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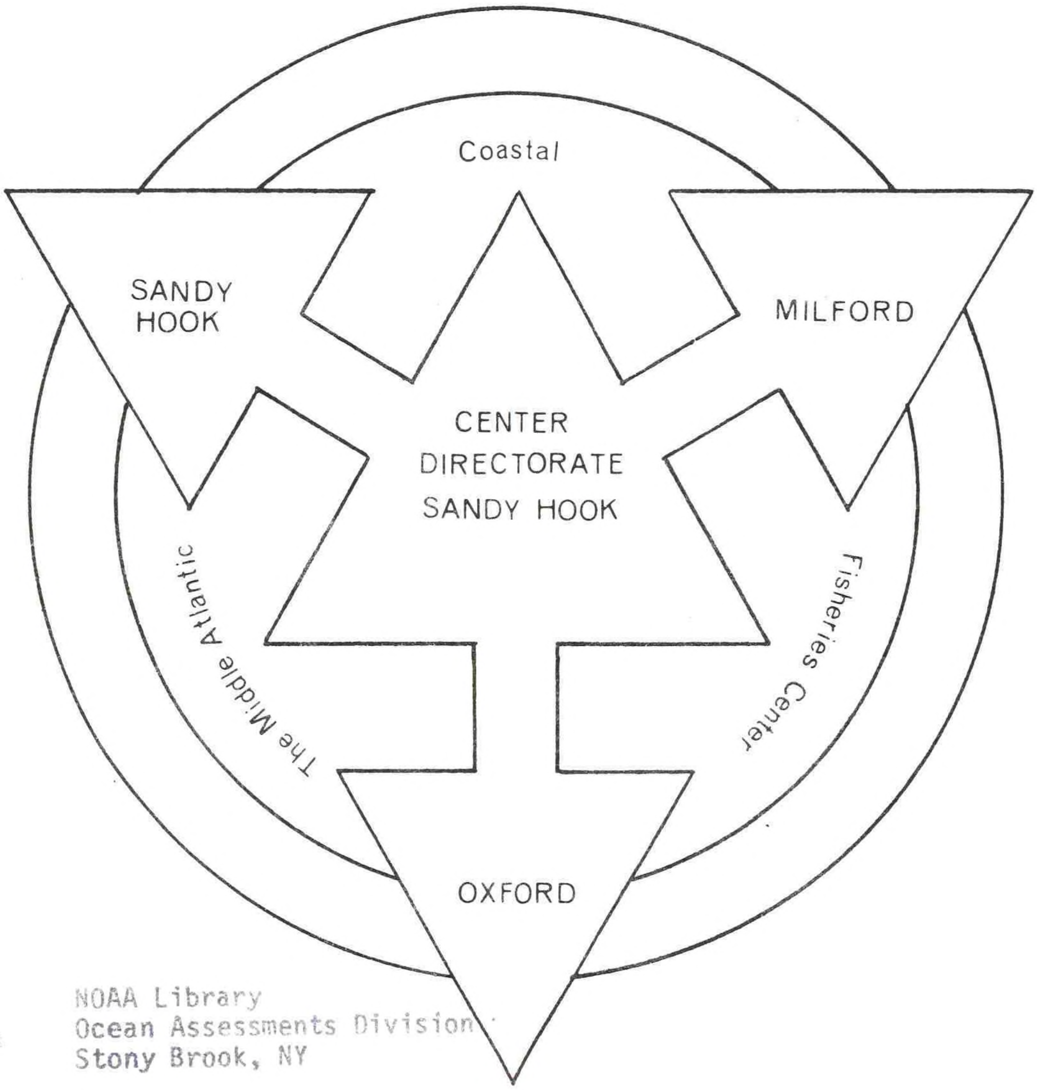
LIVING RESOURCE-RELATED ASPECTS OF OCEAN DUMPING IN THE NEW YORK BIGHT

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



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Living Resource - Related Aspects of Ocean Dumping in the New York Bight

This document was prepared in response to a NOAA/MESA request for "working - Level" scientific advice and data. It does not represent the views or the policies of the National Marine Fisheries Service. Ocean-dumping recommendations are policy matters for higher NMFS and NOAA levels.

Prepared by
Middle Atlantic Coastal Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U. S. Department of Commerce

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I. Present Nearshore Sites

A. Introduction

The New York Bight is one of the most active sites in the world for aquatic disposal of solid wastes. Each year 5×10^6 yds^3 of wet sewage sludge are disposed of in an area approximately 5 nautical miles SE of Ambrose Light. In addition, large quantities of acid wastes containing some particulate materials as well as substantial amounts of contaminated dredging spoils and relatively innocuous "cellar dirts" are spoiled near Ambrose Light. Near the southern boundary of the Bight several municipalities and industries are dumping a variety of solid wastes which have their origins in the Philadelphia-Trenton-Wilmington area.

Finally, the Hudson River and other, smaller, streams transport seaward a variety of solid materials, some of "natural" origin but much of them having their origins in the one billion gallons of raw sewage which daily pass through the Verrazano Narrows.

Ocean disposal of solid wastes, particularly sewage sludge and dredging spoils, has had demonstrable effects on the physical and biological components of the Bight ecosystem. These effects are often serious but not completely delineated and necessitate consideration of alternative ways of disposing of sludge and other solid wastes. The alternatives include, but are not limited to, 1) moving the disposal sites further offshore, 2) inducing greater dilution of wastes by discharging them over far greater areas or into dispersing settled wastes with clean sediments, and 5) land recycling or incineration.

B. Present Disposal Operations

Approximately 9.6 million tons per year of solid wastes, including dredging spoils and sewage sludge, were dumped in the New York Bight between 1964 and 1968. This was apparently the largest sediment source discharging directly into the North Atlantic Ocean (Gross, 1970). These materials, and certain chemical wastes, are disposed of at designated disposal points in the Bight; most of these are inshore in the basin at the head of the Hudson Shelf Valley, but one site, #106, the toxic waste disposal area, is located over a hundred miles offshore of the entrance to New York Harbor.

Each year, from 1960 through 1963, some 0.11 million dry tons of sewage sludges, consisting of 4.5% solids in a liquid base, were disposed of in the New York Bight and western Long Island Sound. During the period 1964-1968 the annual average increased to 0.15 million dry tons. Dredging spoils increased from 6.4 to 6.8 million tons during the same period.

Although not known with complete precision, it is likely that the amounts of sludge dumped in the ocean will continue to increase annually; this will be due principally to population increase in the metropolitan area and the more efficient removal of solids from sewage subject to improved treatment.

C. Benefits of Nearshore Discharge of Solid Wastes

The principal benefits accruing from dumping at designated nearshore disposal sites are relative ease of operations and comparatively low costs. Small, economical barges can transport sludge and spoils to the designated disposal areas in most weather conditions. The sites for disposal can be located with inexpensive Loran or radar units.

If disposal operations are to be conducted far offshore, or at stations accurately located on a grid of closely spaced stations, larger vessels and more accurate navigation will be necessary. The cost of operation over and beyond the capital costs of equipment increase substantially with each additional mile that a particular waste is transported.

It has been suggested that the addition of highly organic wastes, and hence nutrients, to the water column may significantly increase the productivity of the Bight apex. If, indeed, increased nutrient levels can be translated into an increase in primary productivity, this is not apparently reflected in an increase in the standing stocks of zooplankton. The diversity and abundance of zooplankton in the areas of the Bight apex receiving solid wastes, including sewage sludge, appear similar to other uncontaminated portions of the Middle Atlantic Bight. There does not, therefore, at the present time appear to be any benefit resulting from ocean dumping in terms of the augmentation of marine food chains which might culminate in commercially valuable species.

D. Ecological Damage Resulting from Present Disposal Practices

The various impacts of these disposal operations are, in part, known from several reports and published papers. The diversity and abundances of benthic fauna have been diminished at the centers of the impact areas, toxic heavy metals associated with sludges and contaminated spoils have been measured and found to accumulate at the centers of the impact zones, and coliform bacteria, indicators of pathogenic microorganisms, are concentrated in sediments impinged upon by both sewage sludge and contaminated dredging spoils.

Preliminary studies, both published (Mahoney et al., 1973; Pearce, 1974) and unpublished suggest that disease of commercially and recreationally important finfish and shellfish may be more prevalent in the New York Bight than in waters uncontaminated by ocean dumping and other sources of pollution.

The aforementioned damage can conceivably be attributed to point discharge or point dumping in the Bight, i.e., the discharge of wastes in an unvarying manner at a specific site may overburden the assimilative capacity of the sediment-water interface in the circumscribed area.

E. Specific Effects of Sewage Sludge vs. the Total Effects of Ocean Disposal

Recent reports in the news media and internal government reports have emphasized the impact of sewage sludge to the exclusion of all other wastes. Separate reports and published papers indicate, however, that other solid wastes, particularly contaminated dredging spoils, may extensively impinge upon living marine resources, albeit over smaller areas. Contaminated spoils from heavily polluted harbors also constitute a possible hazard to public health. The toxic heavy metal content of dredging spoils removed from polluted harbors is similar to or exceeds the values reported for sewage sludge. Repeated observations also indicate that coliform bacteria, both total and fecal, are abundant in dredging spoils; this suggests that a public health problem exists in regard to these materials.

Because dredging spoils have many of the same characteristics as sludge it seems difficult to conceive of altering the sludge dumping activities without giving due consideration to the problem of disposing of dredging spoils in the Bight apex. In fact, the spoils may represent an even greater hazard since sludge can be treated with chlorine or other biocides at the sewage processing plants to reduce the microbial burdens.

F. Necessity for Change

From the previous sections it can be adjudged that present practices for ocean disposal of solid wastes have had a direct effect on living marine resources; the more subtle, indirect effects on living resources, aesthetics and public health may have even greater significance. Biologists can only make educated guesses as to the effects which ocean dumping has had on the reproduction, behavior and other aspects of the biology of living resources. The general deterioration in water quality and aesthetics of the New York Bight are more obvious and demonstrable; fishermen report their lines, traps and anchors fouled with sludge. A variety of unsightly objects known to be associated with human sewage can be collected from the sediment-water interface offshore and from the local metropolitan beaches adjacent to the Bight. More recently scientists have reported findings which suggest that sewage sludge and dredging spoils have spread from the designated points of disposal. An informal report from the Atlantic Oceanographic and Meteorological Laboratory indicates that the bulk of the sludge bed reposes to the west and north of the designated point for disposal. The absolute volumes of solid wastes which are transported from the designated points of disposal and their rates of movement are unknown. There is, however, an obvious potential problem, particularly if the volumes of solid waste discharged to the Bight increase.

The foregoing is especially true when the public health implications are considered. Values of coliform bacteria far above acceptable limits have been measured in the waters and sediments collected from the Bight apex, especially at the sites directly receiving dredging spoils and sewage sludge. The Shellfish Sanitation branch of the U. S. Public Health Service has closed to shellfish harvesting those portions of the Bight adjacent to the dumping grounds. This drastic step was taken because of consistently high coliform counts in these waters. These findings and actions stress the necessity for taking alternative steps in regard to ocean disposal of sewage sludge and other contaminated or toxic solid wastes.

G. Rehabilitation of Contaminated Sediments

Recently, engineers and marine scientists have suggested the possibility that heavily contaminated sediment-water interfaces can be buried or "capped" by layers of clean sediments (Bongers and Khattack, 1972; Pratt and O'Connor, 1974). Although this is potentially feasible in protected inshore aquatic environments, with relatively small surface areas, the problems inherent in accurately and uniformly laying a strata of clean, relatively dense sediments over the very soft, often flocculent, contaminated sediments extensively distributed in the Bight probably precludes the use of this technique. Assuming that the contaminated sludge beds and spoils can be capped, it is not known if the covering layers would remain in place during the winter storms and hurricanes which are known to impinge upon sediments in water depths of over 100 feet. If present disposal practices continue under the premise that dispoiled environments can later be capped, a serious error of commission may occur.

The use of artificial reefs may be a feasible technique to restore bottom communities and productivity in areas impoverished of "normal" abundance and diversity of benthic fauna. The placement of reefs on relatively sterile or unproductive bottoms has been demonstrated to provide surface areas colonizable by epibenthic organisms which augment the food webs utilized by reef-dwelling and demersal finfish. It is believed that artificial reefs would function to increase standing crops of biomass when placed on sediments impoverished by sewer sludge and contaminated spoils. It is not known if heavy metals and other toxic materials in contaminated sediments will be incorporated into the tissues of epibenthic organisms which habituate reefs placed on such sediments nor is it known if toxins in such organisms would be passed to or concentrated in the higher elements of marine food chains.

Present "Special-Purpose" Deep Water Sites; Station 106

A. Present Operations

This offshore stations has been used historically for the disposal of industrial wastes deemed to be too toxic for point discharge into estuaries and coastal waters, including the acid waste disposal site in the Bight apex. Use of site 106 is sporadic in most instances; dumping is often done within the guidelines of a specific permit. The total amounts of specific elements or materials dumped are not known.

B. Benefits

Obvious benefits accrue through the use of this far offshore (100 miles) disposal site. Water depths are such that dilution can occur before the wastes come in contact with bottom sediments and associated demersal finfish and benthic invertebrates. This station is a sufficient distance offshore to preclude the impingement of toxic wastes on the productivity of the important nearshore coastal zone; it has been assumed that the wastes discharged at site 106 are greatly diluted even if carried shoreward by current systems.

It should be emphasized, however, that there is little knowledge available in regard to the assimilative capacity of the open ocean or the effects of greatly diluted toxic materials on marine life, especially the delicate egg and larval stages.

C. Long-Range Implications

As noted in the previous paragraph, there is little information upon which rational scientists can base predictions as to the long-range effects of far offshore disposal of toxic industrial wastes. There is some information which indicates that certain categories of organic wastes are degraded extremely slowly in great water depths. The same may be true for specific toxic chemicals contained in wastes. Because of this gross lack of knowledge, the disposal of any category of wastes in deep oceanic waters should be approached with utmost caution.

Finally, the disposal of any waste materials outside of the legal jurisdiction of this nation is fraught with international implications especially where commercially valuable living resources may be involved. If it should be demonstrated that such practices do impinge upon such species, the operation of a highly capitalized disposal system could be truncated.

III. Proposed Offshore Alternative Sites

A. Benefits

Disposal operations for certain categories of solid waste in the New York Bight have resulted in conditions which indicate a necessity for alternative methodologies. It has been demonstrated that toxic materials are accumulating, low dissolved oxygen values obtain in the Bight as a result of introducing highly organic sludges, and the benthic communities are consequently stressed. More recently, some investigators have stated that sludges are moving onto the shores of Long Island.

Moving the disposal sites to new locations further offshore has the short-ranged benefits of allowing a recovery of the stressed inshore resources and reducing the possibility of having sludges, or other materials having their origins in sludge, wash ashore. This would result in an improvement in aesthetics, reduce the possibility for public health problems and allow demersal and benthic invertebrates to recolonize those areas impoverished of normal populations.

B. Problems - Economic-Social

While industrial wastes are now disposed of at Site 106 at the expense of the industrialist and rightly so, the question of the expense of annually barging some 5.0 million cubic yards of sewage wastes to the alternative offshore sites redounds directly upon the taxpayer. Such costs as a minimum, would include the design, construction and operation of a totally new, much larger fleet of sea-worthy, self-propelled barges, a greatly expanded system of regulation and enforcement, design and construction of greatly enlarged sludge-holding facilities at dock-side and employment of truly qualified vessel officers and seamen.

The present fleet, operating on a 24-hour/day basis, performs a 16-mile roundtrip from Rockaway to the current dump site (omitting distances traveled between the dock and Rockaway and the distances traveled while actually dumping the sludge). If we assume an eight-hour interval for the above mentioned roundtrip, then the usage of the proposed alternative dump site involving a roundtrip of approximately 120 miles, would require, in good weather, some 60 hours duration in open ocean waters. To maintain the same level of daily sludge disposal would therefore require a fleet of vessels approximately 8 to 10 times as large as at present.

The question of regulation and enforcement is of special interest when voyages of 100 miles or more are proposed. "Short-dumping", an allegedly common practice even with the present nearshore dump site, is a practical certainty with respect to the proposed offshore sites. It will be necessary to pass punitive legislation to deter such practices and equally necessary to place inspectors onboard the barges. It will also probably be necessary to equip each vessel with a recognizable electronic signal whereby, through triangulation at two geographically separate stations onshore, progress to and arrival at the offshore dump site may be constantly monitored.

In summary, it is a practical certainty that enormous economic pressures against moving of the dump site will be generated.

C. Biological

There are three prime aspects of life history that are important to consider: feeding, spawning and utilization (by man and other marine organisms) as food.

The species of fish (and shellfish) concerned eat bottom organisms, other fish and plankton. This activity is, of course, continuous, but some species inhabit the area primarily on feeding migrations, e.g., herring. Many are strictly demersal, spending most of the time near the bottom, but even the pelagic species occur on the bottom during daylight hours.

For many of the species the area is important for spawning and rearing activities. This is indicated in Tables 1, 2 and in figures 2 and 23. The eggs of many species concerned are spawned on the bottom and throughout the water column. Most of the larvae are found in the upper 100 meters, some species (skates, sculpins) have egg cases or clusters attached to bottom vegetation. Shellfish larvae settle out on the bottom quite early in their life.

In addition, it is possible that migration patterns or critical spawning behavior of some species may be dependent upon extremely delicate chemical cues in the environment. Hence putting a large dump site in the migratory path might have a very significant effect even if direct lethal effects are not detectable.

Figures 2-15 show the relative abundances and distributions of the larvae of 14 species of finfish collected during coastal surveys by the Sandy Hook Laboratory of the Middle Atlantic Coastal Fisheries Center. More detailed information is provided in attachments 1-4 for summer flounder, black sea bass, sand lance and zooplankton volumes. Figures 16-23 depict the numbers of finfish species and numbers of larvae collected during each cruise at each station during the surveys. These figures illustrate the relative importance of Bight waters for spawning and completion of the planktonic larval stage.

We must warn against misinterpretation of data from this preliminary survey. While spawning areas undoubtedly shift somewhat from year to year, this preliminary source material has been successfully used for planning subsequent field work, i.e., to predict when and where larval concentration of a given species can be found.

There are four molluscan shellfish species that have commercial significance or potential importance in the Middle Atlantic Bight. They include the surf clam, Spisula solidissima; sea scallop, Placopecten magellanicus; ocean quahog, Arctica islandica and southern quahog, Mercenaria campechiensis.

General distribution of the surf clam and ocean quahog (Figs. 24-26 from Merrill and Ropes, 1969, "The general distribution of the surf clam and ocean quahog", Proc. Natl. Shellfish Assoc. 59: 49-45) are more detailed in figures 25 and 27 from manuscripts in preparation. Both species are abundant in the Middle Atlantic Bight area and surf clams are the most important commercial bivalve in the United States today. In 1973, 82.2 million pounds of shucked meats were marketed. The fishery extends from Long Island, New York to Virginia. A Rhode Island fishery for the underutilized ocean quahog landed 1.3 million pounds of meats in 1973. Ocean quahogs are abundant and an important potential resource.

We have information on both species from a 144 station cruise of August, 1970 which covered shelf bottom from 6-40 f. in waters off New Jersey and the Delmarva peninsula. Sampling was done with a 4-ft. knife dredge towed for 4 minutes. The average depth of surf clams was 27 f. at 87 stations with yields of over 1 bu/tow at only 5 stations. Average depth of ocean quahogs was 23 f., occurring at 108 stations. Yields of over 1 bu/tow occurred at 32 stations. Ocean quahogs occurred in 87 percent of stations deeper than 23.5 f.

Proposed dump sites are situated in areas obviously inhabited by ocean quahogs. The northern site represents a potential harvesting site and the southern sector occupies one worked by the Atlantic City fishery from time to time.

Sea scallops support a fishery in the Middle Atlantic Bight, although from 1965 to 1970 landings have declined from 7.6 to 1.4 million pounds of meats. Distribution and abundance of the species were depicted as recently as 1960 and earlier in 1913. (Figs. 28,29) Merrill, 1960 "Abundance and distribution of sea scallops off the Middle Atlantic Coast", Proc. Natl. Shellfish Assoc. 51: 74-80).

Southern quahogs are a potential commercial bivalve related to the northern quahog or hard clam (Mercenaria mercenaria). Fig. 26 & 27 showing its distribution and abundance indicates it is available, but no fishery is utilizing the resource today. As the figure shows it is restricted to offshore ocean beds whereas inshore beds of the northern quahog are commercially important.

A statement (Attachment 5) prepared in early 1971 on contamination of marine life in the ocean by dumping wastes is enclosed. It is directed at the surf clam resource although other bivalves are of equal importance and would be included in any recommendation to terminate ocean dumping. From figures enclosed with the statement and those for species other than the surf clam, we can surmise that dumping will have serious effecs on several presently and potentially important bivalve resources.

The Middle Atlantic Coastal Fisheries Center is presently completing a survey of surf clam and ocean quahog resources, using a hydraulic dredge to assess biomass and distribution of exploitable species. The survey covers ground from Long Island to south of Cape Hatteras principally from 20 f. shoreward in a station grid array of 5x10 n.m. intercepts. In the area of proposed dumping the transects extend out to 30 f.

The recent collections taken in the proposed dump sites are summarized in Table 3, which also contains clam and quahog data from earlier cruises and a list of bottom macrofauna associated with the catches. The public health hazards of the dumping of sewage sludge in the New York Bight have special significance with respect to shellfish, at least some of which are consumed raw. In this connection the U. S. Food and Drug Administration closed two areas of 150 sq. mi. surrounding the New York Bight and Delaware Bay dump sites to clamming in the late 1960's. Since then in cooperation with the Middle Atlantic Coastal Fisheries Center, they have monitored the closed areas and have tested the water quality off the shores of New Jersey. The early closure has been continued on the basis of monitoring acitvities. During the cruise, tissue samples are routinely being collected for heavy metals analysis.

Data have been obtained on research vessel trawl and dredge surveys of the area which were conducted in the spring, summer and fall of each year since 1973. Figure 1 illustrates the two depth strata (15-30 fathoms, and 30-60 fathoms) which cover the area of concern. The randomly - selected trawl and dredge stations occupied over the years virtually blanket the proposed alternate dump site area; at each station, on the average, twelve different species of fish were caught on each trawl. A list of species caught is given in Table 1. There are 25 species of finfish and 4 species of invertebrates which are most frequently caught and which represent the most significant biomass. Note that 25 other species occur regularly in the area but in lower abundance.

A list of species taken in the spring and summer of 1974 during research cruises (Table 4) shows the diversity consistency, relative abundance and weight of species in our 15-30 f. sampling stratum overlaying the proposed alternate dump sites. Flounders and hakes are the predominant forms during warmer months.

<u>These data indicate without question that there are no localities within the area that do not harbor significant quantities of fish and shellfish.</u>

All of these species also occupy areas outside of the geographical strata illustrated herein. Many of the species migrate through the area on a seasonal basis because of inshore-offshore and north-south movements. Thus, for example, herring and mackerel migrate from north of Georges Bank (mackerel all the way from Gulf of St. Lawrence to Cape Hatteras) passing through the Bight twice a year; summer flounder, hakes, butterfish, and squid occupy the Bight area throughout the summer-fall season, and then migrate from the nearshore areas out to the 100-150 fathom area in the fall and winter, to return again the following spring. Thus, any direct effects on the fish by the material dumped could have a very wide-range consequencr.

The most recent processed samples of ichthyoplankton from in and around the proposed sites are summarized in Table 2 and figures 30 to 34.

D. Exploitation of Available Living Marine Resources

The potential commercial finfish yield from the area off New England and Mid-Atlantic approximates one million metric tons annually. The shellfish potential might double this. The sportfish catch may well be as great as the commercial catch.

The yields and fishing activity within the immediate area of concern i probably about 10 percent of the total; however, the stocks of fish are common to the fisheries of the whole area.

The commercial catch of every species of fish in the area, either singly or in aggregate, is limited under the regulations of the International Commission for the Northwest Atlantic. Seventeen nations are members of this Convention and subject to its regulations. The U. S. fisheries have suffered more than a 50 percent decline in yield over the last ten years due in part to competition from foreign fisheries. The current regulatory program is designed to restrict fishing effort in order to bring the stocks of fish back to higher levels of abundance and provide for recovery and expansion of U. S. fisheri Many of the species of most value to U. S. fishermen occupy the Bigh area. For example, the catch of yellowtail flounder in the area will l totally prohibited in an attempt to allow the population to recover to it full potential.

Commercial fishing activity occurs everywhere in the area outside of 15 fathoms to about 150 fathoms. There is a definite seasonal shift in effort, more offshore in the winter and early spring and inshore in the late spring-autumn period. U. S. fishing effort is concentrated more in the 15-30 fathom area, and is heaviest in the warmer seasons when the flounders and other desired species are more available in inshore areas.

E. Summary of Bio-Social Problems

The nature and magnitude of long-term and short-term effects of the dumping on the fishery resources, and the other living resources and environment which supports them simply cannot be predicted with assurance on the basis of available data. However, any potential advers effects, some of which have been demonstrated, would act on a very productive ecosystem, one of the most productive in the world, on which the U. S. and other nations depend for obtaining significant amounts of protein. Consideration of the fishery resource data does not indicate that any specific site for dumping could be chosen to minimize effects when the biomass is considered in total.

IV. Some Alternative Recommendations

A. Background Discussion

Consideration of the foregoing problems, both economic and biological in nature, which are associated with the proposed re-location of the sewage sludge dump site to an off-shore location, led to the severe recommendation of alternative methodologies for dumping, rather than an alternative dump site. While costs of dumping would be increased under these recommendations, the increase would be far less than required for the proposed off-shore site. On the plus side, these recommendations would (1) prevent environmental degradation of the biologically rich off-shore site, (2) provide an opportunity for re-habilitation of the present site, and (3) rendering a virtue out of a necessity, could, under careful supervision, beneficiate the marine environment.

B. Assumptions

The following assumptions apply:

1. The most important biomass-limiting factor in the ocean is the relative lack of mineralized nutrients necessary for primary productivity and for the initiation of biological food-chains. This appears still to hold true in the impacted ecology of the NYB-dump si[te.] Aerobic oxidation is still continuing despite an estimated deposit over 40 years, of some 140 million cubic yards of sludge in one 20-square mile area. Such aerobic oxidation releases mineralized nutrients, encourages development of bacterial populations, facilitate[s] development of ciliated protozoan populations which feed on the bact[eria] and the development of crustacean populations which, in turn, feed o[n] the protozoans. The mineralized nutrients, in turn, provide food fo[r] the various benthic filter-feeders and suspension - feeders. Large populations of benthic organisms on the periphery of the dump si[te,] of aerobic bacteria within the site sediments and of ciliated protozoa[ns] in the water column just above the site sediments attests the richnes[s] of the nutrient burden in the area.

The ecological problem in the New York Bight stems from the fact that while (1) the ocean was considered to have an almost infinite capacity to assimilate degradable wastes and, in terms of biomass, even to benefit, but (2) that regulation-minded officials demanded, for ease of control, that the entire annual waste burden (now about

5 million cubic yards per annum) be deposited within one very small area of the ocean.

The validity of the concept that the ocean, treated rationally, has an almost infinite capacity to assimilate nutrient wastes is attested by th fact that, despite the intense concentrations of enormous waste-depos in one relatively small area over the past forty years, oxidation is st progressing aerobically, albeit in a stressed oxygen-depleted water-column. In all probability, if such deposits had been uniformly distributed over a 1,000 square mile area instead of a twenty square mil area, oxidation would have been so rapid that no detectable residues oxidizable carbon compounds would have built up.

The problem of ocean dumping stems also from the hitherto generally accepted theorem: (1) that the commonly-owned resources (ocean) could be used to eliminate the cost to the producer, (industrial or municipal) of aesthetically and responsibly disposing of their wastes that enforcement of regulations for disposal in commonly -owned resources, should be on a least-cost basis, i. e., should be in one small designated area.

This short sighted policy has now been made a part of the Federal Regulations and almost insures additional ecological damage if ocean dumping is continued.

C. Recommendations

The several possible considerations in addition to re-location of the present dump-site area. (1) Careful distribution, in randolmly selec 1-mile square stations, of individual barge-loads of sludge; such stations to be units of a grid of at least 600 square miles.
In this option, dumping must be completed within the assigned squar mile area but , mode of dumping would be at the discretion of the barge-master. Inasmuch as no further dumping would be allowed in this specific area untill 599 other grid-areas had been utilized, th normal oxidation processes theoretically have had ample opportunity to dispose of the dumped material.
(2) Construction of an artificial island, consisting of bulk head-like wall enclosures, land-fill for this island would be sewage-sludge. Wall enclosures should be so constructed as to permit escape of liquid phase of the sludge and of the water - soluble nutrients.
(3) Usage of the steamships separation zones(Chart:1215) for a series of twenty mile transects radiating fan-like from Ambrose Light. Each barge could be assigned a specific transect for each load and would be required to traverse the transect in such a manner that the load would be distributed over a twenty mile area.

In this option, dumping must be carefully controlled as to both compass direction and rate. There is a limited number of possible transects and, therefore, the full length of each transect must be utilized in order to ensure the maximum opportunity for rapid oxidation of the sludge - material.

D. Enforcement

The key to successful usage of options #1 and #3 is enlightened enforcement. Inspectors on board the barges would be required to certify that the dump began at the designated point, and was completed in a manner consistent with the regulations. All sewage sludge, over a period of time, would be sampled, according to accepted statistical principles, at dockside, to determine the minimal practical levels of contaminants, and henceforth, barge-loads would routinely be analyzed for conformity with the accepted minimal levels. Barge-loads, with contaminant burdens exceeding these levels, would be considered toxic industrial wastes and would be deposited at Site #106.

E. Research Needed

In the event that options #1 or #3 are accepted for the interim period, 1964-1980, a comprehensive research and monitoring operation should be sponsored by NOAA and/or EPA, whereby the biological hypothese underlying the recommendations might be tested, damage, if any might be assessed and remedial changes might be made. At best, the recommendations might relieve, for all time, the nation-wide problems associated with sludge- dumping while the proposed relocation of the dump -site (without the movement of the dredge-spoils site) would be of very doubtful value, but would be certainly expensive and biologically destructive. In addition to the above, a comprehensive attempt to rehabilitate the present impacted dump-site area should be undertaken. Design, construction and monitoring programs for evaluation of the effectiveness of artificial reefs as rehabilitation instruments is both a moral and an aesthetic as well as a public health obligation.

V. Summary of all Recommendations

1. As marine biologists, charged with the responsiblity for the well-being and conservation of our living marine resources and of thei several habitats, we recommend immediate and total cessation o all ocean-dumping activities.

2. All considerations as to methods of alleviating the adverse effect of sewage-sludge dumping must include the neighboring dredge-spoils disposal site which is equally contaminated and which is about five times as great in terms of annual increments of solid material. Failure to include this site in such considerations cou vitiate subsequent attempts at alleviation and rehabilitation.

3. There is no apparent alternate dump-site on the shelf of the New York Bight where the shelf is considered in the light of distributions, abundances and diversities of the commercially and recreationally very valuable indigenous living marine resour

4. Consideration, for alleviation of the adverse environmental effect ocean-dumping, should be given to construction of artificial islan consisting of bulk-headed enclosures, the interiors of which woul be filled with wastes currently being disposed of at sea.

5. Consideration, for alleviation of the adverse environmental effect of ocean-dumping, should be given to a change in methodology of sludge and spoil dumping; initially this would be done in a research mode to test the hypothesis that, under controlled conditions, dumping may be beneficial to the marine environment. Specifically, consideration should be given to widespread dispers of sludge and dredge-spoils in place of the current practice of concentrated dumping at a particular site.

6. Immediate consideration should be given to ways and means to accelerate the rehabilitation of the present near-shore dump-site All work on rehabilitation and on dispersed ocean dumping should be done under the direction of the Federal agencies charged with responsibility for conservation of living marine resources.

7. Again, if, as a minimum, recommendations #2, and #3 and eithe #4 or #5 are not deemed acceptable, we recommend the immediat and total cessation of all ocean dumping.

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APPENDIX

Tables

Figures

Attachments

TABLES

FIGURES

Attachment Reprints

Table 1

Fish species commonly found in the vicinity of Hudson Canyon within the d[...] range 15-60 fathoms, which are of commercial or recreational importance ([...] as well as current). Relative abundance is indicated in terms of signific[...] concentrations (X), Presence (P) or Absence(-) as found on standardized b[...] trawl surveys in the fall and spring from 1968-1972. Significant occurre[...] Larvae (L) or Migrations(M) throughout the area are also indicated

			ADULT STAGES			
			FALL		SPRING	
Species	LARVAL STAGES	Migrations	(15-30 fm) Stratum 1	31-60 fm Stratum 2	15-30 fm Stratum 1	31-60 f[...] Stratu[...]
Yellowtail fldr	L		X	X	X	X
Winter fldr			X	P	X	P
Summer fldr	L	M	X	-	-	X
Four-spot fldr	L		P	X	P	X
Windowpane fldr	L		X	P	X	P
Witch fldr	L		P	P	P	P
Silver hake	L	M	X	X	P	X
Red hake	L	M	X	X	P	X
White hake			P	P	P	P
Spotted hake	L		P	P	-	P
Ocean pout			P	P	X	P
Cod	L	M	P	-	x	x
Scup		M	P	-	-	P
Butterfish	L	M	X	X	-	P
N. Searobin			P	P	P	X
Sea raven			P	P	P	P
Longhorn sculpin			X	X	X	P
Spiny dogfish		M	X	P	P	X
Smooth dogfish		M	P	-	-	-
Little skate			X	X	X	X
Winter skate		M	P	P	X	P
Goosefish			X	X	X	X
Lobster		M	P	X	P	X
Scallop			P	X	P	X
Longfin squid		M	X	X	-	X
Shortfin squid			P	P	-	-
Atlantic mackerel	L	M	P	P	P	X
Atlantic herring		M	-	P	X	X
Alewife		M	-	-	P	X
Blueback		M	-	-	P	P
Round herring		M	X	P	-	-
Bluefish	L	M	X	-	-	-
Miscellaneous	L	M	P	P	P	P
Average catch (lb) per standard 30-minute trawl			574	167	181	454

Table 2 - Ichthyoplankton catch in and near alternate dump sites — R. V. *Albatross* IV Cruise 73-8, Sept. 27-Oct. 5, 1973.

STATION	LOCATION	DATE	DEPTH (Meters)	TIME	H_2O SAMPLED M^3	ICHTHYOPLANKTON SPECIES	NO. OF SPECIMENS
9	49°29' 72°08'	27/9/73	57	1651-1655	117.1	*Urophycis* sp.	643
						Merluccius bilinearis	4
						Bothus sp.	1
						Citharichthys arctifrons	491
						Ophidiidae-Zoarcidae	3
						Hippoglossina oblongus	15
						Peprilus triacanthus	5
						Labrid-Scarid	1
						Unidentified	2
						Eggs	113
11	40°33' 72°45'	28/9/73	33	0010-0015	186.2	*Urophycis* sp.	31
						Scophthalmus aquosus	4
						Merluccius bilinearis	1
						Hippoglossina oblongus	1
						Paralichthys dentatus	1
						Citharichthys arctifrons	15
						Unidentified	6
						Eggs	47
12*	40°13' 72°46'	28/9/73	49	0221-0225	124.7	*Urophycis* sp.	484
						Merluccius bilinearis	54
						Peprilus triacanthus	1
						Hippoglossina oblongus	10
						Gobiidae	1
						Ophidiidae-Zoarcidae	6
						Citharichthys arctifrons	223
						Eggs	71

Table 2 - Continued

STATION	Location	DATE	DEPTH (Meters)	TIME	H_2O SAMPLED M^3	ICHTHYOPLANKTON SPECIES	NO. OF SPECIMENS
13*	39°48' 73°09'	28/9/73	48	0603-0605	109.0	Urophycis chuss	1
						Urophycis regius	686
						Hippoglossina oblongus	8
						Ophidiidae-Zoarcidae	1
						Merluccius bilinearis	18
						Gobiidae	3
						Citharichthys arctifrons	149
						Etropus microstomus	1
						Peprilus triacanthus	4
						Unidentified	3
						Eggs	180
14*	40°08.5' 73°07.5'	28/9/73	44	0825-0830	104.2	Urophycis sp.	238
						Citharichthys arctifrons	124
						Lophius americanus	2
						Ophidiidae-Zoarcidae	2
						Merluccius bilinearis	9
						Hippoglossina oblongus	6
						Peprilus triacanthus	2
						Eggs	32
16	40°17' 73°34'	28/9/73	22	1338-1343	137.4	Urophycis sp.	72
						Prionotus sp.	1
						Hippoglossina oblongus	1
						Gobiidae	2
						Clupeiformes	2
						Eggs	293

Table 2- Continued

STATION	LOCATION	DATE	DEPTH (Meters)	TIME	H_2O SAMPLED M3	ICHTHYOPLANKTON SPECIES	NO. OF SPECIMENS
20	39°20' 73°32'	29/9/73	46	0137-0141	123.6	*Urophycis regius*	459
						Merluccius bilinearis	13
						Ophidiidae-Zoarcidae	4
						Gobiidae	2
						Lophius americanus	2
						Synodontidae	1
						Centropristis striata	1
						Engraulis eurystole	7
						Citharichthys arctifrons	155
						Etropus microstomus	17
						Hippoglossina oblongus	10
						Eggs	202
77	39°56' 72°35'	5/10/73	71	1449-1456	267.0	*Bothus* sp.	1
						Hippoglossina oblongus	7
						Citharichthys arctifrons	37
						Gobiidae	1
						Saurida brasiliensis	2
						Ophidiidae-Zoarcidae	93
						Merluccius bilinearis	3
						Urophycis sp.	703
						Engraulis eurystole	26
						Eggs	124
78	39°56' 72°35'	5/10/73	57	1530-1637	262.1	*Urophycis* sp.	810
						Ophidiidae-Zoarcidae	15
						Anchoa hepsetus	1
						Merluccius bilinearis	25
						Gobiidae	1
						Hippoglossina oblongus	10

* Samples inside alternate sites

Table 3 - Shellfish samples collected in hydraulic surf clam dredge.
Part 1 - Surf clams and ocean quahogs.

Cruise Dates	Tow No.	Location		Surf Clams			Ocean Quahogs		
				No.	Bu.	Avg. Size	No.	Bu.	Avg. Size
		AREA I							
1965 (5/26-6/23)	140	40°11'	72°43'	0	-	-	247	1.7	87
	141	40°15'	72°49'	0	-	-	142	1.0	87
	143	40°05'	72°52'	0	-	-	94	0.7	89
1969 (6/20-7/2)	237	40°13'	72°44'	0	-	-	610	3.0	79
1970 (8/13-8/24)	28	40°15'	72°50'	0	-	-	63	0.4	86
	37	40°05'	72°50'	0	-	-	277	1.3	76
		AREA II							
1965 (5/26-6/23)	67	39°42'	73°22'	32	1.6	134	75	0.5	108
	149	39°50'	73°19'	0	-	-	10	0.1	73
	158	39°47'	73°13'	0	-	-	11	0.1	80
	153	39°35'	73°12'	0	-	-	35	0.2	106
	154	39°38'	73°17'	13	0.2	108	21	0.1	103
1966 (8/14-8/27)	168	39°37'	73°23'	18	0.3	145	9	0.1	113
	171	39°36'	73°13'	1	0.1	77	40	0.3	111
	172	39°39'	73°18'	27	0.3	130	116	0.8	106
	173	39°43'	73°24'	36	0.8	148	15	0.1	111
	175	39°49'	73°23'	8	0.2	132	29	0.2	105
	185	39°46'	73°21'	12	0.2	117	8	0.1	100
1970 (8/13-8/24)	54	39°37'	73°15'	4	0.1	112	32	0.4	107
	55	39°44'	73°25'	6	0.2	162	19	0.2	112
1974 (6/28)	236	39°50'	73°16'	3	0.1	85	5	0.1	93
	237	39°40'	73°16'	0	-	-	51	0.5	105
	238	39°30'	73°16'	4	0.1	160	10	0.1	109
	239	39°30'	73°23'	0	-	-	8	0.1	110
	240	39°40'	73°23'	0	-	-	11	0.1	113
	241	39°50'	73°23'	0	-	-	1	0.1	115
1974 (8/9)	374	39°46'	73°18'	0	-	-	39	0.3	94
	375	39°43'	73°18'	0	-	-	28	0.2	107
	376	39°41'	73°18'	0	-	-	53	0.3	107
	377	39°39'	73°18'	0	-	-	17	0.2	82
	378	39°37'	73°18'	1	0.1	116	13	0.1	No data
	379	39°33'	73°18'	0	-	-	4	0.1	118
	380	39°37'	73°22'	1	0.1	62	14	0.4	109
	381	39°37'	73°13'	0	-	-	3	0.1	108

Table 3 - Shellfish samples collected in hydraulic surf clam dredge
Part 2 - Associated Species

AREA I

Cruise Dates	Tow No.	Species
1965	140	1-Ensis, 2-Buccinum, 1-Cancer
	141	1-Lunatia, 2-Aphrodite, 3-Ensis
	143	1-Lunatia
1969	237	1-Placopecten, 8-Modiolus, 3-Aphrodite, 1-Pagurus, 1-Buccinum, 2-sea urchins
1970	28	3-Placopecten, 1-Aphrodite, 3-Venericardium, 1-Buccinum, 1-sea urchin
	37	1-sea urchin, 1-sulfur sponge

AREA II

Cruise Dates	Tow No.	Placopecten	Lunatia	Cancer	Asterias	Echinoderms	Others
1965(5/26-6/23)	67	-	1	-	6	-	1-Ensis, 3-Astarte
	149	6	-	-	1	-	13-Ensis, 1-Aphrodite 1-Venericardium
	150	2	-	-	-	-	2-Ensis, 1-Venericard 2-Echinus
	154	11	2	-	-	-	2-Ensis, 1-Aphrodite
1966(8/14-27)	168	-	-	-	-	25	10-Astarte, 1-Aphrodi
	171	-	-	-	-	5	1-Aphrodite, 2-Ensis, 2-sea urchins
	172	-	-	2	-	-	1-Aphrodite, 2-Ensis, 1-Pagurus
	173	-	2	1	-	-	1-Aphrodite, 7-Ensis
	175	4	2	-	-	-	-
	185	2	-	-	-	50	-
1970(8/13-24)	54	-	-	-	-	-	2-Pagurus, 1-Buccinum
	55	-	-	-	-	-	1-Astarte
1974(6/28)	238	-	-	-	-	-	1-Aphrodite
	239	-	-	-	-	-	1-Aphrodite
1974(8/9)	374	6	-	1	-	-	5-Modiolus
	375	-	1	-	1	-	-
	376	-	-	1	1	-	-
	377	1	-	1	-	-	-
	378	1	-	1	3	-	-
	379	3	1	-	16	-	1-Ensis
	380	-	-	-	1	-	-
	381	1	1	3	3	-	-

Table 4 --Trawl survey catch summary from strata 94 (15-30 f) during 1974.

VESSEL/MONTH	ALB. II-MARCH		DEL. II-JUNE		DEL. II-JULY		DEL. II-AUGUST	
No. of Tows	7		5		7		7	
Species	Avg. Wt. (lbs)	Avg. No.	Avg. Wt. (lbs)	Avg. No.	Avg. Wt. (lbs)	Avg. No.	Avg. Wt. (lbs)	Avg. No.
ELASMOBRANCHS								
Little skate	21	25	3	4	97	145	53	62
Big skate	–	–	0	0	0	0	0	0
Smooth dogfish	0	0	0	0	0	0	2	–
Spiny dogfish	524	125	0	0	0	0	0	0
TELEOSTS								
Sea raven	–	1	8	5	–	–	–	–
Longhorn sculpin	–	1	1	2	–	–	–	3
Spotted hake	0	0	–	–	1	12	–	2
Northern searobin	0	0	–	–	–	–	–	–
Striped searobin	0	0	0	0	–	–	0	0
Goosefish	16	3	6	–	7	2	9	3
Planehead filefish	0	0	0	0	–	–	–	–
Red hake	14	18	–	1	21	41	6	23
Silver hake	24	86	–	4	5	39	–	–
Gadid sp.	0	0	0	0	–	3	0	0
Eel pout	8	5	–	–	1	5	2	6
Grey sole	–	–	0	0	0	0	0	0
Fluke	0	0	–	–	0	0	0	0
Winter flounder	–	1	4	4	6	7	1	2
Four spot	1	8	3	10	9	33	4	14
Windowpane	8	8	2	4	9	17	3	6
Etropus sp.	0	0	0	0	–	5	–	–
Yellowtail	24	38	2	3	–	2	–	3
Gulf Stream flounder	–	–	0	0	0	0	0	0
Butterfish	0	0	0	0	9	22	2	34
Sand lance	–	5	0	0	–	–	4	74
Eel	0	0	0	0	–	–	0	0
Rock gunnel	0	0	0	0	–	–	0	0
Scup	–	–	–	–	0	0	0	0
Black seabass	0	0	–	–	0	0	–	–
Alewife	7	24	0	0	0	0	0	0
Hickory shad	–	–	0	0	0	0	0	0
American shad	–	–	0	0	0	0	0	0
Atlantic herring	–	1	0	0	0	0	0	0
Blueback herring	–	–	0	0	0	0	0	0
Cod	15	1	0	0	0	0	0	0
Cunner	–	–	0	0	0	0	0	0
Round herring	0	0	0	0	0	0	–	–
Mackerel	2	2	0	0	0	0	0	0
Bothidae sp.	0	0	0	0	0	0	–	15
Snake eel	0	0	0	0	0	0	–	–
White hake	0	0	0	0	0	0	–	–
Cornetfish	0	0	0	0	0	0	–	–
INVERTEBRATES								
Loligo-Longfin squid	3	18	–	–	12	46	33	415
Illex-Shortfin squid	–	–	–	–	–	3	–	1
Scallops - sea	7	58	3	15	56	233	23	96
Lobster	–	–	0	0	1	1	–	–
Cancer irroratus	1	3	0	0	Not weighed	36	No data	
Cancer borealis	–	–	0	0	0	0	No data	

– = less than 1.2 lb. or less than 1 fish/tow

Fig. 1

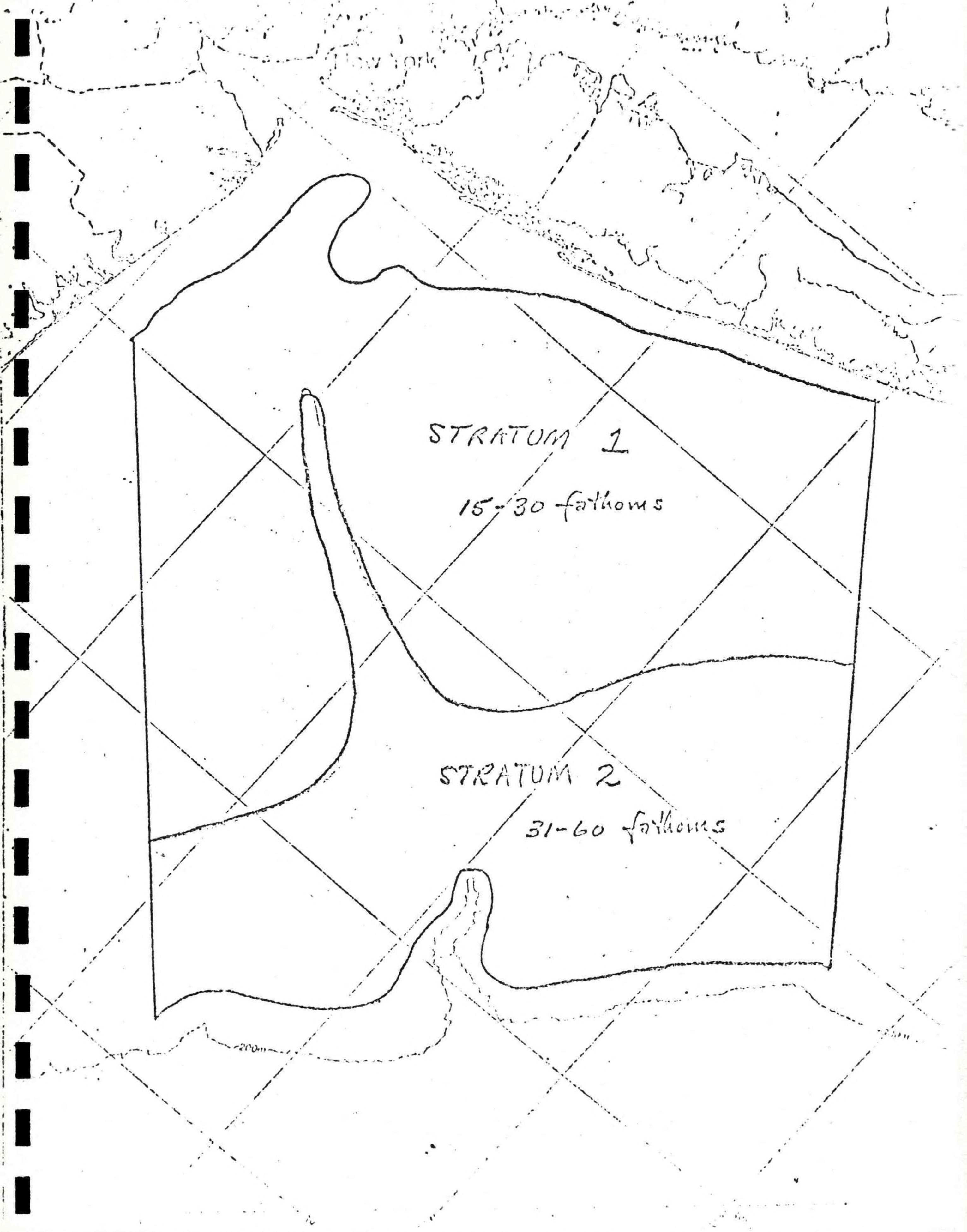


Fig.2

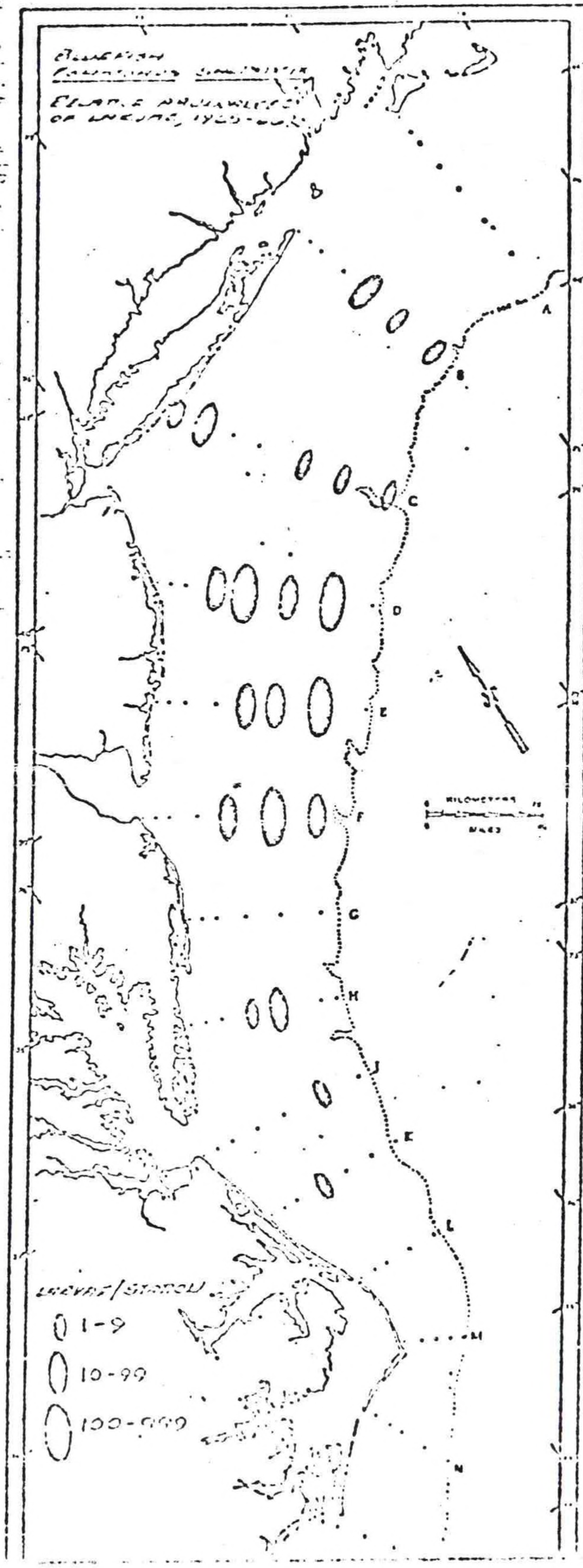
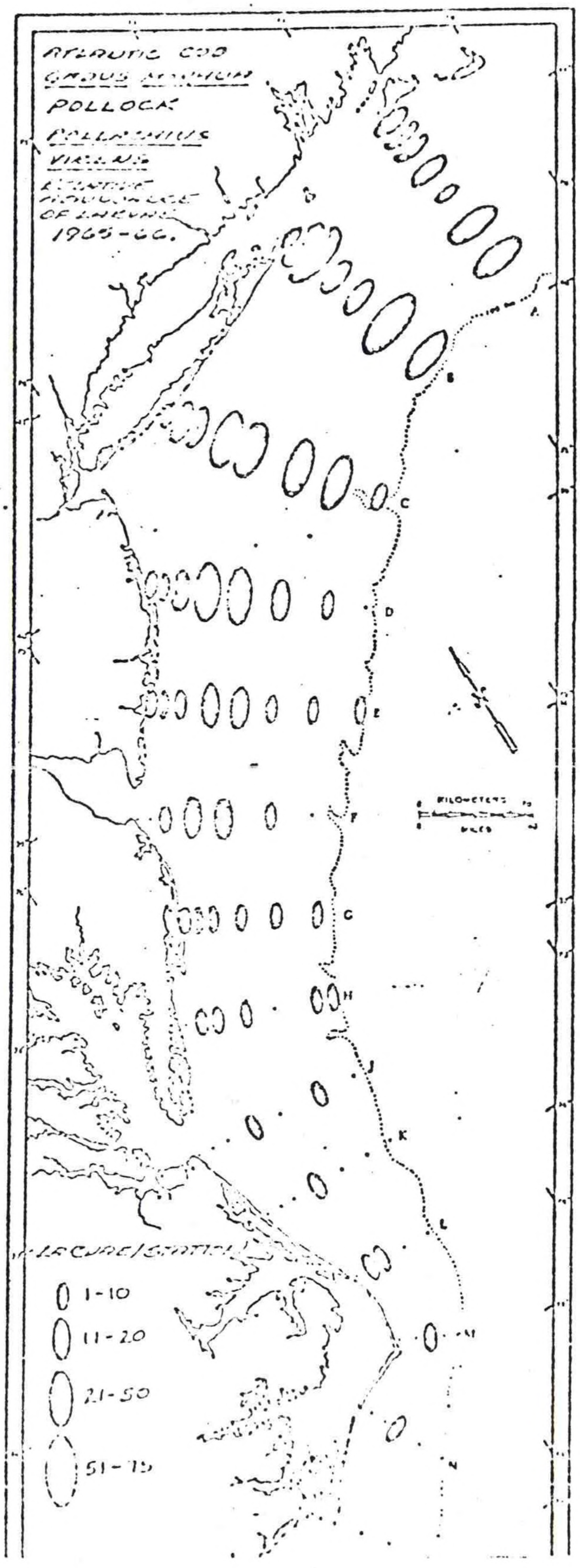


Fig. 3.



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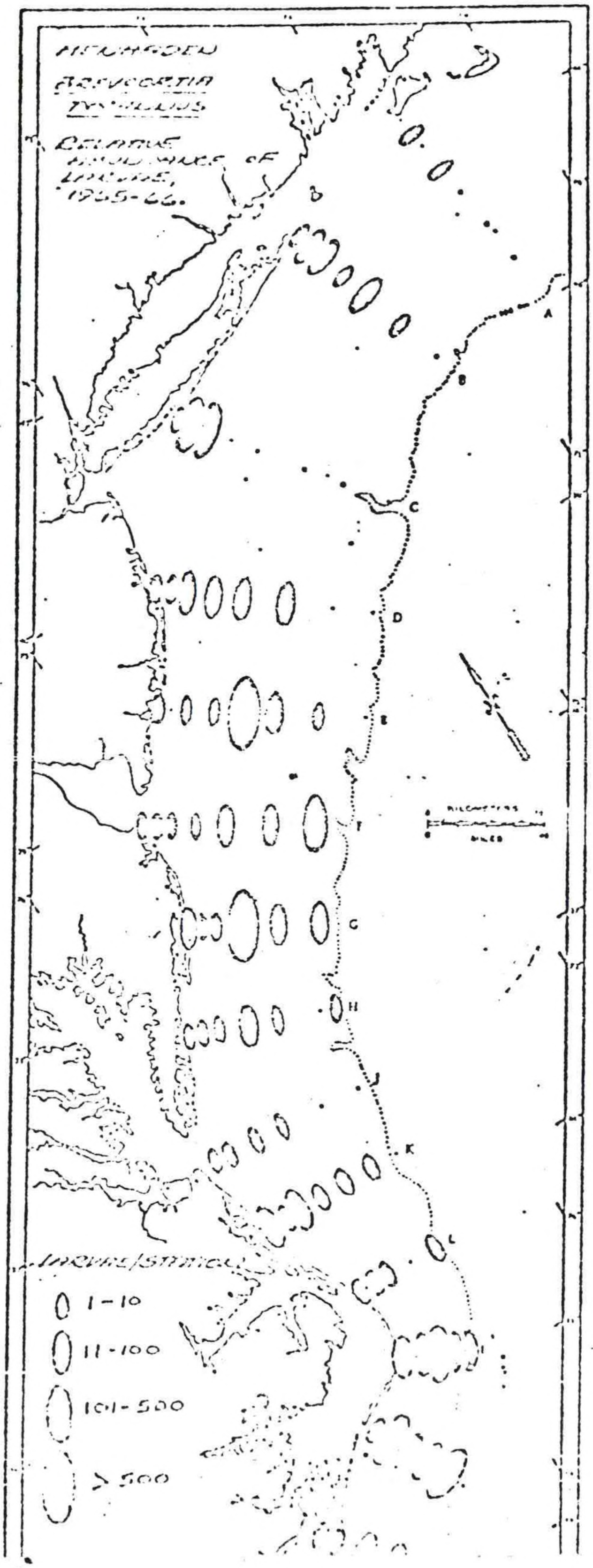
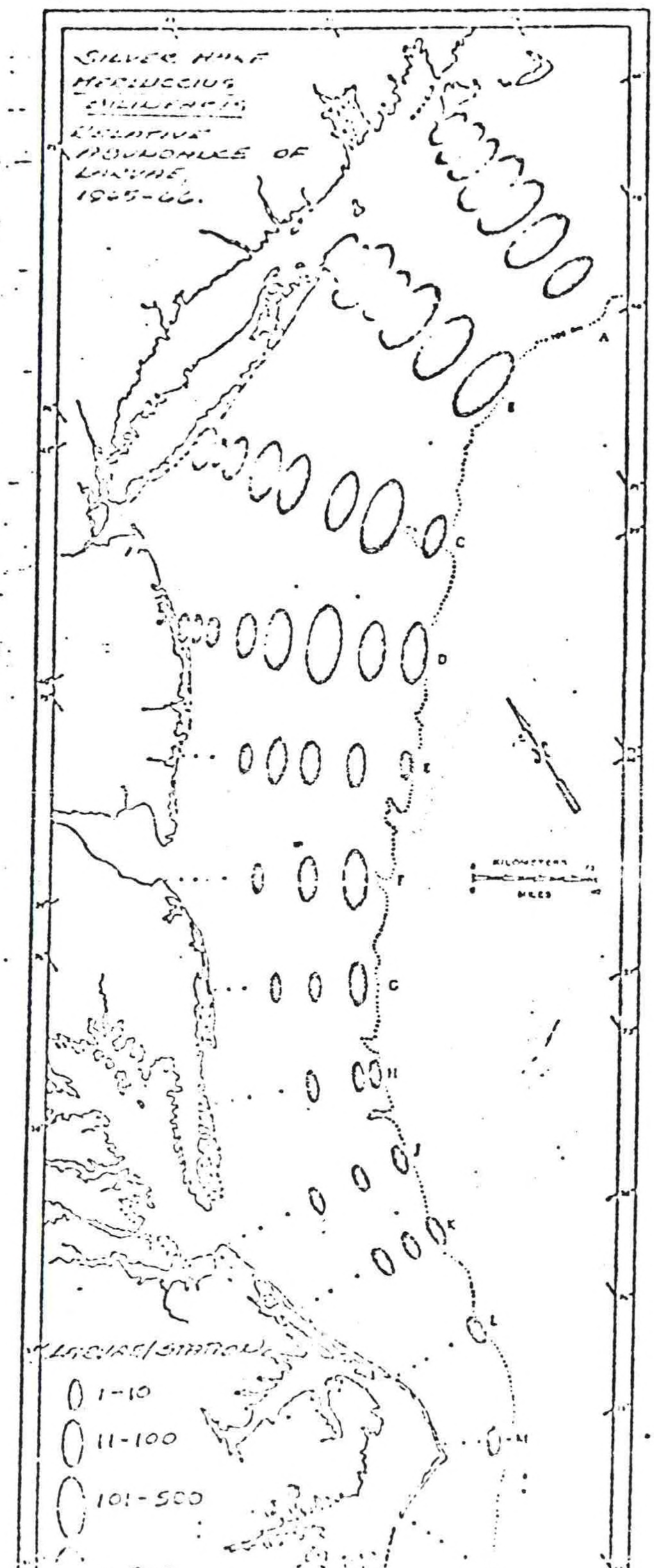


Fig.5



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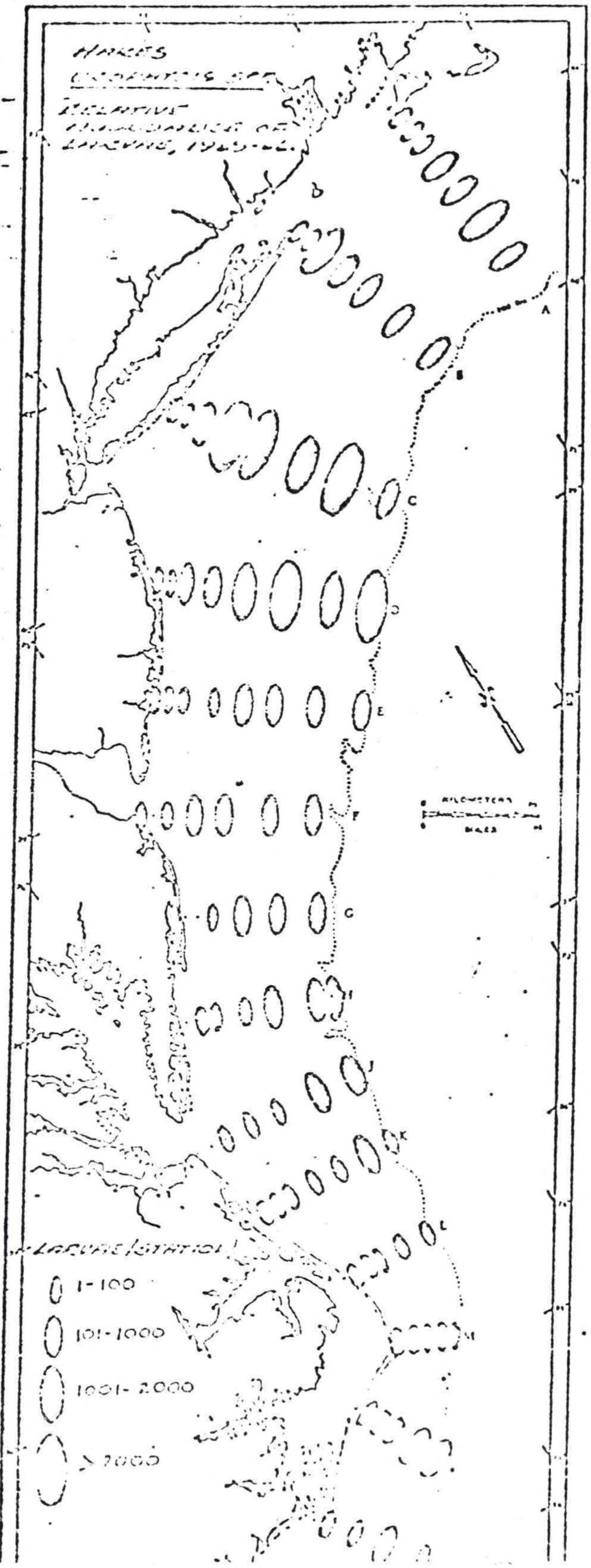

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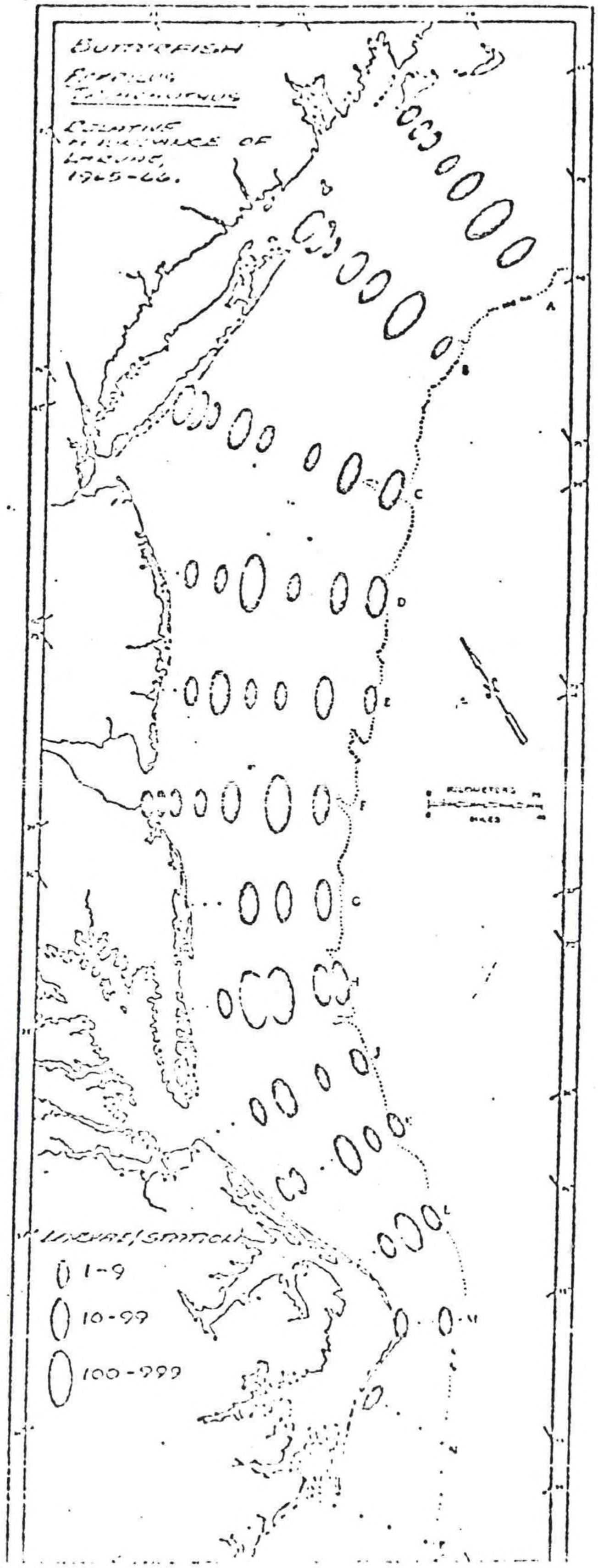

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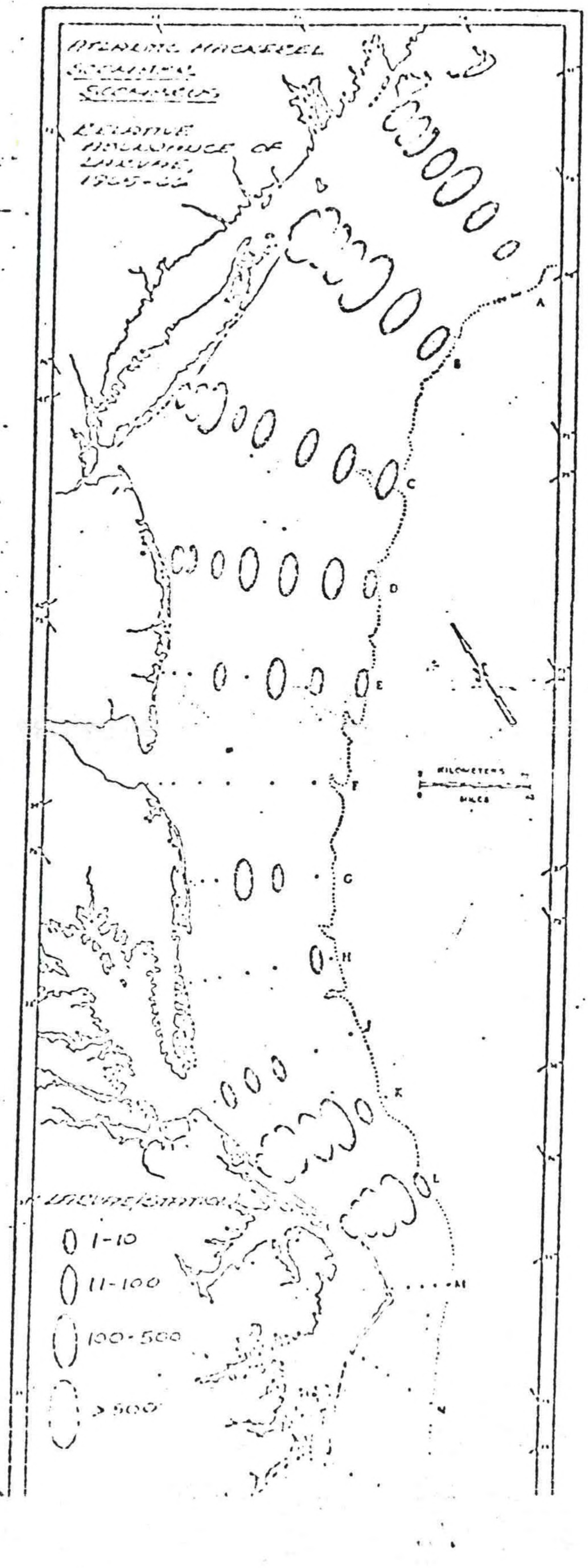
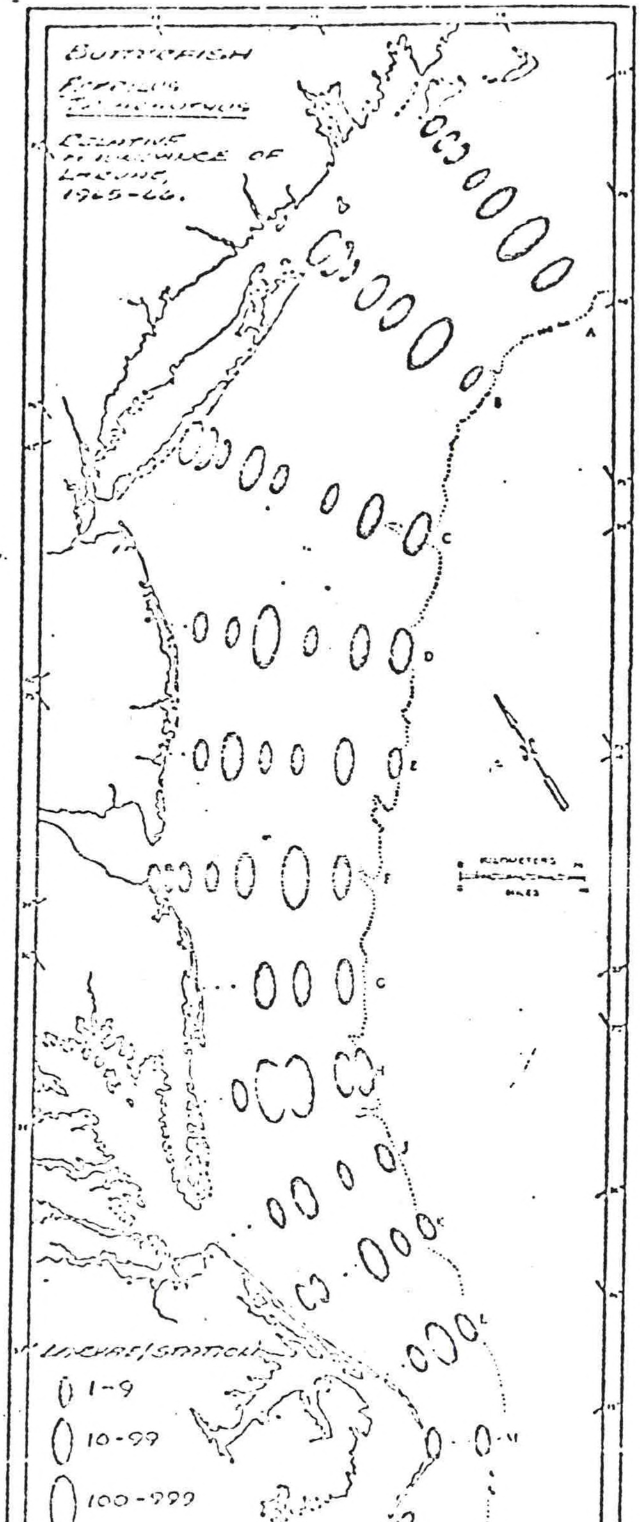


Fig. 7



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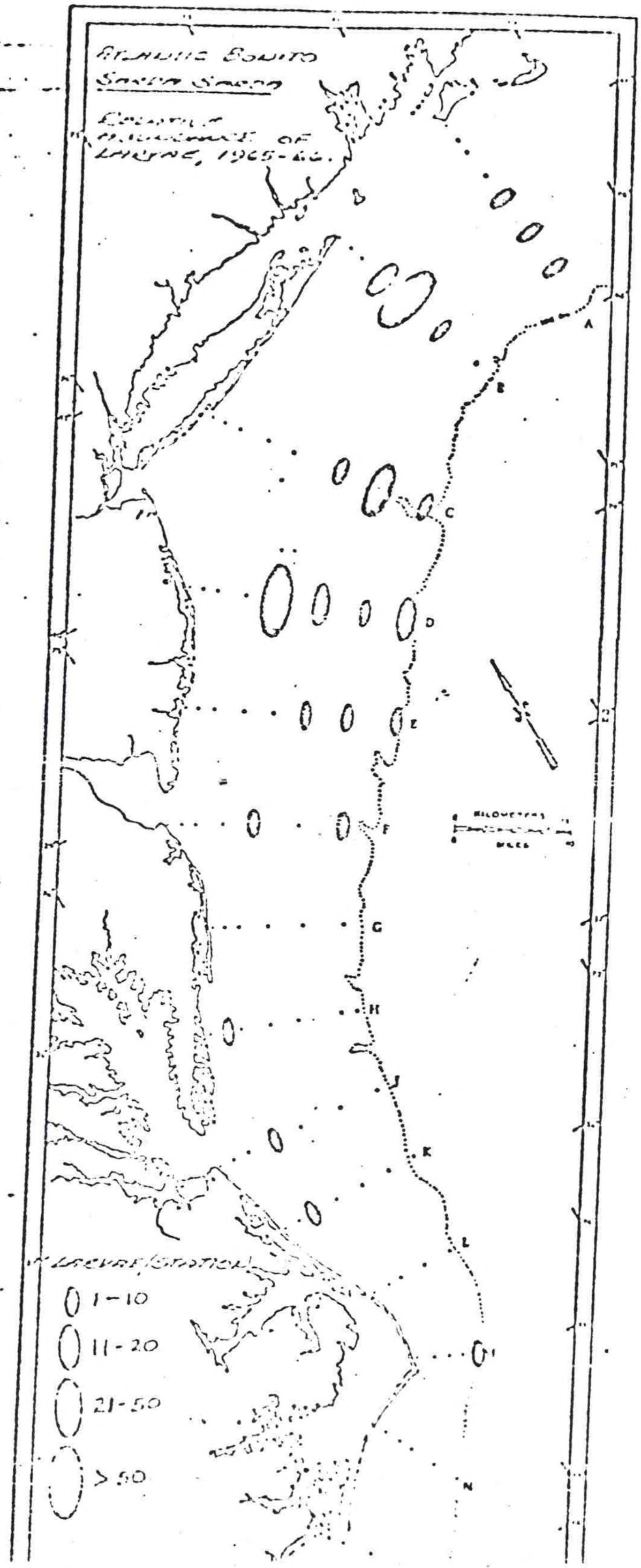
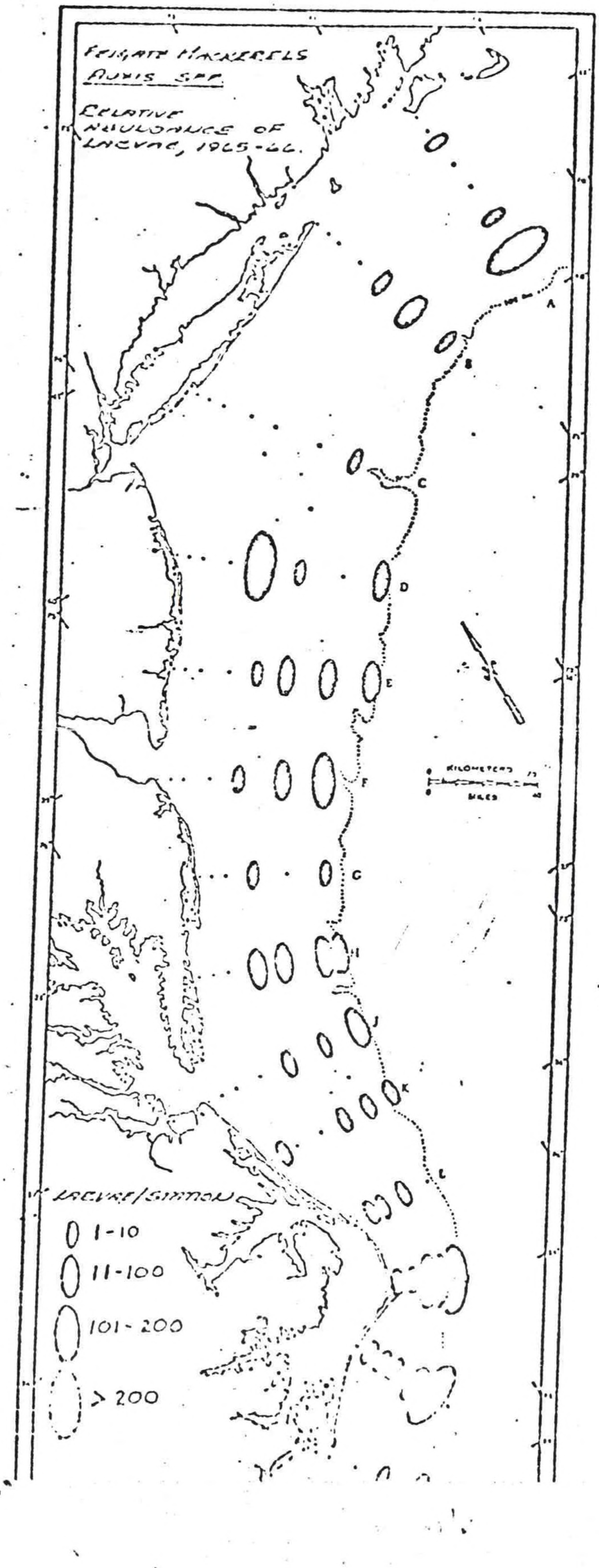


Fig. 10



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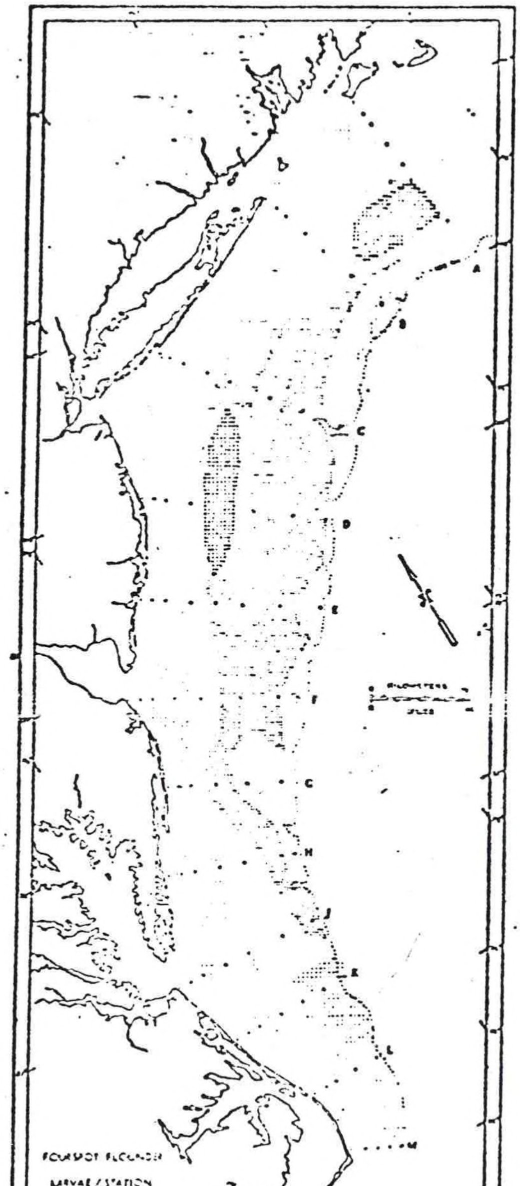

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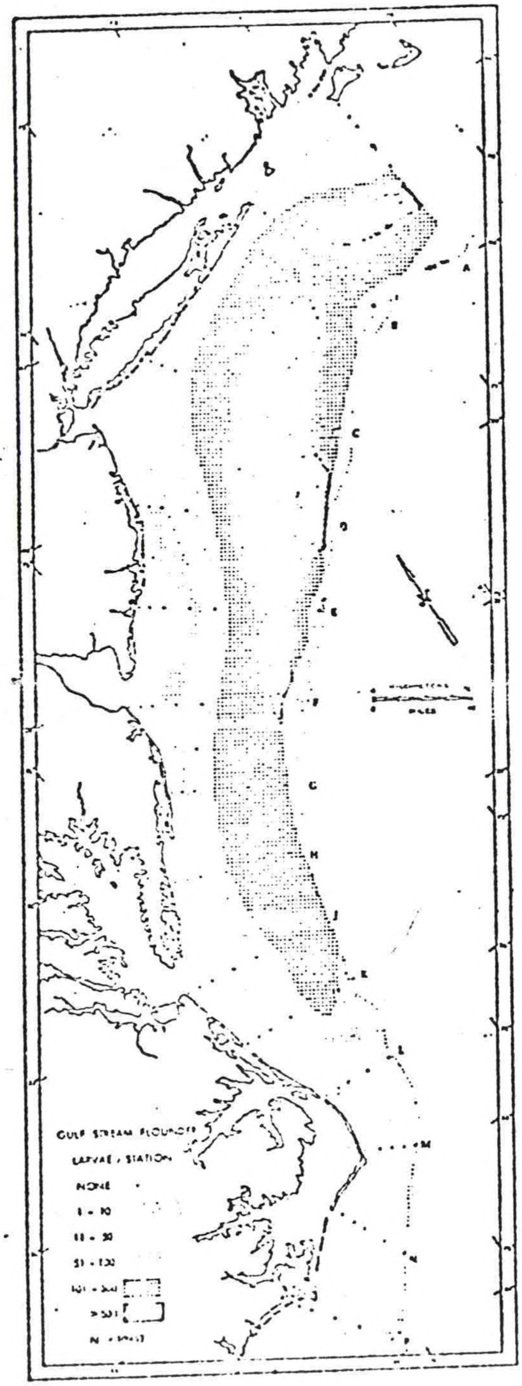


Fig. 13

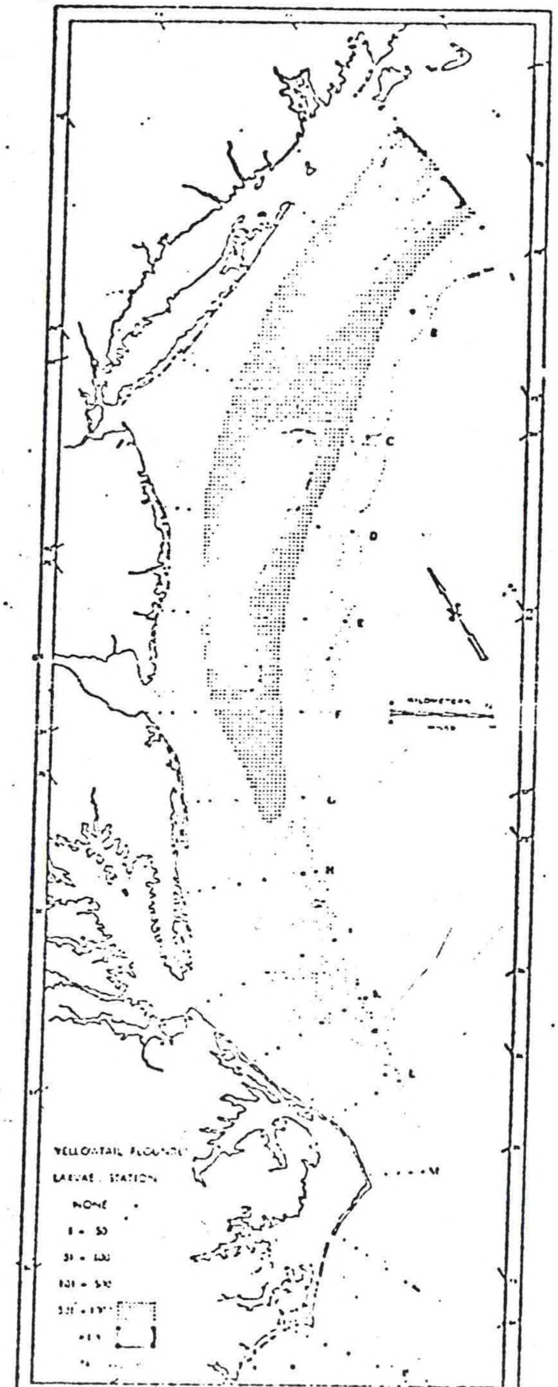


Fig. 14

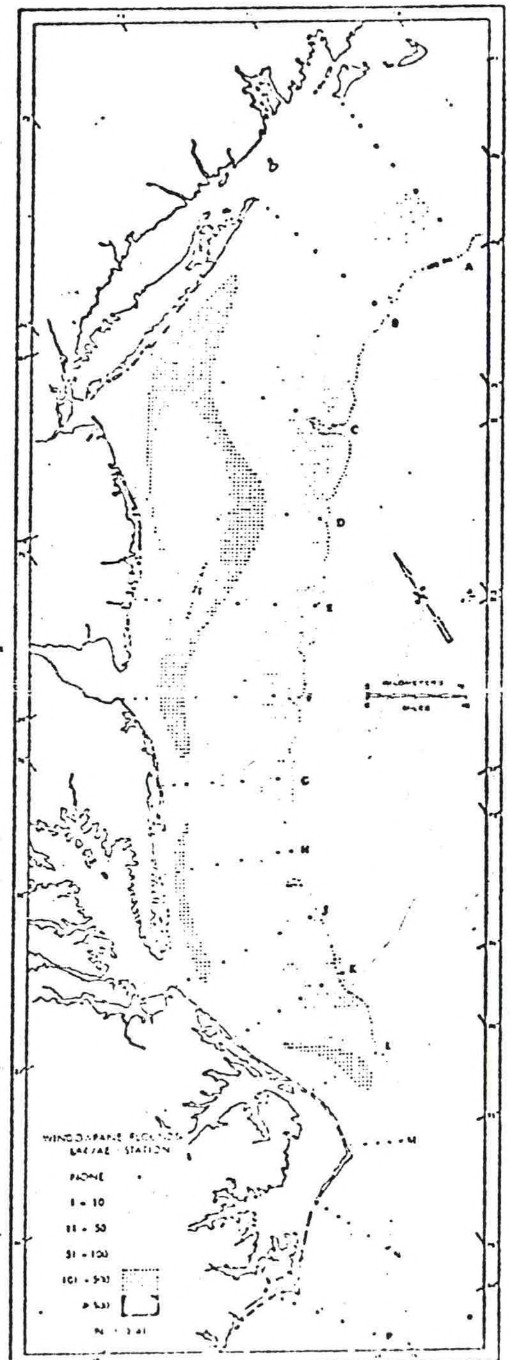


Fig. 15

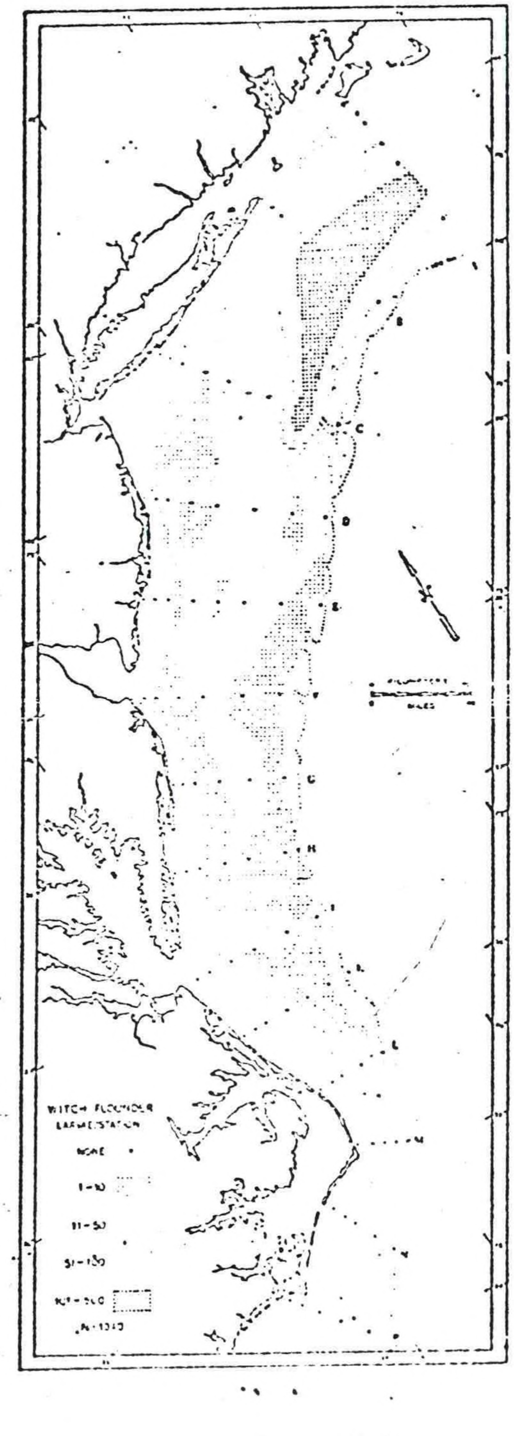
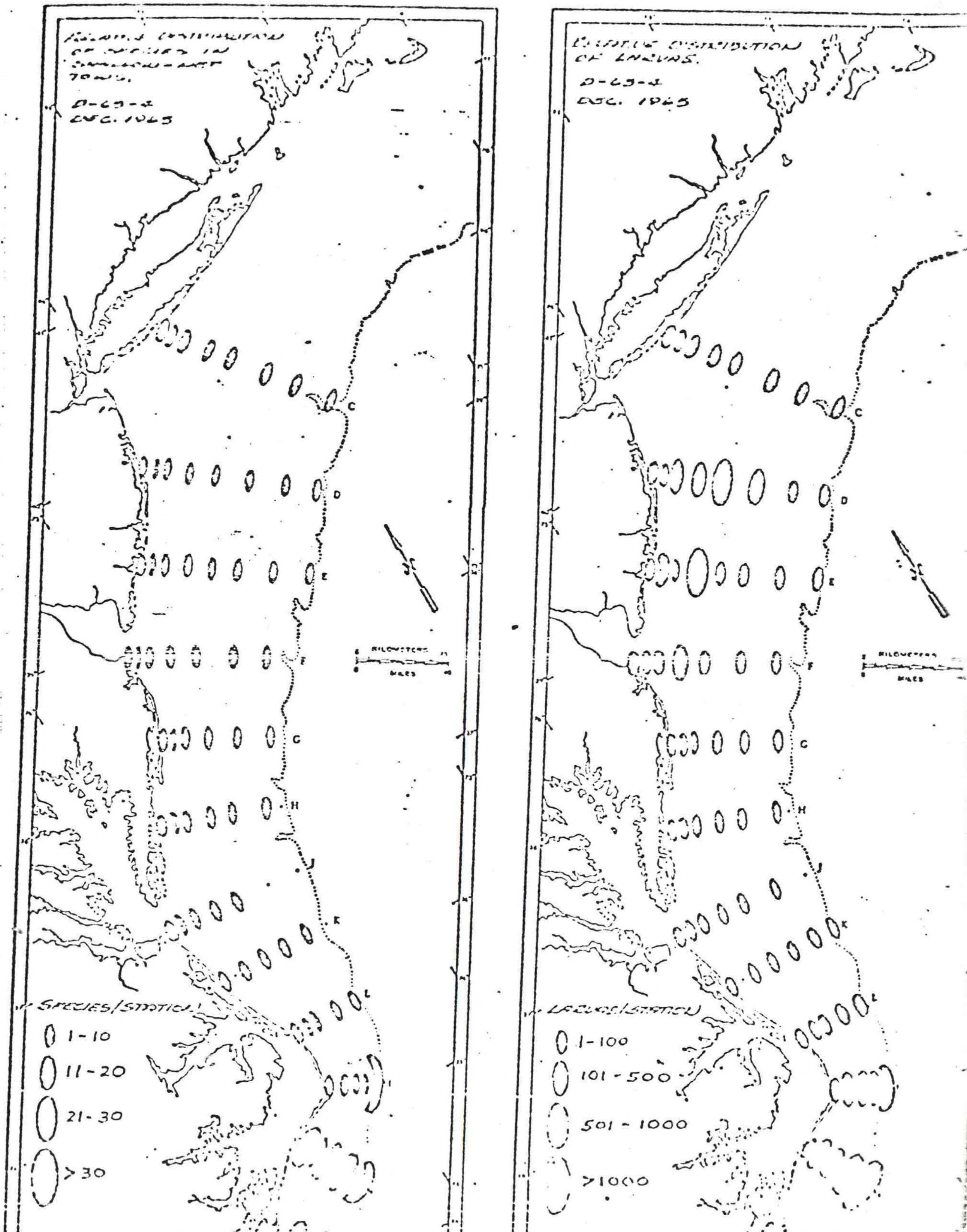


Fig. 16



D-65-4
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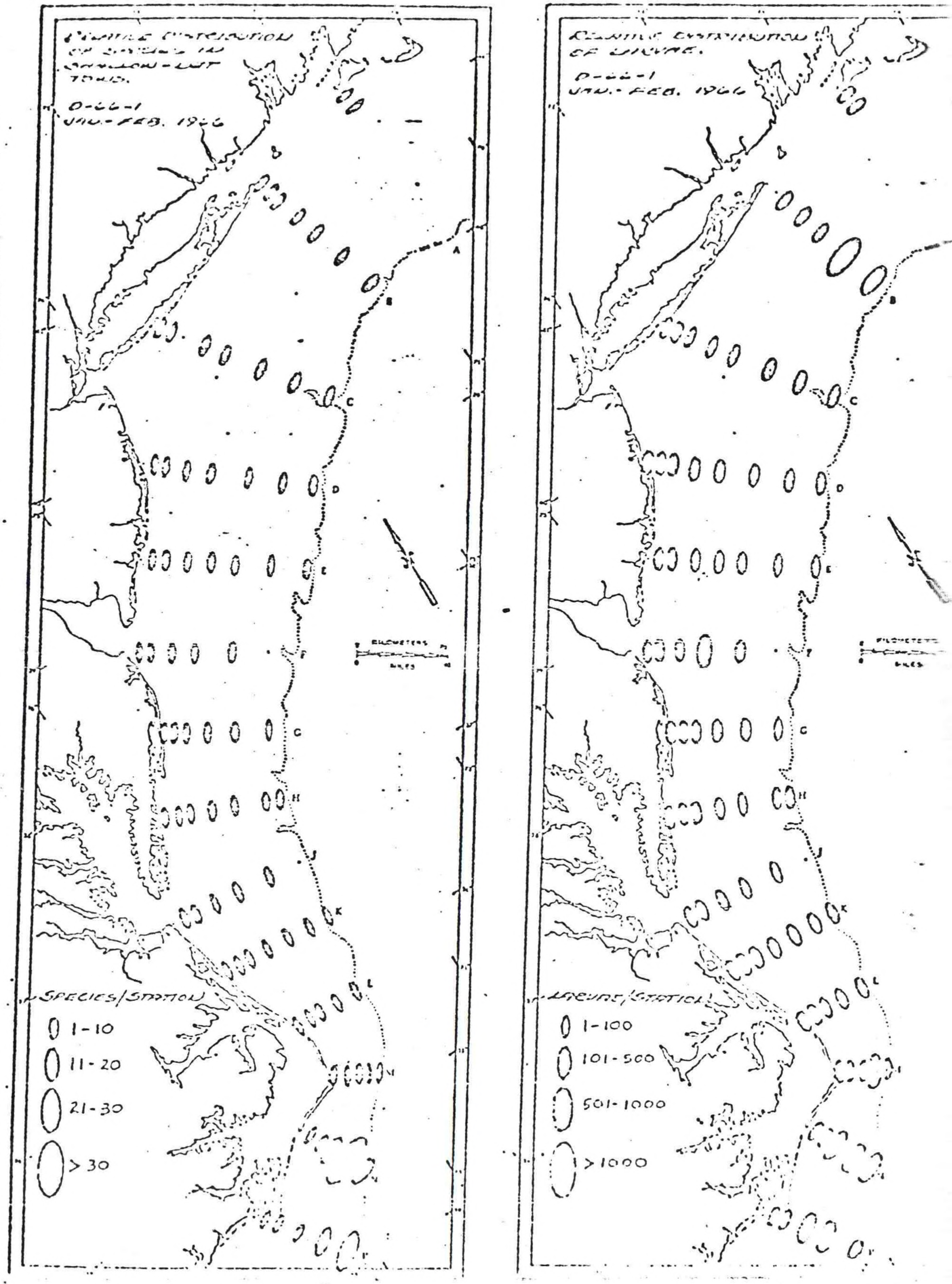
11-20
21-30
>30
OF LARVAE.
D-65-4
DEC. 1965
LARVAE/STATION
1-100
101-500
501-1000
>1000

Fig. 17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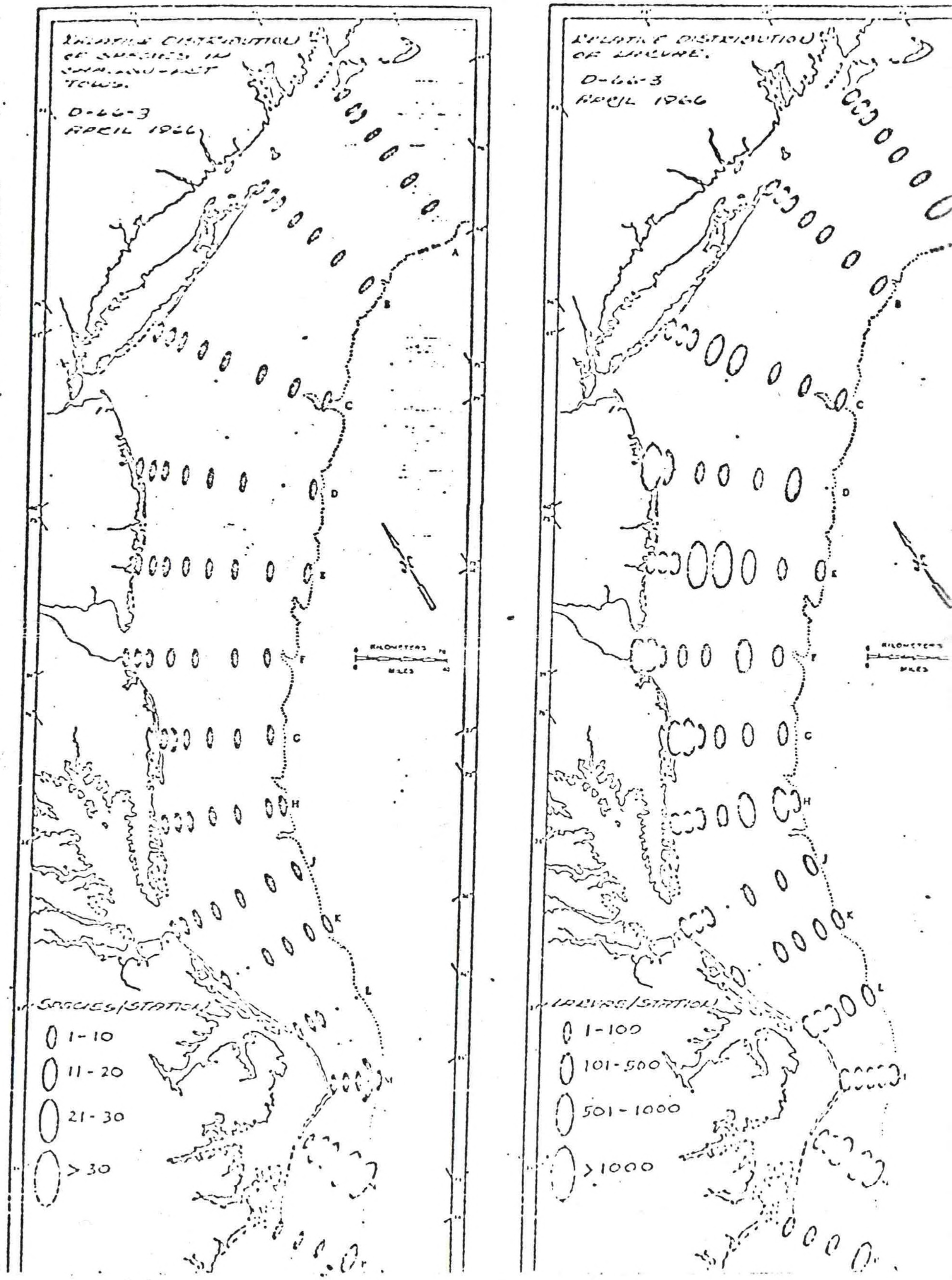
11-20
21-30
> 30
1-100
101-500
501-1000
>1000

Fig. 18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SPECIES/STATION
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11-20
21-30
> 30
RELATIVE DISTRIBUTION OF LARVAE.
D-66-3
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LARVAE/STATION
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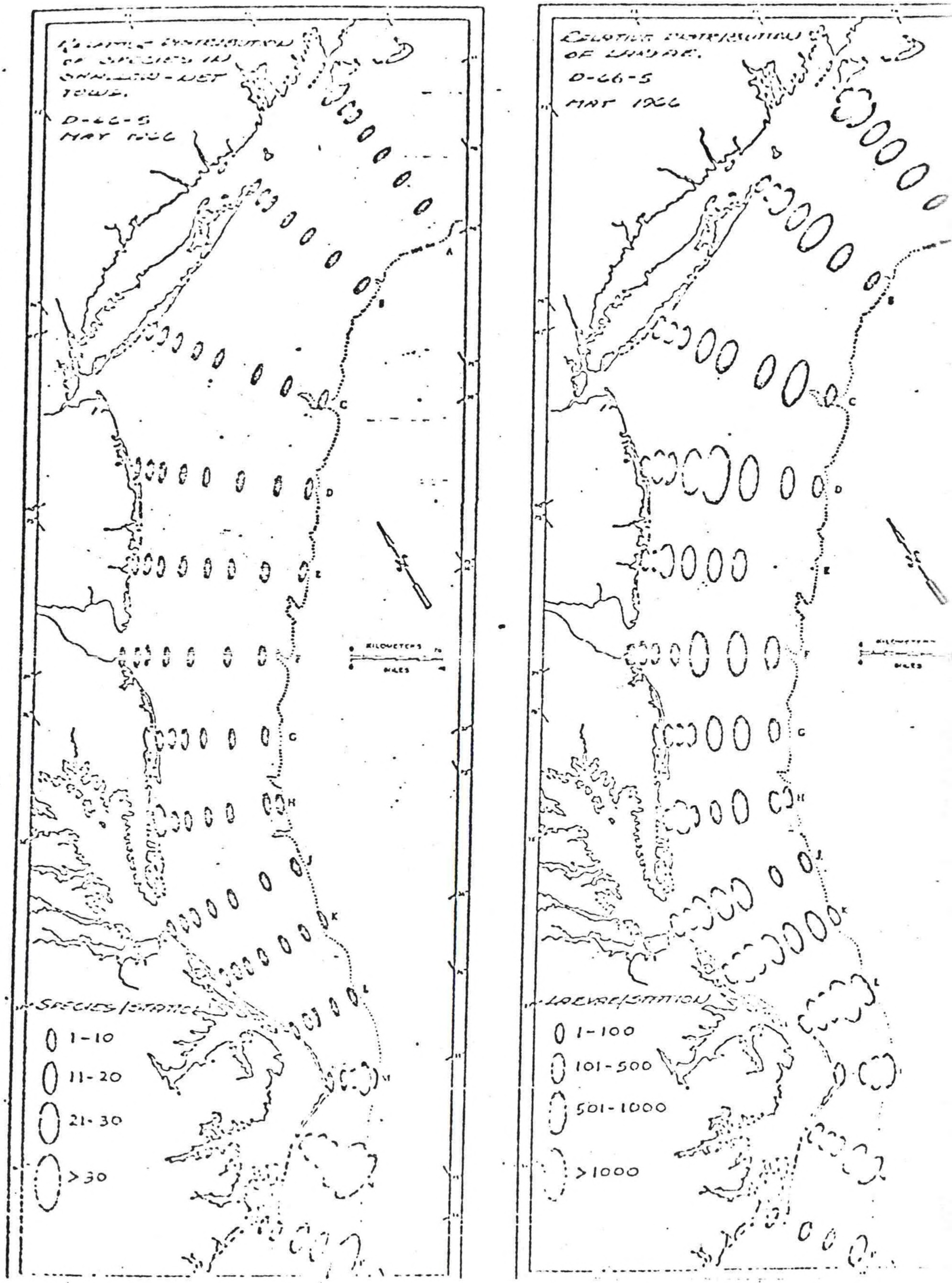
101-500
501-1000
>1000

Fig. 19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11-20
21-30
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MAY 1966
LARVAE/STATION
1-100
101-500
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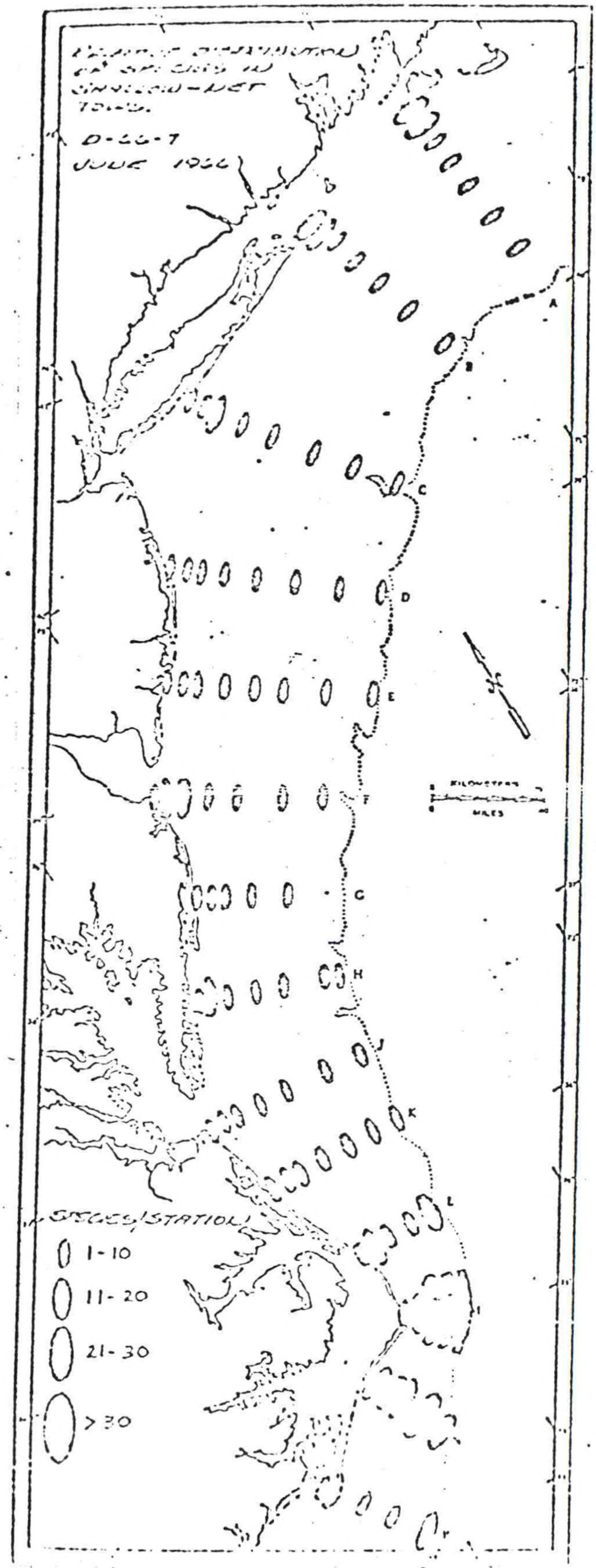
B
C
D
E
F
G
H
J
K
L
KILOMETERS
MILES

Fig. 20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21-30
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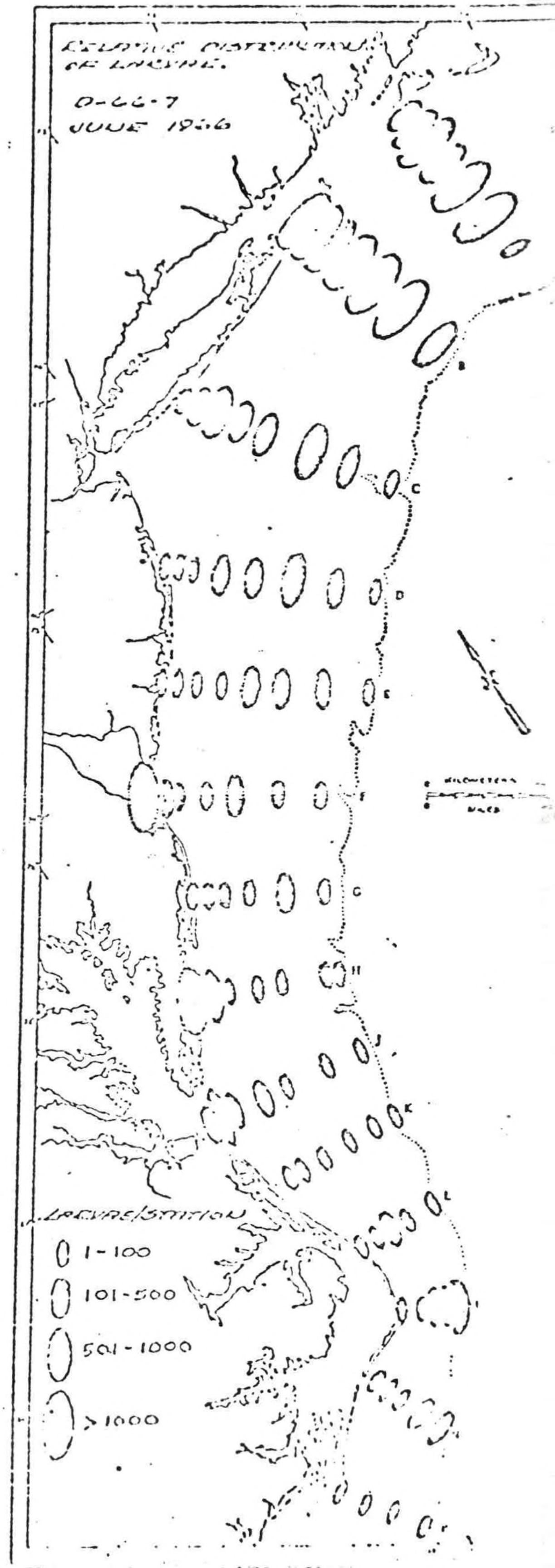
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JUNE 1966
LARVAE/STATION
1-100
101-500
501-1000
>1000

Fig. 21

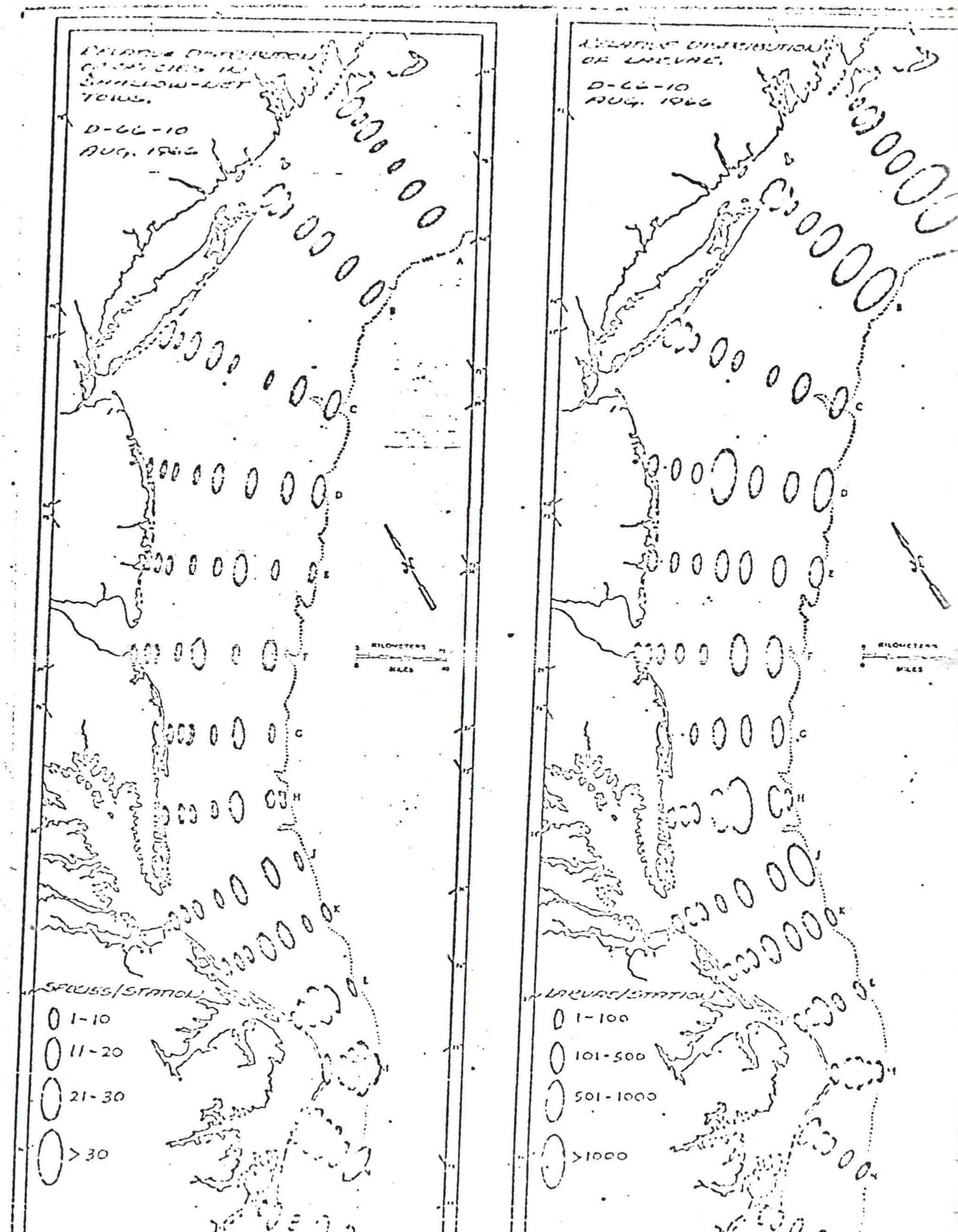

D-66-10
SPECIES/STATION
1-10
11-20
21-30
>30
D-66-10
LARVAE/STATION
1-100
101-500
501-1000
>1000

Fig. 22

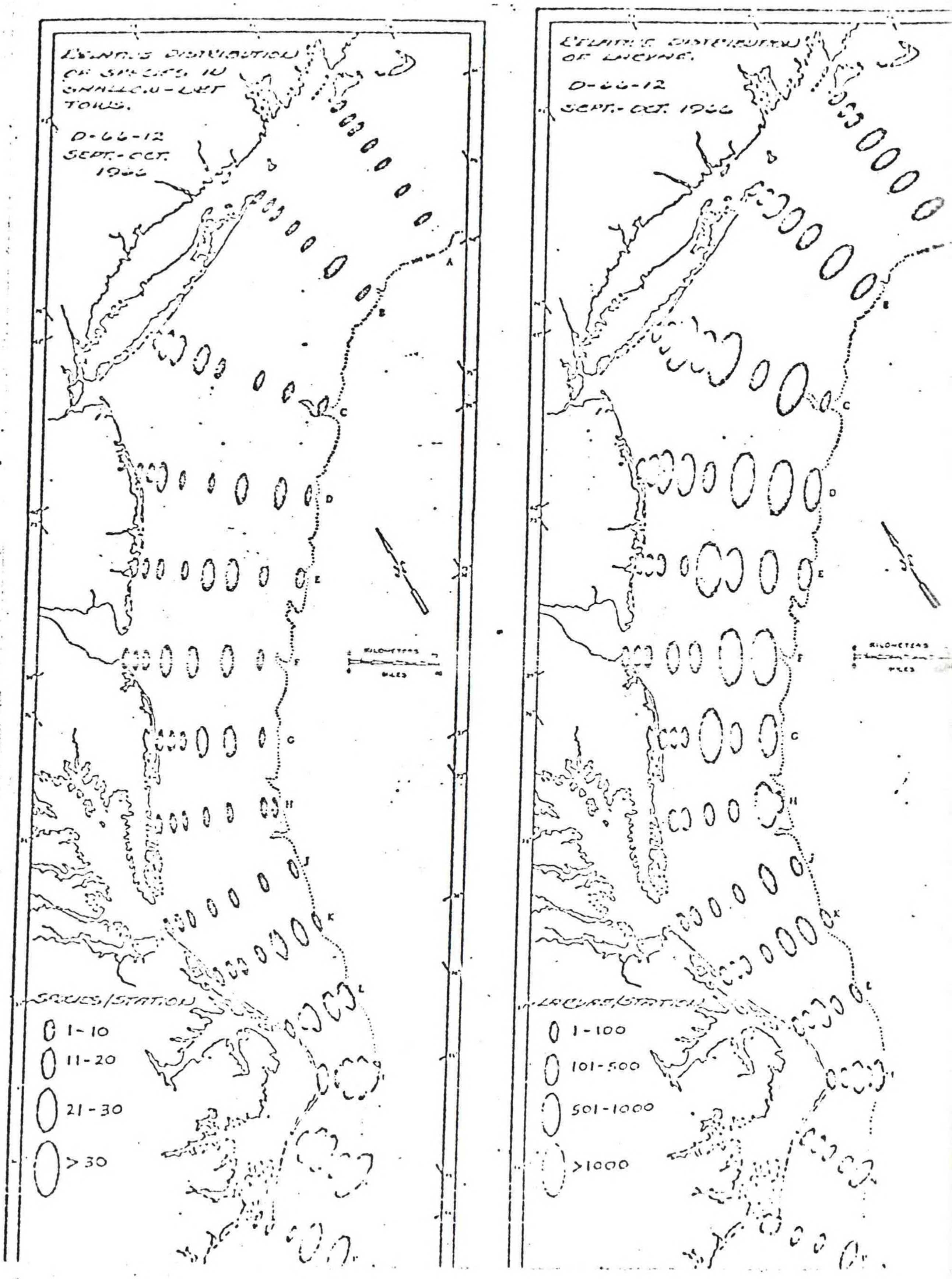


Fig. 23

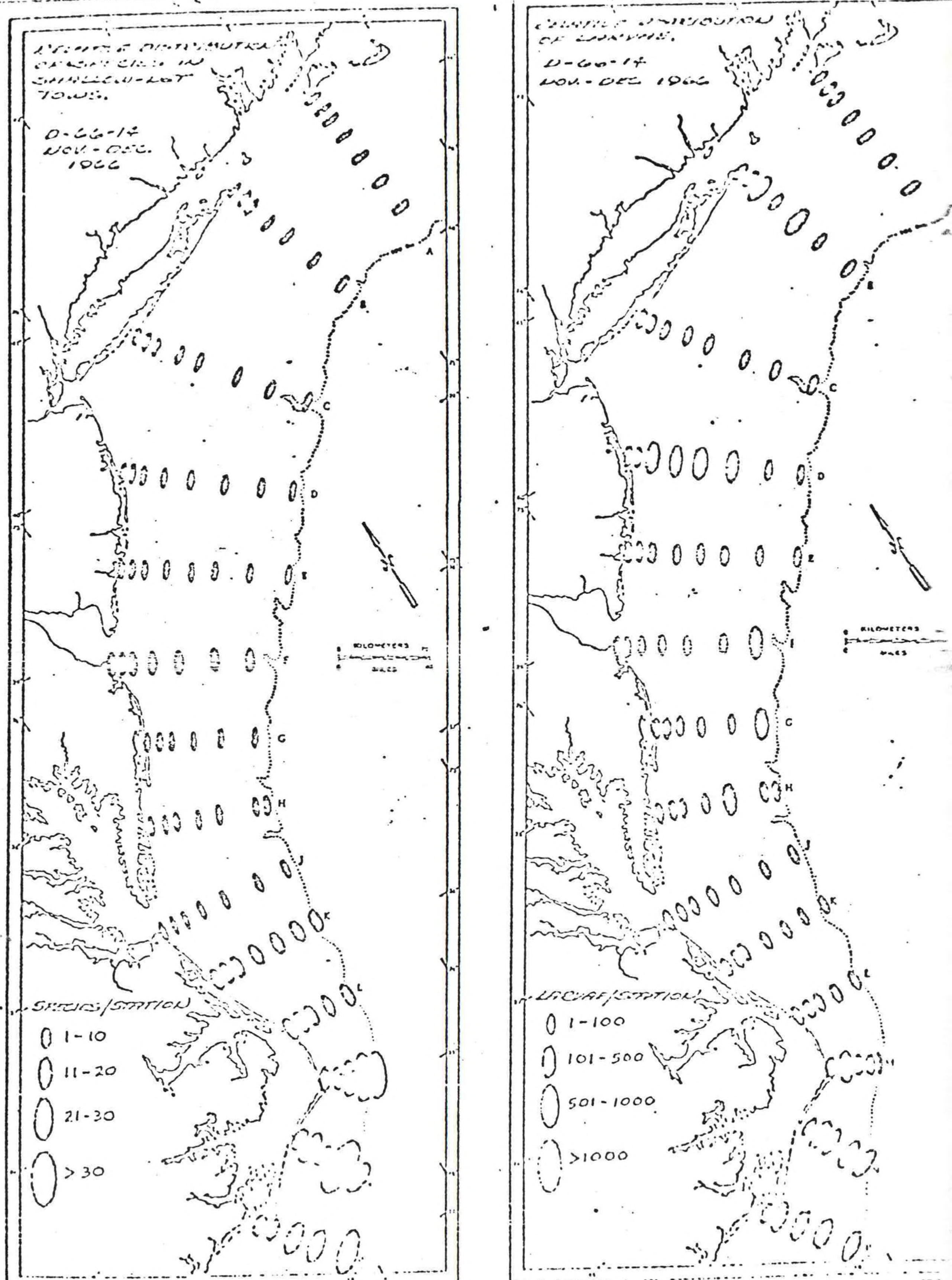
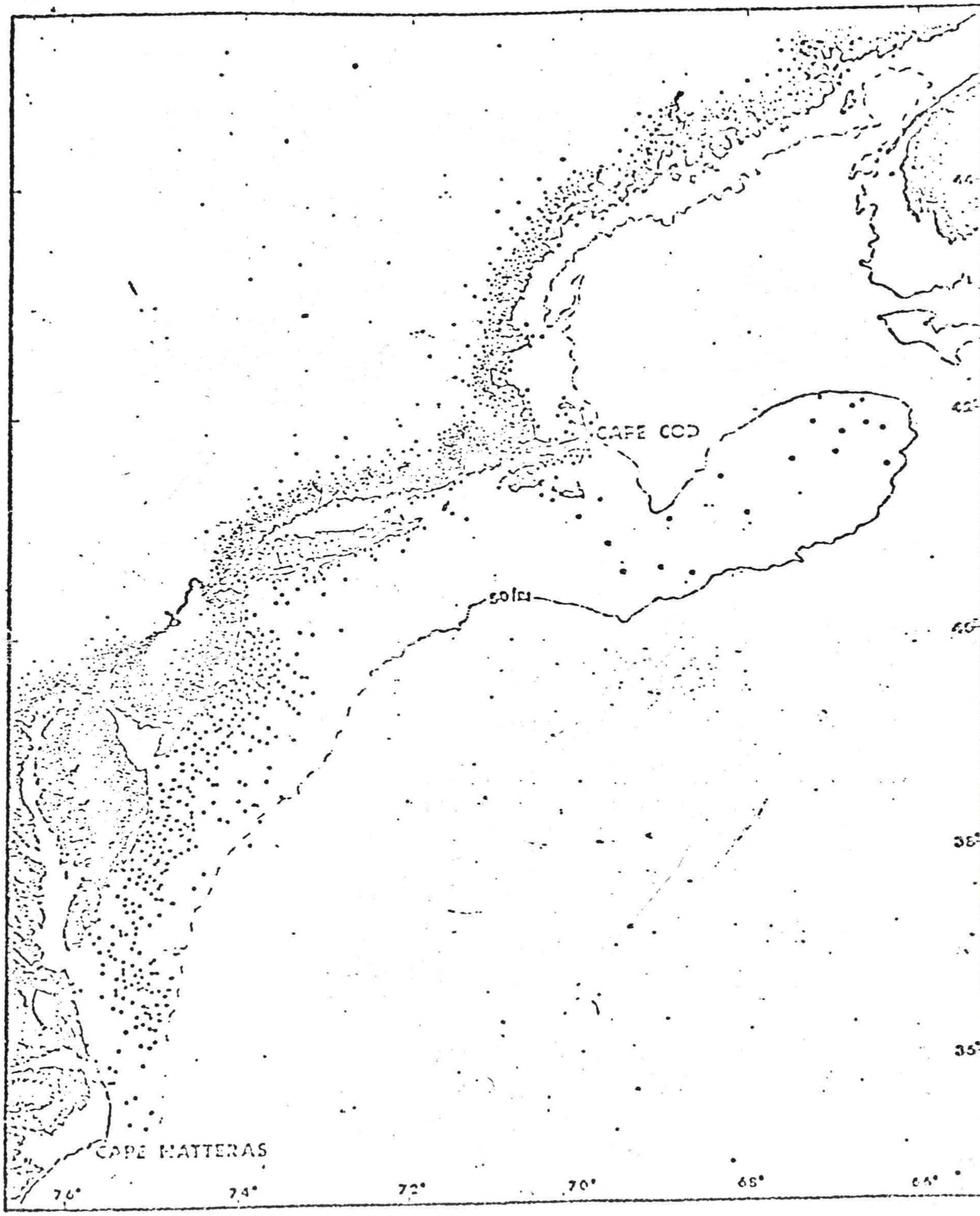
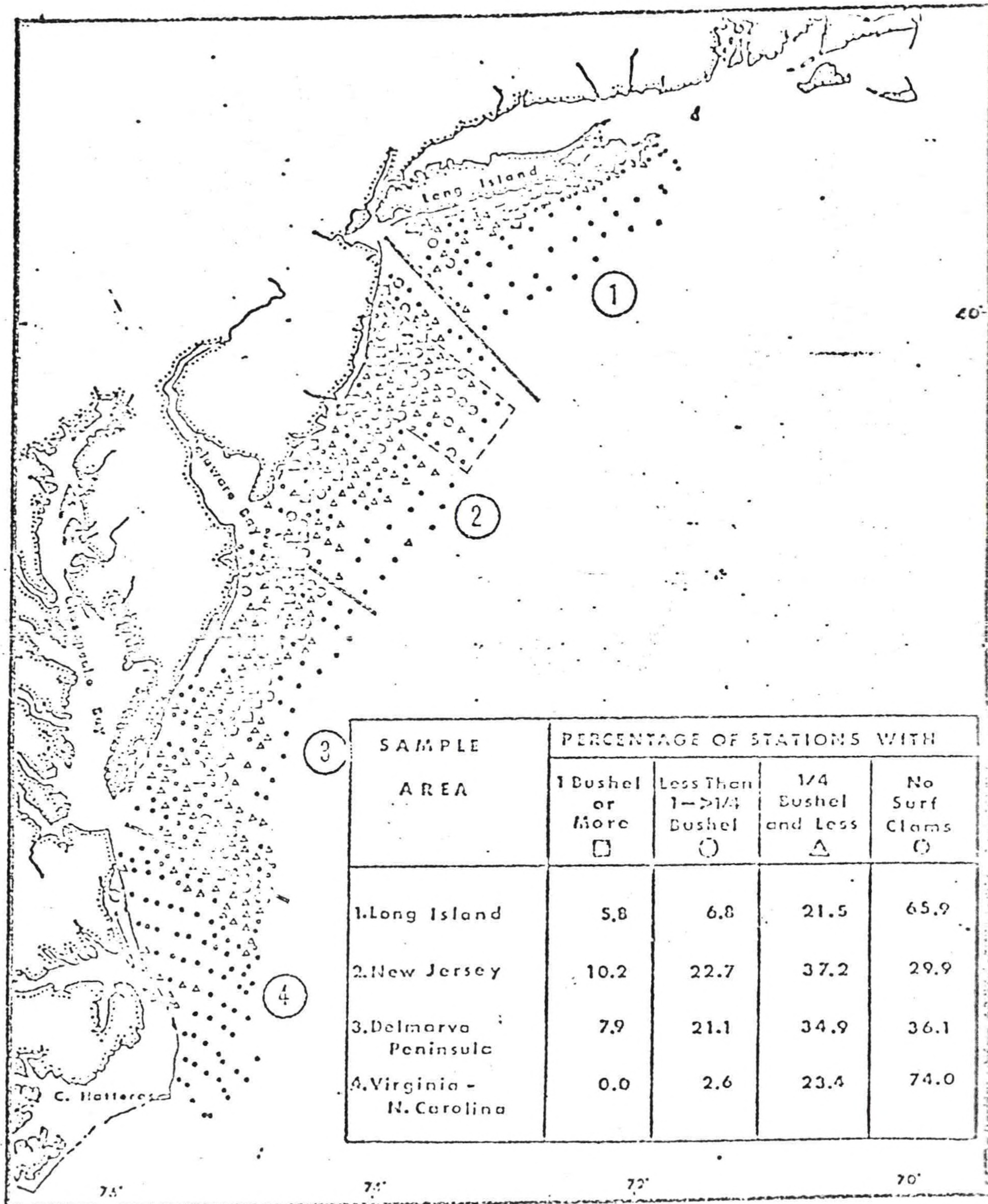


Fig. 24



Surf clam distribution (Merrill and Ropes, 1969) Fig

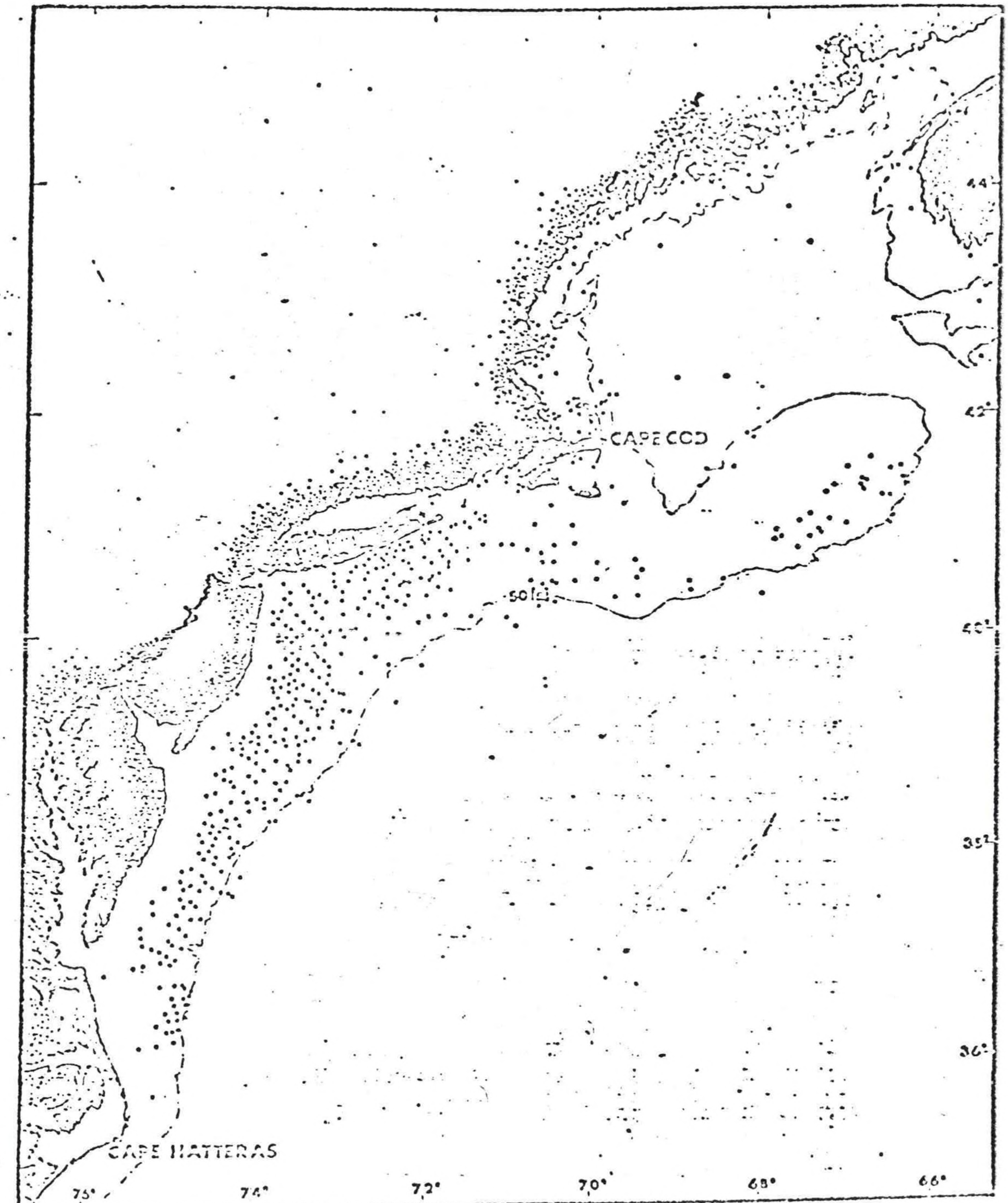
Fig. 25



SAMPLE AREA	PERCENTAGE OF STATIONS WITH			
	1 Bushel or More ☐	Less Than 1—>1/4 Bushel ◌	1/4 Bushel and Less △	No Surf Clams ◌
1. Long Island	5.8	6.8	21.5	65.9
2. New Jersey	10.2	22.7	37.2	29.9
3. Delmarva Peninsula	7.9	21.1	34.9	36.1
4. Virginia - N. Carolina	0.0	2.6	23.4	74.0

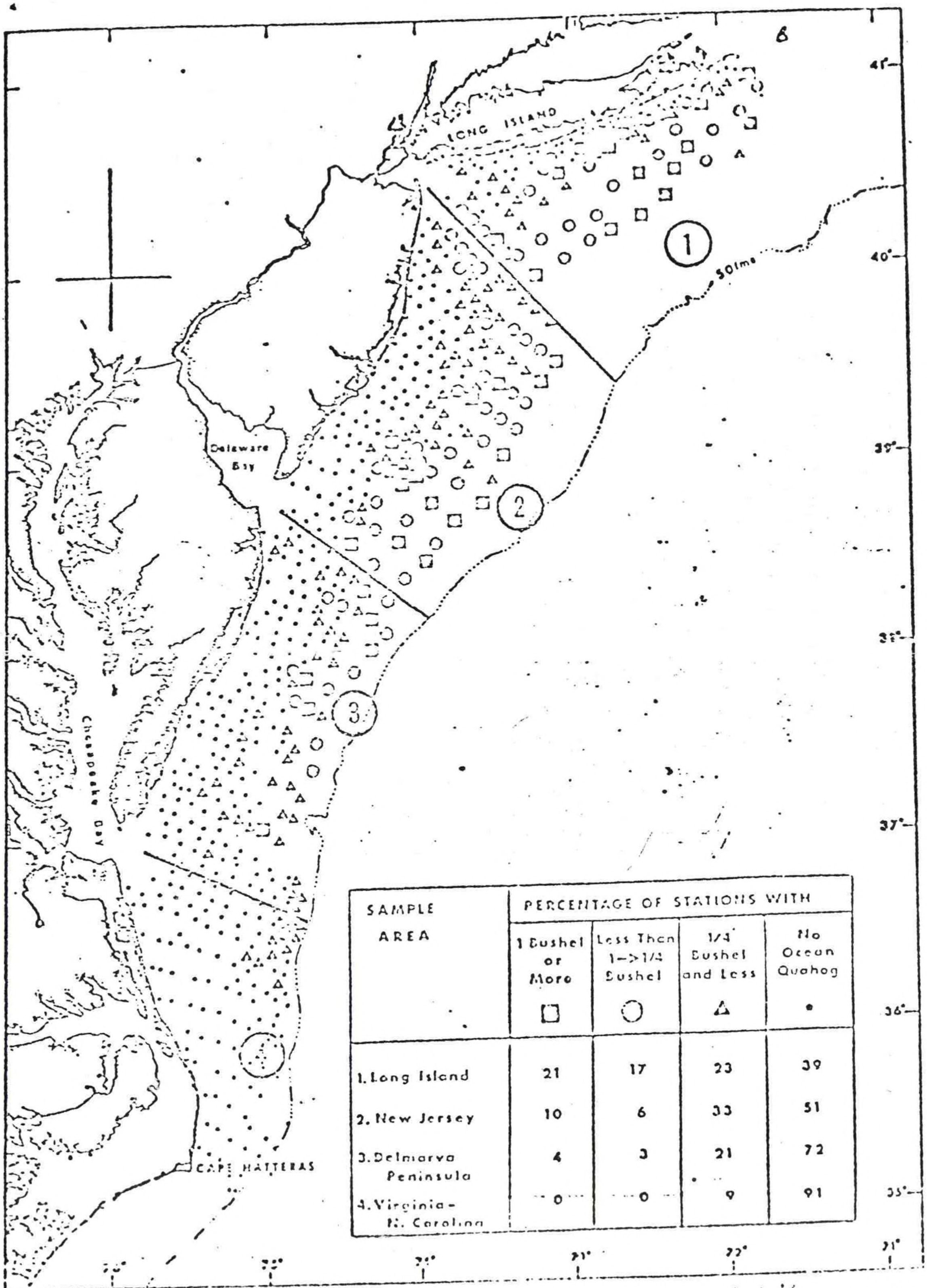
Surf clam distribution
ms in prep

Fig. 26



Ocean Quahog
distribution
Merrill & Ropes, 1969

Fig. 27



SAMPLE AREA	PERCENTAGE OF STATIONS WITH			
	1 Bushel or More □	Less Than 1->1/4 Bushel ○	1/4 Bushel and Less △	No Ocean Quahog •
1. Long Island	21	17	23	39
2. New Jersey	10	6	33	51
3. Delmarva Peninsula	4	3	21	72
4. Virginia-N. Carolina	0	0	9	91

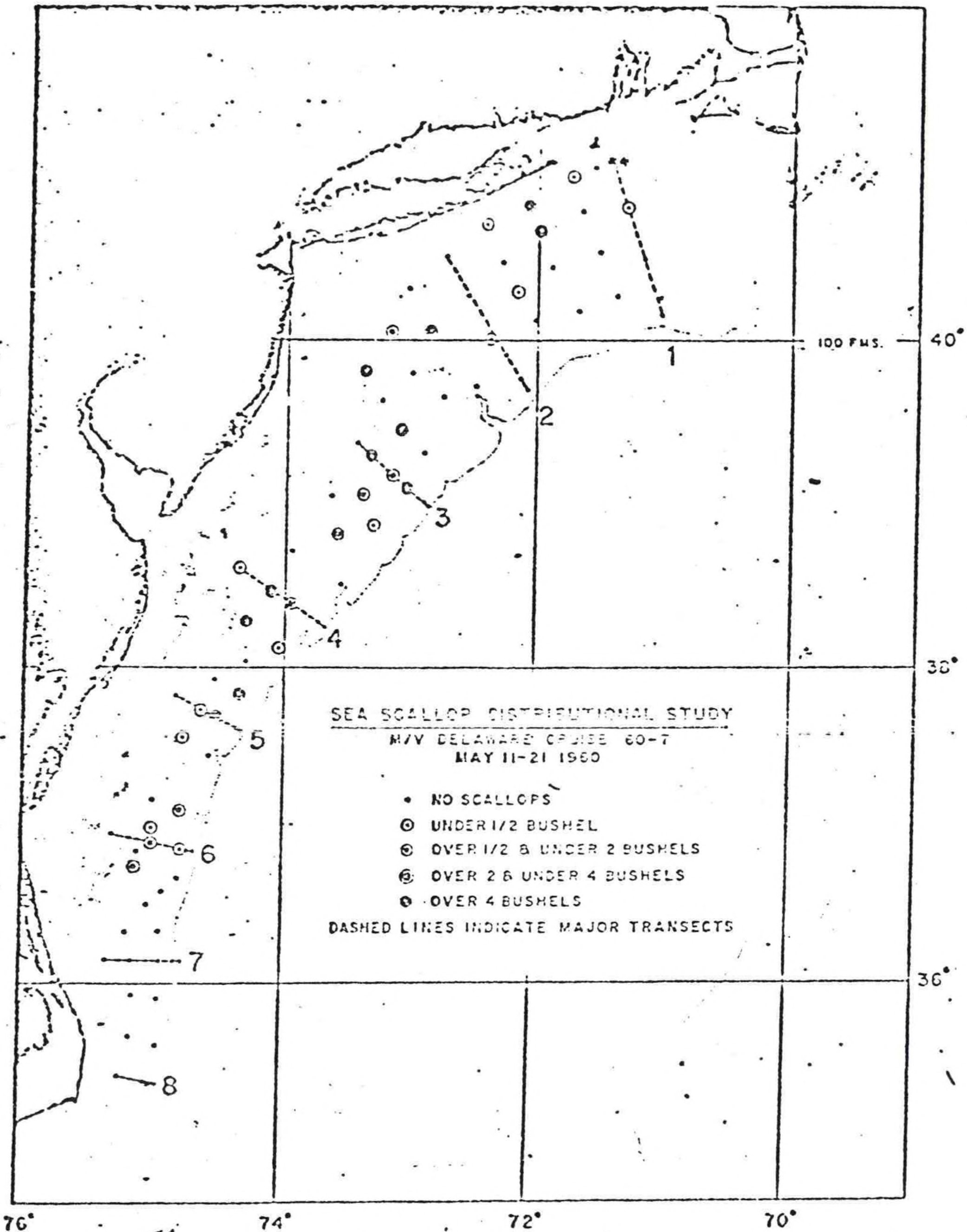
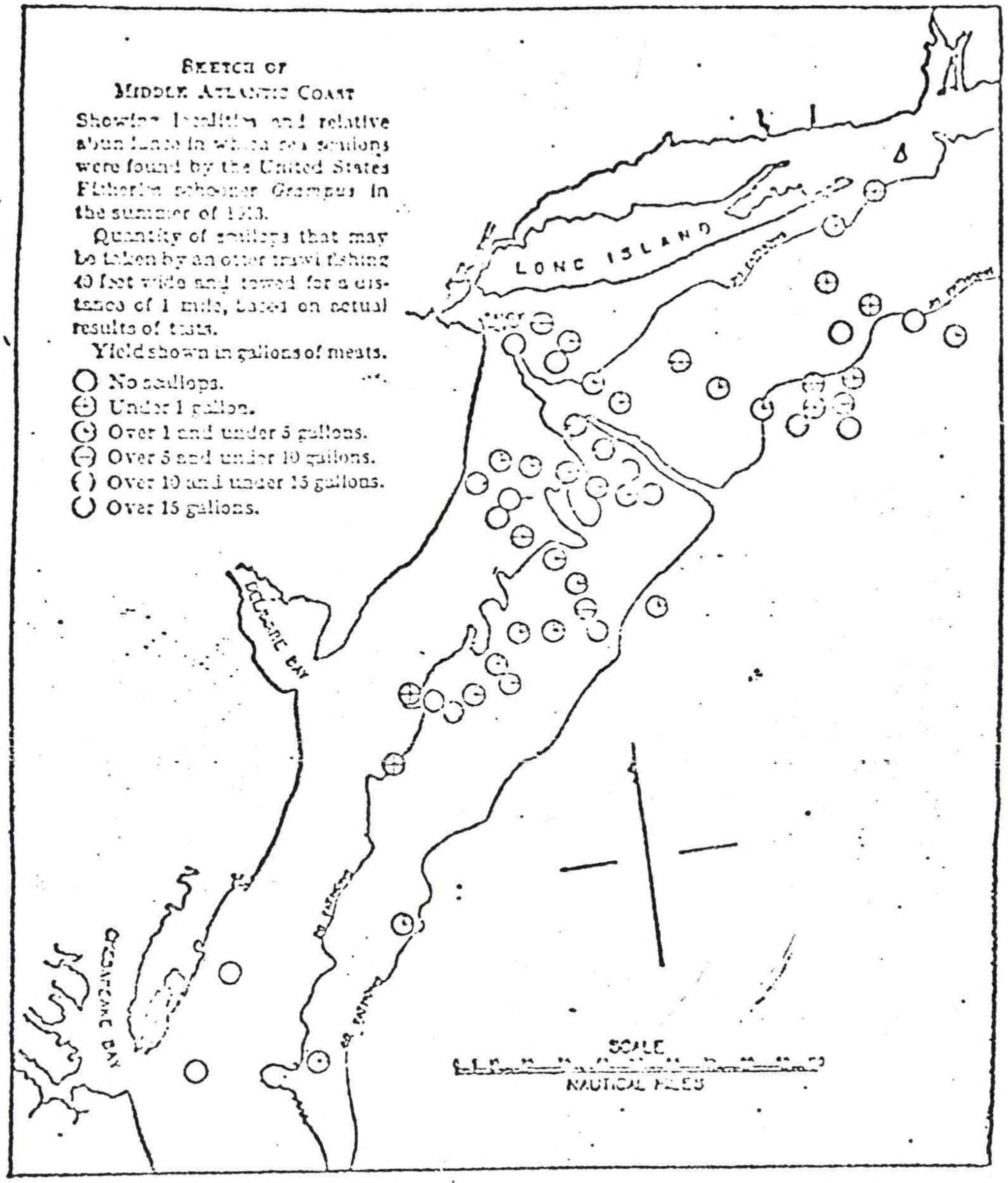


Fig. 5A. Chart of the Middle Atlantic Coast showing abundance and distribution of sea scallops. Yield shown in bushels of scallops taken in a ten-foot standard sea scallop dredge with three-inch rings and towed an average distance of 0.94 miles in 15 minutes.

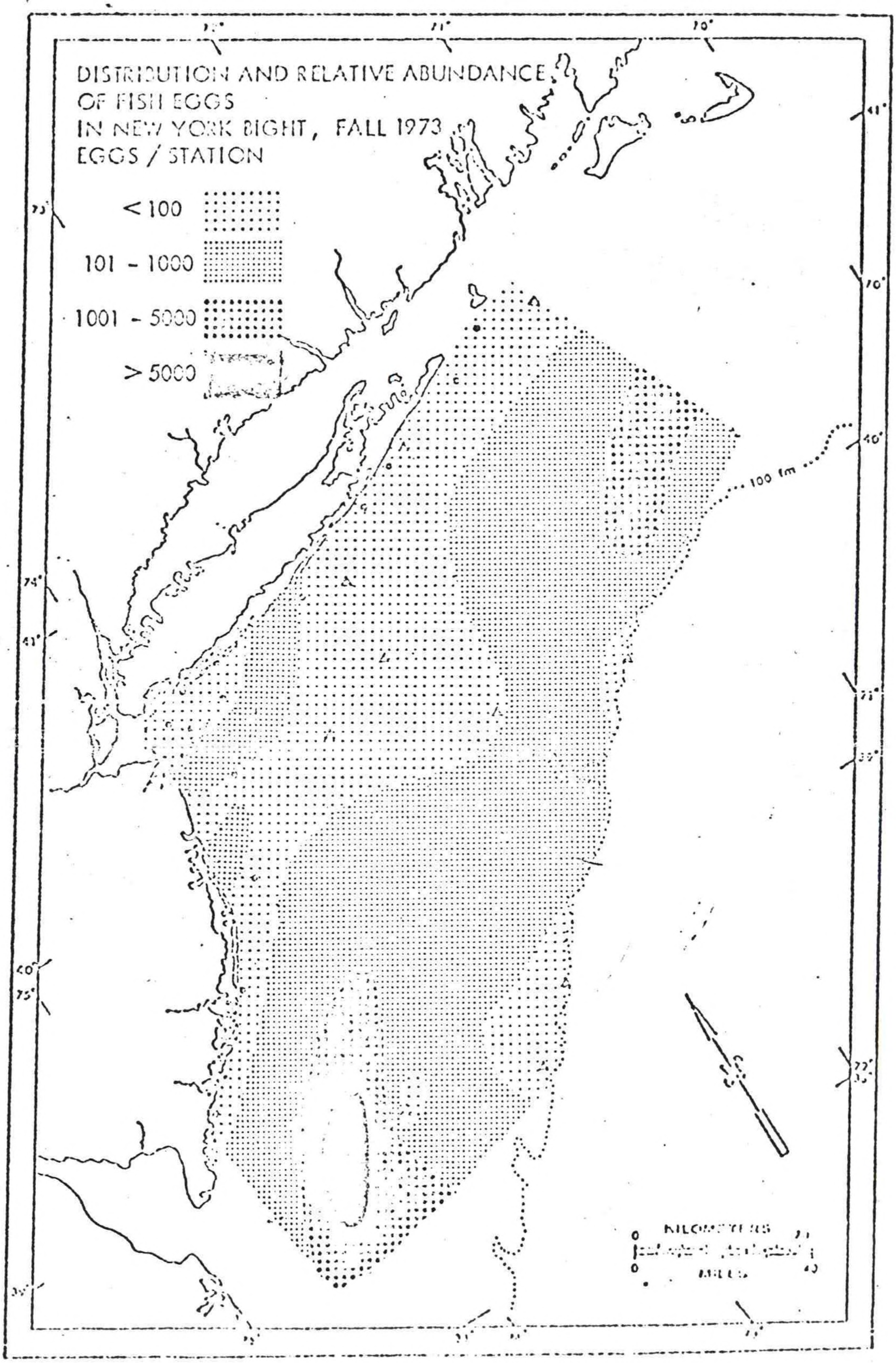
Fig. 29



6A

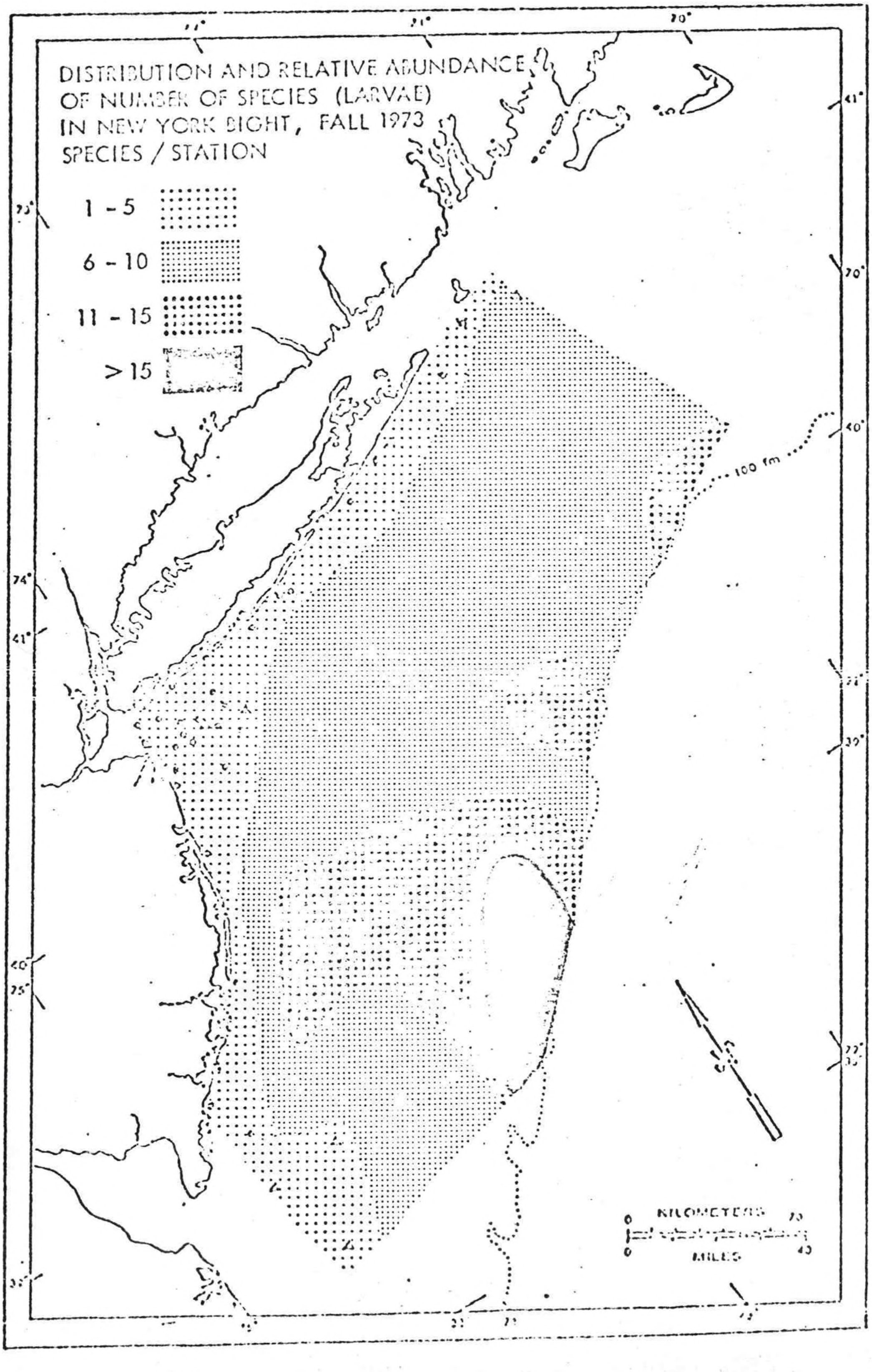
Fig. 2. Chart of the Middle Atlantic coast showing abundance and distribution of sea scallops during cruise of the Grampus in 1913.

Fig. 30



DISTRIBUTION AND RELATIVE ABUNDANCE OF FISH EGGS IN NEW YORK BIGHT, FALL 1973
EGGS / STATION
< 100
101 - 1000
1001 - 5000
> 5000
100 fm

Fig. 31



DISTRIBUTION AND RELATIVE ABUNDANCE
OF NUMBER OF SPECIES (LARVAE)
IN NEW YORK BIGHT, FALL 1973
SPECIES / STATION
1 - 5
6 - 10
11 - 15
> 15
100 fm
KILOMETERS
MILES

Fig. 32

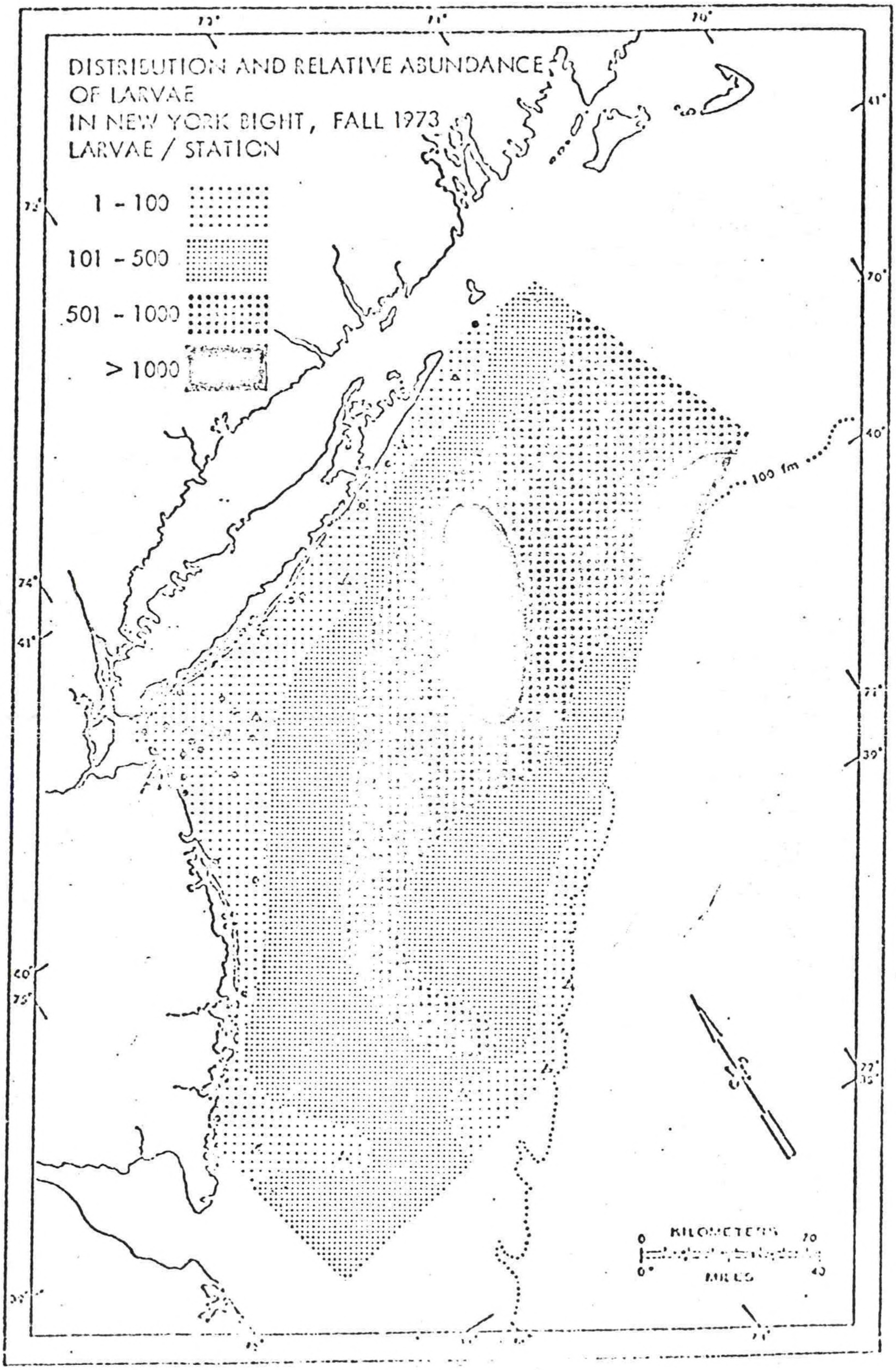

DISTRIBUTION AND RELATIVE ABUNDANCE
OF LARVAE
IN NEW YORK BIGHT, FALL 1973
LARVAE / STATION
1 - 100
101 - 500
501 - 1000
> 1000
100 fm
KILOMETERS
MILES

Fig. 33

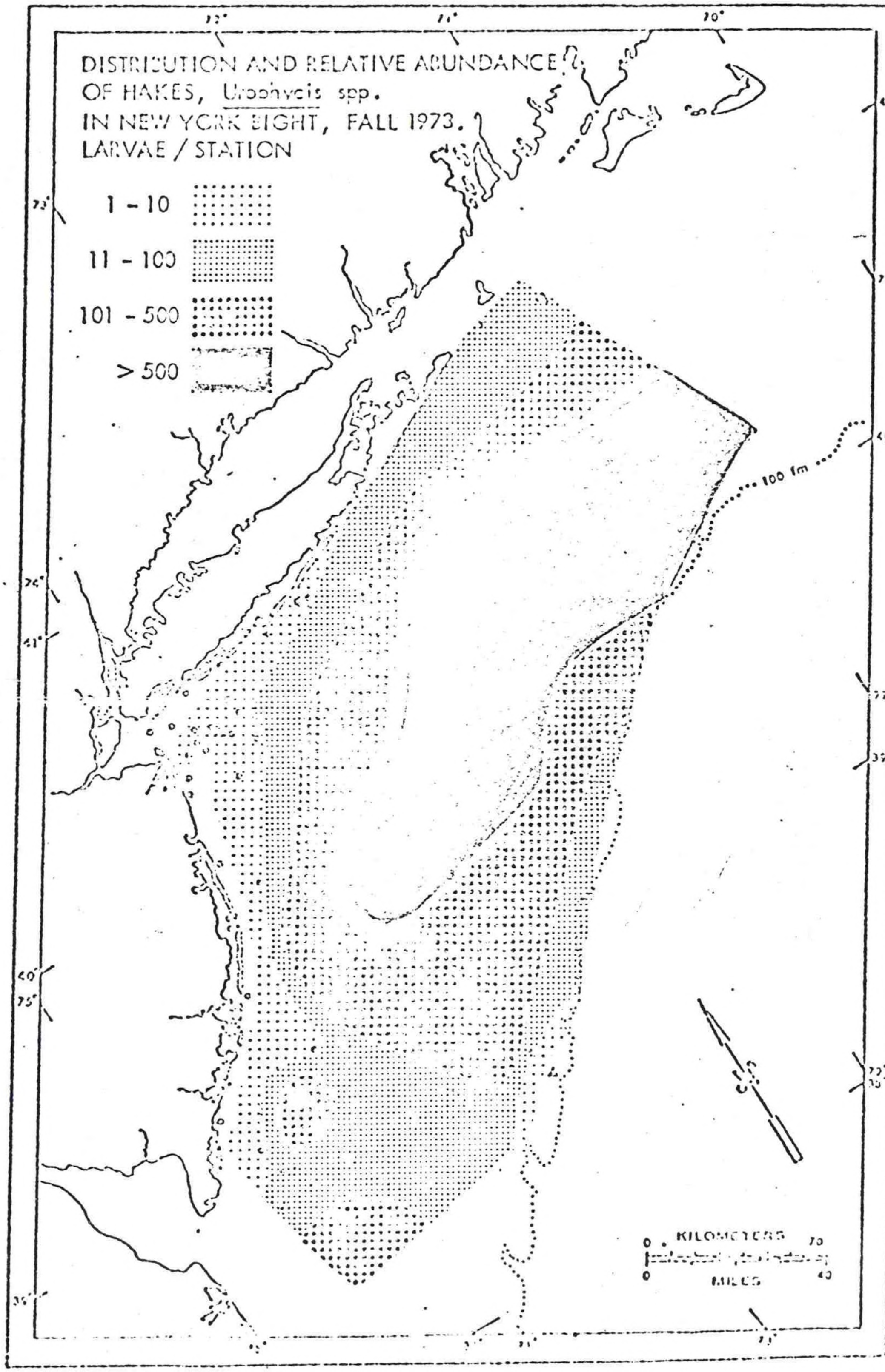
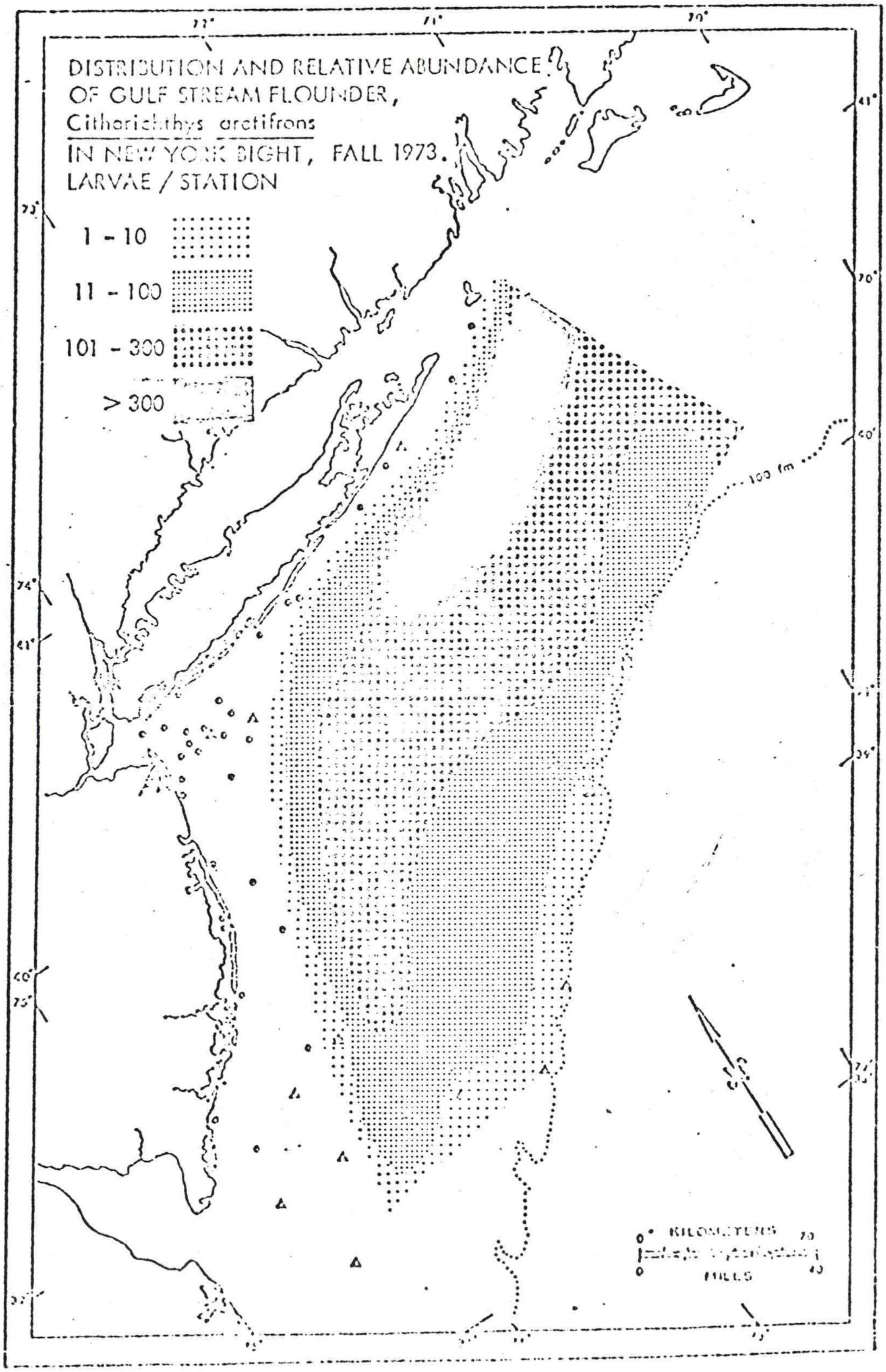

DISTRIBUTION AND RELATIVE ABUNDANCE
OF HAKES, Urophycis spp.
IN NEW YORK BIGHT, FALL 1973.
LARVAE / STATION
1 - 10
11 - 100
101 - 500
> 500
100 fm
KILOMETERS
MILES

Fig. 34



DISTRIBUTION AND RELATIVE ABUNDANCE
OF GULF STREAM FLOUNDER,
Citharichthys arctifrons
IN NEW YORK BIGHT, FALL 1973.
LARVAE / STATION
1 - 10
11 - 100
101 - 300
> 300
100 fm
KILOMETERS
MILES

STATEMENT BY NATIONAL MARINE FISHERIES SERVICE

BIOLOGICAL LABORATORY, OXFORD, MARYLAND

This statement is directed to the problem of contamination of marine life by ocean dumping of polluted matter. We feel that we are qualified to speak on this subject since for the past 8 years our research biologists have been studying the most abundant commercial marine mollusk on the Atlantic coast, the surf clam, Spisula solidissima. The fishery for this large bivalve produced 66.8 million pounds of edible meats in 1970, over four times as much as produced by the hard clam fishery, the nearest competitor. These clam meats are used in almost all of the canned and processed clam products consumed by the public. It has been demonstrated that changes in the environment will change the faunal composition of the area. Therefore, maintenance of a valuable fishery producing large quantities of essential protein from the aquatic environment is equally important in our view, as the public health concern with potential contaminants of the marine resource.

On May 19, 1970, the Food and Drug Administration issued a warning, essentially closing to the shellfishery an area of about 120 square miles around the sewage dump site at New York and around the sewage dump site just off of Delaware Bay, because these areas were found to be polluted and the shellfish contaminated. These closures represent a considerable loss to the surf clam fishery.

We have established from intensive ocean sampling the coastal distribution of the surf clam over most of the area from the tip of Long Island to Cape Hatteras (Fig. 1). Surf clams are most abundant from nearshore to depths of about 120 feet, although they can be found in depths of 200 feet or more and nearly 50 miles offshore. Highest clam densities are particularly significant along the entire New Jersey coast, where the center of the fishery is presently located.

We have routinely interviewed vessels working off the New Jersey coast to determine fishing intensity (Fig. 2). Data from the interviews at the Cape May-Wildwood port show that 7.6 percent of the vessels had fished at the Delaware dump site in 1968 and 4.4 percent in 1969. The percentage of the fleet found actually fishing at the dump site was used to estimate an annual catch and value of the site to the fishermen. In 1968, the estimates were 1.4 million pounds of meats worth $158 thousand; and the same data for 1969 were 1.0 million pounds worth $112 thousand. For both years, 2.4 million pounds of meats worth $270 thousand were taken, or nearly 3 percent of the total U. S. landings. The 1970 closure, therefore, represents a dramatic loss to the Cape May fishery.

Settlement of larval surf clams is fortuitous, depending on many factors such as seasonal temperature, current direction and intensity, light, sediment type, and length of survival. The clams fished for today settled 5 or more years ago and the abundance of any one year class is influenced by many environmental and biological factors. Therefore, abundance and distribution of clams is a constantly shifting mosaic pattern. For this reason, we chose five areas (Fig. 3), evenly spaced along the coast, to measure the potential loss to the resource from contaminant closures. The five areas are, about the same depth and equal in size to the closed area, and the estimates are based on a comprehensive survey of the surf clam resource in 1965. The five areas contained an average 207.7 million clams living in the bottom, and the most productive area (No. 1 of Fig. 3) contained 284.6 million clams. Thus, if an average area could be completely fished, it would provide about 64 million pounds of meats, or nearly the equivalent of the entire 1970 catch of 66.8 million pounds which was worth $7.7 million.

The Delaware closed area is considered to be somewhat marginal, at the present time, as a productive fishery area. But that occasional combination of ideal circumstances can occur at any location at any time, to provide a dense concentration of surf clams. Such a potential can never be realized if the environment is degraded and the clams polluted by ocean dumping.

We will not comment on the New York dump site, because the National Marine Fisheries Service laboratory at Sandy Hook, N. J., has recently completed a 2-year study of this area for the Corps of Engineers and their detailed report will be available shortly. However, we would like it to be known that quantities of juvenile surf clams have been found near the New York dump site and it might be assumed that surf clams would be abundant in the area, if they were not limited by the long-range physical and chemical damage of ocean dumping.

The impact of contaminants in the marine environment goes beyond the most visible problem of bacterial concentration and disease transmission. It is known that heavy metals (e.g., mercury, lead, cadmium, chromium, etc.), pesticides, petroleum byproducts, radionuclides, and other chemical materials can be concentrated in areas used for ocean dumping. We tend to picture the concentration of contaminants directly over the dump site center, but consideratio of ocean currents indicates that the materials may be widely dispersed, or even concentrated in pockets remote from the original site of disposal. Biological concentration may be equally critical in assessing the final impact of contaminants from ocean dumping. For example, plankton taking in low levels of contaminants near the dump site may be consumed by a predator and contaminants concentrated tens or hundreds of miles away. Although we know that many of these materials can be harmful to man, we have only meager information about the effects on the aquatic environment and living marine resources. Levels of contaminants that cause physiological changes in marine organisms, pathways of physical and biological concentration within the web of life, and tolerance to lengthy exposure to sublethal concentrations, are a few of the factors that need immediate evaluation.

The Oxford laboratory, in cooperation with other facilities of the National Marine Fisheries Service, is undertaking a detailed coastal study of selected dump sites in comparison with control, or uncontaminated, areas. By choosing similar target animals available at all sites, sampling on a regular periodic schedule, and subjecting the samples to a broad array of analytical procedures, both chemical and biological, we expect to begin to find answers to some of the problems that now face us.

Ocean dumping is undesirable—the ocean is no more a source of limitless dilution than the streams, rivers, lakes, and estuaries have been. Dumping further offshore only delays that point in time when a lasting solution must be found. Recent evidence indicates that materials deposited in deeper water are preserved for future generations, rather than undergoing normal decomposition and return of elements to the ecosystem. Even if ocean dumping is stopped immediately, we do not know the rate of natural recovery processes in dump sites, nor do we know the [illegible] methods to reclaim these areas by direct action.

We recommend that ocean dumping be terminated at the earliest possible moment. Until this can be accomplished, we recommend strict enforcement of the existing regulations for ocean dumping. If the ultimate problem is to be resolved, a concentrated technological effort must be made to find methods of recycling waste materials, and techniques must be developed to reclaim those areas of the Continental Shelf already despoiled by ocean dumping.

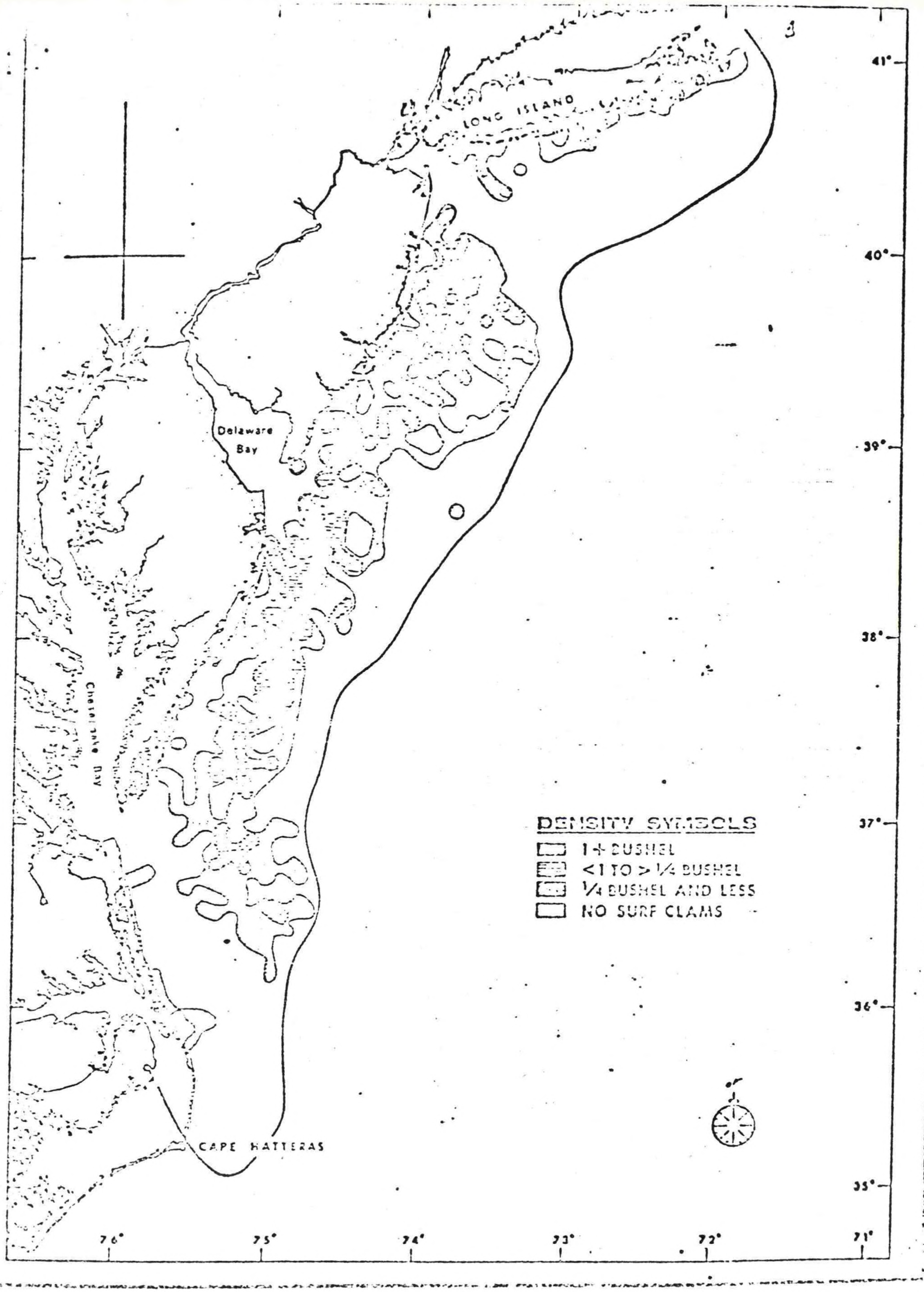


Figure 1. The distribution and density of surf clams along the middle Atlantic coast from the results of a [illegible] survey by NMFS.

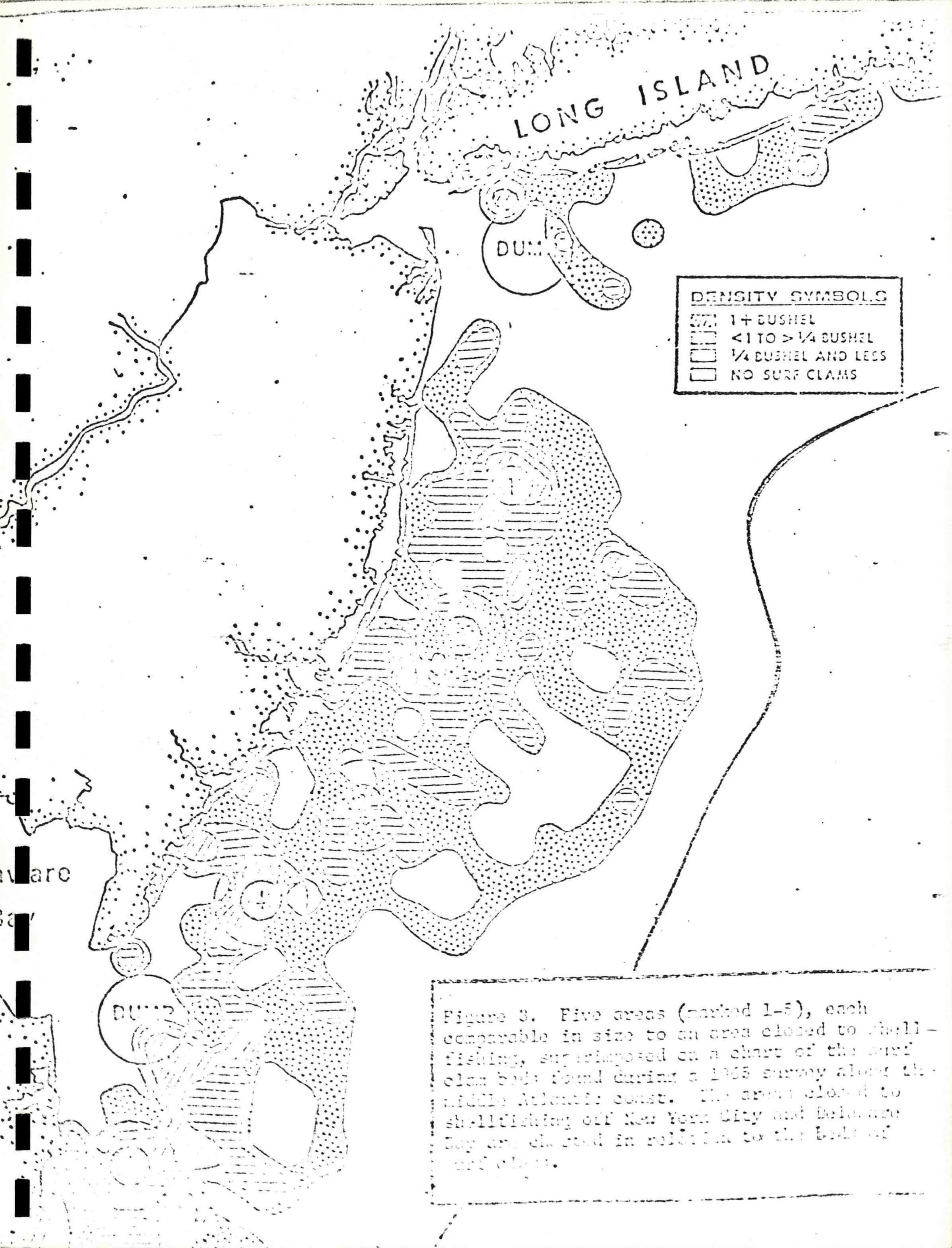


Figure 3. Five areas (marked 1-5), each comparable in size to an area closed to shell-fishing, superimposed on a chart of the surf clam beds found during a 1965 survey along the middle Atlantic coast. The areas closed to shellfishing off New York City and Delaware Bay are charted in relation to the beds of surf clams.