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Distribution of Biomass and Density of Macrobenthic Invertebrates on the U.S. Continental Shelf off Martha's Vineyard, Massachusetts

Don Maurer[1] and Roland L. Wigley[2]

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Signature Marvin D. Grosslein

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Northeast Fisheries Center
Woods Hole, MA. 02543

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[1]University of Delaware, College of Marine Studies, Lewes, DE 19958

[2]Present address: 35 Wilson Road, Woods Hole, MA 02543

INTRODUCTION

Research on the ecology of benthic invertebrates of the Middle Atlantic continental shelf has accelerated in recent years (early 1970's) because of a wide variety of human activities there. These activities range from fishing, recreation, transportation on one hand to mineral recovery, waste disposal and oil exploration on the other. These activities were important factors in prompting an assessment of the needs for future research in this productive part of the ocean (Saila, 1973). One part of this assessment was undertaken by Pratt (1973) who reviewed, in considerable detail, the status of the benthic fauna in the Middle Atlantic Bight. Pratt noted that with the exception of Lee's (1944) work in Menemsha Bight, some taxonomic studies, and studies on commercially important species, there had been a dearth of information published on quantitative areal distribution and standing crop biomass of the macrobenthic invertebrate fauna on the Middle Atlantic Bight continental shelf until relatively recent times (early 1970's). A similar view was expressed by Menzies et al. (1973). The majority of reports on quantitative benthic studies published in the late 1950's and into the 1960's dealt with inshore areas. His review, however, did not include a major report on the quantitative distribution of the macrobenthos of the Middle Atlantic Bight continental shelf and slope (Wigley and Theroux, in press) which was submitted to the MESA, New York Bight Program Office later in 1973.

Pratt's (1973) review included descriptionsand discussions of level bottom assemblages in a variety of sediments from the continental shelf, submarine canyons, beaches and estuaries. He described particular communities or associations in the latter habitat. In addition to level bottom assemblages, epifaunal assemblages were discussed together with sections on important or characteristic species within major taxa (Crustacea, Polychaeta, Mollusca).

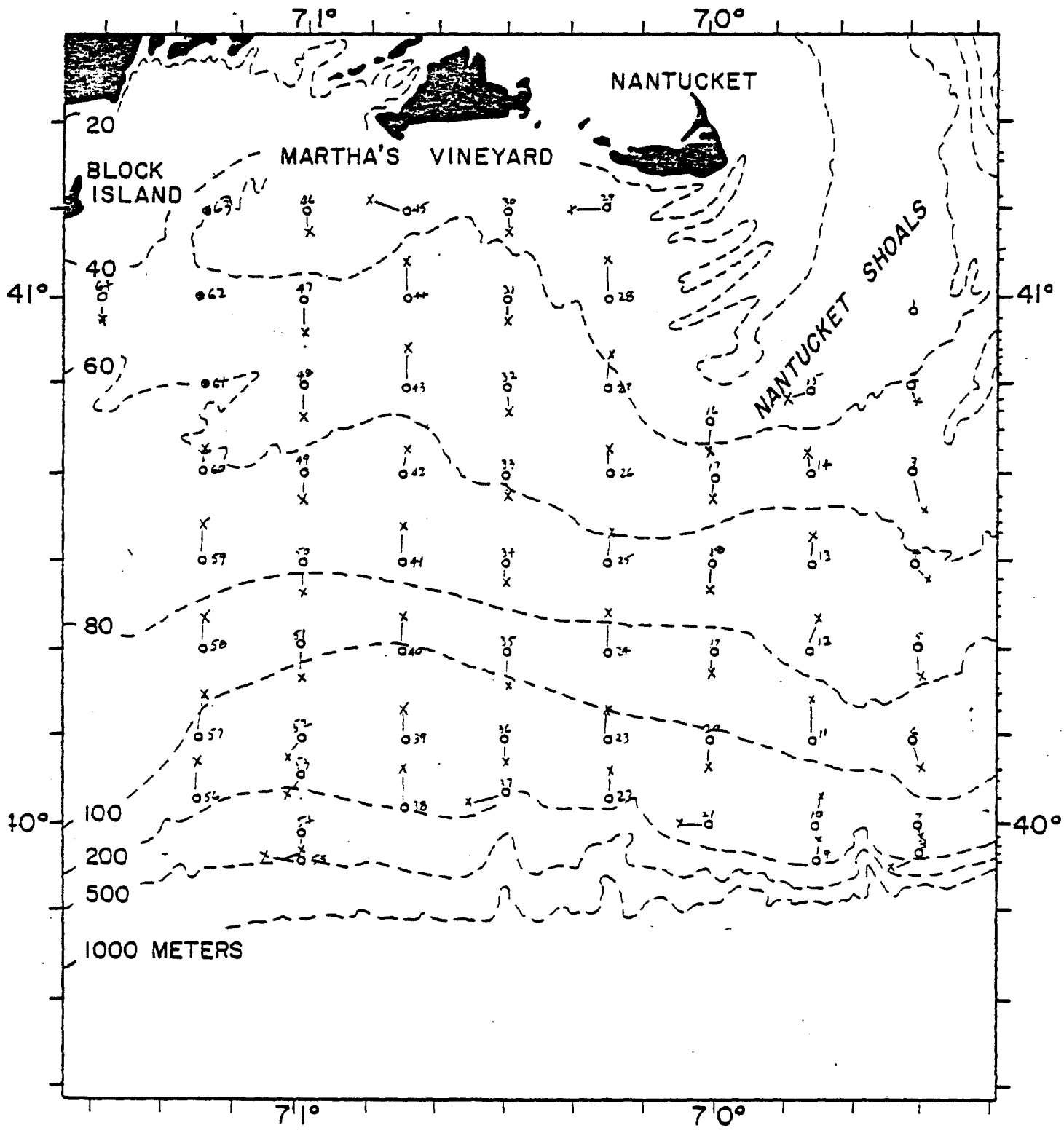


Figure 1. Location of stations of bottom samples for fauna O and sediment X off Martha's Vineyard.

The purpose of the present account is to report in detail on the biomass and density distribution of macrobenthic invertebrates on the continental shelf off Martha's Vineyard, Massachusetts (Figure 1). This report represents a portion of a larger study from Georges Bank to the Florida Keys undertaken by the Benthic Dynamics Investigation of the Northeast Fisheries Center. Although interest in biomass of fisheries and fish food is not exclusive with the Service, the quantitative geographic definition of these variables has been strongly pursued for some time (Wigley, 1961; Wigley and Emery, 1967; Wigley, 1968). These efforts have tended to emphasize density-dependent food relationships with reference to food habits of New England groundfish (Wigley, 1956, 1958, 1965, 1968, and Wigley and Theroux, 1965).

Data for the present study were initially gathered in 1962. However, since that time portions of the study were prepared for publication. Two species of Pogonophora, Siboglinum ekmani and Siboglinum sp. (subsequently identified as S. atlanticum) were described from the deepest stations in the study area (Wigley, 1963). The first measurements of quantitative comparison of offshore meiobenthos and macrobenthos in the western Atlantic Ocean were also based on this study (Wigley and McIntyre, 1964). Data from one transect (10 stations) were included. In a larger report the distribution of macroscopic remains of recent animals from marine sediments were described in detail (Wigley and Stinton, 1973). This report provided information on the durable portions of recently dead animals in the context of the fate or disposition of prefossils.

The present account is the most complete coverage to date of data (8 transects, 64 stations) collected from the 1962 cruise. It includes description (maps) and discussion of biomass and density of major taxa.

Table 1. Station location and physical features, including bottom sediment composition and median particle size.

Station number	Station location		Water depth	Bottom water temperature	Bottom sediment parameters							
						Median	Composition			Nitrogen	Organic	Carbon
	Lat. (N)	Long. (W)			Type	diameter	Sand	Silt	Clay	(Kjeldahl)	carbon	Nitrogen
			m	^{o}C		ϕ	%	%	%	%	%	
1	40° 58'	69° 30'	46	8.6	Sand-gravel	---	---	---	---	---	---	---
2	40° 51'	60° 31'	46	8.6	Sand	1.00	100.0	0.0	0.0	0.003	0.050	17.0
3	40° 40'	69° 31'	51	7.7	Sand	2.35	100.0	0.0	0.0	0.010	0.11	11.1
4	40° 30'	69° 29'	62	7.1	Sand	2.54	100.0	0.0	0.0	0.019	0.13	6.9
5	40° 21'	69° 30'	76	9.4	Sand	3.47	81.0	12.7	6.3	0.070	0.46	6.6
6	40° 10'	69° 31'	91	8.6	Sand	2.23	90.0	10.0	0.0	0.034	0.26	7.7
7	40° 00'	69° 30'	128	11.9	Sand	2.79	84.5	10.2	5.3	0.031	0.24	7.8
8	39° 57'	69° 30'	183	11.9	Sand	2.89	86.0	9.8	4.2	0.022	0.12	5.5
9	39° 56'	69° 45'	201	8.9	Sand	2.70	85.0	10.7	4.2	0.035	0.22	6.3
10	40° 00'	69° 45'	139	11.7	Silty-sand	3.85	57.0	33.4	9.5	0.087	0.61	7.0
11	40° 10'	69° 45'	95	7.3	Silty-sand	3.70	69.0	23.6	7.5	0.064	0.41	6.5
12	40° 20'	69° 46'	79	6.7	Sand	3.48	85.5	9.2	5.4	0.059	0.41	7.0
13	40° 30'	69° 45'	73	7.2	Sand	2.63	95.0	1.9	3.2	0.026	0.17	6.6
14	40° 40'	69° 45'	59	7.5	Sand	2.24	100.0	0.0	0.0	0.004	0.03	7.9
15	40° 50'	69° 45'	37	9.2	Sand	2.05	100.0	0.0	0.0	0.003	0.02	8.0

Table 1. (Continued)

Station number	Station location		Water depth	Bottom water temperature	Bottom sediment parameters							
						Median	Composition			Nitrogen	Organic	Carbon
	Lat. (N)	Long. (W)			Type	diameter	Sand	Silt	Clay	(Kjeldahl)	carbon	Nitrogen
16	40° 46'	70° 00'	38	8.1	Sand	2.67	100.0	0.0	0.0	0.018	0.08	4.6
17	40° 39'	69° 59'	49	7.5	Sand	3.27	81.0	10.3	8.7	0.072	0.39	5.5
18	40° 30'	70° 00'	73	6.8	Sand	3.65	67.0	25.3	7.7	0.082	0.55	6.8
19	40° 20'	69° 59'	91	6.7	Sand	3.79	62.0	31.4	6.7	0.069	0.48	6.9
20	40° 10'	70° 00'	117	11.4	Sand	4.12	45.0	44.8	10.2	0.080	0.58	7.2
21	40° 00'	70° 00'	165	(11.4)	Sand	3.35	66.0	23.9	10.1	0.058	0.48	8.4
22	40° 03'	70° 15'	183	10.8	Silty-sand	2.18	66.8	23.6	9.6	0.060	0.59	9.9
23	40° 10'	70° 15'	113	11.6	Silty-sand	4.31	36.2	53.4	10.4	0.092	0.70	7.6
24	40° 20'	70° 15'	90	7.8	Silty-sand	4.12	47.0	38.9	14.1	0.133	0.92	6.9
25	40° 30'	70° 15'	70	6.6	Sand	3.83	58.8	30.7	10.5	0.076	0.52	6.8
26	40° 40'	70° 15'	51	7.2	Sand	3.37	85.9	10.2	3.8	0.048	0.19	4.0
27	40° 50'	70° 15'	44	8.1	Sand	3.43	86.1	9.3	4.5	0.035	0.20	5.7
28	41° 00'	70° 15'	33	9.4	Sand	3.35	90.1	4.2	4.7	0.033	0.13	4.0
29	41° 11'	70° 16'	27	12.2	Sand	1.35	100.0	0.0	0.0	0.011	0.07	6.9
30	41° 10'	70° 30'	38	8.3	Sand	2.03	100.0	0.0	0.0	0.018	0.11	6.2
31	41° 00'	70° 30'	48	7.5	Sand	2.81	79.5	14.1	6.4	0.044	0.28	6.3
32	40° 50'	70° 30'	59	6.9	Sand	3.30	67.5	24.1	3.5	0.073	0.51	7.0
33	40° 40'	70° 30'	62	6.7	Silty-sand	3.48	60.0	25.3	14.7	0.137	0.84	6.2

Table 1. (Continued)

Station	Station location		Water	Bottom water	Bottom sediment parameters							
						Median	Composition			Nitrogen	Organic	Carbon
number	Lat. (N)	Long. (W)	depth	temperature	Type	diameter	Sand	Silt	Clay	(Kjeldahl)	carbon	Nitrogen
34	40° 30'	70° 30'	73	7.5	Sandy-silt	4.54	33.2	49.0	17.8	0.148	1.03	6.9
35	40° 20'	70° 30'	97	10.0	Sandy-silt	4.67	12.3	72.3	15.4	0.146	1.12	7.6
36	40° 10'	70° 30'	128	12.1	Silty-sand	2.26	82.8	10.2	7.0	0.046	0.41	8.9
37	40° 04'	70° 29'	220	9.4	Sand	1.79	88.8	6.2	5.0	0.038	0.28	7.5
38	40° 02'	70° 44'	194	10.8	Silty-sand	3.61	53.6	31.8	14.6	0.113	0.63	5.6
39	40° 10'	70° 45'	132	11.7	Silty-sand	5.02	14.5	66.4	19.1	0.183	1.05	5.7
40	40° 20'	70° 46'	106	9.2	Sand-silt-clay	5.01	14.0	61.6	24.5	0.212	1.46	6.9
41	40° 30'	70° 45'	79	6.7	Sandy-silt	4.86	19.3	62.6	18.1	0.194	1.03	5.3
42	40° 40'	70° 45'	66	6.4	Silty-sand	3.42	55.8	29.7	14.5	0.112	0.69	6.2
43	40° 50'	70° 45'	55	6.8	Sand	2.37	85.5	7.8	6.7	0.054	0.22	4.1
44	41° 00'	70° 45'	51	6.7	Sand	1.48	100.0	0.0	0.0	0.008	0.07	8.7
45	41° 10'	70° 45'	38	8.6	Sand-gravel	1.00	100.0	0.0	0.0	0.006	0.06	10.6
46	41° 10'	71°00'	40	9.7	Sand	1.59	100.0	0.0	0.0	0.007	0.08	11.2
47	41° 00'	71° 00'	51	6.4	Sand-gravel	2.53	85.1	6.8	8.1	-	-	-
48	40° 50'	71° 00'	59	6.1	Sand	2.30	83.4	8.5	7.7	0.046	0.23	5.0
49	40° 40'	71° 00'	70	6.3	Sandy-silt	5.09	16.4	61.0	22.6	0.220	1.09	5.0
50	40° 30'	71° 00'	84	6.3	Clayey-silt	5.84	3.1	69.3	27.6	0.245	1.24	5.0
51	40° 21'	71° 00'	99	9.4	Sandy-silt	4.77	31.2	49.0	19.8	0.150	0.94	6.3

Table 1. (Continued)

Station	Station location		Water	Bottom water	Bottom sediment parameters							
						Median	Composition			Nitrogen	Organic	Carbon
number	Lat. (N)	Long. (W)	depth	temperature	Type	diameter	Sand	Silt	Clay	(Kjeldahl)	carbon	Nitrogen
52	40° 10'	71° 00'	146	10.8	Silty-sand	2.35	70.0	17.5	11.5	0.067	0.45	6.7
53	40° 06'	71° 00'	179	10.8	Silty-sand	4.77	24.1	54.1	21.8	0.124	1.04	8.4
54	39° 59'	71° 00'	366	(6.1)	Silt	5.16	25.2	66.8	8.0	0.112	0.88	7.9
55	39° 56'	71° 00'	567	(6.1)	Silt	4.39	42.7	36.3	21.0	0.160	1.17	7.3
56	40° 03'	71° 16'	183	10.3	Sand	2.18	86.0	8.4	5.6	0.050	0.21	4.1
57	40° 10'	71° 15'	110	10.8	Silty-sand	2.68	66.0	23.6	10.4	0.009	0.74	7.5
58	40° 20'	71° 15'	91	9.0	Silty-sand	3.29	52.0	35.3	12.7	0.136	0.81	5.9
59	40° 30'	71° 15'	77	6.7	Silty-sand	2.95	69.5	19.5	11.0	0.086	0.32	3.7
60	40° 40'	71° 15'	62	6.2	Sand	2.38	76.6	16.1	7.3	0.060	0.29	4.9
61	40° 50'	71° 15'	62	6.4	Sand	3.00	87.9	6.5	5.6	0.044	0.20	4.5
62	41° 01'	71° 16'	48	6.7	Sand	1.63	100.0	0.0	0.0	0.009	0.06	7.1
63	41° 10'	71° 15'	38	8.1	Sand	2.14	100.0	0.0	0.0	0.008	0.06	7.9
64	41° 00'	71° 30'	55	6.9	Sand	2.38	89.4	6.1	4.5	0.042	0.24	5.6

MATERIALS AND METHODS

Field and Laboratory

Samples were collected June 11-20, 1962 from the National Marine Fisheries Service's R/V DELAWARE at 64 stations south of Martha's Vineyard, Massachusetts (Figure 1, Table 1). Stations were spaced at intervals of 16 km on a grid pattern with eight north-south transects at right angles to the depth contours. At each station (except station 7) two quantitative bottom samples were collected with a Smith-McIntyre grab. This instrument effectively sampled a 0.1 m^2 area of bottom to a depth of 10-17 cm. At sea materials for macrobenthic studies were washed through a 1.0 mm mesh screen. From one grab haul per station a meiobenthos core was extracted. This study and procedure was previously described (Wigley and McIntyre, 1964). Macrobenthos remaining on the screen after washing were removed and preserved in a solution of neutral formalin.

In the laboratory macrobenthos were sorted, identified to species whenever possible, counted and weighed. External moisture was removed from specimens by blotting. Shells, internal skeletons and exoskeletons were included in the values expressed as grams or grams/m^2 wet weight or biomass.

Sediment samples were collected with a Dietz-LaFond grab at each station and at two localities equally spaced between stations along the cruise. The location of sediment samples used in conjunction with biological analyses is depicted in Figure 1. Of 186 samples, 60 were analyzed in detail for particle size and the remaining 126 were examined in the laboratory by field techniques. Names of sediment types follow the classification of Shepard (1954). The median sediment size (ø), % sand, % silt, % clay, % kjeldahl nitrogen, % organic carbon measured, and carbon/nitrogen ratio of the sediments were determined. Standard sieving procedures were employed to measure sediment size. References for measuring the chemical composition of the sediments can be found in Hathaway (1971). Based on sediment analyses a composite sediment type map was made (Figure 2). A list of environmental data per station is contained in Table 1.

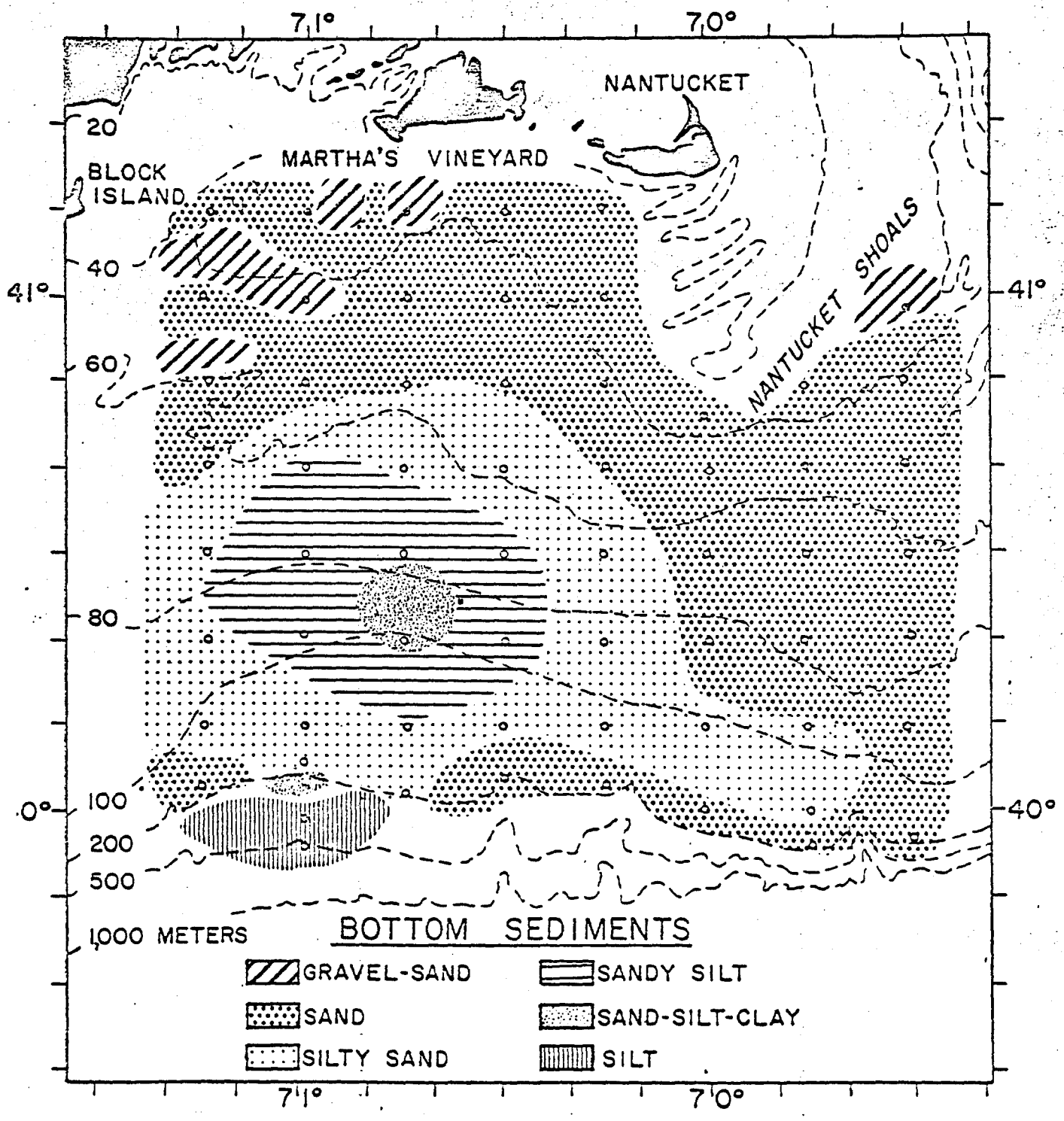


Figure 2. Sediment map of the study area.

ANALYSIS

Wet weight and number per taxon by station were punched on cards and a computer listing was prepared. There was no significant difference in biomass and density between replicates. Based on the listing the average biomass and density per station of major taxa (Amphipoda, Bivalvia, Asteroidea etc.) were determined and distribution maps were plotted by computer.

GEOLOGY, PHYSIOGRAPHY AND SEDIMENT COMPOSITION

Milliman (1973) provides the most recent and comprehensive review of the marine geology off southern New England. According to him the most conspicuous feature on the continental shelf is the abundance of ridges and swales (also termed sand ridges and sand shoals). Nantucket Shoals and Georges Bank contain good examples of these morphological features. The origin and age of the ridge and swale topography varies from area to area. The ridges off southern New England including Nantucket Shoals probably represent relict features that have been maintained or are altered by tidal currents and major storms.

The study area encompasses about 130 km square and extends across the continental shelf to the upper portion of the continental slope. Bottom topography is moderately smooth. Water depths increase gradually and rather uniformly from shore outward to the shelf break at approximately 120 m. The average gradient of the continental slope off the Middle Atlantic Bight varies from 2 to 7^{o} (Milliman, 1973), and beyond the shelf break in the study area, the depth gradient is relatively steep averaging 4^{o} (Wigley and Stinton, 1973). The most distinguishing feature on the shelf break is the number of gullies and canyons that transect the slope (Figure 1).

The continental shelf sediment is dominated by sand size particles (62-2000 μ). Sediments with high gravel concentrations occur on Nantucket Shoals. Sands commonly contain 5-50% iron-stained grains and are locally quartz-rich. Mud is normally present in small amounts on the shelf.

Six major sediment types occurred in the study area (Figure 2). Terminology follows the Wentworth particle size classification (Twenhofel and Tyler, 1941) and nomenclature is that of Shepard (1954). Sand, silty sand and sandy silt occurred over a large area whereas gravel-sand, sand-silt-clay and silt comprised a limited areal distribution. Sand covered more than half the area mainly in shallow water (0 to 60-80 m) except in the eastern sector and a narrow (6 km) band parallel to and just below the outer periphery of the continental shelf. In shallow water the sands were silt-free and occasionally mixed with large quantities of shell (mollusks and echinoderm plates). Admixtures of silt occurred with sand over most of the remaining area.

A large (80 x 100 km) area of fine grained sediment occurred in the southwestern sector. This area has been referred to as the mud patch. A relatively circular area of sand-silt-clay near its center was surrounded by an inner band of sandy silt which grades to an outer band of silty sand. Illite is normally the most important clay mineral and organic content is higher here than in the surrounding sand (Table 1). The origin of these fine sands is unclear. Some workers considered them modern, others, relict, still others considered them the result of glacial outwash or erosion from Nantucket Shoals (Milliman, 1973). Regardless of their origin this is the largest known natural area of fine grained sediment on the Middle Atlantic Shelf. Sediments on the continental slope were dominated by silt and clay.

HYDROGRAPHY

A review of the physical oceanography of the Middle Atlantic Shelf can be found in Bumpus et al. (1973). Colton and Stoddard (1973) provide a summary of bottom water temperature from 1940 to 1966.

Within the study area salinity values increase from 32^{o}/oo or less along the coast to 32 - 33.5^{o}/oo over the shelf and to 34 - 35^{o}/oo near the shelf break. Salinity values change from a winter maximum to a vernal-summer freshening to an autumnal progression culminating again in winter maxima. In addition to seasonal runoff from land, salinity may be influenced by local physiography (slopes and shoals).

The water temperature regime is typically considered warm-temperate with boreal influence seasonally significant. Surface temperatures are substantially higher than bottom ones; offshore surface waters are somewhat warmer than inshore waters throughout most of the year. Temperatures throughout the water column change seasonally and slightly from year to year.

A cell of cold bottom water (6.1-6.9^{o}C) extends in an east-west band from the New York region eastward to longitude $69^{o}30'$W (Figure 3). This cell occurs at depths of 40-80 m roughly the mid-shelf region. The cold cell is bounded on the north by higher coastal water temperatures (>12^{o}C) and on the south by values of 10 to 20^{o}C near the shelf break. Long term (1940-1966) annual maximum and minimum bottom-water temperatures near the shelf break were 16-17^{o}C and 1-2^{o}C respectively (Colton and Stoddard, 1973). However, the annual range here is normally from 3^{o}C in February-March to 14^{o}C in September-November (Wigley and Stinton, 1973). Non-tidal movements of water masses here are generally westward. Water in the Gulf of Maine and Nantucket Sound tends to flow turbulently south-westerly across Nantucket Shoals into the Martha's Vineyard area.

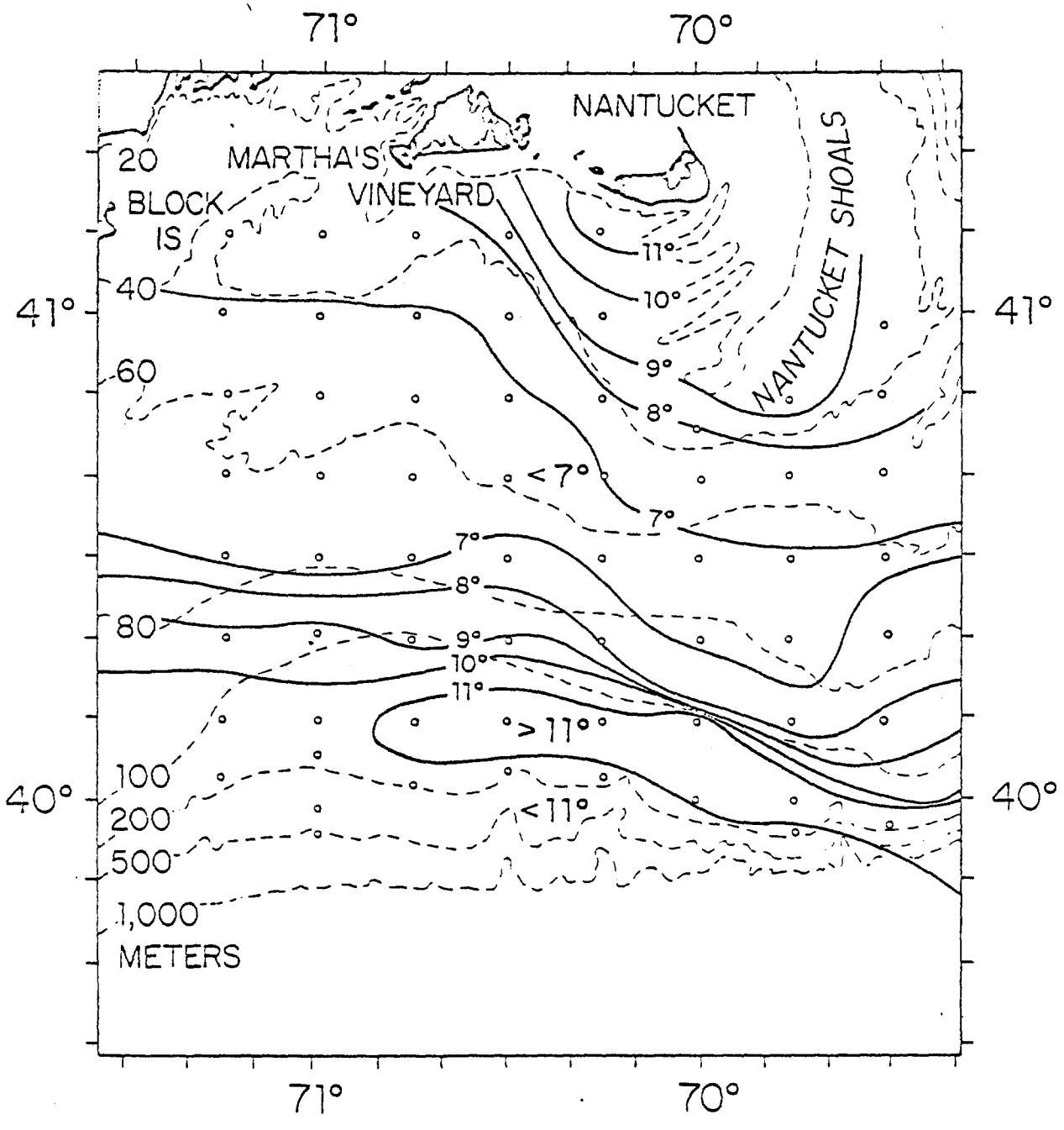


Figure 3. Bottom water temperature (^{o}C) in study area.

FAUNAL COMPOSITION

A taxonomic list of benthos is presented in Table 2. Although Pycnogonida, Mysidacea, Cirripedia, and Amphineura were listed, they were not treated quantitatively because they occurred so infrequently or in few numbers. The list contains 214 genera and/or species together with unidentified groups at higher taxonomic levels. For example, the Porifera and Nemertea have not yet been identified beyond Phylum. Moreover, some of the identified genera include several species in this geographic region. As a result the number of genera and/or species is conservative. Approximately 24.3% of the fauna were mollusks, (bivalves, gastropods, scaphopods, amphineurans), 27.1% are arthropods (amphipods, decapods, cumaceans, isopods, mysids, cirripeds, copepods, tanaidaceans, pycnogonids), polychaetes 24.3%, echinoderms 10.7%, and miscellaneous taxa 13.6%. Miscellaneous taxa included sipunculids, coelenterates, nemerteans, ectroprocts, ascidians, pogonophorans and hemichordates.

TAXONOMIC ANALYSIS

General

Major taxa were pooled and treated in five groups: Crustacea (Decapoda, Cumacea, Isopoda, Amphipoda), Mollusca (Scaphopoda, Gastropoda, Bivalvia), Annelida (Polychaeta), Echinodermata (Ophiuroidea, Holothuroidea, Echinoidea, Asteroidea), Miscellaneous (Porifera, Coelenterata, Nemertea, Sipunculida, Pogonophora, Ectoprocta, Enteropneusta, Ascidiacea). Biomass (wet weight g/m^2) and density (no./m^2) of major taxa per station are presented in Tables 3 and 4.

Almost 190,000 individuals and 15,500 grams of specimens were quantitatively collected. The average biomass and density was 245.7 g/m^2 and 3008 individuals/m^2 per station, respectively. Biomass and density were distributed among the taxa as follows: Crustacea (4.1% and 62.5%), Mollusca (56.7% and 5.9%), Annelida (10.9% and 20.3%), Echinodermata (21.3% and 7.0%), Miscellaneous (7.0% and 4.3%).

Table 2. Taxonomic list of species from the study area.

Porifera

Coelenterata
- Hydrozoa
  - *Hydractinia echinata*
- Anthozoa
  - *Cerianthus* sp.
  - *Edwardsia* sp.
  - *Epizoanthus americanus*
  - *Pennatula aculeata*
  - *Stylatula elegans*

Nemertea

Annelida
- *Aglaophamus circinata*
- *Ammotrypane aulogaster*
- *Amphitrite* sp.
- *Ancistrosyllis* sp.
- *Aphrodita hastata*
- *Arabella iricolor*
- *Aricidea jeffreysii*
- *Asychis biceps*
- *Brada* sp.
- *Capitella* sp.
- *Ceratocephale loveni*
- *Chaetozone* sp.
- *Chone infundibuliformis*
- *Cossura longocirrata*
- *Drilonereis longa*
- *Eunice pennata*
- *Flabelligera* sp.
- *Glycera robusta*
- *Clycera tesselata*
- *Goniada brunnea*
- *Goniada maculata*
- *Harmothoe extenuata*
- *Hyalinoecia tubicola*
- *Laonice cirrata*
- *Leanira* sp.
- *Lumbrineris fragilis*
- *Lumbrineris tenuis*
- *Melinna cristata*
- *Nephtys bucera*
- *Nephtys incisa*
- *Nereis pelagica*
- *Ninoe nigripes*
- *Notocirrus* sp.

Annelida (cont'd)
- Onuphis conchylega
- Onuphis opalina
- Onuphis quadricuspis
- Orbinia ornata
- Owenia sp.
- Paradiopatra sp.
- Paramphinome pulchella
- Paraonis neopolitana
- Phyllodoce mucosa
- Prionospio sp.
- Scalibregma inflatum
- Sphaerodorum gracilis
- Spio sp.
- Spiochaetopterus sp.
- Spiophanes bombyx
- Sternaspis scutata
- Sthenelais limicola
- Streblosoma spiralis
- Tharyx sp.

Sipunculida
- Golfingia catherinae
- Golfingia elongata
- Golfingia margaritacea
- Golfingia minuta
- Golfingia (Phascoloides) sp.
- Onchnesoma steenstrupi
- Phascolion strombi

Arthropoda
- Amphipoda
  - Aeginina longicornis
  - Ampelisca compressa
  - Ampelisca macrocephala
  - Anonyx sp.
  - Byblis serrata
  - Caprella sp.
  - Casco bigelowi
  - Corophium sp.
  - Dulichia sp.
  - Eriopisa elongata
  - Harpinia propinqua
  - Haustoriidae
  - Hippomedon serratus
  - Lembos sp.
  - Leptocheirus pinguis
  - Orchomenella groenlandica
  - Paraphoxus sp.
  - Photis macrocoxa
  - Phoxocephalus holbolli
  - Protomedia fasciata

Amphipoda (cont'd)
- Siphonoecetes smithianus
- Stenopleustes gracilis
- Unciola irrorata
- Unciola leucopis

Decapoda
- Axius serratus
- Cancer borealis
- Cancer irroratus
- Catapagurus sharreri
- Crangon septemspinosa
- Bythocaris nana
- Dichelopandalus leptocerus
- Europrognatha rastellifera
- Hyas coarctatus
- Munida iris
- Pagurus acadianus
- Pagurus arcuatus
- Pagurus politus
- Pontophilus brevirostris

Isopoda
- Calathura sp.
- Chiridotea tuftsi
- Cirolana polita
- Edotea triloba
- Ptilanthura tenuis

Cumacea
- Diastylis polita
- Diastylis quadrispinosa
- Eudorella emarginata
- Eudorellopsis sp.
- Leptocuma minor
- Leptostylis sp.
- Petalosarsia declivis

Mysidacea
- Bathymysis renoculata
- Erythrops erythropthalma
- Hypererythrops caribbaea
- Mysis mixta
- Neomysis americana

Cirripedia
- Balanus sp.

Pycnogonida
- Achelia spinosa
- Paranymphon spinosum

Mollusca

Amphineura
- Chaetoderma nitidulum

Bivalvia
- Anomia sp.
- Arctica islandica
- Astarte undata

Bivalvia (cont'd)
- Bathyarca pectunculoides
- Cerastoderma pinnulatum
- Crenella glandula
- Cuspidaria perrostrata
- Cuspidaria striata
- Cyclocardia borealis
- Ensis directus
- Hiatella sp.
- Lyonsia arenosa
- Lyonsia hyalina
- Macoma calcarea
- Mesodesma arctatum
- Mytilidae
- Nucula proxima
- Nucula tenuis
- Nuculana acuta
- Pandora gouldiana
- Pandora inflata
- Periploma papyratium
- Phacoides blakeanus
- Phacoides filosus
- Placopecten magellanicus
- Siliqua costata
- Spisula solidissima
- Tellina agilis
- Thracia sp.
- Thyasira ferruginosa
- Thyasira gouldi
- Thyasira ovata
- Thyasira trisinuata
- Yoldia sapotilla

Scaphapoda
- Cadulus pandionis
- Cadulus verrilli
- Dentalium occidentale

Gastropoda
- Alvania carinata
- Buccinum undatum
- Colus stimpsoni
- Crepidula plana
- Crucibulum striatum
- Cylichna alba
- Epitonium dallianum
- Lunatia heros
- Lunatia triseriata
- Nassarius trivitatus
- Neptunea sp.
- Polinices sp.
- Retusa gouldi
- Scaphander sp.

Echinodermata
- Asteroidea
  - *Asterias vulgaris*
  - *Astropecten americana*
  - *Astropecten* sp.
  - *Henricia sanguinolenta*
  - *Leptasterias tenera*
  - *Porania* sp.
- Echinoidea
  - *Brisaster fragilis*
  - *Echinarachnius parma*
- Ophiuroidea
  - *Amphilimna olivacea*
  - *Amphioplus abditus*
  - *Amphioplus macilentus*
  - *Amphiura fragilis*
  - *Amphiura otteri*
  - *Axiognathus squamatus*
  - *Ophiura robusta*
  - *Ophiura sarsi*
- Holothuroidea
  - *Caudina arenata*
  - *Chiridota* sp.
  - *Cucumaria frondosa*
  - *Havelockia scabra*
  - *Molpadia oolitica*
  - *Psolus fabricii*
  - *Stereoderma unisemita*

Ectoprocta
- *Dendrobeania murrayana*
- *Electra hastingsae*
- *Electra pilosa*
- *Haplota clavata*
- *Hippothoa hyalina*
- *Scruparia chelata*

Ascidiacea
- *Bostrichobranchus pilularis*
- *Ciona intestinalis*
- *Cnemidocarpa mollis*
- *Heterostigma singulare*
- *Molgula citrina*
- *Molgula complanata*
- *Molgula siphonalis*

Pogonophora
- *Siboglinum atlanticum*
- *Siboglinum ekmani*

Hemichordata
- Enteropneusta
  - *Balanoglossus* sp.

Table 3. Biomass (G/m^2) of Major Taxa Per Station.

Station Number	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	PORONOPHORA	SIPUNCULA	MOLLUSCA	Gastropoda	Bivalvia	Scaphapoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
1	12.0	1.1	8.2	22.6	-	-	45.2	0.5	44.7	-	18.9	-	-	3.6	15.3	-	-	-	-	-	51.6	-	-	159.6
2	2.9	-	-	3.1	-	-	-	-	-	-	2.2	-	0.1	2.0	0.1	-	-	-	-	-	1.1	-	-	9.3
3	-	-	0.2	0.5	-	-	928.4	-	928.4	-	1.2	0.1	0.1	1.0	-	2.7	-	2.7	-	-	-	-	0.1	933.1
4	-	18.7	3.1	68.5	-	11.9	934.8	392.7	542.1	-	9.2	0.2	0.1	8.8	0.1	11.8	-	11.8	-	-	4.7	-	1.9	1064.6
5	-	0.9	1.7	45.4	-	1.2	272.8	0.1	272.4	-	52.6	0.2	4.3	40.9	7.1	1.8	-	0.9	-	0.9	-	-	-	376.0
6	-	1.9	0.2	32.5	-	-	47.5	-	47.5	-	18.9	0.1	0.1	12.5	6.2	7.4	3.5	-	3.9	-	-	-	4.0	112.4
8	-	6.2	-	11.7	-	0.1	-	-	-	-	0.2	0.1	-	0.1	-	105.3	-	-	106.3	-	-	-	-	123.4
9	0.9	10.9	0.1	14.8	-	0.1	6.8	-	5.7	1.1	0.7	-	0.1	0.6	-	1.1	-	-	1.1	-	-	-	1.2	36.6
10	-	10.5	0.3	4.7	-	0.1	3.0	-	3.0	-	0.2	0.1	-	0.1	-	86.4	-	38.4	34.1	13.9	0.1	-	-	105.3
11	-	11.6	0.9	10.6	-	2.1	6.0	0.1	5.9	-	1.9	0.1	0.7	1.1	-	71.4	25.0	-	46.4	-	-	-	7.1	119.6
12	-	5.0	1.5	26.7	-	0.1	1413.0	0.1	1412.9	-	16.9	0.1	0.1	16.7	-	12.3	12.2	-	0.1	-	-	10.2	-	1485.7
13	-	0.3	3.8	118.8	-	0.2	65.6	1.0	64.6	-	32.3	0.7	3.2	27.9	0.5	0.5	0.5	-	-	-	-	-	1.5	223.0
14	-	0.1	0.2	13.3	-	5.4	0.2	0.1	0.1	-	2.4	0.1	0.2	2.1	-	20.9	-	20.7	0.1	0.1	0.1	-	0.1	42.7
15	-	-	0.1	6.8	-	-	0.1	-	0.1	-	4.0	-	-	3.9	0.1	-	-	-	-	-	-	-	-	11.0
16	-	-	-	2.6	-	-	1.4	-	1.4	-	4.6	0.1	0.1	4.3	-	0.6	-	0.6	-	-	0.1	-	7.7	16.9
17	-	0.6	0.4	44.9	-	3.6	545.2	9.1	536.1	-	14.8	0.1	0.2	14.5	-	7.8	-	7.8	-	-	-	-	3.1	620.4
18	-	0.1	0.6	29.4	-	0.1	469.3	0.2	469.1	-	13.5	0.1	1.1	12.3	-	-	-	-	-	-	-	-	0.2	513.2
19	-	-	1.4	8.8	-	0.1	1.2	-	1.2	-	8.4	-	-	8.4	-	615.9	562.4	-	21.6	31.9	-	-	0.5	636.3
20	-	342.3	-	1.3	-	0.1	0.8	-	0.8	-	0.2	0.1	-	0.1	-	15.3	-	-	12.7	2.6	-	-	-	360.0
21	-	-	-	4.9	-	0.1	6.4	-	6.4	-	0.2	0.1	-	0.1	-	284.0	-	251.6	32.3	0.1	-	-	-	295.6
22	-	-	-	5.7	-	4.1	0.2	-	0.2	-	0.1	-	-	0.1	-	86.6	10.2	-	76.4	-	-	-	-	96.7
23	-	1.9	2.0	15.6	-	0.2	2.2	-	2.2	-	0.3	0.1	0.1	0.1	-	38.5	12.8	-	15.6	10.1	-	-	11.0	71.7
24	-	3.8	20.0	15.3	-	-	0.3	-	0.3	-	2.1	-	-	2.1	-	188.9	175.5	-	13.4	-	-	-	-	230.4
25	-	-	1.3	20.8	-	-	9.4	0.1	9.3	-	5.6	0.2	-	1.9	3.5	-	-	-	-	-	-	-	-	37.1
26	-	0.1	2.6	73.4	-	0.1	7.2	0.1	7.1	-	12.2	0.2	0.1	11.9	-	-	-	-	-	-	0.1	-	-	95.6
27	-	0.1	3.1	72.7	-	-	77.8	-	77.8	-	20.0	0.2	1.1	18.7	-	2.4	-	2.4	-	-	-	-	-	176.1
28	-	0.1	1.8	83.9	-	11.0	933.1	1.0	932.1	-	7.8	0.1	2.6	4.9	0.2	4.7	-	4.7	-	-	0.1	-	-	1042.5
29	-	5.2	5.8	60.2	-	-	44.4	0.1	44.3	-	9.8	0.2	0.2	8.3	1.1	-	-	-	-	-	16.5	-	22.4	167.0
30	-	-	4.1	3.4	-	11.9	808.0	-	808.0	-	15.5	1.1	1.3	13.1	-	9.1	-	9.1	-	-	-	-	2.8	854.8
31	-	2.1	0.3	35.7	-	10.1	23.2	10.6	12.6	-	63.4	0.2	0.7	62.5	-	7.1	-	6.3	-	0.8	4.0	-	0.2	146.1
32	-	-	0.4	16.9	-	-	3.4	0.1	3.3	-	0.4	0.1	-	0.3	-	0.5	-	-	-	0.5	-	-	-	20.6
33	-	-	0.3	31.3	-	-	7.0	0.1	6.9	-	1.1	0.2	0.1	0.8	-	455.0	454.9	0.1	-	-	-	-	-	494.7
34	-	2.0	0.1	15.9	-	1.4	5.3	0.2	5.1	-	6.1	0.1	0.1	5.8	0.1	216.0	211.5	-	4.5	-	-	-	-	246.8
35	-	7.4	2.0	21.9	-	3.7	4.2	0.3	3.9	-	1.6	0.1	-	1.5	-	108.7	66.8	-	41.9	-	-	-	-	149.5
36	-	18.7	0.7	15.3	-	-	0.9	-	0.9	-	0.3	0.1	-	0.2	-	33.9	-	-	33.9	-	-	-	37.6	107.4
37	-	-	2.7	2.6	-	-	1.6	0.1	1.5	-	0.1	-	-	0.1	-	244.6	8.4	177.1	59.1	-	-	-	0.2	251.6
38	-	1.4	-	24.1	-	0.1	0.3	0.1	0.1	0.1	2.9	-	2.4	0.5	-	8.4	8.2	-	0.2	-	-	-	-	37.2
39	-	-	1.1	10.0	-	-	3.6	0.1	3.5	-	0.1	-	-	0.1	-	74.5	-	32.9	41.6	-	-	-	7.2	96.5
40	-	5.3	0.1	2.4	-	-	12.5	0.1	12.4	-	5.0	0.1	0.1	4.8	-	58.7	2.4	23.0	33.3	-	-	-	7.6	91.6
41	-	6.6	-	10.3	-	-	0.1	-	0.1	-	5.8	0.1	-	5.7	-	37.5	-	-	1.0	36.5	-	-	5.6	64.9
42	-	0.9	0.1	32.6	-	-	0.1	0.1	-	-	3.2	0.1	-	3.1	-	-	-	-	-	-	-	-	-	36.9
43	-	-	0.1	22.4	-	-	23.0	0.1	22.9	-	14.9	0.1	0.1	14.7	-	0.1	-	-	0.1	-	-	-	-	60.5
44	-	-	0.2	44.0	-	-	0.8	0.7	0.1	-	23.2	0.1	2.6	20.5	-	-	-	-	-	-	-	-	-	68.2
45	-	-	-	37.6	-	-	-	-	-	-	16.4	0.1	0.1	16.2	-	-	-	-	-	-	-	-	49.7	103.7
46	-	-	0.1	11.8	-	-	1.6	0.3	1.3	-	23.3	0.3	0.4	22.6	-	0.1	-	0.1	-	-	-	-	5.4	42.3
47	-	-	1.0	10.3	-	-	-	-	-	-	13.0	0.3	3.9	8.8	-	-	-	-	-	-	-	-	1.0	25.3
48	-	-	0.1	49.2	-	-	1326.5	0.5	1326.0	-	41.0	0.4	0.8	37.7	2.1	0.1	-	-	-	0.1	-	-	-	1416.9
49	-	0.5	0.1	38.5	-	-	11.1	0.2	10.9	-	3.7	-	-	3.7	-	0.1	-	-	-	0.1	-	-	-	54.0
50	-	1.5	-	48.1	-	-	3.1	0.1	3.0	-	0.2	0.1	-	0.1	-	183.2	138.7	-	11.9	32.6	-	-	32.8	268.9
51	-	17.8	0.1	53.8	-	0.1	9.5	0.1	9.4	-	3.1	0.1	0.1	2.9	-	33.5	15.8	-	17.7	-	-	5.3	10.1	133.3
52	-	9.9	0.1	25.3	-	-	13.9	0.1	13.8	-	0.1	-	-	0.1	-	10.2	3.9	-	6.3	-	-	2.0	-	61.5
53	0.2	2.9	0.1	8.4	-	0.1	6.6	-	6.6	-	0.1	-	-	0.1	-	61.0	23.7	-	37.3	-	-	-	-	79.4
54	-	0.3	-	13.2	0.1	13.4	1.2	0.2	0.9	0.1	0.3	-	0.1	0.2	-	3.4	2.6	-	0.8	-	-	-	-	31.9
55	-	-	-	8.3	0.2	-	2.2	0.1	2.1	-	0.1	-	-	0.1	-	10.3	-	-	10.3	-	-	0.1	-	21.2
56	-	1.3	1.1	8.7	-	-	4.3	0.1	4.2	-	0.2	-	0.1	0.1	-	17.0	-	-	8.7	8.3	-	-	-	32.6
57	-	1.8	-	-	-	0.1	-	-	-	-	0.2	0.1	-	0.1	-	31.7	10.2	-	21.5	-	-	-	8.8	42.6
58	-	7.9	0.6	19.2	-	-	15.3	1.0	14.3	-	0.3	-	-	0.3	-	72.8	-	-	22.2	50.6	-	-	3.3	119.4
59	-	8.8	0.1	23.4	-	-	5.1	-	5.1	-	0.6	-	-	0.6	-	2.8	-	-	2.8	-	-	-	9.7	50.5
60	-	-	0.2	114.7	-	6.8	24.3	0.2	24.1	-	26.6	0.1	0.1	26.4	-	-	-	-	-	-	-	-	15.1	187.7
61	-	-	0.2	40.5	-	0.1	0.9	0.2	0.7	-	69.7	0.4	0.1	69.2	-	0.1	-	-	-	0.1	-	-	-	111.5
62	-	0.1	-	14.8	-	7.6	7.9	7.8	0.1	-	17.6	0.1	3.7	13.8	-	0.1	-	0.1	-	-	-	-	1.7	49.8
63	-	-	-	28.2	-	0.1	-	-	-	-	5.6	0.1	0.3	5.2	-	56.3	-	56.2	0.1	-	-	-	-	90.2
64	-	-	-	21.0	-	13.1	622.5	0.1	622.4	-	12.8	0.4	0.1	12.1	0.2	0.5	-	0.5	-	-	-	-	0.4	670.3

Table 4. Density (no./m^2) of major taxa per station.

Station no.	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	PODOPHORA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	Total
1	11	11	11	1146	-	-	22	11	11	-	1192	-	-	1171	21	-	-	-	-	-	1932	-	-	4324
2	11	-	-	53	-	-	-	-	-	-	73	-	31	31	11	-	-	-	-	-	11	-	-	148
3	-	-	32	42	-	-	11	-	11	-	170	11	21	138	-	21	-	21	-	-	-	-	111	287
4	-	144	21	1380	-	41	37	11	26	-	2379	82	36	2251	10	138	-	138	-	-	11	-	111	4139
5	-	16	16	1129	-	11	179	16	163	-	10887	47	21	10868	21	32	-	11	-	21	-	-	-	12340
6	-	10	62	985	-	-	279	-	279	-	8970	16	27	8916	11	225	36	-	189	-	-	-	62	10563
8	-	21	-	572	-	62	114	-	114	-	31	10	-	21	-	489	-	-	489	-	-	-	-	1289
9	11	140	11	483	-	11	166	-	123	43	222	-	11	211	-	32	-	-	32	-	-	-	11	1087
10	-	51	10	170	-	10	61	-	61	-	36	10	-	26	-	379	-	10	339	30	10	-	-	727
11	-	23	28	500	-	28	491	12	479	-	564	35	11	518	-	1096	81	-	1015	-	-	-	23	2753
12	-	10	15	678	-	10	159	10	149	-	9383	10	10	9333	-	41	31	-	10	-	-	51	-	10317
13	-	10	10	1346	-	20	255	10	245	-	19083	71	10	18992	10	30	10	-	20	-	-	-	41	20795
14	-	10	26	820	-	31	20	10	10	-	371	37	37	297	-	412	-	392	10	10	10	-	10	1710
15	-	-	10	26	-	-	21	-	21	-	526	-	-	514	10	-	-	-	-	-	-	-	-	581
16	-	-	-	456	-	-	21	-	21	-	631	16	32	583	-	11	-	11	-	-	11	-	196	1326
17	-	10	21	1082	-	28	115	47	68	-	3031	62	62	2907	-	172	-	172	-	-	-	-	31	4488
18	-	10	15	651	-	10	308	40	268	-	3030	20	10	3000	-	-	-	-	-	-	-	-	10	4034
19	-	-	20	394	-	51	230	-	230	-	2708	-	-	2708	-	861	200	-	651	10	-	-	10	4274
20	-	20	-	41	-	18	27	-	27	-	84	12	-	72	-	344	-	10	324	10	-	-	-	534
21	-	-	-	172	-	20	153	-	153	-	25	10	-	15	-	335	-	15	310	10	-	-	-	705
22	-	-	-	199	-	61	71	-	71	-	41	-	-	41	-	416	10	-	406	-	-	-	-	788
23	-	35	20	379	-	101	81	-	81	-	50	20	20	10	-	576	10	-	556	10	-	-	51	1293
24	-	20	30	318	-	-	25	-	25	-	111	-	-	111	-	283	91	-	192	-	-	-	-	787
25	-	-	25	838	-	-	576	20	556	-	343	20	-	313	10	-	-	-	-	-	-	-	-	1782
26	-	10	15	1184	-	10	722	20	702	-	1312	66	10	1236	-	-	-	-	-	-	10	-	-	3263
27	-	31	10	750	-	-	357	-	357	-	1999	56	20	1923	-	15	-	15	-	-	-	-	-	3162
28	-	10	10	1225	-	21	82	10	72	-	1737	10	222	1484	21	16	-	16	-	-	10	-	-	3111
29	-	20	21	867	-	-	82	20	62	-	1326	36	42	1238	10	22	-	22	-	-	31	-	541	2910
30	-	-	16	993	-	48	37	-	37	-	1409	595	56	758	-	22	-	22	-	-	-	-	49	2574
31	-	10	10	833	-	10	239	56	183	-	3883	137	15	3731	-	20	-	10	-	10	10	-	10	5025
32	-	-	25	247	-	-	101	10	91	-	76	10	-	66	-	10	-	-	-	10	-	-	-	459
33	-	-	15	490	-	-	475	354	121	-	152	51	20	81	-	20	10	10	-	-	-	-	-	1152
34	-	30	10	227	-	20	162	51	111	-	883	35	10	788	20	112	56	-	56	-	-	-	-	1414
35	-	30	20	379	-	40	1030	404	626	-	131	20	-	111	-	576	71	-	505	-	-	-	-	2206
36	-	76	10	394	-	-	30	-	30	-	50	10	-	40	-	424	-	-	424	-	-	-	333	1317
37	-	-	10	61	-	-	131	10	121	-	30	-	-	30	-	368	40	10	318	-	-	-	20	620
38	-	42	-	965	-	62	82	10	62	10	139	-	19	129	-	20	10	-	10	-	-	-	-	1310
39	-	-	10	177	-	-	91	20	71	-	20	-	-	20	-	717	-	10	707	-	-	-	106	1121
40	-	51	10	61	-	-	570	30	540	-	166	10	10	146	-	1606	20	778	808	-	-	-	51	2515
41	-	30	-	182	-	-	51	-	51	-	1393	40	-	1353	-	30	-	-	20	10	-	-	81	1767
42	-	10	10	1020	-	-	133	102	31	-	1571	10	-	1561	-	-	-	-	-	-	-	-	-	2744
43	-	-	10	783	-	-	46	31	15	-	1960	10	10	1940	-	10	-	-	10	-	-	-	-	2789
44	-	-	10	959	-	0	46	20	26	-	2800	31	102	2667	-	-	-	-	-	-	-	-	-	3815
45	-	-	-	841	-	-	-	-	-	-	5623	10	10	5603	-	-	-	-	-	-	-	-	98	6562
46	-	-	31	619	-	-	58	21	37	-	4381	68	21	4292	-	16	-	16	-	-	-	-	73	5178
47	-	-	20	444	-	-	-	-	-	-	3075	30	81	2964	-	0	0	0	-	-	-	-	20	3559
48	-	-	16	1804	-	-	198	73	125	-	3681	276	16	3338	21	16	-	-	-	16	-	-	-	5685
49	-	15	10	1116	-	-	177	81	96	-	813	-	-	813	-	30	-	-	-	30	-	-	-	2151
50	-	10	-	333	-	-	252	10	242	-	40	20	-	20	-	126	15	-	101	10	-	-	51	812
51	-	51	20	273	-	10	394	30	364	-	111	10	30	71	-	747	45	-	702	-	-	30	71	1707
52	-	77	10	979	-	-	280	10	270	-	10	-	-	10	-	471	10	-	461	-	-	10	-	1837
53	10	10	10	328	-	20	273	-	273	-	25	-	-	25	-	222	10	-	212	-	-	-	-	898
54	-	20	-	803	51	197	91	25	51	15	25	-	10	15	-	35	10	-	25	-	-	-	-	1222
55	-	-	-	432	36	-	30	10	20	-	10	-	-	10	-	20	-	-	20	-	-	10	-	538
56	-	51	10	503	-	-	133	10	123	-	118	-	10	108	-	72	-	-	62	10	-	-	-	885
57	-	10	-	259	-	36	71	-	71	-	66	20	-	46	-	550	10	-	540	-	-	-	15	1007
58	-	35	15	374	-	-	576	10	566	-	51	-	-	51	-	697	-	-	687	10	-	-	61	1809
59	-	35	10	490	-	-	56	-	56	-	15	-	-	15	-	126	-	-	126	-	-	-	354	1086
60	-	-	15	938	-	15	525	20	505	-	1955	90	10	1495	-	-	-	-	-	-	-	-	126	3174
61	-	-	15	756	-	10	122	20	102	-	3442	162	30	3250	-	10	-	-	-	10	-	-	-	4355
62	-	12	-	871	-	53	62	52	10	-	4980	12	72	4896	-	10	-	10	-	-	-	-	54	6042
63	-	-	-	380	-	21	-	-	-	-	1929	73	25	1830	-	135	-	125	10	-	-	-	-	2465
64	-	-	-	439	-	63	83	10	73	-	3681	177	10	3483	11	10	-	10	-	-	-	-	10	4286

The total average biomass and density per station are depicted in Figures 4-5. Medium biomass (100-1000g/m^2) in the north central area yielded to a low biomass (1-100g/m^2) area with irregular boundaries. In turn the low biomass area graded to a medium biomass area which contained the high biomass area (>1000 g/M^2) in the east central section. The medium biomass area shifted to a low area near the 200 m contour. Mollusca, Annelida, and shallow water echinoderms contributed heavily to the high biomass areas.

The density pattern was more regular than biomass. High (>3000/m^2) and medium (1000-3000/m^2) densities occurred in the north gradually ranging to medium and low densities (10-1000/m^2) in the south. Density on the east side was more complex in that it passed from high to low to medium to high again, to medium and once again to low. Crustacea and Annelida contributed greatly to the high density areas.

Stations were grouped into ranges of depth, temperature, median sediment size and silt-clay. The average biomass and density of major taxa were determined for these grouped stations. The highest average total biomass and density were recorded (Tables 5-12) in 60-80 m (354.6 g/m^2 and 5120.4/m^2), 7.0-7.9 °C (372.2 g/m^2 and 4466.1/m^2), 3.0-3.9 ϕ (377.8 g/m^2) and 1.0-1.99 ϕ (3610.7/m^2) and 0-20% silt-clay (336.2 g/m^2 and 4246.7/m^2). A depth range of 40-80 m, temperature 6.0-7.9 °C, 2.0-3.99 ϕ, and 0-60% silt-clay more accurately encompassed the main distribution of biomass. In the same vein the principal distribution of density was accounted for by a depth range of 0-100 m, temperature 6.0-9.9 °C, 1-399 ϕ and 0-40% silt-clay (Tables 5-12).

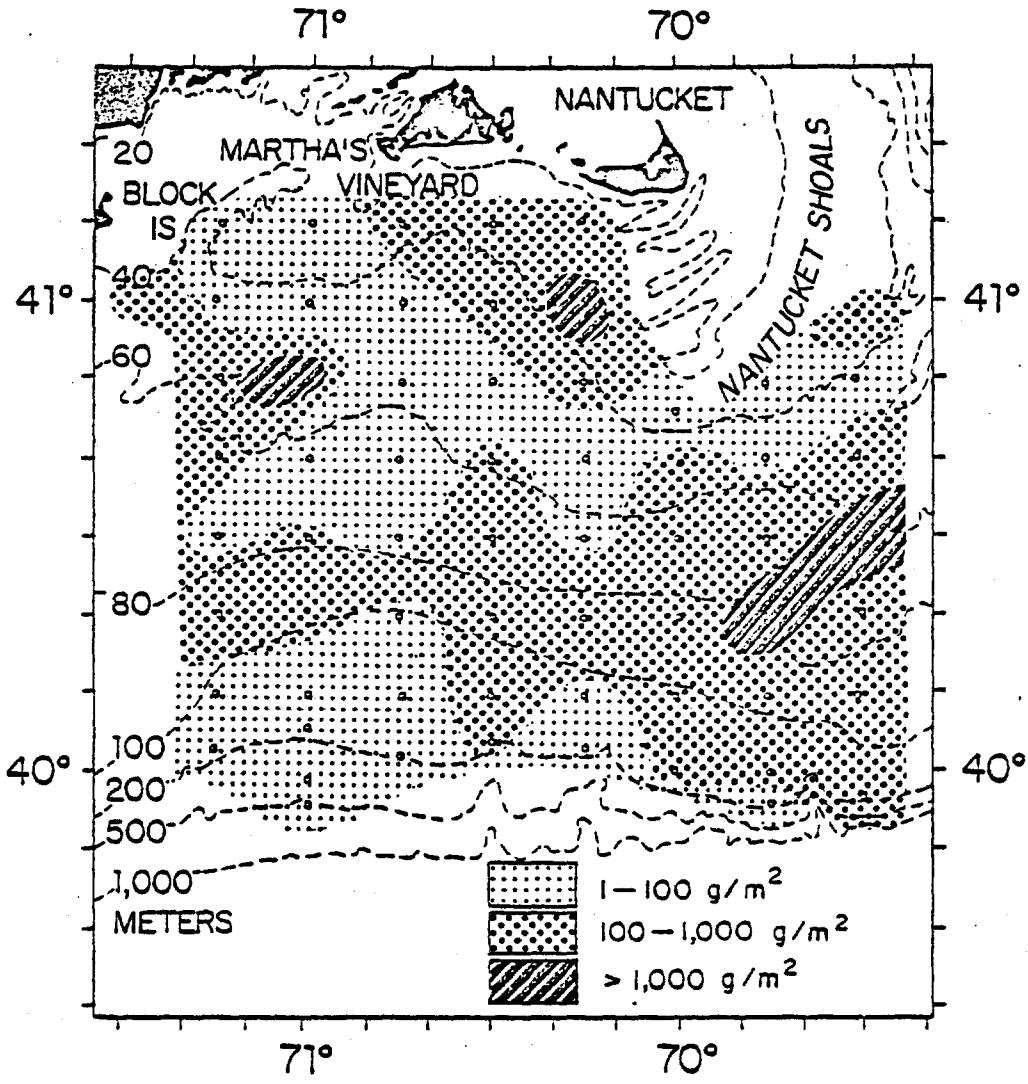


Figure 4. Quantitative distribution of biomass (g/m^2) for all taxonomic groups involved.

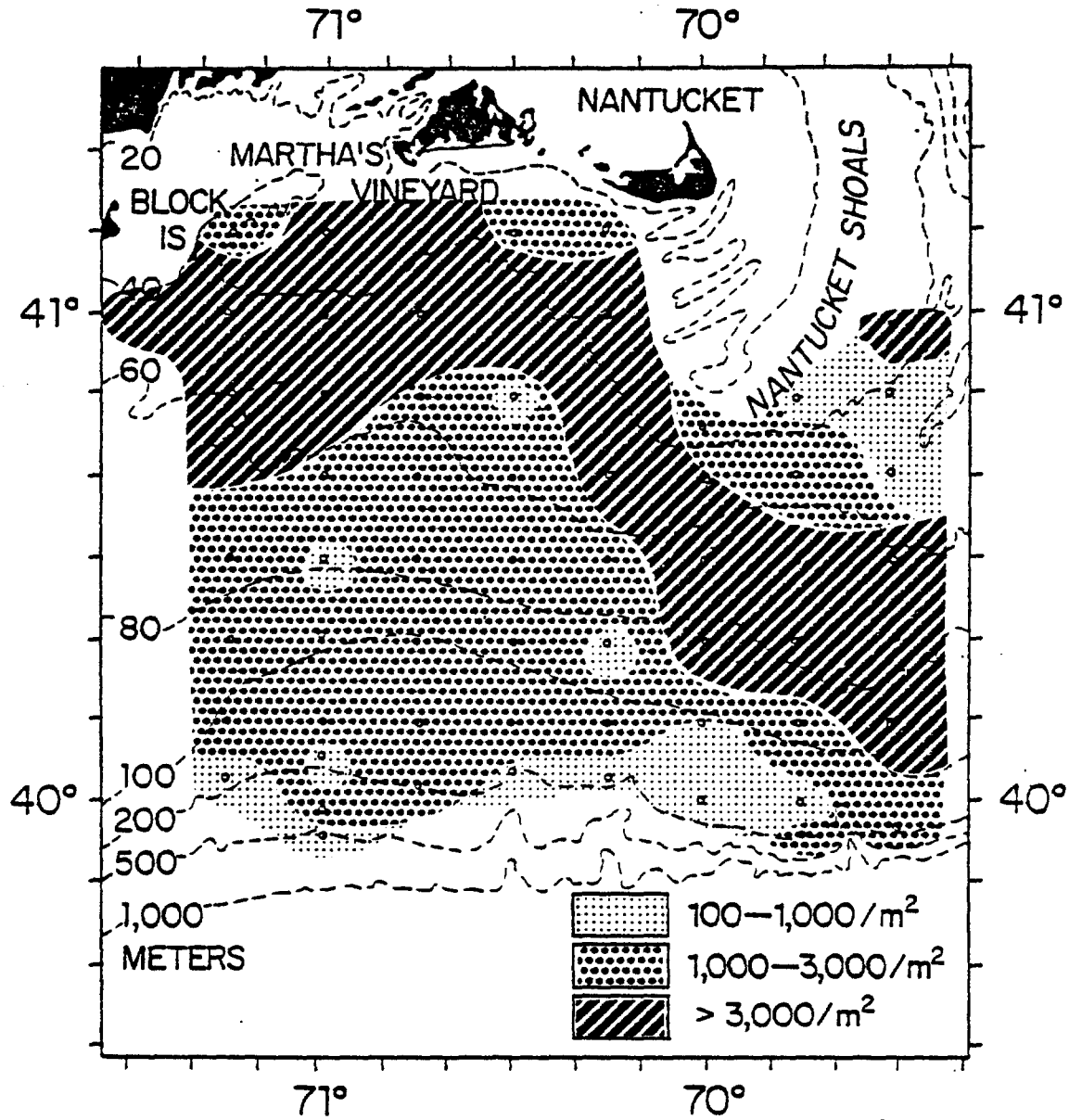


Figure 5. Quantitative distribution of individuals (no./m^2) for all taxonomic groups involved.

Table 5. Average biomass (g/m^2) of major taxa per depth range.

Water depth	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	PHORONIDEA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
n																								
0-40(n=9)																								
Total	12.00	6.40	22.80	257.10	0	23.00	1833.80	1.90	1831.90	0	105.80	2.00	5.00	82.10	16.70	70.80	0	70.70	0.10	0	68.27	0	87.96	2487.1
x	1.30	0.71	2.53	28.56	0	2.56	203.80	0.21	203.54	0	11.75	0.22	0.56	9.12	1.86	7.90	0	7.90	0.01	0	7.58	0	9.77	276.4
s	4.00	1.72	3.60	27.90	0	8.00	379.80	0.34	379.60	0	6.90	0.30	0.86	6.70	5.10	18.40	0	18.40	0.03	0	17.40	0	16.60	387.9
40-60(n=16)																								
Total	2.89	3.10	0.95	694.60	0	60.70	3574.00	29.50	3544.50	0	309.90	3.00	13.90	290.60	2.40	497.30	454.00	40.60	0.20	1.60	5.30	0	6.60	5163.3
x	0.18	0.19	0.56	43.48	0	3.79	223.38	1.84	211.50	0	19.37	0.19	0.87	18.20	0.15	31.10	28.40	2.50	0.01	0.10	0.33	0	0.41	322.7
s	0.72	0.53	0.90	93.00	0	6.20	409.48	3.70	409.60	0	21.20	0.13	1.30	20.90	0.50	113.20	113.70	5.40	0.03	0.23	1.00	0	0.86	409.8
60-80(n=13)																								
Total	0	44.30	12.60	593.10	0	21.70	3213.70	395.00	2818.70	0	176.20	2.00	9.00	153.90	11.30	466.00	362.90	12.70	20.30	70.10	4.70	10.20	66.80	4609.3
x	0	3.40	0.97	45.60	0	1.67	247.20	30.38	216.80	0	13.55	0.15	0.69	11.84	0.87	35.80	27.90	0.98	1.56	5.39	0.36	0.78	5.10	354.6
s	0	5.30	1.30	35.00	0	3.60	444.90	108.86	406.03	0	15.30	0.18	1.40	12.70	2.10	73.70	67.10	3.30	3.40	12.90	1.30	2.80	9.50	441.8
80-100(n=7)																								
Total	0	50.40	33.20	162.10	0	6.10	84.00	1.50	82.50	0	36.30	0.40	0.90	28.80	6.20	1098.55	848.95	0	167.10	82.50	0	5.30	25.00	1500.9
x	0	7.20	4.74	23.20	0	0.87	12.00	0.21	11.79	0	5.19	0.06	0.13	4.11	0.89	156.90	121.30	0	23.90	11.80	0	0.76	3.57	214.4
s	0	6.10	7.40	15.60	0	1.50	16.50	0.36	16.50	0	6.60	0.05	0.26	4.60	2.30	210.50	203.90	0	15.20	20.80	0	2.00	3.88	190.4
100-200(n=16)																								
Total	1.10	413.10	0.30	155.50	0	5.01	63.10	0.60	61.30	1.20	10.90	0.80	2.80	7.30	0	1157.21	79.80	523.03	519.38	36.00	0.10	2.00	73.60	1889.9
x	0.07	25.80	0.02	9.70	0	0.31	3.94	0.04	3.83	0.08	0.68	0.05	0.17	0.46	0	72.30	4.98	32.69	32.46	2.20	0.01	0.12	4.60	118.1
s	0.20	84.60	0.80	7.70	0	1.00	4.30	0.05	4.30	0.30	1.30	0.05	0.60	1.20	0	81.60	6.80	73.30	28.40	4.40	0.03	0.50	9.60	97.60
>200(n=2)																								
Total	0	0.30	0	0.30	0.30	13.40	3.40	0.30	3.00	0.10	0.40	0	0.10	0.30	0	13.70	2.60	0	11.10	0	0	0.10	0	31.90
x	0	0.15	0	0.15	0.15	6.70	1.70	0.15	1.50	0.05	0.20	0	0.05	0.15	0	6.85	1.30	0	5.55	0	0	0.05	0	15.95
s	0	0.20	0	0.21	0.07	9.50	0.70	0.07	0.85	0.07	0.14	0	0.07	0.07	0	4.87	1.80	0	6.70	0	0	0.07	0	7.57

Table 6. Average biomass (g/m^2) of major taxa per bottom temperature range.

Bottom water temperature °C	POLIFERA	CELENTERATA	NEMERTEA	ANNELIDA	PORIFORMORA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
6.0-6.9(n=21)																								
Total	0	22.80	7.60	624.20	0.30	41.40	3932.10	10.90	3921.10	0.10	278.60	2.90	12.80	257.10	5.80	1321.90	1170.80	0.70	48.60	101.80	0	10.30	67.00	6306.20
x	0	1.10	0.40	29.70	0.01	1.97	187.20	0.52	186.70	0.01	13.30	0.14	0.61	12.20	0.28	62.90	55.80	0.03	2.30	4.80	0	0.49	3.20	300.30
s	0	2.40	0.50	23.40	0.05	4.30	426.00	1.70	426.10	0.02	16.70	0.13	1.22	16.40	0.87	164.10	154.50	0.11	5.50	12.10	0	2.20	7.80	437.60
7.0-7.9(n=10)																								
Total	0	39.30	39.50	396.90	0	34.80	2516.15	413.90	2102.25	0	145.60	1.80	5.40	137.70	0.70	527.10	412.50	49.30	64.40	0.90	8.90	0	14.00	3722.25
x	0	3.90	3.95	39.70	0	3.48	251.60	41.40	210.20	0	14.56	0.18	0.54	13.80	0.07	52.70	41.20	4.90	6.40	0.09	0.89	0	1.40	372.20
s	0	6.30	6.30	37.30	0	4.40	395.10	123.50	334.30	0	19.60	0.19	0.97	19.00	0.16	81.90	81.10	6.90	14.70	0.25	1.80	0	2.30	367.20
8.0-8.9(n-8)																								
Total	14.89	3.10	15.60	202.70	0	12.00	979.90	0.50	979.40	0	102.00	1.70	3.10	75.60	21.60	75.81	3.50	68.30	4.01	0	52.80	0	64.20	1523.00
x	1.90	0.39	1.95	25.30	0	1.50	122.50	0.06	122.40	0	12.75	0.20	0.39	9.50	2.70	9.50	0.44	8.50	0.50	0	6.60	0	8.20	190.40
s	4.20	0.72	3.00	23.80	0	4.20	278.60	0.18	278.60	0	7.40	0.36	0.51	6.40	5.50	19.30	1.20	19.50	1.40	0	18.20	0	17.10	274.90
9.0-9.9(n=8)																								
Total	0	32.00	7.20	225.90	0	12.30	1246.20	2.70	1243.50	0	96.10	0.80	7.50	80.40	7.40						0.10	5.30	26.60	
x	0	4.00	0.90	28.24	0	1.53	155.70	0.30	155.40	0	12.00	0.10	0.93	10.10	0.93						0.01	0.66	3.30	
s	0	6.30	1.00	29.70	0	3.80	327.60	0.42	327.40	0	18.00	0.11	1.60	14.40	2.50						0.04	1.90	3.90	
10.0-10.9(n-7)																								
Total	0.80	24.70	6.60	94.10	0	8.10	29.50	0.60	28.80	0.10	5.20	0.20	2.50	2.50	0	323.60	123.00	0	192.30	8.30	0	2.00	8.80	502.80
x	0.03	3.50	0.94	13.40	0	1.20	4.20	0.10	4.10	0.01	0.74	0.03	0.36	0.36	0	46.20	17.60	0	27.47	1.20	0	0.28	1.26	71.82
s	0.08	3.70	1.30	10.10	0	1.90	5.00	0.11	5.00	0.04	1.10	0.05	0.90	0.53	0	39.90	22.90	0	26.70	3.10	0	0.76	3.30	41.60
11.0-11.9(n=7)																								
Total	0.90	371.80	3.50	63.00	0	0.61	22.80	0.10	21.60	1.10	1.90	0.50	0.20	1.20	0	605.15	12.80	322.95	242.70	26.70	0.10	0	19.40	1089.16
x	0.13	53.10	0.50	9.00	0	0.09	3.25	0.01	3.10	0.16	0.27	0.07	0.03	0.17	0	86.50	1.80	46.10	34.67	3.80	0.01	0	2.77	155.59
s	0.34	127.60	0.77	5.50	0	0.07	2.40	0.04	2.40	0.42	0.20	0.05	0.05	0.19	0	95.00	4.80	92.20	34.20	6.80	0.04	0	4.50	122.20
12.0-12.9(n-2)																								
Total	0	23.90	9.20	75.50	0	0	45.30	0.10	45.20	0	10.10	0.30	0.20	8.50	1.10	33.90	0	0	33.90	0	16.47	0	59.96	274.33
x	0	11.90	4.60	37.80	0	0	22.65	0.05	22.60	0	5.10	0.15	0.10	4.30	0.55	16.90	0	0	16.95	0	8.20	0	29.90	137.20
s	0	9.50	5.50	31.70	0	0	30.80	0.07	30.70	0	6.70	0.07	0.14	5.70	0.78	24.00	0	0	24.00	0	11.60	0	10.80	42.90

Table 7. Average biomass (g/m^2) of major taxa per sediment grain size range.

Sediment grain size	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	PHORONIDEA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
1.0-1.99 (n=7)																								
Total	2.80	9.30	11.90	174.10	0	7.60	56.30	9.00	47.30	0	92.60	0.80	7.10	83.50	1.20	244.00	8.40	177.30	59.10	0	17.87	0	79.36	692.02
X	0.41	0.76	1.60	24.87	0	1.10	8.04	1.28	6.76	0	13.20	0.11	1.00	11.90	0.17	34.90	1.20	25.30	8.40	0	2.50	0	11.30	98.90
s	1.90	1.90	3.20	22.40	0	2.90	16.30	2.90	16.80	0	9.40	0.11	1.50	8.80	0.40	92.40	3.20	66.90	22.30	0	6.20	0	10.70	84.30
2.0-2.99 (n=22)																								
Total	0.90	80.70	11.35	629.40	0	51.90	4028.65	405.50	3622.05	1.10	252.20	3.20	10.00	229.80	9.20	396.60	28.30	98.80	269.10	9.30	0.90	2.00	89.30	5551.90
X	0.04	3.70	0.52	28.60	0	2.36	183.10	18.40	164.60	0.05	11.50	0.14	0.45	10.40	0.42	18.00	1.30	4.49	11.80	0.40	0.40	0.09	4.10	252.40
s	0.19	5.90	1.00	32.90	0	4.30	387.50	83.60	359.40	0.23	16.40	0.17	1.02	15.60	1.40	29.20	3.10	12.60	27.30	1.80	1.30	0.43	8.50	392.80
3.0-3.99 (n=10)																								
Total	0	39.20	29.20	593.20	0	30.60	4579.10	12.40	4566.60	0.10	247.10	3.40	14.10	210.80	10.80	1632.60	1062.65	315.05	156.90	98.80	0.30	10.20	17.00	7178.50
X	0	2.10	1.60	31.20	0	1.61	241.00	0.65	240.30	0.005	13.00	0.18	0.74	11.50	0.57	85.90	55.90	16.60	8.26	5.20	0.02	0.54	0.89	377.80
s	0	3.80	2.10	24.00	0	3.60	409.30	2.10	408.80	0.02	18.40	0.24	1.20	17.20	1.80	174.00	160.70	57.60	14.90	13.50	0.04	2.30	1.90	403.90
4.0-4.99 (n=5)																								
Total	0.20	383.66	24.30	150.80	0.20	5.60	31.20	0.70	30.50	0	19.40	0.60	0.30	18.40	0.10	709.70	506.10	0	154.40	49.20	0	5.40	26.70	1357.16
X	0.02	42.60	2.70	16.75	0.02	0.62	3.47	0.08	3.40	0	2.15	0.07	0.03	2.04	0.01	78.90	56.20	0	17.20	5.50	0	0.60	2.90	150.80
s	0.06	112.50	6.50	15.10	0.06	1.20	3.20	0.10	3.20	0	2.40	0.05	0.05	2.30	0.03	76.00	81.00	0	13.80	12.10	0	1.80	4.70	109.10
5.0-5.99 (n=8)																								
Total	0	7.60	1.30	112.20	0.10	13.40	31.60	0.70	30.70	0.10	9.30	0.20	0.20	8.90	0	319.70	163.70	55.00	87.60	32.70	0	0	47.60	642.70
X	0	1.60	0.26	22.40	0.02	2.68	6.30	0.14	6.14	0.02	1.86	0.04	0.04	1.80	0	63.90	28.70	11.20	17.80	6.50	0	0	9.50	108.60
s	0	2.20	0.47	19.70	0.04	5.90	5.10	0.05	5.20	0.04	2.30	0.05	0.05	2.30	0	74.30	61.50	15.70	19.00	14.60	0	0	13.50	93.50

Table 8. Average biomass (g/m²) of major taxa per silt-clay [illegible]

Sediment silt-clay content	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	POGONOPHORA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
%																								
0-20 (n=31)																								
Total	3.80	70.20	37.45	989.60	0	66.40	8075.95	414.20	7660.65	1.10	463.20	6.00	26.10	413.40	17.70	541.10	24.60	294.70	212.40	9.40	22.67	10.20	140.76	10421.
x̄	0.12	2.30	1.20	31.90	0	2.10	260.60	13.40	247.10	0.03	14.90	0.19	0.84	13.30	0.57	17.50	0.79	9.50	6.90	0.30	0.73	0.32	4.60	336.
s	0.60	5.00	1.80	28.80	0	4.20	435.30	70.40	420.40	0.18	16.90	0.23	1.30	14.70	1.70	47.30	2.70	32.50	21.90	1.50	3.00	1.80	11.40	438.
20-40 (n=11)																								
Total	0	34.30	12.00	274.40	0	23.50	553.00	11.30	541.70	0	115.40	0.80	2.60	112.00	0	1110.15	611.65	257.90	207.30	33.30	4.00	2.00	41.60	2170.
x̄	0	3.10	1.10	24.90	0	2.10	50.30	1.02	49.20	0	10.50	0.07	0.24	10.20	0	100.93	55.60	23.40	18.80	3.02	0.36	0.18	3.80	197.
s	0	4.60	2.60	31.80	0	3.50	139.20	3.20	139.40	0	19.40	0.06	0.40	19.20	0	190.20	168.30	75.70	24.70	9.60	1.20	0.60	5.40	204.
40-60 (n=9)																								
Total	0	366.80	22.60	157.60	0.20	8.30	38.40	1.50	36.80	0.10	15.70	0.70	2.50	9.00	3.50	837.05	638.60	38.45	92.90	67.10	0.10	0.10	3.30	1442.
x̄	0	40.80	2.50	17.50	0.02	0.03	4.30	0.16	4.10	0.01	1.70	0.08	0.28	1.00	0.39	93.00	70.90	4.30	10.30	7.50	0.01	0.01	0.48	160.
s	0	113.10	6.60	11.10	0.07	0.03	5.30	0.30	5.00	0.03	1.90	0.08	0.80	1.10	1.20	149.20	155.10	12.80	11.90	16.80	0.03	0.01	1.10	168.
60-80 (n=5)																								
Total	0.20	24.90	2.30	106.90	0.10	15.20	24.80	0.50	24.20	0.10	9.90	0.30	0.40	9.10	0.10	388.80	302.80	0	76.90	10.10	0	5.30	21.10	559.
x̄	0.04	4.90	0.46	21.40	0.02	3.00	4.96	0.10	4.80	0.02	2.00	0.06	0.08	1.80	0.02	77.76	60.60	0	15.20	2.02	0	1.10	4.20	119.
s	0.08	7.20	0.86	18.40	0.04	6.80	3.40	0.10	3.40	0.04	2.60	0.05	0.04	2.50	0.04	83.90	85.90	0	14.30	4.50	0	2.40	8.80	83.
80-100 (n=6)																								
Total	0	20.30	3.30	131.20	0	3.70	34.60	0.80	33.70	0	16.40	0.40	0.10	15.90	0	462.66	207.90	55.88	129.68	69.20	0	0	63.20	725.
x̄	0	3.40	0.60	21.90	0	0.62	5.80	0.13	5.60	0	2.70	0.07	0.02	2.70	0	77.10	34.70	9.30	21.60	11.50	0	0	8.90	120.
s	0	3.10	0.83	17.90	0	1.50	4.90	0.10	4.90	0	2.50	0.05	0.04	2.40	0	63.40	57.40	14.80	19.70	17.90	0	0	12.20	79.

Table 9. Average density (no./m^2) of major taxa per depth range.

Water depth	PORIFERA	COELENTERATA	ACHAETEA	ANNELIDA	PHORONIDEA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
n																								
0-40 (n=9)																								
Total	11	21	94	6552	0	90	323	62	261	0	18752	808	409	17473	62	222	0	212	10	0	1984	0	957	29006
x̄	1.2	2.3	10.4	728.0	0	10.0	35.9	6.9	29.0	0	2083.6	89.8	45.4	1941.4	6.9	24.7	0	23.6	1.1	0	220.4	0	106.3	3222.9
s	3.7	4.6	10.1	391.0	0	16.9	31.5	8.9	25.5	0	1743.4	191.4	68.8	1766.3	9.0	43.1	0	39.1	3.3	0	641.9	0	175.6	1866.4
40-60 (n=16)																								
Total	11	83	205	11537	0	203	2597	703	1894	0	34656	1128	537	32948	43	726	10	660	20	56	41	0	135	50194
x̄	0.7	5.2	12.8	721.1	0	12.7	162.3	43.9	118.4	0	2166.0	70.5	33.6	2059.3	2.7	45.4	0.6	40.0	1.3	3.5	2.6	0	8.4	3137.1
s	2.8	8.6	9.9	444.6	0	20.0	201.0	85.7	180.7	0	1628.5	77.7	29.7	1577.7	6.2	106.0	2.5	102.9	3.4	8.5	4.6	0	15.1	1879.2
60-80 (n=13)																								
Total	0	320	157	10308	0	127	2870	371	2499	0	51385	405	107	50802	71	662	112	146	333	71	11	51	674	66565
x̄	0	24.6	12.1	792.9	0	9.8	220.8	28.5	192.2	0	3952.7	31.2	8.2	3907.8	5.5	50.9	8.6	11.2	25.6	5.5	0.8	3.9	51.8	5120.4
s	0	37.8	7.1	403.1	0	12.2	167.6	31.7	171.2	0	5713.7	26.0	10.6	5696.0	7.9	50.0	17.0	37.3	42.4	9.8	3.1	14.1	98.9	5888.7
80-100 (n=7)																								
Total	0	169	195	3193	0	129	3025	456	2569	0	12646	81	68	12486	11	4485	524	0	3941	20	0	30	227	24099
x̄	0	24.1	27.9	456.1	0	18.4	432.1	65.1	367.0	0	1806.6	11.6	9.7	1783.7	1.6	640.7	74.9	0	563.0	2.9	0	4.3	32.4	3442.7
s	0	16.7	15.9	230.9	0	21.2	319.7	149.8	209.2	0	3299.3	13.2	13.6	3287.8	4.2	309.6	63.2	0	296.5	4.9	0	11.3	31.3	3319.9
100-200(n=16)																								
Total	21	584	111	5743	0	401	2334	90	2191	53	1111	102	61	948	0	7021	120	833	5998	70	0	10	576	17912
x̄	1.3	36.5	6.9	358.9	0	25.1	145.9	5.6	136.9	3.3	69.4	6.4	3.8	59.3	0	438.8	7.5	52.1	374.9	4.4	0	0.6	36.0	1119.5
s	3.6	38.1	6.1	289.1	0	30.8	134.9	8.9	129.4	10.9	60.8	7.3	6.3	68.6	0	367.5	10.6	193.7	226.3	8.1	0	2.6	64.5	499.5
>200 (n=2)																								
Total	0	20	0	1235	87	197	121	35	71	15	35	0	10	25	0	55	10	0	45	0	0	10	0	1760
x̄	0	10.0	0	617.5	43.5	98.5	60.5	17.5	35.5	7.5	17.5	0	5.0	12.5	0	27.5	5.0	0	22.5	0	0	5.0	0	880.0
s	0	14.1	0	262.3	10.6	139.3	43.1	10.6	21.9	10.6	10.6	0	7.1	3.5	0	10.6	7.1	0	3.5	0	0	7.1	0	483.7

Table 10. Average density (no./m^2) of major taxa per bottom temperature range.

Bottom water temperature °C	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	POGONOPHORA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
6.0-6.9 (n=21)																								
Total	0	152	231	14648	87	409	3721	888	2818	15	44673	929	301	43321	42	1371	266	46	963	96	0	61	696	66049
$\bar{x}$	0	7.2	11.0	697.5	4.1	19.5	177.2	42.3	134.2	0.7	2127.3	44.2	18.1	2062.9	2.0	65.3	12.7	2.2	45.9	4.6	0	2.9	33.1	3145.2
s	0	10.5	8.3	366.2	13.3	45.1	166.3	76.8	152.6	3.3	2250.1	71.7	29.5	2222.8	5.4	185.8	43.6	4.8	142.7	7.8	0	11.2	80.8	2325.0
7.0-7.9 (n=10)																								
Total	0	267	203	7712	0	186	2077	217	1860	0	31757	536	212	30969	40	2281	238	730	1293	20	20	0	137	44640
$\bar{x}$	0	26.7	20.3	771.2	0	18.6	207.7	21.7	186.0	0	3175.7	53.6	21.2	3096.9	4.0	228.1	23.8	73.0	129.3	2.0	2.0	0	13.7	4464.0
s	0	42.1	8.6	478.1	0	13.5	234.5	21.3	232.9	0	5736.6	39.4	18.6	5722.9	7.0	332.1	37.1	128.5	316.8	4.2	4.2	0	13.9	5956.8
8.0-8.9 (n=8)																								
Total	22	52	99	5573	0	69	716	11	705	0	21826	766	202	20815	43	408	36	173	199	0	1954	0	405	31124
$\bar{x}$	2.8	6.5	12.4	696.6	0	8.6	89.5	1.4	88.1	0	2728.3	95.8	25.3	2601.9	5.4	51.0	4.5	21.6	24.9	0	244.3	0	50.6	3890.5
s	5.1	11.0	21.0	368.7	0	17.5	143.2	3.9	144.0	0	3025.1	203.4	16.6	3072.1	8.0	83.6	12.7	42.6	66.4	0	682.0	0	69.4	3310.7
9.0-9.9 (n=8)																								
Total	0	163	122	3760	0	42	2011	127	1884	0	17957	145	304	17456	52	3482	105	831	2515	31	10	30	276	27861
$\bar{x}$	0	20.4	15.3	471.0	0	5.3	251.4	15.9	235.5	0	2244.6	18.1	38.0	2182.0	6.5	435.3	13.1	103.9	314.4	3.9	1.3	3.8	34.5	3482.6
s	0	22.2	7.4	479.0	0	7.9	228.7	10.6	223.3	0	3822.4	25.4	75.2	3797.4	9.6	566.3	19.4	272.5	364.1	7.8	3.5	10.6	32.9	3872.4
10.0-10.9 (n=7)																								
Total	10	220	50	3612	0	219	1940	434	1496	10	528	40	20	468	0	2327	121	0	2196	10	0	10	15	8931
$\bar{x}$	1.4	31.4	7.1	516.0	0	31.3	277.1	62.0	213.7	1.4	75.4	5.7	2.9	66.9	0	332.4	17.3	0	313.7	1.4	0	1.4	2.1	1275.9
s	3.8	27.3	7.6	325.8	0	25.9	344.2	150.9	203.6	3.8	53.0	9.8	4.9	47.3	0	227.5	24.0	0	217.5	3.8	0	3.8	5.7	545.7
11.0-11.9 (n=7)																								
Total	11	267	51	1994	0	222	693	20	630	43	468	62	31	375	0	2872	10	45	2757	60	10	0	168	6756
$\bar{x}$	1.6	38.1	7.3	284.9	0	31.7	99.0	2.9	90.0	6.1	66.9	8.9	4.4	53.6	0	410.3	1.4	6.4	393.9	8.6	1.4	0	24.0	965.1
s	4.2	48.4	7.6	194.8	0	36.4	49.4	7.6	42.6	16.3	71.7	7.0	8.0	72.4	0	216.7	3.8	6.3	215.7	10.7	3.8	0	40.7	306.0
12.0-12.9 (n=2)																								
Total	0	96	31	1261	0	0	112	20	92	0	1376	46	42	1278	10	446	0	22	424	0	31	0	874	4227
$\bar{x}$	0	48.0	15.5	630.5	0	0	56.0	10.0	46.0	0	688.0	23.0	21.0	639.0	5.0	223.0	0	11.0	212.0	0	15.5	0	437.0	2113.5
s	0	39.6	7.8	334.5	0	0	36.8	4.1	22.6	0	902.3	18.4	29.7	847.1	7.1	284.3	0	15.6	299.8	0	21.9	0	147.1	1126.4

Table 11. Average density (no./m^2) of major taxa per sediment grain size range.

Sediment grain size	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	POGONOPHORA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
1.0-1.99 (n=7)																								
Total	11	32	41	4271	0	53	379	123	256	0	19213	157	278	18757	21	416	40	58	318	0	42	0	786	25244
$\bar{x}$	1.6	4.6	5.9	610.1	0	7.6	54.1	17.6	36.6	0	2747.7	22.4	39.7	2679.6	3.0	59.4	5.7	8.3	45.4	0	6.0	0	112.3	3606.3
s	4.2	8.1	8.2	391.8	0	20.0	46.0	17.7	43.3	0	2326.7	24.5	36.1	2315.6	5.1	136.3	15.1	8.8	120.2	0	11.8	0	192.6	2534.6
2.0-2.99 (n=22)																								
Total	11	594	283	14485	0	371	2656	241	2372	43	52413	1026	352	50962	73	3605	76	704	2779	46	42	10	1199	75669
$\bar{x}$	0.5	27.0	12.9	658.4	0	16.9	120.7	11.0	107.8	2.0	2382.4	46.6	16.0	2316.5	3.3	163.9	3.5	32.0	126.3	2.1	1.9	0.4	54.5	3439.5
s	2.3	44.1	14.1	443.9	0	22.4	130.3	19.8	124.2	9.2	4296.8	69.6	19.0	4272.3	5.9	196.0	8.3	88.8	194.4	4.7	4.2	2.1	105.1	4525.0
3.0-3.99 (n=19)																								
Total	0	258	281	13618	0	317	4959	681	4268	10	41935	1174	482	40227	52	3726	332	271	3022	101	30	51	184	65359
$\bar{x}$	0	13.6	14.8	716.7	0	16.7	261.0	35.8	224.6	0.5	2207.1	61.8	25.4	2117.2	2.7	196.1	17.5	14.3	159.1	5.3	1.6	2.7	9.7	3440.0
s	0	15.7	7.4	347.2	0	18.8	209.2	80.7	206.9	2.3	3038.7	134.7	50.9	3038.9	6.8	332.3	48.3	38.9	303.4	8.5	3.7	11.7	18.3	3076.1
4.0-4.99 (n=9)																								
Total	10	226	110	2559	36	209	2073	495	1578	0	2768	137	60	2551	20	2910	283	10	2587	30	0	40	203	11144
$\bar{x}$	1.1	25.1	12.2	284.3	4.0	23.2	230.3	55.0	175.3	0	307.6	15.2	6.7	283.4	2.2	323.3	31.4	1.1	287.4	3.3	0	4.4	22.6	1238.2
s	3.3	14.8	10.9	120.3	12.0	32.0	326.1	132.1	207.8	0	483.3	14.9	11.2	469.6	6.7	260.3	35.0	3.3	251.0	5.0	0	10.1	34.7	589.0
5.0-5.99 (n=5)																								
Total	0	96	20	2490	51	197	1181	166	1000	15	1064	30	20	1014	0	2514	45	788	1641	40	0	0	208	7821
$\bar{x}$	0	19.2	4.0	498.0	10.2	39.4	236.2	33.2	200.0	3.0	212.8	6.0	4.0	202.8	0	502.8	9.0	157.6	328.2	8.0	0	0	41.6	1564.2
s	0	19.3	5.5	446.1	22.8	88.1	198.3	27.7	204.3	6.7	340.9	8.9	5.5	345.6	0	679.6	8.9	346.8	395.3	13.0	0	0	44.1	731.4

Table 12. Average density (no./m^2) of major taxa per silt-clay % range.

Sediment silt-clay content	PORIFERA	COELENTERATA	NEMERTEA	ANNELIDA	POGONOPHORA	SIPUNCULIDA	MOLLUSCA	Gastropoda	Bivalvia	Scaphopoda	CRUSTACEA	Cumacea	Isopoda	Amphipoda	Decapoda	ECHINODERMATA	Holothuroidea	Echinoidea	Ophiuroidea	Asteroidea	ECTOPROCTA	ENTEROPNEUSTA	ASCIDIACEA	TOTAL
%																								
0-20 (n=31)																								
Total	22	581	428	22855	0	438	3566	401	3122	43	99296	1984	1036	96140	136	2746	117	988	1574	67	94	51	1560	131637
$\bar{x}$	0.7	18.7	13.8	737.3	0	14.1	115.0	12.9	100.7	1.4	3203.1	64.0	33.4	3101.3	4.4	88.6	3.8	31.9	50.8	2.2	3.0	1.6	50.3	4246.4
s	2.7	36.8	12.6	424.3	0	19.9	143.6	17.4	141.6	7.7	4088.7	115.8	42.9	4089.4	7.0	142.6	10.8	79.2	126.7	5.3	6.7	9.2	114.2	4298.5
20-40 (n=11)																								
Total	0	165	133	5662	0	231	2525	148	2377	0	11973	282	46	11645	0	3885	311	25	3509	40	10	10	548	25142
$\bar{x}$	0	15.0	12.1	514.7	0	21.0	229.8	13.5	216.1	0	1088.5	25.6	4.2	1058.6	0	353.2	28.3	2.3	319.0	3.6	0.9	0.9	49.8	2285.6
s	0	23.5	9.8	297.4	0	20.9	163.6	18.7	157.1	0	1459.7	40.3	5.9	1429.6	0	373.7	61.7	5.2	334.0	5.0	3.0	3.0	107.2	1639.4
40-60 (n=9)																								
Total	0	178	105	4648	36	90	1985	506	1469	10	2497	103	30	2354	10	1763	111	30	1572	50	10	10	61	11383
$\bar{x}$	0	19.8	11.7	516.4	4.0	10.0	220.6	56.2	163.2	1.1	277.4	11.4	3.3	261.6	1.1	195.9	12.3	3.3	174.7	5.6	1.1	1.1	6.8	1264.8
s	0	19.3	10.9	348.5	12.0	20.5	245.4	116.2	227.7	3.3	494.8	16.4	7.1	495.4	3.3	245.9	29.8	5.0	238.4	10.1	3.3	3.3	20.3	737.1
60-80 (n=5)																								
Total	10	146	60	2010	51	348	1001	106	880	15	1064	65	70	909	20	1692	131	0	1551	10	0	30	122	6534
$\bar{x}$	2.0	29.2	12.0	402.0	10.2	69.6	200.2	21.2	176.0	3.0	212.8	13.0	14.0	181.8	4.0	338.4	26.2	0	310.2	2.0	0	6.0	24.4	1306.8
s	4.5	15.8	8.4	231.3	22.8	80.1	132.7	21.7	135.7	6.7	359.6	14.8	11.4	339.7	8.9	308.3	22.5	0	303.9	4.5	0	13.4	34.2	294.2
80-100 (n=6)																								
Total	0	136	50	2248	0	40	2171	545	1626	0	2563	90	10	2463	0	3085	106	788	2141	50	0	0	289	10582
$\bar{x}$	0	22.7	8.3	374.7	0	6.7	361.8	90.8	271.0	0	427.2	15.0	1.7	410.5	0	514.2	17.7	131.3	356.8	8.3	0	0	48.2	1763.0
s	0	18.1	7.6	381.6	0	16.3	376.8	256.0	252.3	0	557.4	15.2	4.1	550.4	0	609.4	27.5	316.8	361.8	11.7	0	0	42.6	668.8

Crustacea

The Crustacea which accounted for 4.1% of the biomass and 62.5% of the density of the fauna contained four orders distributed as follows: Decapoda (5.7% and 0.2%), Cumacea (1.3% and 2.1%), Isopoda (5.0% and 1.0%), Amphipoda (88% and 96.7%). Medium biomass (1.0-50 g/m^2) and scattered cases of high biomass (>50 g/m^2) occurred over two-thirds of the area (Figure 6). Low biomass (0.1-1.0 g/m^2) occurred along the southern and southwestern edge. The boundary between medium and low biomass was very sharp. The biomass and density pattern of Crustacea were mainly influenced by the distribution of amphipods.

In terms of density the pattern for Crustacea was generally similar to biomass with a few differences. The boundary between high (>1000/m^2) and medium (200-999/m^2) densities and low density (10-199/m^2) was not as sharp and clusters of various densities were more scattered than with biomass (Figure 7). Since the amphipods dominated the distribution of the crustaceans, discussion of average biomass and density of the crustaceans will be treated later with the amphipods.

Decapoda

Within the Crustacea the Decapoda comprised 5.7% of the biomass and 0.2% of the density. Crangon septemspinosa, Pagurus pubescens, Cancer spp., and Pandalus spp. were characteristic species. Decapods were mainly collected in low to medium (0.1-49 g/m^2) biomass and low density (10-25/m^2) from the northern and eastern portions of the area (Figures 8-9).

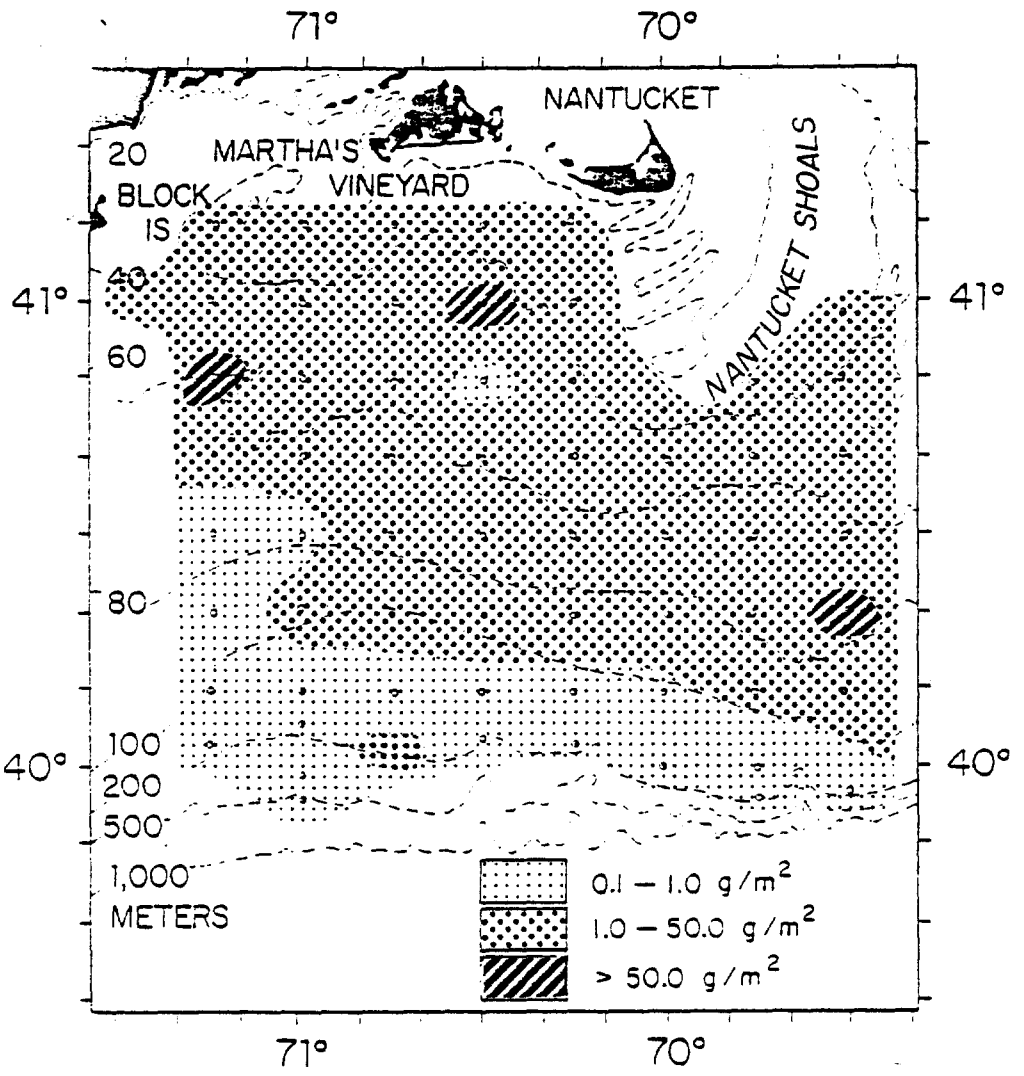


Figure 6. Quantitative distribution of biomass (g/m^2) for Crustacea.

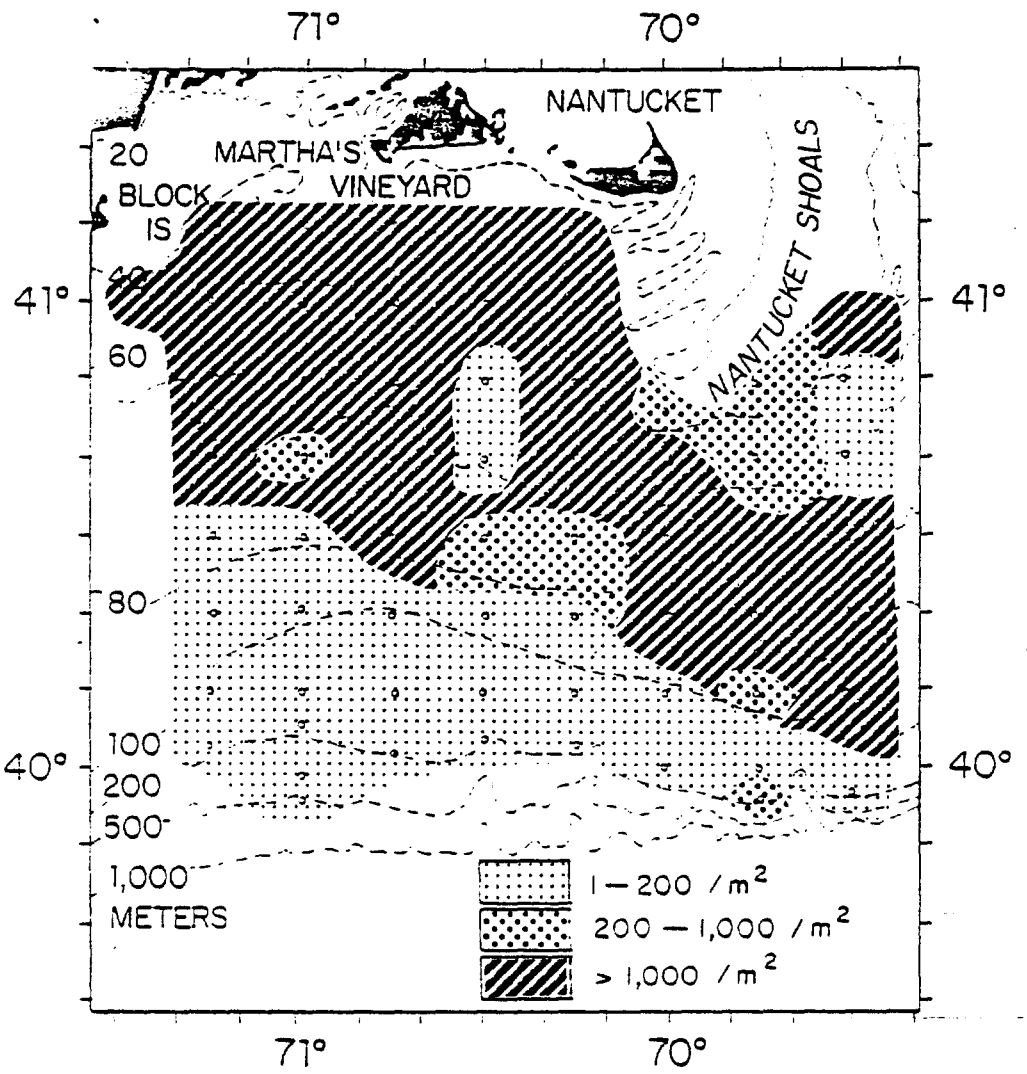


Figure 7. Quantitative distribution of individuals (no./m^2) for Crustacea.

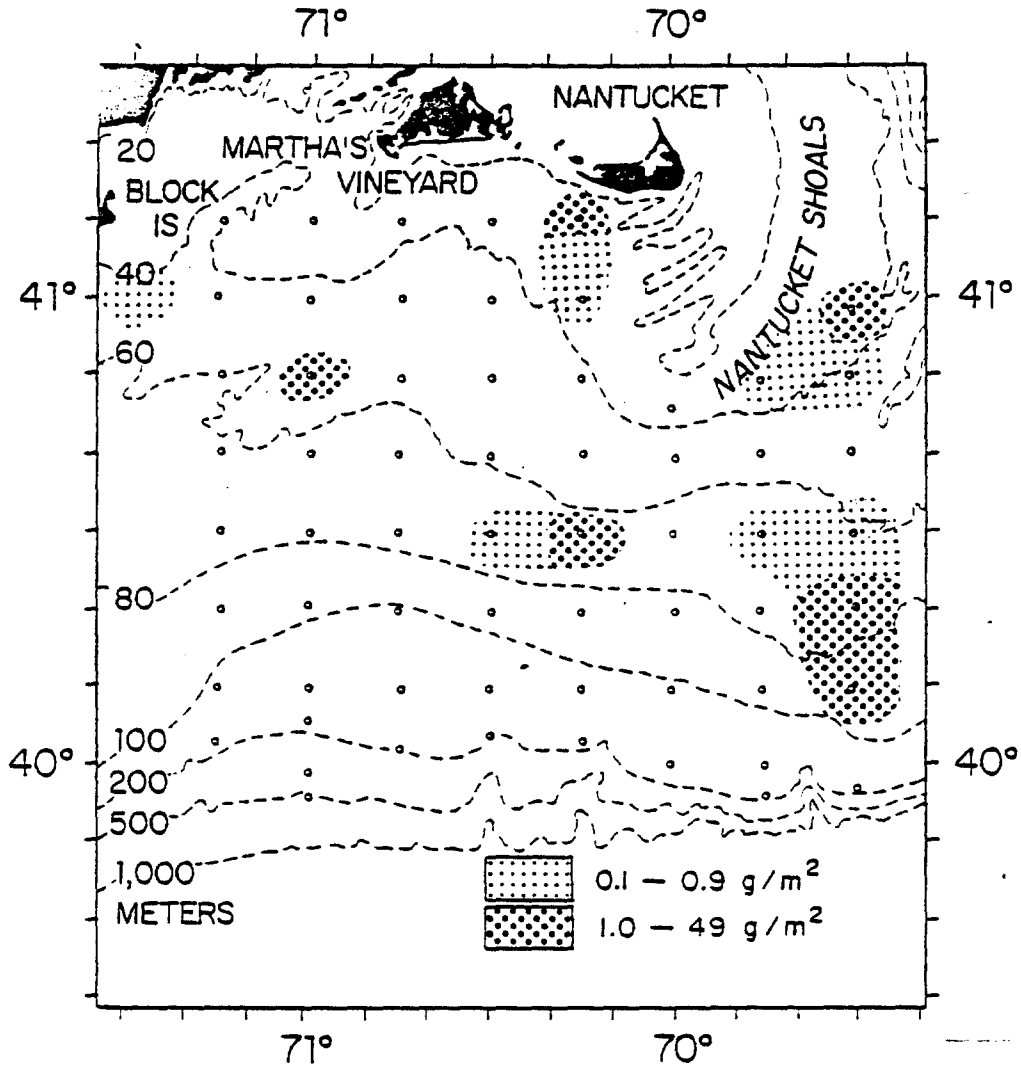


Figure 8. Quantitative distribution of biomass (g/m^2) for Decapoda.

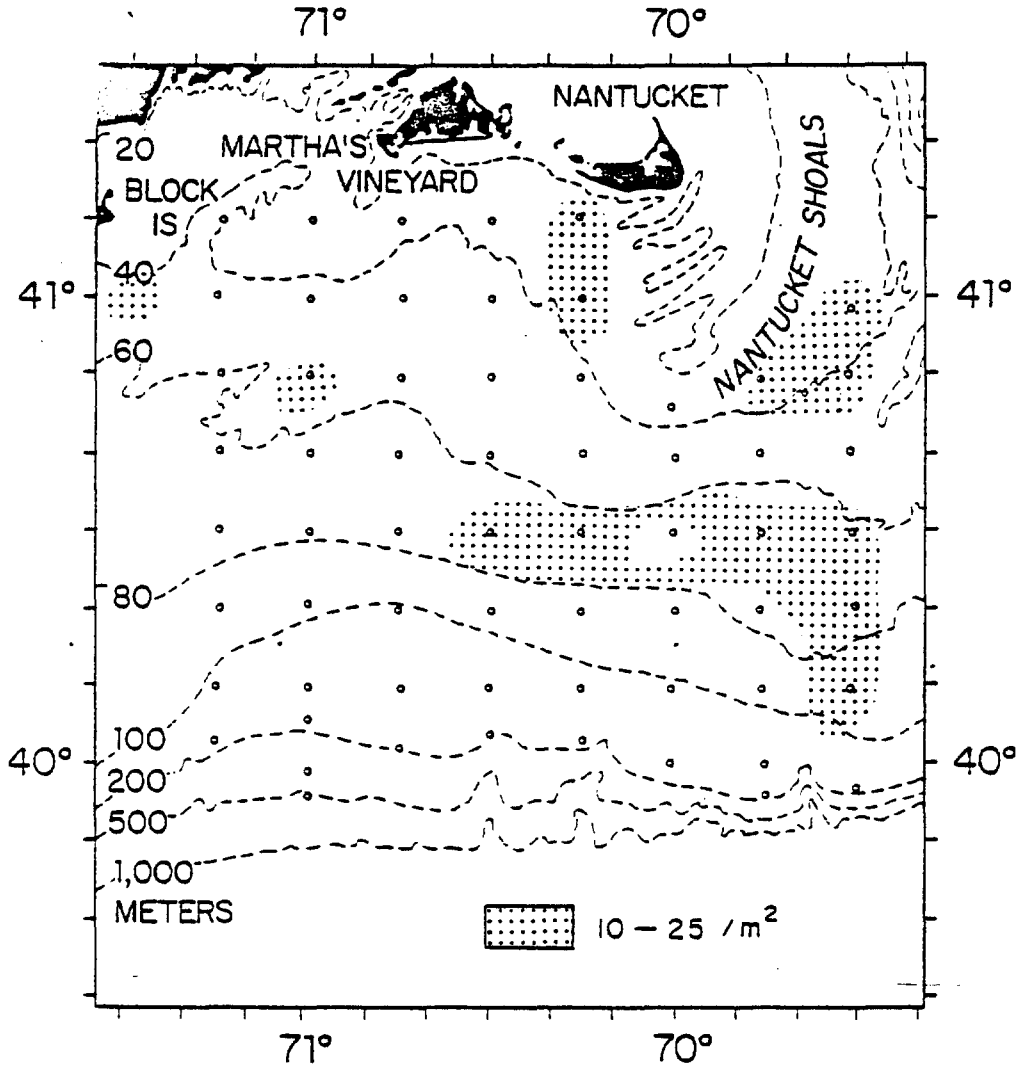


Figure 9. Quantitative distribution of individuals (no./m^2) for Decapoda.

An example of a species that occurred throughout the area was C. septemspinosa. In contrast some other decapod species were limited to the deeper stations. This group included: Hyas sp., Euprognatha sp., Munida sp., and Geryon sp.

The highest average biomass and density of decapods was recorded (Tables 5-12) from 0-40 m (1.8 g/m^2 and $6.9/m^2$), 8.0-8.9 °C (2.7 g/m^2) and 9.0-9.9 °C ($6.5/m^2$), 3.0-3.99 ϕ (0.57 g/m^2) and 2.0-2.99 ϕ ($3.3/m^2$), and 0-20% silt-clay (0.57 g/m^2 and $4.4/m^2$). However, the biomass of decapods occurred mainly from 0-100 m, 6.0-6.9 °C, 1.0-3.99 ϕ, and 0-20 and 40-60% silt-clay. Density was similar except that it encompassed 1.0-4.99 ϕ and 40-80% silt-clay.

Cumacea

Within the Crustacea cumaceans comprised 1.3% of the biomass and 2.1% of the density. Diastylis polita, D. quadrispinosa, Eudorella emarginata, Leptostylis sp., Eudorellopsis sp., and Leptocuma sp. were representative species. Cumaceans occurred widely and were relatively evenly distributed in terms of biomass (0.1-1.0 g/m^2) and density (10->400/m^2). They were not commonly sampled in the southwest portion of the study area (Figures 10-11).

The highest average biomass and density of cumaceans was reported (Tables 5-12) in 0-40 m (0.22 g/m^2 and 89.8 g/m^2), 8.0-8.9 °C (0.2 g/m^2 and $95.8/m^2$), 3.0-3.99 ϕ (0.18 g/m^2 and $61.8/m^2$) and 0-20% silt-clay (0.19 g/m^2 and $64/m^2$). However, the principal distribution of biomass was sampled in 0-80 m, 6.0-9.9 °C, 1.0-3.99 ϕ and 0-20% silt-clay. The main density pattern was similar to biomass.

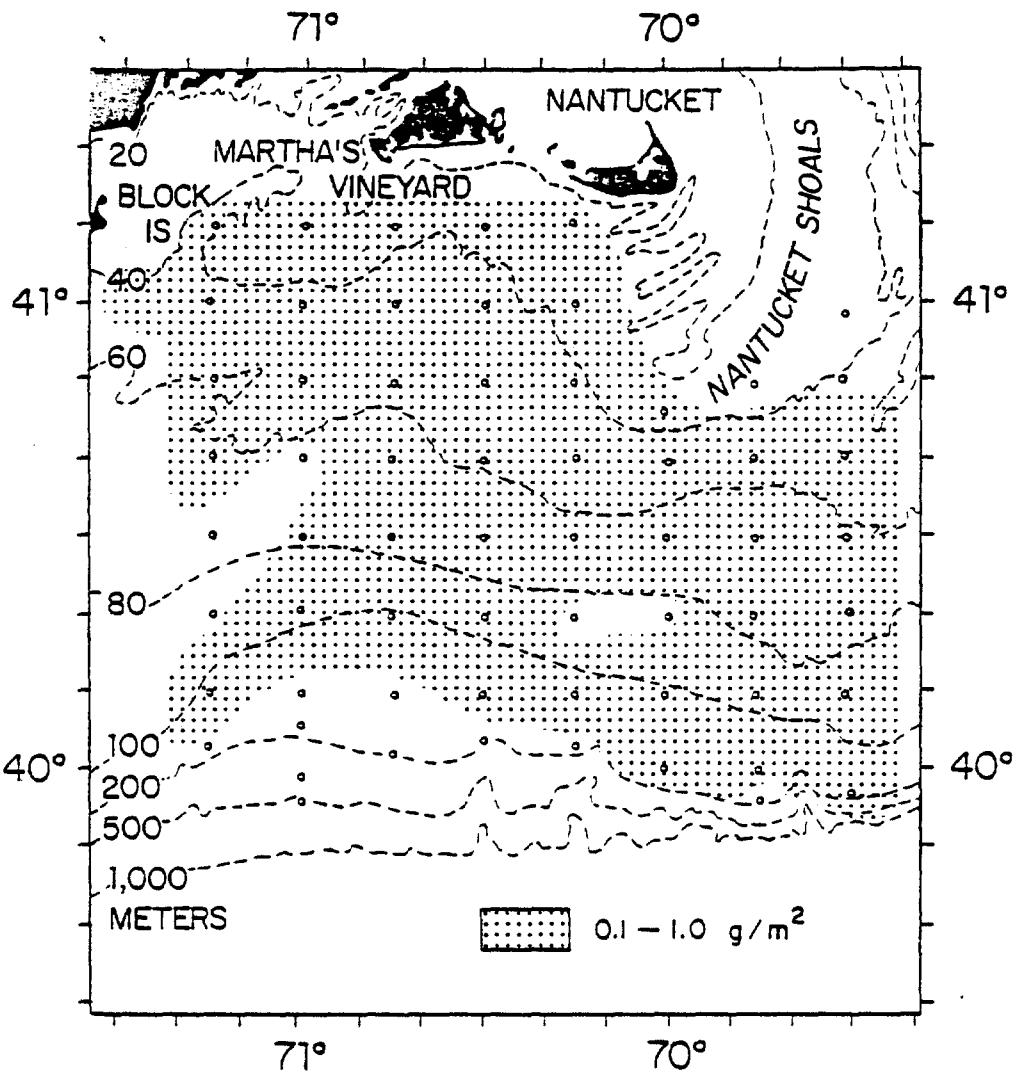


Figure 10. Quantitative distribution of biomass (g/m^2) for Cumacea.

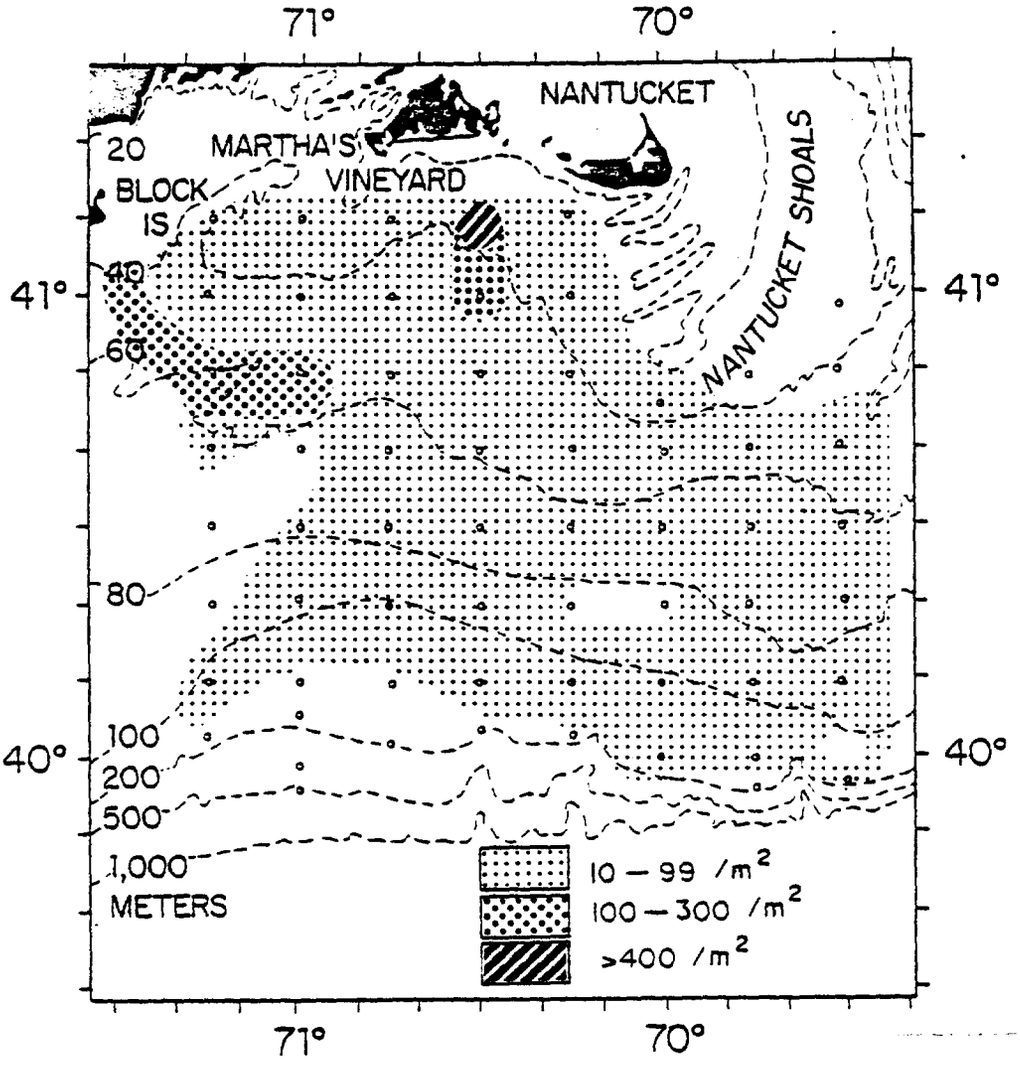


Figure 11. Quantitative distribution of individuals (no./m^2) for Cumacea.

Isopoda

Within the Crustacea isopods comprised 5.0% of the biomass and 1.0% of the density. Cirolana polita, Chiridotea tuftsi, Ptilanthura tenuis, Edotea triloba and Calathura sp. were characteristic species. Isopods occurred in alternating bands of low (0.1-0.9 g/m^2) and medium (1.0-10 g/m^2) biomass mainly in the shallow half of the area. However, isopods also ranged into the deeper half along the east side and occurred in clusters in the deeper half (Figures 12-13). In general, density was low (10-99/m^2).

The highest average biomass and density of isopods were collected (Tables 5-12) from 40-60 m (0.87 g/m^2) and 0-40 m (45.4/m^2), 9.0-9.9 °C (0.93 g/m^2 and 38/m^2), 1.0-1.99 ϕ (1.0 g/m^2 and 39.7/m^2) and 0-20% silt-clay (0.84 g/m^2 and 33.4/m^2. However, the principal distribution of biomass ranged from 0-80 m, 6.0-9.9 °C, 1.0-3.99 ϕ and 0-20% silt-clay (Tables 5-12). Cirolana polita was a good example of a shallow water, clean sand dweller.

Amphipoda

The distribution of biomass and density for the Crustacea was dominated by the amphipods. Amphipoda comprised 88.0% of the biomass and 96.7% of the density within the Crustacea. Leptocheirus pinguis, Unciola irrorata, Caprella spp., Corophium spp., ampelescids including Ampelisca compressa, A. macrocephala, Byblis serrata; phoxocephalids, photids and haustoriids were characteristic taxa. Most of the area contained medium biomass (1.0-49 g/m^2) of amphipods. There was a sharp break in biomass and density along the 100 m contour (Figures 14-15). The highest density (18,992/m^2) of macrobenthos collected for the area involved amphipods (Table 4, Figure 15) which were particularly well developed in the east central portion directly south of Nantucket Shoals.

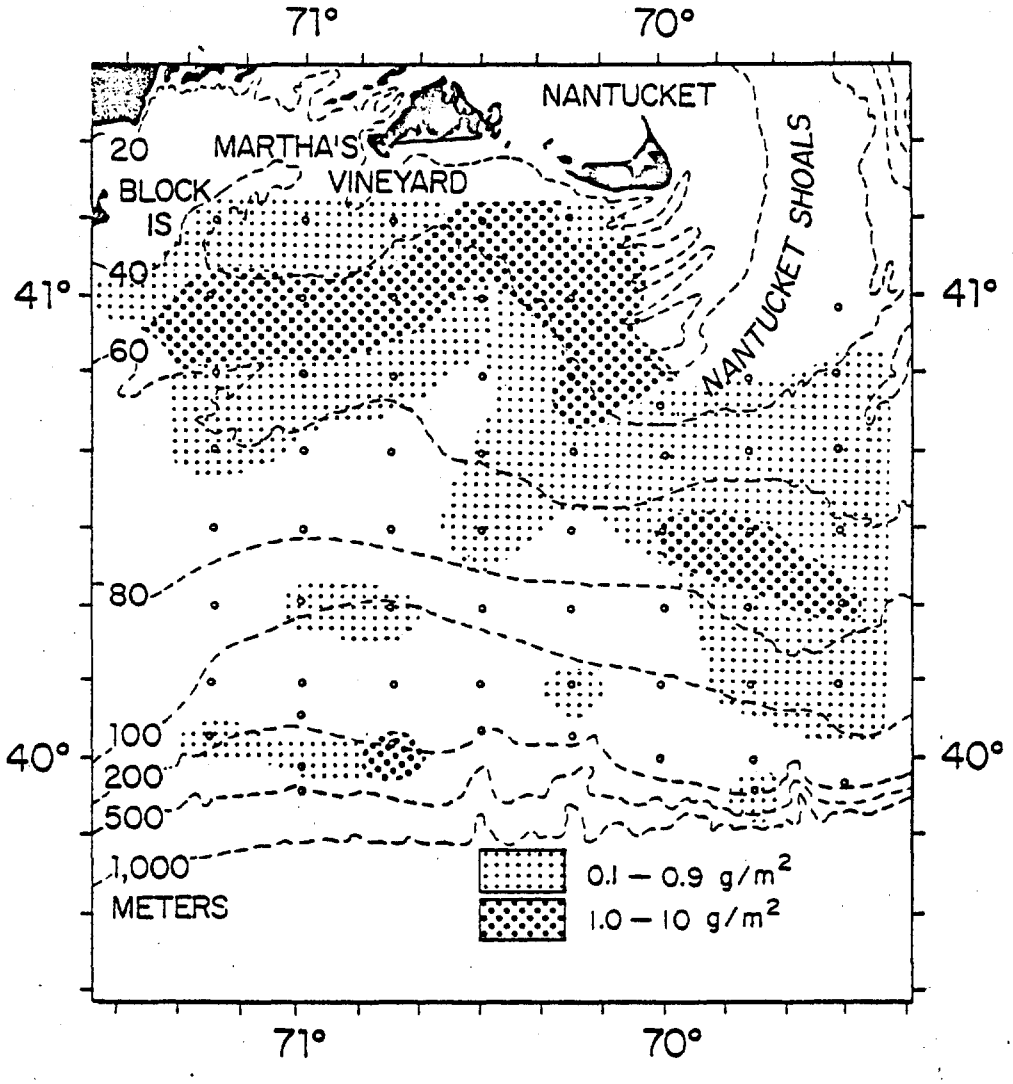


Figure 12. Quantitative distribution of biomass (g/m^2) for Isopoda.

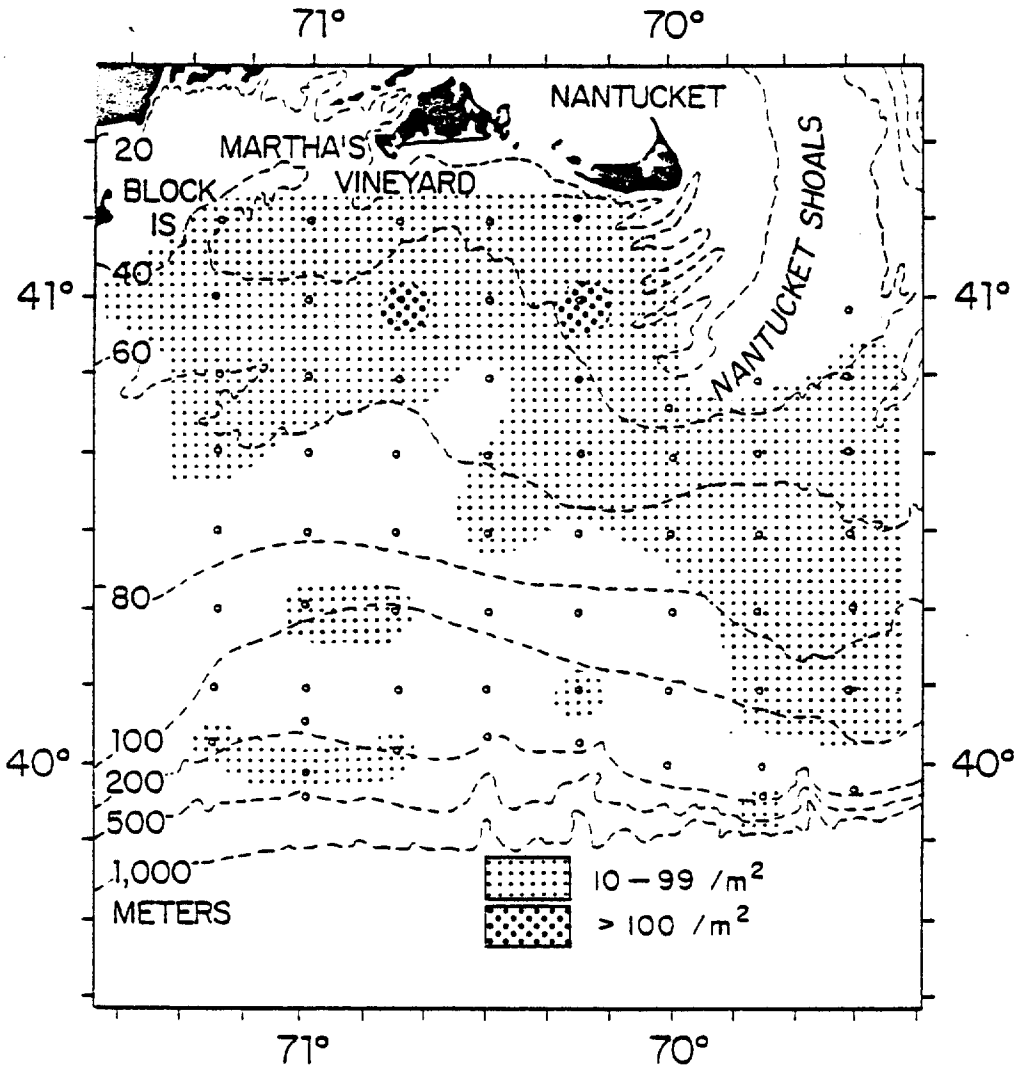


Figure 13. Quantitative distribution of individuals (no./m^2) for Isopoda.

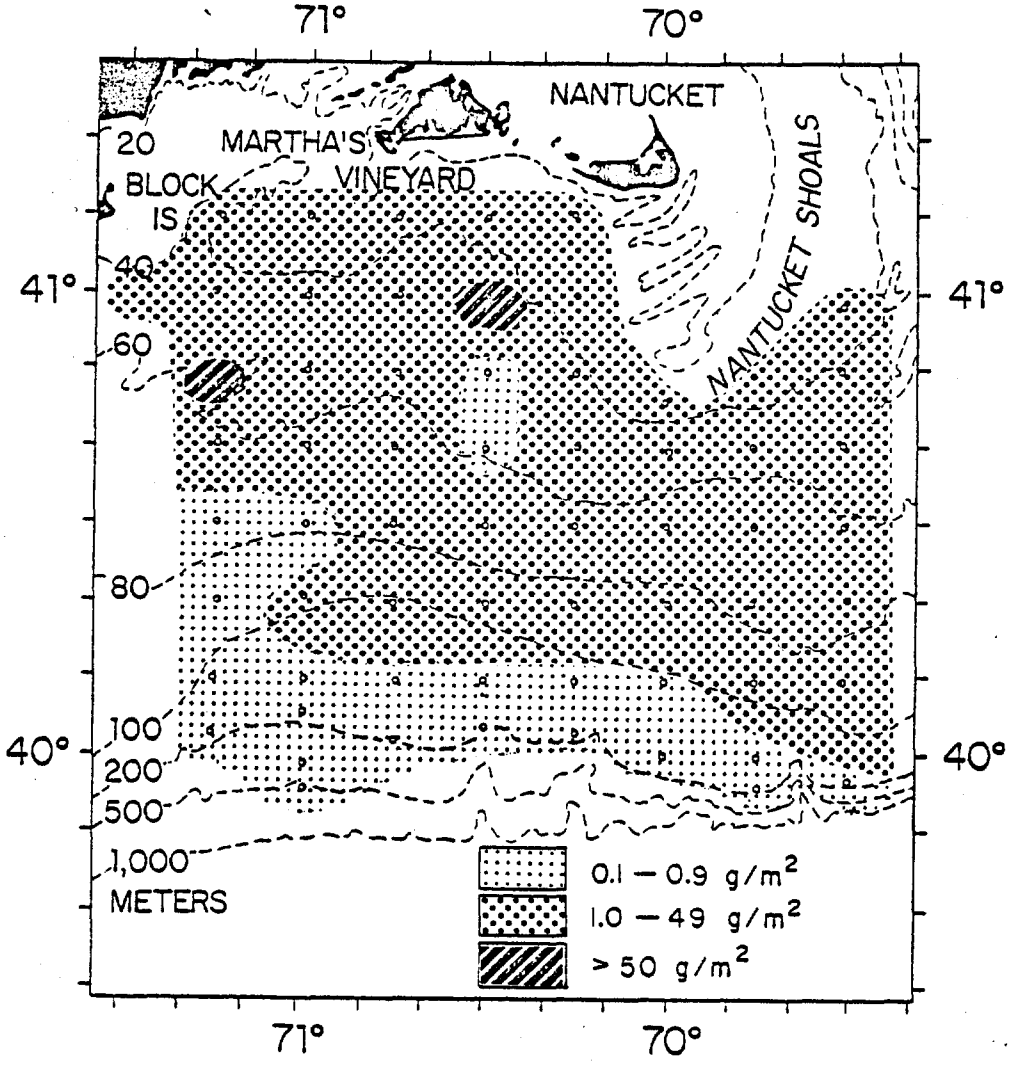


Figure 14. Quantitative distribution of biomass (g/m^2) for Amphipoda.

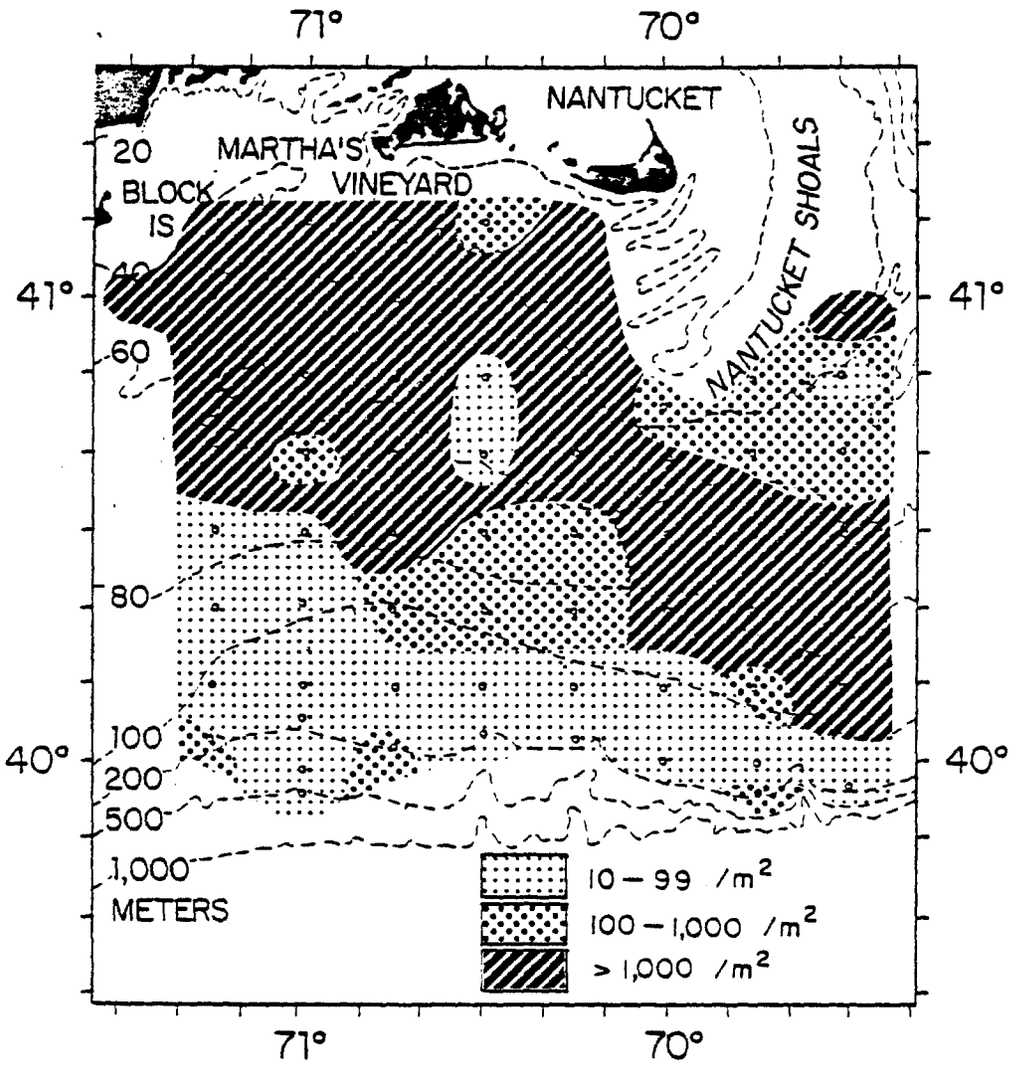


Figure 15. Quantitative distribution of individuals (no./m^2) for Amphipoda.

The highest average biomass and density of amphipods (Crustacea) were distributed (Tables 5-12) as follows: 40-60 m (18.2 g/m^2) and 60-80 m (3907.8/m^2), 7.0-7.9 °C (13.8 g/m^2 and 3096.9/m^2), 1-1.99 ϕ (11.9 g/m^2 and 2679.6/m^2), 0-20% silt-clay (13.3 g/m^2 and 3101.3/m^2). However, the main biomass occurred in 0-100 m, 6.0-9.9 °C, 1.0-3.99 ϕ, and 0-40% silt-clay. The principal density pattern was similar to biomass. The distribution of two important amphipod groups, the aorids and caprellids, were primarily restricted to clean sand.

Mollusca

The Mollusca which accounted for 56.7% of the biomass and 5.9% of the density contained three principal classes distributed as follows: Scaphopoda (0.1% and 0.6%), Gastropoda (4.8% and 15.2%), Bivalvia (95.1% and 84.2%). Distribution of biomass ranged from medium (20-99 g/m^2) and clusters of high concentration (>100 g/m^2) in the north to low biomass (0.1-19 g/m^2) in the south. The widest area of high biomass occurred in the east central portion (Figure 16). Since the distribution of molluscan biomass and density was mainly influenced by the bivalves, the description of average biomass and density with regard to environmental ranges will be treated in the bivalve section.

In contrast to shelf amphipods where there was close association between biomass and density, there was no association between biomass and density of mollusks because of the size differences among species. This can be inferred when density (Figure 17) is compared to biomass (Figure 16) of mollusks. Density distribution was very different from biomass distribution. High (>400/m^2) and medium densities (100-399/m^2) which occurred in the central portion were enclosed by a low density envelope (10-99/m^2) north and south.

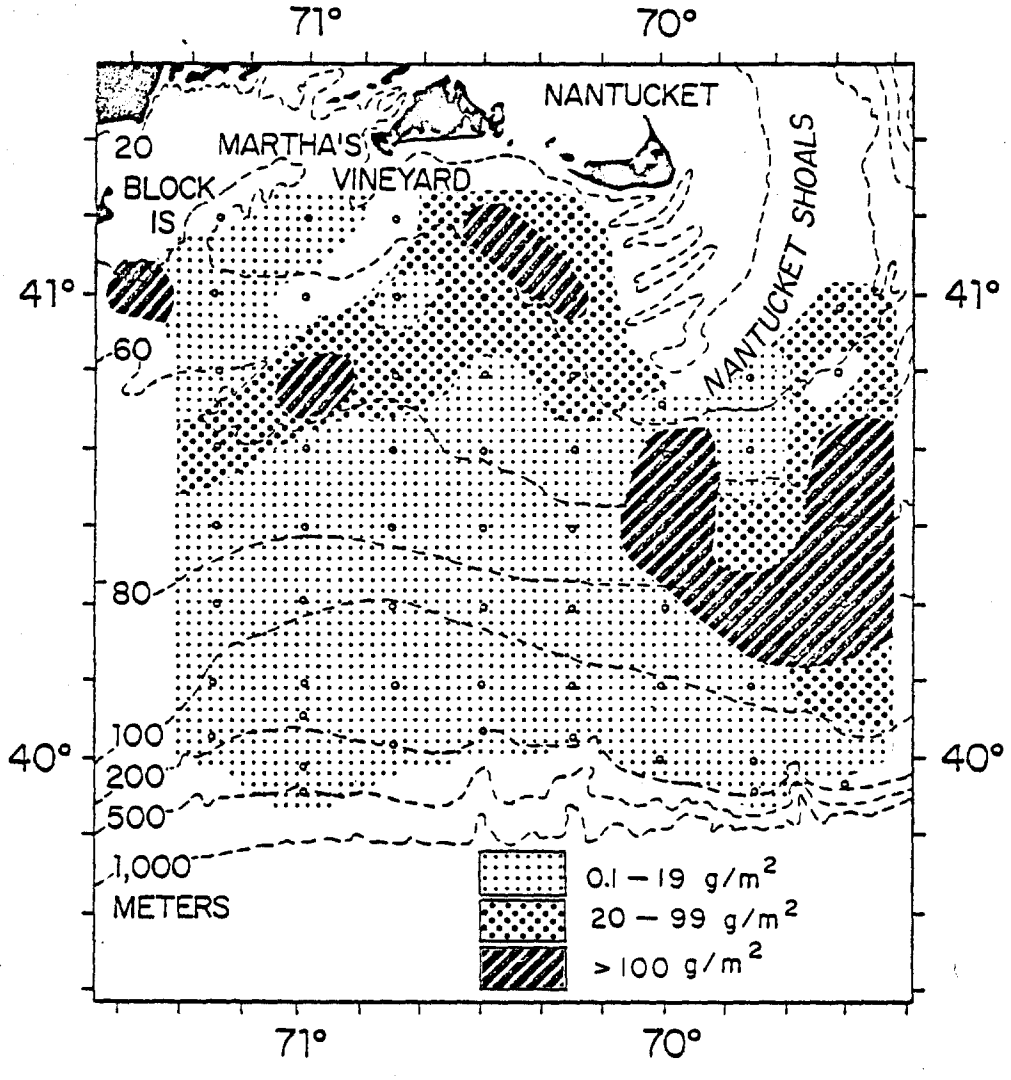


Figure 16. Quantitative distribution of biomass (g/m^2) for Mollusca.

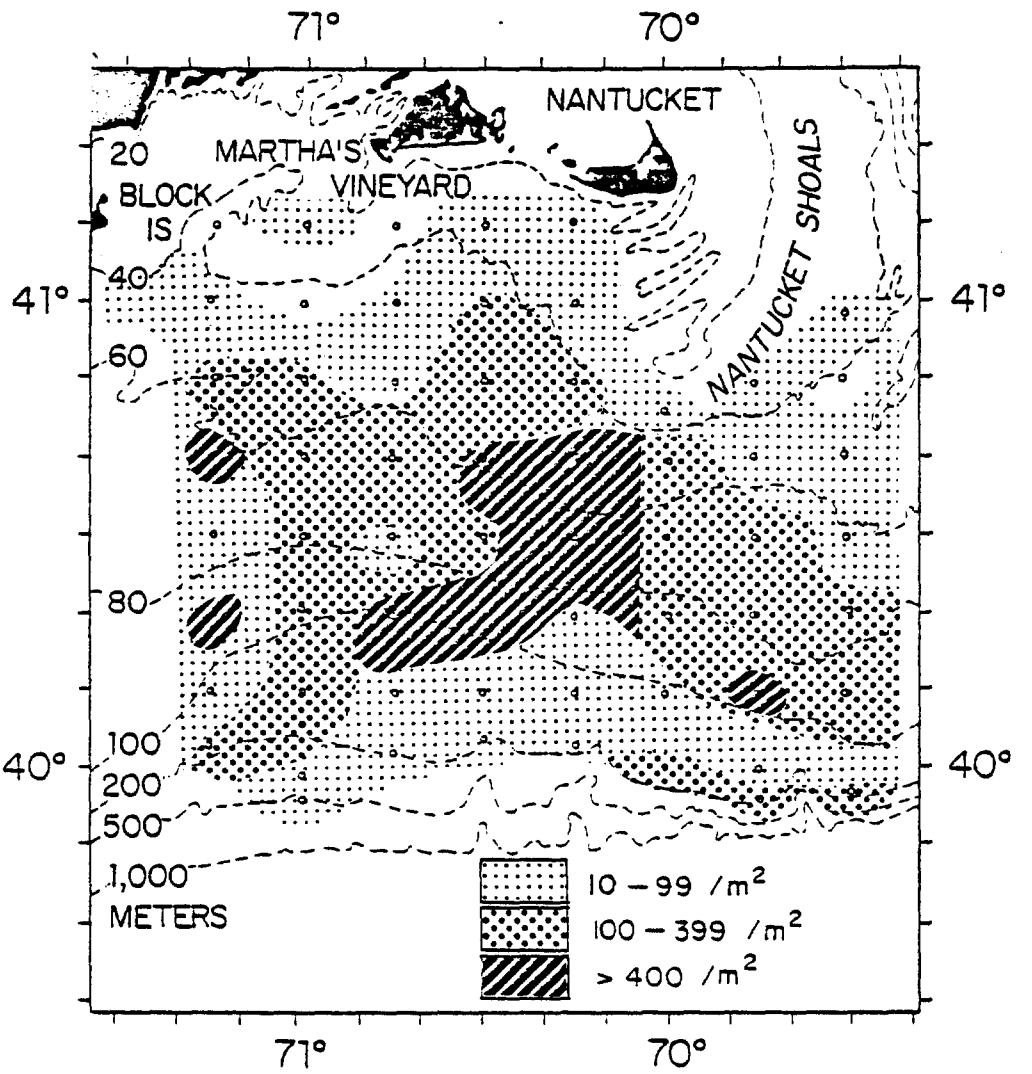


Figure 17. Quantitative distribution of individuals (no./m^2) for Mollusca.

Scaphopoda

Scaphopods comprised 0.1% of the biomass and 0.6% of the density within the Mollusca. Cadulus pandionis and Dentalium occidentale were characteristic species and were only sampled at deep stations (Figures 18-19). Scaphopods occurred in low biomass (0.05 to 0.08 g/m^2) and density (3.3-7.5/m^2) in water deeper than 200 m, ranging from 6.0-11.9 °C, 2.0-5.99 ϕ and 0-80% silt-clay (Tables 5-12).

Gastropoda

Within the Mollusca gastropods comprised 4.8% of the biomass and 15.2% of the density. Species composition included large types such as Buccinum undatum, Lunatia heros, L. triseriata, Colus stimpsoni; intermediate sizes such as Nassarius trivittatus, Crepidula plana, and small types such as Retusa gouldi, Cylichna alba and Alvania carinata. Gastropods occurred mainly in low biomass (0.1-0.9 g/m^2) and density (10-99/m^2) throughout the study area except for the southeast corner and a few stations in the northeast and northwest (Figures 20-21).

The highest average biomass and density of gastropods were recorded (Tables 5-12) from 60-80 m (30.3 g/m^2) and 80-100 m (65.1/m^2), 7.0-7.9 °C (41.4 g/m^2) and 10.0-10.9 °C (62/m^2), 2.0-2.99 ϕ (18.4 g/m^2) and 3.0-3.99 ϕ (35.8/m^2), and 0-20% silt-clay (13.4 g/m^2) and 80-100% silt-clay (90.8/m^2). These data suggest that the distribution of biomass involved relatively narrow environmental conditions compared to conditions influencing density. Based on Tables 5-12 it can be inferred that the distribution of the main contributors to gastropod biomass occurred in different conditions than the main contributors to density. Biomass was mainly influenced by large to

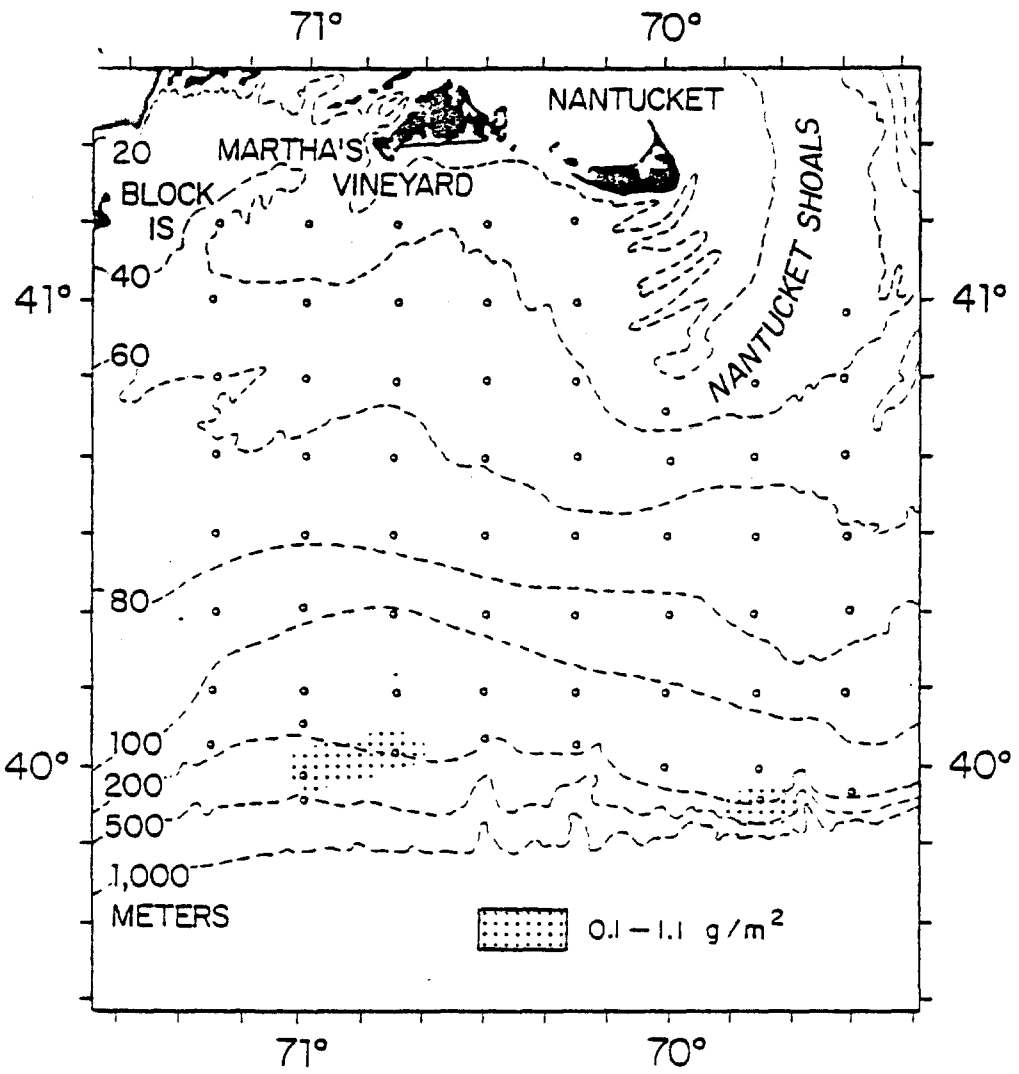


Figure 18. Quantitative distribution of biomass (g/m^2) for Scaphopoda.

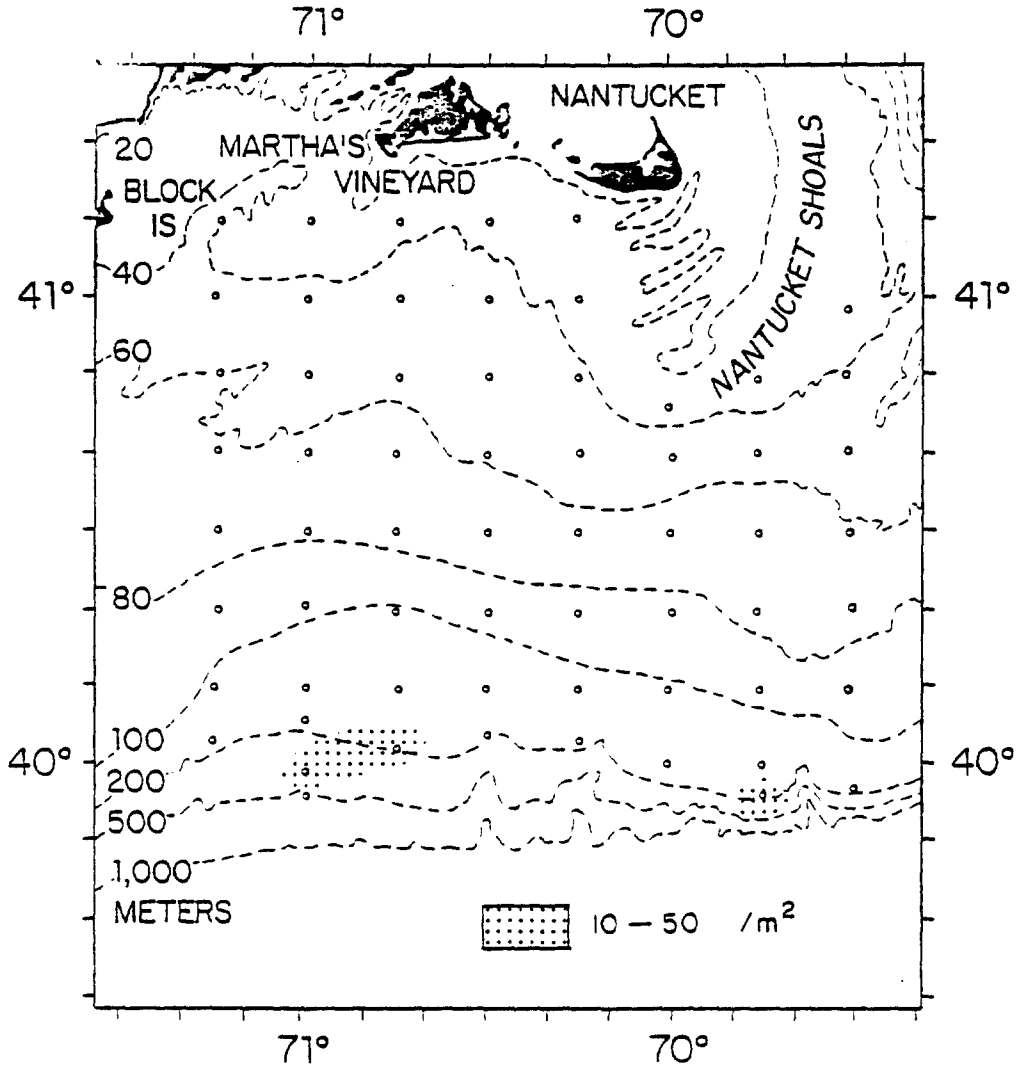


Figure 19. Quantitative distribution of individuals (no./m^2) for Scaphopoda.

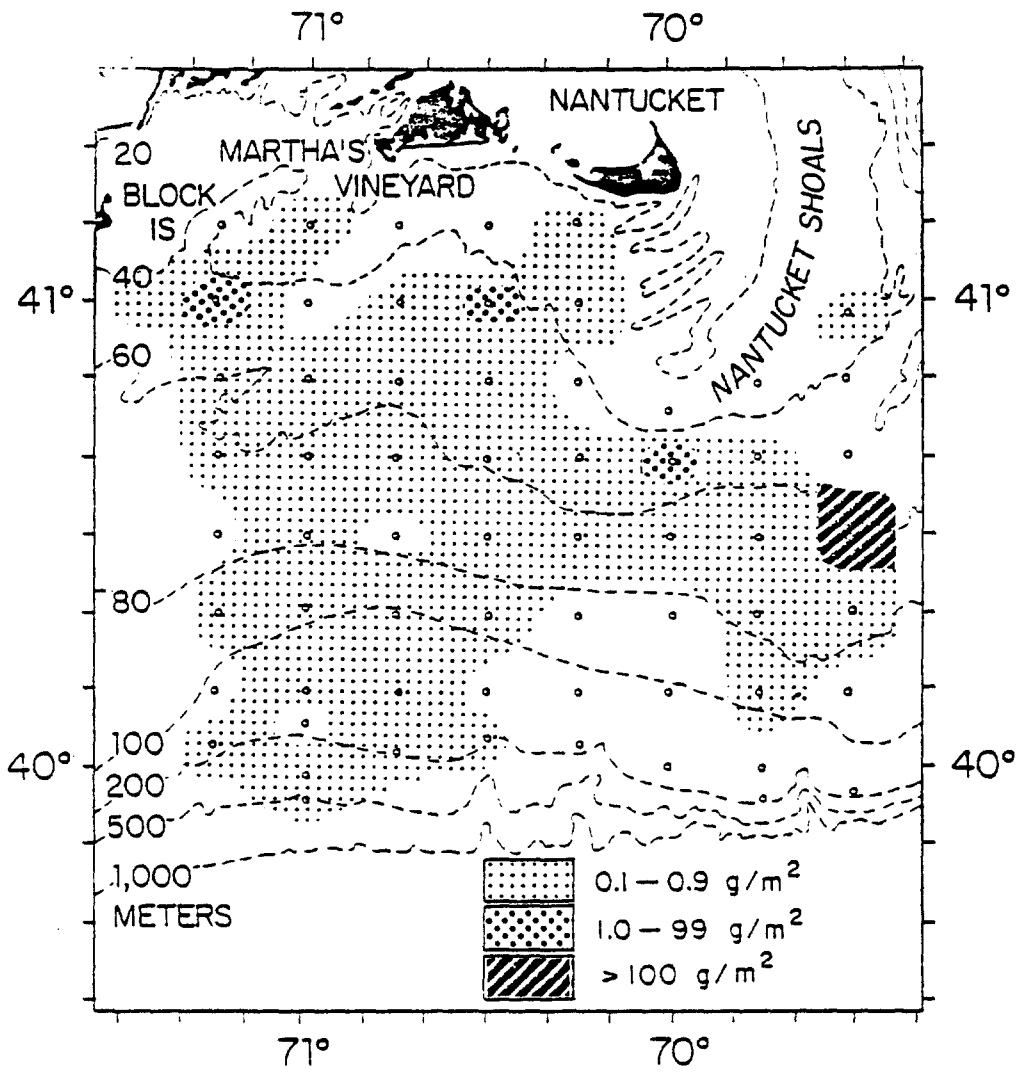


Figure 20. Quantitative distribution of biomass (g/m^2) for Gastropoda.

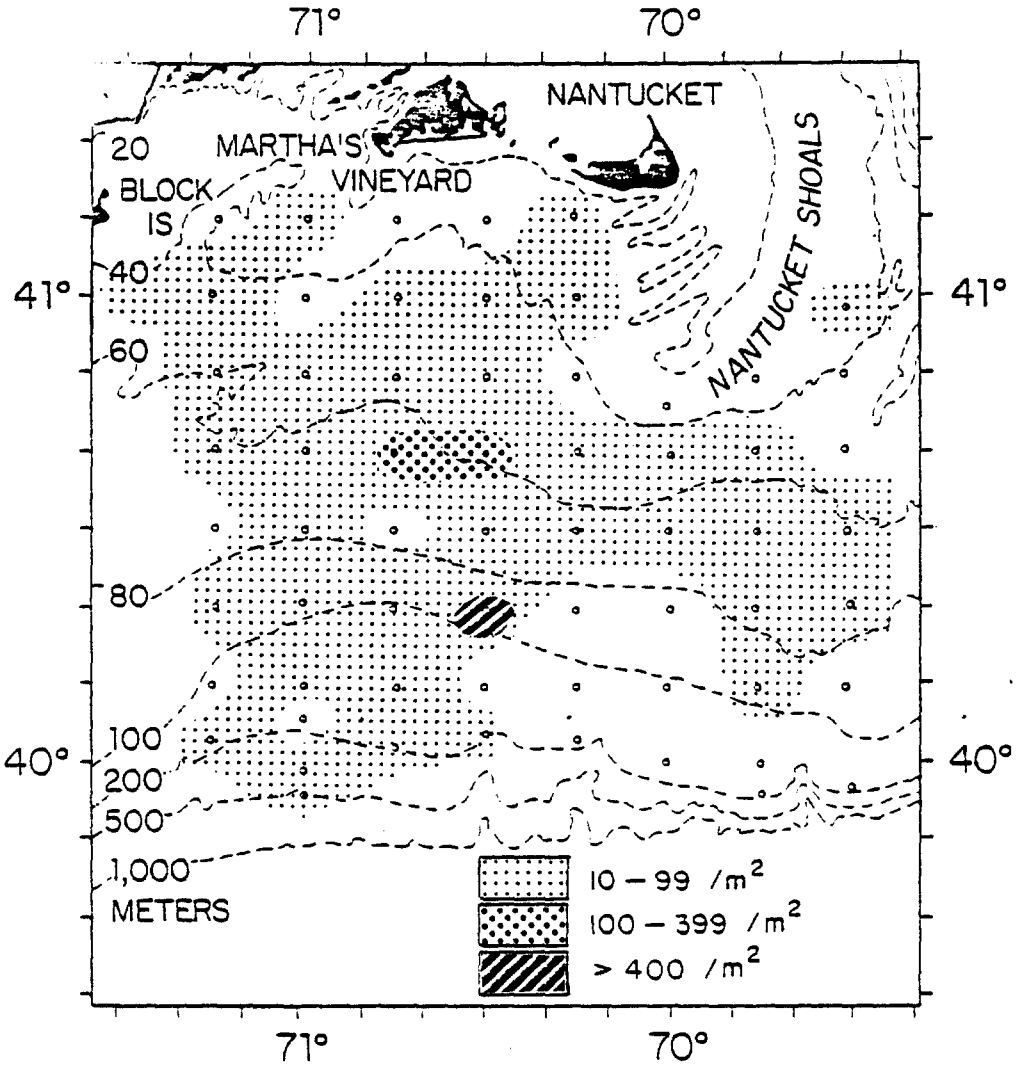


Figure 21. Quantitative distribution of individuals (no./m^2) for Gastropoda.

intermediate size, shallow water, sand dwelling species (Colus, Nassarius, Buccinum, Lunatia) and density by smaller, deep water, silt-sand and sandy-silt species (Alvania carinata).

Bivalvia

Within the Mollusca bivalves comprised 95.1% of the biomass and 84.2% of the density. Principal species included: Arctica islandica, Astarte undata, Cerastoderma pinnulatum, Cyclocardia borealis, Thyasira spp., Phacoides spp., Lyonsia arenosa, L. hyalina, Pandora spp., Bathyarca pectunculoides, Nuculana acuta, Yoldia sapotilla, Nucula spp., and Cuspidaria spp. Bivalves occurred throughout the area with high (>100 g/m^2) and medium (10-99.9 g/m^2) biomass in the shallow half and low biomass (0.1-9.9 g/m^2) in the deeper half. The highest biomass occurred in the east central portion south of Nantucket Shoals (Figure 22). Once again size differences among the major species produced density patterns dissimilar to biomass pattern. High (>400/m^2) and medium (100-399/m^2) densities occurred in the center of the area in large clusters in both clean sand and silt-sand and sand silt (Figure 23).

The highest average biomass and density of bivalves was recorded (Tables 5-12) in 40-60 m (221.5 g/m^2) and 80-100 m (367/m^2), 7.0-7.9 °C (210.2 g/m^2) and 9.0-9.9 °C (235.5/m^2), 3.0-3.99 ϕ (240.3 g/m^2, and 224.6/m^2), and 0-20% silt clay (247.1 g/m^2) and 80-100% silt-clay (271/m^2). Because of size differences the highest average biomass did not always agree with the highest density in a given environmental range. Species of bivalves tended to form clusters which responded to specific environmental conditions.

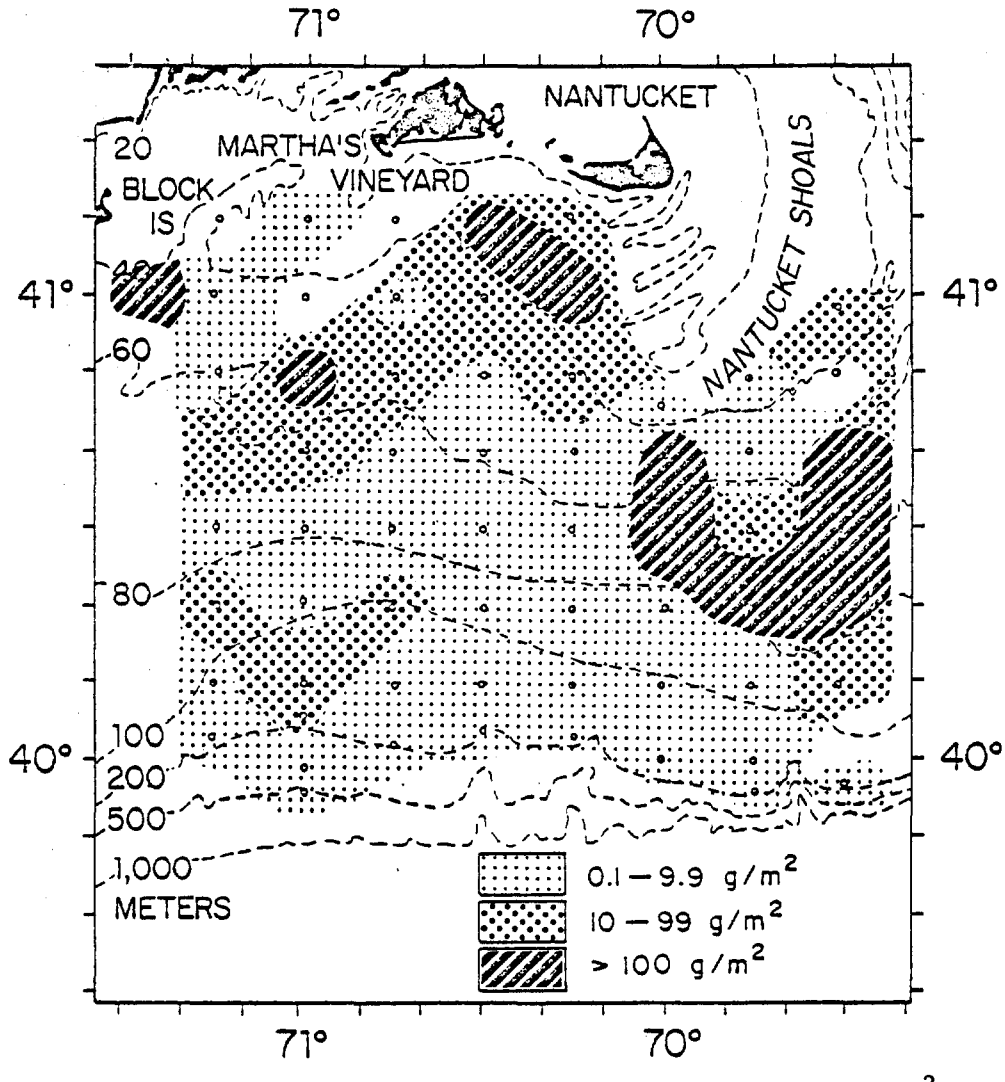


Figure 22. Quantitative distribution of biomass (g/m^2) for Bivalvia.

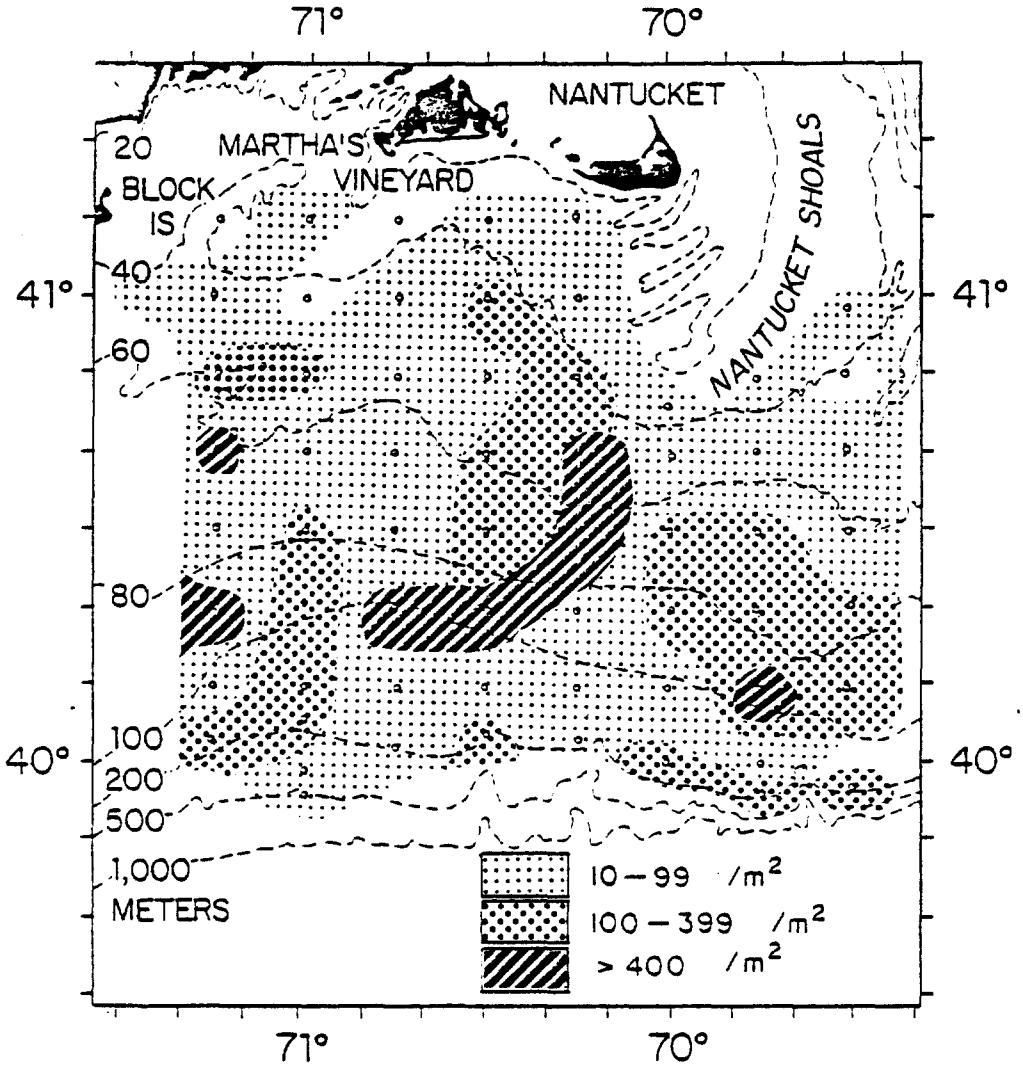


Figure 23. Quantitative distribution of individuals (no./m^2) of Bivalvia.

For example, C. pinnulatum and A. islandica occurred mainly in relatively shallow water with sand whereas Cuspidaria striata, C. perrostrata, Bathyarca pectunculoides, Nuculana acuta occurred mainly in deeper water with silty sand or sandy silt. Species of Phacoides occurred commonly below 60 m but in both sand and silt. In contrast to a specific habitat some species (Nucula, Astarte, Yoldia) occurred in a variety of sediment types throughout the depth range. Mollusks chiefly represented by A. islandica were among the most important taxa influencing biomass throughout the area. Small bivalves also contributed greatly to the density distribution.

Annelida

The annelids, in this case exclusively polychaetes, comprised 10.9% of the total biomass and 20.3% of the total density. Many species of polychaetes were identified (Table 2) but the principal species included: maldanids, cirratulids (Cossura longocirrata, Chaetozone sp., Tharyx sp.), spionids (Spiophanes bombyx, Spio sp., Prionospio), flabelligerids (Brada sp.), Scalibregma inflatum, Sternaspis scutata, glycerids (Glycera spp.), Lumbrineris spp., Nephtys spp., nereids (Nereis spp. and Ceratocephale loveni), onuphids (Onuphis spp. and Hyalinoecia tubicola) and paraonids. High (>100 g/m^2) and medium (40-99 g/m^2) biomass occurred mainly in the shallow half of the study area in two irregularly shaped shallow to deep bands ranging from clean sand to fine sediment on the west and coarse sediment on the east (Figure 24). These two bands were enclosed within a larger area of low biomass (0.1-39 g/m^2). The density pattern was more irregular than the biomass pattern. High (>1000/m^2) and medium (500-999/m^2) density were generally sampled from the shallow half and low density (10-499/m^2) from the southern half. The east side included rapidly changing high, low, medium, high, medium, low densities from north to south. The largest area of high density also occurred south of Nantucket Shoals (Figure 25).

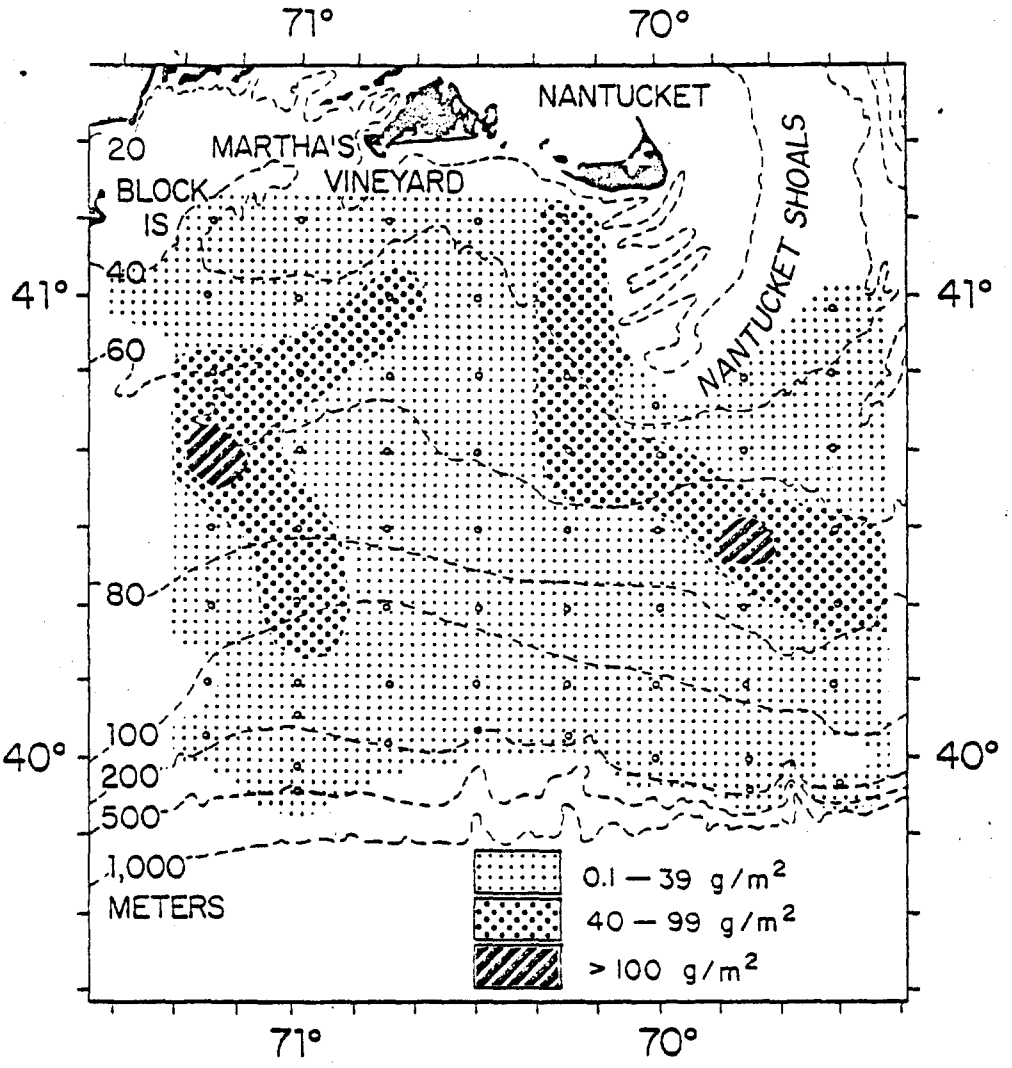


Figure 24. Quantitative distribution of biomass (g/m^2) for Annelida.

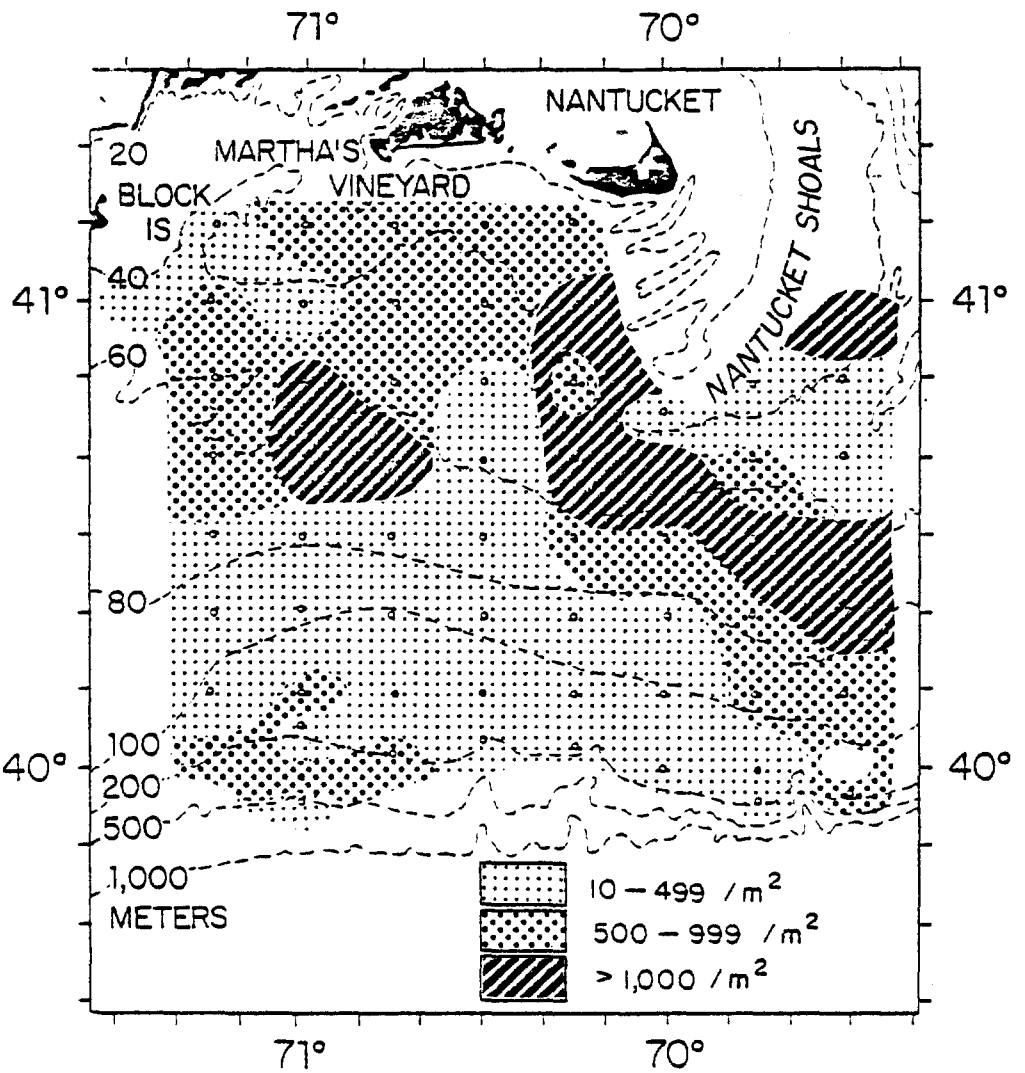


Figure 25. Quantitative distribution of individuals (no./m^2) for Annelida.

The highest average biomass and density of polychaetes was reported (Tables 5-12) from 60-80 m (45.6 g/m^2 and 792.9/m^2), 7.0-7.9 °C (39.7 g/m^2 and 771.2/m^2), 3.0-3.99 ϕ (31.2 g/m^2 and 716.7/m^2), and 0-20% silt-clay (31.9 g/m^2 and 737.3/m^2). Even with these maxima polychaetes were more evenly distributed throughout the depth, temperature, PHI and silt-clay ranges than any of the major taxa.

It was stated earlier that many bivalve species tend to form clusters presumably responding to local environmental gradients. A number of polychaete species showed similar clustering patterns. For example, maldanids (2-49 g/m^2) and Scalibregma inflatum (2-18 g/m^2) were best developed in shallow water and clean sand. In contrast terebellids and Sternaspis scutata were best developed in deeper water with fine grained sediment. Species of Nepthys occurred throughout the area, although particular species are known to occur in restricted sediment types. The fact that polychaetes occurred so widely and abundantly together with the fact that they have few hard parts, made them important constituents of macrobenthos and hence potential fish food.

Echinodermata

The Echinodermata which accounted for 21.3% of the biomass and 7.0% of the density of the fauna contained four classes distributed as follows: Ophiuroidea (21.7% and 78.6%), Holothuroidea (52.9% and 5.9%), Echinoidea (19.7% and 13.8%), Asteroidea (5.7% and 1.7%). Low biomass (0.1-49 g/m^2) and low density(10-499/m^2) occurred in the shallow two-thirds of the study area while medium to high biomass (50->100 g/m^2) and density (500->1000/m^2) were situated in the deeper portion (Figure 26). Medium density changed

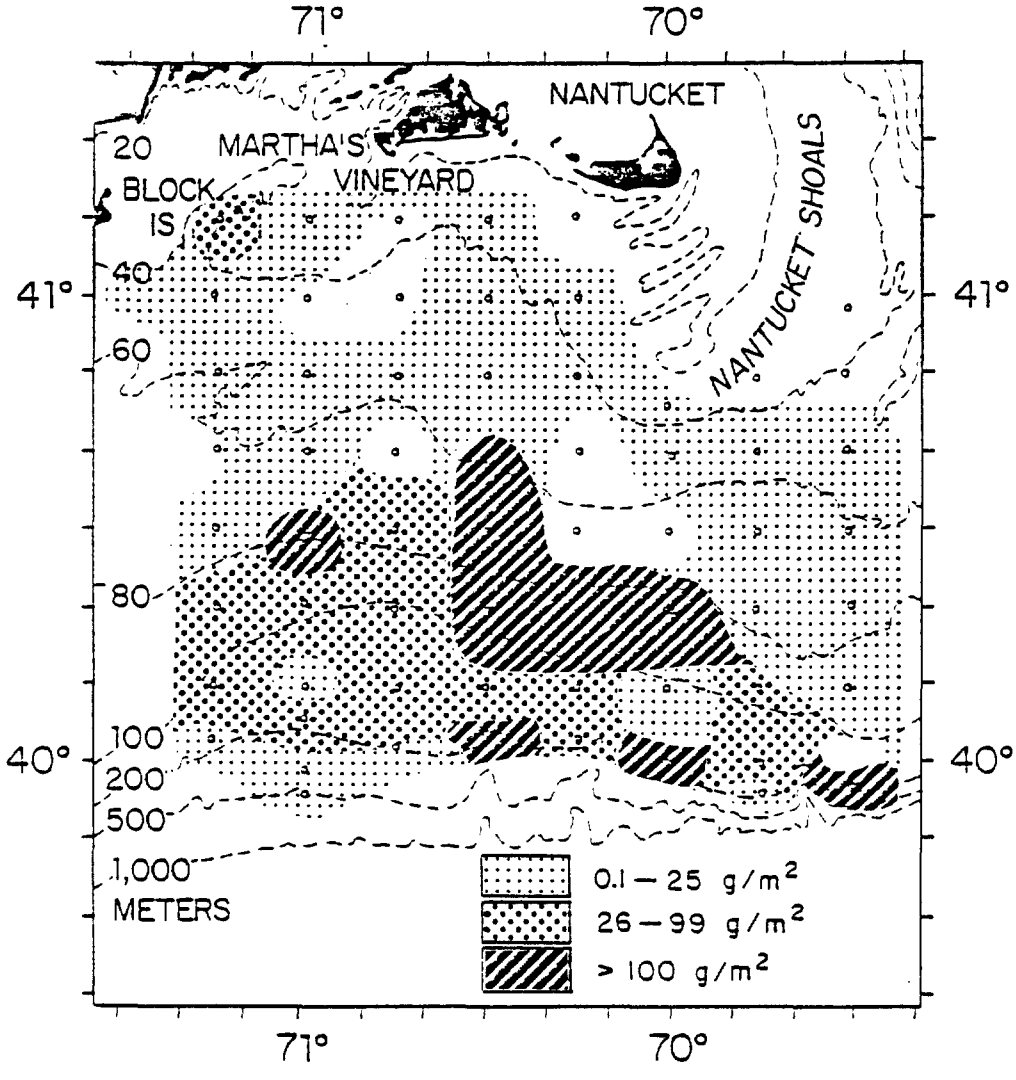


Figure 26. Quantitative distribution of biomass (g/m^2) for Echinodermata.

rapidly to low density between 100-200 m (Figure 27). Echinoids mainly contributed to the distribution of echinoderms in water shallower than 80 m whereas ophiuroids and holothurians were important in water deeper than 80 m.

The highest average biomass and density were collected from 80-100 m (156.9 g/m^2 and 640.7/m^2), 11.0-11.9 °C (86.5 g/m^2) and 9.0-9.9 °C (435.3/m^2), 3.0-3.99 ϕ (85.9 g/m^2) and 5.0-5.99 ϕ (502.8/m^2), 20-40% silt-clay (100.9 g/m^2) and 80-100% silt-clay (514.2/m^2). Regardless of these maxima considerable biomass and density of echinoderms occurred in general ranges of each environmental variable (Tables 5-12).

Ophiuroidea

This class comprised 21.7% of the biomass and 78.6% of the density within the Echinodermata. Amphilimna olivacea, Amphioplus abditus, A. macilentus, Amphiura otteri, A. fragilis, Axiognathus squamatus, Ophiura sarsi were characteristic species. Ophiuroids were mainly restricted to the deeper half of the area (Figures 28-29) where they occurred in low biomass (0.1-49 g/m^2) and medium to high density (100->499/m^2).

The highest average biomass and density of ophiuroids occurred in 100-200 m (32.5 g/m^2) and 80-100 m (563/m^2), 11.0-11.9 °C (34.7 g/m^2 and 393.9/m^2), 5.0-5.99 ϕ (17.5 g/m^2 and 328.2/m^2), 80-100% silt-clay (21.6 g/m^2 and 346.8 m^2). Actually considerable biomass and density occurred in several peaks of environmental variables (Tables 5-12).

Holothuroidea

Holothurians comprised 52.9% of the biomass and 5.9% of the density within the Echinodermata. Synapta sp., Astichopus sp., Molpadia sp., and Havelockia scabra were characteristic species. This class was almost exclusively collected in the deeper half where it occurred in a band of

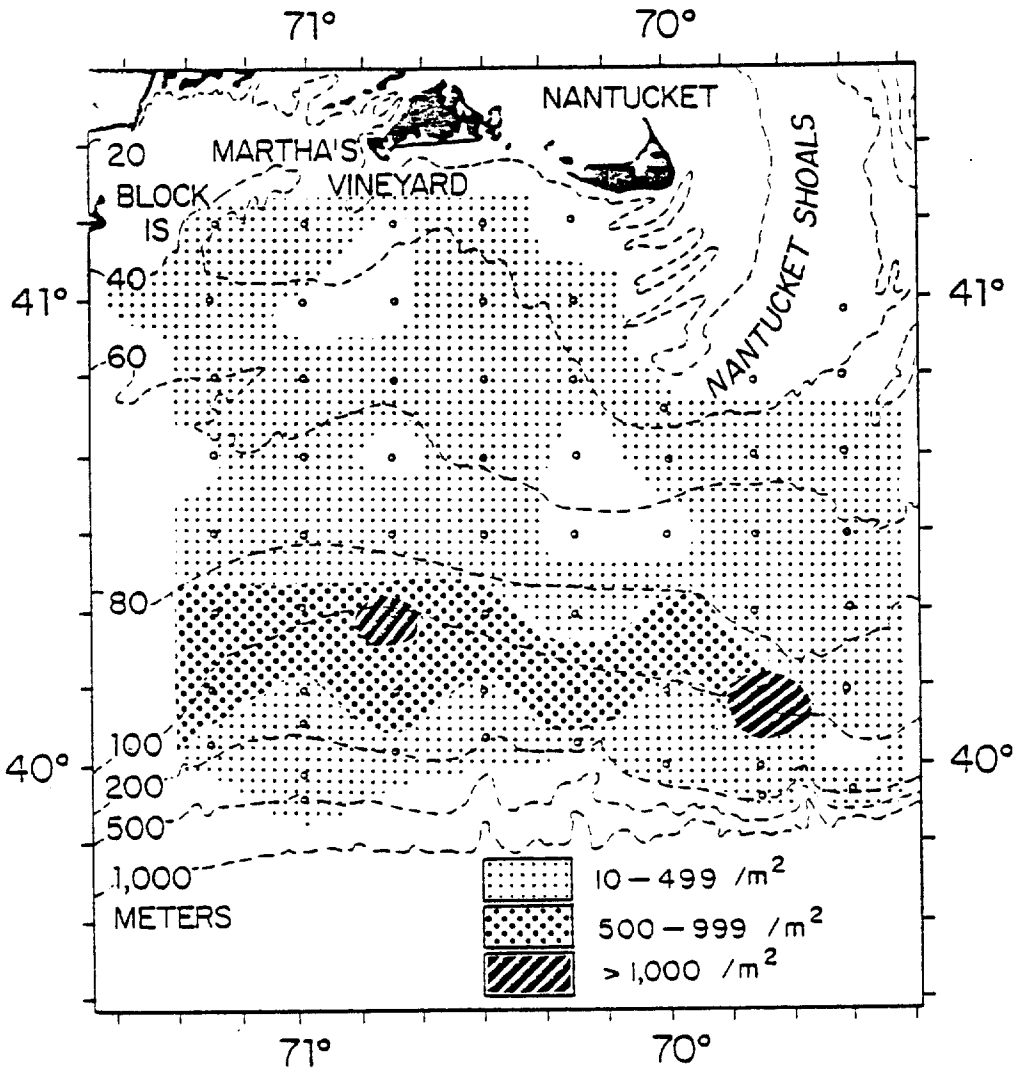


Figure 27. Quantitative distribution of individuals (no./m^2) for Echinodermata.

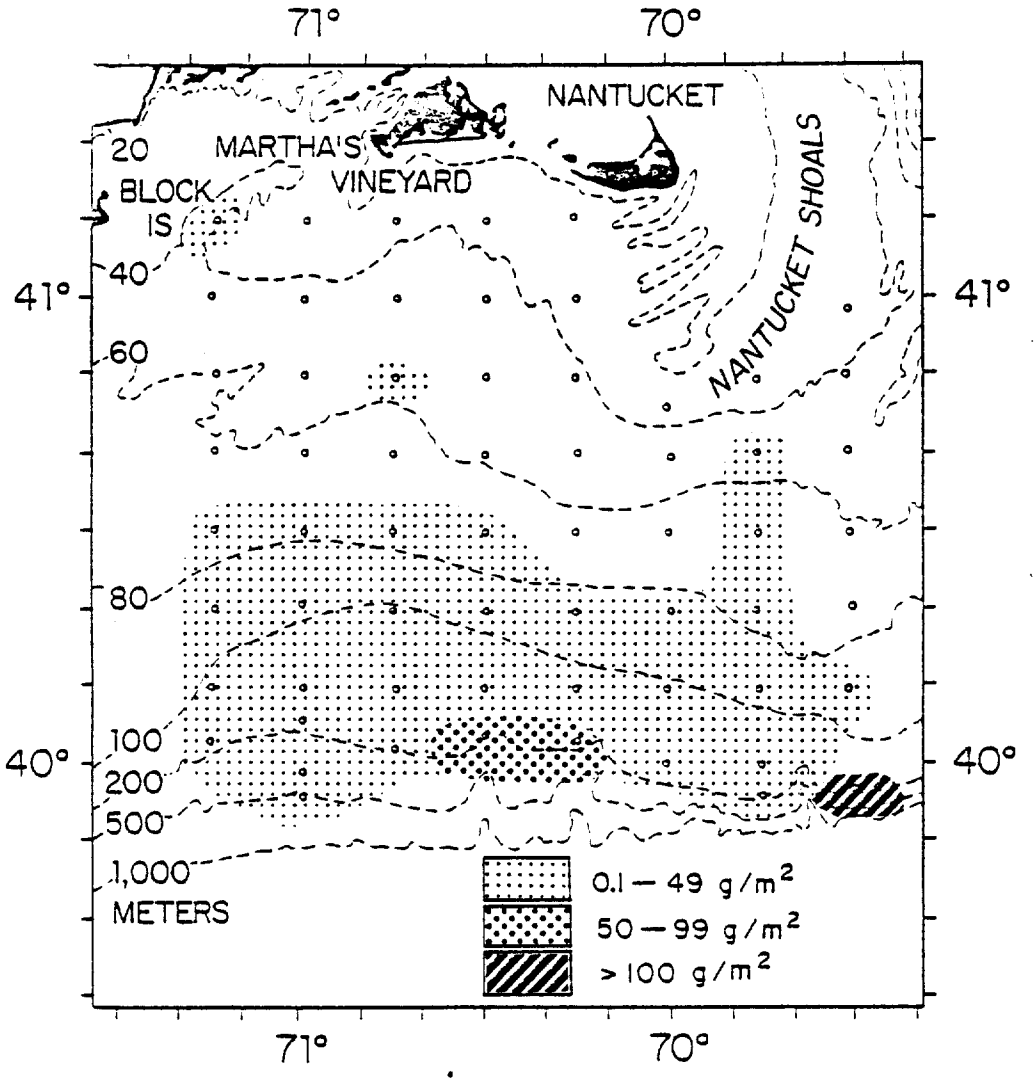


Figure 28. Quantitative distribution of biomass (g/m^2) for Ophiuroidea.

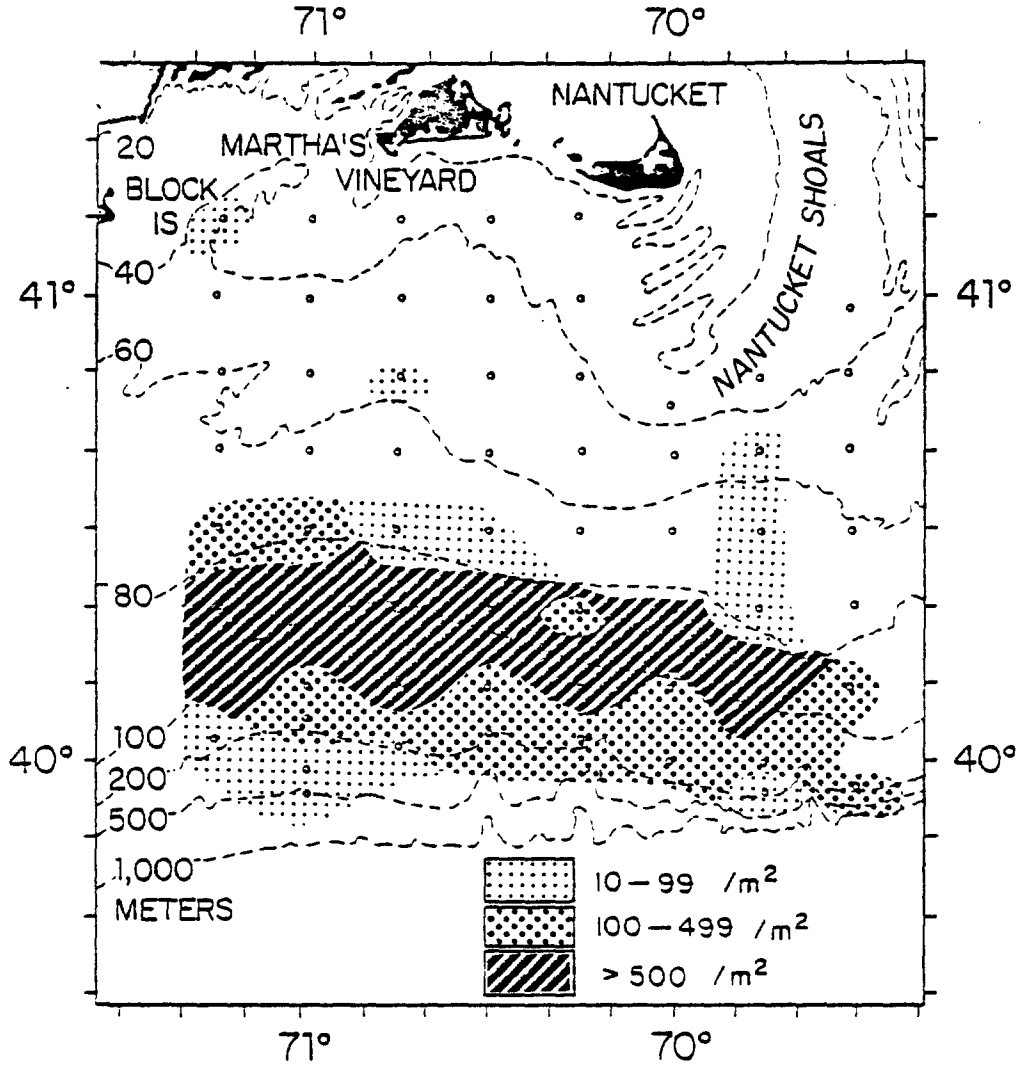


Figure 29. Quantitative distribution of individuals (no./m^2) for Ophiuroidea.

high (>100 g/m^2) and low (0.1-49 g/m^2) biomass in a low (10-99/m^2) density area (Figures 30-31).

The highest average biomass and density were reported (Tables 5-12) for 80-100 m (121.3 g/m^2 and 74.9/m^2), 6.0-6.9 °C (55.8 g/m^2) and 7.0-7.9 °C (23.8/m^2), 4.0-4.99 ϕ (56.2 g/m^2 and 31.4/m^2), and 40-60% silt-clay (70.9 g/m^2) and 20-40% silt-clay (28.3/m^2). Havelockia scabra illustrates well the distribution of typical holothurians in this study. It occurred mainly in deeper water which consisted of a fine grained sediment.

Echinoidea

This class contained 19.7% of the biomass and 13.8% of the density within the Echinodermata. Two species dominated this class: Echinarachnius parma and Brisaster fragilis. The distribution of echinoids was essentially influenced by the distribution of the two species. As a result there was an irregular band or zone of echinoids (E. parma) in the shallow half and a series of clusters (B. fragilis) in the southern half (Figures 32-33).

The highest average biomass and density of echinoids was recorded for 100-200 m (32.7 g/m^2 and 52.1/m^2), 11.0-11.9 °C (46.1 g/m^2) and 9.0-9.9 °C (103.9/m^2), 1.0-1.99 ϕ (25.3 g/m^2) and 5.0-5.99 ϕ (157.6/m^2), 20-40% silt-clay (23.4 g/m^2) and 80-100% silt-clay (131.3/m^2). These maxima require further clarification.

In terms of depth the 32.7 g/m^2 and 52.1/m^2 in 100-200 m reflected the distribution of B. fragilis. The second peak of 7.9 g/m^2 and 40/m^2 in 0-60 m represented the distribution of E. parma. With regard to median sediment size the high value (25.3 g/m^2) in 1.0-1.99 ϕ and second density peak (32/m^2) in 2.0-2.99 ϕ represented E. parma while the second biomass

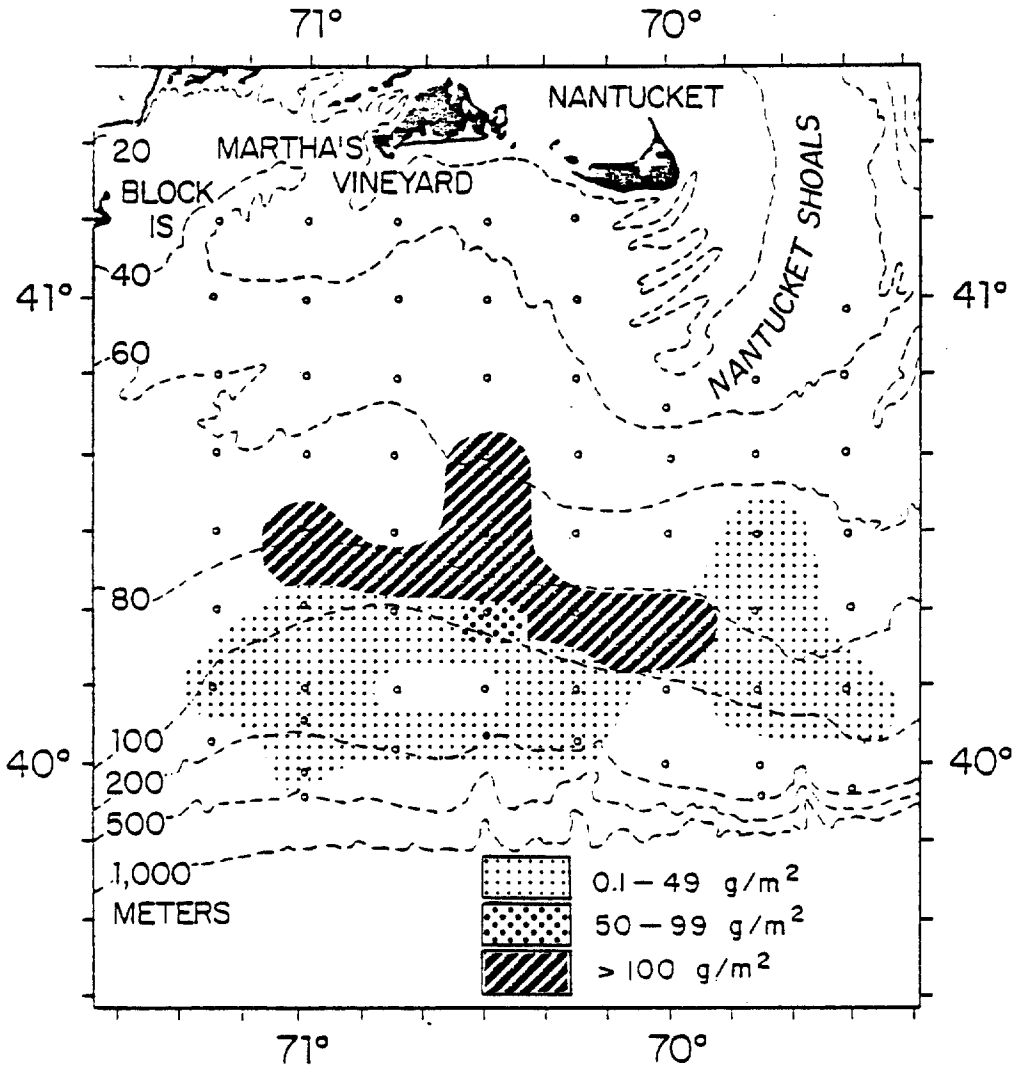


Figure 30. Quantitative distribution of biomass (g/m^2) for Holothuroidea.

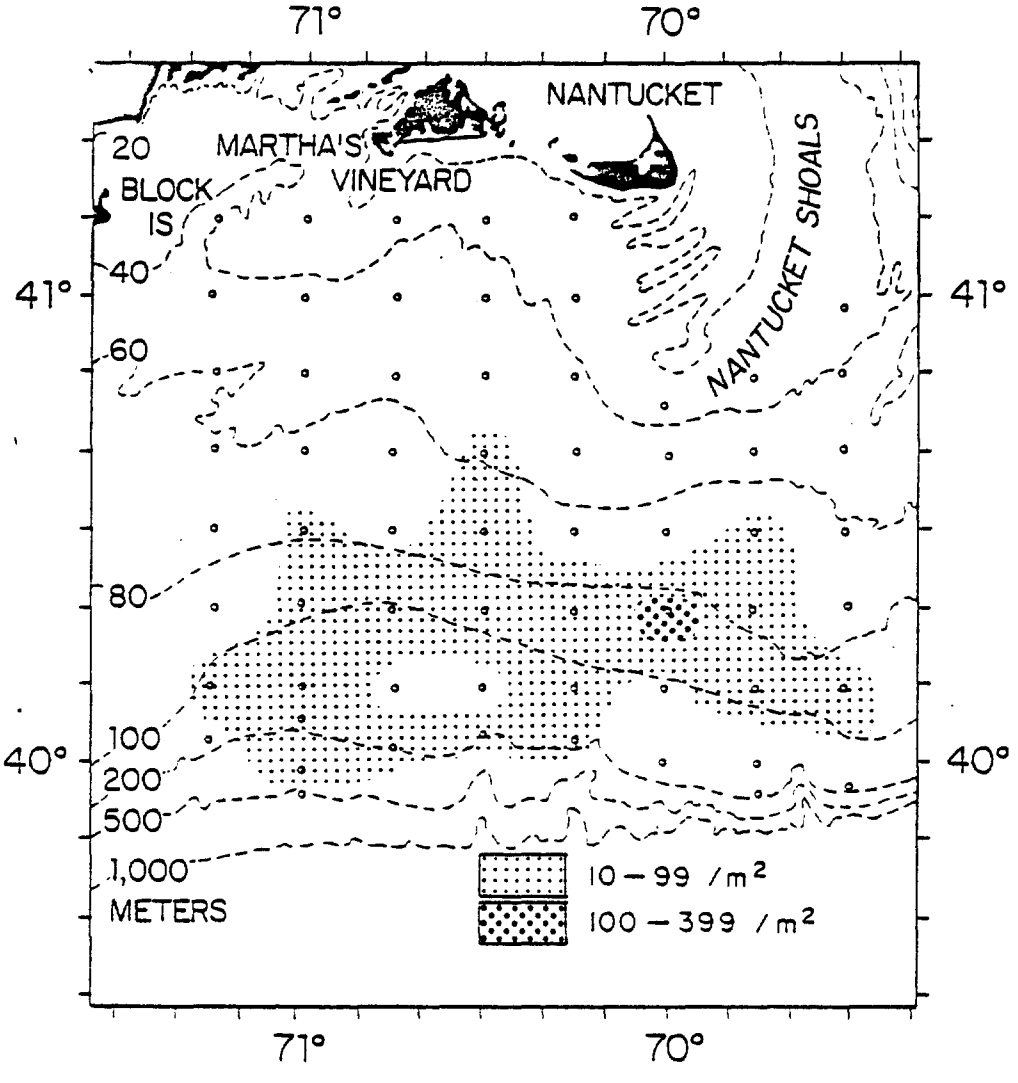


Figure 31. Quantitative distribution of individuals (no./m^2) for Holothuroidea.

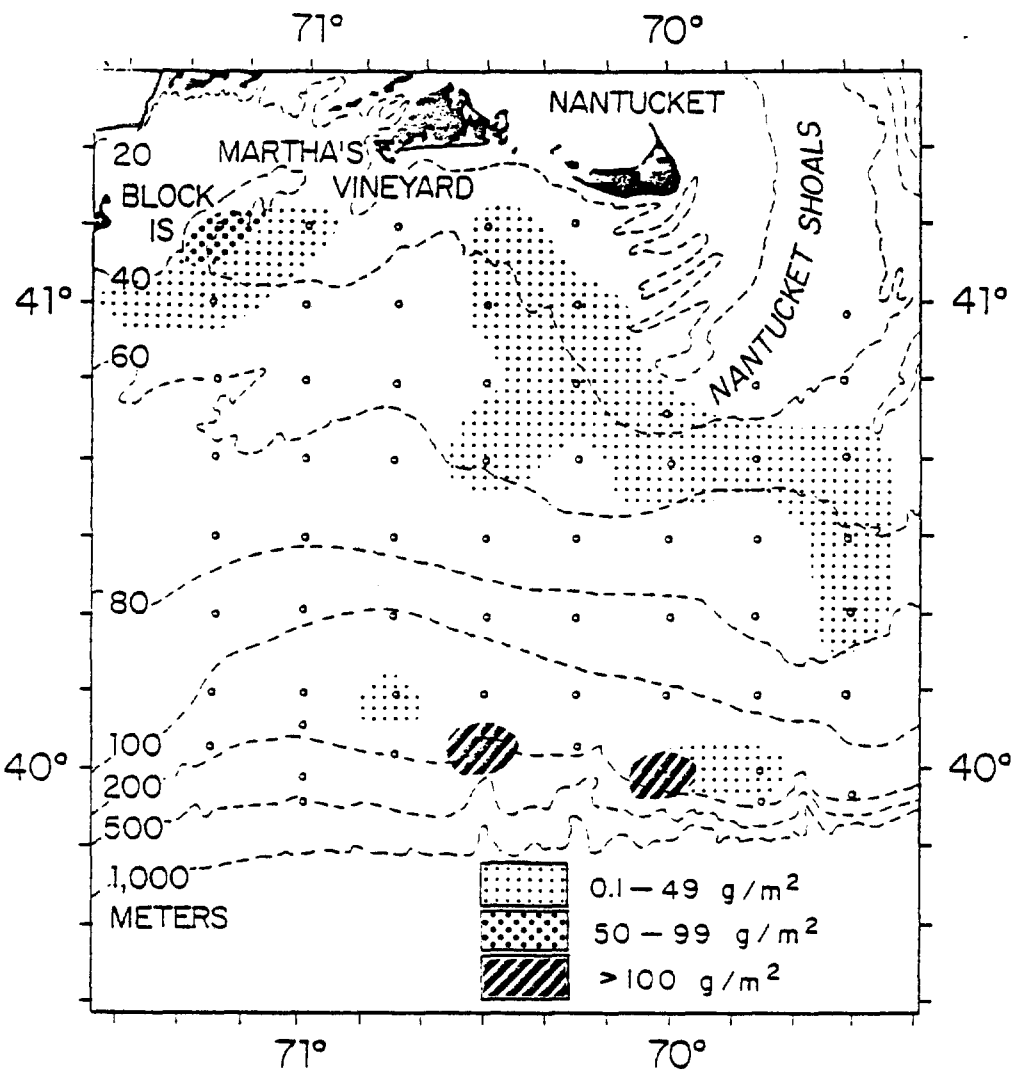


Figure 32. Quantitative distribution of biomass (g/m^2) for Echinoidea.

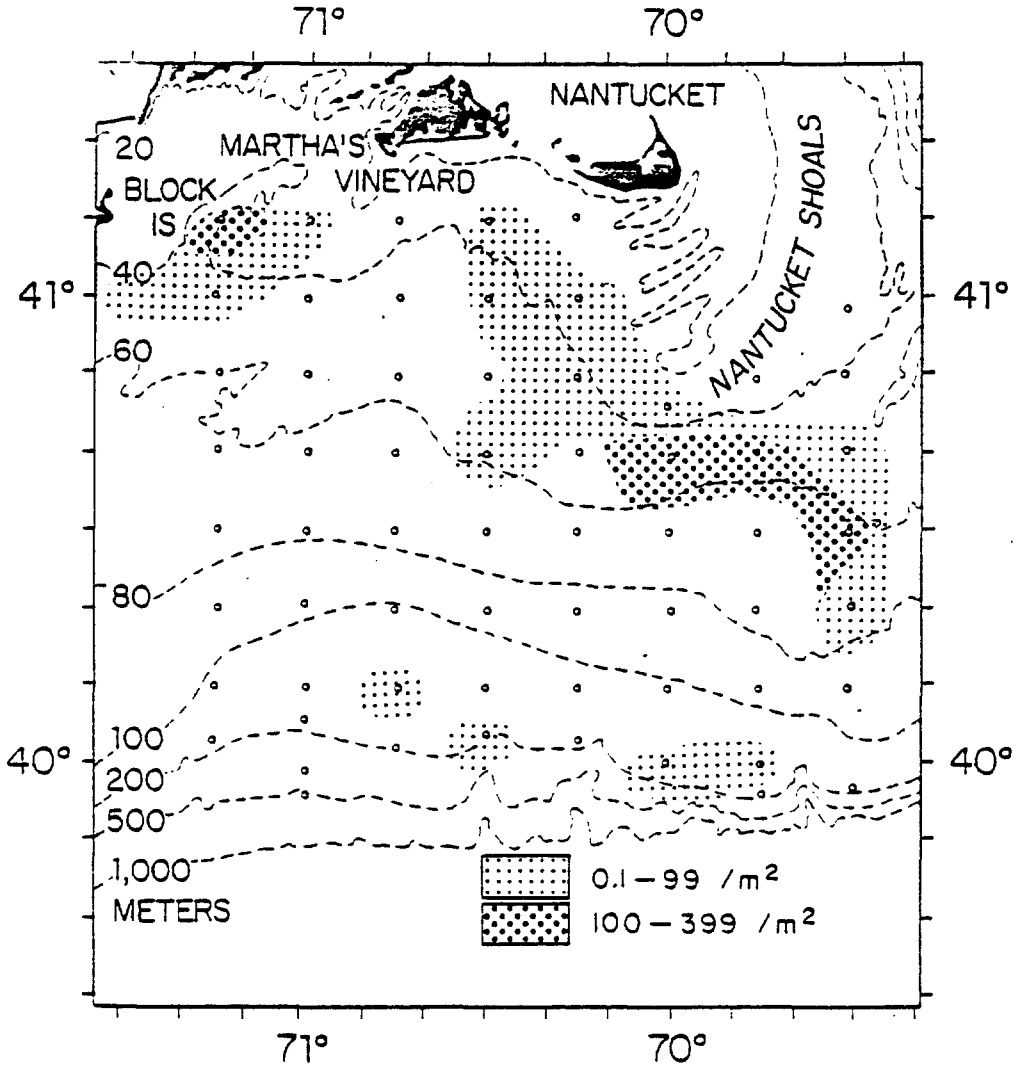


Figure 33. Quantitative distribution of individuals (no./m^2) for Echinoidea.

peak (16.6 g/m^2) in 3.0-3.99 ϕ and high density (157.6/m^2) in 5.0-5.99 ϕ reflected B. fragilis. Distribution according to percent silt-clay was also divided into two extremes. On one hand E. parma occurred in the highest average biomass (23.4 g/m^2) and second highest density (31.9/m^2) in 20-40% and 0-20% silt-clay, respectively. On the other hand B. fragilis occurred in the third highest biomass (9.3 g/m^2) and highest density (131.3/m^2) in 80-100% silt-clay. Relationships with temperatures were more complex because of the cold water cell at moderate depths (Figure 3).

Asteroidea

This class comprised 5.7% of the biomass and 1.7% of the density within the Echinodermata. The asteroids included: Asterias sp., Leptasterias sp., Porania sp., Henricia sp., Astropecten americana and A. cingulatus. Asteroids were sampled in low biomass (0.1-49 g/m^2) and low density (1-99/m^2), in irregular clusters in both halves of the area (Figures 34-35).

The highest average biomass and density per environmental category are presented for purposes of completeness and comparison with other echinoderms and taxa, even though asteroid patterns might be more reliably based on qualitative sampling gear in this case. The highest average biomass and density of asteroids occurred (Tables 5-12) in 80-100 m (11.8 g/m^2) and 60-80 m (5.5/m^2), 9.0-9.9 °C (12.8 g/m^2) and 11.0-11.9 °C (8.6/m^2), 5.0-5.99 ϕ (6.5 g/m^2 and 8.0/m^2), and 80-100% silt-clay (11.5 g/m^2 and 8.3/m^2). Asterias sp. represented a shallow water species and Astropecten americana and A. cingulatus were deeper water species.

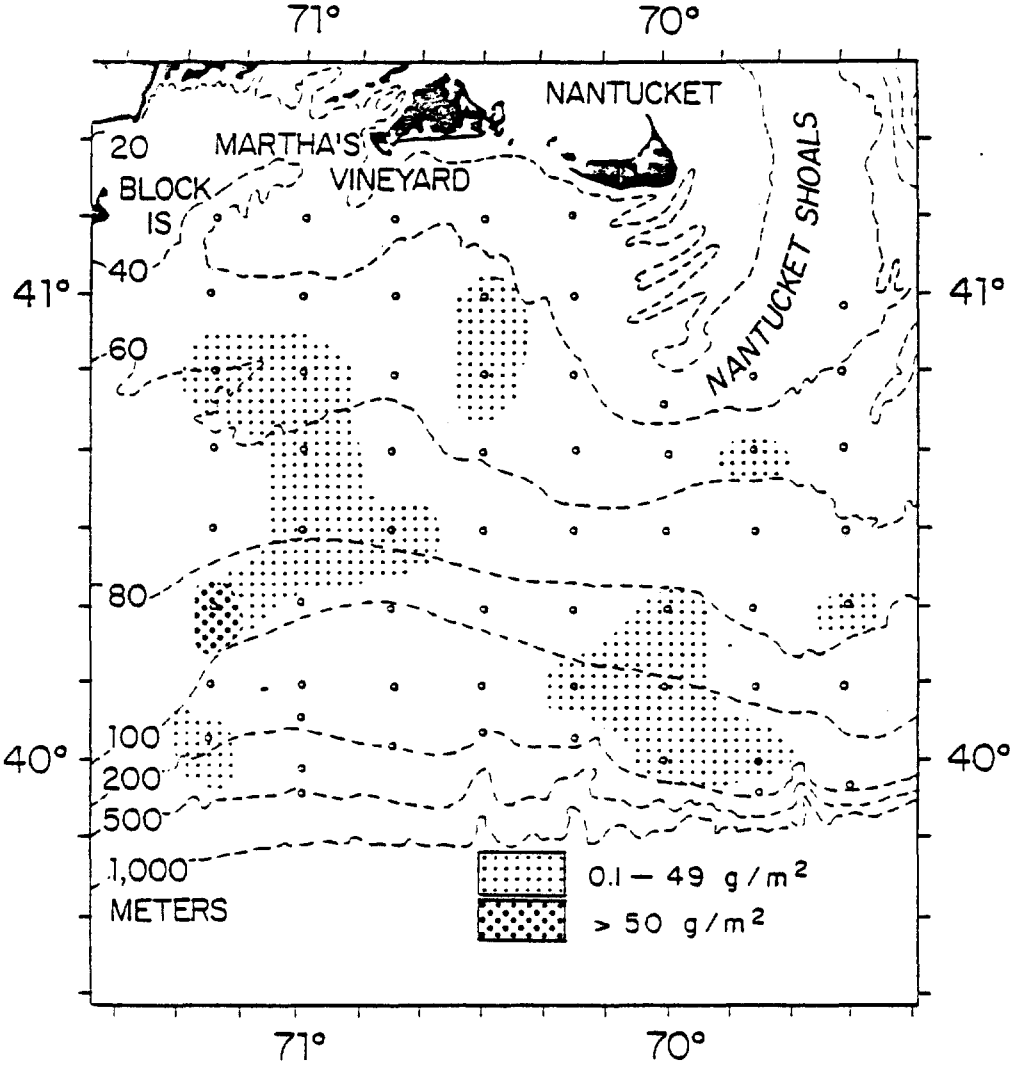


Figure 34. Quantitative distribution of biomass (g/m^2) for Asteroidea.

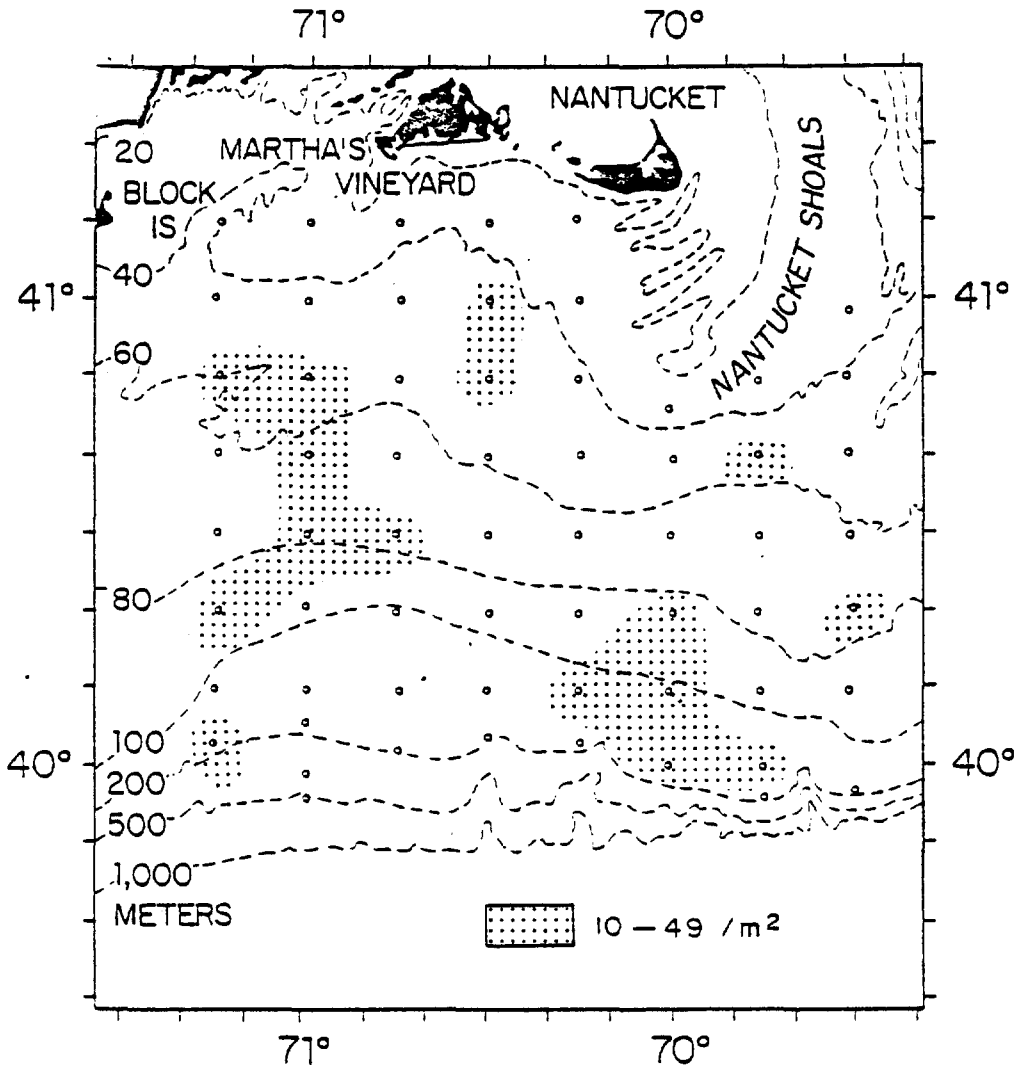


Figure 35. Quantitative distribution of individuals (no./m^2) for Asteroidea.

Miscellaneous

Eight phyla were placed in an artificial group termed miscellaneous which accounted for 7.0% of the biomass and 4.3% of the density of the fauna. These phyla were distributed within miscellaneous as follows: Attached Phyla - Porifera (1.5% and 0.5%), Coelenterata (47.7% and 15.2%), Ectoprocta (7.2% and 25.5%), Ascidiacea (23.9% and 32.3%); free living Phyla - Nemertea (7.9% and 9.8%), Sipunculida (10.1% and 14.3%), Pogonophora (0.1% and 1.1%), Enteropneusta (1.6% and 1.3%). Because of the artificial lumping, distribution in the miscellaneous group was almost meaningless compared to other major taxa (Crustacea or Echinodermata). However, in terms of its relative contribution to total biomass and density, distributions and averages were included (Figures 36-37, Tables 5-12). There was medium (>10 g/m^2) biomass in the north central portion which changed to low biomass (0.1-9.9 g/m^2) between 40-80 m, which changed to medium biomass between 80 and 100 m, and once again reverted to low biomass near 200 m. The density pattern was broadly similar to biomass but it was considerably more irregular with general clusters of medium density (100-399/m^2) enclosed within a low density (10-99/m^2) area.

Occurrence of miscellaneous at almost all stations was influenced by the distribution of Nemertea and Sipunculida. Biomass and density was primarily influenced by coelenterates, ascidiaceans, sipunculids, nemertea and ectoprocts.

Attached Phyla

Porifera

Porifera comprised 1.5% of the biomass and 0.5% of the density within Miscellaneous. Species within the Porifera were not identified.

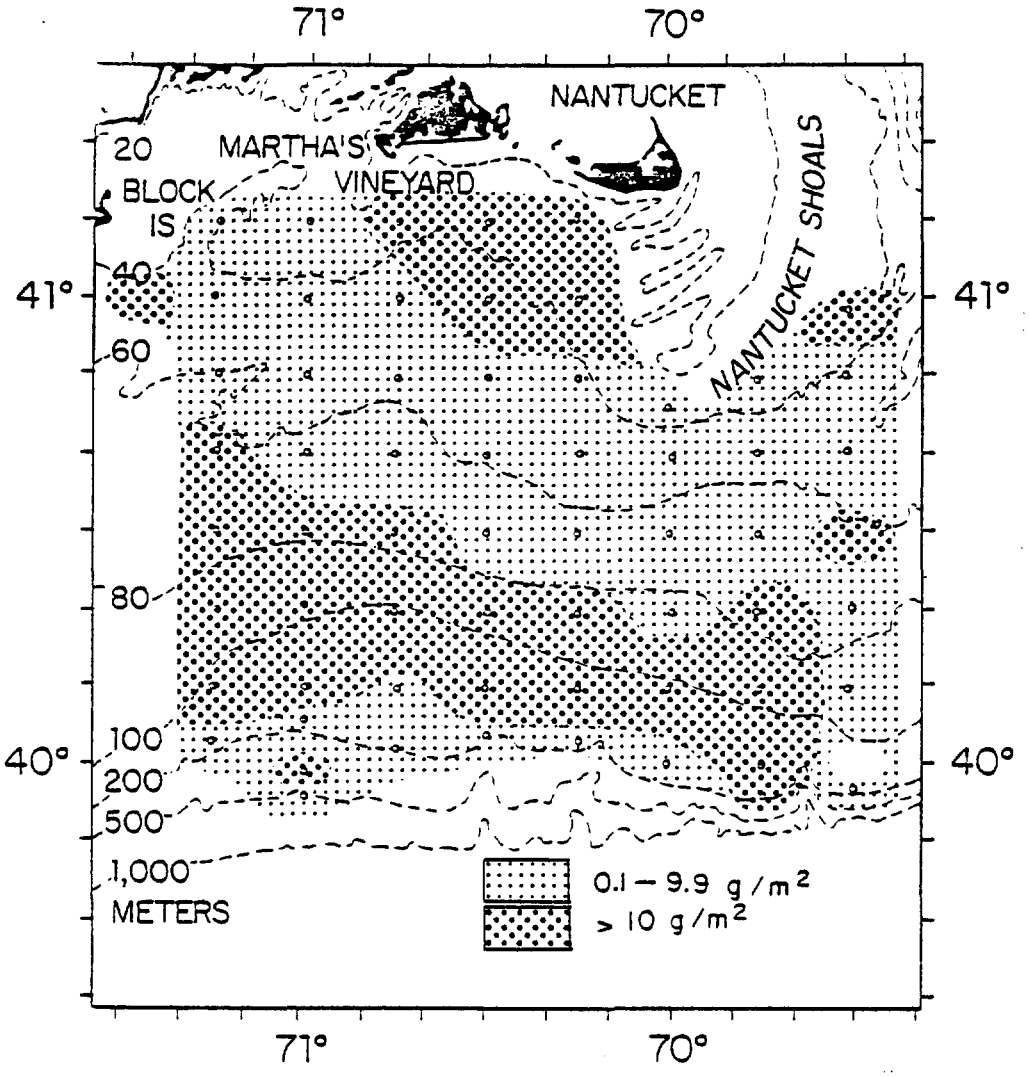


Figure 36. Quantitative distribution of biomass (g/m^2) for miscellaneous taxa.

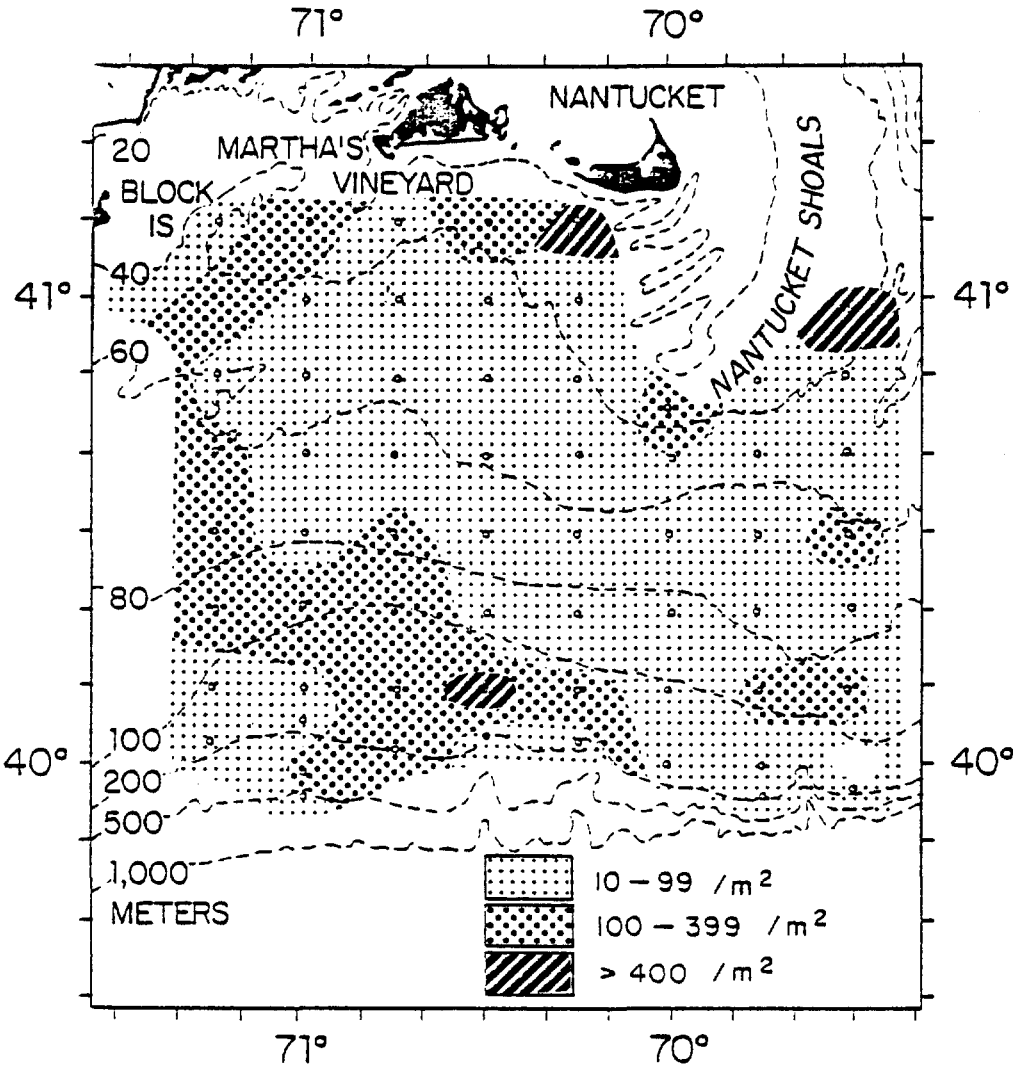


Figure 37. Quantitative distribution of individuals (no./m^2) for miscellaneous taxa.

Porifera were collected in each corner of the study area except the northwest (Figures 38-39). The highest average biomass and density of Porifera were reported (Tables 5-12) from 0-40 m (1.3 g/m^2) and 100-200 m ($1.3/m^2$), 8.8-8.9 °C (1.9 g/m^2 and $2.8/m^2$), 1.0-1.99 ϕ (0.41 g/m^2 and $1.6/m^2$), 0-20% silt-clay (0.12 g/m^2) and 60-80% silt-clay ($2.0/m^2$).

Coelenterata

Coelenterates accounted for 47.7% of the biomass and 15.2% of the density within the Miscellaneous. Coelenterates were represented by Pennatulacea (Pennatula aculeata), Alcyonacea, Hydrozoa and Zoantheria (Edwardsia sp., Cerianthus sp., Epizoanthus americanus). Coelenterates occurred at most stations in the deeper two thirds and irregularly in the shallow third (Figures 40-41). In general biomass and density were low, 0.1-9.9 g/m^2 and $10-99/m^2$, respectively, with a few clusters of medium to high biomass (10->100 g/m^2) and medium density (>$100/m^2$), in the deeper half.

The highest average biomass and density of coelenterates were (Tables 5-12) from 100-200 m (25.8 g/m^2 and $36.5/m^2$), 11.0-11.9 °C (53.1 g/m^2) and 12.0-12.9 °C ($48/m^2$), 4.0-4.99 ϕ (42.6 g/m^2 and 2.0-2.99 ϕ ($27/m^2$), and 40-60% silt-clay (40.8 g/m^2) and 60-80% silt-clay ($29.2/m^2$). Regardless of the maxima there were other peaks of distribution throughout the environmental variables (Tables 5-12) which suggested that several dominant species of diverse habit occurred here. For example, hydrozoans tended to occur in the shallow water, clean sand area while alcyonaceans tended to occur in deeper water fine sediment areas.

Ectoprocta

Ectoprocta comprised 7.2% of the biomass and 25.5% of the density within the Miscellaneous. They were collected in the northeast corner (Figures 42-43) in mostly low biomass (0.1-9.9 g/m^2) and low density ($10-99/m^2$).

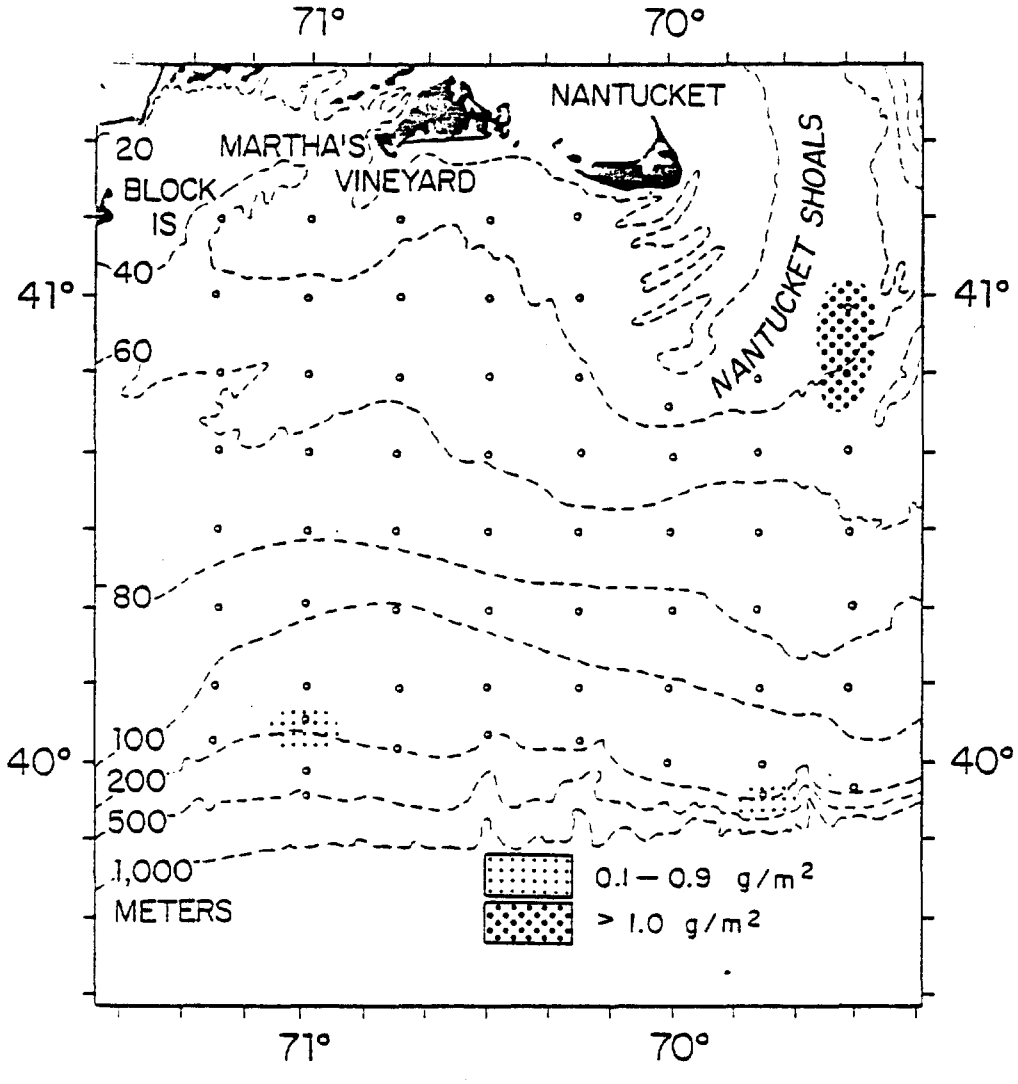


Figure 38. Quantitative distribution of biomass (g/m^2) for Porifera.

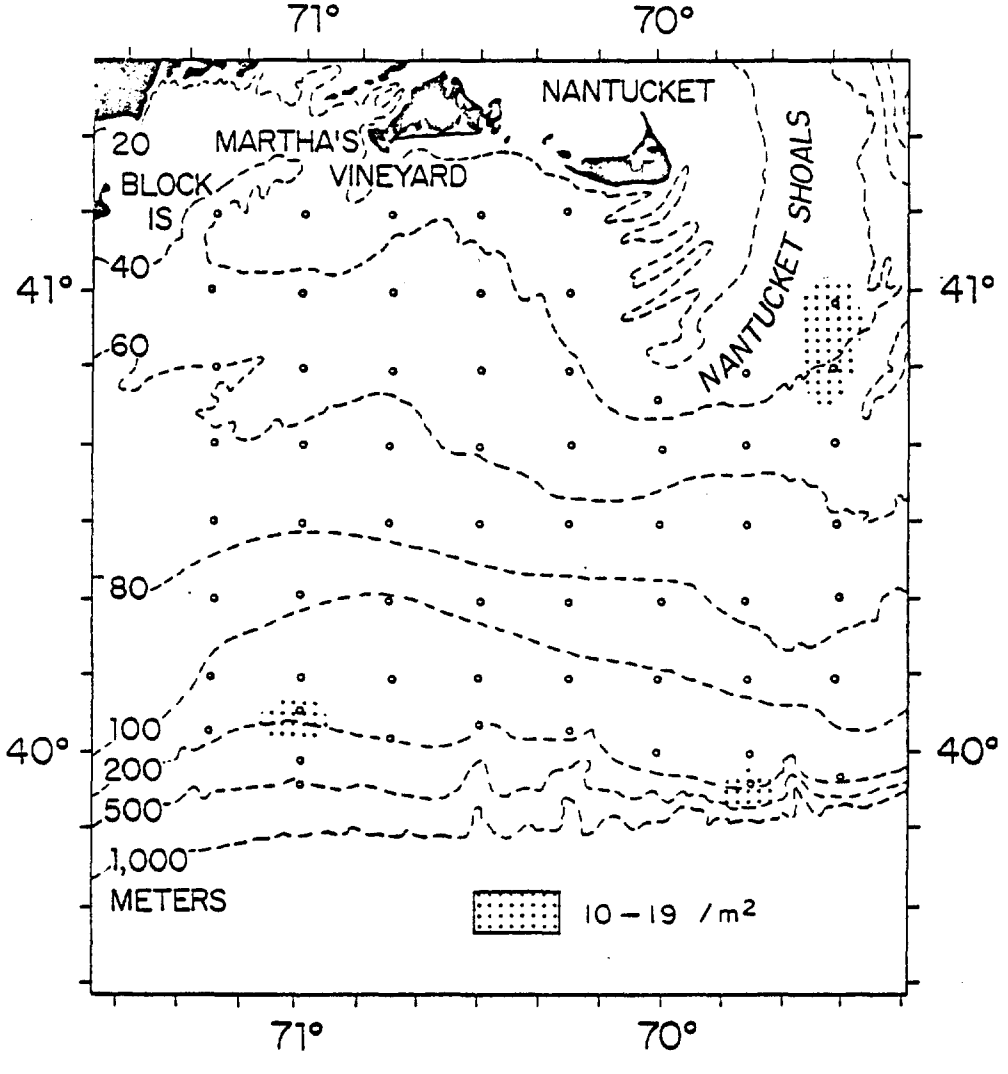


Figure 39. Quantitative distribution of individuals (no./m^2) for Porifera.

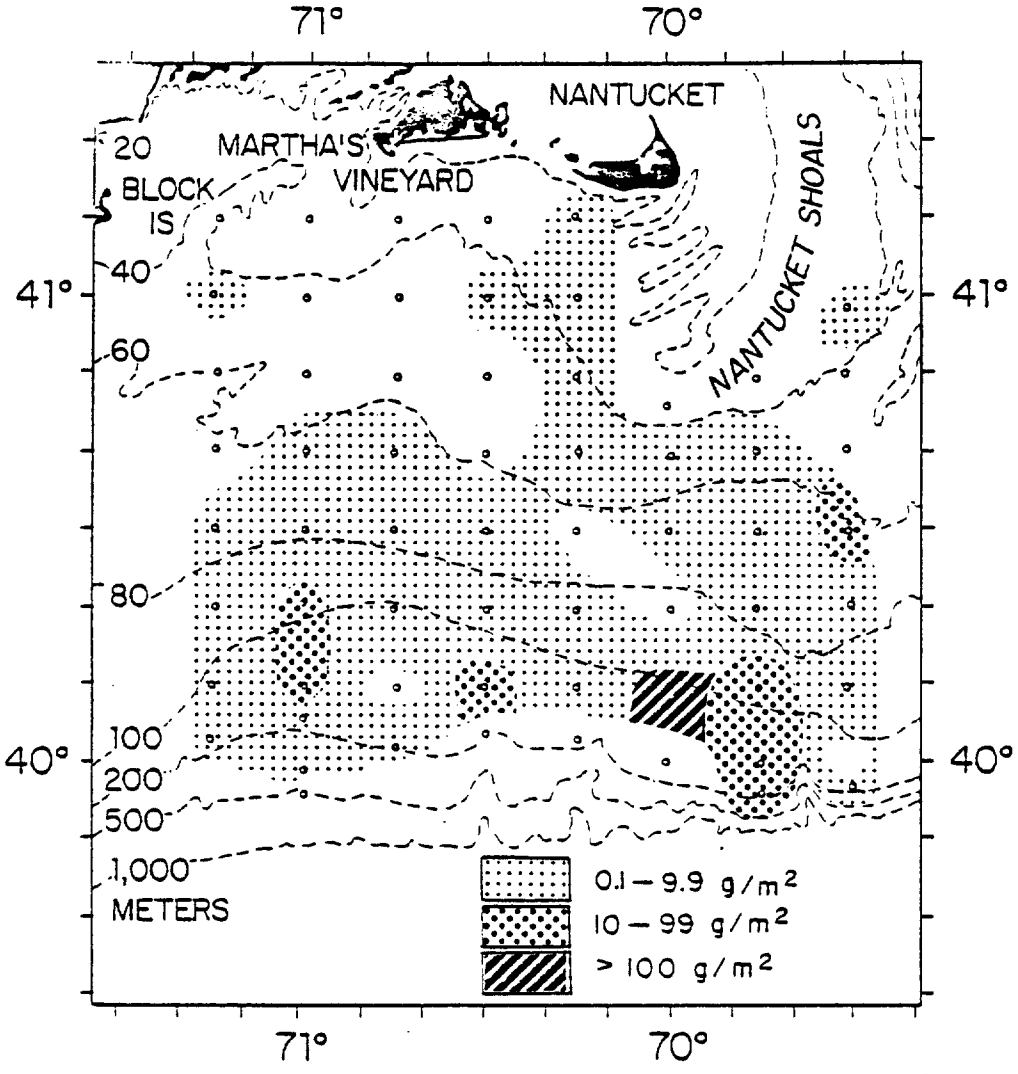


Figure 40. Quantitative distribution of biomass (g/m^2) for Coelenterata.

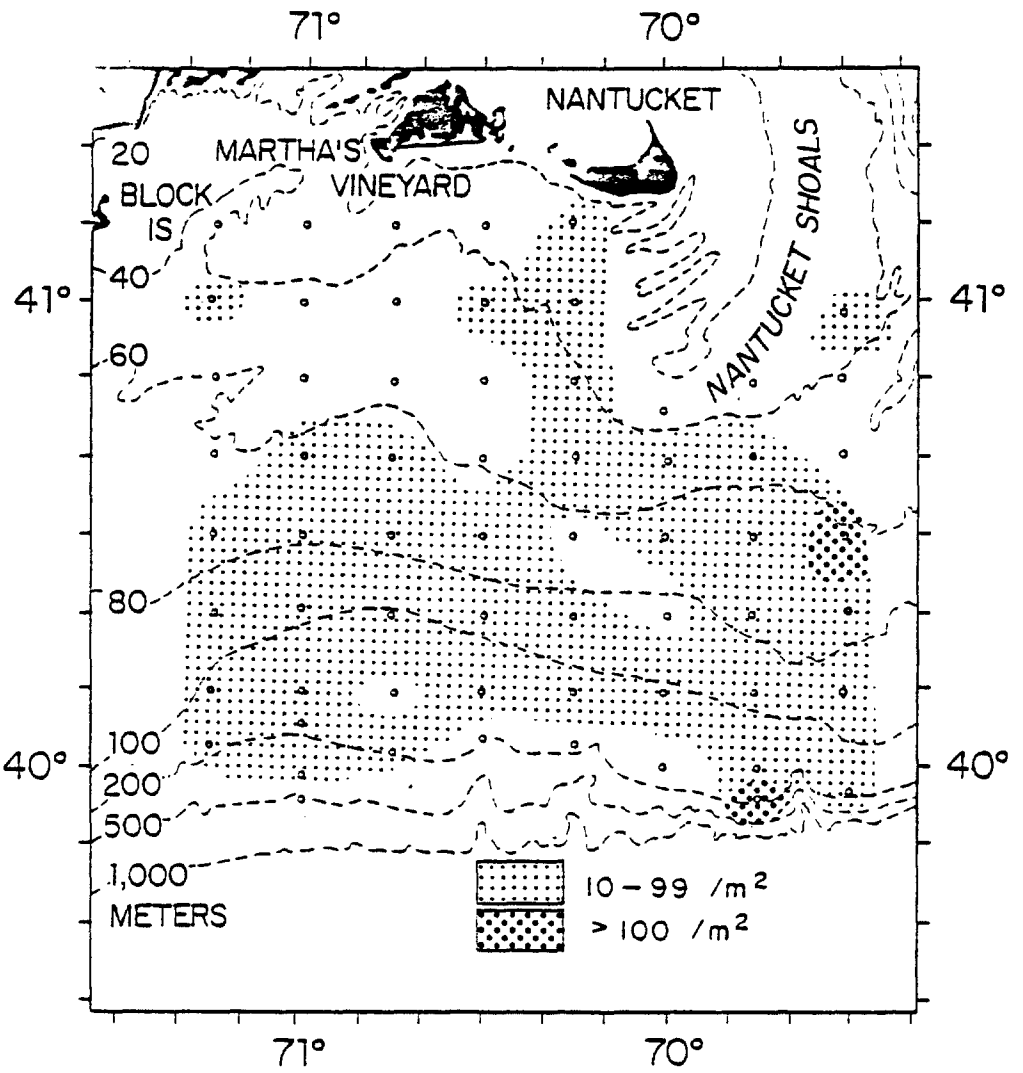


Figure 41. Quantitative distribution of individuals (no./m^2) for Coelenterata.

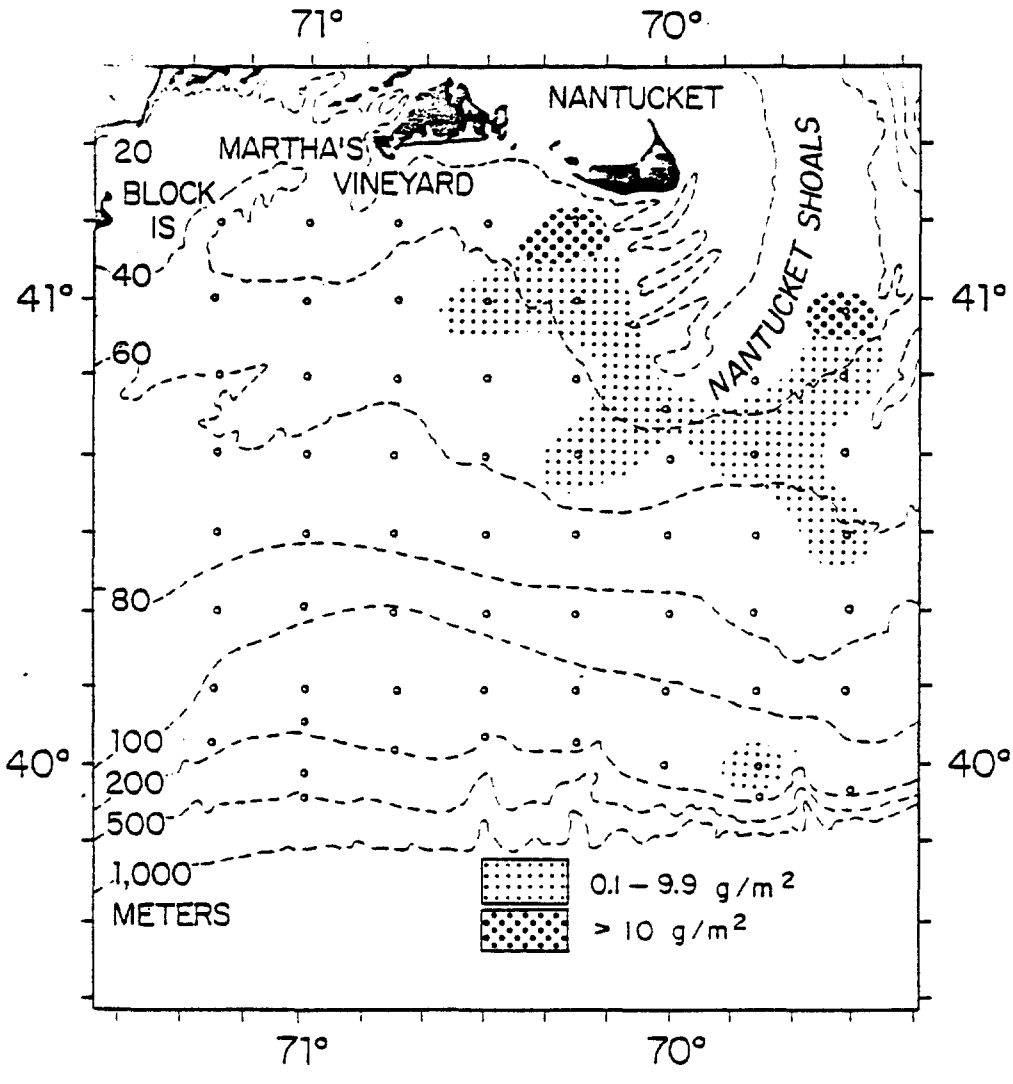


Figure 42. Quantitative distribution of biomass (g/m^2) for Ectoprocta.

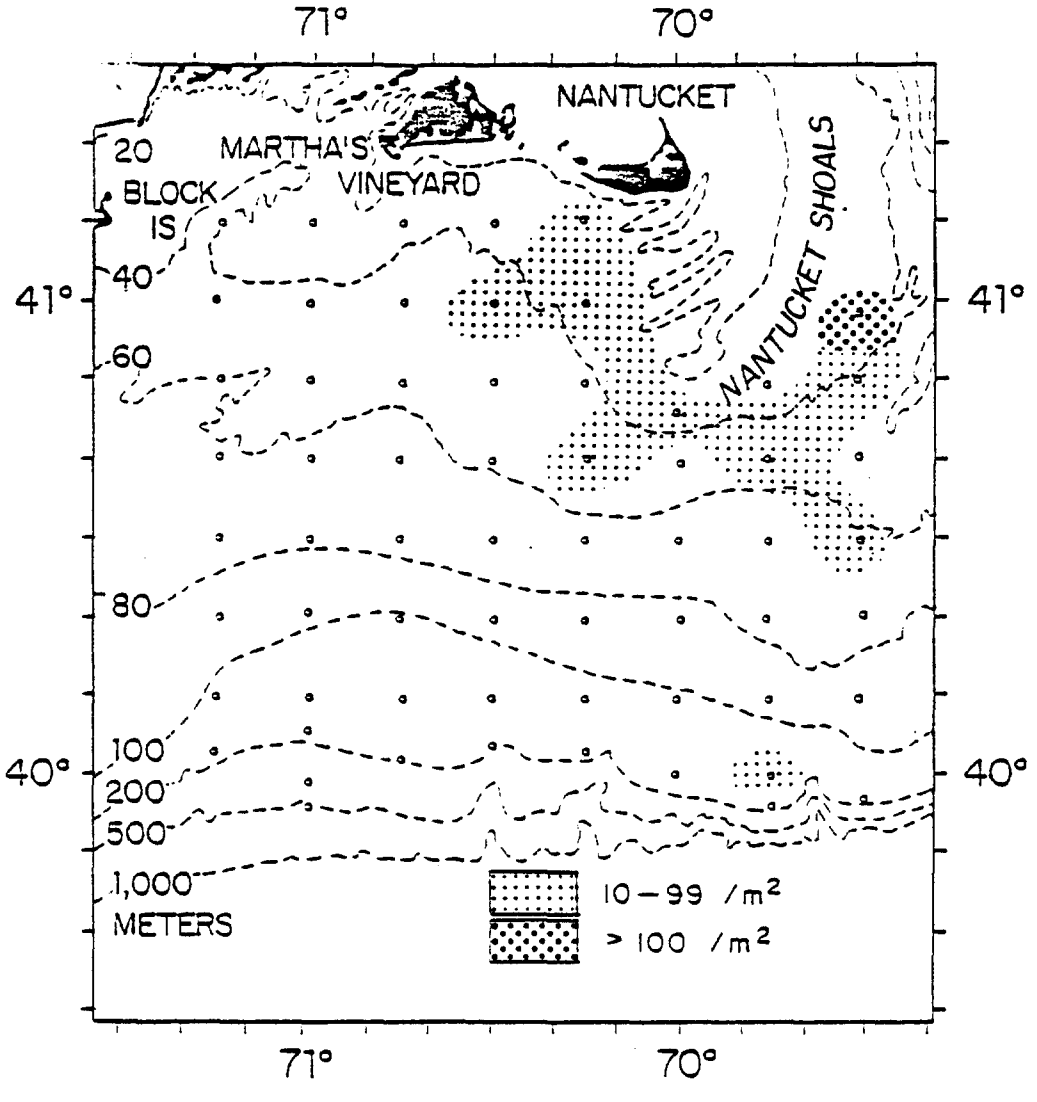


Figure 43. Quantitative distribution of individuals (no./m^2) for Ectoprocta.

The highest average biomass and density of Bryozoa was sampled (Tables 5-12) from 0-40 m (7.6 g/m^2 and 220.4/m^2), 12.0-12.9 °C (8.2 g/m^2) and 8.0-8.9 °C (244.3/m^2), 1.0-1.99 ϕ (2.5 g/m^2 and 6.0/m^2), 0-20% silt-clay (0.73 g/m^2 and 3.0/m^2).

Ascidiacea

The Ascidiacea contained 23.9% of the biomass and 32.3% of the density within Miscellaneous. Principal species included: Molgula spp. and Bostrichobranchus spp. The distribution of ascidiaceans was unusual. The central portion yielded no specimens. Low biomass (0.1-9.9 g/m^2) and density (10-99/m^2) occurred in irregular patterns (Figures 44-45) around the periphery with scattered smaller clusters of medium to high biomass (10->30 g/m^2) and density (100->400/m^2).

The highest average biomass and density of ascidiaceans was recorded (Tables 5-12) from 0-40 m (9.8 g/m^2 and 106.3/m^2), 12.0-12.9 °C (29.9 g/m^2 and 437/m^2), 1.0-1.99 ϕ (11.3 g/m^2 and 112.3/m^2) and 80-100% silt-clay (8.9 g/m^2) and 0-20% silt-clay (50.3/m^2). Biomass and density occurred in considerable abundance throughout the range of sediment variables.

Free Living

Nemertea

Nemertea comprised 7.9% of the biomass and 9.8% of the density within Miscellaneous. No species were identified. Nemerteans were widely distributed but occurred in low density (10-99/m^2) throughout the area. With regard to biomass nemerteans occurred in low concentration (0.1-0.9 g/m^2) on the west side and medium biomass (>1 g/m^2) on the east with one large cluster of low biomass stations in the northeast corner (Figures 46-47).

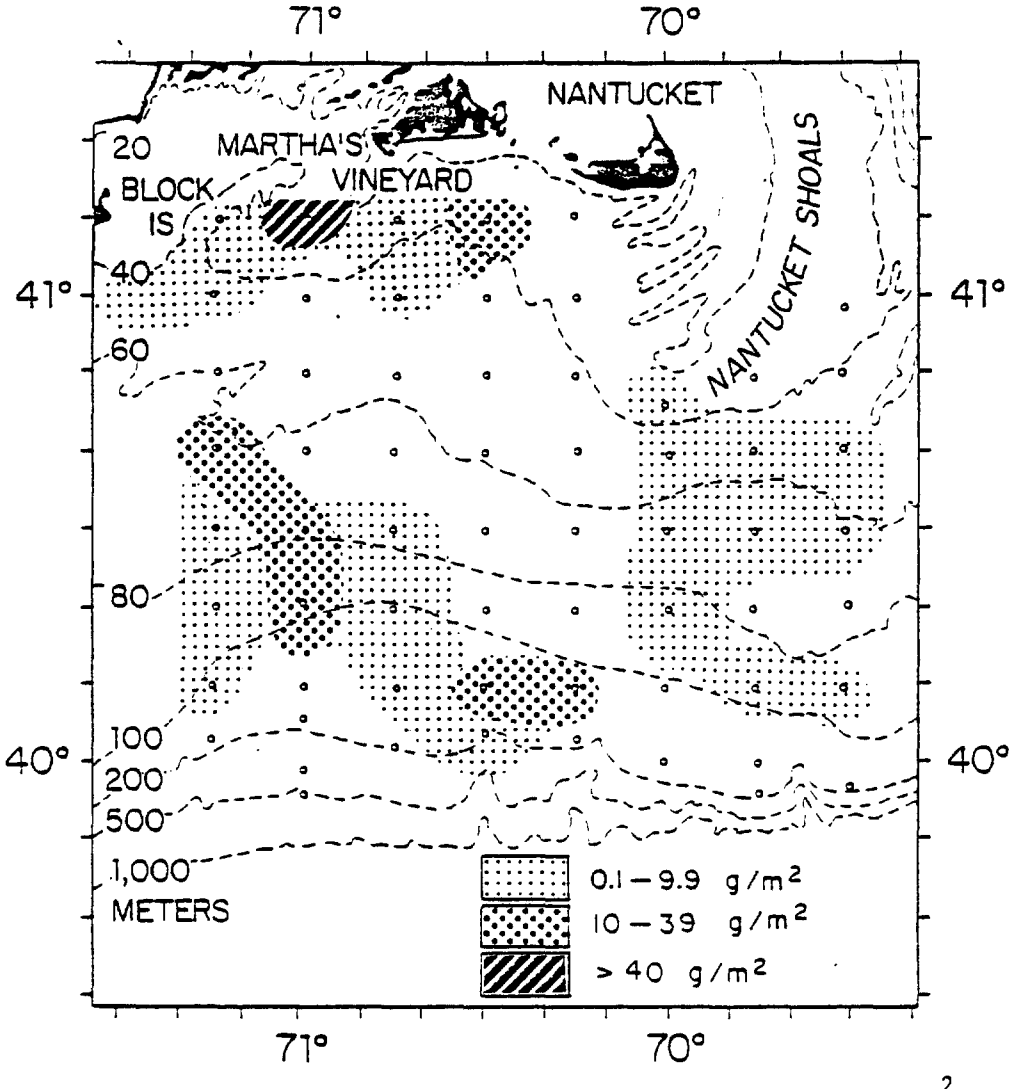


Figure 44. Quantitative distribution of biomass (g/m^2) for Ascidiacea.

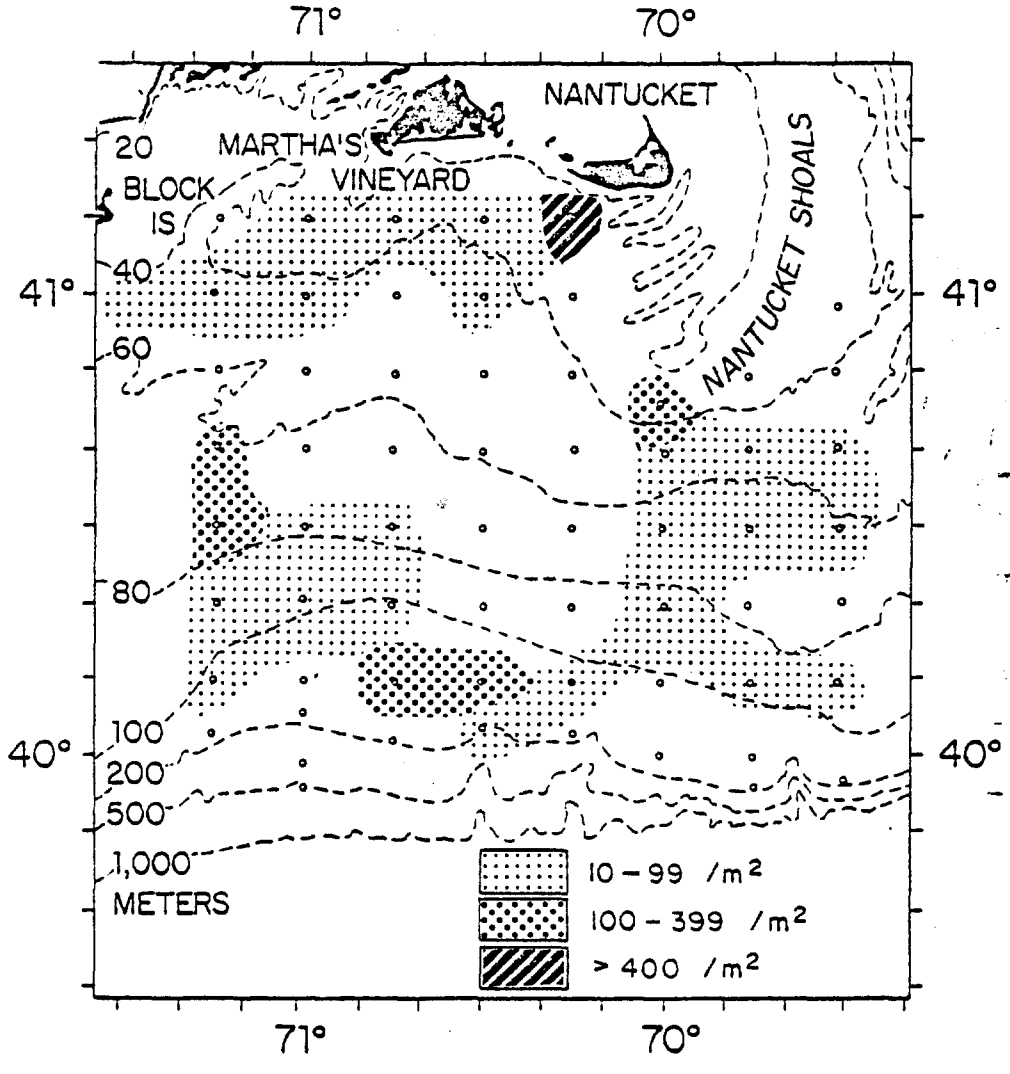


Figure 45. Quantitative distribution of individuals (no./m^2) for Ascidiacea.

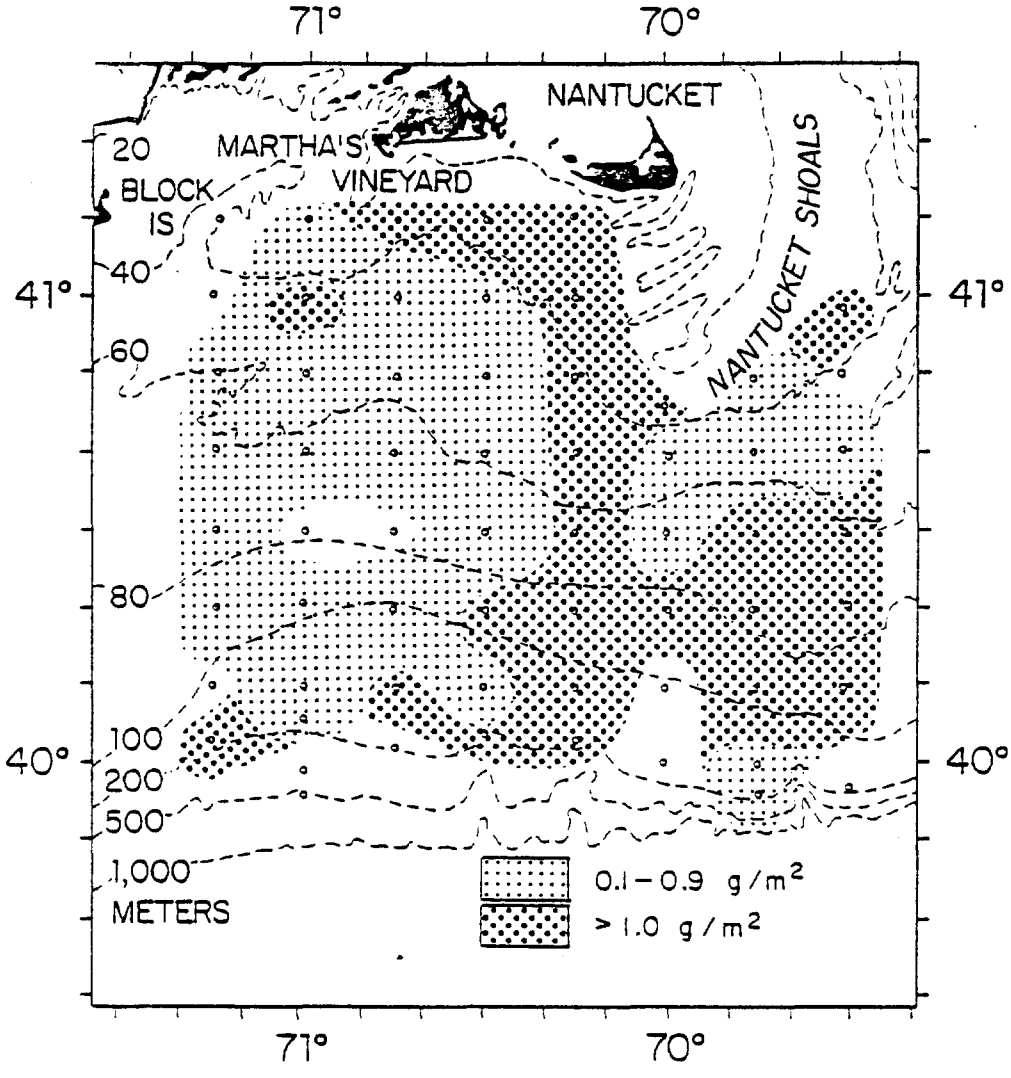


Figure 46. Quantitative distribution of biomass (g/m^2) for Nemertea.

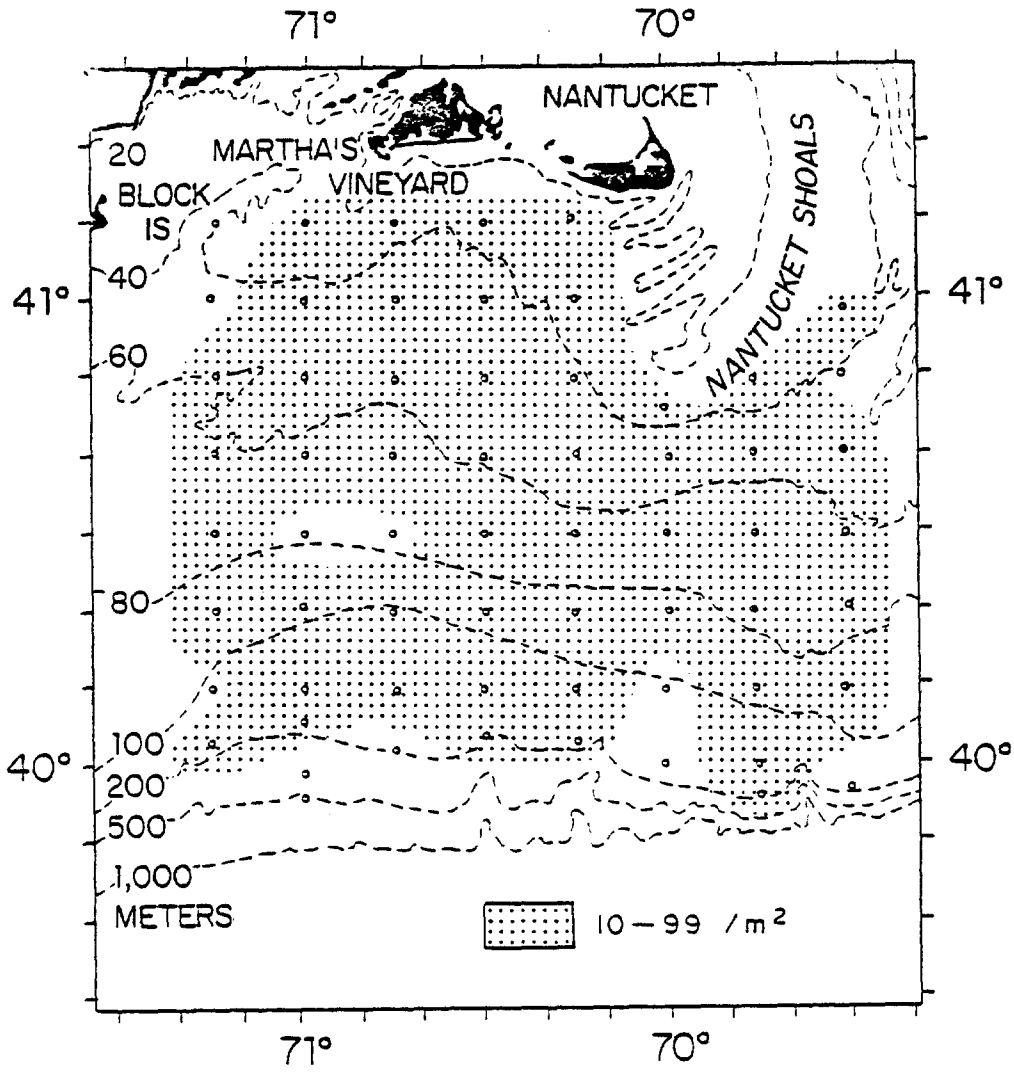


Figure 47. Quantitative distribution of individuals (no./m^2) for Nemertea.

The highest average biomass and density of Nemertea was sampled (Tables 5-12) from 80-100 m (4.7 g/m^2 and 27.9/m^2), 12.0-12.9 °C (4.6 g/m^2) and 7.0-7.9 °C (20.3/m^2), 4.0-4.99 ϕ (2.7 g/m^2) and 3.0-3.99 ϕ (14.8/m^2), 40-60% silt-clay (2.5 g/m^2) and 0-20% silt-clay (13.8/m^2). Regardless of the maxima nemerteans occurred in relatively considerable density and biomass throughout broad environmental variables.

Sipunculida

The Sipunculida contained 10.1% of the biomass and 14.3% of the density within Miscellaneous. Golfingia catherinae, G. elongata, G. margaritacea, G. minuta, Onchnesoma sp., and Phascolion sp. were some of the species. Sipunculids occurred in irregular size and shape clusters ranging from north to south with greater development on the east side (Figures 48-49). Biomass and density were generally low (0.1-4.9 g/m^2 and 10-99/m^2). Medium biomass (>5 g/m^2) occurred more frequently in the shallow half.

The highest average biomass and density of sipunculids was (Tables 5-12) recorded in >200 m (6.7 g/m^2 and 98.5/m^2), 7.0-7.9 °C (3.5 g/m^2) and 11.0-11.9 °C (31.7/m^2), 5.0-5.99 ϕ (2.7 g/m^2 and 39.4/m^2), 60-80% silt-clay (3.0 g/m^2 and 69.6/m^2). Several species of Golfingia occurred in water deeper than 80 m while Phascolion sp. was collected throughout the depth range but in higher frequency in shallow water. Sipunculids of the western North Atlantic were described in detail by Cutler (1973).

Pogonophora

Pogonophora comprised 0.1% of the biomass and 1.1% of the density within Miscellaneous. Siboglinum atlanticum and S. ekmani were the only species. Pogonophorans were collected only at two stations, the deepest

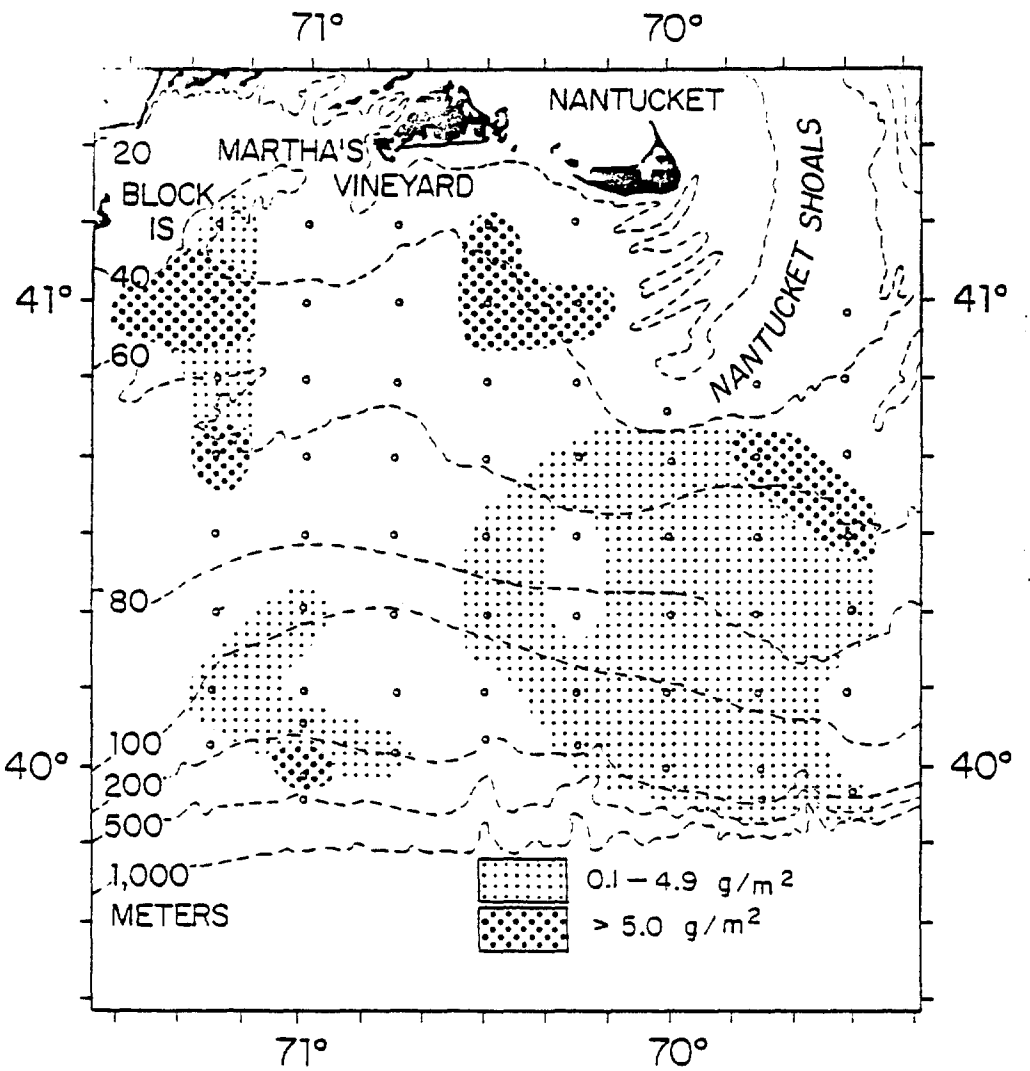


Figure 48. Quantitative distribution of biomass (g/m^2) for Sipunculida.

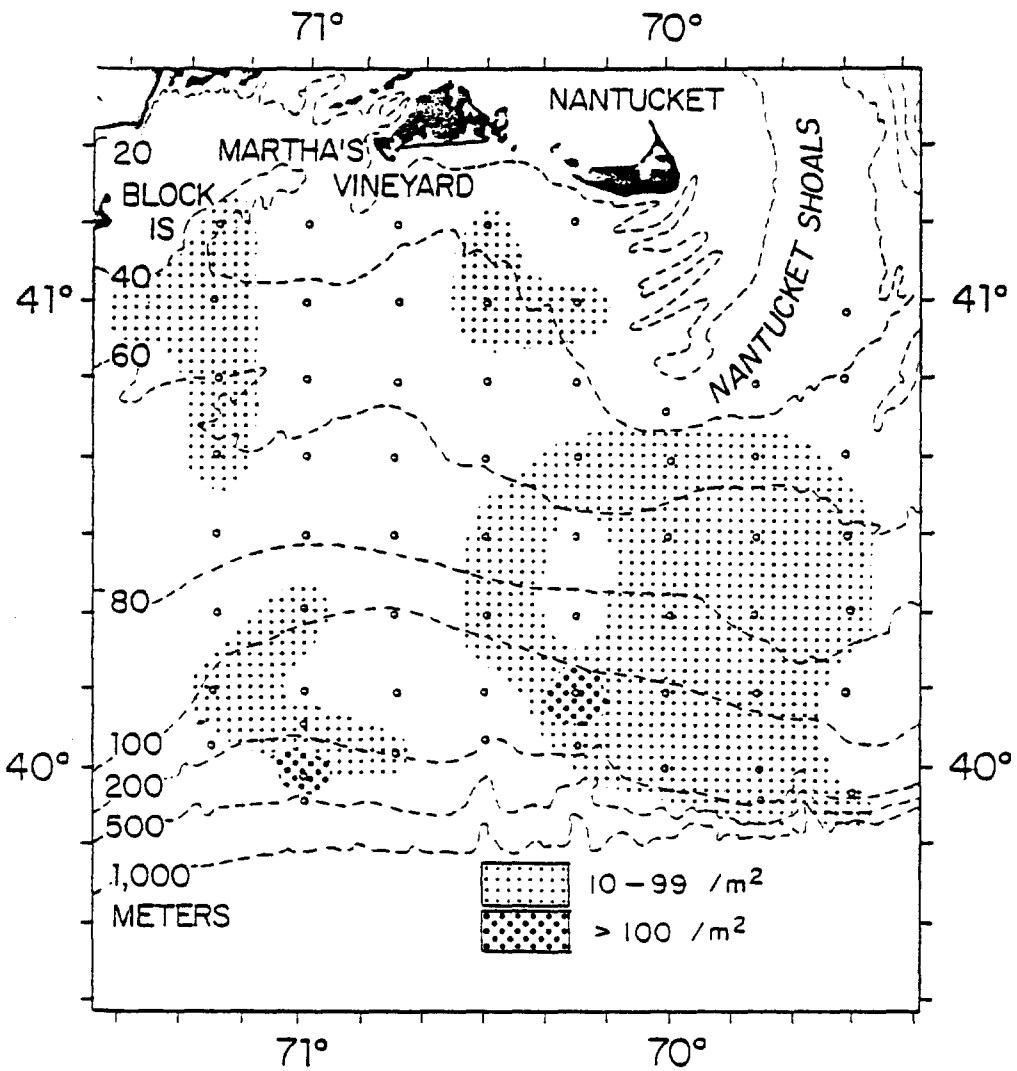


Figure 49. Quantitative distribution of individuals (no./m^2) for Sipunculida.

ones in the study. The occurrence of these two species was described earlier (Wigley, 1963). Even though they were limited in distribution their average biomass and density are included: >200 m (0.15 g/m^2 and 43.5/m^2), 6.0-6.9 °C (0.01 g/m^2 and 4.1/m^2), 4.0-5.99 ϕ (0.02 g/m^2) and 5.0-5.99 ϕ (10.2/m^2), 40-80% silt-clay (0.02 g/m^2) and 60-80% silt-clay (10.2/m^2).

It appears that pogonophorans may be near their upper bathymetric limit here (Wigley, 1963).

Enteropneusta

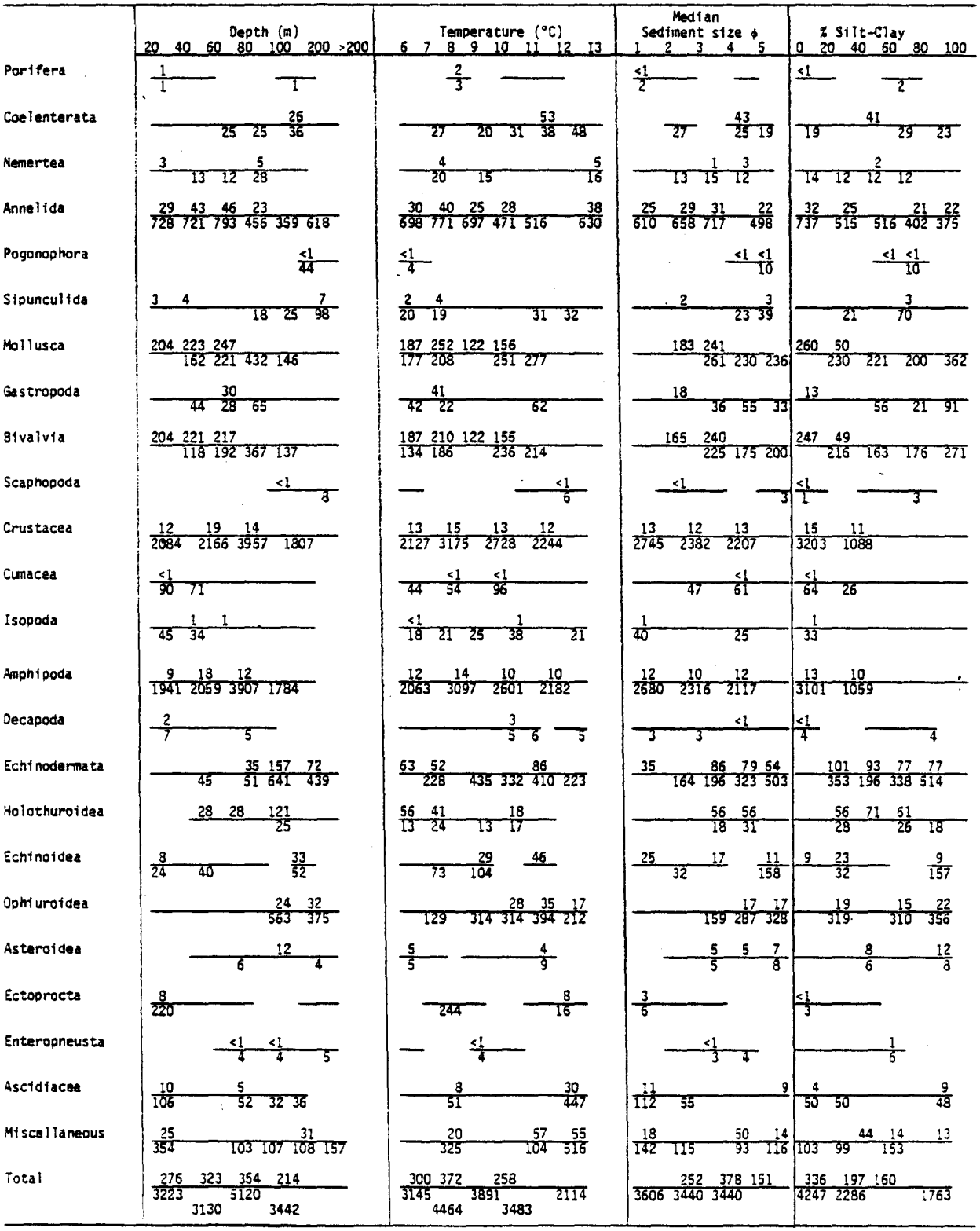
Enteropneusts accounted for 1.6% of the biomass and 1.3% of the density within Miscellaneous. Balanoglossus sp. was the only species recorded. Enteropneusts were collected at only four stations. The highest average biomass and density of enteropneusts was reported (Tables 5-12) in 60-80 (0.8 g/m^2) and 80-100 m (4.3/m^2), 9.0-9.9 °C (0.7 g/m^2 and 3.8/m^2), 4.0-4.99 ϕ (0.6 g/m^2 and 4.4/m^2), and 60-80% silt-clay (1.1 g/m^2 and 6.0/m^2).

Summary of Taxonomic Analysis

A summary of average biomass and density of major taxa in relation to depth, temperature, median sediment size and silt-clay is presented in figure 50. Figure 50 contains the total range of a taxon per environmental variable together with high values of average biomass and density plotted for a specific mid-range.

Total average biomass and density were well developed between 0-100 m. Amphipods, bivalves, polychaetes and echinoderms mainly influenced the distribution of biomass and density. The biomass of Crustacea, Mollusca (except

Figure 50. Summary of average biomass (g/m^2) and density ($no./m^2$) of major taxa (B/D) in relation to depth, temperature, median sediment size and silt-clay.



Scaphopoda), Ectoprocta, Porifera and Ascidiacea occurred mostly in shallow to medium depth (0-100 m). Density was similar to biomass but it ranged deeper for Mollusca and Ascidiacea. The biomass of Scaphopoda, Echinodermata, Coelenterata, Pogonophora and Enteropneusta was higher in medium to deep water (80->200 m). Their density tended to range from 60->200 m. Biomass and density of polychaetes, nemerteans, and sipunculids occurred relatively evenly throughout the depth range.

Temperature

The presence of a cold water cell bounded by warmer water on the north and south (Figure 3) made it difficult to interpret distribution according to temperature. In this case there was a shallow water (0-50 m) and deep water (80-100 m) zone both containing water ranging from 7-12 °C. Even though the maximum biomass of certain taxa was associated with shallow water (Ectoprocta) and deep water (Ophiuroidea), their maximum biomass according to temperature was similar (11.0-12.9 °C). The Coelenterata, another deep water taxon, had its highest biomass in 11.0-11.9 °C, a temperature normally associated with depths of approximately 40 m for this time of the year. Thus it is important to bear in mind here the relative position of the cold water cell in relation to depth when comparing distribution according to temperature.

Median Sediment Size

Total biomass was well developed between 2.0-5.0 ϕ whereas density peaked between 1.0-4.0 ϕ. Biomass of Crustacea and Mollusca and density of the former occurred mainly between 1.0-4.0 ϕ. Biomass and density of Echinodermata, Coelenterata and Sipunculida and density of Mollusca peaked between 3.0-5.99 ϕ. Annelids again ranged in considerable biomass and density throughout the range of median sediment size as did the Nemertea to a lesser extent.

Silt-Clay

Total biomass and density were well represented in sediment containing 0.60% silt-clay. Biomass of Crustacea, Mollusca, Echinoidea and Asteroidea was associated with low percent silt-clay while the biomass of Sipunculida, Pogonophora, Enteropneusta, and Ophiuroidea was associated with greater than 60% silt-clay. The density of Mollusca, Ophiuroidea, Echinoidea, Coelenterata and Sipunculida was also associated with sediment containing more than 60% silt-clay.

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