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Ecological survey, upper James River, Surry Nuclear Power Station site, July 1973

Michael E. Bender

Marion Y. Hedgepeth

et al

Bender, Michael

A Post-Operational Study of the

James River in the Vicinity of Hog Point

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Ecological Survey - Upper James River

Surry Nuclear Power Station Site

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Virginia Institute of Marine Science
Gloucester Point, Virginia

by

M. E. Bender
M. Hedgepeth
M. Cavell
R. Jordan
E. Tennyson

Introduction

Beginning in May of 1969 field surveys have been conducted in the Hog Island area of the James River to characterize the biota of the region. The objective of these surveys has been to determine any significant changes in the biota related to the operation of the nuclear power station. Although during the period of study, methods and stations have been changed to adjust the study to changing regulations, its basic character has remained. Communities surveyed have included benthos, epibenthos, zoo- and phytoplankton, fish, and fouling organisms.. In addition, special studies of thermal tolerance have been conducted on oysters and Rangia clams. During this study period an additional aspect was added when entrainment studies to determine zooplankton mortality when entrapped in the thermal plume were initiated.

This report presents a summary of the data collected from January through June of 1973 and some comparisons between previous conditions are presented. However, it should be stressed that climatic conditions seem to be responsible for many changes noticed and hence conclusions related to plant operation are generally not possible.

Methods

All station locations and sampling methods have been described in previous reports with the exception of the entrainment studies. Figure 1 shows the location of the transects utilized in the entrainment study. During this study conducted in June, dye was introduced into the outfall and at intervals after release plankton tows were made within the plume marked by the dye. The samples collected were then stained with a vital stain to differentiate between living and dead organisms. The staining technique has been described by Dressel (1972) in the pre-operational report.

Results and Discussion

Total counts and dominant phytoplankton species collected during the months of January, February, March, April, May and June are shown in tables 1-6. Plankton biomass increased during the study period from approximately 200 cells/ml during January to 5300 cells/ml during June. A corresponding increase is reflected in chlorophyll "a" values shown in Table 7 where the mean level rose from 2.6 ug/1 in January to 4.9 ug/1 in June.

As can be seen from the data presented, neither the dominant species nor the numbers present show any relationship to the plant discharge. During the winter season the plankton were dominated by Skeletonema costatum, Asterionella formosa, Melosira sp., Ankistrodesmus sp. and Nitzschia sp.; while in spring populations Cyclotella sp., Melosira sp., Nitzschia, Kutzingiana, and flagellates were dominant.

Zooplankton collected from each of seven stations during the months of January through June are tabulated in tables 8-13. Average densities per tow ranged from approximately 4,000 in January to about 50,000 in June. Although these increases show general agreement with increases in phytoplankton biomass, the greater quantity of zooplankton appears to exceed the available food from this source.

Over the period of study the stations ranked as follows, based on numbers of organisms from low density to high: Jamestown Island, Deepwater Shoals, Hog Point South, Cobham Bay, Intake, Cobham Bay South and Cobham Bay North. The station located nearest the outfall (CBS) ranked second during the study period while the station off Jamestown Island (CBN) showed the highest populations. No correlations between thermal regime and population levels were revealed by correlation analysis.

Collections of benthos made during the study period are tabulated in Tables 14, 15 and 16, while diversity calculations based on these collections are shown in Table 17. Considering the yearly changes from the 1972 to 1973 collections, diversity increased at 11 stations in the winter, 9 stations in the spring and 12 stations in June. Biomass, however, showed a drastic decline during the same sampling periods with the collections in February of 1973 showing the lowest levels. Without doubt the increased freshwater inflow which the river has been experiencing during the last year is responsible for these changes. At those stations closest to the outfall, 4, 5, 8, 9 and 10, diversity increased at four of the stations between 1972 and 1973. When comparing the winter and spring collections of 1971 and 1973 at these same stations, diversity decreased at four of the stations during the winter and increased at four during June. Dominant organisms in terms of numbers and benthic biomass are the brackish water clam, Rangia cuneata, Scolecolepides viridis, Corophium lacustre and Macoma balthica. These species have been the dominant organisms in this region since the study was initiated.

Fouling organisms collected on plates during the study period are shown in Table 18. Generally fewer species were collected when compared to the 1972 study; however, July and August are the most critical months for this group and better comparisons can be made once that data are available.

The results of the entrainment study are shown in Table 19, and the stations indicated are shown in Figure 1. Data have been normalized to the quantity of water passing through the plankton net on each transect. Although this was our first attempt at such an investigation, we feel that the staining technique worked very well and with further refinement, i.e. replication, the effects of entrainment should be adequately evaluated by the method.

The temperatures observed along the transects are shown below:

Intake	27.0
Outfall	32.4
E1	30.5
E2	29.0
E3	28.0

At the outfall a significant percentage of the major zooplankters failed to take up the stain indicating that they were dead. Most severely affected were amphipods, *Acartia*, and cyclopoid copepods. Along transect E1 there appeared to be significant recovery of amphipods, *Acartia* and copepod naupli; however, from the decrease in numbers of these individuals it is believed that the dead organisms settled to the bottom and hence the increase in survival. Only the cyclopoid copepods showed increases in numbers and mortality. Survivals along the other transects within the plume were similar to the control.

The discharge structure appears to act as breeding grounds for the amphipods since they are only found in samples at the outfall and directly outside.

Figure 1

JAMES RIVER SAMPLING STATIONS

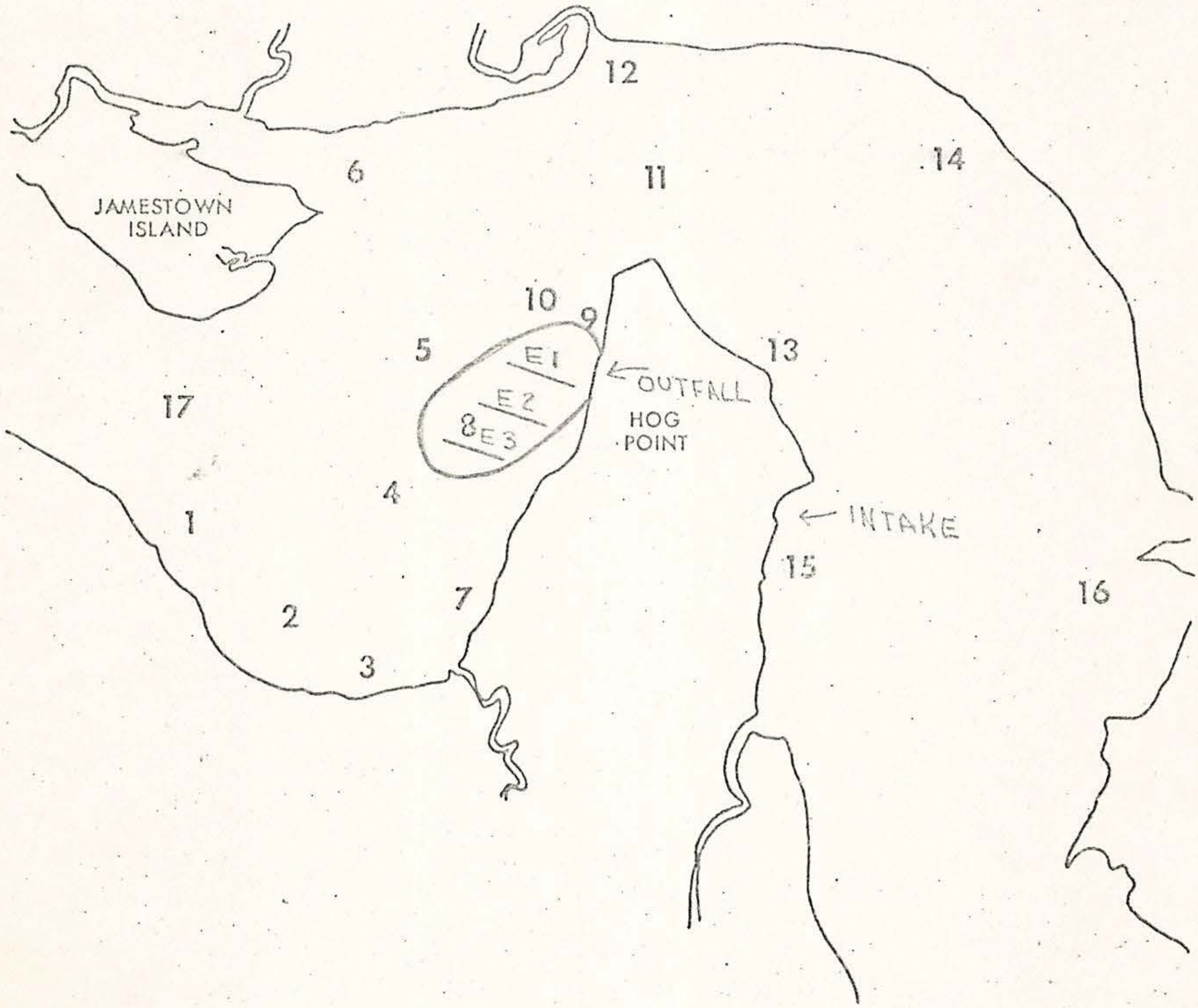

Table 1

James River Phytoplankton

January 1973

Station	Total Cells/ml	Dominant Organisms
DWS	200	2-8μ flagellates *Skeletonema costatum* *Melosira* sp.
Intake - River	300	2-10μ flagellates *Skeletonema costatum* *Melosira* sp.
Intake - Canal	400	5-8μ flagellates *Melosira* sp. *Skeletonema costatum* *Asterionella formosa*
HPS	200	5-8μ flagellates *Melosira* sp. *Skeletonema costatum* *Asterionella formosa*
Discharge - River (CBS)	100	5-10μ flagellates *Ankistrodesmus* sp. *Melosira* sp. *Asterionella formosa*
Discharge - Canal	50	*Ankistrodesmus* sp. *Melosira* spp. *Skeletonema costatum*
CBN	300	2-8μ flagellates *Melosira* spp. *Ankistrodesmus* sp. *Skeletonema costatum*
Cobham Bay	200	2-10μ flagellates *Melosira* spp. *Asterionella formosa*
J.I.	200	5-10μ flagellates *Melosira* spp. *Asterionella formosa*

Table 2

James River Phytoplankton

February 1973

Station	Total Cells/ml	Dominant Organisms
DWS	900	2-5μ flagellates Asterionella formosa
Intake - River	900	3-10μ flagellates Skeletonema costatum Ankistrodesmus sp. Nitzschia spp.
Intake - Canal	1400	Skeletonema costatum Asterionella formosa Melosira sp. Nitzschia spp.
HPS	400	Skeletonema costatum Asterionella formosa Melosira spp. Nitzschia spp.
Discharge - River (CBS)	300	4-8μ flagellates Ankistrodesmus sp. Asterionella formosa Nitzschia spp.
Discharge - Canal	800	5μ flagellates Skeletonema costatum Ankistrodesmus sp. Nitzschia spp.
CBN	1400	5-8μ flagellates Ankistrodesmus sp. Melosira spp. Asterionella formosa Nitzschia spp.
Cobham Bay	500	3-8μ flagellates Asterionella formosa Melosira sp. Nitzschia spp.
J.I.	900	2-8μ flagellates Asterionella formosa Melosira spp. Nitzschia spp.

Table 3
James River Phytoplankton
March 1973

Station	Total Cells/ml	Dominant Organisms
DWS	200	3-8μ flagellates *Nitzschia* spp. *Asterionella formosa*
Intake - River	400	5-8μ flagellates *Nitzschia* spp. *Asterionella formosa*
Intake - Canal	300	8μ flagellate *Nitzschia* spp. *Asterionella formosa*
HPS	300	2-8μ flagellates *Nitzschia* spp. *Asterionella formosa*
Discharge - River (CBS)	600	5μ flagellates *Nitzschia* spp. *Asterionella formosa*
Discharge - Canal	500	8μ flagellate *Nitzschia* spp. *Asterionella formosa*
CBN	500	3-5μ flagellates *Nitzschia* spp. *Asterionella formosa*
Cobham Bay	400	5-8μ flagellates *Nitzschia* spp. *Asterionella formosa*
J.I.	600	2-8μ flagellates *Nitzschia* spp. *Asterionella formosa*

Table 4

James River Phytoplankton

April 1973

Station	Total Cells/ml	Dominant Organisms
DWS	700	*Nitzschia Kützingiana* *Melosira* sp. *Cyclotella* sp. 3-5µ flagellates
Intake - River	3700	*Nitzschia Kützingiana* *Melosira* sp. *Cyclotella* sp. 3-8µ flagellates
Intake - Canal	2800	*Melosira* sp. *Cyclotella* sp. *Nitzschia Kützingiana*
HPS	1500	*Nitzschia Kützingiana* *Melosira* sp. 3-8µ flagellates
Discharge - River (CBS)	1700	*Nitzschia Kützingiana* *Melosira* sp. 4-8µ flagellates
Discharge - Canal	3000	*Melosira* sp. *Cyclotella* sp. *Nitzschia Kützingiana*
CBN	1100	*Nitzschia Kützingiana* *Melosira* sp. 3-10µ flagellates
Cobham Bay	1400	*Nitzschia Kützingiana* *Cyclotella* sp. 3-8µ flagellates *Melosira* spp. *Asterionella formosa*
J.I.	800	*Cyclotella* sp. *Nitzschia Kützingiana* 3-5µ flagellates *Melosira* spp. *Asterionella formosa*

Table 5
James River Phytoplankton

May 1973

Station	Total Cells/ml	Dominant Organisms
DWS	6300	*Cyclotella* sp. *Melosira* sp. *Nitzschia Kützingiana* 5-15μ flagellates
Intake - River	5200	*Cyclotella* sp. *Nitzschia Kützingiana* *Melosira* sp. 5-10μ flagellates
Intake - Canal	3200	*Melosira* sp. *Nitzschia Kützingiana* *Cyclotella* sp.
HPS	3500	*Cyclotella* sp. *Nitzschia Kützingiana* *Melosira* sp. *Glenodinium* sp. 2-8μ flagellates
Discharge - River (CBS)	1800	*Cyclotella* sp. *Nitzschia Kützingiana* 2-10μ flagellates *Melosira* sp.
Discharge-Canal	3700	*Melosira* sp. *Nitzschia Kützingiana* *Cyclotella* sp.
CBN	2300	*Nitzschia Kützingiana* *Cyclotella* sp. *Melosira* sp. 2-15μ flagellates
Cobham Bay	5200	*Melosira* spp. *Cyclotella* sp. *Nitzschia Kützingiana* 2-8μ flagellates
J.I.	5600	*Melosira* spp. *Cyclotella* sp. *Cryptomonas* spp. *Chroomonas* sp.

Table 6

James River Phytoplankton

June 1973

Station	Total Cells/ml	Dominant Organisms
DWS	7300	*Melosira* sp. *Cyclotella* sp. *Nitzschia Kützingiana* 5-10μ flagellates
Intake - River	6500	*Cyclotella* sp. *Nitzschia Kützingiana* 5-10μ flagellates *Melosira* sp.
Intake - Canal		
HPS	4200	*Melosira* sp. 2-10μ flagellates *Cyclotella* sp. *Nitzschia Kützingiana*
Discharge - River (CBS)	3800	*Cyclotella* sp. *Nitzschia Kützingiana* 5-15μ flagellates *Melosira* sp.
Discharge - Canal		
CBN	3000	*Nitzschia Kützingiana* *Cyclotella* sp. *Melosira* sp. 2-15μ flagellates
Cobham Bay	7500	*Cyclotella* sp. *Melosira* sp. *Nitzschia Kützingiana* 2-10μ flagellates
J.I.	5400	*Cryptomonas* sp. *Melosira* sp. *Chroomonas* sp. *Cyclotella* sp.

Table 7

Surface Chlorophyll a Levels in µg/l

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.
Tower DWS	2.4	2.4	2.6	2.7	5.0	6.1
Intake	2.6	3.4	3.2	5.9	4.8	6.4
Tower HPS	2.6	2.2	2.8	4.3	4.2	5.2
Tower CBS	2.4	3.0	2.8	3.7	3.8	4.9
Cobham Bay	2.6	2.6	2.8	4.1	5.3	4.3
Tower J.I.	2.5	2.6	3.0	3.0	3.9	3.7
Tower CBN	2.6	2.4	3.0	3.0	4.1	4.3

Table 8.

James River Plankton - January 1973

DWS

Organism	Number		Total
Copepod nauplius	120	(x32)	3840
Acartia sp. copepodid	9		288
Eurytemora sp.	8		256
Cyclopoid copepod	4		128
Harpacticoid copepod	2		64
Rotifer	15		480
Polychaete larva	3		196
Total	161		5152

Intake Canal

Organism	Number		Total
Copepod nauplius	94	(x32)	3008
Acartia sp. copepodid	12		384
Acartia tonsa adult	1		32
Cyclopoid copepod	19		608
Harpacticoid copepod	3		196
Rotifer	10		320
Total	139		4448

HPS

Organism	Number		Total
Copepod nauplius	62	(x32)	1984
Acartia sp. copepodid	3		96
Acartia tonsa adult	2		64
Cyclopoid copepod	15		480
Bosmina sp.	1		32
Rotifer	9		288
Polychaete larva	2		64
Total	94		3008

CBN

Organism	Number		Total
Copepod nauplius	143	(x32)	4576
Acartia sp. copepodid	21		672
Acartia tonsa adult	3		96
Cyclopoid copepod	13		416
Cladocera (unid.)	3		96
Rotifer	10		320
Polychaete larva	4		128
Total	197		6304

Table 8.

James River Plankton - January 1973

CBS

Organism	Number		Total
Copepod nauplius	149	(x32)	4768
Acartia sp. copepodid	6		192
Eurytemora sp.	12		384
Cyclopoid copepod	5		160
Daphnia sp.	3		96
Total	175		5600

Cobham Bay

Organism	Number		Total
Copepod nauplius	78	(x32)	2496
Acartia sp. copepodid	2		64
Cyclopoid copepod	11		352
Rotifer	17		544
Total	108		3456

Jamestown Island

Organism	Number		Total
Copepod nauplius	52	(x32)	1664
Eurytemora sp.	3		96
Cyclopoid copepod	12		384
Bosmina sp.	3		96
Rotifer	19		608
Polychaete larva	4		128
Total	93		2976

Table 9.

James River Plankton - February 1973

Deep Water Shoals

Organism	Number		Total
Copepod nauplius	54	(x32)	1728
Acartia copepodids	10		320
Acartia tonsa adults	1		32
Cyclopoid copepodids	5		160
Eucyclops sp. adult	2		64
Rotifer	14		448
Polydora sp. larva	1		32
Annelid larva (unid.)	2		64
Total	89		2848

CBS Tower

Organism	Number	(x32)	Total
Copepod nauplius	108		3456
Acartia copepodid	4		128
Acartia tonsa adult	1		32
Cyclopoid copepodids	15		480
Eucyclops sp.	4		128
Harpacticoid	1		32
Cyclops sp.	2		64
Daphnia sp.	1		32
Bosmina sp.	1		32
Total	137		4384

Intake Canal

Copepod nauplius	131	(x32)	4192
Acartia copepodid	28		896
Acartia tonsa adult	1		32
Cyclopoid copepodid	15		480
Eucyclops sp.	2		64
Harpacticoid	2		64
Rotifer	8		256
Bosmina sp.	1		32
Total	188		6016

Table 9.

James River Plankton - February 1973

Hog Point South

Organism	Number		Total
Copepod nauplius	229	(x32)	7328
Acartia copepodid	8		256
Acartia tonsa	3		96
A. clausii	1		32
Cyclopoid copepodid	26		832
Eucyclops sp.	2		64
Barnacle nauplius	2		64
Rotifer	7		224
Total	278		8896

Cobham Bay

Cyclopoid copepodid	6	(x32)	192
Eucyclops sp.	2		64
Total	8		256

Jamestown Island

Eucyclops sp.	3	(x32)	96
Cyclopoid copepod (unid.)	1		32
Annelid larva (unid.)	1		32
Total	5		160

Table 10.

James River Plankton - March 1973

DWS

Organism	Number		Total
Copepod nauplius	71	(x32)	2272
Acartia sp. copepodid	9		288
Acartia tonsa adult	2		64
Rotifer	10		320
Polychaete larva	2		64
Total	94		3008

Intake Canal

Organism	Number		Total
Copepod nauplius	117	(x32)	3744
Acartia sp. copepodid	36		1152
Acartia tonsa adult	2		64
Cyclopoid copepod	4		128
Rotifer	10		320
Harpacticoid copepod	2		64
Total	171		5472

HPS

Organism	Number		Total
Copepod nauplius	176	(x32)	5632
Acartia sp. copepodid	29		928
Acartia tonsa adult	3		96
Cyclopoid copepod	9		288
Barnacle nauplius	3		96
Rotifer	8		256
Total	228		7296

CBN

Organism	Number		Total
Copepod nauplius	199	(x32)	6368
Acartia sp. copepodid	53		1696
Acartia tonsa adult	3		96
Cyclopoid copepod	12		384
Cladocera (unid.)	4		128
Bosmina sp.	1		32
Rotifer	16		512
Total	288		9216

Table 10.

James River Plankton - March 1973

CBS

Organism	Number		Total
Copepod nauplius	115	(x32)	3680
Acartia sp. copepodid	29		928
Acartia tonsa adult	2		64
Cyclopoid copepod	24		768
Harpacticoid copepod	2		64
Podon sp.	1		32
Rotifer	9		288
Total	182		5824

Cobham Bay

Organism	Number		Total
Copepod nauplius	54	(x32)	1728
Acartia sp. copepodid	6		192
Acartia tonsa adult	1		32
Cyclopoid copepod	28		896
Clodocera (unid.)	6		192
Rotifer	17		544
Polychaete larva	3		96
Total	115		3680

Jamestown Island

Organism	Number		Total
Copepod nauplius	61	(x32)	1952
Acartia sp. copepodid	14		448
Cyclopoid copepod	9		288
Bosmina sp.	3		96
Rotifer	8		256
Total	95		3040

Table 11.

James River Plankton - April 1973

Deep Water Shoals

Organism	Number		Total
Copepod nauplii	105	(x32)	3360
Acartia sp. copepodid	62		1984
Acartia tonsa adult	2		64
Rotifer	12		384
Harpacticoid	4		128
Polychaete larva (unid.)	3		96
Total	188		5986

Intake Canal

Organism	Number		Total
Copepod nauplii	93		2976
Acartia sp. copepodid	72		2404
Acartia tonsa adult	4		128
Harpacticoid	8		256
Rotifer	9		288
Polychaete larva (unid.)	2		64
Total	188		5986

HPS

Organism	Number		Total
Copepod nauplii	58	(x32)	1856
Acartia sp. copepodid	55		1760
Cyclopoid copepod	11		352
Harpacticoid copepod	3		96
Rotifer	3		96
Fish larva (unid.)	1		32
Total	131		4192

CBN

Organism	Number		Total
Copepod nauplius	845	(x32)	27,040
Acartia sp. copepodid	472		15,104
Acartia tonsa adult	3		96
Eurytemora sp.	1		32
Cyclopoid copepod	23		736
Bosmina sp.	2		64
Cladocera (unid.)	5		160
Rotifer	21		672
Polychaete larva	10		320
Total	1382		44,224

Table 11.

James River Plankton - April 1973

CBS

Organism	Number	(x32)	Total
Copepod nauplius	224		7168
Acartia sp. copepodid	115		3680
Acartia tonsa adult	3		96
Eurytemora sp.	1		32
Cyclopoid copepod	34		1088
Harpacticoid copepod	4		128
Bosmina sp.	1		32
Podon sp.	1		32
Cladocera (unid.)	1		32
Rotifer	13		416
Polychaete larva (unid.)	1		32
Total	398		12,736

Cobham Bay

Organism	Number	(x32)	Total
Copepod nauplius	337	(x32)	10,784
Acartia sp. copepodid	77		2464
Acartia tonsa adult	1		32
Eurytemora sp.	1		32
Cyclopoid copepod	14		448
Harpacticoid copepod	6		192
Barnacle nauplius	2		64
Bosmina sp.	6		192
Cladocera (unid.)	2		64
Rotifer	18		576
Polychaete larva	1		32
Total	465		14,880

Jamestown Island

Organism	Number	(x32)	Total
Copepod nauplius	190	(x32)	6080
Acartia sp. copepodid	122		3904
Acartia tonsa adult	1		32
Cyclopoid copepod	26		832
Harpacticoid copepod	3		96
Bosmina sp.	2		64
Cladocera (unid.)	4		128
Rotifer	12		384
Polychaete larva	5		160
Total	367		11,744

Table 12.

Plankton Samples - James River - VEPCO
May 24, 1973

Deep Water Shoals

Organism	Number		Total
Copepod nauplius	569	(x64)	36,416
Acartia sp. copepodid	4		256
Acartia tonsa adult	4		256
Cyclopoid copepod	10		640
Barnacle nauplius	3		192
Bosmina sp.	5		320
Podon sp.	1		64
Gastropod larva	2		128
Polychaete larva	10		640
Rotifer	158		10,112
Total	766		49,024

Intake Canal

Organism	Number		Total
Copepod nauplius	687	(x44)	43,968
Acartia sp. copepodid	11		704
Acartia tonsa adult	3		192
Cyclopoid copepod	32		2,048
Barnacle nauplius	2		128
Barnacle cyprid	1		64
Bosmina sp.	67		4,288
Gastropod larva	1		64
Polychaete larva	95		6,080
Rotifer	8		512
Total	907		58,048

Hog Point South

Organism	Number		Total
Copepod nauplius	531	(x32)	16,992
Acartia tonsa adult	2		64
Eurytemora sp.	7		224
Acartia sp. copepodid	34		1,088
Cyclopoid copepod	21		672
Harpacticoid copepod	18		576
Podon sp.	1		32
Daphnia sp.	1		32
Barnacle nauplius	2		64
Polydora sp. larva	4		128
Polychaete larva	7		224
Gastropod larva	6		192
Rotifer	1		32
Total	635		20,320

Table 12
-2-

CBN

Organism	Number		Total
Copepod nauplius	166	(x64)	10,624
Acartia sp. copepodid	37		2,368
Acartia tonsa adult	6		384
Cyclopoid copepod	78		4,992
Bosmina sp.	45		2,880
Polychaete larva	2		128
Rotifer	10		640
Total	324		20,736

CBS

Organism	Number		Total
Copepod nauplius	551	(x64)	35,264
Acartia sp. copepodid	13		832
Acartia tonsa adult	4		256
Cyclopoid copepod	31		1,984
Bosmina sp.	39		2,476
Podon sp.	1		64
Cladocera (unid.)	1		64
Polychaete larva	3		192
Rotifer	10		640
Total	653		41,792

Cobham Bay

Organism	Number		Total
Copepod nauplius	996	(x64)	63,744
Acartia sp. copepodid	22		1,408
Acartia tonsa adult	1		64
Cyclopoid copepod	76		4,864
Bosmina sp.	34		2,176
Daphnia sp.	1		64
Cladocera (unid.)	2		128
Polyphemus pediculus	1		64
Polychaete larva	3		192
Gastropod larva	3		172
Rotifer	78		4,992
Total	1,207		77,248

Table 12.

Jamestown Island

Organism	Number		Total
Copepod nauplius	731	(x64)	46,784
Acartia tonsa adult	1		64
Cyclopoid copepod	14		896
Barnacle nauplius	1		64
Barnacle cyprid	1		64
Bosmina sp.	25		1,600
Cladocera (unid.)	1		64
Gastropod larva	1		64
Polychaete larva	2		128
Rotifer	68		4,352
Total	845		54,080

Table 13.

Plankton Samples - James River - VEPCO
June 1973

Deep Water Shoals

Organism	Number		Total
Copepod nauplius	592	(x64)	37,888
Acartia sp. copepod	6		384
Acartia tonsa adult	5		320
Cyclopoid copepod	12		768
Barnacle nauplius	4		256
Bosmina sp.	7		448
Podon sp.	2		128
Gastropod larvae	1		64
Polychaete larva	2		128
Rotifer	61		3,904
Total			44,288

Intake Canal

Organism	Number		Total
Copepod nauplius	715	(x64)	45,760
Acartia sp. copepodid	19		1,216
Acartia tonsa adult	21		1,344
Cyclopoid copepod	61		3,904
Barnacle nauplius	1		64
Bosmina sp.	25		1,600
Gastropod larva	2		128
Polychaete larva	101		6,464
Rotifer	9		576
Eurytemora sp.	4		256
Total			61,312

Hog Point South

Organism	Number		Total
Copepod nauplius	299	(x64)	19,136
Acartia tonsa adult	5		320
Eurytemora sp.	11		704
Acartia sp. copepodid	19		1,216
Cyclopoid copepod	29		1,856
Harpacticoid copepod	11		704
Barnacle nauplius	1		64
Polydora sp. larva	6		384
Polychaete larva	90		5,760
Gastropod larvae	2		128
Rotifer	111		7,104
Total			37,376

Table 13.

CBN

Organism	Number		Total
Copepod nauplius	192	(x64)	12,288
Acartia sp. copepodid	47		3,008
Acartia tonsa adult	7		448
Cyclopoid copepod	91		5,824
Bosmina sp.	50		3,200
Polychaete larva	27		1,728
Rotifer	15		960
Daphnia sp.	5		320
Total			27,776

CBS

Organism	Number		Total
Copepod nauplius	620	(x64)	39,680
Acartia sp. copepodid	19		1,216
Acartia tonsa adult	11		704
Cyclopoid copepod	37		2,368
Bosmina sp.	42		2,688
Podon sp.	5		320
Cladocera (unid.)	2		128
Polychaete larva	27		1,728
Rotifer	19		1,216
Total			51,776

Cobham Bay

Organism	Number		Total
Copepod nauplius	820	(x64)	52,480
Acartia sp. copepodid	82		5,248
Acartia tonsa adult	3		192
Cyclopoid copepod	79		5,056
Bosmina sp.	20		1,280
Dahpnia sp.	2		128
Cladocera (unid.)	1		64
Polychaete larva	11		704
Gastropod larva	12		768
Rotifer	42		2,688
Total			68,480

Table 13.

Jamestown Island

Organism	Number		Total
Copepod nauplius	611	(x64)	39,104
Acartia tonsa adult	4		256
Cyclopoid copepod	29		1,856
Bosmina sp.	19		1,216
Cladocera (unid.)	2		128
Gastropod larvae	5		320
Polychaete larva	27		1,728
Rotifer	41		2,624
Total			47,232

Feb. 1973

Table 14

SPECIES, NUMBER OF INDIVIDUALS AND TOTAL WET WEIGHT IN GRAMS AT EACH STATION (BENTHOS)

SPECIES	STATIONS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gammarus sp.	5				1		1	4		4	1	3			1	1
Dipteran larvae	1		5	8	1	1	1	1	1	1	6	2	5		1	
Corophium lacustre							1				1		1	1		2
Cyathura polita																
Laeonereis culveri							3			1		1			1	
Congeria leucophaeta																
Macoma mitchelli																
M. balthica					1								1			3
Brachidontes recurvus											3			1		
Lepidactylus dytiscus			1				1								1	1
Monoculodes edwardsi											1			1		
Tubulanus pellucidus											1					
Heteromastus filiformis																
Leptocheirus plumulosus																
Edotea triloba								1		1			1	1		
Nereis succinea																
Chiridotea almyra																
Mya arenaria																
Lysipiddes grayi																
Unid. Nemertean	1							1	1							
Unid. capitellids																
Rangia cuneata	36	19		9	5		6		2	1	15	1	1	13		
Scolecolepides viridis	3	1			1		2				1	1	2			
Biomass (wet wt. in gms.)	342.5	404	-	154.5	107.0	-	281.0	0.5	35.0	0.5	324.0	6.5	51.0	224.0	-	7.0

May

Table 15

SPECIES, NUMBER OF INDIVIDUALS AND TOTAL WET WEIGHT IN GRAMS AT EACH STATION (BENTHOS)

SPECIES	STATIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gammarus sp.		1	1		7	3				2	4			11	1	
Dipteran larvae	1			1	3		2	1		2				1	1	
Corophium lacustre				1		1		4	2	1	12		3	7	3	2
Cyathura polita																
Laeonereis culveri																
Congeria leucophaeta																
Macoma mitchelli																
M. balthica												1		1		1
Brachidontes recurvus																
Lepidactylus dytiscus								2	4							
Monosulodes edwardsi																
Tubulanus pellucidus																
Heteromastus filiformis																
Leptocheirus plumulosus																
Edotea triloba					1	1			4		25				1	
Nereis succinea																
Chiridotea almyra																
Mya arenaria																
Lysipiddes grayi																
Unid. oligochaetes					1		2			2						
Unid. amphipods															2	
Rangia cuneata	46	5	3	49	16	57	2	7			10	1	7	6	7	3
Scolecolepides viridis			1		22		1	1	6	1	23		4			
Biomass (wet wt. in gms.)	720	105	145	740	98	847	133	111	1.0	0.5	211	1.0	150	103	116	.45

June

Table 16

SPECIES, NUMBER OF INDIVIDUALS AND TOTAL WET WEIGHT IN GRAMS AT EACH STATION (BENTHOS)

SPECIES	STATIONS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gammarus sp.	2	3	1	3	1	1	6	1		3		3	7	5	11	
Dipteran larvae		4	2	3	3		2	7		2	2					
Corophium lacustre			3	1	3			7	1		7	4	4	4	1	2
Cyathura polita																
Laeonereis culveri																
Congeria leucophaeta																
Macoma mitchelli																
M. balthica													1	3	2	2
Brachidontes recurvus																
Lepidactylus dytiscus									3		4					4
Monosulodes edwardsi																
Tubulanus pellucidus																
Heteromastus filiformis																
Leptocheirus plumulosus																
Edotea triloba			1		2							1	4			
Nereis succinea																
Chiridotea almyra																
Mya arenaria																
Lysipiddes grayi																
Unid. Nemertean										1		1		1		
Unid. capitellids																
Rangia cuneata	1	2		39	8	25	2	3	1	1	1	1	3	3	1	26
Scolecolepides viridis		3	11	4	9	1		2	6	4	3		1	6	4	2
Biomass (wet wt. in gms.)	14	43	0.5	615	133	369	183	61	20	81	17	86	152	91	89	489

Table 17

BENTHIC DIVERSITY

Station	Winter 71	Winter 72	Winter 73	Spring 71	Spring 72	Spring 73	June 72	June 73
1	0.77	-	1.12	0.44	0.84	0.15	0.84	0.92
2	2.03	1.00	0.29	1.65	0.86	0.65	0.87	1.96
3	1.76	2.43	0.65	1.88	1.30	1.37	1.30	1.68
4	1.85	0.44	1.00	1.24	1.56	0.28	1.56.	1.17
5	2.02	1.00	1.88	1.39	1.51	1.91	1.51	2.24
6	0.47	1.09	-	1.26	0.59	0.51	0.59	0.45
7	2.43	1.46	2.42	2.11	2.37	1.52	2.40	1.37
8	2.39	1.23	1.66	1.71	1.51	1.93	1.51	2.02
9	1.21	1.34	1.50	1.48	1.87	1.90	1.87	1.62
10	2.05	1.00	2.00	1.50	1.66	2.25	1.67	2.12
11	1.73	1.85	2.14	2.07	0.97	2.01	0.97	2.06
12	2.24	2.17	2.16	1.84	1.57	1.00	1.57	2.05
13	2.46	1.88	2.22	0.97	0.91	1.50	0.91	2.30
14	0.27	0.36	1.26	0.83	1.07	1.88	1.07	2.43
15	2.15	2.24	2.00	2.28	1.05	2.14	1.05	1.72
16	2.36	1.45	1.84	2.53	0.86	1.46	0.86	1.39

Table 18

FOULING PLATE STUDY - VEPCO-SURRY

1973

	No. organisms/dm^2			
	March		June	
	Vertical	Horizontal	Vertical	Horizontal
Station CBN				
Balanus improvisus			2.9	4.8
Corophium sp.	13.4	22.0	33.6	39.4
Total No. of Genera	1	1	2	2
Total No. of Organisms	13.4	22.0	36.5	44.2
Station DWS				
Balanus improvisus			6.7	8.6
Corophium sp.			29.8	16.3
Gammarus sp.		.96		
Total No. of Genera	0	1	2	2
Total No. of Organisms	0	.96	36.5	24.9
Station CBS				
Balanus improvisus			.96	.96
Corophium sp.	.96		20.2	16.3
Membranipora tenuis		1.4		
Total No. of Genera	1	1	2	2
Total No. of Organisms	.96	1.4	21.2	17.3

Table 19

Entrainment Study - June 1973

	% Stained	% Not stained	Total
Outfall			
Copepod nauplius	70	30	36,352
Acartia tonsa	50	50	1,664
Cyclopoid copepod	60	40	2,048
Amphipod (unid.)	30	70	3,392
Transect - E_1			
Copepod nauplius	90	10	28,416
Acartia tonsa	70	30	1,472
Cyclopoid copepod	54	46	3,264
Amphipod (unid.)	70	30	1,024
Transect - E_2			
Copepod nauplius	90	10	33,408
Acartia tonsa	85	15	1,344
Cyclopoid copepod	83	17	1,600
Rotifer	95	5	2,112
Transect - E_3			
Copepod nauplius	90	10	42,624
Acartia tonsa	85	15	1,408
Cyclopoid copepod	93	7	1,856
Intake			
Copepod nauplius	85	15	28,416
Acartia sp. copepodid	100	0	384
Acartia tonsa	83	17	704
Cyclopoid copepod	95	5	896