Ocean Resources: Living

A Staff Working Paper

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Note: This staff working paper is one of a series of Issue and Policy Alternative Papers presenting facts, analyses, and conceptual policy alternatives on coastal resources and coastal land and water uses. The purpose of this draft document is to stimulate discussion and comments that will assist preparation of the management program for the New Jersey coastal zone. This report was prepared in part with financial assistance from the National Oceanic and Atmospheric Administration under the federal Coastal Zone Management Act, P.L. 92-583. Comments, criticisms, additions, and suggestions are welcome and should be addressed to the New Jersey Office of Coastal Zone Management.

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I. Introduction

Living marine resources such as finfish and shellfish resources are important in maintaining the ecological balance of the marine environment and have provided recreation, employment and expenditures in local, regional, and state economies. Finfish and shellfish products are important for intrastate consumption and interstate export. Overfishing of certain desirable species and water quality degradation have contributed to an alarming rate of decline in fishery harvests and changes in the ecological balance. The management of living marine resources is the central issue.

Multiple pressures face the valuable living marine resources. These include the following:

1. Ocean dumping of domestic wastes (sewage sludge), contaminated dredge spoils, and industrial waste chemicals have reduced available shellfish harvest areas and may have stimulated the algal boom which resulted in the extensive fish kill during the summer of 1976.

2. Energy developments in offshore and nearshore waters from OCS oil and gas extraction, proposed floating nuclear power plants, and offshore oil ports pose potential adverse environmental impacts. Potential impacts of offshore energy facilities include accidental and chronic oil spills, release of radioactive substances and thermal discharges.

3. Intensive harvest of living marine resources by domestic and foreign fishing activities may have damaged the renewable quality of certain fish stocks.

This paper is intended to further debate on important living marine resource issues. The first sections briefly defines these issues in the coastal area and then presents alternative policies which could be past of the coastal zone management program in New Jersey.

Section III describes physical characteristics of New Jersey's marine environment which influence living marine resources. Each group of living marine resources are briefly described along with the utilization groups.

Section IV analyes the present and potential problems impacting living marine resources. Two appendices conclude the paper. The first presents tables and figures and the last lists reference sources.

I. Issue

Conservation, management, and proper utilization of living marine resources of New Jersey is a large question which has yet to be addressed through a cohesive state or regional policy. There is little question that certain marine fish stocks have been adversely affected through ocean and estuarine water quality degradation and overfishing by domestic and foreign commercial fishermen. Harvest of most important recreational finfish species are unregulated, while others only have minimal regulation. Proposed energy developments in New Jersey's coastal zone have the potential to adversly impact living marine resources.

II. Policy Alternatives

Marine fishing and shellfishing activities are valuable to recreational and commercial fishermen and local coastal communities, but only certain species and fishing methods are presently regulated by the State.

State laws mostly cover the commercial industry, while few regulations apply to recreational fishermen. Harvest of such finfish species as striped bass, summer flounder, shortnose and Atlantic sturgeon, American shad, and Atlantic menhaden is regulated either through licensing of commercial netters, size or daily limits, or restricted seasons. Sport fishing harvests of most species, however, exceed commercial harvests. The ocean shellfishing controls which do exist were enacted only after the industry was threatened with collapse.

The State could address the viability of the marine ecology and of its recreational and commercial fishing industries with the following policies:

1. Cooperate fully with NOAA/National Marine Fisheries Service in establishing Regional Fishery Management Councils, under the Fishery Conservation and Management Act of 1976. These regional regional councils aim to establish management techniques for migratory fish species which cannot be adequately managed by one state alone.

2. Establish an intrastate marine fisheries conservation program. This might best be accomplished by sponsoring a regular series of meetings on marine related problems between researchers and state personnel. Up to date information on New Jersey's marine environmental conditions could be exchanged in order to formulate state management policies.

3. Expand state management of marine fishes to cover all important migratory species. Cooperation and coordination with all Atlantic Coastal states is essential for the success of any marine fisheries management program. The following information should be collected for each species as part of a management program.

a. Total distribution of the species
b. Racial composition (identity of populations)
c. Spawning grounds and habits
d. Migratory routes
e. Growth rate and longevity
f. Food habits
g. Predators and competitors
h. Behavioral patterns
i. Abundance
j. Fishing intensity
k. Size and age composition of total catch
l. Measures of natural and fishing mortality

Conservation laws covering migratory species in one state along will have little positive effect unless established in consort with other Atlantic coastal states.

4. Foster communication between oil companies developing OCS oil and gas reserves and state commercial fishing industries. This would include charter and party boat operators as well as commercial netters and shellfish fishermen. This communication could aid siting and planning decisions for onshore bases for OCS exploration and development.

III. Physical Characteristics and Natural Functions

A. General Oceanographic Characteristics of New Jersey's Marine Environment.

The Atlantic Ocean bordering the state of New Jersey is known as the New York Bight. The Bight extends seaward over 15,000 square miles (39,000 sq. km.) south from Long Island to Cape May, New Jersey, out to the edge of the continental shelf about 100 miles offshore. The boundaries of this region are illustrated in Figure 1. Water depths over the relatively smooth shelf range from 6 to 200 meters (20 to 600 feet). Water depths plunge to 6,000 feet into the deep ocean basin known as the abyssal plain, eastward of the continental shelf break.

The bathymetry of the continental shelf is rather uniform, although a variety of geomorphologic features, such as relict drainage channels, scarps and terraces, systems of sand ridges and smaller bedforms exist. Virtually the entire shelf is covered by a veneer of sand, up to several meters thick. The frequent storm tracks coupled with the predominant southerly drift of water has induced the formation of submarine sand ridges separated by clay lined depression, called swales. These bathymetric features are important congregation points for migratory marine fishes and shellfish habitat.

The shelf surface also displays a series of scarps and terraces which were formed in response to erosion and deposition during periods of a lower constant sea level. These relict features suggest there has been little deposition of sediments on the shelf since the last sea level rise (EPA, 1976).

During colder climatic periods, vast amounts of water were tied up in huge glacial ice sheets which covered most continental land masses in the northern hemisphere, with a corresponding lowering of sea level. The continental shelf was then exposed dry land. Continued discharges of the major rivers; Hudson, Delaware, Susquehanna, during warmer climatic periods gouged channels across the shelf and formed the submarine canyons along the shelf break. Many of these shelf channels have since been filled with sediments from upland erosion and deposition by an advancing and retreating ocean, and near-shore currents. Today, the submarine canyons and channels are important migratory routes for pelagic marine fishes and excellent lobster habitat.

Submarine rock outcroppings are limited to one area of the New Jersey coastal sea. This area is known as the Shrewsbury Rocks and is located off Monmouth Beach. The majority of this more extensive reef is covered with sediments. A more detailed description of the geology of the continental shelf is presented in the Environmental Issue and Policy Alternative paper entitled, "Ocean Resources: Mineral".

B. Circulation Pattern of New Jersey's Marine Waters

Circulation of the waters of the New York Bight can be generally described as a counter-clockwise gyre (circular motion) although it is much more complex. The predominant surface drift is westward along Long Island, turning southward paralleling the New Jersey coastline. This circulation pattern is strongly influenced by the predominant influx of freshwater, northwesterly winds, by mixing of the shelf water with more saline oceanic waters near the shelf edge, and the northeasterly Gulf Stream Current. Predominant surface currents and inferred bottom drift are illustrated in Figures 2 and 3. The waters of the New York Bight are an extremely fertile part of the world's oceans partially as a result of the circulation pattern.

The shelf water mass tends to exhibit a two-layer profile. In winter, Bight waters are characterized by well-mixed conditions, due to low volume river runoff and wind driven vertical mixing. Coldest water temperatures occur near shore and increase steadily offshore, as a result of Gulf Stream eddies mixing along the continental slope. Consequently, slope waters are important wintering areas for coastal fishes. Many species of estuarine dependent and marine fishes exhibit an annual inshore-offshore migration pattern. Finfish which winter in the warmer shelf waters include: Atlantic, mackerel, Atlantic menhaden, black seabass, bluefish, butterfish, red hake, scup, summer flounder (fluke), and silver hake (whiting) (DEP, 1975B).

During the warmer months, shelf waters become progressively more stratified, due to greater river runoff and calm weather conditions. An enormous mass of cool bottom water extends from Montauk, Long Island to just south of Delaware Bay. This is believed to be left over winter water, which had been chilled during the preceeding winter and remained cold even after the spring warming of the surface waters. A thermocline, a layer of rapid changing temperature, sharply separates the warmer surface water from cooler bottom water. This cold water bubble, known as the Middle Atlantic cold cell, lays near the bottom of the shelf, below the thermocline at depths of 15 to 30 meters. The Middle Atlantic Cold Cell is shaped roughly similar to a triangle, with the vertex 6 to 10 miles off Asbury Park; the northern point is about 20 miles off Montauk, and the south point is about 45 miles off Delaware Bay (Freeman and Walford, 1974). The ocean surface water temperature may reach 70-75^{o}F, whereas deeper waters below the thermocline, water temperatures remain about 10^{o}F cooler.

Finfish diversity is greatly enhanced by the presence of the Middle Atlantic Cold Cell. Boreal or cold-water species are permanent residents in this region rather than casual visitors, and may belong to southern races of their respective species (Freeman and Walford, 1974). Boreal fishes include: cod, redfish (ocean perch), and pollock. In addition to these demersal species, tropical oceanic (pelagic) fishes such as the tunas (bluefin, yellowfin, bigeye, skipjack,

and albacore), bonito, mackerel scad, white and blue marlin, mako shark, and dolphin tend to concentrate just above the thermocline where they are able to find an abundance of food, particularly along the slopes of the submarine canyons (Freeman and Walford, 1974).

The New York Bight lies adjacent to the heavily urbanized/industrialized New York City/North New Jersey and Philadelphia/Wilmington/Camden metropolitan areas and consequently receives the largest volume of ocean dumping of sewage sludge, dredge spoils and industrial chemical wastes in the nation. Additional massive pollution loads are received in the Bight through urban runoff, gaged runoff, coastal municipalities sewage outfalls, and atmospheric fallout. The various sources of water pollution in the Bight are illustrated in Figure 4. Sinderman (1975) states that as a rule, the degree of estuarine and coastal pollution is directly proportional to human population density in the adjacent land areas.

Even though extensive areas of coastal and estuarine waters of New Jersey are severely contaminated at the present time, the New York Bight continues to be an extremely valuable finfish, shellfish, and marine wildlife resource area.

C. Fisheries Resources

The Atlantic Ocean bordering the State of New Jersey is one of the richest fish, shellfish, and wildlife resource areas of the world. This great fertility is due in part to the extensive width of the continental shelf, discharge of nutrient rich rivers, extensive shallow tidal estuarine habitat, and ocean water circulation pattern and consequent temperature regime. The physical characteristics and natural processes has long ago established the New York Bight as a major domestic fishing and more recently a foreign fishing area.

Marine fishery resources of New Jersey are harvested by two distinctly different groups of fishermen: sport and commercial. Some fish species are harvested by both groups, while others are almost exclusively sport species or commerical species.

1. Recreational Marine Fisheries

Marine sport fishing is a major industry of the coastal areas of the Mid-Atlantic States, providing household food, vast recreational opportunities, and expenditures into local economies. The 1970 Salt-Water Angling Survey (Deuel, 1973) estimated that 3.4 million anglers fished from Maine to Cape Hatteras, in 1970. A more recent survey by Ridgely and Deuel (1975) covering the same area estimated there were 10.8 million marine anglers during 1973-74. This large increase reflects both a real increase in marine fishing participants and an expanded sampling method.

Over 2.7 million people annually participate in marine sport fishing and shellfishing in New Jersey (Ridgely and Deuel, 1975). This represents the highest number of participants in any state sampled, from Maine to Maryland. Of that total, 1.6 million people reside in New Jersey, with the remaining number mostly coming from Pennsylvania and New York (792,000 and 300,000) respectively (Ridgely and Deuel, 1975). The New Jersey Bureau of Fisheries Management (Pyle, personal communication) estimates marine fishing provides 83 million/man days of recreation in New Jersey with approximately $10.42 expenditures/day yielding a total of $86.5 million to the state economy. Of this total, fin fishing yielded approximately $50 million and shellfishing $36.5 million (which is predominantly an estuarine activity). Important sport fishing species and harvest rates are summarized in Tables 1 and 2.

Estimated number of participants and man/days of recreation provided to New Jersey residents by the marine environment.

	Participants	Man/days recreation
Ocean fishing	493,000	17,000,000
Estuarine fishing	483,000	20,000,000
Surf fishing	231,000	11,000,000
Crabbing	645,000	25,000,000
Clamming	16,000	10,000,000
	1,868,000 Total	83,000,000 Total

Source: Figley (1976)

2. Commercial Marine Fisheries

Saila and Pratt (1973) and Gusey (1976) report there are approximately 300 species of marine fishes are known to occur in the waters of the Mid-Atlantic Bight, with one half of that number consistently found from year-to-year. About 80 species of finfish and shellfish are listed in commercial fisheries statistics compiled the National Oceanic and Atmospheric Administration (NOAA). Only 30 species of marine and estuarine finfishes and shellfish are of significant commercial value to New Jersey. These are listed in Table 3.

Commercial fishermen operating out of New Jersey, New York, and Delaware, during 1974, landed 210 million pounds of fish and shellfish, valued at $43 million (Gusey, 1976). These figures include estuarine species. The total harvest from the Mid-Atlantic Bight (Cape Cod to Cape Hatteras including George's Bank) amounted to 1.8 billion pounds landed by United States commercial fishermen. An additional 200 million pounds of finfish were harvested by foreign fleets (Gusey, 1976). The total harvest for the Mid-Atlantic Bight is estimated in excess of 2.1 billion pounds of fish and shellfish. Nearly 9,000 men and more than 5,000 vessels and boats participate in commercial fisheries in the Mid-Atlantic Bight.

New Jersey ranked seventh nationally in commercial fisheries landings by weight, totaling over 209 million pounds, and valued at $18.4 million. 1956 was the record year for commercial fishing in New Jersey, with more than one half a billion pounds (540 million) landed. The bulk of this record catch was Atlantic menhaden, an industrial fish which processed into high protein animals feed and oil which is used in margarine and paints.

As Table 3 indicates, the total weight of marine fish and shellfish landed in New Jersey was 209.7 and 166.9 million pounds for the years 1973 and 1974, respectively. These annual harvests yielded $18.4 million and $16.9 million dock-side values to New Jersey commercial fishermen (NOAA, 1975). Marine fisheries harvests for the years 1973 and 1974, contributed approximately $184 million and $166.9 million to the state economy, which represents approximately .3% of the 1974 gross state product (Silver, personal communication), based on a standard resource multiplier developed by University of Rhode Island. In New Jersey alone, there were 2,693 full-time and part-time fishermen during 1973 (NOAA, 1974). An additional 2,066 people were employed in 102 processing and wholesale establishments during 1972 (NOAA, 1974) in New Jersey.

Secondary industries dependent on marine resources include fishing tackle stores, marinas and boat supply houses, seafood resturants and retail seafood outlets. Statistics for the entire state of number of establishments, sales, payroll, and number of employees, for retail seafood outlets, sporting good stores, and boat dealers are summarized in Table 4.

Table 5 ranks by weight landed, most important marine and estuarine commercial finfish species in New Jersey during 1973 and 1974. It can be seen from this table that relative ranks do not vary greatly from year to year. Also, although the menhaden harvest was in excess of 100 million pounds, the value of catch by weight was worth about $.02/lb., whereas fluke yielded nearly $.32/lb., the highest for finfishes. Table 6 summarizes landing values and rank of marine and estuarine shellfish. Surf clams harvests in 1974 totaled 22 million pounds valued at nearly $3 million. Lobster were the second most valuable shellfish, at nearly $2 million. Hard clams and oysters were New Jersey's most valuable estuarine shellfish each harvest totaling in excess of $1 million. Although crabs and squid harvests weights exceeded other shellfish species, their landing values were lower.

Values of finfish and shellfish ranked by price/pound are summarized in Table 7. Lobsters were most valuable fishery resource, followed closely by other shellfish. Fluke (summer flounder) was most valuable marine fish ranked by price/lb. Menhaden was lowest price/lb. finfish, reflexing the industrial uses of this species.

3. Potential Fisheries Resources

Not all presently important sport or commercial finfish or shellfish have a long history of intensive fishing. Surf clams, haddock, and whiting were formerly only of marginal importance, with little market acceptance. Other species not harvested today have moderate to high potential value. This would include such shellfish as the ocean quahog, northern shrimp, red and rock crabs. There are vast untapped standing stocks of ocean quahogs offshore New Jersey, but there is little interest outside of use as fish bait, consequently only $109,387 were harvested in 1945 (Wigley and Emery, 1968). Surf clam gear might be used to harvest this species, although they are usually found in deeper waters. The north shrimp and red crabs and rock crabs could have a higher value if properly marketed. Red crabs are found in deep continental slope waters. This species is somewhat similar to the Alaskan king crab, although smaller.

Finfish species of presently low commercial importance, which have greater potential value are: Altantic herring, spiny dogfish, and squid. These species have little esteem as food fish in the U.S. Sea herring, Atlantic mackerel, and squid have been intensely harvested by foreign trawling fleets in the Mid-Atlantic Bight in recent years. These fish stocks could become an important export product, if direct foreign harvest were prohibited within the 200 mile limit.

In the past year, there has been a tremendous increase in angling for sharks. People who a short time ago would never dream of wasting their time fishing for them, are now sailing offshore almost daily and spending large sums of money to catch one (Freeman, 1976). In a matter of a few months after the accidental rod and reel catch of tilefish in 1967 off New Jersey, some twenty large party, charter, and private boats began making the necessary 200 mile round trip to the edge of the continental shelf. Fifty years ago, giant bluefin tuna, weighing 300-1,000 pounds, were looked upon as a nuisance. These large fish, along with smaller fish called "footballs", are now a bases for an important fishery (Freeman), 1976). Regulations allocating catch of bluefin have recently been enacted.

Mariculture or aquaculture is another potential marine/ estuarine industry in New Jersey. This state has extensive estuarine areas which would be suitable for expansion of this industry. Oysters are presently cultivated in Delaware Bay, and formerly in Raritan Bay before pollution extinguished the industry there. Other species which have greater potential and good market value are: hard clams and blue-claw crabs. These estuarine species are generally more tolerent of adverse environmental conditions and have a rapid growth rate. Much more research is needed on the life cycles and environmental requirements of all potential mariculture species before this industry could expand successfully in New Jersey.

D. Marine Wildlife Resources

There are three main groups of marine wildlife found in New Jersey's nearshore and offshore oceanic waters; marine birds, marine mammals, and marine reptiles. The first group is by far the most numerous.

1. Marine Birds

Marine birds whether pelagic (open ocean inhabitants usually more than 5 miles offshore) or littoral (nearshore inhabitants not usually greater than 5 miles offshore) are frequently overlooked when considering living marine resources. Pelagic bird species which spend virtually their entire lives over the open ocean, except for onshore breeding, are usually out of sight of land and human inhabitants. Littoral species, such as gulls and terns, which inhabit beaches and inlets, have much wider contact with humans. Table 8 summarizes species, habitat frequency, and general abundance of marine birds which occur in the Mid-Atlantic Bight.

As a group, their cumulative impact on the marine environment must be substantial. Very little documentation is available on population numbers, environmental requirements, and ecological relationships. Three hundred and eighty species of birds have been observed within the Mid-Atlantic Bight, which is the area lying between Cape Cod and Cape Hatteras. This includes estuarine and upland species as well (Heppren and Gould, 1973 and Gusey, 1976). Approximately 80% of this number occur regularly as year-around residents, seasonal residents, or as regular migrants.

Within the New York Bight approximately 30 pelagic birds species and 41 littoral bird species are known to occur (Heppner and Gould, 1973). Predominantly estuarine and wetland bird species, are discussed in a separate paper on the estuarine environment.

The petroleum industry estimates there are 75 avian species which may be effected by petroleum activities in the Mid-Atlantic region (Gusey, 1976). These include pelagic, littoral, and estuarine birds, and form the bulk of the total avial population in nearshore and offshore waters.

2. Marine Mammals

Marine mammals (seals, whales, and porpoises) are fairly common in the New York Bight. Pilson and Goldstein (1973) report that 36 species of marine mammal occurred within the New York Bight in the past.

The right whale, Eubalaena glacialis, so called because it was the right one to hunt being slow and easy to kill, was once plentiful in the Mid-Atlantic coastal seas in former days. This species supported the whaling ports of Long Island during the early 1800's until populations were extinguished and interests shifted to the sperm whale. Today, marine mammals are of no economic importance in the United States, since enactment of the federal Marine Mammals Protection Act of 1972, 16 U.S.C.

This act established a moratorium on the taking of marine mammals and a ban on the importation of marine mammal products. Gusey (1976) states that with few exceptions, information about the number of any species of marine mammal which may be found within the Mid-Atlantic Bight is unknown. What information is available is based on solely upon casual sightings or strandings. Hence, for many animals, one can not definitely say that the species in question occurs with any regularity today within the Mid-Atlantic Bight (Gusey, 1976). Marine mammals have been designated by this Department as endangered, threatened, or peripheral. Table 9 lists marine mammals which have occured or may occur in the Mid-Atlantic Bight.

3. Marine Reptiles

Sea turtles are the only group of marine reptiles found in New Jersey's marine environment. While not common in near or offshore waters, some do appear each year, probably traveling north with the Gulf Stream. These large animals have been taken for food and for their shells. They are also preyed upon by sharks, and, as they must come ashore to deposit eggs on the beach, the eggs are taken for food and young turtles are preyed upon by gulls and fish. Sea turtles are not known to breed in New Jersey.

Five species of sea turtles are known to occur in New Jersey's coastal waters, these are listed below. Each species has been designated by the Department as endangered or peripheral, and therefore deserve special protection.

Marine Reptiles of New Jersey	Status*
Atlantic green turtle, Chelonia mydas	E
Atlantic hawkbill, Eretmochelys imbricata	E
Atlantic ridley, Lepidochelys kempi	E
Atlantic leatherback, Dermochelys coriocea	E
Atlantic loggerhead, Caretta caretta	P

*Endangered, Threatened, Peripheral and Undetermined Wildlife Species in New Jersey - Official List. New Jersey Register Vol. 7 (1975).

IV. Analysis

A. Commercial and Recreational Fishing

The commercial marine fishing industry in New Jersey is in a period of decline, while recreational marine fishing has increased significantly. The 1973 commercial harvest totaled 209.7 million pounds. This total does not represent the historic peak in commercial fishing harvests or activities, but rather points on a trend of diminishing values of this industry. Figure 5 depicts recent trends in finfish and shellfish landings for New Jersey, New York and Delaware. It is obvious that commercial fisheries have lost economic importance in these states. Concurrent with diminishing landing wieghts and values of fish and shellfish, has been a loss in employment and diversity of local economies. During 1951, there were 13,382 commerical fishermen in these three states. This number has declined to 8,611 by 1973 (Gusey, 1976).

Edwards (1975) estimates that, for the period 1963-65, about 22% of the available fin fishery resources of the Mid-Atlantic region were being harvested. In the period 1964-67 the standing crops of fish decreased about 40%, indicating that the ecosystem was probably being harvested near the maximum rate. Grosslein (1975) draws attention to the heavy foreign fishing in the 1960's, which may have caused significant declines in the biomass (standing crop) of most species of finfish in the continental shelf waters from Hudson Canyon north to Nova Scotia. He estimates that the standing crop of commercial finfish and squid has declined well over 50% since 1967. Species most severely affected include:

sea herring, flounders, hakes, and haddock. Grosslein postulates that these declines are a result of heavy foreign fishing, especially by unselective bottom trawls in winter and spring, when may species are concentrated offshore on the Mid-Atlantic shelf. Gusey (1976) states that foreign competition and exploitation has had a profound effect upon the North Atlantic fisheries, especially those of New England states. He further draws attention to the inequity in fishing vessels. The best of the U.S. trawler fleets consists of vessels under 150 feet in length with a crew of 17 or less, while Soviet factory ships are 270 feet with crews of 100 men. It should be noted that a significant portion of the U.S. catch are nearshore and estuarine species of finfish and shellfish, while foreign landings are almost exclusively finfish on the continental shelf.

It is popular today to discuss fishing resources in terms of commercial or recreational species. But, with rare exception, no species of finfish is harvested wholly by one group or the other. It is true, however, that certain species or groups are predominantly taken by one group of fishermen. While both commercial fishermen and anglers strive to catch fish, commercial men need to catch substantial quantities in order to stay in business. As a result, commercial operators have concentrated on pelagic fishes which live mainly in the upper levels of the sea and which form dense schools, such as: menhaden, tunas, mackerels, and herring. The demersal species, which congregate close to the bottom, include: flounders, Atlantic cod, haddock and hakes (Freeman, 1976), are also taken in great numbers.

Recreational fishermen tend to catch a greater variety of species. They usually concentrate on predatory species such as: bluefish, striped bass, Atlantic mackerel, weakfish, fluke, billfish and tunas. Figure 6 depicts finfish harvest of the Atlantic coast yielding 10 million pounds or more to recreational and commercial fishermen in 1960 and 1970.

All fishing activities are dependent on the same resource base. Forage fishes (herbivorous or omnivorous species which are usually preyed upon by larger species) such as Atlantic menhaden serve to illustrate this point. This species is the largest commercial harvest is the principal food of bluefish, which is the largest recreational harvest. In addition, menhaden are used as cut bait or ground into chum by sport fishermen. Menhaden, as are other forage species (alewife, anchovies, killfish, shinners, and a host of invertebrates) are estuarine dependent.

All but a very few of important marine finfishes are migratory. Their movements can be correlated to a considerable degree with water temperature, or other factors such as: location and availability of food or suitable spawning habitat. Migrations are usually north-south along the coast or inshore-offshore. These migratory patterns present a considerable problem for fisheries management.

In order for any marine fisheries management program to succeed, it is essential that all government agencies within

whose jurisdiction a species passes, collaborate in designing an effective system of regulatory measures. Conservation laws covering a migratory species in one state alone will have little effect, unless developed in consort with all other Atlantic coastal states. Regulation must cover the range of harvesting activities, and not be directed towards only one group.

As part of any management program the following information is essential for each species to be managed:

1. Total distribution of the species
2. Racial composition (identity of populations)
3. Spawning grounds and habits
4. Migratory routes
5. Growth rates and longevity
6. Feeding habits
7. Predators and competitors
8. Behavior patterns
9. Abundance
10. Fishing intensity
11. Size and age composition of total catch
12. Measures of natural and fishing mortality

Much of this information for the majority of marine fishes is not well known. Figure 7 illustrates the extent of present knowledge of some important species. This chart was prepared in cooperation with Mr. Bruce Freeman, NOAA/NMFS and Dr. Lionel Walford, N.J. Marine Science Consortium.

B. Energy Developments

The potential impacts of energy developments and marine mineral extractions on marine fish and shellfish has been elaborated in Issue and Policy Alternative Paper, Ocean Resources: Mineral. The potential adverse impacts on marine wildlife, especially marine birds could be enormous. Oil spills are the greatest threat to marine birds. Mortalities have been high in these species in Santa Barbara and the British Isles, resulting form massive oil spills. Very little quantitative information is presently available on pelagic birds inhabiting offshore New Jersey waters, on the effects on hydrocarbon contamination of marine food chains and sub-lethal effects of oil on marine organisms.

C. Water Quality Degradation

Ocean water quality degradation has eliminated 85,650 acres of productive nearshore ocean waters from harvest by surf clam fishermen in New Jersey. Areas of heavy metal and organic contamination are shown in Figure 8. Pollution has been documented to cause fin rot and shell erosion in marine organisms in New Jersey. The reader should consult Issue and Policy Alternative Paper, Estuarine and Wetland Resources for a more detailed discussion of marine and estuarine diseases. Quantification of loss of finfish, shellfish, wildlife resources though water born disease is not presently available.

The recent massive fish and shellfish kill in New Jersey's offshore waters during the summer of 1976 points out the magnitude of this problem. This most recent kill affected an area over 3,000 square miles, as shown in Figure 9. Sport divers first became aware of an environmental disturbance in the vicinity of wrecks off Long Branch during July 4 week-end (Yananton, personal communication). Finfish and shellfish were observed behaving abnormally. Later observations at same sites revealed many dead and decaying demersal marine species. Scuba divers reported the fish kill to move south and east, away from the sewage dump site. Commercial trawlers reported catching dead finfish, up to 75% of their catch. Catches of American lobsters dropped by 30%, with some fishermen returning to port with nothing. Surf clam mortalities may have exceeded 50% in the affected area, thus affecting reproductive potential of depleated stocks for years to come.

The exact cause of this kill has been determined to have resulted from an explosive algal bloom of the dino-flagellate, Ceratium tripos, in the thermocline. Massive quantities of dead algal material rained down onto the ocean bottom, coating it with a slimy layer. Bacteria decomposition of alage reduced dissolved oxygen levels on the ocean resulting in anoxic waters. After all dissolved oxygen was removed, bacteria switched to anaerobic metabolism which releases hydrogen sulfide which is highly toxic to marine organisms. As a result, many species of benthic shellfish (surf clams and lobsters) and demersal fish (hake, ocean pout, fluke,

and sea bass) died from suffocation (Paulson, 1976). The oxygen levels in surface water were unaffected. Surface finfish species such as bluefish, striped bass and menhaden exhibited little mortality. The exact causes stimulating this bloom have not been determined. Ocean disposal of sewage sludge and dredge spoils have been implicated as contributing factors, along with calm weather conditions, successive sunny days, and stratification of the water column (Paulson, 1976).

This is not the first marine fish kill which has occurred offshore New Jersey. Previous fish kills have occurred during 1968, 1973 and 1974. The extent of these kills was not documented. The economic cost of this most recent fish kill has been estimated at $92.5 million to the fishing industry in New Jersey. This total is broken down below:

Estimated Cost of the 1976 Fish Kill.

$ 25,000,000	Loss in sport fishing revenues
1,445,000	Loss in commercial finfish stocks (over 4 year period)
2,070,000	Loss in commercial lobster catch (over 4 year period)
65,000,000	Loss in commercial sea clam stocks (over 7 year period)*
171,300,000	Loss in associated economy due to reduced commercial landings.
$264,815,000	Total

*Based upon estimate that only 70% of last stocks are harvestable.

Source: New Jersey Division of Fish, Game and Shellfisheries

Appendix A

Tables and Figures

Table 1. - Important Marine Sport Fishing Species Taken in New Jersey.
(Estuarine dependent sport species are listed in Table 2)

Common Name	Ranks by Weight	Number Caught*	Estimated Weight (pounds)*
Black Sea Bass	4	3,844,000	6,710,000
Bonitos	12	54,000	282,000
Cod	13	154,000	230,000
Red Drum	14	97,000	83,000
Red Hake	10	497,000	904,000
Silver Hake	9	912,000	1,436,000
Kingfish	6	1,911,000	2,402,000
Atlantic Mackerel	1	18,441,000	29,250,000
Puffers	2	27,608,000	16,568,000
Sea Robins	3	5,831,000	6,741,000
Sharks (all species)	7	245,000	1,680,000
Tautog	8	383,000	1,619,000
Tunas	11	54,000	886,000
Miscellaneous	5	2,634,000	3,947,000

Source: 1970 Salt-water Angling Survey (Deuel, 1973).

* Harvest totals given are for Mid-Atlantic States: New Jersey to Cape Hatteras, N.C., will represent best statistics presently available.

Table 2 - Harvest of Important Estuarine Dependent Fishes of New Jersey

Common Name	Sport Fishing[1] (1970) Rank by Weight	Number	Estimated Weight (lbs)	Commercial Fishing[2] (1974) Rank by Weight	Weight (lbs)	Land Value (dollars)
Alewife & Blueback Herring	-	----	----	12	10,600	$ 424
Bluefish	1	12,351,000	49,720,000	5	1,003,115	115,100
Croaker	7	4,617,000	3,831,000	10	45,180	6,470
Black Drum	8	26,000	1,454,000	11	33,317	3,095
American Eel	7	367,000	740,000	6	216,214	75,586
Summer Flounder (fluke)	8	4,191,000	7,742,000	2	3,499,419	1,153,421
Winter Flounder	5	7,496,000	12,881,000	8	140,242	17,136
Menhaden	-	----	----	1	107,307,501	2,734,831
White Perch	6	15,072,000	12,592,000	9	102,011	23,123
American Shad	5	1,541,000	4,231,000	7	121,558	26,144
Striped Bass	2	9,857,000	27,262,000	5	713,616	177,203
Scaup (porgy)	6	1,188,000	2,127,000	3	6,039,977	879,679
Spot	3	32,952,000	21,573,000	13	10,522	1,438
Sturgeon	-	-----	----	14	9,972	1,965
Weakfish	4	9,397,000	14,039,000	4	2,686,175	312,221

Sources:

1. 1970 Salt-water Angling Survey (Deuel, 1973). Sport harvests are for Mid-Atlantic States: New Jersey to Cape Hatteras, N.C.

2. New Jersey Landings - Annual Summary 1974 (NOAA, 1975)

Table 3. - NEW JERSEY LANDINGS, 1973 AND 1974

Annual TOTAL

SPECIES	1973 POUNDS	1973 DOLLARS	1974 POUNDS	1974 DOLLARS
FISH				
ALEWIVES	7,000	280	10,600	424
AMBERJACK	659	47	663	39
ANGLERFISH	36	2	1,351	93
BLUEFISH	887,256	132,755	1,003,115	115,100
BONITO	891	181	2,211	453
BUTTERFISH, UNCLASSIFIED	1,029,938	157,593	979,337	135,203
CARP	108,662	8,448	47,693	3,113
CATFISH	12,214	1,903	6,862	1,007
COD	85,004	26,501	337,284	82,125
CREVALLE	-	-	567	30
CROAKER, UNCLASSIFIED	37,069	7,401	45,180	6,470
CUNNER	190	7	298	15
DRUM, BLACK	24,423	2,033	33,317	3,095
EELS, COMMON	230,878	54,760	216,214	75,584
EELS, CONGER	6,793	1,033	5,316	949
FLOUNDERS, BLACKBACK	155,493	15,923	140,242	17,136
FLOUNDERS, FLUKE	3,091,541	1,103,242	3,499,419	1,153,421
FLOUNDERS, GRAY SOLE, UNCL	36,278	6,149	35,304	7,564
FLOUNDERS, LEMON SOLE	18	13	-	-
FLOUNDERS, SAND	2,500	234	-	-
FLOUNDERS, YELLOWTAIL, UNCL	1,052,966	122,512	265,618	48,925
HADDOCK, UNCLASSIFIED	1,636	367	366	125
HAKE, RED	1,116,404	87,900	893,396	54,495
HAKE, WHITE, UNCLASSIFIED	61,378	10,535	57,815	11,172
HALIBUT	26	13	-	-
HERRING, SEA	114,072	2,579	346,615	14,048
KING MACKEREL	1,054	542	279	56
KING WHITING OR KINGFISH	1,606	231	804	100
MACKEREL, ATLANTIC	1,154,801	93,647	774,039	109,013
MENHADEN	154,483,250	3,939,309	107,307,501	2,734,831
OCEAN PERCH, ATLANTIC	-	-	75	11
OCEAN POUT	-	-	26	1
POLLOCK	893	151	1,348	132
PORGY OR SCUP, UNCLASSIFIED	2,970,040	772,910	6,039,977	879,679
SEA BASS, UNCLASSIFIED	693,525	268,663	777,592	251,480
SEA ROBIN	7,189	347	967	48
SEA TROUT, GREY Weakfish	2,562,545	338,772	2,686,175	312,221
SHAD	142,783	27,377	121,558	26,144
SHARKS, DOGFISH	5,437	255	758	42
SHARKS, UNCLASSIFIED	3,396	237	1,803	159
SKATES	-	-	2,435	123
SPANISH MACKEREL	105	35	1,634	306
SPOT	9,527	935	10,522	1,438
STRIPED BASS	766,163	210,877	713,616	177,203
STURGEON	18,423	2,998	9,972	1,965
SWORDFISH	4,752	5,096	7,208	12,337
TAUTOG	22,586	1,058	21,532	1,040
TILEFISH	711,125	233,960	838,216	262,969
TUNA, BLUEFIN	1,251,757	267,166	872,578	231,788
TUNA, LITTLE	654	48	1,427	150
TUNA, UNCLASSIFIED	201	13	-	-
WHITE PERCH	141,795	31,836	102,011	23,123
WHITING	6,449,617	868,295	7,022,206	587,208
UNCLASSIFIED FOR FOOD	6,452	850	11,429	1,776
UNCLASSIFIED FOR INDUSTRIAL	-	-	6,078	423
TOTAL FISH	179,478,663	8,808,419	135,262,549	7,346,354
SHELLFISH				
CRABS, BLUE, HARD	2,572,680	663,100	2,745,160	671,205
CRABS, BLUE, SOFT AND PEELER	22,913	15,528	125,515	52,918
CRABS, RED	26,663	1,564	25,263	1,860
CRABS, ROCK	192,984	11,113	345,693	22,212
LOBSTERS, AMERICAN, UNCL	1,363,146	2,234,391	1,191,297	1,915,856
SHRIMP, SALTWATER (HEADS-ON)	4,992	2,974	-	-
CLAMS, HARD (MEATS)	1,853,665	1,640,505	1,741,000	1,739,312
CLAMS, SOFT, PUBLIC (MEATS)	17,292	18,914	87,240	72,700
CLAMS, SURF (MEATS)	21,588,249	2,709,121	22,656,648	2,948,367
CONCHS (MEATS)	150,767	38,505	107,714	31,790
MUSSELS, SEA (MEATS)	-	-	7,050	3,755
OYSTERS (MEATS)	1,397,288	1,329,232	1,009,914	1,028,702
SCALLOPS, BAY (MEATS)	60,641	71,628	16,248	24,372
SCALLOPS, SEA (MEATS)	415,557	760,263	327,686	506,860
SQUID	584,433	134,914	1,286,819	237,034
TERRAPIN	500	250	500	250
TURTLES, LOGGERHEAD	20	2	-	-
TURTLES, SLIDERS	525	53	600	60
TURTLES, SNAPPER	25,579	5,067	27,181	5,502
TURTLES, UNCLASSIFIED	450	32	1,705	146
TOTAL SHELLFISH	30,217,144	9,637,156	31,103,233	9,262,901
GRAND TOTAL	209,695,807	18,445,575	166,365,782	16,609,255

NOTE: ---EIGHTS SHOWN ARE POUNDS (LIVE) WEIGHT, EXCEPT AS NOTED. WEIGHT OF SCALLOPS IS WEIGHT OF SHELL-CLOSING MUSCLE. THE 1974 DATA MAY INCLUDE REVISIONS SINCE PUBLICATION OF MONTHLY BULLETINS.

from : NOAA (1975)

Table 4. - Some secondary marine resource dependent industries in New Jersey.

	Number of Establishments	Sales	Payroll	Number of Employees
Retail Seafood Outlets	83	$14,038,000	$1,204,000	227
Sporting Goods Stores	594	$89,419,000	$9,700,000	1,699
Boat Dealers	121	$48,971,000	$4,639,000	622

Source: U.S. Department of Commerce (1974)

Table 5. - Landing values and rank of ten largest dollar catches of commercial marine fish landed in New Jersey during 1973 and 1974.

1973				1974			
Species	Value	Rank	Weight (pounds)	Species	Value	Rank	Weight (pounds)
Menhaden	3,939,000	#1	154,483,000	Menhaden	2,734,000	#1	107,307,000
Fluke (summer flounder)	1,103,000	2	3,091,000	Fluke	1,153,000	2	3,499,000
Whiting (Silver Hake)	886,000	3	6,449,000	Scup (porgy)	879,000	3	6,039,000
Scup (porgy)	772,000	4	2,970,000	Whiting	587,000	4	7,022,000
Weakfish (seatrout)	338,000	5	2,562,000	Weakfish	312,000	5	2,686,000
Sea Bass	268,000	6	693,000	Tilefish	262,000	6	838,000
Bluefin Tuna	267,000	7	1,251,000	Sea Bass	251,480	7	777,000
Tilefish	233,000	8	711,000	Bluefin Tuna	231,000	8	872,000
Striped Bass	210,000	9	766,000	Striped Bass	177,000	9	713,000
Butterfish	157,000	10	1,029,000	Butterfish	135,000	10	979,000

Source: New Jersey Landings - Annual summary 1974 (NOAA, 1975)

Table 6.- Landing values and rank of ten largest dollar catches of marine and estuarine shellfish in New Jersey during 1974.

MARINE SPECIES	Value	Rank	Weight (pounds)	$/pound
Surf Clams	$2,948,000	#1	22,656,000	.13
Lobster	1,915,000	2	1,191,000	1.60
Sea Scallops	506,000	6	327,000	1.54 *
Squid	237,000	7	1,286,000	.18
Conch	31,000	9	107,000	.29
ESTUARINE SPECIES				
Hard Clams	1,739,000	3	1,741,000	.99
Oysters	1,028,000	4	1,009,000	1.01
Crabs (hard and soft)	724,000	5	2,870,000	.25
Soft Clams	72,000	8	87,000	.82
Bay Scallops	24,000	10	16,000	1.50 *

source: NOAA (1975)

*Note: Values are calculated on basis of shell-closing muscle only.

Table 7. - Rank by value/pound of twenty most valuable species of finfish and shellfish landed in New Jersey by commercial fishermen during 1974.

Rank	Species	$/lb.	Rank	Species	$/lb.
# 1	American Lobster	1.60	11	Bluefin Tuna	.26
# 2	Sea Scallops *	1.54	12	Blue Claw Crabs	.25
# 3	Bay Scallops *	1.50	13	Striped Bass	.24
# 4	Oysters	1.01	14	Squid	.18
# 5	Hard Clams	.99	15	Scup (porgy)	.14
# 6	Soft Clams	.82	16	Surf Clams	.13
# 7	Fluke	.32	17	Butterfish	.13
# 8	Sea Bass	.32	18	Weakfish	.11
# 9	Tilefish	.31	19	Whiting (Silver Lake)	.08
#10	Conch	.29	20	Menhaden	.02

* Note: Values are calculated on basis of shell-closing muscle only.

source: NOAA (1975)

TABLE 8.-

MIGRATORY WATERFOWL AND OTHER MARINE BIRDS OF THE MID-ATLANTIC BIGHT

	PELAGIC OR OPEN OCEAN >5 MILES	LITTORAL OR OUTER SHORE <5 MILES	BAYS/ SOUNDS	FREQUENCY IN AREA	DATES PRESENT	PERIODS OF GREATEST ABUNDANCE AND ESTIMATED NUMBERS
Common Loon	X		X	Common, abundant, migrant, Winter	Year-round	April, November 500
Red-throated Loon	X		X	Common, abundant, migrant, Winter	Nov., Dec., April	Nov. & April 500
Red-necked Grebe	X			Uncommon, fairly common, migrant, irregular Winter	Oct. - April	- 100
Horned Grebe	X		X	Common, abundant, migrant, Winter	Oct. - Dec.	1,000
Pied-billed Grebe			X	Fairly common, migrant, uncommon in Winter	Sept. & April	September 100
Whistling Swan			X	Uncommon, Winter migrant	Nov. - March	100
Canada Goose			X	Abundant, migrant, Winter visitor	March - Nov.	March 10,000
Brant			X	Abundant, migrant, Winter visitor	Dec. - April	100,000
Mallard			X	Common, abundant, resident & migrant	All year	500
Black Duck			X	Abundant Fall migrant, Winter visitor Spring	All year	- 5,000
European Widgeon			X	Uncommon, migrant Winter visitor	Oct. - March	100
American Widgeon			X	Common, abundant migrant, Winter visitor	Sept. - April	5,000
Ring-necked Duck			X	Locally common, abundant migrant, Winter visitor	Oct. - Mid-April	500
Canvasback			X	Common, Winter visitor	Nov. - early April	1,000
Greater Scaup			X	Abundant, Winter visitor	All year	100,000
Lesser Scaup			X	Fairly common, Spring migrant, rare Winter visitor		-
Common Goldeneye	X		X	Common or abundant Winter visitor	Nov. early April	5,000
Bufflehead	X		X	Locally common, abundant Winter visitor	Mid-Oct. - April	500
Oldsquaw	X		X	Common, ocasionally abundant Winter visitor	All year	5,000
Common Eider	X		X	Common, abundant migrant, Winter visitor	Oct. - April	100,000
White-winged Scoter	X		X	Abundant migrant	Nov. - March	100,000
Surf Scoter	X		X	Common, abundant migrant	Oct. - April	100,000
Common Scoter	X		X	Common, abundant migrant	Oct. - April	100,000
Ruddy Duck			X	Common, abundant Fall migrant, Winter visitor	Oct. - March	1,000
Hooded Merganser			X	Common, abundant migrant	Oct. - April	100
Red-brested Merganser			X	Common, abundant migrant	Nov. - March	10,000
Common Merganser			X	Uncommon, Winter visitor	Nov. - April	100
American Coot			X	Common, abundant, Fall migrant, Winter visitor	All year	1,000
Fulmar	X	X		Accidental	Oct. - Jan.	100
Cory's Shearwater (North Atlantic Shearwater)	X	X		Common - abundant, late Summer & Fall visitor	July - Mid Nov.	Late Aug. - Late Oct. 1,000
Great Shearwater	X	X		Rare common Summer visitor	Late May - early Oct.	500
Sooty Shearwater	X	X		Casual - abundant Summer visitor	Late May - Mid Sept.	Peak, late May-early June 500
Audubon's Shearwater	X	X		?	?	?
Manx Shearwater	X			Casual	?	?
Leach's Storm Petrel	X	X		Casual, Summer & Fall visitor	Early May - early Nov.	-
Wilson's Storm-Petrel	X	X		Common - Abundant, Summer visitor	Late May - late Aug.	10,000
Frigate Storm-Petrel	X			Casual	?	?
Harcourt's Storm-Petrel	X			Casual	?	?
Bermuda Petrel	X			Accidental	?	?

from: Gusey (1976)

TABLE 8. (Continued)

MIGRATORY WATERFOWL AND OTHER MARINE BIRDS OF THE MID-ATLANTIC BIGHT

	PELAGIC OR OPEN OCEAN >5 MILES	LITTORAL OR OUTER SHORE <5 MILES	BAYS/ SOUNDS	FREQUENCY IN AREA	DATES PRESENT	PERIODS OF GREATEST ABUNDANCE AND ESTIMATED NUMBERS
Black-Capped Petrel	X			Casual	?	?
Gannet	X	X		Common, abundant migrant	Late March - Mid May Late Oct. - early Dec.	-
Red Phalarope	X	X		Common, Summer, Fall migrant	Late March-Late April, Sept.-early Nov.	5,000
Northern Phalarope	X	X	X	Rare Fall migrant, casual Spring migrant	July - Sept.	100
Pomarine Jaeger	X	X		Uncommon, rare migrant	Early May - Mid November	100
Parasitic Jaeger	X	X		Regular migrant	Early May - Mid November	100
Long-Tailed Jaeger	X			Casual migrant	Late May - early June Early Aug. - early Sept.	-
Glaucous Gull		X	X	Uncommon, rare - regular Winter visitor	All year	100
Iceland Gull		X	X	Uncommon, regular Winter visitor	Nov. - March	Dec. - Feb. 100
Great Black-Backed Gull		X	X	Common, abundant resident & migrant	All year	Sept. 5,000
Herring Gull		X	X	Very abundant resident	All year	Dec. - Feb. 100,000
Ring-Billed Gull		X	X	Common, Abundant migrant Winter visitor	All year	Aug.-Nov. 5,000
Black-Headed Gull			X	Uncommon, rare Winter visitor, occasional Summer visitor	Nov. - late March	100
Laughing Gull		X	X	Common, abundant migrant, Summer visitor uncommon Winter visitor	All year	late March - Mid Dec. 5,000
Bonaparte's Gull		X	X	Common, abundant migrant, Winter visitor	Oct. - May	10,000
Black-Legged Kittiwake	X	X		Uncommon, common Winter visitor	Nov. - Feb.	500
Gull-Billed Tern		X		Rare, irregular Spring & Fall visitor	Early June - Mid Sept.	100
Forester's Tern		X		Uncommon - common Fall migrant, Summer resident		500
Common Tern		X	X	Abundant migrant, Summer resident	May - Mid October	5,000
Artic Tern	X			Accidental	-	-
Roseate Tern		X		Uncommon, abundant Spring resident, Fall migrant	Mid May - Sept.	1,000
Least Tern		X		Common, abundant migrant, fairly common Summer resident	May - Mid Sept.	500
Royal Tern		X		Rare, Summer & Fall visitor	July - Oct.	100
Sandwich Tern		X		Casual	Sept.	-
Caspian Tern		X	X	Uncommon migrant, Summer resident in N.J.	Aug.-Sept.	500
Black Tern		X		Uncommon occasionally abundant migrant, occasionally Summer visitor	Late May - early Oct.	5,000
Black Skimmer		X		Local Summer resident, common abundant, occasional Summer visitor	Mid May - Mid Oct.	5,000
Razorbill Auk	X	X	X	Rare, irregular Winter visitor	Late Dec. - early March	100
Common Murre	X	X	X	Casual	-	100
Thick-Billed Murre	X	X	X	Rare, irregular Winter visitor	Dec. - Feb.	100
Dovekie	X	X		Rare, regular Winter visitor	Mid Nov. - early March	100
Black Guillemot		X		Casual, rare Winter visitor	Nov. - March	100
Common Puffin		X	X	Casual, Winter visitor	Nov. - March	100
White-Tailed Tropic-Bird	X			Casual, far offshore	-	-
Blue-Faced Booby	X			Normal & regular off Cape Hatteras	-	-
Frigate Bird	X			Casual, off Carolinas	-	-

from: Gusey (1976)

Table 9.- Marine Mammals Which Have Occurred or May Occur in the Mid-Atlantic (Adapted from Pilson and Goldstein, 1973)

* denotes those that occur or have been reported in the area in recent times.

** denotes those that occur or have been reported in the area in recent times and are "endangered species," (U.S. Department of Interior, 1974)

Odobenidae	
Odobenus rosmarus	Walrus
Phocidae	
*Phoca vitulina	Harbor seal
Halichoerus grypus	Gray seal
Pagophilus groenlandicus	Harp seal
*Cystophora cristata	Hooded seal
Trichechidae	
Trichechus manatus	Manatee
Balaenidae	
*Eubalaena glacialis**	Right whale
Eschrichtiidae	
Eschrichtius robustus	Gray whale
Balaenopteridae	
*Balaenoptera acutorostrata	Minke whale
Balaenoptera borealis	Sei whale
*Balaenoptera physalus**	Fin whale
Balaenoptera musculus	Blue whale
*Megaptera novaeangliae**	Hump-backed whale
Delphinidae	
Steno bredanensis	Rough-toothed dolphin
*Tursiops truncatus	Bottle-nosed dolphin
*Grampus griseus	Grampus or Risso's dolphin
Lagenorhynchus albirostris	White-beaked dolphin
Lagenorphynchus acutus	White-sided dolphin
*Stenella dubia	Spotted dolphin
Stenella caeruleoalba	Striped dolphin
*Delphinus delphis	Common dolphin
Pseudorca crassidens	False killer whale
*Globicephala melaena	Pilot whale
Globicephala macrorrhyncha	Short-finned pilot whale
*Orcinus orca	Killer whale
Phocoena phocoena	Harbor porpoise
Monodontidae	
Delphinapterus leucas	Beluga or white whale
Physeteridae	
Physeter catodon	Sperm whale
*Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale
Ziphiidae	
Mesoplodon bidens	North Sea beaked whale
*Mesoplodon europeus	Antillean beaked whale
Mesoplodon mirus	True's beaked whale
Mesoplodon densirostris	Dense-beaked whale
*Ziphius cavirostris	Goode-beaked whale
Hyperoodon ampullatus	North Atlantic bottled-nosed whale

source: BLM (1976)

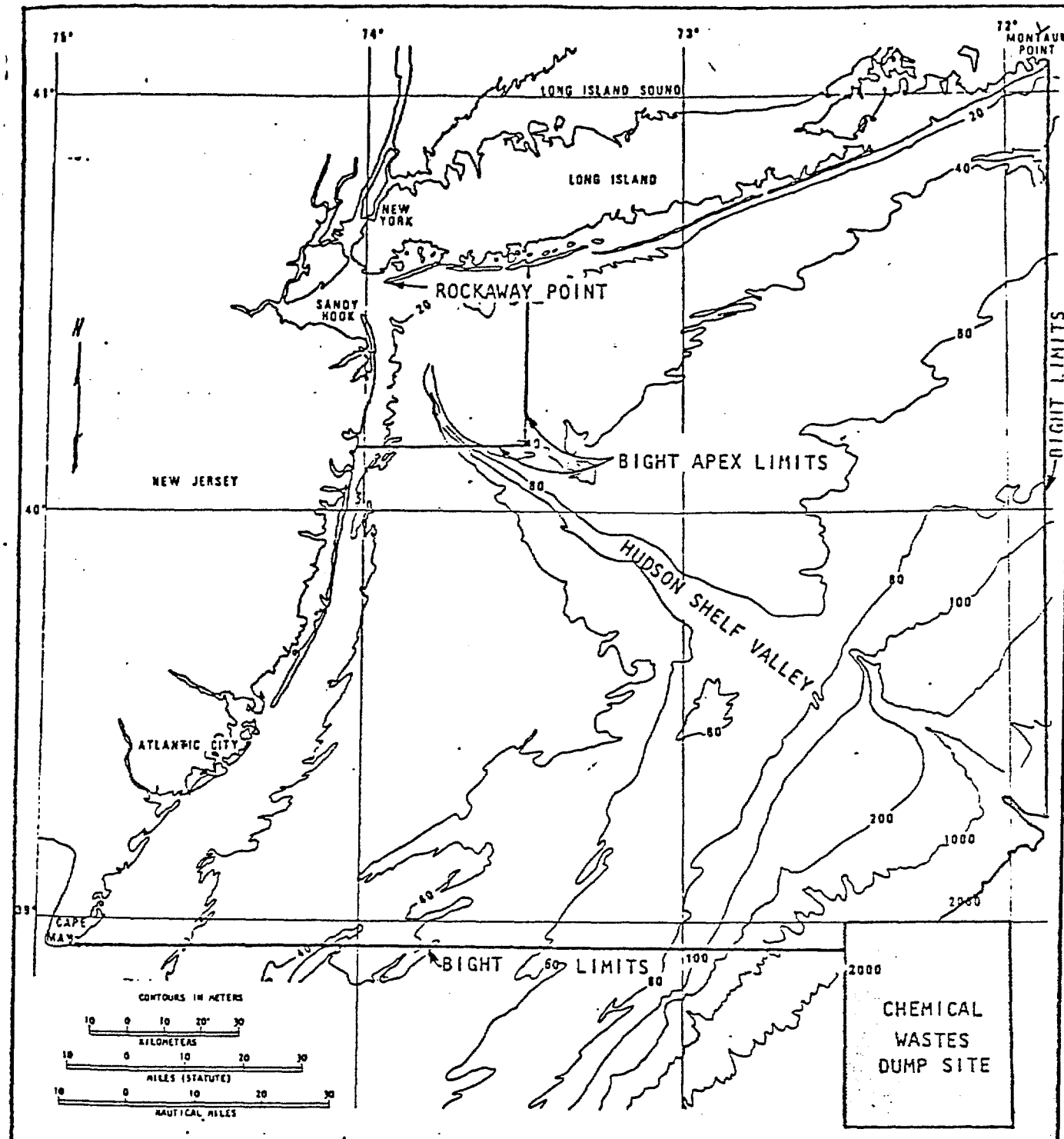
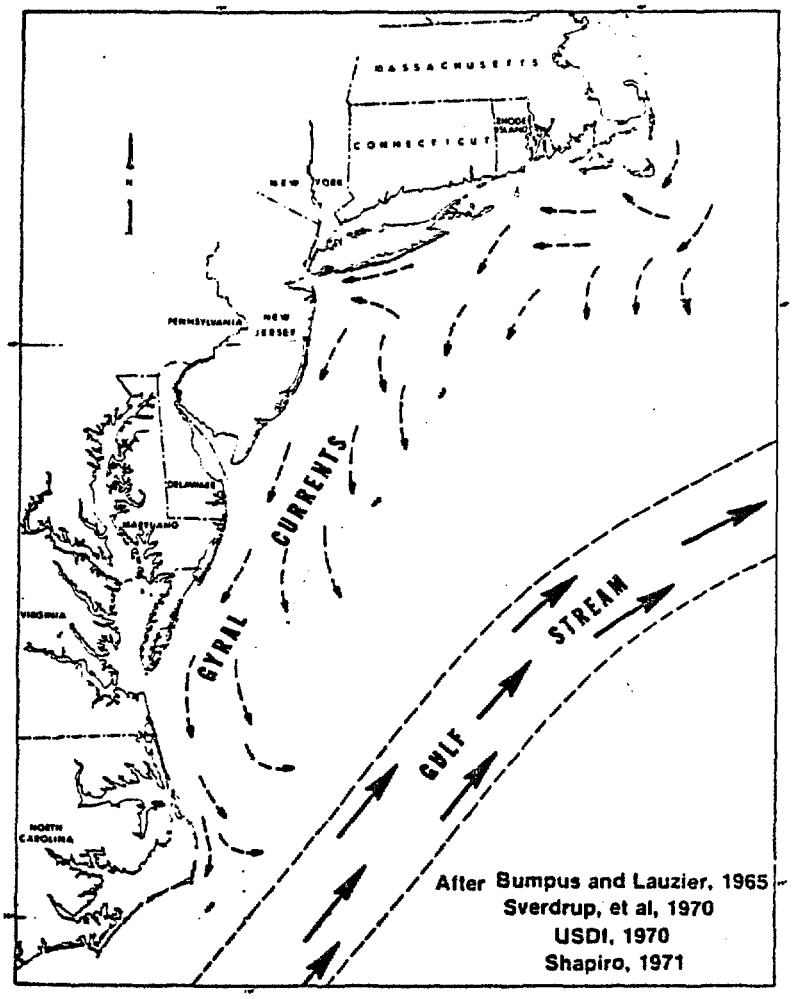


Figure 1. - THE NEW YORK BIGHT

source: EPA (1976)

Figure 2. - GULF STREAM AND GYRAL CURRENTS



from: Gusey (1976)

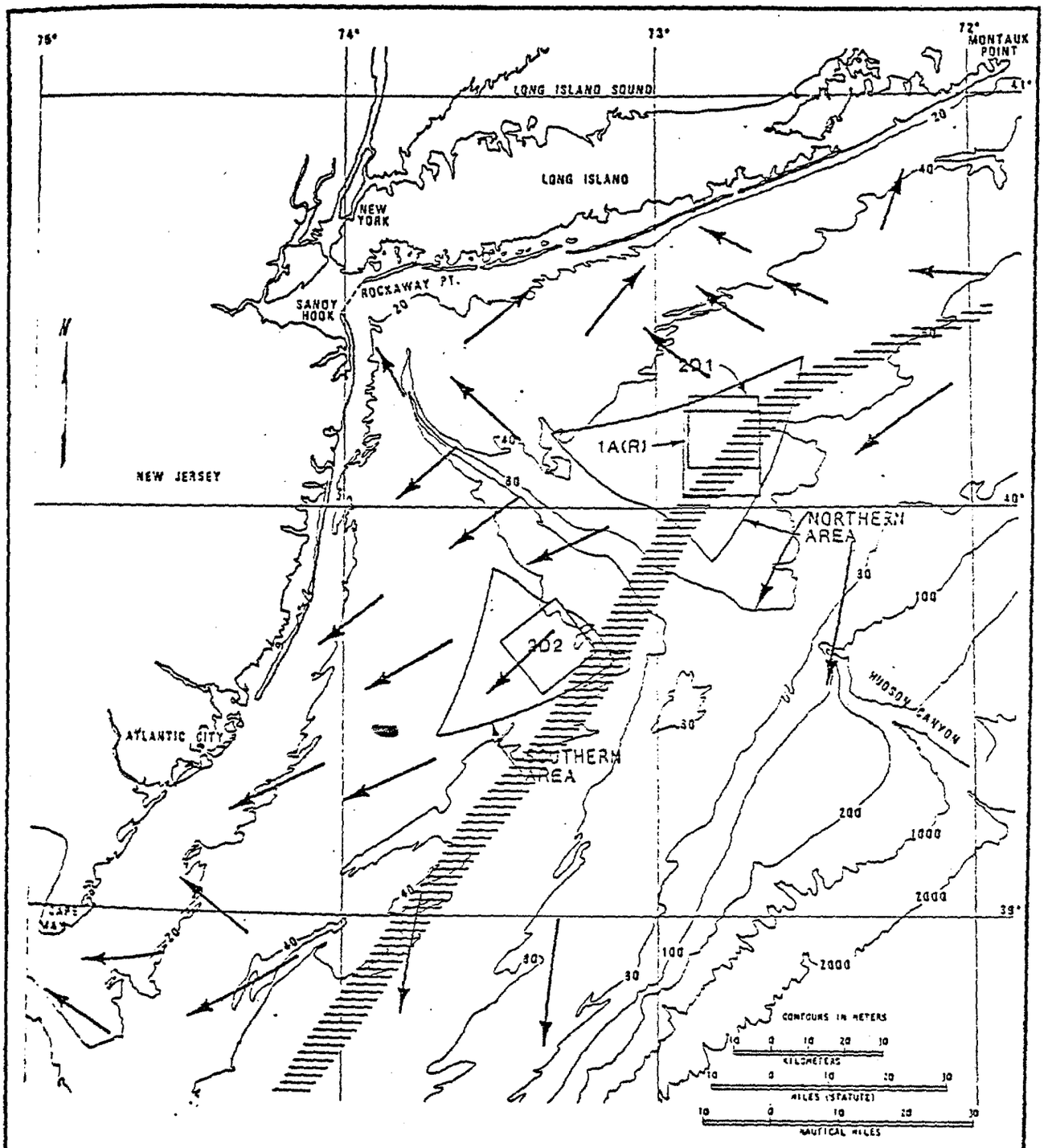


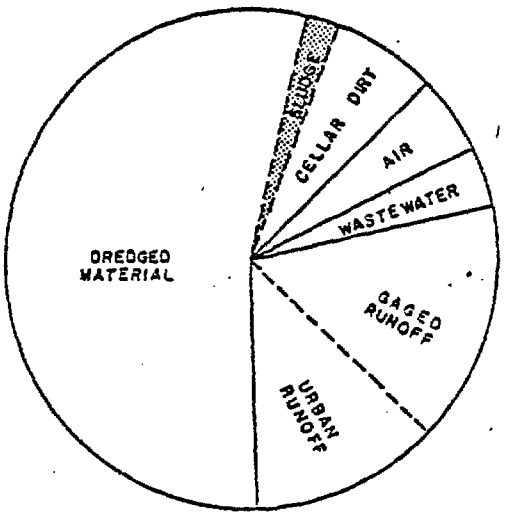
Figure 3.- GENERAL RESIDUAL CURRENT ALONG THE BOTTOM OF THE NEW YORK BIGHT

KEY:

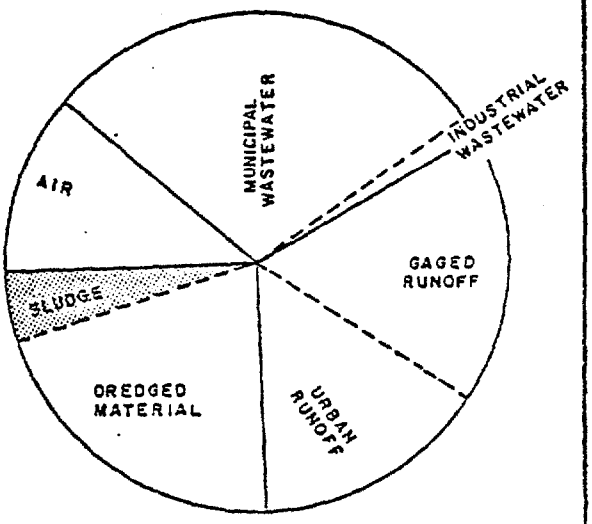
SHADED AREA INDICATES LINE OF DIVERGENCE OF ONSHORE AND OFFSHORE FLOW

NOTE: MAGNITUDE IS NOT IMPLIED BY LENGTH OF ARROWS

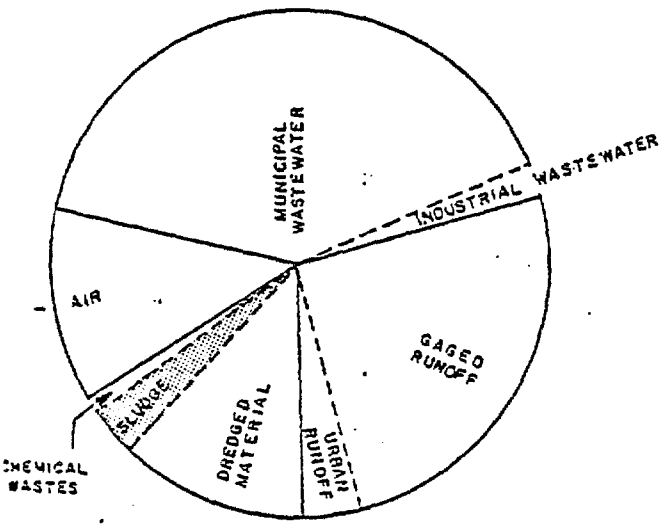
SOURCES: BUMPUS, 1965; CHARLESWORTH, 1968. from; EPA (1976)



SUSPENDED SOLIDS



ORGANIC CARBON



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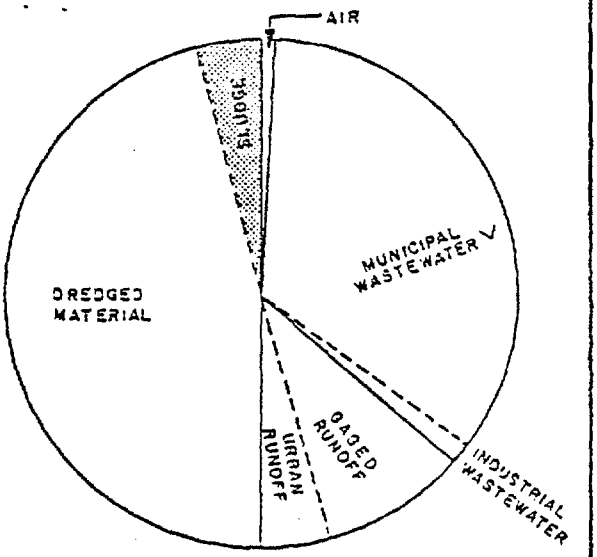

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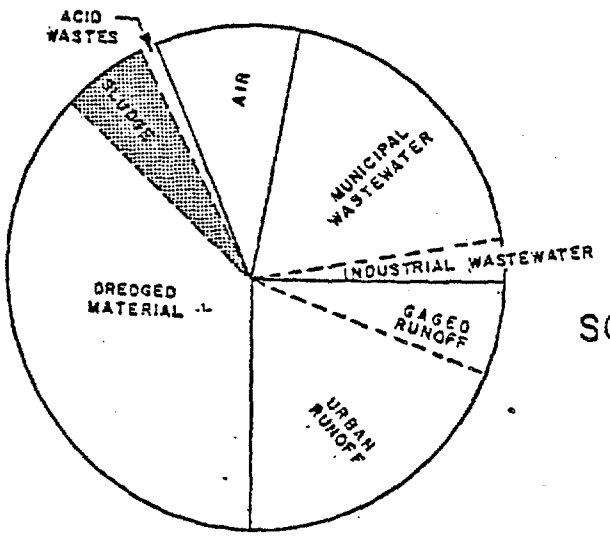


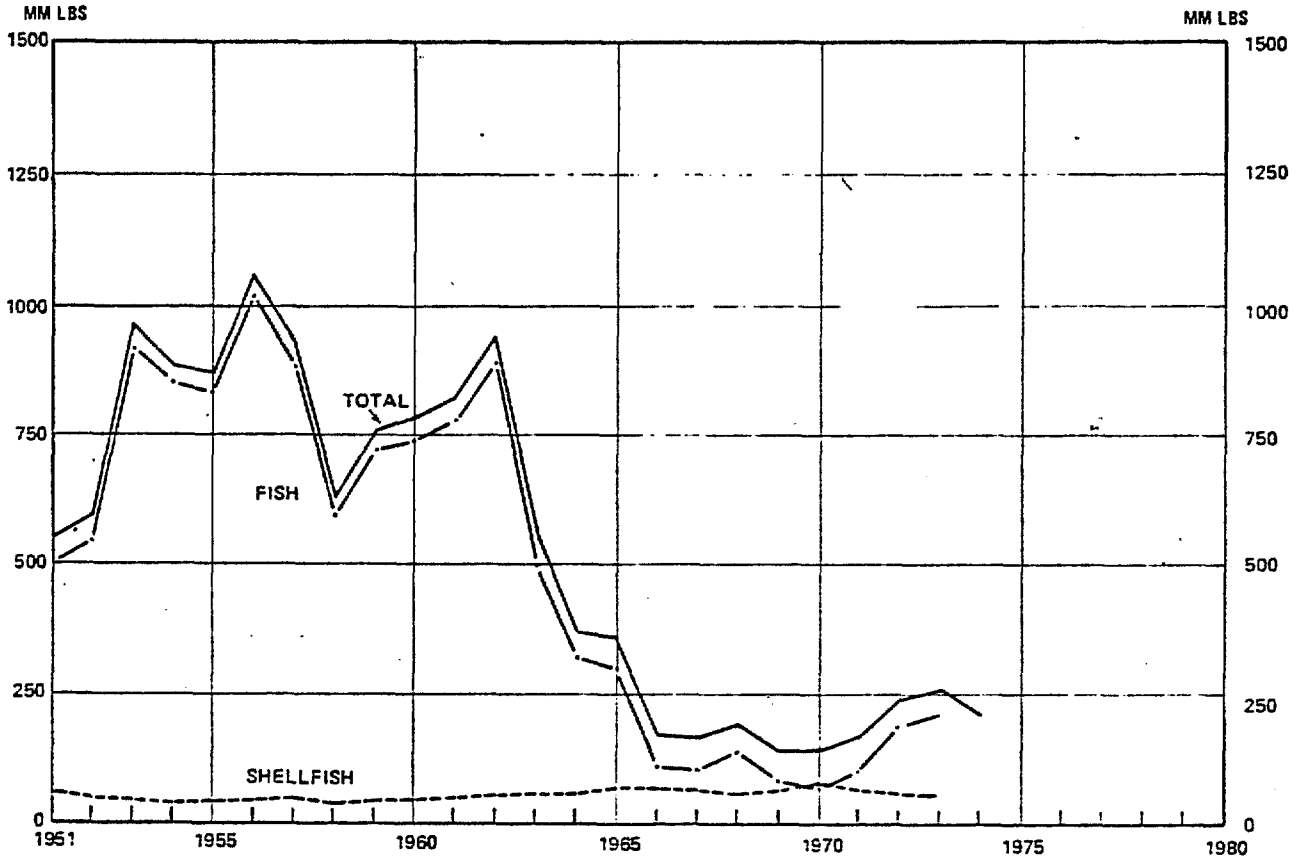
LEAD

Figure 4. -

SOURCES OF POLLUTANTS IN THE NEW YORK BIGHT

SOURCE : MUELLER AND JERIS , UNPUB. from: EPA (1976)

Figure 5. - FISH & SHELLFISH LANDINGS
MID-ATLANTIC COAST
(NEW YORK, NEW JERSEY, DELAWARE)



from: Gusey (1976)

SOURCE: NMFS, NOAA, FISHERY STATISTICS, 1951-1974

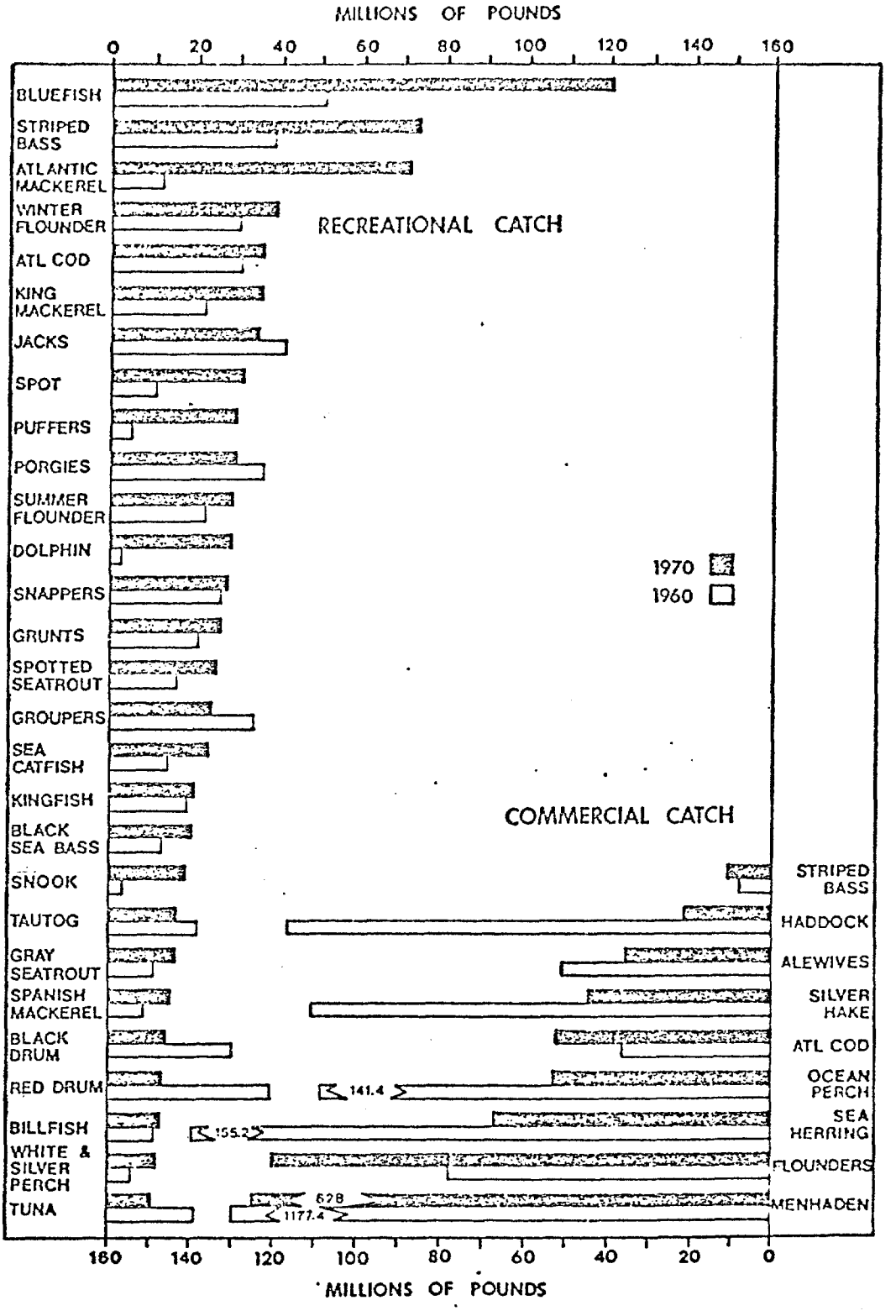
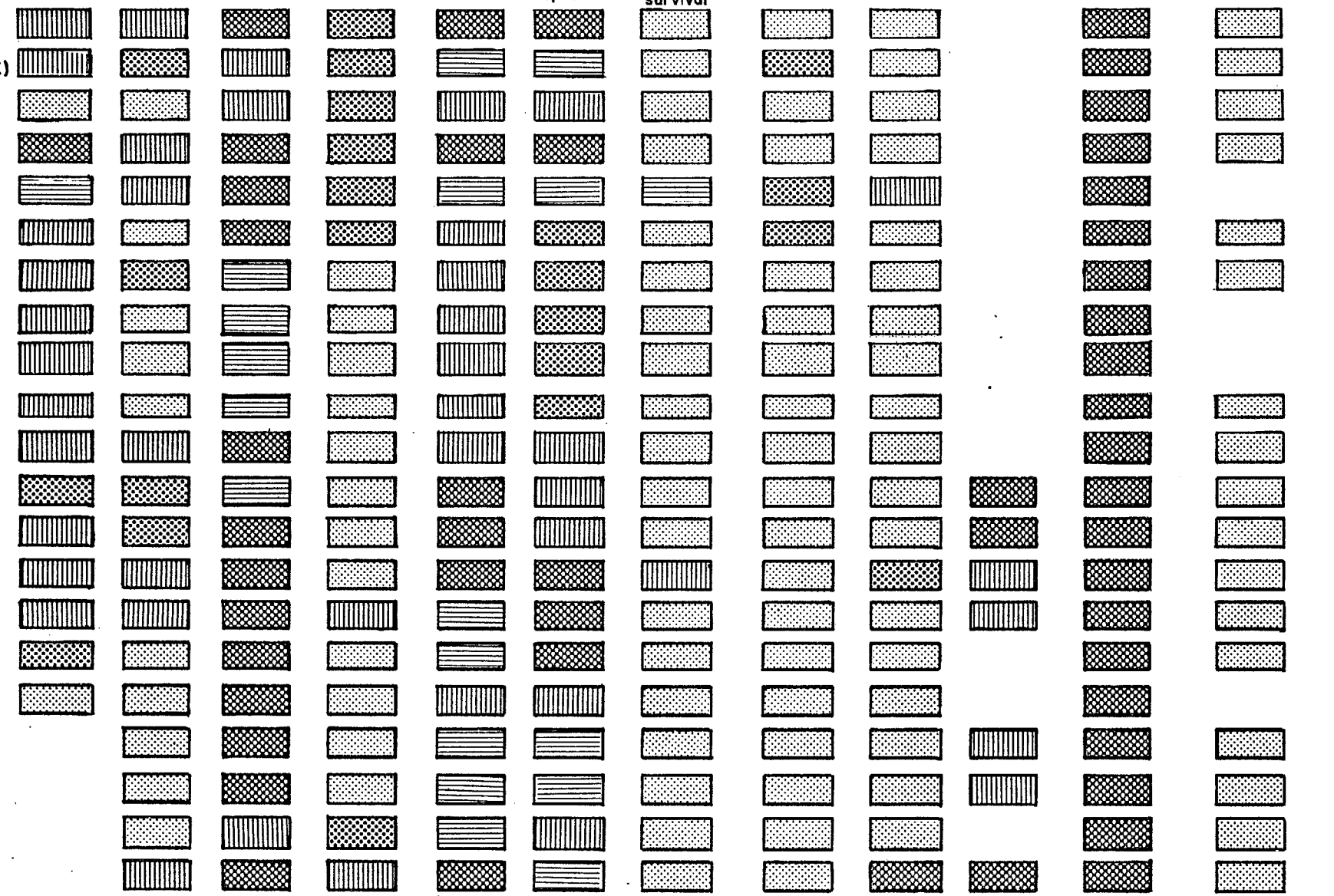


Figure 6.- Graph showing finfishes of the Atlantic coast yielding 10 million pounds or more to recreational and commercial fishermen in 1960 and 1970. from: Freeman (1976).

NEW YORK – NEW JERSEY – DELAWARE

Figure 7. - STATE OF KNOWLEDGE – MIDDLE ATLANTIC AND CHESAPEAKE FISHES



source: Freeman and Walford (1976)

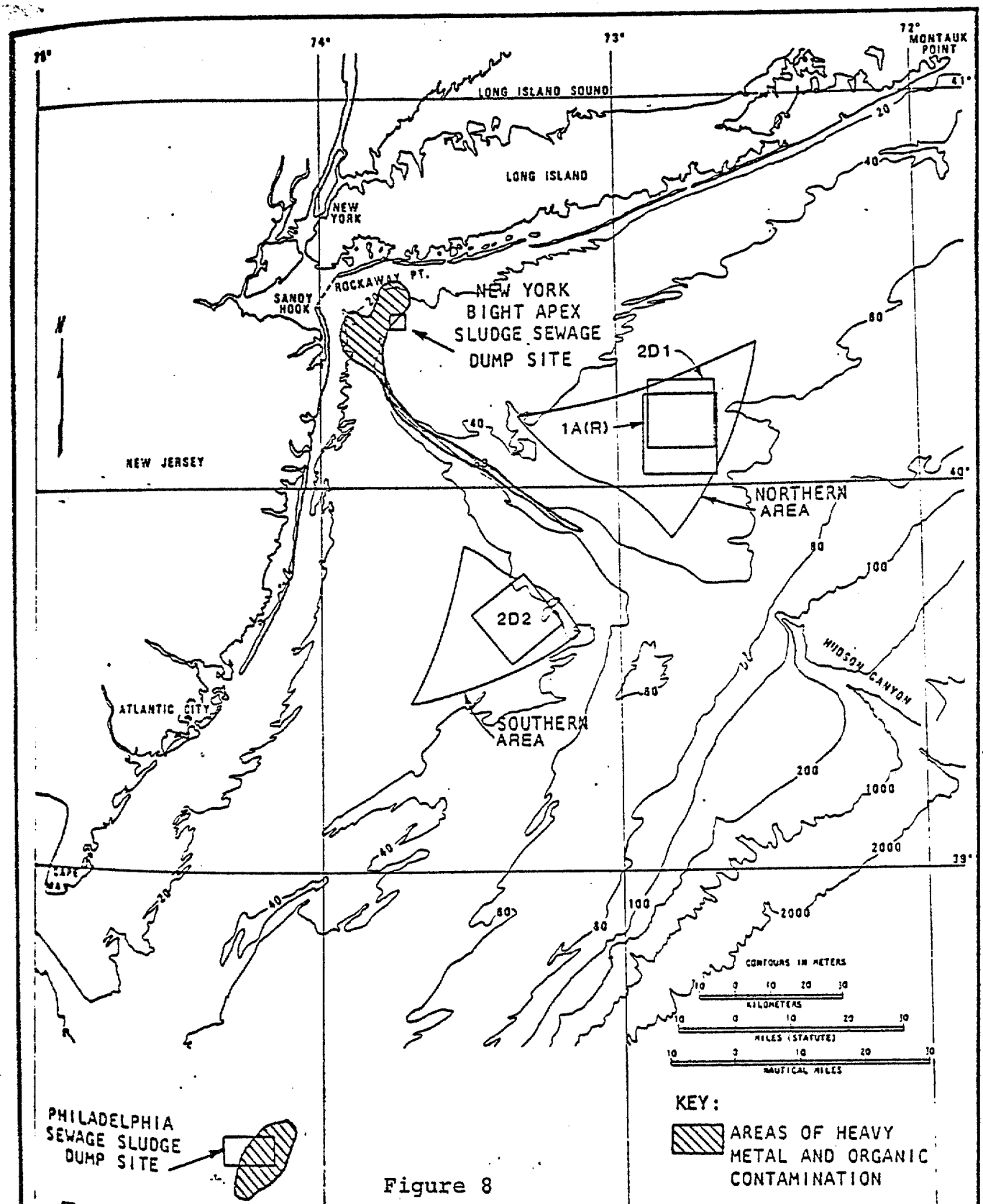


Figure 8

BOTTOM AREAS AFFECTED AT EXISTING SEWAGE SLUDGE DUMP SITES IN THE MID-ATLANTIC BIGHT

SOURCES: LEAR, 1973; CARMODY ET AL.; 1973; HATCHER AND KEISTER, 1975.

DAMES & MOORE

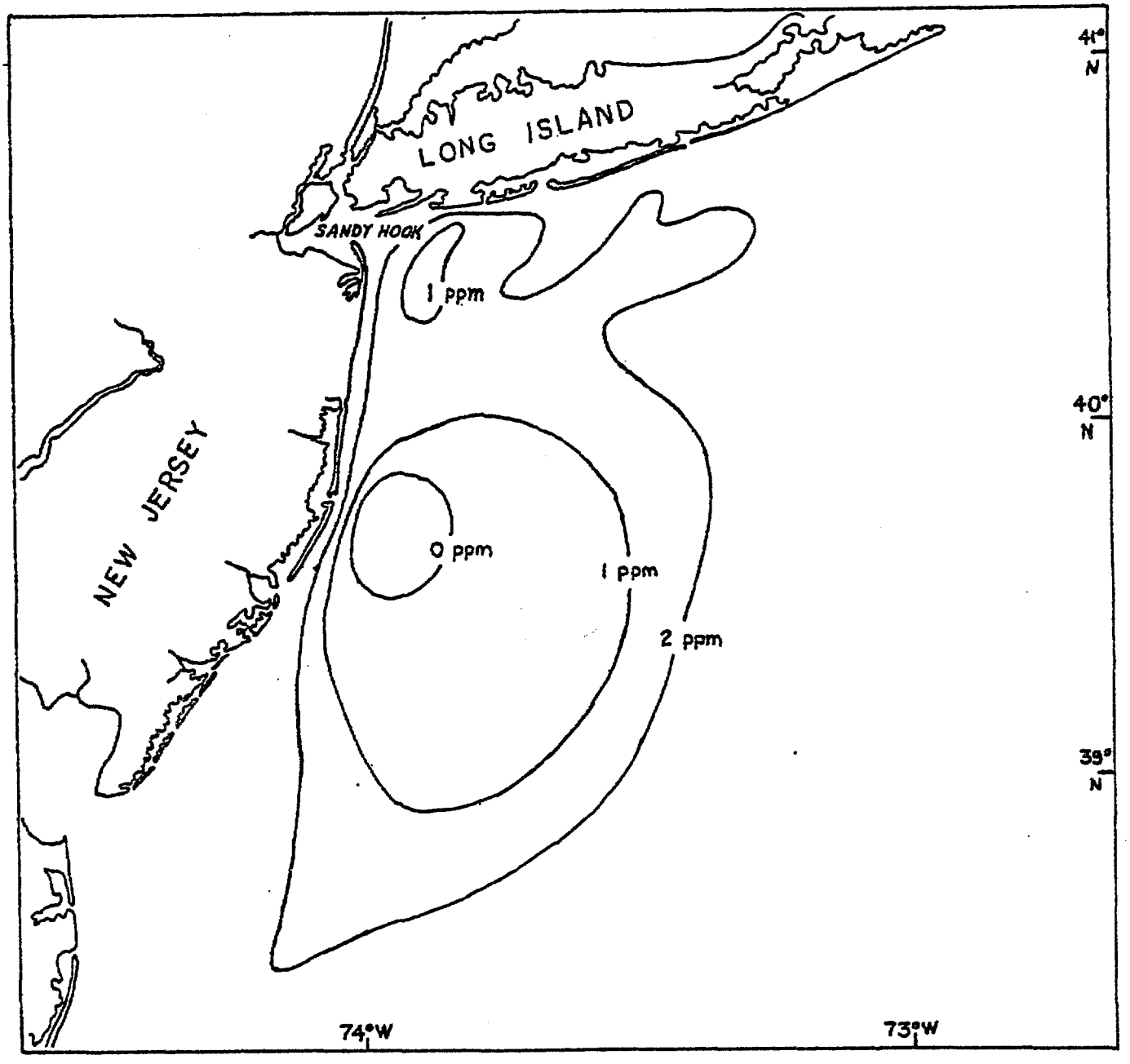


Figure 9 - Areas of extremely low dissolved oxygen concentration on the ocean bottom. During part of the summer of 1976 oxygen concentration measured in parts per million (PPM).

From: Sharp (1976)

Appendix B

References

References

Booda, L. L. Fishery Management and Enforcement Face Formidable Complications. Sea Tech., Vol. 17(6)-12-15, 1976.

Deuel, D. G. 1970 Salt-Water Angling Survey. Current Fishery Stat. No. 6200, NOAA/NMFS, 1973.

Edwards, R. L. Middle Atlantic Fisheries, Recent Changes in Populations and the Outlook. in Abstracts Spec. Symp. Mid. Atl. Contin. Shelf and N.Y. Bight, Am. Mus. Nat. Hist., N.Y., p. 17, 1975.

Figley, W. M. Fishermen Access in New Jersey's Marine Environment. N.J. Dept. Envir. Protec., Bur. Fish, Nacote Creek Res. Stat. Aug., 1976.

Freeman, B. L. A Description of Recreation Finfishing in Relation to the Utilization Living Marine Resources. (in press), U.S. Dept. Comm., NOAA/NMFS, Sandy Hook Lab., 10 p. manuscript, 1976.

Freeman, B. L. and L. A. Walford. (Personal Communication) NOAA/Nat. Mar. Fish. Ser. and N.J. Mar. Sci. Consortium, July, 1976.

Grosslein, M. D. Some Results from Fish Serveys in the Mid-Atlantic. in Abstracts Spec. Symp. Mid. Atl. Contin. Shelf and N.Y. Bight., Am. Mus. Nat. Hist., N.Y. p. 29, 1975.

Gusey, W. F. The Fish and Wildlife Resources of the Middle Atlantic Bight. Environ. Affairs, Shell Oil Co., Houston, Texas, 1976.

Heppner, F. H. and L. L. Gould. Birds of the Atlantic from Cape Hatteras to Cape Cod. in Coastal and Offshore Environmental Inventory, Cape Hatteras to Nantucket Shoal., Univ. of Rhode Island, Mar. Pub. Series No. 2, 1973.

National Oceanic and Atmospheric Administration (NOAA) Fisheries of the United States, 1974. Current Fisheries Stat. No. 6400, U.S. Dept. Comm., Nat. Mar. Fish. Ser., Washington, D.C., 1974.

National Oceanic and Atmospheric Administration (NOAA) New Jersey Landings Annual Summary 1974. Current Fisheries Stat. No. 6713, U.S. Dept. Comm, Nat. Mar. Fish. Ser., Washington, D.C., 1975.

New Jersey Department of Environmental Protection (DEP) Endangered, Threatened, Peripheral and Undetermined Wildlife Species in New Jersey. New Jersey Register Vol. 7, p. 146, April 10, 1975a.

New Jersey Department of Environmental Protection (DEP) Environmental Map of New Jersey-Fisheries Resources Map B. Bureau of Geology and Topography, Trenton, N.J., 1975b.

Paulson, M. E. Q. and E. Goldstein. Marine Mammals. in Coastal and Offshore Environmental Inventory, Cape Hatteras to Nantucket Shoals. Univ. of Rhode Island, Mar. Pub. Series No. 2., 1973.

Pyle, L. B. (Personal Communication) N.J. Bureau of Fisheries, N.J. Dept. Envir. Prot., July, 1976.

Ridgely, J. E. and D. G. Deuel. Participation in Marine Recreational Fishing Northeastern United States 1973-74. Current Fisheries Stat. No. 6236, U.S. Dept. Comm., NOAA/NMFS, Statistics and Market News Div., Washington, D.C., 1975.

Saila, S. B. and S. D. Pratt. Mid-Atlantic Bight Fisheries. in Coastal and Offshore Environmental Inventory, Cape Hatteras to Nantucket Shoals. Univ. of Rhode Island, Mar. Pub. Series No. 2, 1973.

Sharp, J. H., ed. Anoxia on the Middle Atlantic Shelf During the Summer of 1976. Rpt. on a Workshop held in Washington, D.C. Oct., 15 and 16, 1976, Office International Decade Ocean Exp., Nat. Sci. Found., Contract N. OCE77000465, November, 1976.

Sinderman, C. L. Effects of Coastal Pollution on Fish and Fisheries. in Abstracts Spec. Symp. Mid. Atl. Contin. Shelf. and N.Y. Bight., Am. Mus. Nat. Hist., N.Y. p. 63, 1975.

Silver, V. Economic Contribution of the New Jersey Fishing Industry. N.J. Dept. Envir. Prot. 13 p. memo, April 10, 1976.

U.S. Bureau of Land Management (BLM). Final Environmental Statement, Proposed 1976 Outer Continental Shelf Oil and Gas Lease Sale Offshore the Mid-Atlantic States.

U.S. Department of Commerce. 1972 Census of Retail Trade Area Statistics, New Jersey. RC72-A-31, Washington, D.C., 1974.

U.S. Environmental Protection Agency (EPA). Environmental Impact Statement on the Ocean Dumping of Sewage Sludge in the New York Bight, Draft prepared by Dames & Moore. Contract No. 68-01-2834 N.Y., N.Y., February, 1976.

Wigley, R. L. and K. O Emery. Submarine Photos of Commercial Shellfish Off Northeastern United States. Comm. Fish. Review Vol. 10(3):43-49, 1968.

Yananton, P.M. (Personal Communication) Environmental Commission,
Eastern Dive Boat Association, December 1976.