4 and 5).

### Hydrographic data

Ranges of salinity, water temperature, and dissolved oxygen taken during 24 hour stations are presented in Tables 8, 9, and 10, and intake data are shown in Figures 6, 7, and 8.

Salinities during 1978 remained relatively low until fall when a prolonged dry spell elevated salinities (Table 8; Fig. 6). During the spawning season (April, May), salinities remained below 1 ‰ except for the last half of April.

Water temperature at the intake was at a minimum of 1 C on 16-17 February and a maximum of 32 C on 17-18 August (Table 10; Fig. 7). Water temperature at the discharge usually exceeded intake temperatures by 4-9 C unless one or both generation units were inoperative.

Dissolved oxygen data show no oxygen deficiencies (4 mg/l) at either the intake or discharge though readings were between 4 mg/l and 5 mg/l in late June and August (Table 10; Fig. 8).

### Statistical Results

An examination of simple correlation matrices of potential regression variables in original and log-transformed scales was made to identity the final form of variables. In general, correlations were higher between transformed dependent variables ( $Y_i$ ) and independent variables ( $X_j$ ) in their original scale, except for fish and egg species diversities. Little or no improvement in correlations were found by transforming either species diversity or the independent variables.

Although many simple correlation coefficients ( $r$ ) between the dependent and independent variables were declared highly significant ( $P < 0.001$ ), most correlations were not high (maximum  $r = 0.67$ ). All independent variables, except depth, period, and tide, were significantly correlated ( $P < 0.05$  or better) with five or more of the dependent variables.

Descriptive statistics of the dependent and independent variables, are shown in Table 11 and the results of the regression analysis appear in Table 12. Each final regression equation is discussed separately, then overall patterns are summarized.

The regression coefficients ( $b_j$ 's) are partial coefficients which estimate the effects of a particular variables while holding constant or controlling for other variables

### Total Abundance of Fish ( $Y_1$ ):

All independent variables except tide and the dummy seasons were retained in the final regression equation as significant predictors of total abundance of fish ( $Y_1$ ). The equation for  $Y_1$  was highly significant ( $P < 0.001$ ) and about two-thirds of the variation in total abundance of fish was accounted for by the regression ( $R^2 = 0.64$ ).

Depth, temperature and period had positive  $b_j$ 's; i.e., their partial effects on fish abundance were positive. The remaining variables had negative  $b_j$ 's.

Within the ranges of values observed, the equation predicts an increasing total abundance of fish with an increasing depth or temperature, or with a decreasing salinity or dissolved oxygen, holding other variables constant.  $Y_1$  was significantly higher at the mouth of the intake canal than in the discharge canal (recall location was coded as 0 = intake, 1 = discharge). A significantly higher fish abundance was found at night than day (period was coded as 0 = day, 1 = night).

### Abundance of Fish Species ( $Y_2$ ):

Depth, temperature, salinity, period, winter and spring were retained in the equation for  $Y_2$ . The highly significant regression explained over half of the variation in abundance of fish species ( $R^2 = 0.55$ ). The partial regression coefficients for salinity and winter were negative; the others were positive. The equation predicts  $Y_2$  will

increase as temperature and sampling depth increase and as salinity decreases. A significantly higher abundance of fish species was found at night than day. No significant difference in fish species abundance was detected between the two sampling locations.

Dummy seasons were included in the analysis to mathematically reduce the unexplained variation in the model and to remove factors which could confound the analysis. After allowing for the effects of other variables in the equation, spring had a significantly higher abundance of fish species than the reference season summer; for winter, the converse was true. This suggests that other seasonal effects (in addition to those accounted for by variables in the equation) tend to decrease fish abundance in winter and increase it in spring. Factors which may be reflected in the season variables include time and duration of migrations of parent populations, recruitment, wind direction, currents, fishing efficiency of gear, and other unmeasured factors. For example, the high abundance of ctenophores during the summer would decrease the gear efficiency by clogging nets and would lead to lower abundance estimates in this season.

#### Fish Species Diversity ( $Y_3$ ):

The equation for  $Y_3$ , significant at  $P < 0.001$ , explained 35 percent of the variation in fish species diversity. All



independent variables except dissolved oxygen, tide and spring were significant. Fish species diversity will increase as depth and temperature increase and as salinity decreases. Holding other variables constant, diversity was significantly higher ( $P < 0.01$ ) in the discharge canal than at the power plant intake structure. Two plausible explanations for this unusual pattern are (a) additional species which were not present in samples taken at the intake inhabit and reproduce in the high level intake canal, and (b) the efficiency and selectivity of the sampling gear differed between the two locations. Samples at night had a higher fish species diversity than samples during daylight. Unmeasured seasonal factors collectively represented by the seasons fall and winter tended to decrease the diversity in these seasons.

Total Abundance of Eggs ( $Y_4$ ):

The regression of  $Y_4$  on all independent variables, except depth, dissolved oxygen and location, was highly significant and explained 30 percent of the variation in egg abundance. The partial effects of temperature, salinity, tide, winter and spring were positive, while those for period and fall were negative. The equation predicts a higher temperature or salinity. Significantly more eggs were collected at high tide and during the day. Unmeasured seasonal factors in winter and spring tended to increase egg abundance during these seasons compared to

summer. The converse was true for fall. There was no significant difference in egg abundance between intake and discharge samples.

Abundance of Egg Species ( $Y_5$ ):

The highly significant regression equation for  $Y_5$  explained 36 percent of the variation in egg species abundance. Temperature, location and spring had positive  $b_j$ 's; fall had a negative  $b_j$ . The remaining independent variables were not selected as significant predictors of egg species abundance. Abundance of egg species was significantly higher in the discharge canal.

Egg Species Diversity ( $Y_6$ ):

Although the final equation for  $Y_6$  was highly significant, only 23 percent of the variation in egg diversity was explained by the regression. Since the primary objective of the analysis was to assess the effects of the independent variables and not to predict diversity, a low  $R^2$  does not hinder the analysis.

Dissolved oxygen, location and spring were selected as positive predictors of egg diversity and winter was selected as a negative predictor. Other independent variables were not found to be significant. The discharge canal had a higher egg diversity than the intake.

Abundance of Anchoa mitchilli Fish ( $Y_7$ ):

Fifty-nine percent of the variation in  $Y_7$  was explained by the highly significant regression of anchovy abundance on all independent variables except salinity, location and fall. Depth, temperature, period and tide had a positive relationship with anchovy abundance but dissolved oxygen and spring had a negative relationship. A higher anchovy abundance is predicted at night and at high slack water. The partial effect of spring on  $Y_7$  was negative. No difference in anchovy abundance was found between the two sampling locations.

Abundance of Gobiosoma boscii Fish ( $Y_8$ ):

The highly significant equation for goby abundance explained 56 percent of the variation in  $Y_8$  and retained all independent variables except salinity, period and tide. Depth, temperature, fall and spring had positive partial regression coefficients. Dissolved oxygen and location had negative coefficients. Goby abundance was significantly higher at the mouth of the intake canal and in fall and spring.

Abundance of Anchoa mitchilli Eggs. ( $Y_9$ ):

The highly significant equation for anchovy egg abundance explained 37 percent of the variation in  $Y_9$ . All independent variables except dissolved oxygen and fall were retained as significant predictors of anchovy egg

abundance. Independent variables with significant positive partial regression coefficients were depth, temperature, salinity, tide and spring. Location and period had negative partial regression coefficients. Intake and day collections had a higher anchovy egg abundance.

#### Summary of Regression Analysis:

A nonparametric ranking procedure was developed to assess the relative importance of the independent variables. Direct comparisons of partial regression coefficients are not useful since the independent variables were measured in different units. However, comparisons between standardized coefficients (dependent and independent variables standardized to unit variance) can be used to determine the relative effect of each independent variable on the dependent variables. The procedure consisted of ranking the absolute values of the standardized  $b_j$ 's in each equation, summing the individual ranks for each variable across all equations, and ranking these sums to give an overall measure of relative importance (Table 13). Ties were assigned average ranks, and seasons were not included in the analysis.

Overall, temperature ranked first in relative importance and was retained in all but one of the regression equations as a highly significant ( $P < 0.01$  or better) predictor of fish and egg abundances and diversities. The relationship between temperature and the dependent variables was positive;

within the range of temperatures encountered during the study, abundance and diversity will increase as temperature increases.

Salinity was the second most important independent variable and was retained in five equations. The relationship between fish abundance, fish species abundance and fish species diversity was negative; i.e., these dependent variables increased as salinity decreased. For total abundance of eggs and abundance of anchovy eggs, the converse was true.

Location was third in relative importance and was a significant variable in six equations. The pattern of its effect was mixed. Significantly higher total abundance of fish, goby abundance, and anchovy egg abundance were found at the mouth of the intake canal. On the other hand, fish species diversity, abundance of egg species and egg species diversity were higher in the discharge canal. The presence of resident populations of fishes within the intake canal proper is a complicating factor. The location variable is a net measure of the mechanical removal of fish and eggs as the water passes through the plant. Additional fishes inhabiting the intake or discharge canal could account for the unexpected gain in fish and egg species diversities. Also, the stresses of passage through the plant could make some species more susceptible to capture in the discharge canal and would result in inflated estimates.

Depth was fourth in importance and was retained in six equations. Depth had no significant effect on total egg abundance, egg species abundance and egg species diversity but was positively related to the other dependent variables. Fish abundance, fish species abundance, fish species diversity, anchovy abundance, goby abundance and anchovy egg abundance increased as sampling depth increased. If samples contained a majority of negatively buoyant larvae this pattern would be explained. Also, surface effects (e.g., wind, currents, turbulence, and velocity) may have resulted in a decreased gear efficiency for surface samples.

Period was fifth in relative importance and was retained in six regression equations as a highly significant independent variable. The relationship between period and all fish abundance and diversity variables except goby abundance was positive; fish abundance and fish species diversity were significantly higher at night than during the day. If net avoidance was greater during the day because of increased visibility, this pattern could result from diurnal differences in the catch efficiency of the sampling gear. The opposite pattern was observed for total egg abundance and anchovy egg abundance which were significantly higher during the day. No explanation for this pattern can be offered at this time.

Dissolved oxygen ranked sixth in overall importance. Egg species diversity increased as dissolved oxygen

increased. Total abundance of fish, anchovy abundance and goby abundance increased with a decreasing dissolved oxygen. Apparently, levels of dissolved oxygen were not low enough to result in a decreased fish abundance.

Tide was the least important independent variable and was retained in only three equations. Tide had little or no effect upon the overall fish community structure. It was a significant factor, however, in the total abundance of eggs and the abundance of anchovy fish and eggs; these dependent variables increased as tide increased, i.e., abundance was greater at late flood, high slack and early ebb than at other tide stages.

## CONCLUSIONS

VIMS ichthyoplankton data collected at VEPCO Surry Nuclear Power Plant since 1976 reveal a decrease in the overall catch of fish eggs and larvae in our samples. The two dominant species, bay anchovy and naked goby have each decreased by forty percent or more. While this decrease may seem great, in actuality it may not be, and it cannot be directly attributed to mortality inflicted by the power plant. Natural fluctuations of considerable magnitude do occur in fish populations and these fluctuations reflect changes in natural mortality. Natural mortality from the egg to juvenile stage is 99 percent or more (Pearcy, 1962; Ahlstrom, 1954). Success of a given yearclass is correlated with natural mortality and conditions on the spawning and nursery grounds. Thus, from year to year there may be natural fluctuations in species abundance of one or more orders of magnitude similar to those we have observed at VEPCO Surry.

The decrease in catch of ichthyoplankton at VEPCO Surry is attributable to variations in salinity patterns more than to other factors. Salinity at VEPCO may vary from 0‰ to 14‰ depending on meteorological conditions and seasons. Since anchovies constitute nearly 60 percent of the catch (as eggs and larvae) and anchovies prefer higher salinities for spawning (Lippson and Moran, 1974), lower river salinities near Hog Island in 1978 caused the decreased catches of anchovy.



The decline in catch of gobies is unexplainable at this point. If salinity were the major factor influencing gobies, they should have increased slightly in 1977 (as did anchovies) and decreased in 1978. However, they have declined each year since the inception of this sampling program. Naked goby are seldom captured in trawl or seine surveys. They inhabit oyster bar communities and other areas where crevices, etc. afford shelter. It is impossible to obtain a realistic estimate of their adult population from present data. We have no estimates of concentrations of larvae in mainstream either; therefore, effect of the plant on adult population levels cannot be determined.

Bay anchovy and naked goby are not important commercially, but are principal forage species for commercially important species such as weakfish (Cynoscion regalis), bluefish (Pomatomus saltatrix), striped bass (Morone saxatilis), and catfishes (Ictalurus spp.), etc. (Hildebrand and Schroeder, 1928). Even though they constitute the major portion of our catches, their centers of abundance are not located near the VEPCO Surry Nuclear Power Plant since each species prefers slightly higher salinities.

The James River has been subjected to numerous stresses in recent years, i.e., organic and inorganic pollutants, siltation, flooding, etc. To extract any one stress (e.g., VEPCO Surry) from such a combination is extremely difficult, especially when the effects of other stresses have not been

analyzed. Coupled with sampling variability, natural population fluctuations, biological attributes of ichthyoplankton, environmental factors, and other sources of variability inherent in any sampling program, any changes other than those of catastrophic proportions are difficult to assess.

Multiple regression techniques explained some of the complex relationships between environmental factors and the abundance and diversity of fish and eggs, and isolated factors which tend to confound the analysis of data from general field surveys. These techniques were successful in identifying the dominant environmental factors and assessing their relative importance.

This study was designed to identify and enumerate ichthyoplankton entering and leaving VEPCO Surry Nuclear Power Station. This objective has been satisfied. The impact of the plant upon the adult populations cannot be determined from these data alone. Without larval fish concentrations from the mainstream and continual monitoring of population levels, biological impact assessment is impossible. Even with these data, other stresses (i.e., Kepone, chlorination, dredging etc.) would have to be eliminated before any direct impact could be shown.

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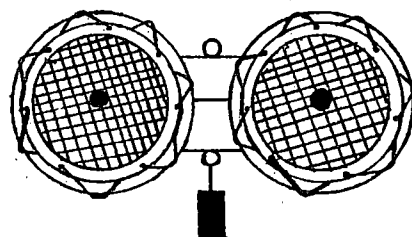
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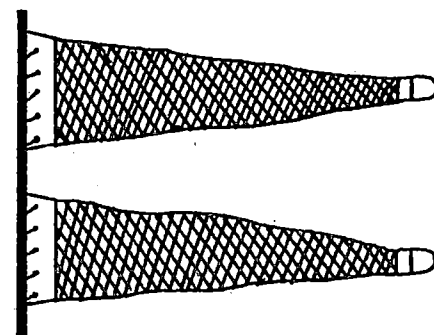
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FRONT VIEW



TOP VIEW

Figure 1. Paired net apparatus used at VEPCO Surry Nuclear Power Plant for ichthyoplankton collections.

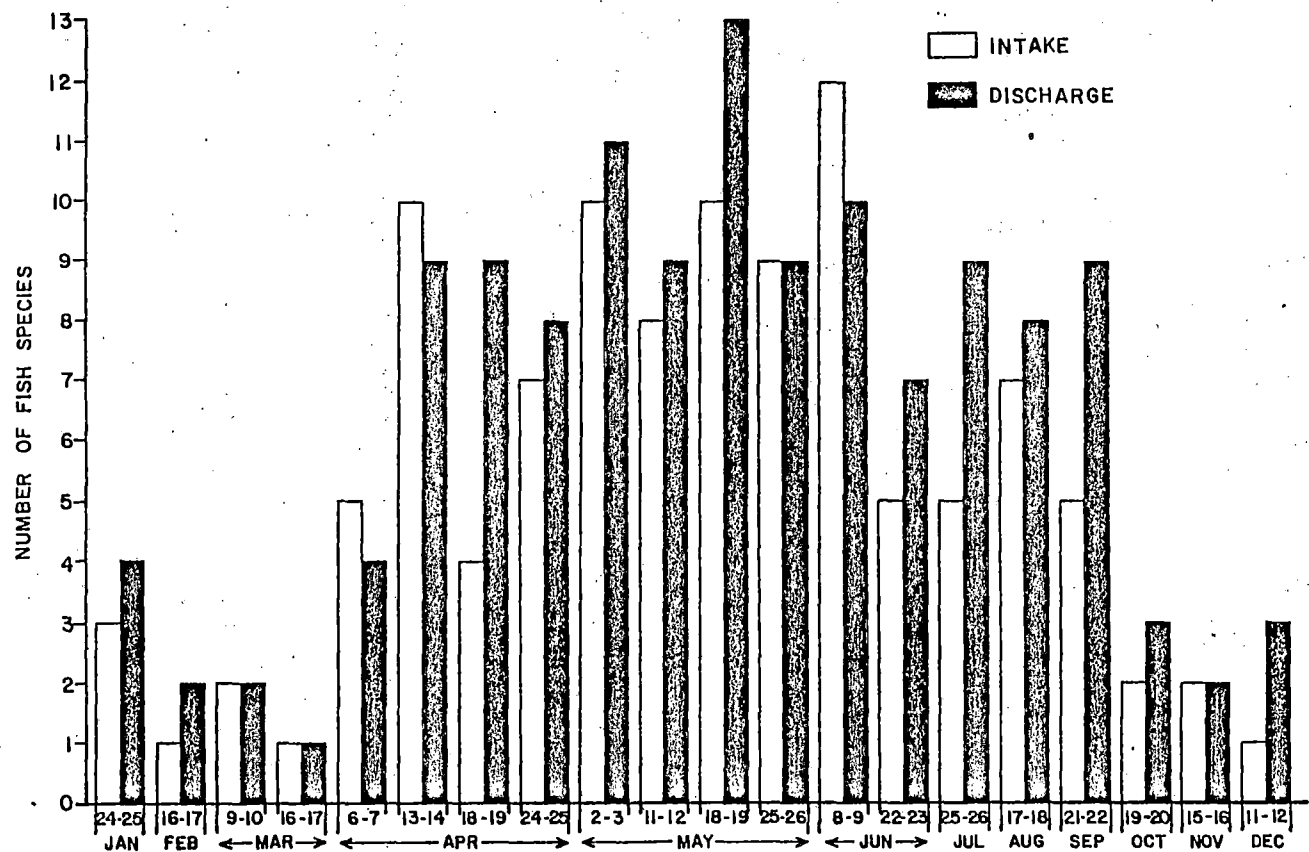


Figure 2. Number of fish species captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

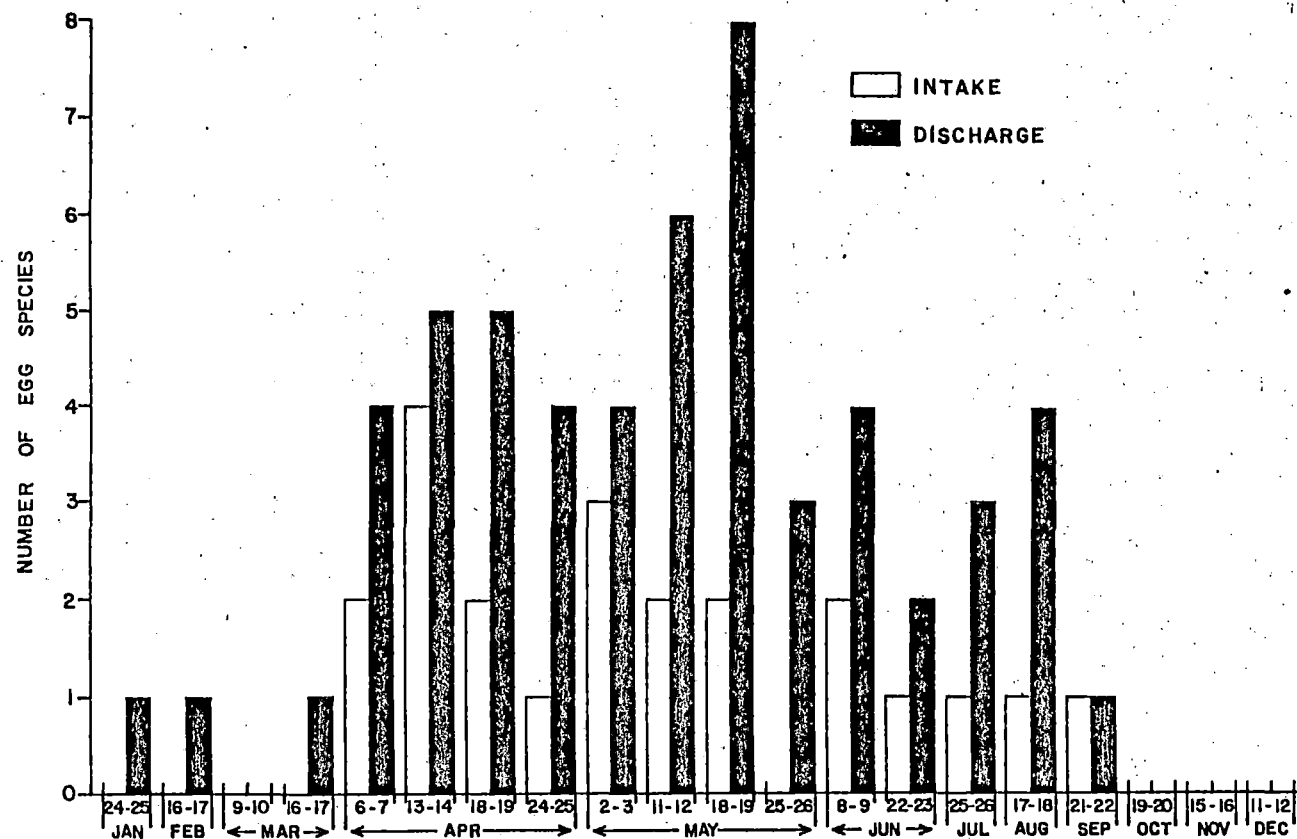


Figure 3. Number of egg species captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.



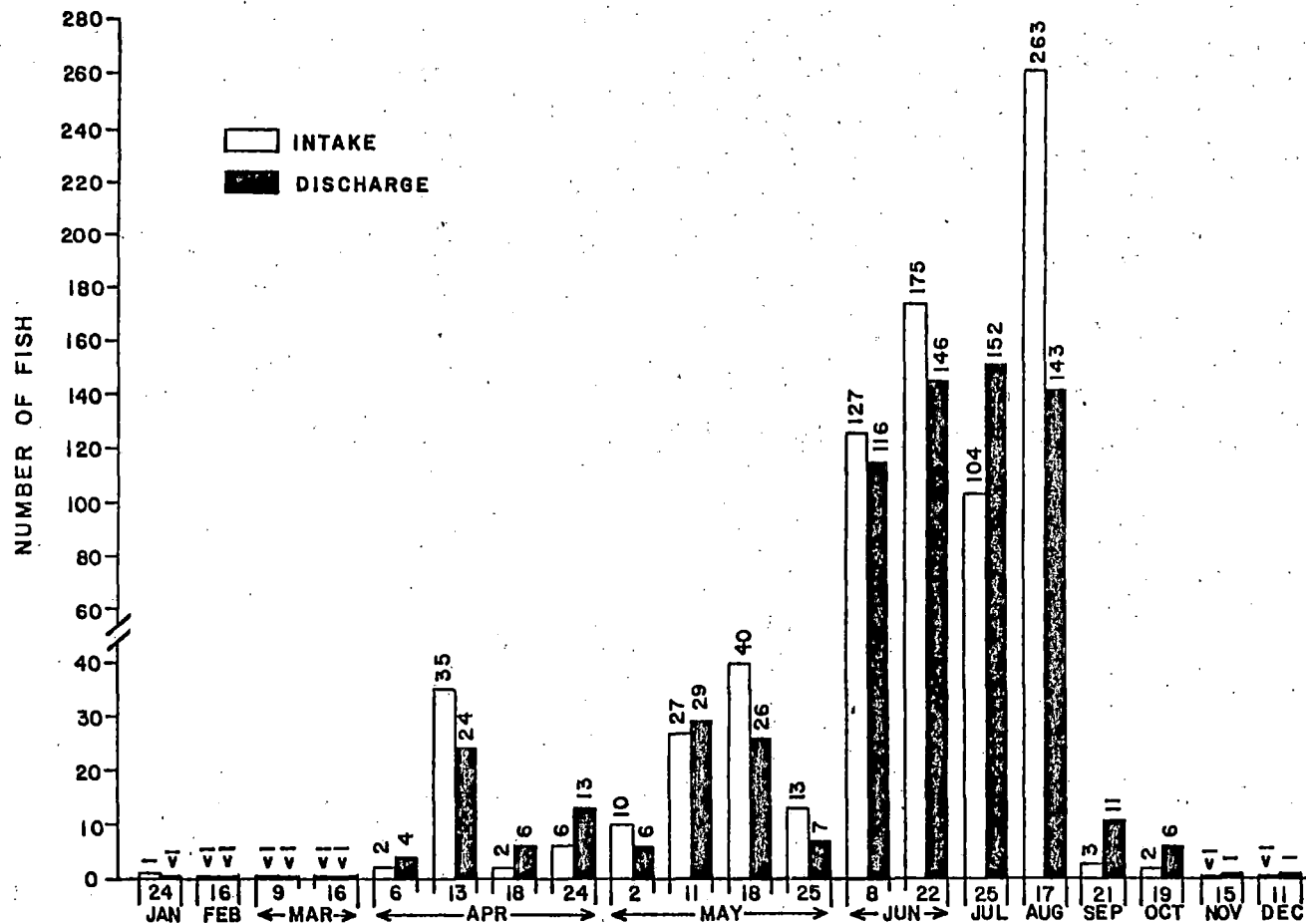


Figure 4. Average number of fish per sample (100 m<sup>3</sup>) captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

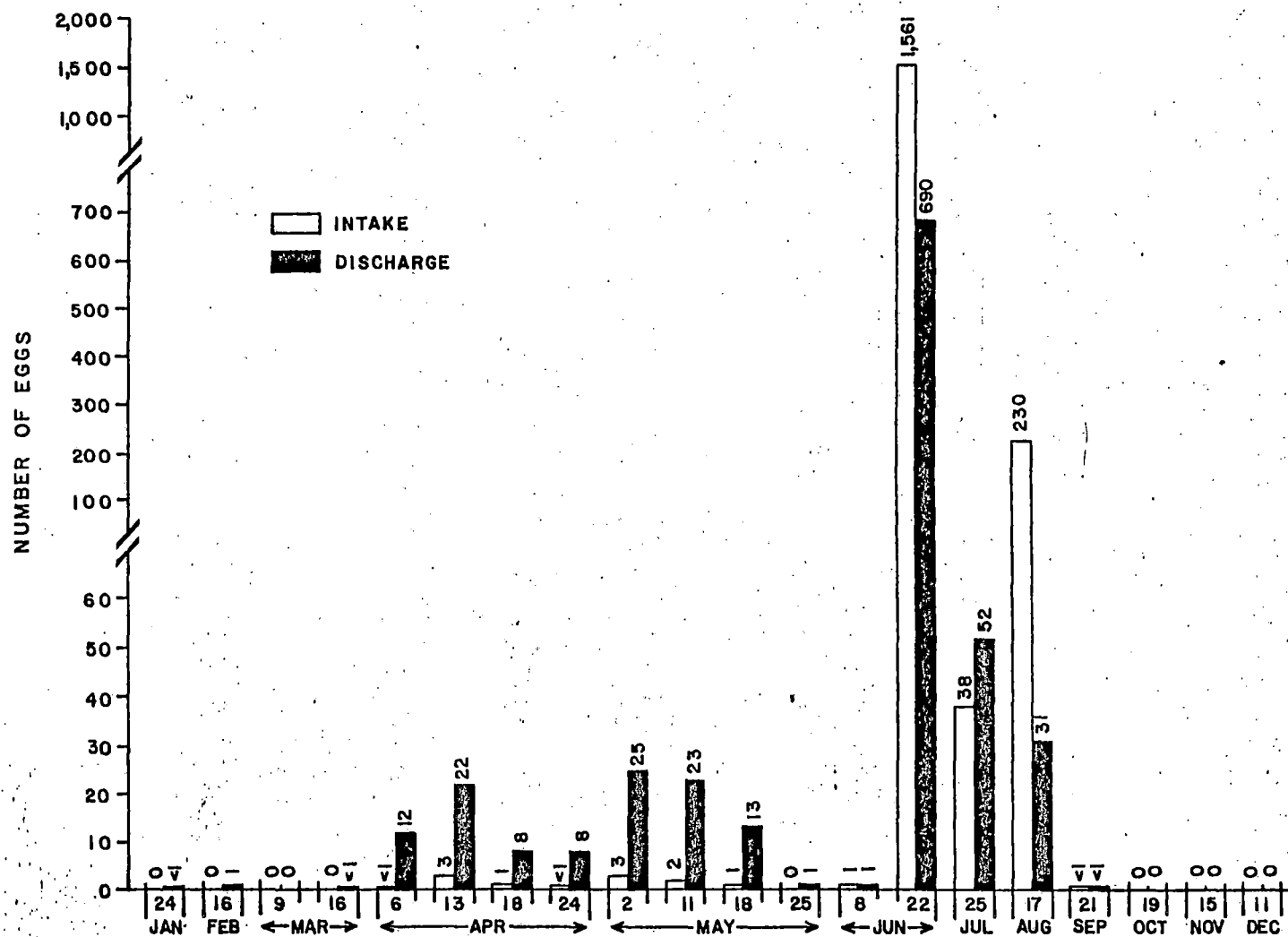


Figure 5. Average number of eggs per sample ( $100 \text{ m}^3$ ) captured during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

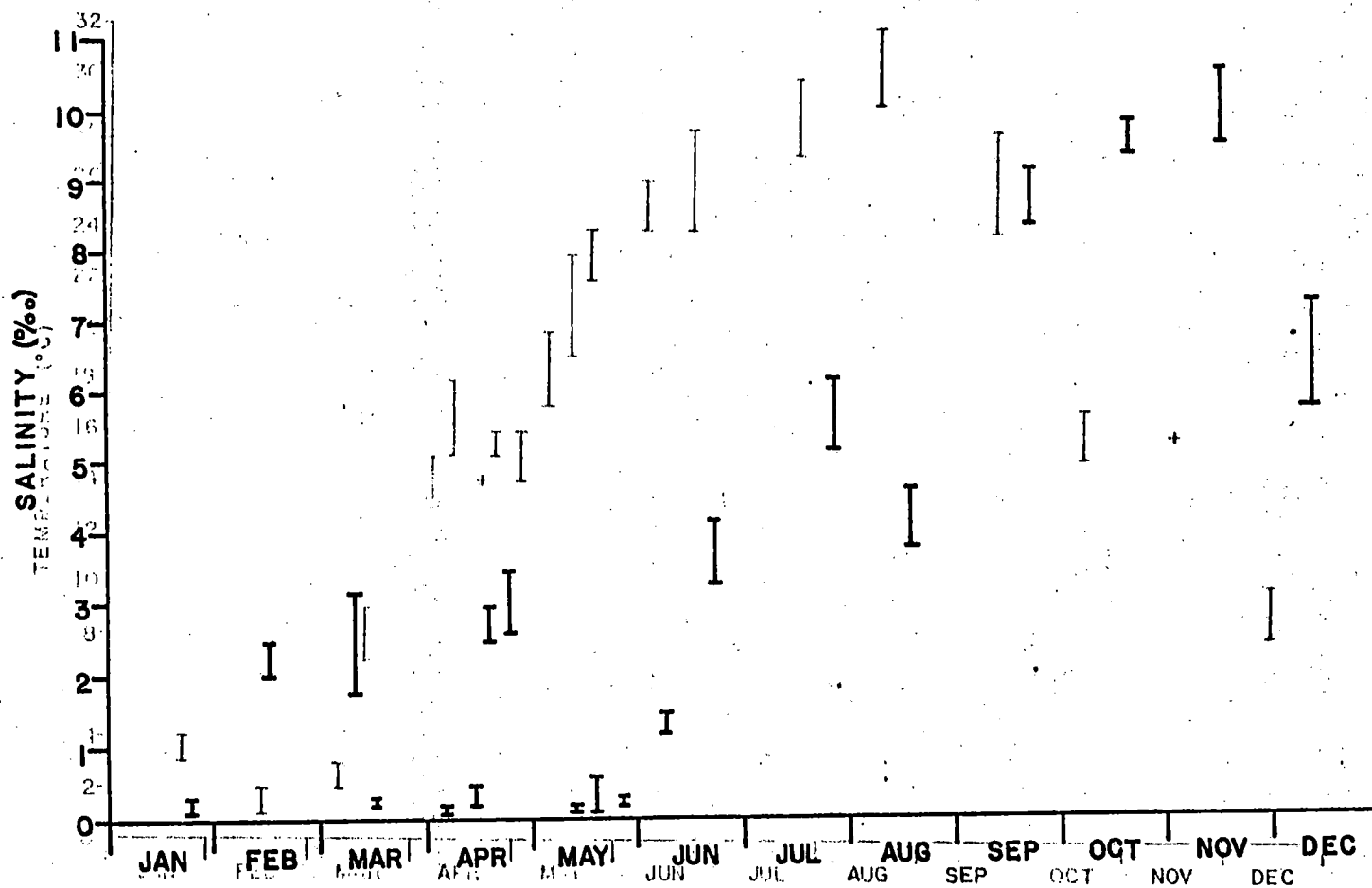


Figure 6. Ranges of salinity (‰) at the intake during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

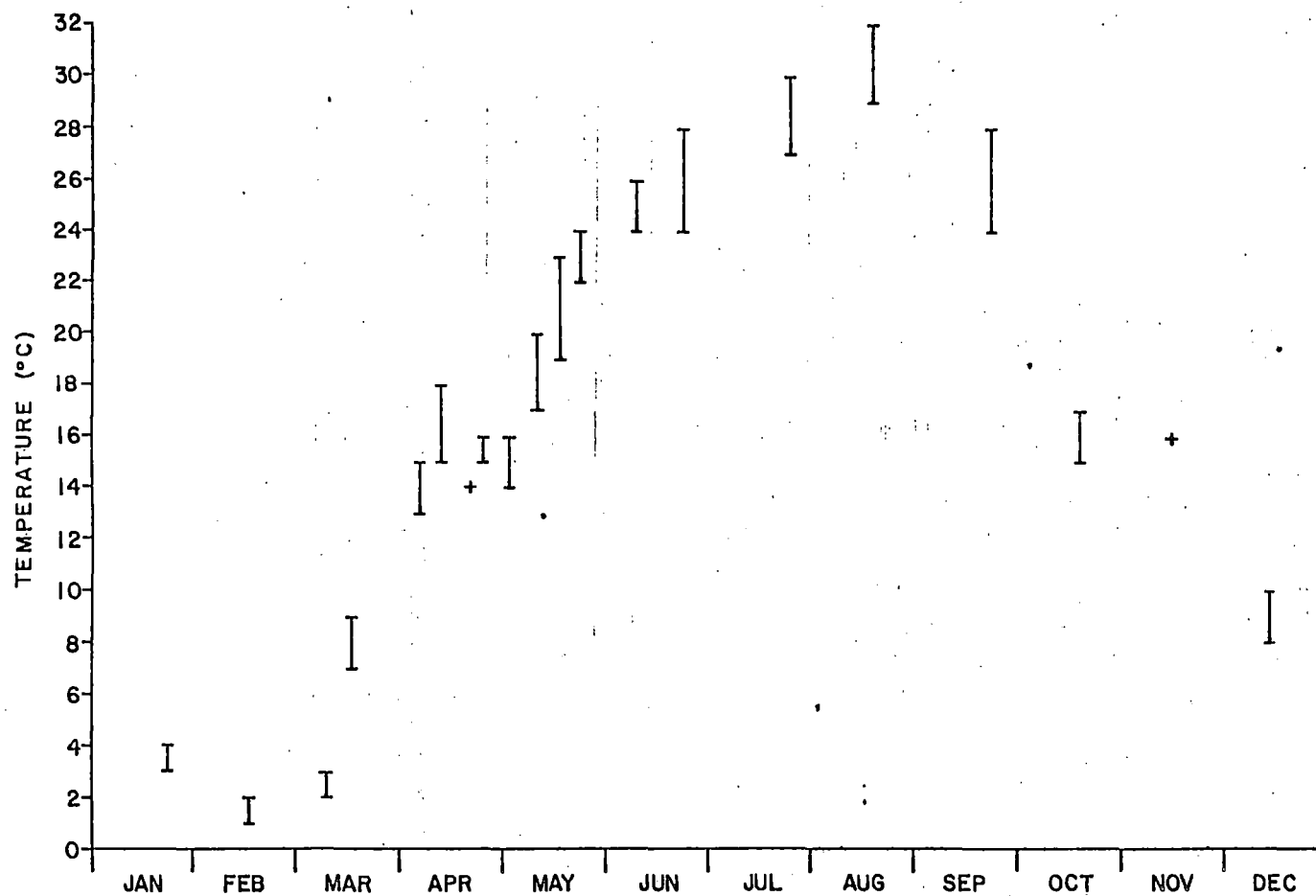


Figure 7. Ranges of water temperature (C) at the intake during plant entrainment stations at VEPCO Surry Nuclear Power Plant in 1978.

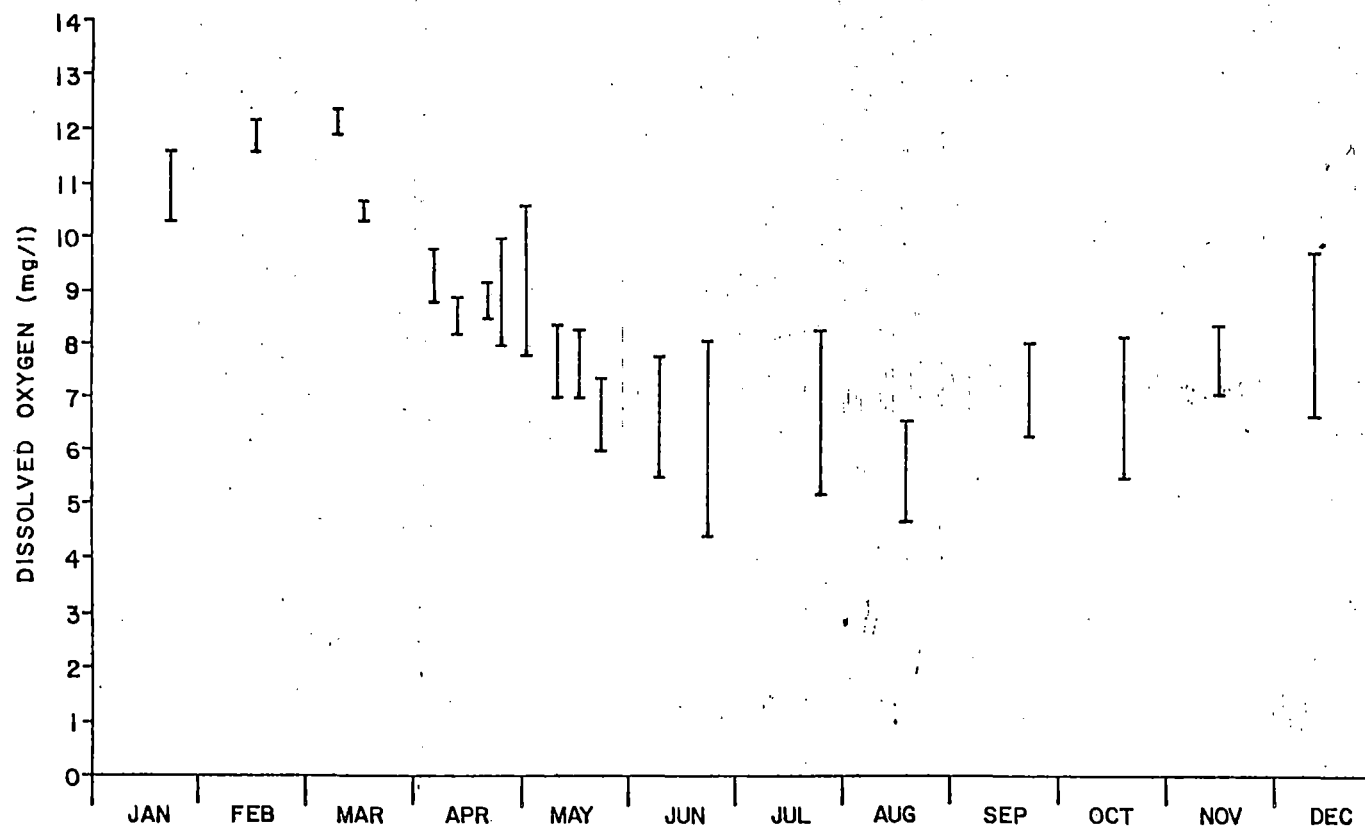


Figure 8. Ranges of dissolved oxygen (mg/l) at the intake during plant entrainment stations at VEPSCO Surry Nuclear Power Plant in 1978.

Table 1. Ichthyoplankton sampling schedule for plant and plume entrainment studies at VEPCO Surry Nuclear Power Plant (January through December 1978).

Study	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plant Entrainment	X	X	XX	XXXX	XXXX	XX	X	X	X	X	X	X
Plume Entrainment	X	X	XX	XXXX	XXXX	XX	XX	XXXX	XX	X	XX	XX

Table 2. Dependent ( $Y_i$ ) and independent ( $X_j$ ) variables for statistical analysis (standardized catch is number collected per 100 cubic meters of water strained per collection).

Variable	Definition	
$Y_1$ , Total abundance of fish	$Y_1 = \log_e (C_1 + 1)$ , where $C_1$ = standardized catch of fish	
$Y_2$ , Abundance of fish species	$Y_2 = \log_e (C_2 + 1)$ , where $C_2$ = number of fish species	
$Y_3$ , Fish species diversity	$Y_3 = -\sum p_k \log_e p_k$ , where $p_k = \frac{n_k}{N}$ , $n_k$ = number of fish of the $k^{\text{th}}$ species, and $N$ = total number of fish	
$Y_4$ , Total abundance of eggs	$Y_4 = \log_e (C_4 + 1)$ , where $C_4$ = standardized catch of eggs	
$Y_5$ , Abundance of egg species	$Y_5 = \log_e (C_5 + 1)$ , where $C_5$ = number of egg species	
$Y_6$ , Egg species diversity	$Y_6 = -\sum p_k \log_e p_k$ , where $p_k = \frac{n_k}{N}$ , $n_k$ = number of eggs of the $k^{\text{th}}$ species, and $N$ = total number of eggs	$\infty$
$Y_7$ , Abundance of <u>A. mitchilli</u> fish	$Y_7 = \log_e (C_7 + 1)$ , where $C_7$ = standardized catch of <u>A. mitchilli</u> fish	
$Y_8$ , Abundance of <u>G. bosci</u> fish	$Y_8 = \log_e (C_8 + 1)$ , where $C_8$ = standardized catch of <u>G. bosci</u> fish	
$Y_9$ , Abundance of <u>A. mitchilli</u> eggs	$Y_9 = \log_e (C_9 + 1)$ , where $C_9$ = standardized catch of <u>A. mitchilli</u> eggs	
$X_1$ , Collection depth	Meters	
$X_2$ , Water temperature	°C	
$X_3$ , Salinity	ppt	
$X_4$ , Dissolved oxygen	mg/l	
$X_5$ , Location dummy variable	0 = intake, 1 = discharge	

Table 2. (continued).

Variable	Definition																				
$X_6$ , Period dummy variable	0 = day (5 to 16.9 h EST), 1 = night (17.0 to 4.9 h EST)																				
$X_7$ , Tide	Represented by a cosine function: +1.0 = slack before ebb -1.0 = slack before flood																				
$X_8, X_9, X_{10}$ , Season dummy variables	<table><tr><th>Season</th><th><math>X_8</math>, Fall =</th><th><math>X_9</math>, Winter =</th><th><math>X_{10}</math>, Spring =</th></tr><tr><td>Summer (July, Aug., Sept.)</td><td>0</td><td>0</td><td>0</td></tr><tr><td>Fall (Oct., Nov., Dec.)</td><td>1</td><td>0</td><td>0</td></tr><tr><td>Winter (Jan., Feb., March)</td><td>0</td><td>1</td><td>0</td></tr><tr><td>Spring (April, May, June)</td><td>0</td><td>0</td><td>1</td></tr></table>	Season	$X_8$ , Fall =	$X_9$ , Winter =	$X_{10}$ , Spring =	Summer (July, Aug., Sept.)	0	0	0	Fall (Oct., Nov., Dec.)	1	0	0	Winter (Jan., Feb., March)	0	1	0	Spring (April, May, June)	0	0	1
Season	$X_8$ , Fall =	$X_9$ , Winter =	$X_{10}$ , Spring =																		
Summer (July, Aug., Sept.)	0	0	0																		
Fall (Oct., Nov., Dec.)	1	0	0																		
Winter (Jan., Feb., March)	0	1	0																		
Spring (April, May, June)	0	0	1																		



Table 3. Number of species captured during 24-hour stations at VEPCO Surry Nuclear Power Station in 1978.

NUMBER OF SPECIES								
DATE	INTAKE			DISCHARGE			Species occurring at both intake and discharge	
	Fish	Eggs	Both*	Fish	Eggs	Both*	Fish	Eggs
Jan. 24-25	3	0	0	4	1	0	3	0
Feb. 16-17	1	0	0	2	1	0	0	0
Mar. 09-10	2	0	0	2	0	0	1	0
Mar. 16-17	1	0	0	1	1	0	0	0
Apr. 06-07	5	2	1	4	4	1	3	2
Apr. 13-14	10	4	2	9	5	4	7	4
Apr. 18-19	4	2	1	9	5	3	3	2
Apr. 24-25	7	1	1	8	4	2	6	1
May 02-03	10	3	2	11	4	3	9	3
May 11-12	8	2	1	9	6	3	5	2
May 18-19	10	2	1	13	8	4	7	2
May 25-26	9	0	0	9	3	1	4	0
June 08-09	12	2	2	10	4	2	9	2
June 22-23	5	1	1	7	2	2	4	1
July 25-26	5	1	1	9	3	1	4	1
Aug. 17-18	7	1	1	8	4	2	7	1
Sep. 21-22	5	1	1	9	1	0	5	0
Oct. 19-20	2	0	0	3	0	0	2	0
Nov. 15-16	2	0	0	2	0	0	2	0
Dec. 11-12	1	0	0	3	0	0	1	0

\* Species occurring as both fish and eggs

Table 4. Species and calculated number of fish per 100 m<sup>3</sup> captured during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978.

JANUARY 24 - 25, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
MENIDIA BERYLLINA			5										
	14:00												
MENIDIA BERYLLINA				3				6					
	18:00												
ALCSA AESTIVALIS MENIDIA BERYLLINA			4									3	
	22:00												
ANGUILLA ROSTRATA MORONE AMERICANA						4	5		3				
	2:00												
MORONE AMERICANA					3				3				
	6:00												
MENIDIA BERYLLINA		3											

Table 4. (continued).

FEBRUARY 16 - 17, 1978

SPECIES	STATION TIME	INTAKE -----						DISCHARGE -----					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
MENIDIA BERYLLINA			5										
	14:00												
MENIDIA MENIDIA								2					
	18:00												
MENIDIA BERYLLINA			4										
	6:00												
ANGUILLA ROSTRATA										3		3	

Table 4. (continued).

MARCH 9 - 10, 1978

SPECIES	STATION TIME	INTAKE -----						DISCHARGE -----					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANGUILLA ROSTRATA					5								
	18:00												
MENIDIA BERYLLINA									3				
	22:00												
ANGUILLA ROSTRATA									3				
MORONE AMERICANA					4								

Table 4. (continued).

MARCH 16 - 17, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANGUILLA ROSTRATA							3						
	22:00												
ALCSA AESTIVALIS											3		

Table 4. (continued).

APRIL 6 - 7, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
BREVOORTIA TYRANNUS								10			5		
MORONE AMERICANA													
14:00													
BREVCORTIA TYRANNUS		4						4		4			
18:00													
ANGUILLA ROSTRATA		5						8		5	4		
BREVCORTIA TYRANNUS												4	45
22:00													
ANGUILLA ROSTRATA													
BREVOORTIA TYRANNUS						4						14	5
2:00													
ANGUILLA ROSTRATA		4						4					
BREVOORTIA TYRANNUS			5	9	8	4	7		4	8	4	10	10
MENIDIA BERYLLINA												3	
MORONE AMERICANA						12	3						
TRINECTES MACULATUS						4							

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	6:00												
BREVOORTIA TYRANNUS								4		3		3	6
MORONE AMERICANA		4		4		4							
MORONE SAXATILIS					4								

Table 4. (continued).

APRIL 13 - 14, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA SP.			5										
BREVOORTIA TYRANNUS				8	4			5	5		11	4	19
CYPRINUS CARPIO												2	2
OCROSOYA CEPEDIANUM										4			2
MORONE AMERICANA	14			8	7	15	10	5	13	4	26	9	6
MORONE SAXATILIS	5			4	4					2			
SPECIMEN MANGLED									3				
14:00													
ALOSA SAPIDISSIMA							4						
BREVOORTIA TYRANNUS	12	6		4			4			11	9	9	
OCROSOYA SP.										2			
LEICSTOMUS XANTHURUS												2	
MORONE AMERICANA	42	35		35	64	54	15		16	23	22	17	55
MORONE SAXATILIS	12	6			21					7	2	7	5
SPECIMEN MANGLED							4						
18:00													
BREVOORTIA TYRANNUS										2	6	6	4
CYPRINUS CARPIO									3	2			2
MORONE AMERICANA	87	38		26	12	17	5	3	28	7	13	25	34
MORONE SAXATILIS	8	17		10	12	6	5		5	2	4	2	4
SPECIMEN MANGLED									3				



Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
22:00													
ALCSA SP.													2
ANGUILLA ROSTRATA		3	3		3								
BREVOORTIA TYRANNUS		3		3		17	6	3				13	20
CYPRINUS CARPIO											2		
DCRCSOMA CEPEDIANUM										2	2	4	2
MENIDIA BERYLLINA		3											
MORONE AMERICANA		7		6	3	3	6			12	9	11	4
MORONE SAXATILIS				3	3	7		3		2			2
2:00													
ANGUILLA ROSTRATA							5			2	2		
BREVOORTIA TYRANNUS				11	12	5	20				5	15	14
CYPRINIDAE		6											
CYPRINUS CARPIO				5				3					5
LEIOSTOMUS XANTHURUS					4					2	2		2
MORONE AMERICANA		18	23	32	19	82	92	9	9	10	19	12	45
MORONE SAXATILIS		36	17		27	24	15		3	12	12	7	5
6:00													
BREVOORTIA TYRANNUS		14	10			3		3		4	4	7	2
CYPRINUS CARPIO									3	2			2
DCRCSOMA CEPEDIANUM										2			
MORONE AMERICANA		10	3	6	5	6	14		3	11	24	13	17
MORONE SAXATILIS		3		3			3			2	2		17

Table 4. (continued).

APRIL 18 - 19, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ANCHOA MITCHILLI									3				
BREVOORTIA TYRANNUS								3					
MORONE AMERICANA			4										2
14:00													
ANCHOA MITCHILLI						7				5	5	3	5
BREVOORTIA TYRANNUS											5	8	10
OCROSTOMA CEPEDIANUM												5	
MORONE AMERICANA									3	3		3	
MORONE SAXATILIS			3		3							5	
18:00													
ANCHOA MITCHILLI		5								3	3	11	8
ANGUILLA ROSTRATA									3				
BREVOORTIA TYRANNUS												5	
LEIOSTOMUS XANTHURUS										3	3		
MENIDIA BERILLINA		5											
MORONE SAXATILIS													3
22:00													
ANCHOA MITCHILLI				5	8					5		8	8
ANGUILLA ROSTRATA								3	3		3	8	
BREVOORTIA TYRANNUS									3	3	3	8	3
MENIDIA BERILLINA			5		4								
MORONE AMERICANA											3		

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	2:00												
ALOSA SP.										2			
ANCHOA MITCHILLI											2		7
ANGUILLA ROSTRATA										2			
BREVOORTIA TYRANNUS										12			5
DOROSOMA CEPEDIANUM											2		
	6:00												
BREVOORTIA TYRANNUS													3
CYPRINUS CARPIO													3
MORONE AMERICANA													5

0200 INTAKE SAMPLING ABORTED

3

Table 4. (continued).

APRIL 24 - 25, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
BREVOCRTIA TYRANNUS										6	3	6	9
LEICSTOMUS XANTHURUS							4						
MORONE AMERICANA						4							
14:00													
ANCHOA MITCHILLI										3		9	4
BREVCORTIA TYRANNUS							4			5		2	4
LEICSTOMUS XANTHURUS													2
MORONE SAXATILIS													2
18:00													
ALCSA PSEUDOHARENGUS											3		
ALCSA SP.												2	
ANCHOA MITCHILLI				6		4	4	3	3	14	8	25	15
ANGUILLA ROSTRATA										3			2
BREVCORTIA TYRANNUS					4	4	4	3		16	11	8	13
DECESOMA SP.	11												
MORONE AMERICANA									3				
MORONE SAXATILIS	11												
22:00													
ANCHOA MITCHILLI		7		14	24	9	10			13	6	9	20
ANGUILLA ROSTRATA							5						3
BREVCORTIA TYRANNUS				5	5	9	5			6	12	3	3
LEICSTOMUS XANTHURUS							5				6		3
MORONE AMERICANA									3				

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
2:00													
ANCHCA MITCHILLI				8		8	4			24	6	10	18
BREVOORTIA TYRANNUS						4		6		12	3	10	18
LEIOSTOMUS XANTHURUS				4						6	18	6	
MORONE AMERICANA												3	
6:00													
ANCHCA MITCHILLI				5			3			3	3	7	12
BREVOORTIA TYRANNUS							3	5	3	6	9	2	15
LEIOSTOMUS XANTHURUS												2	
MORONE SAXATILIS											3		

Table 4. (continued).

MAY 2 - 3, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA SP.		18			10								6
BREVOORTIA TYRANNUS												7	
LEIOSTOMUS XANTHURUS								4					
MCRENE SAXATILIS						5	6						
POMCXIS NIGROMACULATUS												3	
14:00													
ALCSA PSEUDCHARENGUS			5		18		9						
ALCSA SP.								12					
BREVCORTIA TYRANNUS										7			
OCROSOMA CEPEDIANUM						5							
OCROSOMA SP.									4			3	
18:00													
ALCSA PSEUDCHARENGUS							7						
ALCSA SP.		23									4		4
BREVCORTIA TYRANNUS					5								
OCROSOMA CEPEDIANUM											4		
OCROSOMA PETEKENSE													4
OCROSOMA SP.					16								
LEIOSTOMUS XANTHURUS								8				4	11

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
22:00													
ALCSA SP.		7	6								3		
ANCHOA MITCHILLI												7	
DOROSOMA CEPEDIANUM												3	
DOROSOMA PETENENSE					6							3	
ICTALURUS PUNCTATUS													6
LEICSTOMUS XANTHURUS				6						3	3	3	16
MORONE AMERICANA		7			6							3	
MORONE SAXATILIS					6	12						3	
NOTROPIS HUDSONIUS		7	19	13			14				3	3	
2:00													
ALCSA PSEUDOHARENGUS					4								
ALCSA SP.							9						
ANCHOA MITCHILLI						6		4	10	6		3	6
BREVOORTIA TYRANNUS							9			3			
DOROSOMA CEPEDIANUM			4								3		
DOROSOMA PETENENSE										3			
DOROSOMA SP.		8											
LEICSTOMUS XANTHURUS						6				3			9
MORONE AMERICANA						6						6	
MORONE SAXATILIS					4							3	3
NOTROPIS HUDSONIUS		24	7						3	3			3
6:00													
ALCSA SP.		6											4
ANCHOA MITCHILLI													4
DOROSOMA PETENENSE					7			4					
DOROSOMA SP.		13											
MORONE AMERICANA													4
NOTROPIS HUDSONIUS													11
SPECIMEN MANGLED			5										

Table 4. (continued).

MAY 11 - 12, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA PSEUDOCARENGUS			14										
ALCSA SP.		34		18	31	28	34	27	10	14	19	45	39
BREVCORTIA TYRANNUS												8	
LEIOSTOMUS XANTHURUS											3	4	
NECIDIA BERYLLINA			5										
MORONE AMERICANA		4											4
MORONE SAXATILIS		9		6	23	9	11	4	7		3	4	4
14:00													
ALCSA AESTIVALIS		8											
ALCSA PSEUDOCARENGUS													8
ALCSA SP.		8	56	35	7	7	5	46	53	30	34	43	19
BREVCORTIA TYRANNUS							5						
CYPRINUS CARPIO											4		
ETHEOSTOMA CLMSTEDI										4			
MORONE AMERICANA				7									4
MORONE SAXATILIS						7							
NOTROPIS HUDSONIUS		8	19					4			4	4	
16:00													
ALCSA PSEUDOCARENGUS			10										
ALCSA SP.		78	57	9		4	4	11		7	38	28	37
BREVCORTIA TYRANNUS					11	4	4				3		
MORONE AMERICANA											3		
NOTROPIS HUDSONIUS				9						3			4



Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
22:00													
ALCSA SP.					6		28	16	3	23	10	65	12
BREVOORTIA TYRANNUS				15				6					
LEIOSTOMUS XANTHURUS								6	25	4		4	4
MORONE SAXATILIS								6	3	8		4	
NOTROPIS HUDSONIUS							7	10	3		3	9	
2:00													
ALCSA PSEUDCHARENGUS	10												
ALCSA SP.		30		26	13	74	20			4	16	16	14
BREVCORTIA TYRANNUS					6								
DOROSOMA CEPEDIANUM					6								
LEIOSTOMUS XANTHURUS								6	3	11	6		11
NOTROPIS HUDSONIUS		8					7	3	3			8	4
6:00													
ALCSA PSEUDCHARENGUS	5												
ALCSA SP.	36	4				9	17	3	3	8	10	18	11
BREVOORTIA TYRANNUS												5	7
CYPRINUS CARPIO										4			
LEIOSTOMUS XANTHURUS											3		
MORONE SAXATILIS				9			26	3		4		9	
NOTROPIS HUDSONIUS				5		4	4		3	4	10		7

Table 4. (continued).

MAY 18 - 19, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA PSEUDCHARENGUS													4
ALCSA SP.		9	14	9	23	8	7		4	4	3	8	
BREVOGRTIA TYRANNUS							3		4				
CYPRINLS CARPIO											3		4
GOBIOSEMA BOSCI				9		19						16	8
LEIOSTOMUS XANTHURUS							7						
MORONE AMERICANA						8	27		7	4	3		15
MORCNE SAXATILIS		9	5	41	14	89	120	8	7	7	3	28	83
14:00													
ALCSA AESTIVALIS		6											
ALCSA PSEUDCHARENGUS		6											
ALCSA SP.		6	4	10						3		3	7
BREVOGRTIA TYFANNUS						5							
CYPRINLS CARPIO													3
GOROSOMA CEPEDIANUM				5	21	5					9	10	
GOBIOSEMA BOSCI								4	3		3		
LEIOSTOMUS XANTHURUS								4		3			
MORCNE AMERICANA						9	4					7	
MORCNE SAXATILIS				10	16	9	8	4		7	12	3	3
18:00													
ALCSA SP.		7		5			4					5	4
BREVOGRTIA TYFANNUS							4						
CYPRINUS CARPIO										4		9	
GOBIOSEMA BOSCI						9	12		3		3	5	
MORCNE AMERICANA				5		9			3				
MORCNE SAXATILIS				10	5	30	31	3	3	7	10	5	16
NOTRCPIS HUDSONILS						4							

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
22:00													
ALCSA AESTIVALIS													4
ALCSA SP.				6									4
ANCHCA MITCHILLI	8					4							
BREVOORTIA TYRANNUS				6		4	4				4		
CYPRINUS CARPIO											4		
GOBIOSOMA BOSCI										4			4
ICTALURUS PUNCTATUS											4		
LEICSTOMUS XANTHURUS					4						11		
MORONE AMERICANA						9				4			
MORONE SAXATILIS	25	5		35	37	17	12	18	6	24	14	10	25
NOTROPIS HUCSONIUS					4				3			5	
2:00													
ALCSA PSEUDOHARENGUS			4	5									
ALCSA SP.				10	3	4	10				13		4
ANCHCA MITCHILLI					3								
ATHERINIDAE											3		
BREVOORTIA TYRANNUS				5	3	35	20	4		7	16	4	4
DORSOMA CEPEDIANUM	7	22		5			3			3			
GOBIOSOMA BOSCI	7	9		5				8				13	
LEIOSTOMUS XANTHURUS					10	12	10	8	4	10	25	13	8
MORONE AMERICANA					13	23	3	4			3		4
MORONE SAXATILIS				36	30	88	63	12	11	7	6	35	12
NOTROPIS HUCSONIUS									4				
SPECIMEN MANGLED						4							
6:00													
ALCSA PSEUDOHARENGUS										4			
ALCSA SP.	20	5		5	7			4	4	8		4	
ANGUILLA ROSTRATA									4				
BREVOORTIA TYRANNUS					4								
GOBIOSOMA BOSCI				5						4			
MORONE AMERICANA					4							9	
MORONE SAXATILIS	15			30	7	9	4	12	4	23	25	17	12
NOTROPIS HUCSONIUS									4			4	

Table 4. (continued).

MAY 25 - 26, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA SP.		6	17			4				2	2		
CORCSOMA CEPEDIANUM			4										4
MORCNE SAXATILIS													
14:00													
ALCSA SP.		9	4	4							3		
BREVOORTIA TYRANNUS						4							
LEICSTOMUS XANTHURUS										3		4	4
MORCNE SAXATILIS						4							
18:00													
ALCSA AESTIVALIS					4								
ALCSA SP.		4	26								3	3	3
BREVOORTIA TYRANNUS												3	
LEICSTOMUS XANTHURUS				5		18	22			3			9
MENIDIA BERYLLINA								3					
MORCNE SAXATILIS						4						6	
22:00													
ALCSA PSEUDCHARENCUS				4									
ALCSA SP.					10			4					7
ANGUILLA ROSTRATA											3		
BREVOORTIA TYRANNUS		9		4									
FUNDULUS HETEROCLITUS										4			
ICTALURUS PUNCTATUS										4			
LEICSTOMUS XANTHURUS				76	59	52	18	4		25	10	4	23
MENIDIA BERYLLINA								4					
NOTROPIS HUDSONIUS			4										
TRINECTES MACULATUS					3								

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
2:00													
ALCSA SP.				5		4			4				7
ANCHOA MITCHILLI							4						
BREVOORTIA TYRANNUS				5			4						
LEIOSTOMUS XANTHURUS				5		22						4	
MORONE SAXATILIS		5								4			
NOTROPIS HUDSONIUS											4		
6:00													
ALCSA SP.			5										
BREVOORTIA TYRANNUS			5										
LEIOSTOMUS XANTHURUS					16		7			7	12	25	34

Table 4. (continued).

JUNE 8 - 9, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA SP.		4		9									
ANCHCA MITCHILLI						4				6			
GOBIOSOMA BCSCI				172	152	74	80	17	19	55	51	82	
MEMBRAS MARTINICA								3	6	6	6	3	
14:00													
ANCHCA MITCHILLI													3
GOBIOSOMA BCSCI		5	5	127	98	124	94	10	26	85	104	192	185
MEMBRAS MARTINICA		5								6			
MENIDIA BERYLLINA								3				12	3
18:00													
ALCSA SP.			4										
ANCHCA MITCHILLI							3		3				
DORSOMA CEPEDIANUM			4										
DORSOMA PETENENSE									3	3	3		
GOBIOSOMA BCSCI		76	84	73	56	100	109	25	6	81	74	106	93
ICTALURUS PUNCTATUS										3			
LEIOSTOMUS XANTHURUS					3					3	6	3	
MEMBRAS MARTINICA						4		3					
MENIDIA BERYLLINA								3		3	3		
MENIDIA MENIDIA						4							
22:00													
ANCHCA MITCHILLI		5			8								
EREVCORTIA TYRANNUS					4			3					
GOBIOSOMA BCSCI		42	12	235	111	218	236		37	117	130	240	150
LEIOSTOMUS XANTHURUS					4	8		3	3	13	3	3	3
MENIDIA BERYLLINA					8	17	4				3	3	3
MORONE SAXATILIS							4			3			
TRINECTES MACULATUS						4							

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
2:00													
ANCHOA MITCHILLI					7		8						3
BREVOORTIA TYRANNUS		10	5										
DCROSCOMA PETENENSE				9							3		
GOBIOSOMA BOSCI		19	52	511	382	306	213	60	27	344	210	565	470
LEIOSTOMUS XANTHURUS										14			
MEMBRAS MARTINICA				14									
MENIDIA BERYLLINA				9		10					3		
MENIDIA MENIDIA								4					
MORONE SAXATILIS										3			
6:00													
ANCHOA MITCHILLI			7	4		4	3						
DCROSCOMA PETENENSE						4			3				
GOBIOSOMA BOSCI		122	147	65	71	100	88	24	29	58	66	71	74
LEIOSTOMUS XANTHURUS						4							
MENIDIA BERYLLINA				4						3			3
MENIDIA MENIDIA									3				

Table 4. (continued).

JUNE 22 - 23, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ANCHOA MITCHILLI				75	7		107	3		20	16	15	27
GOBIOSOMA BOSCI		35	32	509	248	53	71	10	14	56	69	178	120
MEMBRAS MARTINICA										3			
14:00													
ANCHOA MITCHILLI				83		50	49			3		49	31
GOBIOSOMA BOSCI				167		212	249		6	41	16	423	497
18:00													
ANCHOA MITCHILLI						4			3	6	3	17	7
CYNOSEICIA REGALIS												4	
FUNDULLUS HETEROCLITUS			19										
GOBIOSOMA BOSCI			38	22	27	109	123	21	29	66	50	82	83
22:00													
ENTIRE 2200 SAMPLING ABORTED													
2:00													
ANCHOA MITCHILLI				43	37	101	81	16	3	37	13	31	28
GOBIOSOMA BOSCI		19		296	232	1067	550	22	30	351	269	295	316
LEICSTOMUS XANTHURUS										4		4	
MEMBRAS MARTINICA								6	3				
MENIDIA BERYLLINA						59	10				3	4	



Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
6:00													
ANCHOA MITCHILLI		8		17	21	13	8	7		24	13	32	24
CYNOSCION REGALIS					4								4
GOBIOSOMA BOSCI		8	9	67	74	31	25		3	87	114	410	263
MORONE SAXATILIS													4

Table 4. (continued).

JULY 25 - 26, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ANCHOA MITCHILLI		5		46	27	7	7	13	9	12	3	42	33
GOBIOSOMA BOSCI				63	27	286	255	28	9	15	21	61	47
MEMBRAS MARTINICA		34										3	3
MENIDIA BERYLLINA									3				
14:00													
ANCHOA MITCHILLI				43	15	86	73	7	10	41	20	72	80
CYNOSEICN REGALIS												3	
FUNDULUS HETEROCILITUS			4	6									
GOBIOSOMA BOSCI				68	44	111	105	7		7	7	34	37
MEMBRAS MARTINICA		18		6									
MENIDIA BERYLLINA		18											
18:00													
ANCHOA MITCHILLI			5	4	8	170	189	22	27	81	38	117	168
GOBIOSOMA BOSCI						44	64		7	66	84	203	262
HYPSUBLENNIUS FENTZI												3	
MEMBRAS MARTINICA				4	8	24	15						9
MENIDIA MENIDIA								4					
SYNGNATHUS FUSCUS										3			
22:00													
ANCHOA MITCHILLI				65	31	56	29	39	17	18	17	53	40
GOBIOSOMA BOSCI			4	52	21	11	29	6		88	52	67	99
MENIDIA BERYLLINA				4									
MICROPOGON UNDULATUS										3			

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	2:00												
ANCHOA MITCHILLI								3	6	89	90	102	164
CYNOSCION REGALIS											3		6
GOBIOSOMA BOSCI								14		38	93	119	155
MEMBRAS MARTINICA											3	3	
MENICIA MENIDIA										5			
	6:00												
ANCHOA MITCHILLI		27			12		86	41	45	75	107	243	221
GOBIOSOMA BOSCI		13			81		522	25	139	158	148	615	526
MEMBRAS MARTINICA			6	69						3			3

Table 4. (continued).

AUGUST 17 - 18, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ANCHOA MITCHILLI		5		500		133	327	3	6	25	40	74	94
ATHERINIDAE		5											
GOBIOSOMA BOSCI				1500	1000	385	1551	68	113	137	86	101	184
MEMBRAS MARTINICA		15											
MENIDIA BERYLLINA		15											3
14:00													
ANCHOA MITCHILLI				42	43	17	17	25	19	31	33	183	147
CYNOPTERON REGALIS						3				2			
GOBIOSOMA BOSCI				472	355	98	121	113	89	233	213	430	343
18:00													
ANCHOA MITCHILLI		34	24	27	11	8	12	5	3	46	55	208	167
GOBIOSOMA BOSCI				46	54	113	113	30	44	61	35	126	104
MENIDIA BERYLLINA											3		
22:00													
ANCHOA MITCHILLI		23	30	159	95	144	109	32	42	62	72	39	63
CYNOPTERON REGALIS												2	
GOBIOSOMA BOSCI				17	37	58	59	41	54	51	55	56	27
MEMBRAS MARTINICA		23				14	8						
MENIDIA BERYLLINA		11		11	11		4					2	
MENIDIA MENIDIA				6									
TRINectes MACULATUS							4						
SPECIMEN MANGLED							4						

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
2:00													
ANCHOA MITCHILLI		9	23	78	80	195	163	11	40	58	50	83	60
GOBIOSOMA BOSCI		13	34	53	31	78	89	37	30	23	62	63	60
MEMBRAS MARTINICA		4						5			2		5
MENIDIA BERYLLINA		4				8	14					5	
MENIDIA MENIDIA				5	4							2	
TRINECTES MACULATUS								3					
6:00													
ANCHOA MITCHILLI		8		129	150	60	33	10	22	32	29	21	32
GOBIOSOMA BOSCI		38	39	42	16	80	104	7	30	10	32	21	23
MEMBRAS MARTINICA				3									
SYNGNATHUS FUSCUS											2		

Table 4. (continued).

SEPTEMBER 21 - 22, 1978

SPECIES	STATION TIME	INTAKE				DISCHARGE				
		SURFACE		MIDWATER		SURFACE		MIDWATER		
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	
10:00										
ANCHOA MITCHILLI					4			5	9	6
GOBIOSOMA BOSCI										3
14:00										
ANCHOA MITCHILLI									8	11
GOBIOSOMA BOSCI					3					
SYNGNATHUS FUSCUS					3					
18:00										
ANCHOA MITCHILLI					3	5		12	12	10
GOBIOSOMA BOSCI						2				7
										5
22:00										
ANCHOA MITCHILLI				4		6	14	11	8	12
ANGUILLA RESTRATA									3	7
GOBIOSOMA BOSCI				4		3	3		2	18
MEMBRAS MARTINICA										16
MICROGOBIUS THALASSINUS										3
MICROPOGON UNDULATUS							8	2		3
SYMPHURUS PLAGIOSA										3
SYNGNATHUS FUSCUS									3	
2:00										
ANCHOA MITCHILLI				13		4	7	20	11	3
GOBIOSOMA BOSCI				3	6	8	4		3	8
MEMBRAS MARTINICA										13
MICROGOBIUS THALASSINUS				3						5
MICROPOGON UNDULATUS								6		3
MORONE AMERICANA										2
SYNGNATHUS FUSCUS										2

Table 4. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	6:00												
ANCHCA MITCHILLI						13	13	6	6	3	3	10	12
GOBIOSCMA BOSCI						4					3		
MICROPOGON UNDULATUS						4					3		

Table 4. (continued).

OCTOBER 19 - 20 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANCHOA MITCHILLI							4						
	14:00												
ANCHOA MITCHILLI				5		3	8			3		6	6
	18:00												
ANCHOA MITCHILLI				3		3	7	5		5	3	22	5
MICROPGGON UNDULATUS													3
	22:00												
ANCHOA MITCHILLI					5	5		6	7	3	12	25	19
GEBIOSOMA BOSCI									4				
MICROPGGON UNDULATUS						5			4		6	6	13
	2:00												
ANCHOA MITCHILLI				4	10	4	6						
	6:00												
ANCHOA MITCHILLI				4	4	5	5		3	3		2	
MICROPGGON UNDULATUS													2



Table 4. (continued).

NOVEMBER 15 - 16, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANCHOA MITCHILLI											3		
	14:00												
ANCHOA MITCHILLI								3				4	
	18:00												
ANCHOA MITCHILLI							3						
MICROPOGON UNDULATUS										5		7	12
	22:00												
ANCHOA MITCHILLI			5										
MICROPOGON UNDULATUS												2	

Table 4. (continued).

DECEMBER 11 - 12, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	14:00												
ANCHOA MITCHILLI												2	2
	18:00												
ANCHOA MITCHILLI				4	5							4	2
MICROPOGON UNULATUS								3	3			4	
	22:00												
MICROPOGON UNULATUS													2
	2:00												
ALCSA AESTIVALIS												2	
ANCHOA MITCHILLI													2
MICROPOGON UNULATUS													4

Table 5. Species and calculated number of fish eggs per 100 m<sup>3</sup> captured during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978.

JANUARY 24 - 25, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

18:00

UNIDENTIFIED

Table 5. (continued).

FEBRUARY 16 - 17, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	2:00												
UNIDENTIFIED										19		3	

Table 5. (continued).

MARCH 16 - 17, 1978

SPECIES	STATION TIME	<u>INTAKE</u>						<u>DISCHARGE</u>					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

14:00

UNIDENTIFIED

10

Table 5. (continued).

APRIL 6 - 7, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
CYPRINUS CARPIO										30	33	20	9
DCROSCOMA SP.												5	
MORONE AMERICANA						4					14		9
	14:00												
CYPRINUS CARPIO								4					12
MORONE AMERICANA										7		8	
	18:00												
MORONE AMERICANA								4	8				
UNIDENTIFIED								4					
	22:00												
DCROSCOMA SP.		6						26	5	5		14	
MORONE AMERICANA								5				5	
	2:00												
CYPRINUS CARPIO												3	3
MORONE AMERICANA												3	3
	6:00												
CYPRINUS CARPIO								4					
DCROSCOMA SP.								27	17	21	17	3	46
MORONE AMERICANA										7	3	7	25
UNIDENTIFIED									4	7		3	6

Table 5. (continued).

APRIL 13 - 14, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
CYPRINUS CARPIO								8	10	56	73	76	56
DOROSOMA SP.								5	8			2	
MORCNE AMERICANA								3				4	
	14:00												
ALCSA SP.						4						2	
CYPRINUS CARPIO		24	12		7			3					2
DOROSOMA SP.										14	4		7
MORCNE AMERICANA								3	3		4	2	
UNIDENTIFIED									3				2
	18:00												
ALCSA SP.												6	4
CYPRINUS CARPIO			3			6	10		3				2
DOROSOMA SP.									3		2	23	15
MORCNE AMERICANA												2	4
UNIDENTIFIED							5						
	22:00												
ALCSA SP.										2		4	
CYPRINUS CARPIO		3								2			
DOROSOMA SP.										5	2	2	2
MORCNE AMERICANA												2	
	2:00												
CYPRINUS CARPIO						5				5	9	56	83
DOROSOMA SP.										5		5	21
MORCNE AMERICANA								3	3	2	7	7	17

Table 5. (Continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	6:00												
ALCSA SP.								3		2		2	
CYPRINUS CARPIO		7			3		6	8	5	18	9	30	25
DERCSCMA SP.			3							11			
MORONE AMERICANA								5		11	6	4	4



Table 5. (continued).

APRIL 18 - 19, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ALCSA SP.											3		
CYPRINUS CARPIO		11					3						
CCROSOMA SP.								6	3		3		2
MORONE AMERICANA									8		13	5	9
	14:00												
CYPRINUS CARPIO		3		4				6				3	
CCROSOMA SP.												8	
MORONE AMERICANA										5			
	18:00												
CCROSOMA SP.								3		13	9		3
	22:00												
CCROSOMA SP.								9					3
MORONE AMERICANA										3	3		
	2:00												
ALCSA SP.								5	8				
CCROSOMA SP.										7	2	2	
MORONE AMERICANA											7	5	8
	6:00												
CCROSOMA SP.											15	15	18
MORONE AMERICANA		5									10	10	10
UNIDENTIFIED											15	16	5

0200 INTAKE SAMPLING ABORTED

08

Table 5. (continued).

APRIL 24 - 25, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ALCSA SP.										3			3
DCRCSOMA SP.								3	6		3		
MCRONE AMERICANA									3		6		
	14:00												
DCRCSOMA SP.										3	5	2	
MORONE AMERICANA									3		2	2	2
	18:00												
ALCSA SP.								3					
COROSOMA SP.										5	5	10	
MCRONE AMERICANA									3		3	2	4
	22:00												
COROSOMA SP.								2	3		3	12	3
MCRONE AMERICANA								6	7		3		7
UNIDENTIFIED									3				3
	2:00												
DCRCSOMA SP.													
MCRONE AMERICANA								19	13	49	33		3
				4			4		3	3	3	3	3
	6:00												
DCRCSOMA SP.													7
MCRONE AMERICANA								6			12	2	10
UNIDENTIFIED													2

Table 5. (continued).

MAY 2 - 3, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
CYPRINUS CARPIO									4	7	7	10	45
OCROSOMA SP.													10
MORONE AMERICANA								4		3	3	31	55
14:00													
CYPRINUS CARPIO		4							4	7	3	14	22
OCROSOMA SP.					9			4	4			3	
MORONE AMERICANA									7		3	14	22
18:00													
CYPRINUS CARPIO			8										
OCROSOMA SP.		6										4	4
MORONE AMERICANA										4	16	8	
22:00													
CYPRINUS CARPIO										3			
OCROSOMA SP.									3	7		7	
MORONE AMERICANA				6				25	3	10	3	13	16
2:00													
OCROSOMA SP.												3	
MORONE AMERICANA		4		9				29	21	26	15	80	45
6:00													
ALCSA SP.												4	
CYPRINUS CARPIO								4		4	8	8	29
OCROSOMA SP.					18			8			23		4
MORONE AMERICANA		19	5	20			11	25	20	20	42	16	51

Table 5. (continued).

MAY 11 - 12, 1978

SPECIES	STATION TIME	INTAKE				DISCHARGE			
		SURFACE		MIDWATER		SURFACE		MIDWATER	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00									
ALCSA SP.								26	
CYPRINUS CARPIO						8		25	36
OCROSOA CEPEDIANUM							3	4	23
MORONE AMERICANA							3	7	16
									49
									14
14:00									
CYPRINUS CARPIO		28		7		4			4
OCROSOA SP.					5				4
MORONE AMERICANA								4	22
									4
18:00									
ALCSA SP.								9	
OCROSOA SP.						7		3	9
MORONE AMERICANA									4
22:00									
ALCSA SP.								4	4
MORONE AMERICANA								8	9
									4
2:00									
CYPRINUS CARPIO					7			3	7
OCROSOA SP.							6		
MENIDIA BERILLINA									4
MORONE AMERICANA						10			24
									7

Table 5. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	6:00												
ALCSA SP.										14		18	33
CYPRINUS CARPIO		5							3	53	28	37	22
DCRCSMA SP.									9				
MCRONE AMERICANA				5		4		18	12	38	35	73	45

Table 5. (continued).

MAY 18 - 19, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
10:00													
ALCSA SP.												4	4
CYPRINUS CARPIO								4		7	10	28	26
MORCNE AMERICANA			5					8	4	15	7	33	30
14:00													
CYPRINUS CARPIO			8		5			4	3				
ECRCSCMA SP.								4				3	7
MORCNE AMERICANA										3			
18:00													
CYPRINUS CARPIO										4			4
MENIDIA BERYLLINA											3		
MENIDIA MENIDIA													4
MORCNE AMERICANA										4			
22:00													
ALCSA SP.												5	4
CYPRINUS CARPIO												5	
ECRCSCMA SP.									6				
MORCNE AMERICANA										4		5	
UNIDENTIFIED													4
2:00													
ALCSA SP.													8
CYPRINUS CARPIO								4	4	14	13	18	8
ECRCSCMA CEPEDIANUM													4
MORCNE AMERICANA						4				6		35	20

Table 5. (continued).

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	6:00												
CYPRINUS CARPIO										4			
MORONE AMERICANA					4			11		4		13	23
UNIDENTIFIED													6

Table 5. (continued).

MAY 25 - 26, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ALCSA SP.								4					
	14:00												
MORCNE AMERICANA												4	
	6:00												
CYPRINUS CARPIO								4		7	3	16	



Table 5. (continued).

JUNE 8 - 9, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	14:00												
ANCHOA MITCHILLI		5										3	
UNIDENTIFIED													
	18:00												
ANCHOA MITCHILLI												3	
	22:00												
ANCHOA MITCHILLI				5		4	4					3	∞
CORCSOMA SP.													∞
MENIDIA BERYLLINA				5		4							
	2:00												
ANCHOA MITCHILLI				5	7	5		4		3			
CORCSOMA SP.												3	
MENIDIA BERYLLINA													
	6:00												
ANCHOA MITCHILLI							3		12				

Table 5. (continued).

JUNE 22 - 23, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANCHOA MITCHILLI		752	617	4000	1628	9579	7107	197	90	436	548	629	371
	14:00												
ANCHOA MITCHILLI						70	46	178	212	428	239	318	317
	18:00												
ANCHOA MITCHILLI		162	132	315	164	134	138	80	32	164	171	172	33
	2:00												
ANCHOA MITCHILLI		170	123	1022	849	7647	4569	202	280	317	188	372	323
	6:00												
ANCHOA MITCHILLI MEMBRAS MARTINICA		904	435	1346	730	1430	1197	2231	1556	2425	2059	3336 5	2781

68

ENTIRE 2200 SAMPLING ABORTED

Table 5. (continued).

JULY 25 - 26, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANCHOA MITCHILLI								9	6	6	3	6	
	14:00												
ANCHCA MITCHILLI				80	15	157	251	25	3	4	10	14	6
	18:00												
ANCHOA MITCHILLI UNIDENTIFIED		6	15	4	4	5	19		3	6	40	3	
	22:00												
ANCHOA MITCHILLI UNIDENTIFIED		4	4	9		46	15	12				6	27
	2:00												3
ANCHOA MITCHILLI CYPRINCDON VARIEGATUS									3		6		
	6:00										3		
ANCHOA MITCHILLI		13	12	216	101		113	222	317	301	211	230	385

Table 5. (continued).

AUGUST 17 - 18, 1978

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
ANCHOA MITCHILLI		30	88	2000	5500	70	245	174	226	161	205	69	160
	14:00												
ANCHOA MITCHILLI		15	4	63	49	73	107	29		10	2	9	14
	18:00												
ANCHOA MITCHILLI		3			7	12			5				5
	2:00												
ANCHCA MITCHILLI										12		2	2
CYPRINODON VARIEGATUS													2
GOBIOSOMA BOSCI													10
	6:00												
ANCHOA MITCHILLI									2				
FUNDULUS DIAPHANUS										2			

Table 5. (continued).

SEPTEMBER 21 - 22, 1970

SPECIES	STATION TIME	INTAKE						DISCHARGE					
		SURFACE		MIDWATER		BOTTOM		SURFACE		MIDWATER		BOTTOM	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	10:00												
FUNDULUS DIAPHANUS								3					
	22:00												
ANCHOA MITCHILLI							3						

Table 6. Average (yearly) number of fish and fish eggs captured per sample (by depth) during 24-hour stations at VEPCO Surry Nuclear Power Station in 1978.

	Intake Surface	Discharge Surface	Intake Midwater	Discharge Midwater	Intake Bottom	Discharge Bottom
Fish	11	11	49	30	57	59
% Change		0%		-39%		4%
Eggs	16	29	78	39	142	50
% Change		81%		-50%		-65%

Table 7. Average number per sample of dominant species (fish and fish eggs) captured during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978.

1978	INTAKE							DISCHARGE						
Date	<u>Anchoa</u> <u>mitchilli</u>	<u>Anchoa</u> <u>mitchilli</u> (eggs)	<u>Gobiosoma</u> <u>bosci</u>	<u>Micropogon</u> <u>undulatus</u>	<u>Brevoortia</u> <u>tyrannus</u>	<u>Morone</u> <u>saxatilis</u>	<u>Morone</u> <u>americana</u>	<u>Anchoa</u> <u>mitchilli</u>	<u>Anchoa</u> <u>mitchilli</u> (eggs)	<u>Gobiosoma</u> <u>bosci</u>	<u>Micropogon</u> <u>undulatus</u>	<u>Brevoortia</u> <u>tyrannus</u>	<u>Morone</u> <u>saxatilis</u>	<u>Morone</u> <u>americana</u>
Jan. 24-25	0	0	0	0	0	0	<1	0	0	0	0	0	0	<1
Feb. 16-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar. 09-10	0	0	0	0	0	0	<1	0	0	0	0	0	0	0
Mar. 16-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr. 06-07	0	0	0	0	1	<1	1	0	0	0	0	3	0	<1
Apr. 13-14	0	0	0	0	4	7	23	0	0	0	0	5	3	14
Apr. 18-19	1	0	0	0	0	<1	<1	2	0	0	0	2	<1	<1
Apr. 24-25	3	0	0	0	2	<1	<1	6	0	0	0	6	<1	<1
May 02-03	<1	0	0	0	<1	1	1	1	0	0	0	<1	<1	<1
May 11-12	0	0	0	0	1	3	<1	0	0	0	0	1	2	<1
May 18-19	<1	0	2	0	3	23	3	0	0	2	0	1	13	2
May 25-26	<1	0	0	0	1	<1	0	0	0	0	0	<1	<1	0
Jun. 08-09	1	1	121	0	1	<1	0	<1	1	111	0	<1	<1	0
Jun. 22-23	24	1,561	147	0	0	0	0	14	690	131	0	0	<1	0
Jul. 25-26	34	38	64	0	0	0	0	60	52	90	<1	0	0	0
Aug. 17-18	75	230	183	0	0	0	0	53	30	89	0	0	0	0
Sep. 21-22	2	<1	1	<1	0	0	0	7	0	2	1	0	0	<1
Oct. 19-20	2	0	0	<1	0	0	0	4	0	<1	1	0	0	0
Nov. 15-16	<1	0	0	<1	0	0	0	<1	0	0	1	0	0	0
Dec. 11-12	<1	0	0	0	0	0	0	<1	0	0	<1	0	0	0

Table 8. Ranges of salinity (‰) during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978.

DATE			I N T A K E			D I S C H A R G E		
			Surface	Midwater	Bottom	Surface	Midwater	Bottom
Jan. 24-25	High		0.2	0.2	0.3	0.2	0.2	0.2
	Low		0.1	0.1	0.1	0.1	0.1	0.1
Feb. 16-17	High		2.2	2.5	2.5	2.5	2.4	2.4
	Low		2.0	2.0	2.0	2.1	2.1	2.1
Mar. 09-10	High		3.1	3.2	3.2	3.2	3.2	3.2
	Low		1.8	1.8	2.3	2.1	2.2	2.3
Mar. 16-17	High		0.3	0.3	0.3	0.3	0.3	0.3
	Low		0.2	0.2	0.2	0.2	0.2	0.2
Apr. 06-07	High		0.2	0.2	0.2	1.6	0.5	0.2
	Low		0.1	0.1	0.1	0.1	0.1	0.1
Apr. 13-14	High		0.4	0.4	0.5	0.4	0.4	0.4
	Low		0.2	0.3	0.2	0.3	0.3	0.3
Apr. 18-19	High		2.8	2.8	3.0	3.0	3.1	3.0
	Low		2.5	2.6	2.5	2.6	2.6	2.6
Apr. 24-25	High		3.2	3.3	3.5	3.3	3.3	3.3
	Low		2.6	2.6	2.6	2.6	2.6	2.5
May 02-03	High		Data misplaced			0.5	0.5	0.5
	Low					0.3	0.3	0.3
May 11-12	High		0.2	0.1	0.1	0.1	0.1	0.1
	Low		0.1	0.1	0.1	0.1	0.1	0.1



Table 8. (Continued)

DATE			I N T A K E			D I S C H A R G E		
			Surface	Midwater	Bottom	Surface	Midwater	Bottom
May	18-19	High	0.6	0.3	0.4	0.3	0.3	0.3
		Low	0.1	0.1	0.1	0.1	0.1	0.1
May	25-26	High	0.3	0.3	0.3	0.4	0.4	0.4
		Low	0.2	0.2	0.2	0.2	0.2	0.2
June	08-09	High	1.5	1.5	1.4	1.9	1.5	1.5
		Low	1.2	1.3	1.3	1.3	1.2	1.2
June	22-23	High	4.1	4.1	4.2	4.0	4.0	4.0
		Low	3.3	3.5	3.7	3.4	3.4	3.4
July	25-26	High	6.0	6.0	6.2	6.0	6.0	6.0
		Low	5.2	5.2	5.3	4.0	5.3	5.3
Aug.	17-18	High	4.6	4.6	4.6	4.7	4.7	4.7
		Low	3.8	3.8	3.9	3.8	3.9	3.9
Sept.	21-22	High	9.2	9.2	9.2	9.2	9.2	9.2
		Low	8.4	8.5	8.5	8.5	8.5	8.4
Oct.	19-20	High	9.8	9.6	9.9	9.7	9.7	9.7
		Low	9.4	9.4	9.4	9.4	9.4	9.4
Nov.	15-16	High	10.5	10.6	10.6	10.6	10.6	10.6
		Low	9.6	9.6	9.6	9.7	9.7	9.7
Dec.	11-12	High	7.3	7.2	7.2	7.1	7.0	7.0
		Low	5.7	5.7	5.8	5.7	5.7	5.7

Table 9. Ranges of water temperature (C) during 24-hour stations at VEPCO Surry Nuclear Power Plant in 1978.

DATE			I N T A K E			D I S C H A R G E		
			Surface	Midwater	Bottom	Surface	Midwater	Bottom
Jan. 24-25	High		4	4	4	12	12	12
	Low		3	3	3	11	11	11
Feb. 16-17	High		2	2	2	10	10	10
	Low		1	1	1	9	9	9
Mar. 09-10	High		3	3	3	12	11	11
	Low		2	2	2	11	10	11
Mar. 16-17	High		9	9	9	18	18	18
	Low		7	7	7	15	16	16
Apr. 06-07	High		15	15	14	20	20	20
	Low		13	13	13	19	19	18
Apr. 13-14	High		18	17	17	24	24	24
	Low		15	15	15	22	22	21
Apr. 18-19	High		14	14	14	21	21	21
	Low		14	14	14	21	20	20
Apr. 24-25	High		16	16	16	22	22	21
	Low		15	15	15	19	19	19
May 02-03	High		16	16	16	22	22	20
	Low		14	14	14	20	19	20
May 11-12	High		20	20	19	25	24	24
	Low		17	17	17	23	22	22

Table 9. (Continued)

DATE			I N T A K E			D I S C H A R G E		
			Surface	Midwater	Bottom	Surface	Midwater	Bottom
May	18-19	High	23	22	21	28	28	27
		Low	20	20	19	25	25	24
May	25-26	High	24	24	23	24	24	24
		Low	22	22	22	22	22	22
June	08-09	High	26	26	26	31	30	30
		Low	24	24	24	29	28	28
June	22-23	High	28	28	27	35	32	32
		Low	24	24	24	31	30	30
July	25-26	High	30	30	30	35	34	34
		Low	27	27	27	32	32	32
Aug.	17-18	High	32	31	31	39	38	38
		Low	29	29	29	37	35	37
Sept.	21-22	High	28	27	27	35	34	34
		Low	24	24	24	33	32	32
Oct.	19-20	High	17	17	17	27	26	26
		Low	15	15	15	26	25	24
Nov.	15-16	High	16	16	16	25	24	23
		Low	16	16	16	23	23	25
Dec.	11-12	High	10	10	10	18	17	18
		Low	8	9	9	14	13	13

Table 10. Ranges of dissolved oxygen (mg/l) during 24-hour stations at VEPCO Surry Power Plant in 1978.

DATE			I N T A K E			D I S C H A R G E		
			Surface	Midwater	Bottom	Surface	Midwater	Bottom
Jan.	24-25	High	11.6	11.6	11.6	11.2	11.6	11.3
		Low	10.3	11.2	11.2	10.2	9.2	9.8
Feb.	16-17	High	12.1	12.1	12.2	14.9	12.1	12.0
		Low	11.8	11.6	11.8	11.5	11.4	11.4
Mar.	09-10	High	12.4	12.4	12.4	12.3	12.3	12.4
		Low	12.0	12.0	11.9	11.3	11.4	11.4
Mar.	16-17	High	10.6	10.7	10.7	10.6	10.4	10.5
		Low	10.4	10.3	10.4	10.3	10.0	10.2
Apr.	06-07	High	9.8	9.8	9.6	9.2	9.3	9.3
		Low	8.9	9.0	8.8	8.9	8.7	8.4
Apr.	13-14	High	8.9	8.7	8.9	8.7	9.5	8.6
		Low	8.2	8.3	8.3	8.1	8.3	8.3
Apr.	18-19	High	9.1	8.9	9.2	9.0	9.0	9.0
		Low	8.5	8.6	8.7	8.3	8.5	8.5
Apr.	24-25	High	9.6	10.0	9.8	9.0	9.2	9.2
		Low	8.0	8.2	8.3	8.3	8.5	8.3
May	02-03	High	9.2	9.1	10.6	8.4	8.7	8.3
		Low	8.0	7.8	7.9	7.7	8.0	8.0
May	11-12	High	8.0	8.4	7.9	8.0	8.0	8.2
		Low	7.0	7.8	7.1	7.5	7.6	7.5

Table 10. (Continued)

DATE			I N T A K E			D I S C H A R G E		
			Surface	Midwater	Bottom	Surface	Midwater	Bottom
May	18-19	High	7.6	8.2	8.3	7.5	9.2	7.7
		Low	7.2	7.0	7.4	6.3	6.9	6.6
May	25-26	High	7.4	7.3	7.3	7.3	7.1	7.2
		Low	6.9	6.0	6.4	6.6	6.7	7.0
June	08-09	High	7.8	6.7	6.7	6.6	7.1	6.5
		Low	5.7	5.8	5.5	5.3	5.7	6.0
June	22-23	High	7.1	7.3	8.1	6.6	6.7	6.6
		Low	4.5	4.4	5.1	4.3	5.5	5.9
July	25-26	High	8.1	8.0	8.3	6.9	6.9	7.0
		Low	5.2	6.1	6.4	6.2	6.1	6.0
Aug.	17-18	High	6.3	6.3	6.6	6.1	6.2	6.2
		Low	4.8	4.7	5.5	4.7	4.6	5.3
Sept.	21-22	High	7.8	7.9	8.1	6.7	6.5	6.5
		Low	6.4	6.6	6.3	5.6	5.9	5.2
Oct.	19-20	High	8.1	8.2	8.1	7.8	7.9	7.8
		Low	6.5	6.5	5.5	6.9	7.1	5.4
Nov.	15-16	High	7.9	8.0	8.4	11.5	7.6	7.9
		Low	7.5	7.1	7.4	6.5	6.9	7.1
Dec.	11-12	High	9.8	9.5	9.7	9.9	9.7	9.7
		Low	7.1	7.4	6.7	7.8	8.0	8.7

Table 11. Descriptive statistics of dependent ( $Y_i$ ) and independent ( $X_j$ ) variables.

Variable	January-December 1978 (N = 656)				May-October 1978 (N = 316)			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
$Y_1$ , Total abundance of fish	2.3	2.10	0.0	8.01	-	-	-	-
$Y_2$ , Abundance of fish species	0.8	0.64	0.0	2.30	-	-	-	-
$Y_3$ , Fish species diversity	0.3	0.44	0.0	1.8	-	-	-	-
$Y_4$ , Total abundance of eggs	1.2	1.94	0.0	9.7	-	-	-	-
$Y_5$ , Abundance of egg species	0.3	0.45	0.0	1.6	-	-	-	-
$Y_6$ , Egg species diversity	0.1	0.24	0.0	1.2	-	-	-	-
$Y_7$ , Abundance of <u>A. mitchilli</u> fish	-	-	-	-	1.6	1.86	0.0	6.2
$Y_8$ , Abundance of <u>G. bosci</u> fish	-	-	-	-	2.1	2.40	0.0	7.8
$Y_9$ , Abundance of <u>A. mitchilli</u> eggs	-	-	-	-	1.2	2.31	0.0	9.7
$X_1$ , Depth	3.1	2.09	1.0	7.0	3.1	2.06	1.0	7.0
$X_2$ , Temperature	19.7	8.70	1.0	39.0	26.2	5.57	15.0	39.0
$X_3$ , Salinity	3.0	3.34	0.0	11.0	3.5	3.52	0.0	10.0
$X_4$ , Dissolved oxygen	8.4	1.92	4.3	14.9	6.9	0.87	4.3	9.2
$X_5$ , Location	0.5	0.50	0	1	0.5	0.50	0	1
$X_6$ , Period	0.5	0.50	0	1	0.5	0.50	0	1

Table 11. (continued).

Variable	January-December 1978 (N = 656)				May-October 1978 (N = 316)			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
X <sub>7</sub> , Tide	0.0	0.70	-1	1	0.1	0.70	-1	1
X <sub>8</sub> , Fall	0.1	0.35	0	1	0.1	0.30	0	1
X <sub>9</sub> , Winter	0.2	0.41	0	1	-	-	-	-
X <sub>10</sub> , Spring	0.5	0.50	0	1	0.6	0.50	0	1

Table 12. Summary statistics for final stepwise regression equations.

Y <sub>i</sub>	Final Equation				b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub>	b <sub>8</sub>	b <sub>9</sub>	b <sub>10</sub>	b <sub>11</sub>
	R <sup>2</sup>	F <sub>s</sub>	DF	Sig.	Depth	Temp.	Salinity	Dissolved Oxygen	Location	Period	Tide	Fall	Winter	Spring	Constant
Y <sub>1</sub> , Total abundance of fish	0.64	191	6,649	0.001	0.201***	0.176***	-0.225***	-0.159*	-0.542***	0.338***	ns	ns	ns	ns	0.345
Y <sub>2</sub> , Abundance of fish species	0.55	135	6,649	0.001	0.046***	0.040***	-0.062***	ns	ns	0.173***	ns	ns	-0.250**	0.142	-0.074
Y <sub>3</sub> , Fish species diversity	0.35	51	7,649	0.001	0.024***	0.008**	-0.028***	ns	0.095**	0.127***	ns	-0.236***	-0.410***	ns	0.192
Y <sub>4</sub> , Total abundance of eggs	0.30	40	7,648	0.001	ns	0.095***	0.110**	ns	ns	-0.462***	0.260**	-0.604	1.150**	1.731***	-1.782
Y <sub>5</sub> , Abundance of egg species	0.36	91	4,651	0.001	ns	0.009***	ns	ns	0.230***	ns	ns	-0.144***	ns	0.346***	-0.126
Y <sub>6</sub> , Egg species diversity	0.23	49	4,651	0.001	ns	ns	ns	0.034***	0.152***	ns	ns	ns	-0.149***	0.155***	-0.514
Y <sub>7</sub> , Abundance of <u>A. mitchilli</u> fish	0.59	74	6,309	0.001	0.274***	0.126***	ns	-0.450***	ns	0.387**	0.193*	ns	NA	-1.305***	1.051
Y <sub>8</sub> , Abundance of <u>G. borei</u> fish	0.56	65	6,309	0.001	0.326***	0.401***	ns	-0.459**	-1.455***	ns	ns	1.724***	NA	2.194***	-6.970
Y <sub>9</sub> , Abundance of <u>A. mitchilli</u> eggs	0.37	26	7,308	0.001	0.106	0.292***	0.402***	ns	-1.420***	-0.669**	0.358*	ns	NA	3.748***	-9.256

R<sup>2</sup>, Coefficient of multiple determinationF<sub>s</sub>, t-statistic for test of significance

DF, Degrees of freedom

Sig., Significance of regression

b<sub>j</sub>, Partial regression coefficient

\*, Significant, P&lt;0.05

\*\*, Highly significant, P&lt;0.01

\*\*\*, Very highly significant, P&lt;0.001

ns, Not significant, P&gt;0.10

NA, Not applicable



Table 13. Standardized partial regression coefficients with ranks of relative importance in parentheses.

$Y_i$	Depth	Temperature	Salinity	Dissolved Oxygen	Location	Period	Tide
$Y_1$	0.200 (3)	0.727 (1)	-0.358 (2)	-0.145 (4)	-0.129 (5)	0.080 (6)	ns (7)
$Y_2$	0.150 (3)	0.542 (1)	-0.326 (2)	ns (6)	ns (6)	0.136 (4)	ns (6)
$Y_3$	0.116 (4)	0.168 (2)	-0.212 (1)	ns (6.5)	0.109 (5)	0.146 (3)	ns (6.5)
$Y_4$	ns (6)	0.427 (1)	0.189 (2)	ns (6)	ns (6)	-0.119 (3)	0.094 (4)
$Y_5$	ns (5)	0.167 (2)	ns (5)	ns (5)	0.257 (1)	ns (5)	ns (5)
$Y_6$	ns (5)	ns (5)	ns (5)	0.276 (2)	0.318 (1)	ns (5)	ns (5)
$Y_7$	0.304 (2)	0.376 (1)	ns (6.5)	-0.210 (3)	ns (6.5)	0.104 (4)	0.073 (5)
$Y_8$	0.279 (3)	0.929 (1)	ns (6)	-0.166 (4)	-0.302 (2)	ns (6)	ns (6)
$Y_9$	0.094 (6)	0.703 (1)	0.611 (2)	ns (7)	-0.307 (3)	-0.145 (4)	0.109 (5)
Sum of Ranks	37	15	31.5	43.5	35.5	40	49.5
Overall Rank of Relative Importance	4	1	2	6	3	5	7

### 3.6 FISH MORTALITIES

Fish impingement estimates for the low-level screens for the time period of January 1, 1978 to December 30, 1978 are reported. Due to ice damage to the screens, samples were not taken during the period from February 5 through March 4. These estimates are based on two five-minute replicates taken daily Monday through Friday and extrapolated to reflect weekly values.

The low-level screens, which were specifically designed to reduce fish impingement mortality, stopped an estimated 4,043,054 fish from entering the high level canal during this time period. Of this total, an estimated 3,796,682 individuals were returned to the river alive. The average eleven-month survival was 94% with a range of 83% to 99%.

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week Of January 1

Through January 7, 1978

Ave. No. Circ. Pumps: 8  
Temperature Min-Max: 3.1 - 4.4  
Salinity Min-Max: 1.6 - 2.9  
Survival Percentage: 99.5 %

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	200-299	288	0
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	300-399	576	0
051	Gizzard shad	Dorosoma cepedianum	140-199	23,112	0
275	Threadfin shad	Dorosoma petenense	60-79	4,968	0
026	Alewife	Alosa pseudoharengus	100-119,120-139	864	0
027	Blueback herring	Alosa aestivalis	60-79	30,528	144
037	Atlantic menhaden	Brevoortia tyrannus	80-99	6,048	0
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina	60-79	504	0
150	Atlantic silverside	Menidia menidia	80-99	2,232	0
135	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	80-99	91,800	648
033	Spot	Leiostomus xanthurus	80-99	648	0
005	Atlantic croaker	Micropogon undulatus	40-59	1,224	72
151	Hogchoker	Trinectes maculatus	80-99	360	0
107	Silvery minnow	Hybognathus nuchalis	120-139	144	0
231	Striped mullet	Mugil cephalus	140-199	144	0
TOTAL				163,440	864

Week Of January 8 Through January 14, 1978

Ave. No. Circ. Pumps:	<u>8</u>
Temperature Min-Max:	<u>0.7 - 6.0</u>
Salinity Min-Max:	<u>0.0 - 4.9</u>
Survival Percentage:	<u>99</u> %

R - 9/75

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week Of January 15

Through January 21, 1978

Ave. No. Circ. Pumps:	<u>8</u>	
Temperature Min-Max:	<u>3.1</u>	<u>- 5.4</u>
Salinity Min-Max:	<u>0.3</u>	<u>- 0.0</u>
Survival Percentage:	<u>98</u>	<u>%</u>

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	72	0
039	White catfish	Ictalurus catus	200-299	2,304	0
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	400-499,500+	216	0
051	Gizzard shad	Dorosoma cepedianum	140-199	35,928	288
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	100-119	576	0
027	Blueback herring	Alosa aestivalis	60-79	69,408	2,088
037	Atlantic menhaden	Brevoortia tyrannus			
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina	60-79	1,152	72
150	Atlantic silverside	Menidia menidia	100-119	72	0
135	Pumpkinseed	Lepomis gibbosus	80-99	72	0
032	White perch	Morone americana	80-99	43,272	936
033	Spot	Leiostomus xanthurus			
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus			
122	Mummichog	Fundulus heteroclitus	80-99	144	0
031	Striped bass	Morone saxatilis	140-199	144	0
231	Striped mullet	Mugil cephalus	140-199	576	0
R - 9/75		3.6-4	TOTAL	153,936	3,384

LOW LEVEL WEEKLY REPORT

Through January 28, 1978

Ave. No. Circ. Pumps: 7  
 Temperature Min-Max: 2.7 - 6.0  
 Salinity Min-Max: 0.0 - 0.4  
 Survival Percentage: 99 %

R - 9/75

Week Of January 29 Through February 4, 1978

Ave. No. Circ. Pumps:	<u>7</u>	
Temperature Min-Max:	<u>0.4</u>	- 2.6
Salinity Min-Max:	<u>0.0</u>	- 0.3
Survival Percentage:	<u>99</u>	%

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	300-399	360	0
039	White catfish	Ictalurus catus	140-199	61,632	72
116	Brown bullhead	Ictalurus nebulosus	200-299	144	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	300-399	288	0
051	Gizzard shad	Dorosoma cepedianum	140-199	18,144	432
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis	60-79	1,140	72
037	Atlantic menhaden	Brevoortia tyrannus			
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina.	60-79	936	0
150	Atlantic silverside	Menidia menidia	80-99	144	0
135	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	80-99	39,456	1,296
033	Spot	Leiostomus xanthurus			
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus			
100	Sea lamprey	Petromyzon marinus	500 +	72	0
052	Carp	Cyprinus carpio	300-399	288	0
122	Mummichog	Fundulus heteroclitus	80-99	504	0
231	Striped mullet	Mugil cephalus	140-199	288	0
031	Striped bass	Morone saxatilis	140-199,200-299	216	0
R - 9/75                      3.6-6                      TOTAL				123,912	1,872

Week Of March 5 Through March 11, 1978

\* 7 pumps with 1 screen operating

R - 9/75



LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>7 *</u>	
Temperature Min-Max:	<u>6.3 - 9.5</u>	
Salinity Min-Max:	<u>0.7 - 0.2</u>	
Survival Percentage:	<u>99</u>	%

\* 7 pumps with 1 screen operating

Through March 18, 1978

[illegible]

Ave. No. Circ. Pumps:	<u>7</u>	*
Temperature Min-Max:	<u>8.0</u>	- <u>11.2</u>
Salinity Min - Max:	<u>0.0</u>	- <u>0.2</u>
Survival Percentage:	<u>99.6</u>	%

Week Of March 19 Through March 25, 1978

[illegible]

1

170

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Sal

\* 5

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas	60-79	432	0
110	Spottail shiner	Notropis hudsonius	80-99	144	0
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	576	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	80-99, 100-119	432	0
027	Blueback herring	Alosa aestivalis	80-99	9,504	0
037	Atlantic menhaden	Brevoortia tyrannus	140-199	576	0
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia	100-119	288	0
135	Pumpkinseed	Lepomis gibbosus	120-139, 140-199	576	288
032	White perch	Morone americana	60-79, 80-99	864	0
033	Spot	Leiostomus xanthurus			
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus			
122	Mummichog	Fundulus heteroclitus	60-79	2,736	0
137	Largemouth bass	Micropterus salmoides	300-399	288	0
142	Yellow perch	Perca flavescens	100-119	144	0
031	Striped bass	Morone saxatilis	80-99	144	0
R - 9/75                      3.6-10                      TOTAL				16,704	288

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week Of April 2

Through April 8, 1978

Ave. No. Circ. Pumps:  $\frac{5 *}{12.8} - 14.7$   
Temperature Min-Max:  $\frac{0.0}{0.0} - \frac{0.0}{0.0}$   
Salinity Min-Max:  $\frac{100}{100} \%$   
Survival Percentage:  $\frac{100}{100} \%$

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius	80-99, 100-119	864	0
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis	80-99	5,040	0
037	Atlantic menhaden	Brevoortia tyrannus	60-79, 120-139	288	0
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina	60-79	288	0
50	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus	100-119, 140-199	288	0
032	White perch	Morone americana	80-99	2,880	0
033	Spot	Leiostomus xanthurus			
005	Atlantic croaker	Micropogon undulatus	40-59	288	0
151	Hogchoker	Trinectes maculatus	60-79, 80-99	2,448	0
122	Mummichog	Fundulus heteroclitus	40-59	3,456	0
138	Black crappie	Pomoxis nigromaculatus	200-299	144	0
TOTAL				15,984	0

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 8 \*  
Temperature Min-Max: 15.1 - 16.9  
Salinity Min-Max: 0.0 - 0.2  
Survival Percentage: 99 %

\* 8 pumps with 4 screens operating

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	140-199	576	0
116	Brown bullhead	Ictalurus nebulosus	140-199	288	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius	80-99	144	0
060	American eel	Anguilla rostrata	200-299	144	0
051	Gizzard shad	Dorosoma cepedianum	140-199, 400-499	576	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	200-299	720	0
027	Blueback herring	Alosa aestivalis	60-79	4,032	0
037	Atlantic menhaden	Brevoortia tyrannus	140-199	4,464	0
103	Bay anchovy	Anchoa mitchilli	60-79	432	432
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus	100-119, 140-199	1,008	0
032	White perch	Morone americana	80-99	7,920	0
033	Spot	Leiostomus xanthurus	100-119	8,784	0
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	60-79	2,304	0
122	Mummichog	Fundulus heteroclitus	60-79	2,592	0
136	Bluegill	Lepomis macrochirus	200-299	288	0
TOTAL				34,272	432

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>8</u> *
Temperature Min-Max:	<u>13.9 - 14.9</u>
Salinity Min-Max:	<u>1.6 - 3.3</u>
Survival Percentage:	<u>96</u> %

\* 8 pumps with 6 screens operating

Week Of April 16

Through April 22, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas	60-79	144	0
110	Spottail shiner	Notropis hudsonius	80-99	720	0
060	American eel	Anguilla rostrata	200-299,300-399	432	0
051	Gizzard shad	Dorosoma cepedianum	140-199	144	144
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	200-299	1,584	0
027	Blueback herring	Alosa aestivalis	200-299	4,608	288
037	Atlantic menhaden	Brevoortia tyrannus	100-119	9,936	0
103	Bay anchovy	Anchoa mitchilli	60-79	38,016	2,880
149	Tidewater silverside	Menidia beryllina	40-59	432	288
150	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus	120-139	432	0
032	White perch	Morone americana	80-99	14,544	0
033	Spot	Leiostomus xanthurus	100-119	9,936	0
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	60-79	4,464	0
122	Mummichog	Fundulus heteroclitus	40-59	288	0
148	Rough silverside	Membras martinica	100-119	288	0
031	Striped bass	Morone saxatilis	120-139	288	0
R - 9/75				86,256	3,600
3.6-13					
TOTAL					

the

Survival Percentage:



LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>5</u>	
Temperature Min-Max:	<u>13.4</u>	<u>- 15.6</u>
Salinity Min-Max:	<u>0.0</u>	<u>- 0.8</u>
Survival Percentage:	<u>99</u>	<u>%</u>

Week of April 30

Through May 6, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	120-139,200-299	576	0
039	White catfish	Ictalurus catus	200-299	144	0
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	1,584	0
051	Gizzard shad	Dorosoma cepedianum	140-199	432	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis	80-99,140-199	432	0
037	Atlantic menhaden	Brevoortia tyrannus	80-99,120-139	3,024	0
103	Bay anchovy	Anchoa mitchilli	40-59	2,448	144
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus	140-199	576	0
032	White perch	Morone americana	80-99	7,776	144
033	Spot	Leiostomus xanthurus	100-119	9,072	144
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	60-79	2,304	0
030	American shad	Alosa sapidissima	120-139	288	0
122	Mummichog	Fundulus heteroclitus	60-79	288	0
188	Redbreast sunfish	Lepomis auritus	120-139,140-199	432	0
031	Striped bass	Morone saxatilis	200-299	288	0
R - 9/75		3.6-15	TOTAL	29,664	432



SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 5  
 Temperature Min-Max: 14.0 - 18.3  
 Salinity Min-Max: 0.0 - 0.1  
 Survival Percentage: 97 %

Through May 13, 1978

[illegible]

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>5</u>	
Temperature Min-Max:	<u>17.6</u>	<u>- 21.3</u>
Salinity Min-Max:	<u>0.0</u>	<u>- 0.1</u>
Survival Percentage:	<u>99</u>	<u>%</u>

Week of May 14

Through May 20, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	432	0
039	White catfish	Ictalurus catus	200-299	288	0
116	Brown bullhead	Ictalurus nebulosus	80-99	288	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius	80-99	144	0
060	American eel	Anguilla rostrata	200-299	1,008	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	200-299	144	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus =	120-139	2,592	0
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus	120-139, 140-199	1,584	0
032	White perch	Morone americana	80-99	2,304	0
033	Spot	Leiostomus xanthurus	120-139	3,168	288
005	Atlantic croaker	Micropogon undulatus	80-99	144	0
151	Hogchoker	Trinectes maculatus	40-59	34,272	288
122	Mummichog	Fundulus heteroclitus	80-99	288	0
136	Bluegill	Lepomis macrochirus	120-139	1,008	0
137	Largemouth bass	Micropterus salmoides	300-399	288	0
R - 9/75		3.6-17	TOTAL	47,952	576

Ave. No. Circ. Pumps:	<u>5</u>
Temperature Min-Max:	<u>20.7</u> - <u>22.9</u>
Salinity Min-Max:	<u>0.1</u> - <u>0.4</u>
Survival Percentage:	<u>96</u> %

Through May 27, 1978

[illegible]

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week Of May 28

Through June 3, 1978

Ave. No. Circ. Pumps: 4  
Temperature Min-Max: 22.7 - 23.6  
Salinity Min-Max: 0.6 - 1.0  
Survival Percentage: 91 %

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	1,440	0
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	1,296	0
051	Gizzard shad	Dorosoma cepedianum	200-299	432	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	100-119	4,896	864
103	Bay anchovy	Anchoa mitchilli	60-79	432	0
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus	140-199	288	0
032	White perch	Morone americana	100-119	2,880	0
033	Spot	Leiostomus xanthurus	40-59	18,000	2,448
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	40-59	7,776	144
148	Rough silverside	Membras martinica	60-79	0	144
031	Striped bass	Morone saxatilis	140-199	432	0
003	Summer flounder	Paralichthys dentatus	20-39	288	0
TOTAL				38,160	3,600

Week Of June 4

Ave. No. Circ. Pumps:	<u>5</u>	
Temperature Min-Max:	<u>21.9 - 25.5</u>	
Salinity Min-Max:	<u>0.9 - 1.3</u>	
Survival Percentage:	<u>96</u>	%

[illegible]

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 5  
Temperature Min-Max: 21.9 - 25.2  
Salinity Min-Max: 1.0 - 2.4  
Survival Percentage: 96 %

Week Of June 11

Through June 17, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299, 300-399	864	144
039	White catfish	Ictalurus catus	140-199	864	0
116	Brown bullhead	Ictalurus nebulosus	200-299	144	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	432	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	200-299	144	0
027	Blueback herring	Alosa aestivalis	300-399	144	0
037	Atlantic menhaden	Brevoortia tyrannus	100-119	28,368	1,728
103	Bay anchovy	Anchoa mitchilli	60-79	576	144
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	100-119	1,872	0
033	Spot	Leiostomus xanthurus	60-79	40,896	1,728
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	40-59	27,936	0
052	Carp	Cyprinus carpio	120-139	144	0
009	Bluefish	Pomatomus saltatrix	200-299	144	0
031	Striped bass	Morone saxatilis	40-59, 120-139	432	288
TOTAL				102,960	4,032

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>5</u>	
Temperature Min-Max:	<u>24.8 - 26.1</u>	
Salinity Min-Max:	<u>3.0</u>	<u>4.2</u>
Survival Percentage:	<u>95</u>	%

Week of June 18

Through June 24, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	400-499	144	0
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	1,152	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	100-119	25,632	1,140
103	Bay anchovy	Anchoa mitchilli	60-79	1,008	864
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus	120-139	288	0
032	White perch	Morone americana	100-119	4,032	0
033	Spot	Leiostomus xanthurus	120-139	50,112	2,160
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	40-59	7,920	576
052	Carp	Cyprinus carpio	140-199	432	144
009	Bluefish	Pomatomus saltatrix	60-79	432	144
136	Bluegill	Lepomis macrochirus	100-119	144	0
031	Striped bass	Morone saxatilis	40-59	1,584	0
003	Summer flounder	Paralichthys dentatus	200-299	288	0
R - 9/75		3.6-22	TOTAL	93,168	5,328

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 5  
Temperature Min-Max: 25.0 - 26.8  
Salinity Min-Max: 3.4 - 3.9  
Survival Percentage: 95 %

Week Of June 25

Through July 1, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	288	0
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	576	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	100-119	20,592	1,584
103	Bay anchovy	Anchoa mitchilli	60-79	2,016	720
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	120-139	3,024	0
033	Spot	Leiostomus xanthurus	60-79	56,736	3,024
005	Atlantic croaker	Micropogon undulatus	100-119, 140-199	720	0
151	Hogchoker	Trinectes maculatus	40-59	33,408	432
122	Mummichog	Fundulus heteroclitus	80-99	144	0
R - 9/75				117,504	5,760
3-6-23					
TOTAL					



SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 6  
Temperature Min-Max: 24.3 - 25.4  
Salinity Min-Max: 5.2 - 6.4  
Survival Percentage: 97 %

Week of July 2 Through July 8, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	576	0
039	White catfish	Ictalurus catus	40-59, 140-199	1,440	0
116	Brown bullhead	Ictalurus nebulosus	40-59	288	0
108	Golden shiner	Notemigonus crysoleucas	100-119	288	0
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	1,440	0
051	Gizzard shad	Dorosoma cepedianum	300-399	144	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	1,008	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	100-119	21,744	720
103	Bay anchovy	Anchoa mitchilli	60-79	288	288
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	40-59, 120-139	2,448	0
033	Spot	Leiostomus xanthurus	60-79	63,072	2,016
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	40-59	8,928	576
009	Bluefish	Pomatomus saltatrix	200-299	576	0
031	Striped bass	Morone saxatilis	40-59	288	0
TOTAL				105,528	3,600

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 5  
Temperature Min-Max: 23.7 - 27.1  
Salinity Min-Max: 4.4 - 5.9  
Survival Percentage: 98 %

Week Of July 9 Through July 15

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	720	0
039	White catfish	Ictalurus catus	200-299	864	0
116	Brown bullhead	Ictalurus nebulosus	40-59	14,400	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	720	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	144	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	100-119	49,536	720
103	Bay anchovy	Anchoa mitchilli	60-79	432	720
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
035	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	120-139	576	0
033	Spot	Leiostomus xanthurus	80-99	94,320	864
005	Atlantic croaker	Micropogon undulatus	100-119	144	0
151	Hogchoker	Trinectes maculatus	40-59	4,752	288
052	Carp	Cyprinus carpio	300-399	144	0
009	Bluefish	Pomatomus saltatrix	100-119	144	0
007	Weakfish	Cynoscion regalis	40-59	144	0
R - 9/75 3.6-25 TOTAL				167,040	2,592

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>5</u>	
Temperature Min-Max:	<u>26.0</u>	<u>27.2</u>
Salinity Min-Max:	<u>5.3</u>	<u>7.4</u>
Survival Percentage:	<u>95</u>	%

Week Of July 16 Through July 22, 1978

[illegible]

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week Of July 23

Through July 29, 1978

Ave. No. Circ. Pumps:  $\frac{6}{27.8 - 30.4}$   
Temperature Min-Max:  $\frac{5.5 - 6.9}{}$   
Salinity Min-Max:  $\frac{99}{}$  %  
Survival Percentage:  $\frac{99}{}$  %

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	200-299	144	0
116	Brown bullhead	Ictalurus nebulosus	40-59	16,992	288
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	720	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	288	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	120-139	8,208	288
103	Bay anchovy	Anchoa mitchilli	60-79	3,024	288
149	Tidewater silverside	Menidia beryllina			
050	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	40-59	3,744	0
033	Spot	Leiostomus xanthurus	80-99	68,256	864
005	Atlantic croaker	Micropogon undulatus	80-99	144	0
151	Hogchoker	Trinectes maculatus	40-59	1,296	0
009	Bluefish	Pomatomus saltatrix	140-199	144	0
031	Striped bass	Morone saxatilis	40-59, 60-79	576	0
007	Weakfish	Cynoscion regalis	40-59	1,008	0
R - 9/75 3.6-27 TOTAL				104,544	1,728

Week of July 30

Ave. No. Circ. Pumps:	<u>6</u>
Temperature Min-Max:	<u>27.3 - 28.4</u>
Salinity Min - Max:	<u>5.4 - 6.9</u>
Survival Percentage:	<u>98</u> %

[illegible]

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week of Aug. 6

Through Aug. 12, 1978

Ave. No. Circ. Pumps:	7 *
Temperature Min-Max:	<u>27.2 - 28.4</u>
Salinity Min - Max:	<u>3.2 - 4.5</u>
Survival Percentage:	<u>96</u> %

\* 7 pumps with 6 screens operating

[illegible]

LOW LEVEL WEEKLY REPORT

Week of August 13

Through August 19, 1978

Ave. No. Circ. Pumps:	<u>7 *</u>
Temperature Min-Max:	<u>28.3 - 29.9</u>
Salinity Min-Max:	<u>3.9 - 4.8</u>
Survival Percentage:	<u>97</u> %

\* 7 Pumps with 6 Screens Operating

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	60-79	2,880	0
116	Brown bullhead	Ictalurus nebulosus	60-79	1,728	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299	432	0
051	Gizzard shad	Dorosoma cepedianum	120-139	1,728	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	576	0
027	Blueback herring	Alosa aestivalis	200-299	144	0
037	Atlantic menhaden	Brevoortia tyrannus	120-139	21,168	288
103	Bay anchovy	Anchoa mitchilli	20-39	1,296	144
149	Tidewater silverside	Menidia beryllina			
050	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus	140-199	144	0
032	White perch	Morone americana	40-59	13,392	864
033	Spot	Leiostomus xanthurus	80-99	23,760	864
005	Atlantic croaker	Micropogon undulatus	100-119	1,152	0
151	Hogchoker	Trinectes maculatus			
122	Mummichog	Fundulus heteroclitus	80-99	288	0
009	Bluefish	Pomatomus saltatrix	120-139	2,448	0
031	Striped bass	Morone saxatilis	60-79	576	0
007	Weakfish	Cynoscion regalis	40-59, 60-79	432	0
003	Summer flounder	Paralichthys dentatus	200-299	144	0
R - 9/75	3.6-30	TOTAL		72,288	2,160

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 7 \*  
Temperature Min-Max: 24.3 - 27.6  
Salinity Min-Max: 4.2 - 6.3  
Survival Percentage: 92 %

\* 7 Pumps with 6 Screens operating.

Week Of August 20 Through August 26

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	60-79	1,440	0
116	Brown bullhead	Ictalurus nebulosus	60-79	576	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299,300-399	288	0
051	Gizzard shad	Dorosoma cepedianum	120-139	1,440	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	576	288
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden.	Brevoortia tyrannus	120-139	26,928	1,296
103	Bay anchovy	Anchoa mitchilli	60-79	3,024	1,152
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia	40-59	288	0
135	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	140-199	2,592	0
033	Spot	Leiostomus xanthurus	60-79	32,400	3,312
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus			
009	Bluefish	Pomatomus saltatrix	140-199	144	0
011	Harvestfish	Peprilus alepidotus	40-59	432	144
007	Weakfish	Cynoscion regalis	60-79,200-299	288	0
TOTAL				70,416	6,192



SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>7 *</u>
Temperature Min-Max:	<u>27.5 - 28.4</u>
Salinity Min-Max:	<u>6.0 - 7.0</u>
Survival Percentage:	<u>95 %</u>

Week Of Aug. 27 Through Sept. 2, 1978

\* 7 pumps with 6 screens operating

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	200-299	288	0
116	Brown bullhead	Ictalurus nebulosus	80-99	144	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	200-299, 400-499	432	0
051	Gizzard shad	Dorosoma cepedianum	120-139	2,736	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	288	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	120-139	13,392	144
103	Bay anchovy	Anchoa mitchilli	80-99	1,008	288
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia	60-79	0	288
135	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	140-199	1,296	0
033	Spot	Leiostomus xanthurus	80-99	8,496	144
005	Atlantic croaker	Micropogon undulatus	60-79	288	0
151	Hogchoker	Trinectes maculatus	140-199	144	0
011	Harvestfish	Peprilus alepidotus	60-79	2,160	576
007	Weakfish	Cynoscion regalis	60-79	0	288
204	Crevalle jack	Caranx hippos	80-99	144	0
009	Bluefish	Pomatomus saltatrix	140-199	432	0
003	Summer flounder	Paralichthys dentatus	200-299	288	0
R - 9/75		3.6-32	TOTAL	31,536	1,728

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

week of Sept. 3

Through Sept. 9, 1978

Ave. No. Circ. Pumps:	<u>7*</u>
Temperature Min-Max:	<u>26.3 - 27.4</u>
Salinity Min-Max:	<u>6.9 - 7.4</u>
Survival Percentage:	<u>96 %</u>

\* 7 Pumps with 6 Screens operating

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	500+	288	0
039	White catfish	Ictalurus catus	80-99	1,296	144
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	1,152	144
275	Threadfin shad	Dorosoma petenense		-	
026	Alewife	Alosa pseudoharengus	60-79	288	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	120-139	3,312	0
103	Bay anchovy	Anchoa mitchilli	40-59, 80-99	2,448	288
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia	60-79, 80-99	720	0
135	Pumpkinseed	Lepomis gibbosus	140-199	144	0
032	White perch	Morone americana	120-139, 140-199	432	0
033	Spot	Leiostomus xanthurus	60-79	15,552	432
005	Atlantic croaker	Micropogon undulatus	60-79	432	0
151	Hogchoker	Trinectes maculatus	100-119	288	0
196	Atlantic needlefish	Strongylura marina	200-299	288	0
148	Rough silverside	Membras martinica	60-79, 80-99	144	288
011	Harvestfish	Peprilus alepidotus	80-99	4,320	0
R - 9/75                                  3.6-33                  TOTAL				31,104	1,296

LOW LEVEL WEEKLY REPORT

Week of Sept. 10

Through Sept. 16, 1978

Ave. No. Circ. Pumps:	<u>7</u>	
Temperature Min-Max:	<u>24.0</u>	<u>26.5</u>
Salinity Min-Max:	<u>6.7</u>	<u>9.3</u>
Survival Percentage:	<u>95</u>	%

[illegible]

Week of Sept. 17

Ave. No. Circ. Pumps:	6 *
Temperature Min-Max:	<u>25.4 - 27.3</u>
Salinity Min-Max:	<u>7.0 - 8.3</u>
Survival Percentage:	<u>98</u> %

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	1,296	144
039	White catfish	Ictalurus catus	140-199	144	0
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	1,440	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus			
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	120-139	1,584	0
103	Bay anchovy	Anchoa mitchilli	40-59	144	0
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	80-99	720	0
033	Spot	Leiostomus xanthurus	80-99	22,176	576
005	Atlantic croaker	Micropogon undulatus	80-99	144	0
151	Hogchoker	Trinectes maculatus			
052	Carp	Cyprinus carpio	140-199	288	0
122	Mummichog	Fundulus heteroclitus	60-79	144	0
011	Harvestfish	Peprilus alepidotus	60-79	1,728	0
031	Striped Bass	Morone saxatilis	60-79, 80-99	432	0
R - 9/75                      3.6-35                      TOTAL				30,240	720

Ave. No. Circ. Pumps:	<u>7 *</u>
Temperature Min-Max:	<u>21.9 - 23.1</u>
Salinity Min-Max:	<u>7.4 - 9.4</u>
Survival Percentage:	<u>98</u> %

\* 7 Pumps with 5 screens operating

Through Sept. 30, 1978

[illegible]

Week of Oct. 1

Ave. No. Circ. Pumps:

Temperature Min-Max:

Salinity Min - Max:

**Survival Percentage:**

6

$$\overline{20.7} - 21.8$$

8.3 - 10.1

98 %

[illegible]

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>5</u>	
Temperature Min-Max:	<u>15.9 - 20.3</u>	
Salinity Min-Max:	<u>8.2 - 9.3</u>	
Survival Percentage:	<u>99</u>	%

Week of Oct. 8

Through Oct. 14, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	1,152	0
039	White catfish	Ictalurus catus	80-99	9,072	0
116	Brown bullhead	Ictalurus nebulosus	60-79	3,456	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	140-199	576	0
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	576	0
027	Blueback herring	Alosa aestivalis			
037	Atlantic menhaden	Brevoortia tyrannus	140-199	19,152	144
103	Bay anchovy	Anchoa mitchilli	80-99	1,152	864
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia	100-119	288	0
035	Pumpkinseed	Lepomis gibbosus			
032	White perch	Morone americana	140-199	11,664	0
033	Spot	Leiostomus xanthurus	100-119	58,032	576
005	Atlantic croaker	Micropogon undulatus	140-199	288	0
151	Hogchoker	Trinectes maculatus	80-99	2,304	0
122	Mummichog	Fundulus heteroclitus	60-79,80-99	432	0
231	Striped mullet	Mugil cephalus	200-299	288	0
011	Harvestfish	Peprilus alepidotus	80-99	2,160	0
031	Striped bass	Morone saxatilis	140-199	2,448	0
TOTAL				113,040	1,584

Ave. No. Circ. Pumps:	6*	
Temperature Min-Max:	16.4	- 17.6
Salinity Min-Max:	8.9	- 10.4
Survival Percentage:	98	%

\* 6 Pumps with 5 Screens operating

R - 9/75

3.6-39

TOTAL

129,312

3,024



LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>6 *</u>
Temperature Min-Max:	<u>15.8 - 17.9</u>
Salinity Min-Max:	<u>8.2 - 10.8</u>
Survival Percentage:	<u>95</u> %

\*6 Pumps with 5 Screens operating

Week of Oct. 22 Through Oct. 28, 1978

[illegible]

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>6</u>	*
Temperature Min-Max:	<u>14.1</u>	- 16.4
Salinity Min-Max:	<u>10.3</u>	- 11.1
Survival Percentage:	<u>93</u>	%

\* 6 pumps with 5 screens operating.

Through Nov. 4, 1978

R - 9/75

TOTAL

315,072

22,752

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>6</u>	
Temperature Min-Max:	<u>15.0</u>	<u>16.0</u>
Salinity Min-Max:	<u>10.7</u>	<u>11.4</u>
Survival Percentage:	<u>98</u>	%

Week of Nov. 5

Through Nov. 11, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	200-299	576	0
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum			
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	4,752	144
027	Blueback herring	Alosa aestivalis	60-79	37,296	576
037	Atlantic menhaden	Brevoortia tyrannus	100-119	9,072	0
103	Bay anchovy	Anchoa mitchilli	60-79	7,632	720
149	Tidewater silverside	Menidia beryllina	60-79	720	0
150	Atlantic silverside	Menidia menidia	80-99	288	0
035	Pumpkinseed	Lepomis gibbosus	60-79	2,592	0
032	White perch	Morone americana	120-139	720	0
033	Spot	Leiostomus xanthurus	100-119	6,768	0
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	80-99	1,008	0
122	Mummichog	Fundulus heteroclitus	80-99	1,440	0
148	Rough silverside	Membras martinica	60-99	144	0
011	Harvestfish	Peprilus alepidotus	80-99	144	0
R - 9/75                                  3.6-42                                  TOTAL				73,152	1,440

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>7</u>	<sup>*</sup>
Temperature Min-Max:	<u>14.7 - 15.8</u>	
Salinity Min-Max:	<u>10.4 - 11.8</u>	
Survival Percentage:	<u>93</u>	%

\* 7 pumps with 6 screens operating

Through Nov. 18, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus			
116	Brown bullhead	Ictalurus nebulosus	40-59	288	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	2,592	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	2,160	144
027	Blueback herring	Alosa aestivalis	40-59	119,232	9,360
037	Atlantic menhaden	Brevoortia tyrannus	100-119	8,352	0
103	Bay anchovy	Anchoa mitchilli	60-79	3,456	2,304
149	Tidewater silverside	Menidia beryllina	40-59, 60-79	576	0
150	Atlantic silverside	Menidia menidia			
135	Pumpkinseed	Lepomis gibbosus	60-79	1,152	0
032	White perch	Morone americana	60-79	2,592	288
033	Spot	Leiostomus xanthurus	100-119	14,256	0
005	Atlantic croaker	Micropogon undulatus	120-139	144	0
151	Hogchoker	Trinectes maculatus	60-79, 80-99	576	0
148	Rough silverside	Membras martinica	60-79	1,152	288
122	Mummichog	Fundulus heteroclitus	60-79	9,792	0
120	Sheepshead minnow	Cyprinodon variegatus	40-59	288	0
007	Weakfish	Cynoscion regalis	140-199	288	0
R - 9/75 3.6-43 TOTAL				166,896	12,384

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>6</u>	
Temperature Min-Max:	<u>13.6</u>	- <u>14.1</u>
Salinity Min-Max:	<u>8.7</u>	- <u>10.2</u>
Survival Percentage:	<u>89</u>	%

Page 10 of 11 Nov. 19

Through Nov. 25, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	60-79, 100-119	720	0
116	Brown bullhead	Ictalurus nebulosus			
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	288	288
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	9,360	576
027	Blueback herring	Alosa aestivalis	60-79	338,256	31,680
037	Atlantic menhaden	Brevoortia tyrannus	100-119	4,896	0
103	Bay anchovy	Anchoa mitchilli	40-59	12,960	13,536
149	Tidewater silverside	Menidia beryllina			
150	Atlantic silverside	Menidia menidia	60-79	864	0
135	Pumpkinseed	Lepomis gibbosus	40-59	5,184	576
032	White perch	Morone americana	60-79	2,880	0
033	Spot	Leiostomus xanthurus	100-119	2,448	0
005	Atlantic croaker	Micropogon undulatus	120-139	2,016	0
151	Hogchoker	Trinectes maculatus			
030	American shad	Alosa sapidissima	100-119	576	0
122	Mummichog	Fundulus heteroclitus	40-59	4,896	0
231	Striped mullet	Mugil cephalus	200-299	144	0
136	Bluegill	Lepomis macrochirus	140-199	288	0
031	Striped bass	Morone saxatilis	100-119	288	0
213	Silver perch	Bairdiella chrysura	120-139	144	0
144	Naked goby	Gobiosoma boscii	40-59	144	0
R - 9/75                      3.6-44                      TOTAL				386,352	46,656

LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>7*</u>	
Temperature Min-Max:	<u>10.5</u>	- <u>11.3</u>
Salinity Min-Max:	<u>9.8</u>	- <u>11.2</u>
Survival Percentage:	<u>95</u>	%

Of November 26, 1978 Through December 2, 1978

\* 7 pumps with 6 screens operating

[illegible]

Week of Dec. 3

Ave. No. Circ. Pumps:	<u>6</u>	
Temperature Min-Max:	<u>11.6</u>	<u>- 13.2</u>
Salinity Min-Max:	<u>7.3</u>	<u>- 9.7</u>
Survival Percentage:	<u>94</u>	<u>%</u>

[illegible]

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Week of Dec 10

Through Dec. 16, 1978

Ave. No. Circ. Pumps:	5	
Temperature Min-Max:	7.8	10.3
Salinity Min-Max:	5.4	7.6
Survival Percentage:	95	%

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	100-119	432	144
116	Brown bullhead	Ictalurus nebulosus	40-59	288	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	576	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79-80-99	1,440	288
027	Blueback herring	Alosa aestivalis	40-59	122,256	4,896
037	Atlantic menhaden	Brevoortia tyrannus	80-99,120-139	432	0
103	Bay anchovy	Anchoa mitchilli	40-59	144	0
149	Tidewater silverside	Menidia beryllina	60-79	1,584	288
150	Atlantic silverside	Menidia menidia	80-99	3,888	288
135	Pumpkinseed	Lepomis gibbosus	40-59	576	0
032	White perch	Morone americana	60-79	9,216	1,152
033	Spot	Leiostomus xanthurus	80-99	3,024	0
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	80-99	144	144
122	Mummichog	Fundulus heteroclitus	60-79	3,024	0
007	Weakfish	Cynoscion regalis	140-199	0	288
003	Summer flounder	Paralichthys dentatus	120-139	288	0
TOTAL				147,312	7,488



LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps:	<u>5</u>
Temperature Min-Max:	<u>6.2 - 8.5</u>
Salinity Min-Max:	<u>3.9 - 7.3</u>
Survival Percentage:	<u>97</u> %

Week Of Dec. 17 Through Dec. 23, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus			
039	White catfish	Ictalurus catus	100-119	1,728	0
116	Brown bullhead	Ictalurus nebulosus	60-79, 200-299	432	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata			
051	Gizzard shad	Dorosoma cepedianum	140-199	864	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79	5,328	720
027	Blueback herring	Alosa aestivalis	60-79	372,528	11,808
037	Atlantic menhaden	Brevoortia tyrannus	80-99	720	144
103	Bay anchovy	Anchoa mitchilli	60-79	864	0
149	Tidewater silverside	Menidia beryllina	60-79	864	0
150	Atlantic silverside	Menidia menidia	80-99	11,232	144
135	Pumpkinseed	Lepomis gibbosus	60-79	864	0
032	White perch	Morone americana	60-79	20,880	2,016
033	Spot	Leiostomus xanthurus	80-99	3,600	0
005	Atlantic croaker	Micropogon undulatus			
151	Hogchoker	Trinectes maculatus	80-99	3,024	0
030	American shad	Alosa sapidissima	140-199	144	0
122	Mummichog	Fundulus heteroclitus	60-79	2,880	0
007	Weakfish	Cynoscion regalis	100-119	288	0
372	Inshore sand lance	Ammodytes hexapetrus	140-199	288	0
R - 9/75		3.6-48	TOTAL	426,528	14,832

SURRY POWER STATION  
LOW LEVEL WEEKLY REPORT

Ave. No. Circ. Pumps: 5  
Temperature Min-Max: 4.4 - 7.0  
Salinity Min-Max: 4.0 - 6.4  
Survival Percentage: 95% %

Week of Dec. 24 Through Dec. 30, 1978

VIMS CODE	COMMON NAME	SCIENTIFIC NAME	MODAL SIZE (mm)	ALIVE	DEAD
040	Channel catfish	Ictalurus punctatus	80-99	144	0
039	White catfish	Ictalurus catus	100-119	576	0
116	Brown bullhead	Ictalurus nebulosus	60-79, 140-199	432	0
108	Golden shiner	Notemigonus crysoleucas			
110	Spottail shiner	Notropis hudsonius			
060	American eel	Anguilla rostrata	140-199	576	0
051	Gizzard shad	Dorosoma cepedianum	140-199, 300-399	720	0
275	Threadfin shad	Dorosoma petenense			
026	Alewife	Alosa pseudoharengus	60-79, 80-99	864	144
027	Blueback herring	Alosa aestivalis	60-79	135,216	8,064
037	Atlantic menhaden	Brevoortia tyrannus	120-139	720	0
103	Bay anchovy	Anchoa mitchilli			
149	Tidewater silverside	Menidia beryllina	60-79	432	720
150	Atlantic silverside	Menidia menidia	80-99	9,792	0
135	Pumpkinseed	Lepomis gibbosus	60-79	288	0
032	White perch	Morone americana	60-79	79,056	3,024
033	Spot	Leiostomus xanthurus	80-99	1,440	288
005	Atlantic croaker	Micropogon undulatus	20-39, 40-59	864	144
151	Hogchoker	Trinectes maculatus	100-119	482	0
122	Mummichog	Fundulus heteroclitus	80-99	1,008	0
R - 9/75 3.6-49 TOTAL				232,560	12,384

Appendix 3.0

RIVER BIOTA STUDIES AT THE VEPCO

SURRY NUCLEAR POWER STATION

Section I

RIVER BIOTA STUDIES AT THE VEPCO  
SURRY NUCLEAR POWER STATION

by

Robert A. Jordan  
Patricia A. Goodwin  
and  
Charles E. Sutton

## Contents

	Page No.
List of Tables	iii
List of Figures	v
Acknowledgements	vi
Introduction	1
Methods	
Station Locations	5
Sampling and Sample Analysis Methods	5
Sampling Design	12
Data Presentation and Analysis	12
Results - Plankton Studies	
Data Presentation	16
Phytoplankton Distribution Patterns	16
Zooplankton Distribution Patterns	19
Results - Benthos Study	
Data Presentation	44
Benthos Distribution Patterns	44
Results - Fouling Organisms Study	56
Conclusions	64
References	65
Appendix A	
Hydrographic Data Tables	66
Appendix B	
Biological Data Tables for the Plankton Studies	77
Appendix C	
Biological Data Tables for the Benthos Study	80

# List of Tables

<u>TEXT</u>		Page No.
Table No.	Title	
1	Plankton Sampling Station Locations	6
2	Benthos and Fouling Plate Station Locations	8
3	Summary of Biological Sampling Effort	13
4	Environmental Conditions During Plankton Sampling Runs, 1978	17
5	James River Phytoplankton ANOVA Summary 2-28-78	21
6	James River Phytoplankton ANOVA Summary 4-18-78	23
7	James River Phytoplankton ANOVA Summary 5-23-78	24
8	James River Phytoplankton ANOVA Summary 6-20-78	25
9	James River Phytoplankton ANOVA Summary 7-11-78	26
10	James River Phytoplankton ANOVA Summary 8-23-78	28
11	James River Phytoplankton ANOVA Summary 9-19-78	30
12	James River Phytoplankton ANOVA Summary 11-14-78	32
13	James River Zooplankton ANOVA Summary 2-28-78	33
14	James River Zooplankton ANOVA Summary 4-18-78	34
15	James River Zooplankton ANOVA Summary 5-23-78	35
16	James River Zooplankton ANOVA Summary 6-20-78	36
17	James River Zooplankton ANOVA Summary 7-11-78	38
18	James River Zooplankton ANOVA Summary 8-23-78	40
19	James River Zooplankton ANOVA Summary 9-19-78	42
20	James River Zooplankton ANOVA Summary 11-14-78	43
21	Seasonal and Spatial Distributions of Major Benthic Animals - 1978	46
22	Benthos Station Sediment Characteristics 6-29-78	54
23	Fouling Organisms of 1978, Station DWS	58
24	Fouling Organisms of 1978, Station CBN	60
25	Fouling Organisms of 1978, Station CBS	62

# List of Tables (cont.)

## Appendix A

Table No.	Title	Page No.
A1	James River Hydrographic Data 1978, Plankton Sampling Runs	67
A2	James River Hydrographic Data 1978, Benthos Sampling Runs	71

## Appendix B

B1	James River Chlorophyll Concentrations, 1978	78
B2	James River Phytoplankton Cell Counts, 1978	79

## Appendix C

C1	James River Benthos; January 18, 1978	81
C2	James River Benthos; April 10, 1978	83
C3	James River Benthos; June 13, 1978	85
C4	James River Benthos; July 12, 1978	87
C5	James River Benthos; August 7, 1978	89
C6	James River Benthos; October 18, 1978	91
C7	Diversity and Related Parameters for Benthic Samples; January 18, 1978	93
C8	Diversity and Related Parameters for Benthic Samples; April 10, 1978	94
C9	Diversity and Related Parameters for Benthic Samples; June 13, 1978	95
C10	Diversity and Related Parameters for Benthic Samples; July 12, 1978	96
C11	Diversity and Related Parameters for Benthic Samples; August 7, 1978	97
C12	Diversity and Related Parameters for Benthic Samples; October 18, 1978	98

## List of Figures

Figure No.	Title	Page No.
1	Location of the Surry Power Station	2
2	Surry Power Station Cooling Water Canal System Showing In-Plant Sampling Stations	4
3	Plankton Sampling Stations	7
4	Benthos and Fouling Plate Stations	9
5	Temporal Distribution of <u>Rangia cuneata</u> in the Study Area, May 1969 - Oct. 1978	55



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## Introduction

The Surry Power Station, operated by the Virginia Electric and Power Company, is located on a peninsula that extends into the James River on its south shore. The tip of the peninsula is known as Hog Point, and it is approximately 30 miles (48 km) upstream from Chesapeake Bay and 50 miles (80 km) downstream from Richmond (Fig. 1). The section of the river bordering this peninsula is the transition zone between fresh water and saline water, where the salinities encountered are near the tolerance minima for most estuarine and marine species and near the tolerance maxima for freshwater species. Therefore, the biological community consists of a few resident species that can tolerate the entire range of conditions, and of visitors from upstream and downstream that can survive until their tolerance limits are exceeded. The region is biologically significant mainly as a nursery ground and migration corridor for fish species that are harvested elsewhere. The fish populations in the vicinity of the power station have been monitored by VEPCO personnel. VIMS was engaged by VEPCO to monitor the lower trophic levels, including the phytoplankton, zooplankton, benthic macroinvertebrates and fouling organisms. The monitoring study has been in progress since May, 1969, and intensified sampling programs for phytoplankton and zooplankton were conducted in the years 1975 through 1978. The present report covers the study period January through December 1978.

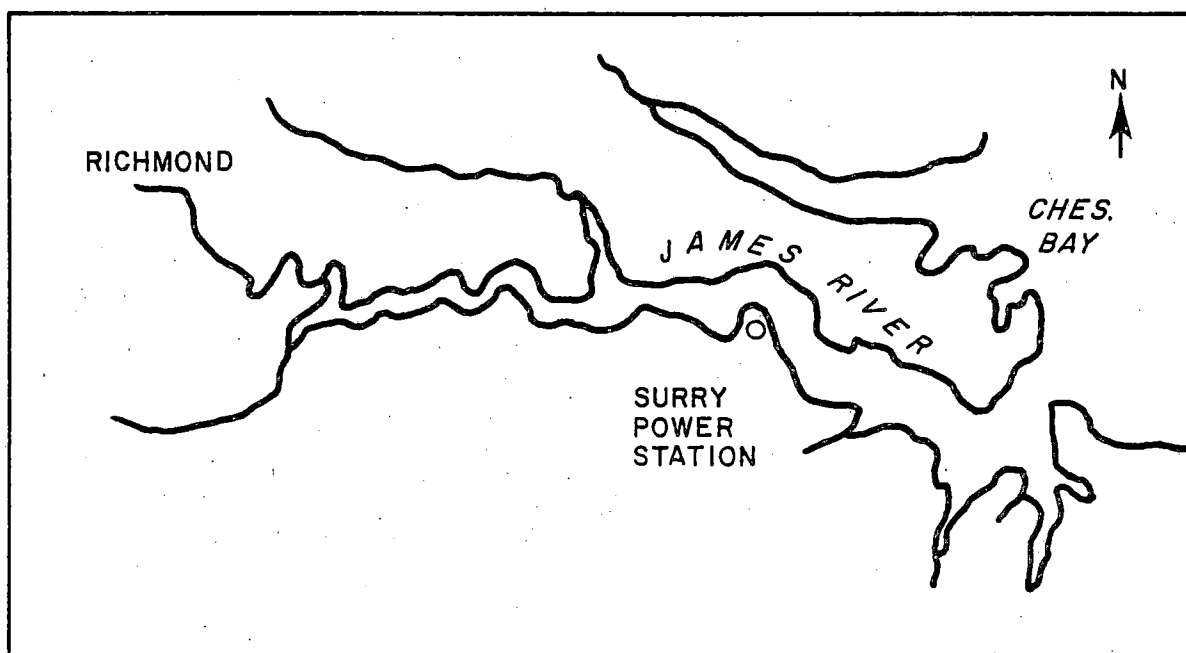
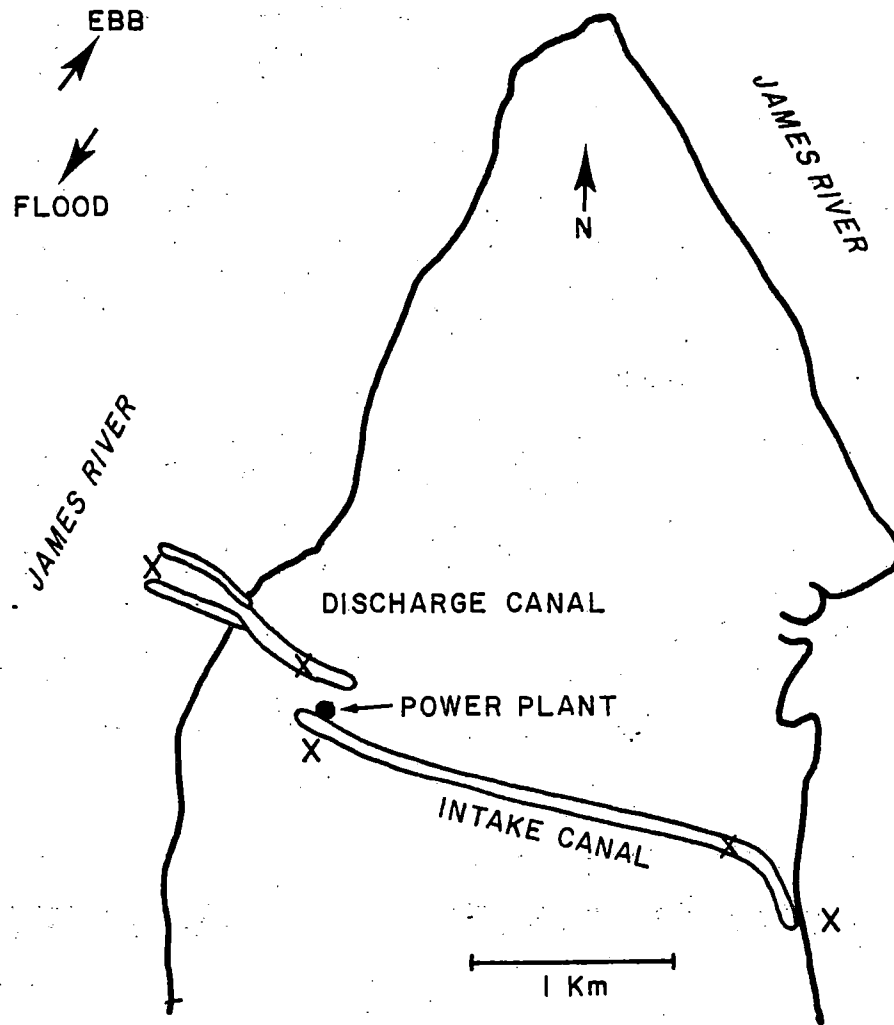


Figure 1. Location of the Surry Power Station.

The first of the two units of the power plant began commercial operation in December 1972, the second in May 1973. Together they require a cooling water flow of  $106\text{m}^3\text{sec}^{-1}$ , which is pumped from the river on the downstream side of the peninsula into a 2.74 km long elevated intake canal in which it flows by gravity for approximately 33 minutes to the power plant (Fig. 2). The water then flows by gravity through the condensers, where its temperature is raised a maximum of  $8.3^\circ\text{C}$ , into a 1 km long sea level discharge canal which has a time of passage of approximately 28 minutes. The cooling water encounters a constriction at the discharge canal mouth, which boosts its velocity to  $1.8\text{ m}\cdot\text{sec}^{-1}$ , causing turbulent mixing of the cooling water with the river water. On ebbing tides the plume hugs the shore downstream from the discharge and elongates, while on flooding tides it is oriented upstream and remains more compact.



X-SAMPLING STATIONS

Figure 2. Surry Power Station cooling water canal system showing in-plant sampling stations.

## Methods

### Station Locations

Table 1 and Figure 3 show the locations of the phytoplankton and zooplankton sampling stations used in the river study. The intake canal was sampled at its upstream and downstream ends, while the discharge canal was sampled near the highway bridge about 0.8 km upstream from the canal mouth (Fig. 2). The benthos and fouling plate stations are shown in Table 2 and Figure 4.

### Sampling and Sample Analysis Methods

Phytoplankton samples were accompanied by samples for determinations of chlorophyll a concentration, salinity, and dissolved oxygen concentration. Water temperature and Secchi Disk transparency were measured at each station. A non-metallic 2-liter Van Dorn bottle was used for sampling of phytoplankton and related parameters. Phytoplankton samples were preserved with Lugol's iodine solution, and cell counts and identifications were performed using the inverted microscope method. Chlorophyll a samples were preserved with mercuric chloride (40 mg/l), and stored in opaque bottles on ice until return to the laboratory. They were then filtered through glass fiber filters, which were subsequently ground in 90% acetone to extract the chlorophyll a. The chlorophyll concentration in the extract was determined using a Turner Fluorometer, model 111.

Table 1

## Plankton Sampling Station Locations

Station	Depth (m)	Location
DWS	2	Adjacent to tower (QK Fl Lt "A")
Intake	1	Outside intake forebay - zooplankton sampling
	8	Inside intake forebay - phytoplankton sampling
HPS	5	Adjacent to tower (QK Fl Lt "C")
HPW3	2.5	Adjacent to tower (QK Fl Lt "D")
HPW2	3	Adjacent to tower (QK Fl Lt "E")
HPW1	1	Off west shore of Hog Point, midway between HPS and discharge
Discharge	2.5	Discharge canal mouth
CBE	1	Off west shore of Gravel Neck, south of discharge
CBC	3	Midway between discharge and range markers near Cobham Wharf
JI	8	Adjacent to tower (QK Fl Lt "G")
Intake Canal Uptake and Downstream		Within Surry power plant intake canal (sampled by VEPCO personnel)
Discharge Canal		Within Surry power plant discharge canal (sampled by VEPCO personnel)

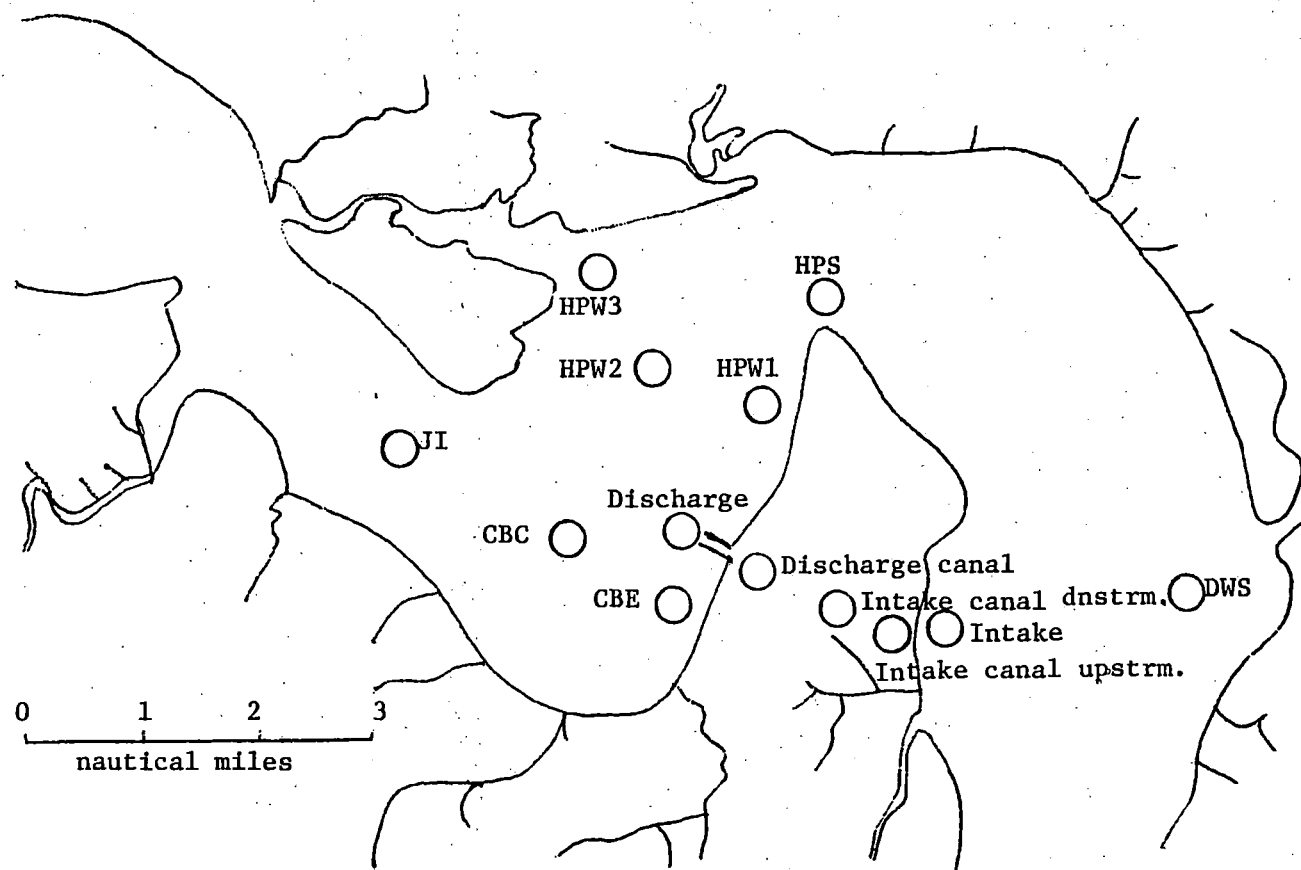


Figure 3. Plankton sampling stations



Table 2

## Benthos and Fouling Plate Station Locations

<u>Station</u>	<u>Depth (m)</u>	<u>Location</u>
1	1.5	Off tower (QK Fl 38 ft.) near Cobham Wharf
2	2.5	Cobham Bay, off Chestnut Bluffs
3	1	Cobham Bay, between mouths of College Run and Lower Chippokes Creek
4	3	Center of Cobham Bay
5	3	Tower (QK Fl Lt "E")
6	1	In Thorofare off marker tower R "4"
7	1	Cobham Bay, off Gravel Neck
8	4	Tower (QK Fl Lt "F")
9	1	West of Hog Point
10	4	Between station 9 and black buoy "45"
11	5	Tower (QK Fl Lt "C")
12	.5	Off mouth of College Creek
13	1	East of Hog Point, on line with black and white buoy "J29"
14	6	Black and white buoy "J35"
15	1	Off power plant intake
16	2	Tower (QK Fl Lt "A")
DWS	2	Tower (QK Fl Lt "A")
CBN	2.5	Tower (QK Fl Lt "D")
CBS	3	Tower (QK Fl Lt "F")

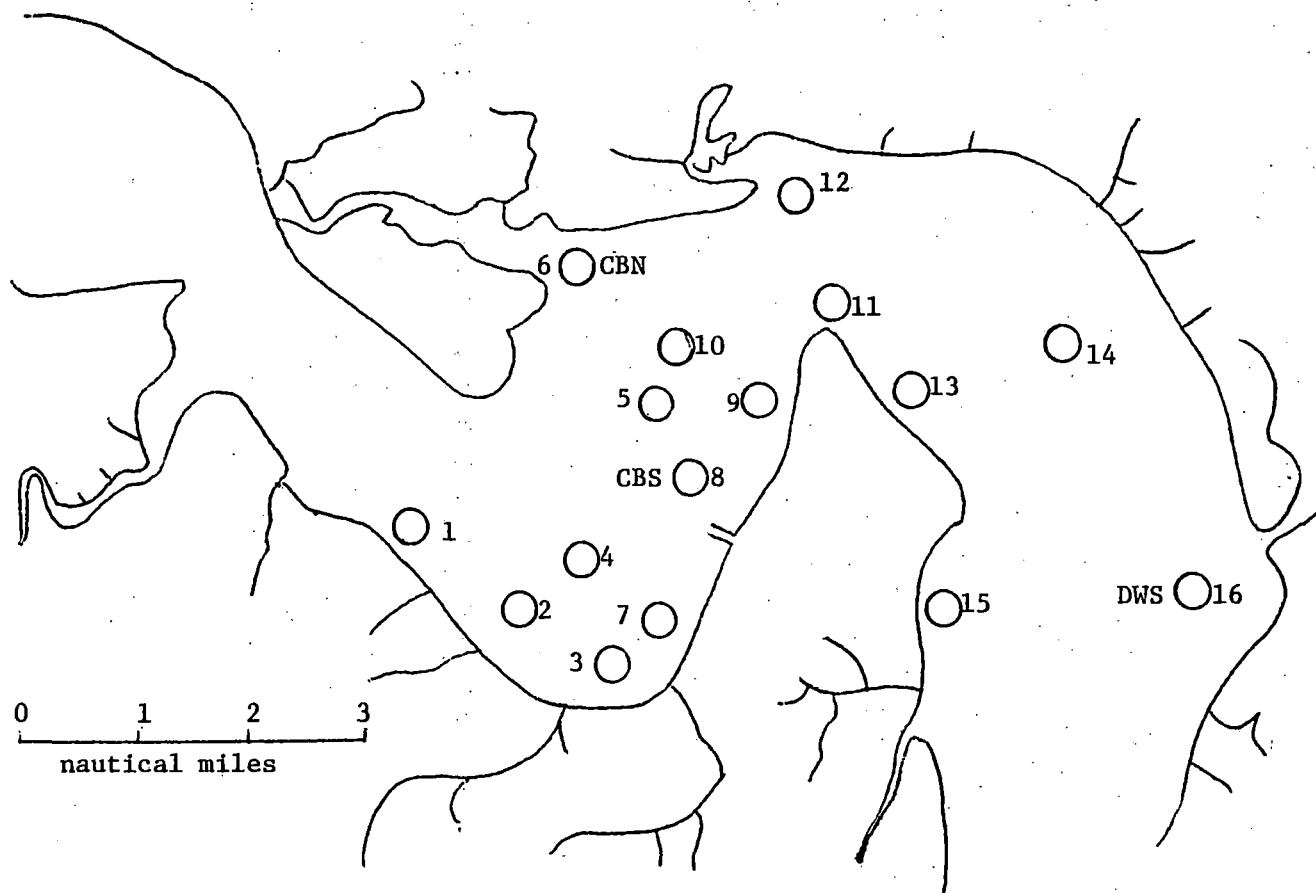


Figure 4. Benthos and fouling plate stations.

Zooplankton samples were taken with a 12.5 cm diameter Clarke-Bumpus quantitative sampler, equipped with a No. 20 (76 $\mu$  pore size) net. Tow duration ranged from one minute to five minutes, depending on the turbidity conditions encountered. Samples were preserved with 5% buffered formalin, and counts and identifications were made using an Olympus dissecting microscope. Measurements of water temperature, salinity, dissolved oxygen, Secchi Disk transparency, and water depth accompanied each zooplankton tow.

Benthos was sampled with a .05 m<sup>2</sup> Ponar grab. The samples were sieved through 1.0 mm and 0.5 mm mesh screens, and the organisms were preserved in a formalin solution containing the stain Phloxine B. Counts and identifications were made under a dissecting microscope.

Fouling organisms were collected on 125 x 75 mm asbestos boards suspended in the river. Two pairs of horizontal and vertical fouling plates were suspended from a VEPCO instrument tower located at each station, one pair being replaced bi-monthly, the other pair yearly. The attached organisms were preserved by freezing, and were counted and identified under a dissecting microscope.

Temperature measurements were performed using a Hydrolab model RT-125 research thermometer equipped with a model L5 A50 thermistor probe. Salinity was measured on a Beckman model RS-7B salinometer. Dissolved oxygen concentrations were determined by the azide modification of the Winkler technique.

On June 29 a sediment sample was taken at each benthos sampling station for determination of particle size distribution and organic matter content. This was done in order to provide an updated basis for retaining or revising the station groupings employed in depicting the spatial distributions of the benthic organisms in relation to sediment type. The samples were taken with a K.B.<sup>®</sup> type heavy duty corer with a 20 inch (50.8 cm) long, 2 inch (5.08 cm) inside diameter core tube (Wildco Model 2400). The top 15 cm segment of each core was extruded in the field into a plastic bag and stored on ice. In the laboratory the contents of each bag were homogenized and approximately 10 g of the wet homogenate were weighed into a tared crucible for determination of organic content by loss on ignition. Ignition was performed for one hour at 500°C. A second aliquot of each wet homogenate was screened through a 63 $\mu$  pore size sieve for separation into a sand fraction ( $>63\mu$ ) and a silt-clay fraction ( $<63\mu$ ). The relative oven dry weights (105°C) of these fractions were obtained. A third aliquot was wet sieved in the same manner. The sand fraction of this aliquot was dried (125°C) and its particle size distribution was obtained using the VIMS Rapid Sand Analyzer (Zeigler et al., 1960).

The particle size distribution of the fine particle fraction was obtained using a Coulter Counter model TA<sup>®</sup> (Coulter Electronics, Inc.). The fine and coarse size distributions were combined graphically, and from the graphs the sand, silt, and clay percentages for each benthos station were obtained.

### Sampling Design

The sampling dates, stations, and biological parameters sampled are shown in Table 3. Phytoplankton and zooplankton samples for investigation of entrainment effects were taken in the intake and discharge canals by Surry Power Plant personnel. In all, eight complete plankton runs, including replicated sampling of surface phytoplankton, chlorophyll a, and zooplankton at ten river stations and of phytoplankton and zooplankton at three canal stations, were performed during the study year.

Benthos sampling was performed quarterly during the winter, spring, and fall, and monthly during the summer. Two samples were taken per station per sampling run.

All of the fouling plates were recovered on schedule in 1978. The annual plates were taken along with the bimonthly plates on June 29.

### Data Presentation and Analysis

The raw data for each section of the study are presented in an appendix. Most of the plankton data have been subjected to an analysis of variance, followed by Student-Newman-Keuls' test (Steel and Torrie, 1960) to identify significant differences among sampling stations. Log or square root transformations were performed when necessary to normalize the data prior to analysis. Within the body of the report, data summaries are presented, which include parameter means and which depict differences that are significant at at least the .05 level.

Table 3

Summary of Biological Sampling Effort; sampling dates, stations sampled,  
and types of samples taken (Ph = phytoplankton, C = chlorophyll a, Z = zooplankton,  
B = benthos, F = fouling organisms)

Plankton Stations	Date (1978)							
	2 - 28	4 - 18	5 - 23	6 - 20	7 - 11	8 - 23	9 - 19	11 - 14
DWS	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
Intake	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
HPS	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
HPW3	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
HPW2	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
HPW1	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
Discharge	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
CBE	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
CBC	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
JI	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z	Ph,C,Z
Intake Canal Upstrm.	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z
Intake Canal Dnstrm.	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z
Discharge canal	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z	Ph,Z

Table 3 (continued)

Benthos Stations	Date (1978)					
	1 - 18	4 - 10	6 - 13	7 - 12	8 - 7	10 - 18
1	B	B	B	B	B	B
2	B	B	B	B	B	B
3	B	B	B	B	B	B
4	B	B	B	B	B	B
5	B	B	B	B	B	B
6	B	B	B	B	B	B
7	B	B	B	B	B	B
8	B	B	B	B	B	B
9	B	B	B	B	B	B
10	B	B	B	B	B	B
11	B	B	B	B	B	B
12	B	B	B	B	B	B
13	B	B	B	B	B	B
14	B	B	B	B	B	B
15	B	B	B	B	B	B
16	B	B	B	B	B	B

Fouling Plate Stations	Date (1978)					
	2 - 28	5 - 3	6 - 29	8 - 23	10 - 18	12 - 29
DWS	F	F	F	F	F	F
CBN	F	F	F	F	F	F
CBS	F	F	F	F	F	F

The benthos data presented in this report include only the organisms recovered on the 1.0 mm mesh screen, which is the sieving device that was used in all preceding years of the study. The data for the 0.5 mm sieve organisms will be included in a subsequent compilation of the Surry study data.



## Results - Plankton Studies

### Data Presentation

The hydrographic data for the plankton sampling runs are presented in Appendix Table A1. The raw biological data are in appendix B, Table B1 (chlorophyll a) and Table B2 (total phytoplankton cell counts). The river tidal and water temperature conditions on the plankton sampling dates are summarized in Table 4, while the phytoplankton and zooplankton analysis of variance results are presented in Tables 5-20.

### Phytoplankton Distribution Patterns

On the phytoplankton ANOVA summary tables (Tables 5-12) station means for chlorophyll a, total cell counts, and individual species cell counts are listed in ascending order. Means not sharing an underline are significantly different at the .05 level according to Student-Newman-Keuls' test.

Many of the significant differences detected by the variance analyses could be attributed to longitudinal gradients of phytoplankton abundance in the segment of the James River included in the study. Species that were most abundant toward the downstream limit of the study area included Skeletonema costatum, Chaetoceros sp., and Asterionella japonica in February; Skeletonema costatum and Rhizosolenia minima in June; Cyclotella meneghiniana in July; and Skeletonema costatum in August. The opposite longitudinal pattern was exhibited by Melosira subsalsa in May, Melosira sp. in July, and Skeletonema costatum in September.

Table 4

## Environmental Conditions During Plankton Sampling Runs, 1978

Date	Tide	Surface Salinity Range (°/oo)	Discharge Temp. minus Intake Temp. (°C)	Discharge Surface Temp. (°C)	No. of Power Plant Units Operating	Stations Affected by Plume
Feb. 28	LWS-Flood	.37- 2.89	8.8	12.70	2	CBE,CBC,HPW1,HPS
Apr. 18	Ebb	.08- 2.64	7.0	21.20	2	HPW1,HPS, HPW2
May 23	Flood	.07- .34	6.4	28.10	1	CBE,CBC,HPW1
June 20	Flood	.73- 3.35	5.9	32.35	1	CBE,HPW1
July 11	Flood	1.24- 5.29	5.4	32.20	1	CBE,HPW1,HPS
Aug. 23	Flood	1.24- 6.21	9.0	37.50	2	CBE,CBC,HPW1,HPS
Sept. 19	Flood	3.95- 8.47	8.6	34.70	2	CBE,CBC,HPW1
Nov. 14	Flood	6.99-11.33	8.1	23.30	2	CBE,CBC,HPW1

In addition to longitudinal gradients, there were also distributions showing maximum abundance at one or two individual stations in the study area. For example, Katodinium rotundatum and the 16  $\mu$  Chroomonas sp. were most numerous at DWS in February, the Cyclotella meneghiniana population density was highest at DWS in June, and the 2  $\mu$  flagellate was most abundant at CBE in July.

In the cooler months of the year, the Surry Power Station affected the phytoplankton community in the vicinity of the discharge mainly by contributing organisms transported from the intake area. This pattern was apparent for Skeletonema costatum in February, Nitzschia vermicularis in April, and Amphiprora sp. in November. This type of transport also occurred in the summer, for Gyrosigma sp. in August and September. In these two months there were also species that declined in abundance or actually disappeared from the cooling water as it flowed from the intake to the discharge canal mouth. The two species of Chroomonas showed this pattern in both months; Katodinium rotundatum and the 3  $\mu$  flagellate showed losses in September. No similar declines were exhibited by these species in November.

One organism, that occurred in the study for the first time in the 1978 samples, appeared to originate in the embayment at the upper end of the intake canal. It was observed in the August and September canal samples, and is designated as a 2.5  $\mu$  flagellate in Tables 10 and 11. It was probably a zoospore or gamete released by algae attached to the intake canal walls.

### Zooplankton Distribution Patterns

The zooplankton ANOVA results appear in Tables 13-20. As with the phytoplankton results, population density means are listed in ascending order, and means that are not significantly different (.05 level) are joined by underlines.

In most of the sampling months, but particularly in September and November, there were species that were distributed uniformly, according to the statistical test, throughout the study area. Most of the distributions that were not uniform involved longitudinal gradients of population densities within the study area. These included higher population densities toward the upstream limit of the study area: Bosmina sp. in February; Eurytemora sp., Acartia sp., cyclopoid copepods, and Bosmina sp. in April; copepod nauplii, rotifers, and Bosmina sp. in May; copepod nauplii, cyclopoid copepods, Bosmina sp., and other cladocerans in June; Bosmina sp. in July; and cyclopoid copepods, Bosmina sp., and other cladocerans in August. Distributions in which higher population densities appeared at the downstream-most stations were observed for copepod nauplii and barnacle nauplii in April, barnacle nauplii and polychaete larvae in May, and barnacle nauplii in August. In addition, two atypical longitudinal distributions appeared: rotifers in June were more abundant at the upstream-most and downstream-most stations than at intermediate stations, and copepod nauplii in February, and copepod nauplii and polychaete larvae in July were most abundant at intermediate stations.

The power plant influenced the composition of the zooplankton on the discharge side of Hog Point mainly by introducing water richer or poorer in a certain species than the receiving water. Organisms that were transported through the cooling water canal system from an area of high population density at the power plant intake into an area of lower population density near the discharge included barnacle nauplii in July and polychaete larvae in February, April, June, and August. There was an apparent production of barnacle nauplii in the canal system in May, June, and November. In two of the sampling months there was an apparent reduction in numbers of a particular species in the water passing through the canals: copepod nauplii in August and Acartia sp. in September. In areas of the river beyond the readily indentifiable cooling water plume, however, these power plant effects became rapidly obscured by the natural upstream-downstream variations in zooplankton population densities that are typical of the study area.

Table 5

## James River Phytoplankton ANOVA Summary 2-28-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{ml}^{-1}$ )	CBE 1.5	HPW1 1.7	CBC 1.7	JI 1.8	HPS 1.8	HPW3 2.0	HPW2 2.1	DWS 2.3	INT 2.3	Dis. 3.0			
Total cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 127	HPW3 157	JI 192	CBC 235	HPW1 352	CBE 356	HPS 397	DWS 474	INT 721	ICU 871	DC 1061	ICD 1166	Dis. 1296
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis. 7	CBC 9	HPW2 10	HPS 11	DWS 12	HPW3 15	CBE 15	INT 16	JI 18	HPW1 22	DC 23	ICD 24	ICU 24
16 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 1	JI 2	ICU 2	HPW3 4	ICD 4	DC 4	CBE 5	HPS 6	INT 7	Dis. 8	CBC 8	HPW1 9	DWS 28
<u>Katodinium rotundatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3 0	HPW2 0	JI 1	HPS 7	DC 7	CBC 8	HPW1 11	Dis. 11	ICU 12	INT 13	CBE 14	ICD 14	DWS 47
<u>Cyclotella</u> sp.1( $\text{cells}\cdot\text{ml}^{-1}$ )	CBE 0	JI 0	ICD 1	CBC 2	HPW1 3	DWS 4	HPS 5	ICU 5	DC 5	INT 6	HPW3 9	HPW2 11	Dis. 11
<u>Cyclotella meneghiniana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 0	HPW3 1	DWS 2	HPS 2	Dis. 2	INT 3	HPW1 3	CBE 4	CBC 8	DC 8	ICD 9	ICU 10	JI 10
<u>Cyclotella</u> sp.2( $\text{cells}\cdot\text{ml}^{-1}$ )	ICU 4	ICD 5	DWS 6	INT 8	DC 8	HPS 9	CBE 11	CBC 11	Dis. 12	HPW1 14	HPW3 15	JI 15	HPW2 28
<u>Skeletonema costatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 44	HPW3 80	JI 86	CBC 121	HPW1 192	CBE 225	HPS 296	INT 507	ICU 610	DWS 703	DC 791	ICD 954	Dis. 1051
<u>Chaetoceros</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 2	HPW3 5	JI 5	HPS 20	CBC 21	CBE 34	HPW1 41	INT 76	Dis. 89	ICU 105	ICD 109	DC 119	DWS 137

Table 5 (cont.)

## James River Phytoplankton ANOVA Summary 2-28-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

<u>Asterionella japonica</u> (cells·ml <sup>-1</sup> )	HPW3 0	HPW2 0	JI 0	CBC <u>3</u>	CBE 4	DWS 6	HPS 6	DC 7	HPW1 8	INT 14	ICD 19	ICU 25	Dis. 36
<u>Ankistrodesmus</u> sp. (cells·ml <sup>-1</sup> )	HPW3 0	INT <u>1</u>	HPW1 <u>1</u>	Dis. <u>1</u>	DC <u>1</u>	HPW2 3	ICU 4	HPS 5	CBC 5	CBE 6	JI 6	ICD 6	DWS <u>8</u>
<u>Cryptomonas</u> sp. (cells·ml <sup>-1</sup> )	DWS 0	CBE 0	HPW3 <u>1</u>	HPW1 <u>1</u>	HPS 2	INT 2	ICU 2	CBC 3	ICD 3	Dis. 3	DC 5	JI 6	HPW2 <u>11</u>

Table 6

## James River Phytoplankton ANOVA Summary 4-18-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{ml}^{-1}$ )	HPW1 1.2	DWS 1.2	CBE 1.4	HPW3 1.5	HPS 1.8	CBC 1.8	JI 2.0	HPW2 2.2	Dis. 2.6	INT 2.6			
Total Cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 698	HPW1 698	DC 736	ICD 776	CBE 828	DWS 912	ICU 1189	CBC 1190	JI 1280	INT 1318	HPS 1383	HPW3 1383	Dis. 1576
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis. 26	CBC 26	JI 26	HPW1 39	CBE 39	HPS 52	HPW2 64	DWS 78	DC 78	ICD 78	IC U 90	HPW3 90	INT 232
16 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 0	CBE 0	HPW3 13	HPW1 13	CBC 13	JI 13	Dis. 26	DWS 32	DC 52	HPS 90	ICD 90	ICU 104	INT 129
5 $\mu$ Cryptophyte ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW1 52	DC 52	INT 104	HPW2 116	ICU 130	ICD 130	DWS 148	JI 181	Dis. 232	CBE 246	CBC 258	HPS 284	HPW3 375
<u>Melosira subsalsa</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI 26	HPS 52	HPW2 64	HPW1 64	CBE 64	HPW3 90	DWS 116	ICU 116	CBC 130	INT 155	ICD 168	DC 207	Dis. 232
<u>Cyclotella meneghiniana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	INT 0	CBE 0	DWS 26	Dis. 52	HPS 64	DC 78	ICD 90	ICU 103	HPW2 129	HPW1 129	HPW3 142	CBC 206	JI 284
<u>Nitzschia kützingiana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	DWS 39	ICU 78	ICD 78	DC 90	CBE 103	INT 104	HPW1 129	HPW2 130	Dis. 130	HPW3 181	HPS 207	JI 298	CBC 336
<u>Nitzschia vermicularis</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2 0	HPW3 0	CBE 0	CBC 0	JI 0	DWS .5	DC 4	HPW1 6	HPS 7	ICU 7	INT 11	ICD 11	Dis. 17
<u>Ankistrodesmus</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	CBE 13	CBC 13	ICD 13	DC 13	HPW2 39	INT 52	JI 65	HPS 78	HPW3 90	DWS 91	ICU 155	HPW1 156	Dis. 232
3 $\mu$ Flagellate ( $\text{cells}\cdot\text{ml}^{-1}$ )	DWS 13	ICD 13	DC 26	HPS 39	HPW1 39	HPW2 52	INT 78	ICU 78	HPW3 90	CBC 90	CBE 104	JI 129	Dis. 207



Table 7

## James River Phytoplankton ANOVA Summary 5-23-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{l}^{-1}$ )													
	CBE	HPW1	Dis.	INT	JI	CBC	DWS	HPS	HPW2	HPW3			
	5.9	6.9	7.0	7.2	8.5	8.8	10.2	10.4	13.0	15.7			
Total cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC	Dis.	ICD	ICU	HPW1	HPS	INT	CBE	DWS	CBC	HPW2	JI	HPW3
	3671	3891	4292	4589	4602	4654	4977	5158	5868	6050	7962	8260	15,175
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPS	DC	CBC	ICU	DWS	ICD	HPW2	INT	Dis.	JI	HPW1	HPW3	CBE
	110	181	207	207	233	298	310	362	375	400	414	530	568
20 $\mu$ <u>Cryptomonas</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC	HPW3	ICU	DWS	Dis.	HPW2	INT	ICD	HPS	CBE	JI	HPW1	CBC
	0	13	13	26	26	52	78	78	78	104	104	116	130
5 $\mu$ <u>Cryptophyte</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis.	DC	HPW3	ICU	CBE	JI	ICD	HPS	DWS	INT	HPW2	CBC	HPW1
	18	18	36	55	73	74	91	91	110	128	128	128	146
<u>Melosira subsalsa</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis.	ICU	INT	DC	ICD	HPW1	HPS	CBE	DWS	CBC	HPW2	JI	HPW3
	1616	1628	1732	1771	2055	2172	2508	2702	3322	3916	5688	6024	12,604
<u>Nitzschia kützingiana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI	Dis.	CBE	CBC	HPW3	DC	HPW1	DWS	HPS	HPW2	ICD	INT	ICU
	543	608	620	698	736	788	866	918	918	995	1124	1512	1797
<u>Cyclotella meneghiniana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	ICU	ICD	HPS	DC	JI	INT	HPW2	Dis.	CBC	CBE	HPW3	HPW1	DWS
	272	362	388	400	517	543	633	686	698	711	724	736	853

Table 8

## James River Phytoplankton ANOVA Summary 6-20-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{l}^{-1}$ )				HPW2	Dis.	CBE	HPW1	CBC	HPW3	DWS	JI	INT	HPS
				2.8	3.7	3.8	3.8	3.8	4.1	5.1	5.4	6.2	7.0
Total cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPS	DC	ICD	Dis.	CBC	HPW3	HPW2	HPW1	DWS	CBE	ICU	INT	JI
	1332	1344	1460	1784	1848	1848	1862	2443	2921	3116	3180	3244	3374
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC	ICD	HPS	Dis.	INT	HPW2	ICU	HPW3	DWS	CBC	HPW1	CBE	JI
	181	194	246	259	375	466	478	492	517	672	802	1034	1318
<u>Melosira subsalsa</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	ICD	Dis.	HPS	CBC	INT	HPW1	HPW2	DWS	ICU	DC	HPW3	CBE	JI
	0	52	104	142	142	155	156	156	194	194	349	362	362
<u>Skeletonema costatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3	CBC	JI	CBE	DWS	DC	ICD	HPS	HPW1	Dis.	HPW2	INT	ICU
	0	0	0	13	52	65	90	104	130	246	246	426	568
<u>Cyclotella meneghiniana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPS	CBC	Dis.	DC	ICD	HPW2	HPW3	HPW1	INT	CBE	ICU	JI	DWS
	194	323	388	426	517	543	582	595	698	840	892	995	1577
<u>Nitzschia kützingiana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC	DWS	JI	HPW1	CBE	ICD	Dis.	CBC	HPW2	ICU	HPW3	HPS	INT
	64	129	142	155	168	194	220	232	246	258	272	298	414
<u>Rhizosolenia minima</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI	HPW3	CBC	HPW2	HPW1	DWS	DC	CBE	HPS	Dis.	ICD	ICU	INT
	0	13	13	90	194	130	155	181	181	388	414	478	556
3 $\mu$ Flagellate ( $\text{cells}\cdot\text{ml}^{-1}$ )	DWS	HPS	HPW3	HPW2	Dis.	CBE	ICU	JI	ICD	CBC	DC	INT	HPW1
	0	13	13	13	26	26	26	39	39	52	52	78	90

Table 9

## James River Phytoplankton ANOVA Summary 7-11-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{l}^{-1}$ )	Dis. 5.6	JI 6.3	CBE 6.8	CBC 7.6	HPS 7.8	HPW1 8.0	HPW2 8.6	Int. 9.0	HPW3 11.0	DWS 11.3			
Total cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	ICD 4373	DC 5512	Dis. 5746	CBC 5980	JI 6074	CBE 6463	ICU 6968	HPW2 7522	HPW1 7779	HPS 7909	Int. 8314	HPW3 9311	DWS 10705
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	Int. 233	DC 388	ICU 388	Dis. 388	HPW3 414	HPS 440	HPW2 492	ICD 517	HPW1 646	CBE 698	DWS 698	JI 750	CBC 776
16 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI 0	CBC 52	HPW3 78	Int. 78	HPS 129	Dis. 129	ICD 155	DC 181	ICU 181	HPW2 181	DWS 258	HPW1 272	CBE 284
<u>Pyramimonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis. 0	ICD 0	DC 0	CBE 26	CBC 103	HPW3 129	Int. 155	JI 181	DWS 207	ICU 207	HPW2 232	HPW1 284	HPS 388
<u>Skeletonema</u> <u>costatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	CBE 268	DC 600	JI 634	CBC 857	ICD 926	HPW1 1053	Dis. 1170	HPS 1332	HPW2 1602	ICU 1926	Int. 2808	DWS 2872	HPW3 2958
<u>Cyclotella</u> <u>meneghiniana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3 542	ICD 543	JI 568	Dis. 594	HPS 672	DC 698	CBC 698	HPW1 750	CBE 904	HPW2 905	ICU 1215	DWS 1293	Int. 1422
<u>Melosira</u> <u>subsalsa</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	Int. 0	HPW2 0	Dis. 0	ICU 0	ICD 0	DC 0	CBC 1008	DWS 1086	HPS 1163	CBE 1525	HPW1 1551	JI 1732	HPW3 2301
<u>Melosira</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	DWS 0	Int. 0	HPW2 0	Dis. 0	ICU 0	ICD 0	DC 0	CBE 58	HPW1 108	HPS 155	CBC 394	JI 502	HPW3 524

Table 9 (cont.)

## James River Phytoplankton ANOVA Summary 7-11-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

<u>Rhizosolenia minima</u> (cells·ml <sup>-1</sup> )	JI 129	CBC 284	HPW2 310	Dis. 465	HPW3 465	DC <u>646</u>	ICD 647	Int. 698	ICU 724	CBE 1112	DWS 1215	HPS 1318	HPW1 <u>1576</u>
<u>Amphiprora</u> sp. (cells·ml <sup>-1</sup> )	CBE 0	JI 0	DWS <u>2</u>	HPW2 4	HPS 4	ICU 5	Dis. 5	CBC 6	DC 7	ICD 8	Int. 10	HPW1 12	HPW3 <u>13</u>
3 $\mu$ Flagellate (cells·ml <sup>-1</sup> )	HPW1 0	CBE 0	CBC 0	HPW3 <u>26</u>	DWS <u>52</u>	HPW2 <u>52</u>	ICD 78	JI 130	HPS 155	ICU 1603	Int. 1784	DC 2172	Dis. <u>2172</u>
2 $\mu$ Flagellate (cells·ml <sup>-1</sup> )	ICD 130	Int. 155	HPW1 194	ICU 258	DC 259	HPW3 310	DWS 336	Dis. 362	JI 388	CBC 543	HPW2 543	HPS 543	CBE <u>956</u>

Table 10

## James River Phytoplankton ANOVA Summary 8-23-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{l}^{-1}$ )	Dis.	CBC	DWS	JI	HPW1	HPW3	INT	HPW2	CBE	HPS			
	3.8	3.8	4.3	5.5	5.9	5.9	6.0	6.1	6.4	6.5			
Total cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis.	DWS	DC	ICD	ICU	JI	INT	HPS	HPW3	HPW1	CBC	CBE	HPW2
	2212	2496	2516	2994	3064	4251	4436	4666	4674	5490	6070	6218	6702
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis.	DC	ICU	DWS	HPS	HPW1	INT	ICD	JI	HPW2	CBE	HPW3	CBC
	0	13	65	116	116	155	168	194	220	258	272	298	646
16 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	Dis.	HPW3	HPW2	CBC	DC	JI	HPS	HPW1	CBE	ICD	DWS	ICU	INT
	13	26	26	26	39	52	64	65	78	90	129	168	246
<u>Pyramimonus</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI	CBC	CBE	DC	HPW2	HPW1	Dis.	HPS	HPW3	DWS	ICD	ICU	INT
	0	39	64	90	103	103	116	142	168	181	194	582	594
<u>Skeletonema costatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	CBE	CBC	JI	DWS	HPW2	ICD	Dis.	DC	HPW1	HPW3	INT	HPS	ICU
	307	476	593	691	724	770	804	1016	1066	1158	1192	1292	1374
<u>Gyrosigma</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW2	CBE	JI	CBC	HPW1	HPS	HPW3	Dis.	DC	DWS	ICD	ICU	INT
	0	.50	.50	2	3	4	4	4	5	6	9	12	17
<u>Cyclotella meneghiniana</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC	HPW3	ICD	DWS	INT	HPW2	Dis.	ICU	HPS	JI	CBC	HPW1	CBE
	13	26	52	104	104	104	116	130	207	220	272	478	504
<u>Nitzschia</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	DWS	JI	HPS	Dis.	ICU	DC	ICD	HPW2	HPW1	INT	CBC	HPW3	CBE
	26	26	39	78	78	78	78	103	116	142	142	156	168
2 $\mu$ Flagellate ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3	JI	DC	CBC	ICD	DWS	HPS	Dis.	HPW2	HPW1	INT	CBE	ICU
	0	0	52	64	116	116	155	155	181	272	284	349	828

Table 10 (continued)

## James River Phytoplankton ANOVA Summary 8-23-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

3 $\mu$ Flagellate (cells $\cdot$ ml $^{-1}$ )	Jl	DWS	CBE	CBC	HPW1	HPW2	HPS	HPW3	ICU	Dis.	INT	DC	ICD
	0	<u>13</u>	<u>13</u>	<u>13</u>	<u>39</u>	<u>90</u>	<u>207</u>	<u>246</u>	<u>272</u>	<u>710</u>	<u>711</u>	<u>866</u>	<u>878</u>
12 $\mu$ Flagellate (cells $\cdot$ ml $^{-1}$ )	DC	DWS	Dis.	ICU	INT	ICD	Jl	CBC	CBE	HPW1	HPW2	HPS	HPW3
	0	<u>13</u>	<u>13</u>	<u>39</u>	<u>116</u>	<u>116</u>	<u>220</u>	<u>310</u>	<u>400</u>	<u>492</u>	<u>556</u>	<u>569</u>	<u>634</u>
2.5 $\mu$ Flagellate (cells $\cdot$ ml $^{-1}$ )	DWS	INT	HPS	HPW3	HPW2	HPW1	Dis.	CBE	CBC	Jl	DC	ICD	ICU
	0	0	0	0	0	0	0	0	0	0	<u>324</u>	<u>762</u>	<u>15,214</u>

Table 11

## James River Phytoplankton ANOVA Summary 9-19-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{l}^{-1}$ )	DWS 1.7	HPW2 1.8	HPW1 2.0	CBE 2.5	CBC 2.6	HPS 2.6	JI 2.8	Int. 3.2	Dis. 3.3	HPW3 3.7			
Total cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC 880	HPS 1270	HPW2 1286	CBC 1378	Dis. 1524	ICD 1567	DWS 1774	CBE 1883	HPW1 1894	JI 2034	HPW3 2143	ICU 2804	Int. 3643
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	CBC 103	JI 142	DC 155	HPS 155	HPW3 155	HPW2 181	Dis. 232	ICD 258	HPW1 336	DWS 356	ICU 388	CBE 414	Int. 853
16 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	ICD 0	DC 0	Dis. 0	HPS 13	ICU 26	CBC 39	HPW3 65	HPW2 78	CBE 90	JI 104	HPW1 129	Int. 181	DWS 181
5 $\mu$ Cryptophyte ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI 26	CBE 39	DC 52	HPS 52	HPW1 52	CBC 90	ICD 104	HPW3 116	HPW2 129	Dis. 129	ICU 129	DWS 181	Int. 517
<u>Pyramimonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC 0	HPS 26	CBC 26	ICD 78	Dis. 78	JI 90	HPW2 116	HPW1 130	HPW3 130	DWS 136	Int. 155	ICU 284	CBE 336
<u>Katodinium rotundatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	ICU 0	DC 26	ICD 26	Dis. 26	HPS 39	CBC 52	HPW2 103	HPW1 116	DWS 207	CBE 272	JI 336	Int. 362	HPW3 375
<u>Skeletonema costatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	DC 11	ICD 30	ICU 39	Dis. 47	Int. 114	DWS 155	HPW2 246	CBE 298	HPW1 440	HPS 466	CBC 582	HPW3 853	JI 918
<u>Nitzschun longissima</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3 4	JI 13	HPW1 16	CBC 90	CBE 90	DWS 116	HPW2 129	HPS 155	Int. 258	DC 310	ICD 336	Dis. 440	ICU 672
<u>Gyrosigma</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	JI 1.5	HPW3 10	CBE 12	HPW1 14	CBC 18	HPW2 24	HPS 41	DC 61	ICD 63	ICU 76	Dis. 78	DWS 84	Int. 232

Table 11 (cont.)

## James River Phytoplankton ANOVA Summary 9-19-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

3 $\mu$ Flagellate (cells·ml <sup>-1</sup> )	Dis. 0	HPS 39	CBC 52	HPW2 64	DWS 65	DC 78	CBE 90	JI 90	HPW3 104	HPW1 116	ICD 181	ICU 336	Int. 362
<u>Gymnodinium</u> sp. (cells·ml <sup>-1</sup> )	HPW3 .5	CBC 2	JI 4	HPW1 6	HPW2 7	DC 7	CBE 9	ICD 10	HPS 14	Dis. 24	ICU 39	DWS 74	Int. 76
2.5 $\mu$ Flagellate (cells·ml <sup>-1</sup> )	DWS 0	Int. 0	HPS 0	HPW3 0	HPW2 0	HPW1 0	CBE 0	CBC 0	JI 0	DC 646	ICD 1137	Dis. 1732	ICU 2792



Table 12

## James River Phytoplankton ANOVA Summary 11-14-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Chl <u>a</u> ( $\mu\text{g}\cdot\text{l}^{-1}$ )	DWS 1.7	HPW2 1.8	HPW1 2.0	CBE 2.5	CBC 2.6	HPS 2.6	JI 2.8	Int. 3.2	Dis. 3.3	HPW3 3.7			
Total Cells ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3 569	HPW2 814	CBE 846	HPW1 853	ICD 853	DC 853	Dis. 904	HPS 924	JI 938	ICU 950	CBC 996	Int. 1022	DWS 1164
8 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW1 84	HPW3 90	CBE 97	HPS 103	JI 110	DC 110	HPW2 116	Dis. 129	ICD 129	DWS 155	Int. 168	ICU 181	CBC 207
16 $\mu$ <u>Chroomonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW1 58	HPW3 97	HPS 110	HPW2 122	CBC 142	CBE 148	DC 148	ICD 174	Int. 194	JI 206	Dis. 213	ICU 226	DWS 349
5 $\mu$ Cryptophyte ( $\text{cells}\cdot\text{ml}^{-1}$ )	Int. 20	HPW3 58	ICD 65	CBE 71	ICU 71	DC 71	JI 78	Dis. 104	HPS 110	HPW2 129	DWS 142	HPW1 174	CBC 188
<u>Pyramimonas</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW1 6	Dis. 20	HPW3 26	HPW2 26	ICD 26	HPS 32	DWS 46	CBC 46	Int. 52	JI 58	ICU 58	CBE 97	DC 97
<u>Katodinium rotundatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPS 0	HPW3 0	HPW2 13	ICU 13	CBE 20	CBC 20	DWS 26	DC 32	ICD 46	Dis. 52	JI 71	Int. 78	HPW1 116
<u>Skeletonema costatum</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPS 6	HPW2 6	HPW3 26	HPW1 26	CBC 26	CBE 48	JI 52	ICD 58	Int. 58	DWS 71	ICU 71	DC 90	Dis. 155
<u>Nitzschia longissima</u> ( $\text{cells}\cdot\text{ml}^{-1}$ )	CBE 20	CBC 20	HPW1 26	DC 39	Dis. 46	DWS 52	HPW2 78	JI 84	ICU 84	ICD 84	HPW3 129	Int. 148	HPS 168
<u>Amphiprora</u> sp. ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW1 0	CBE 0	HPW3 1	JI 1	CBC 2	HPW2 2	HPS 2	DWS 3	Dis. 4	DC 4	ICU 5	ICD 5	Int. 6
3 $\mu$ Flagellate ( $\text{cells}\cdot\text{ml}^{-1}$ )	HPW3 20	ICD 32	Int. 39	ICU 52	Dis. 58	DC 84	HPS 116	DWS 129	HPW2 181	CBC 181	JI 200	HPW1 238	CBE 272

Table 13

## James River Zooplankton ANOVA Summary 2-28-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	CBE	ICU	INT	JI	DC	DWS	HPW2	CBC	ICD	Dis.	HPW3	HPS	HPW1
	67	100	113	117	128	131	134	161	173	196	272	282	413
Barnacle nauplii (No./100 l)	CBE	DC	ICU	INT	HPW2	JI	HPW1	CBC	DWS	ICD	HPW3	Dis.	HPS
	5	5	9	9	9	10	11	12	13	16	17	18	20
Polychaete larvae (No./100 l)	JI	HPW2	CBE	CBC	HPW3	DWS	HPW1	ICU	DC	HPS	Dis.	INT	ICD
	3	5	19	22	23	24	50	60	62	62	69	72	88
<u>Eurytemora</u> sp. (No./100 l)	CBE	HPS	HPW2	JI	INT	HPW1	Dis.	CBC	DC	HPW3	ICU	DWS	ICD
	6	12	18	24	24	26	30	33	33	36	39	46	54
<u>Acartia</u> sp. (No./100 l)	HPS	INT	CBE	CBC	DWS	HPW2	JI	HPW1	HPW3	Dis.	ICU	DC	ICD
	0	.6	.7	.8	.8	2	2	3	4	6	7	9	28
Harpacticoid copepods (No./100 l)	CBE	DC	HPW2	JI	Dis.	INT	HPS	CBC	HPW1	DWS	HPW3	ICD	ICU
	0	0	.6	2	4	5	5	5	5	6	8	9	12
Cyclopoid copepods (No./100 l)	DC	HPS	CBE	HPW2	JI	Dis.	INT	CBC	ICU	HPW1	ICD	HPW3	DWS
	0	2	3	4	5	7	7	7	9	10	14	16	26
Rotifers (No./100 l)	DWS	CBE	INT	CBC	HPW2	HPS	JI	Dis.	ICD	HPW3	DC	ICU	HPW1
	0	6	9	10	16	16	24	30	39	39	40	46	48
<u>Bosmina</u> sp. (No./100 l)	DWS	INT	Dis.	ICD	CBE	HPW2	HPS	DC	CBC	HPW3	ICU	HPW1	JI
	0	0	0	0	.7	1	2	2	2	3	4	4	4

Table 14

## James River Zooplankton ANOVA Summary 4-18-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	JI	HPW3	HPW1	CBE	DC	CBC	HPW2	DWS	HPS	INT	Dis.	ICU	ICD
	472	523	699	808	1097	1484	1592	1620	1902	2051	2291	4454	4795
Barnacle nauplii (No./100 l)	JI	DC	CBE	CBC	HPW3	HPW1	ICD	Dis.	HPW2	ICU	DWS	HPS	INT
	5	12	34	57	73	74	114	122	172	174	210	288	360
Polychaete larvae (No./100 l)	DWS	DC	HPW2	JI	HPS	Dis.	CBE	HPW1	ICU	CBC	ICD	HPW3	INT
	.65	36	40	44	67	71	97	106	107	111	149	167	189
<u>Eurytemora</u> sp. (No./100 l)	CBE	DC	Dis.	DWS	HPW1	INT	HPS	HPW2	ICU	CBC	HPW3	ICD	JI
	74	130	153	175	225	234	315	377	406	465	469	522	632
<u>Acartia</u> sp. (No./100 l)	CBE	DC	Dis.	DWS	INT	ICD	HPW2	HPS	ICU	JI	HPW1	CBC	HPW3
	13	15	20	36	43	51	62	66	68	76	82	87	124
Harpacticoid copepods (No./100 l)	CBE	JI	CBC	HPW3	DWS	INT	ICU	Dis.	DC	HPW1	HPW2	HPS	ICD
	6	18	18	26	26	33	38	50	52	71	125	129	557
Cyclopoid copepods (No./100 l)	CBE	DC	HPS	INT	HPW3	ICD	DWS	ICU	Dis.	HPW1	HPW2	CBC	JI
	5	6	8	12	15	15	17	23	23	30	33	40	61
Rotifers (No./100 l)	INT	HPS	DC	HPW1	ICU	CBE	DWS	JI	HPW3	CBC	HPW2	ICD	Dis.
	1	2	3	4	6	6	7	7	8	9	10	11	22
<u>Bosmina</u> (No./100 l)	DWS	DC	ICU	Dis.	ICD	INT	HPW1	HPS	CBE	HPW2	CBC	HPW3	JI
	.6	.9	.9	1	2	4	5	6	8	18	19	24	42

Table 15

## James River Zooplankton ANOVA Summary 5-23-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	HPW2	DC	ICD	INT	ICU	HPW1	DWS	Dis.	HPS	CBE	CBC	HPW3	JI
	34	41	197	521	641	700	832	996	1242	1916	1950	1975	2454
Polychaete larvae (No./100 l)	HPW2	Dis.	CBE	CBC	JI	DC	ICD	HPW1	ICU	HPW3	HPS	INT	DWS
	0	0	0	0	0	0	2	6	8	22	40	127	1059
<u>Eurytemora</u> sp. (No./100 l)	ICD	HPW2	DC	DWS	INT	ICU	HPW1	Dis.	CBE	HPW3	CBC	HPS	JI
	10	13	20	41	44	63	67	76	96	109	152	201	280
<u>Acartia</u> sp. (No./100 l)	DC	ICD	HPW2	CBE	HPW3	DWS	JI	HPW1	INT	Dis.	HPS	CBC	ICU
	.85	2	4	6	7	11	12	15	19	20	22	22	24
Harpacticoid copepods (No./100 l)	CBE	JI	HPW2	HPW1	DC	ICU	Dis.	DWS	CBC	INT	HPW3	ICD	HPS
	4	6	8	10	14	17	20	24	27	31	31	32	131
Cyclopoid copepods (No./100 l)	HPW2	DWS	CBE	DC	ICD	HPW3	HPW1	JI	HPS	ICU	INT	CBC	Dis.
	7	24	36	41	50	105	124	162	169	195	237	279	1683
Rotifers (No./100 l)	DC	ICD	HPW2	ICU	Dis.	INT	CBE	HPS	HPW1	DWS	CBC	HPW3	JI
	4	6	14	15	99	112	153	173	181	354	432	1495	2159
<u>Bosmina</u> sp. (No./100 l)	HPW2	DC	DWS	ICD	CBE	HPW1	Dis.	HPS	INT	HPW3	ICU	CBC	JI
	11	23	49	73	100	182	195	225	238	243	254	264	291
Barnacle nauplii (No./100 l)	JI	CBC	CBE	Dis.	HPW1	HPW2	HPW3	HPS	Int.	ICD	DC	ICU	DWS
	0	0	0	0	0	0	0	0	0	0	.9	1.8	7.7

Table 16

## James River Zooplankton ANOVA Summary 6-20-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	DC	ICD	HPW1	CBE	Dis.	ICU	CBC	HPS	DWS	HPW2	HPW3	INT	JI
	332	524	1973	2246	2689	2825	4352	6672	6839	7742	8557	8619	18531
Barnacle nauplii (No./100 l)	HPW3	HPW2	INT	JI	HPS	CBE	CBC	DWS	HPW1	ICD	DC	ICU	Dis.
	0	0	15	16	24	42	46	47	90	196	206	211	400
Polychaete larvae (No./100 l)	JI	HPW1	CBE	HPW2	CBC	HPW3	DC	DWS	ICD	Dis.	HPS	ICU	INT
	0	7	9	10	27	28	33	52	55	84	101	134	235
Pelecypod larvae (No./100 l)	ICD	CBE	ICU	DC	HPW3	HPW1	JI	CBC	Dis.	DWS	HPW2	HPS	INT
	53	143	157	207	468	541	731	887	1250	1282	3372	3614	3827
<u>Eurytemora</u> sp. (No./100 l)	ICD	CBE	DC	HPW1	ICU	Dis.	DWS	HPW3	JI	INT	HPS	CBC	HPW2
	25	40	63	79	100	126	251	251	316	631	794	1000	1259
<u>Acartia</u> sp. (No./100 l)	HPW3	CBE	HPW1	JI	ICD	DC	Dis.	DWS	ICU	CBC	HPW2	HPS	INT
	13	18	18	26	29	35	123	126	130	162	284	289	360
Harpacticoid copepods (No./100 l)	CBE	HPW1	ICD	ICU	DC	Dis.	HPW2	DWS	HPS	HPW3	CBC	INT	JI
	2	4	14	16	16	20	20	22	34	53	62	68	93
Cyclopoid copepods (No./100 l)	ICU	ICD	DWS	DC	Dis.	INT	CBC	HPW1	CBE	HPS	HPW2	JI	HPW3
	2	3	3	5	8	15	24	27	64	74	93	123	247
Rotifers (No./100 l)	DC	ICD	CBE	Dis.	HPW1	HPW2	ICU	CBC	HPS	HPW3	DWS	INT	JI
	12	16	44	61	63	70	78	80	212	539	595	875	2181
<u>Bosmina</u> sp. (No./100 l)	DWS	HPS	Dis.	DC	ICD	HPW1	ICU	INT	CBE	CBC	HPW2	JI	HPW3
	0	0	0	0	.9	6	7	15	20	42	53	84	244

Table 16 (continued)

## James River Zooplankton ANOVA Summary 6-20-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Other Cladocerans (No./100 l)	ICD	DC	HPW1	ICU	DWS	Dis.	CBE	HPS	INT	HPW2	CBC	JI	HPW3
	4	11	21	25	29	30	33	84	243	514	529	923	1584
Gastropod larvae (No./100 l)	HPW3	DWS	HPW2	INT	HPW1	CBE	CBC	ICU	ICD	HPS	JI	DC	Dis.
	0	1	3	8	13	14	26	26	27	30	32	33	51

Table 17

## James River Zooplankton ANOVA Summary 7-11-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	ICU	DC	Dis.	ICD	JI	DWS	INT	HPW3	CBC	HPS	HPW1	CBE	HPW2
	21	690	745	1287	1480	1772	1839	2194	2768	3687	3692	3952	4105
Barnacle nauplii (No./100 l)	ICU	JI	ICD	DC	HPW3	HPW2	CBC	INT	CBE	Dis.	HPW1	DWS	HPS
	3	29	31	70	74	76	126	144	156	214	232	314	636
Polychaete larvae (No./100 l)	ICU	HPW3	DC	JI	ICD	CBE	INT	CBC	DWS	Dis.	HPW2	HPW1	HPS
	.9	6	14	24	26	39	41	49	66	67	79	122	199
Pelecypod larvae (No./100 l)	ICU	DC	ICD	Dis.	INT	JI	HPW2	CBC	CBE	HPW1	HPS	HPW3	DWS
	3	29	36	67	120	152	165	166	178	196	263	317	405
<u>Eurytemora</u> sp. (No./100 l)	ICU	ICD	DC	Dis.	HPW1	INT	DWS	HPS	HPW3	CBE	CBC	JI	HPW2
	3	3	4	73	111	150	197	261	259	327	690	736	1148
<u>Acartia</u> sp. (No./100 l)	ICU	ICD	DC	HPW1	HPS	Dis.	CBE	INT	HPW3	CBC	HPW2	JI	DWS
	18	54	107	244	391	441	441	504	544	605	834	874	918
Harpacticoid copepods (No./100 l)	INT	ICU	HPW3	DWS	HPS	DC	Dis.	ICD	CBE	HPW1	HPW2	CBC	JI
	0	.9	4	7	16	18	20	23	57	82	83	92	96
Cyclopoid copepods (No./100 l)	DWS	INT	HPW3	Dis.	DC	ICU	ICD	HPS	HPW1	CBE	CBC	HPW2	JI
	0	0	0	0	3	4	4	11	12	42	177	295	326
Rotifers (No./100 l)	ICU	DC	INT	HPS	JI	ICD	CBE	HPW1	Dis.	HPW3	HPW2	CBC	DWS
	2	25	31	33	35	37	39	53	54	116	120	162	171

Table 17 (continued)

## James River Zooplankton ANOVA Summary 7-11-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )Bosmina sp. (No./100 l)

DWS	INT	Dis.	ICU	ICD	DC	HPW1	CBE	HPW3	HPS	JI	HPW2	CBC
0	0	0	0	0	0	<u>4</u>	<u>18</u>	<u>20</u>	<u>21</u>	<u>97</u>	<u>149</u>	<u>229</u>

## Gastropod larvae (No./100 l)

HPW3	DWS	JI	HPW1	ICU	INT	DC	ICD	HPW2	CBC	Dis.	HPS	CBE
0	<u>21</u>	<u>21</u>	<u>28</u>	<u>35</u>	<u>52</u>	<u>58</u>	<u>61</u>	<u>70</u>	<u>99</u>	<u>100</u>	<u>100</u>	<u>166</u>



Table 18

## James River Zooplankton ANOVA Summary 8-23-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	DC	ICU	ICD	Dis.	DWS	HPS	INT	CBE	HPW1	CBC	HPW3	HPW2	JI
	156	458	459	648	759	1114	1444	1691	2409	2917	3376	3598	3676
Barnacle nauplii (No./100 l)	HPW2	CBC	HPW3	JI	CBE	ICD	DC	ICU	HPS	INT	Dis.	DWS	HPW1
	3	5	8	11	29	46	55	59	92	94	112	267	280
Polychaete larvae (No./100 l)	CBC	JI	CBE	HPW3	HPW2	HPS	DC	HPW1	ICD	ICU	INT	DWS	Dis.
	2	5	6	14	16	35	50	57	60	74	102	109	209
Pelecypod larvae (No./100 l)	DC	ICD	ICU	HPS	Dis.	INT	HPW2	JI	DWS	CBC	CBE	HPW1	HPW3
	24	36	48	190	259	329	330	352	429	456	587	1104	1647
<u>Eurytemora</u> sp. (No./100 l)	Dis.	DC	ICD	HPS	ICU	CBE	INT	HPW2	HPW1	CBC	DWS	HPW3	JI
	0	.9	2	6	7	8	23	28	31	41	60	100	120
<u>Acartia</u> sp. (No./100 l)	ICD	HPS	CBE	DC	HPW2	INT	HPW1	JI	Dis.	ICU	CBC	HPW3	DWS
	12	20	73	73	95	104	118	137	153	211	247	317	404
Harpacticoid copepods (No./100 l)	HPW2	HPS	INT	CBE	DWS	CBC	ICU	ICD	HPW3	DC	Dis.	HPW1	JI
	3	3	4	4	5	6	12	17	17	21	41	47	57
Cyclopoid copepods (No./100 l)	INT	Dis.	DWS	ICD	ICU	DC	HPS	CBE	HPW1	HPW2	HPW3	CBC	JI
	0	0	1	3	3.5	4	6	10	63	83	99	215	390
Rotifers (No./100 l)	DC	ICU	ICD	HPW2	DWS	Dis.	HPW3	INT	HPW1	JI	HPS	CBC	CBE
	10	22	26	97	116	150	204	205	212	335	340	352	414
<u>Bosmina</u> sp. (No./100 l)	DWS	INT	Dis.	ICU	DC	ICD	HPS	CBE	HPW1	HPW3	HPW2	CBC	JI
	0	0	0	.9	.9	2	5	20	54	65	118	255	995

Table 18 (continued)

James River Zooplankton ANOVA Summary 8-23-78

Parameters

Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Other Cladocerans (No./100 l)	INT	Dis.	ICU	DC	DWS	ICD	CBE	HPS	HPW1	HPW2	CBC	HPW3	JI
	0	0	0	0	<u>3</u>	<u>6</u>	<u>12</u>	<u>20</u>	<u>31</u>	<u>37</u>	<u>108</u>	<u>116</u>	<u>192</u>
Gastropod larvae (No./100 l)	HPW2	HPS	DC	ICU	ICD	INT	CBE	JI	HPW3	HPW1	CBC	DWS	Dis.
	<u>6</u>	<u>9</u>	<u>14</u>	<u>15</u>	<u>18</u>	<u>19</u>	<u>25</u>	<u>29</u>	<u>30</u>	<u>31</u>	<u>41</u>	<u>44</u>	<u>48</u>

Table 19

## James River Zooplankton ANOVA Summary 9-19-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	Dis.	ICU	DC	ICD	HPW1	DWS	HPW2	JI	CBC	CBE	INT	HPW3	HPS
	738	843	1096	1164	1211	1296	1446	1532	1775	2411	2994	3290	3861
Barnacle nauplii (No./100 l)	DWS	HPW2	ICU	JI	CBE	HPS	INT	CBC	ICD	HPW3	HPW1	Dis.	DC
	71	98	142	163	188	188	191	221	259	280	297	354	460
Polychaete larvae (No./100 l)	DWS	CBE	JI	HPW2	Dis.	CBC	HPS	HPW3	DC	HPW1	INT	ICU	ICD
	34	37	38	49	76	79	80	88	92	109	117	190	226
Pelecypod larvae (No./100 l)	ICU	DWS	DC	ICD	Dis.	INT	HPW1	HPS	HPW2	CBC	CBE	JI	HPW3
	67	142	158	173	269	340	470	882	1278	1595	2045	3742	4730
<u>Eurytemora</u> sp. (No./100 l)	INT	HPW3	ICD	HPW2	ICU	CBE	DWS	HPW1	HPS	DC	Dis.	CBC	JI
	0	0	4	6	7	8	10	12	13	16	23	44	44
<u>Acartia</u> sp. (No./100 l)	ICD	CBE	Dis.	ICU	DC	HPW1	HPW2	DWS	CBC	JI	HPW3	INT	HPS
	39	87	133	152	238	241	270	431	606	666	847	920	1323
Harpacticoid copepods (No./100 l)	INT	HPS	HPW2	ICU	DWS	JI	CBE	DC	ICD	HPW3	HPW1	CBC	HPS
	0	0	0	0	2	3	3	4	5	6	9	10	27
Cyclopoid copepods (No./100 l)	HPW2	Dis.	ICD	ICU	DC	HPW3	DWS	HPS	HPW1	CBE	JI	CBC	INT
	0	0	0	4	4	5	6	7	9	9	10	15	19
Rotifers (No./100 l)	CBC	Dis.	HPW3	HPW1	DC	DWS	JI	ICU	ICD	HPW2	HPS	CBE	INT
	66	66	88	120	120	124	139	141	164	264	339	442	762
Gastropod larvae (No./100 l)	DWS	CBC	CBE	INT	HPW2	DC	HPW1	ICD	ICU	JI	Dis.	HPW3	HPS
	11	13	14	19	22	23	29	30	35	54	68	85	97
Coelenterate medusae (No./100 l)	DWS	HPS	CBE	DC	HPW1	HPW3	ICU	CBC	HPW2	JI	Dis.	INT	ICD
	0	0	0	0	3	3	4	6	8	8	10	19	34

Table 20

## James River Zooplankton ANOVA Summary 11-14-78

## Parameters

## Stations and Means

(Stations not sharing an underline are significantly different,  $\alpha \leq .05$ )

Copepod nauplii (No./100 l)	DC	ICD	Dis.	HPW1	DWS	HPS	ICU	CBC	JI	INT	HPW2	CBE	HPW3
	102	181	183	201	308	399	406	517	578	592	629	714	1088
Barnacle nauplii (No./100 l)	JI	HPW2	HPW3	HPW1	CBC	CBE	DWS	HPS	ICU	INT	DC	ICD	Dis.
	2	6	10	14	14	14	17	23	33	39	84	106	128
Polychaete larvae (No./100 l)	DC	HPW1	ICD	ICU	Dis.	DWS	JI	CBC	CBE	INT	HPS	HPW3	HPW2
	35	73	82	87	164	176	281	285	309	336	394	1092	1111
Pelecypod larvae (No./100 l)	INT	DWS	DC	HPW1	Dis.	ICD	ICU	HPW2	HPS	JI	HPW3	CBE	CBC
	4	5	5	6	10	16	21	24	29	29	39	43	49
<u>Eurytemora</u> sp. (No./100 l)	INT	HPS	Dis.	DC	ICU	JI	ICD	CBC	HPW3	HPW1	DWS	CBE	HPW2
	0	0	0	0	.9	2	2	3	3	5	10	11	41
<u>Acartia</u> sp. (No./100 l)	DC	ICD	Dis.	CBE	DWS	ICU	CBC	HPW1	INT	JI	HPW3	HPS	HPW2
	9	9	42	70	78	106	135	136	142	194	289	325	465
Cyclopoid copepods (No./100 l)	HPS	HPW3	HPW1	CBE	JI	ICU	DWS	CBC	DC	ICD	HPW2	INT	Dis.
	0	0	0	0	0	0	.6	.8	.9	2	3	4	10
Rotifers (No./100 l)	DC	DWS	INT	ICD	ICU	HPW1	Dis.	HPS	CBC	JI	CBE	HPW3	HPW2
	4	5	8	8	8	15	16	19	33	106	115	284	291
Gastropod larvae (No./100 l)	DWS	INT	HPS	HPW3	HPW2	HPW1	Dis.	CBE	ICU	JI	CBC	DC	ICD
	0	0	0	0	0	0	0	.7	.9	1	3	4	5

## Results - Benthos Studies

### Data Presentation

The hydrographic data associated with the 1978 benthos sampling runs appear in Appendix Table A2. The benthos biological data are in Appendix C, Tables C1-C6 (species counts) and C7-C12 (diversity indices).

### Benthos Distribution Patterns

The 1978 spatial distributions for the major benthic organisms of the study area are presented in Table 21. In this table the stations have been organized into three groups, based on the results of the sediment analyses performed in June (Table 22). Within the sediment groups control stations and stations at locations potentially under the influence of the power plant plume are indicated.

The 1978 spatial distributions of several of the benthic species were similar to distributions observed in previous study years (Jordan et al. 1977, 1978). Four of the six stations where Conger*ia leucophaeta* was found (Table 21C) had a clayey-silt substrate, and three of the six stations were influenced by the plume. Heteromastus filiformis (Table 21I) was also found mainly at plume stations, particularly at station 11 where it had been most abundant in the 1977 study. Leptocheirus plumulosus (Table 21N), which had shown an apparent avoidance of the plume in three previous study years (Jordan et al. 1977, 1978), was collected least frequently at plume stations 8 and 11 in 1978.

Species that were collected more frequently at sandy stations were Corbicula manilensis (Table 21E) and Lepidactylus dytiscus

(Table 21M). Species that were more numerous in the finer sediment types included Rangia cuneata, Scolecopides viridis, Gammarus sp., Leptocheirus plumulosus, and Cyathura polita (Tables 21 A, G, K, N, and O, respectively).

The overall abundance of Rangia cuneata in the 1978 benthos samples was lowest in April (Figure 5). The total number collected was 52, just one more than the total for April 1977 which was the lowest number of Rangia collected since the study began in 1969. The low point in 1977 followed an obvious winter kill, that was revealed by large numbers of decomposing individuals present in the March 1977 samples (Figure 5). Neither the January nor the April 1978 samples contained recently deceased Rangia. The only evidence that low winter temperatures in 1978 may have adversely affected the Rangia population in the study area is the observation that the total numbers of individuals collected during the study year at the control stations were generally lower than the total numbers collected at the plume stations, for the two fine sediment groups (Table 21A). Thus there is a suggestion of a positive effect of the power plant plume on Rangia survival in 1978.

Table 21

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

A. Rangia cuneata (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand				Plume	Sand-Silt-Clay						Clayey-Silt				Total	
	Control					Plume						Control					Plume
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18	4	3	13		2	9	1	8	3	13	5	13			13	7	94
Apr. 10	3	1		1	1		2	6	1	3		4	1	1	19	9	52
June 13	4	4	1	2	7	2	28	6	4	3	15	4		4	13	6	103
July 12	3	1		13	6	1	22	5		5	6	9			3	9	83
Aug. 7	13	3	14	9	7	8	10	15	6	18	26	3	16		15	21	184
Oct. 18	4	8	3	5	3	13	7	6	4	36	6	10	4	2	10	17	138
Total	31	20	31	30	26	33	70	46	18	78	58	43	21	7	73	69	654

46

B. Rangia cuneata (g per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)						(Clayey-Silt)					Total
	Control				Plume	Control				Plume		Control			Plume		
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18	1.60	.62	8.64		1.68	1.72	1.15	2.52	.04	.99	1.70	5.67			4.04	1.82	32.19
Apr. 10	2.72	.76		.02	.73		1.40	1.74	.48	1.11		1.68	.14	.02	5.45	3.81	20.06
June 13	1.72	.04	.90	.05	1.92	.20	7.90	1.83	.63	1.27	.04	1.06		.72	3.89	.54	22.71
July 12	.03	.42		.74	1.96	.02	12.23	3.15		1.62	.64	5.16			.65	1.29	27.91
Aug. 7	6.66	.03	.03	.17	3.96	.22	3.73	3.30		7.16	3.41	1.47	.10		2.95	1.83	35.02
Oct. 18	3.86	1.06	.03	.03	1.25	.19	2.73	.65	.80	2.52	1.85	3.37	.03	.01	1.78	2.16	22.32
Total	16.59	2.93	9.60	1.01	11.50	2.35	29.14	13.19	1.95	14.67	7.64	18.41	.27	.75	18.76	11.45	160.21

Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

C. Conger leucophaeta (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					Sand-Silt-Clay						Clayey-Silt					Total
	Control				Plume	Control			Plume	Control			Plume				
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18																	0
Apr. 10															1		1
June 13																	0
July 12																	0
Aug. 7														3		1	4
Oct. 18			3							1			1		1	7	13
Total	0	0	3	0	0	0	0	0	0	1	0	0	1	3	2	8	18

47

D. Macoma mittelli (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)					(Clayey-Silt)					Total	
	Control				Plume	Control			Plume	Control			Plume				
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4		8
Jan. 18	1		2		1	2		2		5	2	2	1		1		19
Apr. 10																	0
June 13																	0
July 12																	0
Aug. 7							1				1		2				4
Oct. 18				1				2		7			12				22
Total	1	0	2	1	1	2	1	4	0	12	3	2	15	0	1	0	45



Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

E. Corbicula manilensis (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					Sand-Silt-Clay						Clayey-Silt					Total
	Control		Plume			Control		Plume				Control		Plume			
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18										1							1
Apr. 10			1														1
June 13																	0
July 12			3														3
Aug. 7																1	1
Oct. 18			2														2
Total	0	0	6	0	0	0	0	0	0	1	0	0	0	0	0	1	8

48

F. Hydrobia sp. (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)						(Clayey-Silt)					Total
	Control				Plume	Control				Plume		Control			Plume		
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18			2							5							7
Apr. 10	1			3		17		2		2					7		32
June 13		4			1												5
July 12																	0
Aug. 7					1		1							1			3
Oct. 18																	0
Total	1	4	2	3	2	17	1	2	0	7	0	0	0	1	7	0	47

Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

G. Scolecopides viridis (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					Sand-Silt-Clay						Clayey-Silt					Total
	Control				Plume	Control			Plume			Control			Plume		
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18			1					1		3	1						6
Apr. 10		1		1	1	2		1		2			1	1	2		12
June 13				3		13	7		3	25			4		5	3	63
July 12			1		1	2	30	4	1	25		2			9	6	81
Aug. 7						1	1	3		1	7				2		15
Oct. 18				1	2	4	3	5	1	1							17
Total	0	1	2	5	4	22	41	14	5	57	8	2	5	1	18	9	194

49

H. Nereis succinea (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)						(Clayey-Silt)						Total
	Control				Plume	Control			Plume			Control			Plume			
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8		
Jan. 18	2		17	1				3		4	1	1		2		6	37	
Apr. 10	5	2	1	2				3		1	1					6	21	
June 13							3	1			1						5	
July 12								1			1						2	
Aug. 7	2			1				1			2						6	
Oct. 18	1	3	1		15				6	2	4		1	1		1	35	
Total	10	5	19	4	15	0	3	9	6	7	10	1	1	3	0	13	106	

Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

I. Heteromastus filiformis (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					Sand-Silt-Clay					Clayey-Silt					Total	
	Control		Plume			Control		Plume			Control		Plume				
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4		8
Jan. 18										3					1		4
Apr. 10						1				2					2		5
June 13				1						4							5
July 12										5	2						7
Aug. 7										4	2						6
Oct. 18										16							16
Total	0	0	0	1	0	1	0	0	0	34	4	0	0	0	3	0	43

J. Oligochaetes (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)						(Clayey-Silt)						Total
	Control				Plume	Control				Plume	Control				Plume			
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8		
Jan. 18			1							1							2	
Apr. 10													1				1	
June 13							1										1	
July 12	1						1										2	
Aug. 7					1	4	3				1		2		5		16	
Oct. 18					3					1							4	
Total	1	0	1	0	4	4	5	0	0	2	1	0	3	0	5	0	26	

Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

K. Gammarus sp. (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand				Plume	Sand-Silt-Clay				Plume	Clayey-Silt				Plume	Total	
	Control	Control	Control	Control		Control	Control	Control	Control		Control	Control	Control	Control			
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18						1									1		2
Apr. 10	1														1		2
June 13														1	3		4
July 12							11			1							12
Aug. 7										1		1	1				3
Oct. 18																	0
Total	1	0	0	0	0	1	11	0	0	2	0	1	1	1	5	0	23

L. Corophium lacustre (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand				Plume	(Sand-Silt-Clay)				Plume	(Clayey-Silt)				Plume	Total	
	Control					Control					Control						
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	Total
Jan. 18				1												1	2
Apr. 10								1									1
June 13									1							1	2
July 12			1		3		106									3	113
Aug. 7			1		3	1	1		9			1	1	5	1		23
Oct. 18			10											1			11
Total	0	0	12	1	6	1	107	1	10	0	0	1	1	6	1	5	152

Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

M. Lepidactylus dytiscus (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					Sand-Silt-Clay						Clayey-Silt					Total
	Control				Plume	Control			Plume			Control			Plume		
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8	
Jan. 18		2								1							3
Apr. 10		3	4		6	3			6							1	23
June 13		2	1						1				1				5
July 12		3	3						6								12
Aug. 7		3	9														12
Oct. 18				2					5								7
Total	0	13	17	2	6	3	0	0	18	1	0	0	0	1	0	1	62

N. Leptocheirus plumulosus (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)						(Clayey-Silt)						Total
	Control				Plume	Control			Plume			Control			Plume			
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8		
Jan. 18			2				1	1					1				5	
Apr. 10										1							1	
June 13	1		2	25	4		25	3	5		8	10	1		8	1	93	
July 12	4	5		1	6		12	29	1		8	25		20	13		124	
Aug. 7	1	2	4	12	4	1	19	17	4		23	2	7	3	11	2	112	
Oct. 18				7	1	5	8	13				7	1	10	10		62	
Total	6	7	8	45	15	6	65	63	10	1	39	44	9	34	42	3	397	

Table 21 (continued)

## Seasonal and Spatial Distributions of Major Benthic Animals - 1978

O. *Cyathura polita* (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					Sand-Silt-Clay						Clayey-Silt						Total
	Control				Plume	Control			Plume	Control			Plume					
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8		
Jan. 18			2					1		3		3	1	2	1	1	14	
Apr. 10				1								1	1		1		4	
June 13										1						1	2	
July 12				2			3					1				2	8	
Aug. 7							3			2		1	1	3	3		13	
Oct. 18			2					3			1	1		2			9	
Total	0	0	4	3	0	0	6	4	0	6	1	7	3	7	5	4	50	

53

P. Dipteran larvae (No. per 0.1 m<sup>2</sup>)

## Substrates and Station Numbers

Date	Sand					(Sand-Silt-Clay)						(Clayey-Silt)						Total
	Control				Plume	Control				Plume		Control			Plume			
	1	3	12	15	7	5	6	16	9	11	13	2	10	14	4	8		
Jan. 18	1											1			1			2
Apr. 10						1						1			1			3
June 13																		0
July 12						1									1			2
Aug. 7																		0
Oct. 18																		0
Total	0	0	1	0	0	0	2	0	0	0	0	2	0	0	1	1	7	

Table 22

Benthos Station Sediment Characteristics June 29, 1978

Sediment type	Station No.	Loss on Ignition (%)	Sand ( $>63\mu$ ) (%)	Silt ( $4\mu - 63\mu$ ) (%)	Clay ( $<4\mu$ ) (%)
Sand	1	1.23	97.6	0.5	1.9
	3	0.35	98.8	0.4	0.8
	12	0.27	99.6	0.2	0.2
	15	2.34	91.3	6.0	2.7
	7	0.49	97.5	1.4	1.1
Sand-silt-clay	5	5.55	50.7	33.8	15.5
	6	6.52	36.7	37.3	26.0
	16	8.14	52.8	23.0	24.2
	9	3.31	33.5	37.0	29.5
	11	2.21	77.2	12.0	10.8
	13	1.86	68.9	17.3	13.8
Clayey silt	2	8.74	25.4	40.8	33.8
	10	8.56	13.6	43.9	42.5
	14	9.32	5.8	47.2	47.0
	4	9.67	12.0	56.4	31.6
	8	9.17	7.0	49.0	44.0

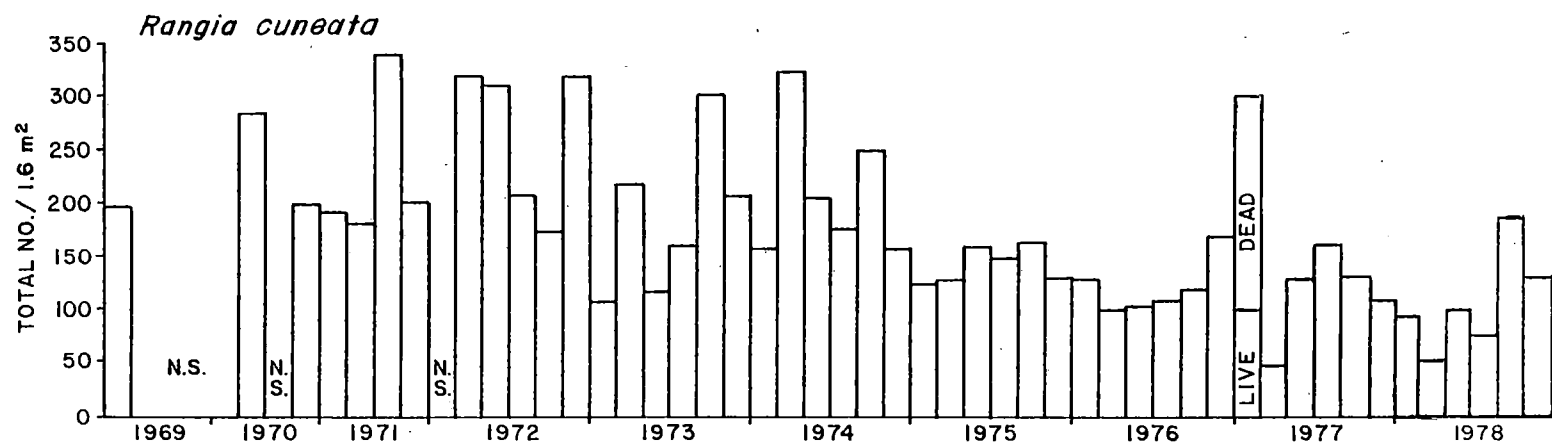


Figure 5. Temporal distribution of Rangia cuneata in the study area, May 1969 - Oct.. 1978.

N.S. = Not sampled



### Results - Fouling Organisms Study

The 1978 fouling organism data appear in Tables 23-25. Very few organisms were found on the plates exposed during the January-February and March-April periods. The May-June plates at station DWS were densely colonized by barnacles, while only a few appeared on the CBS plates and none were present on the CBN plates exposed during this period. Colonization by Corophium lacustre was distinctly more dense on the annual than on the May-June bimonthly plates recovered at stations CBS and CBN.

During the second half of the year colonization by barnacles and Corophium lacustre was the most dense in the July-August period at station CBN, in the September-October period at station CBS, and was similarly dense in these two periods at station DWS.

Congerina leucophaeta occurred in small numbers on the July-August and September-October plates from station DWS. This species exhibited higher population densities at the other two stations, and was especially abundant on the horizontal plate recovered from station CBN in August. The November-December plates from all stations yielded a few barnacles, but the most numerous species on most of the plates was Corophium lacustre. Ectoprocts were present on plates recovered from all three stations in the second half of the year, but occurred most consistently and achieved the densest coverage at station DWS.

The differences observed among the fouling plate stations appear to relate to the locations of the stations relative to the longitudinal salinity gradient of the James River. Seasonally,

colonization by barnacles commenced first at the downstream-most (highest salinity) station, DWS. Coincidentally this was the only river station at which barnacle nauplii were found in the zooplankton samples taken in May (Table 15). The presence of barnacle nauplii in the intake and discharge canal samples suggests that the barnacles attached to the May-June plates at CBS could have originated from larvae pumped through from the power plant intake or produced by adults residing in the cooling water canals. Ectoproct coverage was also greatest at Station DWS. Congeria leucophaeta, an oligohaline pelecypod (Wass et al. 1972), was least abundant at station DWS. The temporal patterns of fouling organism colonization at the two upstream stations, CBN, remote from the power plant, and CBS, near the discharge canal mouth, were similar. The major quantitative differences between these two stations appeared on the September-October plates, which supported higher barnacle and Corophium populations at CBS. This is the major possible power plant effect apparent in the 1978 fouling plate data, and could relate to the attachment of barnacle larvae released from the power plant cooling canal system. The resulting establishment of a large surface area, on and among the barnacle shells, would be favorable for subsequent Corophium colonization.

Table 23

Fouling Organisms  
1978  
Station DWS

<u>Horizontal Plate</u>		<u>No. Organisms/dm<sup>2</sup></u>			
		<u>Jan-Feb</u>	<u>Mar-Apr</u>	<u>May-Jun</u>	<u>Annual*</u>
Barnacles	<u>Balanus sp.</u>			113	89
Bivalves	<u>Brachidontes recurvus</u>				
	<u>Congeria leucophaeta</u>				
Amphipods	<u>Corophium lacustre</u>			523	841
	<u>Leptocheirus plumulosus</u>				
	<u>Gammarus sp.</u>			8	1
Polychaetes	<u>Nereis succinea</u>				
	<u>Scolecoides viridis</u>				
Decapods	<u>Rhithropanopeus harrisii</u>				
Ectoprocts	<u>Bowerbankia sp.</u>				
	<u>Membranipora tenuis</u>				
Hydroids		X		X	X
Dipteran Larvae				1	
Total No. of Genera (not including Hydroids and Dipteran Larvae)		0	0	3	3
Total No. of Organisms (not including Ectoprocts and Hydroids)		0	0	645	931
<u>Vertical Plate</u>					
Barnacles	<u>Balanus sp.</u>			318	531
Bivalves	<u>Brachidontes recurvus</u>				
	<u>Congeria leucophaeta</u>				
Amphipods	<u>Corophium lacustre</u>		1	712	579
	<u>Leptocheirus plumulosus</u>				
	<u>Gammarus sp.</u>			40	7
Polychaetes	<u>Nereis succinea</u>				
	<u>Scolecoides viridis</u>				
Decapods	<u>Rhithropanopeus harrisii</u>				
Ectoprocts	<u>Bowerbankia sp.</u>				
	<u>Membranipora tenuis</u>				
Hydroids				X	X
Dipteran Larvae			2	4	5
Total No. of Genera (not including Hydroids and Dipteran Larvae)		0	1	3	3
Total No. of Organisms (not including Ectoprocts and Hydroids)		0	3	1074	1122

Table 23 (Cont.)

Fouling Organisms  
1978  
Station DWS

Horizontal Plate		No. Organisms/dm <sup>2</sup>		
		July-Aug	Sep-Oct	Nov-Dec
Barnacles	<u>Balanus</u> sp.	79	59	10
Bivalves	<u>Brachidontes recurvus</u>			
	<u>Congeria leucophaeta</u>	16	5	
Amphipods	<u>Corophium lacustre</u>	759	280	21
	<u>Leptocheirus plumulosus</u>			
	<u>Gammarus</u> sp.			2
Polychaetes	<u>Nereis succinea</u>		29	
	<u>Scolecoides viridis</u>			
Decapods	<u>Rhithropanopeus harrisii</u>		3	
Ectoprocts	<u>Bowerbankia</u> sp.			
	<u>Membranipora tenuis</u>	X	X	X
Hydroids		X	X	X
Dipteran Larvae				
Total No. of Genera (not including Hydroids and Dipteran Larvae)		4	6	4
Total No. of Organisms (not including Ectoprocts and Hydroids)		854	376	33
<u>Vertical Plate</u>				
Barnacles	<u>Balanus</u> sp.	29	201	14
Bivalves	<u>Brachidontes recurvus</u>			
	<u>Congeria leucophaeta</u>	2	4	1
Amphipods	<u>Corophium lacustre</u>	233	297	108
	<u>Leptocheirus plumulosus</u>			
	<u>Gammarus</u> sp.		1	2
Polychaetes	<u>Nereis succinea</u>	2	23	
	<u>Scolecoides viridis</u>			
Decapods	<u>Rhithropanopeus harrisii</u>			
Ectoprocts	<u>Bowerbankia</u> sp.			
	<u>Membranipora tenuis</u>	X	X	X
Hydroids		X	X	X
Dipteran Larvae				
Total No. of Genera (not including Hydroids and Dipteran Larvae)		5	6	5
Total No. of Organisms (not including Ectoprocts and Hydroids)		266	526	125

Table 24

Fouling Organisms  
1978  
Station CBN

<u>Horizontal Plate</u>		No. Organisms/dm <sup>2</sup>			<u>Annual</u>
		<u>Jan-Feb</u>	<u>Mar-Apr</u>	<u>May-Jun</u>	
Barnacles	<u>Balanus sp.</u>				
Bivalves	<u>Brachidontes recurvus</u>				
	<u>Congeria leucophaeta</u>				
Amphipods	<u>Corophium lacustre</u>	1	2	156	476
	<u>Leptocheirus plumulosus</u>		3		
	<u>Gammarus sp.</u>		1	70	56
Polychaetes	<u>Nereis succinea</u>				
	<u>Scolecoplepides viridis</u>				
Decapods	<u>Rhithropanopeus harrisii</u>				
Ectoprocts	<u>Bowerbankia sp.</u>				
	<u>Membranipora tenuis</u>	X			
Hydroids		X		X	X
Dipteran Larvae			11	24	8
Total No. of Genera (not including Hydroids and Dipteran Larvae)		2	3	2	2
Total No. of Organisms (not including Ectoprocts and Hydroids)		1	17	250	540
<u>Vertical Plate</u>					
Barnacles	<u>Balanus sp.</u>				18
Bivalves	<u>Brachidontes recurvus</u>				
	<u>Congeria leucophaeta</u>				
Amphipods	<u>Corophium lacustre</u>	1		150	408
	<u>Leptocheirus plumulosus</u>		1	2	
	<u>Gammarus sp.</u>		4	24	135
Polychaetes	<u>Nereis succinea</u>				
	<u>Scolecoplepides viridis</u>				
Decapods	<u>Rhithropanopeus harrisii</u>				
Ectoprocts	<u>Bowerbankia sp.</u>				
	<u>Membranipora tenuis</u>				
Hydroids		X	X	X	X
Dipteran Larvae			3	22	24
Total No. of Genera (not including Hydroids and Dipteran Larvae)		1	2	3	3
Total No. of Organisms (not including Ectoprocts and Hydroids)		1	8	198	585

Table 24 (Cont.)

Fouling Organisms  
1978  
Station CBN

<u>Horizontal Plate</u>		No. Organisms/dm <sup>2</sup>		
		<u>July-Aug</u>	<u>Sep-Oct</u>	<u>Nov-Dec</u>
Barnacles	<u>Balanus</u> sp.	125	107	14
Bivalves	<u>Brachidontes recurvus</u>			
	<u>Congeria leucophaeta</u>	295	83	5
Amphipods	<u>Corophium lacustre</u>	501	101	117
	<u>Leptocheirus plumulosus</u>	1		
	<u>Gammarus</u> sp.	34	3	59
Polychaetes	<u>Nereis succinea</u>		3	
	<u>Scolecoides viridis</u>			
Decapods	<u>Rhithropanopeus harrisii</u>		10	
Ectoprocts	<u>Bowerbankia</u> sp.			
	<u>Membranipora tenuis</u>	X	X	X
Hydroids		X	X	X
Dipteran Larvae		1		
Total No. of Genera (not including Hydroids and Dipteran Larvae)		6	7	5
Total No. of Organisms (not including Ectoprocts and Hydroids)		957	307	195
<u>Vertical Plate</u>				
Barnacles	<u>Balanus</u> sp.	305	255	21
Bivalves	<u>Brachidontes recurvus</u>			
	<u>Congeria leucophaeta</u>	101	23	
Amphipods	<u>Corophium lacustre</u>	774	111	2
	<u>Leptocheirus plumulosus</u>			
	<u>Gammarus</u> sp.	22	1	2
Polychaetes	<u>Nereis succinea</u>			
	<u>Scolecoides viridis</u>			
Decapods	<u>Rhithropanopeus harrisii</u>	2	9	
Ectoprocts	<u>Bowerbankia</u> sp.			
	<u>Membranipora tenuis</u>			X
Hydroids		X	X	X
Dipteran Larvae		2		
Total No. of Genera (not including Hydroids and Dipteran Larvae)		5	5	4
Total No. of Organisms (not including Ectoprocts and Hydroids)		1206	399	25

Table 25  
Fouling Organisms  
1978  
Station CBS

Horizontal Plate		No. Organisms/dm <sup>2</sup>			
		Jan-Feb	Mar-Apr	May-Jun	Annual
Barnacles	<u>Balanus</u> sp.			11	1
Bivalves	<u>Brachidontes recurvus</u>				
	<u>Congeria leucophaeta</u>				
Amphipods	<u>Corophium lacustre</u>			33	62
	<u>Leptocheirus plumulosus</u>				
	<u>Gammarus</u> sp.			3	65
Polychaetes	<u>Nereis succinea</u>				
	<u>Scolecoides viridis</u>				
Decapods	<u>Rhithropanopeus harrisii</u>				
Ectoprocts	<u>Bowerbankia</u> sp.				
	<u>Membranipora tenuis</u>				
Hydroids				X	X
Dipteran Larvae			2	4	27
Total No. of Genera (not including Hydroids and Dipteran Larvae)		0	0	3	3
Total No. of Organisms (not including Ectoprocts and Hydroids)		0	2	51	155
<u>Vertical plate</u>					
Barnacles	<u>Balanus</u> sp.	1		3	1
Bivalves	<u>Brachidontes recurvus</u>				
	<u>Congeria leucophaeta</u>				
Amphipods	<u>Corophium lacustre</u>			12	28
	<u>Leptocheirus plumulosus</u>		5		1
	<u>Gammarus</u> sp.			2	3
Polychaetes	<u>Nereis succinea</u>				
	<u>Scolecoides viridis</u>				
Decapods	<u>Rhithropanopeus harrisii</u>				
Ectoprocts	<u>Bowerbankia</u> sp.				
	<u>Membranipora tenuis</u>	X		X	
Hydroids		X			X
Dipteran Larvae			1	3	11
Total No. of Genera (not including Hydroids and Dipteran Larvae)		2	1	4	4
Total No. of Organisms (not including Ectoprocts and Hydroids)		1	6	20	44

Table 25 (Cont.)

Fouling Organisms  
1978  
Station CBS

Horizontal Plate		No. Organisms/dm <sup>2</sup>		
		July-Aug	Sep-Oct	Nov-Dec
Barnacles	<u>Balanus sp.</u>	256	212	8
Bivalves	<u>Brachidontes recurvus</u>			
	<u>Congeria leucophaeta</u>	119	139	1
Amphipods	<u>Corophium lacustre</u>	606	1439	56
	<u>Leptocheirus plumulosus</u>		2	
	<u>Gammarus sp.</u>	3		6
Polychaetes	<u>Nereis succinea</u>		8	
	<u>Scolecoplepides viridis</u>			
Decapods	<u>Rhithropanopeus harrisii</u>	1	4	
Ectoprocts	<u>Bowerbankia sp.</u>			
	<u>Membranipora tenuis</u>		X	X
Hydroids		X	X	X
Dipteran Larvae				
Total No. of Genera (not including Hydroids and Dipteran Larvae)		5	7	5
Total No. of Organisms (not including Ectoprocts and Hydroids)		985	1804	71
<u>Vertical Plate</u>				
Barnacles	<u>Balanus sp.</u>	148	427	11
Bivalves	<u>Brachidontes recurvus</u>			
	<u>Congeria leucophaeta</u>	62	30	
Amphipods	<u>Corophium lacustre</u>	387	733	19
	<u>Leptocheirus plumulosus</u>			
	<u>Gammarus sp.</u>	6		3
Polychaetes	<u>Nereis succinea</u>		12	
	<u>Scolecoplepides viridis</u>			
Decapods	<u>Rhithropanopeus harrisii</u>		8	
Ectoprocts	<u>Bowerbankia sp.</u>			
	<u>Membranipora tenuis</u>		X	X
Hydroids		X	X	X
Dipteran Larvae				
Total No. of Genera (not including Hydroids and Dipteran Larvae)		4	6	4
Total No. of Organisms (not including Ectoprocts and Hydroids)		603	1210	33



### Conclusions

The major findings of previous study years (Jordan et al. 1976, 1977, 1978), regarding the effects of the Surry Power Station cooling water discharge on the James River plankton and benthos populations, were again confirmed by the 1978 study. Negative entrainment effects were observed for both phytoplankton and zooplankton species in August and September, but reduced population densities of these species were not observed at river stations beyond the immediate discharge canal mouth. As in previous years barnacle nauplii were contributed to the river by the cooling water canals, and in this study year in particular there was a high population density of barnacles attached to the autumn fouling plates at the station closest to the discharge, that may have reflected this contribution. In the summer 1978 phytoplankton data there was an indication that the canals may also have been a source for the motile reproductive stages of an attached alga.

In the benthos, an amphipod that had appeared to avoid the discharge plume in previous years exhibited this pattern again in 1978. The Rangia distribution suggested that the plume may have favored the survival of this species through the winter of 1977-78.

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Appendix A  
Hydrographic Data Tables

Table A1

## James River Hydrographic Data 1978

## Plankton Sampling Runs

Date	Parameter	Station									
		DWS	INTAKE	HPS	HPW3	HPW2	HPW1	DISCHARGE	CBE	CBC	JI
2-28	Time (EST)	1013	1040	1109	1132	1152	1214	1235	1702	1638	1610
	Secchi Depth (cm)	17	23	21	17	18	22	21	21	19	17
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	3.45	3.95	7.35	4.20	3.55	6.65	12.70	8.10	5.50	3.60
	Sal. (°/oo)	2.62	2.28	1.42	.64	.37	1.48	2.89	1.31	1.06	.43
	D.O. (mg/l)	11.74	11.64	10.92	12.07	12.01	11.62	11.37	11.68	11.45	12.05
	Sample Depth (m)	1	3.75	2	1	1.5	1	1	1	1.75	4
	Temp. (°C)	3.40	3.85	7.60	4.20	3.50	6.55	12.60	7.40	5.65	3.90
	Sal. (°/oo)	2.63	2.29	1.61	.63	.38	1.45	2.89	1.43	1.17	.53
	D.O. (mg/l)	11.80	11.23	11.84	12.03	12.03	11.43	11.60	11.56	11.66	11.80
	Sample Depth (m)	2	7.5	4	2	3	2	2		3.5	8
	Temp. (°C)	3.40	3.85	7.65	4.15	3.45		12.70		5.60	4.00
	Sal. (°/oo)	3.07	2.29	1.68	.65	.39		2.86		1.21	.64
	D.O. (mg/l)	11.97	11.43	11.39	12.05	12.38		11.47		11.82	11.74
	Sample Depth (m)	1	3.5	2	1	1.5	1	1		1.5	3.5
	Temp. (°C)	14.20	14.15	15.80	14.90	15.80	16.80	21.20		15.40	15.05
	Sal. (°/oo)	2.59	2.63	1.22	.81	.75	1.09	2.60		.33	.08
	D.O. (mg/l)	8.50	8.76	8.16	9.12	8.62	8.58	8.72		8.70	8.76
4-18	Time (EST)	1002	1032	1106	1137	1206	1233	1303	1329	1355	1426
	Secchi Depth (cm)	61	30	36	40	29	35	35	54	36	32
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	14.20	14.15	15.90	14.90	15.90	16.10	21.20	15.00	15.40	15.20
	Sal. (°/oo)	2.37	2.64	1.22	.42	.75	1.05	2.58	.44	.34	.08
	D.O. (mg/l)	8.94	8.56	8.64	8.94	8.64	8.48	8.54	8.62	8.46	8.50
	Sample Depth (m)	1	3.5	2	1	1.5	1	1		1.5	3.5
	Temp. (°C)	14.20	14.15	15.80	14.90	15.80	16.80	21.20		15.40	15.05
	Sal. (°/oo)	2.59	2.63	1.22	.81	.75	1.09	2.60		.33	.08
	D.O. (mg/l)	8.50	8.76	8.16	9.12	8.62	8.58	8.72		8.70	8.76
	Sample Depth (m)	2	7	4	2	3	2	2		3	7
	Temp. (°C)	14.20	14.25	15.80	14.90	15.80		21.05		15.40	15.05
	Sal. (°/oo)	4.51	2.80	1.26	.26	.76		2.57		.34	.09
	D.O. (mg/l)	8.44	9.06	9.42	8.24	8.36		8.96		8.58	8.50

Table A1 (cont.)

## James River Hydrographic Data 1978

## Plankton Sampling Runs

Date	Parameter	Station									
		DWS	INTAKE	HPS	HPW3	HPW2	HPW1	DISCHARGE	CBE	CBC	JI
5-23	Time (EDT)	0956	1028	1101	1128	1149	1215	1242	1304	1351	1415
	Secchi Depth (cm)	27	31	21	31	23	30	25	44	43	34
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	21.80	21.55	21.85	21.40	21.80	23.55	28.10	23.10	22.00	21.80
	Sal. (°/oo)	.26	.30	.12	.07	.10	.16	.34	.11	.11	.09
	D.O. (mg/l)	7.38	7.64	7.24	7.82	7.58	7.86	7.10	8.02	7.32	8.16
	Sample Depth (m)	1	3.75	2.25	1.5	1.75	1	1	1	1.75	3.75
	Temp. (°C)	21.60	21.50	21.85	21.60	21.85	23.50	27.90	22.60	22.05	21.60
	Sal. (°/oo)	.26	.37	.11	.08	.09	.17	.33	.12	.10	.10
	D.O. (mg/l)	7.56	7.18	7.38	8.08	7.72	7.76	7.78	7.58	7.66	8.06
	Sample Depth (m)	2	7.5	4.5	3	3.5	2	2		3.5	7.5
	Temp. (°C)	21.60	21.50	22.00	21.70	22.00	27.90			22.10	21.50
	Sal. (°/oo)	.26	.40	.11	.08	.10	.32			.10	.27
	D.O. (mg/l)	7.10	7.04	7.30	7.92	7.70	7.50			7.78	7.96
	Sample Depth (m)	1	3.75	2	1.25	1.75	1	1	.75	1.75	3.5
	Temp. (°C)	25.60	26.20	26.50	25.85	26.10	28.75	32.30	29.80	26.40	26.10
	Sal. (°/oo)	3.13	2.84	2.26	.73	1.90	1.98	3.37	1.98	1.31	.68
	D.O. (mg/l)	7.91	7.36	7.17	7.60	7.41	7.55	7.15	7.51	6.98	7.53
6-20	Time (EDT)	1013	1039	1106	1127	1144	1204	1223	1245	1300	1320
	Secchi Depth (cm)	46	37	20	31	37	47	36	39	35	35
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	25.80	26.40	26.40	26.20	26.70	28.80	32.35	30.00	27.20	27.40
	Sal. (°/oo)	3.06	2.97	2.28	.74	1.96	1.97	3.35	1.68	1.18	.73
	D.O. (mg/l)	7.55	7.36	6.73	7.49	7.22	7.49	6.96	7.49	7.43	7.87
	Sample Depth (m)	1	3.75	2	1.25	1.75	1	1	.75	1.75	3.5
	Temp. (°C)	25.60	26.20	26.50	25.85	26.10	28.75	32.30	29.80	26.40	26.10
	Sal. (°/oo)	3.13	2.84	2.26	.73	1.90	1.98	3.37	1.98	1.31	.68
	D.O. (mg/l)	7.91	7.36	7.17	7.60	7.41	7.55	7.15	7.51	6.98	7.53
	Sample Depth (m)	2	7.5	4	2.5	3.5	2	2		3.5	7
	Temp. (°C)	25.50	26.20	26.60	26.00	26.10	32.35			26.40	26.40
	Sal. (°/oo)	3.29	2.88	2.27	.78	1.83	3.36			1.36	1.23
	D.O. (mg/l)	8.01	7.28	7.05	7.42	7.04	7.07			7.20	7.30

Table A1  
(cont.)  
James River Hydrographic Data 1978  
Plankton Sampling Runs

Date	Parameter	Station									
		DWS	INTAKE	HPS	HPW3	HPW2	HPW1	DISCHARGE	CBE	CBC	JI
7-11	Time (EDT)	1050	1132	1210	1236	1257	1315	1336	1440	1503	1530
	Secchi Depth (cm)	47	32	47	36	40	61	39	38	37	36
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	27.10	26.80	28.90	27.10	27.10	28.30	32.20	27.60	27.30	26.90
	Sal. (°/oo)	5.29	4.40	3.13	2.00	1.34	3.04	4.78	2.65	1.78	1.24
	D.O. (mg/l)	6.83	6.53	6.81	6.91	6.65	6.97	6.11	6.45	7.16	6.61
	Sample Depth (m)	1	2.75	1.25	1.25	1.75	1	1	1	1.5	2.5
	Temp. (°C)	26.90	26.30	28.80	27.00	26.90	28.10	31.90	28.50	27.30	26.80
	Sal. (°/oo)	5.34	4.50	3.14	2.01	1.34	3.02	4.80	2.90	1.80	1.35
	D.O. (mg/l)	6.63	6.65	6.53	7.44	6.61	6.73	6.13	6.41	6.69	6.75
	Sample Depth (m)	2	5.5	2.5	2.5	3.5		2		3	5
	Temp. (°C)	26.90	26.20	28.70	26.90	26.90		31.90		27.30	26.70
	Sal. (°/oo)	5.26	4.71	3.16	2.09	1.37		4.77		1.83	1.23
	D.O. (mg/l)	6.53	6.61	6.81	6.83	6.93		5.97		6.57	6.93
	Time (EDT)	1000	1045	1120	1200	1220	1243	1334	1420	1445	1510
	Secchi Depth (cm)	52	52	61	45	53	52	35	52	52	45
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	28.20	28.75	30.80	29.20	29.25	31.50	37.50	29.90	30.40	29.30
	Sal. (°/oo)	6.21	5.28	3.25	1.70	1.35	3.28	5.82	1.49	1.35	1.24
	D.O. (mg/l)	6.12	6.14	6.42	6.44	6.26	6.72	6.54	7.40	6.88	6.38
	Sample Depth (m)	1	2	2	1.25	1.75	1	1	1	1.75	3.5
	Temp. (°C)	27.90	28.40	30.30	28.80	28.80	31.70	37.40	30.10	30.20	29.00
	Sal. (°/oo)	6.25	5.41	3.76	1.72	1.38	3.45	5.82	1.57	2.63	1.30
	D.O. (mg/l)	5.76	6.28	6.06	6.48	6.12	6.30	6.26	7.54	6.00	6.14
	Sample Depth (m)	2	4	4	2.5	3.5		2		3.5	7
	Temp. (°C)	27.80	28.10	30.10	28.85	29.00		37.40		30.80	29.10
	Sal. (°/oo)	6.25	5.55	3.79	1.75	1.39		5.74		2.92	1.77
	D.O. (mg/l)	5.98	5.86	5.84	6.16	6.14		6.38		6.08	5.86

Table A1  
(cont.)  
James River Hydrographic Data 1978  
Plankton Sampling Runs

Date	Parameter	Station									
		DWS	INTAKE	HPS	HPW3	HPW2	HPW1	DISCHARGE	CBE	CBC	JI
9-19	Time (EDT)	1012	1047	1125	1147	1210	1230	1300	1345	1402	1425
	Secchi Depth (cm)	76	44	32	65	51	79	47	57	58	52
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	26.10	26.05	26.90	26.70	26.90	28.40	34.70	29.50	27.50	26.50
	Sal. (°/oo)	6.90	8.40	6.55	4.59	5.69	5.69	8.47	5.67	5.57	3.95
	D.O. (mg/l)	6.37	6.15	6.23	6.27	6.27	6.49	5.55	6.37	6.11	6.21
	Sample Depth (m)	1	4	2.25	1.25	1.75	1	1	1	1.5	4
	Temp. (°C)	26.10	26.00	26.90	26.60	26.90	28.60	34.60	29.80	27.50	26.70
	Sal. (°/oo)	6.95	8.56	6.52	4.64	5.70	5.72	8.47	5.72	5.56	4.59
	D.O. (mg/l)	6.23	6.05	6.19	6.19	6.11	4.62	5.57	6.35	5.97	6.09
	Sample Depth (m)	2	8	4.5	2.5	3.5		2		3.25	8
	Temp. (°C)	26.10	26.05	26.90	26.60	27.00		34.60		27.50	26.80
	Sal. (°/oo)	7.17	8.60	6.55	4.73	5.62		8.43		5.56	5.38
	D.O. (mg/l)	6.01	5.99	6.11	6.17	6.25		5.55		6.07	6.63
	Time (EDT)	0845	0917	0947	1010	1036	1105	1137	1234	1258	1328
	Secchi Depth (cm)	110	63	52	40	73	104	50	86	82	66
	Sample Depth (m)	0	0	0	0	0	0	0	0	0	0
	Temp. (°C)	15.20	15.20	15.90	15.90	16.25	18.40	23.30	16.90	17.60	16.50
	Sal. (°/oo)	9.93	11.02	10.01	8.06	9.20	8.71	11.33	6.99	8.69	7.21
	D.O. (mg/l)	7.72	7.76	7.68	7.96	7.82	7.86	7.60	8.08	7.78	--
11-14	Sample Depth (m)	1.25	4	2.5	1.5	2	1	1	1	2	4.5
	Temp. (°C)	15.10	15.20	16.00	15.90	16.20	17.90	23.25	17.20	17.40	16.10
	Sal. (°/oo)	10.89	11.06	9.99	8.06	9.20	9.00	11.31	7.41	8.95	8.17
	D.O. (mg/l)	7.68	7.86	7.76	7.86	7.70	7.90	7.51	8.46	7.78	7.60
	Sample Depth (m)	2.5	8	5	3	4	2	2		4	9
	Temp. (°C)	15.10	15.20	16.00	15.90	16.25	17.90	23.20		17.30	16.10
	Sal. (°/oo)	11.09	10.98	9.94	8.10	9.17	9.00	11.24		9.19	8.46
	D.O. (mg/l)	7.78	7.68	7.82	7.68	7.74	7.70	7.27		7.80	6.99

Table A2

## James River Hydrographic Data 1978

		Benthos Sampling Runs							
Date	Station	6	12	14	16	15	13	11	10
Jan. 18	Time (EST)	1005	1025	1036	1051	1115	1127	1135	1149
	Secchi Depth (cm)	18	22	16	22	15	21	24	17
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	2.80	2.60	2.30	2.60	4.90	6.80	6.80	4.70
	Sal. (°/oo)	.14	.17	.09	.10	.32	.18	.18	.14
	D.O. (mg/l)	12.07	12.21	11.70	12.07	12.01	11.70	12.75	11.40
	Sample Depth (m)	1.5	1	8	2			4	4
	Temp. (°C)	2.75	2.70	2.30	2.65			6.80	4.70
	Sal. (°/oo)	.33	.16	.10	.10			.17	.14
	D.O. (mg/l)	13.17	12.27	11.88	11.97			11.68	11.48
	Station	5	9	8	4	7	3	2	1
	Time (EST)	1200	1215	1225	1236	1246	1256	1305	1317
	Secchi Depth (cm)	18	18	17	13	33	23	17	21
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	5.00	9.20	4.40	3.50	3.80	3.60	2.80	3.40
	Sal. (°/oo)	.38	.20	.11	.09	.10	.10	.08	.10
	D.O. (mg/l)	11.56	10.54	11.36	11.16	11.88	11.62	11.99	11.94
	Sample Depth (m)	3		4	3			1.5	5
	Temp. (°C)	5.00		4.80	3.70			2.80	3.40
	Sal. (°/oo)	.15		.11	.09			.08	.10
	D.O. (mg/l)	11.42		11.50	11.60			11.34	11.82



Table A2  
(cont.)

James River Hydrographic Data 1978

		Benthos Sampling Runs							
Date	Station	6	12	14	16	15	13	11	10
April 10	Time (EST)	1003	1016	1034	1050	1103	1116	1125	1134
	Secchi Depth (cm)	26	29	31	28	19	22	23	30
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	14.55	15.4	15.20	15.05	14.80	15.35	16.35	16.00
	Sal. (°/oo)	.10	.10	-	.14	.18	.14	.10	.10
	D.O. (mg/l)	8.45	8.46	8.98	8.69	9.00	9.04	8.45	8.77
	Sample Depth (m)	1.5		7	2			4.5	4
	Temp. (°C)	14.55		15.05	15.00			16.00	16.00
	Sal. (°/oo)	.58		3.66	.16			-	.10
	D.O. (mg/l)	8.42		8.54	8.87			9.10	8.86
	Station	5	9	8	4	7	3	2	1
	Time (EST)	1142	1150	1220	1230	1240	1247	1256	1305
	Secchi Depth (cm)	26	25	25	24	28	32	26	43
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	16.35	17.40	16.35	15.85	18.20	16.10	15.20	15.60
	Sal. (°/oo)	.10	.11	.10	.10	.12	.09	-	-
	D.O. (mg/l)	8.96	8.69	8.71	8.82	8.94	9.16	9.06	8.86
	Sample Depth (m)	3		4	4			2	
	Temp. (°C)	16.35		16.35	15.60			15.20	
	Sal. (°/oo)	.13		.10	-			.09	
	D.O. (mg/l)	8.54		8.63	8.69			9.08	

Table A2  
(cont.)

James River Hydrographic Data 1978

		Benthos Sampling Runs							
Date	Station	6	12	14	16	15	13	11	10
June 13	Time (EDT)	0710	0723	0738	0750	0805	0815	0823	0840
	Secchi Depth (cm)	26	23	40	42	31	30	34	33
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	25.0	24.3	24.9	23.9	23.8	23.8	25.4	24.8
	Sal. (°/oo)	.20	.23	.58	1.89	1.75	1.29	.70	.53
	D.O. (mg/l)	7.39	6.80	6.64	7.43	6.94	6.88	6.84	6.98
	Sample Depth (m)	1.5		7	2			4.5	4
	Temp. (°C)	24.7		24.5	23.8			25.4	24.8
	Sal. (°/oo)	.30		.76	1.86			.72	.54
	D.O. (mg/l)	4.65		7.23	8.02			6.88	6.80
	Station	5	9	8	4	7	3	2	1
	Time (EDT)	0849	0859	0931	0940	0948	0958	1035	1045
	Secchi Depth (cm)	29	29	47	36	22	26	39	40
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	25.3	25.2	24.9	24.5	23.2	24.4	24.6	24.2
	Sal. (°/oo)	.67	.58	.33	.21	.18	.18	.16	.14
	D.O. (mg/l)	6.88	6.68	6.82	6.74	7.59	7.39	7.04	7.11
	Sample Depth (m)	3		4	3			2	
	Temp. (°C)	25.1		24.6	24.5			24.4	
	Sal. (°/oo)	.65		.30	.22			.16	
	D.O. (mg/l)	6.86		6.72	6.80			6.80	

Table A2  
(cont.)

James River Hydrographic Data 1978

		Benthos Sampling Runs							
Date	Station	6	12	14	16	15	13	11	10
July 12	Time (EDT)	0656	0709	0722	0736	0750	0806	0816	0828
	Secchi Depth (cm)	35	36	63	39	27	33	34	47
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	25.6	25.0	25.7	25.6	24.2	25.0	26.3	25.8
	Sal. (°/oo)	2.15	2.49	6.18	5.65	5.01	4.05	3.69	3.81
	D.O. (mg/l)	7.01	6.03	6.93	7.36	5.99	6.71	7.04	6.79
	Sample Depth (m)	1		7	2			4.5	4
	Temp. (°C)	25.3		26.4	25.3			26.1	25.8
	Sal. (°/oo)	2.74		7.55	6.01			3.70	3.78
	D.O. (mg/l)	6.45		5.73	6.41			6.73	6.71
	Station	5	9	8	4	7	3	2	1
	Time (EDT)	0837	0845	0855	0906	0916	0925	0940	0950
	Secchi Depth (cm)	34	37	50	40	36	26	39	44
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. (°C)	25.9	26.0	26.8	25.9	27.0	24.5	25.0	24.0
	Sal. (°/oo)	3.20	2.83	3.21	2.06	3.14	2.00	1.71	1.23
	D.O. (mg/l)	7.14	6.93	6.71	6.71	6.73	7.20	6.95	7.64
	Sample Depth (m)	3		4	3			2	
	Temp. (°C)	25.7		26.3	26.1			25.0	
	Sal. (°/oo)	3.34		3.29	2.68			1.72	
	D.O. (mg/l)	6.43		7.01	6.57			6.91	

Table A2  
(cont.)

James River Hydrographic Data 1978

Date	Station	6	12	14	16	15	13	11	10
Aug. 7	Time (EDT)	0742	0756	0814	0835	0853	0858	0910	0922
	Secchi Depth (cm)	33	37	48	26	25	28	31	28
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. ( $^{\circ}$ C)	27.5	27.2	28.5	28.0	27.0	29.8	32.5	28.2
	Sal. ( $^{\circ}$ /oo)	1.26	1.45	2.30	3.40	4.15	2.98	3.46	1.22
	D.O. (mg/l)	5.44	5.89	6.15	5.99	4.65	6.21	5.85	5.85
	Sample Depth (m)	1		6	1.5			4	3.5
	Temp. ( $^{\circ}$ C)	27.5		28.5	28.0			32.5	28.0
	Sal. ( $^{\circ}$ /oo)	1.38		2.52	3.42			3.42	1.26
	D.O. (mg/l)	6.01		6.11	5.97			5.80	6.03
	Station	5	9	8	4	7	3	2	1
	Time (EDT)	0925	0933	0943	0955	1003	1015	1025	1033
	Secchi Depth (cm)	35	41	31	27	26	27	32	42
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. ( $^{\circ}$ C)	28.0	31.8	28.2	28.0	27.5	28.0	28.2	28.0
	Sal. ( $^{\circ}$ /oo)	1.03	3.42	1.34	.86	1.55	1.52	1.02	1.35
	D.O. (mg/l)	5.87	6.27	5.72	5.86	6.48	6.09	5.74	6.88
	Sample Depth (m)	2.5		3	2.5			1.75	
	Temp. ( $^{\circ}$ C)	28.0		27.8	27.8			28.0	
	Sal. ( $^{\circ}$ /oo)	1.04		1.30	.89			1.04	
	D.O. (mg/l)	5.12		5.66	5.83			5.76	

Table A2  
(cont.)

James River Hydrographic Data 1978

		Benthos Sampling Runs							
Date	Station	6	12	14	16	15	13	11	10
Oct. 18	Time (EDT)	0940	1005	1020	1045	1140	1155	1206	1222
	Secchi Depth (cm)	80	66	79	106	51	60	34	71
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. ( $^{\circ}$ C)	15.4	16.1	17.5	17.3	17.0	16.8	18.4	18.1
	Sal. ( $^{\circ}$ /oo)	5.08	6.83	7.28	9.30	9.84	9.02	8.46	7.04
	D.O. (mg/l)	7.78	7.52	7.90	7.94	7.86	8.02	7.94	8.24
	Sample Depth (m)	1.5		7	2.5		1	5	4.5
	Temp. ( $^{\circ}$ C)	16.5		17.0	16.7		16.8	18.3	17.4
	Sal. ( $^{\circ}$ /oo)	6.09		8.85	10.66		9.04	8.46	7.95
	D.O. (mg/l)	8.04		7.74	7.84		7.84	7.92	7.98
	Station	5	9	8	4	7	3	2	1
	Time (EDT)	1230	1240	1300	1310	1347	1357	1408	1417
	Secchi Depth (cm)	34	76	67	46	56	90	79	106
	Sample Depth (m)	0	0	0	0	0	0	0	0
	Temp. ( $^{\circ}$ C)	17.6	19.8	19.0	17.8	20.9	17.6	17.4	17.1
	Sal. ( $^{\circ}$ /oo)	7.38	7.68	7.43	6.40	7.04	5.57	5.91	5.28
	D.O. (mg/l)	8.06	7.92	7.78	8.12	7.98	8.40	8.26	8.90
	Sample Depth (m)	3.5	1	4.5	3.5	1	1	2.5	1
	Temp. ( $^{\circ}$ C)	17.6	19.6	18.5	18.0	20.8	17.5	16.7	17.0
	Sal. ( $^{\circ}$ /oo)	7.48	7.66	7.50	6.56	7.00	6.04	5.65	5.28
	D.O. (mg/l)	8.04	7.96	7.84	8.10	8.14	8.58	8.34	8.72

Appendix B  
Biological Data Tables for the  
Plankton Studies

Table B1

James River Chlorophyll Concentrations 1978  
( $\mu\text{g Chl a}$  per liter, surface samples, two samples per station)

Station	Date							
	Feb. 28	Apr. 18	May 23	June 20	July 11	Aug. 23	Sept. 19	Nov. 14
DWS	2.2	1.3	8.9	5.2	11.7	3.9	4.9	1.7
	2.4	1.2	11.5	4.9	10.9	4.7	5.2	1.8
Intake	2.3	2.6	7.2	5.5	9.4	5.8	7.6	3.5
	2.4	2.7	7.2	6.9	8.6	6.2	7.6	3.0
HPS	1.5	1.8	11.5	7.4	7.9	7.1	3.0	3.5
	2.2	1.8	9.2	6.6	7.8	5.8	3.2	1.8
HPW3	1.9	1.4	15.8	4.5	10.8	5.6	3.0	3.7
	2.0	1.8	15.7	3.8	11.2	6.2	3.0	3.7
HPW2	1.8	2.4	15.5	3.1	8.9	6.3	3.5	1.8
	2.3	2.1	10.6	2.6	8.3	6.0	3.2	1.9
HPW1	1.7	1.2	6.9	4.2	8.2	5.8	2.9	1.8
	1.7	1.3	6.8	3.5	7.8	6.0	3.2	2.1
Discharge	3.0	2.7	7.3	3.9	5.5	3.8	3.0	4.0
	2.9	2.5	6.6	3.5	5.7	3.7	2.5	2.7
CBE	1.6	1.6	5.4	3.9	5.4	6.7	4.9	2.0
	1.4	1.3	6.5	3.7	8.1	6.0	4.6	3.1
CBC	1.8	1.8	8.6	4.1	7.5	3.6	2.6	2.7
	1.7	1.8	8.9	3.6	7.8	4.0	1.8	2.5
JI	1.7	1.9	8.3	6.5	6.2	5.7	2.8	2.8
	2.0	2.1	8.7	4.4	6.4	5.4	2.9	2.8

Table B2

James River Phytoplankton Cell Counts, 1978  
(Total cells per ml, surface samples, two samples per station)

Station	Date							
	Feb. 28	Apr. 18	May 23	June 20	July 11	Aug. 23	Sept. 19	Nov. 14
DWS	1050 950	900 900	6600 5100	2900 2950	9850 11550	2450 2550	1750 1800	1300 1000
Intake	700 750	1350 1300	4800 5150	3850 2650	8000 8650	4600 4300	3850 3450	950 1100
HPS	450 350	1500 1250	4900 4400	1250 1400	7900 7900	4850 4500	1100 1400	900 950
HPW3	150 150	1300 1450	16400 13950	1950 1750	9550 9100	4600 4750	2050 2250	550 550
HPW2	150 100	700 700	7400 8550	1950 1800	7250 7800	6800 6600	1250 1300	750 900
HPW1	350 350	700 700	5100 4100	2150 2750	7650 7900	5500 5500	1900 1900	900 850
Intake Canal (Upstream)	750 1000	1000 1350	4600 4600	3500 2850	7350 6550	3550 2600	3400 2200	900 1000
Intake Canal (Downstream)	1200 1100	800 750	4650 3950	1600 1300	4150 4600	2700 3250	1400 1750	900 800
Discharge Canal	1100 1050	650 800	3750 3600	1250 1450	5450 5600	2150 2900	900 850	900 850
CBE	400 300	900 800	4350 5950	3200 3050	4350 8600	6600 5850	1850 1950	850 850
CBC	250 250	1100 1250	6250 5850	2050 1650	6450 5500	5550 6600	1050 1700	1050 950
JI	200 200	1450 1100	9000 7500	3900 2850	6350 5800	4900 3600	1850 2250	950 950
Discharge	1400 1200	1650 1500	4400 3350	1800 1800	5700 5800	2150 2300	1400 1650	950 850



Appendix C

Biological Data Tables for  
the Benthos Study

Table C1

James River Benthos; January 18, 1978

Species, Number of Individuals and Total Wet Weight  
(Without Clam Shell) in Grams per 0.1 m<sup>2</sup> at Each Station

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Mollusks</u>																
<u>Rangia cuneata</u>	4	13	3	13	9	1	2	7	3		13	13	5			8
<u>Congeria leucophaeta</u>																
<u>Macoma mitchelli</u>	1	2		1	2		1			1	5	2	2			2
<u>Macoma balthica</u>																
<u>Corbicula manilensis</u>											1					
<u>Hydrobia sp.</u>											5	2				
<u>Mya arenaria</u>																
<u>Modiolus demissus</u>								5							2	2
Unknown gastropod		1												1		1
<u>Annelids</u>																
Polychaetes																
<u>Scolecopelides viridis</u>											3	1	1			1
<u>Nereis succinea</u>	2	1						6			4	17	1	2	1	3
<u>Lysipidides grayi</u>																
<u>Polydora ligni</u>																
<u>Laeonereis culveri</u>	1															
<u>Heteromastus filiformis</u>				1							3					
Oligochaetes											1	1				
<u>Amphipods</u>																
<u>Gammarus sp.</u>				1	1											
<u>Corophium lacustre</u>								1							1	
<u>Lepidactylus dytiscus</u>			2								1					
<u>Leptocheirus plumulosus</u>						1						2		1		1
<u>Monoculodes edwardsi</u>																
<u>Caprella sp.</u>										1						

Table C1 (cont'd)

Species	1	2	3	4	5	6	Station		9	10	11	12	13	14	15	16
							7	8								
<u>Decapods</u>																
<u>Callinectes</u> <u>sapidus</u>																1
<u>Isopods</u>																
<u>Cyathura</u> <u>polita</u>		3		1				1		1	3	2		2		1
<u>Edotea</u> <u>triloba</u>																
<u>Chiridotea</u> <u>almyra</u>									1							
<u>Diporan</u> <u>larvae</u>		1										1				
<u>Nemerteans</u>					1			1								
<u>Hydroids</u>				X	X		X	X		X	X					X
<u>Balanus</u> <u>sp.</u>								13			2				32	16
<u>Nematodes</u>						1										
<u>Ectoprocts</u>				X		X		X			X	X		X	X	
Biomass (grams)	1.62	5.70	.63	4.05	1.74	1.16	1.70	1.84	.04	.01	1.10	8.70	1.74	.02	.02	2.55

Table C2

James River Benthos; April 10, 1978

Species, Number of Individuals and Total Wet Weight  
(Without Clam Shell) in Grams per 0.1 m<sup>2</sup> at Each Station

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Mollusks</u>																
<u>Rangia cuneata</u>	3	4	1	19		2	1	9	1	1	3			1	1	6
<u>Congeria leucophaeta</u>				1												
<u>Macoma mitchelli</u>																
<u>Macoma balthica</u>							1	2								
<u>Corbicula manilensis</u>												1				
<u>Hydrobia sp.</u>	1			7	17						2				3	2
<u>Mya arenaria</u>																
<u>Modiolus demissus</u>								4								1
Unknown gastropod										1						
<u>Annelids</u>																
Polychaetes																
<u>Scolecoides viridis</u>			1	2	2		1			1	2			1	1	1
<u>Nereis succinea</u>	5		2					6			1	1	1		2	3
<u>Lysipidides grayi</u>																
<u>Polydora ligni</u>																
<u>Laeonereis culveri</u>																
<u>Heteromastus filiformis</u>				2	1						2					
Oligochaetes										1						
Nemertean				1												
Oyster spat																3

Table C2 (cont'd)

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Amphipods</u>																
<u>Gammarus</u> sp.	1			1												
<u>Corophium lacustre</u>																1
<u>Lepidactylus dytiscus</u>			3		3		6	1	6			4				
<u>Leptocheirus plumulosus</u>											1					
<u>Monoculodes edwardsi</u>																
<u>Caprella</u> sp.																
<u>Isopods</u>																
<u>Cyathura polita</u>		1		1						1					1	
<u>Edotea triloba</u>															1	
<u>Chiridotea almyra</u>												2				
<u>Dipteran larvae</u>																
		1				1		1								
<u>Nemerteans</u>																
<u>Hydroids</u>																
		X		X		X		X		X	X	X		X	X	X
<u>Balanus</u> sp.								13								2
<u>Nematodes</u>																
<u>Ectoproct</u>																
								X			X	X			X	X
Biomass (Grams)	2.74	1.70	.78	5.47	.04	1.43	.74	3.84	.49	.15	1.13	.02	.01	.02	.04	1.76

Table C3

James River Benthos; June 13, 1978  
 Species, Number of Individuals and Total Wet Weight  
 (Without Clam Shell) in Grams per 0.1 m<sup>2</sup> at Each Station

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Mollusks</u>																
<u>Rangia cuneata</u>	4	4	4	13	2	28	7	6	4		3	1	15	4	2	6
<u>Congeria leucophaeta</u>																
<u>Macoma mitchelli</u>																
<u>Macoma balthica</u>																
<u>Corbicula manilensis</u>																
<u>Hydrobia</u> sp.			4				1									
<u>Mya arenaria</u>																
<u>Modiolus demissus</u>																
Shellless Opisthobranch															1	
<u>Annelids</u>																
Polychaetes																
<u>Scolecopelides viridis</u>				5	13	7		3	3	4	25				3	
<u>Nereis succinea</u>						3							1			1
<u>Lysipiddes grayi</u>																
<u>Polydora ligni</u>																
<u>Laeonereis culveri</u>																
<u>Heteromastus filiformis</u>											4				1	
Oligochaetes						1										
<u>Amphipods</u>																
<u>Gammarus</u> sp.				3											1	
<u>Corophium lacustre</u>								1	1							
<u>Lepidactylus dytiscus</u>			2						1			1		1		
<u>Leptocheirus plumulosus</u>	1	10		8		25	4	1	5	1		2	8		25	3
<u>Monoculodes edwardsi</u>																
<u>Caprella</u> sp.																

Table C3 (cont'd.)

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Isopods</u>																
<u>Cyathura polita</u>								1			1					
<u>Edotea triloba</u>																
<u>Chiridotea almyra</u>					2						7					
<u>Decapods</u>																
<u>Rhithropanopeus harrisii</u>										1						
<u>Dipteran Larvae</u>																
<u>Nemerteans</u>					1				1							
<u>Hydroids</u>				X		X		X	X	X	X	X	X		X	∞
<u>Balanus</u> sp.	2							1						1		
<u>Nematodes</u>																
<u>Ectoprocts</u>								X	X		X		X	X		
Biomass (grams)	1.75	1.10	.06	4.00	.25	8.10	2.05	.60	.65	1.05	1.30	.90	.05	.72	.10	1.90

Table C4

James River Benthos; July 12, 1978  
 Species, Number of Individuals and Total Wet Weight  
 (Without Clam Shell) in Grams per 0.1 m<sup>2</sup> at Each Station

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Mollusks</u>																
<u>Rangia cuneata</u>	3	9	1	3	1	22	6	9			5		6		13	5
<u>Congeria leucophaeta</u>																
<u>Macoma mitchelli</u>																
<u>Macoma balthica</u>																
<u>Corbicula manilensis</u>												3				
<u>Hydrobia sp.</u>																
<u>Mya arenaria</u>																
<u>Modiolus demissus</u>																
<u>Annelids</u>																
<u>Polychaetes</u>																
<u>Scolecoides viridis</u>		2		9	2	30	1	6	1		25	1				4
<u>Nereis succinea</u>													1			1
<u>Lysipidde grayi</u>						4										
<u>Polydora ligni</u>																
<u>Laeonereis culveri</u>																
<u>Heteromastus filiformis</u>											5		2			
<u>Oligochaetes</u>	1					1										
<u>Amphipods</u>																
<u>Gammarus sp.</u>						11					1					
<u>Corophium lacustre</u>						106	3	3				1				
<u>Lepidactylus dytiscus</u>			3						6			3				
<u>Leptocheirus plumulosus</u>	4	25	5	13		12	6		1				8	20	1	29



Table C4 (cont'd.)

## Species

	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Monoculodes edwardsi</u>																
<u>Caprella</u> sp.																
<u>Isopods</u>																
<u>Cyathura polita</u>		1				3		2							2	
<u>Edotea triloba</u>																
<u>Chiridotea almyra</u>					1						1					
<u>Dipteran Larvae</u>				1		1										
<u>Nemerteans</u>																
<u>Hydroids</u>	X	X		X	X	X					X			X		∞
<u>Balanus</u> sp.																
<u>Nematodes</u>																
Biomass (grams)	.05	5.25	.44	.67	.02	12.30	2.00	1.35	.02		1.64	.02	.65	.02	.80	3.20

Table C5

James River Benthos; August 7, 1978

Species, Number of Individuals and Total Wet Weight  
(Without Clam Shell) in Grams per 0.1 m<sup>2</sup> at Each Station

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Mollusks</u>																
<u>Rangia cuneata</u>	13	3	3	15	8	10	7	21	6	16	18	14	26		9	15
<u>Congeria leucophaeta</u>								1						3		
<u>Macoma mitchelli</u>						1				2			1			
<u>Macoma balthica</u>																
<u>Corbicula manilensis</u>								1								
<u>Hydrobia sp.</u>						1	1							1		
<u>Mya arenaria</u>																
<u>Modiolus demissus</u>														1		
<u>Annelids</u>																
<u>Polychaetes</u>																
<u>Scolecoplepides viridis</u>				2	1	1					1		7			3
<u>Nereis succinea</u>	2												2		1	1
<u>Lysipiddes grayi</u>																
<u>Polydora ligni</u>														2		
<u>Laeonereis culveri</u>																
<u>Heteromastus filiformis</u>											4		2			
<u>Oligochaetes</u>				5	4	3	1			2			1			
<u>Amphipods</u>																
<u>Gammarus sp.</u>		1								1	1					
<u>Corophium lacustre</u>		1		1	1	1	3		9	1		1		5		
<u>Lepidactylus dytiscus</u>			3									9				
<u>Leptocheirus plumulosus</u>	1	2	2	11	1	19	4	2	4	7		4	23	3	12	17

Table C5 (cont'd.)

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Monoculodes edwardsi</u>																
<u>Caprella</u> sp.																
<u>Isopods</u>																
<u>Cyathura polita</u>		1		3		3				1	2			3		
<u>Edotea triloba</u>																
<u>Chiridotea almyra</u>					7						9					
<u>Dipteran Larvae</u>																
<u>Nemerteans</u>													1			
<u>Hydroids</u>			X				X				X					
<u>Balanus</u> sp.							1								1	
<u>Nematodes</u>		1														
<u>Ectoprocts</u>							X									
Biomass (grams)	7.70	1.50	.05	3.00	.25	3.75	4.00	2.85	.05	.12	7.20	.05	3.35	.02	.20	3.35

Table C6

James River Benthos; October 18, 1978

Species, Number of Individuals and Total Wet Weight  
(Without Clam Shell) in Grams per 0.1 m<sup>2</sup> at Each Station

Species	Station															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Mollusks</u>																
<u>Rangia cuneata</u>	4	10	8	10	13	7	3	17	4	4	36	3	6	2	5	6
<u>Congeria leucophaeta</u>								7		1	1	3				
<u>Macoma mitchelli</u>										12	7				1	2
<u>Macoma balthica</u>												3				
<u>Corbicula manilensis</u>												2				
<u>Hydrobia sp.</u>																
<u>Mya arenaria</u>																
<u>Modiolus demissus</u>																
<u>Annelids</u>																
Polychaetes																
<u>Scolecoides viridis</u>					4	3	2		1		1				1	5
<u>Nereis succinea</u>	1		3				15	1	6	1	2	1	4	1		
<u>Lysipidides grayi</u>																
<u>Polydora ligni</u>																
<u>Laeonereis culveri</u>																
<u>Heteromastus filiformis</u>											16					
<u>Oligochaetes</u>							3				1					
<u>Amphipods</u>																
<u>Gammarus sp.</u>																
<u>Corophium lacustre</u>												10		1		
<u>Lepidactylus dytiscus</u>									5						2	
<u>Leptocheirus plumulosus</u>		7		10	5	8	1			1				10	7	13

Table C6 (cont'd.)

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Station																
<u>Monoculodes edwardsi</u>					1											
<u>Caprella</u> sp.																
<u>Isopods</u>																
<u>Cyathura polita</u>		1										2	1	2		3
<u>Edotea triloba</u>																
<u>Chiridotea almyra</u>					1							1				
<u>Decapods</u>																
<u>Rhithropanopeus harrisii</u>								2								
<u>Dipteran Larvae</u>																
<u>Nemerteans</u>					1					1		3				
<u>Hydroids</u>		X			X							X				
<u>Balanus</u> sp.					1			5							6	
<u>Nematodes</u>																
Biomass (grams)	4.00	3.40	1.15	1.80	.25	2.75	1.30	2.25	.82	.05	3.02	.08	1.90	.02	.04	.70

Table C7  
Diversity and Related Parameters for Benthic Samples

January 18, 1978

Station Number	Number of Individuals	Number of SPECIES	SHANNON Formula H-PRIME	RICHNESS S-1/LN N
1	8	4	1.7500	1.4427
2	21	6	1.7799	1.6423
3	5	2	0.9710	0.6213
4	17	5	1.2577	1.4118
5	13	4	1.3520	1.1696
6	3	3	1.5850	1.8205
7	3	2	0.9183	0.9102
8	34	7	2.2970	1.7015
9	4	2	0.8113	0.7213
10	3	3	1.5850	1.8205
11	41	11	3.0261	2.6928
12	41	9	2.2943	2.1543
13	9	4	1.6577	1.3654
14	6	4	1.9183	1.6743
15	36	4	0.6699	0.8372
16	36	10	2.4823	2.5115
All Stations Combined	280	23	3.0497	3.9043

Table C8  
Diversity and Related Parameters for Benthic Samples

April 10, 1978

Station Number	Number of Individuals	Number of SPECIES	SHANNON Formula H-PRIME	RICHNESS S-1/LN N
1	10	4	1.6855	1.3029
2	6	3	1.2516	1.1162
3	7	4	1.8424	1.5417
4	34	8	2.0180	1.9850
5	23	4	1.2087	0.9568
6	3	2	0.9183	0.9102
7	9	4	1.4466	1.3654
8	36	7	2.3326	1.6743
9	7	2	0.5917	0.5139
10	5	5	2.3219	2.4853
11	11	6	2.4817	2.0852
12	8	4	1.7500	1.4427
13	1	1	0.0000	
14	2	2	1.0000	1.4427
15	9	6	2.4194	2.2756
16	19	8	2.7206	2.3774
All Stations Combined	190	22	3.3393	4.0020

Table C9

## Diversity and Related Parameters for Benthic Samples

June 13, 1978

Station Number	Number of Individuals	Number of SPECIES	SHANNON Formula H-PRIME	RICHNESS S-1/LN N
1	7	3	1.3788	1.0278
2	14	2	0.8631	0.3789
3	10	3	1.5219	0.8686
4	29	4	1.8073	0.8909
5	18	4	1.2752	1.0379
6	64	5	1.7014	0.9618
7	12	3	1.2807	0.8048
8	13	6	2.1416	1.9494
9	15	6	2.2826	1.8463
10	6	3	1.2516	1.1162
11	40	5	1.6094	1.0843
12	4	3	1.5000	1.4427
13	24	3	1.1432	0.6293
14	7	4	1.6645	1.5417
15	32	5	1.1609	1.1542
16	10	3	1.2955	0.8686
All Stations Combined	305	16	2.5297	2.6075



Table C10

## Diversity and Related Parameters for Benthic Samples

July 12, 1978

Station Number	Number of Individuals	Number of SPECIES	SHANNON Formula H-PRIME	RICHNESS S-1/LN N
1	8	3	1.4056	0.9618
2	37	4	1.2466	0.8308
3	9	3	1.3516	0.9102
4	26	4	1.5700	0.9208
5	4	3	1.5000	1.4427
6	190	9	2.0314	1.5247
7	16	4	1.7641	1.0820
8	20	4	1.7822	1.0014
9	8	3	1.0613	0.9618
10	0	0	0.0000	0.0000
11	37	5	1.4442	1.1078
12	8	4	1.8113	1.4427
13	17	4	1.6457	1.0589
14	20	1	0.0000	0.0000
15	16	3	0.8684	0.7213
16	39	4	1.1702	0.8189
All Stations Combined	455	14	2.6185	2.1241

Table C11

## Diversity and Related Parameters for Benthic Samples

August 7, 1978

Station Number	Number of Individuals	Number of SPECIES	SHANNON Formula H-PRIME	RICHNESS S-1/LN N
1	16	3	0.8684	0.7213
2	9	6	2.4194	2.2756
3	8	3	1.5613	0.9618
4	37	6	2.1008	1.3847
5	22	6	2.1116	1.6176
6	39	8	2.1203	1.9107
7	16	5	1.9746	1.4427
8	26	5	1.0759	1.2277
9	19	3	1.5090	0.6792
10	30	7	1.9852	1.7641
11	35	6	1.8839	1.4063
12	28	4	1.5990	0.9003
13	63	8	2.0105	1.6895
14	18	7	2.6214	2.0758
15	22	3	1.2072	0.6470
16	37	5	1.6190	1.1078
All Stations Combined	425	21	2.6470	3.3046

Table C12

## Diversity and Related Parameters for Benthic Samples

October 18, 1978

Station Number	Number of Individuals	Number of SPECIES	SHANNON Formula H-PRIME	RICHNESS S-1/LN N
1	5	2	0.7219	0.6213
2	18	3	1.2327	0.6920
3	11	2	0.8454	0.4170
4	21	3	1.2286	0.6569
5	26	7	2.0960	1.8416
6	18	3	1.4807	0.6920
7	24	5	1.6636	1.2586
8	32	5	1.7891	1.1542
9	16	4	1.8050	1.0820
10	20	6	1.7710	1.6690
11	67	8	1.9389	1.6648
12	25	8	2.5845	2.1747
13	11	3	1.3222	0.8341
14	16	5	1.6738	1.4427
15	22	6	2.2426	1.6176
16	29	5	2.0311	1.1879
All Stations Combined	361	18	3.0416	2.8868