Characterization of Phytoplankton Biomass and Community Size-composition near the Deepwater Dumpsite 106 and Philadelphia Dumpsite

by

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Report No. SHL 82-20
(August 1982)

Introduction

The purpose of this paper is to characterize the phytoplankton communities in slope and outer shelf water adjacent to the Deepwater Dumpsite "106" and in the vicinity of the Philadelphia Dumpsite (figure 1). The characterization of these sites is based on chlorophyll *a* measurements, an index of phytoplankton biomass, made during 54 Northeast Fisheries Center surveys.

Methods

Water samples for pigment analysis were collected on 54 cruises from October 1977 through March 1982 as part of an extensive ongoing monitoring and assessment program to characterize the principle biological components of the ecosystem over the northwest Atlantic continental shelf from Cape Hatteras to Nova Scotia. Generally, at each sampling location water for pigment analysis was collected from standard depths of 1, 5, 10, 15, 20, 25, 30, 35, 50 and 75 m or bottom whichever came first. After spring 1980, 100 m sampling depth was added and routinely sampled.

On board the vessel samples were size-fractionated into netplankton (>20 μm) and nannoplankton (<20 μm) and analyzed for chlorophyll *a* using the fluorometric method described in Evans and O'Reilly (in press). The chlorophyll concentrations of the two size fractions were added to generate an estimate of the total chlorophyll *a* found at each depth sampled. The weighted water column average of total chlorophyll was calculated for each station sampled and then contoured using SYMAP program, version 5, Harvard Center for Environmental Design Studies, Laboratory for Computer Graphics and Spatial Analysis.

In this report two areas, the Philadelphia Dumpsite and the Deepwater 106 dumpsite are being characterized. The Philadelphia dumpsite by definition lies between latitudes 38°20' and 38°25' and longitudes 74°10' and 74°20'. To have more data to work with, we have expanded the dumpsite area to be characterized to the area between latitudes 38°00' and 38°40' and longitudes 73°40' and 74°40' with a bottom depth between 40 and 60 m (figure 1). The deepwater 106 dumpsite lies between latitudes 38°40' and 39°00' and longitudes between 72°00' and 72°30'. To examine chlorophyll distribution, the area potentially affected by material dumped at site 106 (through warm core eddy interaction) as defined by Mert Ingham (see figure 1), was divided into two subareas, 1) the slope, the area seaward of the shelf break between 200 and 2000 m and 2) the outer shelf (area approximately between 60 m to 200 m). Data are not available for the area beyond the 2000 m isobath.

The water column in all regions examined was divided into euphotic (water column down to 1% light intensity depth (LID)) and subeuphotic (water column below the 1% LID) layers. The 1% LID used in this report was determined by averaging all LID measured over four sampling years in each area. The average 1% light depths were 33, 35 and 42 m for the Philadelphia dumpsite, outer shelf and slope areas, respectively.

Data collected in each area from all four years sampled were pooled to form a synthetic year so that the general features of the annual cycle of phytoplankton abundance (chlorophyll a) could be described. A weighted average chlorophyll a (mg/m^3) was determined for each station occupied within a study area. The weighted averages for total chlorophyll a, netplankton chlorophyll a and nannoplankton chlorophyll a were arithmetically averaged for the euphotic and subeuphotic layers in each region. The chlorophyll a (mg/m^3) in the netplankton size-fraction and in the nannoplankton size fraction in each layer were graphed by month to get an understanding of community structure throughout the year. The percentage of the total community chlorophyll contributed by nannoplankton was determined by dividing total chlorophyll a by the chlorophyll a found in the nannoplankton size fraction.

Results and Discussion

Mid-Atlantic Bight - Outer Shelf Region

High monthly average standing stocks of phytoplankton (1.45 - 2.74 mg Chla/m^3) were measured in the euphotic layer during the unstratified season, between November and March whereas low standing stocks (0.64 - 0.77 mg chla/m^3) were measured during the stratified season, April through October (figure 2). Generally, netplankton were more prevalent when the water column was unstratified and nannoplankton were more prevalent during the stratified season.

The highest standing stocks and the greatest netplankton dominance were observed during the March "spring bloom". A secondary peak, consisting of equal levels of nannoplankton and netplankton, was observed in November, after the fall turnover.

The average concentration of chlorophyll a in the euphotic layer was equal to or slightly greater than chlorophyll concentration in the subeuphotic layer except during May, July, and October when euphotic stocks were 1.8, 2.1 and 3.3 times greater than subeuphotic stocks. The annual average chlorophyll a concentration in the euphotic layer (1.21 mg/m^3) was slightly greater than that for the subeuphotic layer (1.02 mg/m^3). Nannoplankton comprised 52% of the annual average biomass in the euphotic layer and 36% of the average biomass in the subeuphotic.

The size-composition of the phytoplankton changed seasonally but the size-composition of the plankton in the euphotic and the subeuphotic layers was similar, with netplankton tending to be slightly more abundant in the subeuphotic layer. An exception to the above generalization occurred in April and June when nannoplankton strongly dominated the euphotic layer and netplankton strongly dominated the subeuphotic. In general, during the stratified season, standing stocks were more variable below than above the euphotic layer.

Mid-Atlantic Bight-Slope

Over the slope, the highest standing stocks of chlorophyll a (0.51 - 1.78 mg/m^3) were measured during the unstratified season and the lowest (less than 0.5 mg/m^3) between June and August; a seasonal pattern similar to that observed in the outer mid-Atlantic Bight shelf. The highest chlorophyll a concentrations were found during the "spring bloom" in March (1.78 mg/m^3 in the euphotic layer and 0.88 mg/m^3 in the subeuphotic). A secondary peak was seen in November (1.24 mg Chla/m^3 in the euphotic and 0.78 mg Chla/m^3 in the subeuphotic layer) (Table 1).

The average chlorophyll concentration in the euphotic layer was consistently greater than that measured in the subeuphotic layer, except in July and August when biomass in both layers was similar (Table 1).

In general, nannoplankton dominated both layers throughout the year except during spring bloom when netplankton strongly dominated and during November and December when netplankton and nannoplankton contributed equally to community biomass.

Nannoplankton played a larger role over the slope than in the outer shelf. Average chlorophyll a concentration in water over the slope was usually lower than that measured in water over the outer continental shelf (figure 2).

Philadelphia Dumpsite

The Philadelphia Dumpsite is located in the middle of the onshore-offshore biomass (chlorophyll a/m^3) gradient typically seen on the shelf in the Middle Atlantic Bight (figure 3). As in the outer shelf and slope regions, the highest chlorophyll a concentrations were found in both euphotic and subeuphotic layers during the March spring bloom when the average chlorophyll a concentration in both layers was greater than 4.5 mg/m^3 and netplankton comprised 80-86% of the community. Elevated concentrations were also found in November after the fall turnover, but unlike the slope and outer shelf there was a third time when elevated biomass concentrations were observed. This was in June during the stratified season. The representativeness of this peak is questionable. Data collected from the two years we sampled this area in June conflict. Biomass concentrations in 1981 were high while concentrations in 1978 were more similar to lows observed during other summer months.

The annual average chlorophyll a concentration in the euphotic layer (2.02 mg/m^3) was slightly less than that for the subeuphotic layer (2.20 mg/m^3). On an annual basis netplankton accounted for 66% of the standing stocks in the euphotic layer and 75% of the stocks below the euphotic layer.

Summary

Recurrent gradients in the phytoplankton concentrations are usually found in the Mid-Atlantic Bight; average water column concentrations of chlorophyll a decrease (often by a factor of 5-10) from the shore to the area over the slope. The magnitude of the phytoplankton standing stocks as well as the size composition of the phytoplankton at the Philadelphia dumpsite is typical of the midshelf of the Middle Atlantic Bight shelf. Our analysis of the outer shelf and slope do not embrace the actual 106 site, however, they do characterize the phytoplankton ecology over the slope contiguous to 106.

There is also a gradient in size-composition of the phytoplankton community from the shore to the slope. On an annual basis netplankton were more abundant at the Philadelphia site and nannoplankton were more abundant over the outer shelf and slope near the 106 site. Over the Philadelphia Dump Site nannoplankton accounted for 34% and 25% of the annual standing stocks in the euphotic and subeuphotic layer respectively, and accounted for 52% and 36% respectively in the euphotic and subeuphotic layers over the outer shelf. They accounted for 63 and 59% respectively of the biomass in the euphotic and subeuphotic layers over the slope.

In all three regions examined netplankton were more abundant in the subeuphotic than in the euphotic layer. This may be a result of higher sinking rates of the larger netplankton. Additionally concentrations of chlorophyll below the euphotic layer were slightly greater than above the euphotic layer (euphotic/subeuphotic ration = 0.90) at the Philadelphia dumpsite whereas at the outer shelf and slope the ratios were 1.2 and 2.0 respectively. Our findings of relatively high biomass below the euphotic layer at the Philadelphia site may have a bearing on the biological oxygen demand of the deeper subpycnocline water at this site.

The annual cycle of phytoplankton biomass over the outer shelf and the slope was similar. The highest average standing stocks were found in March associated with "spring bloom". The lowest were found during the stratified season from summer to early fall. A second peak in biomass was observed in November after fall turnover. The annual cycle of biomass in the Philadelphia dumpsite was similar to the outer shelf and slope except that biomass concentrations during the stratified season were not low during all months. Biomass concentrations were high in June.

The results of this study are supported by an earlier set of observations made by Yentsch (1977) in July, September and November of 1957, and January and May of 1958. The highest concentrations of chlorophyll, averaging roughly 3.25 mg chl$\underline{a}$/m^3 in the New York Bight outer shelf and slope surface water, were measured during the November sampling. Lowest values, averaging roughly 0.40 mg chl$\underline{a}$/m^3 were observed during July. Sampling did not occur between February and April and consequently the major spring maxima was not observed by Yentsch.

In general, earlier studies around the Philadelphia Dumpsite support our conclusions. Smith (1973) reported standing stocks of phytoplankton decreased with distance from shore. Smith found dinoflagellates dominant in surface water during spring and summer with diatoms prevalent in bottom waters.

<u>Bibliography</u>

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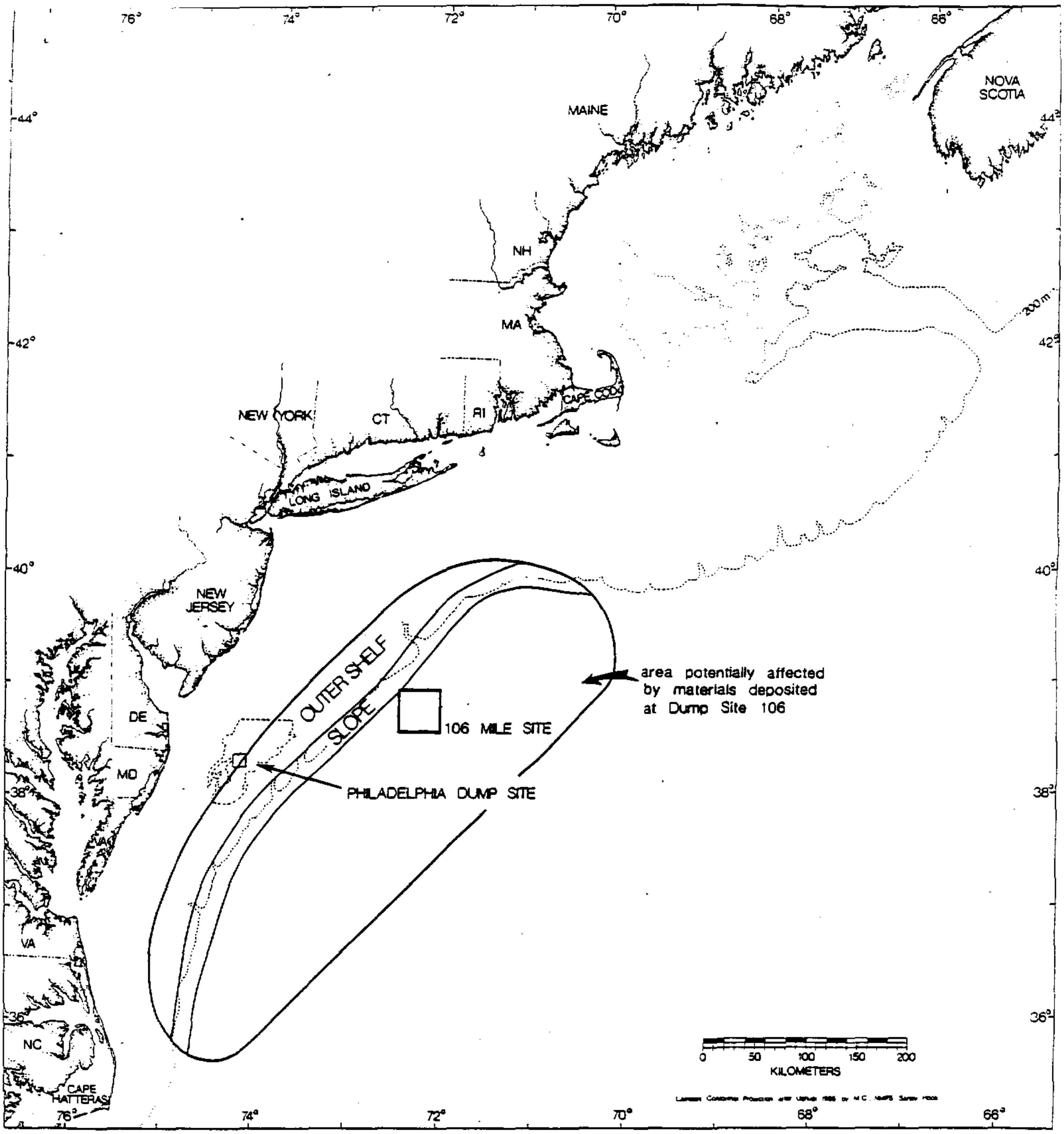


Figure 1. Location of outer shelf and slope study areas, location of Philadelphia and 106-mile dumpsites, and location of warm core eddy interaction envelope.

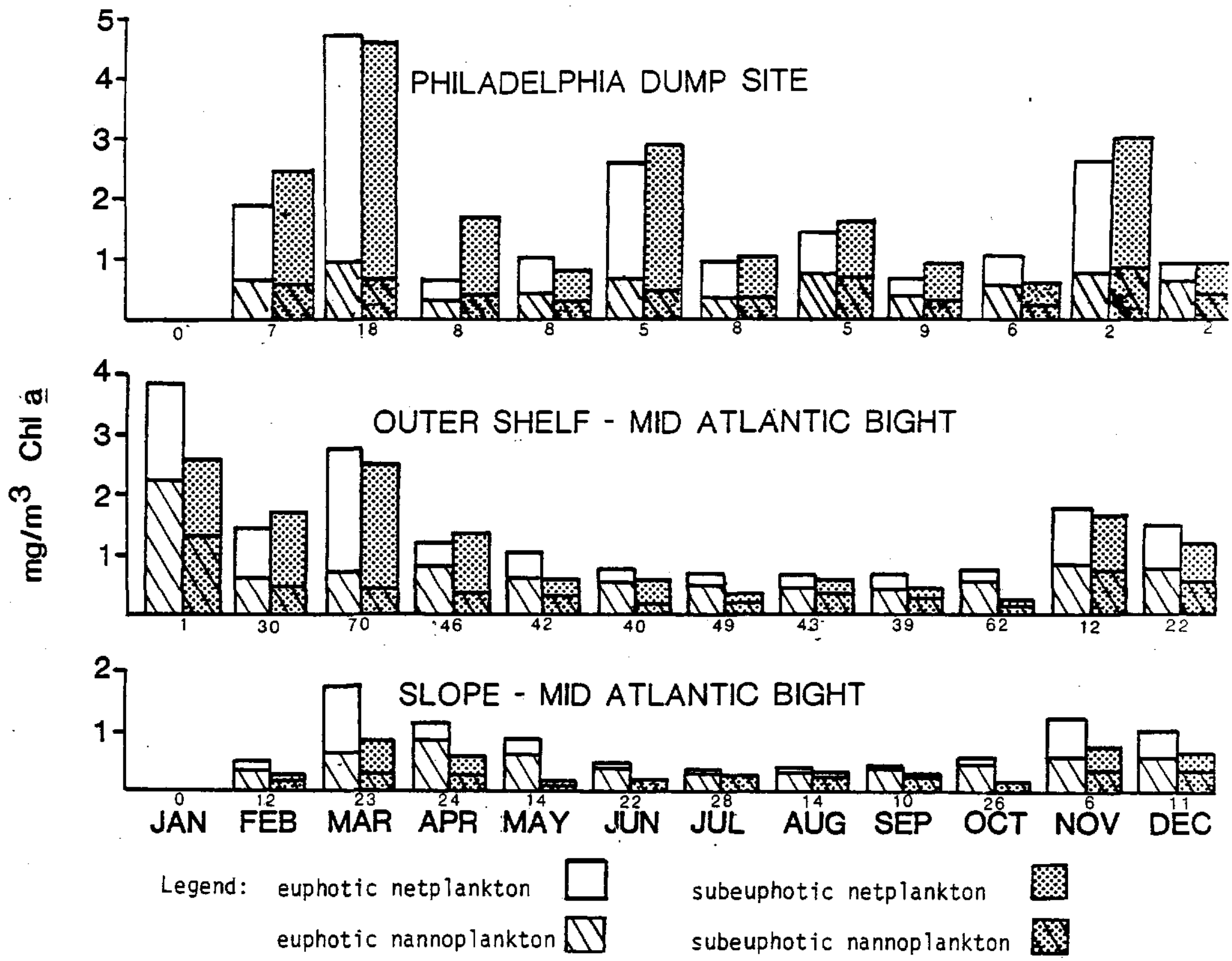
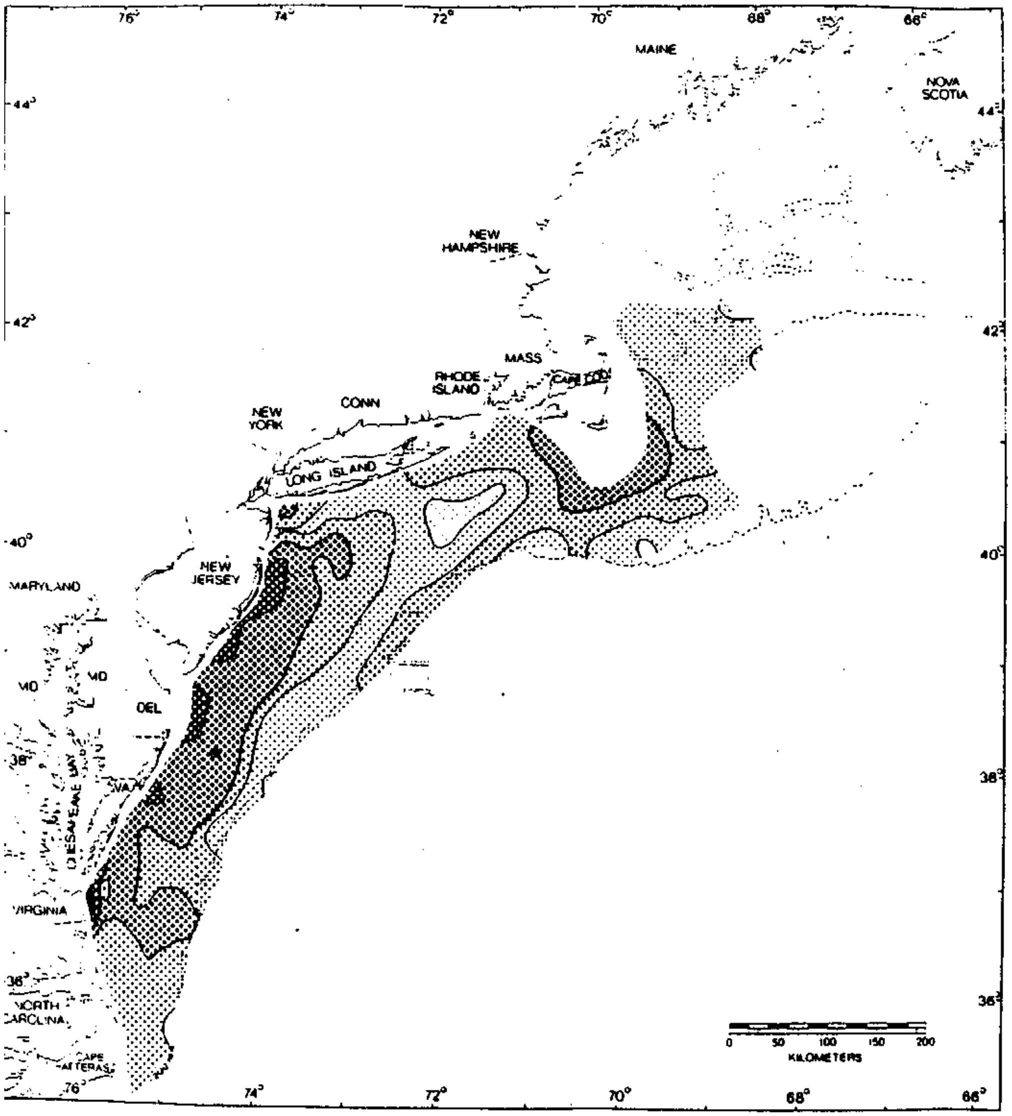


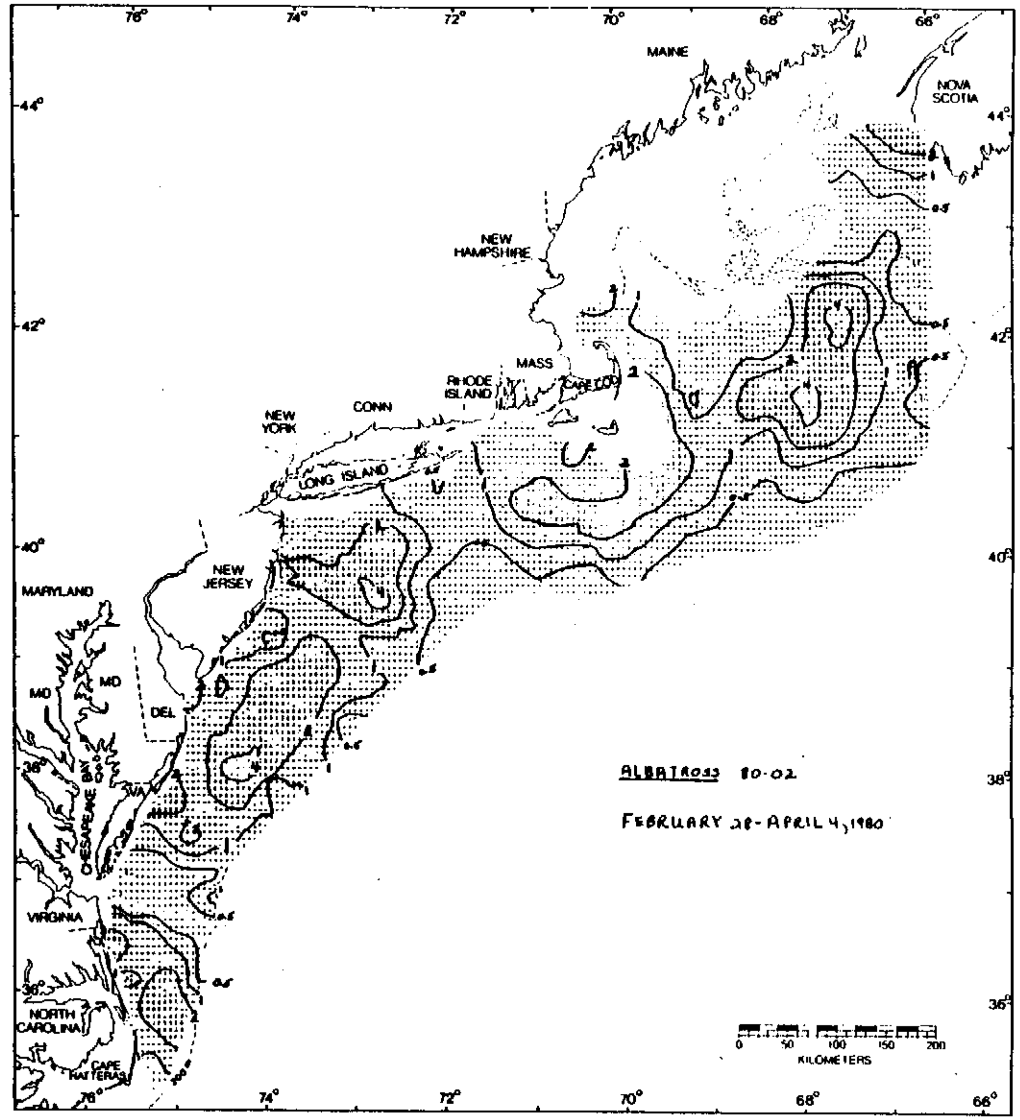
Figure 2. Monthly concentration of nannoplankton and netplankton chlorophyll a in the euphotic and subeuphotic layers at the Philadelphia dumpsite and in outer shelf and slope water of the Mid-Atlantic Bight. Numbers below bars indicate the number of times observations were made in sampling area over four-year period.

Figure 3.

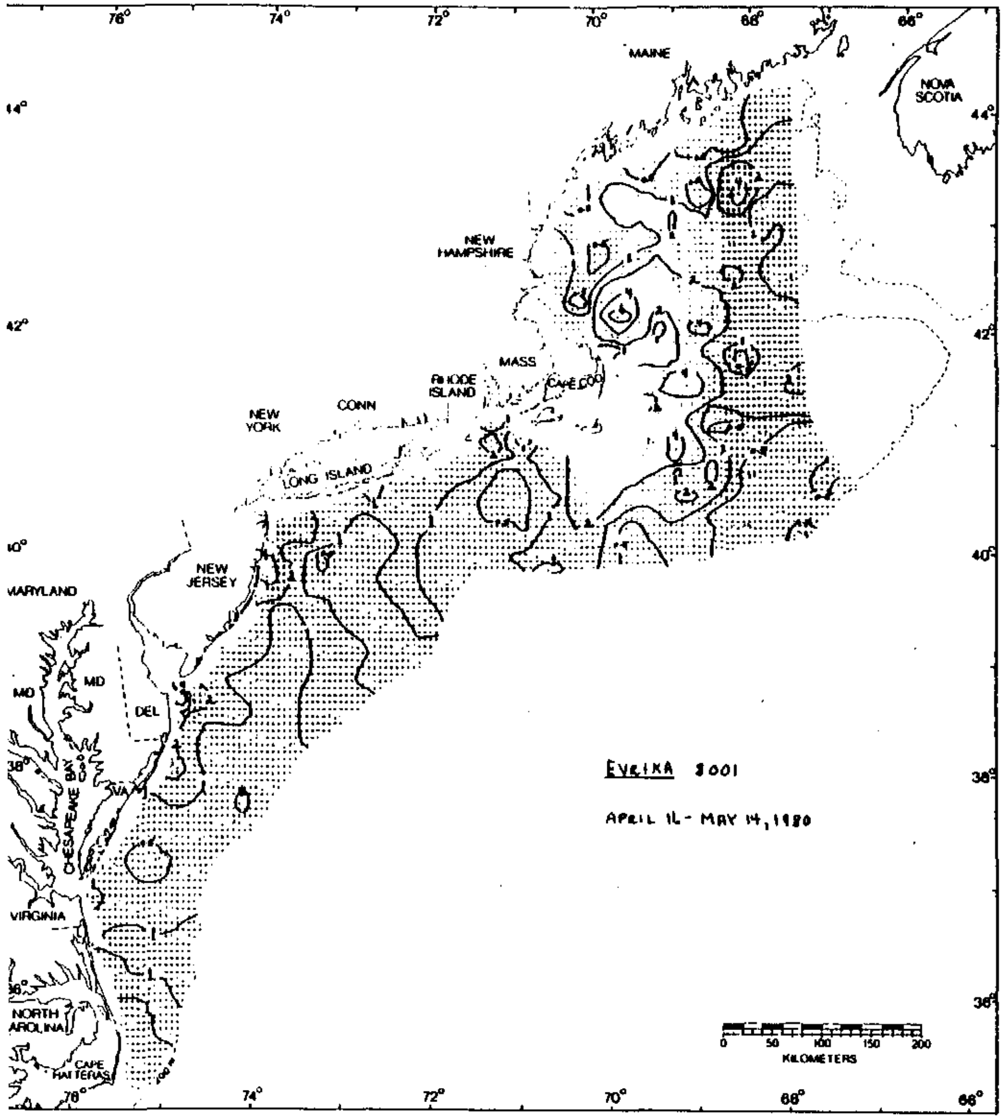
Distribution of chlorophyll a mg/m^3 during eight months of the year.



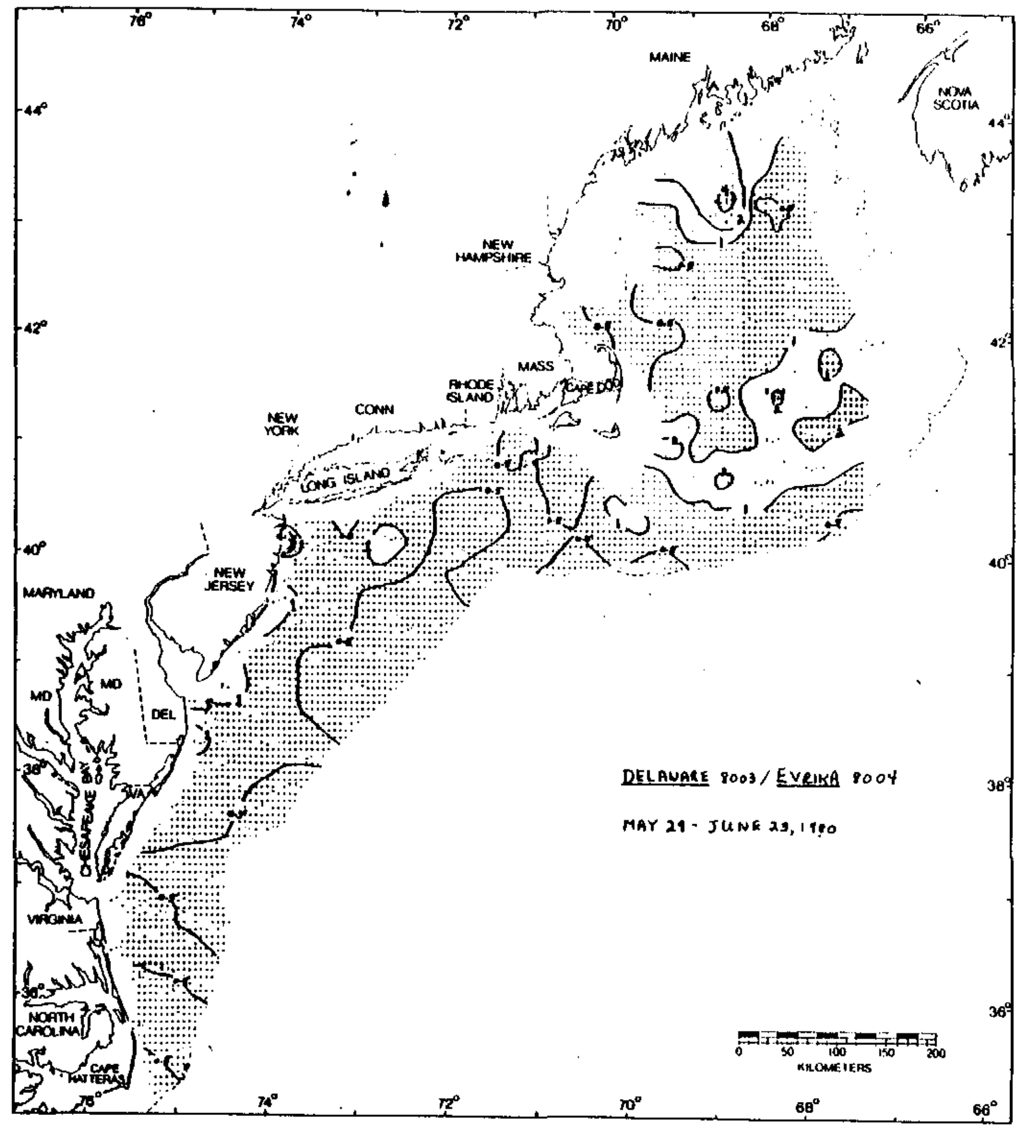
Delaware II 79-03, February 24-March 14, 1979



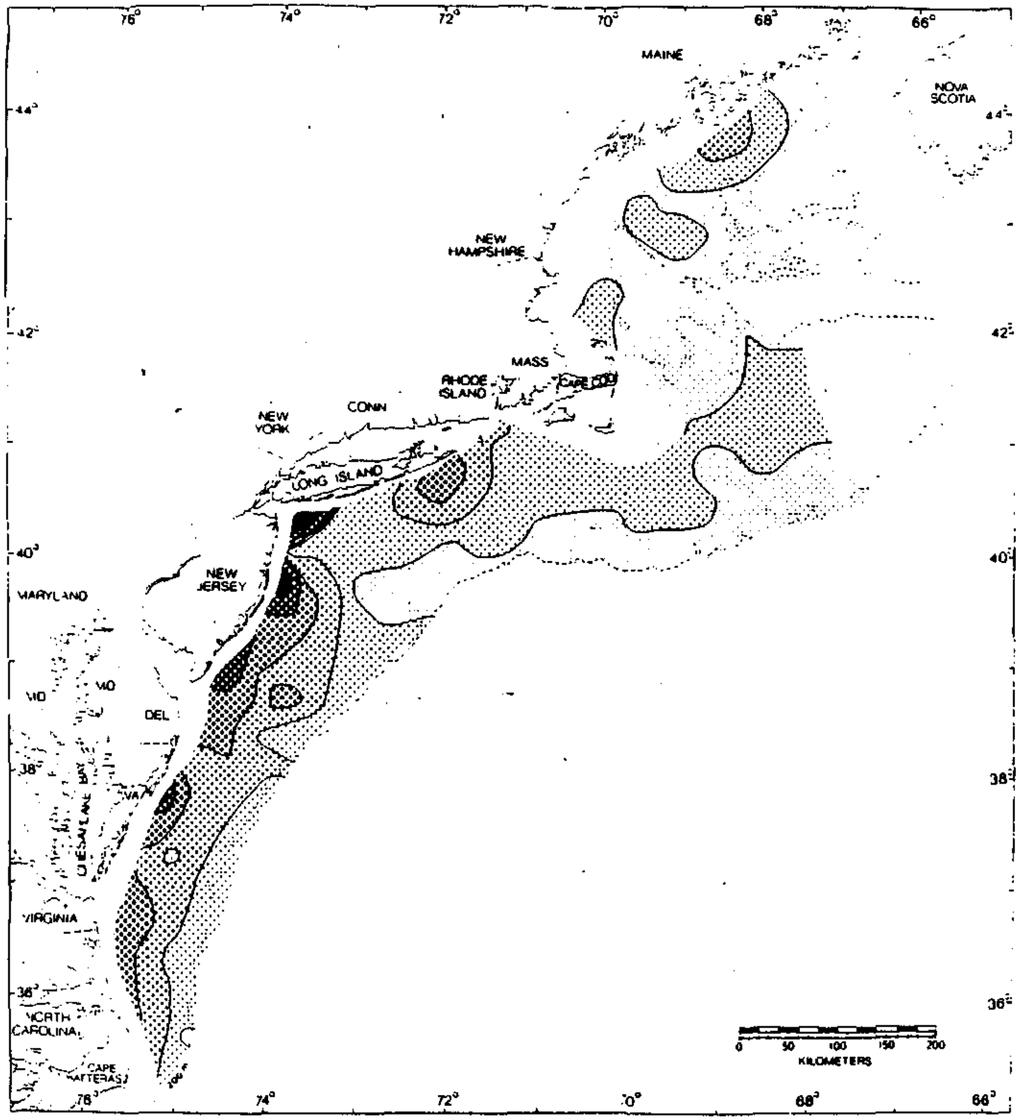
Albatross IV 80-02, February 28-April 4, 1980



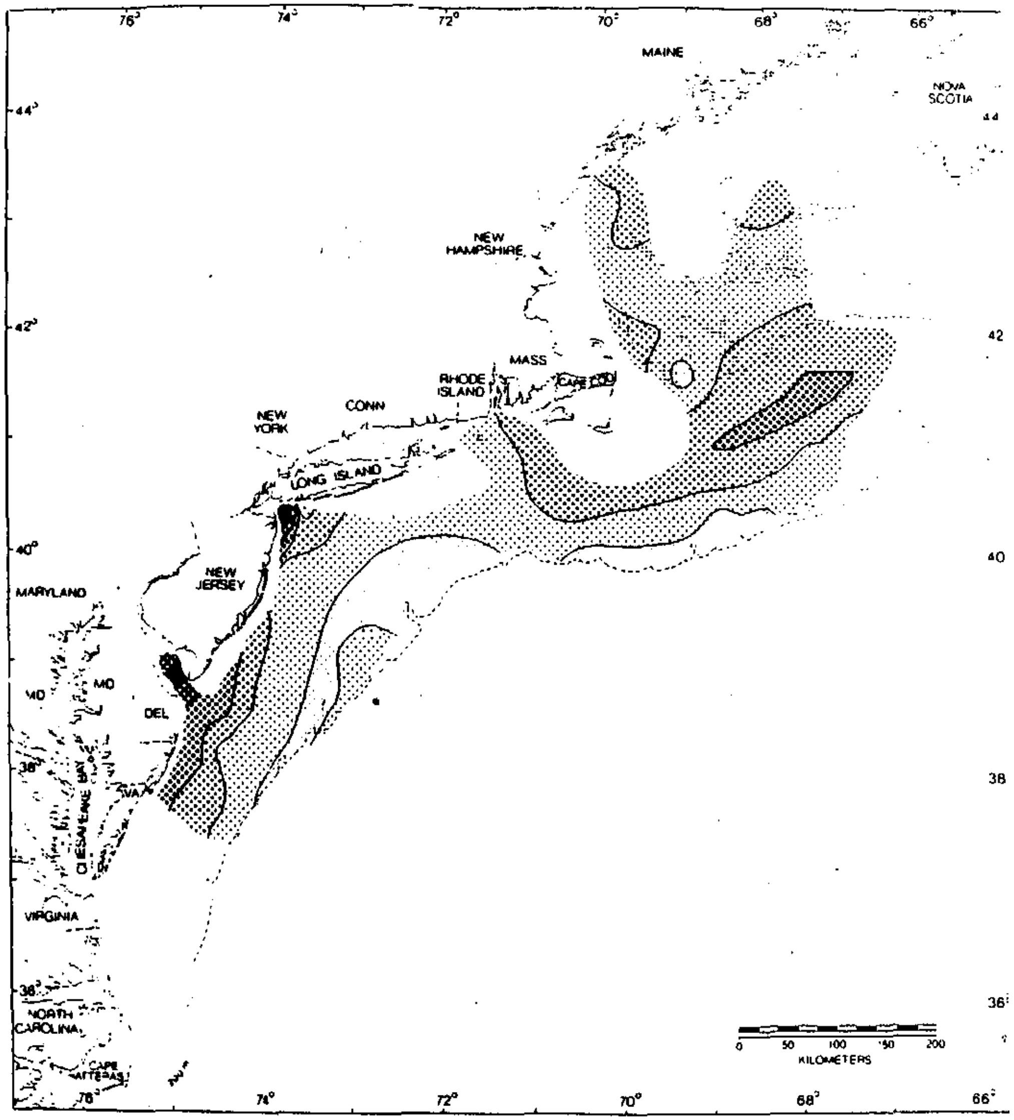
Evrika 80-01, April 16-May 14, 1980



Delaware II 80-03/Evrika 80-04, May 23-June 29,1980



Belogorsk 79-01. August 11-September 2,1979



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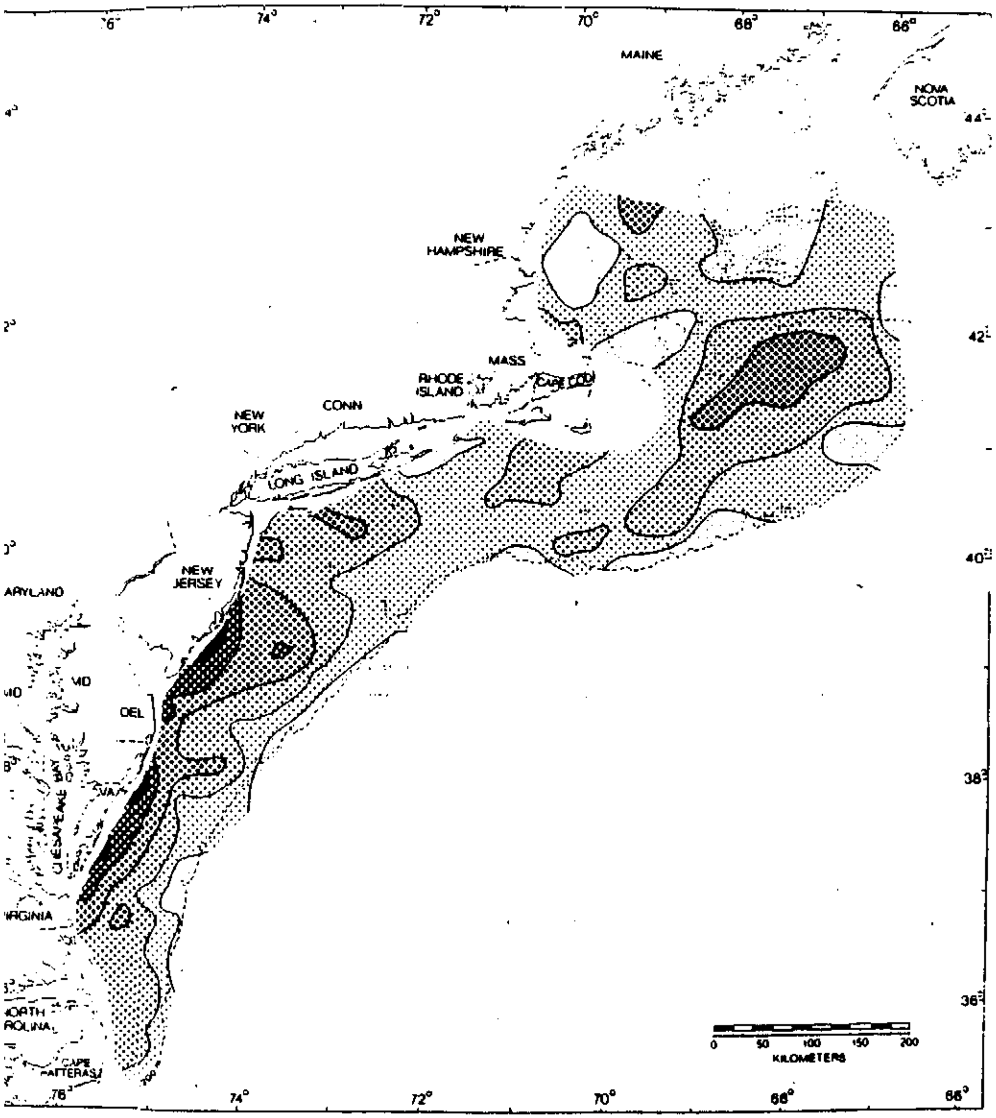

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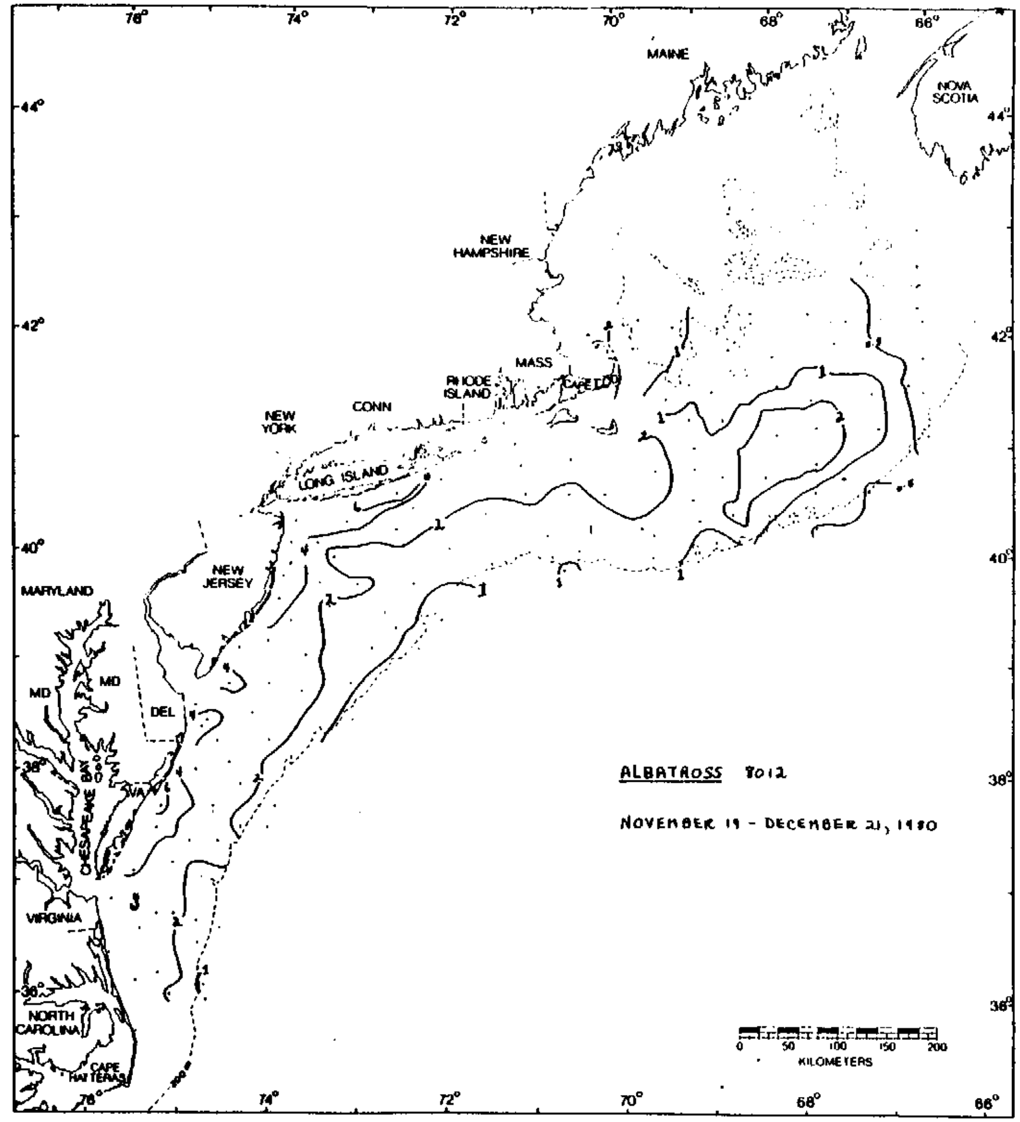

Albatross IV 80-12, November 19-December 21, 1980

	Outer shelf-Mid-Atlantic Bight				Slope-Mid-Atlantic Bight				Philadelphia Dumpsite			
	Euphotic		Subeuphotic		Euphotic		Subeuphotic		Euphotic		Subeuphotic	
	$\bar{x}$ chl*a*(mg/m^3)	% nan	$\bar{x}$ chl*a*(mg/m^3)	% nan	$\bar{x}$ chl*a*(mg/m^3)	% nan	$\bar{x}$ chl*a*(mg/m^3)	% nan	$\bar{x}$ chl*a*(mg/m^3)	% nan	$\bar{x}$ chl*a*(mg/m^3)	% nan
January	3.85	59	2.57	51								
February	1.45	42	1.70	27	0.51	71	0.23	87	1.94	35	2.51	24
March	2.74	26	2.53	17	1.78	37	0.88	35	4.74	20	4.65	14
April	1.20	68	1.34	28	1.16	76	0.61	46	0.66	47	1.74	22
May	1.05	59	0.58	50	0.88	72	0.16	69	1.01	45	0.77	40
June	0.77	71	0.60	32	0.48	81	0.23	70	2.63	25	2.90	17
July	0.68	72	0.32	63	0.34	91	0.29	83	0.96	36	1.01	35
August	0.64	72	0.60	62	0.39	82	0.33	82	1.45	52	1.62	42
September	0.69	68	0.44	64	0.45	87	0.32	84	0.64	59	0.85	38
October	0.75	76	0.23	65	0.57	86	0.19	84	1.06	50	0.60	33
November	1.80	48	1.67	44	1.24	49	0.78	50	2.59	29	2.97	27
December	1.50	51	1.18	49	1.06	57	0.65	55	0.88	65	0.88	43

Table 1. Monthly average chlorophyll *a* and % nannoplankton in the euphotic and subeuphotic layers at the Philadelphia dumpsite and in outer shelf and slope waters of the Mid-Atlantic Bight.