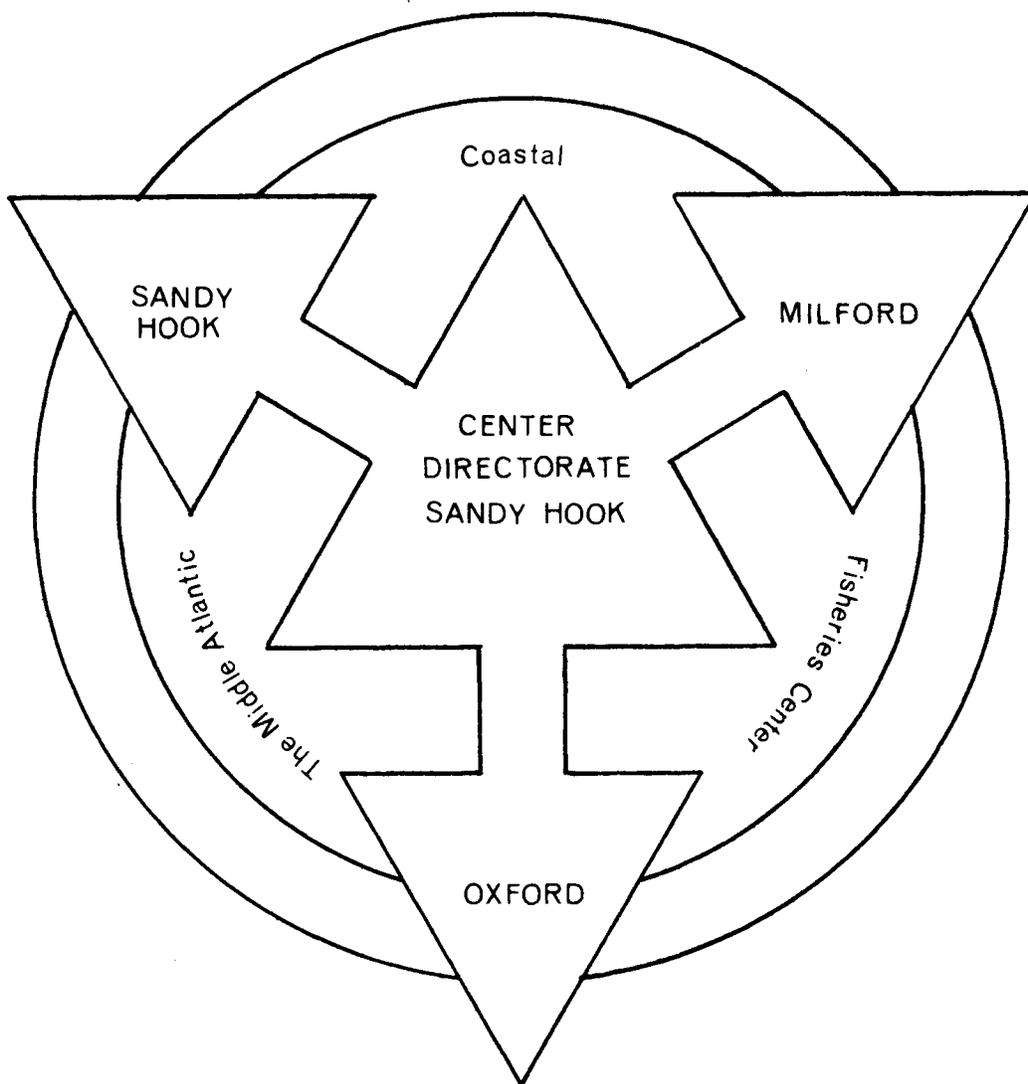


BRIEFING BOOK: MACFC ENVIRONMENT-ORIENTED
MARINE RESEARCH



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

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



Informal Report No. 20

February 1, 1974

BRIEFING BOOK ON THE
ENVIRONMENTAL AND ENVIRONMENTALLY-
RELATED INVESTIGATIONS OF THE
MIDDLE ATLANTIC COASTAL FISHERIES
CENTER, NMFS

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THE MIDDLE ATLANTIC COASTAL FISHERIES CENTER

ORGANIZATION The Middle Atlantic Coastal Fisheries Center is one of a series of research centers established recently by the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U. S. Department of Commerce. Each of these centers represents a consolidation and grouping of several laboratories, often in different geographical locations.

The Middle Atlantic Coastal Fisheries Center is a component of the Northeast Region, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U. S. Department of Commerce. The Center is a consolidation and integration of the Sandy Hook (N.J.) Marine Laboratory, the Oxford (Md.) Biological Laboratory, the Milford (Conn.) Biological Laboratory, and the former Ann Arbor (Mich.) Technological Laboratory (now based at Milford). These units (regrouped and subdivided by disciplines) function under direct line authority of the Center Director, Dr. Carl Sindermann, who is responsible to the Director, NMFS Northeast Region, for broad integrated programs of research on living coastal resources. The Center is composed of a Directorate, an associated centralized Administrative Unit, and four major research units. Research facilities of the Center are located at Sandy Hook, N. J., Milford, Conn., Oxford, Md., and Greenbackville, Va. Center headquarters are at Sandy Hook.

MISSION The mission of the Center is to develop, establish, and to prosecute aggressively an integrated, multi-disciplinary research program on the biology and ecology of the living marine coastal organisms of the North Atlantic Ocean, especially in the zoogeographic area known as the Middle Atlantic Bight. This program is to be carried out in full cooperation with other interested Federal and State agencies, and with local academic and other research institutions. The research responsibilities of the major research units are as follows:

RESEARCH
PROGRAMS

Ecosystems Investigations (Dr. J. B. Pearce, Director of Investigations) are primarily concerned with benthic-zooplankton food chain studies, physiological responses to toxins and organic wastes, zoogeographic distribution of benthic populations, evolution and succession of reef structures, and with surveys and analyses of the effects of man-made environmental changes on abundance and distribution of marine organisms. A major immediate responsibility is the New York Bight area, where such man-made changes are most profound.

Important aspects of ecosystems investigations concern environmental chemistry and microbiology. This work, located principally at the Milford facility, is primarily concerned with the determination of the level of chemical contaminants in marine resources, food chain organisms and in the environment of the marine animals. It is also concerned with the distribution of microorganisms (bacteria, viruses, fungi and algae) in the marine animals, as well as in the estuarine, inshore and marine environment with particular attention to the effects of man-made changes on the flora and the introduction and survival of potential human pathogens in the marine environment.

Resource Assessment Investigations (Dr. A. S. Merrill, Director of Investigations) are primarily concerned with assessment of abundance, distribution, and surplus yields of important coastal fish and shellfish species of the Middle Atlantic Bight and adjacent waters. Fisheries biological studies constitute an important aspect of the investigations. Included are: studies of life histories, distributions, migrations, physiology and behavior of coastal species of the Middle Atlantic Bight and adjacent waters; subpopulation studies using immunogenetic and biochemical techniques, statistical and geographical inventories and atlases of marine sportfish; and larval fish distribution, abundance, and physiology.

Experimental Biology Investigations (Dr. J. E. Hanks, Director of Investigations) are primarily concerned with genetic manipulation of selected mariculture species and with mutagenesis related to environmental factors; as well as with experimental studies of the effects of environmental factors, natural and man-made, on growth, development, behavior, and survival of marine fish and shellfish.

Pathobiology Investigations (Dr. A. Rosenfield, Director of Investigations) are primarily concerned with pathogens which affect living marine resources, with environmental influence on marine diseases, with assessment of the impact of diseases on such resources, and with effective methods of control of diseases in mariculture.

CRITICAL PROBLEM AREAS The Middle Atlantic Coastal Fisheries Center, because of the nature of existing staff competence and location of facilities, is admirably suited for the development and execution of integrated programs of coastal fisheries research. Among the critical problem areas to be confronted are: effects of increasing levels of pollution and other man-made environmental changes on the survival and abundance of fishes; biology, ecology, and behavior of species whose distribution or migration extend beyond State boundaries; study and surveillance of living resources within the 12-mile contiguous zone; study of trends in coastal fisheries production -- both recreational and commercial, and determination of causes for certain obvious declines in abundance and shifts in centers of abundance; and assessment of the impact of disease on marine animals.

Critical immediate problems which occupy the attention of the Middle Atlantic Coastal Fisheries Center at present include: coordination and integration of research efforts of component laboratories oriented toward a few broad programs (e. g. , New York Bight Study; effects of pollutants on fish); increased emphasis on research in coastal fisheries resource problems; development of effective cooperative working relations with other research groups; and development of effective communication with all groups who can use information developed by the Center's research.

ECOSYSTEMS INVESTIGATIONS (SANDY HOOK AND MILFORD)

To an ever greater extent the yield of marine fisheries is dependent upon water quality in coastal marine environments. Anadromous species of fish and shellfish have traditionally been the first species affected by deteriorated coastal and estuarine waters. There seems little doubt, however, that the deterioration of coastal environments is having or will have an effect on coastal and offshore marine species which reproduce in or migrate through coastal and estuarine ecosystems.

The effects of deteriorated environments do not always impinge directly upon commercial and game finfish or shellfish; rather, polluted waters or physically disrupted environments may result in an elimination of or diminution in the standing crops of invertebrates important as forage species in marine food chains or disrupt the flora and fauna which play an important role in stabilizing marine sediments. Finally, invertebrate species, which are often attached forms unable to avoid polluted waters, are excellent indicator organisms which can be used to assess change in environmental quality.

The Ecosystems Investigations program was developed to provide data for a comprehensive overview of the coastal and estuarine environments of the Middle Atlantic Bight. This program includes four closely integrated investigations. The Biological Oceanography Investigation was designed to provide data on baseline distributions and life histories of benthic, natatory and planktonic invertebrates and their relationships to marine and estuarine finfish. The Marine Contaminants and Coastal Ecosystems Investigation is concerned principally with the effects of pollution and environmental deterioration on the living resources of coastal and estuarine ecosystems.

The Environmental Chemistry and Microbiology Investigation consists of several projects designed to quantitate the distribution and abundance of marine microorganisms of heavy metals and other known toxins and their effects on higher plants and animals.

EXPERIMENTAL BIOLOGY INVESTIGATIONS
(MILFORD)

There exists, at all levels of both the public and the private sectors, considerable alarm that the living marine resources of the estuarine, coastal and offshore waters of the Middle Atlantic Bight are being adversely affected by extensive offshore dumping of untreated wastes and by run-offs of highly polluted waters. The mode and intensity of such adverse physiological effects is largely unknown. Baseline findings of marine environmental quality cannot be interpreted without such knowledge nor can rational water quality standards be established or enforced when such knowledge is lacking. Quantitative, controlled exposure experiments, both static and chronic, on living organisms, and involving all stages in their life histories, followed by a battery of analytical tests are necessary to permit evaluation, standards-development, successful enforcement, and resource conservation. The nucleus of such a research team, expert in hatching, rearing and algology and in the physiology, genetics, pathology and chemistry of living marine organisms became available through the termination of a molluscan aquaculture program at Milford Laboratory. Should the aquaculture program be reactivated, these groups could, with a relatively small increment in personnel, service both programs. 1) determine lethal effects of a large variety of known pollutants on the larval, juvenile and adult stages of molluscs, crustaceans, and finfish as well as on marine phytoplankton and benthic fauna inasmuch as these form the base of the food chain for all living marine organisms; 2) determine the long-term sub-acute effects of exposure to a large variety of known pollutants on the larval, juvenile and adult stages of molluscs, crustaceans and shellfish; 3) define the physiological and biochemical pathways affected and relate them to the metabolic disorders, tissue abnormalities, etc., which result in death or permanent damage to the living marine organisms; 4) determine effects of marine pollutants on the chromosomes, and genetic development of the American oyster, *C. virginica*, initially, and on other fish and shellfish. Evaluate findings in terms of specific pollutants and of population genetics.

PATHOBIOLOGY INVESTIGATIONS
(OXFORD)

Disease- and parasite-induced mortalities are among the paramount factors limiting the abundance of marine fish, crustaceans, and mollusks. Mass mortality of aquatic animals grown under intensive controlled culture conditions is often a consequence of disease. Host susceptibility to disease is directly influenced by environmental stress and there are no ways of knowing what stresses are significant in limiting populations without studying their effects upon the animals themselves. Adequate knowledge of disease prevalence, whether nutritionally, genetically or environmentally induced, is fundamental to the success of resource assessment, prediction and management and, where necessary, for preventative legislation.

One must recognize that it is the exception rather than the rule for abnormalities (pathoses) or mortalities (during any stage of the animal's life history) to be caused by any single extrinsic or intrinsic factor acting alone. Rather, it is usually a combination of infectious and/or noninfectious factors acting competitively, sequentially, complementarily, or synergistically on or in these animals to modify their behavior, physiology, growth, development, reproduction or to render them more susceptible to the same or still other infectious and non-infectious agents or predators.

The Pathobiology Investigations group is composed of two units: Experimental Pathobiology Investigation and Comparative Pathobiology Investigation. Two additional units, Disease/Mariculture Investigation and Disease/Stress-Induced Investigation, are in the planning stages. By employing both comparative observational and experimental studies and team approaches, disease research on marine organisms will be conducted with the present Pathobiology Investigations staffs at the Oxford facility. Primary emphasis will continue to be placed on studies of problems related to infectious disease.

The Pathobiology Investigations at Oxford Laboratory have long recognized the need to study the causes of mortalities of all marine animals, and have been pioneers in disease studies. Originally with mollusks, recently with crustaceans, and presently with fish, the Investigations will continually expand their research efforts to effect a multispecies approach to the study of disease. A multispecies study of disease has been substantially more productive than limiting the research effort to only a single species, since from the aspect of comparative and experimental pathology, invaluable basic information has been acquired on both disease processes and defense mechanisms.

ROLE OF THE MIDDLE ATLANTIC COASTAL FISHERIES CENTER IN THE NOAA NEW YORK BIGHT STUDY

It is now almost universally recognized that the nearshore waters of the oceans cannot be considered simultaneously as a stable source of living resources and as a waste disposal area. The ecosystems of the sea are resilient up to a point, but man's rapid encroachment into and degradation of inshore waters lead to genuine fear for the continued productivity of such waters.

Environmental degradation resulting from man's activities has readily observable effects on the inshore marine ecosystems, and on the living resources which are integral parts of that ecosystem. Such effects are usually negative, resulting in reduction in quantity and quality of products derived from the degraded environment. While we may feel, intuitively, that harmful changes result from environmental contamination, it is necessary to develop a body of demonstrated facts to support or refute any suppositions we may make. Vital to this development is establishment of a baseline of present information about distribution and abundance of living resources; determination of rates of change, as derived from historical data, present surveys and future monitoring; and experimental verification of effects of environmental factors such as pollutants on living organisms.

Of particular importance are assessments and analyses of changes and rates of changes, in environmental factors such as abundance of food chain organisms, and in abundance and distribution of fish and shellfish -- as influenced by changing environmental conditions. Some of the necessary background data are available from earlier research; other data will be acquired during the course of the New York Bight project. Experimental studies are essential in providing a link between observed population changes and the causes of such changes.

In the New York Bight, there have been few investigations of productivity and ecosystems structure. Although some recent preliminary effort has been directed toward the measurement of energy conversion rates for selected marine gamefish, a much more ambitious program will eventually be required to understand primary productivity and the various efficiencies and interactions at trophic levels within the biotic components of the ecosystem. Some definition of energy pathways and efficiency of conversion rates will be developed by component researches of the entire New York Bight program.

NOAA, as the federal agency concerned with the quality, quantity, and effective management of living marine resources, must address itself specifically to those environmental factors such as pollution which affect the resources negatively. On the other hand, there may be positive effects of man's activities on ocean resources (such as increased growth rates or increased productivity) which must also be examined. The intimate relation of ocean ecosystems with production of food makes it imperative that a broad approach to marine environmental problems be maintained.

The New York Bight, an area of the world's oceans severely degraded by human activities, is an excellent location for intensive examination of the impact of environmental changes on living marine resources, since we may learn the most from waters that we have insulted the most. The biological program for the New York Bight therefore contains the following principal elements:

- (1) Establishment of biological baselines by an intensive examination of distribution and abundance of resource and food-chain organisms; and determination of rates of change in populations by compilation and analysis of existing historical data, as well as data obtained by ongoing and planned surveys;

- (2) Description of the present levels of principal pollutants in water, sediments, and living organisms; and

- (3) Determination by controlled laboratory experiments of the effects of pollutants in various concentrations on living resources, at many stages in their life histories and during various exposure times.

When biological information is combined with that developed by other NOAA components -- physical and chemical oceanography, sediment analyses, etc. -- it should be possible to (1) provide greater understanding of the impact of existing man-induced changes on living marine resources; (2) describe the effects of particular contaminants singly or in combination on living organisms including specific aspects of disease; and (3) develop an initial predictive model for use in the Bight and elsewhere of the impact of pollutants on marine ecosystems.

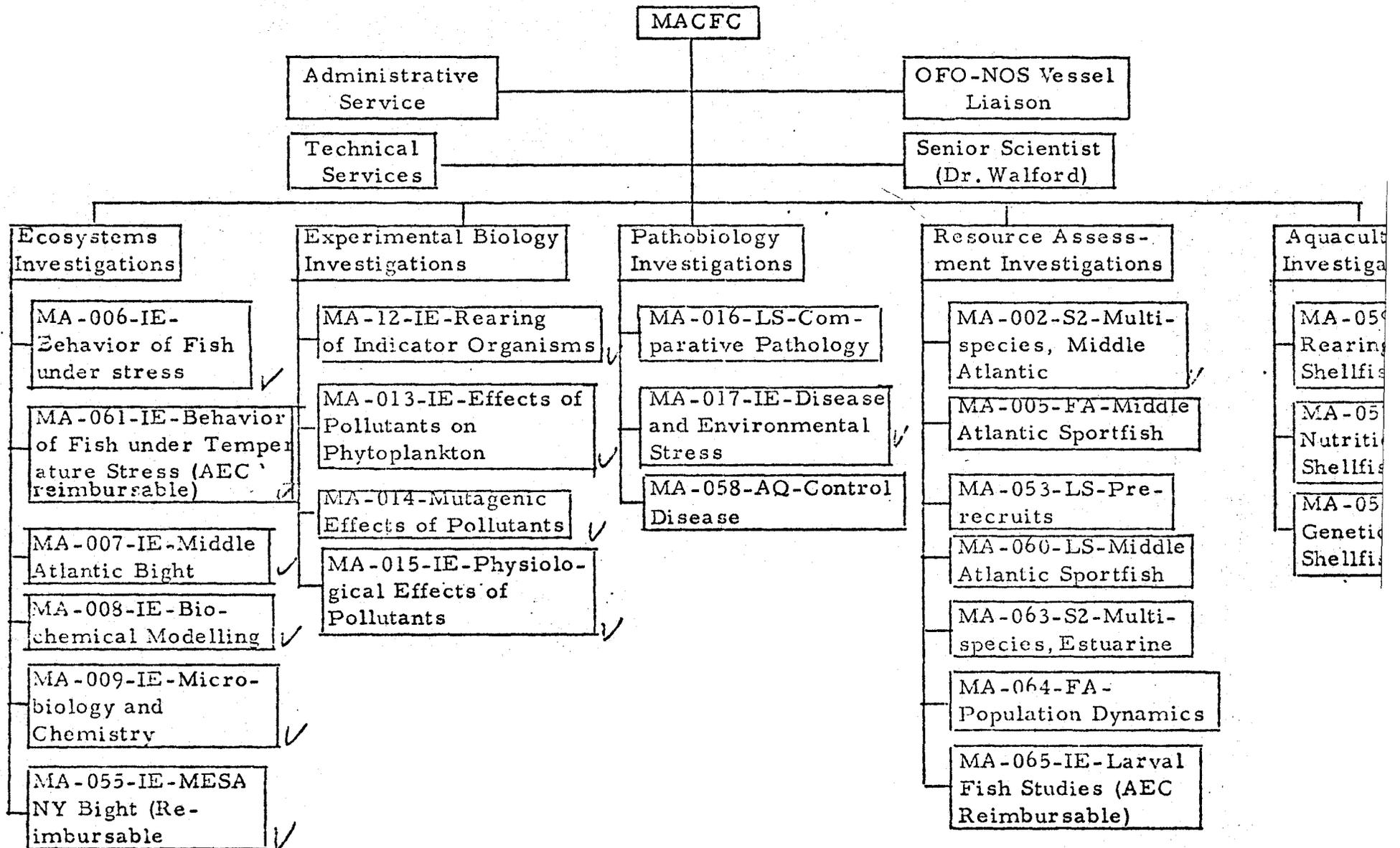
Information will be of significant value to many user groups, including ocean industries of all kinds, sewage treatment districts and engineers, municipal and regional land and water use planners, Environmental Protection Agency (EPA), Food and Drug Administration (FDA), Corps of Engineers, River Basins Commissions, state fisheries and environmental management departments, citizen conservation groups, fishermen and fishery industries, and groups concerned with developing models of ocean systems. Information will be summarized, analyzed, and presented in as many forms as possible, to best meet the needs of diverse user groups.

The National Marine Fisheries Service, through its Middle Atlantic Coastal Fisheries Center (NMFS/MACFC) has substantial ongoing research in the New York Bight. Other federal agencies (EPA, FDA, Corps of Engineers, etc.) conducted specialized research. Through the NOAA/New York Bight program it should be possible to expand the work significantly -- both the in-house and that supported by contracts. The project should provide the proper vehicle to bring broad capabilities -- governmental as well as academic -- to focus on the problem of the impact of man-induced environmental changes on marine ecosystems and on living marine resources.

It should be clearly understood that a substantial body of largely uncorrelated information about the New York Bight already exists, and that there are ongoing programs of research -- governmental and academic. NMFS/MACFC has been and is one of the principal participants in pollution-oriented research in this area. From work carried out to date has emerged much significant

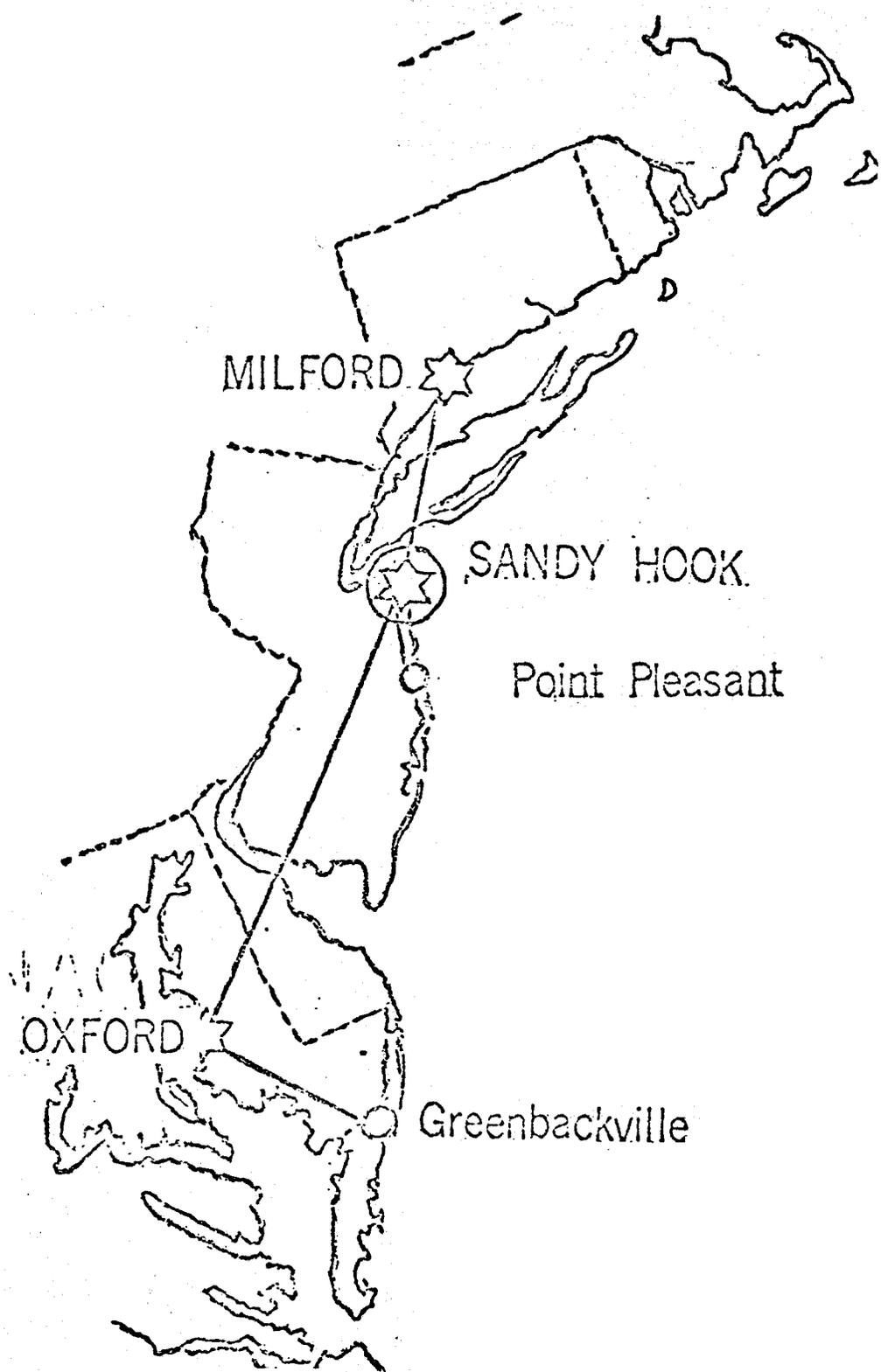
information, such as the well-documented deleterious effect of ocean dumping on the benthos of the continental shelf in the vicinity of the dump sites (see the following summary report), and the significant decline in landings of many species of fish in the general New York Bight area. During the course of the New York Bight project it should be possible to correlate all existing data and to add significantly to it, to provide a much clearer understanding of man's impact on the nearshore environment and its resources.

TASK-ORIENTED ORGANIZATION CHART, MACFC, FY 1976^{1/}



^{1/} Assumes full funding of all indicated FY'76 increases

✓ indicates task directly involved in ecological studies



FACILITIES OF THE CENTER

Laboratory facilities of the Center are located at Sandy Hook, New Jersey, Oxford, Maryland, and Milford, Connecticut, with a substation at Greenbackville, Va. The Center's ocean operations are carried out on the research stern trawler "Delaware II", as well as a number of intermediate and smaller vessels. Administration and data processing are centered at Sandy Hook, and the Delaware II is based there.

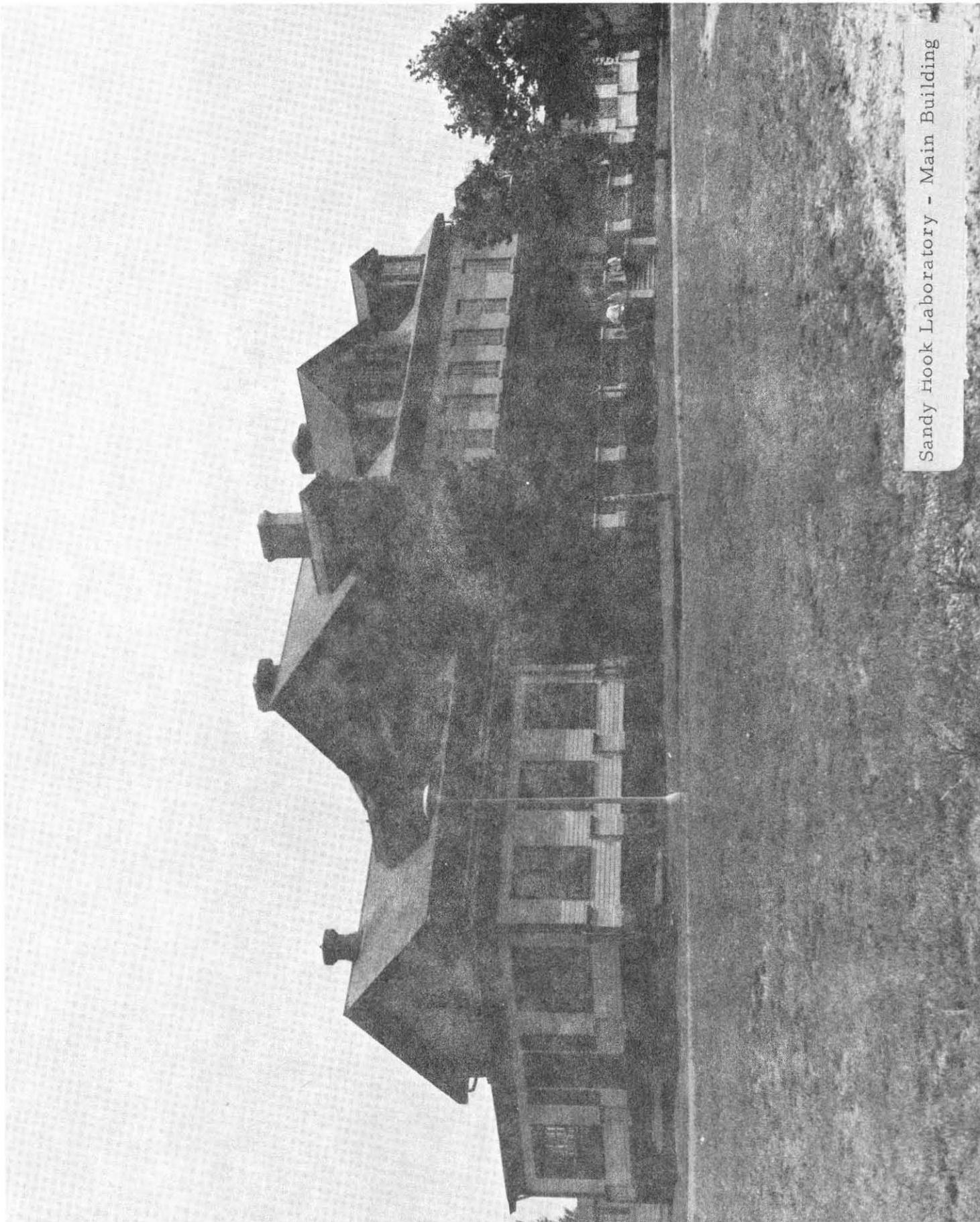
SANDY HOOK LABORATORY

This laboratory is in northern New Jersey on the narrow peninsula of Sandy Hook, which separates the Atlantic Ocean from Sandy Hook Bay. The main building is a former hospital with floor area of 30,000 sq. ft. on four floors. An annex adds some 20,000 sq. ft. of laboratory and office space.

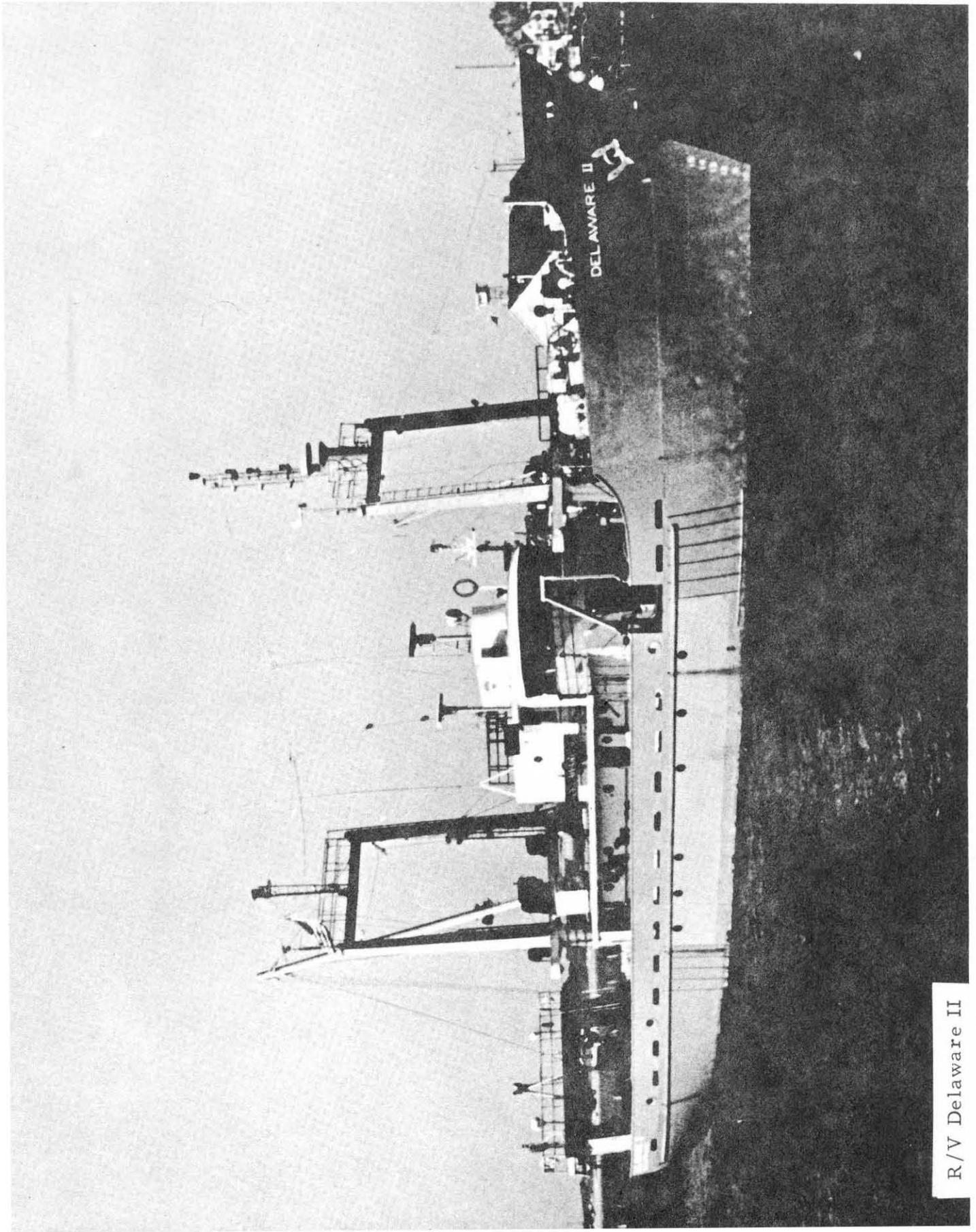
The laboratory facilities include dormitory, shops, offices, library, conference rooms, darkroom, aquaria and laboratory suites for chemistry, microbiology, fish behavior, benthic and plankton studies. There are special laboratories for phytoplankton culture, fish culture, experimental ecology of invertebrates, and for the effect of environmental factors on behavior and survival of marine organisms.

The main building is supplied with sea water pumped through a well point in the bay bottom. Aquarium facilities include a 32,000 gallon sea tank with complete environmental control for behavioral studies. Other aquaria range from 30 to 3,000 gallons capacity.

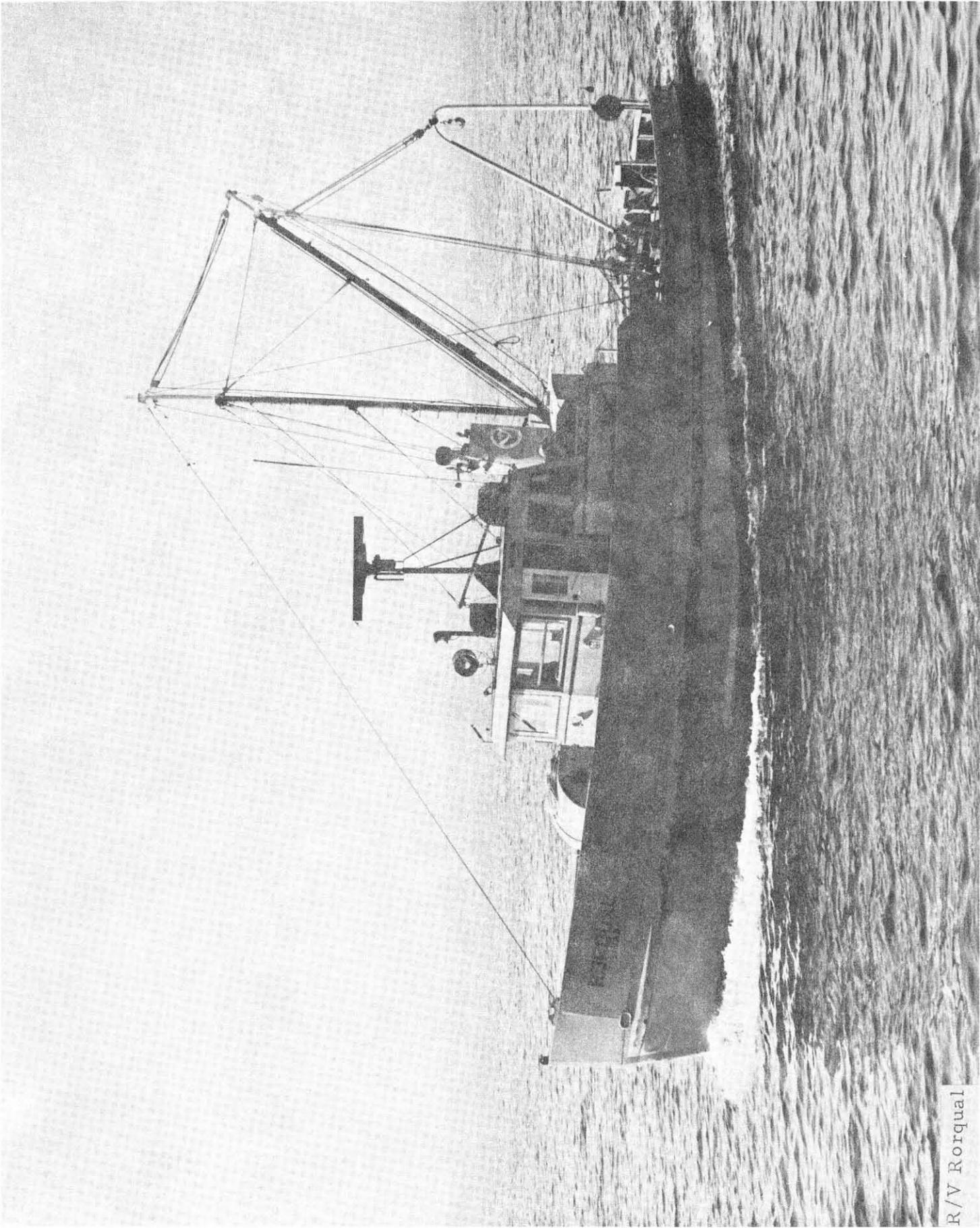
Vessels are berthed at deepwater piers near the laboratory. The docking area includes a large pier for the Delaware II and protected berths for the Rorqual and smaller boats. A pier shed combines diving locker, storage, and shore power supply.



Sandy Hook Laboratory - Main Building



R/V Delaware II



R/V Rorqual

MILFORD LABORATORY

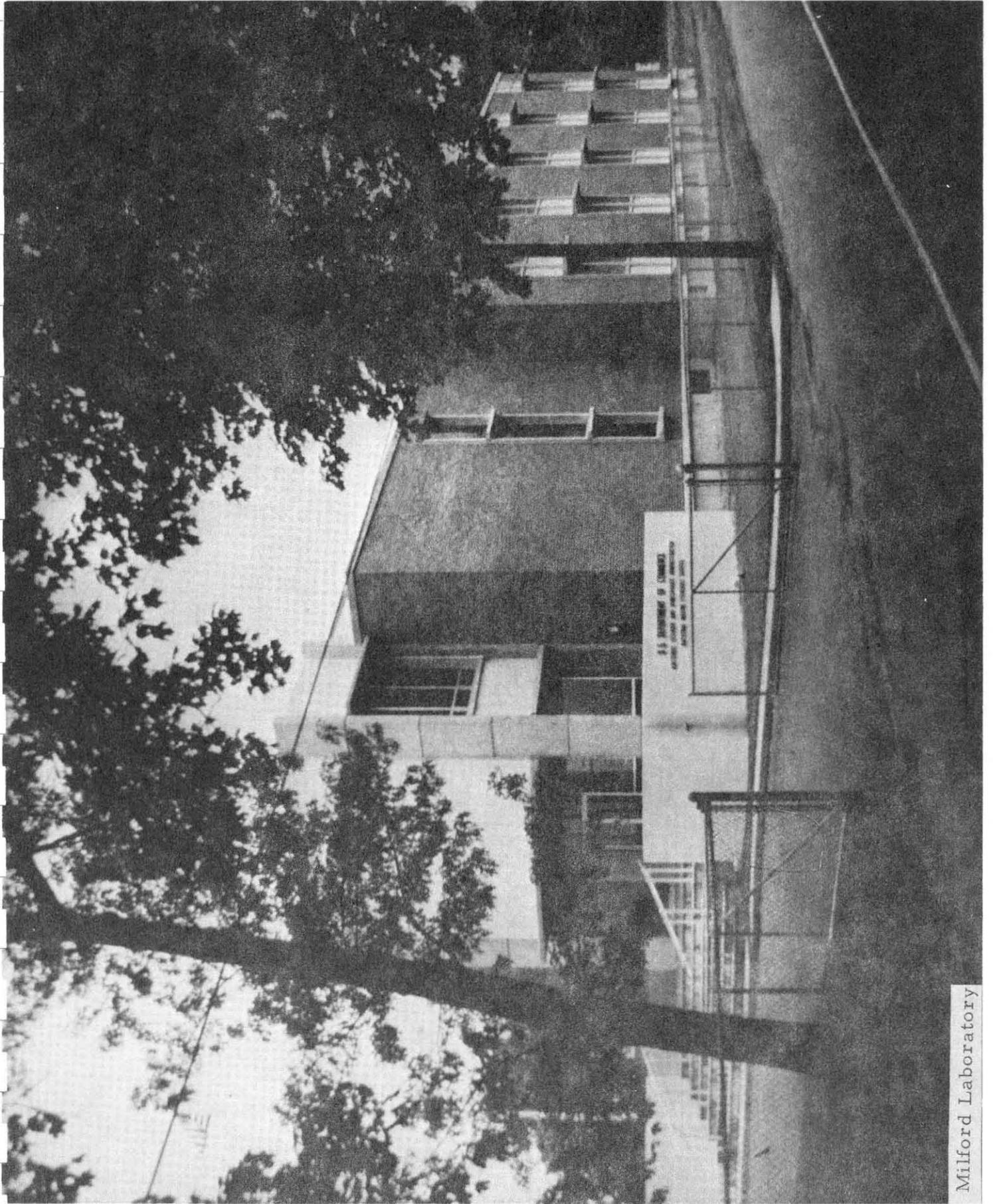
The Milford Laboratory, established in 1931, is located on Milford Harbor, a short distance from the open waters of Long Island Sound, within a short distance of mud flats, salt marshes, salt-water embayments, and tidal estuaries with bottom types ranging from soft mud to hard sand and rock.

A modern, three-story laboratory building was completed in 1966. It has more than 28,000 square feet of floor space and contains 17 research laboratories, an experimental shellfish hatchery, administrative offices, a combined library-conference room, and a lobby-display area. Each laboratory can be supplied with up to 100 amps of electrical energy, hot and cold running sea water, hot and cold domestic water, fresh well water, natural gas, and compressed air. Eleven of the research laboratories have constant temperature water tables. Two additional rooms, one for algal stock cultures and one for mass culturing of algae can be maintained at 55°F the year round.

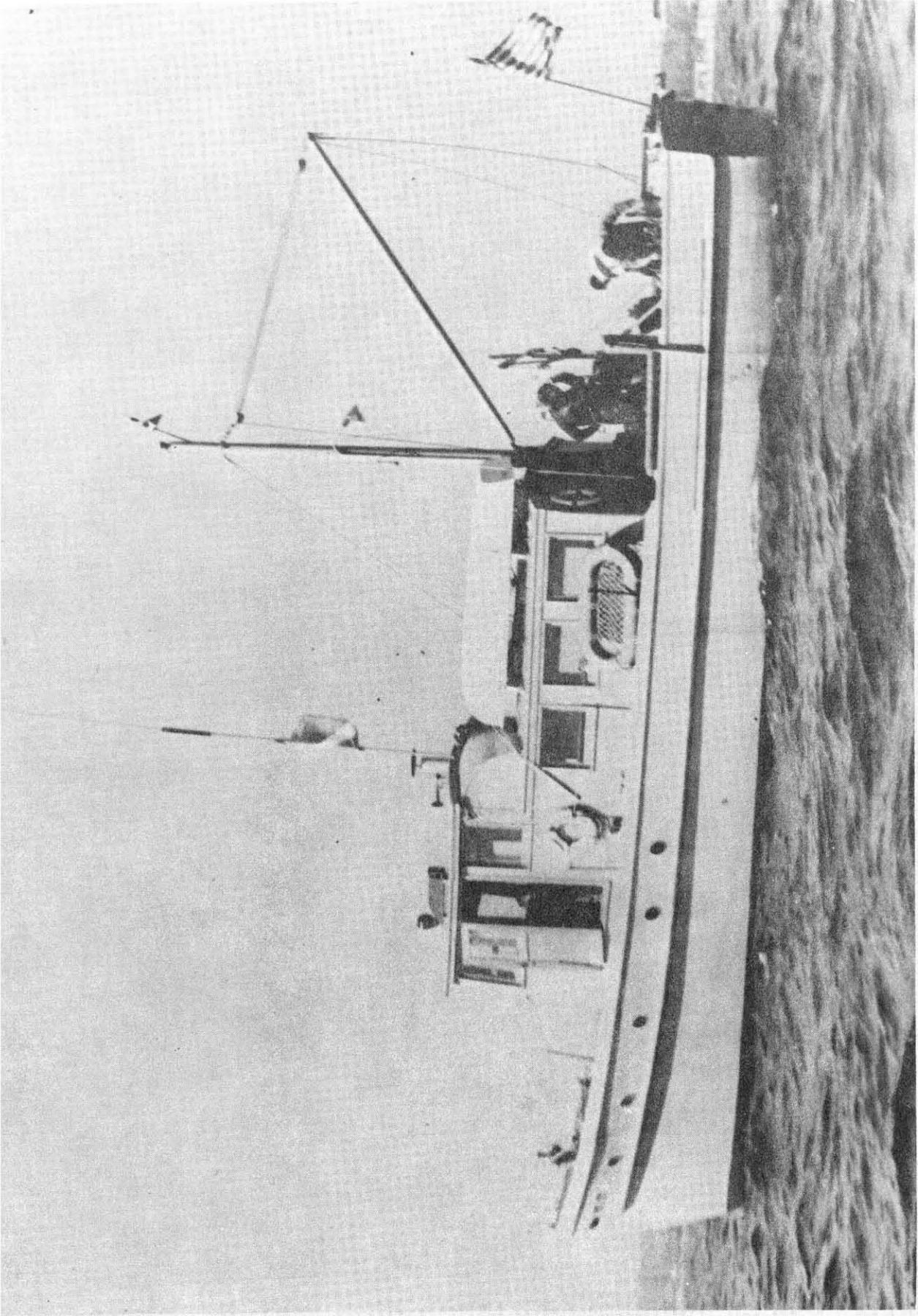
A tank farm of 54 fiberglas tanks, 30 feet by 4 feet by 18 inches, was completed in 1969. These tanks are used for rearing, holding, and experimentation with oysters and clams.

Research of the laboratory has concentrated on development of biological information and techniques important to mariculture. Emphasis has been placed on seed oyster production and predator control. More recent studies have emphasized the effects of pollutants on survival and well-being of marine animals -- particularly in their young stages.

The Laboratory operates a 50-foot research vessel, the Shang Wheeler. It has standard hydrographic gear and dredge equipment for sampling bottom organisms. A small laboratory on the main deck can accommodate four to six scientists.



Milford Laboratory



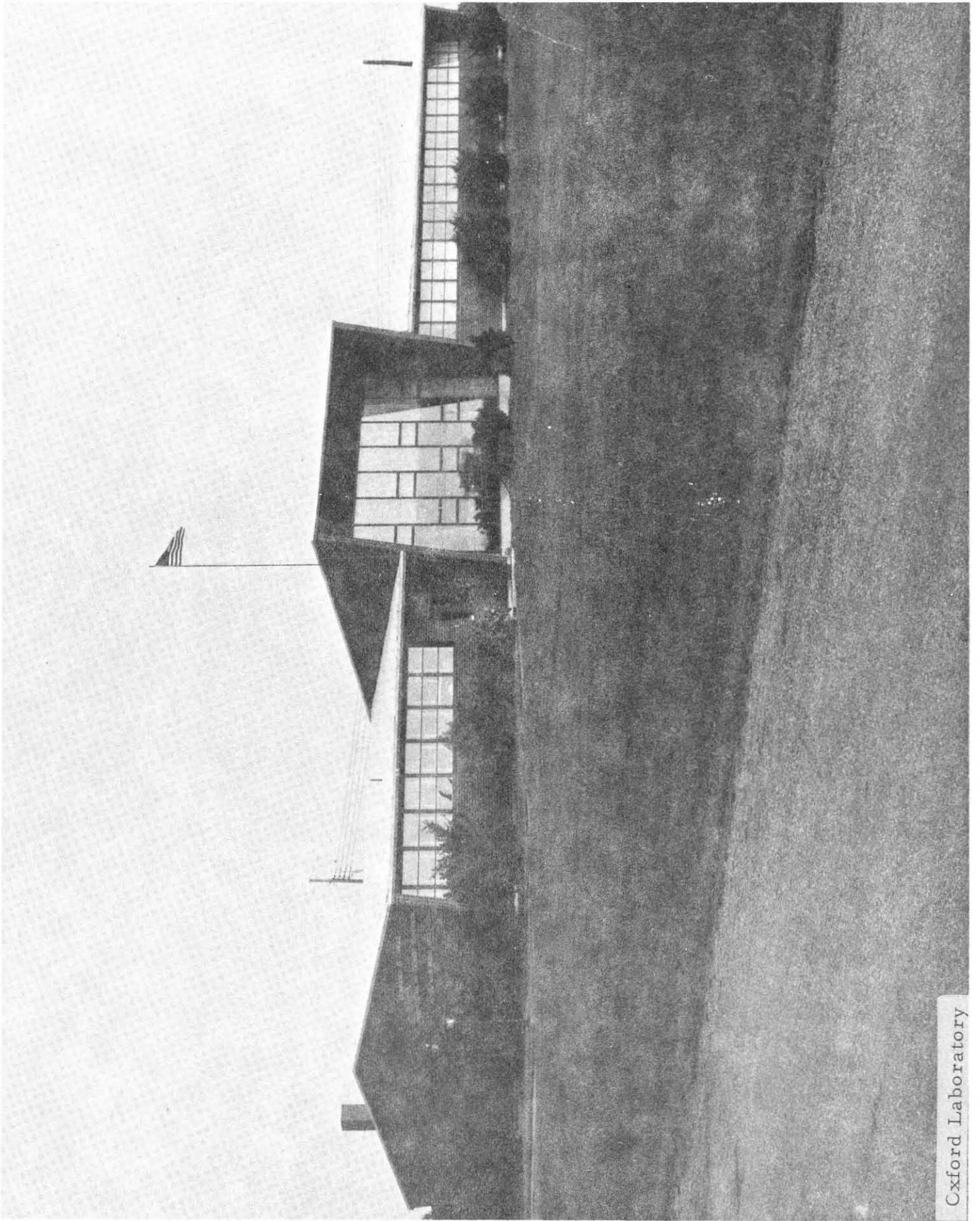
R/V Shang Wheeler

OXFORD LABORATORY

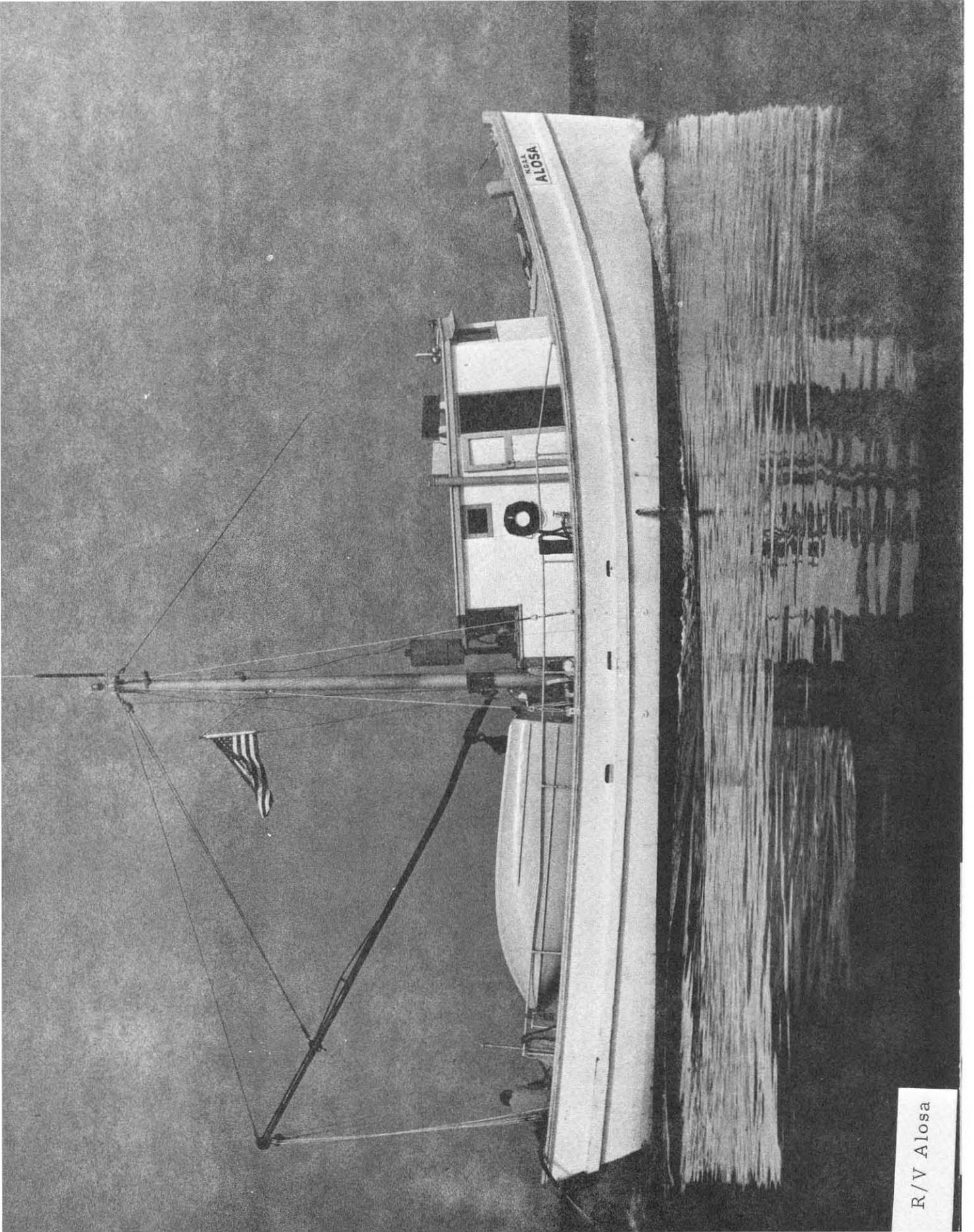
The Oxford (Md.) Laboratory is located on the eastern shore of Chesapeake Bay, probably the most important estuary on the United States east coast. The Bay is an excellent breeding, nursery, and feeding ground for many sport and commercially important fishes. In the ocean adjacent to this area and in seaside bays are surf clams, hard clams, crabs, and many fish species of recreational and commercial importance.

The laboratory, built in 1960, has 13,000 square feet of floor space for chemical, microbiological, environmental, histological, and immunological studies; and two rooms with running estuarine water supplying a series of indoor and outdoor tanks. Office space, a conference room, and an excellent library are included in the main building. Other adjacent facilities comprise a shop-storage building, a small laboratory building for visiting investigators, an animal house, a greenhouse for culturing algae, and 4 one-quarter-acre earthen ponds for shellfish culture in a controlled environment.

Present investigations are concerned directly with pathology and resource assessment (with emphasis on invertebrates). Strong emphasis has been given to research on problems of shellfish mortalities, including identification and life histories of pathogens, control of predators, and the effects of environmental changes. Close liaison is maintained with State research and management agencies, and the shellfish industries. Research programs have concentrated on the oyster Crassostrea virginica, and the surf clam, Spisula solidissima.



Oxford Laboratory



R/V Alosa

EXISTING SPECIALIZED FACILITIES NMFS

The existing statutory marine mission requirements have dictated the development or purchase of highly specialized equipment and facilities. Such equipment is uniquely useful in studies of the physiological effects of pollutants on living marine organisms.

The following are listings of such specialized facilities at the Sandy Hook and Milford Laboratories.

Sandy Hook Laboratory:

1. Fish Behavior (Environmentally controlled) Tanks.
2. Large Ocean-going Vessels (R/V Delaware, R/V Rorqual).
3. Benthic Faunal Sorting Facility.
4. Small-boat Fleet.

Milford Laboratory:

1. Raw Sea-water Treatment Facility.
2. Sea-water Reservoir Facility.
3. Acute/Static Exposure Facility.
4. Chronic/Continuous-flow Exposure Facility.
5. Waste-water Treatment Facility.
6. Larval Food-Supply Facility.
7. Mutagenicity Survey Facility (Expansion planned).
8. Egg, Larval and Adult Rearing and Holding Facility.
9. Small Vessel.

RATIONALE FOR INVOLVEMENT OF NOAA/NMFS IN MARINE ENVIRONMENTAL STUDIES

1. The National Oceanic and Atmospheric Administration has statutory responsibility for (1) the management of living marine resources, (2) the management of the coastal zone, and (3) for management of offshore dumping practices. In turn, most federal agencies have recognized the lead agency status of NOAA in matters dealing with the marine environment.

In the case of management of living marine resources, NOAA has delegated this responsibility to the National Marine Fisheries Service. Responsibility for management of the coastal zone and of offshore dumping practices has been delegated to NOAA's Office of Coastal Zone Management. Both of these NOAA organizations look to the Middle Atlantic Coastal Fisheries Center for the biological research and recommendations necessary for management decisions in the Middle Atlantic Ocean.

2. Implicit in the anticipated management decisions are socio-economic impacts which for the Middle Atlantic Bight alone, will directly involve literally millions of users of the marine environment and untold billions of dollars. Such decisions will involve local, municipal, county, state, national and international deliberations. With respect to management of the coastal zone, management of offshore dumping practices and management of the living marine resources NOAA possesses, to a greater or lesser degree, certain regulatory authorities. Only NOAA possesses the wide variety of skills, scientific disciplines, specialized facilities and equipment necessary for the comprehensive, scientifically adequate understanding of the marine environment necessary for management decisions and enforcement.

3. All of the research underway in the Middle Atlantic Coastal Fisheries Center is responsive to one or more of these statutory responsibilities. Indeed, all work underway fits one or more of the management objectives approved by the Office of Management and Budget for NOAA and its subsidiary organizations.

4. Management of living marine resources required a thorough knowledge of the environmental factors which govern spatial distributions and natural mortalities of marine organisms - as one basis for predicting future abundances and harvestable surpluses. Consequently, NMFS routinely collects ancillary physical and chemical oceanographic data and attempts to correlate these data with fluctuations in abundances and spatial distributions of marine organisms as well as with observed mortalities of these organisms. In addition, NMFS has long been interested in preserving natural marine habitats from the effects of man-induced, mortality-causing changes. Prior to 1970, NMFS, and its parent agencies, were the only organizations which, by mission and by need, supported environmental quality research in the offshore marine waters.

5. The fisheries organizations have as a result a long and honorable tradition of public service in this area, dating back to warnings in the 1880's as to the adverse effects on living marine resources of hydrographic leakages into Raritan Bay, as to the adverse effects of river dumping and clamming practices on anadromous fisheries stocks, on the effects of wetlands development on stocks of estuarine-dependent marine fishes, of the dangers to the living marine resources and to the public health of inadequate sanitary treatment of sewage discharges.

THE ROLE OF EPA IN THE MARINE ENVIRONMENT

The sole statutory responsibility of EPA in the marine environment is that of assurance through enforcement of water quality. In marine ecology, this is only one aspect of the infinitely complex interaction of the physical, chemical and biological components of the marine universe. Data necessary for the development and enforcement of marine water quality standards will routinely be available through necessary physiological, ecological and oceanographic research now performed by NOAA and its subsidiary organizations. NOAA has publicly and repeatedly expressed its intention to turn over all such data to EPA for its use in standards development. While EPA, at higher levels, may be receptive to this procedure, repeated experiences with lower-level staff members indicates that a strong policy thereto does not exist at all EPA levels. Thus, we find EPA studying alternate dump site areas within the NOAA-MESA ocean research area, EPA personnel consulting with NMFS personnel to construct finfish behavioral facilities duplicative of those long in use for environmental research at our Sandy Hook Laboratory. One EPA study is, in fact, mounted and prosecuted from a research Center located in Corvallis, Oregon.

A satisfactory division of labor was tacitly recognized by the parent agencies of the Environmental Protection Administration (EPA) and the National Oceanic and Atmospheric Administration (NOAA). Thus, the former restricted their activities to fresh-water areas and run-offs while the parent fisheries organizations studied the quality of the marine environment as a necessary prerequisite for the conservation of living marine resources. Indeed, this was the basis upon which the reprogramming of the Milford Laboratory to controlled studies on the effects of pollutants upon the physiology, mutagenesis and pathology of living marine organisms was approved by OMB, EPA signed a formal agreement that no real duplication of effort existed or was planned. In the recent past, this division of labor has been gradually discarded by EPA, until now we find them planning and, in many cases, staffing up for and prosecuting programs in the offshore marine environment for which adequate facilities, staff and programs already exist in the fisheries and oceanography organizations.

Inasmuch as the environmental quality investigations of NMFS are much more broadly based than are those of EPA, i.e., induced changes in behavior, migrations, pathology and in the physiology of living marine organisms, and are being prosecuted from a broader base of specialized facilities and knowledge, a rational management procedure for EPA would be to support NOAA as the lead research agency, contingent upon receipt of data for standards development, and to use its scarce personal resources in other environmental problem areas.

SYNOPSIS OF SCOPE AND EXPERIMENTAL PARAMETERS OF CENTER'S ECOLOGICAL INVESTIGATIONS

The fundamental mission of the Middle Atlantic Coastal Fisheries Center is to gain the detailed knowledge of living marine resources (both commercial and recreational) necessary to make recommendations for the management and allocations of these resources. Such knowledge must include information on natural and man-induced mortalities and/or fluctuations in abundance and in spatial and temporal distributions. To the extent that these mission-oriented needs involve considerations of hydrographic, ecological, physiological and pathobiological conditions the Center's four major Investigations research units are integrated, permitting maximum information for all scientific disciplines from each cruise, providing compatible ADP data management and affording multi-variate correlations of scientific observations hitherto impossible to achieve.

The classical reasons for declines in fish and shellfish abundances are (1) overfishing, (2) epizootics, and (3) degraded environments. There is every evidence that two or more of these conditions prevail in the waters of the New York Bight and in immediately contiguous waters of Raritan Bay and Long Island Sound. The traditional hydrographic observations taken by resource assessment investigations are totally inadequate to assess the impacts of conditions #2 and #3 above.

The Center has therefore initiated extensive ecological baseline studies (1) to supplement the usual hydrographic information, (2) to supply information to NMFS/Water Resources necessary for responses to Environmental Impact Statements, (3) to form a base against which to measure future changes in marine habitat, and (4) to relate controlled studies on the physiological effects of pollutants on living marine organisms to conditions prevailing in the ocean waters.

The intensive field phase of the baselines studies on Long Island Sound was completed in September, 1973, with the termination of the third quasi-synoptic cruise. Chart #1 illustrates the 158 grid-oriented stations occupied. The transects were spaced at 5° (3.7 miles intervals) and stations on each transect were spaced at 2-3 mile intervals. Table #1 affords information on all experimental variables involved. This work is supportive to and partially funded by the New England River Basins Commission. The report, scheduled for May, 1974,

will form a major basis for future decisions on usage of the Long Island Sound. All data are to be included in the Center's data bank and will be available for incorporation in resource assessment correlations.

The intensive field phase of the Raritan Bay (includes Sandy Hook Bay and Lower New York Bay) study will be completed in the near future. Chart #2 illustrates the grid-oriented stations occupied. Table #1 affords information on all experimental variables involved. This work is supportive to and partially funded by NOAA/MESA New York Bight Project. All data are being included in the Center's data bank and will be available for incorporation in resource assessment correlations. To utilize this information, to locate, more precisely, the epicenter of the fin rot epizootic and to establish guidelines for future planned contractual estuarine resource assessment (Raritan, Delaware and Chesapeake Bays), monthly "riverine" resource assessment cruises will be initiated in Raritan Bay during June, 1974.

The intensive field phase of the baseline studies along the entire nearshore coast of New Jersey was performed as an adjunct to a State-Federal financed census of the abundances and distributions of immature, inshore surf clams. Some 246 stations from Sandy Hook to Cape May were occupied and sampled during the summer of 1972. A formal report on the surf clam stocks has been submitted. Laboratory studies of the ecological samples are in process; progress has been slower on these analyses than on other baseline studies due to inadequate funds and lack of personnel. All data are being deposited in the Center's data bank where it will be available for incorporation in resource assessment correlations. (Chart #3)

The intensive field phase of MESA activities in the apex of the New York Bight are scheduled for completion during calendar year 1974. Chart #4 illustrates the 103 grid-oriented stations being occupied. Transects are spaced at 3 n. mile intervals and the stations on each transect are at 2 n. mile intervals. All stations have been occupied for the summer, fall and winter seasons. Table #1 affords information on all experimental variables involved. This work is supportive to NOAA and is almost wholly funded by MESA-NYB. Two quarterly reports have been submitted thus far. All work is either on schedule or only slightly and temporarily behind. All data are being included in the Center's data bank where it will be available for incorporation in resource assessment correlations.

Future MESA operations will include the offshore waters of the New York Bight outside of the currently studied apex. No stations or transects have yet been established.

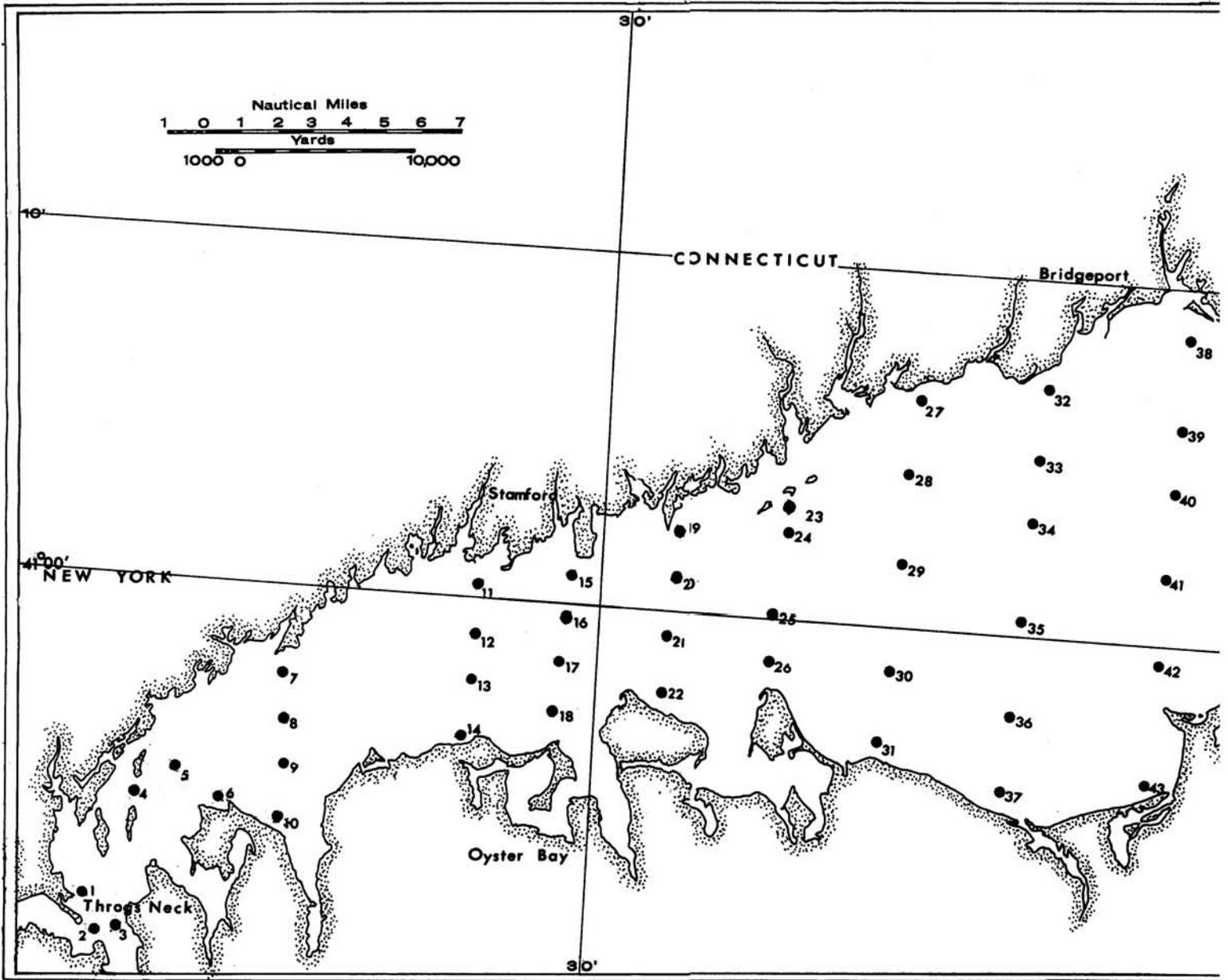
This report has thus far emphasized the field operations. For each such field station occupied, it is conservatively estimated that from 200 to 300 man-hours of work, in-house or contractual, in the laboratories are required. As of December 30, 1973, all laboratory work on all parameters listed in Table #1 were on or only slightly and temporarily behind schedule.

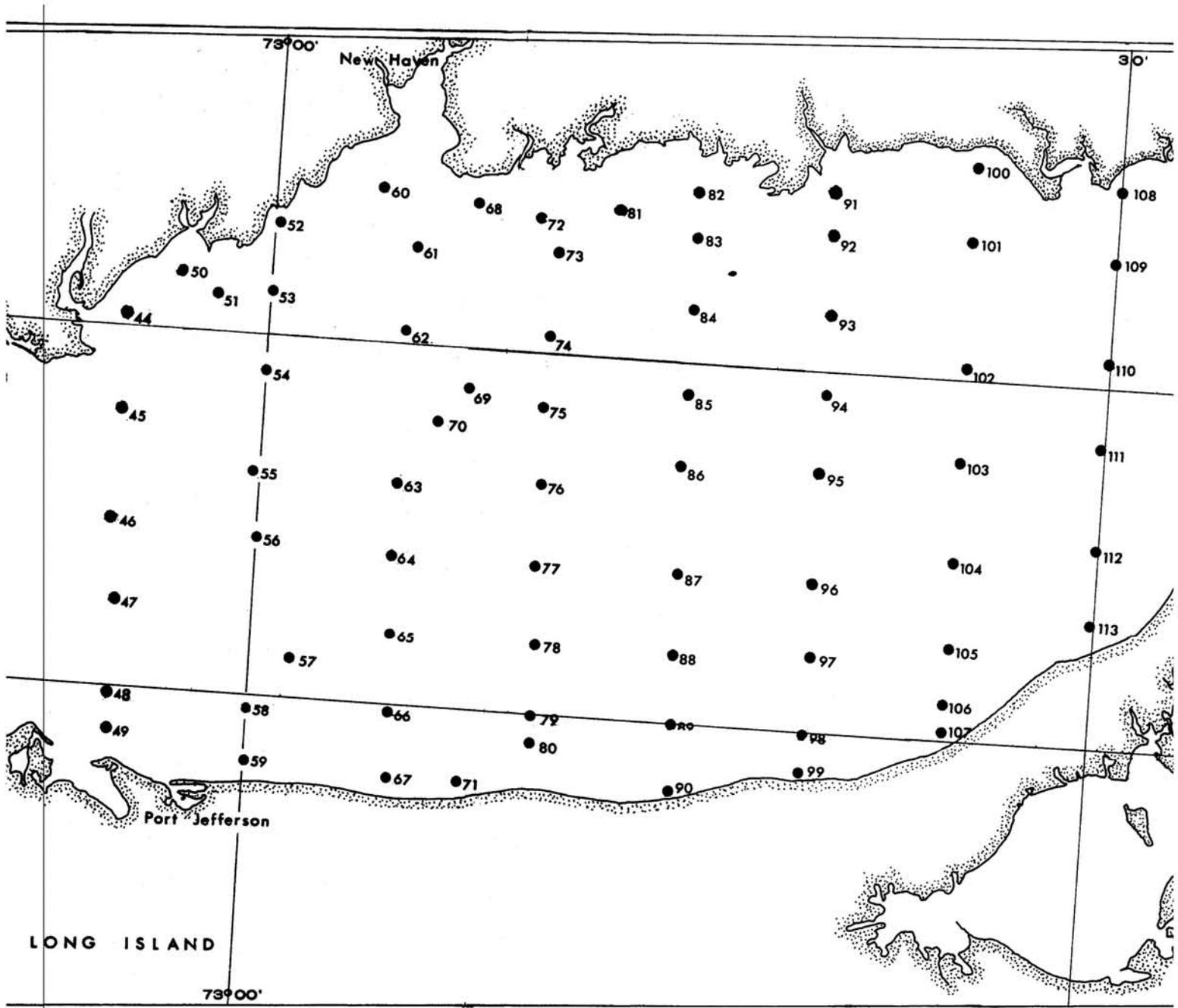
It is important to understand that the accumulation of the data resulting from these current studies and from other previously completed studies will afford a comprehensive documentation of the present condition of the marine environment of the entire New York Bight and its contiguous waters, the most complex and most untimely used and abused marine environment in the northern hemisphere. These documents, as developed, will be made available to local, State and Federal officials and decision-makers involved in multi-use planning for the marine environment. At that time, NMFS/MACFC activities in the area will consist of monitoring operations necessary for detection of further changes in the environment.

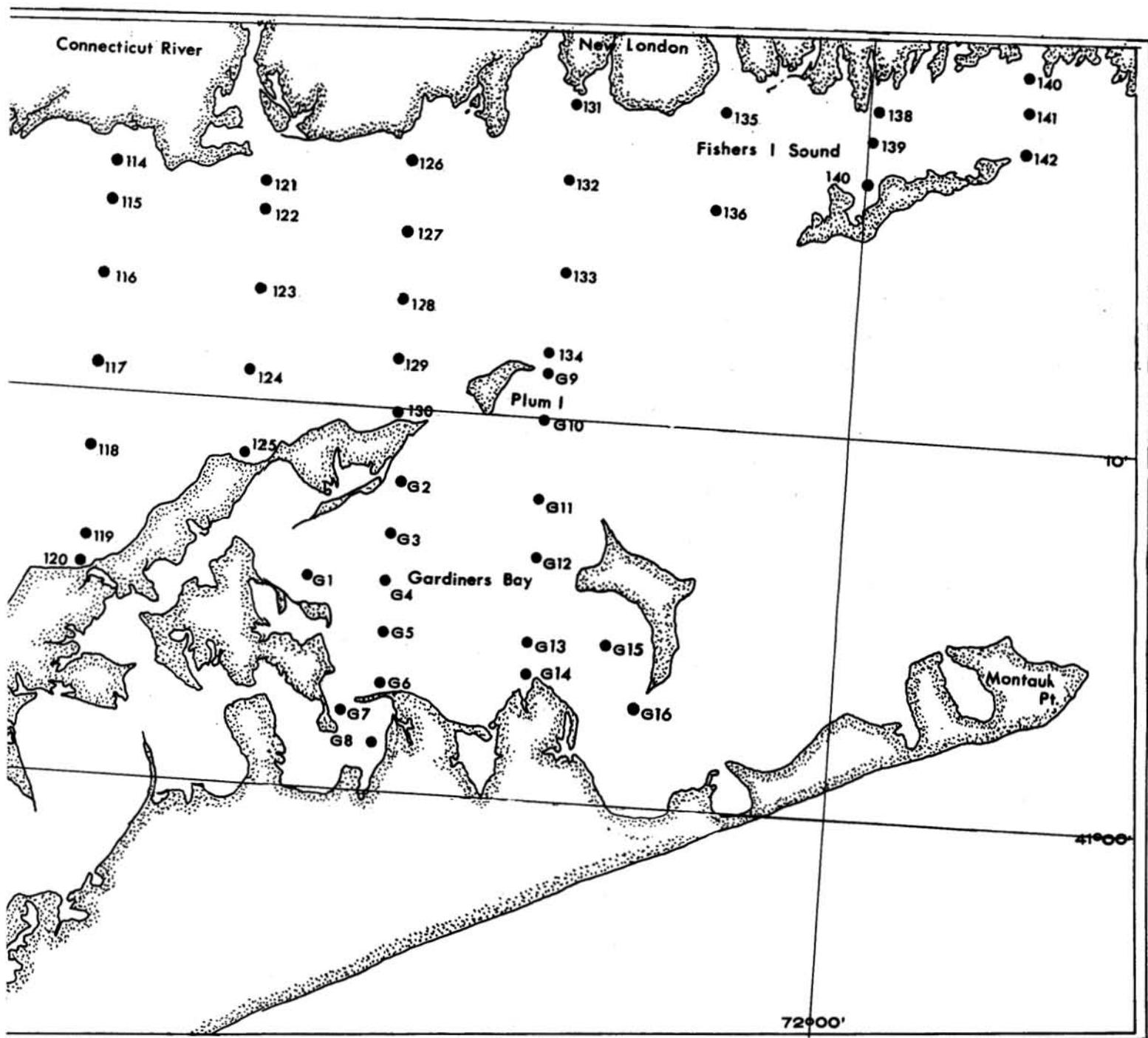
Studies	Parameters					Chart #1 - Status of Environmental Information on N.Y. Bight and contiguous waters
	Long Island Sound	Raritan Bay	East River Studies (David's Isl.)	MESA - NYB Apex	MESA - Offshore	
	x	x	x	x	x	Dissolved oxygen - surface
	x		x			" " - mid-depths
	x	x	x	x	x	" " - bottom
	x	x	x	x	x	Benthic macrofauna - distribution
	x	x	x	x	x	" " - diversity
		x				" " - biomass
				x	x	Benthic meiofauna - biomass
		x	x	x	x	" " - nematodes, copepods
			x	x		" " - ciliated protozoans
			x	x		" " - amoebae protozoans
			x	x		" " - foraminifera
					x	Bacterial populations - taxon determination
	x					" " - distribution
						" " - physiology
	x	x	x	x	x	Sediments; grain size distribution
	x	x	x	x	x	" ; % organic carbon
	x	x	x	x	x	" ; % carbonate
	5	5	5	3	5	Nutrients (3 to 5 different nutrients)
	x	x	x	x	x	" - Water column
						" - Sediments
	x	x	x	x	x	Heavy metals (7 to 11): sediments
						" " " : water column
	x	x		x		" " " : tissues
			x	x		Primary Productivity - phytoplankton
			x	x		Seabed Respiration/O2 consumption
		x	x	✓		Diseases; fin rot
		x	x			" ; exoskeleton necrosis
		x	x	✓		" ; gill blackening
	x	x	x	✓	x	Salinity; surface
	x	x	x		x	" ; mid-depth
	x	x	x	✓	x	" ; bottom
	x	x	x	✓	x	Temperature; surface
	x	x	x		x	" ; mid-depth
	x	x	x	✓	x	" ; bottom
						Mutagenicity - gametogenesis ² /
						" - dominant lethals
						" - chromosome damage
			x		x	Zooplankton
			x			Demersal finfish - biomass
			x			" " - distribution

1/ To begin in late calendar '74 or early calendar '75. 2/ to be initiated in late fiscal '74. V = Inconclusive Information

Table #1

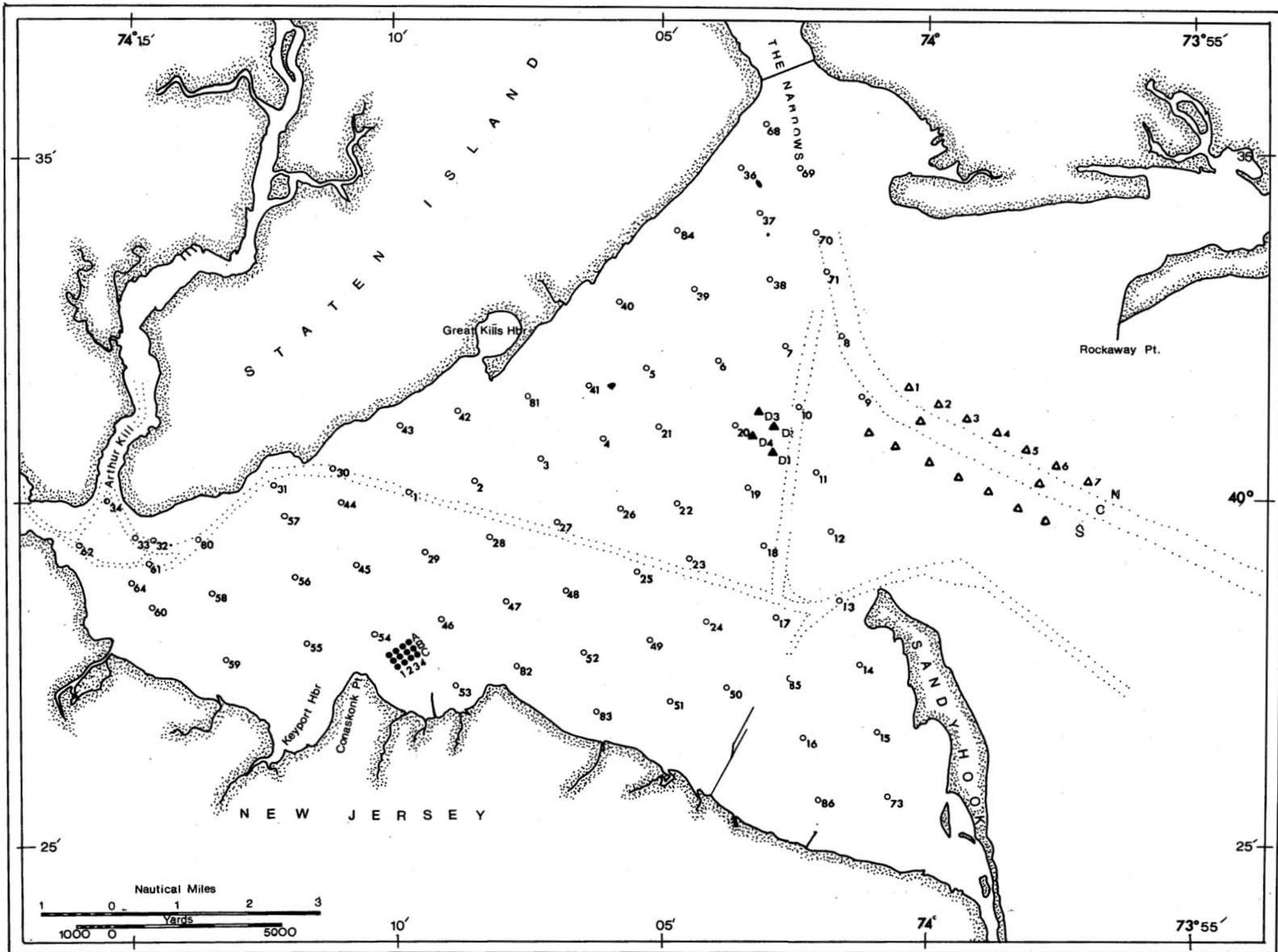


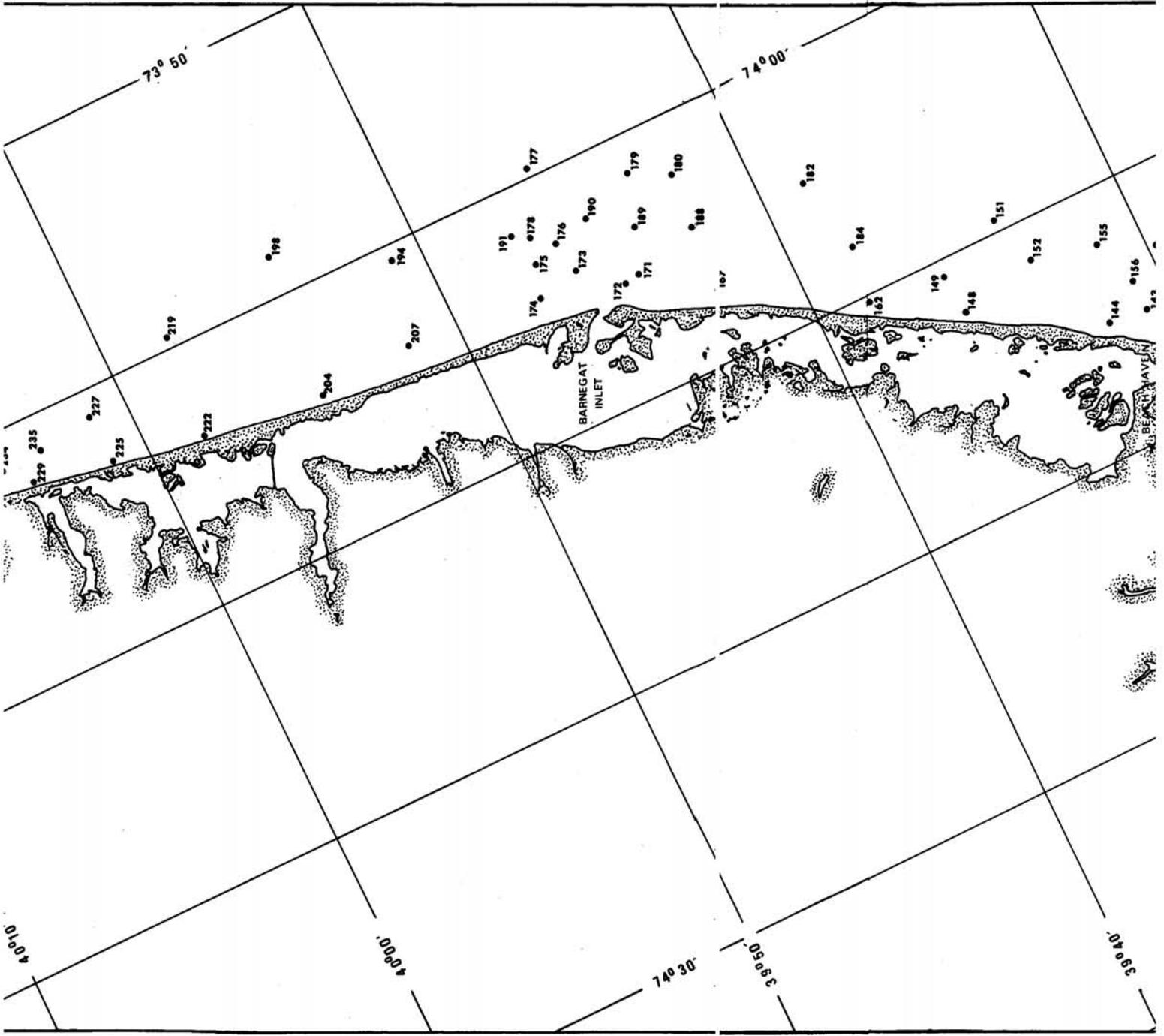


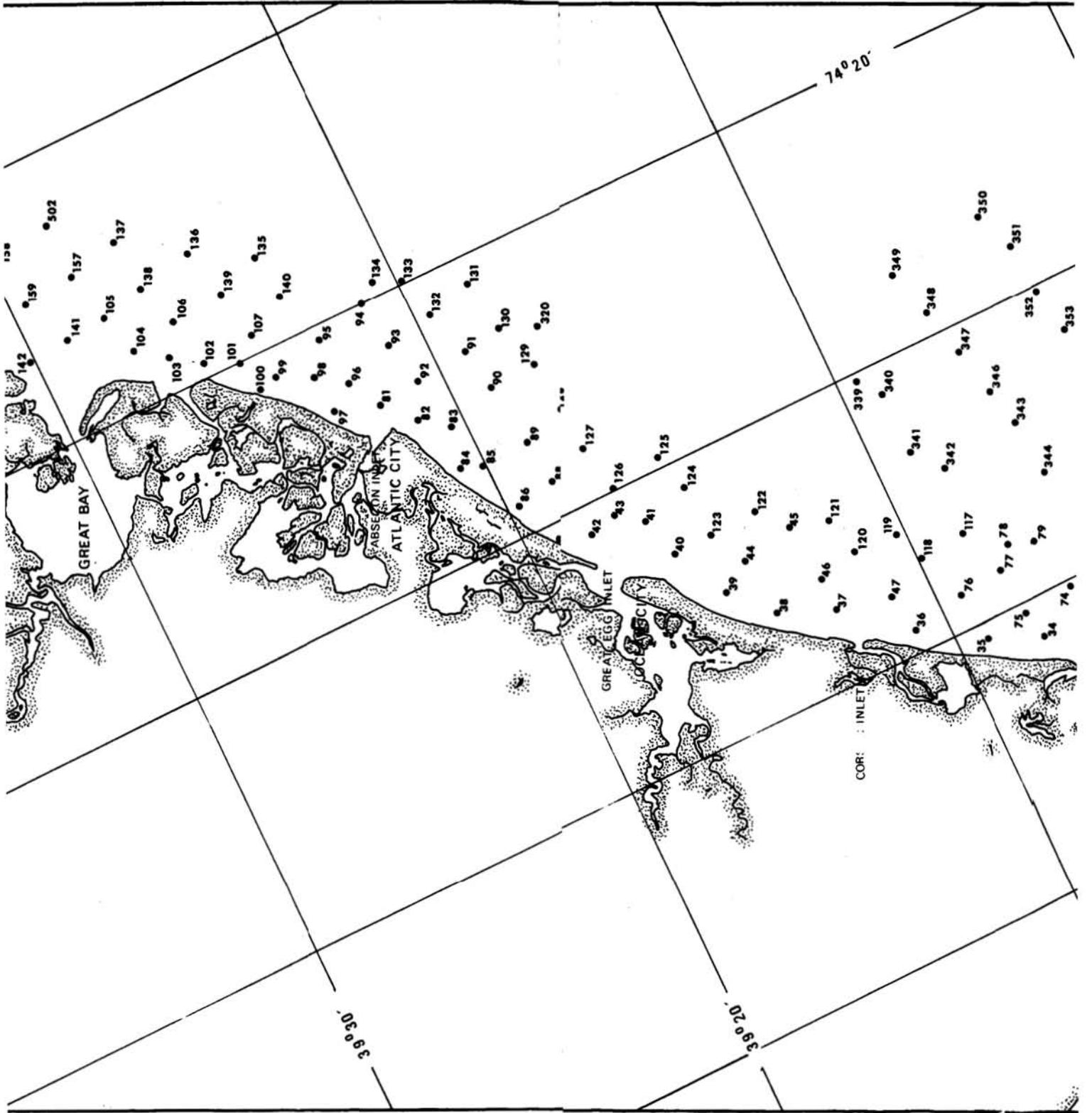


72°00'

Chart No. 1 - Long Island Sound







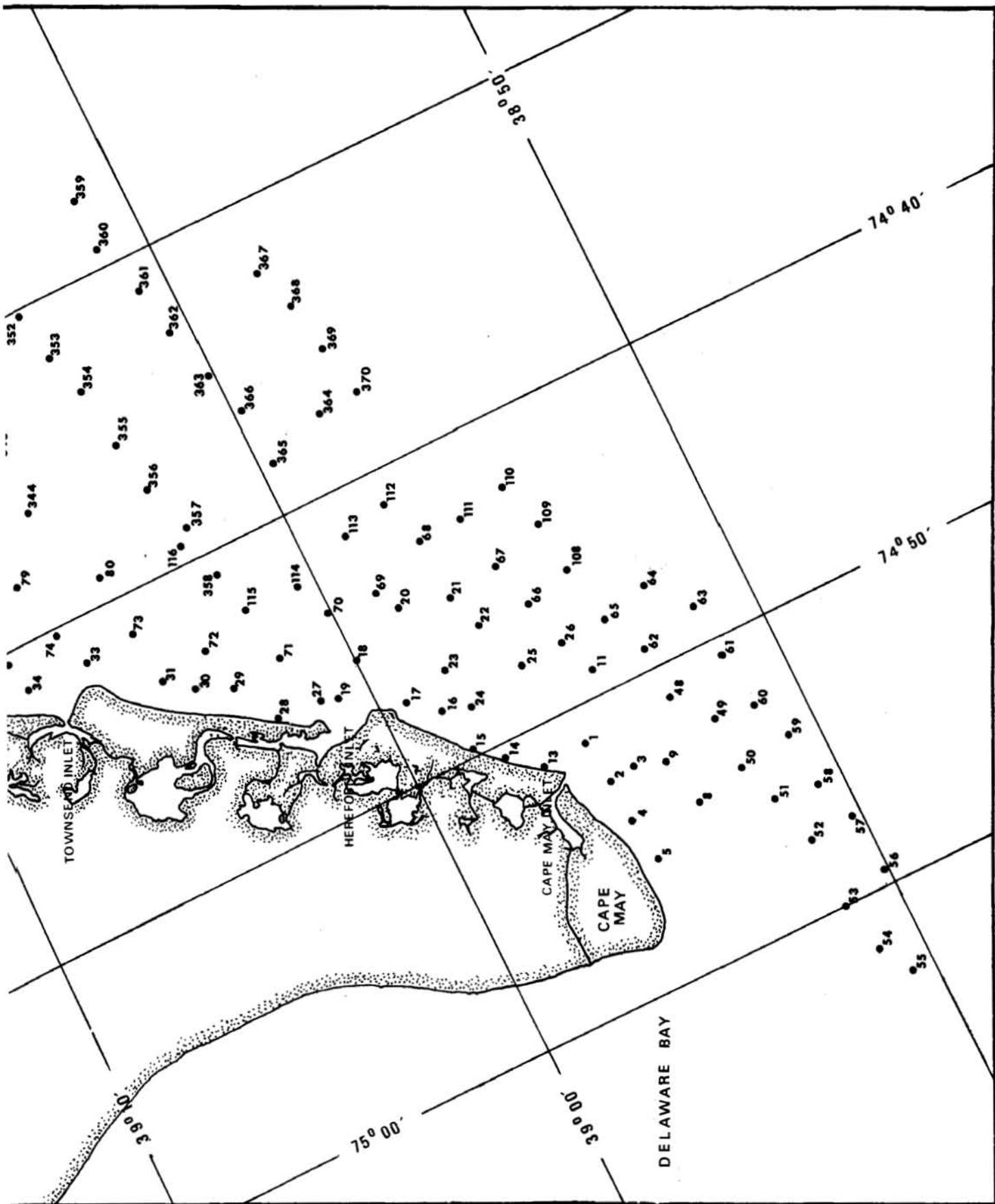


Chart No. 3 - New Jersey Coast

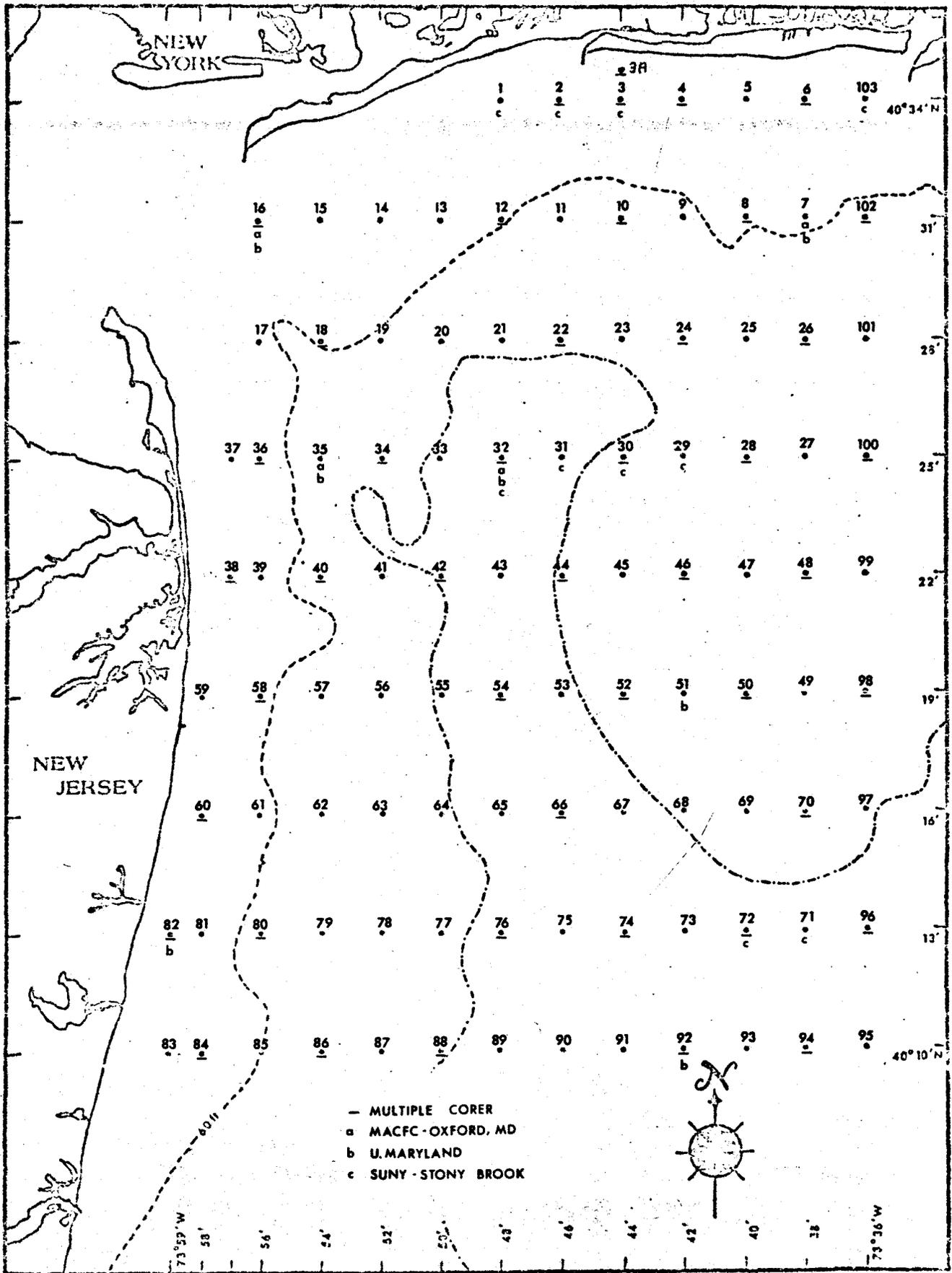


Chart #4 - New York Bight Apex

ACCOMPLISHMENTS TO DATE

1. Sandy Hook:

- a. Prepared comprehensive, 9-volume report on Effects of Ocean Dumping for the Corps of Engineers, 1972.
- b. Completed field operations aspects of comprehensive, multi-variable, ecological survey of Long Island Sound. Occupied and sampled approximately 336 stations during three seasonal cruises. Report to New England River Basins Commission scheduled for May, 1974.
- c. Completed field operations aspects of comprehensive, multi-variable ecological survey of onshore waters along entire New Jersey coast. Some 280 stations occupied and sampled. Laboratory analysis of samples in progress.
- d. Completed 4 quarterly surveys of benthic communities in Raritan Bay. Occupied and sampled some 78 stations. Survey (field) continuing. Laboratory analysis of samples underway. One major report completed.
- e. Completed 3 of 8 scheduled intensive field surveys of New York Bight Apex (MESA). Some 270 stations occupied and sampled. Approximately 100 parameters to be analyzed for each survey. In addition, completed field aspects of MESA reconnaissance cruises - some 300 samples generated. Laboratory analysis of all data underway. Quarterly Report submitted October, 1973; reconnaissance data report scheduled for March, 1974.
- f. Established and manned major benthos sorting facility, now in full operation.
- g. Completed intensive study of East River ecology - in and around David's Island. Report submitted to Battelle Institute, 1973.
- h. Defined, with 95% probability, epicenter of fin rot epizootic is located in New York Bight Apex - Raritan Bay complex. Studies on etiology of disease continuing.

2. Milford:

- a. Completed acute/static exposure tests of two species of crabs, to copper and cadmium, for effects on osmoregulation and oxygen consumption.
- b. Completed acute/static exposure tests of four species of bivalves to very low concentrations of silver - for effects on osmoregulation and oxygen consumption.
- c. Completed acute/static exposure tests of mud snails - to five different heavy metals (Cu, Ag, As, Cd, Zn) - for effects on osmoregulation and oxygen consumption.
- d. Designed, constructed and placed in operation three major equipment items:
 - 1) Raw sea-water treatment facility.
 - 2) Long-term, sub-acute, continuous flow exposure facility (c/c-w).
 - 3) Waste-water treatment facility.
- e. Determined LC₀, LC₅₀ and LC₁₀₀ of 11 different heavy metals on oyster embryos.
- f. Determined LC₀, LC₅₀ and LC₁₀₀ for cadmium on mud crabs.
- g. Determined LC₀, LC₅₀ and LC₁₀₀ for five heavy metals (Hg, Ag, Zn, Ni, Pb) on hard-clam embryos.
- h. Demonstrated that proportional diluters in c/c-w exposure facility maintained precise concentrations of test contaminants.
- i. Demonstrated uptake of contaminants in flesh and organs of test animals.
- j. Completed multi-disciplinary study of physiological responses of representative finfish to various levels of cadmium. Comprehensive, six-part manuscript now in press.
- k. Demonstrated widespread and drastic mutagenic effects of heavy metals (Ag, Cd, As, Mn), even below LC₀ levels, on oyster eggs. Extensive review of mutagenicity completed.

FUTURE STUDIES UNDER CONSIDERATION

1. Sandy Hook:

- a. Continue and complete laboratory (and contract) analyses of Long Island Sound and New Jersey coast samples.
- b. Continue biological research associated with the MESA-PDP for the New York Bight Apex.
- c. Participate in interagency baseline study of alternative deep-water dump site off Delaware Bay.
- d. Conduct baseline (pre-, and post-) surveys of proposed Naval dredge and spoils areas off New London, Conn. Analyze and interpret samples.
- e. Initiate biological research associated with the MESA-PDP for New York Bight areas outside of the Apex.
- f. Continue stress-related behavioral research on finfish.
- g. Continue studies on stress-related diseases of finfish ("fin rot") and crustacea ("gill-blackening" and "exo-skeleton necrosis").

2. Milford:

- a. Continue operation of exposure facilities as cooperative services to Center (and outside) scientists. Expand numbers of representative living marine organisms available through completion of studies on induction of spawning and hatching and development of techniques for rearing and holding organisms.
- b. Conduct multi-generation study of C. fornicata, to assess long-term effects (mutagenic etc.) of exposure to low levels of pollutants.
- c. Continue studies on osmoregulation, oxygen consumption, etc., as affected by pollutants - expand to obtain data on all representative organisms (lobsters, striped bass, cunner, etc.) at all life cycle stages.
- d. Conduct study to determine whether phagocytic (bacteria-destroying) capacity of finfishes is adversely affected by exposure to pollutants, thus reducing resistance to disease.
- e. Develop light- and electron-microscope slide files of normal and exposed tissues of cunner and striped bass through use of exposure facility.
- f. Complete histopathological studies of abnormalities induced in blue crabs by exposure to pollutants.
- g. Initiate survey of exposure-induced mutagenesis in embryos, larvae and adults of several species of molluscs.

SUMMATION

1. For successful assessment of living marine resources and of the harvestable surpluses, quantitative knowledge of the nature, scope and intensity of mortalities induced by man-made environmental changes is necessary.
2. For successful interpretation and/or confirmation of field observations on fluctuations in abundances and of species diversities, as well as in spatial and temporal distributions of living marine resources, controlled studies on all physiological effects of individual pollutants and of mixture of pollutants are mandatory. Such studies must include all stages of the life cycle: egg, larvae, juvenile and adult.
3. It should be clear that while identical methodologies and even identical marine organisms may be used by the MACFC and EPA-Narragansett, the objectives of the work and the uses to which the resultant information are to be put are totally different. The MACFC program is a broadly based, fundamental and integrated multi-discipline study designed to yield quantitative information on the physiological effects of pollutants on the vertebrate and invertebrate marine populations and subpopulations. Data pertinent to the development of water quality standards is available to EPA.
4. To prevent massive duplicative investments in vessels, specialized facilities and marine-oriented skills and scientific disciplines, logical management theory would dictate that EPA defer to, and financially support, offshore ecosystems research in NOAA while emphasizing its studies in fresh-water rivers, lakes and streams.

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and oxygen consumption. Special Scientific Report-Fisheries.
(In review).

Thurberg, F. P., M. A. Dawson and R. S. Collier

Effects of copper and cadmium on osmoregulation and oxygen
consumption in two species of estuarine crabs. Submitted to
Marine Biology.

Thurberg, F. P., A. Calabrese and R. Greig

The effects of silver on oxygen consumption of bivalves at
various salinities. (In preparation).

FUNDING FY 1974 FOR ENVIRONMENTAL STUDIES
(TOTAL DIRECT FUNDS)

Milford

Experimental Biology	\$ 419.0
Chemistry and Microbiology (Ecosystems)	194.0

Sandy Hook

Ecosystems	422.2
MESA -NYBight (including \$145.0 university contracts)	309.9
Resource Assessment (that portion relevant to NYBight study	<u>38.0</u>
TOTAL.....	\$1,383.1