SEABROOK ENVIRONMENTAL STUDIES,
JULY THROUGH DECEMBER 1977

PLANKTON
TECHNICAL REPORT IX-1

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1.0 INTRODUCTION

Since 1969, plankton studies designed to establish a preoperational data base of species occurrence, abundance and distribution have been conducted in the Hampton-Seabrook estuary and nearshore waters. A formal preoperational program was instituted in July 1975, resulting in two July-June annual reports (NAI, 1977, 1978). Report IX-1, compiled to shift subsequent reporting periods to a January-December annual cycle, presents plankton results from July-December 1977 and includes comparisons to the two previous years of formal preoperational monitoring.

The plankton program includes zooplankton, phytoplankton and ichthyoplankton studies in addition to chlorophyll *a*, primary productivity and nutrient measurements; ichthyoplankton results are presented with the finfish program. Beginning in July 1977, the phytoplankton sampling regime was expanded to include whole water samples in addition to 76 µm net samples. The whole water samples are designed to sample small (<76 µm) species (=nanoplankton) not captured by the net. For zooplankton sampling a 505 µm meter net replaced a 333 µm Bongo net to sample macro- rather than meso- zooplankton. The 76 µm phytoplankton and zooplankton pump samples, collected during the night in previous years, are now collected during the day.

The net phytoplankton assemblage in the Gulf of Maine and specifically in coastal New Hampshire is composed largely of diatoms and

armored dinoflagellates (NAI, 1977). Diatoms typically reach peak abundance levels in spring and fall with minima occurring in winter and summer. Dinoflagellate densities tend to reach peak levels during the warmer months. Maximum concentrations of the critical plant nutrients, nitrogen and phosphorous, often occur in winter, when low light levels tend to limit phytoplankton growth (NAI, 1977). Net phytoplankton species that have been abundant during certain seasons each year and were selected as indicator species include: *Skeletonema costatum* (late summer and late fall), *Chaetoceros debilis* (spring) and *Ceratium longipes* (early summer).

Patterns of zooplankton abundance are more complicated. Populations of holoplankton, composed mostly of herbivorous or omnivorous copepods, tend to follow the phytoplankton peaks. Four indicator species have historically exhibited the following distributional trends: *Oithona similis*, ubiquitous; *Eurytemora herdmani*, inshore and in summer; *Pseudocalanus* spp., offshore and in late summer and fall; and *Calanus finmarchicus*, offshore and from spring to midsummer. Among the more abundant meroplankton are the larvae of bivalve molluscs, gastropods, barnacles and polychaete worms. Because meroplankton includes the young of many economically important shellfish such as clams, mussels and decapod crustaceans, as well as finfish eggs and larvae, it is given particular emphasis. The tychoplankton includes harpacticoid copepods, nematodes, mysids, amphipods, cumaceans and juvenile decapod crustaceans. The zooplankton, like the phytoplankton, exhibits defined seasonal trends in the Gulf of Maine.

2.0 METHODS

2.1 FIELD COLLECTIONS

Plankton samples were taken twice monthly from July through December 1977 as indicated in Table 2.1-1 at Stations 2, 5 and 6 (Figure 2.1-1).

2.1.1 Pump Samples: Net Phytoplankton and Microzooplankton

Four replicate submersible pump samples were collected during daylight hours at Station 2, 1 m below the surface and 2 m above the bottom (Figure 2.1-1). Each pump discharged on deck into its own small, 76 μm mesh plankton net, set into a specially designed stand that filled with seawater to within 15 cm of the top of the net. Each net was fitted with an 8-dram (33-ml) vial on its cod end. The volume filtered was approximately 100 liters. Contents were thoroughly rinsed from the nets after pumping, and fixed in borax-buffered 5% formalin.

2.1.2 Whole Water Samples: Phytoplankton, Chlorophyll *a*, Nutrients and Primary Productivity

Near-surface (1 m) and near-bottom (2 m above) water samples were collected during daylight hours with either a submersible pump or water sampler at Station 2; at Station 5, only near-surface samples were collected. From all whole water collections, 2 one-quart jars containing 50 ml of Lugol's iodine fixative were filled for phytoplankton taxonomic analysis. From monthly near-surface collections at both Stations 2 and 5, 1 gallon was reserved for chlorophyll *a* determinations, 250 ml frozen as soon as possible for nutrient analyses and 400 ml reserved for pH determinations; in addition, four 250 ml BOD bottles (2 light and 2 dark) were prepared for primary productivity experiments.

TABLE 2.1-1. PLANKTON SAMPLING SCHEDULE. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

DATE	PUMPED SAMPLES[a]	WHOLE WATER PHYTOPLANKTON SAMPLES[b]	WHOLE WATER PHYTOPLANKTON PLUS WATER SAMPLES[c]	1 m 505 µm NET SAMPLES[d]
	STATION	STATION	STATION	STATION
6 July	2		2, 5	2, 5, 6
20 July	2	2		2, 5, 6
3 August	2		2, 5	2, 5, 6
23 August	2	2		2, 5, 6
7 September*	2		2, 5	2, 5, 6
23 September	2	2		
4 October	2		2, 5	2, 5, 6
18 October	2	2		
1 November	2		2, 5	2, 5, 6
23 November	2	2		
15 December	2		2, 5	2, 5, 6
27 December				2, 5, 6

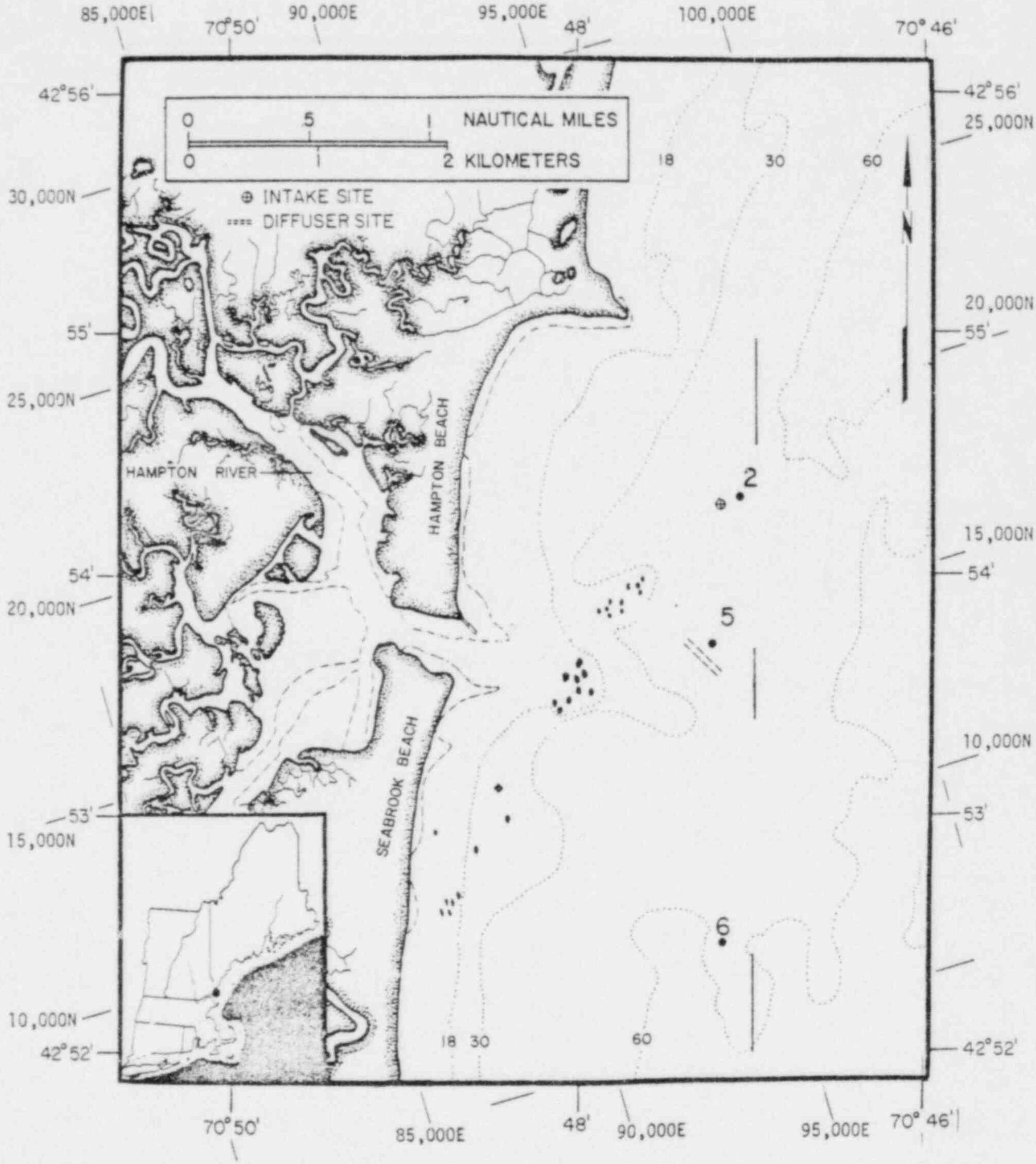
[a] net phytoplankton and microzooplankton ($\geq$76 µm)

[b] whole water phytoplankton only

[c] primary productivity, chlorophyll *a*, and nutrients

[d] macrozooplankton (and ichthyoplankton)

* primary productivity only on 8 September.



● MICROZOOPLANKTON AND/OR PHYTOPLANKTON STATIONS
——— MACROZOOPLANKTON AND ICHTHYOPLANKTON STATIONS

Figure 2.1-1. Plankton sampling stations. Seabrook Ecological Studies, July through December, 1977.

At Stations 2 and 5, temperature and conductivity profiles were made with a Beckman thermistor/salinometer (Model RS5-3). Duplicate dissolved oxygen samples and a salinity sample were also collected near surface and near bottom.

2.1.3 Net Tows: Macrozooplankton

Four replicate sequential oblique tows were made at night at Stations 2, 5 and 6 with 1 m diameter 505 μm meshed nets. Each tow was 5 or 10 minutes in duration depending on plankton densities and was taken from approximately 2 m off the bottom to the surface. The volume filtered was estimated with a General Oceanics digital flow meter. Upon retrieval, each net was thoroughly washed and the contents fixed in borax-buffered 5 to 10% (depending on plankton density) formalin.

2.2 LABORATORY ANALYSES

2.2.1 Net Phytoplankton and Microzooplankton

Net phytoplankton taxa from pump samples (2 field replicates from each depth) were enumerated from two independent, one-ml subsamples in a Sedgwick-Rafter counting cell. Each subsample was placed under a compound microscope at 100X and three random passes across the width of the Sedgwick-Rafter cell examined. Net phytoplankton cells were identified to species as far as practical.

From pump samples, all four field replicates from each depth were analyzed as follows for microzooplankton: the volume of the vial was concentrated to a known amount based upon the relative settled volume of the plankton and detritus. The sample was agitated with a calibrated bulb pipette in an attempt to homogeneously distribute the contents. A 1 ml aliquot was quickly removed and placed in a Sedgwick-Rafter cell and examined under a compound microscope. Zooplankton taxa

were identified using magnifications of 40X to 200X. Aliquoting and enumeration continued until 300 to 400 organisms had been counted; the entire sample was enumerated when less than 300 organisms were encountered.

2.2.2 Whole Water Phytoplankton

Whole water collections were reduced to sample volumes of 33 ml by decanting the Lugol's-preserved liquid after the plankton settled. The sample was placed in an 8-dram vial and mixed by inverting 30 times. Two 0.1-ml subsamples were withdrawn and each placed in a Palmer-Maloney counting cell. Each subsample was examined under a compound microscope at 200x, and the entire contents counted and identified to the lowest practical taxon. During counting, cells and chains were classified by means of a 76 μm ocular micrometer grid into two size classes (greater than or less than 76 μm).

2.2.3 Chlorophyll *a* and Nutrients

Chlorophyll *a* water samples were divided into four 900 ml subsamples and filtered through a glass fiber filter. Near the end of filtration, 2 ml of saturated $MgCO_3$ solution was added to retard sample degradation. Glass fiber filters were frozen pending laboratory extraction of pigment. Extraction of plant pigment consisted of macerating the filter in 90% aqueous acetone and centrifuging. Following extraction, fluorescence was determined before and after acidification (with 5% HCl) using a Turner fluorometer which had been calibrated spectrophotometrically (EPA, 1973; Strickland and Parsons, 1972). Chlorophyll *a* and phaeophytin concentrations (mg/m^3) were computed.

Water samples were also analyzed for the following series of plant nutrients utilizing a Technicon Autoanalyzer system and EPA Methods (1974).

NUTRIENT	METHOD
total phosphorus	persulfate digestion in block digester followed by automated colorimetric ascorbic acid reduction
orthophosphate	automated colormetric ascorbic acid reduction
nitrite	automated cadmium reduction, without cadmium column in place
nitrate	automated cadmium reduction
ammonia	automated idophenol blue

Concentrations were expressed as µg/l.

2.2.4 Primary Productivity

Samples were inoculated with five microcuries of ^{14}C as sodium bicarbonate as soon as they arrived at the laboratory, and incubated for four hours at ambient seawater temperature in a flow-through temperature box with 1000-1100 lux fluorescent illumination. Samples were then fixed with 2 ml of 40% formalin, filtered through a 25 mm Millipore membrane filter (0.45 µm pore size) at about 15 psi, dried on a planchet in a desiccator and counted using a Nuclear Chicago Model 186 gas flow scintillometer. Primary productivity was calculated as mg C/m^3/hr (Strickland and Parsons, 1972). Productivity to biomass ratios were computed as mgC/m^3/hr divided by mg chl *a*/m^3.

2.2.5 Macrozooplankton

Each sample to be analyzed* was split using a Folsom Plankton Splitter into fractions which provided counts of at least 30 individuals of each species to be identified; generally, no more than 1/4 of the original sample was analyzed. Zooplankton taxa were enumerated by species and general life stage, when practical, using a dissecting microscope

*Three of the four 1 m 505 µm meshed net tows at each station were randomly selected for macrozooplankton analysis on all sampling dates (Table 2.1-1) except on 27 December, when only Station 2 was analyzed.

at magnifications between 6x and 150x. Selected taxa (*Crangon septemspinosa*, *Cancer* spp., *Neomysis americana* and Euphausiacea) were identified to detailed developmental stage. *Neomysis americana* only were identified as immature, male, female (ovigerous or larvigerous); carapace length was measured to the nearest 0.1 mm and brood pouch contents were counted.* If copepod taxa were considered rare, they were sorted and counted (at least 30 of each indicator species) from an appropriate split; if abundant, up to 3 one or two-ml aliquots were quickly removed with a Stempel pipette from the recombined sample of known volume. Abundances (individuals/1000m^3) were computed.

3.0 RESULTS AND DISCUSSION

3.1 PHYTOPLANKTON

3.1.1 Results

Total net phytoplankton abundance was low over the study period, with maxima of 728 cells/liter in July and 422 cells/liter in September (Table 3.1-1). Of the 76 total phytoplankton taxa, 42 were captured in net samples (Appendix Table 1). Abundances are presented for those taxa comprising either more than 10% of total net density during any sampling period or more than 1% of total net density for the six month period (Table 3.1-2). Five species including, *Ceratium longipes*, *Coscinodiscus* sp., *Chaetoceros teres*, *Guinardia flaccida* and *Chaetoceros affinis* exceeded an average of 100 cells/l overall, and represented 76% of the total net phytoplankton over that six month period. Species dominating samples during peak density periods were *Ceratium longipes* in July, *Chaetoceros teres* and *Guinardia flaccida* in September, and *Coscinodiscus* sp. in November/December.

Total phytoplankton densities from whole water samples exceeded $4x10^6$ cells/liter in October and November at Stations 2 and 5; maximum

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** N. americana* data will be presented in the 1978 Annual Reports.

TABLE 3.1-1. ABUNDANCES (cells/l) OF WHOLE WATER AND NET PHYTOPLANKTON AT EACH STATION AND DEPTH. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

DATE	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER
NET PHYTOPLANKTON	7/6	7/20	8/3	8/23	9/1	9/23	10/4	10/18	11/1	11/23	12/15
STATION 2											
Surface	8	244	26	30	422	140	121	250	309	374	39
Bottom	728	137	7	68	41	150	28	82	99	29	244
WHOLE WATER PHYTOPLANKTON											
STATION 2											
Surface	1,320	1,810	1,650	33,550	61,820	43,780	68,200	2,947,120	3,831,410	404,580	8,910
Bottom	32,560	2,130	4,510	10,230	203,390	12,870	7,810	236,830	173,030	13,200	9,020
STATION 5											
Surface	1,100	NS	7,040	NS	42,020	NS	331,560	NS	4,099,480	NS	7,590

NS=not sampled

TABLE 3.1-2. NUMERICAL ABUNDANCE (cells/liter) OF NET PHYTOPLANKTON, HAVING DENSITIES OF EITHER >10% DURING ANY SAMPLING PERIOD OR >1% OF TOTAL DENSITY FOR THE ENTIRE COLLECTION PERIOD, AT STATION 2 SURFACE AND BOTTOM. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

		CERATIUM LONGIPES	*COSCINODISCUS* SP.	*CHAETOCERES TERES*	*GUINARDIA FLACCIDA*	*CHAETOCERES AFFINIS*	*RHIZOSOLENIA DELICATULA*	*SKELETONEMA COSTATUM*	*PERIDINIUM DEPRESSUM*	*LICMOPHORA ABBREVIATA*	CHLOROPHYCEAE	*CERATIUM TRIPOS*	*ASTERIONELLA GLACIALIS*	PENNALES	*PROROCENTRUM MICANS*	*CHAETOCEROS* SP.
STATION 2 SURFACE																
J	7/6	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	7/20	220	1	2	0	0	0	0	10	11	0	0	0	1	0	0
A	8/3	24	0	0	0	0	0	0	1	1	0	0	0	0	0	0
	8/23	4	16	0	1	0	0	0	1	0	0	0	0	0	0	0
S	9/7	7	1	190	101	14	0	50	4	2	0	0	1	0	0	11
	9/23	46	1	21	0	55	0	2	1	4	0	0	0	3	1	1
O	10/4	15	4	19	0	4	0	24	20	0	0	0	0	13	0	4
	10/18	17	3	0	4	0	10	8	2	0	0	1	2	4	0	4
N	11/1	23	92	1	7	0	86	7	0	0	0	5	0	10	61	4
	11/23	68	248	0	0	0	0	0	0	0	0	53	0	0	0	0
D	12/15	0	39	0	0	0	0	0	0	0	0	0	0	1	0	0
STATION 2 BOTTOM																
J	7/6	692	0	0	0	0	0	0	34	1	0	0	0	0	0	0
	7/20	109	1	0	0	0	0	0	9	19	0	0	0	0	0	0
A	8/3	4	7	0	0	0	0	0	2	1	0	0	0	0	0	0
	8/23	2	1	2	17	0	0	0	1	28	0	1	0	0	0	0
S	9/7	1	1	100	182	46	0	0	1	6	0	0	0	0	0	39
	9/23	11	0	41	0	89	0	5	0	2	0	0	0	0	0	0
O	10/4	1	4	0	0	0	0	6	0	0	0	0	1	0	0	0
	10/18	18	7	0	10	30	2	6	1	0	0	0	16	2	0	0
N	11/1	12	42	5	3	0	12	3	1	0	0	1	4	1	1	0
	11/23	12	10	0	0	0	0	0	0	0	0	4	0	0	1	0
D	12/15	2	161	0	0	0	0	0	0	0	72	2	0	0	0	0

density ($4x10^6$ cells/liter) was recorded at Station 5 in November (Table 3.1-1). Of the 76 total taxa, 52 were collected in whole water samples. Taxa considered dominant (>10% of any whole water sample or >1% of total whole water phytoplankton during the 6-month period) are presented in Table 3.1-3. The five most numerous taxa, each representing greater than 1% of total whole water phytoplankton, were *Olisthodiscus luteus, Prorocentrum triestinum, Skeletonema costatum, Peridinium trochoideum* and *Guinardia flaccida*; collectively they represented 96% of the whole water phytoplankton. Peak whole water phytoplankton densities recorded in November at Stations 2 and 5 and in October at Station 2 were dominated by *Olisthodiscus luteus* in surface samples. *Prorocentrum* spp. and *Rhizosolenia delicatula* also contributed to high densities recorded in October and November at Station 2 (Table 3.1-1, 3.1-3).

Biomass (chlorophyll *a*) and primary productivity (carbon 14 uptake/hour) peaked in November and declined to minimum values in December (Table 3.1-4), generally corresponding to whole water phytoplankton abundance trends, but not to net phytoplankton densities. Nutrient studies (Table 3.1-4) indicated that peak concentrations of orthophosphate, ammonia and nitrite were not well-defined. Nitrate peaked in December following the phytoplankton bloom, while maximum total phosphorus concentrations generally occurred during November and December. Lowest values for orthophosphate, total phosphorus and nitrate were found in July.

3.1.2 Discussion

Densities of net phytoplankton were low from July through December 1977. In 1976, although densities were considered low relative to 1975 (NAI, 1978), they exceeded 1,000 cells/liter frequently and 2,000 cells/liter in several instances. Maximum 1977 densities were less than 800 cells/liter. Total phytoplankton (whole water) densities were generally two orders of magnitude greater than those in net phytoplankton samples. The whole water method, instituted in July 1977, captures

TABLE 3.1-3. NUMERICAL ABUNDANCE OF WHOLE WATER PHYTOPLANKTON 10% ON ONE OR MORE COLLECTION DATES OR 10% OF TOTAL WHOLE WATER PHYTOPLANKTON AT STATION 2 SURFACE, BOTTOM AND STATION 5. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

		OLISTHODISCUS LUTEUS	*SKELETONEMA COSTATUM*	*PERIDINIUM TROCHOIDEUM*	*GYMNODINIUM FLACCIDUM*	*OLISTHODISCUS* SP.	*RHIZOSOLENIA DELICATULA*	*DINOPHYSIS NORVEGICA*	*NAVICULA CRUCIGERA*	*CHROOMONAS* SP.	*CERATIUM LONGIPES*	*PARALIA SULCATA*	*BIDDULPHIA ALTERNANS*	PENNALES	*PROROCENTRUM MICANS*	*CYLINDROTHECA CLOSTERIUM*	*CHAETOCEROS* SP.	CRYPTOPHYCEAE	*PROROCENTRUM TRIESTINUM*
STATION 2 SURFACE																			
J	7/6	0	0	0	0	0	440	0	0	220	220	0	0	0	0	0	0	0	0
	7/20	0	1,065	107	0	0	213	0	0	0	107	0	0	0	0	107	0	213	0
A	8/3	0	0	0	0	0	0	0	0	330	220	0	0	220	0	0	0	0	0
	8/23	0	0	7,260	9,130	0	220	220	0	0	0	0	0	0	0	0	0	0	0
S	9/7	0	0	42,900	4,960	0	220	0	0	0	0	0	0	0	0	0	0	0	0
	9/23	0	0	27,280	0	0	0	2,750	0	550	110	1,100	660	110	8,360	440	0	0	0
O	10/04	0	43,010	1,540	0	0	0	3,190	0	220	110	660	220	0	770	15,6[illegible]0	0	0	110
	10/18	2,661,560	880	20,680	0	0	6,050	330	0	110	110	0	0	0	51,810	330	0	0	201,960
N	11/1	3,615,810	440	770	440	0	16,280	110	0	5,060	0	0	0	0	5,390	0	0	0	184,140
	11/23	395,010	0	0	0	0	3,520	0	0	2,750	0	0	0	0	220	0	0	0	770
D	12/15	[illegible]	880	0	0	0	0	0	0	4,290	0	330	0	440	0	0	0	0	0
STATION 2 BOTTOM																			
J	7/6	0	250	0	0	0	0	16,280	0	0	14,740	0	0	0	0	[illegible]	0	0	0
	7/20	0	0	0	0	0	0	1,810	0	0	0	0	0	0	0	[illegible]	0	[illegible]	0
A	8/3	0	0	0	0	0	0	3,850	0	0	110	0	0	0	0	[illegible]	0	0	0
	8/23	0	0	[illegible]	6,160	0	0	1,650	0	0	0	770	0	0	0	33[illegible]	0	0	0
S	9/7	0	0	94,710	[illegible]7,770	0	440	21,890	0	0	0	0	220	0	660	0	0	0	2,860
	9/23	0	0	1,980	0	0	0	4,070	0	330	0	990	2,530	330	110	330	0	0	110
O	10/04	0	2,530	0	0	0	0	0	0	0	110	990	1,980	330	0	330	0	0	0
	10/18	189,750	660	660	550	0	4,840	220	33,000	440	110	550	440	0	1,430	0	0	0	0
N	11/1	88,330	0	0	660	66,110	12,320	0	0	1,980	0	0	0	990	0	10	0	0	2,550
	11/23	8,140	0	0	0	0	[illegible]540	0	0	110	0	1,430	0	1,430	0	0	0	0	770
D	12/15	330	3,080	0	0	0	0	0	0	3,190	0	1,100	0	220	0	0	0	0	0
STATION 5 SURFACE																			
J	7/6	0	0	0	0	0	0	0	0	0	440	0	0	550	0	[illegible]	0	110	0
	7/20	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	[illegible]	[illegible]	NS	NS	NS	NS
A	8/3	0	330	0	0	0	0	660	0	1,100	220	0	0	[illegible]	[illegible]	[illegible]100	1,870	0	0
	8/23	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	[illegible]	NS	NS	NS	NS	NS
S	9/7	0	7,090	14,190	15,070	0	0	110	0	0	0	0	0	[illegible]	4,6[illegible]	0	330	0	0
	9/23	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	[illegible]	NS	NS	NS	NS
O	10/04	0	107,670	2,640	0	0	0	660	0	0	0	0	0	0	[illegible]100	0	0	0	0
	10/18	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
N	11/1	3,678,490	6,930	12,100	0	0	17,600	110	0	0	660	0	0	0	6,160	0	0	0	173,470
	11/23	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
D	12/15	1,980	11,100	0	0	0	0	0	0	3,520	0	0	0	[illegible]	0	110	0	0	0

NS=not sampled

TABLE 3.1-4. PRIMARY PRODUCTIVITY (mg C/m^3/hr), BIOMASS (mg/m^3), PHAEOPHYTIN (mg/m^3), RATIO OF PRODUCTIVITY TO BIOMASS (C/Chl/hr), TEMPERATURE (°C), SALINITY (⁰/oo), ORTHOPHOSPHATE NITRATE, (μg/l), NITRITE (μg/l), AND AMMONIA (μg/l) AT STATIONS 2 AND 5. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

DATE	PRIMARY PRODUCTIVITY (mg C/m^3/hr) REPLICATE 1	PRIMARY PRODUCTIVITY (mg C/m^3/hr) REPLICATE 2	BIOMASS CHLOROPHYLL *a* (mg/m^3)	PHAEOPHYTIN	RATIO OF PRODUCTIVITY TO BIOMASS (C/Chl/hr)	TEMPERATURE*	SALINITY*	ORTHOPHOSPHATE PO_4-P (μg/l)	TOTAL PHOSPHOROUS TOTAL P (μg/l)	NITRATE NO_3-N (μg/l)	NITRITE NO_2-N (μg/l)	AMMONIA NH_3-N (μg/l)
6 July 1977												
STA 2	1.31	1.28	0.53± .06	0.28 .06	2.44	11.3	31.6	6.0	6.0	8.0	3.0	no data
STA 5	1.50	1.23	0.57± .05	0.38 .09	2.40	10.3	31.6	7.0	9.0	6.0	1.0	no data
3 August 1977												
STA 2	4.37	4.34	1.25± .08	0.65 .04	3.48	11.0	31.8	10.0	16.0	6.0	1.0	no data
STA 5	4.65	3.32	1.12± .05	0.79 .04	3.56	10.9	31.9	16.0	22.0	11.0	2.0	no data
7,8 September 1977												
STA 2	3.79	5.05	1.19± .11	0.39 .04	3.71	13.9	32.0	16.0	29.0	<10.0	1.0	20.0
STA 5	3.54	3.74	0.97± .07	0.39 .07	3.75	13.8	31.7	10.0	16.0	<10.0	1.0	60.0
4 October 1977												
STA 2	7.18	7.06	2.43± .36	1.22 .06	2.93	11.9	31.8	16.0	19.0	20.0	4.0	50.0
STA 5	6.39	6.43	2.46± .19	1.26 .08	2.61	11.8	31.9	20.0	26.0	20.0	4.0	40.0
1 November 1977												
STA 2	11.21	12.13	12.48± .49	4.39 .58	0.94	10.5	30.9	19.0	41.0	10.0	1.0	30.0
STA 5	10.91	12.53	14.28± .61	5.03 .77	0.82	10.4	30.7	14.0	22.0	10.1	1.0	50.0
15 December 1977												
STA 2	1.39	NS	0.50± .07	0.55 .08	2.78	5.2	32.1	4.0	46.0	140.0	4.0	30.0
STA 5	1.09	NS	0.41± .25	0.67 .35	2.66	4.4	31.6	15.0	25.0	900.0	3.0	10.0

*averaged over all depths at 2 m intervals from surface to bottom.

NS = not sampled

small species not sampled by the 76 μm mesh net, such as *Olisthodiscus luteus* (35 μm), *Peridinium trochoideum* (28 μm) and *Prorocentrum triestinum* (18-22 μm x 6-11 μm). *Skeletonema costatum* and *Guinardia flaccida* were collected by both methods but abundances were underestimated by nets. Both *S. costatum* and *G. flaccida* are chain-forming diatoms that may either pass through or be captured in net samples depending upon their orientation to the mesh. The most dense November bloom, dominated by *O. luteus*, was only partially detected by the net samples. Consequently, the whole water method instituted to more carefully monitor the community, has provided information not available through pumped net phytoplankton samples.

Dominant net species from July through December 1977 were similar to those recorded for the same period in 1976, except that *Chaetoceros teres* and *Guinardia flaccida,* although present in moderate numbers in 1976, were not previously considered as dominants. In July 1975 three characteristic species were selected as indicator species. The first of these, *Chaetoceros debilis,* did not appear as a dominant from July through December 1977; it was recorded once in net samples in September and was undetected in whole water samples. As seen in the first two years of the preoperational monitoring program, *C. debilis* blooms during spring with minor secondary peaks during November, and consequently is not expected to occur as a dominant from July-December. *Skeletonema costatum,* historically a late summer, early fall dominant with no clear depth preference, was prominent in September and October 1977 net surface samples, and October whole water surface samples. *Ceratium longipes* was collected in highest densities in net and whole water July 1977 bottom samples. Historically (1975, 1976) it has been prominent during warmer months in near-surface waters.

Spatial affinities were not generally apparent in July-December 1977 net samples. In previous years net surface samples usually had equal or greater densities than bottom samples. Whole water samples for 1977 generally showed that surface samples exceeded bottom samples by an order of magnitude, although individual samples varied between surface and bottom maxima. *Ceratium longipes* had historically shown a surface

affinity during the warmer months; in 1977 it was collected in July bottom samples from both net and whole water programs. *Skeletonema costatum* had previously shown no clear depth preference; in September and October 1977, it was abundant in surface samples. *Olisthodiscus luteus*, the main component of the November bloom, was predominant in surface whole water samples. Overall, it appears that there was a trend toward surface affinity in the community and in some select species.

Maximal whole water phytoplankton densities and peak biomass values in November 1977 coincided with peak primary productivity and a low productivity to biomass (P/B) ratio. Monthly P/B ratios were similar through the sample period except during the November bloom, which suggests that cell "efficiency" (carbon uptake) was comparatively low in November. Nutrient deficiency or reduced light (including turbidity caused by the high cell density), may have had an inhibitory effect on cell proliferation; the lower November productivity per unit biomass was followed by a biomass decline in December.

In 1975 and 1976 biomass values peaked in March and September, respectively, coincident with high but not maximal net cell densities. The better fit of 1977 whole water densities to biomass/productivity cycles may indicate that peaks in biomass are related to blooms of small-celled taxa not adequately sampled by the 76 µm net; consequently, net phytoplankton density maxima and peak biomass did not coincide. Primary productivity has been highest in the fall of each year, preceded by a peak P/B ratio in 1976 and 1977. Possibly contributing to the late 1977 fall bloom were high fall concentrations of some nutrients including ammonia, phosphate and orthophosphate. Nutrient concentrations which overall were high in the fall and early winter were generally similar to but not specifically consistent with previous years observations.

3.2 ZOOPLANKTON

3.2.1 Results

Approximately 185 zooplankton taxa/life stages were identified and enumerated from 76 µm mesh net pump samples (microzooplankton) and

oblique 505 μm meter net tows (macrozooplankton) from July through December 1977 (Appendix Tables 2-4). For all planktonic components, holo-, mero- and tychoplankton, more macrozooplankton taxa were collected than microzooplankton. The most diverse group overall (greatest number of taxa/life stages) were the tychoplankton which comprised 97 taxa and/or life stages, including crustaceans such as cumaceans, isopods, amphipods, mysids and harpacticoids; however tychoplankton contributed 2% to the total species density. The 45 holoplankton taxa/life stages, predominantly calanoid copepods, comprised 90% of the total zooplankton density (Table 3.2-1). Forty-three meroplankton taxa and/or life stages contributed approximately 8% to total density and included larval hydrozoans, polychaetes, gastropod and bivalve molluscs, barnacle and decapod crustaceans.

Microzooplankton were collected in greater density than macrozooplankton (Table 3.2-2): maximum densities were $3.7x10^5/m^3$ (July) compared to $1.1x10^3/m^3$ (October), respectively. Densities for both were maximal from July through September and declined to a December minimum. At Station 6, macrozooplankton abundance remained high through November due to high *Centropages typicus* densities. Differences in abundance of microzooplankton between surface and bottom waters were not marked, although for the first time bottom water affinities for some species were observed. Detection of depth preference changes may be related to the July 1977 change from night to day pump collections for phytoplankton, zooplankton and water chemistry.

Dominant micro-holoplankton, largely composed of calanoid copepod nauplii and copepodites, displayed maximum abundances in summer, and decreased to a December minimum (Tables 3.2-3, 3.2-4). *Pseudocalanus* spp. copepodites were the only micro-holoplankters which showed a consistent depth affinity; they were collected most abundantly in near bottom waters on all sample dates. Tintinnids, *Oithona* spp. nauplii and copepodites, and *Temora longicornis* adults also showed some affinity for near-bottom waters. *Centropages* spp. copepodites and unspecified mesozoans were more dense in near-surface waters. *Pseudocalanus* spp. adults were more commonly found in near-bottom waters.

TABLE 3.2-1. RELATIVE PROPORTIONS (% OF TOTAL) OF HOLOPLANKTON, MEROPLANKTON AND TYCHOPLANKTON BY COLLECTION DATE FOR MICROZOOPLANKTON AND MACROZOOPLANKTON. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

	SAMPLE DATE											
	7/6	7/20	8/3	8/23	9/7	9/23	10/4	10/18	11/1	11/23	12/15	12/27
Microzooplankton												
Holoplankton	83.9	96.6	98.8	94.8	70.7	85.3	90.8	95.0	97.6	98.0	98.0	NS
Meroplankton	15.8	3.1	0.7	1.5	29.1	10.5	6.7	3.5	1.8	1.7	1.4	NS
Tychoplankton	0.3	0.3	0.5	3.5	0.2	4.2	2.6	1.5	0.7	0.2	0.5	NS
Macrozooplankton												
Holoplankton	89.7	81.0	76.2	74.1	89.2	NS	94.5	NS	98.9	NS	95.9	96.0
Meroplankton	10.2	18.0	23.2	25.7	10.3	NS	1.3	NS	0.2	NS	<0.1	0.1
Tychoplankton	0.1	1.0	0.6	0.2	0.5	NS	4.3	NS	0.9	NS	4.0	3.8

NS=not sampled

TABLE 3.2-2. ABUNDANCES (no/m^3) OF TOTAL MICROZOOPLANKTON AND MACROZOOPLANKTON AT EACH STATION AND DEPTH FROM JULY 1977 THROUGH DECEMBER 1977. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

	STATION	TOW DEPTH	SAMPLE DATE 7/6	7/20	8/3	8/23	9/7	9/23	10/4	10/18	11/1	11/23	12/15	12/27
Microzooplankton (76 µm pump samples)		SUR	4,720	76,200	22,600	3,970	11,600	11,900	8,870	13,500	11,400	29,600	1,840	NS
	2	BOT	366,000	30,500	8,530	66,200	75,600	20,500	9,080	4 100	3,970	3,170	2,990	NS
		AVERAGE	[illegible]	53,400	15,600	35,100	43,600	16,200	9,000	8,800	7,700	16,400	2,420	NS
Macrozooplankton (1 m, 505 µm net)	2	OBL	464	440	293	423	526	NS	124	NS	178	NS	34	42
	5	OBL	266	502	186	316	325	NS	173	NS	221	NS	121	NA
	6	OBL	417	474	187	243	343	NS	1,100	NS	404	NS	88	NA
		AVERAGE	382	472	222	327	398	NS	466	NS	268	NS	81	42

NS=not sampled

NA=not analyzed

TABLE 3.2-3. ABUNDANCES (no/m^3) OF MICROZOOPLANKTON (>10% ON ONE OR MORE COLLECTION DATES, OR SIX-MONTH ABUNDANCE >1% OF TOTAL ABUNDANCE) AT STATION 2, SURFACE AND BOTTOM. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

TAXA	DEPTH	SAMPLE DATE 7/6	7/20	8/3	8/23	9/7	9/23	10/4	10/18	11/1	11/23	12/15
Pseudocalanus/Calanus nauplii	S	10	21,000	2,180	17	2,690	1,370	1,240	1,330	385	9,670	391
	B	93,500	1,680	795	4,070	8,410	3,090	320	1,680	2,020	1,250	1,470
Pseudocalanus spp. copepodite	S	0	15,700	4,300	0	61	481	259	42	52	815	76
	B	69,800	16,900	6,400	14,300	18,600	5,460	1,730	171	511	361	819
Oithona spp. nauplii	S	411	17,646	8,880	871	4,020	[illegible]	1,060	4,100	6,330	6,850	620
	B	19,000	263	14	1,010	3,120	1,860	206	90	95	191	86
Copepoda nauplii	S	282	6,830	1,260	427	2,070	2,300	1,270	2,070	2,660	2,140	257
	B	25,300	3,280	231	3,850	9,420	1,750	276	410	91	79	8
Temora longicornis copepodites	S	72	469	35	0	12	1,060	128	8	0	0	0
	B	49,700	2,710	4	769	269	105	173	0	23	0	0
Oithona spp. copepodite	S	2,450	7,190	4,160	490	640	380	3,420	3,520	818	1,270	302
	B	19,700	599	65	645	1,100	2,850	1,030	198	240	364	56
Tintinnidae	S	372	246	29	1,970	123	116	135	13	0	0	0
	B	12,600	509	128	32,190	1,760	43	382	133	23	0	25
Mytilus edulis veligers	S	0	709	0	17	156	26	10	42	5	402	18
	B	30,800	452	0	0	3,490	43	0	31	34	21	13
Bivalve umbone veliger	S	10	868	42	6	18	0	10	8	0	0	0
	B	16,800	180	28	0	560	50	0	31	6	0	0
Gastropod veliger	S	0	523	86	0	4	18	43	8	21	48	0
	B	7,960	30	10	73	4,970	114	103	103	27	26	30
Hiatella spp. veliger	S	5	64	0	6	0	6	0	4	0	9	0
	B	2,260	0	0	0	132	268	0	10	11	0	0
Oithona spp. Female	S	563	1,920	529	34	181	25	249	381	99	164	39
	B	4,540	410	27	248	132	268	257	41	96	52	17
Centropages spp. copepodite	S	0	0	24	0	44	811	201	1,070	510	4,010	93
	B	0	0	0	0	21	315	7	109	23	268	60
Pseudocalanus spp. Female	S	0	754	278	0	0	31	0	0	0	325	8
	B	1,030	642	103	1,080	1,920	663	217	56	129	16	59
Mesozoan	S	0	0	0	0	1,140	872	30	125	5	0	0
	B	0	0	0	124	349	55	15	21	0	0	0
Temora longicornis Male	S	0	0	11	22	0	49	12	17	5	0	0
	B	0	130	9	1,370	681	199	2,070	58	79	5	0
Temora longicornis Female	S	3	72	4	23	30	67	18	0	0	0	0
	B	0	275	0	1,310	525	121	1,010	36	28	0	0
Bryozoan cyphonautes larvae	S	0	0	0	0	0	1,430	360	50	0	10	0
	B	0	0	0	0	28	79	4	26	11	0	4

TABLE 3.2-4. DOMINANT TAXA AND MAXIMUM DENSITIES FROM EACH SAMPLE TYPE AND PLANKTON COMPONENT (FROM TABLES 3.2-3, 3.2-). SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

HOLOPLANKTON

MICROZOOPLANKTON	MAXIMUM DENSITY (no./m^3)	MACROZOOPLANKTON	MAXIMUM DENSITY (no./m^3)
Pseudocalanus/calanus nauplii	93,500	*Calanus finmarchicus* copepodites	187
Pseudocalanus spp. copepodite	69,800	*Centropages typicus* male	358
Oithona spp. nauplii	19,000	Euphausid calytopsis larvae	193
Oithona spp. copepodites	19,700	Euphausid furcilia larvae	125
copepod nauplii	25,300	*Tortanus discaudatus* male	74
Temora longicornis copepodites	49,700		

MEROPLANKTON

bivalve veligers	16,800	*Cancer borealis* larvae zoea	63
Mytilus edulis veligers	30,800	*Evalus pusiolus* larvae	43
Hiatella spp. veligers	2,260	*Carcinus maenas* zoea	24
gastropod veligers	7,960		
Bryozoan cyphonautes larvae	1,430		

TYCHOPLANKTON

		Neomysis americana juvenile	38

TABLE 3.2-5. ABUNDANCES (no./1000 m^3) OF MACROZOOPLANKTON TAXA (>10% ON ONE OR MORE COLLECTION DATES, OR 6-MONTH ABUNDANCE >1% OF TOTAL ABUNDANCE) AT STATIONS 2, 5 AND 6. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977

TAXA	STATION	SAMPLE DATE 7/6	7/20	8/3	8/23	9/7	10/4	11/1	12/15	12/27
	2	18,200	39,600	149,000	180,000	257,000	8,700	396	1,460	2,830
Calanus finmarchicus copepodite	5	21,300	79,200	132,000	142,000	174,000	12,400	841	1,753	0
	6	31,500	124,000	93,000	89,400	187,000	83,400	11,300	1,120	0
	2	989	5,080	4,480	8,260	82,600	58,600	78,700	17,200	3,030
Centropages typicus female	5	1,560	54,600	288	2,040	30,600	101,000	112,000	69,000	0
	6	3,850	4,100	12,900	32,600	21,000	566,000	215,000	54,000	
	2	1,140	5,890	305	312	41,200	26,000	70,200	11,500	472
Centropages typicus male	5	312	35,000	288	0	15,600	33,900	92,200	35,000	0
	6	865	1,870	4,460	13,100	6,450	358,000	166,000	19,800	0
	2	193,000	139,000	738	27,900	299	1,240	5	16	11
Euphausiacea calyptopsis	5	61,300	96,000	419	7,750	9	838	42	48	0
larvae	6	188,000	95,900	309	3,500	0	2,720	77	35	0
	2	125,000	16,500	12,300	11,000	936	460	2	48	3
Euphausiacea furcilia larvae	5	57,700	44,800	4,230	10,500	54	297	62	64	0
	6	105,000	47,300	6,280	8,260	43	11,100	29	81	0
	2	39,900	73,700	18,300	8,000	4,100	11,500	1,640	315	5,260
Tortanus discaudatus male	5	33,300	64,500	8,450	12,200	26,900	5,980	706	0	0
	6	27,200	48,100	6,740	4,450	10,800	4,940	0	396	0
	2	28,200	26,900	23,100	62,100	31,700	0	0	0	0
Cancer borealis zoea	5	36,000	14,100	3,550	63,300	3,890	0	44	0	0
	6	19,000	63,800	9,280	13,500	11,000	82	65	0	0
	2	26,000	33,400	9,490	14,500	6,710	4,400	3,100	262	4,660
Tortanus discaudatus female	5	38,900	27,500	8,800	7,200	17,000	1,860	941	0	0
	6	18,200	35,600	8,890	2,010	20,400	1,470	561	0	0
	2	6,950	42,500	11,400	38,300	6,070	106	47	8	2
Eualus pusiolus larvae	5	2,280	43,000	4,830	24,000	3,960	36	622	16	0
	6	3,870	10,700	3,760	2,750	1,660	131	38	2	0
	2	2,580	0	305	2,090	51,800	1,180	7	0	0
Podon spp.	5	0	0	5	0	47,000	99	1	0	0
	6	1,350	0	0	3,190	59,300	12	3	0	0
	2	3,700	9,210	20,800	4,940	6,680	341	7	0	1
Carcinus maenas zoea	5	1,900	6,220	7,700	4,060	1,950	1,090	11	2	0
	6	3,100	7,900	23,700	2,770	3,080	363	9	3	0
	2	2,100	7,910	4,370	3,620	780	0	0	184	3
Pseudocalanus spp. female	5	3,460	5,430	4,200	3,300	0	0	2,030	286	0
	6	6,750	16,300	3,730	24,900	0	0	561	715	0
	2	0	1,100	950	22,200	6,670	0	792	0	199
Metridia lucens copepodite	5	0	3,400	579	10,600	438	0	488	407	0
	6	969	6,210	327	21,500	688	497	561	0	0
	2	0	0	0	0	5,420	411	13,300	1,010	56
Centropages spp. copepodite	5	0	451	0	369	3,310	5,260	10,300	9,990	0
	6	1,450	0	0	2,080	2,210	3,380	4,840	1,210	0
	2	88	1,360	335	40	35	4,770	4,900	104	88
Neomysis americana juvenile	5	174	320	2	2	164	1,100	427	154	0
	6	0	3	13	0	2	38,100	458	650	0
	2	93	538	387	846	897	535	793	1,043	22,000
Sagitta elegans	5	3	347	121	1,850	194	508	215	1,700	0
	6	177	131	178	417	39	4,910	240	1,460	0

Dominant macro-holoplankton were composed largely of copepods and euphausid larvae (Tables 3.2-4 and 3.2-5). Euphausid larvae and adults of *Tortanus discaudatus* occurred in highest densities during July and generally decreased in abundance through December. The most abundant species collected during the six month period, *Centropages typicus* adults and copepodites, occurred in highest densities from September through early December. Although adults of *Calanus finmarchicus* were collected in only low abundances (averaged over all stations), copepodites of this species were the second most abundant group and occurred in highest densities during August and September.

Meroplankton were dominated by gastropod and bivalve veligers, bryozoan larvae and decapod larvae (Tables 3.2-3, 3.2-4, 3.2-5). The micro-meroplankton, bivalve and gastropod veligers, were collected in moderate to high abundances during July and early September. Bryozoan cyphonautes larvae were the only micro-meroplankton taxon which showed any depth affinity; they were more dense in near surface waters. The macro-meroplankton were dominated by decapods which were most numerous from July through September.

Although the tychoplanktonic assemblage was diverse, only one species, *Neomysis americana*, was collected in high densities (Tables 3.2-4 and 3.2-5). Juvenile forms outnumbered adults; both life stages were collected in highest densities by 505 μm towed nets during October and November.

3.2.2 Discussion

Organism density trends generally substantiated patterns observed in previous data. Microzooplankton densities, which are expected to substantially exceed macrozooplankton densities and which did so in 1975-76 and 1976-77, were one to three orders of magnitude higher than for macrozooplankton during the July through December 1977 period. For both net and pump sampling programs in 1977, the observed seasonal abundance pattern was also generally characteristic of the same period in 1975 and 1976: densities were highest from July through September and subsequently

declined to a December minimum. An occurrence of unusually high densities of *Modiolus modiolus* veligers in October 1976 caused the only deviation from this pattern.

Relative densities of holo-, mero- and tychoplankton were consistent since 1975, although the numbers of species within meropplankton and tychoplankton increased with the intensified effort to identify decapod larvae and individual tychoplanktonic taxa. The increased effort to identify decapod larvae and individual tychoplanktonic taxa. The increased effort expanded the list of species identified from about 70 taxa in 1975 and 1976 to 185 taxa in 1977.

Taxa identified in 1975 as important seasonal components of the zooplankton community were designated as indicator species (NAI, 1976). These included *Oithona* spp., *Calanus finmarchicus* and *Eurytemora herdmani* all of which have historically been ubiquitous in the study area, with a surface affinity and with population maxima from late spring to early fall. In 1977, these holoplankton taxa showed similar seasonal trends to other years, with slightly lower densities than previously observed, and no surface affinity. In 1977 *Calanus finmarchicus* copepodites were the dominant macrozooplankter. Maximum densities occurred in August and September and were comparable to previous years. *Calanus finmarchicus* is the dominant offshore species in the Gulf of Maine ISherman, 1970) with copepodites abundant in the spring and summer. *Eurytemora herdmani* has exhibited a pronounced seasonality in abundance, favoring the mid-summer period. In 1977 *Eurytemora* spp. copepodite abundances were maximal in July and August, with densities slightly exceeding the previous two years.

4.0 SUMMARY

A total of 76 phytoplankton taxa were identified from the 76 μm net pumped samples and from whole water samples taken from July through December 1977. The whole water method collected higher densities than net samples and sampled an assemblage including smaller, (<76 μm) forms not sampled by the net. Net phytoplankton reached maximum density in July, while whole water plankton were most abundant in November reflecting a bloom of *Olisthodiscus luteus*. Chlorophyll *a* concentration maxima coincided with the whole water density maximum. Net phytoplankton densities were low compared to 1975 and 1976, while chlorophyll *a* concentrations were either similar to or greater than those observed in previous years. The observed low net phytoplankton density is not believed to be representative of a decline in either overall phytoplankton levels or in those species characterized as net phytoplankton. Both chlorophyll *a* and whole water sample results support this contention.

In the zooplankton, 185 taxa/life stages were identified from 76 μm net pumped samples (microzooplankton) and 505 μm meter net samples (macrozooplankton). Zooplankton from pump samples have consistently occurred in higher densities than from towed samples. Both components were maximal from July through September with a December minimum; in the macrozooplankton high densities continued through November due to high abundances of *Centropages typicus*. Numbers and species composition were similar to previous years except where influenced by program modifications. The most notable differences were a substantial increase in overall species richness, reflecting initiation of tychoplankton and decapod larval identification to species and the inclusion of decapod larvae in species counts.

5.0 LITERATURE CITED

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APPENDICES

APPENDIX TABLE 1. TAXONOMIC LIST OF NET AND WHOLE WATER PHYTOPLANKTON COLLECTED FROM JULY THROUGH DECEMBER 1977. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

	SAMPLE TYPE
Class: Bacillarophyceae	
Order: Centrales	
Centrales sp.	a
Biddulphia alternans	b
Biddulphia aurita	c
Ceratulina bergonii	b
Chaetoceros affinis	a
Chaetoceros brevis	a
Chaetoceros debilis	a
Chaetoceros decipiens	a
Chaetoceros laciniosis	a
Chaetoceros lorenzianus	a
Chaetoceros sp.	a
Chaetoceros teres	a
Corethron hystrix	b
Coscinodiscus sp.	c
Detonula confervacea	a
Guinardia flaccida	c
Melosira nummuloides	a
Melosira sp.	a
Isthmia nervosa	a
Katodinium rotundatum	b
Olisthodiscus luteus	b
Olisthodiscus sp.	b
Paralia sulcata	c
Prorocentrum nicans	c
Prorocentrum redfieldi	b
Prorocentrum triestinum	b
Rhizosolenia alata	c
Rhizosolenia delicatula	c
Rhizosolenia hebetata	b
Rhizosolenia setigera	b
Skeletonema costatum	c
Thalassiosira nordenskioldii	b
Thalassiosira rotula	a
Order: Pennales	c
Asterionella glacialis	c
Cocconeis scutellum	b
Cyclindrotheca closterium	c
Grammatophora angulosa	c
Grammatophora marina	a
Gyrosigma balticum	c
Gyrosigma fusciola	b
Gyrosigma/Pleurosigma sp.	c

Continued

APPENDIX TABLE 1. (Continued)

	SAMPLE TYPE
Licmophora abbreviata	c
Licmophora flabellata	c
Navicula crucigera	b
Navicula sp.	c
Nitzschia longissima	b
Pennales	b
Rhabdonema arcuatum	a
Thalassionema nitzschioides	a
Thalassionema sp.	b
Class: Dinophyceae	
Order: Peridiniales	
Amphidinium sp.	b
Ceratium fusus	c
Ceratium horridum	a
Ceratium lineatum	a
Ceratium longipes	c
Ceratium minutum	b
Ceratium sp.	a
Ceratium tripos	c
Gyrodinium sp.	b
Peridinium depressum	c
Peridinium sp.	b
Peridinium triquetrum	b
Peridinium trochoideum	b
Order: Dinophysiales	
Dinophysis acuminata	b
Dinophysis norvegica	b
Dinophysis rotundatum	b
Class: Chlorophyceae	
Order: Chlorococcoles	
Pediastrum sp.	b
Class: Chlorophyceae	
Order: Volvocales	
Chlamydomonas sp.	b
Class: Cryptophyceae	b
Order: Cryptomonadales	
Chroomonas sp.	b
Class: Chrysophyceae	
Order: Chrysomonadales	
Dictyocha fibula	b
Dictyocha speculum	b
Class: Euglenophyceae	
Order: Englenales	
Eutreptiella sp.	b

a = collected in 76 μm net sample
b = collected in whole water sample
c = collected in both 76 μm net and whole water samples

APPENDIX TABLE 2. TAXONOMIC LIST OF HOLOPLANKTON IDENTIFIED FROM OBLIQUE 505 μm TOWS (Ω) AND 76 μm PLANKTON PUMP SAMPLES (*), JULY THROUGH DECEMBER 1977. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

KEY: * Microzooplankton
Ω Macrozooplankton

HOLOPLANKTON

PHYLUM:	PROTOZOA	
Subphylum:	Ciliophora	
Order:	Tintinnida	*
PHYLUM:	ANNELIDA	
Class:	Polychaeta	
	Tomopteris helgolandica	Ω
	Tomopteris spp. larvae	Ω
PHYLUM:	ARTHROPODA	
Class:	Crustacea	
Subclass:	Branchiopoda	
Suborder:	Cladocera	
	Evadne spp.	Ω
	Evadne herdmanni	Ω
	Penilia averostris	*
	Podon spp.	Ω*
	Podon leuckarti	Ω
Subclass:	Ostrocoda (planktonic)	*
Subclass:	Copepoda	
	Copepoda nauplii	*
Order:	Calanoida	
	Acartia spp. copepodite	*
	Acartia hudsonica (=clausi)	Ω
	Acartia hudsonica female	*
	Acartia hudsonica male	*
	Acartia longiremis copepodite	Ω
	Acartia longiremis female	*Ω
	Acartia longiremis male	*Ω
	Aetideus armatus copepodite	Ω
	Anomalocera opalus	Ω
	Anomalocera opalus copepodite	Ω
	Calanus finmarchicus copepodite	Ω*
	Calanus finmarchicus female	Ω
	Calanus finmarchicus male	Ω
	Calanus spp. copepodite	*
	Centropages spp. copepodite	Ω*
	Centropages hamatus female	Ω*

Continued

APPENDIX TABLE 2. (Continued)

	Centropages hamatus male	*
	Centropages typicus female	Ω*
	Centropages typicus male	Ω*
	Eurytemora spp. nauplii	*
	Eurytemora herdmani copepodite	*
	Eurytemora herdmani male	*
	Eurytemora herdmani female	*
	Eurytemora herdmani ovigerous	*
	Metridia lucens copepodite	Ω
	Metridia lucens female	Ω
	Metridia lucens male	*Ω
	Paracalanus spp. copepodite	*
	Paracalanus parvus copepodite	*
	Paracalanus parvus female	*
	Paracalanus parvus male	*
	Pseudocalanus spp. copepodite	Ω*
	Pseudocalanus spp. female	Ω*
	Pseudocalanus spp. male	Ω*
	Pseudocalanus/Calanus nauplii	*
	Temora spp. copepodite	*
	Temora longicornis copepodite	Ω*
	Temora longicornis female	Ω*
	Temora longicornis male	Ω*
	Tortanus discaudatus copepodite	*Ω
	Tortanus discaudatus female	*Ω
	Tortanus discaudatus male	*Ω
	Tortanus discaudatus egg	*
Order:	Harpacticoida	
	Microsetella norvegica	*
Order:	Cyclopoida	*
	Cyclopoid copepodite	*
	Oithona spp. nauplii	*Ω
	Oithona spp. copepodite	*Ω
	Oithona spp. female	*Ω
	Oithona spp. male	*Ω
Superorder:	Hyperiidae	Ω
	Parathemisto guadichaudi	Ω
Superorder:	Eucarida	
Order:	Euphausiacea	
	Cyrtopia larvae	Ω
	Calyptopis larvae	Ω*
	Furcilia larvae	Ω*
	Thysanoessa spp. cyrtopia larvae	Ω
	Thysanopoda acutifrons cyrtopia	Ω
Superorder:	Gammaridea	
	Calliopius laeviusculus	Ω
	Calliopius laeviusculus ovigerous	Ω

Continued

Unidentified (freshwater) larvae

APPENDIX TABLE 2. (Continued)

		Pontogenia inermis	Ω
		Pontogenia inermis ovigerous	Ω
		Rhachotropis oculata	Ω
PHYLUM:	CHORDATA		
		Urochordata	Ω
PHYLUM:	CHAETOGNATHA		
		Sagitta elegans	Ω*

APPENDIX TABLE 3. TAXONOMIC LIST OF MEROPLANKTON IDENTIFIED FROM OBLIQUE 505 m TOWS ( ) AND 76 m PLANKTON PUMP SAMPLES (*), JULY THROUGH DECEMBER 1977. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

KEY: * Microzooplankton
Ω Macrozooplankton

MEROPLANKTON

PHYLUM:	CNIDARIA		
Class:	Hydrozoa		
		Aglantha spp.	Ω
		Catablema vesicarum	Ω
		Euphysa aurata	Ω
		Hydrozoan medusal stage	Ω*
		Hybocodon prolifer	Ω
		Phialidium spp.	Ω
		Sarsia spp.	Ω
PHYLUM:	ANNELIDA		
Class:	Polychaeta		
		Nereis pelagica	Ω
		Polychaete egg	*
		Polychaete larvae	*
		Polychaete nectochaete larvae	Ω
		Procerae spp.	Ω
PHYLUM:	MOLLUSCA		
Class:	Gastropoda		
		Gastropoda veligers	*
		Littorina littorea eggs	Ω*
		Opisthobranchia veligers	*
Class:	Bivalvia		
		Anomia spp. veliger	*
		Bivalve st. hinge veligers	*
		Bivalve umbone veligers	*
		Ensis directus veligers	*
		Hiatella spp. veliger	*
		Mytilidae juvenile	Ω
		Mytilidae veliger	Ω
		Mytilus edulis veliger	*
		Placopecten magellanicus veliger	Ω

Continued

APPENDIX TABLE 3. (Continued)

PHYLUM:	ARTHROPODA	
Class:	Crustacea	
Order:	Harpacticoida	
	Harpacticoida nauplius	Ω
Order:	Cyclopoida	
	Caligus elongata ovigerous	Ω
Order:	Monstrilloida	
	Monstrillidae	Ω
Subclass:	Cirripedia	
	Cirripedia nauplii	Ω
	Cirripedia cypris	*
	Hansens nauplii	*
Subclass:	Malacostraca	
Superorder:	Hyperiidae	Ω
	Hyperoche medusurum	Ω
Superorder:	Eucarida	
Order:	Decapoda	
	Brachyura zoea	Ω
	Calacaris templemanni	Ω
	Cancer borealis megalops	Ω
	Cancer borealis zoea	Ω*
	Cancer borealis stage I	Ω
	Cancer borealis stage II	Ω
	Cancer borealis stage III	Ω
	Cancer borealis stage IV	Ω
	Cancer borealis stage V	Ω
	Carcinus maenas zoea	Ω*
	Carcinus maenas stage III	Ω
	Caridea zoea	Ω
	Caridion gordoni larvae	Ω
	Crangon septemspinosa zoea	Ω*
	Crangon septemspinosa stage I	Ω
	Crangon septemspinosa stage II	Ω*
	Crangon septemspinosa stage III	Ω
	Crangon septemspinosa stage IV	Ω
	Crangon septemspinosa stage V	Ω
	Crangon septemspinosa stage VI	Ω*
	Eualus pusiolus	Ω
	Homarus americanus stage I	Ω
	Pagurus spp. stage I	Ω
	Pagurus spp. stage II	Ω
	Pagurus spp. stage III	Ω
	Pagurus spp. stage IV	Ω
PHYLUM:	BRYOZOA	
	Bryozoan cyphonautes larvae	*

APPENDIX TABLE 4. TAXONOMIC LIST OF TYCHOPLANKTON IDENTIFIED FROM OBLIQUE 505 μm TOWS (Ω) AND 76 μm PLANKTON PUMP SAMPLES (*), JULY THROUGH DECEMBER 1977. SEABROOK ECOLOGICAL STUDIES, JULY THROUGH DECEMBER 1977.

KEY: * Microzooplankton
Ω Macrozooplankton

PHYLUM:	PROTOZOA	
Subphylum:	Sarcomastigophora	
Order:	Foraminiferida	*
PHYLUM:	PLATYHELMINTHES	Ω
PHYLUM:	RHYNCHOCOELA	
	Cerabratulus sp.	Ω
PHYLUM:	NEMATODA	
	Unspecified nematod	*Ω
PHYLUM:	ANNELIDA	
Class:	Polychaeta	
Order:	Phyllodocidae	
	Goniada maculata	Ω
	Procerae	Ω
	Nepthys spp.	Ω
	Nereis sp.	Ω
	Scalibregma inflatum	Ω
Order:	Polynoidae	
	Unidentified juvenile	Ω
Order:	Cirratulidae	
	Chaetozone spp.	Ω
Order:	Terebellidae	
	Polycirrus tenuiseta	Ω
Order:	Flabelligeridae	
	Pherusa plumosa	Ω
PHYLUM:	MOLLUSCA	
Class:	Gastropoda	
Subclass:	Opisthobranchia	*
	Aeolidacea	Ω
	Coryphellidae	Ω
Class:	Bivalvia	
	Unspecified bivalve	*Ω

Continued

APPENDIX TABLE 4. (Continued)

PHYLUM:	ARTHROPODA	
Class:	Arachnidae	
Order:	Acari	
	Parasitengona	Ω
Class:	Crustacea	
Subclass:	Ostracoda	
	Unspecified benthic ostracod	Ω
Subclass:	Copepoda	
Order:	Harpacticoida	
	Alteutha oblonga	Ω*
	Tegastidae	*
	Thalestris longimana	
	Unspecified harpacticoids	*
	Zaus spinatus	
Superorder:	Peracarida	
Order:	Cumacea	
	Diastylis spp.	Ω
	Diastylis oviergous	Ω
	Diastylis sculpta	Ω
	Diastylis sculpta ovigerous	Ω
	Diastylis polita	Ω
	Diastylis polita ovigerous	Ω
	Diastylis quadrispinosa	Ω
	Eudorellopsis deformis	Ω
	Eudorella pusilla	Ω
	Lamprops quadriplicata	Ω
	Leucon americanus	Ω
	Petalosarsia declivis	Ω
	Pseudoleptocuma minor	Ω
	Pseudoleptocuma minor ovigerous	Ω
	Unspecified cumacean	Ω*
Order:	Isopoda	
	Edotea triloba	Ω
	Chiridotea spp.	Ω
	Chiridotea tuftsi	Ω
	Idotea spp.	Ω
	Idotea balthica	Ω
	Idotea phosphorea	Ω
	Unspecified isopod	Ω
Order:	Amphipod	
	Acanthanotozoma serratum	Ω
	Aeginina longicornis	Ω
	Amphiporeia virginiana	Ω
	Corophium spp.	Ω
	Corophium spp. ovigerous	Ω
	Corophium acherusicum	Ω
	Corophium bonelli	Ω
	Corophium bonelli ovigerous	Ω
	Corophium insidiosum	Ω
	Cymadusa compta	Ω
	Dexamine thea	Ω
	Erichthonius rubricornis	Ω
	Gammarellus angulosus	Ω

Continued

APPENDIX TABLE 4. (Continued)

	Gammarus spp.	Ω
	Gammarus lawrencianus	Ω
	Ischyrocerus anguipes	Ω
	Ischyrocerus anguipes ovigerous	Ω
	Jassa falcata	Ω
	Jassa falcata ovigerous	Ω
	Leptocheirus pinguis	Ω
	Marinogammarus stoerensis	Ω
	Monoculodes spp.	Ω
	Monoculodes tuberculatus	Ω
	Orchomenella pinguis	Ω
	Photis macrocoxa	Ω
	Pleustes panoplus	Ω
	Stenothoidae	Ω
	Synchelidium americanum	Ω
	Syrrhoe crenulata	Ω
	Tiron spiniferum	Ω
	Unciola irrorata	Ω
	Unspecified amphipod	Ω
	Unidentified Aoridae	Ω
Order:	Mysidacea	
	Erythrops erythrophthalma	Ω
	Mysis mixta male	Ω
	Mysis mixta female	Ω
	Neomysis americana	Ω
	Neomysis americana juvenile	Ω
	Neomysis americana male	Ω
	Neomysis americana female	Ω
	Neomysis americana ovigerous	Ω
	Neomysis americana larvigerous	Ω
Superorder:	Eucarida	
Order:	Decapoda	
	Brachyura megalops	Ω
	Cancer irroratus juvenile	Ω
	Carcinus maenus megalops	Ω
	Caridion gordoni post larva	Ω
	Crangon septemspinosa	Ω
	Crangon septemspinosa ovigerous	Ω
	Crangon septemspinosa post larva	Ω
	Eualus pusiolus larvae	Ω
	Eualus pusiolus megalops	Ω
	Eualus gaimardii post larva	Ω
	Hippolytidae	Ω
	Hyas coarctatus megalops	Ω
	Pagurus spp. glaucothoe	Ω

Continued

APPENDIX TABLE 4. (Continued)

Class:	Insecta		
Order:	Hemiptera		
Family:	Corixidae		Ω
PHYLUM:	BRYOZOA		
		Bryozoan statoblast	Ω