REVIEW OF ENVIRONMENTAL STRESS AND FISHERY RESOURCES, MIDDLE ATLANTIC BIGHT

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1. INTRODUCTION.

In response to a request made by the Acting Associate Administrator in memos dated 16 February and 3 March 1978, the following information has been developed in order to: 1) indicate areas off the northeast and middle Atlantic states which are already stressed by various forms of pollution as evidenced by several scientific measurements and 2) show areas which are important as habitats and nursery grounds to commercial finfish and shellfish and to marine gamefish species.

2. ENVIRONMENTAL STRESS.

This information will be of importance to USEPA in assessing those coastal and estuarine areas which are already overstressed and which should be considered in regard to upgrading sewage discharges from raw and primary to secondary levels. In preparing this submission certain indicators of stress were considered. For instance, elevated levels of nutrients and primary production in coastal waters and adjunct embayments were considered to be related to organic input from sewage outfalls and dumping of wastes. Elevated metal values in sediments and waters were deemed to be related to waste discharges into coastal and estuarine waters; it should be noted, however, that while metals are found in most domestic sewage discharges, domestic systems are not the sole or even principal source of heavy metals in the environment. Industrial discharges, spills and dumping are all sources of metals and other toxic substances.

Other measurements such as seabed oxygen consumption may be elevated due to organics added by ocean outfalls but, again, naturally accumulating organic matter can on occasion result in increased oxygen consumption by the seafloor sediments and associated organisms.

Finally, massive environmental changes such as hypoxia or low dissolved oxygen, occurring over thousands of square miles in the Middle Atlantic Bight, are the result of an undetermined number of environmental perturbations and conditions which culminated in the mortality of living marine resources. While exact causes have not been determined, such events, which occurred in the summers of 1976 and 1977, can be taken as prima facie evidence of environmental stress.

Numerous papers have considered the presence of coliform and other bacteria as indicators of pollution and stress in the New York Bight and other waters (Koditschek and Guyre, 1974; Babinchak et al., 1977; Nitkowski et al., 1977; Dudley et al., 1977). Fig. 1 shows the distribution of coliform bacteria in sediments from areas of the New York Bight used for disposal of sewage sludge and dredging spoils. Similarly high values have been reported in sediments and waters of

Raritan Bay, Sandy Hook Bay and other estuaries adjunct to the Bight. The persistent nature of these bacteria, as indicators of fecal contamination, have resulted in closures of inshore embayments and parts of the Bight apex to the harvesting of bivalves for immediate human consumption.

Moreover, it is now well-known that other forms of bacteria are associated with sediments receiving wastes due to terrigenous export and ocean dumping (Nitkowski et al., 1977). Again, there is reason to suspect that diseases of estuarine and marine fin- and shellfish (Mahoney et al., 1973) may be related to the presence of pathogenic bacteria having their origin in domestic and agriculture wastes.

The exact sources of fecal contamination in coastal waters have not been delineated but it can be assumed that they include: 1) inadequately treated sewage from outfalls, 2) runoff from land masses and septic tanks, 3) raw sewage in riverine systems entering coastal waters, and 4) ocean dumping. Fig. 2 indicates the locations of sewer outfalls in metropolitan New York waters. Numerous outfalls drain sewage from several New Jersey and Long Island coastal municipalities.

Even with primary treatment or low grade secondary treatment, nutrients are released to coastal waters from sewer outfalls. These nutrients serve to sustain unusually high levels of primary production and, consequently, plankton blooms, including red tides. O'Reilly et al. (1976) note that despite the very thin euphotic layer (2.3-6 meters) resulting from terrigenous-, sewage-, and phytoplankton-derived sources of particulates, the annual production in the sewage-polluted lower Hudson estuarine system is 817 $gC/m^2/year$. This annual value surpasses all previously reported measurements in estuarine and marine ecosystems where the dominant form of plant life is phytoplankton. Major inorganic plant nutrients (nitrate, ammonium, phosphate, silicate) are superfluous year-round. Light intensity, and not nutrient concentrations, primarily regulates growth rates of phytoplankton and integral daily productivity.

Malone (1977) states that: "In contrast to other temperate estuaries along the east coast of North America, major nutrient supplies were not depleted and phytoplankton growth did not become nutrient limited at any time during this study. With the possible exception of SiO_4-Si which reached its annual minimum in July, phytoplankton productivity within the Upper Bay had little impact on the concentrations of major nutrients which were typically higher in the surface layer than in the bottom layer. These observations are consistent with the conclusion that the concentrations of major nutrients are primarily a function of fresh water flow, sewage discharge and mixing between fresh and salt water inputs." Again this suggests an unusual nutrient loading in the lower Hudson estuary with a net transport seaward. Fig. 3 dramatically demonstrates the seaward movement of entrained materials from the lower Hudson and Raritan Bay estuarine system. Ryther and Dunstan (1971) reported that evidence for pollution extends seaward to the east from the New York metropolitan area for a distance of less than 80 km whereas indications of pollution occur "...at least 240 km to the south, along the New Jersey coast to Delaware Bay, presumably the direction of flow of the water pushed out of the bight."

This reported southward movement of water in which are entrained various nutrients and pollutants having their origins in waste and terrestrial runoff undoubtedly impinges upon coastal areas which receive additional stress due to sewer outfalls. Thomas et al. (1976) reported the highest rates of seabed oxygen consumption for a station near a municipal sewage outfall off Asbury Park, N. J. (Fig. 4). Unusually high levels of oxygen consumption within the water column and at the seabed-water interface are often the cause of hypoxia or reduced levels of dissolved oxygen sufficient to cause extensive mortalities of fin- and shellfish. Figures 5 and 6 indicate the distributions of dissolved oxygen in the Middle Atlantic Bight in early September of 1976 and 1977. In 1977 the low dissolved oxygen was particularly characteristic of coastal waters, areas that would undoubtedly be further stressed by effluents from oceanic outfalls or indirectly by effluents discharged into embayments having egress to the sea. Since Ryther and Dunstan (1971) indicate that heavily burdened waters from the Bight apex may be carried beyond Delaware Bay, additional organic loading from outfalls on the Delmarva Peninsula could be considered as additive and therefore stressful.

As previously noted, Ryther and Dunstan (1971) indicate that suspended matter entrained in waters having their origin in the New York Bight may be carried seaward to the east for approximately 80 km. Swift (1974) and Hunt et al. (1977) indicate a vigorous southward transport of sands from the New York Bight, along the Middle Atlantic continental shelf, to Cape Hatteras where the materials appear to be funneled to the deep ocean floor (Hunt et al., 1977; Rona, 1977). Organic materials as well as toxic substances from the lower Hudson estuary and New York Bight apex could possibly become entrained with these sands; thus a transport system exists whereby stressful substances can be moved from the inner shelf to deeper waters and to areas not directly receiving stress from outfalls and ocean dumping.

Several classes of contaminants have been identified in the sediments and waters of the lower Hudson estuary and the Middle Atlantic Bight. Greig and McGrath (1977) presented information on the distribution of heavy metals in Raritan, Sandy Hook and Lower Bays (Fig. 7, Table 1). These values were exceptional and pose additional problems in that when harbor dredging occurs, highly contaminated sediments are removed from these deteriorated embayments and transported several kilometers to sea where they are dumped. The metals in Raritan Bay sediments posed an early environmental stress on marine resources; Nelson (1916) noted that metals, especially copper, had affected shellfish at the time of the WWI. The seaward transport of contaminated sediments and sludges has resulted in a large area characterized by elevated heavy metals (Carmody, Pearce and Yasso, 1973)(Figs. 8-10). Likewise, extraordinarily high levels of petroleum hydrocarbons are found in sediments of Raritan Bay and the offshore dumping areas (Fig. 11). Again, observations by fishery biologists before the turn of the century (Goode, 1887) indicated that petroleum had affected finfish and shellfish resources early in our industrial history.

As noted early in this review, metals, petroleum and other categories of contaminants found in esturine and coastal waters are not solely relatable to sewer outfalls. However, most sewage discharged through outfalls contain these contaminants and others; therefore, in areas already overburdened with organic and inorganic residues and contaminants, additional materials <u>may</u> prove stressful. If elevated metals in sediments and waters are indicative of other forms of pollution, and consequent stress, then coastal and estuarine waters outside the New York metropolitan area can be deemed polluted or stressed. Metal concentrations are also elevated in Long Island Sound, especially in the western end (Fig. 12, Table 2, from Greig, Reid and Wenzloff, 1977), and in Delaware Bay (Figs. 13 and 14, from Bopp and Biggs, 1972), as well as dumpsites for Philadelphia and Camden sewage sludge located in inshore waters (Fig. 15 and Table 3, from Watling et al., 1974) and offshore areas (Figs. 16 and 17, from Lear et al., 1977).

Concentrations at or near background levels are found in Block Island Sound (Fig. 18, Table 4, from Steimle et al., 1976), the Baltimore Canyon Trough (Fig. 19, from Radosh et al., 1978), and over large portions of the Mid-Atlantic Bight continental shelf (Figs. 20 and 21, from Harris et al., 1977).

Heavy metals in sediments are frequently the result of point discharge or dumping of contaminated wastes or dredging spoils. Recent research (Waldhauer et al., 1978) indicated, however, that waters emanating from Arthur Kill and Raritan Bay and Lower Bays have unusually high values of Cu and Pb (Fig. 23 and Table 5). Portions of these heavy metal burdens are bound to suspended inorganic and organic matter which, upon settling, add to the metal loading of sediments. Similarly, metals bound to particulates from inadequately treated sewage discharged from outfalls may be carried considerable distances from the out fall before settling. Recent research on contaminant heavy metals in living resources (NMFS, 1978; Wenzloff et al., 1978) indicates that organisms from the New York Bight apex and metropolitan area have higher values for heavy metals than do those organisms taken farther south (Figs. 23, 24 and 25). Again, it can be assumed that metals, bound to suspended matter, are carried varying distances from point of origin according to the specific gravity of the carrying material.

While living resources from the Bight analyzed for metals do not post any immediate problem to the public's health, little is known in regard to the effects of elevated tissue burdens of metals on the well-being of the organism. Since most of the metals of concern have been demonstrated to have physiological effects, usually deleterious, it can safely be assumed that metals added to the environment increases stress on marine organisms.

Finally, MIT/MIAS (1976) and others have suggested that in the foreseeable future efforts will be made to excavate marine aggregates from offhore areas. Fig. 26 indicates the distribution of marine sands and gravels over the continental shelf off the New England and Middle Atlantic states. Fig. 27 shows the location of present mineral development activities and ocean dumping. If highly organic suspended and dissolved materials continue to be discharged into coastal and estuarine waters, there will be a concomitant increase in organic matter in marine sediments. With dredging and mining of sediments the organic matter will be resuspended where it may play a role in organic enrichment of the water column followed by blooms and other stressful effects. Metals, hydrocarbons and other toxic substances associated with the resuspended organic matter may impact on or stress living resources and enter trophic systems, i.e. the food chain.

3. RESOURCE ORGANISMS.

The Middle Atlantic Bight, from Cape Hatteras to the Canadian border, is an important area for recreational and commercial fishing. The following figures indicate the distribution of certain larval fish as well as adult finfish and shellfish. Most of the species shown are available to both recreational anglers and commercial fishermen.

Obviously all species are not shown but the examples provided constitute a subgroup indicating that the Middle Atlantic Bight and adjunct embayments and estuaries are important habitats for marine fishes. Fish which are regarded as summer species typically range up the inner shelf toward New England from either offshore or from more southern overwintering areas. Larval and juvenile forms of many species are to one degree or another estuarine dependent. Additional maps of juvenile availability in Atlantic coastal estuaries and inner shelf waters are figured in pp. 270-294 of a workshop proceedings volume enclosed as Appendix A.

Figures 28-31 show the distribution of larvae of important species in the Middle Atlantic Bight. Figures 32-42 indicate the distribution of some of the important species of adult finfish in the Middle Atlantic Bight. The distributions of commercially important shellfish likely to be affected by increased environmental stress in estuaries and coastal waters of the Bight are given in Figs. 43-48. A significant portion of the New York Bight has already been closed to the harvesting of bivalve shellfish (Fig. 49).

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Fig. 1 Faecal coliforms/100 ml of sediment in the New York Bight; 0–20 (○); 21–100 (⦶); 101–1000 (◑); 1001–46 000 (●). The geometric mean of all the FC counts is shown for multi-sampled stations. The numbers to the left or above the stations identify multi-sampled stations and signify the number of sampling times. Five additional stations in the Hudson Shelf Valley located 38, 43, 47, 60, and 80 miles from the sewage disposal site were sampled once and all were negative for faecal coliforms.

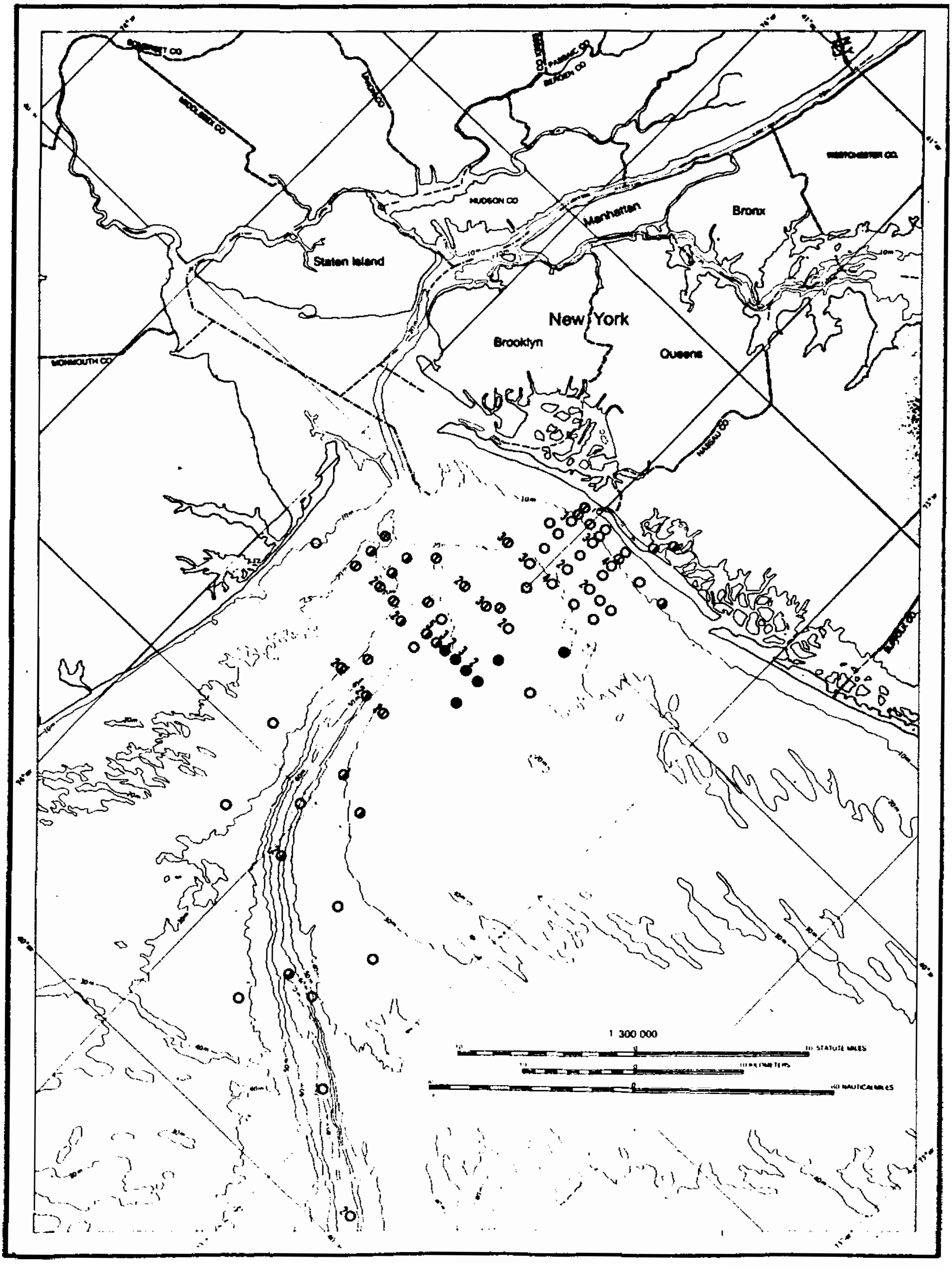


Figure 2. Locations of sewer treatment facilities in the New York metropolitan area.

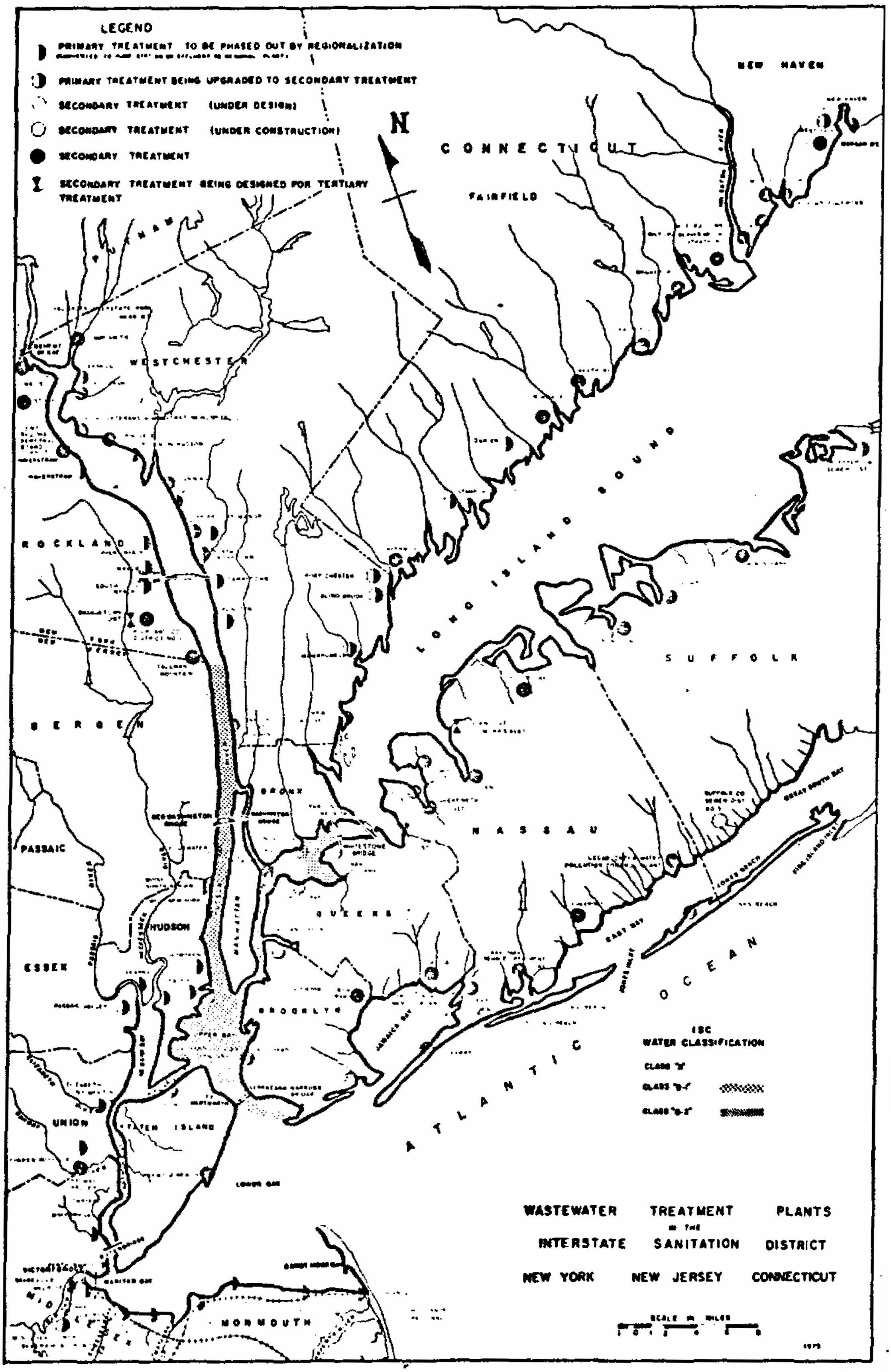


Figure 3. Photograph taken by U-2 aircraft; shows discharge of highly turbid waters from Lower and Raritan Bays, elevated values for organic content, chlorophyll, primary production, and inorganic suspended matter and dissolved substances associated with outflow.

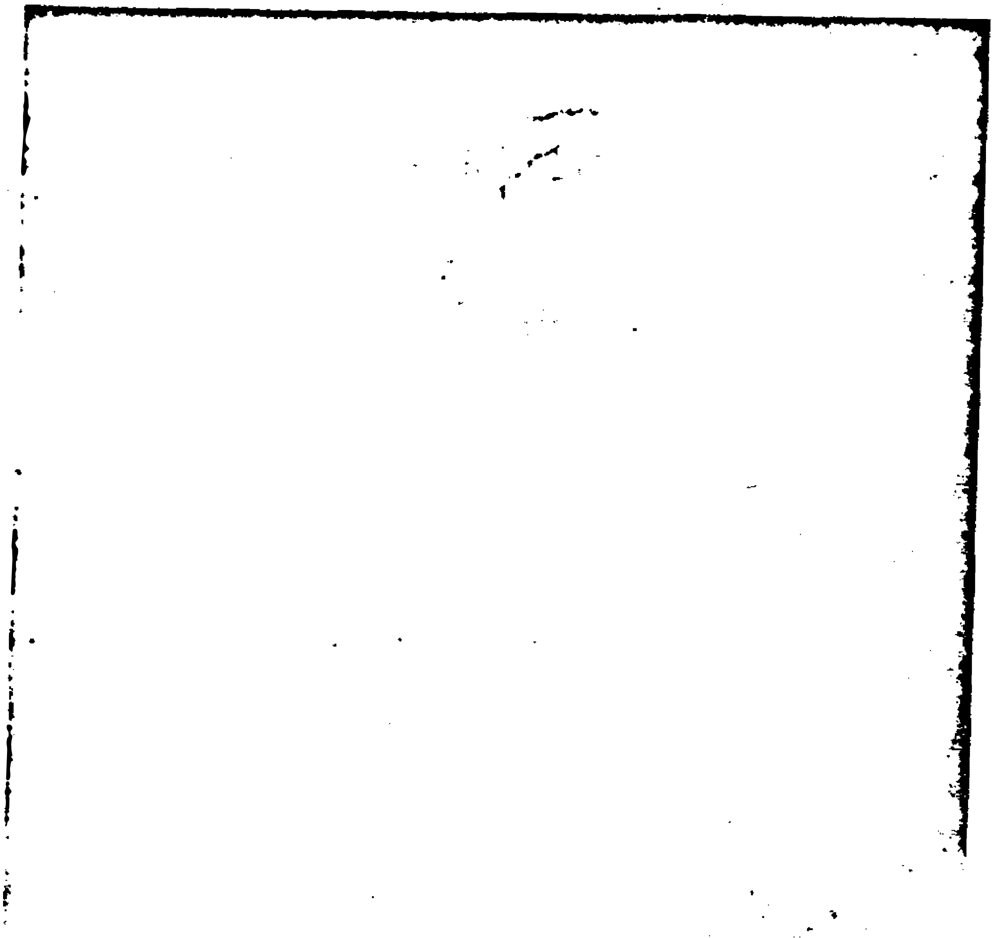


Figure 4. Seabed oxygen consumption in ml O_2 m^{-2} h-1 during period 26 August - 6 September 1974; note exceptionally high values for seabed oxygen consumption off Asbury Park outfall.

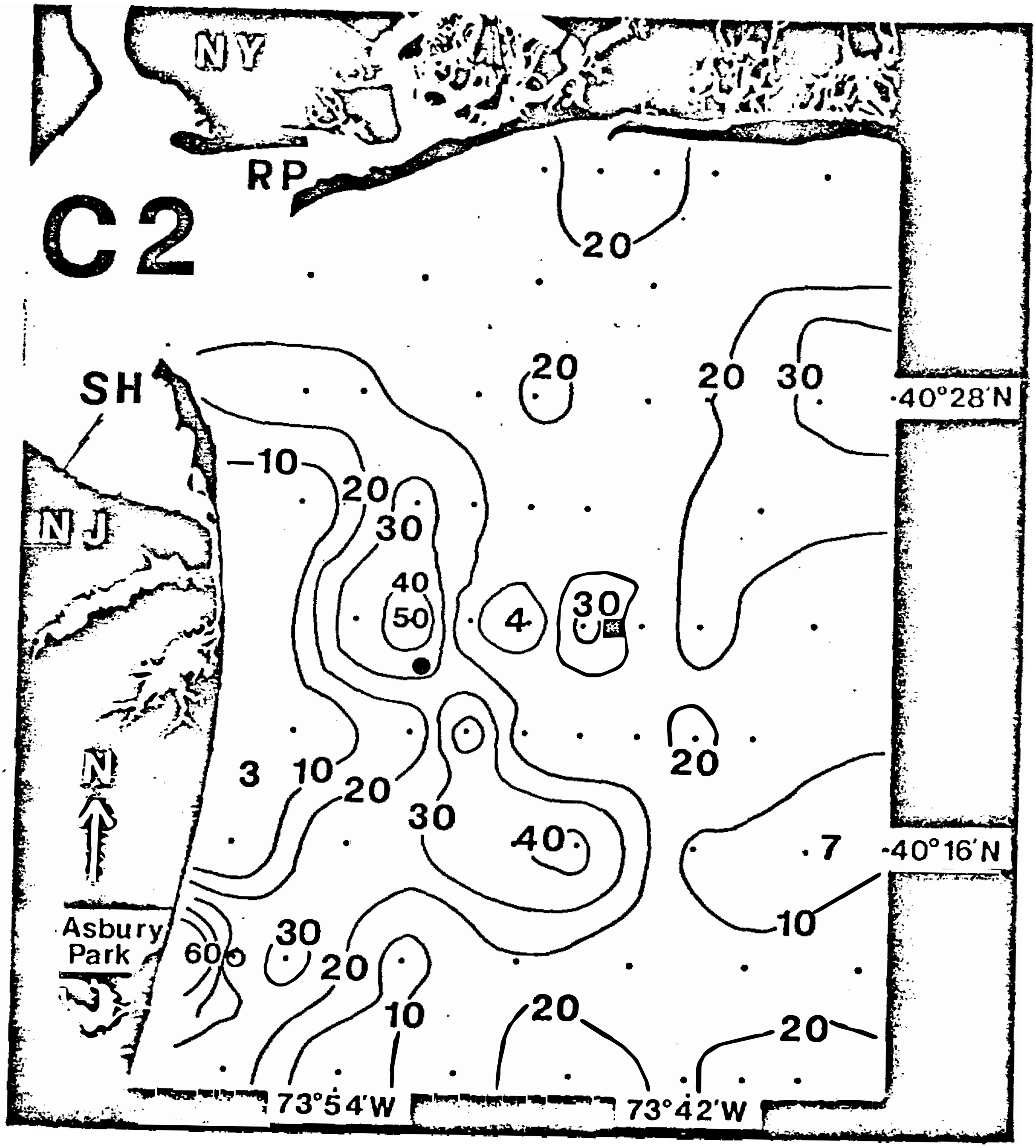


Figure 5. Distribution of bottom dissolved oxygen in September 1976.

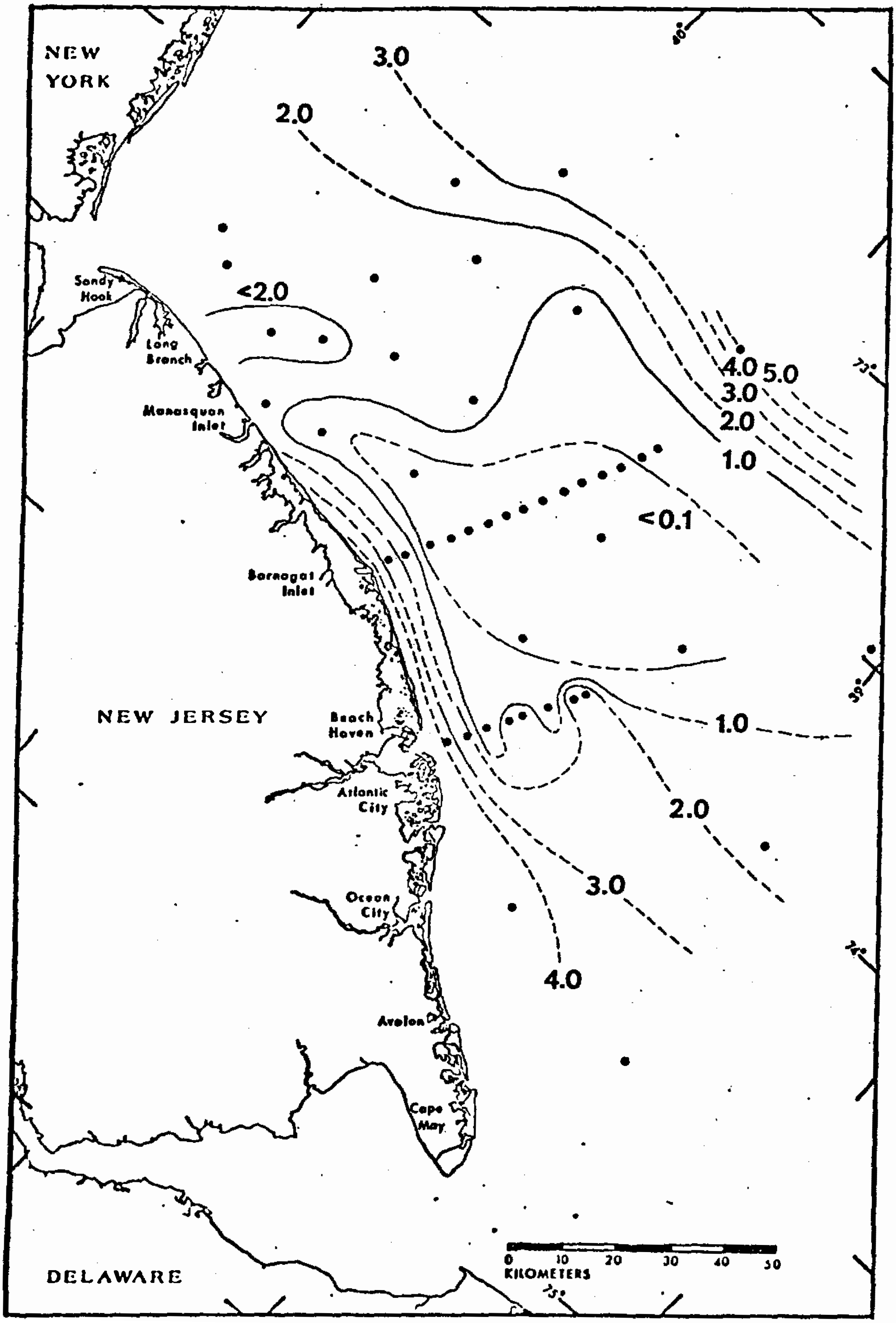


Figure 6. Distribution of bottom dissolved oxygen in September 1977.

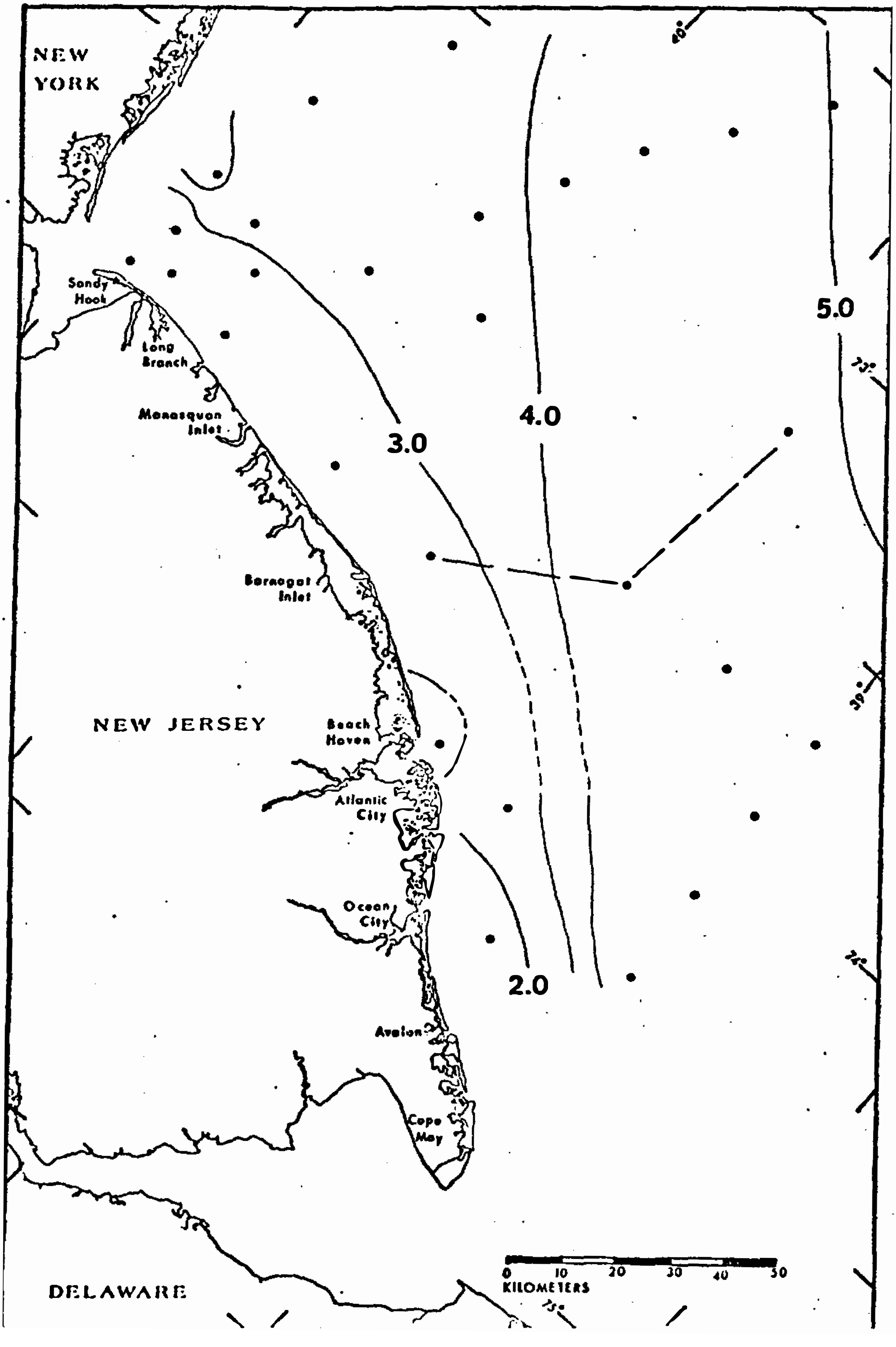
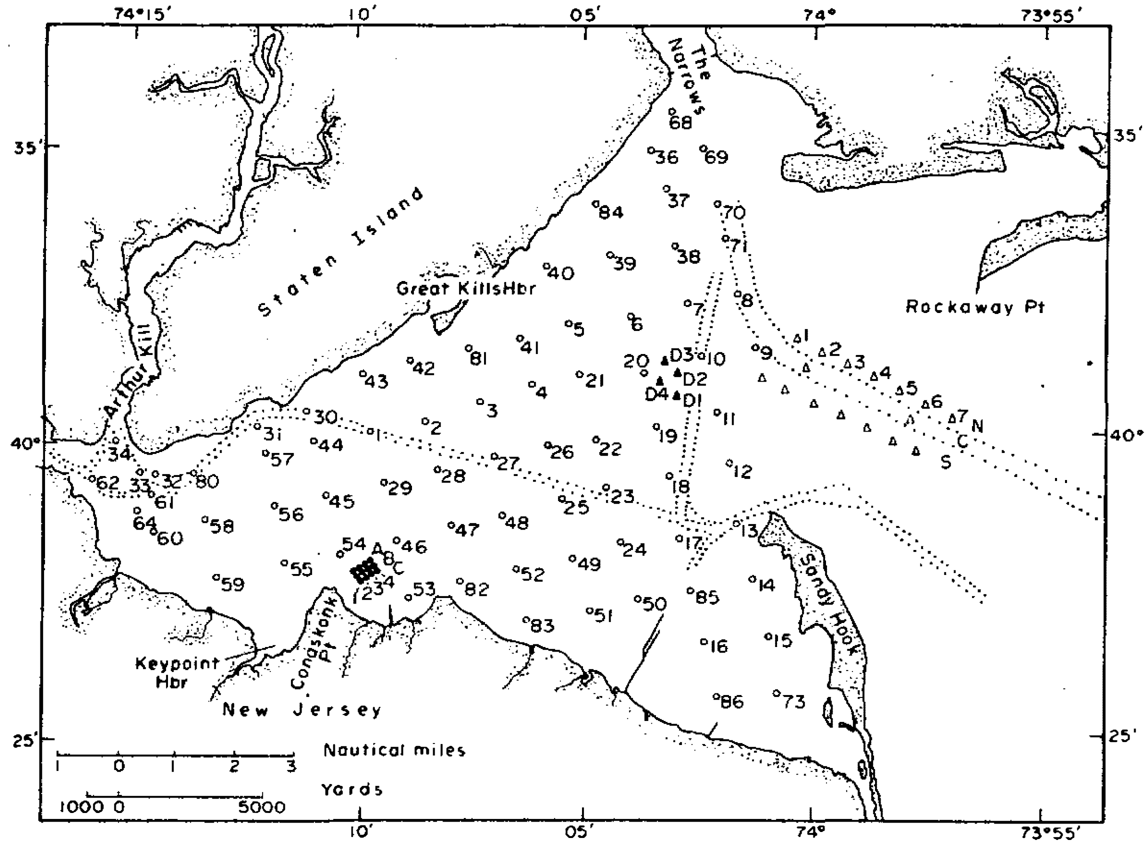


Figure 7. Station locations for sediment sampling of Raritan Bay. (From Greig and McGrath, 1977.)



Figues 8, 9, and 10.

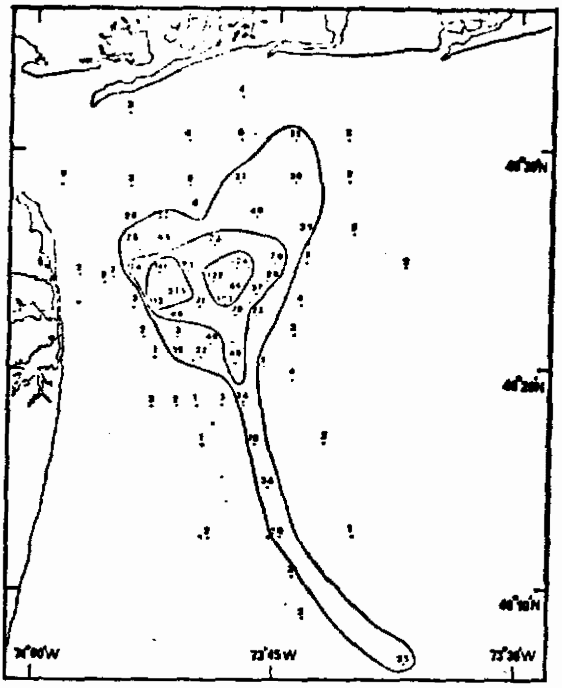


Fig. 8 Concentration of copper in ppm of dry sediment. Approximate Isopleths at 25, 50 and 100 ppm.

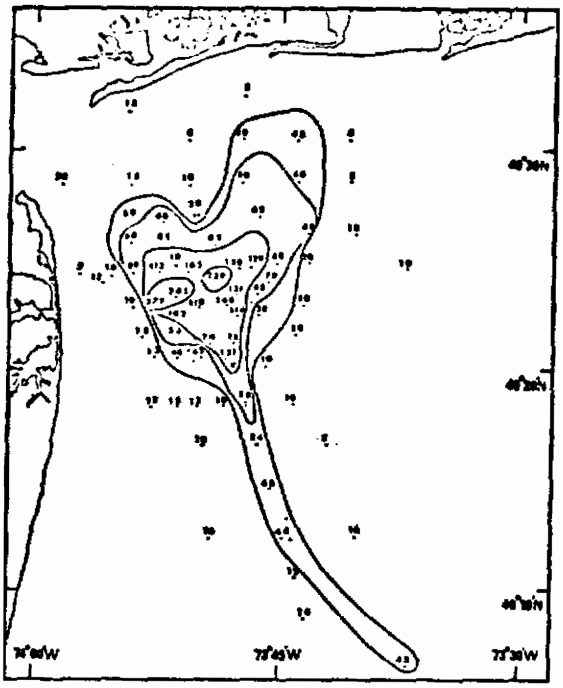
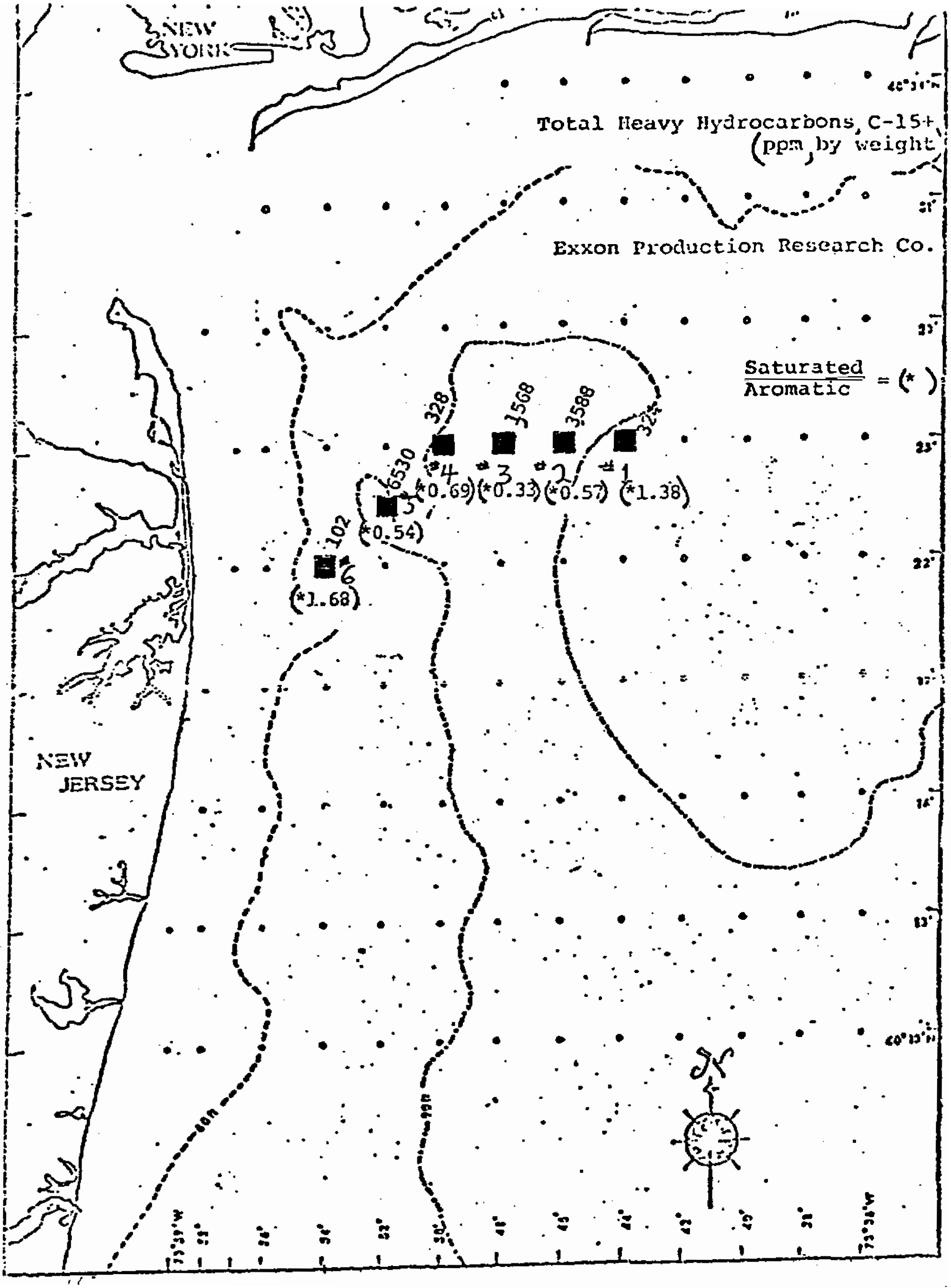


Fig. 9 Concentration of lead in ppm of dry sediment. Approximate Isopleths at 25, 50, 100 and 200 ppm.

Fig. 10 Concentration of chromium in ppm of dry sediment. Approximate Isopleths at 25, 50 and 100 ppm.

values was Station 611, about 30 km south of the dumping sites. Beyond this point stations in the Hudson Valley gave results close to normal values. Approximately 60 km^2 of sediment contained concentrations of Cu, Cr, Pb, and Zn ten times higher than normal, and about 170 km^2 had values five times normal.

Figure 11. Sample locations and values for Smith-McIntyre bottom grab samples analyzed for total heavy hydrocarbons (C-15^+) and the ratio of saturated to aromatic portions thereof.



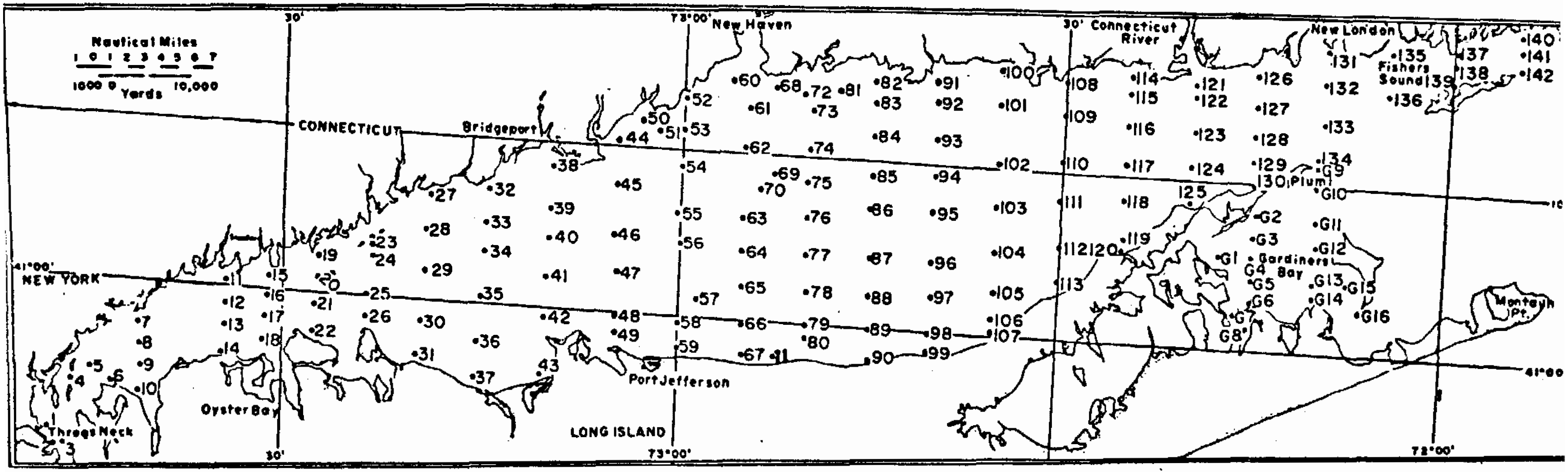


Figure 12. Station locations for measurements of trace metals in sediments of Long Island Sound. (From Greig, Reid and Wenzloff, 1977.)

Figure 13. (From Boggs and Biggs, 1972.)

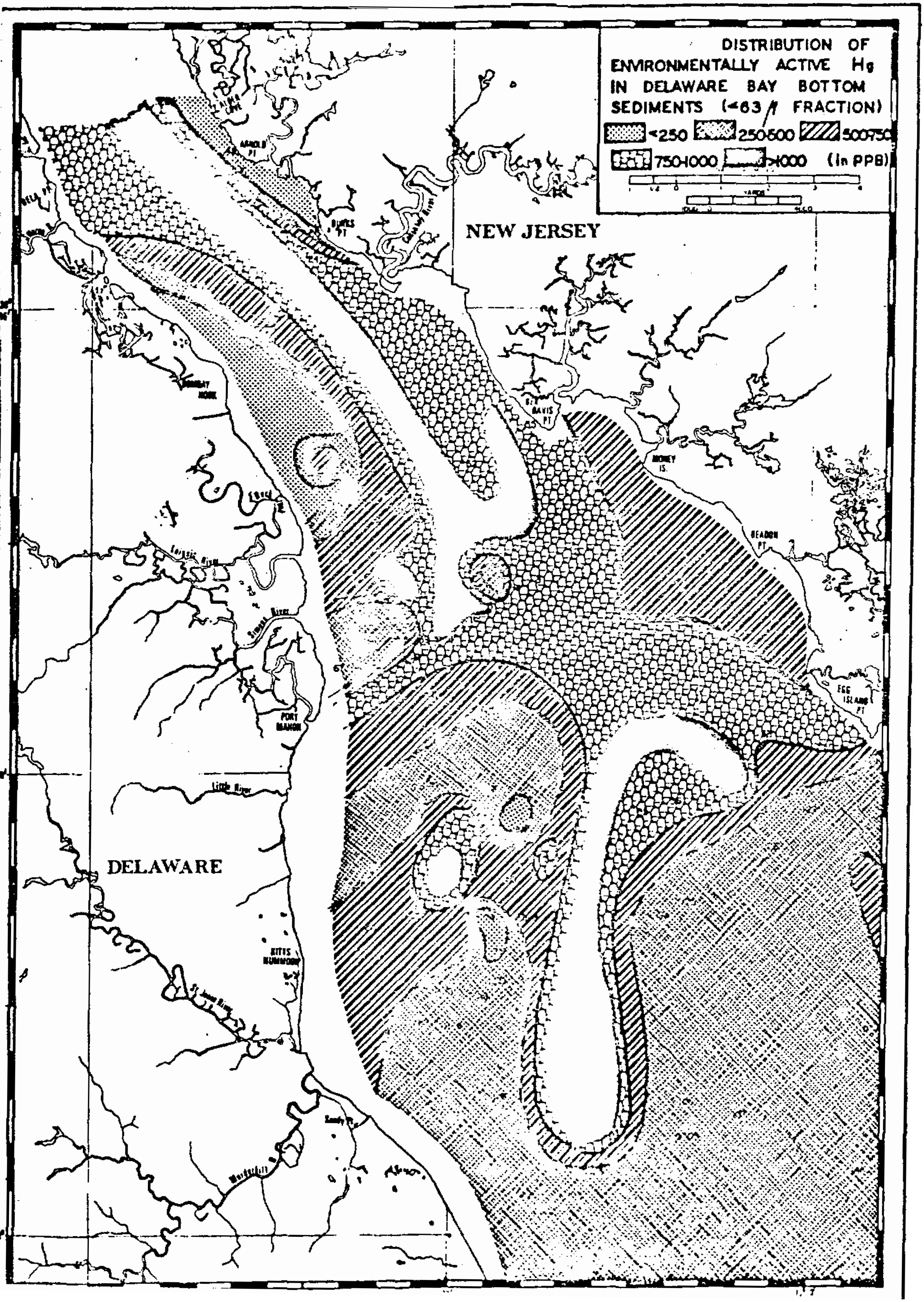
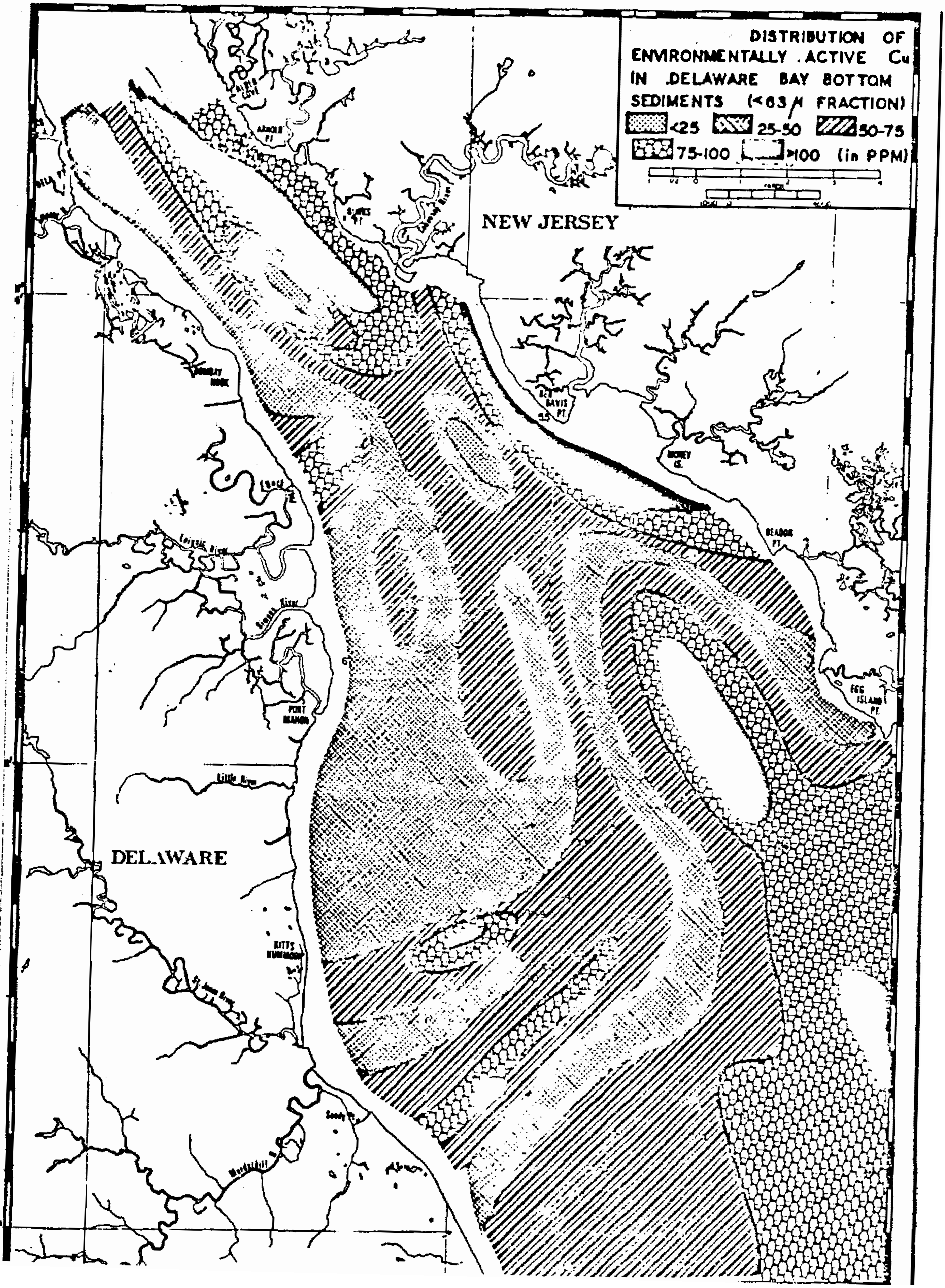


Figure 14. (From Boggs and Biggs, 1972.)



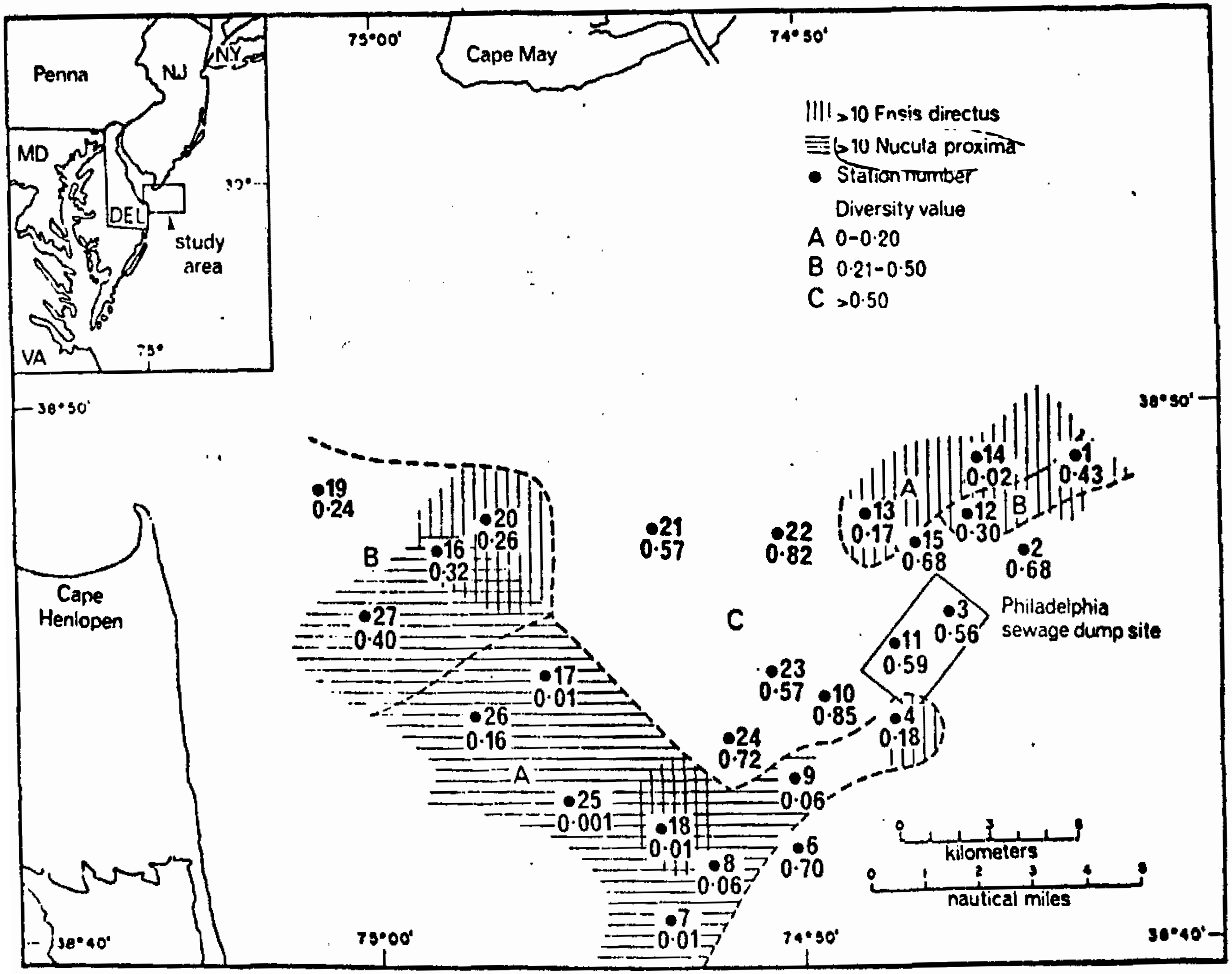
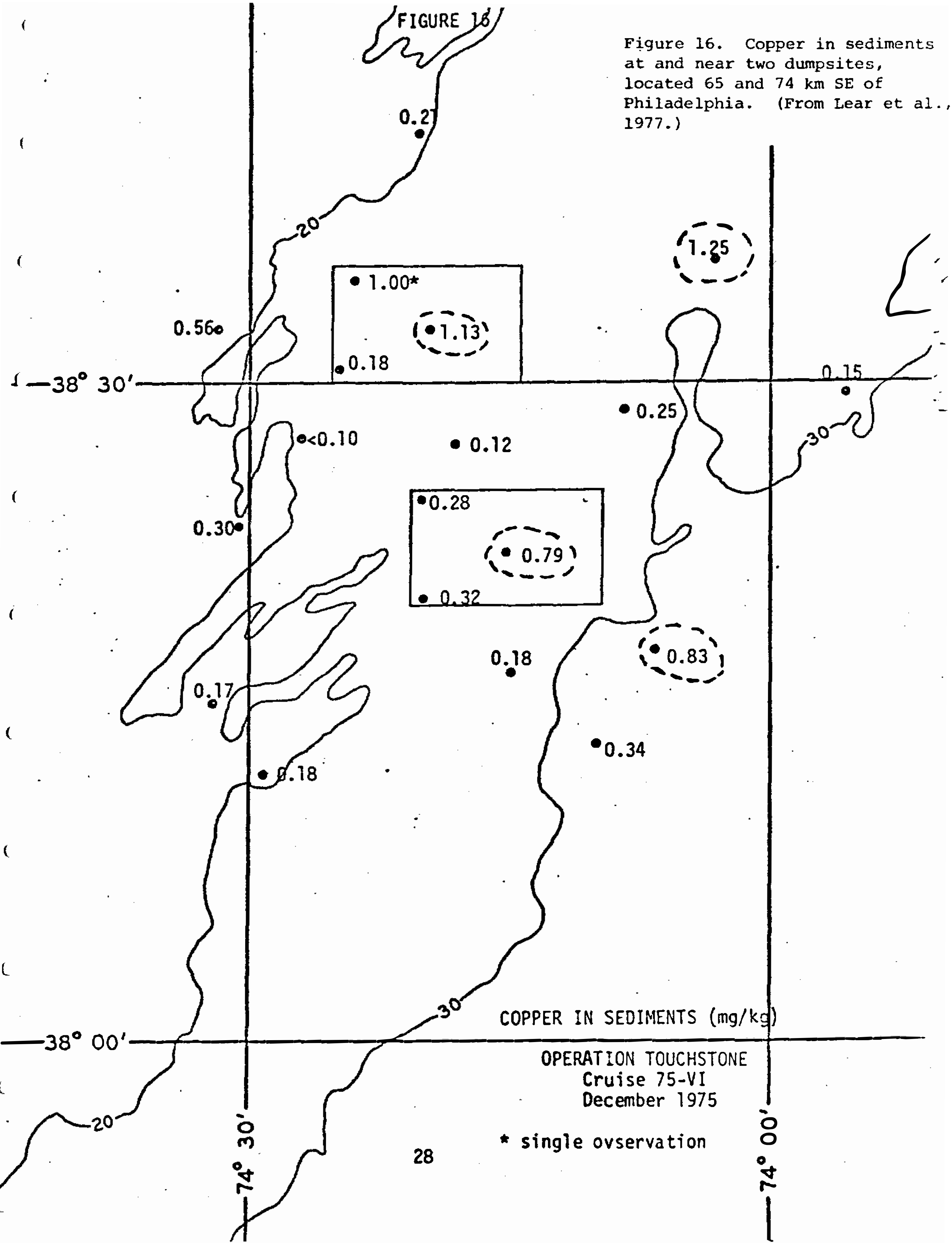


Figure 15. Map of sampling area showing Philadelphia sewage dumping site off the mouth of Delaware Bay. (From Watling, et al., 1974.)

FIGURE 16

Figure 16. Copper in sediments at and near two dumpsites, located 65 and 74 km SE of Philadelphia. (From Lear et al., 1977.)



COPPER IN SEDIMENTS (mg/kg)

OPERATION TOUCHSTONE
Cruise 75-VI
December 1975

* single ovservation

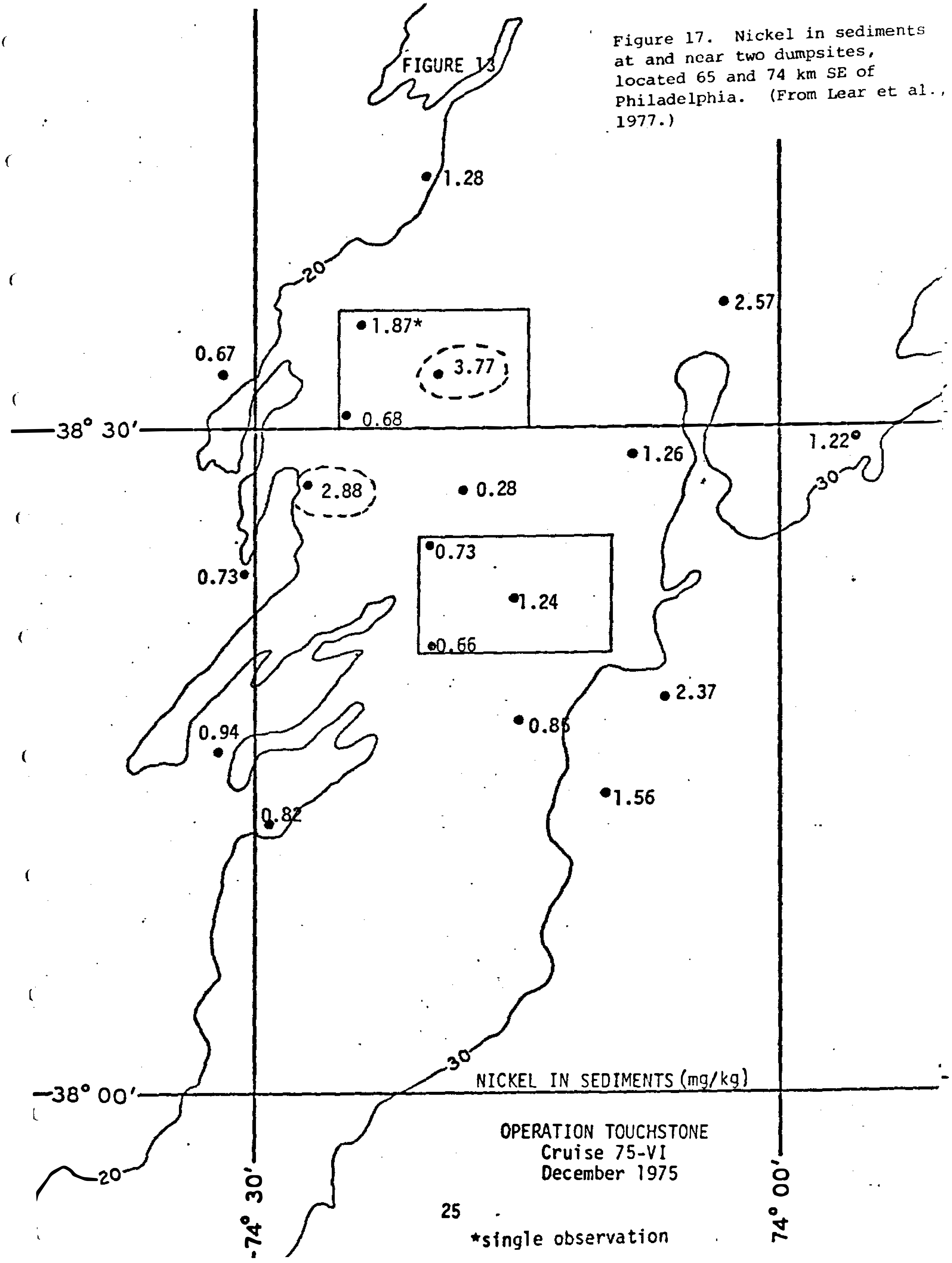


Figure 17. Nickel in sediments at and near two dumpsites, located 65 and 74 km SE of Philadelphia. (From Lear et al., 1977.)

Figure 18.

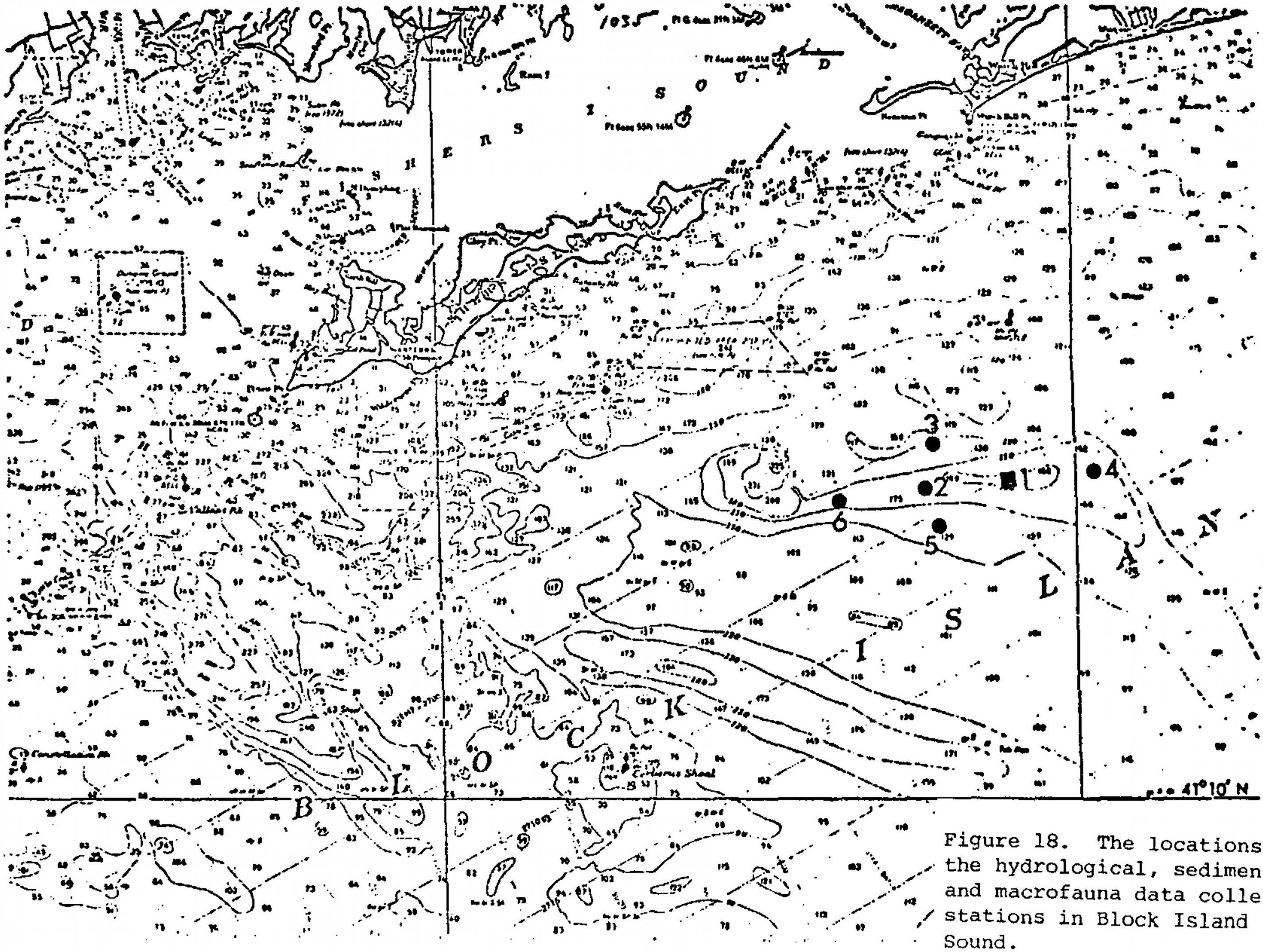


Figure 18. The locations of the hydrological, sediment and macrofauna data collection stations in Block Island Sound.

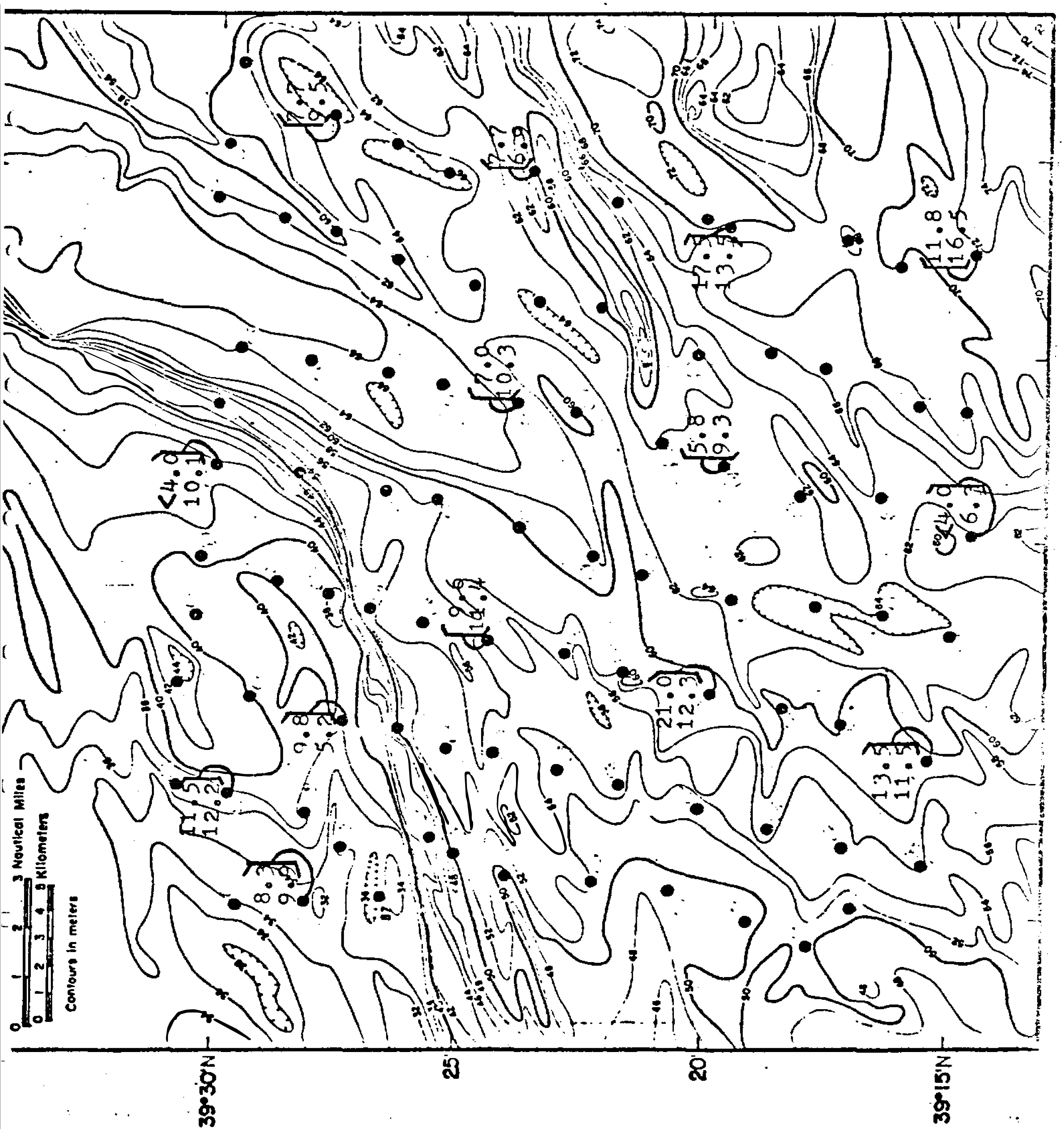


Figure 19. Concentrations of Ni (upper value) and Zn (lower) in surface sediments of Subarea A in Baltimore Canyon Trough. All values are in ppm, dry weight. (From Radosh et al., 1978.)

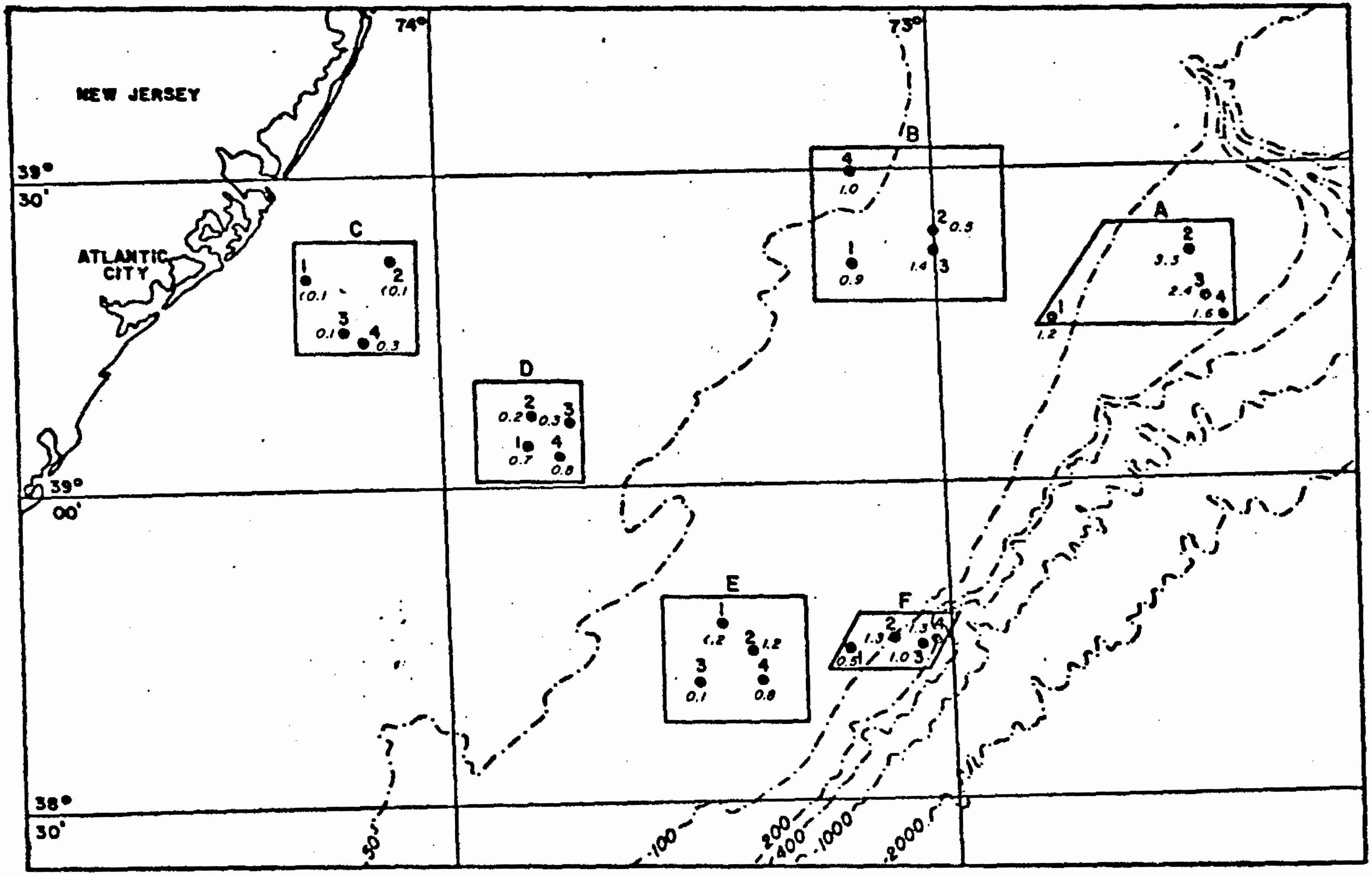


Figure 20. Leachable Ni in ppm dry weight, from Virginia Institute of Marine Science "benchmark" sampling in Middle Atlantic Bight. (From Harris, 1977.)

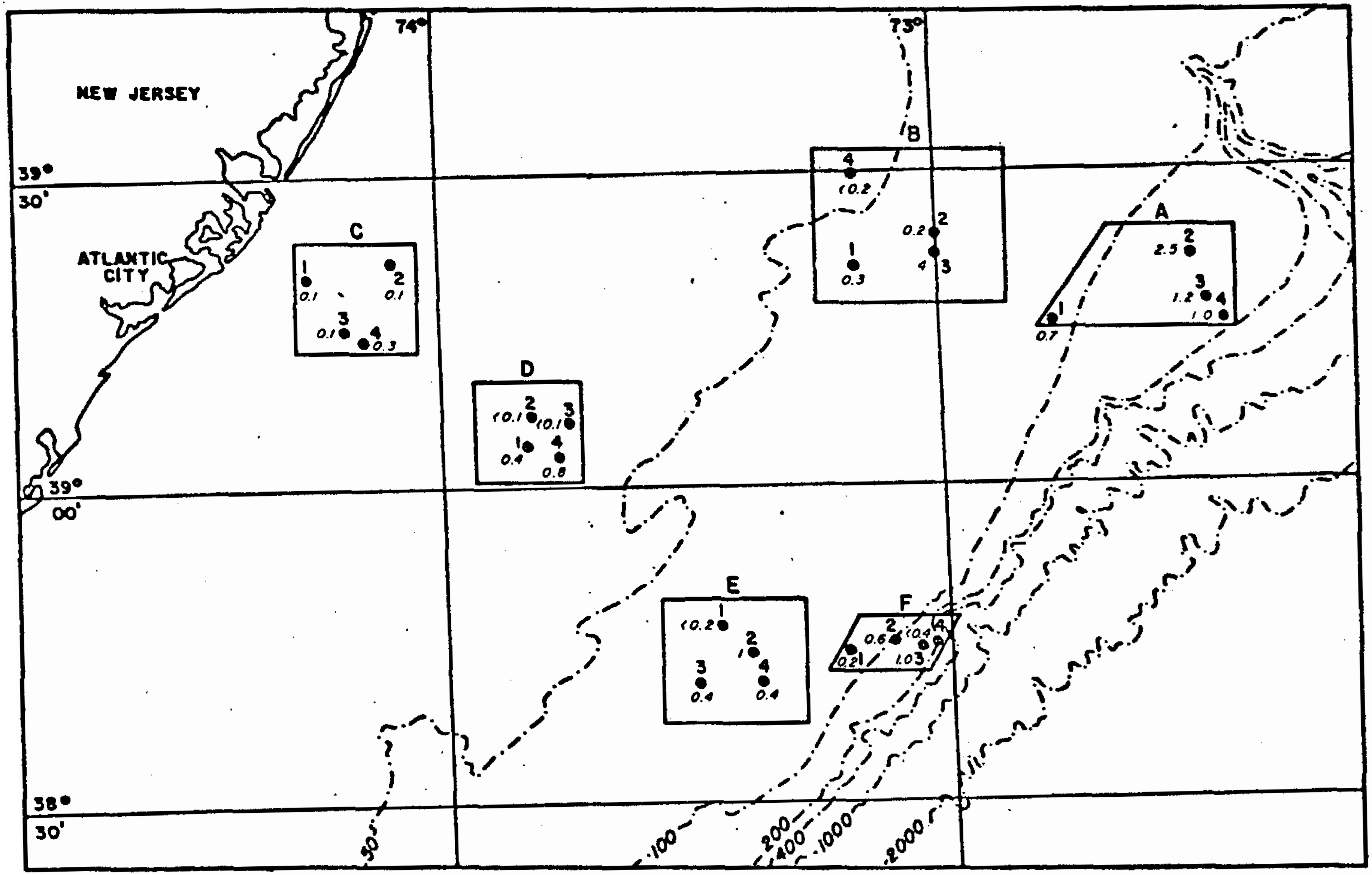


Figure 21. Leachable Cu in ppm dry weight, from Virginia Institute of Marine Science "benchmark" sampling in Middle Atlantic Bight. (From Harris, 1977.)

Figure 22. Sampling stations in Lower, Raritan and Sandy Hook Bays at which water was collected for analyses for cu and pb; see Table 5 for values associated with each station.

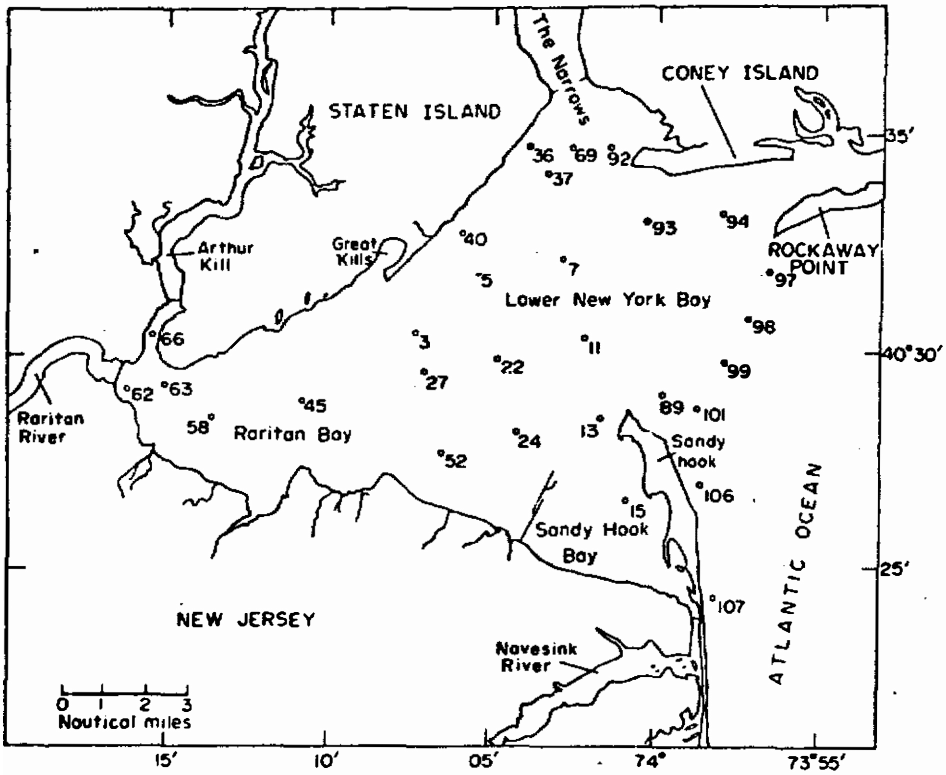


Figure 23. Concentrations of four metals vs. degrees north latitude.

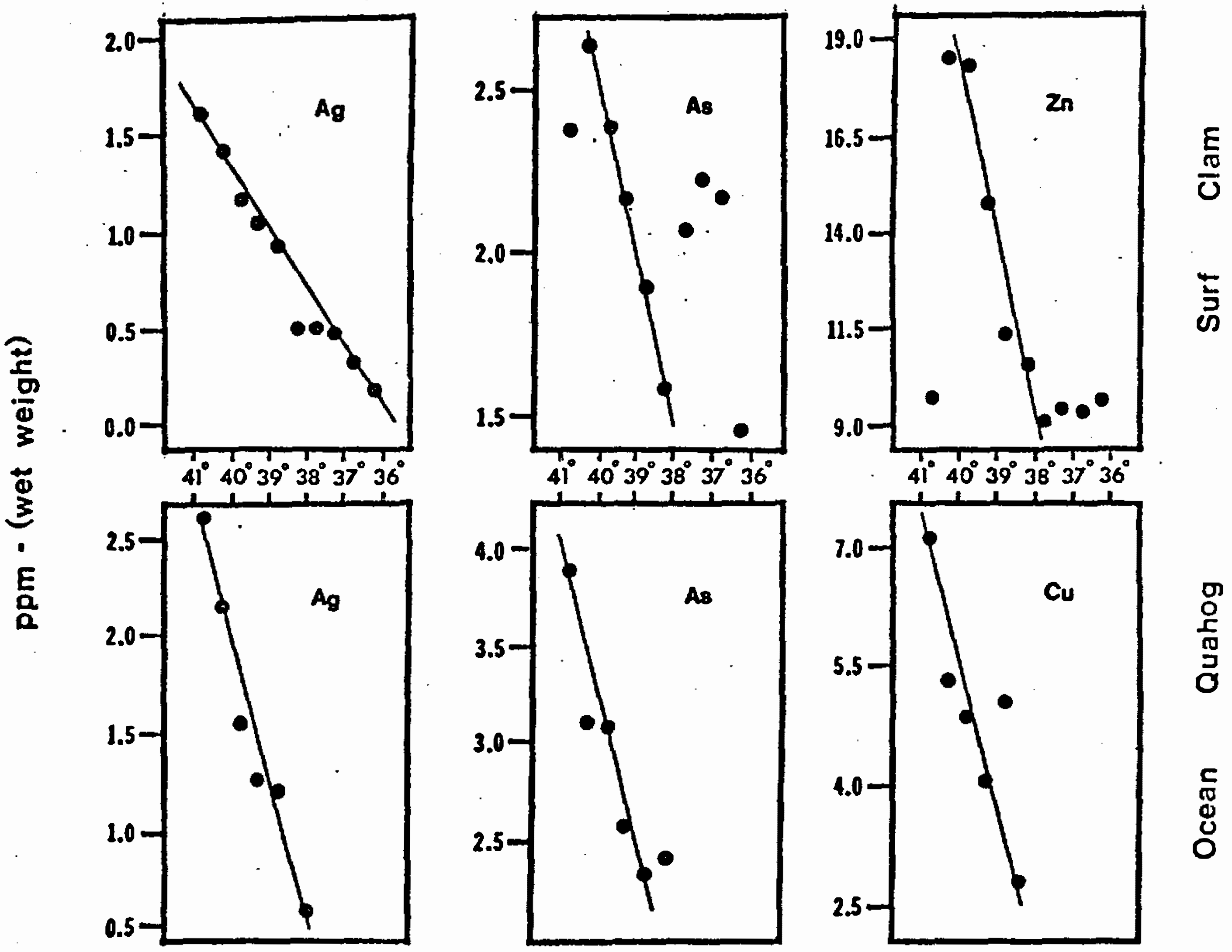


Figure 24. Distribution of Copper in New York Bight Fishes

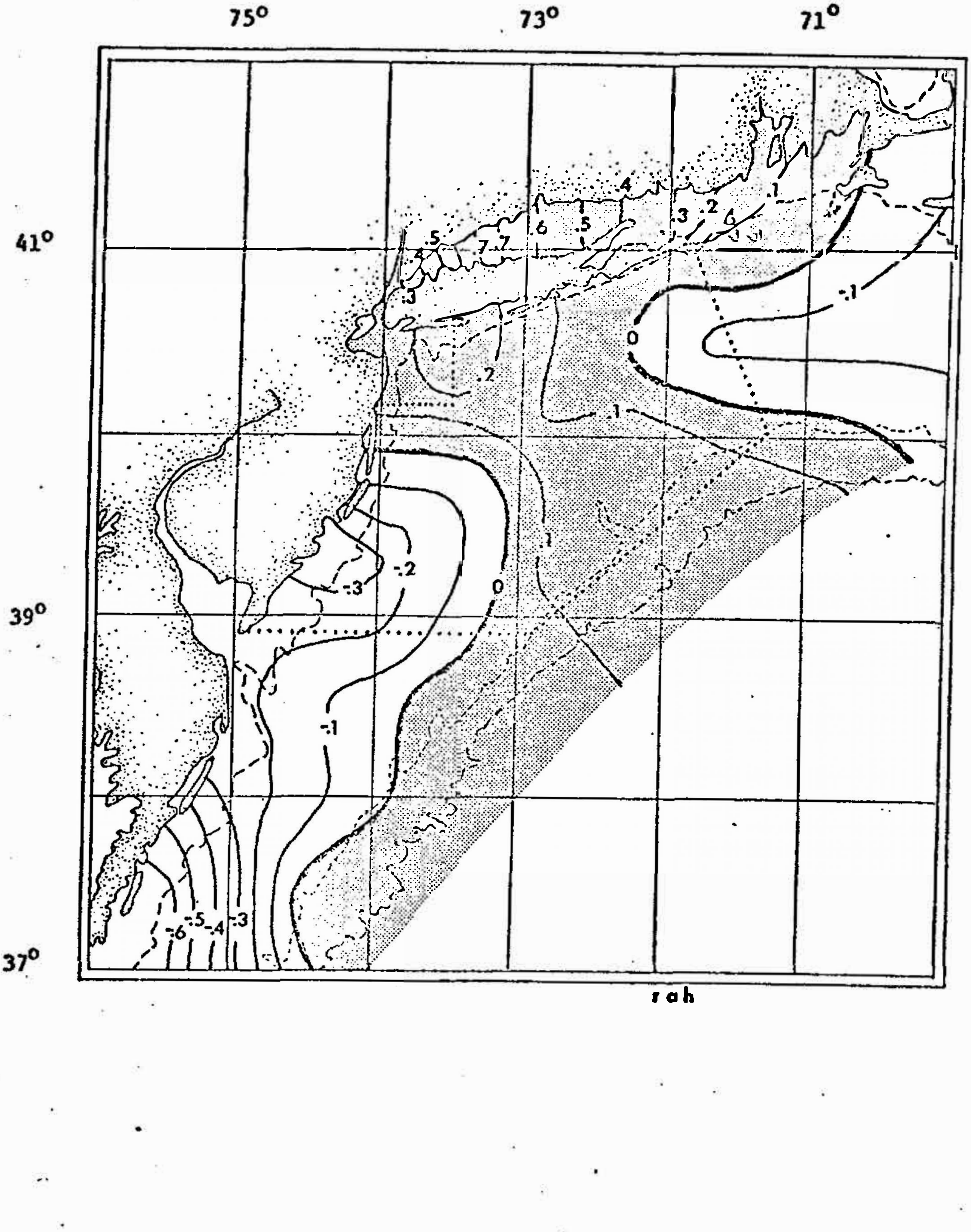


Figure 25. Distribution of Silver in New York Bight Fishes

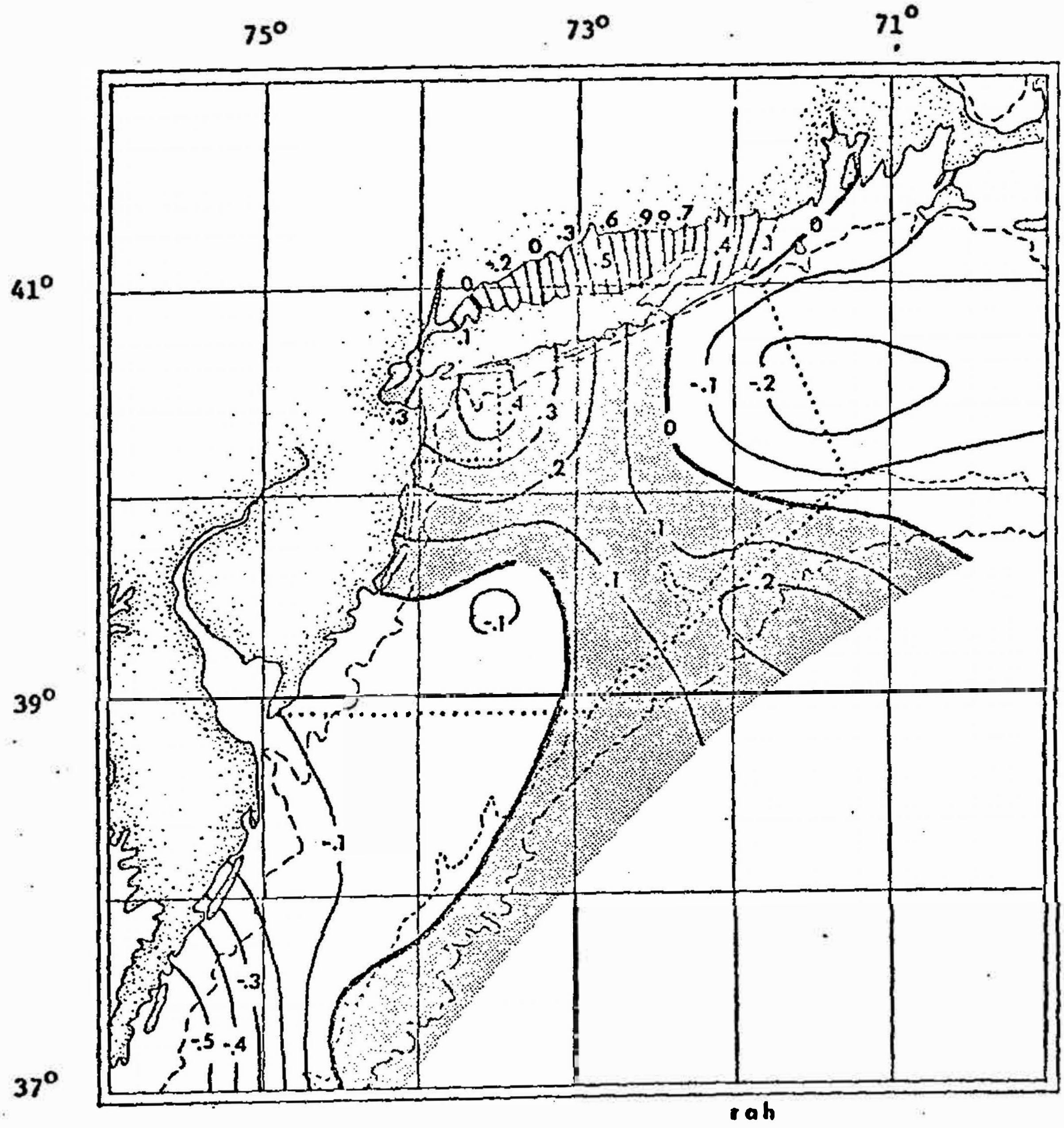


Figure 26. Distributions of gravels, sands, and silt and clay from Middle Atlantic Bight and off New England waters.

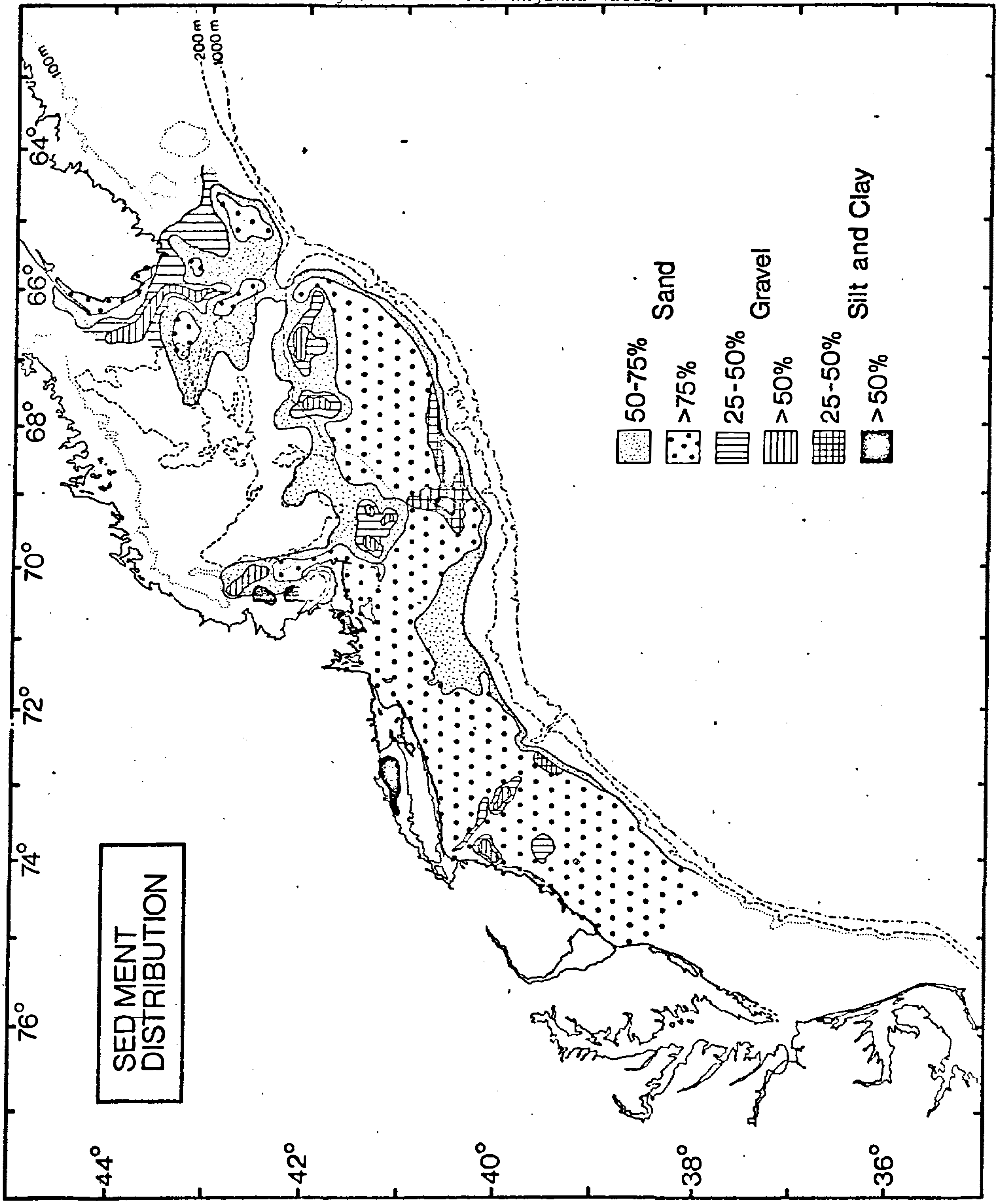
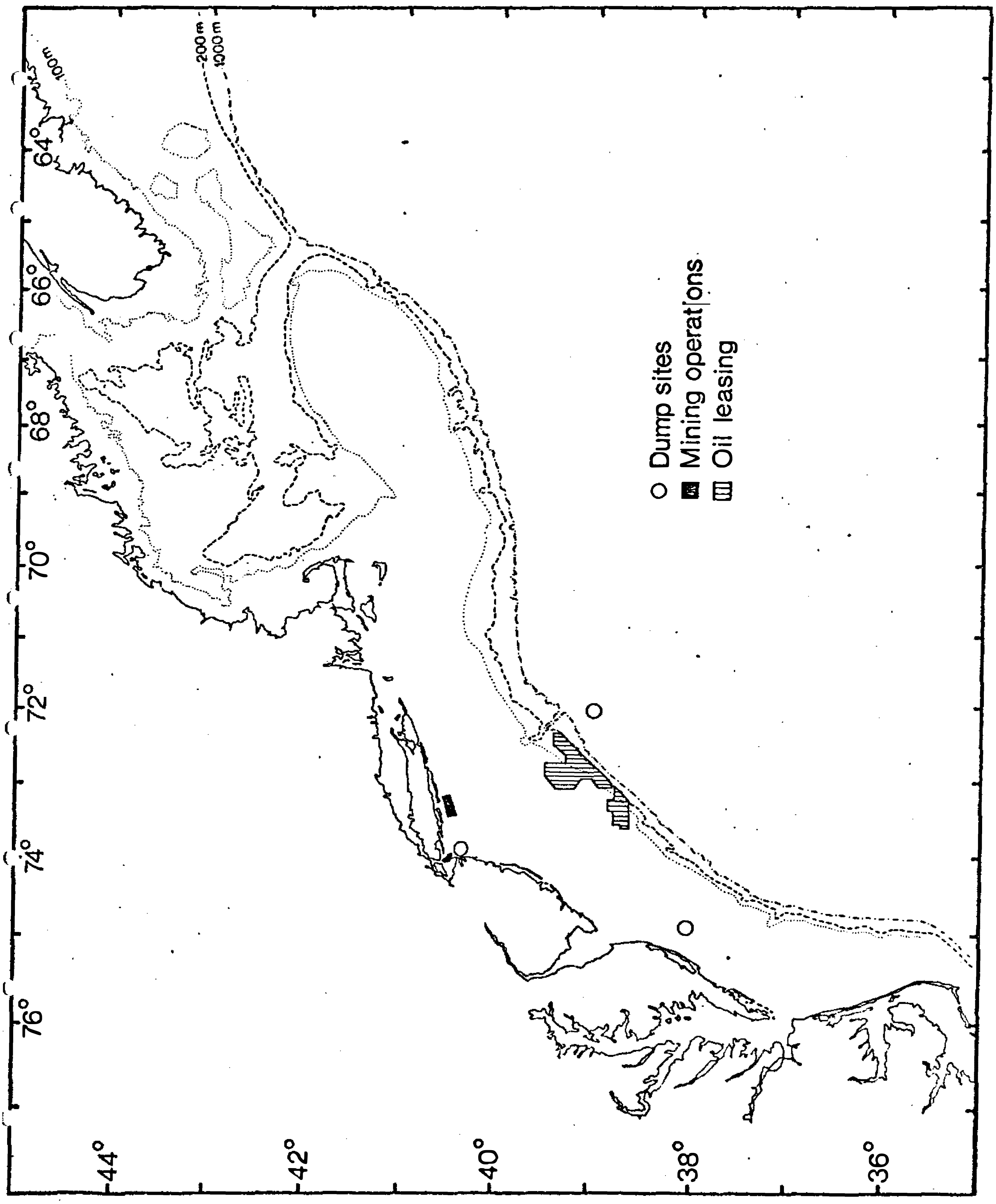


Figure 27. Location of existing dumpsites, petroleum development, and mining operations for marine aggregates.



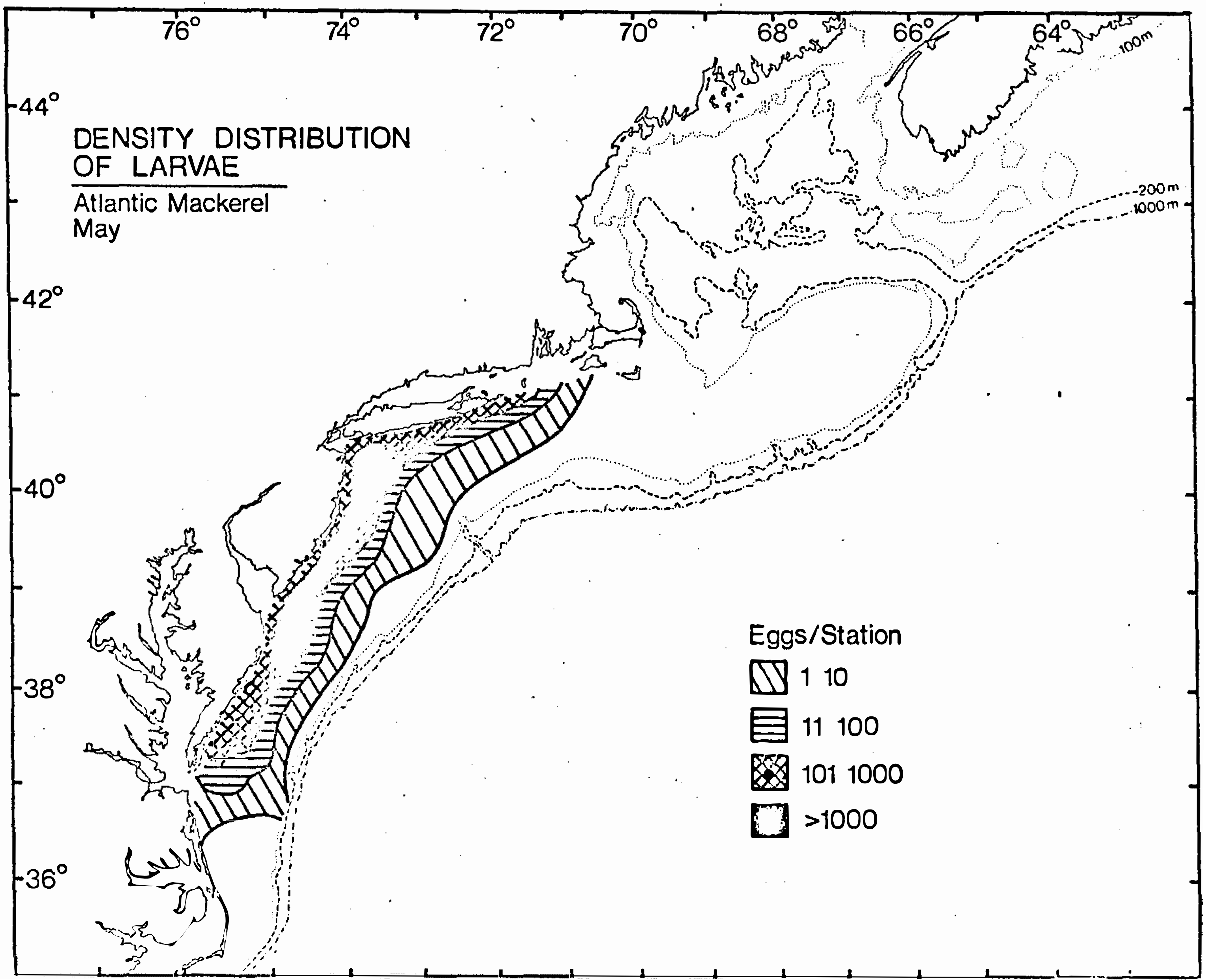

DENSITY DISTRIBUTION OF LARVAE
Atlantic Mackerel
May
76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
100m
200m
1000m
Eggs/Station
1 10
11 100
101 1000
>1000

Figure 28

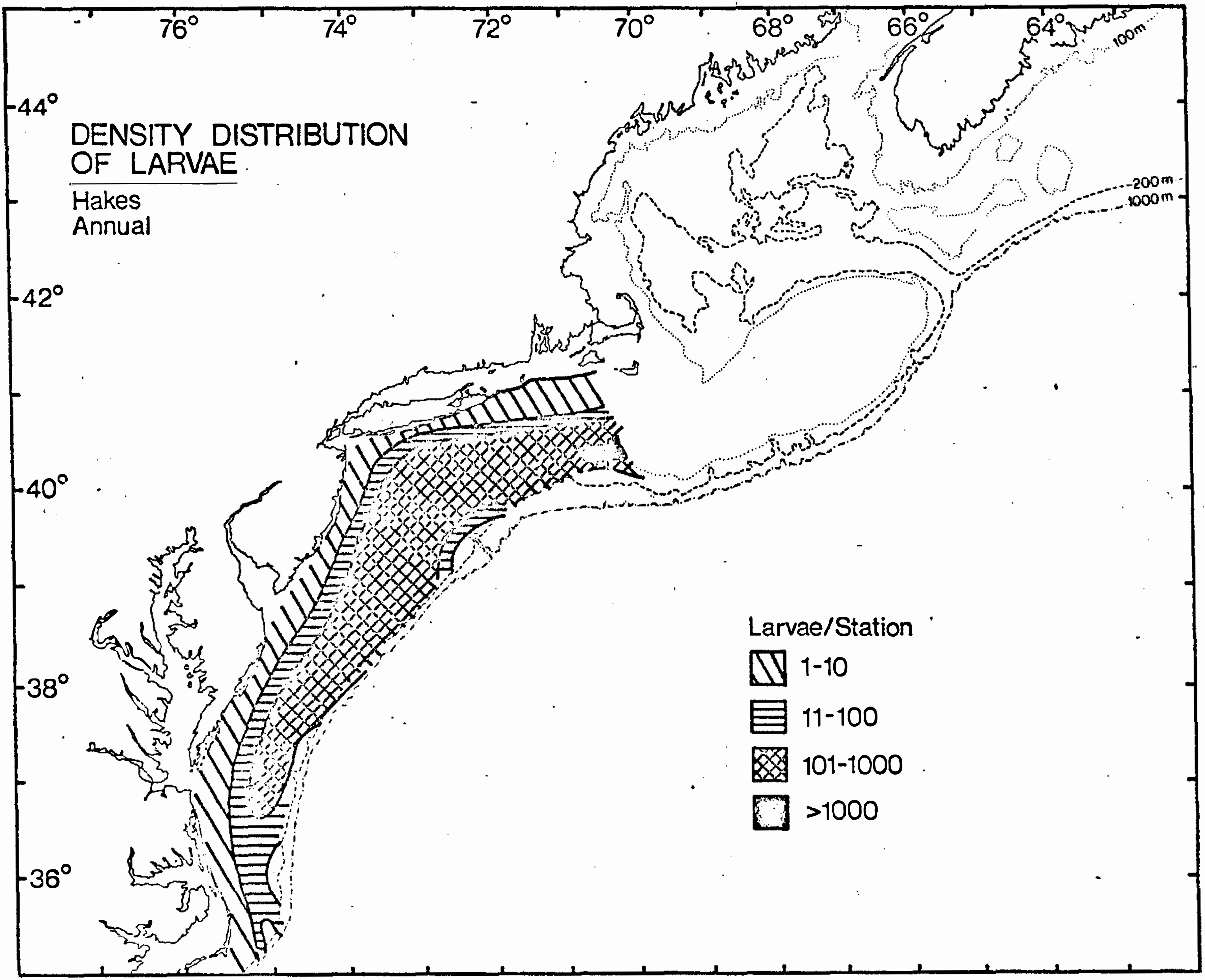
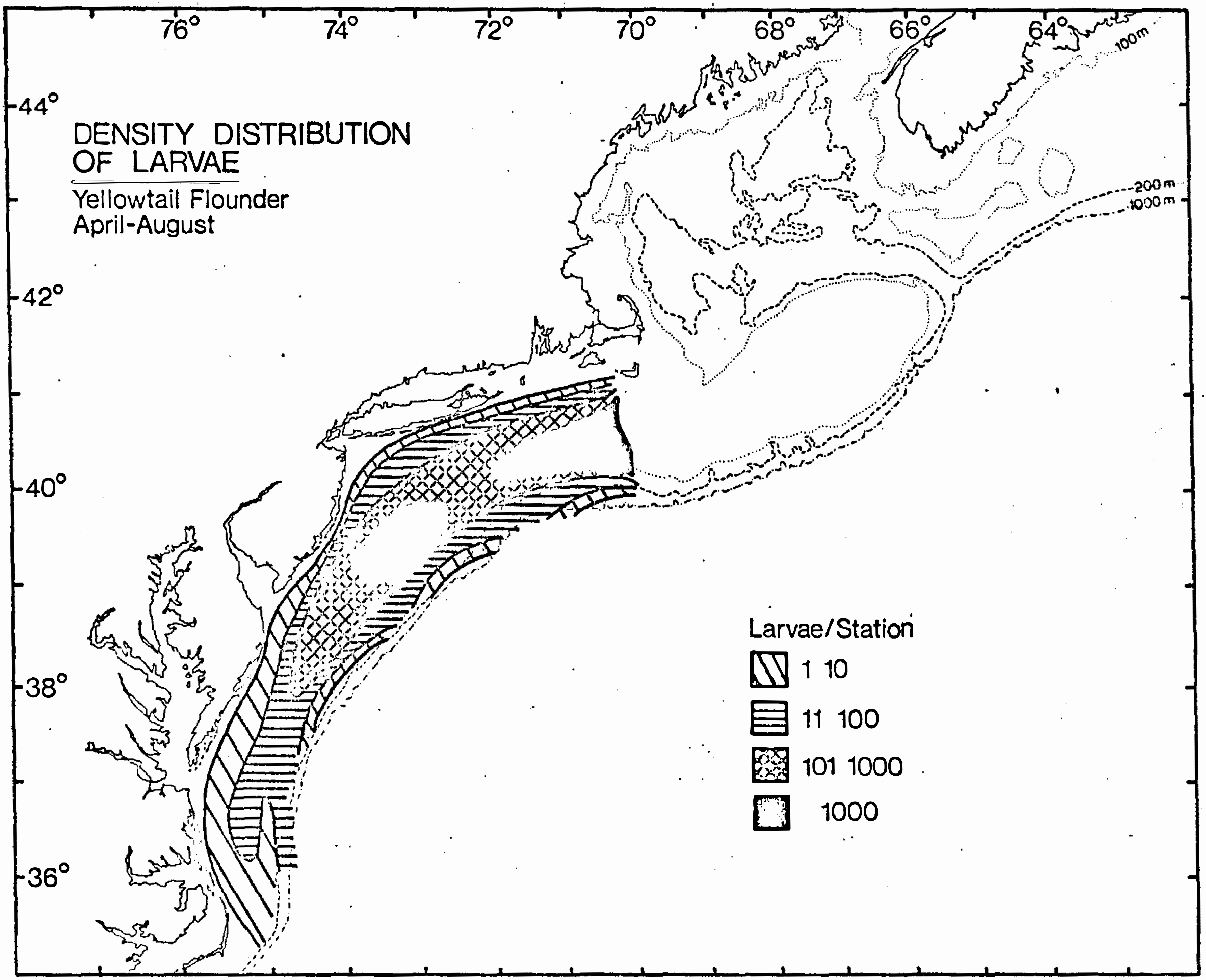

DENSITY DISTRIBUTION OF LARVAE
Hakes
Annual
76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
100m
200m
1000m
Larvae/Station
1-10
11-100
101-1000
>1000

Figure 29

Figure 30


76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
100m
200m
1000m
DENSITY DISTRIBUTION OF LARVAE
Yellowtail Flounder
April-August
Larvae/Station
1 10
11 100
101 1000
1000

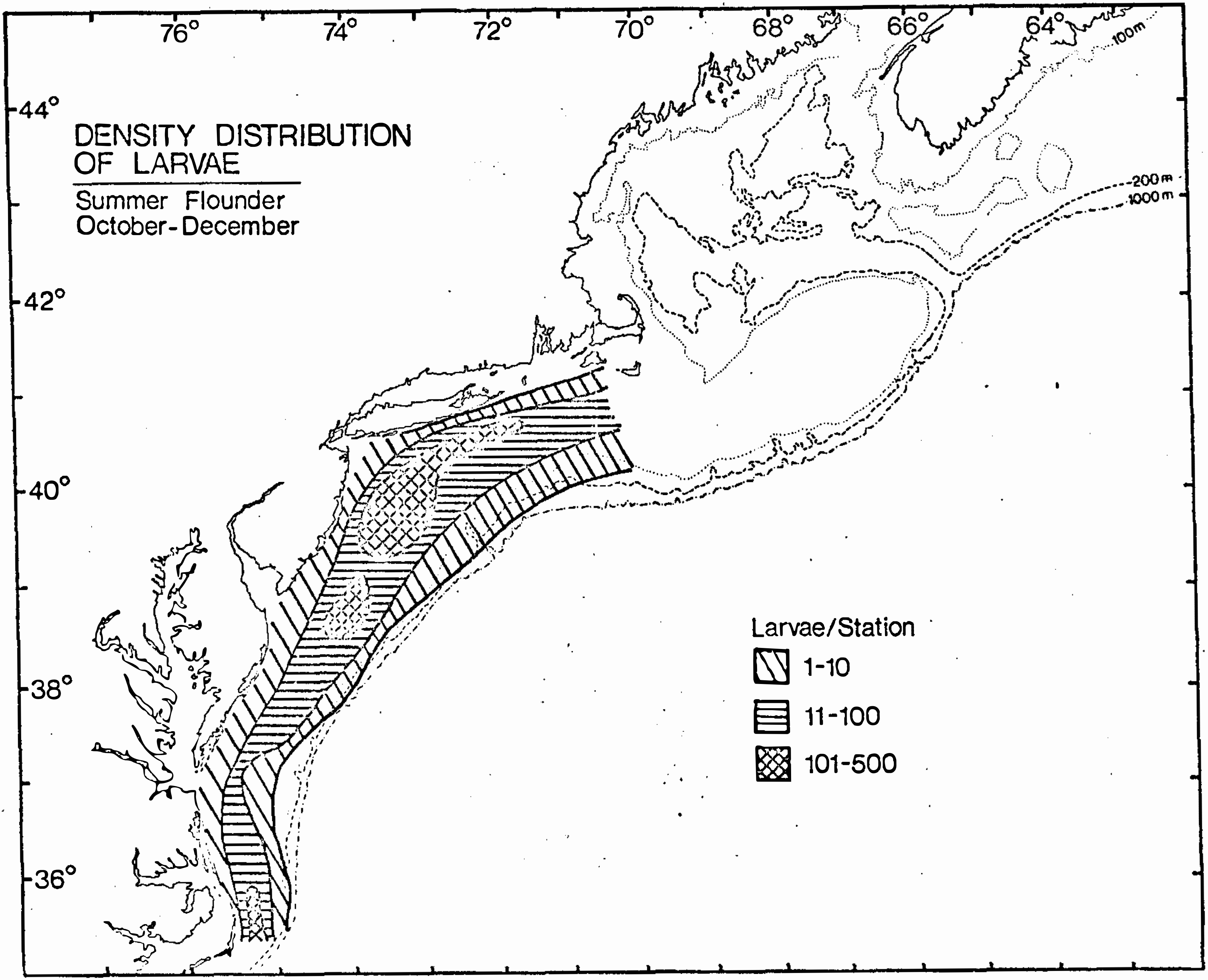

DENSITY DISTRIBUTION OF LARVAE
Summer Flounder
October-December
Larvae/Station
1-10
11-100
101-500
76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
100m
200m
1000m

Figure 31

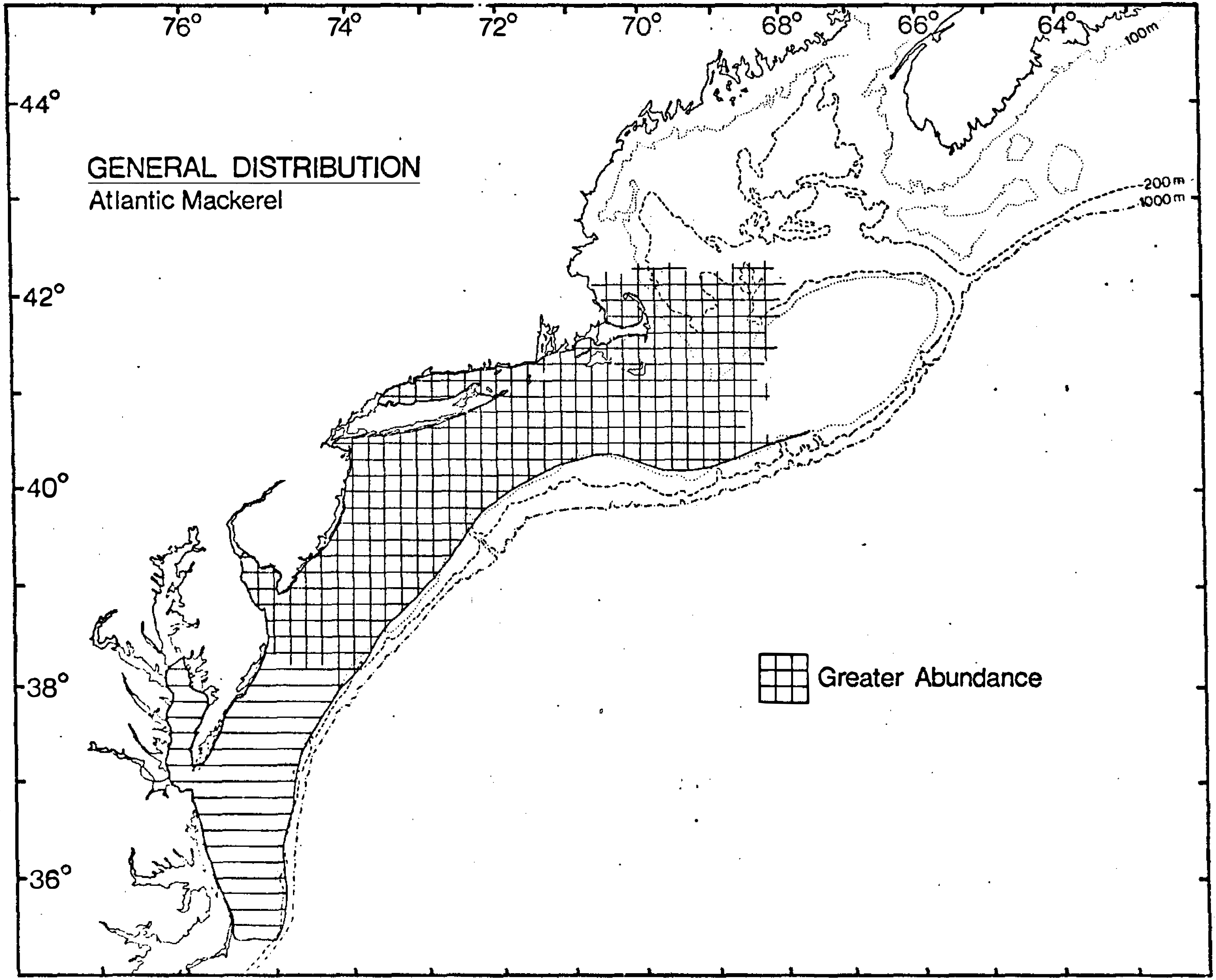

76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
GENERAL DISTRIBUTION
Atlantic Mackerel
100m
200m
1000m
Greater Abundance

Figure 32

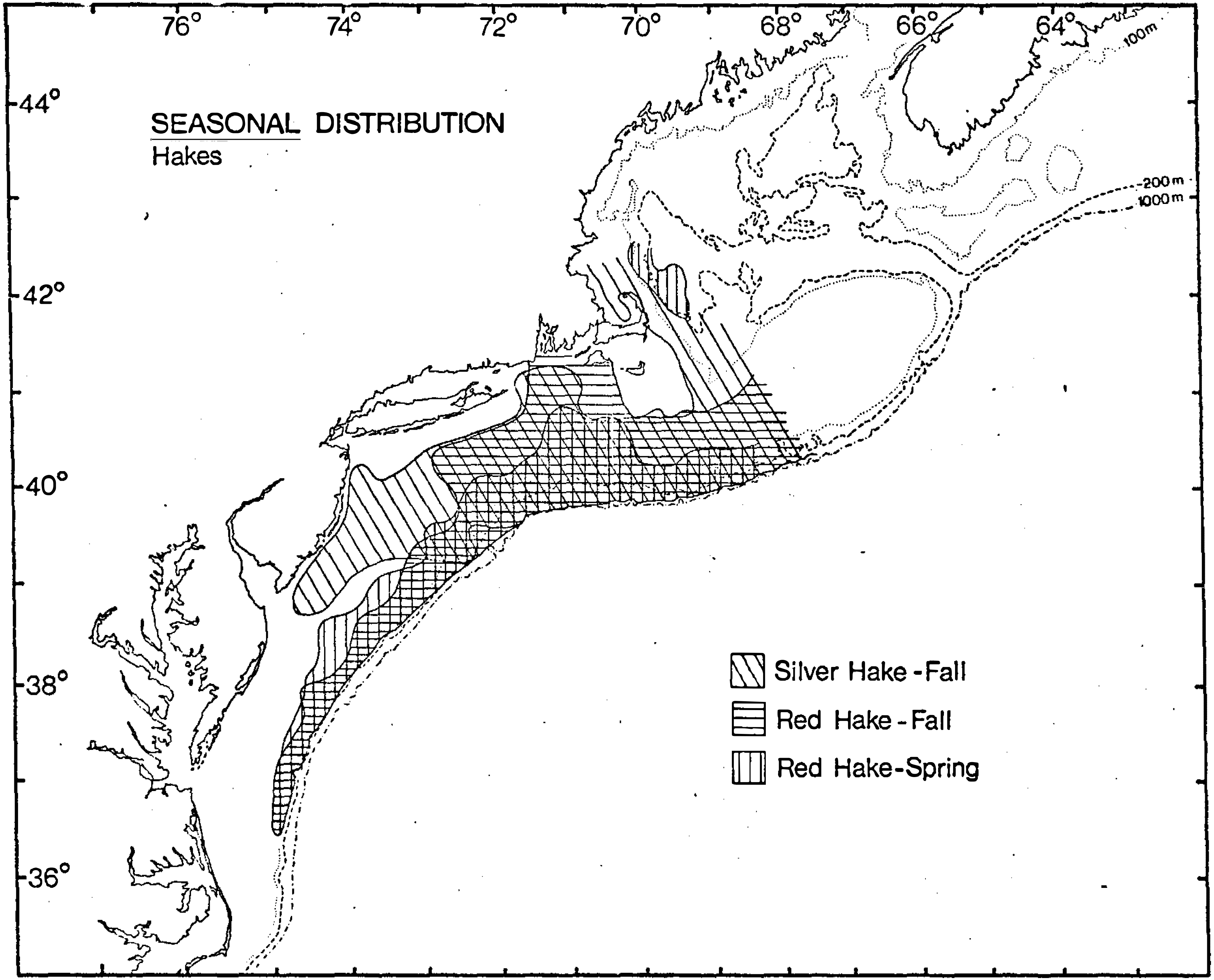
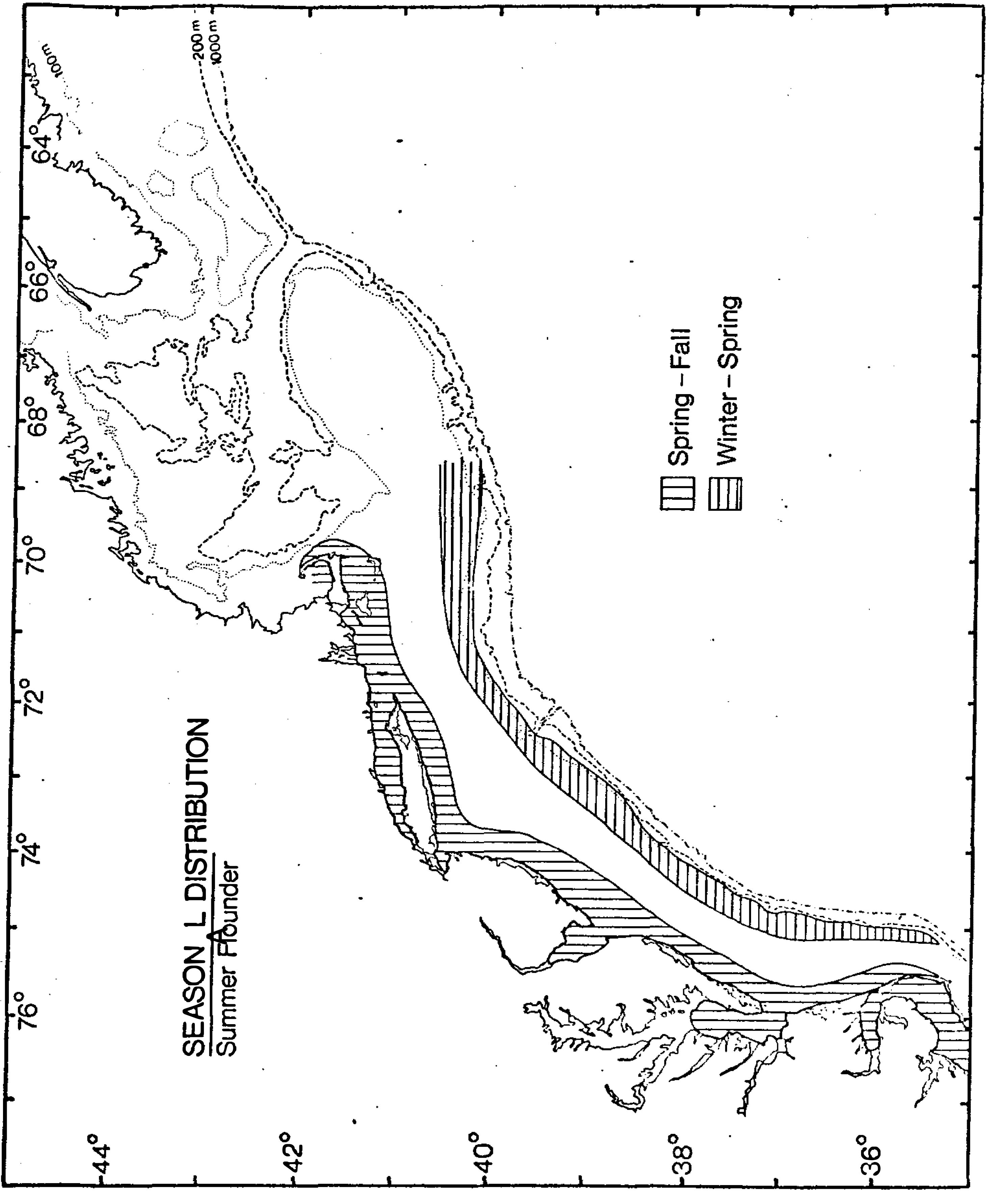

SEASONAL DISTRIBUTION
Hakes
76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
100m
200m
1000m
▧ Silver Hake - Fall
▤ Red Hake - Fall
▥ Red Hake - Spring

Figure 33

Figure 34


SEASON A L DISTRIBUTION
Summer Flounder
Spring - Fall
Winter - Spring
100m
200m
1000m
64°
66°
68°
70°
72°
74°
76°
44°
42°
40°
38°
36°

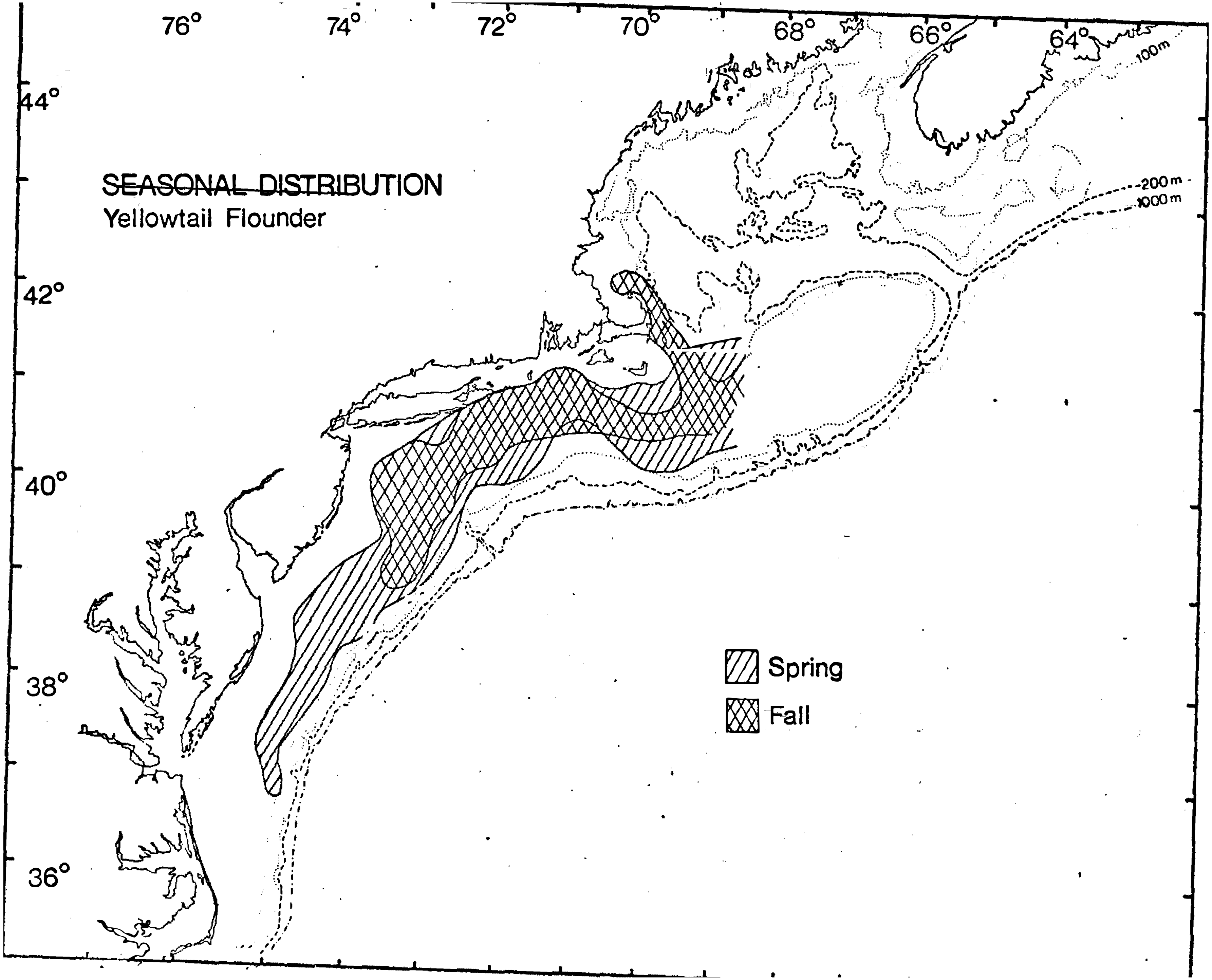

SEASONAL DISTRIBUTION
Yellowtail Flounder
76°
74°
72°
70°
68°
66°
64°
44°
42°
40°
38°
36°
100m
200m
1000m
▨ Spring
▩ Fall

Figure 35

Figures 36-48. General distributions of adult fish and shellfish.

Figure 36.

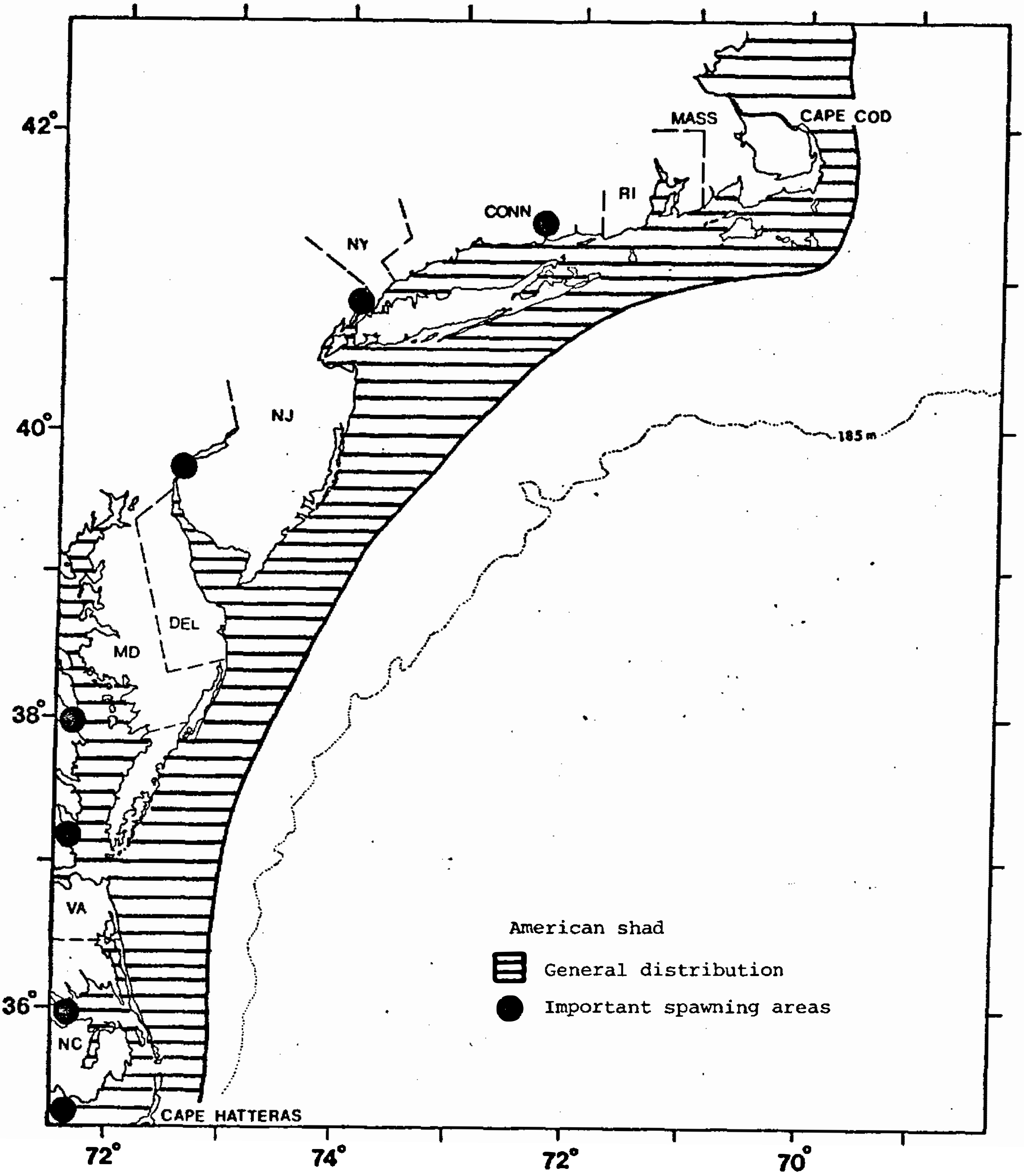

42°
40°
38°
36°
72°
74°
72°
70°
MASS
CAPE COD
RI
CONN
NY
NJ
DEL
MD
VA
NC
CAPE HATTERAS
185 m
American shad
▤ General distribution
● Important spawning areas

Figure 37.

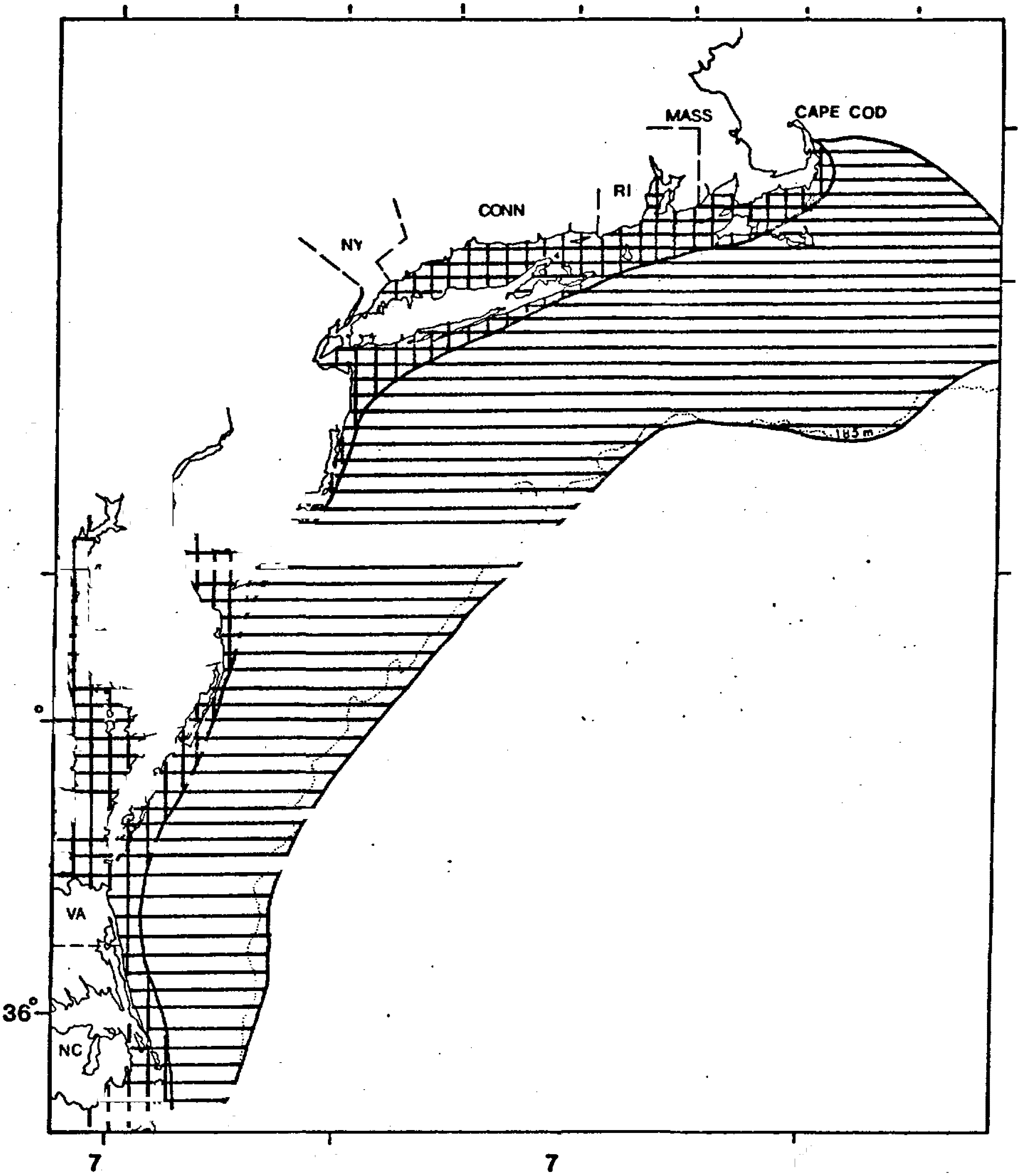


Figure 38.

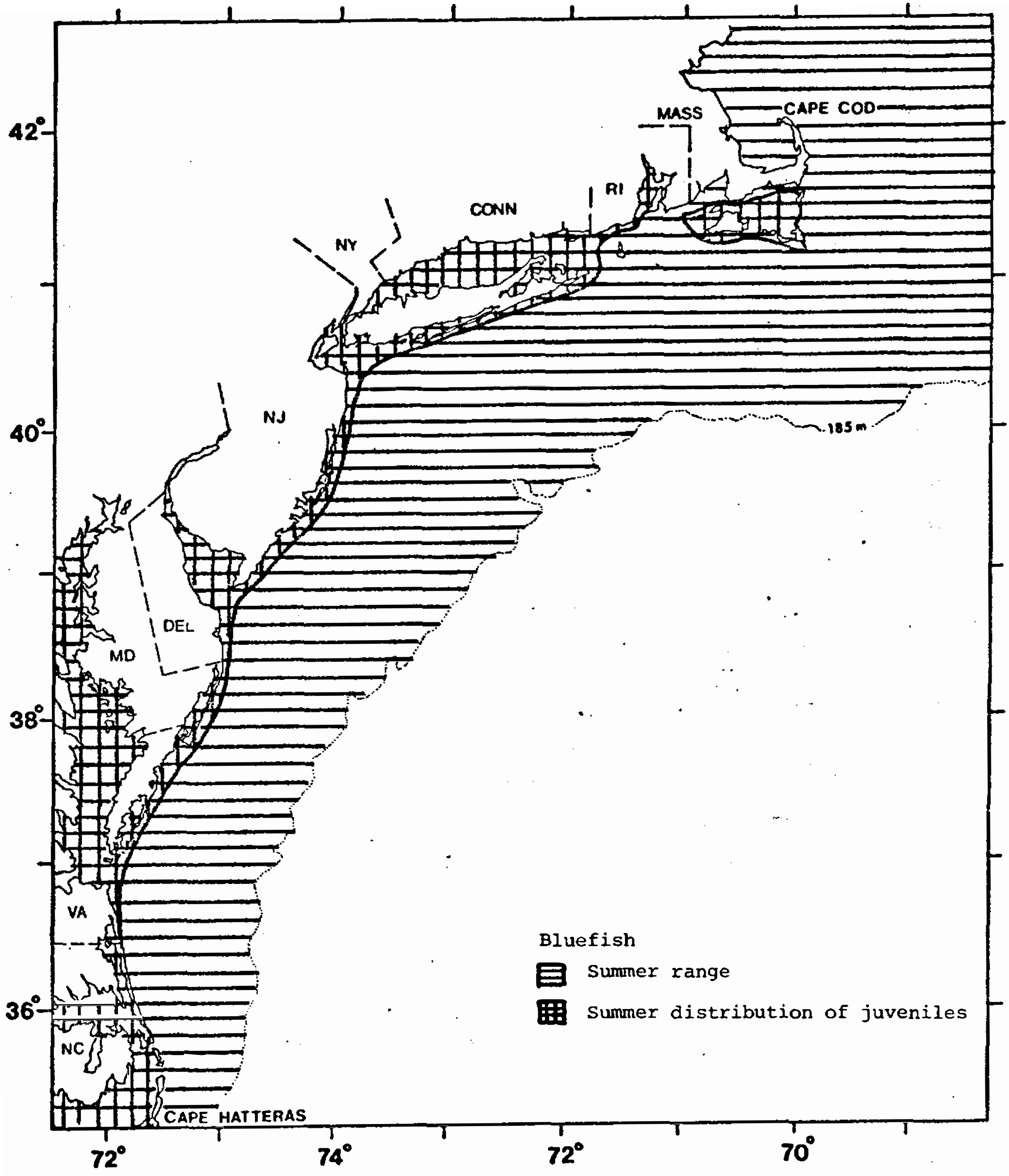

42°
40°
38°
36°
72°
74°
72°
70°
MASS
CAPE COD
RI
CONN
NY
NJ
DEL
MD
VA
NC
CAPE HATTERAS
185 m
Bluefish
Summer range
Summer distribution of juveniles

Figure 39.

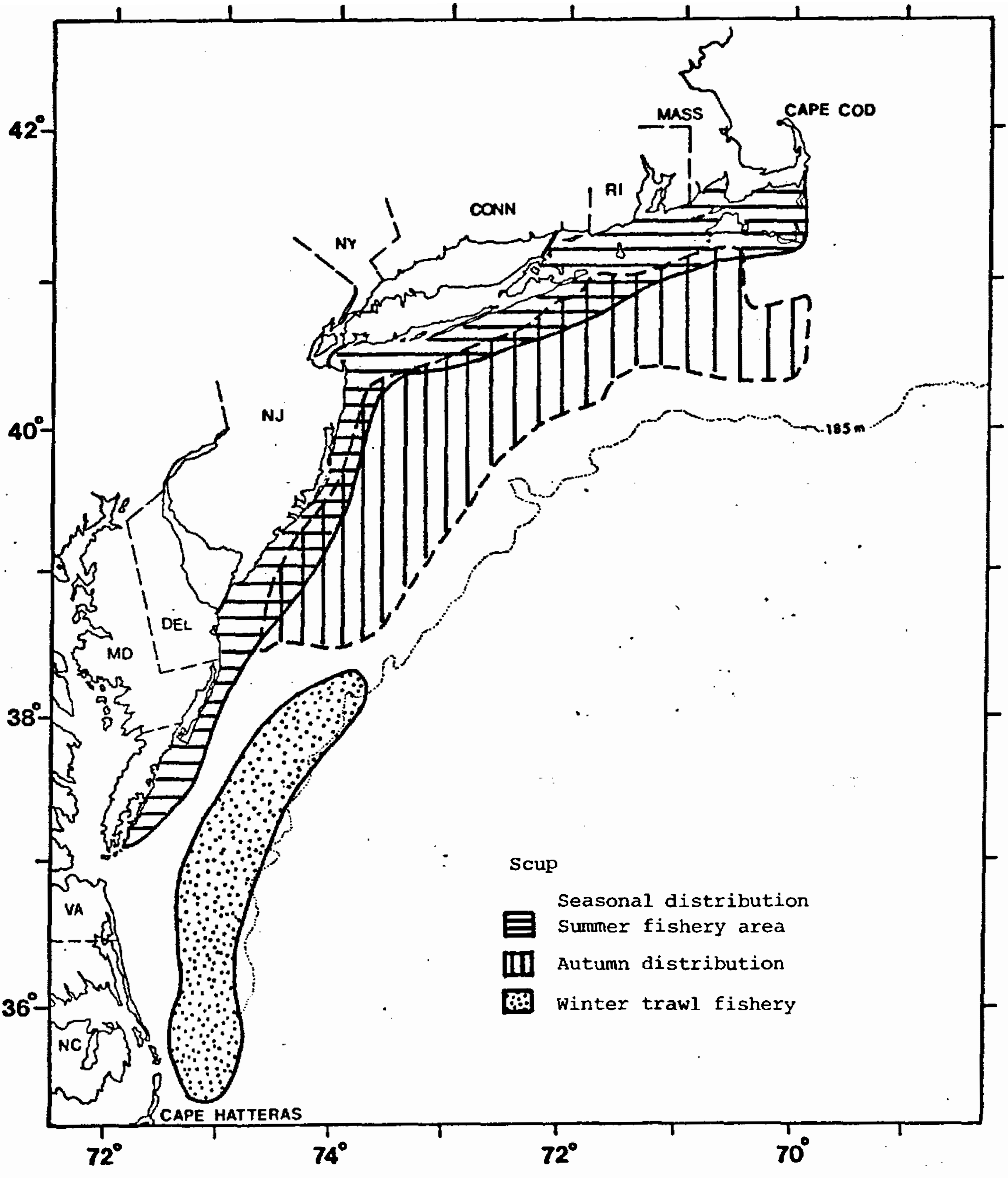

42°
40°
38°
36°
72°
74°
72°
70°
MASS
CAPE COD
RI
CONN
NY
NJ
DEL
MD
VA
NC
CAPE HATTERAS
185 m
Scup
Seasonal distribution
▤ Summer fishery area
▥ Autumn distribution
▒ Winter trawl fishery

Figure 40.

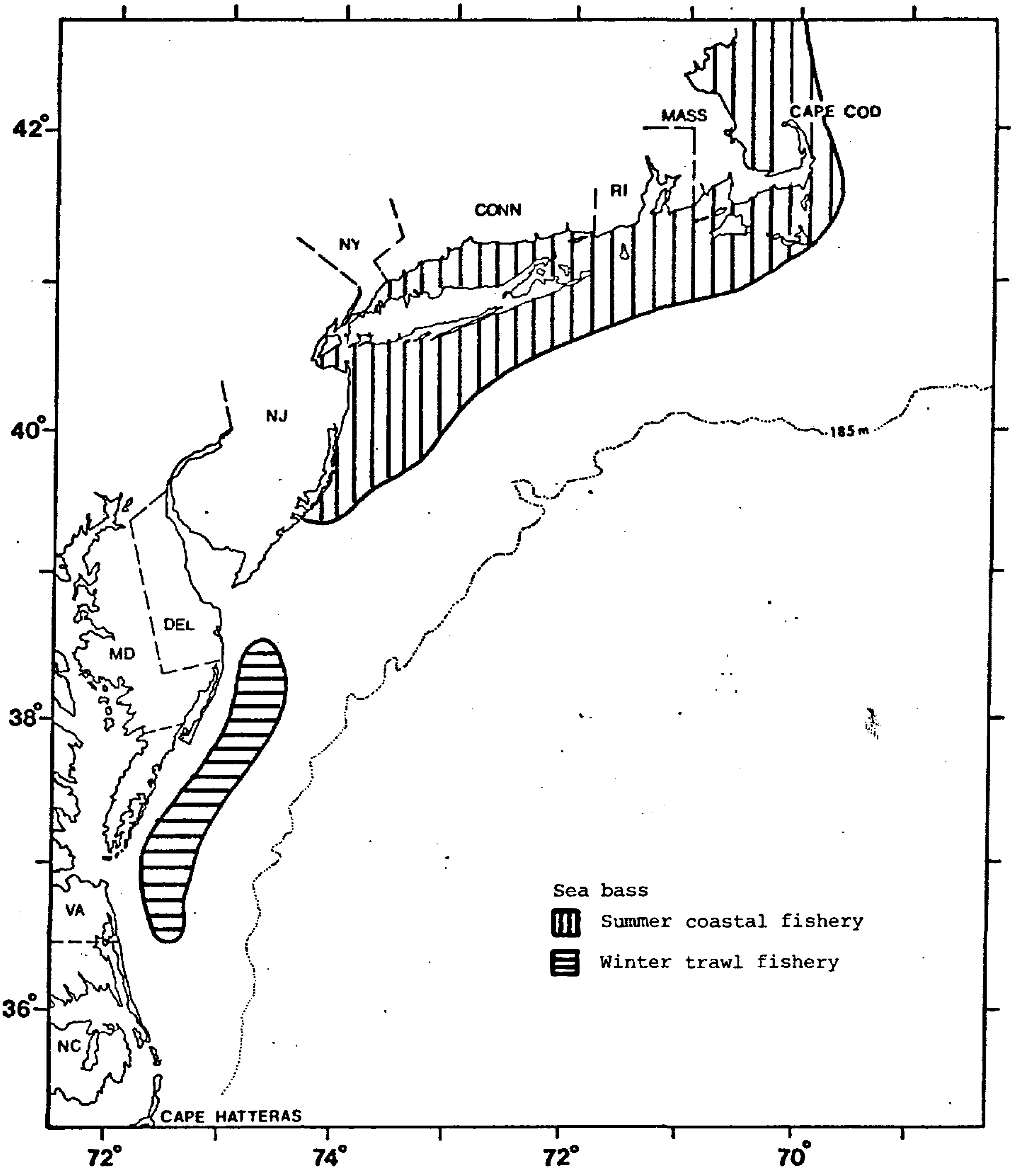
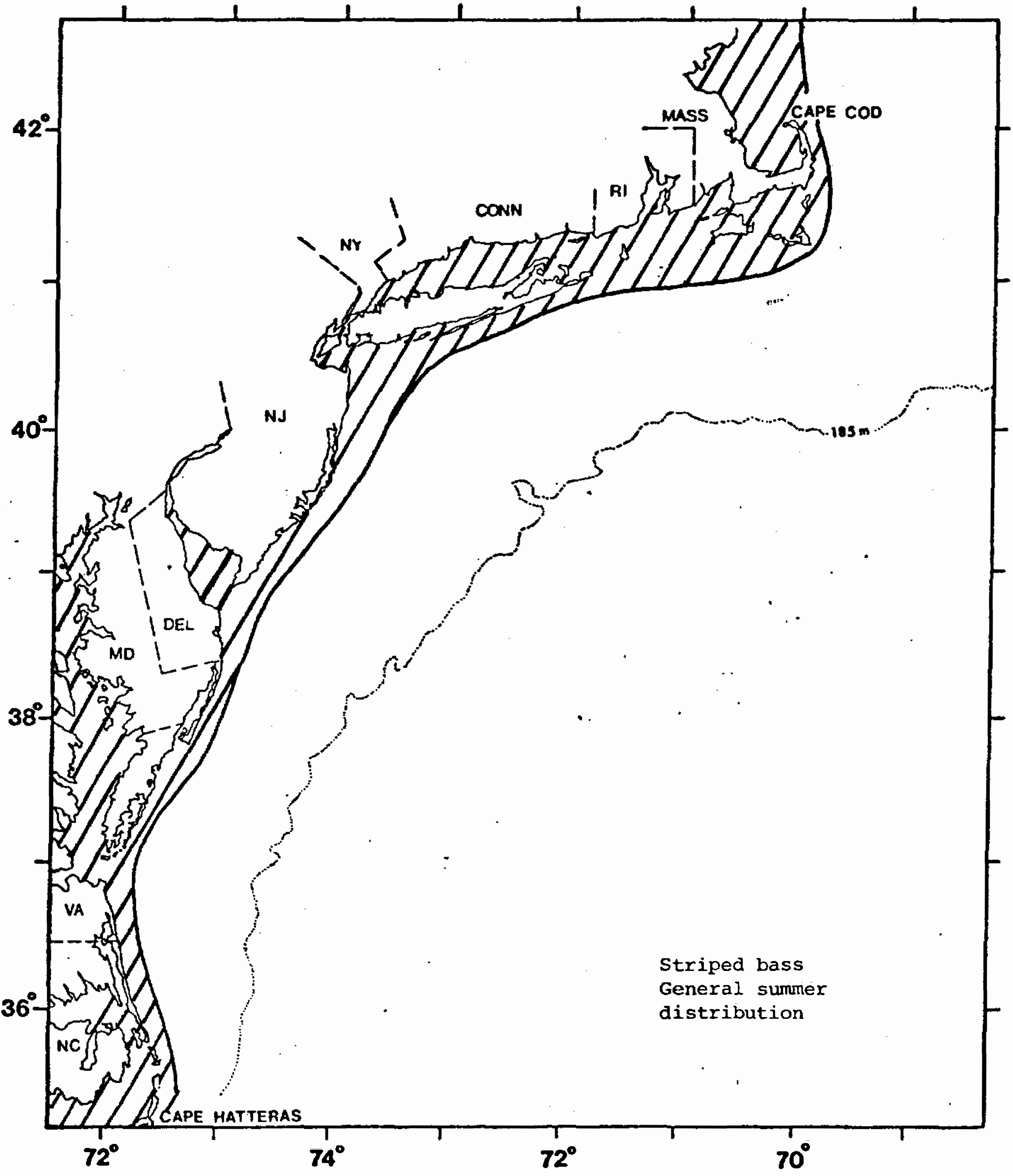
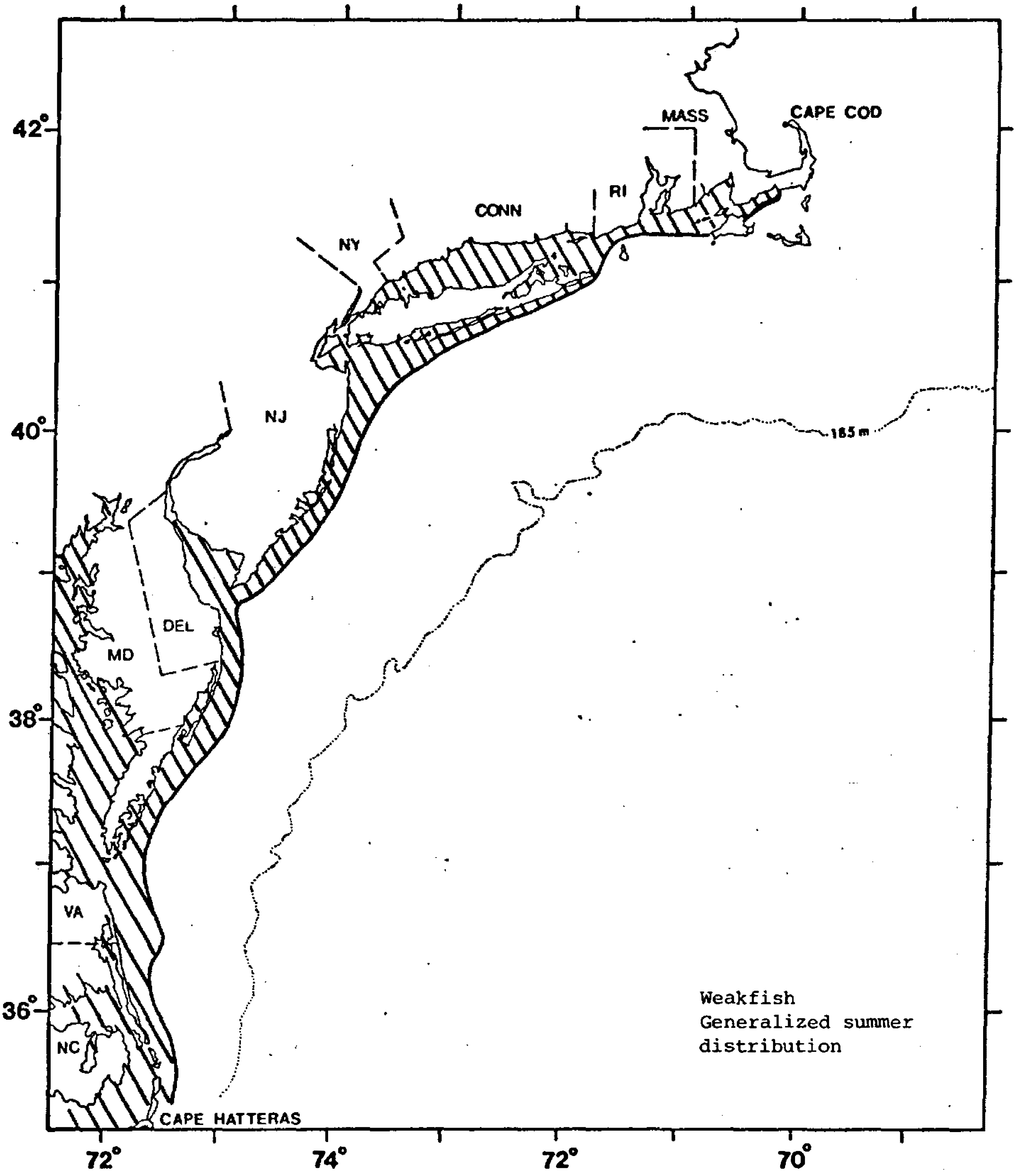

42°
40°
38°
36°
72°
74°
72°
70°
NY
CONN
RI
MASS
CAPE COD
NJ
DEL
MD
VA
NC
CAPE HATTERAS
185 m
Sea bass
▥ Summer coastal fishery
▤ Winter trawl fishery

Figure 41.



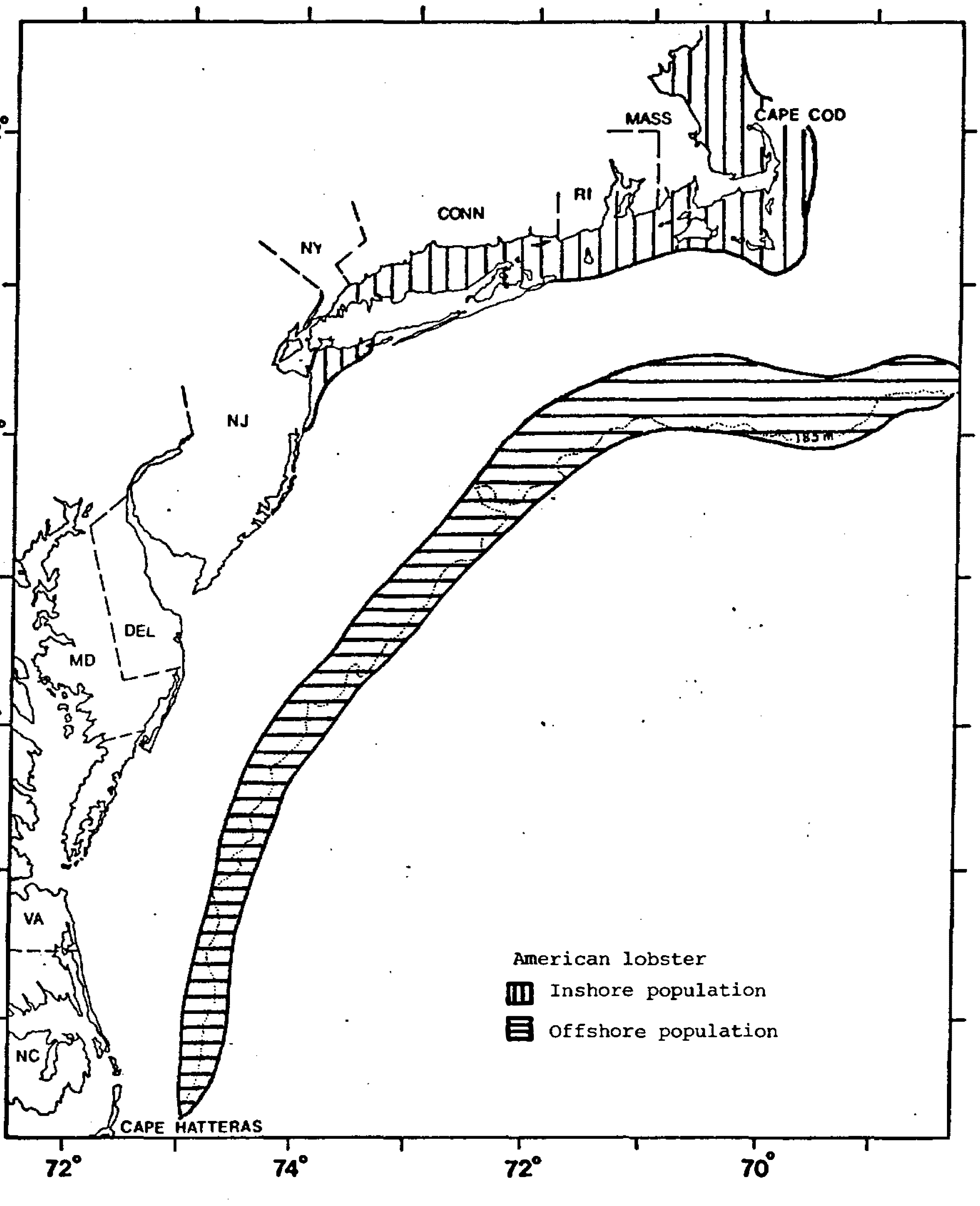
Striped bass
General summer
distribution

Figure 42.



Weakfish
Generalized summer distribution

Figure 43.

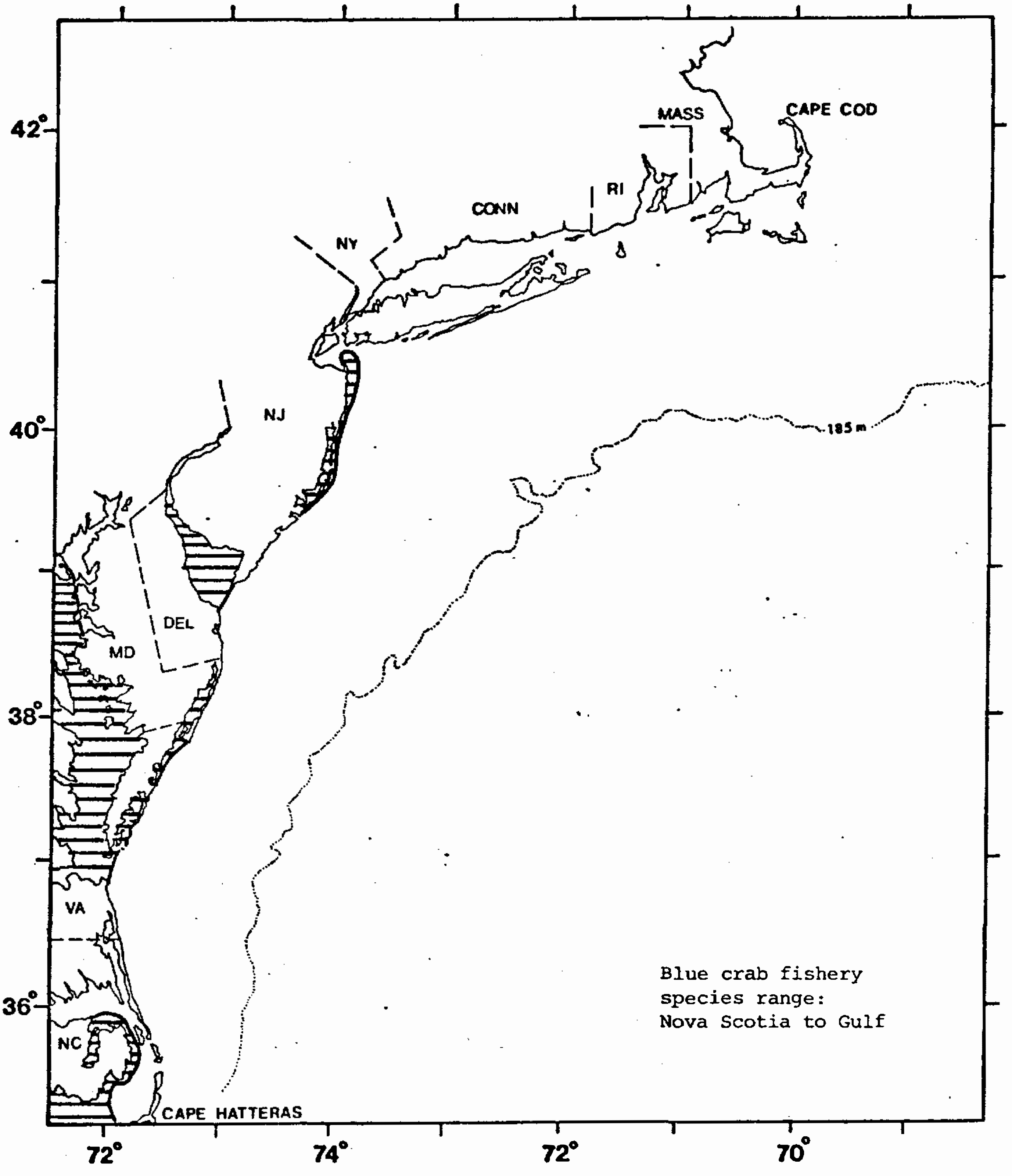


American lobster

▥ Inshore population

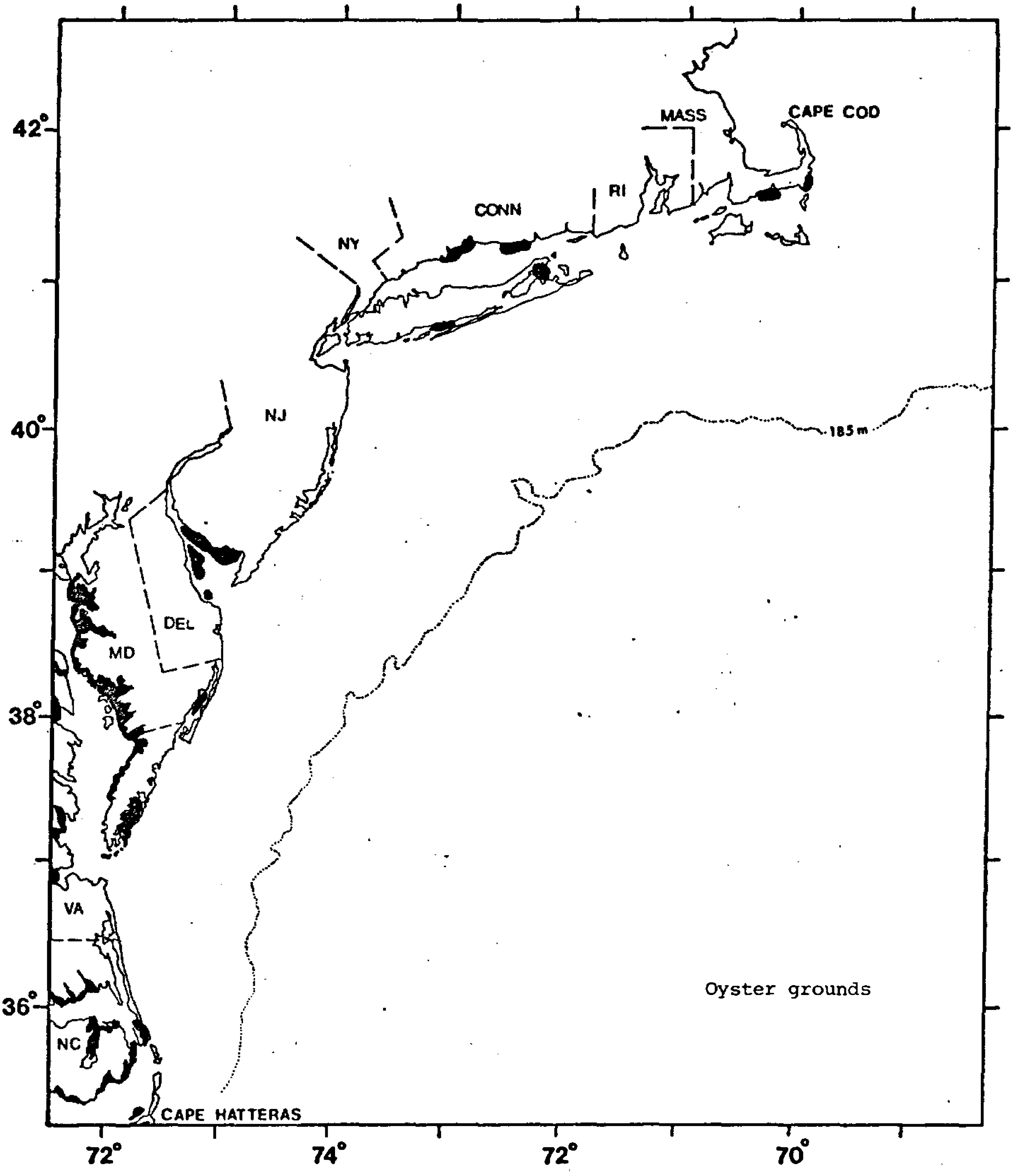
▤ Offshore population

Figure 44.



Blue crab fishery
species range:
Nova Scotia to Gulf

Figure 45.



Oyster grounds

Figure 46.

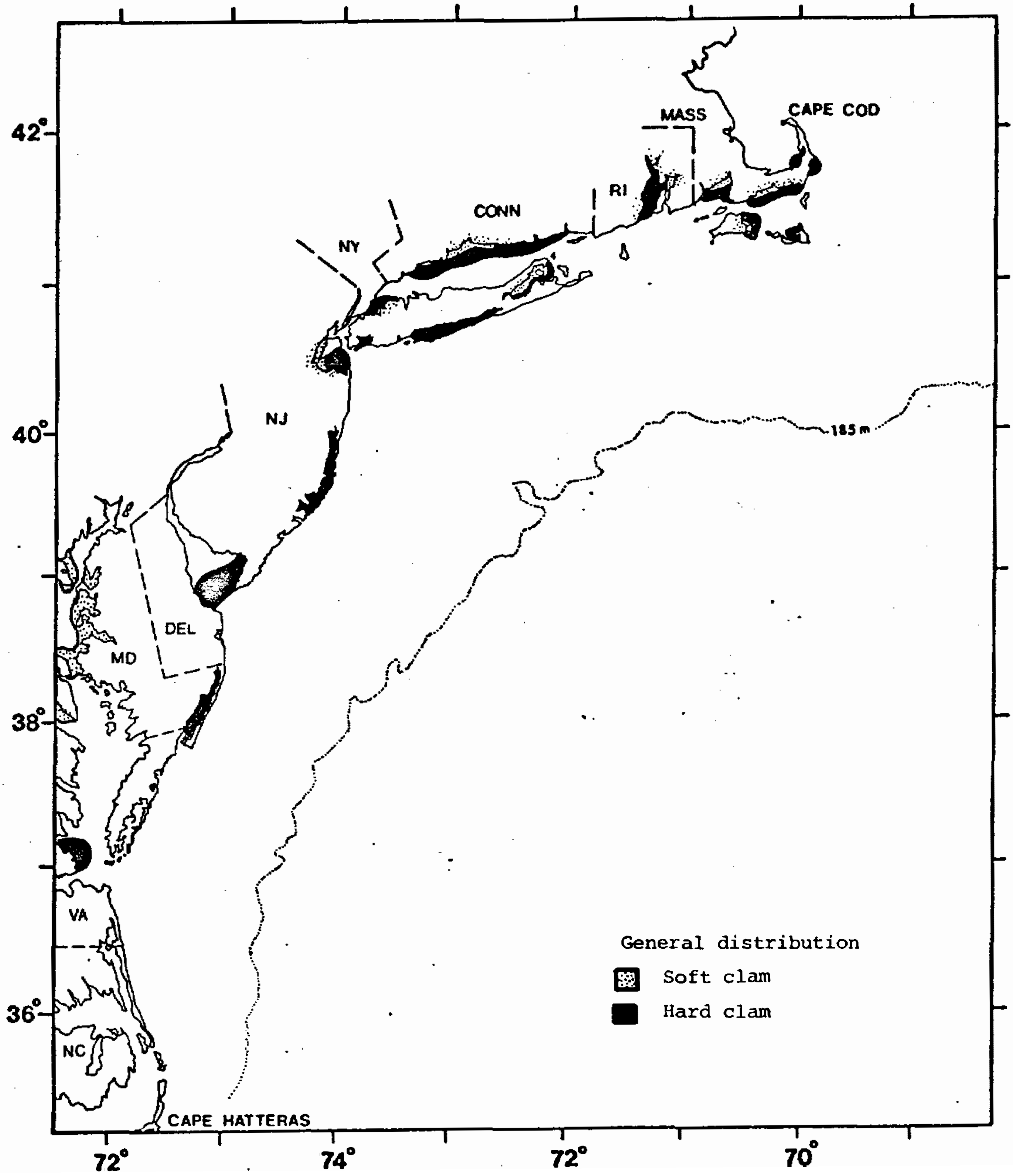

42°
40°
38°
36°
CAPE COD
MASS
RI
CONN
NY
NJ
DEL
MD
VA
NC
CAPE HATTERAS
185 m
General distribution
▨ Soft clam
■ Hard clam
72°
74°
72°
70°

Figure 47.

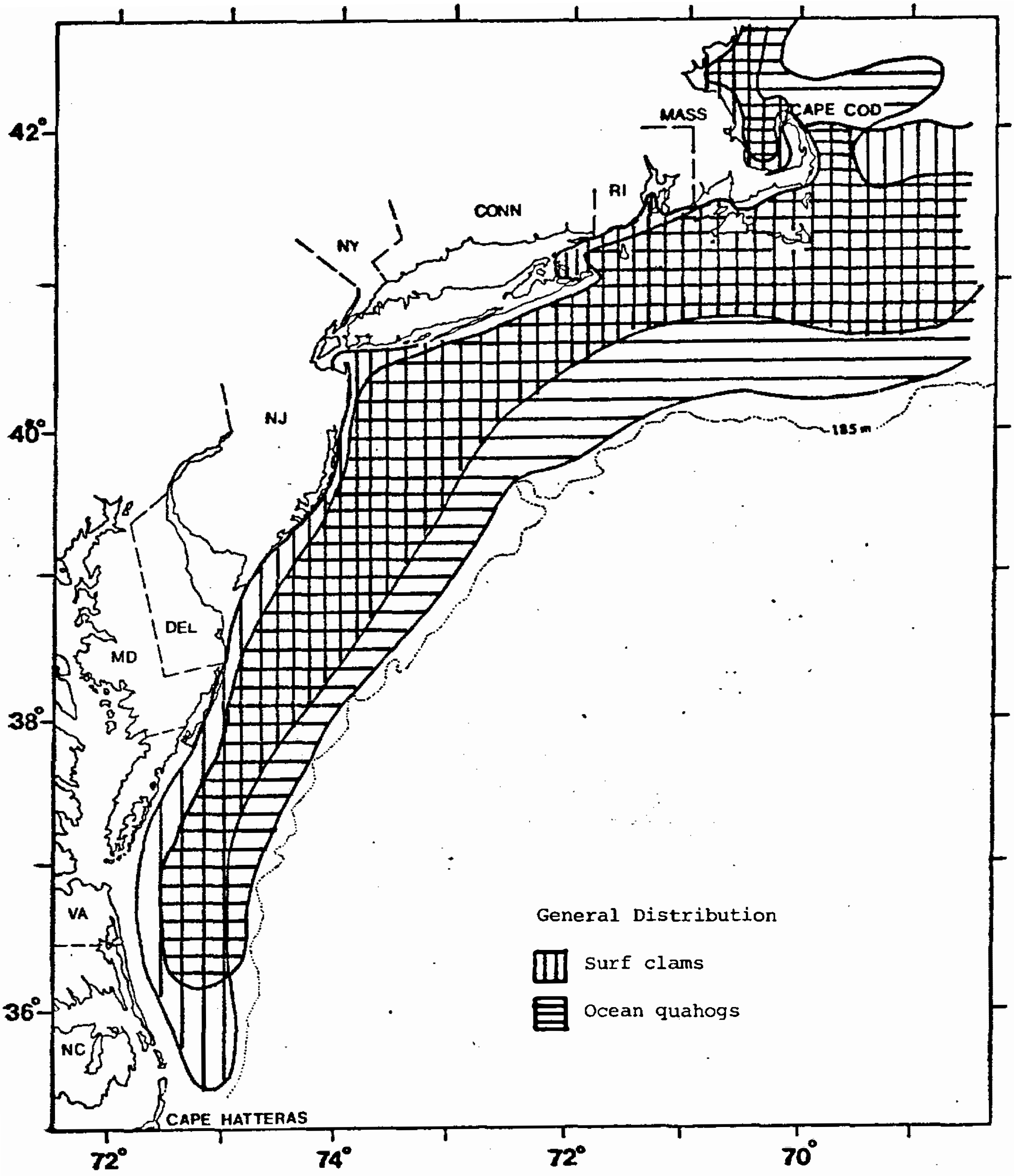

42°
40°
38°
36°
72°
74°
72°
70°
NY
CONN
RI
MASS
CAPE COD
NJ
DEL
MD
VA
NC
CAPE HATTERAS
185 m
General Distribution
Surf clams
Ocean quahogs

Figure 48

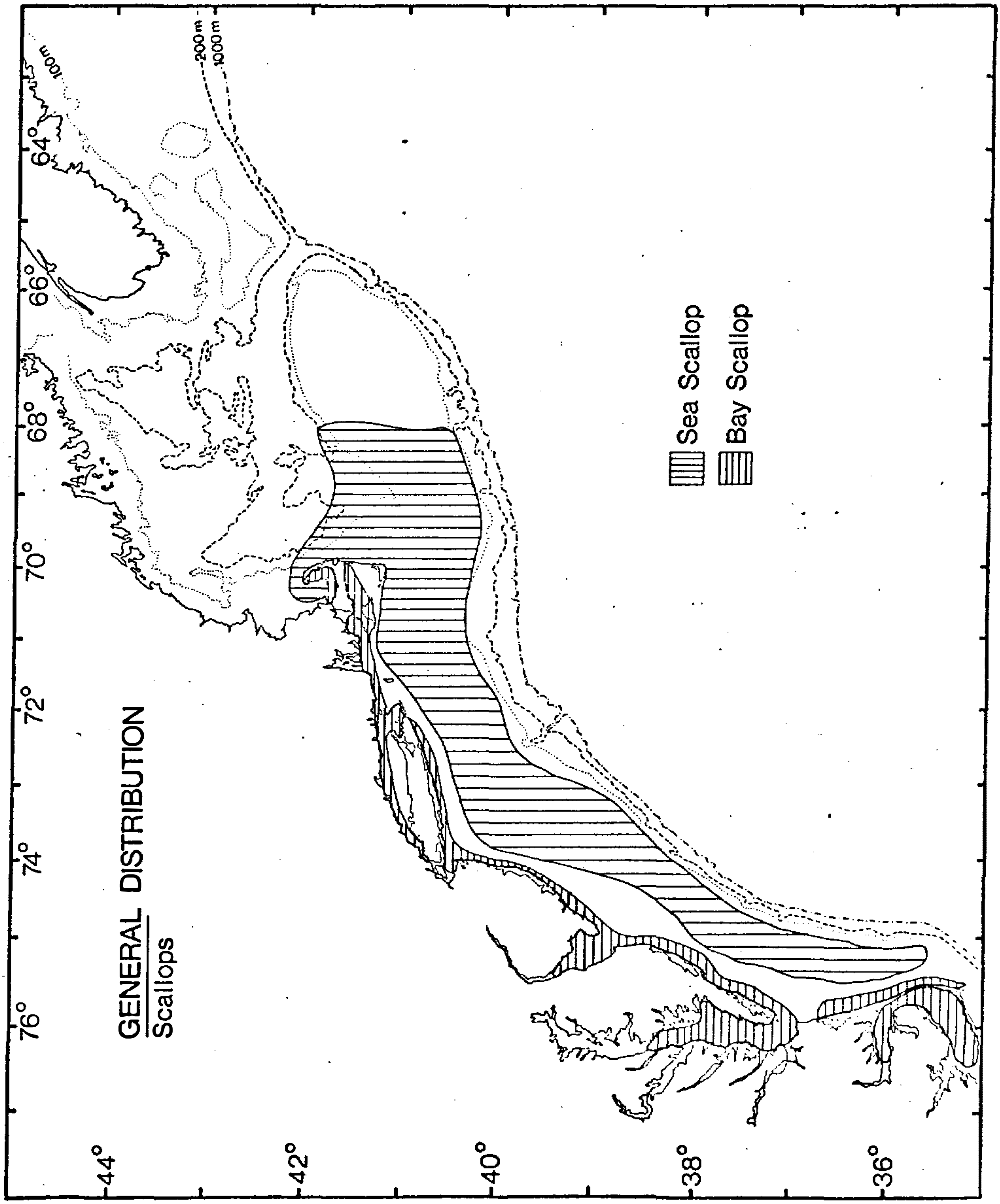

GENERAL DISTRIBUTION
Scallops
Sea Scallop
Bay Scallop
100m
200m
1000m
64°
66°
68°
70°
72°
74°
76°
44°
42°
40°
38°
36°

Figure 49. Areas closed to shellfishing by the Department of Health, Education and Welfare, Food and Drug Administration under the responsibilities of the National Shellfish Sanitation Program.

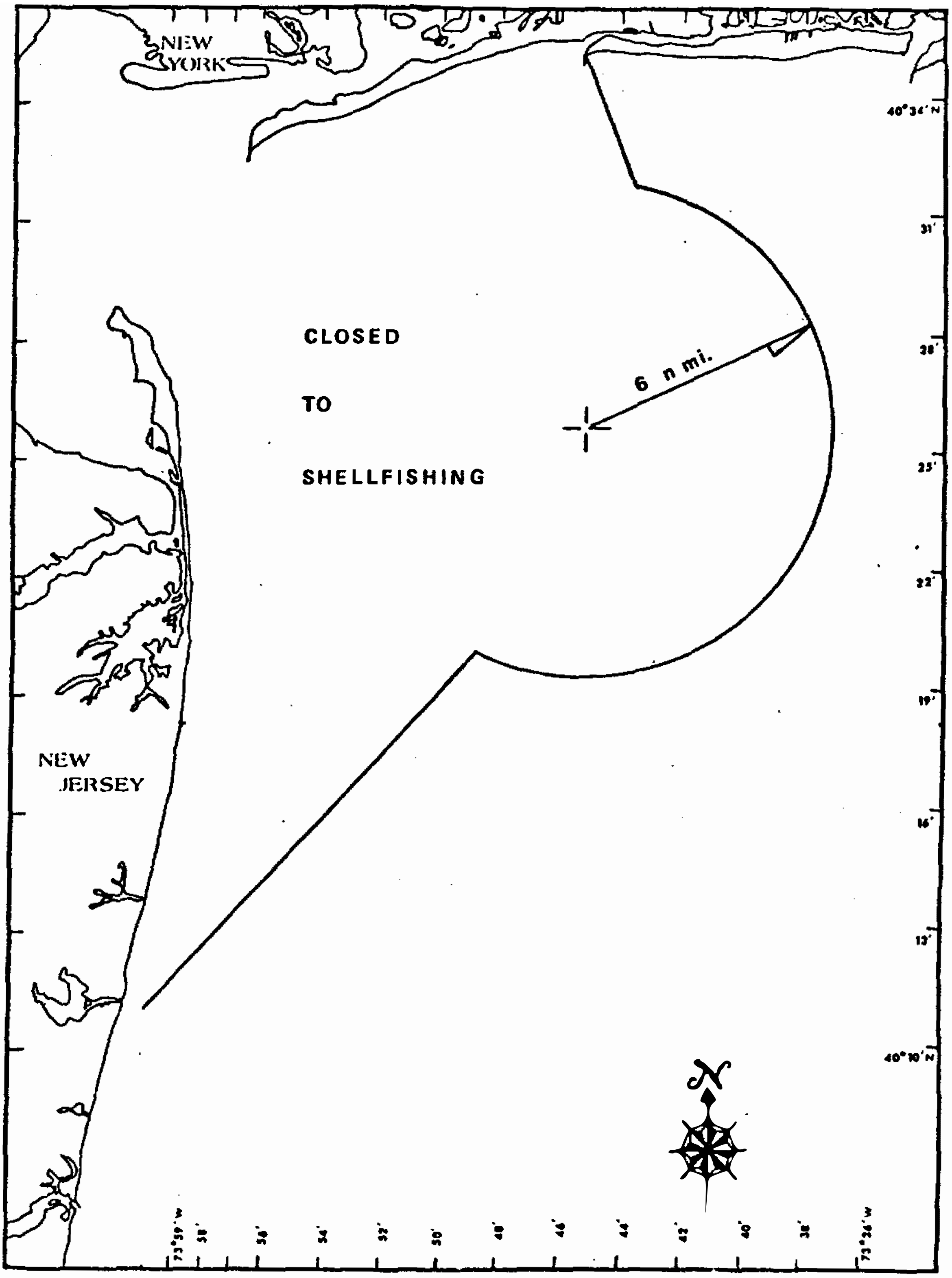


Table 1. Metal concentrations (ppm, dry weight) in the top 4 cm of bottom sediment collected from Raritan Bay. (From Greig and McGrath, 1977.)

Station	Cd		Cr		Cu		Ni		Pb		Zn	
	Jan. Feb.	April May	Jan. Feb.	April May	Jan. Feb.	April May	Jan. Feb.	April May	Jan. Feb.	April May	Jan. Feb.	April May
1	3.0	4.0	100.0	140.0	200.0	240.0	24.0	37.0	120.0	150.0	230.0	230.0
2	5.5	3.0	140.0	80.0	170.0	180.0	24.0	24.0	150.0	110.0	270.0	200.0
3	4.5	<1.0	31.0	24.0	41.0	30.0	7.1	7.6	43.0	30.0	160.0	90.0
4	1.2	—	21.0	—	12.0	—	5.5	—	61.0	—	210.0	—
5	2.5	<3.0	25.0	43.0	26.0	50.0	5.3	9.0	49.0	55.0	140.0	130.0
6	3.0	—	24.0	—	28.0	—	8.8	—	57.0	—	80.0	—
7	<3.0	<3.0	36.0	13.0	47.0	29.0	10.0	<7.0	54.0	50.0	88.0	50.0
8	<1.0	<1.0	3.6	2.0	3.2	<10.0	<2.0	3.6	<6.0	<6.0	12.0	16.0
9	1.8	<1.0	12.6	3.0	16.0	<10.0	8.4	3.6	31.0	8.0	30.0	18.0
10	11.0	<3.0	41.0	18.0	54.0	37.0	19.0	<7.0	89.0	35.0	130.0	55.0
11	<1.0	<1.0	4.8	7.0	4.6	11.0	8.2	6.6	10.0	14.0	36.0	32.0
12	13.0	<1.0	58.0	6.0	96.0	13.0	30.0	8.6	236.0	16.0	180.0	45.0
13	<1.0	<1.0	3.0	3.0	<10.0	<10.0	3.6	5.6	6.0	8.0	20.0	28.0
14	<3.0	7.0	78.0	150.0	170.0	290.0	17.0	37.0	90.0	180.0	210.0	410.0
15	4.0	5.5	200.0	120.0	330.0	260.0	39.0	24.0	240.0	160.0	400.0	430.0
16	6.5	5.5	190.0	160.0	410.0	280.0	37.0	32.0	220.0	180.0	440.0	370.0
17	3.5	4.0	130.0	160.0	220.0	270.0	24.0	29.0	140.0	190.0	250.0	270.0
18	7.5	3.0	97.0	40.0	150.0	44.0	24.0	9.0	160.0	45.0	300.0	86.0
19	<1.0	<3.0	10.0	40.0	6.2	31.0	<2.0	<7.0	20.0	40.0	40.0	110.0
20	<1.0	1.2	9.0	32.0	4.6	23.0	2.0	12.0	22.0	34.0	34.0	100.0
21	<1.0	1.0	21.0	36.0	16.6	24.0	6.8	9.6	55.0	42.0	400.0	120.0
22	<3.0	3.5	37.0	73.0	37.0	76.0	12.0	14.0	50.0	70.0	170.0	160.0
23	4.0	3.5	70.0	100.0	110.0	170.0	20.0	22.0	130.0	110.0	220.0	180.0
24	6.5	5.5	150.0	190.0	280.0	380.0	37.0	39.0	180.0	240.0	360.0	350.0
25	4.5	5.5	110.0	170.0	210.0	360.0	27.0	37.0	140.0	200.0	220.0	360.0
26	<2.5	3.0	26.0	60.0	30.0	65.0	6.5	12.0	35.0	65.0	85.0	150.0
27	8.0	4.5	71.0	100.0	110.0	210.0	22.0	19.0	140.0	120.0	220.0	700.0
28	4.0	3.0	110.0	100.0	210.0	190.0	27.0	24.0	160.0	120.0	230.0	210.0
29	<3.0	<3.0	65.0	85.0	180.0	220.0	14.0	29.0	95.0	220.0	200.0	250.0
30	3.0	3.5	140.0	142.0	260.0	260.0	34.0	34.0	180.0	170.0	260.0	260.0
31	5.0	—	150.0	—	260.0	—	32.0	—	170.0	—	250.0	—
32	<3.0	<3.0	23.0	58.0	55.0	190.0	<7.0	14.0	40.0	90.0	58.0	110.0
33	—	3.0	—	68.0	—	210.0	—	19.0	—	130.0	—	190.0
34	15.0	5.5	260.0	180.0	1230.0	610.0	50.0	39.0	470.0	240.0	580.0	350.0
36	6.0	4.5	160.0	150.0	180.0	210.0	28.0	27.0	200.0	170.0	310.0	210.0
37	—	<1.0	—	22.0	—	13.0	—	9.0	—	26.0	—	60.0
39	<1.0	<3.0	11.0	50.0	8.6	58.0	2.8	9.0	20.0	60.0	64.0	90.0
40	<1.0	<1.0	21.0	15.0	19.0	15.0	6.6	8.6	24.0	20.0	94.0	45.0
41	<1.0	<1.0	15.0	26.0	18.0	22.0	4.8	8.6	20.0	30.0	57.0	95.0
42	—	<1.0	—	11.0	—	14.0	—	4.6	—	18.0	—	36.0
43	<3.0	4.5	35.0	88.0	51.0	180.0	12.0	27.0	50.0	100.0	100.0	225.0
44	4.0	3.5	130.0	133.0	230.0	230.0	32.0	32.0	160.0	150.0	270.0	260.0
45	3.5	4.5	180.0	160.0	450.0	380.0	42.0	39.0	220.0	200.0	400.0	350.0
46	<3.0	<3.0	80.0	40.0	180.0	120.0	19.0	14.0	100.0	70.0	220.0	180.0
47	<1.0	4.0	3.9	108.0	21.0	262.0	35.0	19.0	34.0	180.0	150.0	400.0
48	4.2	<3.0	150.0	24.0	230.0	33.0	22.0	<[illegible].0	210.0	35.0	380.0	140.0
49	3.8	4.0	170.0	140.0	250.0	201.0	23.0	23.0	230.0	210.0	400.0	410.0
51	<3.0	<3.0	25.0	7.0	37.0	9.8	14.0	<5.0	40.0	<15.0	160.0	54.0
52	3.8	3.2	150.0	150.0	250.0	260.0	22.0	20.0	210.0	230.0	420.0	390.0
53	—	3.0	—	90.0	—	290.0	—	27.0	—	120.0	—	280.0
54	—	<1.0	—	23.0	—	23.0	—	6.6	—	18.0	—	90.0
55	5.5	5.5	110.0	120.0	430.0	420.0	34.0	37.0	170.0	180.0	360.0	370.0
56	—	2.5	—	53.0	—	153.0	—	17.0	—	80.0	—	140.0
57	5.5	—	150.0	—	410.0	—	39.0	—	190.0	—	350.0	—
58	—	4.5	—	158.0	—	510.0	43.0	—	—	230.0	—	350.0
59	—	3.5	—	45.0	—	140.0	—	17.0	—	65.0	—	130.0
60	—	3.0	—	50.0	—	160.0	—	24.0		95.0	—	120.0
61	2.5	2.5	110.0	38.0	480.0	100.0	32.0	17.0	210.0	50.0	370.0	100.0
62	—	5.0	—	130.0	—	420.0	—	44.0	—	200.0	—	290.0
64	—	7.5	—	170.0	—	580.0	—	47.0	—	230.0	—	380
66	6.5	—	100.0	—	660.0	—	42.0	—	990.0	—	820.0	—
67	5.5	1.0	170.0	22.0	550.0	71.0	37.0	12.0	250.0	26.0	320.0	50.0
68	5.0	<3.0	40.0	10.0	43.0	<25.0	9.3	<7.0	55.0	30.0	95.0	47.0
69	<1.0	<3.0	14.0	15.0	13.0	<25.0	5.8	<7.0	24.0	30.0	49.0	57.0
70	3.4	<3.0	8.0	25.0	8.8	31.0	9.8	<7.0	34.0	45.0	30.0	56.0
71	<1.0	<1.0	8.4	2.0	7.8	<10.0	3.4	<3.0	10.0	6.0	18.0	13.0
73	3.8	3.8	82.0	83.0	100.0	110.0	22.0	24.0	90.0	100.0	350.0	310.0
85	1.0	<1.0	28.0	27.0	22.0	21.0	7.0	7.6	30.0	20.0	78.0	66.0
86	<3.0	3.2	73.0	99.0	190.0	150.0	32.0	26.0	170.0	110.0	340.0	340.0
87	5.5	6.0	220.0	240.0	320.0	360.0	42.0	43.0	210.0	230.0	460.0	500.0
88	3.3	1.0	200.0	29.0	250.0	41.0	41.0	8.6	200.0	34.0	430.0	150.0
N7	<1.0	—	2.0	—	2.0	—	2.0	—	8.0	—	9.0	—

Table 2. Concentrations of thirteen metals in sediments collected in 1972 from stations in Long Island Sound. (From Greig, Reid and Wenzloff, 1977.)

Station number*	Metal concentrations in sediments (ppm, dry weight)												
	Ag	Cd	Co	Cr	Cu	Hg	Mn	Ni	Pb	Sb	Sc	Se	Zn
1	6.7	3.8	9.9	188.5	258.0	2.2	334.0	34.1	210.0	6.9	3.[illegible]	1.5	291.0
2	6.3	2.4	9.1	95.1	111.0	1.4	213.0	19.8	133.0	4.9	2.4	ND‡	200.0
3	3.9	3.3	11.6	198.2	183.0	—	248.0	41.6	173.0	6.4	4.0	ND	237.0
4	—	ND	7.0	48.8	36.4	0.2	77.0	9.4	33.5	2.1	3.2	ND	84.0
5	4.1	2.2	14.2	187.0	179.0	1.0	398.0	25.2	124.0	10.8	4.9	—	267.0
6	ND	ND	2.9	20.8	8.8	ND	12.0	3.0	6.5	0.8	1.6	ND	14.5
7	ND	1.0	13.3	135.2	80.0	0.4	408.0	19.7	53.0	9.4	0.5	ND	144.0
8	ND	1.8	11.3	158.1	172.0	1.1	523.0	28.3	106.0	8.7	3.8	ND	265.0
9	3.0	1.4	12.1	150.0	175.0	0.7	450.0	27.3	110.0	8.5	3.8	ND	259.0
10	6.1	4.1	14.7	204.4	217.0	1.2	311.0	31.3	161.0	11.3	4.8	ND	354.0
11	0.8	ND	8.6	83.8	59.0	0.2	216.0	15.9	31.0	4.2	4.1	ND	100.0
12	ND	ND	14.8	165.0	157.0	—	413.0	20.1	68.0	9.9	4.3	ND	216.0
13	2.4	ND	14.8	165.6	120.0	0.6	320.0	20.6	76.0	9.4	4.2	ND	186:0
14	—	—	—	—	8.2	—	75.0	5.1	9.5	—	—	—	24.0
15	—	—	—	—	5.7	—	22.1	≤2.2	≤6.0	—	—	—	12.9
16	2.7	1.0	14.2	204.9	177.0	0.7	1218.0	24.3	91.5	9.3	4.4	ND	235.0
17	2.3	ND	13.8	160.3	139.0	—	560.0	22.8	82.5	9.2	4.3	ND	218.0
18	0.5	ND	1.4	12.8	9.3	ND	56.4	3.7	10.0	1.0	0.5	ND	23.7
19	1.7	ND	9.5	124.0	123.0	0.5	277.0	21.9	40.0	7.1	4.4	ND	145.0
20	ND	ND	13.8	164.4	154.0	0.5	455.0	22.0	58.0	9.4	4.4	1.5	195.0
21	ND	ND	14.2	159.9	122.0	0.6	523.0	22.6	77.0	9.1	4.0	ND	201.0
22	0.4	ND	2.7	17.0	10.9	ND	87.4	4.2	8.0	1.4	0.7	ND	32.1
23	—	ND	—	—	15.0	ND	54.2	5.9	6.0	—	-	—	21.4
24	—	—	—	—	63.5	—	178.0	16.7	27.0	—	—	—	87.0
25	—	—	—	—	14.5	—	520.0	5.5	13.5	—	—	—	44.0
26	ND	ND	1.1	4.6	4.0	—	448.0	4.7	≤6.0	0.4	0.2	0.3	12.9
27	1.7	ND	10.9	207.3	231.0	0.6	253.0	17.1	66.0	8.1	4.8	ND	202.0
28	ND	ND	7.3	62.4	35.6	ND	47.1	6.4	14.3	3.3	4.2	ND	53.7
29	ND	ND	13.7	154.6	131.0	0.3	433.0	18.5	49.5	9.7	6.6	2.0	177.0
30	ND	ND	8.3	84.7	107.0	0.4	470.0	24.8	48.0	5.4	3.2	1.2	169.0
31	ND	ND	1.5	8.9	2.4	ND	77.9	2.0	≤6.0	0.4	0.7	ND	4.8
32	ND	ND	3.0	25.9	18.4	ND	53.9	2.7	≤6.0	2.3	1.6	ND	16.7
33	—	—	—	—	179.0	—	322.0	15.3	60.1	—	—	—	189.0
34	—	—	—	—	114.0	—	222.0	14.4	47.1	—	—	—	170.0
35	—	—	—	—	132.0	—	457.0	16.7	55.0	—	—	—	193.0
36	ND	ND	13.3	154.2	135.0	—	342.0	17.3	62.6	8.7	5.1	ND	214.0
37	ND	ND	0.8	6.4	<2.0	—	19.3	<2.5	<4.0	0.7	0.3	ND	4.2
38	1.5	ND	8.4	124.8	162.0	—	100.0	10.5	32.0	4.4	3.2	ND	106.0
39	ND	ND	13.5	277.9	267.0	—	440.0	20.0	85.1	9.0	5.4	ND	250.0
40	ND	ND	13.7	176.9	145.0	—	463.0	16.6	51.4	8.8	5.3	ND	178.0
41	—	—	—	—	101.0	—	259.0	16.0	53.0	—	—	—	178.0
42	ND	ND	7.9	62.6	40.5	—	239.0	8.5	23.0	3.9	2.4	ND	73.0
43	ND	ND	2.4	11.1	2.1	—	14.0	<2.3	<4.0	1.0	0.8	ND	3.9
44	—	—	—	—	269.0	—	187.0	17.1	57.0	—	—	—	214.0
45	—	—	—	—	257.0	—	343.0	16.8	57.3	—	—	—	187.0
46	—	—	—	—	41.7	—	237.0	7.1	21.0	—	-	—	81.0
47	—	—	—	—	18.1	—	155.0	4.2	16.0	—	—	—	43.0
48	ND	ND	11.3	92.3	69.0	—	313.0	10.3	39.0	7.0	3.1	ND	105.0
49	ND	ND	0.8	5.1	<2.0	—	42.9	<2.0	<6.0	0.5	0.4	0.3	2.3
50	—	ND	—	—	27.5	ND	74.0	3.8	11.0	—	—	—	36.0
51	—	—	—	—	26.3	—	93.0	5.9	14.0	—	—	—	42.0
52	2.1	1.6	10.0	180.6	172.0	0.5	202.0	14.9	63.0	6.9	4.3	ND	195.0
53	1.3	ND	6.3	64.7	45.8	ND	75.5	6.4	18.5	2.9	3.6	ND	49.5
54	ND	ND	7.2	70.9	43.3	ND	124.0	5.7	19.0	3.6	3.7	ND	54.5
55	ND	ND	13.1	144.8	94.5	0.3	300.0	15.7	54.5	8.6	5.0	2.0	156.0
56	ND	ND	14.1	133.5	66.0	0.4	226.0	12.7	43.0	9.0	5.7	1.9	118.0
57	ND	ND	7.1	46.3	19.9	ND	91.5	5.2	14.0	2.8	2.6	ND	45.5
58	ND	ND	7.7	74.8	56.5	0.3	219.0	10.0	30.0	4.5	2.9	ND	94.5
59	ND	ND	1.7	9.0	<2.0	ND	68.9	4.7	<6.0	0.9	0.9	ND	6.3
60	ND	1.3	8.3	131.5	105.0	—	199.0	23.6	64.0	5.7	3.7	ND	161.0
61	—	—	—	—	13.3	—	66.3	7.6	13.0	—	—	—	35.7
62	—	—	—	—	37.6	—	185.0	5.7	20.5	—	—	—	49.5
63	—	—	—	—	60.0	—	89.0	14.6	43.5	—	—	—	118.0
64	—	—	—	—	62.0	—	194.0	12.9	42.5	—	—	—	126.0
65	ND	ND	12.5	117.7	76.0	—	213.0	15.1	55.0	8.4	5.3	ND	140.0
66	ND	ND	10.4	103.1	98.5	—	403.0	15.9	52.0	7.0	5.0	ND	157.0
67	ND	ND	0.5	4.9	<2.0	—	15.3	<2.0	<6.0	0.4	0.2	ND	48.0
68	ND	ND	4.0	21.8	4.5	0.2	113.0	26.2	6.5	1.4	2.4	ND	36.5
69	—	—	—	—	86.0	—	280.0	16.8	49.0	—	—	—	138.5
70	—	—	—	—	80.0	—	293.0	15.9	49.5	—	—	—	139.0

Table 2. (continued)

Station number*	Metal concentrations in sediments (ppm, dry weight)												
	Ag	Cd	Co	Cr	Cu	Hg	Mn	Ni	Pb	Sb	Sc	Se	Zn
71	ND	ND	1.0	6.2	<2.0	—	19.3	2.0	6.0	0.4	0.5	0.3	3.9
72	ND	ND	8.8	105.9	88.0	0.3	356.0	17.1	43.5	6.0	4.3	ND	136.0
73	ND	ND	11.9	130.2	82.3	—	206.0	19.9	38.0	7.6	4.7	2.3	127.0
74	1.5	ND	11.9	127.4	82.5	0.4	300.0	16.9	40.0	9.0	6.0	1.9	124.0
75	2.7	ND	12.1	126.6	64.0	0.2	210.0	13.4	44.0	9.3	6.1	3.0	118.0
76	ND	ND	10.6	99.7	49.0	0.2	226.0	12.7	34.0	6.7	6.1	ND	99.0
77	ND	ND	10.4	97.0	59.0	0.2	323.0	14.1	40.0	6.5	5.7	ND	127.0
78	ND	ND	12.9	126.8	88.5	0.3	298.0	17.2	46.0	9.2	6.6	2.1	151.0
79	ND	ND	12.8	127.3	91.5	0.4	268.0	14.6	46.5	8.1	5.5	ND	145.0
80	ND	ND	0.5	2.9	<2.0	ND	41.8	<2.0	<6.0	0.3	0.2	ND	2.9
81	ND	ND	9.9	100.8	61.0	0.1	340.0	12.3	40.5	6.2	4.7	1.2	109.0
82	1.5	ND	7.2	82.4	53.0	—	230.0	40.6	26.0	4.4	4.0	1.0	96.6
83	—	—	—	—	39.4	—	161.0	7.6	25.3	—	—	—	79.0
84	—	—	—	—	—	—	—	—	—	—	—	—	—
85	ND	1.8	8.2	68.6	24.7	—	99.5	6.1	19.0	4.7	4.4	ND	54.5
86	—	—	—	—	23.1	—	129.0	6.0	19.4	—	—	—	61.0
87	—	—	—	—	49.0	—	224.0	9.3	35.4	—	—		102.0
88	—	—	—	—	77.0	—	388.0	13.6	49.6	—	—	—	143.0
89	ND	3.6	12.9	127.5	101.0	—	315.0	13.5	49.6	8.0	5.6	2.5	163.0
90	ND	1.1	0.9	6.5	4.0	—	89.0	<2.0	<6.0	0.4	0.4	ND	11.3
91	0.7	ND	4.4	49.5	35.9	0.1	212.0	27.7	29.5	2.5	2.6	1.3	82.0
92	ND	ND	6.0	51.7	15.9	ND	217.0	9.4	12.0	2.6	4.2	ND	59.0
93	ND	ND	6.5	56.5	15.5	ND	188.0	10.1	12.5	3.1	4.9	1.6	51.0
94	ND	ND	4.0	33.1	20.8	ND	174.0	12.1	21.0	2.1	2.1	ND	70.0
95	0.7	ND	6.3	49.9	24.1	ND	265.0	12.0	20.0	3.3	4.1	ND	73.0
96	ND	2.5	6.5	51.0	22.1	ND	156.0	5.0	18.7	3.3	3.0	ND	60.0
97	ND	2.4	6.7	58.6	30.4	ND	140.0	6.5	27.2	3.9	4.2	ND	84.0
98	ND	ND	2.1	25.6	9.7	ND	65.5	2.7	<6.5	0.9	1.4	ND	36.5
99	ND	ND	0.6	3.3	2.6	ND	31.6	<2.0	<6.0	0.2	0.2	ND	6.6
100	ND	2.6	9.6	103.7	75.5	0.3	285.0	9.5	45.1	5.9	5.6	ND	118.0
101	—	—	—	—	9.7	—	303.0	5.3	20.0	—	—	—	73.5
102	—	—	—	—	10.8	—	119.0	5.2	14.1	—	—	—	47.0
103	—	—	—	—	<2.0	—	60.0	<2.0	<6.0	—	—	—	7.0
104	—	—	—	—	<2.1	—	67.0	4.1	<6.0	—	—	—	11.5
105	—	—	—	—	8.5	—	67.0	3.1	7.0	—	—	—	46.0
106	—	—	—	—	12.3	—	128.0	3.1	7.6	—	—	—	44.0
107	ND	ND	1.3	44.0	3.7	—	74.5	<2.0	<6.0	0.5	0.8	0.7	6.9
108	ND	3.6	9.3	89.5	44.4	0.2	205.0	6.8	28.7	6.3	4.4	1.1	101.0
109	—	—	—	—	9.6	—	62.5	3.9	8.5	—	—	—	30.5
110	—	—	—	—	<2.1	—	123.0	<2.0	<6.0	—	—	—	12.9
111	—	—	—	—	3.9	—	104.0	2.6	6.6	—	—	—	17.8
112	—	—	—	—	4.1	—	298.0	4.2	11.0	—	—	—	58.0
113	ND	ND	1.8	13.6	<2.0	ND	79.0	2.2	6.2	0.6	1.6	1.6	5.3
114	ND	ND	6.9	69.0	25.3	0.1	142.0	9.9	23.2	3.4	4.1	ND	88.0
115	0.5	ND	8.5	47.5	8.7	—	409.0	8.2	22.4	3.7	3.3	ND	80.0
116	ND	ND	5.1	26.6	3.1	—	173.0	8.0	9.2	1.6	3.6	1.6	16.3
117	ND	ND	7.1	—	<2.0	—	76.0	2.6	6.0	1.5	11.0	ND	6.0
118	—	—	—	—	3.6	—	855.0	9.0	10.2	—	—	—	32.6
119	—	—	—	—	3.1	—	286.0	4.5	7.0	—	—	—	52.0
120	ND	ND	0.6	5.2	<2.0	—	42.0	<2.2	<6.0	0.8	0.3	ND	7.9
121	ND	1.9	7.9	51.9	24.5	0.1	62.0	6.4	16.6	4.2	4.6	ND	67.5
122	—	—	—	—	3.2	—	164.0	3.1	6.5	—	—	—	25.9
123	—	—	—	—	3.8	—	263.0	<2.2	8.9	—	—	—	17.8
124	—	4.2	—	—	6.3	ND	315.0	3.8	12.0	—	—	—	23.8
125	ND	ND	3.3	31.2	4.5	ND	25.5	<2.0	<6.6	1.0	4.0	2.2	16.8
126	ND	ND	5.6	54.3	11.5	ND	59.0	3.0	15.3	2.8	4.0	1.4	39.5
127	ND	3.6	9.9	162.7	42.6	—	365.0	9.0	47.8	7.6	5.3	ND	89.0
128	ND	ND	6.4	16.1	3.3	—	179.0	9.2	9.7	3.6	2.0	ND	15.5
129	ND	ND	6.3	37.4	6.1	—	275.0	10.6	13.3	2.5	4.1	ND	24.0
130	ND	ND	1.9	13.0	<2.0	—	79.0	2.2	<6.0	0.5	1.9	ND	9.0
131	ND	ND	3.6	24.9	3.4	ND	30.0	2.4	8.5	1.0	3.4	ND	23.6
132	—	—	—	—	3.5	—	64.5	5.2	7.4	—	—	—	16.7
133	—	—	—	—	32.5	—	181.0	18.5	46.3	—	—	—	99.0
134	—	—	—	—	<2.0	—	72.5	3.8	<6.0	—	—	—	6.5
135	0.3	ND	7.2	67.2	23.0	0.1	77.5	10.4	26.3	4.8	4.5	ND	64.5
136	—	—	—	—	11.8	—	119.0	13.0	13.6	—	—	—	32.5
137	—	—	—	—	—	—	—	—	—	—	—	—	
138	ND	ND	2.1	15.2	<4.0	ND	24.6	2.2	<6.0	2.0	2.3	ND	8.6
139	ND	ND	3.9	35.4	9.4	—	53.0	13.1	19.0	3.2	3.0	ND	32.0
140	ND	ND	3.6	33.5	5.8	—	33.4	4.5	9.2	2.4	3.1	ND	22.3

Table 2. (continued)

TABLE 2 continued

Station number*	Metal concentrations in sediments (ppm, dry weight)												
	Ag	Cd	Co	Cr	Cu	Hg	Mn	Ni	Pb	Sb	Sc	Se	Zn
141	ND	ND	2.2	5.6	3.5	ND	16.2	3.6	<6.0	2.3	1.6	ND	10.9
142	—	ND	—	—	2.5	ND	65.5	8.9	7.3	—	—	—	6.3
143	—	ND	—	—	2.6	ND	71.5	5.4	<6.0	—	—	—	6.5
G-1	ND	ND	1.4	9.0	<2.1	ND	106.0	5.8	6.6	0.7	0.8	ND	10.0
G-2	ND	ND	1.3	15.5	2.2	—	40.3	4.6	<6.0	1.0	2.1	ND	7.2
G-3	ND	ND	3.1	27.1	10.1	—	69.0	5.8	11.5	2.2	2.4	ND	26.6
G-4	ND	ND	1.7	17.2	5.3	—	72.0	6.7	8.0	1.3	1.6	ND	19.4
G-5	ND	ND	1.3	8.3	3.0	—	52.0	4.2	<6.0	0.7	1.0	ND	9.3
G-6	ND	ND	1.9	11.3	<2.0	ND	33.8	<2.0	<6.0	0.8	2.3	ND	5.1
G-7	—	—	—	—	—	0.2	—	—	—	—	—	—	—
G-8	ND	ND	2.0	12.9	2.5	0.3	12.2	2.3	<6.0	0.9	1.6	ND	6.0
G-9	—	ND	—	—	<2.0	0.1	72.0	2.7	<6.0	—	—	—	9.4
G-10	—	ND	—	—	<2.0	0.1	75.0	<2.0	<6.0	—	—	—	3.7
G-11	—	ND	—	—	5.2	0.3	234.0	4.6	9.0	—	—	—	36.0
G-12	ND	ND	6.6	61.3	17.8	0.3	298.0	10.9	24.0	4.5	4.0	3.0	56.0
G-13	—	ND	—	—	3.7	0.2	54.0	8.2	<6.0	—	—	—	18.0
G-14	ND	ND	3.9	55.8	6.3	0.3	85.0	22.7	10.0	1.9	3.3	ND	21.0
G-15	—	ND	—	—	11.8	0.2	45.3	6.7	11.0	—	—	—	32.7
G-16	ND	ND	3.5	25.7	<2.2	—	18.8	8.3	<6.0	1.4	4.5	ND	9.4

*Figure 1 shows the locations of the stations in Long Island Sound. Dash marks indicate that no data were obtained for those metals and stations.
§Metal concentrations indicated as ND were not detectable. Detection limits for these metals were approximately: Ag, 0.3–1 ppm; Cd, 1-1.3 ppm; Hg, 0.06-0.2 ppm; Se, 0.3–1 ppm.

Table 3. Trace metals concentration from the barge sewage sludge and from bottom sediments in sewage sludge disposal area off the mouth of Delaware Bay. (From Watling et al., 1974.)

Element	Barge Sludge	Sediment Samples			
		10	17	7	12
Si	100,000	Major	Major	Major	Major
P	10,000	10,000	10,000	10,000	10,000
Ca	Major	Major	Major	Major	Major
Al	Major	Major	Major	Major	Major
Fe	Major	Major	Major	Major	Major
Zn	20,000	100	100	100	100
Ti	8,000	10,000	10,000	10,000	10,000
Mg	10,000	30,000	30,000	30,000	30,000
Mn	4,000	2,000	2,000	2,000	2,000
Pb	6,000	400	400	400	400
Cr	4,000	400	400	400	400
Cu	4,000	500	500	500	500
Sn	1,000	100	100	100	100
Na	3,000	50,000	50,000	50,000	50,000
Ba	2,000	1,000	1,000	1,000	1,000
Be	1	1	1	1	1
B	100	100	100	100	100
V	100	1,000	500	1,000	500
Ni	1,000	200	200	200	200
Bi	100	10	10	10	10
Mo	50	50	50	50	50
Cd	100	100	100	100	100
Ag	500	5	5	5	5
Zr	200	800	800	500	500
Co	50	100	50	100	50
Sr	100	200	200	200	200

Table 4. A) Metal concentrations in top $1^1/2$ inches of sediment collected from three alternate dumpsite stations in Block Island Sound (March 1975). (From Steimle, et al., 1977.)

		Metal Concentrations (ppm, dry weight)[a]					
Station	Grab	Cd	Cr	Cu	Ni	Pb	Zn
1	2	ND[b]	11.5	ND	15.5	17.5	44.3
1	5	ND	ND	ND	ND	12.5	39.3
2	6	ND	15.8	12.0	18.5	22.5	53.5
2	4	ND	17.0	12.5	17.0	17.5	54.5
3	1	ND	ND	ND	ND	10.0	30.3
3	5	ND	ND	ND	ND	12.5	35.0

a. Values are the means of duplicate measurements.

b. ND - not detectable

Detection limits - Cd = 2.5 Ni = 10.0
Cr = 11.0 Pb = 10.0
Cu = 10.0

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* not measured

Table 5. Concentrations of lead and copper in water and sediment in Raritan and Lower New York Bays. (From Waldhauer et al., 1978.)

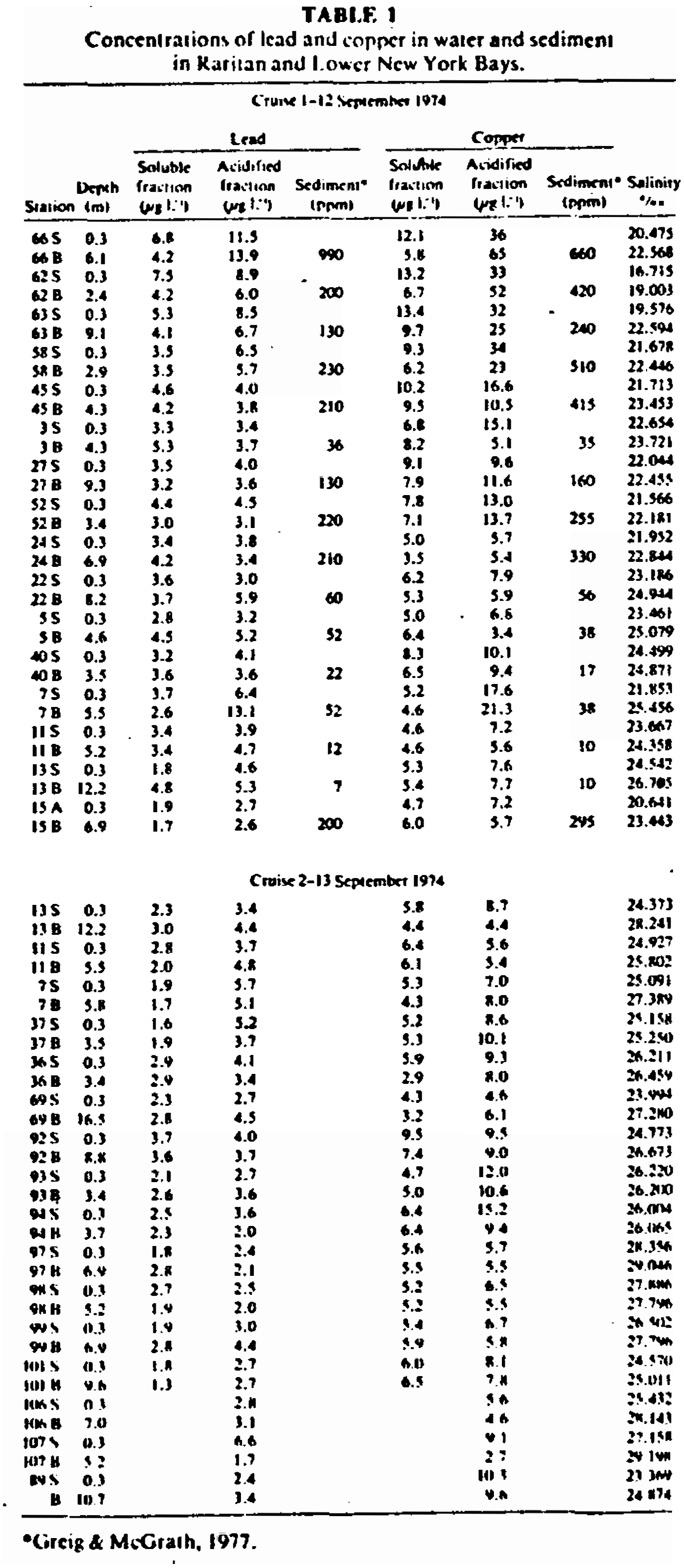

TABLE 1

Concentrations of lead and copper in water and sediment in Raritan and Lower New York Bays.

		Lead			Copper			
Station	Depth (m)	Soluble fraction (μg l^{-1})	Acidified fraction (μg l^{-1})	Sediment* (ppm)	Soluble fraction (μg l^{-1})	Acidified fraction (μg l^{-1})	Sediment* (ppm)	Salinity ‰
Cruise 1–12 September 1974								
66 S	0.3	6.8	11.5		12.1	36		20.475
66 B	6.1	4.2	13.9	990	5.8	65	660	22.568
62 S	0.3	7.5	8.9		13.2	33		16.715
62 B	2.4	4.2	6.0	200	6.7	52	420	19.003
63 S	0.3	5.3	8.5		13.4	32		19.576
63 B	9.1	4.1	6.7	130	9.7	25	240	22.594
58 S	0.3	3.5	6.5		9.3	34		21.678
58 B	2.9	3.5	5.7	230	6.2	23	510	22.446
45 S	0.3	4.6	4.0		10.2	16.6		21.713
45 B	4.3	4.2	3.8	210	9.5	10.5	415	23.453
3 S	0.3	3.3	3.4		6.8	15.1		22.654
3 B	4.3	5.3	3.7	36	8.2	5.1	35	23.721
27 S	0.3	3.5	4.0		9.1	9.6		22.044
27 B	9.3	3.2	3.6	130	7.9	11.6	160	22.455
52 S	0.3	4.4	4.5		7.8	13.0		21.566
52 B	3.4	3.0	3.1	220	7.1	13.7	255	22.181
24 S	0.3	3.4	3.8		5.0	5.7		21.952
24 B	6.9	4.2	3.4	210	3.5	5.4	330	22.844
22 S	0.3	3.6	3.0		6.2	7.9		23.186
22 B	8.2	3.7	5.9	60	5.3	5.9	56	24.944
5 S	0.3	2.8	3.2		5.0	6.6		23.461
5 B	4.6	4.5	5.2	52	6.4	3.4	38	25.079
40 S	0.3	3.2	4.1		8.3	10.1		24.499
40 B	3.5	3.6	3.6	22	6.5	9.4	17	24.871
7 S	0.3	3.7	6.4		5.2	17.6		21.853
7 B	5.5	2.6	13.1	52	4.6	21.3	38	25.456
11 S	0.3	3.4	3.9		4.6	7.2		23.667
11 B	5.2	3.4	4.7	12	4.6	5.6	10	24.358
13 S	0.3	1.8	4.6		5.3	7.6		24.542
13 B	12.2	4.8	5.3	7	5.4	7.7	10	26.705
15 A	0.3	1.9	2.7		4.7	7.2		20.641
15 B	6.9	1.7	2.6	200	6.0	5.7	295	23.443
Cruise 2–13 September 1974								
13 S	0.3	2.3	3.4		5.8	8.7		24.373
13 B	12.2	3.0	4.4		4.4	4.4		28.241
11 S	0.3	2.8	3.7		6.4	5.6		24.927
11 B	5.5	2.0	4.8		6.1	5.4		25.802
7 S	0.3	1.9	5.7		5.3	7.0		25.091
7 B	5.8	1.7	5.1		4.3	8.0		27.389
37 S	0.3	1.6	5.2		5.2	8.6		25.158
37 B	3.5	1.9	3.7		5.3	10.1		25.250
36 S	0.3	2.9	4.1		5.9	9.3		26.211
36 B	3.4	2.9	3.4		2.9	8.0		26.459
69 S	0.3	2.3	2.7		4.3	4.6		23.994
69 B	16.5	2.8	4.5		3.2	6.1		27.280
92 S	0.3	3.7	4.0		9.5	9.5		24.773
92 B	8.8	3.6	3.7		7.4	9.0		26.673
93 S	0.3	2.1	2.7		4.7	12.0		26.220
93 B	3.4	2.6	3.6		5.0	10.6		26.200
94 S	0.3	2.5	3.6		6.4	15.2		26.004
94 B	3.7	2.3	2.0		6.4	9.4		26.065
97 S	0.3	1.8	2.4		5.6	5.7		28.356
97 B	6.9	2.8	2.1		5.5	5.5		29.046
98 S	0.3	2.7	2.5		5.2	6.5		27.806
98 B	5.2	1.9	2.0		5.2	5.5		27.796
99 S	0.3	1.9	3.0		5.4	6.7		26.912
99 B	6.9	2.8	4.4		5.9	5.8		27.796
101 S	0.3	1.8	2.7		6.0	8.1		24.570
101 B	9.6	1.3	2.7		6.5	7.8		25.011
106 S	0.3		2.8			5.6		25.432
106 B	7.0		3.1			4.6		28.143
107 S	0.3		6.6			9.1		27.158
107 B	5.2		1.7			2.7		29.198
89 S	0.3		2.4			10.3		23.369
B	10.7		3.4			9.6		24.874

*Greig & McGrath, 1977.