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SEA GRANT ANNUAL REPORT



July 1, 1975, to September 30, 1976



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration



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U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

National Oceanic and Atmospheric Administration
Dr. Robert M. White, Administrator

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THE SECRETARY OF COMMERCE
Washington, D.C. 20230

May 23, 1977

Dear Sirs:

In accordance with Public Law 94-461, October 8, 1976, I have the honor to submit the Annual Report of the National Sea Grant Program.

I also am enclosing comments from the Director of the Office of Management and Budget and the Director of the Office of Science and Technology Policy. These comments are submitted in accordance with Section 211 (b) of Public Law 94-461.

Sincerely,


Juanita M. Kreps

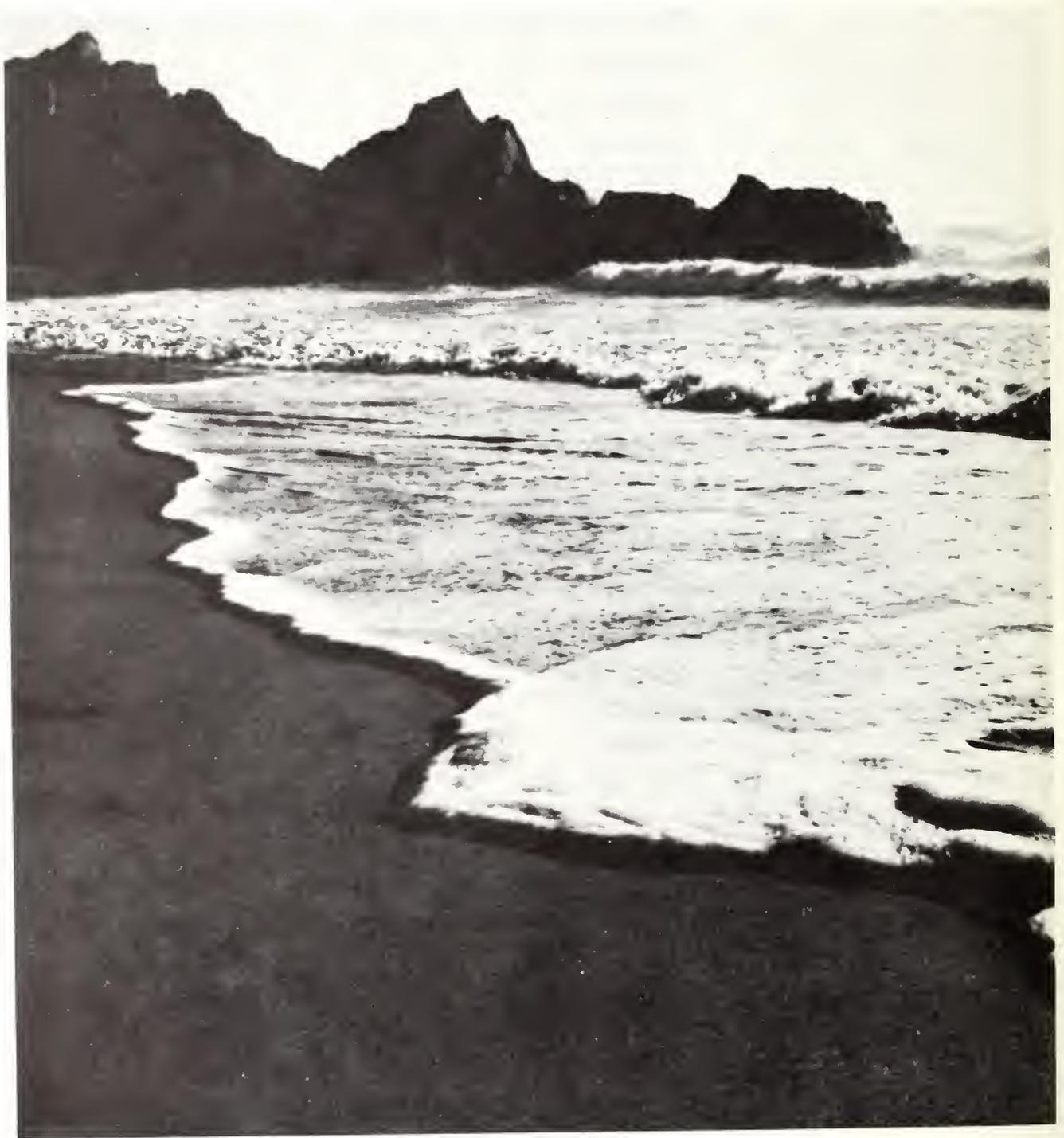
Enclosures

The President
President of the Senate
Speaker of the House of Representatives



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Introduction

When the National Sea Grant Program was established in 1966, the legislation outlined a program for support of activities that would "benefit the United States, and ultimately the people of the world, by providing greater economic opportunities, including expanded employment and commerce . . ." As it has been throughout the history of the Sea Grant Program, that mandate has been the guiding force of Sea Grant activities during the 15-month period covered by this annual report, Fiscal Year 1976 and the Transition Quarter 1976.

The National Sea Grant Program is a unique Federal-State-university partnership. It is the only Federal grant program that mandates and supports in American universities the integration of research, education, and public service in a practical approach to development of marine resources and technology. It is a program, born out of national interest, which permits the identification of significant marine problems by those who are most affected, the pursuit of research to solve those problems, and the dissemination of the results of that research not only to those who originally identified the problem but to the general public as well.

Although the National Sea Grant Program is comparatively new, it is based on a century-old concept. Sea Grant grew out of Land Grant, and it is intended to apply the same types of techniques and philosophies to the management of America's coastal and marine resources that the Land Grant Program applied to the Nation's agricultural resources. The concept of nurturing education and the development of new knowledge in the universities for distribution to the public is the same in both programs.

Research, Education, and Public Service

A compilation of the major activities in the areas of research, education, and marine advisory services (public service) is provided in this report. The examination of the wide spectrum of Sea Grant projects underlines the diversity and intensity of the program and, in many cases, its benefits.

The Land Grant Program, probably more than any other development, was responsible for the tremendous growth and excellence in this Nation's agricultural industry—a record yet to be matched by any other nation. Land Grant required 52 years to be fully formed in its three parts—education, extension, and experiment. Sea Grant is only 10 years old, and that trinity is in full sail.

Sea Grant encourages teams of specialists from many professional disciplines to define problems and to respond to local, State, and regional needs in research. Sea Grant also has encouraged successful inter-institutional cooperation in education and public service. Some of these ties extend across State lines and allow for broader educational opportunities, more efficient use of facilities, and a greater opportunity for solving regional problems.

The Agricultural Cooperative Extension Service remains a key part of Land Grant. Similarly, Marine Advisory Services, including extension service, provide a core element of Sea Grant. They assure timely and effective transfer of knowledge to those who need it, and a successful mechanism for alerting researchers to needs, problems, and opportunities. Sea Grant has broadened the scope of its advisory services by addressing not only problems of ma-

rine industries, but also by providing advice and counsel to local, State, and Federal governments.

While some Sea Grant institutions have oceanographic laboratories, they seldom serve Sea Grant in the same way that agricultural experiment stations serve Land Grant. Sea Grant is oriented towards applied research, solving of specific problems, and is concerned almost exclusively with the coastal zone, including the Great Lakes, and contiguous offshore areas.

One of the significant aspects of the Sea Grant Program has been its ability to identify problems early and to initiate research rapidly. This has been so with a number of problems in the past, some of which gained national prominence 2 and 3 years after having been identified by Sea Grant. Some of these issues, of course, have become responsibilities of other Federal agencies, such as the Office of Coastal Zone Management and the Bureau of Land Management. Examples include:

1. Impacts of Outer Continental Shelf oil and gas development, a major question in 1974. Sea Grant initiated research on these issues at the Massachusetts Institute of Technology and the University of Rhode Island in 1971.
2. Contamination of fish in the Great Lakes by polychlorinated biphenyls, known as PCB's, a major issue in 1974-75. Sea Grant research started at the University of Wisconsin in 1972.

Training and education of technicians, scientists, and administrators in the fields of marine resource use and management remained a central goal within the Sea Grant Program in Fiscal Year 1976 and the Transition Quarter.

Efforts to increase public awareness of the oceans from kindergarten through advanced degree programs continued to receive considerable emphasis during the reporting period, as did the expansion of marine-related courses for specialists in other professional areas, such as economics, engineering, law, and social science.

Sea Grant-trained professionals as resource managers remain in demand by local, State, and Federal agencies, as well as by private industry. Recent statistics indicate that more than 80 percent of the Sea Grant graduates are hired by marine organizations, while many of the remaining 20 percent continue advanced academic work.

Program Innovations

Sea Grant has introduced a number of new features. It was, for example, the first Federal granting program in the marine field to blend successfully the social with the natural sciences, a departure from the traditional marine programs, which categorized work into chemical oceanography, physical oceanography, marine biology, or submarine geology.

With the birth of Sea Grant, a third dimension relating to important institutional factors was added. Components of this new dimension included economics, law, public administration, and sociology.

Sea Grant was the first to introduce the concept of progressive status of its grantees, encouraging growth and maturity from several projects through several stages to the status of Sea Grant College.

From its beginning, the program has been consumer oriented. It has con-

centrated on applied rather than basic research. Its educational support was cast in the same mold by emphasizing economics, engineering, law, and technician training.

In its effort to establish a network of applied marine programs on the Atlantic, Gulf, and Pacific Coasts, in Alaska, Hawaii, and on the Great Lakes, Sea Grant has brought together successfully not only different departments within universities, but different universities as well, and, in some cases, entire educational systems composed of many institutions.

Sea Grant was the first program to use a "closed-circuit" operation in which research, education, and advisory services worked in such a way that each activity would reinforce the other two. Through this new synergism, Sea Grant's approach succeeded in creating some highly dynamic programs encompassing as many as 80 separate projects.

Perhaps more than any other Sea Grant action, the creation of program directorates within the universities reflects the nature of the program. Traditionally, other Federal granting programs have required a direct relationship between the agency and the investigator. This has lessened or eliminated the vital role of the organization for which the scientist works. The Sea Grant Director, as a university employee and controller of the program, has restored the authority and the guidance of the university and engendered local support of the program by sensitivity to local and regional problems. Moreover, the collaboration between the Sea Grant Directors and the National Oceanic and Atmospheric Administration (NOAA) staff has developed a close university-government partnership.

Another aspect of the Sea Grant Program lies in its requirement that at least one-third the cost of all programs must be provided from non-Federal funds. When first proposed, the wisdom of this provision was doubted by many. They were concerned that local support by universities, private business, and State government themselves would not be forthcoming. These fears were never realized. In fact, the matching requirement has turned out to be one of the program's great strengths. During the past year, for example, at least 14 State legislatures included line items in their budgets specifically earmarked for their own Sea Grant programs. While the law requires a minimum of a one-third investment from non-Federal sources, in some cases the amount is more than 50 percent. In other words, the Federal Government is the junior partner in some Sea Grant programs.

Sea Grant places special emphasis on project evaluation. A new technique has been adopted which aids program planning through the evaluation of programs in terms of benefits. A staff of three in the Office of Sea Grant analyzes programs on this basis.

The program has grown significantly in breadth of education, public service, and research and has almost achieved its aim of a complete network of Sea Grant programs in all coastal and Great Lakes States in the Nation and in every territory. Only Illinois, Indiana, Pennsylvania, and some insular territories remain outside the network. During Fiscal Year 1976 and the Transition Quarter, more than 200 companies; 225 Federal, State, and local agencies; and 145 universities were involved in a program encompassing some 700 projects. The program has pro-

duced more than 3,500 technical reports. A total of 3,334 students and 1,482 technicians have been trained under the program's auspices. As of Sept. 30, 1976, 551 graduate students and 318 undergraduate students were involved in Sea Grant projects, while an additional 1,053 technician trainees, as well as 2,130 other students, were enrolled in Sea Grant sponsored courses.

Sea Grant Colleges

During the reporting period, the University of Delaware, the State University System of Florida, and the University of North Carolina achieved Sea Grant College status. Institutions that have exercised leadership in their region for a period of not less than 3 years in the quality, quantity, and productivity of research, education, and advisory services qualify for Sea Grant College status. The designation signifies a commitment by both the university and the Federal Government to achieve the goals of the National Sea Grant Program in a particular region and to continue the financial support of the program, if justified by merit. The three designations brought to 11 the number of colleges and universities that have achieved that highly coveted honor.

Long-Range Goals

Goals of highest priority during the next 5 years:

—Strengthening the partnership between NOAA and the participating institutions.

—Expanding the program to serve all coastal States and territories.

—Improving communication and cooperation among marine industries,

Sea Grant institutions, and all levels of government.

—Furthering cooperative efforts among Sea Grant institutions for more efficient focus on regional and national problems.

—Improving transfer of Sea Grant research results to the consumers.

—Stimulating relay of problems in wise use and development of marine resources to universities.

Benefits

Not all Sea Grant projects have benefits that can be analyzed quantitatively. For example, the level of benefit stemming from using new educational concepts or from cast-

ing universities in the role of direct public service cannot be measured exactly in dollars. There is ample evidence, however, that the Sea Grant Program is an important and worthwhile investment. Moreover, Sea Grant has evoked interest abroad. Scientists from many foreign nations have visited the Office of Sea Grant in Washington, as well as the Sea Grant institutions, for a first-hand review of the program.

Sea Grant shares the national hope that Americans, working together, will achieve a healthier, more prosperous society. It is devoted to achieving wiser use of our oceans. And as we move into Fiscal Year 1977, it will continue to work toward attainment of the goals for which it was designed.

Sea Grant Supported Activities Across the United States





In its research, Sea Grant works closely with more than 20 other Government agencies to coordinate efforts on related projects. Through this relationship, knowledge of what other agencies are doing has helped Sea Grant establish priorities and avoid duplication.

Categories of research carried out in the Sea Grant Program include aquaculture, living resources (other than aquaculture), marine biomedicinals and extracts, mineral resources, coastal zone management support, pollution studies, environmental models, socio-economics,



ocean and coastal law, marine recreation, marine technological research and development, and seafood science and technology.

Aquaculture

The culture or husbandry of aquatic animals and plants is a major element of the National Sea Grant Program. The aim is development of techniques with potential for commercialization.

Aquacultural production worldwide has doubled over the last 5 years and is now 6 million metric tons (13.2 billion pounds)—roughly 10 percent of the world fish production. In the United States, aquaculture produces an estimated 65,000 metric tons (143 million pounds) of seafood yearly. This equals 2 percent of fishery products consumed. About 30 percent of our total landings of Pacific salmon and more than half of the Columbia River salmon caught by commercial and recreational fishermen were released from hatcheries. Private aquaculture produces more than 40 percent of our oysters, half of our catfish and crawfish, and nearly all of our rainbow trout.

There is good potential for expanding our fisheries and food resources by further development of aquaculture. The advancement of aquaculture is cited in the original Sea Grant Act as one of the purposes of the National Sea Grant Program. In recognition of that mandate, Sea Grant has invested heavily in aquacultural research and has aided in development of the NOAA "National Aquaculture Plan."

At least 30 colleges, universities, and other research institutions have projects in aquaculture under auspices of the National Sea Grant Pro-

gram. They range from intensive culture in closed systems to culture in bays and coastal areas where little manipulation of the environment is required.

The research places emphasis on interrelated activities including biology, chemistry, economics, engineering, genetics, marketing, nutrition, pathology, pollution, and processing. Training of aquaculturists and assistance to emerging industries are also considered important responsibilities.

Aquacultural activities have focused primarily on lobster, salmon, shrimp, prawns, oysters, and marine plants. These expensive species have potential for early commercial application, which will greatly help the state of aquacultural art to advance to the point where inexpensive species can be produced in large quantities.

Culture of salmon has been one of the most successful aquacultural efforts so far. Industrial participation already has proved its economic feasibility by introducing pan-sized salmon into domestic and foreign markets.

Techniques for aquaculture of salmon—pioneered at the University of Washington and now applied commercially—provide greatly increased maturation rates, better diets, and less disease. Floating

pens engineered at the university are used commercially. In one system, advantage is taken of the salmon's instinctive homing behavior. The fish are hatched and confined in hatcheries, then they are released to grow in the wild. Three years later, at spawning time, they return to the hatchery after having passed through the commercial fishery. Coho salmon released from hatcheries are genetically stronger than their natural counterparts and enjoy a higher survival rate in the open seas. During the 1975-76 season, for example, 16 percent of the cohos released from one hatchery returned—a total of 5,000 salmon. In nature, less than 1 percent return. Improved strategies of management and genetic improvement of stocks obviously benefit the salmon industry. So far, these benefits have been conservatively estimated at \$200,000—twice the investment in research.

Responding to inquiries from commercial fish processors and other industries in the midwest, the University of Wisconsin (Madison) developed techniques for raising perch and walleye pike. Perch have been grown from fingerlings to a marketable size in 9 to 11 months, a process taking 3 to 4 years in nature. Already a pilot facility for perch and walleye aquaculture has been established near Madison, and several Wisconsin industries and dairy farmers have invested in their own aquacultural facilities.

Aquaculture of shrimp in Asia became possible more than 10 years ago, primarily because of research in Japan. It has not been commercially successful in the United States, but is approaching that goal as a partial result of research in the National Sea Grant Program. The rates of growth have been accelerated so that a marketable product now requires less than a year of feeding. That advance is attracting industrial attention. Additionally, a major breakthrough in reproduction physiology at the University of Houston allowed mating and spawning in captivity and obviated the need to obtain eggs from gravid females in the wild.

Scientists at the University of California moved ahead in aquaculture of the American lobster. Diets have been improved; disease and cannibalism have been reduced. They are also attempting to breed lobsters in captivity and produce strains with rapid growth. At San Diego State University, waste heat from powerplants is being used to speed lobster growth.

While the demand for mollusks remains stable in the United States, natural supplies decline because of overfishing, pollution, and unknown factors. Therefore, there is potential for commercial aquaculture of oysters, clams, and mussels and justification for aquacultural research on mollusks. The research ranges from development of closed-system techniques to improvement of hatcheries that produce seed for planting in open waters.

Scientists at the University of Delaware have grown oysters to market size in a closed system in just 36 weeks instead of the 36 months required in nature. Work on a preliminary design for a commercial prototype system is underway.



Through research into the design and development of an oyster hatchery at the Virginia Institute of Marine Science, oysters can be induced to spawn year-round, an event which occurs only once a year in nature. Special algae diets formulated there reduce the larval life of the oysters from 2 weeks to 9 days.

In a move toward revitalizing South Carolina's oyster industry, scientists at the Marine Resources Institute and Clemson University initiated subtidal oyster culture in salt marsh impoundments and field tested a mechanical harvester they are developing.

Under a cooperative program in northern New England, scientists from the University of New Hampshire, the University of Maine, and the Maine Department of Marine Resources developed techniques to produce blue mussels. Some are on trial commercially.

At the University of Maine, research on the conditions needed for culturing European oysters on rafts has led to the establishment of several commercial operations with investments of well over \$1 million.

Culture of marine plants for human food is common in many Asiatic countries, but in the United States the plants are used as a source of carrageenin and algin, which serve as stabilizers and "smoothing agents" in hundreds of products such as baby food, diet foods, pharmaceuticals, and skin cream. In cooperation with industry, techniques that will optimize growth of cultured species throughout their life cycle and maintain natural stocks have been developed at the University of Hawaii and at the University of Washington.

California Institute of Technology scientists improved methods for mass culture of kelp and defined optimal conditions for planting beds with small plants raised in the laboratory. As a result of this work, a 19-year trend of deterioration was reversed in kelp beds off Dana Point.

Working with partial support from private industry, researchers at the University of New Hampshire studied 5 species of red algae—abundant in northeastern waters—and identified one as a promising source of industrial carrageenin.

At the University of California, giant kelp that doubles its size in less than 2 weeks was developed. The culture and techniques are forming the basis of a new culture facility being built by the Japanese in Hokkaido. Scientists in California also developed a strain of barley that can pass its entire cycle of life in saltwater. Their goal is the development of

highly productive food crops that can be irrigated with seawater.

The deep waters of the oceans are far richer in nutrients in most areas than the surface waters and, in a few coastal areas, natural currents bring these nutrients to the surface—a phenomenon known as upwelling. The Lamont-Doherty Geological Observatory used deep ocean water near St. Croix, Virgin Islands, to fertilize single-celled algae grown in tanks to feed clams and oysters. Three species were grown to market size by this method. The expense of pumping the water from depth proved to be greater than the commercial value of the aquaculture; but the researchers, who are now at the University of Texas, believe that coupling the system with use of the cold deep-sea water for air conditioning, desalinization, or production of pollution-free electricity could make it profitable. These possibilities are under study. In Alaska, artificially upwelled waters have fostered zooplankton cultures of extremely high quality and diatom cultures of high density.

Scientists at the Woods Hole Oceanographic Institution developed techniques for using sewage as the nutrient base for culture of oysters and clams. The technical work is not yet complete, and the safety and economy of the system are still under study.

The substantial progress in aquacultural research is leading to the establishment of new industries. It is a field where government, industry, and universities can work effectively together.

Living Resources

Development of marine resources is fundamental to the Sea Grant Pro-

gram. It is enunciated in the Sea Grant Program Improvement Act of 1976, which labels the major objective of the program to "increase the understanding, assessment, development, utilization and conservation of the Nation's ocean and coastal resources." Other legislation in 1976 that extended U.S. jurisdiction over fishery resources to 200 miles also focuses attention on living marine resources.

More than 70 projects in this category were awarded during Fiscal Year 1976 and the Transition Quarter. Sea Grant funding totaled \$2.2 million, with matching funds of \$1.1 million. The projects were designed to develop methods of assessing stocks to improve technology of harvesting and processing seafood and to refine methods of resource management.

71 Living Resources (other than aquaculture)

Sea Grant funding	\$2,200,000.
Matching funds	1,200,000.

At the University of Washington, acoustic techniques for assessing fishery stocks have been developed and a preliminary evaluation made. By placing salmon in cages and net enclosures, researchers can obtain their acoustic profiles, which can be correlated with known numbers of fish of known size. The acoustic methods also have been used to assess herring stocks. The researchers work in close collaboration with the Washington State Department of Fisheries, the Alaska Department of Fish and Game, and the National Marine Fisheries Service.

Under extended jurisdiction, fisheries of the Gulf of Mexico may have to be diversified in order to accommodate increased domestic fishing when distant-water shrimpers return from waters of Mexico and Brazil. For this reason, Sea Grant researchers in Mississippi and Alabama have been assessing the potential of underutilized stocks for significantly expanded fisheries.

Florida experienced this problem in 1975 when the Bahamian government declared that the spiny lobster was a creature of its continental shelf. This resulted in the return of 160 lobster boats to the fishery of the Florida Keys. An economic study by Sea Grant showed that the return of the boats would result in a net increase of only 6 percent in total lobster landings while the catch per trap would decrease from 30 to 23 pounds and reduce earnings of individual fishermen. This analysis helped the displaced fishermen procure a reallocation and training grant of \$2.3 million from the Economic Development Administration.

The subject of harvesting and processing technology remained of special concern during the year in view of opportunities presented by extended jurisdiction. For example, of the 5.7 million metric tons of fish caught within 200 miles of the United States in 1974, 3.3 million metric tons were caught by foreign fisher-



men. The total foreign exports to the United States in 1974 were 1.3 million metric tons, about half the U.S. landing in the same year. Before the end of this decade, if U.S. fishermen demonstrate the capability and the desire to catch what the foreigners now take, the domestic fishing industry should expand greatly; hence, research on gear and transfer of fishing technology take on special significance. In Rhode Island, a new trawl especially designed to ride high over rocky bottoms was developed and tested. Some fishermen who made use of the net maintain it is 25 percent more efficient than their old trawls. A related program in education and extension was underway to transfer technology and experience from the Eastern Canadian bottomfish industry to Alaska, where an enormous potential exists for pollack and cod. Last year, Russian and Japanese fishermen caught close to 1 million metric tons of these two species in the Bering Sea.

Also of great importance to the development of more extensive domestic fisheries is processing capability. Two Sea Grant researchers, one at Oregon State University and one at the University of Rhode Island (URI), studied the economic consequences of decreased foreign and increased domestic catches. Both studies included methods for analyzing the economic impact on harvesting, processing, and marketing seafood. Because of anticipated legal and sociological impacts of extended jurisdiction, socio-economic and legal studies in this field will be given high priority in Fiscal Years 1977 and 1978.

Resource management is another subject of high Sea Grant priority. While several projects have focused on the management of particular fisheries, perhaps the most significant and pervasive program in this field is the University of Washington's NORFISH project. Broadly stated, the objectives of the project

are to develop and implement improved fishery management techniques for the northeast Pacific Ocean. One of its major efforts was development of a modeling system that can provide complex information at computer terminals. The information, which includes catch, effort, recruitment, growth, natural, and fishing mortality for particular stocks, as well as economic statistics, can be analyzed using various models. The model has a built-in "Monte Carlo simulator" which permits scientists to determine how precise their estimates are. This capability is of great significance because estimates of optimum sustainable yield of some stocks may not be statistically different from estimates of maximum sustainable yield. Another effort on economic efficiency of bottom trawlers indicated that smaller trawlers are more efficient than larger vessels in terms of fuel and labor and suggested that in the future, the U.S. fleet may be more competitive with foreigners, at least within our 200-mile conservation zone. The new methods developed by NORFISH are expected to be of great benefit to the new Regional Fishery Management Councils established under extended jurisdiction.

All aspects of assessment, development, and management of precious coral in Hawaii demonstrate the favorable ratio of cost to benefit that may result from applied academic research. In 1971, the precious coral industry in Hawaii had retail sales of \$2.6 million and employed 100 people. Primarily because of Sea Grant research over a period of 4 years, retail sales jumped to \$11.4 million and employment in the industry to 500. The researchers discovered and mapped the major beds of pink and gold coral and developed a harvesting technique. They also designed a management plan to con-

serve the resources. A total of \$148,500 in Federal money was invested in the project. More than \$550,000 in Federal and State taxes were generated by the precious coral industry in Hawaii in 1975.

Marine Biomedicinals and Extracts

For thousands of years, first in folk culture and later in the more formal fields of medicine and chemistry, land-based plants and animals have been used as a source of chemically active agents to treat a variety of human disorders and diseases. Such well-known substances as belladonna, digitalis, morphine, and even aspirin had their origins in natural land organisms. In fact, most of the drugs now in use are derived from land-based plants and animals or are synthetics based on structures of natural land-based molecules.

Only relatively recently has man turned to the sea as a source of chemically active drugs for treating human illnesses and for use in medical research. Because an estimated four-fifths of the world's animal life and a significant portion of its plant life live in the ocean, and because many marine phyla have no terrestrial representatives, it seems certain that unexploited resources of novel marine bioactive molecules with potential medical application await development. In Fiscal Year 1976 and the Transition Quarter, 8 marine biomedical projects were supported by Sea Grant through \$202,000 in Federal monies and \$103,000 in matching funds.

8 Marine Biomedical Projects

■	Sea Grant funding	\$ 202,000.
■	Matching funds	103,000.

At the University of Oklahoma, a team which includes biochemists, organic chemists, and a pharmacognosist conducted studies aimed at isolating anticancer drugs and drugs active on the central nervous system or in cardiovascular systems. These researchers have identified 246 marine species with confirmed anticancer properties and about a dozen with potentially useful activity in cardiovascular and central nervous systems.

One of the most significant recent developments was the discovery by researchers at the University of California of a substance in an alga that is active against herpes simplex virus. Herpes simplex is a virus responsible for common cold sores, a prevalent form of venereal disease, and an eye infection that causes about 18,000 cases of blindness in the United States each year. The discovery is particularly promising, because there are so few antiviral agents available for use in medicine.

Sixteen projects with a total Sea Grant funding of \$383,000 and matching support of almost \$252,000 were devoted to research in marine extracts. The project objectives varied widely.

16 Marine Extract Projects

■	Sea Grant funding	\$ 383,000.
■	Matching funds	252,000.

At the New York Sea Grant Institute's Agricultural Experiment Station in Geneva, for example, researchers isolated an enzyme from the digestive system of surf clams that holds promise for dissolving dental plaque and breaking up mold in the blood vessels of burn victims. Samples of the enzyme now are being produced in New York and marketed by a firm in California.

In the University of Washington's College of Forest Resources and the Department of Chemistry at the University of Puget Sound, Sea Grant researchers developed new uses for chitosan in nonwoven fabrics and paper. The scientists developed a process for reducing the molecular weight of chitosan, a cationic polymer derived from shellfish wastes, and a theory for predicting how chitosan content affects properties of paper and nonwoven fabrics. They have shown that the addition of only 1 percent chitosan to paper increases its wet strength by 44 percent and improves its printability.

At the University of Rhode Island, a "red-tide" organism that causes paralytic shellfish poisoning in New England was found to have six additional toxins besides the previously known saxitoxin. The structural chemistry and pharmacology of these new toxins are under study. The results of these basic studies are expected to be applied in establishing new regulatory measures and

detoxication procedures, thus eliminating any unnecessary closing of commercial shellfish beds.

Mineral Resources

As man steadily reduces his supplies of nonrenewable land-based resources—gas, hard minerals, and petroleum—he has been turning increasingly to that natural extension of the land, the continental shelf and nearshore area, as a source for these valuable substances.

The Gulf of Mexico has been an important and valuable source of gas, oil, and sulphur for more than a generation. The offshore areas of California and Alaska, too, are receiving increased attention because of their vast stores of gas and oil. And most recently, in the middle-Atlantic area, particularly off the highly industrialized coasts of New Jersey, Delaware, Maryland, and Virginia, petroleum exploration and eventual use are coming closer to reality.

The recovery of any of these resources and the necessary land-based activities that are required for their storage, processing, marketing, and transportation can create major problems and challenges to coastal residents, commercial fishermen, conservationists, industry, and State and Federal regulatory agencies.

In addition, even before recovery can take place, important questions must be answered regarding the location of the resources and the most economical and socially acceptable methods of their extraction.

Although Sea Grant is involved in mineral resources development, its role has been relatively small compared to either the overall needs of

the mineral resources industries or the work of such Federal agencies as the U.S. Geological Survey or the Bureau of Mines. Nevertheless, Sea Grant researchers have made advances in solving some of the problems associated with the exploration and use of marine minerals, including important documentation of the economic, engineering, legal, and sociological aspects of the field.

Twenty-four separate projects were funded in mineral resources during the reporting period with more than \$570,000 in Sea Grant support and almost \$446,000 in matching monies.

24 Mineral Resource Projects

Sea Grant funding	\$ 570,000.
Matching funds	446,000.

In the field of hard minerals, Sea Grant activities concentrated on three major categories: construction materials such as gravel, sand, and shells; industrial metals, including cobalt, copper, iron, manganese, and tin; and phosphates, important in fertilizers.

During the past year, research was conducted at the University of California and the University of Southern California on the availability of gravel, phosphate, and sand off the coast of Southern California and was coupled with analyses of the economic feasibility of mining such deposits. The researchers suggest that marine phosphate deposits there offer the potential for good profitability if more modern and cost-effective recovery techniques can be used. A recent industrial development, the jet-lift-suction system, for example, could prove more efficient and more profitable than the currently used hydraulic dredge.

Much attention recently has been accorded ocean manganese depos-



its by private industry because they are rich in cobalt, copper, and nickel as well as manganese. Scientists estimate that manganese deposits on the ocean floor and the Great Lakes could yield more than the world's current land reserves of copper and 13 times the land reserves of nickel. Some Sea Grant research has turned in this direction. Investigators at the University of Hawaii discovered unanticipated crusts and nodule fields in the Hawaiian Archipelago. These deposits have higher concentrations of cobalt and titanium than nodules found in the deep ocean. Their age,

as estimated by growth on discarded items, is much less than formerly imagined.

Researchers at the University of Wisconsin have made progress in their quest to develop a workable system to extract copper and nickel from manganese nodules. The Wisconsin investigators are exploring a new hydrometallurgical process because the nodules contain such small amounts of these valuable metals (less than 2 percent) and because traditional extraction methods using smelting techniques are inefficient and can create pollution problems. The process uses an aqueous solution to leach the desired metal from the nodules after which it can be reduced to a pure metallic form. The Wisconsin engineers have confirmed the effectiveness of using acidic ferrous chloride to leach metals from nodules and have discovered that di-z-ethylhexylphosphoric acid is selective for copper.

In related work, Wisconsin geological oceanographers, teaming with colleagues at the University of Alaska Sea Grant Program, worked along the coasts of the Seward Peninsula in Alaska to develop reliable underwater techniques for minerals exploration. This effort is a continuation of previous mineral studies in the area and is in direct response to the needs and interests of the marine mining industry.



Coastal Zone Management Support

To optimize man's use of marine resources for the present and the future, it is necessary that a balance of use, conservation, and preservation be maintained. To accomplish this, natural environmental processes must be understood and interpreted, and it is necessary to identify those economic, legal, scientific, and social constraints that impinge on rational management of resources and to develop alternative approaches. Sea Grant research covers such overlapping subjects as coastal zone management, environmental models, and pollution.

A pervasive issue recently has been management of the coastal zone. Needs of the public for scientific information relating to coastal resources naturally brought many research problems to the National Sea Grant Program, even before the Coastal Zone Management Act of 1972. This Act places responsibility for the development and administration of management plans in designated agencies of State governments. Prior to enactment and between enactment and funding, Sea Grant institutions in many States were able to play significant roles in making available objective analyses of the ecological, economic, legal, and socio-political framework within which management strategies would have to be

devised. Help also has been provided in obtaining reliable information on inventories and assessments of resources, their potential uses, and limitations imposed by the environment. Contributions of this nature are made on a regular basis.

The North Carolina Sea Grant College Program completed a study entitled "Ecological Determinants of Coastal Area Management." The report provides the natural histories of North Carolina's barrier islands and estuaries and their implications in management and policy.

The Wisconsin Sea Grant College Program synthesized 4 years of study of Green Bay and historical information to provide the report, "The Green Bay Watershed: Past/Present/Future." It is the most comprehensive study of that region to date.

Several years of coastal studies by the Delaware Sea Grant College Program culminated in two reports, "The Geological Structure of Shoreline of Delaware" and "Delaware's Small Bay Resources." Both are useful in coastal management. Many similar activities have been carried on at other Sea Grant institutions.

Questions of overlapping jurisdictions and the development of guidelines and policies for governance of the seaward side of the coastline have had much less attention than those on the landward side. The California Sea Grant Program has undertaken an analysis of these issues with the results expected to be made in a report for use by the California Coastal Zone Conservation Commission. The New York Sea Grant Institute has similar studies.

"Kadyak: A Background for Living" was produced with partial support

from the Alaska Sea Grant Program. The publication deals with problems in the Kodiak Archipelago, in the Gulf of Alaska. The Kodiak Island fishery is one of the largest on the West Coast.

Industry needs and public sector needs in the New England Coastal Zone were under study by the Massachusetts Institute of Technology. That work is expected to result in an analysis of the relative importance of the various needs and the points at which they conflict or complement each other. The study also should suggest possible opportunities for regional cooperation and more effective communication between those sectors.

Coastal ecosystems are quite complex and subject to extreme and violent environmental changes. Under stable conditions, nutrients and energy in an ecosystem tend to be in equilibrium, but the activities of man can disturb this balance to create instability and ecological deterioration. An understanding of ecosystems and the impact of the activities of man on these systems is essential to the conservation of the unique qualities and resources of the marine environment. The degree to which a Sea Grant program focuses on such problems depends on its capability for study of ecosystems and on the needs for such studies as evidenced by local plans for development and management.

For the past 5 years, Sea Grant researchers at the University of Rhode Island have analyzed ecosystems of Narragansett Bay with a view toward management and evaluation of its response to increased population and development. A numerical simulation model has been developed for many of the biological and nutrient systems of the bay. This model will be used to respond to specific re-



quests of State agencies involved in the planning and decisionmaking process concerning Narragansett Bay. It also can be applied to environments with characteristics similar to those found in the bay. Such ecosystems—with constant high salinity, a plankton-based food web, a well mixed and relatively shallow water column, and low input of organic material and pollutants—can be found in many estuarine and continental shelf areas.

In an extension of the original study, URI is using the existing numerical simulation model in combination



with previously collected field data to develop annual nutrient budgets for nitrogen, phosphorus, and silica in Narragansett Bay. These nutrient budgets are necessary to evaluate the relative importance of sewage inputs to the dynamics of the bay and to understand the coupling of the estuary with the offshore waters of Rhode Island Sound. At present, a detailed nutrient budget for a major estuarine system is not available. Because the understanding of many aspects of coastal ecological systems is based on the development of such tools, the successful application of an existing ecosystem mode to other waters, including the continental shelf, could result in a very substantial savings of time and money for a variety of State and Federal management and funding agencies.

Development of techniques to manage a sea urchin fishery has concerned the University of California because sea urchins eat kelp. In addition to describing such important population parameters as age structure, age of maturation, and natural mortality necessary to manage a sustained yield fishery, researchers are studying the relations between the red urchins and other members of the bottom-dwelling marine community to determine how the selective removal of increasingly large numbers of red urchins will affect the economically important ecosystem.

Researchers at Florida State University studied the Apalachicola drainage system because of its valuable fisheries and because information for proper planning and management was lacking. They determined the fundamental trophic relationships of the system and analyzed short and long term changes in the plant and animal life of the bay. The activities were undertaken because

of local concern about how upland clearing of forests and effluents from pulp mills affect Apalachicola Bay.

Pollution Studies

Pollution of the marine environment, bays and estuaries in particular, poses a continuing threat to living marine resources and recreational waters. Transportation and industries in coastal regions generate air and water pollution. While marine recreation is inhibited by pollution, it also contributes to it, as may the development and use of aquacultural resources, fisheries, and marine minerals.

Seventy-two Sea Grant projects involving pollution studies were funded with \$1.5 million in Federal funding and \$803,000 in matching funds in Fiscal Year 1976 and the Transition Quarter. The studies vary broadly in examining numerous effects and consequences of the discharge of several types of pollutants into marine and estuarine waters and into the Great Lakes. With emphasis on protection of marine resources of commercial or recreational importance, Sea Grant work is concerned primarily with heat, viruses, metals, pesticides, petroleum, and polychlorinated biphenyls (PCB's).

72 Pollution Study Projects

■	Sea Grant funding	\$1,500,000.
■	Matching funds	803,900.

In one of the most significant programs of its kind, Sea Grant researchers at the University of Wisconsin worked to determine the concentrations of PCB's in the fish of Lake Michigan and to quantify in primates the physiological effects of chronic ingestion of PCB's. The sci-

entists reported that salmon and trout contain PCB's at 100,000 to 1 million times the concentration found in the waters surrounding them and that the fish are able to take up these compounds directly from the water in a very short period of time. Because the fish are very slow to eliminate them, recovery from PCB contamination takes a long time.

The researchers also found that monkeys kept on a diet with very high concentrations of PCB's (300 and 5,000 parts per million [ppm]) for 3 months suffered acne, discharges of pus from their eyes, swollen eyelids and lips, hair loss, and weight loss. Particularly ominous was a thickening of stomach walls in view of the known association between chronic irritations of the stomach and cancer. Many of these animals eventually died when kept of prolonged PCB diets.

In related studies, concentrations were reduced to as low as 5.0 and 2.5 ppm, and the monkeys still suffered severe health problems.

PCB's were found to be toxic to primates over a wide dosage range. Although the possibility of man's consuming a steady diet containing these concentrations of PCB's is remote, the Wisconsin scientists believe these data do point out that only small amounts of PCB's are toxic, and that a safe level of consumption has not yet been established for these compounds. Because PCB's are known to accumulate in the tissues of exposed animals, continuous exposure even to minute quantities may be sufficient to cause eventual toxic effects.

At the Massachusetts Institute of Technology, economic and environmental impacts of petroleum development of the continental shelf were studied. In one study, ocean engi-

neers predicted transport of marine oil and surface films by waves. The researchers tested the hypothesis that surface oil films are moved over the seawater because of momentum transfer from wind-generated waves rather than by the wind directly. An analytical model has been developed that accounts for the differing viscosities of oil and water and the boundary tension between them. The model may also demonstrate the role of oil spill thickness in wave-induced movement. By making possible more accurate understanding of oil spill transport mechanisms, this Sea Grant study should lead to better siting of offshore oil production platforms and deep-water terminals and improved use of spill containment and collection systems.

A major problem in protecting the marine environment has been the inability to enforce laws prohibiting oil spills. Unless a spill is actually witnessed, it is usually impossible to determine its source. About 10,000 of these "mystery" spills occur along U.S. coasts each year. University of Rhode Island chemists, partially supported by Sea Grant funds, have perfected a method, using infrared spectroscopy, to identify or "fingerprint" spilled oil and trace it to the source. The method could prove extremely useful to the U.S. Coast Guard, Environmental Protection Agency, and State agencies responsible for dealing with oil pollution.

The method works by shining light through a transparent material containing a thin film of an oil sample. Because oil from different sources has slightly different molecular properties, each sample absorbs specific portions of the light spectrum and produces a unique identification, recorded on a graph. A computer stores the "fingerprint" codes from

different petroleum compounds so that if a "fingerprint" from the source of a mystery oil spill has been previously stored, the computer will match "fingerprints" from the spill and the source. The chemists envision a large computer reference "library" made up of "fingerprints" from oil shipped by tankers. If a spill were to occur, the source could be traced through the computer library. The oil "fingerprinting" technique already has been used to locate the source of a large oil spill in Narragansett Bay and to determine the sources of several others for Coast Guard officials.



Projects at five Sea Grant institutions focused on developing a method for measuring concentrations of viruses in marine waters and shellfish. The urgent need for definitive information on viral pollution of coastal waters and their shellfish was poignantly demonstrated in 1973 by the occurrence of an infectious hepatitis epidemic in the southwestern United States, mainly in Houston, Tex. It was caused by the consumption of contaminated Gulf coast oysters. More than 250 clinical cases of hepatitis were identified. Such disease outbreaks emphasize the need to know more about viral pollution and about the adequacy of present bacteriological criteria for determining the sanitary quality of shellfish and shellfish waters.

Sea Grant researchers at Baylor College of Medicine in Houston investigated reliable methods of assessing viral dangers. They improved the method for detecting viruses in oysters and modified a portable virus concentrator invented by two of the principal research scientists. The improved procedure for detecting viruses was tested in experimentally contaminated pools containing oysters; average efficiency of virus recovery was about 63 percent. The methods were then used to determine the extent of virus contamination of oysters and their surroundings in Sabine Lake. Lamar University collaborated in the Sa-

bine Lake work. Virus data now are being correlated with bacteriological and chemical data on the water and shellfish collected by the Lamar research team.

A number of Sea Grant projects bear directly on the question of environmental impacts of ocean sewage outfalls, in terms of effects on living resources and the potential hazards to human health. Studies were also made on new methods of waste water treatment and on habitat improvement in environments already under stress.

An assessment of the impact of the largest sewer outfall in the Hawaiian Islands suggests that deepwater disposal in combination with modified primary treatment may be sufficient to eliminate present undesirable conditions. Currently about 55 million gallons of raw sewage a day are discharged off Oahu at a depth of 40 feet. Alteration of the community structure of the coral ecosystem was found to extend along the coastline up to a distance of about 5 miles from the outfall. Within 0.4 miles of the outfall, there were no corals at all, and mounds of deposit-feeding polychaete worms were predominant. Off Oahu a new outfall is being built to divert the present discharge 1.5 miles offshore to a depth of 230 feet, where, with advanced treatment, impacts are expected to be insignificant.

Recently completed studies on ocean outfalls off Southwest Florida have shown that waste water, containing high concentrations of bacteria and viruses, is often dispersed into nearshore coastal areas. Recommendations included extending existing ocean outfalls in Southwest Florida to depths of 300 to 400 feet, increasing diffusers to improve mixing and initial dilution, and requiring

all effluents to receive secondary treatment prior to ocean discharge.

An innovative Sea Grant project in ocean engineering relative to the treatment of wastewater and sewage effluents was the development at the Massachusetts Institute of Technology of an irradiation method using high-energy electrons to inactivate pathogens and degrade organic compounds. Electron beams can turn large volumes of waste water and sewage effluent into valuable resources, such as reusable freshwater for cities or fertilizers for agriculture and aquaculture.

On the strength of research results accomplished under Sea Grant, the National Science Foundation supported an intensive laboratory effort that has led to construction of a pilot installation at Boston's Deer Island sewage treatment plant. In addition to the applicability of the electron treatment process to urban sewage treatment centers, its most feasible short term use may be in smaller, specialized systems. During studies on oyster aquaculture systems at the Woods Hole Oceanographic Institution, irradiation completely inactivated selected viruses.

Joint studies also have been pursued with the U.S. Fish and Wildlife Service's Fish Disease Laboratory, where scientists are examining the potential of electron beam irradiation for treating both the influent and effluent waters of experimental fish tanks. The high-energy electron method might also have a significant role in shipboard waste treatment. Moreover, hospital waste water, a potential source of pathogens, also could be sterilized by on-site systems of electron beam irradiation.

The potential of electrolysis as a method for large-scale waste water



treatment also was investigated at Mississippi State University. In preliminary investigations there, bacterial counts were reduced essentially to zero. Design of a demonstration unit is in progress.

A significant aspect of environmental research treats the question of habitat improvement. Several Sea Grant researchers are developing methods for improving stressed environments. At the University of Southern California, scientists are attempting to assess the potential impact of fish cannery wastes discharged into the Los Angeles/Long Beach Harbor Basin. The results of the study are being used by local, State, and Federal agencies to formulate a harborwide master plan for development and management of the basin.

A successful method of habitat improvement was developed in Florida that consists of large-scale transplantation of seagrass to areas previously denuded by thermal efflu-

ents. Researchers at the University of Miami also have been investigating the tolerance limits of the seagrass to a number of environmental factors and analyzing the economic feasibility of the method.

At Louisiana State University, Sea Grant researchers have demonstrated how to remove cheaply and safely the dissolved organic carbon, nitrogen, and phosphorus from sewage by use of marshland fringing a waterway. The project used highly organic waste waters from a menhaden plant at Dulac, La. Primary-treated wastes pumped from a holding pond were sprayed on the crest of a spoil bank and trickled down-slope 120 feet through native roseau cane to a collection ditch leading into a grass marsh. Plant response, nutrient concentrations, and levels of general and coliform bacteria were monitored during and subsequent to the 5 month period of plant operations. Organic matter, nutrients, and coliform bacteria dropped to background levels through plant nutrient uptake and aeration along the drainage path. General bacteria levels, considered beneficial, increased fourfold. The standing crop of another type of marsh grass that has potential economic value as a cellulose source, increased 55 percent. Marsh plants showed a corresponding increase, leading to an increase in fish populations. The most immediate benefits probably will accrue to fish processing businesses and small municipalities—entities that require inexpensive alternatives to technology-intensive sewage treatment.

In Columbia University's Department of Chemical Engineering and Applied Chemistry, laboratory studies on effluents from a Long Island corporation demonstrated the potential of synthetic ultrafilters for treating

effluents resulting from shellfish processing. The researchers are now moving the work to the stage of a pilot plant and coordinating it with the Pacific Utilization Research Center of the National Marine Fisheries Service. The work is of urgent importance because of increasingly stringent Federal and local guidelines for waste disposal.

Environmental Models

For more than a generation, physical models, particularly those built by the Corps of Engineers, have been used to determine important characteristics of bodies of water. Such phenomena as tides, flooding, and erosion, and the effects of man-made changes including dredging and the construction of breakwaters and dams, have been examined in remarkable detail using physical models. With the increased sophistication of computer technology, however, it is now possible to "build" mathematical models of systems that are far more detailed and considerably more accurate than their physical precursors.

These mathematical models, using numbers and magnetic tape rather than water and plaster of paris, are becoming valuable tools in understanding and manipulating complex systems and in gaining insights into alternative management strategies. Sea Grant currently supports aqua-

tic ecosystems analysis and modeling projects at a number of institutions. During Fiscal Year 1976 and the Transition Quarter, 33 projects were conducted with about \$1 million in Federal support and almost \$653,000 in matching contributions.

33 Aquatic Ecosystems Analysis/Modeling Projects

■	Sea Grant funding	\$1,000,000.
■	Matching funds	653,000.

In July 1975, a workshop attended by a number of Sea Grant modelers was convened at the University of Wisconsin to review past accomplishments and to attempt to determine just what Sea Grant's role should be in aquatic ecosystem analysis and modeling. Those attending the workshop concluded that the intentions of the Sea Grant Act could best be served by supporting effective analysis and modeling projects that will lead to better management of aquatic resources and that development of analysis and modeling talent is just as important as production of good tools for aquatic resource management.

The conferees further determined that the established Sea Grant policy of concentrating funds on colleges and universities while involving industry and local government to the maximum is appropriate for aquatic ecosystem analysis and modeling support.

The workshop attendees recommended that logical geographic choices for this work appeared to be the Great Lakes; the bays and harbors of the three coasts, as well as of Alaska and Hawaii; major rivers and other inland waterways; tidal estuaries; and swamps. They also recommended that Sea Grant-supported projects should focus sharply

on management of water quality in support of the highest and best use of the resource involved. They concluded that the acknowledgement and support of modeling projects are essential within whatever region is involved.

An excellent example of the use of environmental modeling techniques to enhance management of water quality is a project at the Massachusetts Institute of Technology. There, scientists at the Ralph M. Parsons Laboratory developed two- and three-dimensional mathematical models of water movement and dispersion in Massachusetts Bay. These computer models, designed to describe the physical characteristics of the bay and to predict the transport and dispersion of pollutants, sediments, and other matter, were created from data gathered on the bay's currents, depth, salinity, and temperature. The circulation and dispersion models are intended to provide planners and pollution control authorities with a method for predicting changes in the water characteristics and quality of Massachusetts Bay and other bays, thereby facilitating disposal of wastes in an environmentally sound manner.

The University of Rhode Island carried out extensive work in hydrodynamic modeling in projects dealing with oil spills, sewage, and tidal charting, all of which have been well received by the users.

Socio-Economics

It is hardly news that man's activities and technologies can place a heavy burden on the marine environment. Some of these burdens are all too obvious. Such enterprises as dredging, oil extraction and transportation, pulp mill operations, seafood

processing, and waste disposal, while critical to our economy and way of life, can place enormous stresses on the oceans and Great Lakes. Other activities, including commercial fishing, recreational boating, and shorefront home construction, can put more subtle, but equally important pressures on the environment. Common to all of these, however, is the requirement—in some cases the legal obligation—that there be a proper balance of preservation, conservation, and development of the Nation's marine resources.

Sea Grant is able to assist those who must make decisions about that "proper balance"—businessmen, conservationists, legislators, and the general public—by providing economic, legal, political, and sociological information on development of marine resources.

88 Marine Law/Socio-Economic Projects

■	Sea Grant funding	\$2,100,000.
■	Matching funds	1,500,000.

During Fiscal Year 1976 and the Transition Quarter, 88 projects in the category of Marine Law and Socio-Economics were conducted with more than \$2 million in Sea Grant support and almost \$1.5 million in matching funds.

Marine resources, especially petroleum reserves, offer considerable opportunities for commercial development. Sea Grant economists at Cornell University, the Massachusetts Institute of Technology (MIT), the University of Delaware and the University of Rhode Island analyzed a number of alternatives for both the Government and oil companies relating to the exploitation of oil and gas on the Atlantic Outer Continental Shelf (OCS).

The Delaware study, written primarily for that state's legislature, provided important information on the onshore effects of possible oil and gas exploration in the Baltimore Canyon Trough. The URI and MIT studies detailed potential offshore oil reserves and expected regional demand, projecting anticipated reserves and probable demand for oil and gas in the Northeast and suggested a number of alternative OCS leasing plans that the authors believe would lower the cost of petroleum extraction to the oil companies and increase revenue to the Government.

These economic and sociological studies were not mere academic exercises. All of them have been put to use by a variety of organizations including the National Ocean Policy Study (NOPS), the Office of Technology Assessment (OTA), the American Petroleum Institute, and a number of private oil companies and State regulatory agencies. Only by knowing the probable size and location of the OCS reserves, the costs of their extraction, and the economic and social effects of their development can organizations make rational judgments that will allow economically and environmentally sound use of these marine resources.

Even before passage in April of the Fishery Conservation and Management Act of 1976, managerial technique for fishery resources was an area of expanding effort by Sea Grant economists. Clearly the domestic and international ramifications of the adoption by Canada, Mexico, and the United States of separate 200-mile economic zones have increased the importance of those Sea Grant efforts. This is especially true because the U.S. 200-mile law requires that manage-



ment of our expanded fishery take into account economic, social, and ecological factors so as to provide the "greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities . . ."

Economists at the University of Rhode Island and Oregon State University investigated the probable economic impact on domestic fisheries of extended jurisdiction and suggested modifications needed to realize the law's full potential. Because the U.S. share of both the North Atlantic and West Coast fisheries is expected to expand under the new act, the economists determined the level of capital investment that fishermen could be expected to undertake in order to harvest the newly acquired stocks. Such information is important not only to the fishermen themselves, but to banks, savings and loan associations, and boatyards as well, because they must be able to anticipate demand for capital and goods well in advance of their actual use.

Underutilized fish species—those that are present in large enough numbers to warrant harvesting but for which no profitable market yet exists—are showing up in increasing number in supermarkets and restaurants. The possibility of marketing such "exotic" animals as alewives, blue mussels, eel, freshwater mullet, red crab, shark, squid, and white sucker has been examined by Sea Grant economists at a number of universities. Researchers at the University of North Carolina were involved in both eel rearing and marketing last year. Live eels, which command premium prices of up to \$3 per pound, enjoy a large overseas market, particularly in Japan. Marketing studies indicate, however, that North Carolina residents would purchase eel in sufficient quantities to encourage distribution of the fish.

In the Great Lakes, such underutilized fish as white sucker and alewives have been marketed with surprising success.

The real goals of those Sea Grant

researchers involved in either biological or economic and marketing studies of underutilized fish are to increase both the availability of such fish (which are generally far cheaper than the more popular species) to the consumer and to broaden the Nation's fisheries. By helping to create markets for products where none existed before, fishermen are encouraged to make better use of the country's natural resources, keeping and selling species that would otherwise have been thrown back or used for industrial purposes.

Because such activities as pleasure boating, skin diving, sportfishing, or simply beach-going involve both private enterprise and socially discrete groups of persons, marine recreation has been studied extensively by Sea Grant-supported economists and sociologists. Many of their results have been both helpful and surprising. For example, a project on marina operations completed in 1976 at Texas A&M University concluded that the popularly held belief that marinas were owned and operated by wealthy entrepreneurs who were reaping substantial profits was entirely wrong. Along the Texas Gulf Coast, the economists found, the vast majority of marinas are family owned, depend heavily on the cheap labor of the owner and his family, and are frequently just breaking even. Because of the high cost of waterfront property, the uncertainty of mortgage interest rates, and the considerable capital outlay required to set up a marina, the Texas A&M study concluded that marina operation is not the kind of business one would become involved in without first taking a careful look at the economic realities of the enterprise.

Ocean and Coastal Law

Both the individual States and the Federal Government have a continuing need for legal research that will inventory, classify, interpret, and evaluate the increasingly complex body of existing laws that affect the development and management of the marine environment. In addition to legal research, there is a simultaneous demand for educational programs for both the public and its lawmakers to clarify the relationship between the law and the oceans and coasts.

The Office of Sea Grant has supported education and research in ocean and coastal law since 1968, when grants were first made to Louisiana State University, Oregon State University, University of Miami,

and University of Washington. During Fiscal Year 1976 and the Transition Quarter, Sea Grant funded 23 projects at 16 institutions with \$535,000 in Federal support and \$397,000 in matching funds. These projects fall into more specific categories within the broad scope of ocean and coastal law, such as

23 Ocean/Coastal Law Projects

Sea Grant funding	\$ 535,000.
Matching funds	397,000.

coastal zone management, course development, international law of the sea, legal advisory services, and social sciences.

The University of Rhode Island's Law of the Sea Institute provided a neutral forum for the discussion of the

200-Mile Limit



international aspects of the regulation, control, exploration, and use of the marine environment. The Tenth Annual Conference, attended by representatives from every major marine interest as well as from many foreign countries, was held June 22-24, 1976, prior to the latest session of the United Nations Conference on Law of the Sea (UNCLOS). The Law of the Sea Institute served an important function for that UN Conference. Because so many of the attendees at the Rhode Island meeting also sit on deliberative councils of the United Nations body, they had a rare opportunity to discuss informally with their colleagues throughout the world the major ocean law issues before the latest meeting of UNCLOS.

A four-man team of Sea Grant researchers from the Louisiana State University, University of Southern California, the University of Rhode Island, and Texas A&M University reviewed the current status of the Law of the Sea to analyze the legal consequences for U.S. coastal States. Considerations and choices available to U.S. coastal States and their decisionmakers were examined from four perspectives:

1. Mineral extraction (including oil and gas).
2. Fisheries and fishery resources.
3. Pollution and other environmental questions.
4. Transportation and offshore facilities.

A Sea Grant legal researcher at Louisiana State University studied alternative methods for bringing about U.S. ocean policy goals after the Law of the Sea Conference, should the Conference fail, either partially or totally. The objectives of his research were to describe the most likely developments in interna-

tional law of the sea for the next 10 to 15 years in major issue areas, including deep seabed mining, economic resource zones, fisheries management, military use of the sea, navigation, scientific research, and protection of the marine environment, and to identify major U.S. ocean policy interests and how each would be affected by the various legal developments previously described.

With growing pressures on the coastal zone caused by competing users, analysis of the legal issues involved has been important in the National Sea Grant Program even prior to the Coastal Zone Management Act of 1972. Much of the Sea Grant research into coastal zone management legal issues has provided assistance to State planners who are developing State coastal zone programs.

For example, at the University of Florida, Sea Grant researchers worked to develop a packet of model ordinances designed to assist Florida's coastal counties in preserving and protecting the public interest in Florida's coastal areas. A Sea Grant researcher at the University of Mississippi compiled and is continuously updating information about State and Federal laws that affect the coastal zone, with the overall goal of moving toward a comprehensive coastal zone management plan for the State of Mississippi. Sea Grant researchers at a number of other institutions including Oregon, Rhode Island, and Wisconsin assisted State and local coastal zone planners by assessing the legal issues involved in coastal zone management.

Other areas of coastal law in which Sea Grant was active included a study at the University of South

Carolina of laws relating to the use of South Carolina's marine resources, and a study at Louisiana State University of the legal, institutional, and policy aspects of site selection for development, pipeline, ports, and waterways in coastal Louisiana.

It should be noted that many of the Sea Grant-supported research projects in coastal law seem to result in "studies" rather than immediate and substantive progress. The reason is two-fold. First, Sea Grant does not consider itself an adversary, pressing for "reforms" that should more properly be carried out through the political process embodied in State legislatures, coastal zone management councils, and the like. Instead, Sea Grant researchers examine facts, suggest alternatives, and provide documentation. Second, Sea Grant "studies" are frequently only an intermediate step in the process of formulating rational and democratic coastal zone management legislation. The actual implementation of those studies, as suggested above, lies with the States and their authorized bodies.

Marine Recreation

Social and physical scientists, as well as engineers, in institutions of the Sea Grant network are engaged in studies that are providing important data on marine recreation and its impact on the coastal zone. During Fiscal Year 1976 and the Transition Quarter, 10 projects were conducted with Federal support of about \$170,000 and matching funds of about \$126,000.

10 Marine Recreation/Impact on Coastal Zone Projects

	Sea Grant funding	\$ 170,000.
	Matching funds	126,000.



The Sea Grant Program at the State University System of New York completed a comprehensive analysis of New York marinas, identifying problems and initiating training courses in marina management techniques and permit procedures. The University of Rhode Island completed an economic study on the marina industry which provides information for planning on the industry's contributions to the State's economy and employment, as well as information on berthing, storage facilities, and planned expansion.

A URI study on how small-boat marinas affect the ecology of the coastal zones revealed, in part, that small boat-marinas are not the polluters that some people had assumed. However, work is still needed with respect to hydrocarbon and heavy metal pollutants as related to the marine environment. As a result of the study, researchers recommended that new marinas be located in areas where tides or currents will flush the water from the area frequently to help prevent high densities of planktonic organisms from occurring. Such densities can seriously deplete the amount of dissolved oxygen and possibly kill fish and other marine life. The study also found that, while some species of fish may not be as attracted to the marina environment as they are to natural marshes, a marina does appear to lure juvenile fish which, in turn, attract sport fish.

The New York Sea Grant Institute has conducted research to assess the role the charter rental boat industry plays in resource use and resource allocation in general recreational patterns. The information will be used by Sea Grant and by State, regional, and local officials in determining the viability of the charter rental boat industry in planning recreational programs.

A bibliography of the life history of important recreational species has been compiled by the University of Washington scientists. Five types of collection gear were evaluated, and a determination made that sufficient numbers of fish can be caught for managerial requirements for tagging and sampling in 1976. Tests for decompression showed that by using hook and line, rockfish could be caught and tagged from depths of up to 30 fathoms. Sampling of the five major species and underwater observations of behavior of bottomfish were made to determine the relationships among behavioral patterns, relative abundance, depth, and time of year.

The State University of New York initiated a study of the impact of recreational salmon fishing on fishermen and communities on the shores of Lake Ontario. The States will use the information in evaluating the costs and benefits of stocking the lake with salmon, and local municipalities will use it in planning for the recreational development that will follow the fishery's growth.

Marine Technological Research and Development

In the National Sea Grant Program, marine technological research and development covers a broad spectrum of research relating to the improved use and management of marine resources. In this category falls research in ocean engineering, resource recovery and utilization, transportation, seafood science and technology, and diving engineering and physiology. In general, the research in this category has application nationally. During the 15-month period covered by this report, 184 projects were conducted with Federal support of more than \$4,350,000 and matching funds of \$2,850,000.

184 Marine Research/Development Projects

■	Sea Grant funding	\$4,350,000.
■	Matching funds	2,850,000.

Sea Grant engineers either individually or in cooperation with private industry or governmental agencies researched offshore platforms, materials and structures, littoral drift, sand transport, wave measurement, floating breakwaters, corrosion, and underwater welding.

The Massachusetts Institute of Technology established theoretical foundations for underwater welding and cutting. Underwater welding techniques have been used since the early 1900's for repair of metal structures in the sea. However, these techniques have been extremely limited in their application because they are expensive to use, and the welds have been of uncertain quality. Underwater welds generally are weaker and more brittle than comparable



welds made in air, and they require operating personnel who combine skills in both diving and welding. Working activities must be carried out in a hazardous environment with limited mobility and poor visibility.

For these reasons, underwater welding applications have been largely restricted to temporary repairs and salvage operations. The study at MIT considered such basic aspects as heat flow, mechanisms of metal transfer, effects of water on metallurgical structures, and properties of welds. This study, and research in other countries, are aiding in development of new methods and techniques to meet the needs in underwater welding, extremely important progress because of the increasing number of offshore structures in operation or being planned.

The University of Hawaii successfully demonstrated the feasibility of constructing and developing large offshore platforms in the ocean environment. A preliminary design con-

cept was developed for a "floating city" with multiple uses as a sea-borne platform. Its feasibility was verified through extensive computerized mathematical analysis and through the use of models. Although use of superstable platforms as conceived for multiple purposes is still sometime in the future, this research already has found application in deepwater ports, offshore drilling platforms, and power plants.

At Oregon State University, new methods were developed for treating internal decay of wooden waterfront structures. Pressure treatment with creosote helps protect the external shell of piles, but does not prevent internal decay. By the new methods tested, liquid fumigants are poured into holes drilled in the pile. The holes are then plugged. The fumigant turns to gas and diffuses through the pile destroying the decay fungi and insects. Each treatment is effective for 5 to 10 years and can be continued indefinitely. Because it costs a minimum of \$500 to replace a pile on Oregon's coast, it is estimated that using liquid fumigants could result in an annual saving of \$50 million. An additional \$125 million could be saved if preventive maintenance practices are used, according to the researchers.

Florida's sand beaches are among the State's most valuable resources because they attract millions of tourists annually. Ironically, the very desirability of this resource has resulted in serious problems from misuse by man, and nearly 300 miles of shoreline are in a critical state of erosion. The University of Florida, with the support of Sea Grant and the Florida Bureau of Beaches and Shores, has attacked the problem. A 5-year project, continuing into 1977, is providing engineers and planners information for dealing

more effectively with problems of coastal erosion. Computations show that large quantities of sand eroding from beaches are being deposited on the outer bars, channels, and inner shoals of inlets. A report, "Littoral Drift Estimates Along the Coastline of Florida," contains 299 monthly-averaged littoral drift "roses," encompassing the entire Florida Coast, and facilitates reliable monitoring of the effectiveness of artificial restoration of eroded beaches.

Engineers at Scripps Institution of Oceanography in California have developed a breakwater of tethered floats that provides protection from waves generated by wind or ships. The prototype is a 150 foot float composed of 836 hollow, hardplastic spheres, 12 inches in diameter, spaced 2 feet center-to-center in each direction. They are individually attached by 5 foot tethers to submerged off-the-bottom rafts which provide the ballast required to submerge the floats. The breakwater reduces wave heights by up to 50 percent.

Other studies on tethered floating breakwaters made from discarded tires were made and are continuing at the Universities of New Hampshire, Rhode Island, and Washington. This type of breakwater, developed at URI, provides low-cost, easily and flexibly deployed wave protection for marinas and harbors.

Sea Grant investigators at the University of Southern California deployed an underwater wave monitoring system to determine the relationship between wave penetration of a breakwater of rubble mound design and harbor surging. Surging within the harbor causes damage to mooring lines and adjacent structures and causes delays in ship loading and



unloading. Breakwaters of this design have been found susceptible to wave penetration from waves of long duration. As a result of the wave monitoring system, a theory of harbor surging — incorporating wave penetration of the breakwater—has been developed. Results of this work will be used to help modify existing breakwaters and to improve design of future structures.

Scientists at the Virginia Institute of Marine Science experimented with a "perched beach," a technique that uses huge sand-filled bags to stabilize beaches. The experimentation proved practical for property owners on the Chesapeake Bay and for the community of Hampton, Va., where efforts were made to preserve the popular Buckroe Beach recreational area.

With fossil fuels becoming increasingly scarce and the cost of extracting the remaining stores of gas, oil, and coal growing commensurately



more expensive, Sea Grant has recognized the need for research dealing with forms of energy derived from the oceans.

Because sea waves long have been envisioned as an inexhaustible source of energy, a project was started at the Massachusetts Institute of Technology to determine the technical feasibility of using floating devices to extract appreciable amounts of energy from ocean waves. And at Scripps Institution of Oceanography in California, work was begun on an assessment of practical ways to make use of the

enormous potential energy created by salinity differences such as those that exist where large rivers flow into the sea.

A cooperative effort by the University of Hawaii and the Johns Hopkins Applied Physics Laboratory is aimed at determining the nature of biological fouling that will occur in power plants that extract ocean thermal energy. Sea Grant also supports researchers at the Woods Hole Oceanographic Institution to design traps for capturing the heat from the sun through absorption on a blackened floor of an artificial pond. The efficiency of the system is improved by filling the pond to a depth of about 3 feet with very dense brine covered by and insulating layer of fresh water.

Scuba diving is an important tool for scientists and engineers working in the marine environment. It is also a popular recreational activity. Because it is becoming more important, the National Sea Grant Program supports research in diving for scientific, industrial, and recreational purposes.

At the University of Wisconsin, several patentable systems to help professional and recreational divers have been developed. These include simplified models for adsorption and elimination of nitrogen by scuba divers, a real-time and scaled-time diving-plan computer, a diving-plan calculator, and a diver life-support monitoring and warning system with automatic surfacing capabilities. Also at the University of Wisconsin, students constructed and launched an underwater habitat, now in use on the bottom of Lake Mendota; and researchers are now developing a novel capsule for emergency escape, a support platform, and an artificial gill which can extract dissolved oxygen directly from the water for the diver.

Seafood Science and Technology

At the turn of the century, the vast majority of seafood consumed in this country was eaten fresh or salt-cured. As a result, most of the seafood consumers in the United States, of necessity, lived within a few miles of the oceans or Great Lakes. The advent of inexpensive methods of manufacturing large quantities of ice, the increased use of industrial and domestic freezing and refrigeration, and the improved efficiency and speed of commercial transportation, have made it possible for persons in Nebraska and Iowa as well as Maine and Florida to enjoy fresh, frozen, and canned seafoods that were not available just a generation ago.

Nevertheless, advancements are still to be made that will improve the sanitary quality, nutritional value, shelf life, appearance, and taste of fresh, frozen, and canned seafoods. For that reason, Sea Grant is working toward the development of new consumer and industrial products from marine fishes, especially underutilized species, and from seafood processing wastes.

Forty-nine projects in seafood science and technology were awarded during Fiscal Year 1976 and the Transition Quarter. Sea Grant funding totalled \$1,136,000, while matching funds were \$743,000.

49 Seafood Science/Technology Projects

	Sea Grant funding	\$1,136,000.
	Matching funds	743,000.

A well established program at Oregon State University (OSU) covered several areas of seafood technology under Sea Grant funding and involved not only research in food technology but work in economics,

industrial engineering, marketing, and consumer use as well. For example, work on determining the major source of microbial contamination of mechanically peeled shrimp revealed the culprit to be inaccessible spots on the rollers and peelers of the machinery. Special washing procedures now adopted by shrimp processors have reduced the microbial load of shrimp by as much as 70 percent.

Work at OSU on using shrimp and crab shell wastes as fertilizer also was encouraging. Greenhouse and field tests on grass and clover plots so far indicate substantial enrichment of the soil from the application of wastes, the disposal of which places a major financial burden on the seafood processor.

In related work at the University of Rhode Island, Sea Grant-supported scientists are using red crab wastes (about 85 percent of the landed weight of this economically valuable species) as a feed supplement for artificially reared salmon. The crab shells are also a natural source of the important pigment that gives salmon flesh its healthy pink color.

One of the simplest, but most far-reaching discoveries in seafood technology took place this past year, also at the University of Rhode Island. The development makes use of a special inexpensive "dipstick" impregnated with an enzyme that turns pink when it touches amines in fish flesh. The amines result from natural bacterial and chemical breakdown in fish and are precursors to spoilage. The "dipsticks" could be used aboard ship, at dockside, or in a food processing plant to accurately and cheaply detect even slight degrees of spoilage. URI scientists are now working on a way to make the system semi-automated,

and several seafood processors and regulatory agencies are cooperating in further development of the enzyme test strip.

One of the major obstacles to reviving and developing the clam fisheries in Alaska is the problem of paralytic shellfish poison (PSP). After 3 years of research, scientists from the University of Alaska have developed a colorimatic chemical method for determination of PSP. Although procedures are still complex, the testing is more simple than the current bioassay and holds promise of being converted into a simplified procedure that can be used aboard ship.

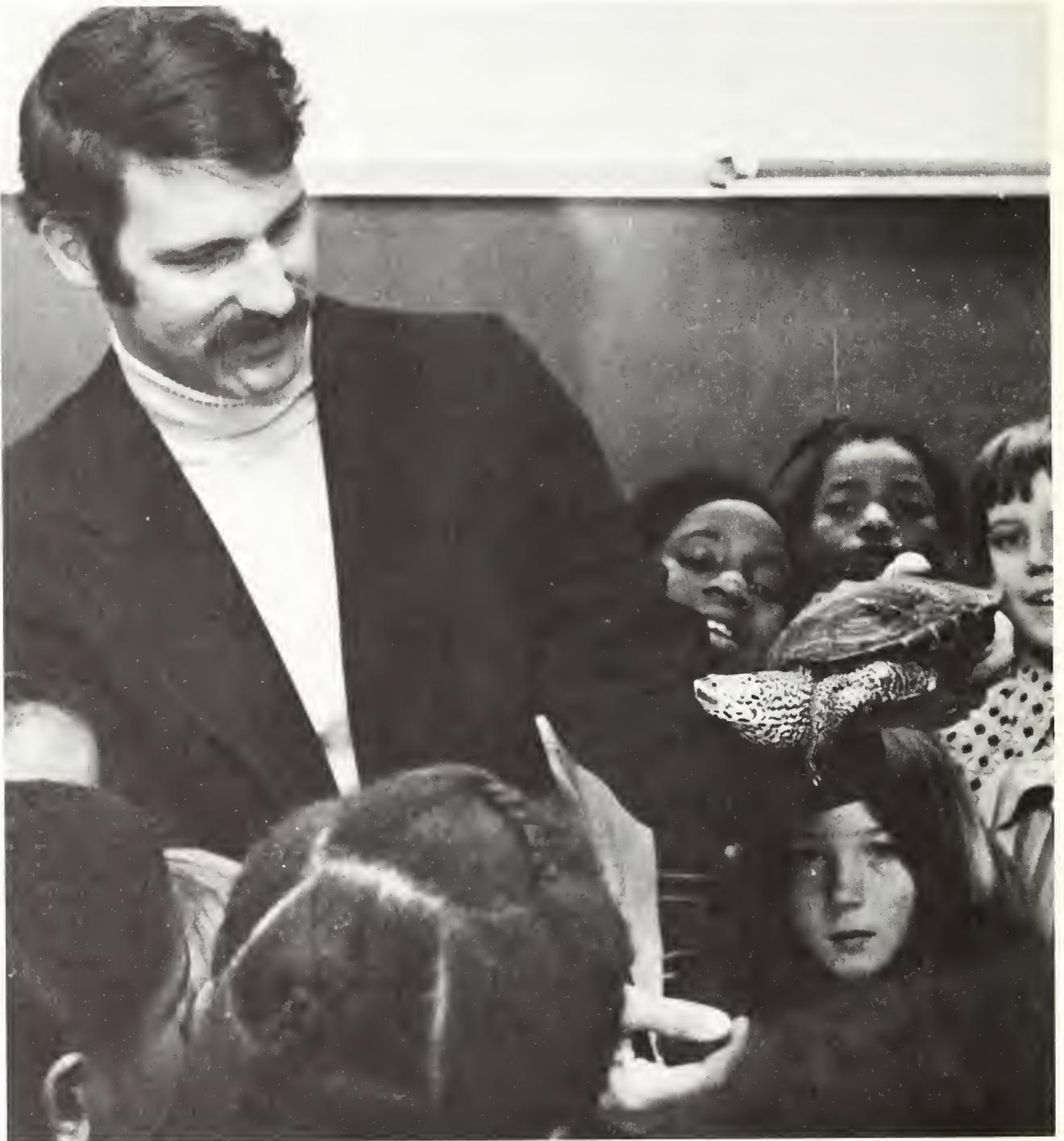
An economically promising project at the University of Georgia dealt with evaluation of a unique method of preserving the large quantities of otherwise unsaleable fish that are caught by shrimp fishermen. Because of the low value of these so-called trash fish (5 to 10 cents per pound, compared to more than \$2.50 per pound for shrimp), shrimpers are unwilling to tie up valuable ice and storage space to hold the incidental catch. The researchers found that by grinding the fish with corn, cornmeal, and molasses and then introducing a harmless acid-producing bacterium, *Lactobacillus*, spoilage was prevented without refrigeration. Tests are being made to determine the suitability of the resultant product as swine feed.

Marine Transportation

Marine transportation provides a vital link in foreign trade, interstate commerce, and the movement of commodities within States. At the Federal level, marine transportation is a primary concern of the Maritime Administration, U.S. Coast Guard, and Corps of Engineers. The Nation-



al Sea Grant Program also undertakes research, however, to assist local, State, and Federal authorities in planning policies for the Apostle Islands National Lakeshore region and a study of alternative types of trans-Lake Michigan transportation services. Of particular importance during Fiscal Year 1976, the Wisconsin Sea Grant Program combined, synthesized, and edited a report covering the results of research over the past several years. The book, entitled "The Great Lakes Transportation System," offers a series of recommendations that form the basis for a program under which the vital Great Lakes-St. Lawrence Seaway Transportation System can continue to develop. Contents include labor relations in Great Lakes-St. Lawrence Seaway transportation, containerization in Great Lakes transportation system, the Great Lakes shipping season, the energy crisis and Great Lakes shipping and commodity flows, and projection for future use of the system.



The Sea Grant College and Program Act of 1966 mandated the education and training of specialists for marine careers. The legislation calls for an increase in the scope of the National Sea Grant Program in developing public awareness of the oceans and related marine activities. Educational projects cover a broad range—from developing graduate and undergraduate courses and curricula in marine fields to preparing educational materials on the marine environment for students in kindergarten through high school.

When the National Sea Grant Program was established 10 years ago, industries were expected to grow rapidly and produce a significant demand for trained technicians. For that reason, Sea Grant stimulated the creation of graduate programs in economics, law, marine affairs, and ocean engineering; supported the improvement of existing programs in marine disciplines; and developed a number of training programs for marine technicians. The marine industries, however, failed to grow at the pace anticipated. The office of Sea Grant has maintained close vigil over the change and, as a result, has been able to supply technicians at a rate in line with the demand.

In the professional area, however, the demand continues for highly trained and experienced professionals, in both Government and industry, particularly for aquaculturists, ocean engineers, resource managers, and other policy level managers. Support by the Office of Sea Grant for academic training of this type has continued accordingly.

More recently, Sea Grant has applied greater emphasis on efforts to increase public awareness of and participation in the ocean and coastal programs—all with an eye toward improved management of all marine resources. This emphasis on general education has been recognized as policy. The Congress appropriated funds specifically to expand this part of the program, and during the coming year, Sea Grant will place a much greater emphasis on projects designed to introduce marine affairs into American primary and secondary education.

Although the National Sea Grant Program does not assume basic educational support, which is the responsibility of the universities themselves, many courses and sometimes entire degree programs are revised and upgraded under its aegis to include new material, techniques, and recent advances in other fields of resource development. The other major educational contribution of the program is support of graduate students for participation in Sea Grant research. Training by that method is immediately applicable in industry and Government.

During Fiscal Year 1976 and the Transition Quarter, 41 projects in professional education were sponsored by Sea Grant with \$383,000 in Federal support and \$737,000 in matching funds.

At the University of Rhode Island, a program leading to a Doctor of Philosophy degree in economics with a marine resource option was continued to help meet a nationwide need for economists familiar with marine problems. Graduates of this program are employed by private industry, State or Federal agencies, or international agencies concerned with marine resource development.

Also at URI, the Sea Grant Program established the first graduate program leading to a Master's Degree in Marine Affairs. This program is aimed at broadening the backgrounds of midcareer executives from various State and Federal agencies, as well as private agencies, to equip them to deal more effectively with marine problems.

Since 1971, Sea Grant has supported an undergraduate ocean projects course at the University of New Hampshire that provides an opportunity for undergraduate students to work as members of an interdisciplinary team in the solution of contemporary problems in the ocean and coastal zone. Under the guidance of a faculty adviser, each team of students defines its problem for the year, prepares and submits a budget, builds prototype models or gathers data, and makes a final presentation before a jury of experts drawn from the ocean community. Most of the projects have been in ocean engineering, but in 1976 other types of ocean-related problems also were studied. Typical topics studied during 1976 included control of a towed submersible, thermal gradient power production, and the value of the Hampton-Seabrook saltmarsh.

A program in law at the University of Washington combines both educational and research objectives. Accomplishments include publication of an analysis of the Washington Shoreline Management Act of 1971 and preparation of a casebook on International Law of the Sea. Course materials on Law of the Sea are being used at the Gonzaga University's School of Law, the School of

Law of the College of William and Mary, and the University of Miami's School of Law.

The University of Miami made a survey recently to determine the current employment of graduates of its program in ocean and coastal law. The study found that most of the graduates were in governmental and industrial positions dealing with their specialties. The positions include Assistant Attorney, Florida Department of Natural Resources; Head, Environmental Law Branch, International Law Division, Office of the Judge Advocate General, Department of the Navy; General Counsel, Marine Mammal Commission; Analyst/Attorney for Marine Science, Ocean and Coastal Resources Project, Congressional Research Service, Library of Congress; Counsel, Florida Department of Environmental Regulation; Environmental Control Officer, Palm Beach County Environmental Control Office; Director of Maritime Law Studies, Louisiana



State University Law School; State of Florida Pilot Commissioner; Special Counsel, Deepsea Ventures, Inc.; and Assistant Professor and Research Associate in Ocean and Coastal Law, Virginia Institute of Marine Science. Others held positions with the Office of the General Counsel in the National Oceanic and Atmospheric Administration and the National Science Foundation.

Vocational Marine Technician Training and Retraining

Sea Grant experience has demonstrated that vocational and technical training programs are most successful when developed by educational institutions that are in close contact with marine industries and other potential employers of the graduates.





Demands for graduates with marine vocational and technical training background vary from region to region and from industry to industry and Sea Grant institutions continuously assess the needs of their respective regions for trained marine technicians. In general, 2-year marine technician courses have been supported in community colleges, although there is no restriction demanding that the course take 2 years or that vocational career education should be limited to community colleges. The involvement of marine industries, which represent potential employers, to assist with planning and to provide financial support and work experience opportunities is extremely helpful and remains highly desirable. Interaction with potential employers allows reasonable probability that graduates will be placed.

During Fiscal Year 1976 and the Transition Quarter, 23 projects in technician training were supported with Federal funds of about \$400,000 and matching funds in excess of \$1 million.

Two projects produced oceanographic technicians for research vessels, two trained commercial divers, and others emphasized commercial fishing, marine applications welding, marine electricity and electronics, and repair and maintenance of diesel and gasoline engines.

Since 1970, with Sea Grant support, Leeward Community College in Hawaii has offered an Associate of Science Degree for students pursuing a specialized course of study in diving, marine sciences, and seamanship. The flexible program care-

fully balances classroom instruction with practical experience in the field. The success of the program is demonstrated by almost full employment of the graduates in marine industries.

At Kodiak Community College, a program was started in 1972 to provide students with a working knowledge of fish handling, fishing methods, navigation, and vessel operation. The program was expanded in 1974 to offer 2-year degrees in fishing technology and seafood processing. Additional curricula for degrees in aquaculture, fishing business and administration, and fisheries law enforcement are planned. Response to the program has been enthusiastic, and the University of Alaska has designated the College as the Alaska Center for Marine Technology Programs.

Sea Grant educational sponsorship now extends well beyond the conventional sectors of professional and technical training and, during Fiscal Year 1976 and the Transition Quarter, 55 projects in the "Other Education" category were supported with Federal funds of more than \$2 million and matching funds of more than \$1.3 million.

While scholarships, public displays, lecture and seminar series, and instructional materials development are supported, by far the greatest portion of education in this category

is in the form of traineeships and development of courses and curricula.

In a project entitled "Public Legislative Studies by Students and Their Professors," 6 candidates for Master's degrees at the State University of New York held internships in the Office of the Science Advisor in the New York State Assembly. To help define legally the limits of wetlands, one intern prepared "The Relationship of *Spartina alterniflora* to Mean High Water." The others also worked on problems of mutual interest to themselves and Assemblymen of New York State.

The "Marine Option Program" at the University of Hawaii was designed to provide undergraduate students from all disciplines a familiarization with marine topics and a marine skill. The program includes a formal lecture series; but more importantly, it allows the students to become involved in practical research and in marine advisory services so that they might acquire first-hand knowledge about marine research and problems. This project has been successful in increasing greatly the number of citizens who are conversant with marine affairs although they are not necessarily involved in them. This is especially important in Hawaii where almost all activities have at least a second-order marine relationship.

The University of Hawaii also developed a program for high school stu-

dents that provides them oceanographic training, including a day at sea aboard a converted schooner, the *Machius*. Referred to as the Blue Water Marine Laboratory, the schooner affords the students a chance not only to go to sea, but also to participate in experiments aboard the ship.

At the University of Delaware, curricular materials in marine subjects for kindergarten through high school have been developed and evaluated. Its set of 75 separate learning units relating to the marine and coastal environment has been distributed nationwide.

In April 1976, the Office of Sea Grant held a workshop on marine education at the Virginia Institute of Marine Science (VIMS) and at Williamsburg, Va. With assistance from the Oceanic Institute, Waimanalo, Hawaii, and from the Link Foundation, the workshop examined the possible need for redefinition of the Sea Grant role in marine education. Participants included representatives from State Sea Grant Programs, as well as Sea Grant Directors, educators, and representatives from other State and Federal agencies.

The workshop resulted in a number of recommendations for improving and upgrading the role of Sea Grant in marine education. Goals established by the conferees included:

1. A marine-literate society, aware of the importance of the oceans and marine environment and the reason for that importance; a society able to understand and participate in public and personal decisions affecting or affected by America's needs in the seas and inland waters.

2. A corps of marine-competent professionals and technicians, Amer-

ica's sea people, educated and trained to carry out the Nation's marine missions, whatever those missions may be.

3. In the coastal regions and near the great inland waters, a public better equipped to use the aquatic environment for recreational renewal, with greater understanding, safety, and enjoyment, and with appreciation of the fragility of the environment and need for its protection.

4. A new breed of public managers, whether elected, appointed, or career-professional, able to make decisions that recognize and ensure proper balance among America's needs and interests on land and sea, for maintenance and preservation of the national resources, as well as their proper and timely use.

The consensus was that Sea Grant, as a university-based program, views its role partially as a catalyst in developing a total approach to marine education.

The conferees agreed that for more than a third of America's 200 years, the oceans that once dominated national life and economics have occupied a secondary and minor role.

Now, at the opening of the third century of nationhood, a new era of American sea ventures is beginning, they agreed. The reasons for the reawakening, they indicated, were many: First, the resources of the land are dwindling and we must look to the sea for energy, food, minerals, and recreation. Second, we recognize the importance of maintaining the good health of the marine environment and of repairing some of the damage we have done, because the health of the oceans is directly linked to our own health as a Nation and as individuals. Third, fisheries



jurisdiction has expanded, with a seaward extension to 200 miles, across continental shelves of great richness and some of earth's most biologically productive waters. Fourth, there is a public reawakening of interest in the oceans that gathers momentum with each passing month and year. Fifth, most Americans now live close to the great waters and are more personally affected by their presence.

This new awareness, of course, has brought a strong and urgent call for more emphasis on marine education. The call comes from educators, State and local officials, private citizens and organizations, scientists, and universities, and the Congress of the United States. It is with that recognition in mind that Sea Grant intends to pursue this important segment of its program.



Marine Advisory Services

If there is any single aspect of the National Sea Grant Program that sets it apart from the literally scores of other Federal agencies that provide funds for research and development, it is the Marine Advisory Services (MAS). When the original Sea Grant legislation was written more than a decade ago, there was concern that a major problem could arise in a program that had as its statutory aim the fostering of *applied* research in the marine field. That problem—finding a way to get the hard, useful, and practical information out of the laboratories and scientific journals and into the hands of those who could really use it—could not have its solution left to chance. Not surprisingly, the legislative authors turned to Sea Grant's conceptual predecessor, the successful Land Grant Program, for guidance. During the latter half of Land Grant's history, both researchers and the public have come to rely heavily on the broad, cohesive network of county agents that makes up Land Grant's agriculture extension service.

Following a lead from this institutionalized arrangement that has agents acting as intermediaries between researchers and users, Sea Grant developed a comprehensive network of what one of the program's founders referred to as "county agents in hip boots." Realistically, Marine Advisory Service agents in any of the 27 States where an MAS program exists are more than county agents with an interest in things marine. In many cases, they are tenured faculty members, researchers, or administrators. In some instances, they are all three. But each of the more than 225 advis-

ory service agents possesses that philosophy embodied in the county agent: diligence, the ability to work effectively with disparate groups of persons ranging from commercial fishermen on their trawlers to biochemists in their laboratories, and a determination to communicate effectively and helpfully. Moreover, many of the staff members of the Marine Advisory Service live in the coastal communities to which they are responsible. Their assimilation into these local communities is one of the keys to their defining problems and winning public acceptance of Sea Grant research and teaching.

Progress Assessment

The Marine Advisory Service originally expanded less rapidly than the other Sea Grant components—research and education. The progress made by local advisory service programs in some cases is more difficult to measure than, say, the discovery by a group of Sea Grant researchers of an antibiotic for treating fish diseases.

From its beginning, the Office of Sea Grant has sought to expand Marine Advisory Services to all coastal and Great Lakes States and the island territories.

In December 1972, the NOAA Advisory Service (NMAS) was established, extending advisory services to the various agencies within NOAA. Administrative responsibility remained in the Office of Sea Grant with the Sea Grant Marine Advisory Services Program serving as the core for the broadened activities in other NOAA agencies. This cooperation has resulted in a greatly expanded base of information and resources upon which local and regional programs can draw to solve their own marine problems.

In addition, as local advisory service centers have grown, an important change has come over the advisory service itself. Agents in virtually all the advisory programs have assumed the role of intermediaries, uncovering marine-related problems that challenge industry, legislatures, the public, and regulatory agencies, and bringing these problems to the attention of their own Sea Grant directors so that they might solve these problems, either through research or direct action. Moreover, because the Marine Advisory Service is a network rather than a group of discrete, isolated programs, the expertise and knowledge of a number of persons at different institutions can be consolidated to meet a given challenge.

The advisory service acts to serve the needs of the community and to inform scientific researchers, through its Sea Grant directors, of vexing issues that exist at the local or regional level that might otherwise have been overlooked.

This service was exemplified by a series of events at the Massachusetts Institute of Technology that began several years ago and culminated during the reporting period.

MIT Marine Advisory agents discovered that commercial fishermen were becoming increasingly uneasy about the towing block system that had been used for years by New England fishermen to stabilize their trawl nets and prevent the tow cables from fouling in the vessels' propellers. Use of the block had led to serious injury among crewmen and resulted in higher insurance

premiums for the boat owners. Engineers at MIT, alerted by their advisory service, had consulted with representatives of the fishing industry to assess the technical problems with the towing block and to begin designing a prototype device. As a result, a series of prototype blocks was distributed to several fishermen for testing under actual sea conditions. The most successful of the prototypes is now in use on a half-dozen fishing boats, and the research has ended. The work is being followed up by advisory agents to ensure that fishermen know of the new block and its advantages and how it can be obtained or manufactured.

National Audience

During Fiscal Year 1976 and the Transition Quarter, nearly \$8,627,000 in Federal Sea Grant dollars and \$4,755,000 in matching funds went into marine advisory service activities.

In terms of exposure to individuals, advisory service personnel—through personal talks, workshops, publications, seminars, exhibits, and special courses—were responsible for an estimated 20 million contacts during the reporting period.

While necessary attention was devoted to the commercial fishing and related industries, more effort was directed toward increasing public knowledge of general marine matters than in any previous year, a trend that is expected to continue in the future. Local marine advisory programs are giving increasing attention to such matters as boating and waterfront safety; shoreline erosion and methods for dealing with it; hurricane protection for both persons and their homes; marine transportation; educational efforts to help consumers choose and prepare fish

(especially the less expensive underutilized species); tips for sport fishermen on weather, boats, bait, and fishing conditions; and general marine education at county fairs, 4-H clubs, expositions, and conferences.

In general, a number of changes, indicative of the maturity of the Marine Advisory Service, have taken place during the reporting period.

Fisheries and Fisheries Technology

Although direct assistance from the Marine Advisory Service to commercial fishermen and those involved in ancillary industries such as gear manufacture, seafood processing, and ship construction, has diminished in recent years in terms of the total effort of the Marine Advisory Services, such activities still constitute a major share of advisory work. This is partly a reflection of the needs perceived by the advisory agents and, to a lesser degree, a reflection of the sources of matching funds.

During the reporting period, a number of Advisory Service programs worked closely with commercial fishermen. Advisory agents at the University of Rhode Island continued to instruct fishermen on a more economical method of harvesting herring. The system, called two-boat midwater trawling, involves two boats pulling a single net. Because the two boats together can pull a larger trawl net and pull it faster and because the underwater noise from the engines tends to herd the herring into the net rather than drive them away, fishermen have realized larger catches at lower per unit cost of harvesting. Landed values of herring in Rhode Island increased annually. Although not all of this increase can

be attributed directly to the two-boat system, the method has been so successful that there are now at least 25 vessels in Massachusetts, New Jersey, and Rhode Island using the system. By the same token, in Georgia, an advisory service team developed a twin trawl net system. This system differs from the two-boat operation in that it uses one boat and four nets to capture shrimp. Considerable interest has been generated in this system among fishermen along both the Eastern Seaboard and the Gulf Coast.

Improved Trawl Net

At Clemson University, marine advisory agents demonstrated the University of Rhode Island improved trawl net system to South Carolina fishermen. In a 3-month trial period aboard one fishing vessel, the fishermen landed 34,526 pounds of five commercial species. That total was within 10,000 pounds of what the annual average for the five species has been for the entire fishing fleet in the State over a 5-year period. The fisherman's gross income increased spectacularly, and—as a result—eight other boat owners now have ordered nets, all being manufactured locally. The use of the new net also has diversified the fishing effort in the State. Previously, most of the effort had been limited to the harvest of shrimp.

In related work at Clemson, the Advisory Service was instrumental in helping eligible fishermen acquire loans for vessel construction and purchase. In 1970, the Production Credit Association (PCA), a network of lending institutions financed by local banks, obtained the statutory authority to make loans to fishermen. Because historically PCA had made loans only for agricultural pur-

poses, its board members did not believe themselves fully qualified to assess loan requests from South Carolina fishermen. For that reason, loans to commercial fishermen were not approved in substantial numbers in the first 3 years of PCA's operation. However, in 1973 a Marine Advisory agent was made a permanent member of the PCA's aquatic advisory board and, as a result, the number of loans to qualified South Carolina fishermen has increased dramatically. In addition, workshops for commercial fishermen and PCA personnel have been held to inform fishermen of the availability of money and the requirements for obtaining loans.

New Fishery

At the University of Hawaii, Marine Advisory agents, working with the State's Department of Planning and Economic Development and the Marine Affairs Coordinating Office, have, in effect, created an interest in a new fishery. Following a series of research excursions aboard the vessel *Easy Rider* to assess the population and distribution of sharks off Hawaii and to determine the best types of boats and gear for harvesting them, some 8,000 pounds of shark were landed and delivered to market. Because of the interest from fishermen in shark following this first assessment of the fishery, the advisory agents held a series of demonstration workshops on how to catch and prepare shark.

At the Virginia Polytechnic Institute (VPI), advisory agents made an economic study of a New England fish processing firm with gross sales of over \$1 million a year. At the company's request, the VPI team, along with experts from the U.S. Department of Agriculture, examined the



firm's financial records, management problems, and sales structure, and made suggestions for improvement. As a result, the company was able to make a financial turnaround. Without the assistance, according to one company official, the firm probably would not be in business. Following the New England work, VPI held a workshop on the west coast to acquaint other advisory agents with VPI's findings and to instruct the agents on how similar work could be carried out in their own areas.

Not all economics studied were aimed at existing businesses. Clemson University advisory agents, for example, completed an economic analysis last year of the blue crab fishery in the State to assist a cooperative considering the construction of a crab processing plant. The Sea Grant team concluded that there would be an insufficient supply of blue crabs to support a plant of a size the businessmen were considering. Similar work by the Advisory Service at the University of Connecticut on plans for a flounder-filleting plant produced the same conclusion: the supply of fish would be insufficient to support the venture being considered. In both cases, a substantial capital loss was probably averted through the efforts of Advisory Service economists.

Outdoor Recreation

In sheer number of participants, marine recreation (boating, diving, fishing, swimming, surfing) is by far the largest coastal industry in the Nation. Advisory service activities in this field range from the mundane—suggesting the best type of bait a sportsman might use for bass fishing—to the noble—holding life-saving courses for SCUBA divers. Last



year, more than 13 percent of advisory service funds were spent directly on marine recreation. (See page 41.)

Because conflicts frequently arise between sport and commercial fishermen, a number of communities have called on advisory service programs to help resolve differences between these two competing groups. Last year, for example, advisory agents in Mississippi brought together sport fishermen and commercial gill netters. The sport fishermen were particularly concerned about declining stocks of speckled trout and attributed the decline to the gill netters. As a result of statistical information presented by the Advisory Service, however, the sport fishermen were shown that the reduction in speckled trout harvest was a reflection of similar declines of certain other fisheries throughout the Mississippi Gulf Coast area and not a direct result of commercial fishing. While the problem—dealing

with declining fisheries—is still there, both the sport and commercial fishermen recognized that the solution lay in better fisheries management.

Industry Assistance

Another area of marine recreation assistance was the construction and placement of special floating-tire breakwaters to protect marinas. The breakwater system, started by researchers at the University of Rhode Island several years ago, uses scrap automobile and truck tires tied together to form floating rafts up to 20 feet wide and 100 feet long.

The rafts, which are anchored to the bottom, provide a substantial wave dampening effect, and, unlike far more expensive stone jetties, result in a minimal disturbance of the marine ecosystem. Through Rhode Island's cooperative efforts with marine advisory programs in New York and New Hampshire, there are now



15 floating-tire breakwaters in place in New England and the Great Lakes. One such breakwater, installed last year in Dunkirk Harbor in Lake Erie with assistance from the Goodyear Tire and Rubber Company, has made the town marina useable again and has provided both peace of mind and substantial dollar savings for local boat owners.

Other assistance to marina operators and those they serve has taken a somewhat indirect approach. At Texas A&M University, for example, a marine advisory agent made a study to determine both the services provided by typical marina operators in the Texas Gulf area and the services that the marina users (recreational boaters, sailors, sport fishermen) thought they could use. In many cases, there was a wide disparity between what the marinas provided and what the users sought. By furnishing marina owners and charter boat operators with information on anticipated demand by their respective customers, the advisory

service was able to broaden the market base of this major coastal business and to ensure better services to recreational boaters.

Impact Workshop

Delaware's Marine Advisory Service organized a workshop last year for members of the recreation industry; Federal, State, and local officials; and representatives of the oil and gas industries to discuss the probable impacts of oil and gas development off the Delaware-Virginia-Maryland coast. The workshop, like a number of others sponsored by various advisory services programs, served as a vehicle for groups with different ideas and objectives to sit down together and discuss the future before problems developed.

Sponsorship of conferences, seminars, and workshops has proved an important human element in the MAS. As a case in point, the Marine Advisory Service at Oregon

State University held a series of conferences with local crab fishermen and the State's towboat operators. For a number of years, crabbers had complained that towboats, bringing lumber barges down the coast, were fouling their floats and tearing up their pots, creating financial hardships for the fishermen. Damage claims against the towboat operators, some in excess of \$100,000, were averaging several a month. The solution—mapping out mutually agreeable shipping lanes—was achieved because the towboat operators and the crabbers, with the advisory service's encouragement, were able to sit down face-to-face and iron out their conflicts.

Marine Science and Education

Without technical assistance, it is clearly difficult, and in some cases impossible, for the American public to make intelligent, rational decisions about the uses of its own coastal areas. To this end, local marine advisory service programs throughout the country have devoted much of their energy to marine science and education. The educational efforts of the marine advisory programs range from the general—nature walks, tours of marine science centers and aquaculture facilities—to the specific—technical conferences for citizens interested in coastal zone management and the political processes that affect it. At Oregon State University, for example, marine advisory agents held a series of workshops to explain the functions— aesthetic, biological, commercial, and economic—of Oregon's estuaries. A workshop held at the mouth of the Columbia River was only one focal point in the series, but it served to point out both the uses and demands of a single estuary and the political realities of attempts to make changes affecting it.

At the University of Washington, Advisory Service personnel during the past year worked with a number of 4-H Clubs, leading field trips and providing many of the 4-H members with their first exposure to marine science. Also at the University of Washington, the Advisory Service held a 2-week summer course for teachers of grades kindergarten through high school. The course was designed to provide the teachers with first-hand experience in such subjects as botany, marine biology, oceanic geology, and pollution.

Public Service Programs

Television, radio, and film have figured prominently in marine education efforts in several of the Advisory Services programs as well. At Oregon State University, a series of programs, produced specifically for educational television, was broadcast during the reporting period. The programs were aimed at high school and junior high school students, informing them about career possibilities in oceanography and related fields and pointing out coastal zone management concerns in the Pacific Northwest.

The University of Wisconsin's "Earthwatch" radio program, now in its fifth year, continues to provide listeners with general environmental information, much of it devoted to the oceans. This award-winning 2-minute program, broadcast 5 days a week over more than 100 radio stations from New York to Wyoming, reaches an estimated 2.5 million persons. In addition, more than 50 newspapers in Wisconsin print a syndicated column based on the "Earthwatch" program. The newspapers are read by some 500,000 persons a month.

Another radio program, produced by Wisconsin with help from other Sea Grant programs, was started during the reporting period. Called "Ocean Soundings," the series consists of 98 one-minute taped broadcasts highlighting activities at Sea Grant-supported institutions across the country. The tapes, narrated by Frank Blair, formerly of the "Today" show, are now being broadcast by more than 100 radio stations from Maine to Hawaii.

Films and video tapes on such subjects as oil spills, commercial fishing, and seafood processing also were produced or distributed by the Sea Grant institutions during the reporting period.

Sea Grant Communications Network

Assisting in the work that the advisory service agents perform are the Sea Grant "Communicators," a corps of more than 50 professional writers, editors, and public affairs officers located at institutions throughout the Sea Grant network. The Sea Grant Program has come to depend heavily on these communicators for a wide variety of functions, including the editing, publishing, and distribution of hundreds of Sea Grant reports; the production of news releases, press conferences, and tours for the news media, visiting scientists, and the general public; and the day-to-day responses to inquiries from businessmen, fishermen, legislators, and others whose lives and livelihoods are affected by the oceans and Great Lakes.

A number of special projects were completed by the Communicators under a program administered through the University of Wisconsin.

Among them was a publication, "Aquaculture 1976," a digest produced by the University of Delaware, which provides a summary of current aquaculture programs supported by the National Sea Grant Program, and an annotated bibliography called "Sea Sources," produced by the University of Washington, which lists almost 200 of the more popular Sea Grant publications in every field of research.

Progress in Management

In addition to the more visible changes in the Marine Advisory Services, progress has been made in a number of other areas. For the most part, these were less apparent because they involved changes in management methods and improved coordination with other advisory service programs or other NOAA organizations. Nevertheless, they reflect measureable growth and improvement in the Marine Advisory Services. They include:

—Increased public contact by marine advisory specialists, coordinators, and field agents, placing them in a better position to assist the Sea Grant Directors and their staffs in evaluating proposals in the early stages so that public needs are reflected in those proposals. This transition has resulted in greater "information transfer" between the researcher and the Advisory Service and, hence, greater benefits for the public.

—A closer relationship between marine advisory programs and other NOAA agencies. These include the Environmental Data Service (EDS), National Environmental Satellite Service (NESS), National Marine Fisheries Service (NMFS), National Weather Service (NWS), and Office

of Coastal Zone Management (OC ZM). For example, cooperation between the Marine Advisory Service program at Humboldt State University in California and NESS has been proving helpful to tuna fishermen off the northern California coast. NESS monitors a NOAA satellite that receives infrared imagery of the eastern Pacific. This imagery is directly related to the temperature of the sea surface. And the sea-surface temperature is an excellent indication of the location of tuna and salmon. By supplying fisherman with charts, updated weekly, indicating the most likely areas of tuna and salmon schools, the Humboldt State advisory service has helped fishermen

cut down on their search time for the tuna and salmon and greatly reduce their fuel and other costs.

—Expanding the network of Marine Advisory Services personnel in the Nation's coastal counties.

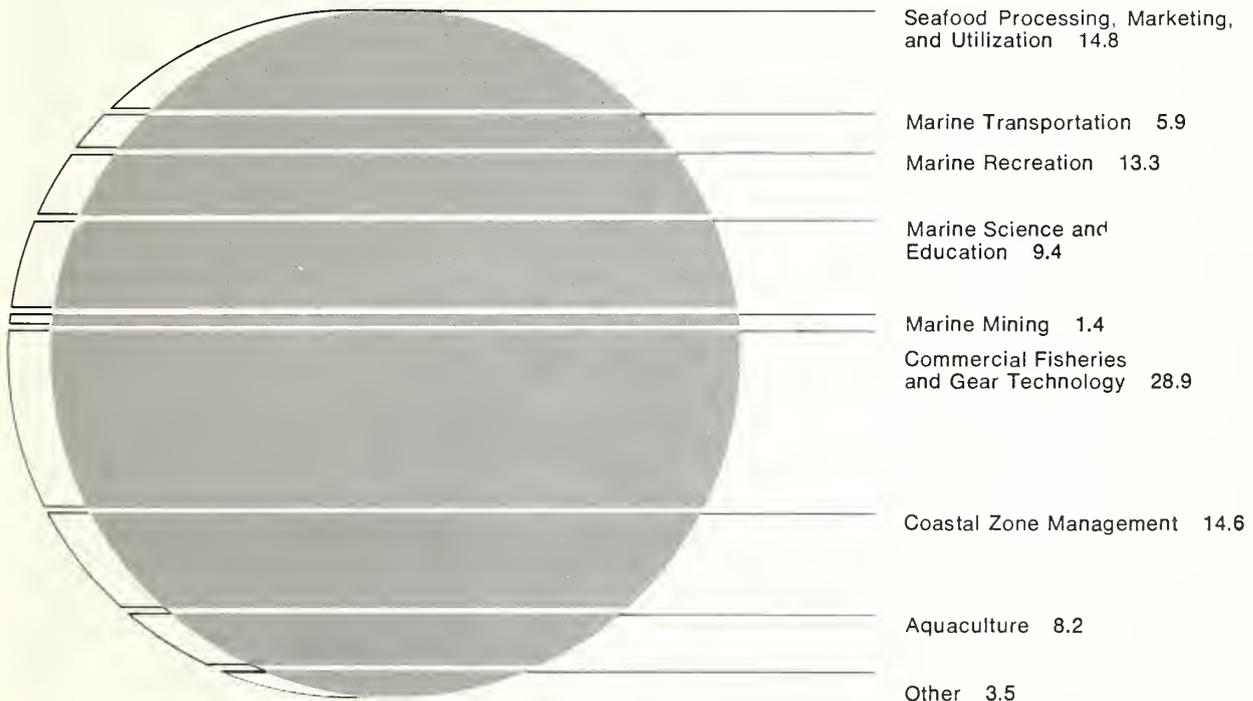
—Establishing closer ties with the Agriculture Department's Cooperative Extension Service. By using these already established information and distribution systems at Land Grant Colleges that have Sea Grant programs, NOAA has gained a much larger base for disseminating Sea Grant advisory service and research findings at a minimal increase in Federal dollars.

—Placing greater emphasis on education of the young in marine-related matters. While in the field of formal education, Sea Grant has devoted much of its energy to training marine scientists, specialists, and technicians, and to developing courses of study for primary and secondary schools, local marine advisory service programs have concentrated on a less formal education approach. Working with 4-H groups and others in primary and secondary schools, the advisory service has been able to foster an appreciation of America's legacy of coastal and marine resources and an awareness of the problems involved in their wise use and development.

Percentage of Sea Grant Dollars Expended on Marine Advisory Service Activities by Category During Fiscal Year 1976 and the Transition Quarter

Sea Grant: \$8,627,000

Matching: \$4,755,000





Program Administration

Sea Grant has taken a functional and flexible approach to the administration of the research it supports in colleges, universities, and other institutions. It authorizes and encourages the development of a process, a system of human resources at the institutions that is capable of responding effectively in a great variety of ways to local and regional problems and to opportunities in the national interest. The 1966 Sea Grant Act provides for "Federal support toward the establishment, development, and operation of programs by Sea Grant Colleges and Federal support of other Sea Grant programs designed to achieve gainful use of our marine resources . . ."

It is under this broad and diversified mandate that the Sea Grant research program operates through a network of educational institutions. Sea Grant support comes in three forms: Project—for individual projects; Coherent—for groups of projects at an individual institution; and Institutional—for large programs at institutions generally acknowledged as having a broad base of activity in marine affairs and which have committed themselves to positive, long term objectives in the field. These programs of support are progressive, with the institutions moving from one type of support to the next on the basis of the quality and the maturity of the three Sea Grant components—research, education, and advisory services. In nearly every case, Institutional and Coherent project proposals have followed individual project participation by the institution. The more specialized Coherent projects are few in number and are restricted to institutions with a unique or rare capability.

Sea Grant research normally is initiated by the Sea Grant institutions in response to local, State, or regional marine-related needs and opportunities, although support of innovative applied research by the academic environment also is a vital part of the research activities.

The first level of authority in the proposal system in use in Sea Grant rests with the Sea Grant Director at the particular institution. In addition to maintaining frequent communications with the National Sea Grant Office in Washington, the local director ascertains the problems, needs, opportunities, and expectations within the region of his institution and structures a program of proposals accordingly. His decisions normally are based on input from a great many sources, including his own Marine Advisory Service, an advisory committee at the institution, and from leaders in industry, government and the marine professions.

Thus, proposed projects receive an initial review at the local level. From there, they go to the Sea Grant Office in Washington where all proposals and programs are monitored and reviewed by technical experts. They call on other experts in academia, government, and industry to help evaluate proposals and programs.

Meanwhile, a group known as a "Site Team"—normally composed of 6 to 10 experts—will visit the institution making the proposal. Team membership usually will include two members of what in the past has been the Sea Grant Advisory Panel (now to be known as the Review Panel), one of whom will have visited the institution the previous year on the site visit; two members of the Sea Grant Office in Washington—the program monitor and an associate monitor; a representative of the National Marine Fisheries Service; a specialist in marine advisory services from the Washington Sea Grant Office; and others who have expertise appropriate to the specific program.

The on-site review lasts 2 or more days and provides a forum for oral presentations by the local director and his investigators and for discussions between them and members of the reviewing panel.

The site team meets in executive session during the visit and formulates advice on and evaluation of the proposed program. The team then meets with Sea Grant officials from the institution for discussion and advisement. The advice includes preliminary suggestions on whether projects should be funded, not funded, or revised for improvement.

On his return to Washington, the program monitor assimilates deliberations from the on-site review and the contents of reviews by mail of individual projects in the program and prepares a report that is reviewed in draft by members of the team of on-site reviewers. The report evaluates the entire program and provides the local director with a level of funding that he uses to prepare a revised proposal in line with the report.

When the grant is made, the local director is designated the official responsible for execution of all the proposed work. This allows him administrative and fiscal flexibility that fosters efficient operation of the program.

Additionally, local directors are provided limited discretionary funds, which permit rapid response to local problems. One example involved the mass stranding of whales and dolphins in Florida in July 1976. To determine the cause of such a stranding in shallow water required immediate investigation. Because discretionary funds were available for such emergencies, the Sea Grant Director in Florida was able to provide immediate approval to dispatch a team of biologists and other marine specialists, and they were on their way to the scene within 2 hours. Discretionary funds also are used to make mini-grants, usually small amounts of money that might be needed for a necessary piece of research equipment or to make emergency data collection.



PUBLIC LAW 94-461—OCT. 8, 1976

90 STAT. 1961

Public Law 94-461
94th Congress

An Act

To improve the national sea grant program and for other purposes.

Oct. 8, 1976
[H.R. 13035]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Sea Grant Program Improvement Act of 1976".

SEC. 2. AMENDMENT TO THE NATIONAL SEA GRANT COLLEGE AND PROGRAM ACT OF 1966.

Sea Grant
Program
Improvement
Act of 1976.
33 USC 1121
note.

Title II of the Marine Resources and Engineering Development Act of 1966 (33 U.S.C. 1101 et seq.) is amended to read as follows:

"TITLE II—NATIONAL SEA GRANT PROGRAM

National
Sea Grant
Program Act.
33 USC 1121
note.
33 USC 1121.

"SEC. 201. SHORT TITLE.

"This title may be cited as the 'National Sea Grant Program Act'.

"SEC. 202. DECLARATION OF POLICY.

"(a) FINDINGS.—The Congress finds and declares the following:

"(1) The vitality of the Nation and the quality of life of its citizens depend increasingly on the understanding, assessment, development, utilization, and conservation of ocean and coastal resources. These resources supply food, energy, and minerals and contribute to human health, the quality of the environment, national security, and the enhancement of commerce.

"(2) The understanding, assessment, development, utilization, and conservation of such resources require a broad commitment and an intense involvement on the part of the Federal Government in continuing partnership with State and local governments, private industry, universities, organizations, and individuals concerned with or affected by ocean and coastal resources.

"(3) The National Oceanic and Atmospheric Administration, through the national sea grant program, offers the most suitable locus and means for such commitment and involvement through the promotion of activities that will result in greater such understanding, assessment, development, utilization, and conservation. Continued and increased Federal support of the establishment, development, and operation of programs and projects by sea grant colleges, sea grant regional consortia, institutions of higher education, institutes, laboratories, and other appropriate public and private entities is the most cost-effective way to promote such activities.

"(b) OBJECTIVE.—The objective of this title is to increase the understanding, assessment, development, utilization, and conservation of the Nation's ocean and coastal resources by providing assistance to promote a strong educational base, responsive research and training activities, and broad and prompt dissemination of knowledge and techniques.

"(c) PURPOSE.—It is the purpose of the Congress to achieve the objective of this title by extending and strengthening the national sea

grant program, initially established in 1966, to promote research, education, training, and advisory service activities in fields related to ocean and coastal resources.

33 USC 1122.

“SEC. 203. DEFINITIONS.

“As used in this title—

“(1) The term ‘Administration’ means the National Oceanic and Atmospheric Administration.

“(2) The term ‘Administrator’ means the Administrator of the National Oceanic and Atmospheric Administration.

“(3) The term ‘Director’ means the Director of the national sea grant program, appointed pursuant to section 204(b).

“(4) The term ‘field related to ocean and coastal resources’ means any discipline or field (including marine science (and the physical, natural, and biological sciences, and engineering, included therein), marine technology, education, economics, sociology, communications, planning, law, international affairs, and public administration) which is concerned with or likely to improve the understanding, assessment, development, utilization, or conservation of ocean and coastal resources.

“(5) The term ‘includes’ and variants thereof should be read as if the phrase ‘but is not limited to’ were also set forth.

“(6) The term ‘marine environment’ means the coastal zone, as defined in section 304(1) of the Coastal Zone Management Act of 1972 (16 U.S.C. 1453(1)); the seabed, subsoil, and waters of the territorial sea of the United States; the waters of any zone over which the United States asserts exclusive fishery management authority; the waters of the high seas; and the seabed and subsoil of and beyond the outer Continental Shelf.

“(7) The term ‘ocean and coastal resource’ means any resource (whether living, nonliving, manmade, tangible, intangible, actual, or potential) which is located in, derived from, or traceable to, the marine environment. Such term includes the habitat of any such living resource, the coastal space, the ecosystems, the nutrient-rich areas, and the other components of the marine environment which contribute to or provide (or which are capable of contributing to or providing) recreational, scenic, esthetic, biological, habitation, commercial, economic, or conservation values. Living resources include natural and cultured plant life, fish, shellfish, marine mammals, and wildlife. Nonliving resources include energy sources, minerals, and chemical substances.

“(8) The term ‘panel’ means the sea grant review panel established under section 209.

“(9) The term ‘person’ means any individual; any public or private corporation, partnership, or other association or entity (including any sea grant college, sea grant regional consortium, institution of higher education, institute, or laboratory); or any State, political subdivision of a State, or agency or officer thereof.

“(10) The term ‘sea grant college’ means any public or private institution of higher education which is designated as such by the Secretary under section 207.

“(11) The term ‘sea grant program’ means any program which—

“(A) is administered by any sea grant college, sea grant regional consortium, institution of higher education, institute, laboratory, or State or local agency; and

“(B) includes two or more projects involving one or more of the following activities in fields related to ocean and coastal resources:

- “(i) research,
- “(ii) education,
- “(iii) training, or
- “(iv) advisory services.

“(12) The term ‘sea grant regional consortium’ means any association or other alliance which is designated as such by the Secretary under section 207.

“(13) The term ‘Secretary’ means the Secretary of Commerce.

“(14) The term ‘State’ means any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Commonwealth of the Mariana Islands, or any other territory or possession of the United States.

“SEC. 204. NATIONAL SEA GRANT PROGRAM.

33 USC 1123.

“(a) **IN GENERAL.**—The Secretary shall maintain, within the Administration, a program to be known as the national sea grant program. The national sea grant program shall consist of the financial assistance and other activities provided for in this title. The Secretary shall establish long-range planning guidelines and priorities for, and adequately evaluate, this program.

Planning
guidelines and
priorities.

“(b) **DIRECTOR.**—(1) The Secretary shall appoint a Director of the national sea grant program who shall be a qualified individual who has—

“(A) knowledge or expertise in fields related to ocean and coastal resources; and

“(B) appropriate administrative experience.

“(2) The Director shall be appointed and compensated, without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, at a rate not in excess of the maximum rate for GS-18 of the General Schedule under section 5332 of such title.

5 USC 3301
et seq.
5 USC 5332
note.

“(c) **DUTIES.**—The Director shall administer the national sea grant program subject to the supervision of the Secretary and the Administrator. In addition to any other duty prescribed by law or assigned by the Secretary, the Director shall—

“(1) apply the long-range planning guidelines and the priorities established by the Secretary under subsection (a);

“(2) advise the Administrator with respect to the expertise and capabilities which are available within or through the national sea grant program, and provide (as directed by the Administrator) those which are or could be of use to other offices and activities within the Administration;

“(3) evaluate activities conducted under grants and contracts awarded pursuant to sections 205 and 206 to assure that the objective set forth in section 202(b) is implemented;

“(4) encourage other Federal departments, agencies, and instrumentalities to use and take advantage of the expertise and capabilities which are available through the national sea grant program, on a cooperative or other basis;

“(5) advise the Secretary on the designation of sea grant colleges and sea grant regional consortia and, in appropriate cases, if any, on the termination or suspension of any such designation; and

“(6) encourage the formation and growth of sea grant programs.

“(d) **POWERS.**—To carry out the provisions of this title, the Secretary may—

5 USC 3301
et seq.
5 USC 5332
note.

Publication.

Rules and
regulations.

33 USC 1124.

“(1) appoint, assign the duties, transfer, and fix the compensation of such personnel as may be necessary, in accordance with the civil service laws; except that five positions may be established without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, but the pay rates for such positions may not exceed the maximum rate for GS-18 of the General Schedule under section 5332 of such title;

“(2) make appointments with respect to temporary and intermittent services to the same extent as is authorized by section 3109 of title 5, United States Code;

“(3) publish or arrange for the publication of, and otherwise disseminate, in cooperation with other services, offices, and programs in the Administration, any information of research, educational, training, and other value in fields related to ocean and coastal resources and with respect to ocean and coastal resources, without regard to section 501 of title 44, United States Code;

“(4) enter into contracts, cooperative agreements, and other transactions without regard to section 3709 of the Revised Statutes of the United States (41 U.S.C. 5);

“(5) accept donations and voluntary and uncompensated services, notwithstanding section 3679 of the Revised Statutes of the United States (31 U.S.C. 665(b)); and

“(6) issue such rules and regulations as may be necessary and appropriate.

“SEC. 205. CONTRACTS AND GRANTS.

“(a) **IN GENERAL.**—The Secretary may make grants and enter into contracts under this subsection to assist any sea grant program or project if the Secretary finds that such program or project will—

“(1) implement the objective set forth in section 202(b); and

“(2) be responsive to the needs or problems of individual States or regions.

The total amount paid pursuant to any such grant or contract may equal 66 $\frac{2}{3}$ percent, or any lesser percent, of the total cost of the sea grant program or project involved.

“(b) **SPECIAL GRANTS.**—The Secretary may make special grants under this subsection to implement the objective set forth in section 202(b). The amount of any such grant may equal 100 percent, or any lesser percent, of the total cost of the project involved. No grant may be made under this subsection unless the Secretary finds that—

“(1) no reasonable means is available through which the applicant can meet the matching requirement for a grant under subsection (a);

“(2) the probable benefit of such project outweighs the public interest in such matching requirement; and

“(3) the same or equivalent benefit cannot be obtained through the award of a contract or grant under subsection (a) or section 206.

The total amount which may be provided for grants under this subsection during any fiscal year shall not exceed an amount equal to 1 percent of the total funds appropriated for such year pursuant to section 212.

Application.

“(c) **ELIGIBILITY AND PROCEDURE.**—Any person may apply to the Secretary for a grant or contract under this section. Application shall be made in such form and manner, and with such content and other submissions, as the Secretary shall by regulation prescribe. The Secretary shall act upon each such application within 6 months after the date on which all required information is received.

“(d) **TERMS AND CONDITIONS.**—(1) Any grant made, or contract entered into, under this section shall be subject to the limitations and provisions set forth in paragraphs (2), (3), and (4) and to such other terms, conditions, and requirements as the Secretary deems necessary or appropriate.

“(2) No payment under any grant or contract under this section may be applied to—

“(A) the purchase or rental of any land; or

“(B) the purchase, rental, construction, preservation, or repair of any building, dock, or vessel;

except that payment under any such grant or contract may, if approved by the Secretary, be applied to the purchase, rental, construction, preservation, or repair of non-self-propelled habitats, buoys, platforms, and other similar devices or structures, or to the rental of any research vessel which is used in direct support of activities under any sea grant program or project.

“(3) The total amount which may be obligated for payment pursuant to grants made to, and contracts entered into with, persons under this section within any one State in any fiscal year shall not exceed an amount equal to 15 percent of the total funds appropriated for such year pursuant to section 212.

“(4) Any person who receives or utilizes any proceeds of any grant or contract under this section shall keep such records as the Secretary shall by regulation prescribe as being necessary and appropriate to facilitate effective audit and evaluation, including records which fully disclose the amount and disposition by such recipient of such proceeds, the total cost of the program or project in connection with which such proceeds were used, and the amount if any, of such cost which was provided through other sources. Such records shall be maintained for 3 years after the completion of such a program or project. The Secretary and the Comptroller General of the United States, or any of their duly authorized representatives, shall have access, for the purpose of audit and evaluation, to any books, documents, papers, and records of receipts which, in the opinion of the Secretary or of the Comptroller General, may be related or pertinent to such grants and contracts.

Record retention.
Regulation.

Audit.

“**SEC. 206. NATIONAL PROJECTS.**

33 USC 1125.

“(a) **IN GENERAL.**—The Secretary shall identify specific national needs and problems with respect to ocean and coastal resources. The Secretary may make grants or enter into contracts under this section with respect to such needs or problems. The amount of any such grant or contract may equal 100 percent, or any lesser percent, of the total cost of the project involved.

Grants and contracts.

“(b) **ELIGIBILITY AND PROCEDURE.**—Any person may apply to the Secretary for a grant or contract under this section. In addition, the Secretary may invite applications with respect to specific national needs or problems identified under subsection (a). Application shall be made in such form and manner, and with such content and other submissions, as the Secretary shall by regulation prescribe. The Secretary shall act upon each such application within 6 months after the date on which all required information is received. Any grant made, or contract entered into, under this section shall be subject to the limitations and provisions set forth in section 205(d) (2) and (4) and to such other terms, conditions, and requirements as the Secretary deems necessary or appropriate.

Application.

“(c) **AUTHORIZATION FOR APPROPRIATIONS.**—There is authorized to be appropriated for purposes of carrying out this section not to exceed \$5,000,000 for the fiscal year ending September 30, 1977. Such sums as may be appropriated pursuant to this subsection shall remain available

until expended. The amounts obligated to be expended for the purposes set forth in subsection (a) shall not, in any fiscal year, exceed an amount equal to 10 percent of the sums appropriated for such year pursuant to section 212.

33 USC 1126.

“SEC. 207. SEA GRANT COLLEGES AND SEA GRANT REGIONAL CONSORTIA.

“(a) DESIGNATION.—(1) The Secretary may designate—

“(A) any institution of higher education as a sea grant college; and

“(B) any association or other alliance of two or more persons (other than individuals) as a sea grant regional consortium.

“(2) No institution of higher education may be designated as a sea grant college unless the Secretary finds that such institution—

“(A) is maintaining a balanced program of research, education, training, and advisory services in fields related to ocean and coastal resources and has received financial assistance under section 205 of this title or under section 204(c) of the National Sea Grant College and Program Act of 1966;

“(B) will act in accordance with such guidelines as are prescribed under subsection (b) (2); and

“(C) meets such other qualifications as the Secretary deems necessary or appropriate.

33 USC 1124,
1123.33 USC 1121
note.*Ante*, p. 1961.

The designation of any institution as a sea grant college under the authority of such Act of 1966 shall, if such designation is in effect on the day before the date of the enactment of the Sea Grant Program Improvement Act of 1976, be considered to be a designation made under paragraph (1) so long as such institution complies with subparagraphs (B) and (C).

“(3) No association or other alliance of two or more persons may be designated as a sea grant regional consortium unless the Secretary finds that such association or alliance—

“(A) is established for the purpose of sharing expertise, research, educational facilities, or training facilities, and other capabilities in order to facilitate research, education, training, and advisory services, in any field related to ocean and coastal resources;

“(B) will encourage and follow a regional approach to solving problems or meeting needs relating to ocean and coastal resources, in cooperation with appropriate sea grant colleges, sea grant programs, and other persons in the region;

“(C) will act in accordance with such guidelines as are prescribed under subsection (b) (2); and

“(D) meets such other qualifications as the Secretary deems necessary or appropriate.

“(b) REGULATIONS.—The Secretary shall by regulation prescribe—

“(1) the qualifications required to be met under paragraphs (2) (C) and (3) (D) of subsection (a); and

“(2) guidelines relating to the activities and responsibilities of sea grant colleges and sea grant regional consortia.

Hearing.

“(c) SUSPENSION OR TERMINATION OF DESIGNATION.—The Secretary may, for cause and after an opportunity for hearing, suspend or terminate any designation under subsection (a).

33 USC 1127.

“SEC. 208. SEA GRANT FELLOWSHIPS.

“(a) IN GENERAL.—The Secretary shall support a sea grant fellowship program to provide educational and training assistance to qualified individuals at the undergraduate and graduate levels of education

in fields related to ocean and coastal resources. Such fellowships shall be awarded pursuant to guidelines established by the Secretary. Sea grant fellowships may only be awarded by sea grant colleges, sea grant regional consortia, institutions of higher education, and professional associations and institutes.

Guidelines.

“(b) **LIMITATION ON TOTAL FELLOWSHIP GRANTS.**—The total amount which may be provided for grants under the sea grant fellowship program during any fiscal year shall not exceed an amount equal to 5 percent of the total funds appropriated for such year pursuant to section 212.

“**SEC. 209. SEA GRANT REVIEW PANEL.**

33 USC 1128.

“(a) **ESTABLISHMENT.**—There shall be established an independent committee to be known as the sea grant review panel. The panel shall, on the 60th day after the date of the enactment of the Sea Grant Program Improvement Act of 1976, supersede the sea grant advisory panel in existence before such date of enactment.

Ante, p. 1961.

“(b) **DUTIES.**—The panel shall take such steps as may be necessary to review, and shall advise the Secretary, the Administrator, and the Director with respect to—

“(1) applications or proposals for, and performance under, grants and contracts awarded under sections 205 and 206;

“(2) the sea grant fellowship program;

“(3) the designation and operation of sea grant colleges and sea grant regional consortia, and the operation of sea grant programs;

“(4) the formulation and application of the planning guidelines and priorities under section 204 (a) and (c) (1); and

“(5) such other matters as the Secretary refers to the panel for review and advice.

The Secretary shall make available to the panel such information, personnel, and administrative services and assistance as it may reasonably require to carry out its duties.

“(c) **MEMBERSHIP, TERMS, AND POWERS.**—(1) The panel shall consist of 15 voting members who shall be appointed by the Secretary. The Director shall serve as a nonvoting member of the panel. Not less than five of the voting members of the panel shall be individuals who, by reason of knowledge, experience, or training, are especially qualified in one or more of the disciplines and fields included in marine science. The other voting members shall be individuals who, by reason of knowledge, experience, or training, are especially qualified in, or representative of, education, extension services, State government, industry, economics, planning, or any other activity which is appropriate to, and important for, any effort to enhance the understanding, assessment, development, utilization, or conservation of ocean and coastal resources. No individual is eligible to be a voting member of the panel if the individual is (A) the director of a sea grant college, sea grant regional consortium, or sea grant program; (B) an applicant for, or beneficiary (as determined by the Secretary) of, any grant or contract under section 205 or 206; or (C) a full-time officer or employee of the United States.

“(2) The term of office of a voting member of the panel shall be 3 years, except that of the original appointees, five shall be appointed for a term of 1 year, five shall be appointed for a term of 2 years, and five shall be appointed for a term of 3 years.

“(3) Any individual appointed to fill a vacancy occurring before the expiration of the term for which his or her predecessor was appointed shall be appointed only for the remainder of such term.

No individual may be appointed as a voting member after serving one full term as such a member. A voting member may serve after the date of the expiration of the term of office for which appointed until his or her successor has taken office, or until 90 days after such date, whichever is earlier.

Chairman,
Vice Chairman.

“(4) The panel shall select one voting member to serve as the Chairman and another voting member to serve as the Vice Chairman. The Vice Chairman shall act as Chairman in the absence or incapacity of the Chairman.

Compensation.
5 USC 5332
note.

“(5) Voting members of the panel shall—

“(A) receive compensation at the daily rate for GS-18 of the General Schedule under section 5332 of title 5, United States Code, when actually engaged in the performance of duties for such panel; and

“(B) be reimbursed for actual and reasonable expenses incurred in the performance of such duties.

“(6) The panel shall meet on a biannual basis and, at any other time, at the call of the Chairman or upon the request of a majority of the voting members or of the Director.

“(7) The panel may exercise such powers as are reasonably necessary in order to carry out its duties under subsection (b).

33 USC 1129.

“SEC. 210. INTERAGENCY COOPERATION.

“Each department, agency, or other instrumentality of the Federal Government which is engaged in or concerned with, or which has authority over, matters relating to ocean and coastal resources—

“(1) may, upon a written request from the Secretary, make available, on a reimbursable basis or otherwise any personnel (with their consent and without prejudice to their position and rating), service, or facility which the Secretary deems necessary to carry out any provision of this title;

“(2) shall, upon a written request from the Secretary, furnish any available data or other information which the Secretary deems necessary to carry out any provision of this title; and

“(3) shall cooperate with the Administration and duly authorized officials thereof.

33 USC 1130.
Submittal to
Congress and
President.

“SEC. 211. ANNUAL REPORT AND EVALUATION.

“(a) ANNUAL REPORT.—The Secretary shall submit to the Congress and the President, not later than February 15 of each year, a report on the activities of, and the outlook for, the national sea grant program.

“(b) EVALUATION.—The Director of the Office of Management and Budget and the Director of the Office of Science and Technology Policy, in the Executive Office of the President, shall have the opportunity to review each report prepared pursuant to subsection (a). Such Directors may submit, for inclusion in such report, comments and recommendations and an independent evaluation of the national sea grant program. Such material shall be transmitted to the Secretary not later than February 1 of each year, and the Secretary shall cause it to be published as a separate section in the annual report submitted pursuant to subsection (a).

33 USC 1131.

“SEC. 212. AUTHORIZATION FOR APPROPRIATIONS.

“There is authorized to be appropriated for purposes of carrying out the provisions of this title (other than section 206) not to exceed

\$50,000,000 for the fiscal year ending September 30, 1977. Such sums as may be appropriated under this section shall remain available until expended.”

SEC. 3. INTERNATIONAL COOPERATION ASSISTANCE.

33 USC 1124a.

(a) **IN GENERAL.**—The Secretary of Commerce (hereafter in this section referred to as the “Secretary”) may enter into contracts and make grants under this section to—

- (1) enhance the research and development capability of developing foreign nations with respect to ocean and coastal resources, as such term is defined in section 203 of the National Sea Grant Program Act; and
- (2) promote the international exchange of information and data with respect to the assessment, development, utilization, and conservation of such resources.

(b) **ELIGIBILITY AND PROCEDURE.**—Any sea grant college and sea grant regional consortium (as defined in section 203 of the National Sea Grant Program Act) and any institution of higher education, laboratory, or institute (if such institution, laboratory, or institute is located within any State (as defined in such section 203)) may apply for and receive financial assistance under this section. Each grant or contract under this section shall be made pursuant to such requirements as the Secretary shall, after consultation with the Secretary of State, by regulation prescribe. Application shall be made in such form, and with such content and other submissions, as may be so required. Before approving any application for a grant or contract under this section, the Secretary shall consult with the Secretary of State. Any grant made, or contract entered into, under this section shall be subject to the limitations and provisions set forth in section 205(d) (2) and (4) of the National Sea Grant Program Act and to such other terms, conditions, and requirements as the Secretary deems necessary or appropriate.

Regulation.

Consultation.

(c) **AUTHORIZATION FOR APPROPRIATIONS.**—There is authorized to be appropriated for purposes of carrying out this section not to exceed \$3,000,000 for the fiscal year ending September 30, 1977. Such sums as may be appropriated under this section shall remain available until expended.

SEC. 4. CONFORMING AND MISCELLANEOUS PROVISIONS.

(a) Section 5314 of title 5, United States Code, is amended by adding at the end thereof the following new paragraph:

“(65) Administrator, National Oceanic and Atmospheric Administration.”

(b) Section 5315 of title 5, United States Code, is amended by adding at the end thereof the following new paragraphs:

“(109) Deputy Administrator, National Oceanic and Atmospheric Administration.

“(110) Associate Administrator, National Oceanic and Atmospheric Administration.”

(c) (1) Section 2(d) of Reorganization Plan Numbered 4 of 1970 (84 Stat. 2090) is amended by striking out “Level V” and “(5 U.S.C. 5316)” and inserting in lieu thereof “Level IV” and “(5 U.S.C. 5315)”, respectively.

5 USC app. II;
15 USC 1511
note.

(2) The individual serving as the Associate Administrator of the National Oceanic and Atmospheric Administration (pursuant to section 2(d) of Reorganization Plan Numbered 4 of 1970) on the date of the enactment of this Act shall continue as the Associate Administrator, notwithstanding the provisions of paragraph (1).

5 USC app. II.

Approved October 8, 1976.

Public Law 94-461, the Sea Grant Program Improvement Act, was signed by President Gerald Ford on October 8, 1976. Designed to improve the National Sea Grant Program, the new Act directs the Secretary of Commerce to issue guidelines for national projects, calls for the development of international programs, and includes mandates for greater emphasis on regional consortia and educational fellowships.

Additionally, the Act directs the establishment of a 15-member review panel. The review panel will be formed to succeed the National Sea Grant Advisory Panel, which for the decade of its existence has proven to be one of the hallmarks of excellence in the program.

The mandate for national projects provides increased emphasis on projects more to the interest of the Nation than on those with purely local or regional benefits. In the international area, emphasis will be directed toward the development of programs by which universities, under Sea Grant sponsorship, may work with sister universities in other countries. Sea Grant will develop guidelines for this program through collaboration with experts in international oceanographic affairs. Sea Grant also will prepare formal draft guidelines for the administration of fellowships by the Sea Grant institutions and other organizations.

The Act also calls for the Secretary of Commerce to make a detailed annual report to the Congress and the President on the activities and outlook for the National Sea Grant Program. The report is designed to supplement annual reporting in *The Federal Ocean Program*. This is the first such report.

Chronology

National Sea Grant Program

- September, 1963** Athelstan Spilhaus, then Dean of the University of Minnesota, speaking before the American Fisheries Society in Minneapolis, suggests a national cooperative effort among academic, State, Federal, and industrial institutions to be known as "Sea Grant" and similar to the Land Grant Program, which had proved so successful in agriculture.
- August, 1965** Senator Claiborne Pell of Rhode Island introduces legislation for a National Sea Grant College and Program Act
- May, 1966** Senate holds hearings on Senator Pell's bill. Congressman Paul Rogers of Florida introduces similar legislation in the House.
- October, 1966** President Lyndon B. Johnson signs the National Sea Grant College and Program Act of 1966 into law.
- February, 1967** National Science Foundation establishes Office of Sea Grant and names Robert B. Abel as first director.
- September, 1967** Office of Sea Grant issues first grants to Massachusetts Institute of Technology in Massachusetts and to Nicholls State College in Louisiana.
- August, 1968** President Johnson signs reauthorization legislation for the National Sea Grant Program.
- July, 1970** President Richard M. Nixon signs reauthorization legislation for National Sea Grant Program.
- October, 1970** Executive government reorganization transfers National Sea Grant Program from the National Science Foundation to the newly established National Oceanic and Atmospheric Administration.
- September, 1971** Secretary of Commerce Maurice Stans designates first Sea Grant Colleges—University of Rhode Island, University of Washington, Oregon State University, and Texas A&M University.
- September, 1972** Secretary of Commerce Peter G. Peterson designates two more Sea Grant Colleges—University of Hawaii and the University of Wisconsin.

- July, 1973** President Nixon signs reauthorization legislation for the National Sea Grant Program. Authorizes \$30 million to be appropriated for Fiscal Year 1974; \$40 million for Fiscal Year 1975, and \$50 million for Fiscal Year 1976.
- August, 1973** Secretary of Commerce Frederick B. Dent designates the University of California as the seventh Sea Grant College.
- March, 1975** Secretary of Commerce Frederick B. Dent designates the State University of New York/Cornell University a Sea Grant College.
- May, 1976** Secretary of Commerce Elliot L. Richardson designates the University of Delaware and the State University System of Florida as Sea Grant Colleges.
- July, 1976** Secretary of Commerce Elliot L. Richardson names the University of North Carolina as the 11th Sea Grant College.
- October, 1976** President Gerald L. Ford signs into law the Sea Grant Program Improvement Act of 1976.

Office of Sea Grant Staff

Robert B. Abel
Director



Hugh J. McLellan
Director, Grants Management

Richard C. Kolf
Associate Program Director

Michael D. McKenzie
Staff Assistant

Charles L. Miller
Administrative Officer

Arthur G. Alexiou
Associate Director
Programs



David B. Duane
Associate Program Manager

David H. Attaway
Associate Program Director

Michael A. Heeb
Assistant Program Manager

Ernest Greenwald
Program Analyst

Robert D. Wildman
Associate Director
Operations



William N. Shaw
Assistant Program Manager

Thomas E. Murray
Assistant Program Director

Leo S. Craig
Executive Officer

Beverly A. Young
Program Assistant

Robert J. Shephard
Program Manager
Marine Advisory Services



Michael Wascom
Congressional Liaison

James C. Elliott
Public Affairs Officer

Program Directors for Sea Grant Institutional Support

Edward Chin
Director, Sea Grant Program
University of Georgia
Athens, Ga.

B. J. Copeland
Director, N.C. Sea Grant Program
North Carolina State University
Raleigh, N.C.

Robert W. Corell
Deputy Director, Sea Grant Program
UME/UNH Joint Program
University of New Hampshire
Durham, N.H.

William S. Gaither
Dean, College of Marine Studies
University of Delaware
Newark, Del.

Niels Rorholm
Coordinator, Sea Grant Program
University of Rhode Island
Kingston, R.I.

Roy W. Hann, Jr.
Acting Director
Center for Marine Resources
Texas A&M University
College Station, Tex.

Dean A. Horn
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Massachusetts Institute of
Technology
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Ronald B. Linsky
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Honolulu, Hawaii

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Division of Marine Resources
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Hugh L. Popenoe
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Sea Grant Program
University of Florida
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Robert A. Ragotzkie
Sea Grant College Program Director
University of Wisconsin
Madison, Wis.

James J. Sullivan
Sea Grant College Program
Manager
University of California, San Diego
La Jolla, Calif.

Jack R. Van Lopik
Director, Center for Wetland
Resources
Louisiana State University
Baton Rouge, La.

William Q. Wick
Director, Sea Grant College
Program
Oregon State University
Corvallis, Ore.

Donald F. Squires
Director, SUNY/Cornell Sea Grant
Program
State University of New York
Albany, N.Y.

Program Directors for Sea Grant Coherent Support

Dean F. Bumpus
Sea Grant Coordinator
Woods Hole Oceanographic
Institution
Woods Hole, Mass.

L. G. Eldredge
Director, Sea Grant Program
University of Guam
Agana, Guam

William J. Hargis, Jr.
Director
Virginia Institute of Marine Science
Gloucester Point, Va.

Edwin B. Joseph
Director, Marine Resources Center
Charleston, S.C.

Theodore H. Kerstetter
Sea Grant Coordinator
Humboldt State University
Trinidad, Calif.

Eugene H. Man
Dean, Office of Research
Coordination
University of Miami
Coral Gables, Fla.

Dianne Jones
Acting Director
Mississippi-Alabama Sea Grant
Consortium
Ocean Springs, Miss.

Alfred M. Beeton
Director, Sea Grant Program
University of Michigan
Ann Arbor, Mich.

Donald H. Rosenberg
Director, Sea Grant Program
University of Alaska
Fairbanks, Alaska

Lionel A. Walford
Director
New Jersey Marine Sciences
Consortium
Fort Hancock, N.J.

Sea Grant Advisory Panel

Sanford S. Atwood
President
Emory University
Atlanta, Ga.

Werner A. Baum
University of Wisconsin
Milwaukee, Wis.

George S. Benton
Vice President, Homewood
Divisions
Johns Hopkins University
Baltimore, Md.

Lynton K. Caldwell
Department of Political Science
Indiana University
Bloomington, Ind.

Jacob J. Dykstra
President, Point Judith Fishermen's
Cooperative Association, Inc.
Narragansett, R.I.

Phillip Eisenberg
Chairman of the Executive
Committee
Hydronautics, Inc.
Washington, D.C.

Robert H. Ellis
Assistant to the President
The Hartford Graduate Center
Hartford, Conn.

J. Osborn Fuller
Department of Geology
Ohio State University
Columbus, Ohio

LeVan Griffis
Southern Methodist University
Dallas, Tex.

Joseph E. Henderson
Seattle, Wash.

Otto Klima
Vice President & General Manager
Re-Entry & Environmental Systems
Div.
General Electric Company
Philadelphia, Penn.

Bernard Le Méhauté
Senior Vice President
Tetra-Tech, Inc.
Pasadena, Calif.

Alton Lennon
Wilmington, N.C.

Harold E. Lokken
Manager, Fishing Vessel Owners
Ass'n.
Seattle, Wash.

John A. Mehos
Vice President
Liberty Fish and Oyster Company
Galveston, Tex.

Lyle S. St. Amant
Assistant Director
Louisiana Wildlife & Fisheries
Commission
New Orleans, La.

H. Burr Steinbach
Woods Hole, Mass.

James H. Wakelin, Jr.
Washington, D.C.

Harvey Weil
Senior Partner
Kleberg, Mobley, Lockett & Weil
Corpus Christi, Tex.

Sea Grant Advisory Panel Members Emeriti

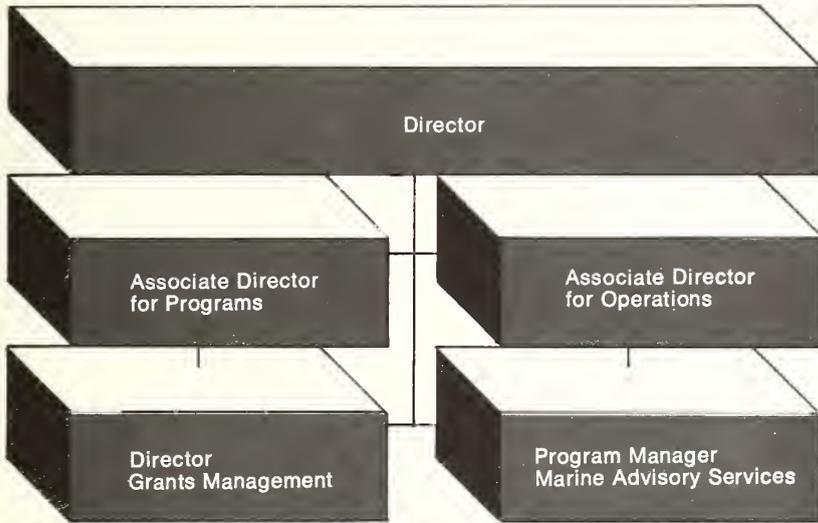
Douglas L. Brooks
Executive Director
National Advisory Committee on
Oceans & Atmosphere
Washington, D.C.

Roy D. Gaul
Office of Naval Research
Arlington, Va.

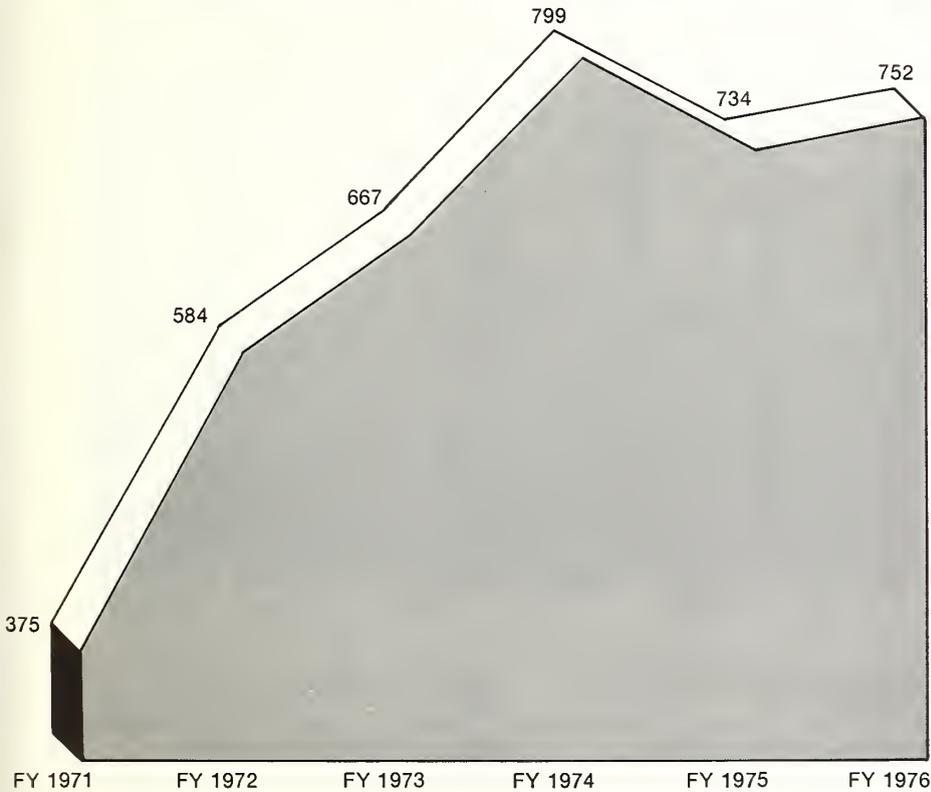
David S. Potter
Vice President
Environmental Activities Staff
General Motors Corporation
Warren, Mich.

Athelstan F. Spilhaus
Special Assistant to the
Administrator
National Oceanic & Atmospheric
Administration
Washington, D.C.

Office of Sea Grant Table of Organization



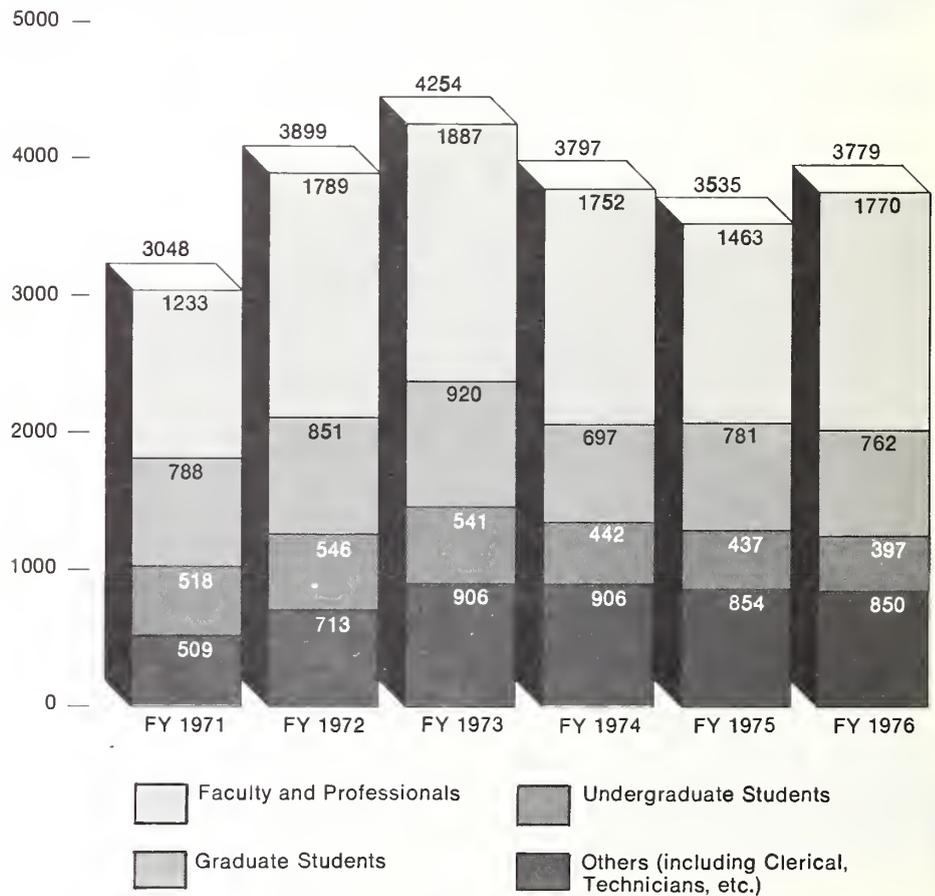
Number of Sea Grant Projects Funded By Fiscal Year



Growth in Sea Grant Funding



Participants in Sea Grant Program



**National Sea Grant Program
List of Grants Awarded in Fiscal Year 1976**

Appendices

Institution	Sea Grant Dollars	Matching Dollars
Alaska		
University of Alaska	\$ 559,100	\$ 524,200
Subtotal	<u>\$ 559,100</u>	<u>\$ 524,200</u>
Arizona		
University of Arizona	\$ 32,900	\$ 51,420
Subtotal	<u>\$ 32,900</u>	<u>\$ 51,420</u>
California		
University of California	\$ 30,100	\$ 7,138
Stanford University	100,000	50,000
Stanford University	110,500	55,458
University of Southern California	435,500	239,020
University of California	1,850,000	1,445,324
Humboldt State University	125,000	81,900
Stanford University	116,000	58,000
Subtotal	<u>\$ 2,767,100</u>	<u>\$ 1,936,840</u>
Connecticut		
University of Connecticut	\$ 47,500	\$ 23,987
Subtotal	<u>\$ 47,500</u>	<u>\$ 23,987</u>
Delaware		
University of Delaware	\$ 10,000	\$ 1,600
University of Delaware	771,200	445,100
Subtotal	<u>\$ 781,200</u>	<u>\$ 446,700</u>
District of Columbia		
National Fisheries Institute	\$ 16,000	\$ 8,000
National Fisheries Institute	3,700	1,900
Subtotal	<u>\$ 19,700</u>	<u>\$ 9,900</u>
Florida		
University of Miami	\$ 335,700	\$ 219,718
State University System of Florida	995,200	947,100
Subtotal	<u>\$ 1,330,900</u>	<u>\$ 1,166,818</u>
Georgia		
University of Georgia	\$ 583,000	\$ 524,471
Subtotal	<u>\$ 583,000</u>	<u>\$ 524,471</u>

Institution	Sea Grant Dollars	Matching Dollars
Hawaii		
University of Hawaii	\$ 5,000	
University of Hawaii	1,388,600	908,806
Oceanic Institute	60,000	38,680
*Oceanic Institute	95,000	
Hawaii Department of Land and Natural Resources	87,000	43,500
Subtotal	\$ 1,635,600	\$ 990,986
Louisiana		
Louisiana State University	\$ 700,400	\$ 615,510
Subtotal	\$ 700,400	\$ 615,510
Maine		
Maine Dept. of Marine Resources	\$ 75,000	\$ 37,500
University of Maine/University of New Hampshire	875,000	559,000
Subtotal	\$ 950,000	\$ 596,500
Maryland		
*Seabrook Hull Associates	\$ 1,400	
University of Maryland	75,000	47,600
Subtotal	\$ 76,400	\$ 47,600
Massachusetts		
Massachusetts Institute of Technology	\$ 998,600	\$ 589,954
Woods Hole Oceanographic Institution	425,000	304,900
Subtotal	\$ 1,423,600	\$ 894,854
Michigan		
University of Michigan	\$ 464,800	\$ 382,330
Subtotal	\$ 464,800	\$ 382,330
Minnesota		
University of Minnesota	\$ 64,600	\$ 35,300
Subtotal	\$ 64,600	\$ 35,300
Mississippi		
Mississippi/Alabama Sea Grant Consortium	\$ 80,000	\$ 61,485
Mississippi/Alabama Sea Grant Consortium	495,000	363,941
Subtotal	\$ 575,000	\$ 425,426
New Hampshire		
University of New Hampshire	\$ 43,300	\$ 25,600
Subtotal	\$ 43,300	\$ 25,600
New Jersey		
New Jersey Marine Sciences Consortium ..	\$ 220,100	\$ 155,900
Subtotal	\$ 220,100	\$ 155,900
New York		
State University of New York/Cornell University	\$ 6,100	
Columbia University	37,100	18,553
State University of New York	1,102,700	677,186
The Society of Naval Architects and Marine Engineers	24,000	42,000
State University of New York/Cornell	79,400	74,795
Subtotal	\$ 1,249,300	\$ 812,534

Institution	Sea Grant Dollars	Matching Dollars
North Carolina		
University of North Carolina	\$ 835,000	\$ 417,500
Subtotal	\$ 835,000	\$ 417,500
Oklahoma		
University of Oklahoma	\$ 90,000	\$ 45,000
Subtotal	\$ 90,000	\$ 45,000
Oregon		
Oregon State University	\$ 1,550,000	\$ 903,400
Oregon State University	57,600	29,000
Oregon State University	500,000	333,041
Subtotal	\$ 2,107,600	\$ 1,265,441
Rhode Island		
University of Rhode Island	\$ 26,000	
University of Rhode Island	1,130,000	603,749
*University of Rhode Island/Sea Grant Depository	70,400	
University of Rhode Island	560,000	280,254
Subtotal	\$ 1,786,400	\$ 884,003
South Carolina		
Marine Resources Center (S.C.)	\$ 360,000	\$ 191,300
Subtotal	\$ 360,000	\$ 191,300
Texas		
Texas A&M University	\$ 1,360,000	\$ 944,477
*Texas A&M University/Sea Grant '70s	64,000	
Texas A&M University	75,000	37,869
Subtotal	\$ 1,499,000	\$ 982,346
Virginia		
Virginia Institute of Marine Science	\$ 21,000	\$ 10,600
Virginia Institute of Marine Science	405,000	226,693
Virginia Polytechnic Institute	45,000	28,964
Virginia Polytechnic Institute	49,700	26,080
Subtotal	\$ 520,700	\$ 292,337
Washington		
University of Washington	\$ 11,600	
University of Washington	1,553,000	819,700
Subtotal	\$ 1,564,600	\$ 819,700
Wisconsin		
University of Wisconsin	\$ 1,131,300	\$ 600,000
Subtotal	\$ 1,131,300	\$ 600,000
American Samoa		
American Samoa	\$ 46,700	\$ 30,100
Subtotal	\$ 46,700	\$ 30,100
Trust Territories		
Marine Resources Division, Trust Territories	\$ 55,100	\$ 68,400
Subtotal	\$ 55,100	\$ 68,400
Total Grant Awards in FY 1976	\$23,520,900	\$15,263,003

* A non-matching grant award.

**National Sea Grant Program
List of Grants Awarded in Fiscal Year 1976
(Transition Quarter)**

Institution	Sea Grant Dollars	Matching Dollars
University of Southern California	\$ 6,800	\$ 3,532
California		
University of California	2,120,000	1,597,421
Stanford University	100,000	50,000
University of Southern California	485,000	422,869
Subtotal	\$ 2,711,800	\$ 2,073,825
Connecticut		
University of Connecticut	\$ 10,000	\$ 5,365
Subtotal	\$ 10,000	\$ 5,365
Delaware		
University of Delaware	\$ 400,000	\$ 290,973
Subtotal	\$ 400,000	\$ 290,973
Florida		
University of Miami	\$ 306,800	\$ 183,300
Subtotal	\$ 306,800	\$ 183,300
Georgia		
University of Georgia	\$ 582,000	\$ 497,000
Subtotal	\$ 582,000	\$ 497,000
Hawaii		
University of Hawaii	\$ 1,170	
*Oceanic Institute	10,000	
University of Hawaii	1,355,000	738,569
Subtotal	\$ 1,366,170	\$ 738,569
Idaho		
University of Idaho	\$ 29,500	\$ 25,100
Subtotal	\$ 29,500	\$ 25,100
Louisiana		
Louisiana State University	\$ 720,000	\$ 570,387
Subtotal	\$ 720,000	\$ 570,387
Maryland		
University of Maryland	\$ 27,500	\$ 9,700
Subtotal	\$ 27,500	\$ 9,700
Massachusetts		
Massachusetts Institute of Technology	\$ 19,800	
Massachusetts Institute of Technology	1,139,700	779,724
Woods Hole Oceanographic Institution	421,007	511,836
Subtotal	\$ 1,580,507	\$ 1,291,560
Michigan		
University of Michigan	\$ 383,100	\$ 297,500
Subtotal	\$ 383,100	\$ 297,500

Institution	Sea Grant Dollars	Matching Dollars
New Hampshire		
University of New Hampshire	\$ 7,500	
Subtotal	\$ 7,500	
Oregon		
Oregon State University	\$ 1,141,800	\$ 699,659
Subtotal	\$ 1,141,800	\$ 699,659
Rhode Island		
University of Rhode Island	\$ 561,000	\$ 280,261
Subtotal	\$ 561,000	\$ 280,261
South Carolina		
South Carolina Marine Resources Center ...	\$ 372,800	\$ 209,400
Subtotal	\$ 372,800	\$ 209,400
Texas		
Texas A&M University	\$ 8,000	\$ 2,150
Texas A&M University	1,310,000	1,010,448
University of Texas at Austin	6,300	3,594
University of Texas Marine Science Institute	314,000	176,000
Subtotal	\$ 1,638,300	\$ 1,192,192
Wisconsin		
University of Wisconsin	\$ 1,225,000	\$ 675,000
Subtotal	\$ 1,225,000	\$ 675,000
Trust Territories		
Micronesia Mariculture Demonstration Center	\$ 10,300	\$ 13,900
Micronesia Mariculture Demonstration Center	55,600	116,400
Subtotal	\$ 65,900	\$ 130,300
Total Grant Awards in FY 1976	\$13,129,670	\$ 9,170,091

* A non-matching grant award.

National Sea Grant Program Source of Matching Funds for Sea Grants Awarded in Fiscal Year 1976

Source of Matching Funds: Government

University of Washington	
Alaska Department of Fish and Game	\$ 4,455
City & Port of Bellingham and Whatcom County Commissioners	4,860
Washington State Department of Ecology	700
Washington State Department of Fisheries	45,448
Sub-Total	\$ 55,463
University of Rhode Island	
Rhode Island Department of Natural Resources	\$ 10,000
Sub-Total	\$ 10,000

Source of Matching Funds: Government

Oregon State University	
Clatsop County, Oregon	\$ 8,700
Coos County, Oregon	9,300
Curry County, Oregon	800
Douglas County, Oregon	1,000
Fish Commission of Oregon	24,600
Lincoln County, Oregon	9,500
National Fisheries Institute	3,500
Otter Trawl Commission of Oregon	2,500
Tillamook County, Oregon	10,300
Sub-Total	<u>\$ 70,200</u>
 University of Miami	
Dade County, Florida	\$ 18,200
Sub-Total	<u>\$ 18,200</u>
 Texas A&M University	
Brazoria County Court, Texas	\$ 12,166
Brazoria County Mosquito Control District, Texas	38,800
Calhoun County Court, Texas	4,620
Cameron County Court, Texas	3,600
Galveston County Court, Texas	4,800
General Land Office, State of Texas	6,550
Matagorda County Court, Texas	5,697
State Education Service Center, Region II	17,600
Texas Bureau of Economic Geology	1,800
Texas Coastal and Marine Council	6,550
Texas Parks and Wildlife Department	3,000
Sub-Total	<u>\$ 105,183</u>
 University of Southern California	
State of California Resources Agency	\$ 73,783
Sub-Total	<u>\$ 73,783</u>
 University of California	
California Cooperative Oceanic Fisheries Investigation ...	\$ 34,948
California Department of Fish and Game	33,094
California Department of Navigation and Ocean Development	54,890
California Division of Oil and Gas	5,000
California Resources Agency	356,035
Los Angeles County, California	9,394
Marin County, California	3,445
Mendocino County, California	3,446
Public Administration Bureau, California	4,026
Sonoma County, California	3,445
Sub-Total	<u>\$ 507,723</u>
 Marine Resources Division, Trust Territories	
Trust Territories of the Pacific	\$ 68,400
Sub-Total	<u>\$ 68,400</u>
 Louisiana State University	
LaFourche Parish School Board, Louisiana	\$ 2,550
LaFourche Parish, Louisiana	1,000
St. Mary Parish, Louisiana	1,000
Terrebonne Parish School Board, Louisiana	7,550
Terrebonne Parish, Louisiana	1,000
Sub-Total	<u>\$ 13,100</u>

Source of Matching Funds: Government

Appendices

University of Hawaii	
City and County of Honolulu, Hawaii	\$ 19,000
Hawaii Department of Education	8,000
Hawaii Division of Fish and Game	2,600
Marine Affairs Coordinator, State of Hawaii	193,750
Pan-Pacific Institute	2,580
Sub-Total	<u>\$ 225,930</u>
Humboldt State University	
California Department of Fish and Game	\$ 3,839
Sub-Total	<u>\$ 3,839</u>
Maine Dept. of Marine Resources	
Maine Department of Marine Resources	\$ 37,500
Sub-Total	<u>\$ 37,500</u>
State University of New York	
Assembly Scientific Staff, New York State Assembly	\$ 3,000
New York State Department of Environmental Conservation	8,567
Sub-Total	<u>\$ 11,567</u>
University of North Carolina	
State of North Carolina, Dept. of Administration	\$ 267,500
Sub-Total	<u>\$ 267,500</u>
State University System of Florida	
City of Tampa, Florida	\$ 28,400
Florida Boards of County Commissions	98,800
Florida Department of Transportation	9,300
Florida Department of Environmental Regulation	1,200
Florida Department of Natural Resources	56,300
Franklin County Board of Commissioners, Florida	14,600
Jacksonville City Bioenvironmental Service, Florida	600
Monroe County, Florida	6,000
Palm Beach County, Florida	2,700
Sub-Total	<u>\$ 217,900</u>
University of New Hampshire	
New England Center, Rhode Island	\$ 3,200
Sub-Total	<u>\$ 3,200</u>
University of Rhode Island	
Rhode Island Department of Natural Resources	\$ 5,000
Sub-Total	<u>\$ 5,000</u>
Oregon State University	
Clatsop County, Oregon	\$ 3,990
Coos County, Oregon	2,970
Curry County, Oregon	1,084
Lincoln County, Oregon	3,909
Oregon Department of Fish and Wildlife	8,796
Otter Trawl Commission of Oregon	1,290
Tillamook County, Oregon	2,809
Sub-Total	<u>\$ 24,848</u>
Total	<u><u>\$ 1,719,336</u></u>

Source of Matching Funds: Academic Institutions

University of Washington

Bellingham Vocation-Technical Institute, Wasnington	\$ 11,508
Clover Park Education Center, Washington	36,712
Grays Harbor College, Washington	25,399
Highline Community College, Washington	58,748
Seattle Community College, Washington	18,251
Shoreline Community College, Washington	18,204
University of Puget Sound, Washington	3,109
University of Washington	509,021
Western Washington State College	1,074
Sub-Total	\$ 682,026

University of Rhode Island

University of Rhode Island	\$ 535,749
Sub-Total	\$ 535,749

Oregon State University

Clatsop Community College, Oregon	\$ 84,600
Monterey Institute of Technology, Guaymas, Mexico	2,850
Oregon State University	183,200
University of Oregon	25,300
Washington State University	3,500
Sub-Total	\$ 299,450

University of Miami

University of Miami, Florida	\$ 170,300
Sub-Total	\$ 170,300

University of Wisconsin

University of Wisconsin	\$ 600,000
Sub-Total	\$ 600,000

Massachusetts Institute of Technology

Maine Maritime Academy	\$ 12,900
Massachusetts Institute of Technology	388,000
University of Massachusetts	20,500
Sub-Total	\$ 421,400

University of Michigan

Michigan State University	\$ 61,355
University of Michigan	317,975
Sub-Total	\$ 379,330

Stanford University

Stanford University	\$ 50,000
Sub-Total	\$ 50,000

Texas A&M University

Baylor College of Medicine, Texas	\$ 16,550
Brazosport College, Texas	4,000
University of Texas at Austin	10,309
University of Houston, Texas	22,700
Sub-Total	\$ 53,559

Stanford University

Stanford University	\$ 55,458
Sub-Total	\$ 55,458

Source of Matching Funds: Academic Institutions

Appendices

Woods Hole Oceanographic Institute	
Woods Hole Oceanographic Institution, Massachusetts ..	\$ 304,900
Sub-Total	\$ 304,900
University of Georgia	
University System of Georgia	\$ 478,166
Sub-Total	\$ 478,166
University of Southern California	
University of Southern California	\$ 98,800
Sub-Total	\$ 98,800
University of California	
California Academy of Science	\$ 10,532
California State University, San Diego	100,796
Moss Landing Marine Laboratories, California	44,969
University of California	415,291
Sub-Total	\$ 571,588
University of Minnesota	
University of Minnesota	\$ 35,300
Sub-Total	\$ 35,300
Louisiana State University	
Louisiana State University	\$ 583,068
Sub-Total	\$ 583,068
University of Delaware	
University of Delaware	\$ 124,600
Sub-Total	\$ 124,600
University of Hawaii	
Doshisha University, Japan	\$ 4,200
University of Hawaii	551,652
Sub-Total	\$ 555,852
Community College of American Samoa	
Community College of American Samoa	\$ 30,100
Sub-Total	\$ 30,100
Humboldt State University	
Humboldt State University, California	\$ 34,601
Sub-Total	\$ 34,601
State University System of New York	
Cornell University, New York	\$ 247,461
New York University and Adelphi University	19,553
State University of New York—Various Campuses	198,789
Sub-Total	\$ 465,803
Oceanic Institute	
Oceanic Institute, Hawaii	\$ 13,680
Sub-Total	\$ 13,680
University of Maryland	
Maryland Cooperative Extension Service	\$ 47,600
Sub-Total	\$ 47,600

Source of Matching Funds: Academic Institutions

Virginia Institute of Marine Science

Virginia Institute of Marine Science	\$ 226,693
Sub-Total	\$ 226,693

Society of Naval Architects and Marine Engineers

Society of Naval Architects and Marine Engineers, District	\$ 42,000
Sub-Total	\$ 42,000

Oregon State University—PASGAP

Humboldt State University, California	\$ 2,063
Oregon State University	4,538
University of Alaska	2,091
University of British Columbia, Canada	2,905
University of California	2,443
University of Hawaii	978
University of Idaho	3,134
University of Southern California	1,890
University of Washington	1,851
Sub-Total	\$ 21,893

State University System of Florida

Florida Atlantic University	\$ 19,600
Florida Institute of Technology	170,900
Florida Junior College	22,200
Florida Keys Community College	12,100
Florida State University	13,600
Florida State University System, Institute of Oceanography	6,000
State University System of Florida	55,500
University of Florida	181,200
University of North Florida	20,300
University of South Florida	2,200
Sub-Total	\$ 503,600

University of Maine/University of New Hampshire

University of New Hampshire	\$ 222,227
University of Maine	192,751
Sub-Total ..	\$ 414,978

Mississippi-Alabama Sea Grant Consortium

Alabama's Institutions of Higher Learning	\$ 64,582
Mississippi's Institutions of Higher Learning	124,359
Sub-Total	\$ 188,941

University of Oklahoma

University of Oklahoma	\$ 45,000
Sub-Total	\$ 45,000

State University of New York

State University of New York/Stony Brook	\$ 27,445
Sub-Total	\$ 27,445

Texas A&M University

Louisiana State University	\$ 6,900
Texas A&M University	6,900
University of California	6,900
University of Rhode Island	6,900
Sub-Total	\$ 27,600

Source of Matching Funds: Academic Institutions

Virginia Polytechnic Institute	
Virginia Polytechnic Institute	\$ 28,964
Sub-Total	<u>\$ 28,964</u>
University of New Hampshire	
University of New Hampshire Marine Program	\$ 3,200
MIT Sea Grant	3,200
New York Sea Grant Program	3,200
University of Maine Sea Grant Program	3,200
University of Massachusetts Sea Grant Project	3,200
University of Rhode Island Sea Grant Program	3,200
Sub-Total	<u>\$ 19,200</u>
New Jersey Marine Sciences Consortium	
Atlantic Community College, New Jersey	\$ 2,600
Kean College of New Jersey	12,400
Montclair State College, New Jersey	1,800
New Jersey Institute of Technology	5,200
New Jersey Marine Sciences Consortium	24,200
Princeton University, New Jersey	27,900
Rutgers University, New Jersey	36,400
Stevens Institute of Technology, New Jersey	45,400
Sub-Total	<u>\$ 155,900</u>
University of Connecticut	
University of Connecticut, Cooperative Extension Service	\$ 23,987
Sub-Total	<u>\$ 23,987</u>
University of Rhode Island	
University of Rhode Island	\$ 272,949
Sub-Total	<u>\$ 272,949</u>
Virginia Polytechnic Institute	
Virginia Polytechnic Institute	\$ 26,080
Sub-Total	<u>\$ 26,080</u>
Stanford University	
Stanford University, California	\$ 58,000
Sub-Total	<u>\$ 58,000</u>
University of Arizona	
Environmental Research Laboratory, University of Arizona	\$ 51,420
Sub-Total	<u>\$ 51,420</u>
Oregon State University	
Clatsop Community College, Oregon	\$ 38,313
Oregon State University	70,621
University of Oregon	8,095
Washington State University	484
Sub-Total	<u>\$ 171,513</u>
Total	<u><u>\$ 8,843,493</u></u>

Source of Matching Funds: Industry

University of Washington

Alaska-Pacific Halvorson, Inc.	\$	5,000
D. Svornich, Inc., Washington		2,000
KCTS-TV, Washington		6,690
Marine Colloids, Washington		15,000
Seattle Metro, Washington		14,221
Various Contributed Industry Services, Washington		15,100
Weyerhaeuser, Washington		4,678
Sub-Total	\$	62,689

University of Rhode Island

Domsea Farms, Rhode Island	\$	2,000
U.S. Divers		5,000
Various Marine Firms, Rhode Island		51,000
Sub-Total	\$	58,000

Oregon State University

Eugene Water and Electric Board, Oregon	\$	3,200
Oregon Aquafoods		1,100
Pacific Power and Light, Oregon		3,200
Port of Brookings, Oregon		20,000
Portland General Electric, Oregon		3,200
Union Carbide, Oregon		10,000
Sub-Total	\$	40,700

University of Miami

Armour Pharmaceutical	\$	9,900
Sub-Total	\$	9,900

Massachusetts Institute of Technology

Boston Edison Company, Massachusetts	\$	25,000
International Copper Research Association, Massachusetts		24,000
Ishikawajima-Harima Heavy Industries Company, Ltd.		1,000
Public Service Electric and Gas Company, Newark, New Jersey		10,300
Sub-Total	\$	60,300

University of Georgia

Pabst Brewing Company, Georgia	\$	5,605
Sub-Total	\$	5,605

University of California

G. D. Searle Co., California	\$	6,710
Marine Colloids, Inc.		21,137
San Diego Gas and Electric, California		28,260
Southern California Edison		40,000
Stauffer Chemical Co., California		671
Sub-Total	\$	96,778

University of Delaware

Lescarden Ltd., Delaware	\$	10,000
Sub-Total	\$	10,000

University of Hawaii

Pacific Aquaculture Corporation	\$	3,600
Sub-Total	\$	3,600

Source of Matching Funds: Industry

Humboldt State University	
Humboldt Bay Fisheries Association, California	\$ 600
Humboldt Fishermen's Marketing Assoc., Inc.	3,500
Sub-Total	<u>\$ 4,100</u>
Oceanic Institute	
Charles E. Culpepper Foundation, Inc., Hawaii	\$ 25,000
Sub-Total	<u>\$ 25,000</u>
Oregon State University	
Various Industries, Oregon	\$ 7,107
Sub-Total	<u>\$ 7,107</u>
State University System of Florida	
Florida Power & Light Corp.	\$ 4,000
Gulf-Tampa Drydock Company, Florida	20,700
Individual Fishermen in Florida	4,000
Various Diving Industry Firms, Florida	130,000
Sub-Total	<u>\$ 158,700</u>
University of Maine/University of New Hampshire	
Abandoned Farms, Inc. (Maine/New Hampshire)	\$ 28,000
Maine Salmon Farms	1,900
Maine Yankee Atomic Power Company	59,338
Marine Colloids, Maine	2,000
North American Salmon Research Center, New Brunswick	700
Sub-Total	<u>\$ 91,938</u>
University of Rhode Island	
Domsea Farms, Inc., Rhode Island	\$ 1,055
Various Diving Equipment Firms, Rhode Island	1,250
Sub-Total	<u>\$ 2,305</u>
Total	<u>\$ 636,722</u>

Source of Matching Funds: Research Institutes and Foundations

Massachusetts Institute of Technology	
Henry L. and Grace Doherty Charitable Foundation, Inc. .	\$ 23,600
Midas Industrial Participation	51,000
National Fisheries Institute, Washington, D.C.	4,000
Welding Research Council, Massachusetts	1,500
Sub-Total	<u>\$ 80,100</u>
University of Michigan	
Michigan Skin Diving Council	\$ 3,000
Sub-Total	<u>\$ 3,000</u>
University of California	
Aquarium Museum Docents, California	\$ 18,176
Tuna Research Foundation	26,840
Sub-Total	<u>\$ 45,016</u>
Louisiana State University	
Ford Foundation	\$ 6,778
Sub-Total	<u>\$ 6,778</u>
University of Delaware	
Marine Research Center, Delaware	\$ 15,000
Sub-Total	<u>\$ 15,000</u>

Source of Matching Funds: Research Institutes and Foundations

University of Hawaii

Hawaiian Academy of Science	\$ 1,500
McInerney Foundation, Hawaii	7,500
Sub-Total	<u>\$ 9,000</u>

National Fisheries Institute, Inc.

National Fisheries Institute, District of Columbia	\$ 8,000
Sub-Total	<u>\$ 8,000</u>

State University of New York

Rockefeller Foundation, New York	\$ 33,121
Sub-Total	<u>\$ 33,121</u>

University of New Hampshire

New England Aquarium, New Hampshire	\$ 3,200
Sub-Total	<u>\$ 3,200</u>

National Fisheries Institute, Inc.

National Fisheries Institute, District of Columbia	\$ 1,900
Sub-Total	<u>\$ 1,900</u>

Oregon State University

National Fisheries Institute, Oregon	\$ 968
Sub-Total	<u>\$ 968</u>
Total	<u>\$ 206,083</u>

Source of Matching Funds: State Government

Oregon State University

State of Oregon	\$ 493,050
Sub-Total	<u>\$ 493,050</u>

South Carolina Marine Resources Center

State of South Carolina	\$ 191,300
Sub-Total	<u>\$ 191,300</u>

Texas A&M University

State of Texas Legislature	\$ 793,987
Sub-Total	<u>\$ 793,987</u>

University of California

California Legislature Appropriation	\$ 192,051
Sub-Total	<u>\$ 192,051</u>

University of Delaware

State of Delaware	\$ 210,000
Sub-Total	<u>\$ 210,000</u>

Humboldt State University

State of California	\$ 36,378
Sub-Total	<u>\$ 36,378</u>

University of Alaska

State of Alaska	\$ 524,200
Sub-Total	<u>\$ 524,200</u>

Source of Matching Funds: State Government

Appendices

State University of New York	
State of New York	\$ 199,816
Sub-Total	\$ 199,816
Hawaii Dept. of Land and Natural Resources	
State of Hawaii	\$ 43,500
Sub-Total	\$ 43,500
State University System of Florida	
State of Florida Legislative Appropriation	\$ 56,300
Sub-Total	\$ 56,300
University of Maine/University of New Hampshire	
State of Maine	\$ 39,300
State of New Hampshire	4,473
Sub-Total	\$ 43,773
Mississippi-Alabama Sea Grant Consortium	
State of Mississippi Legislature	\$ 175,000
Sub-Total	\$ 175,000
Oregon State University	
State of Oregon	\$ 189,712
Sub-Total	\$ 189,712
Total	\$ 3,149,067

Source of Matching Funds: Undesignated Sources

University of California	
Undesignated Source	\$ 7,138
Sub-Total	\$ 7,138
University of Delaware	
Undesignated Source	\$ 1,600
Sub-Total	\$ 1,600
University of Washington	
Undesignated Source	\$ 4,200
Unidentified Sources, Washington Sea Grant Program ...	10,322
Workshops and Other Meetings, Washington Sea Grant Program	5,000
Sub-Total	\$ 19,522
Virginia Institute of Marine Science	
Undesignated Source	\$ 10,600
Sub-Total	\$ 10,600
Mississippi-Alabama Sea Grant Consortium	
Undesignated Source	\$ 61,485
Sub-Total	\$ 61,485
Columbia University	
Undesignated Source	\$ 18,553
Sub-Total	\$ 18,553
University of Miami	
Undesignated Source	\$ 21,318
Sub-Total	\$ 21,318

Source of Matching Funds: Undesignated Sources

Massachusetts Institute of Technology	
Donated Time	\$ 20,300
Sea Grant Lecture Endowment Funds, MIT	6,300
Undesignated Source	1,554
Sub-Total	\$ 28,154
University of Georgia	
Undesignated Source	\$ 40,700
Sub-Total	\$ 40,700
University of Southern California	
Undesignated Funds for University of Southern California	\$ 66,437
Sub-Total	\$ 66,437
University of California	
Donations	\$ 28,774
Undesignated Source	3,394
Sub-Total	\$ 32,168
Louisiana State University	
Undesignated Source	\$ 12,564
Sub-Total	\$ 12,564
University of Delaware	
Undesignated Source	\$ 85,500
Sub-Total	\$ 85,500
University of Hawaii	
David Norquist, Consultant	\$ 1,500
John Randall, Consultant	900
Lowell Funk, Private Investor	35,800
Student Laboratory Fees	10,000
Undesignated Source	66,224
Sub-Total	\$ 114,424
Humboldt State University	
Undesignated Source	\$ 2,982
Sub-Total	\$ 2,982
University of North Carolina	
Undesignated Source	\$ 150,000
Sub-Total	\$ 150,000
State University System of Florida	
Undesignated Source	\$ 10,600
Sub-Total	\$ 10,600
Mississippi-Alabama Sea Grant Consortium	
Undesignated Source	\$ 8,311
Sub-Total	\$ 8,311
State University of New York	
Undesignated Source	\$ 14,229
Sub-Total	\$ 14,229
Texas A&M University	
Undesignated Source	\$ 10,269
Sub-Total	\$ 10,269
Total	\$ 704,770
78	Total Matching Funds \$15,263,003

**National Sea Grant Program
Source of Matching Funds for Sea Grants Awarded in
Fiscal Year 1976 (Transition Quarter)**

Source of Matching Funds: Government

Micronesian Mariculture Demonstration Center

Trust Territories of the Pacific	\$	13,900
Sub-Total	\$	13,900

University of Rhode Island

Rhode Island Department of Natural Resources	\$	5,000
Sub-Total	\$	5,000

Oregon State University

Clatsop County, Oregon	\$	8,382
Coos County, Oregon		6,239
Curry County, Oregon		2,278
Lincoln County, Oregon		8,213
Oregon Department of Fish and Wildlife		18,477
Otter Trawl Commission of Oregon		2,710
Tillamook County, Oregon		5,910
Sub-Total	\$	52,209

Texas A&M University

Brazoria County Court, Texas	\$	12,043
Brazoria County Mosquito Control District, Texas		31,777
Calhoun County Court, Texas		13,738
Cameron County Court, Texas		12,394
Galveston County Court, Texas		12,049
Matagorda County Court, Texas		12,826
San Patricio County Court, Texas		9,936
Texas Parks and Wildlife Department		1,200
Sub-Total	\$	105,963

Louisiana State University

LaFourche Jury, Louisiana	\$	1,000
St. Mary Police Jury, Louisiana		1,000
Terrebonne Jury, Louisiana		1,000
Terrebonne Parish School Board, Louisiana		17,000
Sub-Total	\$	20,000

University of California

California Cooperative Oceanic Fisheries Investigation ..	\$	8,002
California Department of Fish and Game		23,986
California Department of Navigation and Ocean Devel- -opment		60,003
California Department of Parks and Recreation		11,800
California Resources Agency		367,188
Los Angeles County Department of Beaches, California ..		3,870
Marin County, California		2,843
Mendocino County, California		2,843
Monterey County, California		2,843
San Diego County, California		2,843
San Luis Obispo County, California		2,843
Santa Barbara County, California		2,843
Santa Cruz County, California		2,840

Source of Matching Funds: Government

University of California

Sonoma County, California	2,843
Ventura County, California	2,843
Sub-Total	<u>\$ 500,433</u>

University of Hawaii

City and County of Honolulu, Department of Public Works	\$ 21,500
Hawaii Department of Education	24,150
Office of the Marine Affairs Coordinator, State of Hawaii .	164,706
Sub-Total	<u>\$ 210,356</u>

University of Southern California

State of California Resources Agency	\$ 104,320
Sub-Total	<u>\$ 104,320</u>

University of Idaho

Idaho Department of Fish and Game	\$ 10,000
Sub-Total	<u>\$ 10,000</u>
Total	<u>\$ 1,022,101</u>

Source of Matching Funds: Academic Institutions

University of Maryland

University of Maryland	\$ 9,700
Sub-Total	<u>\$ 9,700</u>

Massachusetts Institute of Technology

Massachusetts Institute of Technology	\$ 429,100
Massachusetts Maritime Academy	35,600
New England Aquarium, Massachusetts	2,500
University of Massachusetts	22,400
Sub-Total	<u>\$ 489,600</u>

University of Rhode Island

University of Rhode Island	\$ 272,956
Sub-Total	<u>\$ 272,956</u>

Oregon State University

Clatsop Community College, Oregon	\$ 80,487
Oregon State University	148,360
University of Oregon	17,005
Washington State University	1,016
Sub-Total	<u>\$ 246,868</u>

University of Michigan

Michigan State University	\$ 83,700
University of Michigan	163,800
Sub-Total	<u>\$ 247,500</u>

University of Wisconsin

University of Wisconsin	\$ 675,000
Sub-Total	<u>\$ 675,000</u>

Source of Matching Funds: Academic Institutions

Appendices

Woods Hole Oceanographic Institution

Woods Hole Oceanographic Institution, Massachusetts ..	\$ 511,836
Sub-Total	\$ 511,836

Texas A&M University

Baylor College of Medicine, Texas	\$ 17,840
University of Houston, Texas	22,905
University of Texas at Austin	16,900
Sub-Total	\$ 57,645

Louisiana State University

Louisiana State University	\$ 518,425
Nicholls State University, Louisiana	4,511
University of New Orleans, Louisiana	12,436
University of Southwestern Louisiana	15,015
Sub-Total	\$ 550,387

University of California

Aquarium-Museum Docents, California	\$ 21,344
California Academy of Sciences	16,455
California State University, San Jose	43,727
Humboldt State University	35,191
San Diego State University, California	94,206
Stanford University, California	11,000
University of California	781,668
Sub-Total	\$ 1,003,591

University of Texas at Austin

University of Texas at Austin	\$ 3,594
Sub-Total	\$ 3,594

Stanford University

Stanford University, California	\$ 50,000
Sub-Total	\$ 50,000

University of Hawaii

University of Hawaii	\$ 478,010
University of So. California Institute	11,890
Sub-Total	\$ 489,900

University of Georgia

University System of Georgia	\$ 496,400
Sub-Total	\$ 496,400

University of Texas Marine Science Institute

University of Texas at Austin and Marine Science Institute	\$ 136,826
Sub-Total	\$ 136,826

University of Southern California

University of Southern California	\$ 208,709
Sub-Total	\$ 208,709

University of Delaware

University of Delaware	\$ 89,886
Sub-Total	\$ 89,886

University of Connecticut

University of Connecticut	\$ 5,365
Sub-Total	\$ 5,365

Source of Matching Funds: Academic Institutions

University of Idaho

University of Idaho	\$ 15,100
Sub-Total	\$ 15,100
Total	\$ 5,560,863

Source of Matching Funds: Industry

Massachusetts Institute of Technology

Environmental Devices Corporation, Massachusetts	\$ 5,000
Fugro Geotechnical Consultants—Holland	15,000
Gorman-Rupp Industries, Massachusetts	3,500
Ishikawajima-Harima Heavy Industries Co., Ltd.	1,500
Kawasaki Heavy Industries	3,000
Marine Industry Advisory Services Collegium Members, Mass.	128,800
MIT Sea Grant State-Industry Council	2,500
Overall Economic Development Committee of Cape Ann Inc.	5,000
Sub Ocean Services Ltd., London, England	3,000
Sun Shipbuilding and Dry Dock Company, Massachusetts .	5,000
T.R.W. Inc., Nelson Division, Massachusetts	3,900
Various Fishing Industry Consultants and Services, Mass..	18,600
Westerbeake Fishing Gear Company, Boston, Mass.	300
Wharf Forging and Welding, Boston, Massachusetts	200
Sub-Total	\$ 195,300

University of Rhode Island

Domsea Farms, Inc., Rhode Island	\$ 1,055
Various Diving Equipment Firms, Rhode Island	1,250
Sub-Total	\$ 2,305

University of Michigan

Leland Fish Company, Michigan	\$ 50,000
Sub-Total	\$ 50,000

University of California

Foremost Foods, California	\$ 16,254
Humboldt Fisherman's Association, California	300
L. Greenstone Company, California	3,870
Stauffer Chemical Company, California	3,870
Tavolek Laboratories, Inc., California	5,914
Various Diving Equipment Manufacturers, California	5,160
Sub-Total	\$ 35,368

University of Hawaii

Various Industries, Hawaii	\$ 20,000
Sub-Total	\$ 20,000

University of Georgia

Goodyear, Georgia	\$ 600
Sub-Total	\$ 600

Source of Matching Funds: Industry**University of Texas Marine Science Institute**

G. Unger Vetlesen Foundation, Texas	\$	39,174
Sub-Total	\$	39,174

University of Delaware

Hercules, Lescarden, Ltd.	\$	6,115
Sub-Total	\$	6,115
Total	\$	348,862

Source of Matching Funds: Research Foundations and Institutes**Massachusetts Institute of Technology**

Henry and Grace Doherty Charitable Foundation, Inc., Mass.	\$	30,000
International Copper Research Association, Mass.		28,400
MIT Sea Grant Lecture Endowment Funds		6,500
National Fisheries Institute, Massachusetts		4,500
Sub-Total	\$	69,400

Oregon State University

National Fisheries Institute, Oregon	\$	2,032
Sub-Total	\$	2,032

University of California

Tuna Research Foundation, California	\$	25,800
Sub-Total	\$	25,800

University of Hawaii

Jon Pegg, M.D. with the University of Hawaii Program ...	\$	5,903
North Atlantic Treaty Organization		10,000
Pan Pacific Institute of Ocean Science, Hawaii		2,410
Sub-Total	\$	18,313
Total	\$	115,545

Source of Matching Funds: State Government**Oregon State University**

State of Oregon	\$	398,550
Sub-Total	\$	398,550

Texas A&M University

State of Texas Legislature	\$	846,840
Sub-Total	\$	846,840

University of Delaware

State of Delaware	\$	194,972
Sub-Total	\$	194,972
Total	\$	1,440,362

Source of Matching Funds: Undesignated**Texas A&M University**

Undesignated Source	\$	2,150
Sub-Total	\$	2,150

Source of Matching Funds: Undesignated Sources

University of Southern California	
Undesignated Source	\$ 3,532
Sub-Total	<u>\$ 3,532</u>
Massachusetts Institute of Technology	
Undesignated Matching Funds, MIT Program	\$ 25,424
Sub-Total	<u>\$ 25,424</u>
South Carolina Marine Resources Center	
Undesignated Source	\$ 209,400
Sub-Total	<u>\$ 209,400</u>
University of California	
Donations to University of California Program	\$ 29,652
G. D. Searle	2,580
Sub-Total	<u>\$ 32,232</u>
University of Southern California	
Undesignated Source	\$ 109,840
Sub-Total	<u>\$ 109,840</u>
Micronesia Mariculture Demonstration Center	
Undesignated Source	\$ 116,400
Sub-Total	<u>\$ 116,400</u>
Total	<u>\$ 498,978</u>
Total Matching Funds	\$ 9,170,091





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