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Results of Biological Sampling Conducted for

Impact Analysis for Long-Range Maintenance Dredging
in the Norfolk Naval Complex

Subcontract No. A10392
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Subcontractors Report to

Arthur D. Little, Inc.
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from

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Part I. Trawl Samples

Methods

Seven stations were sampled once on 24 or 25 September and once between 13 November and 5 December, 1974 using a 16 foot semi-balloon otter trawl with a 3/8 inch stretch mesh cod inner liner. Those areas sampled were: Southern Branch of the Elizabeth River (Station 1), Elizabeth River between Déperming Station and Craney Island Oil Pier (Station 2), Elizabeth River Approach Channel (Station 3), Willoughby Bay Approach Channel (Station 4), Little Creek (Station 5), York River channel off Cheatham Annex piers (Station 6), and York River channel off the Coast Guard and Navy fuel piers (Station 7). Five minute tows were performed except at stations 6 and 7 where ten minute tows were performed. The shorter tows at the stations in the Norfolk area were necessitated by the more confined locations and presence of numerous snags.

All fishes and invertebrates caught by the trawl were identified and enumerated.

Results

Those species collected by the trawls are listed by higher taxa in Table 1 together with their common names.

Table 1

SPECIES TAKEN IN TRAWL SAMPLES
September or November-December, 1974

Species	Common Name
FISHES	
Anguillidae <u>Anguilla rostrata</u>	American eel
Congridae <u>Conger oceanicus</u>	Conger eel
Clupeidae <u>Brevoortia tyrannus</u>	Atlantic menhaden
Engraulidae <u>Anchoa mitchelli</u>	Bay anchovy
Batrachoididae <u>Opsanus tau</u>	Oyster toadfish
Atherinidae <u>Menidia menidia</u>	Atlantic silverside
Syngnathidae <u>Syngnathus fuscus</u>	Northern pipefish
Triglidae <u>Prionotus evolans</u>	Striped searobin
Serranidae <u>Centropristis striata</u>	Black sea bass
Pomatomidae <u>Pomatomus saltatrix</u>	Bluefish
Sciaenidae <u>Bairdiella chrysur</u> <u>Cynoscion nebulosus</u> <u>Cynoscion regalis</u> <u>Leiostomus xanthurus</u> <u>Menticirrhus saxatilis</u> <u>Micropogon undulatus</u>	Silver perch Spotted seatrout Weakfish Spot Northern kingfish Atlantic croaker
Stromateidae <u>Peprilus paru</u> <u>Peprilus triacanthus</u>	Harvestfish Butterfish

Table 1 (Continued)

Species	Common Name
Botnidae	
<u>Paralichthys dentatus</u>	Summer flounder
Pleuronectidae	
<u>Pseudopleuronectes americanus</u>	Winter flounder
Soleidae	
<u>Trinectes maculatus</u>	Hogchoker
Cynoglossidae	
<u>Symphurus plaguisa</u>	Blackcheek tonguefish
INVERTEBRATES	
Mollusca, Gastropoda	
<u>Nassarius obsoletus</u>	Mud snail
<u>Doris verrucosa</u>	Sea slug (nudibranch)
Mollusca, Cephalopoda	
<u>Lolliguncula brevis</u>	Squid
Crustacea, Stomatopoda	
<u>Squilla empusa</u>	Mantis shrimp
Crustacea, Decapoda	
<u>Penaeus aztecus</u>	Brown shrimp
<u>Penaeus setiferus</u>	White shrimp
<u>Palaemonetes pugio</u>	Grass shrimp
<u>Crangon septemspinosa</u>	Sand shrimp
<u>Pagurus longicarpus</u>	Hermit crab
<u>Neopanope sayi</u>	Mud crab
<u>Panopeus herbsti</u>	Mud crab
<u>Callinectes sapidus</u>	Blue crab
<u>Libinia dubia</u>	Spider crab
Bryozoa	
<u>Alcyonidium verrilli</u>	Dead man's fingers
Cnidaria, Hydrozoa	
<u>Sertularia argentea</u>	Silver hydroid
Urochordata	
<u>Molgula manhattensis</u>	Sea grape

The composition of each trawl sample taken during the September sampling period is given in Table 2. In general, abundance and diversity of deposit feeding fishes, e.g. flatfishes and sciaenids were greatest at those stations in deep channels (12-17 m) such as stations 1, 3, 6 and 7 and least at stations in shoaler water (4-7 m), such as stations 2 and 4. At the shoal locations anchovies, Anchoa mitchelli, tended to predominate.

The composition of trawl samples during the November-December sampling period (Table 3) was much poorer in species, particularly for the fishes. Flatfishes and some sciaenids (e.g. Cynoscion regalis) which were abundant in September were much less so in the latter sampling period. This diminution of the fish fauna is a usual event during late fall as the water cools and migratory fishes depart the estuary.

Data on temperature, salinity and dissolved oxygen at the seven trawl and plankton stations are presented in Table 4. Large changes in temperature were observed from the September to the November-December sampling period. The richest trawl collections in November-December were from stations 1 and 7 and were collected on 13 and 22 November, respectively. During this period bottom water temperature was 11 to 12°C. Shortly thereafter considerable cooling had occurred and by 5 December when other collections in the Hampton Roads area were made, temperatures were as low as 7°C.

Table 2
Contents of trawl collections, September 1974

Species	STATION						
	1. So. Branch Elizabeth Riv.	2. Elizabeth R. Deperming Sta.	3. Hampton Roads, NOB	4. Willoughby Bay	5. Little Creek	6. York Riv. Cheatham	7. York Riv. C.G. Pier
Fishes							
<u>Anguilla rostrata</u>	1		2			1	
<u>Conger oceanicus</u>			1				
<u>Anchoa mitchelli</u>	45	816	116	840	40	14	50
<u>Opsanus tau</u>						2	
<u>Syngnathus fuscus</u>			1				
<u>Centropristis striata</u>						1	
<u>Pomatomus saltatrix</u>					1		
<u>Bairdiella chrysura</u>	1		5				
<u>Cynoscion regalis</u>	11		77			29	124
<u>Leiostomus xanthurus</u>	27	8	77		8	21	34
<u>Menticirrhus saxatilis</u>						2	
<u>Micropogon undulatus</u>	97 (34 juv.)	2 (1 juv.)	95 (18 juv.)	2	19 (19 juv.) 1	3	23
<u>Peprilus paru</u>							
<u>Peprilus triacanthus</u>			3				
<u>Prionotus evolans</u>		1	5				
<u>Paralichthys dentatus</u>			9			4	
<u>Pseudopleuronectes americanus</u>			1				
<u>Trinectes maculatus</u>	9		299			12	9
<u>Symphurus plagiusa</u>	2		47				11
Mollusca							
<u>Nassarius obsoletus</u>			1				
<u>Doris verrucosa</u>				1			
<u>Lolliguneula brevis</u>			15				
Crustacea							
<u>Squilla empusa</u>	3		12				

Table 2 (Continued)

Species	1. So. Branch Elizabeth Riv.	2. Elizabeth R. Deperming Sta.	3. Hampton Roads, NOB	4. Willoughby Bay	5. Little Creek	6. York Riv. Cheatham	7. York Riv. C.G. Pier
Crustacea (Continued)							
<u>Penaeus aztecus</u>	1		1	1	1		
<u>Penaeus setiferus</u>			8				
<u>Palaemonetes pugio</u>			5	5	2	1	
<u>Crangon septemspinosa</u>	4						
<u>Pagurus longicarpus</u>			1				
<u>Callinectes sapidus</u>	35 (27 juv.)	2 (1 juv.)	3 (1 juv.)	3 (1 juv.)	2	2 (2 juv.)	2
<u>Neopanope sayi</u>			1	9		2	
<u>Panopeus herbsti</u>						1	
<u>Libinia dubia</u>			2			16	17
Bryozoa							
<u>Alcyonidium verrilli</u>			P	P	P		
Total number of individuals	236	829	787	861	74	111	273
Number of fish species	8	4	14	2	5	10	7
Number of invertebrate species	4	1	11	5	4	5	2

Samples taken 24-25 September.

Table 3
Contents of trawl collections, November-December, 1974

Species	STATION						
	1. So. Branch Elizabeth Riv.	2. Elizabeth R. Deperming Sta.	3. Hampton Roads, NOB	4. Willoughby Bay	5. Little Creek	6. York Riv. Cheatham	7. York Riv. C.G. Pier
Fishes							
<u>Brevoortia tyrannus</u>	1	2	7	2	1		
<u>Anchoa mitchelli</u>	13	21	110	142	3		42
<u>Menidia menidia</u>		1					
<u>Cynoscion nebulosus</u>	1						
<u>Cynoscion regalis</u>	8						2
<u>Leiostomus xanthurus</u>	38	1	1		7		375
<u>Micropogon undulatus</u>	67 (3 juv.)	35 (31 juv.)	147 (143 juv.)	5 (4 juv.)	2 (1 juv.)		29 (20 juv.)
<u>Prionotus evolans</u>	4						
<u>Paralichthys dentatus</u>							10
<u>Trinectes maculatus</u>	1					3	
<u>Symphurus plagiusa</u>	2					1	16
Crustacea							
<u>Penaeus aztecus</u>		1					
<u>Penaeus setiferus</u>	2						3
<u>Palaemonetes pugio</u>	1						2
<u>Crangon septemspinosa</u>		29	2	1			1
<u>Callinectes sapidus</u>	5				1	1	
<u>Neopanope sayi</u>				2	2		
Bryozoa							
<u>Alcyonidium verrilli</u>		P		P	P	P	P
Hydrozoa							
<u>Sertularia argentea</u>		P	P	P	P	P	P
Urochordata							
<u>Molgula manhattensis</u>		P	P		P	P	P

Table 3 (Continued)

	STATION						
	1. So. Branch Elizabeth Riv.	2. Elizabeth R. Deperming Sta.	3. Hampton Roads, NOB	4. Willoughby Bay	5. Little Creek	6. York Riv. Cheatham	7. York Riv. C.G. Pier
Total Number of individuals	143	90	267	152	16	5	474
Number of fish species	9	5	4	3	4	2	6
Number of invertebrate species	3	5	3	4	5	5	6

Table 4

Water depth, temperature, salinity and dissolved oxygen and date of sampling of these parameters at each of the trawl/plankton sampling stations

Trawl/Plankton Station	Depth (ft.)	Temperature (°C)		Salinity ‰		Dissolved O ₂ mg l ⁻¹		Date Sampled
		Surface	Bottom	Surface	Bottom	Surface	Bottom	
AUGUST-OCTOBER								
1	50	19.5	19.1	18.76	19.06	6.01	6.30	10-17-74
2	28	18.8	18.6	19.48	19.53	6.78	6.94	10-17-74
3	45	18.5	18.8	20.23	20.78	7.06	6.92	10-17-74
4	11	18.1	18.0	20.01	21.24	7.70	----	10-17-74
5	--	----	----	-----	-----	----	----	-----
6	45	19.0	18.8	19.53	19.94	7.44	6.83	10-18-74
7	45	18.3	18.0	20.87	21.39	7.25	6.63	10-18-74
NOVEMBER-DECEMBER								
1	49	8.9	10.1	21.0	21.8	8.36	8.76	12- 5-74
2	30	7.0	7.1	21.3	21.6	8.74	7.81	12- 5-74
3	45	7.3	7.8	21.7	24.5	9.45	9.23	12- 5-74
4	12	7.0	6.9	23.7	23.7	10.23	9.84	12- 5-74
5	32	10.0	10.0	24.8	25.1	6.34	5.94	11-21-74
6	50	10.5	10.8	19.6	20.9	7.94	7.34	11-22-74
7	40	11.0	10.9	21.6	21.9	9.38	8.68	11-22-74

Part II. Benthos Samples

Methods

Duplicate Ponar grab samples, each covering 0.05 m², were taken at 20 stations during August-October and 19 stations during November-December, 1974. The August-October stations correspond with those at which sediment elutriate samples were taken. The locations of the stations and the periods during which each was sampled are given in Table 5. The contents of each grab were transported back to the laboratory where they were sieved through a 0.5 mm screen. The material retained was preserved in formalin and stained with phloxine B. The samples were carefully examined under a dissecting microscope and all organisms removed, identified and enumerated.

Results

The 78 grab samples yielded at least 88 species of macrobenthic invertebrates (Table 6). The contents of the August-October samples are listed by station in Table 7 and the November-December samples in Table 8.

August-October

Many of the samples, particularly those from dredged areas and berths, are extremely poor in specimens and species. These included samples from stations 1, 2, 3, 7, 8,

Table 5

Location of benthos stations and periods in which they were sampled

Benthos Station Number	Location	August-October	November-December
1	Southern Branch Elizabeth River Reserve Fleet Berth	X	X
2	Southern Branch Elizabeth River Turning Basin, Norfolk Naval Shipyard	X	X
3	Southern Branch, Elizabeth River St. Helena Piers	X	X
4	Elizabeth River Deperming Station	X	X
5	Elizabeth River Craney Island Pier, edge of channel	X	X
6	Elizabeth River Craney Island Pier, adjacent to channel	X	X
7	N.O.B. D&S Pier, inshore of dredged area	X	
8	N.O.B. D&S Pier, in dredged area	X	
9	N.O.B. Pier 7	X	X
10	Willoughby Bay Approach Channel to Small Boat Harbor	X	X
11	Willoughby Bay Small Boat Harbor	X	X
12	Willoughby Bay Approach Channel to Oil Barge Turning Basin	X	X
13	Willoughby Bay Oil Barge Turning Basin	X	X
14	Little Creek Western berths	X	X
15	Little Creek Southern berths	X	X

Table 5 (Continued)

Benthos Station Number	Location	August-October	November-December
16	Little Creek Little Creek Cove	X	
17	York River Cheatham Annex, channel	X	X
18	York River Cheatham Annex, between piers	X	X
19	York River Naval Weapons Station, at draw-bridge	X	X
20	York River Oil Pier (Coast Guard Pier)	X	X
21	Little Creek Approach Channel		X
22	N.O.B. D&S Pier		X

Table 6

Macrobenthic species from grab samples taken
either in August and September, or
November and December, 1974

CNIDARIA

Anthozoa

Diadumene leucolena
Edwardsia elegans

RHYNCHOCOELA

Nemertean (unident.)
Carinomella lactea
Micrura rubra

PHORONIDA

Phoronis muelleri
Phoronis psammophila

ANNELIDA

Polychaeta

Ancistrosyllis jonesi
Arabella irricolor
Aricidea cerruti
Asabellides oculata
Brania clavata
Capitella capitata
Clymenella torquata
Diopatra cuprea
Eteone heteropoda
Glycera americana
Glycera dibranchiata
Glycinde solitaria
Gyptis vittata
Harmothoe sp.
Heteromastus filiformis
Marphysa sanguinea
Nereis succinea
Paraprionospio pinnata
Pectinaria gouldii
Phyllodoce arenae
Polydora ligni
Prionospio cirrifera
Pseudeurythoe paucibranchiata

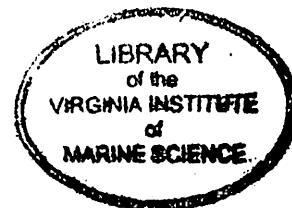


Table 6 (Continued)

Polychaeta (continued)

Sabella microphthalma
Sabellaria vulgaris
Scoloplos fragilis
Sigambra tentaculata
Spio filicornis
Spiochaetopterus oculatus
Streblospio benedicti
Tharyx setigera

Oligochaeta

Pelosclex sp. (including P. gabriellae and P. heterochaetus)

Hirudinea

Ichthyobdella rapax

ECHIURIDA

Echiuran (unident.)

MOLLUSCA

Bivalvia

Alegina elevata
Anadara transversa
Gemma gemma
Macoma balthica
Macoma tenta
Mercenaria mercenaria
Mulinia lateralis
Tellina agilis

Gastropoda

Acteocina canaliculata
Acteon punctostriatus
Crepidula convexa
Cylichna alba
Doridella obscura
Eupleura caudata
Mitrella lunata
Odostomia bisuturalis
Odostomia impressa
Turbonilla interrupta

CRUSTACEA

Cirripedia

Balanus improvisus

Table 6 (Continued)

CRUSTACEA (continued)

Ostracoda

Sarsiella texana
Sarsiella zostericola

Mysidacea

Neomysis americana

Cumacea

Leucon americanus

Isopoda

Cyathura polita
Edotea triloba

Amphipoda

Amphipods (unident.)
Ampelisca abdita
Caprella penantis
Corophium acherusicum
Corophium lacustre
Cymadusa compta
Gammarus mucronatus
Listriella clymenellae
Melita appendiculata
Melita nitida
Paracaprella tenuis
Stenothoe minuta
Unciola serrata

Decapoda

Callinectes sapidus (megalopa)
Neopanope sayi
Ogyrides limicola
Pinnixa sayana
Rhithropanopeus harrisi

ECHINODERMATA

Ophiuroidea

Micropholis atra

UROCHORDATA

Molgula manhattensis

HEMICHORDATA

Hemichordate (unident.)

Table 7

CONTENTS OF SAMPLES FOR MACROBENTHOS
August-October, 1974

STATION 1, Southern Branch Elizabeth River
Reserve Fleet Berth

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	2	2	4
<u>Capitella</u> <u>capitata</u>	2		2
<u>Diadumene</u> <u>leucolena</u>	1		1
<u>Streblospio</u> <u>benedicti</u>	1		1
<u>Nereis</u> <u>succinea</u>		1	1
<u>Tellina</u> <u>agilis</u>	1		1
<u>Mulinia</u> <u>lateralis</u>		1	1
<u>Corophium</u> <u>lacustre</u>		1	1
Total Number of Individuals	7	5	12
Number of Species	5	4	8

STATION 2, Southern Branch Elizabeth River
Turning Basin, Norfolk Naval Shipyard

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	8		8
<u>Acteon</u> <u>punctostriatus</u>	2		2
<u>Nereis</u> <u>succinea</u>		1	1
<u>Mulinia</u> <u>lateralis</u>		1	1
Total Number of Individuals	10	2	12
Number of Species	2	2	4

STATION 3, Southern Branch Elizabeth River
St. Helena Piers

Species	Sample 1	Sample 2	Total
<u>Mulinia</u> <u>lateralis</u>	1		1
Total Number of Individuals	1	0	1
Number of Species	1	0	1

Table 7 (Continued)

STATION 4, Elizabeth River
Deperming Station

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	2	26	28
<u>Scoloplos</u> <u>fragilis</u>	3	6	9
<u>Paraprionospio</u> <u>pinnata</u>	3	2	5
<u>Macoma</u> <u>balthica</u>	3	1	4
<u>Pseudeurythoe</u> <u>paucibranchiata</u>		4	4
<u>Glycinde</u> <u>solitaria</u>	1		1
<u>Nereis</u> <u>succinea</u>		1	1
<u>Mulinia</u> <u>lateralis</u>	1		1
<u>Tellina</u> <u>agilis</u>		1	1
Total Number of Individuals	13	41	54
Number of Species	6	7	9

STATION 5, Elizabeth River
Craney Island Pier, edge of channel

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	5	21	26
<u>Spiochaetopterus</u> <u>oculatus</u>	14	2	16
<u>Acteocina</u> <u>canaliculata</u>	8	8	16
<u>Scoloplos</u> <u>fragilis</u>	6	2	8
<u>Phoronis</u> <u>muelleri</u>	4	3	7
<u>Pseudeurythoe</u> <u>paucibranchiata</u>	4		4
<u>Mulinia</u> <u>lateralis</u>		3	3
<u>Heteromastus</u> <u>filiformis</u>		1	1
<u>Pectinaria</u> <u>gouldii</u>		1	1
<u>Macoma</u> <u>balthica</u>	1		1
<u>Tellina</u> <u>agilis</u>	1		1
Total Number of Individuals	43	41	84
Number of Species	8	8	11

STATION 6, Elizabeth River
Craney Island Pier, adjacent to channel

Species	Sample 1	Sample 2	Total
<u>Sabella</u> <u>microphthalma</u>	2	87	89

Table 7 (Continued)

STATION 6 (continued)

Species	Sample 1	Sample 2	Total
<u>Nereis succinea</u>	1	24	25
<u>Tharyx setigera</u>	2	7	9
<u>Scoloplos fragilis</u>	3	4	7
<u>Peloscolex sp.</u>	2	5	7
<u>Mulinia lateralis</u>		7	7
<u>Pseudeurythoe paucibranchiata</u>	2	4	6
<u>Spiochaetopterus oculatus</u>	5	1	6
<u>Molgula manhattensis</u>		6	6
<u>Diadumene leucolena</u>		3	3
<u>Gyptis vittata</u>	1	1	2
<u>Streblospio benedicti</u>		2	2
<u>Acteocina canaliculata</u>		2	2
<u>Eteone heteropoda</u>		1	1
<u>Glycinde solitaria</u>	1		1
<u>Heteromastus filiformis</u>		1	1
<u>Nemertean (unident.)</u>		1	1
Total Number of Individuals	20	157	197
Number of Species	10	17	19

STATION 7, NOB

D&S Pier, inshore of dredged area

Species	Sample 1	Sample 2	Total
<u>Peloscolex sp.</u>	23	23	46
<u>Acteocina canaliculata</u>	13		13
<u>Tellina agilis</u>	3		3
<u>Capitella capitata</u>	1		1
<u>Eteone heteropoda</u>	1		1
<u>Tharyx setigera</u>		1	1
Total Number of Individuals	41	24	65
Number of Species	5	2	6

Table 7 (Continued)

STATION 8, NOB
D&S Pier, in dredged area

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.		2	2
Total Number of Individuals	0	2	2
Number of Species	0	1	1

STATION 9, NOB
Pier 7

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	18	15	33
<u>Acteocina canaliculata</u>	12	10	22
<u>Scoloplos fragilis</u>	4	1	5
<u>Edwardsia elegans</u>		2	2
<u>Eteone heteropoda</u>		2	2
<u>Tharyx setigera</u>		2	2
<u>Neomysis americana</u>		2	2
<u>Pinnixa sayana</u>	2		2
<u>Glycera dibranchiata</u>		1	1
<u>Nereis succinea</u>	1		1
<u>Pseudeurythoe paucibranchiata</u>	1		1
<u>Macoma balthica</u>	1		1
<u>Tellina agilis</u>		1	1
<u>Balanus improvisus</u>	1		1
Hemichordate (unident.)	1		1
Total Number of Individuals	41	36	77
Number of Species	9	9	15

STATION 10, Willoughby Bay
Approach Channel to Small Boat Harbor

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	33	62	95
<u>Sabellaria vulgaris</u>	30	20	50
<u>Unciola serrata</u>	13	14	27
<u>Nereis succinea</u>	5	18	23
<u>Sabella microphthalma</u>	9	3	12
<u>Acteocina canaliculata</u>	3	3	6

Table 7 (Continued)

STATION 10 (continued)

Species	Sample 1	Sample 2	Total
<u>Corophium acherusicum</u>	2	4	6
<u>Tellina agilis</u>	3	1	4
<u>Glycinde solitaria</u>	2	1	3
<u>Marphysa sanguinea</u>	1	2	3
<u>Arabella irricolor</u>		2	2
<u>Clymenella torquata</u>	2		2
<u>Heteromastus filiformis</u>	2		2
<u>Pectinaria gouldii</u>	2		2
<u>Scoloplos fragilis</u>	2		2
<u>Spiochaetopterus oculatus</u>	1	1	2
<u>Edotea triloba</u>	2		2
<u>Neopanope sayi</u>	1	1	2
<u>Carinomella lactea</u>	1		1
<u>Nemertean (unident.)</u>		1	1
<u>Glycera dibranchiata</u>	1		1
<u>Phyllodoce arenae</u>	1		1
<u>Alegina elevata</u>	1		1
<u>Cylichna alba</u>	1		1
<u>Eupleura caudata</u>		1	1
<u>Mercenaria mercenaria</u>		1	1
<u>Sarsiella texana</u>		1	1
<u>Sarsiella zostericola</u>	1		1
<u>Cyathura polita</u>		1	1
<u>Callinectes sapidus (megalopa)</u>		1	1
<u>Molgula manhattensis</u>		1	1
<u>Hemichordate (unident.)</u>	1		1
Total Number of Individuals	120	139	259
Number of Species	23	20	32

STATION 11, Willoughby Bay
Small Boat Harbor

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	6	10	16
<u>Peloscolex sp.</u>	3	6	9
<u>Paraprionospio pinnata</u>	2	2	4
<u>Scoloplos fragilis</u>	3		3
<u>Aricidea cerruti</u>		1	1
<u>Nereis succinea</u>	1		1
<u>Molgula manhattensis</u>	1		1
Total Number of Individuals	16	19	35
Number of Species	6	4	7

Table 7 (Continued)

STATION 12, Willoughby Bay
Approach Channel to Oil Barge Turning Basin

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	9	16	25
<u>Glycinde</u> <u>solitaria</u>	4	18	22
<u>Phoronis</u> <u>psammophila</u>	6	9	15
<u>Clymenella</u> <u>torquata</u>	3	10	13
<u>Acteocina</u> <u>canaliculata</u>	2	8	10
<u>Spiochaetopterus</u> <u>oculatus</u>	4	5	9
<u>Paraprionospio</u> <u>pinnata</u>	1	6	7
<u>Scoloplos</u> <u>fragilis</u>	4	3	7
<u>Heteromastus</u> <u>filiformis</u>	1	4	5
<u>Spio</u> <u>filicornis</u>	2	2	4
<u>Listriella</u> <u>clymenellae</u>		4	4
<u>Turbonilla</u> <u>interrupta</u>	1	2	3
<u>Pseudeurythoe</u> <u>paucibranchiata</u>		2	2
<u>Leucon</u> <u>americanus</u>	1	1	2
<u>Edwardsia</u> <u>elegans</u>	1		1
<u>Alegina</u> <u>elevata</u>		1	1
<u>Gemma</u> <u>gemma</u>	1		1
<u>Macoma</u> <u>tenta</u>	1		1
<u>Pinnixa</u> <u>sayana</u>		1	1
Total Number of Individuals	41	92	133
Number of Species	15	16	19

STATION 13, Willoughby Bay
Oil Barge Turning Basin

Species	Sample 1	Sample 2	Total
<u>Streblospio</u> <u>benedicti</u>	1	1	2
<u>Peloscolex</u> sp.	1		1
Total Number of Individuals	2	1	3
Number of Species	2	1	2

Table 7 (Continued)

STATION 14, Little Creek
Western berths

Species	Sample 1	Sample 2	Total
<u>Neomysis americana</u>		4	4
<u>Callinectes sapidus</u> (megalopa)		2	2
Total Number of Individuals	0	6	6
Number of Species	0	2	2

STATION 15, Little Creek
Southern berths

Species	Sample 1	Sample 2	Total
<u>Callinectes sapidus</u> (megalopa)		1	1
Total Number of Individuals	0	1	1
Number of Species	0	1	1

STATION 16, Little Creek
Little Creek Cove

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	1	3	4
<u>Caprella penantis</u>	1		1
Total Number of Individuals	2	3	5
Number of Species	2	1	2

STATION 17, York River
Cheatham Annex, channel

Species	Sample 1	Sample 2	Total
<u>Paraprionospio pinnata</u>	20	29	49
<u>Leucon americanus</u>	17	32	49
<u>Peloscolex</u> sp.	6	14	20

Table 7 (Continued)

STATION 17 (continued)

Species	Sample 1	Sample 2	Total
<u>Macoma balthica</u>	11	1	12
<u>Pseudeurythoe paucibranchiata</u>	3	2	5
<u>Heteromastus filiformis</u>		3	3
<u>Nereis succinea</u>	1	2	3
<u>Glycinde solitaria</u>	1	1	2
<u>Sigambra tentaculata</u>		2	2
<u>Edotea triloba</u>		2	2
<u>Eteone heteropoda</u>		1	1
<u>Gyptis vittata</u>	1		1
<u>Odostomia impressa</u>	1		1
<u>Macoma tenta</u>	1		1
<u>Mulinia lateralis</u>		1	1
<u>Ampelisca abdita</u>	1		1
<u>Ogyrides limicola</u>	1		1
Total Number of Individuals	64	90	154
Number of Species	12	12	17

STATION 18, York River
Cheatham Annex, between piers

Species	Sample 1	Sample 2	Total
<u>Phoronis muelleri</u>	34	15	49
<u>Nereis succinea</u>		48	48
<u>Sabella microphthalma</u>		34	34
<u>Peloscolex sp.</u>	14	15	29
<u>Balanus improvisus</u>		28	28
<u>Leucon americanus</u>	22	6	28
<u>Paraprionospio pinnata</u>	14	11	25
<u>Corophium acherusicum</u>	21	2	23
<u>Paracaprella tenuis</u>	10	8	18
<u>Diadumene leucolena</u>		16	16
<u>Heteromastus filiformis</u>	6	7	13
<u>Molgula manhattensis</u>		8	8
<u>Edotea triloba</u>		7	7
<u>Glycinde solitaria</u>	2	3	5
<u>Pseudeurythoe paucibranchiata</u>	5		5
<u>Doridella obscura</u>		3	3
<u>Ampelisca abdita</u>	1	2	3
<u>Sabellaria vulgaris</u>		2	2
<u>Spiochaetopterus oculatus</u>	2		2
<u>Mulinia lateralis</u>		2	2

Table 7 (Continued)

STATION 18 (continued)

Species	Sample 1	Sample 2	Total
<u>Stenothoe minuta</u>		2	2
<u>Brania clavata</u>	1		1
<u>Eteone heteropoda</u>		1	1
<u>Scoloplos fragilis</u>		1	1
<u>Sigambra tentaculata</u>		1	1
<u>Crepidula convexa</u>	1		1
<u>Odostomia bisuturalis</u>	1		1
<u>Macoma balthica</u>	1		1
<u>Macoma mitchelli</u>		1	1
<u>Gammarus mucronatus</u>	1		1
<u>Melita nitida</u>	1		1
<u>Ogyrides limicola</u>	1		1
<u>Rhithropanopeus harrisii</u>		1	1
Total Number of Individuals	138	225	363
Total Number of Species	19	24	33

STATION 19, York River
Naval Weapons Station at draw bridge

Species	Sample 1	Sample 2	Total
<u>Paraprionospio pinnata</u>	17	14	31
<u>Leucon americanus</u>	3	15	18
<u>Nereis succinea</u>	15		15
<u>Glycinde solitaria</u>	4	2	6
<u>Peloscolex sp.</u>	2	4	6
<u>Ampelisca abdita</u>	3	1	4
<u>Scoloplos fragilis</u>	3		3
<u>Molgula manhattensis</u>		3	3
<u>Edwardsia elegans</u>	1	1	2
<u>Heteromastus filiformis</u>	2		2
<u>Acteocina canaliculata</u>	1	1	2
<u>Phoronis muelleri</u>		1	1
<u>Glycera dibranchiata</u>		1	1
<u>Sigambra tentaculata</u>	1		1
<u>Edotea triloba</u>		1	1
<u>Corophium acherusicum</u>	1		1
<u>Ogyrides limicola</u>		1	1
<u>Anadara transversa</u>		1	1
Total Number of Individuals	53	46	99
Number of Species	12	13	18

Table 7 (Continued)

STATION 20, York River
Oil Pier (Coast Guard Pier)

<u>Species</u>	<u>Sample 1</u>	<u>Sample 2</u>	<u>Total</u>
<u>Paraprionospio pinnata</u>	26	30	56
<u>Leucon americanus</u>	7	4	11
<u>Nereis succinea</u>	2	1	3
<u>Ampelisca abdita</u>	1	1	2
<u>Acteocina canaliculata</u>	1	1	2
<u>Edwardsia elegans</u>		1	1
<u>Glycinde solitaria</u>		1	1
<u>Sigambra tentaculata</u>		1	1
<u>Odostomia bisuturalis</u>	1		1
<u>Mulinia lateralis</u>		1	1
<u>Gammarus mucronatus</u>		1	1
Total Number of Individuals	38	42	80
Number of Species	6	10	11

Table 8

CONTENTS OF SAMPLES FOR MACROBENTHOS
November-December, 1974

STATION 1, Southern Branch Elizabeth River
Reserve Fleet Berth

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	4	28	32
<u>Leucon americanus</u>	8	1	9
<u>Peloscolex sp.</u>	5	1	6
<u>Eteone heteropoda</u>	2	3	5
<u>Nereis succinea</u>	1	4	5
<u>Scoloplos fragilis</u>	1	2	3
Amphipods (unident.)	2		2
Nemertean (unident.)	1	1	2
<u>Gyptis vittata</u>		1	1
Total Number of Individuals	24	41	65
Number of Species	8	8	9

STATION 2, Southern Branch Elizabeth River
Turning Basin, Norfolk Naval Shipyard

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	48	8	56
<u>Peloscolex sp.</u>	27	28	55
<u>Capitella capitata</u>	2	10	12
<u>Eteone heteropoda</u>	5	2	7
<u>Nereis succinea</u>	2	2	4
<u>Edotea triloba</u>	2		2
Nemertean	1		1
<u>Aricidea cerruti</u>		1	1
<u>Leucon americanus</u>	1		1
Total Number of Individuals	88	51	139
Number of Species	8	6	9

Table 8 (Continued)

STATION 3, Southern Branch Elizabeth River
St. Helena Piers

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	20	20	40
<u>Peloscolex sp.</u>	2	10	12
<u>Eteone heteropoda</u>	2	1	3
<u>Scoloplos fragilis</u>	2		2
<u>Nemertean (unident.)</u>	1		1
<u>Nereis succinea</u>	1		1
<u>Spiochaetopterus oculatus</u>		1	1
<u>Tellina agilis</u>	1		1
<u>Leucon americanus</u>	1		1
Total Number of Individuals	30	32	62
Number of Species	8	4	9

STATION 4, Elizabeth River
Deperming Station

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	26	19	45
<u>Paraprionospio pinnata</u>	18	17	35
<u>Peloscolex sp.</u>	12	14	26
<u>Scoloplos fragilis</u>	8	6	14
<u>Nemertean (unident.)</u>	1		1
<u>Carinomella lactea</u>		1	1
<u>Nereis succinea</u>	1		1
<u>Sigambra tentaculata</u>		1	1
<u>Pseudeurythoe paucibranchiata</u>		1	1
<u>Spiochaetopterus oculatus</u>		1	1
Total Number of Individuals	66	60	126
Number of Species	6	8	10

Table 8 (Continued)

STATION 5, Elizabeth River
Craney Island Pier, edge of channel

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	36	19	54
<u>Scoloplos fragilis</u>	17	6	23
<u>Paraprionospio pinnata</u>	12	10	22
<u>Streblospio benedicti</u>	9	11	20
<u>Pseudeurythoe paucibranchiata</u>		19	19
<u>Gyptis vittata</u>		2	2
<u>Carinomella lactea</u>		1	1
<u>Nereis succinea</u>	1		1
<u>Glycinde solitaria</u>	1		1
<u>Acteocina canaliculata</u>	1		1
<u>Tellina agilis</u>		1	1
Total Number of Individuals	77	69	146
Number of Species	7	8	11

STATION 6, Elizabeth River
Craney Island Pier, adjacent to channel

Species	Sample 1	Sample 2	Total
<u>Spiochaetopterus oculatus</u>	60	43	103
<u>Scoloplos fragilis</u>	23	13	36
<u>Peloscolex</u> sp.	18	18	36
<u>Glycinde solitaria</u>	21	1	22
<u>Streblospio benedicti</u>	1	21	22
<u>Sabella microphthalma</u>	2	16	18
<u>Acteocina canaliculata</u>	4	8	12
<u>Nereis succinea</u>	3	4	7
<u>Phoronis muelleri</u>	6	1	7
<u>Eteone heteropoda</u>	1	2	3
<u>Drilonereis filum</u>	3		3
<u>Polydora ligni</u>		3	3
<u>Paraprionospio pinnata</u>	1	2	3
<u>Tharyx setigera</u>	2		2
<u>Mulinia lateralis</u>		1	1
Total Number of Individuals	145	133	278
Number of Species	13	13	15

Table 8 (Continued)

STATION 9, NOB
Pier 7

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	42	218	260
<u>Acteocina canaliculata</u>	13	130	143
<u>Spiochaetopterus oculatus</u>		9	9
Hemichordate (unident.)	3	3	6
<u>Nereis succinea</u>	1	4	5
<u>Streblospio benedicti</u>		4	4
<u>Tellina agilis</u>		4	4
<u>Capitella capitata</u>		2	2
<u>Sarsiella zostericola</u>		2	2
<u>Carinomella lactea</u>		1	1
<u>Eteone heteropoda</u>	1		1
<u>Diopatra cuprea</u>		1	1
<u>Turbonilla interrupta</u>	1		1
<u>Mercenaria mercenaria</u>		1	1
<u>Pinnixa sayana</u>		1	1
Total Number of Individuals	61	380	441
Number of Species	6	13	15

STATION 10, Willoughby Bay
Approach Channel to Small Boat Harbor

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	248	82	330
<u>Scoloplos fragilis</u>	18	12	30
<u>Polydora ligni</u>	3	24	27
<u>Streblospio benedicti</u>	21	2	23
<u>Acteocina canaliculata</u>	12	3	15
<u>Paraprionospio pinnata</u>	11	1	12
<u>Sabella microphthalma</u>		8	8
<u>Nereis succinea</u>		5	5
<u>Corophium acherusicum</u>		5	5
<u>Melita nitida</u>		5	5
<u>Palaemonetes pugio</u>		5	5
<u>Eteone heteropoda</u>	3	1	4
<u>Melita appendiculata</u>		4	4
<u>Glycinde solitaria</u>	2	1	3
<u>Tellina agilis</u>		3	3

Table 8 (Continued)

STATION 10 (Continued)

Species	Sample 1	Sample 2	Total
<u>Caprella penantis</u>	3	3	3
<u>Carinomella lactea</u>	1	1	2
<u>Glycera americana</u>	1	1	2
<u>Marphysa sanguinea</u>		2	2
<u>Tharyx setigera</u>	2		2
<u>Mitrella lunata</u>		2	2
<u>Doridella obscura</u>		2	2
<u>Cymadusa compta</u>		2	2
<u>Tubulanus pellucidus</u>		1	1
<u>Capitella capitata</u>	1		1
<u>Spiochaetopterus oculatus</u>	1		1
<u>Glycera dibranchiata</u>	1		1
<u>Ichthyobdella rapax</u>		1	1
Total Number of Individuals	325	176	501
Number of Species	14	24	28

STATION 11, Willoughby Bay
Small Boat Harbor

Species	Sample 1	Sample 2	Total
<u>Peloscolex sp.</u>	18	64	82
<u>Streblospio benedicti</u>	20	55	75
<u>Paraprionospio pinnata</u>	4	4	8
<u>Gyptis vittata</u>	1	1	2
<u>Scoloplos fragilis</u>	1	1	2
<u>Tharyx setigera</u>		1	1
<u>Macoma balthica</u>	1		1
Total Number of Individuals	45	126	171
Number of Species	6	6	7

Table 8 (Continued)

STATION 12, Willoughby Bay
Approach Channel to Oil Barge Turning Basin

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	48	20	68
<u>Peloscolex</u> sp.	16	15	31
<u>Capitella capitata</u>	7	4	11
<u>Gyptis vittata</u>		6	6
<u>Eteone heteropoda</u>	4		4
<u>Tellina agilis</u>	2	2	4
<u>Scoloplos fragilis</u>	1	2	3
<u>Spiochaetopterus oculatus</u>	3		3
<u>Glycinde solitaria</u>	1	1	2
<u>Pseudeurythoe paucibranchiata</u>		2	2
<u>Paraprionospio pinnata</u>		1	1
<u>Phoronis muelleri</u>	1		1
<u>Mulinia lateralis</u>	1		1
Total Number of Individuals	84	53	137
Number of Species	10	9	13

STATION 13, Willoughby Bay Oil Barge Turning Basin

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	46	38	84
<u>Capitella capitata</u>	11	2	13
<u>Peloscolex</u> sp.	1	2	3
<u>Eteone heteropoda</u>	1		1
<u>Polydora ligni</u>	1		1
Total Number of Individuals	60	42	102
Number of Species	5	3	5

Table 8 (Continued)

STATION 14, Little Creek
Western Berths

Species	Sample 1	Sample 2	Total
<u>Capitella capitata</u>	13	4	17
<u>Streblospio benedicti</u>		1	1
<u>Eteone heteropoda</u>		1	1
Total Number of Individuals	13	6	19
Number of Species	1	3	3

STATION 15, Little Creek
Southern Berths

Species	Sample 1	Sample 2	Total
<u>Capitella capitata</u>	2	3	5
Total Number of Individuals	2	3	5
Number of Species	1	1	1

STATION 17, York River
Cheatham Annex, channel

Species	Sample 1	Sample 2	Total
<u>Peloscolex sp.</u>	38	70	108
<u>Paraprionospio pinnata</u>	22	42	64
<u>Pseudeurythoe paucibranchiata</u>	1	17	18
<u>Macoma balthica</u>	13	4	17
<u>Glycinde solitaria</u>		5	5
<u>Heteromastus filiformis</u>	1	4	5
<u>Leucon americanus</u>	2	3	5
<u>Sigambra tentaculata</u>		4	4
<u>Gyptis vittata</u>	3	1	4
<u>Nereis succinea</u>	2	2	4
<u>Streblospio benedicti</u>	1	1	2
<u>Harmothoe sp.</u>		1	1
<u>Ancistrosyllis jonesi</u>		1	1
<u>Scoloplos fragilis</u>		1	1
<u>Asabellides oculata</u>		1	1

Table 8 (Continued)

STATION 17 (Continued)

Species	Sample 1	Sample 2	Total
<u>Neomysis americana</u>	1		1
<u>Micropholis atra</u>		1	1
Total Number of Individuals	84	158	242
Number of Species	10	16	17

STATION 18, York River
Cheatham Annex, between piers

Species	Sample 1	Sample 2	Total
<u>Peloscolex</u> sp.	3	120	123
<u>Paraprionospio pinnata</u>	24	51	75
<u>Heteromastus filiformis</u>	2	17	19
<u>Leucon americanus</u>	8	4	12
<u>Macoma balthica</u>	1	5	6
<u>Glycinde solitaria</u>	2	2	4
<u>Sigambra tentaculata</u>	2		2
<u>Ogyrides limicola</u>	2		2
<u>Diadumene leucolena</u>		1	1
<u>Pseudeurythoe paucibranchiata</u>		1	1
<u>Scoloplos fragilis</u>		1	1
<u>Streblospio benedicti</u>	1		1
<u>Acteocina canaliculata</u>		1	1
<u>Corophium lacustre</u>	1		1
Total Number of Individuals	46	203	249
Number of Species	10	10	14

STATION 19, York River
Naval Weapons Station at draw bridge

Species	Sample 1	Sample 2	Total
<u>Paraprionospio pinnata</u>	6	30	36
<u>Peloscolex</u> sp.	6	17	23
<u>Heteromastus filiformis</u>	13	7	20
<u>Nereis succinea</u>	15	2	17

Table 8 (Continued)

STATION 19 (Continued)

Species	Sample 1	Sample 2	Total
<u>Pseudeurythoe paucibranchiata</u>		10	10
<u>Glycinde solitaria</u>	2	4	6
<u>Streblospio benedicti</u>	3	3	6
<u>Tharyx setigera</u>	4	1	5
<u>Leucon americanus</u>		5	5
<u>Sigambra tentaculata</u>		3	3
<u>Macoma balthica</u>	1	2	3
<u>Gyptis vittata</u>		2	2
<u>Micrura rubra</u>		1	1
<u>Asabellides oculata</u>	1		1
<u>Ampelisca abdita</u>	1		1
<u>Ogyrides limicola</u>		1	1
Total Number of Individuals	52	88	140
Number of Species	10	14	16

STATION 20, York River
Oil Pier (Coast Guard Pier)

Species	Sample 1	Sample 2	Total
<u>Leucon americanus</u>	30	34	64
<u>Paraprionospio pinnata</u>	5	53	58
<u>Streblospio benedicti</u>	1	22	23
<u>Nereis succinea</u>	2	7	9
<u>Sigambra tentaculata</u>		8	8
<u>Heteromastus filiformis</u>		7	7
<u>Corophium acherusicum</u>	2	5	7
<u>Peloscolex sp.</u>	1	2	3
<u>Scoloplos fragilis</u>	1	1	2
<u>Polydora ligni</u>		2	2
<u>Gyptis vittata</u>		1	1
<u>Glycera americana</u>	1		1
<u>Glycinde solitaria</u>		1	1
<u>Sabella microphthalma</u>		1	1
<u>Tellina agilis</u>	1		1
<u>Edotea triloba</u>	1		1
<u>Echiuran (unident.)</u>		1	1
<u>Micrura rubra</u>		1	1
Total Number of Individuals	45	146	291
Number of Species	10	15	18

Table 8 (Continued)

STATION 21, Little Creek
Approach Channel

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	34	47	81
<u>Peloscolex</u> sp.	22	37	59
<u>Spiochaetopterus oculatus</u>	4	11	15
<u>Carinomella lactea</u>		4	4
<u>Tharyx setigera</u>		4	4
<u>Scoloplos fragilis</u>	1	1	2
<u>Paraprionospio pinnata</u>	2		2
<u>Capitella capitata</u>	2		2
<u>Acteocina canaliculata</u>	2		2
Nemertean (unident.)		1	1
<u>Eteone heteropoda</u>	1		1
<u>Glycinde solitaria</u>	1		1
<u>Prionospio cirrifera</u>		1	1
Total Number of Individuals	69	106	175
Number of Species	9	8	13

STATION 22, NOB
D & S Pier

Species	Sample 1	Sample 2	Total
<u>Streblospio benedicti</u>	9	1	10
<u>Peloscolex</u> sp.	7	2	9
<u>Eteone heteropoda</u>	1		1
<u>Nereis succinea</u>	1		1
<u>Scoloplos fragilis</u>	1		1
<u>Sabella microphthalma</u>		1	1
<u>Acteocina canaliculata</u>	1		1
Total Number of Individuals	20	4	24
Number of Species	6	7	7

11, 13, 14, 15, and 16. Seldom have more depauperate assemblages been found in the thousands of collections taken by Institute personnel in the lower Chesapeake Bay region (cf. Boesch, 1973). At these depauperate locations the benthic fauna was limited for the most part to exceptionally tolerant species, e.g. the oligochaete Peloscolex sp., the polychaetes Streblospio benedicti and Nereis succinea and the bivalve Mulinia lateralis. At two of the stations in Little Creek, stations 14 and 15, no permanently benthic species was found and only motile and partially pelagic crab larvae and mysids were found.

The remainder of the collections were of similar composition to those previously taken in these areas. The stations in the lower Elizabeth River area, stations 4, 5, 6, and 9, showed a diversity which, as has been reported by Boesch (1973), is somewhat below that of other habits of similar bottom type and salinity, for example the Willoughby Bay locations, stations 10 and 12. The collections from the York River above Yorktown, stations 17-19, yielded typical mesohaline mud bottom assemblages as indicated by Boesch (1971). The polychaete Paraprionospio pinnata, the bivalve Macoma balthica and the cumacean Leucon americanus are typical of this assemblage. However, the collection from the Yorktown oil pier, station 20, does not include many of the characteristic species of this reach of the estuary. Although it too is dominated by Paraprionospio pinnata and

Leucon americanus, this may be a reflection of the low oxygen stress often found in deep portions of the lower York than to salinity-related distribution patterns. Also it was noted that the sediments at station 20 were grey semi-consolidated clays (i.e. not of recent depositional origin) suggesting that dredging, current scour or ship wash had exposed subsurface sediments. Thus, the composition of the faunal assemblage may be a reflection of early successional development.

Data on water depth, temperature, salinity and dissolved oxygen at the time of collection of benthic samples are listed in Table 9. All bottom salinities were within a relatively narrow range (19.41 - 24.11‰), mitigating the role of salinity in explaining the between-station distribution patterns found. Low dissolved oxygen concentrations were found at many of the deep locations in the Southern Branch of the Elizabeth River and York River. As mentioned above, low dissolved oxygen levels are often found in the lower York in late summer due to stagnation of bottom waters by the presence of a sill at the mouth of the estuary, pronounced vertical density stratification and high biological oxygen demand. Poor flushing and density stratification of the deep dredged channels of the Elizabeth River are apparently the causes of low dissolved oxygen concentration there.

Low oxygen at the bottom was one probable cause of the depauperate nature of the fauna in the berthing areas and

Table 9

Water depth, temperature, salinity and dissolved oxygen
and date of sampling at each of benthos sampling stations
August-October, 1974

Benthos Station	Depth (ft.)	Temperature (°C)		Salinity (‰)		Dissolved O ₂ mg l ⁻¹		Date Sampled
		Surface	Bottom	Surface	Bottom	Surface	Bottom	
1	22	28.0	26.5	16.62	20.78	4.78	2.98	8-29-74
2	45	28.0	26.0	16.95	22.31	4.90	3.3	8-29-74
3	25	28.6	27.0	16.78	21.20	5.02	3.38	8-29-74
4	50	28.0	27.0	18.03	23.65	6.90	3.68	8-29-74
5	22	29.0	27.0	18.63	20.50	9.58	4.66	8-29-74
6	18	----	----	-----	-----	----	----	8-29-74
7	15	28.8	28.0	18.57	20.04	7.40	6.08	8-29-74
8	35	28.6	27.2	18.40	20.09	9.66	5.88	8-29-74
9	44	27.9	26.0	18.61	24.11	7.52	4.30	8-29-74
10	9	18.0	----	22.01	21.24	7.70	7.04	10-18-74
11	10	----	----	20.29*	-----	12.4*	----	10-18-74
12	9	----	----	18.19*	-----	8.26*	----	10-18-74
13	11	----	----	18.22*	-----	8.34*	----	10-18-74
14	22	24.5	----	22.01	-----	8.50	----	9-10-74
15	20	----	----	22.12	-----	9.35	----	9-10-74
16	23	----	----	17.79	-----	8.18	----	9-10-74
17	42	25.0	24.4	18.23	21.86	5.80	2.80	8-30-74
18	18	25.5	25.3	17.89	19.41	5.76	4.50	8-30-74
19	18	25.8	25.1	18.83	20.37	6.32	4.10	8-30-74
20	40	25.6	23.9	19.87	23.75	6.30	1.36	8-30-74

* Sample taken 9-11-74

channels. Certainly also important were the conditions in the bottom sediments, both the soft fluid nature of the sediments and high concentrations of toxic materials in them. Although no chemical analyses were performed on the sediments per se, trace metal concentrations are known to be high in these areas (Bender, et al. 1972). The sediments in the berthing areas and channels were apparently also heavily contaminated with oil, noticeable by its strong odor, the formation of surface films during sample processing and the fouling of laboratory glassware.

November-December

The patterns observed during the August-October sampling largely held as well for the November-December samples. The benthic assemblages in the dredged areas and berths of the Elizabeth River, Willoughby Bay and Little Creek remained depauperate although there was an increase at virtually all these stations in the number of species and faunal density from August-October. This was probably a reflection of the improved dissolved oxygen conditions concomitant with the lowering of temperature (Table 10). Nonetheless toxic conditions in the sediments of these areas probably precluded the establishment of many species characteristic of "healthy" assemblages elsewhere. Relatively tolerant species such as the polychaetes Streblospio benedicti, Capitella capitata, Eteone lactea and Scoloplos fragilis and the oligochaete Pelosclex sp. are among the few which can occupy this

Table 10

Water depth, temperature, salinity and dissolved oxygen and date of sampling at each benthos sampling station November-December 1974

Benthos Station	Depth (ft.)	Temperature (°C)		Salinity (‰)		Dissolved O ₂ mg l ⁻¹		Date Sampled
		Surface	Bottom	Surface	Bottom	Surface	Bottom	
1	30	9.9	10.2	20.6	21.0	8.27	8.07	12- 5-74
2	40	9.4	10.1	20.9	21.5	8.30	8.09	12- 5-74
3	28	8.8	9.8	21.0	21.8	8.36	7.38	12- 5-74
4	45	7.0	7.5	21.5	21.9	7.28	6.59	12- 5-74
5	30	6.9	7.5	21.3	21.8	7.38	5.67	12- 5-74
6	20	---	----	----	----	----	----	12- 5-74
9	38	6.9	7.0	22.3	22.7	7.00	6.68	12- 6-74
10	10	7.1	7.2	23.8	23.8	6.55	7.57	12- 6-74
11	12	7.0	7.1	24.2	23.7	7.61	4.31	12- 6-74
12	12	7.0	7.0	23.8	23.7	8.57	8.04	12- 6-74
13	10	7.0	7.1	23.7	21.3	8.38	7.33	12- 6-74
14	24	11.6	10.4	24.5	27.9	5.94	5.25	11-21-74
15	20	11.2	10.0	24.4	24.5	5.54	5.01	11-21-74
17	40	10.2	10.7	21.4	20.9	8.44	8.38	11-22-74
18	17	10.2	10.7	21.2	21.1	8.23	7.72	11-22-74
19	18	10.6	10.9	21.1	21.2	8.68	8.60	11-22-74
20	40	11.0	10.9	21.0	21.8	9.38	8.68	11-22-74
21	32	10.0	10.0	24.8	25.1	6.34	5.94	11-21-74
22	47	6.8	6.9	21.6	24.1	7.82	6.39	12- 6-74

habitat. Increases in the density of these tolerant species, particularly Streblospio benedicti, were the main contributors to the increase in total density.

At the only stations which showed an appreciable decline in density or number of species, stations 6, 12 and 18, this was attributable to a reduction in epifaunal species, reflecting a lesser amount of habitat space in the form of encrusting epifauna (sponges, hydroids, bryozoans, etc.) available.

Part III. Phytoplankton Samples

Methods

Water samples were taken at the surface and bottom at each of seven stations (Table 11). These stations coincide with the zooplankton and trawl stations. An aliquot of 250 ml was filtered through a 47 mm diameter Gelman type A glass filter and the filters stored under cold dessication. The glass filters were ground and extracted in 90% acetone. Chlorophyll a was measured spectrophotometrically using the methods described in SCOR-UNESCO (1966).

Approximately 1 liter of the water sample was preserved with Lugol's iodine solution for phytoplankton identification. Aliquots of this sample were filtered through 0.45 μ Millipore filters which were dried and clear-mounted on glass slides. The slides were examined and the constituent phytoplankters identified to genus and in some cases to species.

Results

Chlorophyll a concentrations (Table 12) were within the range reported from the southern Chesapeake Bay area (Patten and Warinner, 1961; Manzi, 1973). Very high concentrations were found at stations 2 and 3 in the lower Elizabeth River and off NOB during August and at station 4 in Willoughby Bay

Table 11

Location and sampling dates of phyto- and zooplankton samples

Station	Location	Dates Sampled	
1	Southern Branch, Elizabeth River off St. Helena piers	8-29-74	12- 5-74
2	Elizabeth River, between Deperming Station and Craney Island	8-29-74	12- 5-74
3	Hampton Roads, off N.O.B. Pier 7	8-29-74 (phytoplankton) 10-18-74 (zooplankton)	12- 5-74
4	Willoughby Bay in Approach Channel	10-10-74	12- 5-74
5	Little Creek in main channel	10-10-74	11-21-74
6	York River at Cheatham Annex	8-29-74	11-22-74
7	York River at Yorktown Coast Guard Pier	8-29-74	11-22-74

Table 12
Levels of Chlorophyll a ($\mu\text{g}/\text{l}$)

Station Number	Aug.-Oct.		Nov.-Dec.	
	Surface	Bottom	Surface	Bottom
1	9.03	2.66	6.12	4.45
2	35.70	5.99	4.64	4.47
3	22.66	11.98	12.15	3.59
4	17.39	8.06	24.98	14.18
5	12.74	6.81	4.98	8.78
6	9.20	4.56	2.45	3.29
7	13.76	3.84	3.33	2.62

in December. In the lower Chesapeake Bay Patten and Warriner (1961) reported average chlorophyll a levels of 5-6 $\mu\text{g}/\text{l}$ and Manzi (1973) found typical concentrations of roughly 10 $\mu\text{g}/\text{l}$.

Despite the occurrence of high chlorophyll a concentrations, the larger phytoplankters which can be detected by the filter mounting method employed were relatively low (Table 13). This indicates that small flagellates contained most of the chlorophyll present and thus were the dominant primary producers. This is consistent with the results of other investigators working in Chesapeake Bay who indicate that nanno- and ultraplankton may account for as much as 90% of the primary productivity.

The most abundant phytoplankter observed was the colonial diatom Skeletonema costatum, which was abundant during both sampling periods. Many other taxa, notably Thalassionema nitzschiodes in August-October and Thalassiosira spp. and Rhizosolenia spp. in November-December, were present in lesser abundance. The dominance of Skeletonema during both periods conforms with the patterns described by Marshall (1967a, 1967b) for Hampton Roads, Willoughby Bay and the Elizabeth River.

Skeletonema costatum was also the dominant taxon during both sampling periods in the lower York River. Thalassionema nitzschiodes and Cyclotella sp. were moderately abundant in August and Rhizosolenia spp. in November. The dominance by these forms and the qualitative temporal distribution of the rarer taxa conform to the patterns described by Manzi (1973) for the lower York River estuary.

Table 13

Taxa identified in phytoplankton samples taken during August-October or November-December, 1974
(+ present, ++ abundant)

Taxon	August-October														November-December													
	1		2		3		4		5		6		7		1		2		3		4		5		6		7	
	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
<u>Actinocyclus ehrenbergii</u>	+																											
<u>Amphora ovalis</u>		+						+						+									+					
<u>Asterionella japonica</u>																						+						
<u>Chaetocerus spp.</u>															+	+	+	+					+	+	+	+	+	+
<u>Cocconeis scutellum</u>										+		+										+	+					+
<u>Coccinodiscus spp.</u>	+		+			+	+	+	+	+	+	+	+	+	+				+	+	+	+	+	+	+	+	+	+
<u>Cyclotella sp.</u>					+	+						+			+	+						+	+	+	+	+	+	+
<u>Ditylum brightwelli</u>																												+
<u>Grammatophora marina</u>				+						+		+	+	+									+		+	+		+
<u>Leptocylindrus danicus</u>															+							+	+			+	+	
<u>Mastogloia brauni</u>																+												
<u>Melosira sp.</u>		+	+	+		+		+				+	+														+	+
<u>Navicula spp.</u>	+				+			+				+		+	+			+				+			+	+	+	+
<u>Nitzschia spp.</u>	+	+	+				+	+		+	+	+		+		+	+								+	+	+	+
<u>Nitzschia closterium</u>															+							+	+	+	+	+	+	+
<u>Pleurosigma spp.</u>	+							+				+		+								+	+			+	+	+
<u>Rhizosolenia spp.</u>															+	++	+	+	+	+	+	+	+	+	+	+	+	+
<u>Skeletonemia costatum</u>	++	+	++	+	++	+	++	++	++	+	++	++	++	++	++	+	++	++	++	++	++	++	++	++	++	++	++	++
<u>Thalassionema nitzschiodes</u>	+	+	+	+	+	+	+	+	+	+	+	+	++	+	+	+	++	+	+	+	+	+	+	+	+	+	+	+
<u>Thalassiosira sp.</u>															+	+	+	+	++	+	+	+	+	+	+	+	+	+

Part IV. Zooplankton Samples

Methods

Surface and bottom zooplankton samples were taken at the same 7 stations at which phytoplankton and trawl samples were procured (Table 7), except that at two of them, stations 4 and 5, only surface samples were obtained because of the shallow depths and operating difficulties. It was not possible to analyze the bottom sample taken at station 1 in December because of a large amount of bottom sediment in the sample and the samples from station 2 in December were lost due to improper preservation. Separate surface and near-bottom tows of five minutes duration were made with a Miller high speed plankton sampler equipped with a #202 mesh net. The contents of the net were preserved with formalin and later sorted, identified and counted.

Results

The results of the analysis of the zooplankton samples are summarized in Tables 14 and 15. The August-October samples show high densities of copepods, which are the dominant zooplankters, at stations in the Southern Branch of the Elizabeth River (Station 1), the Elizabeth River Approach Channel (Station 3) and in the York River (stations 6 and 7). The densities of copepods were much less at the

Table 14

Contents of zooplankton samples
August-October, 1974

Taxon	STATION											
	1		2		3		4	5	6		7	
	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Surf.	Surf.	Bot.	Surf.	Bot.
Cnidaria												
ephyrae of <u>Cyanea</u>	-----	-----	-----	----	-----	----	1	-----	-----	-----	-----	-----
<u>Aurelia aurita</u>	-----	2	-----	----	-----	----	-----	-----	-----	-----	1	1
<u>Neomopsis bachei</u>	-----	-----	-----	----	-----	----	-----	-----	-----	5	-----	1
<u>Bougainvillea rugosa</u>	-----	-----	-----	----	-----	----	-----	-----	-----	-----	-----	1
Ctenophora												
<u>Mnemiopsis leidyi</u>	-----	4	1	----	-----	1	-----	-----	-----	15	-----	-----
Mollusca												
bivalve larvae	8	48	-----	----	-----	----	-----	-----	-----	32	320	52
gastropod larvae	4	24	-----	----	-----	40	4	-----	1	32	-----	-----
Annelida												
polychaete larvae	-----	16	2	----	-----	24	4	-----	1	32	96	40
Pycnogonida												
<u>Callipallene brevis</u>	-----	-----	1	----	-----	----	-----	-----	-----	-----	-----	-----
Copepoda												
<u>Acartia tonsa</u>	10,080	10,944	664	400	12,352	106,496	1,552	724	4,368	4,576	24,320	2,872
<u>Pseudodiaptomus coronatus</u>	160	1,472	---	112	1,600	5,632	96	-----	-----	704	1,856	288
<u>Paracalanus crassirostris</u>	-----	-----	36	---	32	-----	-----	4	16	32	-----	-----
<u>Labidocera aestiva</u>	2	16	4	---	2	12	4	4	-----	-----	-----	-----
<u>Oncaea</u> sp.	-----	-----	-----	----	64	-----	-----	-----	-----	-----	-----	16
<u>Oithona</u> sp.	-----	-----	-----	----	-----	-----	4	-----	-----	-----	-----	-----
Unid. harpacticoids	-----	-----	-----	----	12	-----	-----	-----	-----	-----	-----	-----
<u>Euterpina acutifrons</u>	-----	-----	-----	----	-----	-----	4	-----	-----	-----	-----	-----
Cirripedia												
barnacle nauplii	36	-----	144	---	20	-----	36	13	224	-----	176	2
barnacle cyprids	68	32	24	---	24	40	12	1	-----	24	144	6
Cumacea												
<u>Leucon americanus</u>	-----	-----	---	----	-----	-----	1	-----	-----	-----	-----	-----
Isopoda												
<u>Aegathoa</u> (?) <u>medialis</u>	-----	-----	---	----	8	7	6	-----	-----	-----	-----	-----
	-----	-----	---	----	-----	1	-----	-----	-----	-----	-----	-----

Table 14 (Continued)

Taxon	STATION											
	1		2		3		4	5	6		7	
	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Surf.	Surf.	Bot.	Surf.	Bot.
Amphipoda	----	----	----	----	----	----	----	----	----	1	1	----
Mysidacea												
<u>Neomysis americana</u>	----	----	----	----	9	99	----	----	----	1	5	1
<u>Mysidopsis bigelowi</u>	----	----	----	----	----	----	----	----	----	----	----	1
Decapoda (larvae)	40	----	9	----	----	----	----	----	356	64	22	7
<u>Upogebia affinis</u>	4	----	1	----	----	----	----	----	8	20	10	----
<u>Ogyrides limicola</u>	----	----	----	----	----	----	----	----	4	12	----	----
brachyuran zoea	36	----	8	----	----	----	----	----	344	32	12	----
<u>Uca</u> sp.	----	----	6	----	----	----	----	----	?340	----	----	----
<u>Callinectes sapidus</u>	----	----	----	----	----	----	----	----	?4	----	----	----
<u>Rhithropanopeus</u> sp.	----	----	1	----	----	----	----	----	----	----	----	----
<u>Pinnotheres ostreum</u>	----	----	----	----	----	----	----	----	----	8	----	----
brachyuran megalops	----	----	----	----	3	----	----	----	----	----	----	----
Chaetognatha												
<u>Sagitta tenuis</u>	1	2	2	----	1	11	2	----	----	1	3	2
Tunicata												
<u>Oikopleura dioica</u>	----	----	----	----	----	8	----	----	----	----	16	4
Pisces (eggs/larvae)												
<u>Anchoa mitchilli</u>	1/1	----	1/0	----	----	----	----	----	----	4/0	1/0	2/0
<u>Trinectes maculatus</u>	----	----	----	----	----	----	----	----	----	5/0	4/0	1/0
24-hr. Settled Vol. (ml)	3.5	10.0	0.5	(mud)	6.0	17.0	0.5	0.4	3.0	19.0	18.0	2.0

Table 15

Contents of zooplankton samples
November-December, 1974

Taxon	STATION									
	1	3		4	5	6		7		
	Surf.	Surf.	Bot.	Surf.	Surf.	Surf.	Bot.	Surf.	Bot.	
Mollusca										
gastropod larvae	----	----	----	----	1	----	----	----	----	
bivalve larvae	----	----	----	10	----	----	----	----	----	
Annelida										
polychaete larvae	16	----	36	36	1	----	16	----	----	
Copepoda										
<u>Acartia tonsa</u>	276	255	3216	2752	2640	508	5920	1856	2864	
<u>Acartia clausi</u>	10	15	48	32	8	8	----	----	----	
<u>Centropages hamatus</u>	----	11	32	----	8	----	----	16	----	
<u>Pseudodiaptomus coronatus</u>	4	----	----	128	16	----	48	32	16	
<u>Oncaea</u> sp.	----	----	----	48	----	----	----	----	----	
<u>Farranula</u> sp.	----	----	----	----	8	----	----	----	----	
<u>Oithona</u> sp.	----	----	----	----	----	4	----	----	----	
<u>Euterpina acutifrons</u>	2	----	----	----	----	----	----	----	----	
Unident. harpacticoids	----	1	----	----	----	----	----	16	----	
Cirripedia										
barnacle nauplii	16	5	28	18	11	13	64	19	76	
" cypris stages	----	----	1	2	1	2	2	----	----	
Cladocera										
<u>Podon polyphemoides</u>	1	----	1	2	9	18	108	1248	464	
Mysidacea										
<u>Neomysis americana</u>	----	----	----	6	----	----	----	----	----	
Decapoda (larvae)										
<u>Crangon septemspinosa</u>	----	----	1	----	----	----	----	----	----	
Chaetognatha										
<u>Sagitta tenuis</u>	----	----	1	----	----	----	----	----	----	
Settled Volume: (ml)	0.6	0.2	1.0	4.0	0.5	0.5	1.5	0.5	0.7	
				(detritus)						

other locations. The dominant copepod was Acartia tonsa and only one other copepod, Pseudodiaptomus coronatus, was very abundant. The dominance of these two species during the late summer and early fall in the lower Chesapeake Bay area was described by Burrell (1972).

Abundance of zooplankton was lower in November-December. This is normal for this time of year. Sampling in the lower Chesapeake Bay by Dr. George C. Grant showed yearly lows in zooplankton biomass in November and December. Diversity of taxa is also very low during this period. The ratio of Acartia tonsa to Acartia clausi was relatively high indicating that typical winter conditions in which A. clausi dominates had not been reached.

Zooplankters other than copepods were also of low abundance. Amphipods, tunicates, fish eggs and larvae, and decapod larvae (except a single occurrence of Crangon zoea) were absent.

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