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A Post-Operational Study of the
James River in the Vicinity of Hog Point

Semi-Annual report submitted to
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Ecological Survey - Upper James River

Surry Nuclear Power Station Site

July 1973

Virginia Institute of Marine Science
Gloucester Point, Virginia

by

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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/l in January to 4.9 ug/l 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, Scolecopides 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

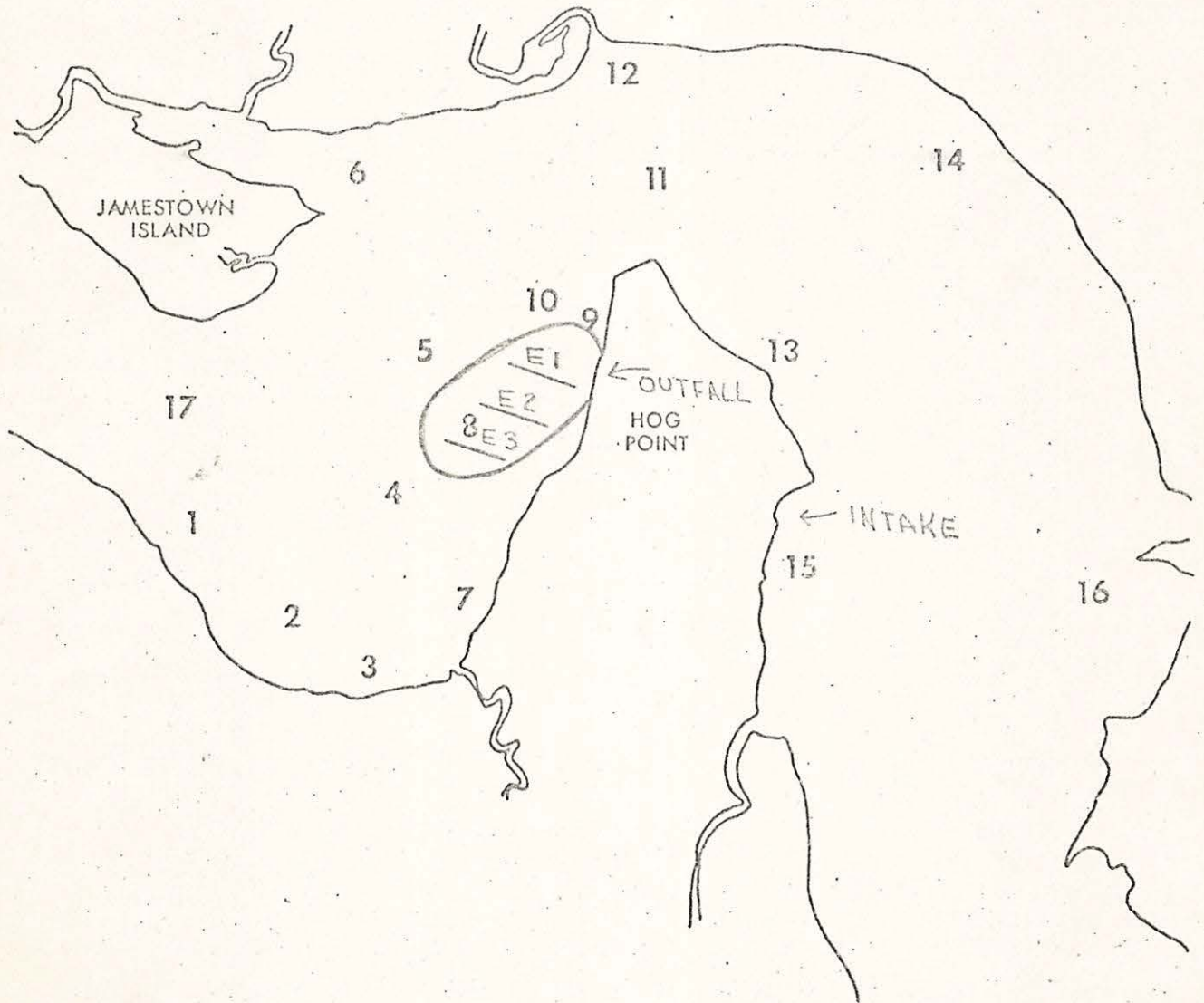


Table 1
James River Phytoplankton
January 1973

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

Table 2
 James River Phytoplankton
 February 1973

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

Table 3
James River Phytoplankton
March 1973

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

Table 4
James River Phytoplankton
April 1973

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

Table 5
James River Phytoplankton

May 1973

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

Table 6
James River Phytoplankton
June 1973

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

Table 7

Surface Chlorophyll a Levels in $\mu\text{g}/\text{l}$

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

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

Intake Canal

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

HPS

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

CBN

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

Table 8.

James River Plankton - January 1973

-2-

CBS

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

Cobham Bay

Copepod nauplius	78	(x32)	2496
<u>Acartia</u> sp. copepodid	2		64
Cyclopoid copepod	11		352
Rotifer	17		544
<u>Total</u>	<u>108</u>		<u>3456</u>

Jamestown Island

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

Table 9.

James River Plankton - February 1973

Deep Water Shoals

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

CBS Tower

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

Intake Canal

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

Table 9.

James River Plankton - February 1973

-2-

Hog Point South

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

Cobham Bay

Cyclopoid copepodid	6	(x32)	192
<u>Eucyclops</u> sp.	2		64
Total	<u>8</u>		<u>256</u>

Jamestown Island

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

Table 10.

James River Plankton - March 1973

DWS

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

Intake Canal

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

HPS

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

CBN

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

Table 10.

James River Plankton - March 1973

-2-

CBS

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

Cobham Bay

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

Jamestown Island

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

Table 11.

James River Plankton - April 1973

Deep Water Shoals

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

Intake Canal

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

HPS

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

CBN

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

Table 11.

James River Plankton - April 1973

-2-

CBS

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

Cobham Bay

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

Jamestown Island

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

Table 12.

Plankton Samples - James River - VEPCO
May 24, 1973

Deep Water Shoals

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

Intake Canal

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

Hog Point South

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

Table 12

-2-

CBN

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

CBS

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

Cobham Bay

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

Table 12.

-3-

Jamestown Island

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

Table 13.

Plankton Samples - James River - VEPCO
June 1973

Deep Water Shoals

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

Intake Canal

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

Hog Point South

Copepod nauplius	299 (x64)	19,136
<u>Acartia tonsa</u> adult	5	320
<u>Eurytemora</u> sp.	11	704
<u>Acartia</u> 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		<u>37,376</u>

Table 13.

-2-

CBN

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

CBS

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

Cobham Bay

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

Table 13.

-3-

Jamestown Island

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

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
<u>Gammarus</u> 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	
<u>Corophium lacustre</u>							1				1		1	1		2
<u>Cyathura polita</u>																
<u>Laeonoreis culveri</u>							3			1		1			1	
<u>Congeria leucohaeta</u>																
<u>Macoma mitchelli</u>																
<u>M. balthica</u>					1								1			3
<u>Brachidontes recurvus</u>											3			1		
<u>Lepidactylus dytiscus</u>			1				1								1	1
<u>Monosulodes edwardsi</u>												1		1		
<u>Tubulanus pellucidus</u>											1					
<u>Heteromastus filiformis</u>																
<u>Lentocheirus plumulosus</u>																
<u>Edotea triloba</u>								1		1			1	1		
<u>Nereis succinea</u>																
<u>Chiridotea almyra</u>																
<u>Mya arenaria</u>																
<u>Lysinoides gravi</u>																
Unid. Nemertean	1							1	1							
Unid. capitellids																
<u>Rangia cuneata</u>	36	19		9	5		6		2	1	15	1	1	13		
<u>Scolecoplepides viridis</u>	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
<u>Gammarus</u> sp.		1	1		7	3				2	4			11	1	
Dipteran larvae	1			1	3		2	1		2				1	1	
<u>Cerophium lacustre</u>				1		1		4	2	1	12		3	7	3	2
<u>Cyathura polita</u>																
<u>Laeonereis culveri</u>																
<u>Congeria leuconhaeta</u>																
<u>Macoma mitchelli</u>																
<u>M. balthica</u>												1		1		1
<u>Brachidontes recurvus</u>																
<u>Lepidactylus dytiscus</u>								2	4							
<u>Monosulodes edwardsi</u>																
<u>Tubularanus pellucidus</u>																
<u>Heteromastus filiformis</u>																
<u>Leptocheirus plumulosus</u>																
<u>Edotea triloba</u>					1	1			4		25				1	
<u>Nereis succinea</u>																
<u>Chiridotea almyra</u>																
<u>Mya arenaria</u>																
<u>Lysipidides grayi</u>																
Unid. oligochaetes					1		2			2						
Unid. amphipods															2	
<u>Rangia cuneata</u>	46	5	3	49	16	57	2	7			10	1	7	6	7	3
<u>Scolecolepides viridis</u>			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
<u>Gammarus</u> sp.	2	3	1	3	1	1	6	1		3		3	7	5	11	
Dipteran larvae		4	2	3	3		2	7		2	2					
<u>Corophium lacustre</u>			3	1	3			7	1		7	4	4	4	1	2
<u>Cyathura polita</u>																
<u>Laeonereis culveri</u>																
<u>Congerina leucophaeta</u>																
<u>Macoma mitchelli</u>																
<u>M. balthica</u>													1	3	2	2
<u>Brachidontes recurvus</u>																
<u>Lepidactylus dytiscus</u>									3		4					4
<u>Monosulodes edwardsi</u>																
<u>Tubulanus pellucidus</u>																
<u>Heteromastus filiformis</u>																
<u>Leptocheirus plumulosus</u>																
<u>Edotea triloba</u>			1		2							1	4			
<u>Nereis succinea</u>																
<u>Chiridotea almyra</u>																
<u>Mya arenaria</u>																
<u>Lysipidde grayi</u>																
Unid. Nemertean										1		1		1		
Unid. capitellids																
<u>Rangia cuneata</u>	1	2		39	8	25	2	3	1	1	1	1	3	3	1	26
<u>Scolecoclepidis viridis</u>		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			Spring			June	
	<u>71</u>	<u>72</u>	<u>73</u>	<u>71</u>	<u>72</u>	<u>73</u>	<u>72</u>	<u>73</u>
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	
	<u>Vertical</u>	<u>Horizontal</u>	<u>Vertical</u>	<u>Horizontal</u>
Station CBN				
<u>Balanus improvisus</u>			2.9	4.8
<u>Corophium sp.</u>	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				
<u>Balanus improvisus</u>			6.7	8.6
<u>Corophium sp.</u>			29.8	16.3
<u>Gammarus sp.</u>		.96		
Total No. of Genera	0	1	2	2
Total No. of Organisms	0	.96	36.5	24.9
Station CBS				
<u>Balanus improvisus</u>			.96	.96
<u>Corophium sp.</u>	.96		20.2	16.3
<u>Membranipora tenuis</u>		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

Outfall	% Stained	% Not stained	Total
Copepod nauplius	70	30	36,352
<u>Acartia tonsa</u>	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
<u>Acartia tonsa</u>	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
<u>Acartia tonsa</u>	85	15	1,344
Cyclopoid copepod	83	17	1,600
Rotifer	95	5	2,112
Transect - E ₃			
Copepod nauplius	90	10	42,624
<u>Acartia tonsa</u>	85	15	1,408
Cyclopoid copepod	93	7	1,856
Intake			
Copepod nauplius	85	15	28,416
<u>Acartia sp. copepodid</u>	100	0	384
<u>Acartia tonsa</u>	83	17	704
Cyclopoid copepod	95	5	896