AN EXAMINATION OF NUTRIENTS ON AND OFF GEORGES BANK IN 1979

by

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1. INTRODUCTION

Phytoplankton primary productivity in the central region of Georges Bank is the highest on the continental shelf between Cape Hatteras and Nova Scotia (O'Reilly and Busch, 1982). The level of this production is, in part, dependent on the availability of nutrients (nitrogen, phosphorus, silicon). The regime of inorganic nutrients in this region has been found to be distinct from others on the shelf (Draxler and Waldhauer, 1982).

2. METHODS

2.1 Data Set on which Study is Based

Inorganic nutrient concentrations (nitrite, nitrate, ammonium, orthophosphorus, dissolved silicon) were determined on filtered seawater samples on 11 cruises between May 1979 and March 1980, which covered the area between Cape Hatteras and Nova Scotia.

2.2 Brief Description of Methodology of Data Analysis

Regions of the continental shelf used by the Environmental Chemistry Investigation (Figure 1) were determined on the basis of recurrent patterns of phytoplankton biomass distribution, hydrography and bathymetry. The fraction of the inorganic nitrogen pool contributed by ammonium was calculated and plotted for the surface and bottom layers by region over a synthetic year (Figure 2). Region GB2 (outer Georges Bank) was divided into subareas representing the northern flank and southern flank. Data for all five nutrients from these two areas plus GB1 (central Georges Bank) were plotted over a year for the surface and bottom layers (Figure 3). Nitrate concentrations along three transects which cross the Gulf of Maine, Georges Bank and extend into the slope water south of Georges Bank (Figure 4) were contoured as vertical sections for five cruises which represent March, May, August, October and December (November on Transect 7) conditions.

3. RESULTS

The fraction of the inorganic nitrogen pool contributed by ammonium (from *in situ* regeneration) in region GB1 has a different seasonal pattern than other regions; most notable is the near congruence of the surface and bottom layers (Draxler and Waldhauer, 1982). In Figure 3 (center), it can be seen that this structure results from relatively constant ammonium (NH_4^+) concentrations throughout the year associated with high nitrate concentrations in winter followed low nitrate concentrations in summer.

Figure 4 shows the positions of transects which cross three distinct geographic regions; the Gulf of Maine, Georges Bank and the deeper oceanic waters south of Georges Bank. In winter, nitrate concentrations in all three areas are high (5-10 μM) and vertically uniform (Figure 5)

except for concentrations greater than 15 μM in the Northeast Channel bottom water which is a major nutrient source for the system via the Gulf of Maine bottom water (Hopkins and Garfield, 1979). Thermal stratification in spring in the Gulf of Maine and the slope waters south of Georges Bank retards vertical mixing of the water which results in depletion of nitrate from the surface layer by phytoplankton assimilation (Figure 6). This process appears to be most intense above the deeper areas (e.g. Transect 5, Figure 6). The depleted layer deepens and becomes further reduced in nitrate in the summer (Figure 7). At the same time, a reservoir of high nitrate water is present in deep areas of the Gulf of Maine. Cooling of the water column in the fall and early winter allows reestablishment of significant vertical mixing which replenishes nitrate in the surface layer (Figures 8 and 9). The nutrient regime over Georges Bank can be seen in these figures (5-9) to be distinct from the Gulf of Maine and the slope waters. In winter, relatively low and vertically uniform nitrate values are found over the western and central sections of Georges Bank (Transects 5 and 6, Figure 5) compared to areas to the north and south. In spring, vertical mixing is maintained over the Bank. In the shallower areas (Transect 6, Figure 6), this promotes depletion of nitrate by phytoplankton activity, while in the deeper water of Transect 7, surface concentrations are higher than in the Gulf of Maine or the slope waters.

The nitrate-depleted conditions continue over central Georges Bank into late October, while areas on all sides experience some replenishment. The resupply appears to be most efficient from the intermediate water of the Gulf of Maine onto the western portion of the Bank, while over the eastern end, slope water may play a more important role. This nitrate is mixed vertically and results in generally higher concentrations over the entire Bank at this time of year than in surface waters north and south of it.

While the dominant observed inorganic nitrogen species on Georges Bank in June through September is ammonium produced by water column regeneration, based on the distribution of phytoplankton biomass (Evans-Zetlin et al., 1982), dissipation of tidal energy along the northern flank of Georges Bank may be introducing significant quantities of nitrate from the Gulf of Maine intermediate water onto the Bank where it is rapidly assimilated.

4. SUMMARY

A seasonal cycle of inorganic nutrient availability is observed on Georges Bank which is distinct from areas to the north (Gulf of Maine) and south (slope water). Following vertically uniform and high winter nitrate levels, intense depletion of nitrate produces low concentrations throughout the water column over the shallow areas of the Bank.

Upon destratification, the continued vertical mixing over the Bank appears to promote the introduction of nitrate from the Gulf of Maine intermediate water, making the Bank relatively high in nitrate. This succession of events is attributable to the unique bathymetry and circulation of Georges Bank and has direct implications for the productivity and distribution of phytoplankton in the region (c.f. O'Reilly and Evans, 1982).

5. REFERENCES

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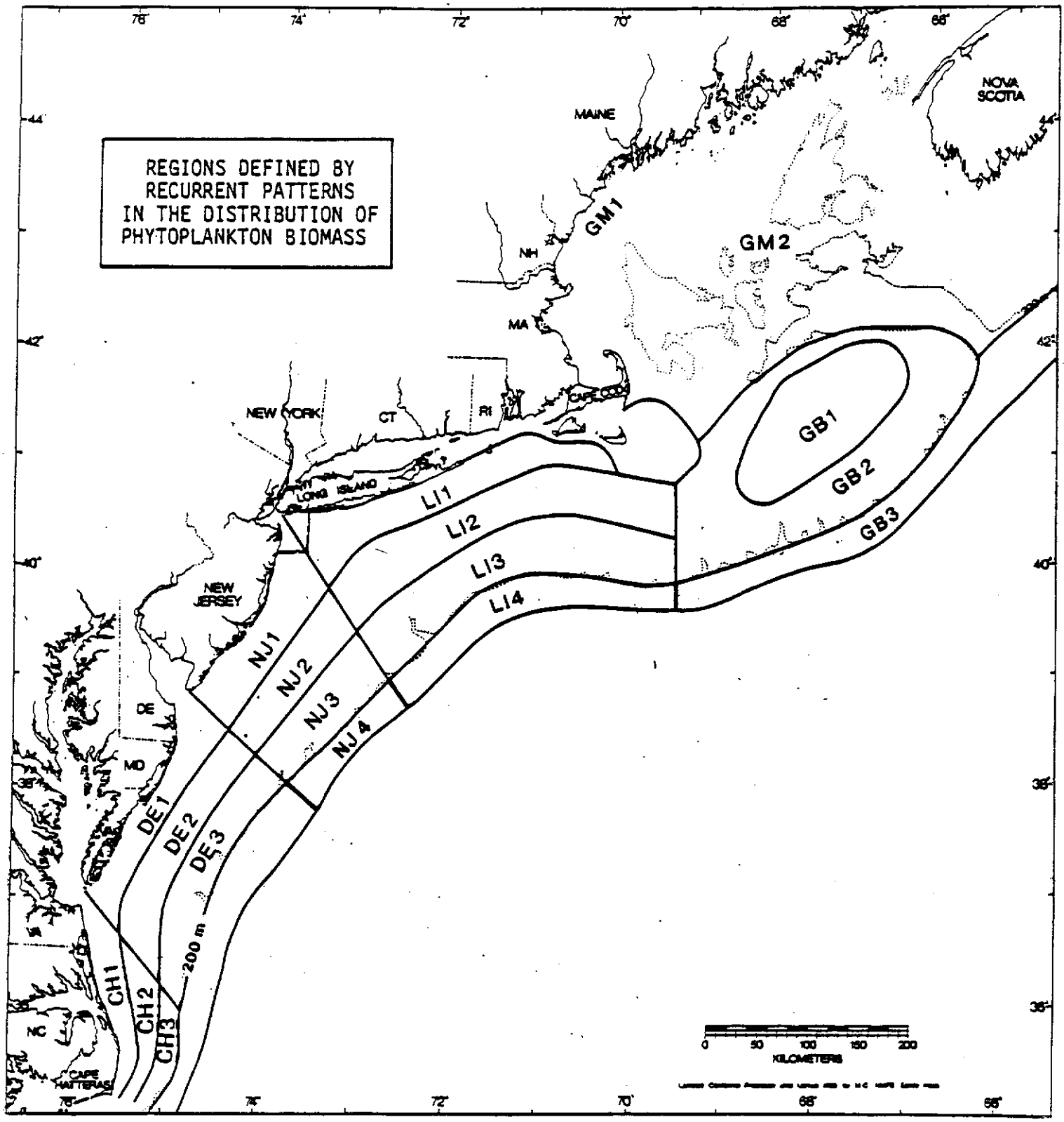
Evans-Zetlin, C. A., J. E. O'Reilly and A. Matte. 1982. Gradients in surface phytoplankton biomass on and around Georges Bank. Northeast Monitoring Program, Sandy Hook Laboratory Report No. 82-11.

Hopkins, T. S. and N. Garfield, III. 1979. Gulf of Maine intermediate water. J. of Marine Research 37(1): 103-139.

O'Reilly, J. E. and C. A. Evans-Zetlin. 1982. A comparison of the abundance (chlorophyll a) and size composition of the phytoplankton communities in 20 subareas of Georges Bank and surrounding water. NEMP-II-82-A-0006 and MARMAP Contribution No. 82-42.

O'Reilly, J. E. and D. A. Busch. 1982. The annual cycle of phytoplankton primary production (netplankton, nannoplankton and release of dissolved organic carbon) for the northwestern Atlantic shelf (Mid-Atlantic Bight, Georges Bank and Gulf of Maine). ICES Report 12. Symposium on Biological Productivity of Continental Shelves with Temperate Zone of the North Atlantic. March 1982.


REGIONS DEFINED BY
RECURRENT PATTERNS
IN THE DISTRIBUTION OF
PHYTOPLANKTON BIOMASS
MAINE
NOVA SCOTIA
NH
MA
NEW YORK
CT
RI
LONG ISLAND
CAPE COD
NEW JERSEY
DE
MD
VA
NC
CAPE HATTERAS
GM1
GM2
GB1
GB2
GB3
LI1
LI2
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NJ1
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200 m
0 50 100 150 200
KILOMETERS

FIGURE 1

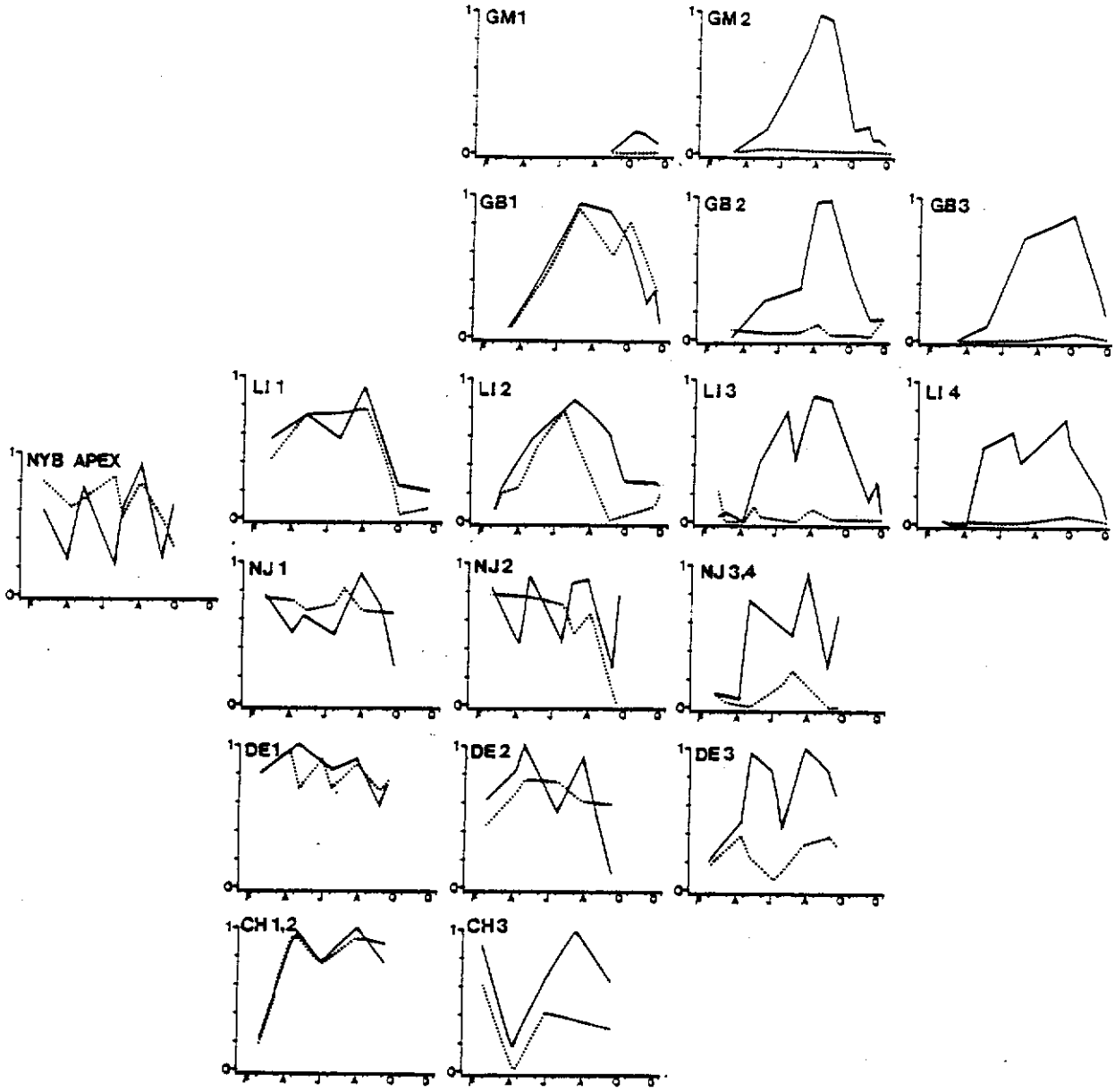

FIGURE 2. FRACTION AMMONIUM NITROGEN ($NH_4^+/NO_2^- + NO_3^- + NH_4^+$) IN THE SURFACE LAYER (SOLID LINE) AND BOTTOM (DASHED LINE) BY REGION FOR 1979 AND ONE CRUISE (AL 80-02) IN 1980.

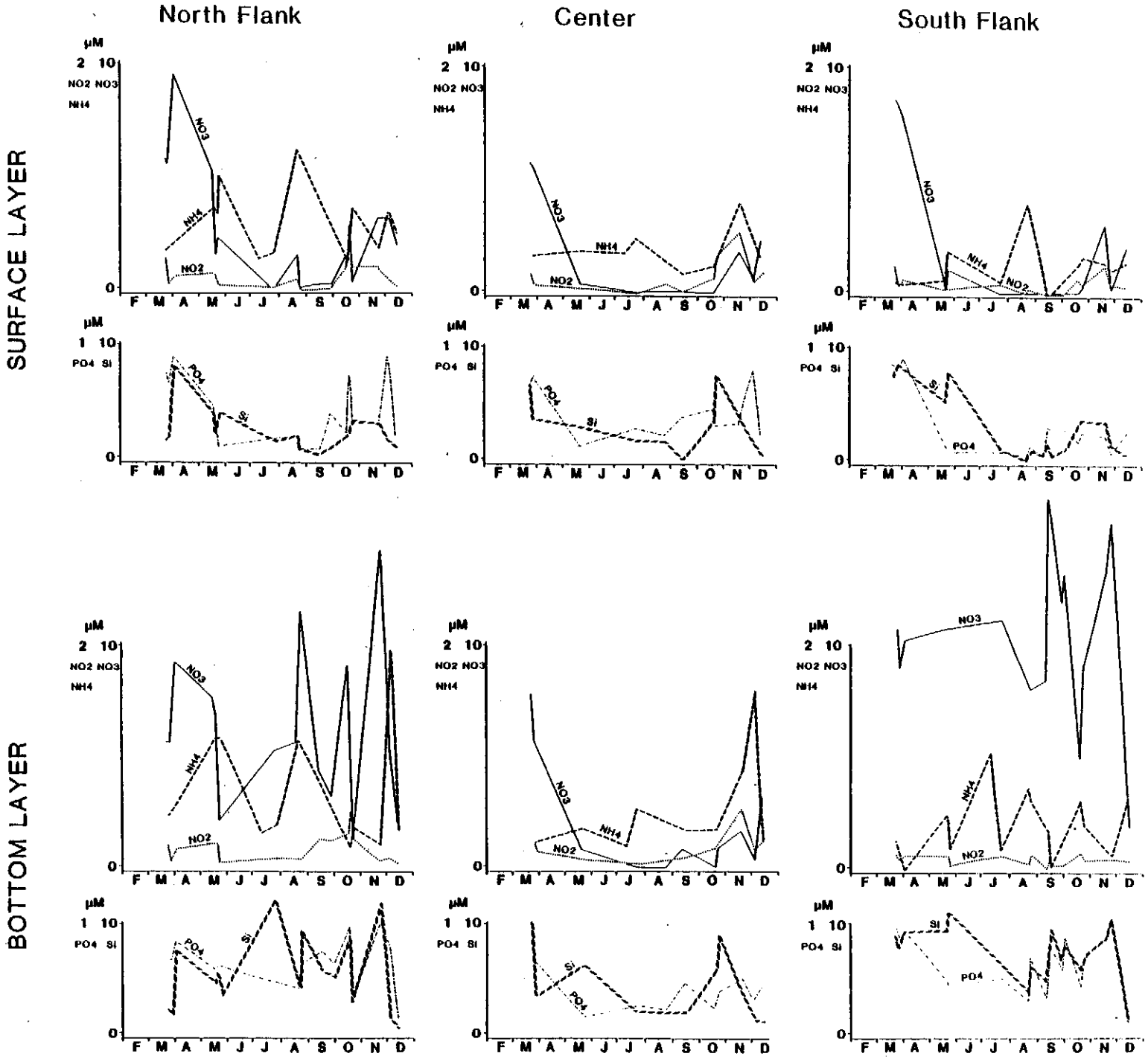

FIGURE 3. ANNUAL NUTRIENT DISTRIBUTIONS IN SURFACE AND BOTTOM LAYERS OF THREE SUB-AREAS OF GEORGES BANK.

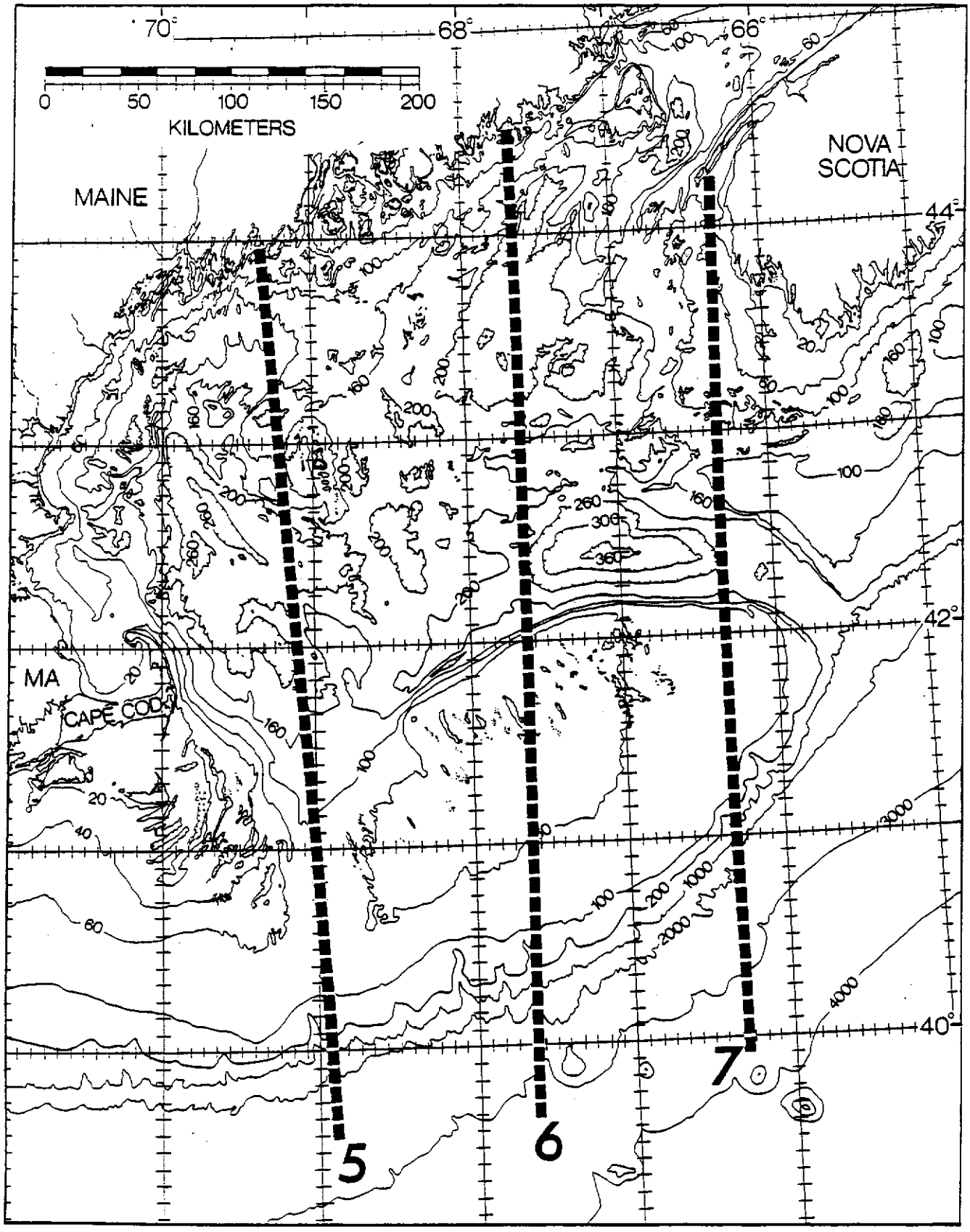

FIGURE 4. LOCATION OF TRANSECTS THROUGH GULF OF MAINE AND ACROSS GEORGES BANK.

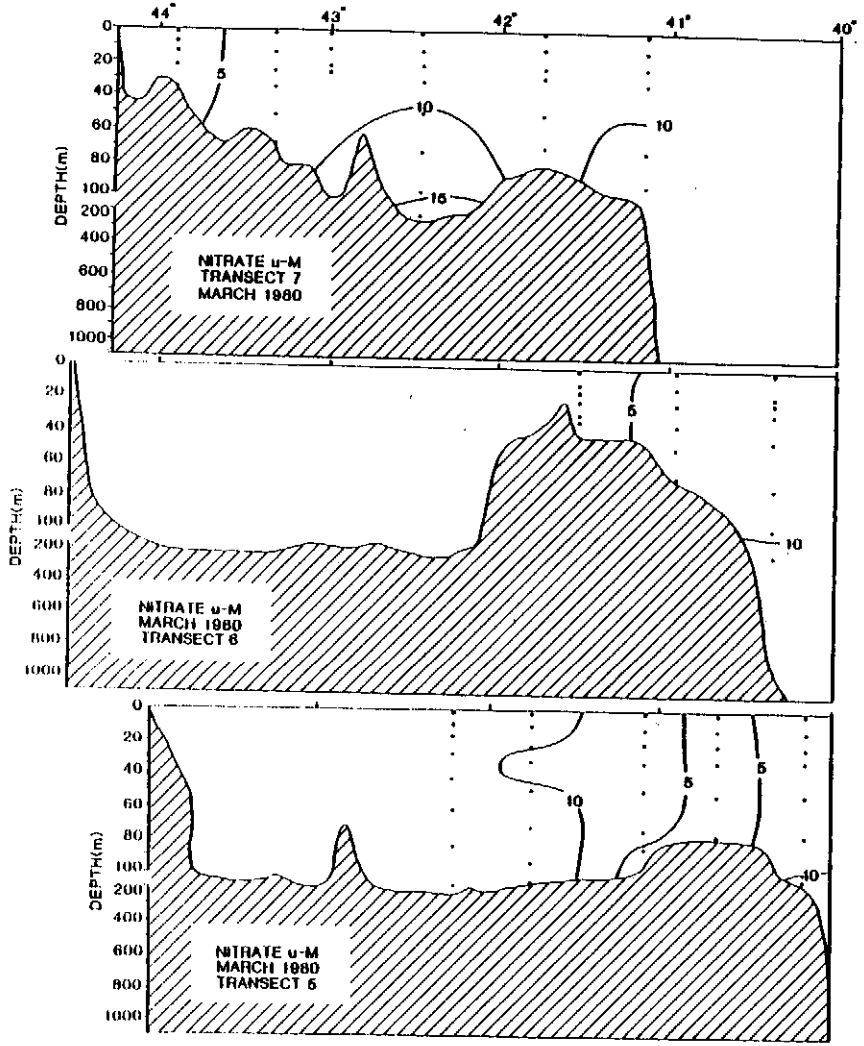

FIGURE 5.

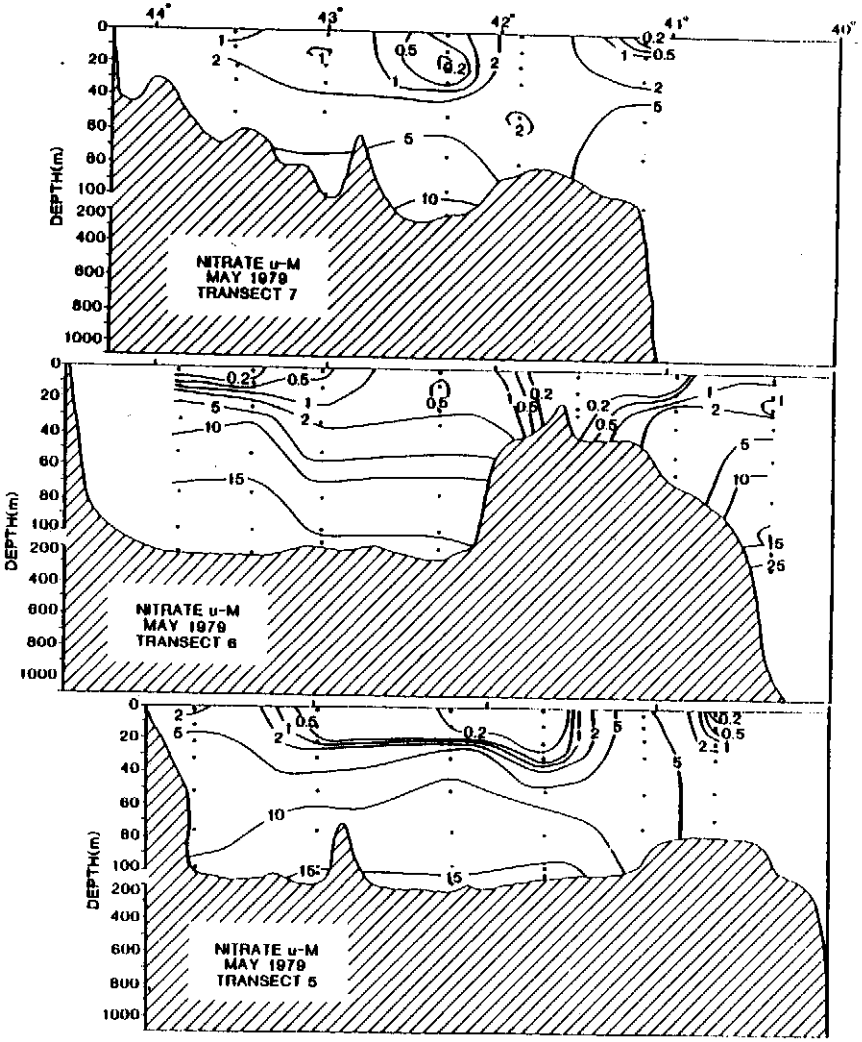

FIGURE 6.

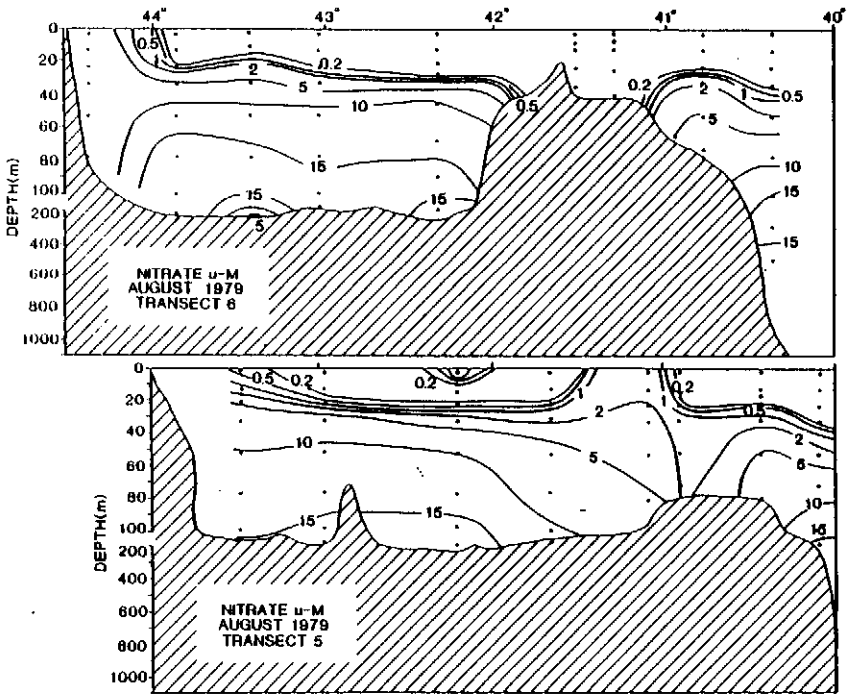

FIGURE 7.

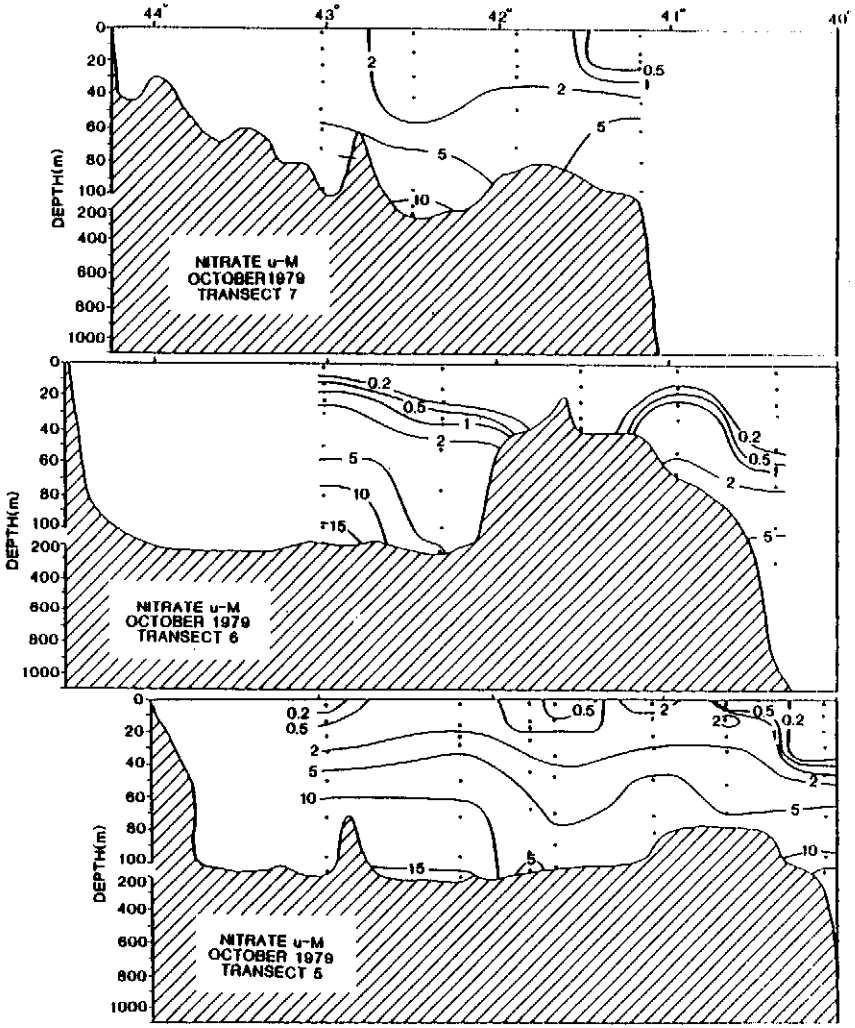

FIGURE 8.

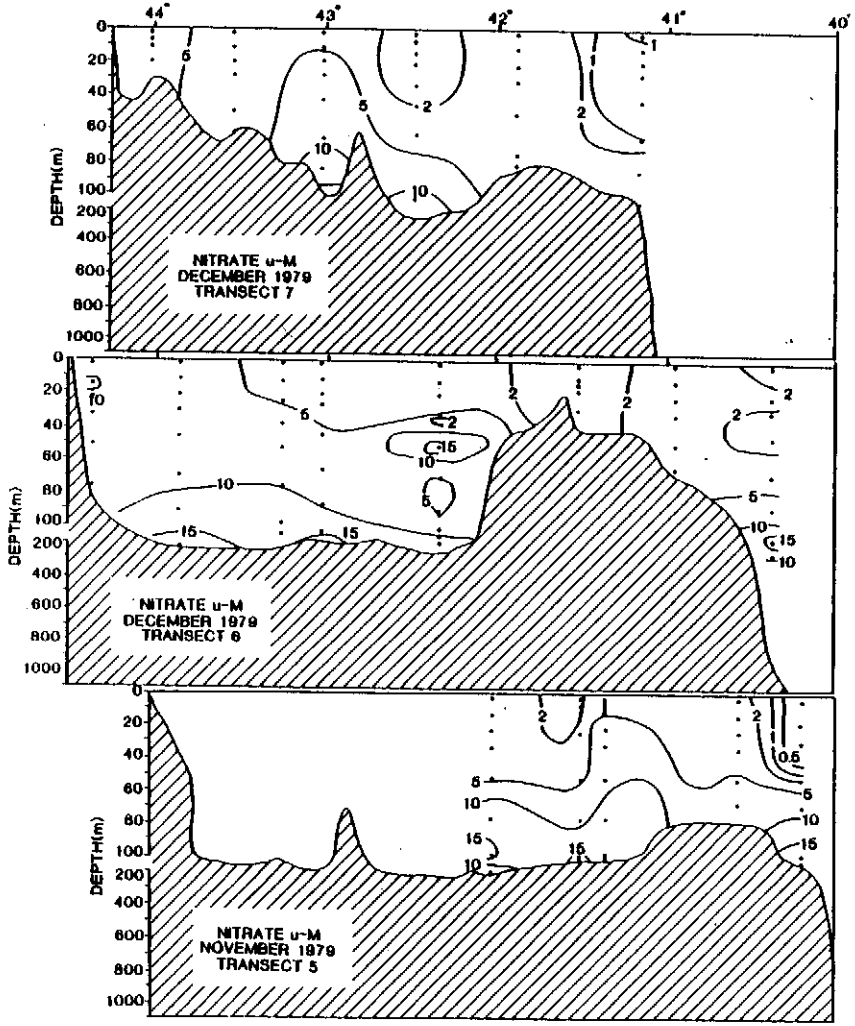
44°
43°
42°
41°
40°
DEPTH(m)
NITRATE u-M
DECEMBER 1979
TRANSECT 7
NITRATE u-M
DECEMBER 1979
TRANSECT 6
NITRATE u-M
NOVEMBER 1979
TRANSECT 5

FIGURE 9.

Georges Bank - Submarine Canyon

Living Resources and Habitat Monitoring Program

Progress Report, January - May, 1982

R. A. Cooper, Director
Manned Undersea Research and Technology Program
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

During the period January 1 - May 15, 1982 MURT personnel finished the analysis of over 10,000 ocean floor photographs from the Georges Bank and submarine canyon monitoring stations. Species densities were computed by habitat type for each monitoring site. Body burdens of trace metals and petrogenic hydrocarbons were determined for the "key indicator" species (lobsters, Jonah crabs, sea scallops, and tilefish) as well as for surficial sediment samples. The annual report (FY1982) was prepared, summarizing two years of monitoring data.

Several technical conferences were attended and talks given on various aspects of the Georges Bank and submarine canyon monitoring program. Considerable exchange of information occurred with representatives from (1) oil companies, (2) Canadian oil-impact research groups, (3) research personnel from the North Sea oil fields, and (4) academia (U.S and Canadian).

The first draft of "Pre-drilling Baselines of Megabenthic Fauna, Habitats and Contaminants at Site Specific Monitoring Stations on Georges Bank and Submarine Canyons" is nearly finished and scheduled to be published as a NOAA Technical Memorandum. An additional manuscript entitled "Oceanographer Canyon--Submarine Topography, Surficial Geology, and Fauna of the Northern Part" has been completed and is scheduled for publication as a U.S.G.S. Open File Report. A third manuscript entitled "Biology and Geology of Veatch Submarine Canyon" is nearly completed; upon completion it will be submitted to the journal, Marine Geology. Two position papers (Submarine Canyons and Deep Water Lobsters; Herring Spawning in the Northwest Atlantic) were prepared for the Center Directorate, pertaining to the U.S.A. position paper being prepared for the World Court on the U.S.A.-Canadian boundary dispute.

The FY1983 Georges Bank-Canyon/Submersible proposal was submitted, reviewed, and accepted by NOAA's Undersea Research Program Office for funding support. A cruise plan was subsequently prepared and submitted. The Johnson-Sea-Link submersible and mother vessel R. V. Johnson are scheduled to arrive Woods Hole July 10 for a 12-day cruise. A cruise plan was also submitted for the Alvin-Lulu submersible cruise to Oceanographer Canyon, scheduled for August 25 through September 3; diver scientists from the University of Connecticut and the Massachusetts Division of Marine Fisheries will be participating in this program.