

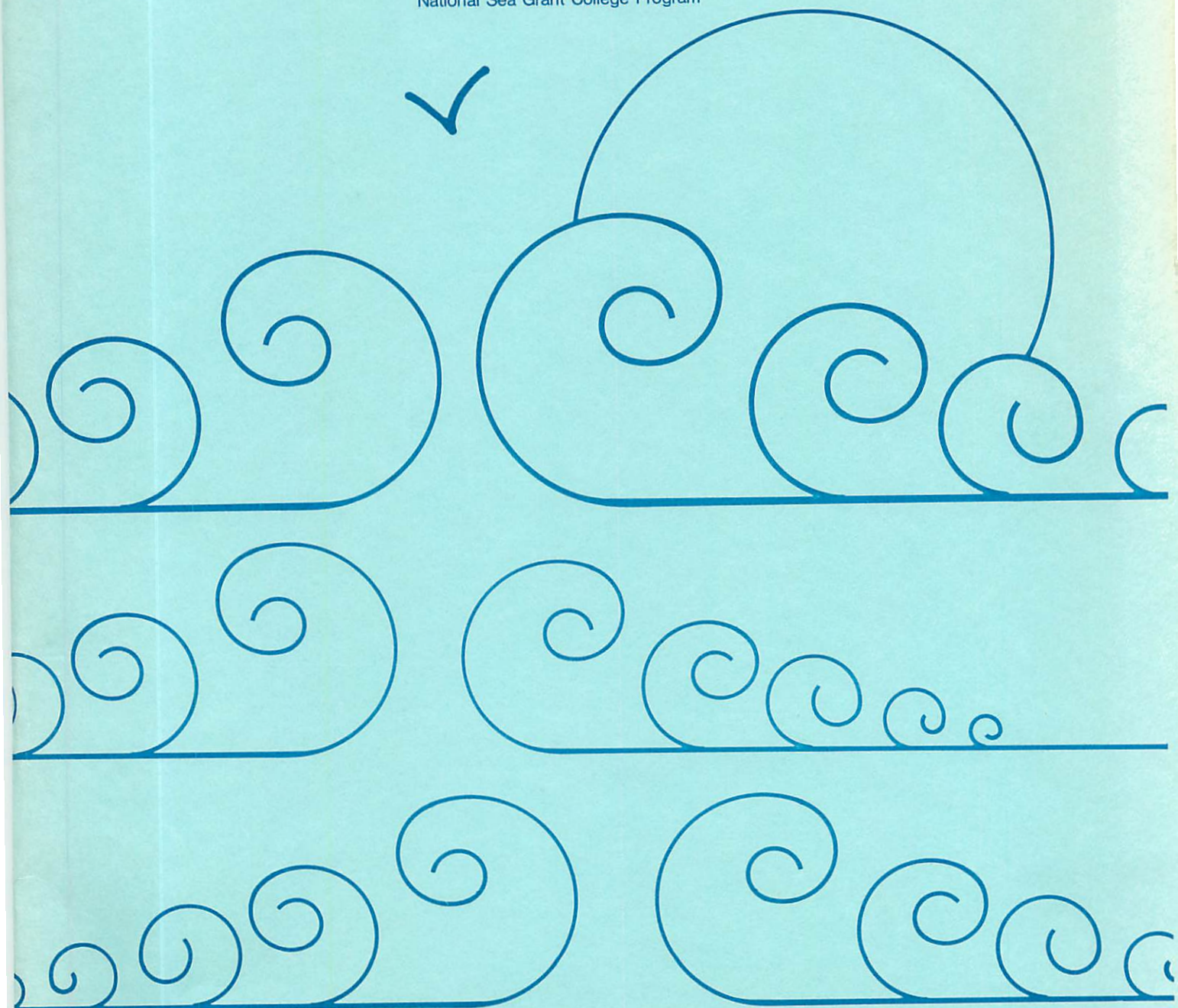
Sea Grant

Biennial Report

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Sea Grant Depository

September 30, 1977 to September 30, 1979

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Sea Grant College Program



Sea Grant

Biennial Report

October 1, 1977 to September 30, 1979



**U.S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary**

**National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator**

**National Sea Grant College Program
Ned A. Ostenso, Director**



THE SECRETARY OF COMMERCE
Washington, D.C. 20230

SEP 8 1980

Dear Sirs:

In accordance with Public Law 94-461, as amended, I am pleased to submit the 1978-1979 Biennial Report of the National Sea Grant College Program.

Also enclosed are 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,

Philip M. Klutznick
Philip M. Klutznick

Enclosures

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

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A Message From the Director, National Sea Grant College Program

During the 2 years covered by this report, the National Sea Grant College Program has undergone fundamental and philosophical changes. Primarily as a result of Congressional guidance, Sea Grant has been working actively in several new fields and has expanded its interest and involvement in other areas where it already had been engaged. The program has been able to broaden its research into projects of crucial national interest and to develop international training and technical assistance for a number of developing nations. Significant strides were made in the development of marine education in elementary and secondary schools, and a fellowship program was initiated to encourage students to conduct research in the marine environment and to join the oceanic community professionally.

As established by Congress in 1966, Sea Grant was a unique Federal grants program responsive to local and regional needs and opportunities. Although the program was given national and international scope by legislative redesign in 1976, it retains its local and regional emphasis.

Because of the varied geographic locations in the Sea Grant network and because of the difference in marine-related problems from one area of the country to another, the program is widely diversified.

The Sea Grant Program seeks out the most pressing needs and opportunities and sets priorities for their investigation. To help



State Sea Grant Program Directors in this process, the National Office of Sea Grant has been restructured along mission lines. However, like many other Federal programs, Sea Grant is limited in its resources, and cannot pursue all the challenges that might be expected of it. Available resources are being used to help the States and the Nation with short and long-term problems, particularly the more critical ones involving coastal and offshore resource management, environmental protection, and economic development.

As we move into the 1980's, we can expect even greater maturity in the Sea Grant Program. On the life cycle scale, the program probably can best be described as having escaped from childhood to enter that exciting and enthusiastic period we recognize as adolescence. It is now about to complete that phase of the life cycle and to accept the responsibilities of maturity without loss of enthusiasm. During its first 13 years of existence, Sea Grant has been creating a new and revolutionary program and demonstrating its unique utility.

Sea Grant's "father," Dr. Athelstan Spilhaus (left) converses with one of Sea Grant's major Congressional supporters, Senator Claiborne Pell of Rhode Island. Both men have been involved since the early 1960's in the foundation and development of the Sea Grant College Program.

The 13th Sea Grant College, Louisiana State University, was designated in 1978, and the 14th—and first bi-State—Sea Grant College at the Universities of Maine and New Hampshire was designated in January 1980. The University of Georgia's application to be the 15th Sea Grant College has been approved by the Sea Grant Review Panel and is pending final processing within the Department of Commerce. Additionally, the University of Alaska has made formal application for Sea Grant College status for consideration at the next meeting of the Review Panel.

Completing the network of Sea Grant Colleges is well underway, and Sea Grant is now in a position to concentrate more effort on using rather than developing the capability. Improving the effectiveness of the program will continue to be a major goal, particularly through interstate cooperation, so that the whole will be greater than the sum of the parts. This is what we call "networking."

More important, Sea Grant will continue to expand the use of this capability, striving to balance research for the present with research for the future, to ensure that the investments in Sea Grant prove useful to the public. The economic benefits of this research to the user will remain important.

Developing a comprehensive U.S. ocean policy has been a major concern for many years. Sea Grant has created a greater recognition of that necessity



through its education and public service efforts to broaden public understanding of the oceans and to develop an oceanic constituency which will express its views to the decision-makers.

In reviewing its program over the past few years, Sea Grant officials have become extremely concerned about one trend. While they have tried to maintain a good mix of research, education, and public service from State to State, the ratio of funding for research in the total budget has steadily declined. This decline is partly due to the erosive forces of inflation (it is possible not to start a research project, but it is impossible not to honor personnel pay raises authorized by the State Legislatures). They are taking steps to correct this trend.

This report shows how Sea Grant research has covered a wide spectrum of marine activities. They include animal and plant aquaculture, environmental studies, energy-related research, fisheries, economics, minerals, physical processes, natural products, transportation systems,

New members of the Sea Grant Review Panel prepare for the swearing-in ceremony. They are, from left to right, Charles L. Drake, Dartmouth College; John Blair, Raytheon Corporation; William C. Ackermann, Illinois State Water Survey; George S. Benton, Associate Administrator for NOAA and former panel member; Christopher Weld, Sullivan & Worcester, Boston; Willard Bascom, Southern California Coastal Water Research Project; and Ned A. Ostenso, Director of Sea Grant.



Louisiana becomes the thirteenth Sea Grant College. Shown with the commemorative plaque just after the awards ceremony are (left to right) Ned A. Ostenso, Director of the National Sea Grant College Program, Richard A. Frank, Administrator for the National Oceanic and Atmospheric Administration (NOAA), Jack R. Van Lopik, LSU's Sea Grant Director, Richard A. Kolf, Program Monitor for LSU's Sea Grant Program, Sally Kuzenski, prize winning writer for the LSU Sea Grant Program, and Paul W. Murrill, Chancellor of LSU-Baton Rouge.

recreation, ocean engineering, ocean and coastal law, seafood science and technology, social science, and undersea research. Within each of these major categories, research is being carried out in many specific areas.

The nationally oriented Near-shore Sediment Transport Study, a major field study, was conducted at Torrey Pines Beach, Calif., resulting in the collection of what is probably the most complete scientific data dealing with hydrodynamic laws governing the transport of marine sediments ever assembled. Another major experiment is planned for 1980.

In the International Cooperation Assistance Program, projects were developed at 11 Sea Grant institutions to enhance research and development capabilities in developing nations. These are being carried out with Chile, Colombia, Costa Rica, Egypt, India, Israel, Malaysia, Mexico, and the South Pacific Nations (Solomons, Fiji, Tuvalu, Kiribati, New Hebrides, Cook, Nauru, Tokelau, Tonga, and Western Samoa).

Sea Grant's Marine Advisory Services have been expanded not only in size but in scope. Its fellowship program has achieved wider acceptance, increasing the number of participants, particularly among minorities, women, and the handicapped. Sea Grant's increased affirmative action activities reached out to many areas to involve greater minority participation in both the management and the activities of the program.

With the improvements in the Sea Grant Program, the opportunities for the development of a program that will have meaningful significance to all mankind loom almost as large as the challenges. But the challenges will be met and the opportunities will be exploited through the Sea Grant ethic, by which Federal and State governments, universities, industry and the public work in partnership while disregarding the traditional barriers among disciplines and institutional ties, between discovery and application, and between the governors and the governed.

Ned A. Ostenso, Director
National Sea Grant College
Program



Fisheries

Although the total supply of fish in the world's oceans remains a finite quantity requiring both conservation and management, the harvest by U.S. fishermen is increasing. This increase is expected to continue for several years, due partly to the harvest by U.S. fleets of fish formerly caught by foreign fishermen. Record catches were recorded in 1978 for flounder, menhaden, pollock, rockfish, sable fish, sharks, crabs, scallops, squid, and the American lobster. In connection with this increased harvest, the U.S. is rapidly expanding the construction of fishing vessels.

These and other factors have renewed interest in fisheries development at the same time that fisheries management occupies the thinking of most of the same organizations. Thus, the National Marine Fisheries Service (NMFS), the State fishery agencies, and the Regional Fishery Management Councils are all facing these dual major, and in some ways conflicting, interests simultaneously. In the last few years, organizations with a primary objective of fishery development have been established in each coastal region of the country. These groups fund and conduct activities to increase the harvest and sale of seafood products from their regions of the country.



University of Maryland researcher handles an oyster dredge, part of Sea Grant's efforts to aid commercial fishermen.

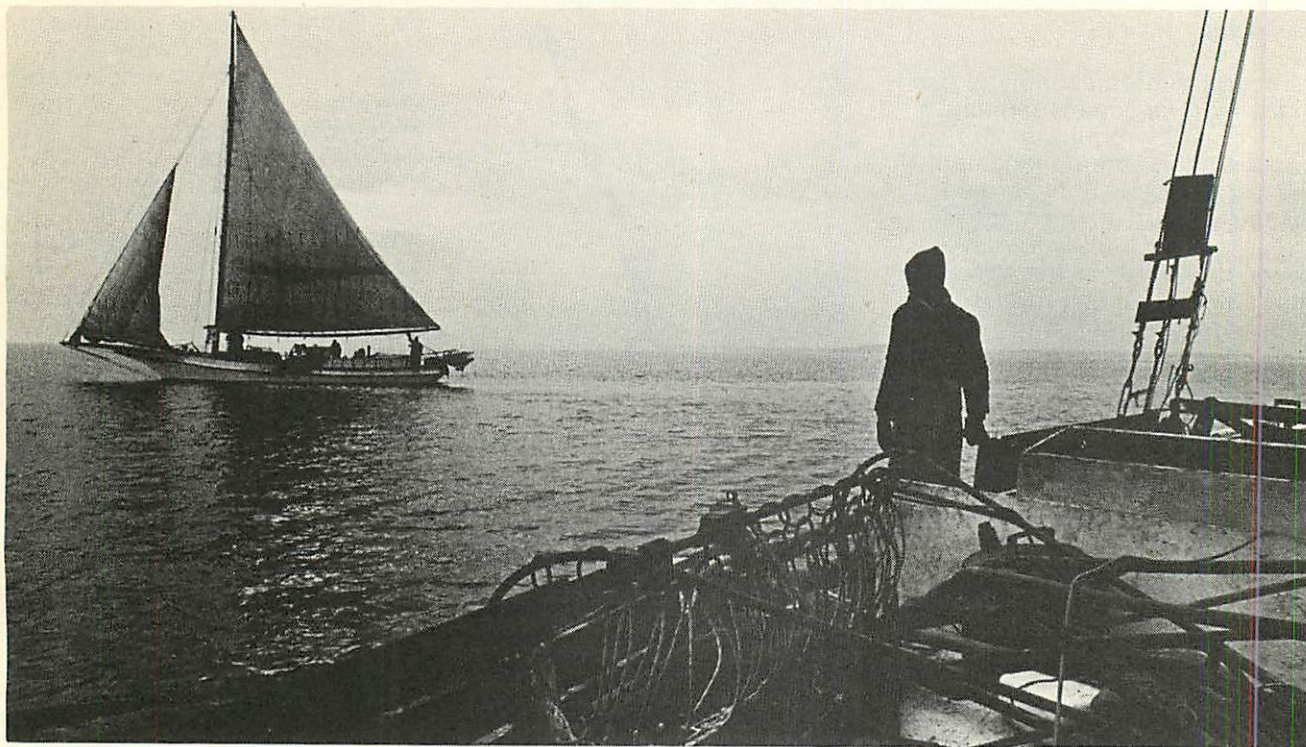
Sea Grant programs continue to be involved heavily with all of these organizations in both fisheries development and fisheries management. Sea Grant efforts in fisheries development are concentrated in two areas: (1) enhancing stocks now heavily harvested, such as salmon and abalone; and (2) exploiting non-traditional species (often referred to as underutilized species). Efforts in this latter area range from work on populations of cephalopods (squid, octopus, etc.), elasmobranchs (sharks, rays, etc.), herring eggs, and sea urchins on the West Coast, to the deep-sea red crab, sand lance, the *Rangia* clam, and spiny dogfish on the East Coast, to carp and sucker in the Great Lakes. Also, exploratory work is underway in some States to develop fisheries for species heavily fished elsewhere, such as a Georgia project on the hard clam.

Research is providing fisheries management information on three principal topics:

(1) *Stock Assessment*, including work on herring, salmon, flatfish (such as the Dover sole), and shallow water, coastal reef fish on the West Coast; spiny lobster and snapper/groupers in Hawaii; tilefish, shellfish (oysters and clams), herring, and swordfish on the East Coast; and whitefish, salmon, smelt, lake trout, and yellow perch in the Great Lakes;

(2) *Recruitment* of new fish into a population, including work on blue and red crabs, spiny lobster, and oysters; and

Hand tonging for oysters, Chesapeake Bay. A fisherman's work is not only dangerous but requires muscle.



A ship of the past, the skipjack, is still used on Chesapeake Bay. Here a skipjack sails past an oyster dredger.

(3) *Socioeconomic, Management, and Policy Studies*, including work to develop and test bioeconomic fishery management models, to analyze the effectiveness of the Fishery Management and Conservation Act, to analyze the economic potential of new fishery ventures, and to develop a body of information to improve our understanding of all groups of people involved in the fishing business.

Several relatively unique Sea Grant programs deserve special attention:

(1) The multi-institutional effort to obtain growth and longevity data on the ocean quahog, which the industry is interested in fishing more heavily. Early studies indicated a very slow growth rate for this clam, which could result in its easily being over harvested.

(2) The University of Hawaii, in cooperation with State and Fed-

eral agencies, is involved in a large, multi-faceted program to obtain information necessary to expand intelligently the fisheries in the Northwestern Hawaiian Islands.

(3) Sea Grant is continuing to perfect new tools and techniques for use by fishery management agencies, such as the University of Washington's efforts in the development and use of acoustic systems for identifying fish populations and the NORFISH fishery management system using complex computerized information on catch, recruitment, growth, and mortality rates.

(4) The program in fisheries education, though limited, is providing 2-year commercial fishermen training options at two institutions on each of the East and West Coasts, a specialized program to train veterinarians in aquatic animal disease problems, and other special curricula for fishery scientists.

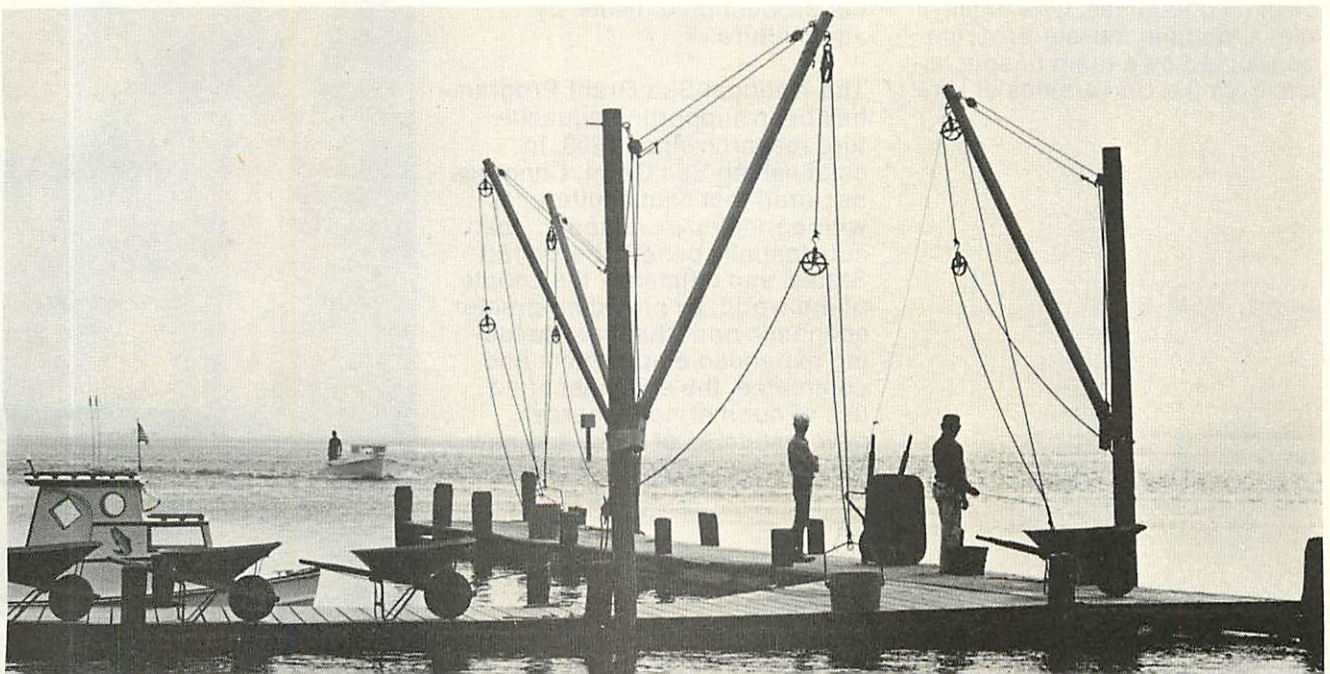
While some of this research is just beginning, these and other projects are yielding results. As a result of research done by the Alaska Sea Grant Program and the Alaska Department of Fish and Game (ADF&G), an untapped clam resource in Prince William Sound is being made available for commercial harvest. Such a resource will help offset the current shortage in the United States. In December 1978, the ADF&G, using data gathered in Sea Grant-sponsored research, showed that it was possible to establish fishing seasons for Littleneck and Butter clams within five designated distribution points in the Sound. Also, the use of hydraulic and mechanical diggers to harvest the clams has been allowed. The only remaining hurdle is Federal approval of a method for certifying that the harvest is free from paralytic shellfish poisoning.

Whitefish, one of the major commercial species harvested from Lake Michigan, have been caught traditionally by gill nets. In 1974, the State of Michigan banned the used of large-mesh gill nets to reduce the incidental catch of lake trout and salmon which

are allocated to the sports fishery. Because about 85 fishing operations were affected by this ban, there was an obvious need for commercial fishing techniques that did not adversely affect the sports fishery. Advisory Service specialists in the Michigan Sea Grant Program evaluated the use of purse seines as a replacement for the gill nets. Using a design from the National Marine Fisheries Service and funds provided by the Upper Great Lakes Regional Commission, a new purse seine was made and tested by a private fishing company's boat and crew. The tests were successful, yielding a total catch of more than 60,000 pounds of Whitefish with a mortality of non-target fish (salmon and trout) of less than 1 percent. Since then, the seine has been modified, has been approved by the State, and is in use for commercial fishing. Fishermen in Wisconsin are now receiving assistance from the Michigan Sea Grant Program in converting their boats to the purse seine gear for fishing on Lake Superior.

In Georgia, 80 percent of the total catch of seafood is shrimp,

Landing a catch of oysters, Chesapeake Bay.



with the fishery restricted to 6 months of the year. The remainder of the year, the boats are either idle or are taken elsewhere to fish for shrimp. The Georgia Sea Grant Program has received many requests to investigate developing an offshore fishery for finfishes, to avoid this idle ship time. In response the Georgia Marine Advisory Service trained fishermen in fish trawling and gear conversion and in the use of Loran for navigation and sonar for fish spotting. Exploratory fisheries research was also carried out on board a chartered vessel. In spite of the handicap posed by lack of knowledge about bottom topography and location of smooth trawlable bottom, results indicated commercial quantities of food fishes. In the most successful trip, four boats landed 25 tons of marketable fish after 3 days of fishing. A number of shrimp fishermen have therefore begun to fish offshore during the off-season, with financial success.

Benefits from Sea Grant programs frequently are not realized until many years after the work was initiated or completed. Also, results sometimes differ from original objectives. One example is the blue mussel program conducted by a team of specialists from the Universities of New

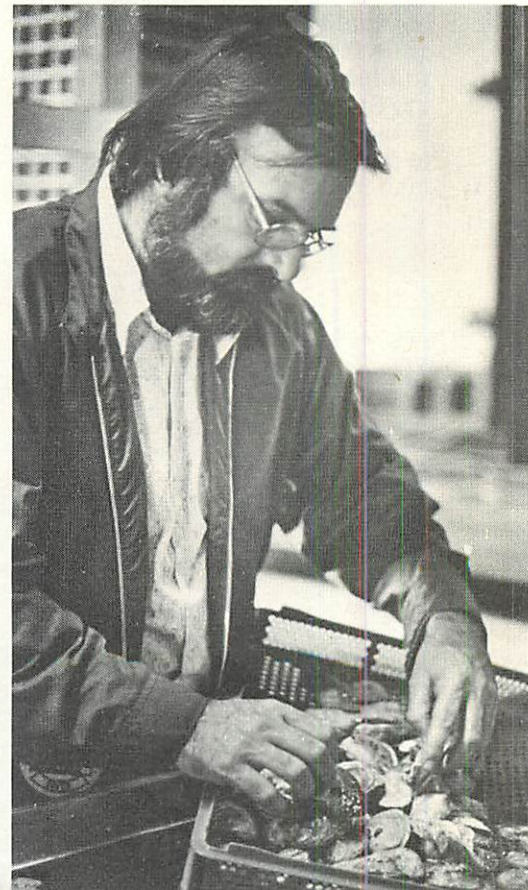
Hampshire and Maine, the Maine Department of Marine Resources, and a private company. The program was designed to improve the harvesting and culture of mussels and to promote their acceptance. The success of this effort to expand the use of a very abundant but largely unused resource is demonstrated by the fact that the harvest of the mussel from Maine waters has increased from 300,000 pounds in 1970 to 2,800,000 pounds in 1978. As a result of this rapid expansion, the State of Maine is now concerned about over-harvesting the blue mussel!

Animal Aquaculture

Aquaculture can be defined as the culture or husbandry of aquatic animals and plants by private industry for commercial purposes or by public agencies to augment natural stocks. Worldwide, about 8.6 percent, or 6 million metric tons (MMT), of a total of 70 MMT of aquatic food landed, comes from aquaculture. In the United States, about 3 percent or 78,000 metric tons of total U.S. landings comes from aquaculture. It is obvious that the U.S. is far behind the world in the production of fishes by aquaculture.

The National Sea Grant Program has been supporting aquaculture research since 1968. In establishing Sea Grant, Congress declared that "aquaculture, as with agriculture on land . . . can substantially benefit the United States, and ultimately the people of the world, by providing greater economic opportunities, including expanded employment and commerce, the enjoyment and use of our marine resources, new resources of food, and new

Gary Pruder, University of Delaware research engineer, examines experimental oysters on newly designed growing rack in the closed-system growing room in the Mariculture Laboratory, Lewes.



means for the development of marine resources."

In Fiscal Year 1979, Sea Grant supported 85 projects in animal aquaculture, with \$3.2 million in Federal, and \$2.9 million in non-Federal funds. In Fiscal 1978, 91 projects were supported, with \$3.3 million in Federal and \$2.9 million in non-Federal funds. Efforts centered on species rated as "high priority" by the NOAA Aquaculture Plan—salmon, marine shrimp, freshwater prawn, American lobster, and oysters.

Molluscs

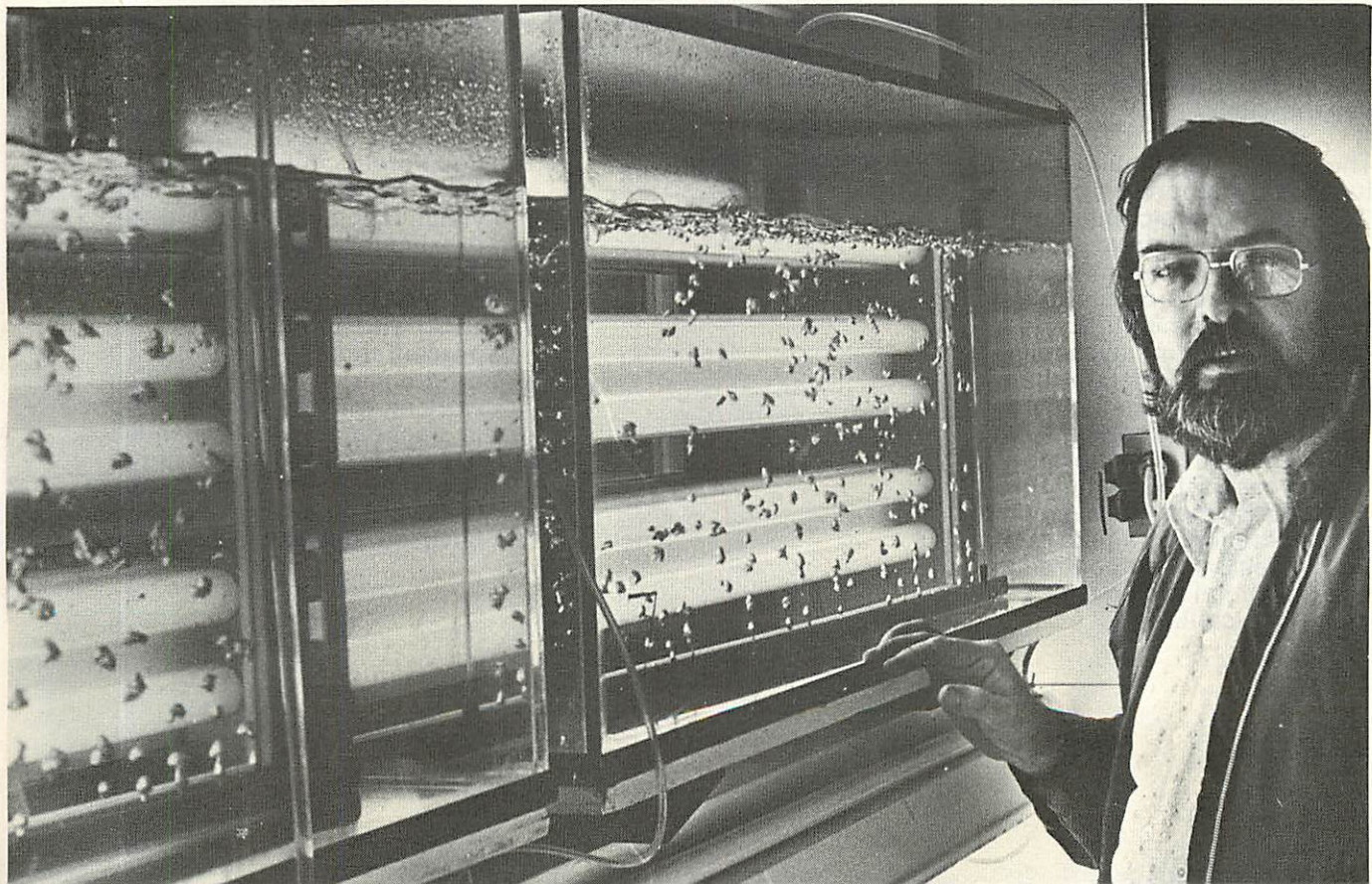
Sea Grant supports a number of projects in molluscan aquaculture, including projects on the Manila clam, mussel, oyster, rock scallop, abalone, and hard clam.

At the University of Washington, researchers are developing

methods for large-scale application of plastic netting for Manila clam stock enhancement; are comparing the intensity and timing of mussel larval recruitment in selected areas of Puget Sound, and comparing settings between natural and artificial substrates; and are continuing to develop hybrid strains of oysters resistant to summer mortalities that occur along the West Coast and in Japan.

At Oregon State University, significant technological advances have been made in oyster culture: demonstrating the feasibility of raising cultchless seed supplied by hatcheries; demonstrating how a commercial hatchery can selectively breed and maintain brood stocks of Pacific oysters; investigating the commercial potential of a Japanese oyster *Crassostrea rivularis*; and developing techniques for setting and growing out oyster larvae.

Gary Pruder, University of Delaware research engineer, checks one of the algae-culturing units for feeding oysters in the closed-system growing room being developed in the Mariculture Laboratory, Lewes.



Studies to refine hatchery and ocean rearing methods for the purple-hinged rock scallop continue in California. This project should establish procedures for commercial aquaculture of this shellfish. Also in California, researchers are studying the remaining unknown biochemical and genetic control mechanisms governing the critical physiological processes of metamorphosis, development, and growth of abalone. Recently it was found that when the chemical GABA is added to a culture of abalone, the abalone undergo metamorphosis. GABA also will be used as a bioassay tool.

Investigators in Georgia are investigating augmenting production of hard clams by seeding and using various protective techniques.

In Virginia, studies continue on larva nutrition; on the development of oyster strains that are resistant to the disease *Perkinsus marina*; and on the genetics and breeding structure of *Mercenaria* clams.

The largest major molluscan culture effort supported by Sea Grant is the development of the controlled mariculture system by researchers at the University of Delaware. The program deals with many areas: nutrition, engineering, microbiology, shell formation, and mineral requirements. Several industries are partners in this program. A \$1.2 million mariculture laboratory is being constructed, with help from the Economic Development Administration, as a pilot operation to demonstrate controlled environmental systems for molluscan culture.



Terry Y. Nosh, aquaculture specialist with the Washington Sea Grant Advisory Program, notes size of chinook fingerlings as Ernest Brannon, assistant professor, College of Fisheries, explains how these fish will be tagged to study their distribution patterns.

At the Woods Hole Oceanographic Institution researchers are trying to correlate the frequency of genetic markers in natural and hatchery-reared populations of hard clams, to improve the genetic stocks of clams for local use, and are assessing the biological and economic feasibility of marine bivalve culture in waste recycling aquaculture systems as a means for tertiary sewage effluent treatment.

As a result of Sea Grant's effort, Maine now has both oyster and mussel industries, with 25 oyster and 4 mussel companies.

Freshwater Prawn

The development of a commercial freshwater prawn (*Macrobrachium*) industry in Hawaii is a direct result of Sea Grant's research and advisory services. In the last 2 years, the number of acres under production has increased from 38.46 to 240, and the number of farmers has increased to 20.

South Carolina has had uniformly good production in its freshwater prawn ponds, with annual yields ranging from 900 to approximately 1,170 pounds per acre. Feed conversion ratios have been reduced from 2:1 to 1.2:1, which translates to a 40 percent reduction in costs. The program is now ready to begin working with the private sector, in a cooperative extension mode, to establish small-scale prawn farming in South Carolina. As in Delaware, Sea Grant's activities have led to legislative authoriza-

tion of a \$1.5 million capital improvement bond issue for the construction of a Mariculture Research and Development Center.

Marine Shrimp

The University of Arizona's association with the Coca Cola Company has led to the construction of a one-acre intensive pilot shrimp farm. This farm has been highly successful, producing 2.3 crops per year, or about 50,000 pounds per acre per year.

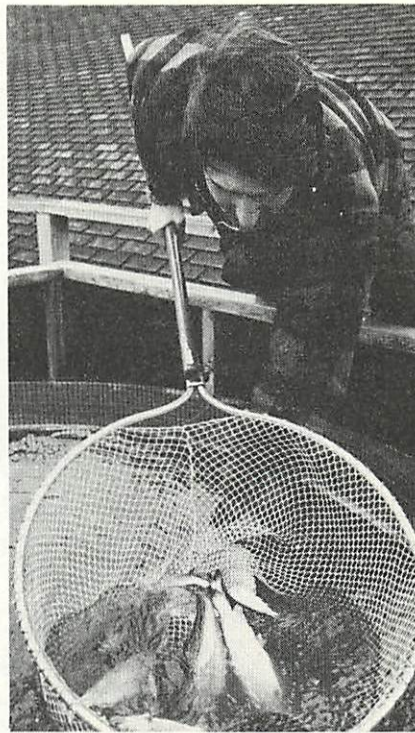
Researchers at Texas A&M University, working in cooperation with Marifarms, Inc., have successfully spawned the white shrimp, *Penaeus setiferus*. Also, major breakthroughs have been made in the spawning of *P. stylitostriis* in captivity, in cooperation with the National Marine Fisheries Service.

Brine Shrimp

At the University of Rhode Island, chemists are analyzing and comparing available strains of brine shrimp for biochemical characteristics. They also are comparing the effectiveness of each strain to support growth and survival of young fish and crabs. The University of Texas is attempting to establish the technical and economic feasibility of producing brine shrimp in the St. Croix artificial upwelling mariculture system.

Finfish-Salmon

The greatest amount of Sea Grant's effort in finfish culture is centered on salmon. At the University of Alaska, researchers are examining the genetic interactions of Auke Creek



Paul Schauer removes salmon for study from a tank at the Finfish Aquaculture System, University of Rhode Island.

hatchery pink salmon with natural spawning stocks. A related project deals with the inheritance of egg and fry characteristics in chum salmon, including the effects of intra-species hybridization on hatchery behavior and susceptibility to bacterial disease stress. In another project, the investigator is developing and testing an economical dry salmon ration made from readily available, locally-produced dry ingredients and a species of abundant, underutilized fresh fish. Also at the University of Alaska, researchers are determining the effects of oil-contaminated food on the growth of young pink salmon.

A major effort in salmon stock enhancement at the University of Washington will:

1. Develop management strategies for increased survival of wild and hatchery stocks of Puget Sound salmon, based on alterations of behavior and quality of smolts.
2. Determine the effects of various hatchery incubation systems on chum salmon fry quality and migration timing.
3. Develop an improved dry production diet for young salmon.
4. Develop a diet specifically for rainbow trout and coho salmon broodstock that will provide for good growth and high-quality gamete production.
5. Recover and analyze the 1978 and 1979 adult salmon returns from experimental lots of coho and chinook marked and released in 1975, 1976, and 1977.



A major salmon pen-rearing company (DomSea Farms) has developed in Puget Sound, as a direct result of both NMFS and Sea Grant efforts. To help this industry, researchers are:

1. Attempting to develop a coho salmon broodstock with desired characteristics for marine pen culture, and

2. Looking at thyroid endocrine control of salmon smoltification to reduce par-reversion.

Sea Grant has contributed to the development of ocean-ranching of salmon. Researchers at the University of Washington found that heated water increases the growth of young salmon to smoltification. The results of this research have been adapted by Weyerhaeuser Company in its Springfield hatchery.

At the University of Idaho, a study has begun to abolish furunculosis and bacterial disease in anadromous Pacific salmon.

At Oregon State University, investigators are studying the interrelationships of dietary lipids and proteins on the growth, quality, and production of cold-water cultured fish. In addition, researchers are attempting to bring back the

Oregon chum salmon resources. Present objectives are to continue artificial propagations of the Whisky Creek stock to accelerate development of an Oregon chum salmon brood stock and to develop and demonstrate a post-incubation strategy with maximum return per unit of hatchery production.

At the University of Rhode Island, investigators are identifying those factors that limit economical production of salmonids in water reuse systems (silos) and evaluating methods to minimize those constraints. They also are assessing the commercial viability of Atlantic salmon aquaculture.

At the Universities of Maine and New Hampshire, studies on the antigenic and genetic characterization of infectious pancreatic necrosis (IPN) virus of salmonids have begun, in hopes of developing an effective vaccine.

Studies continue at the University of Minnesota on preserving gametes from salmonids. The investigators have been able to freeze salmonid spermatozoa and obtain near normal fertility percentages upon thawing. Also, they have successfully frozen fertilized salmonid eggs without terminating development upon thawing.

Other Finfish

Sea Grant has several projects on finfish other than salmon. Researchers at Cornell University are looking at the intensive culture of and suitable diets for walleye.

For 6 years, researchers at the University of Wisconsin have been studying the economic potential of culturing yellow perch, including the develop-

ment of aquaculture systems, energy requirements, and evaluation of water reuse systems. Commercial interest in this species is indicated by the fact that there are now several commercial culture operations in Wisconsin.

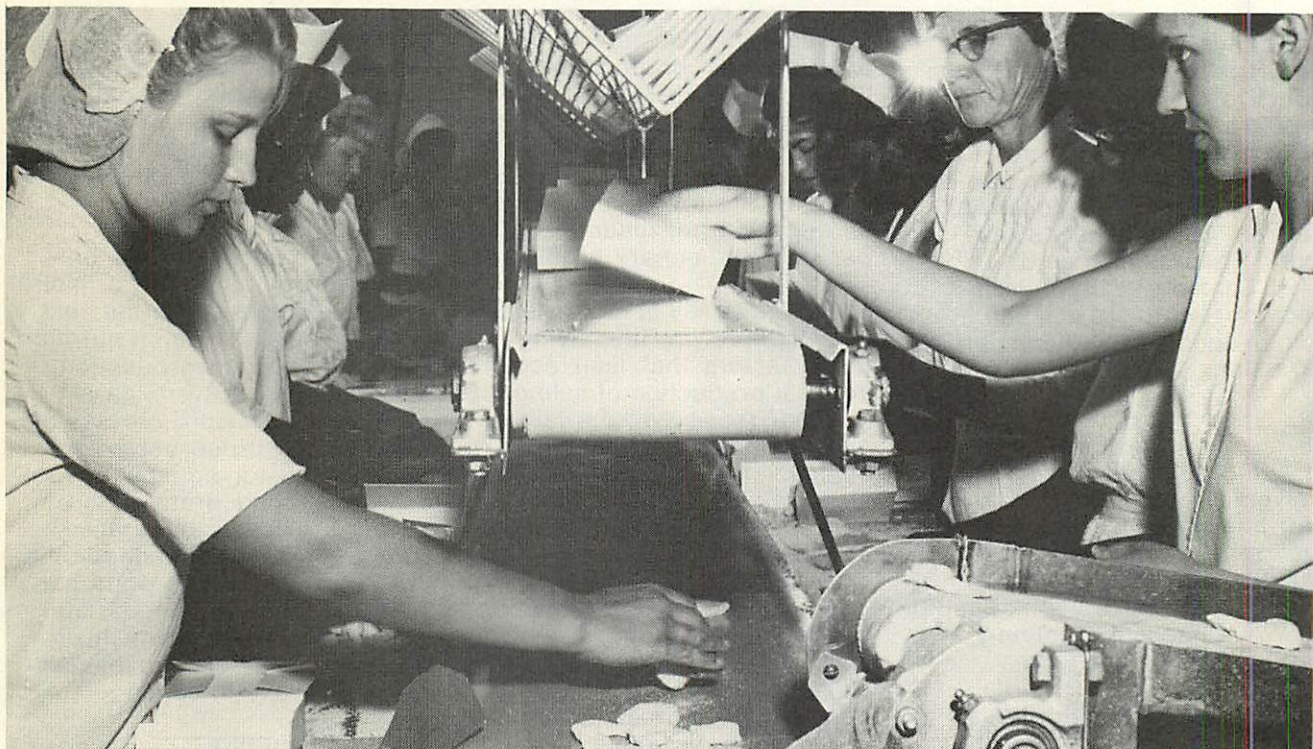
Studies on the potential of culturing eels continue at North Carolina. Emphasis for the next several years will be on nutrition studies and pond production dynamics. North Carolina is also studying hybrid crosses of white bass, striped bass, and white perch for aquaculture to determine food preference of larvae hybrids; comparative survival, growth, and adaptability of the two hybrids to pond and cage culture in both fresh and brackish water; and which of the hybrids is most suitable for continuing experiments.

Plant Aquaculture

Marine and salt-tolerant plants may be cultured for a number of purposes, including food for humans, resource enhancement, resource conservation, or commercially important products like agar or energy. Plants that are cultured include algae, kelp, seagrasses, and halophytes (salt-tolerant plants).

Sea Grant has been supporting plant aquaculture research since 1968. Since Fiscal Year 1975, the magnitude and focus of that support has remained constant. Seaweed culture is at a critical point in its development, with

Research Center tanks of the Division of Fish and Game, Hawaii, are utilized to test the efficiencies of various food mixtures for increasing production of Malaysian prawns.



Processing shrimp at Apalachicola.
Florida News Bureau Photo.

increasing interest from both government and industry. As subjects such as energy from biomass and renewable biological sources of materials are explored in greater depth, Sea Grant's previous investment in the field and the high reputation of its researchers should enable it to maintain its leadership position.

In Fiscal Year 1979, a total of \$405,000 was awarded to 5 universities for 10 projects. Matching funds of \$289,000 were provided from non-Federal sources, including industry. Support for red algae research increased by 19 percent. For the first time in several years, no seagrass project was funded. All but two of the projects funded in FY 79 are continuing efforts.

The high-quality halophyte research being supported by Sea Grant offers substantial long-term benefits. Researchers in California are studying existing food crops—particularly tomatoes, barley, and wheat—in an attempt to breed salt-tolerant strains. In Delaware, researchers taking the opposite tack are attempting to find food uses and methods for large-scale production for existing salt-tolerant tidal marsh plants like *Spartina* and the Salt-Marsh Mallow (*Kosteletzkya virginica*).

Largely supported by the cumulative results of several years of Sea Grant biological research, two demonstration-scale algal farms have been started in the United States. The most complex of these farms is located approximately 5 miles off the coast of Corona Del Mar, Calif. Moored in 600 meters of water, the test farm can accommodate

at least 100 adult *Macrocystis* plants fertilized by upwelled deep water.

Supported by the Gas Research Institute and the Department of Energy, the Marine Biomass Program has allocated almost \$9.3 million for research in the production of kelp which could be anaerobically digested to produce natural gas. A substantial portion of the funding has been devoted to the development and deployment of the test farm.

A smaller, nearshore prototype farm also has been established along the California coast. The farm is off Santa Barbara and is being developed by Neushul Mariculture, Inc. (NMI), with support from the National Science Foundation's Problem Focused Research Applications program. NMI is developing techniques for nearshore farming of algal species to provide a renewable source of industrial chemicals. These shallow water farms might utilize natural upwelling as a nutrient source or use upwelling in conjunction with other fertilizing techniques.

Using techniques developed through Sea Grant research at the University of Hawaii, an experimental seaweed growing project has been started off Semporna on the eastern coast of Malaysia with an initial investment of \$2.3 million. The project is included in Malaysia's economic development plan and is intended to introduce a new industry for fishermen.

Seafood Technology

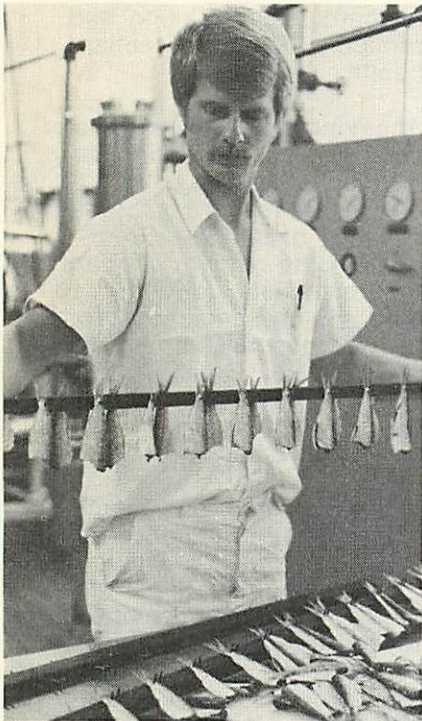
Except in coastal areas where seafood can be eaten fresh, U.S. consumers traditionally have had little dietary dependence on fishery resources, and historically have eaten primarily meat, potatoes and other vegetables. Consequently, the technology for processing, preserving, and transporting red meats, poultry, and vegetables is both sophisticated and efficient, in large part as a result of research at Land Grant Colleges.

Sophistication and efficiency of this kind are largely absent from the seafood processing industry. The archaic methods often practiced, especially by low-volume processors, can result in low profits, high prices, products of lower quality, and inability to compete in international markets. The United States trails several European and Asian nations in the science and practice of seafood processing. This technological inferiority has become a major problem as the fishing industry, in response to the extension of U.S. jurisdiction in marine waters, attempts to harvest and process resources formerly taken by foreign fishing fleets.

With opportunities and associated problems offered by the Fisheries Conservation and Management Act of 1976 (the act which extended the zone of jurisdiction), the U.S. seafood processing industry is facing ever more stringent restrictions on disposal of wastes and stricter regulations on quality of effluents. These complex issues are compounded by concern about the microbial quality of resources in nearshore waters, particularly in shellfishing areas, a large portion of which are closed to fishing because of

concern over pollution and related problems of human health.

Academic food scientists and engineers are working to develop and more efficiently use our fishery resources. Since the passage of the Sea Grant Act of 1966, the number of academic food scientists working in seafood science and technology has increased sharply. The National Sea Grant College Program is the major source of funding for academic research in seafood science and technology, still a relatively undeveloped field. Sea Grant has been the major stimulus for a marine emphasis in a number of highly respected departments of food or animal science, including Cornell University, Texas A&M University, Michigan State University, North Carolina University, University of California at Davis, University of



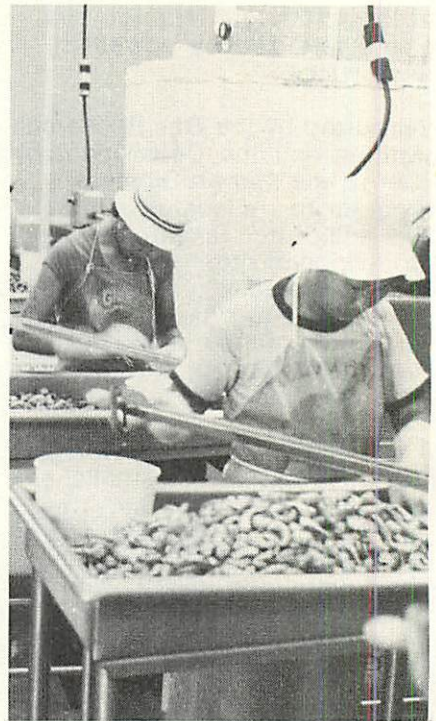
A food technologist prepares a sardine-like product from Lake Michigan alewives, part of a project at the University of Wisconsin to develop new food products from underutilized species in the Great Lakes.

Georgia, and Virginia Polytechnic Institute and State University. Sea Grant also has stimulated increased marine interest at institutions, including the University of Washington and Oregon State University, which were involved in seafood science prior to Sea Grant affiliation.

The yearly Federal expenditure for research in seafood science through Sea Grant, now \$900,000, supports 35 research projects. In addition, most of the 26 major Sea Grant programs have part-time or full-time advisory specialists in seafood science. These specialists are responsible for the especially close link and exchange of information between the fish handlers and processors and the researchers who are now turning out a steady supply of students trained for careers in the seafood industries.

Engineering and Waste Treatment

This area of research is devoted to developing equipment and procedures to solve problems in wastewater treatment or in finfish and shellfish processing, especially of underutilized species not traditionally taken by U.S. fishermen. Some of these potential fisheries—for example, squids and sharks—constitute large resources in U.S. coastal waters; yet there are no commercial processing facilities for squid in the United States. Recognizing this deficiency and the slow and unpleasant manual procedures by which squids now are cleaned and skinned, researchers at the University of California are designing an automatic processing system for squids. So far, they have defined the properties



Many workers in the seafood plants of the Gulf and southeast are Oriental—often either refugees or wives of servicemen. Here they process shrimp from the Atlantic coast of Florida. Florida's Marine Advisory Service has provided information and other advisory services to help these people adapt to their new lives in the States.

Photo by Victoria S. Howarth, VPI&SU.

and factors required to design the system—properties such as surface friction and strong points of attachment of viscera to musculature, factors such as forces necessary for separating body parts and the level of water pressure and period of application required to separate skin from flesh. A prototype system for laboratory testing should be developed during 1980.

In similar work at the Massachusetts Institute of Technology, engineers have developed a machine for skinning spiny dogfish. In cooperation with the National Marine Fisheries Service, the machine currently is being demonstrated to the processing industry.

A combined engineering-microbiological approach is being developed at the University of California for disposing of shellfish wastes, particularly chitin, for which disposal is a severe environmental problem. A minor fraction of the wastes might be diverted into a system which would induce microbiological growth and production of extracellular chitinases, enzymes capable of hydrolyzing chitin. The cell-free chitinases would be used to hydrolyze the bulk of the waste chitin, and the resulting products (primarily sugars) would be used as substrate for production of edible protein by yeasts. So far, the bacterium *Serratia marcescens* has been selected for production of chitinase, the optimum conditions for its growth have been defined, and



Workers at Ponce Seafoods, Port Canaveral, Florida, clean shrimp for packing or processing. Marine Advisory agents not only work with commercial fishermen but also provide information on processing, sanitation, and marketing to seafood processors and retail food merchants.

Photo by Victoria S. Howarth, VPI&SU.

the hydrolytic conditions suitable for maintaining enzymatic stability have been determined. Work is in progress to select suitable organisms for conversion of hydrolysate to protein.

Product Development/ By-Product Recovery

Developing feed for domestic animals and aquaculture species as well as new products for human consumption is the emphasis of research in this category. The researchers' raw materials are wastes from processing, underutilized species, and species not traditionally harvested by the U.S. fishing fleet. The intent is to solve waste disposal problems and to increase the domestic and foreign use of domestically harvested fishes, including the currently discarded by-catches of traditional fisheries.

Cornell University research in this field has resulted in development of a number of commercial products, such as fish chowders and clam broth made from minced fish or processing by-products. This work has demonstrated the feasibility of using formerly wasted protein by expanding the diversity of seafood products available to consumers. The work has been done in close collaboration with seafood processors in New York and has included successful test marketing.

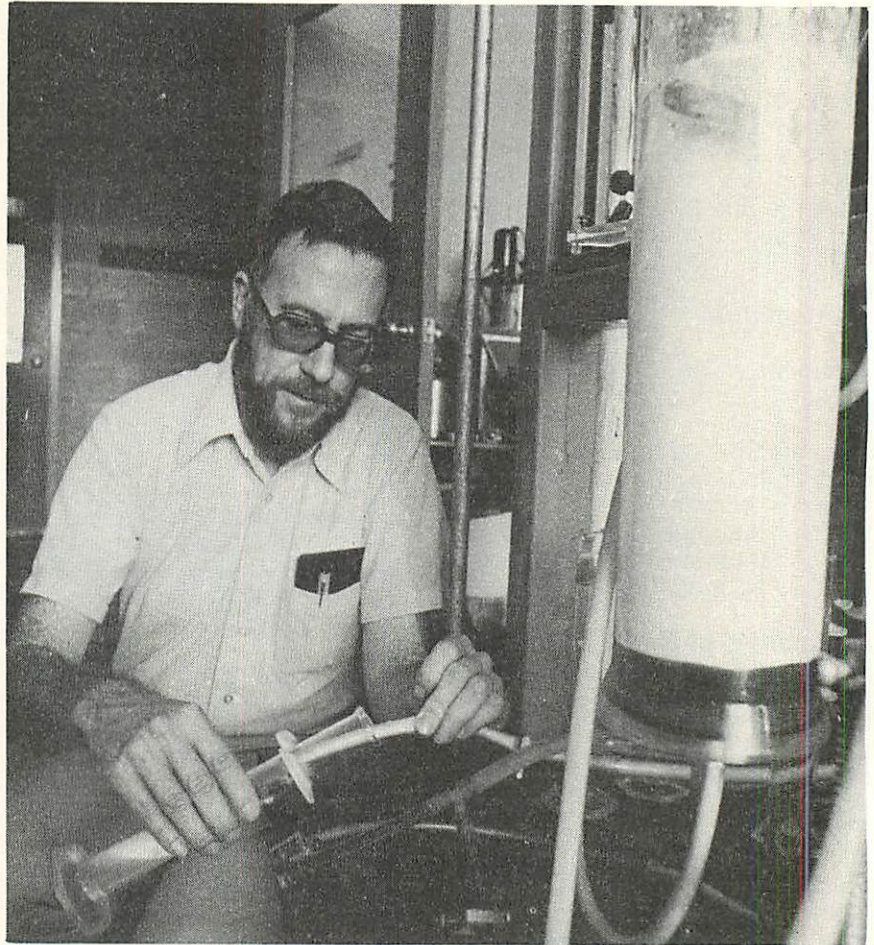
Along similar lines, researchers at the University of Georgia have shown that Yu-sone, a seasoned and semi-dried fish flake, consumed in enormous quantities in the Orient, can be produced without major prob-

lems from various noncommercial species including rays, sharks, croakers, and lizard fish. Researchers also have developed a mechanized production system which currently is under economic evaluation. This exploratory work may further development of a Yuseone industry that would make much more efficient use of the domestic harvest of finfish.

Researchers at the University of Alaska are taking a different tack in their focus on products for domestic animals rather than for humans. Their intent is to determine the feasibility of using wastes from the processing of shrimp, tanner crabs, and king crabs as supplements or replacements for soybean meal in rations for swine. Their preliminary work has demonstrated that up to 50 percent replacement does not reduce either the rate or efficiency of gaining weight. Physical separation of some of the meals produced fractions that could replace up to 100 percent of the soybean meal without any obvious negative effects.

Microbial and Nutritional Quality

Projects in this category of research deal with problems in sanitary procedures in processing facilities and to microbial quality of seafood, especially shellfish, as it is harvested, transported, and marketed. A significant effort also goes into defining the biochemical quality of seafood and its role in human nutrition.



Post-harvest handling of fish on fishing vessels is a special interest of researchers at Oregon State University, who frequently work with fishermen in conducting experiments and in advising on improved procedures of sanitation. An investigation into the causes of high concentrations of bacteria in refrigerated seawater, which is recirculated in many fishing vessels as a means of preserving the catch at low temperature without freezing, has produced modified procedures which drastically lower the numbers of bacteria in the circulating seawater and improve the quality of catch at delivery on shore.

A chemical engineer at the University of Rhode Island, Stanley M. Barnett, collects some clam processing waste from a tank. After processing, the clam waste will produce chitosan, a product useful in cleansing the waste water discharged in seafood processing. Sea Grant researchers at a number of schools are looking at other potential industrial uses for chitosan based on its unique chemical properties.

Texas A&M University researchers have developed a rapid and sensitive procedure for objectively measuring the quality of shrimp. The instrumental procedure uses an electrode specific for ammonia, a product of spoilage, and is expected to be valuable to the shrimp industry in selecting batches for frozen rather than fresh retailing and in controlling quality of product.

In North Carolina, Sea Grant researchers are examining pathogenic microorganisms in seafood, particularly molluscs, in an attempt to improve techniques for their detection and enumeration, and have developed a much more reliable and precise method for measuring fecal coliforms in shellfish, water, and sediments. The "repair-detection" method is expected to result in safer and more selective procedures for closing and opening shellfishing areas and for defining the microbial quality of seafood.

Processing of Seafood

Research in this category is directed primarily at improving packaging and transportation of seafood and at extending the shelf-life of various products.

At the University of Rhode Island, for example, a study is under way to determine the role enzymes can play in extending the stability of fresh fish under refrigerated and hypobaric storage. Hypobaric storage (storage in a partial vacuum) can extend the storage life of numerous kinds of fresh foods, yet no reports have yet been published on the effects of hypobaric conditions on processes of spoilage in fish. The URI researchers believe the technique may be especially

effective when combined with enzymatic techniques for inhibiting growth of degradative organisms.

In Florida, where many small processors produce excellent products from smoked fish, Sea Grant investigators are developing an inexpensive solar system for frying and smoking fish. The impetus is new Federal safety regulations that will require fish processors to install expensive electric or fuel heating units in order to reach the temperatures required to eliminate contamination with the bacterium *Clostridium botulinum*, which produces a deadly toxin.

Projects at Michigan State University, Ohio State University, and the University of Minnesota are defining the factors and procedures for producing high quality products from a number of fishes of the Great Lakes. Researchers are examining the use of mechanical skinners and deboners, use of artificial atmospheres in preservation, and evaluating a variety of possible types of packaging. The results of the research will be important in aiding the currently feeble commercial fishing industry in the Great Lakes.

Marine Natural Products

Research under this heading falls into two groups—developing uses for chitin, a waste product of processing crustacean shellfish, and discovering novel biochemicals whose biological properties make them of potential use in medicine, medical research, and agriculture.

For thousands of years, land-based plants and animals have been used as a source of pharmacologically 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 land organisms. In fact, most of the drugs now in use are derived from land-based plants and animals or are synthetic substances based on structures of natural molecules of terrestrial origin.

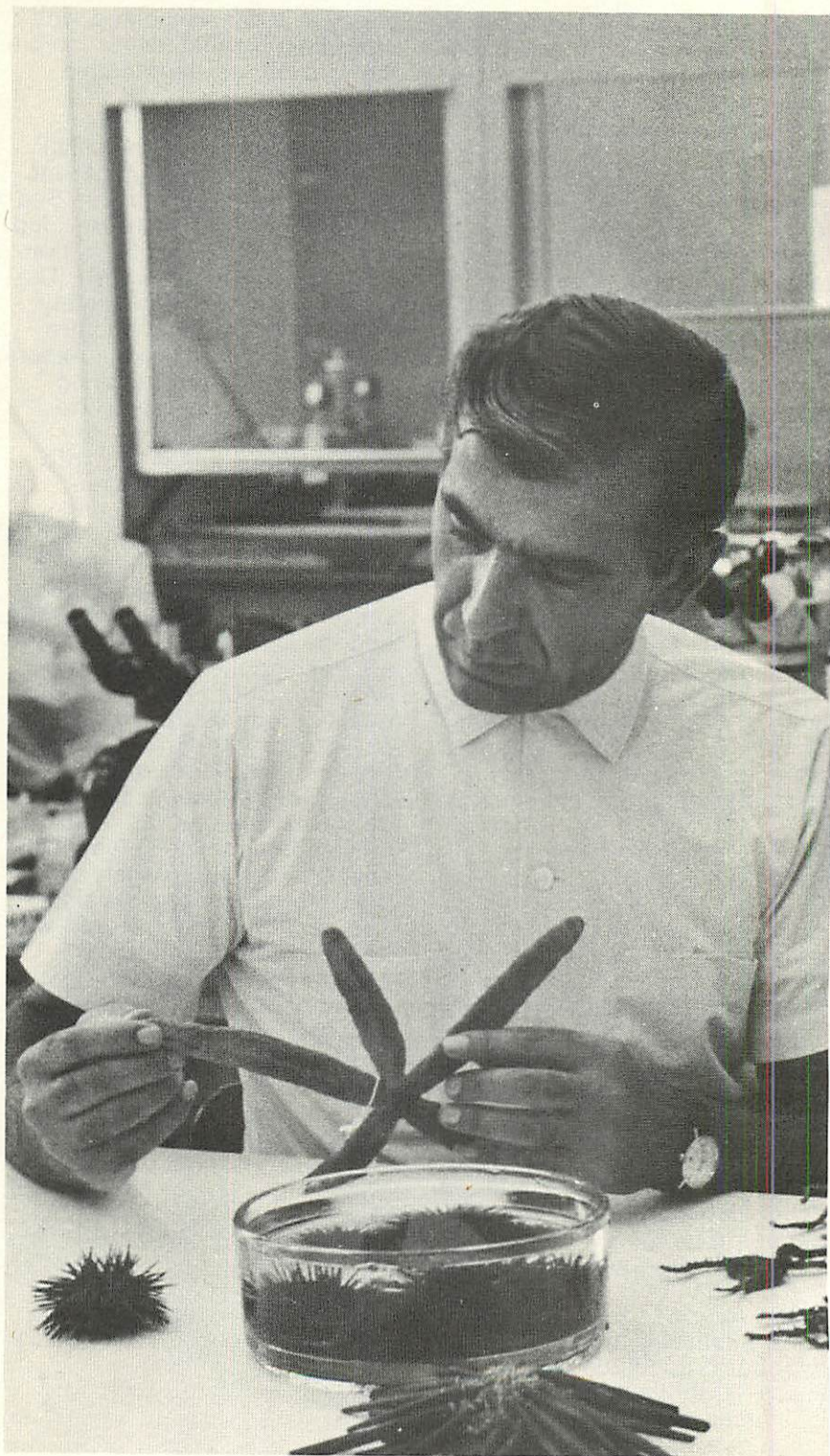
Only relatively recently have humans turned to the sea as a source of novel chemicals for industrial use and of biologically active substances for treating human illnesses and studying medical disorders. The last 10 years, and especially the last 5 years, have been periods of significant progress in the chemistry of natural marine substances. In 1973, fewer than 100 marine organic compounds had been identified; more than 600 are now known.

"Biological activity" is a general term for the ability of chemicals to elicit physiological responses in living systems. Substances like toxins, venoms, and poisons exhibit biological activities of various kinds, including the

ability to affect the central nervous system of the vascular and muscular systems of mammals in positive ways, for example by strengthening the contractions of a weak heart. Even the toxicity of natural substances can be useful in killing internal parasites or insects and weeds detrimental to agricultural crops.

Because biochemical and physiological knowledge is still inadequate for designing synthetic drugs without extensive research and testing, nature will continue to serve for some time as a source of new chemical structures useful because of their biological activity or useful as inspiration for synthetic chemists who design molecules with modified biological activity.

The array of marine bioactive substances may be greater than for terrestrial substances, because approximately 80 percent of animal life lives in the oceans and includes 1 million species in 30 phyla. Some phyla and many smaller subdivisions of plants and animals occur exclusively or primarily in marine waters, and few of their representatives have been subjected to thorough chemical study. This potential is being substantiated by accumulating results of research, much of which in the United States is being undertaken through the National Sea Grant College Program. In 1979, 17 projects were supported with \$553,000 in Federal funds and \$312,000 in matching funds; in 1978, 16 projects received \$456,000 in Federal funds with \$270,000 in matching funds.



California's Sea Grant College Program maintains a subprogram of six projects in marine product development. The primary goal of five of them is elucidation of the chemistry of new marine compounds; the sixth project provides for pharmacological evaluation of new substances isolated through the other projects in the subprogram. This subprogram recently identified more than 25 new substances, which in preliminary biological evaluation have shown promise for application in medicine, medical research, or agriculture. Three are of therapeutic significance. One, elatol, acts in a fashion analogous to vinblastine, a natural product currently used in cancer chemotherapy; another, curcuquinone, has shown enough promise that the University of California has filed a patent disclosure. Two of the new compounds show activity in a bioassay for neuromuscular transmission. One increases the force of contraction of muscles; the other is a neurotoxin which produces paralysis and could be used in surgical procedures in a manner similar to curare. One of 14 compounds tested for diuretic properties showed impressive activity.

Sea Grant scientists at the Osborn Laboratories of Marine Sciences, University of Oklahoma, work with various sea animals in their search for drugs from the sea. Dr. George D. Ruggieri, S.J., observes representatives of various echinoderms (sea urchins and brittle stars) before extraction and testing for biological activity.

A number of extracts and pure compounds have shown significant activity against common insects such as flies, mosquitoes, spider mites, tobacco budworm, and beetles. Most of the substances contain chlorine and/or bromine and are common metabolites of several genera of red algae. Because California's researchers in this field are working in collaboration with industrial laboratories, the more nearly complete evaluation of potentially useful substances and their subsequent actual use is likely.

In a similar program at the University of Oklahoma, researchers over the past 2 years have isolated 21 new compounds and determined the chemical structures of 18 of them. Five of the isolated compounds show levels of cytotoxicity that meet the National Cancer Institute's criteria for further evaluation of anticancer activity; one of these is undergoing *in vivo* testing. Another new compound, dactylone, which was isolated from the sea hare, *Aplysia dactylomela*, was shown to be a potent inhibitor of pentobarbital metabolism, a property giving it the potential of lowering the dosage of pentobarbital used in medicine while increasing the duration of its effects, making it significantly safer and less likely to cause addiction.

A number of other compounds and fractions prepared by the Oklahoma group show promising pharmacological activity in assays on mammalian cardiovascular and central nervous systems.

Cooperative Sea Grant projects at Ohio State University and the American Cancer Research Center in Colorado are working to isolate and identify the substance or substances in the clam, *Mercenaria mercenaria*, which are active against certain malignant tumors in mammals.

At the University of Rhode Island, research in marine natural products is underway for a purpose quite different from the projects already described. This research is directed toward controlling the problem of paralytic shellfish poisoning (PSP), a severe form of human food poisoning caused by transfer of algal toxins to edible shellfish. PSP is commonly associated with "red tides," dense blooms of toxic dinoflagellates. The researchers have shown that not just one substance is responsible for toxicity, as was formerly believed, but a whole family of complex compounds. They believe that determining the toxicity and toxin profiles of dinoflagellates along with studies of their geographic distribution will pinpoint the origin of toxic dinoflagellate blooms and help to predict the occurrence of toxic shellfish in specific regions. They anticipate their results will be useful in developing a procedure for remote spectroscopic sensing of toxic dinoflagellate blooms.

Chitin

Chitin—the substance that makes up the shells of crabs, shrimps, lobsters, and crayfish—is a major part of the waste from processing and creates a waste disposal problem measured in thousands of tons. If a solution is not found, some processing operations may become unprofitable or impossible under new regulations of



the Environmental Protection Agency. A promising solution to these problems is developing uses for chitin; this is the goal of the five Sea Grant projects dealing with chitin or its derivative chitosan.

These research projects are relevant to an emerging industry: two companies in the United States have recently produced or are now producing small quantities of chitosan, and another is considering going into major production. Commercially, however, both market potential and stability of raw material supply are quite uncertain.

At the University of Washington, recent research has shown that chitosan, when formulated in a paint-like coating, can prevent emission of formaldehyde from building materials such as wooden particle boards which are bonded with urea-formaldehyde resins. Formaldehyde, which can be harmful to human

health and causes cancer in mice, is continuously emitted in low concentrations from such products. This problem is of potentially immense importance because particle board has been used in tens of thousands of mobile homes, many of which are occupied by young couples with small children who may be particularly vulnerable to the effects of formaldehyde.

At the University of Delaware and Massachusetts Institute of Technology, researchers have developed effective solvent systems to be used in making chitosan into flexible, thin, transparent films with a wide range of possible applications. Related studies show that the chitosan membranes may have the potential of influencing many heavy-metal ions; thus it may be possible to design types of chitosan for specific purposes, such as selective removal of metal ions from waste effluents.

Some of the most promising work in developing uses for chitin is underway at the University of Southern Mississippi, where chemists are attempting to develop a new class of pesticides and herbicides by chemically conjugating currently used substances to chitin or chitosan. The con-

jugated materials would provide controlled release of the pesticides or herbicides and prevent rapid runoff into drainage waters and transport to municipal water supplies or environmentally sensitive estuaries. Success will allow smaller, safer applications of toxic substances to agricultural lands and provide uses for waste materials in large volume.

There has been little interest in research on chitin and chitosan as an industrial substance outside the National Sea Grant College Program and the Western Regional Research Laboratory of the U.S. Department of Agriculture. However, the importance of research into chitin and its derivative chitosan as a waste in processing of seafood is considered significant and promising.



Marine Environmental Quality

A major goal of the Sea Grant Program is to bring the skills and talents of the Nation's universities to bear on the problems involved in wise use and conservation of our marine resources. In the marine environmental portion of the Sea Grant Program the research objectives are to:

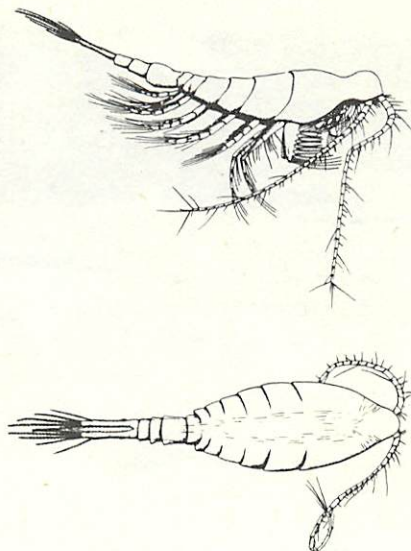
1. Understand marine ecosystems and how they control the abundance of marine life available for human uses.
2. Understand the impact that humans and their waste products are having on marine ecosystems so that the resource managers may protect and revitalize the marine resources within these ecosystems.
3. To provide predictive tools such as models to scientists and managers to help them understand and manage ecosystems.

Scope of Program

The Sea Grant research program in Marine Environmental Research for Fiscal Year 1979 consisted of 164 projects supported by \$7,249,100 in research funds. Of this amount, \$4,653,600 (65 percent) were in Federal funds while the remaining \$2,595,500

Pollution caused by other human uses has caused many seafood-producing areas to be closed to fishing and/or shellfishing. But some marine animals "depurate" themselves in a short time once they are placed in clean water. Here hard clams (quahogs) are taken from a closed area at the mouth of the James River, Virginia, for relaying elsewhere before being marketed.

Photo by Dixie Galyean, VPI&SU.



Tiny marine creatures like this crustacean—no larger than a pinhead—are an important food source for young salmon and trout in the Great Lakes. This member of the zooplankton family also can be a useful indicator of water pollution because it is sensitive to temperature and oxygen content.

Artist Nancy Korda, University of Wisconsin Sea Grant College Program.

(35 percent) were supplied from State, university, and local sources. The 1979 environmental program concentrated on four areas: ecological research (70 projects); pollution-related research (73 projects); modeling research (14 projects); and applied oceanography (7 projects).

All 26 of the Sea Grant College, Institutional, and Coherent Area programs have been involved in environmental research. Projects range from studies of the ecology of coastal wetlands and human impact on these valuable lands to the effects of PCB's (polychlorinated biphenyls) on the food chains in the Great Lakes. Mathematical modeling of pollutant transport, the uptake and fate of potentially carcinogenic hydrocarbons in fish, and the impact of the feeding habits of harbor seals on salmon aquaculture were among other projects begun by local Sea Grant programs.

Support Comparison

Total support for Marine Environmental Research by Sea Grant programs increased by 7 percent between FY 78 and FY 79. Both Federal and non-Federal contributions increased at the same rate, maintaining a ratio of 65 percent Federal and 35 percent non-Federal funding. The number of projects supported increased by 20, or almost 15 percent. The difference in growth rates between the number of projects and the dollar support is reflected in a decrease in the average size of a project from \$46,900 to \$43,400.

In the program area, the major change between FY 78 and FY 79 occurred in the category of ecological research, with an increase of 16 projects and about \$1 million of support. The number



Environmental hazards are not all in the water, nor are they all preventable. This is a Panama City, Florida, beach after a major storm. Much Sea Grant activity in the Gulf of Mexico region in recent years has been concerned with hurricane preparedness.

of pollution-related projects, on the other hand, increased only slightly, from 69 to 73. Actual dollars devoted to pollution-related projects declined between FY 78 and FY 79.

Twenty-seven percent of the Sea Grant research dollar went to Marine Environmental Research in FY 79. This proportion has held steady for several years.

A growing trend in Sea Grant-sponsored research is research subprograms of coordinated projects which address major resource development or management problems within the State and use investigators from a variety of disciplines. Such major marine environmental research programs were active in FY 79, in varying size, in Massachusetts, Rhode Island, New Jersey, Florida, Louisiana, Michigan, Wisconsin, California, and Hawaii.

Realizing that a basic understanding of coastal ecology is needed for intelligent management of marine resources, Sea Grant programs provide strong support for studies in coastal

ecology. The coastal marine ecology program in Sea Grant is probably the largest of any Federal agency.

Sea Grant-sponsored research on the effects of pollutants on our Nation's resources is small in relation to the total Federal effort in pollution research. However, the Sea Grant effort is the only Federal program addressing environmental problems as they are perceived at the State and local level. As such, Sea Grant programs are capable of responding directly and rapidly to the needs of coastal citizens.

Marine Minerals and Petroleum

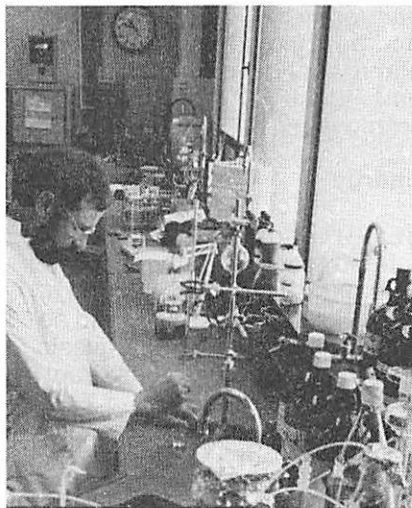
Sea Grant-sponsored research on minerals and petroleum from the oceans are organized into two areas: resource research, assessment, and technology development, for exploration and recovery; and assessment of environmental, socioeconomic, and legal impacts.

The principal marine mineral commodities of interest to the Nation can be thought of in terms of five* groups:

1. Sand, gravel, and shells;
2. Manganese nodules;
3. Heavy mineral placers (a class of deposit containing numerous mineral types);
4. Phosphate rock and lode minerals (grouped because they usually occur in lithified form); and
5. Petroleum (oil and gas).

In the first category, projects in New York, California, and St. Croix have concentrated on assessing sand and gravel resources to determine their availability in these areas of heavy construction, low land reserves, or high import prices. At the University of California, image enhancement techniques developed for use on satellite-generated data are being applied to underwater acoustic surveying. In Oregon, coastal sand and gravel deposits are being tested to determine specifications for aggregate materials suited for different construction purposes.

For category 2, manganese nodules, the technology continues to focus on the chemistry of alternate methods of hydrometallurgical processing of the nodules. The socioeconomic and



Chemical Oceanography lab at the University of Rhode Island.

Photo by Robert J. Izzo, URI.

legal studies are concerned with the principles of property laws in the Law of the Sea, legal implications of conversion of the ocean from "common" to "real" property, and economic and resource-use strategies and issues.

The largest projects in category 5, petroleum from the oceans, have been "pass-through" funds from other Federal agencies, especially from the Department of Energy (DOE). Several projects are developing techniques for better assessing natural—geologic and hydrodynamic—hazards to petroleum-related developments. MIT scientists are progressing on the evaluation of cone penetration rate and the geotechnical properties of marine sediments. University of California/Santa Barbara investigators have developed micro-seismometers and have built, deployed, and collected data of seismic activity in the Santa Barbara channel. A study at the State University of New York/Cornell seeks to extrapolate to the George's Bank and Baltimore Canyon region, the relevant geologic conditions for high pressures encountered in apparent similar strata near Sable Island, Nova Scotia. Engineers at the University of Hawaii, working with the American Gas Association, will obtain wave and force data on pipes set at angles and depths typical of many submarine pipelines in nearshore waters. In another technological field, chemists at Woods Hole Oceanographic Institution (WHOI) are attempting to develop and apply techniques of gas chromatography-thermal distillation as a rapid method to determine petroleum hydrocarbons absorbed on small samples of marine particulate matter. MIT is continuing to study the

* Sea Grant currently is not funding any projects in categories 3 and 4.

effects of oil composition and physical properties on dispersion of oil slicks.

Environmental assessment of oil spills continues at three Sea Grant institutions. Georgia investigators have learned that polychaete worms generally survive oil spills and are solely responsible for degrading benzo(a)pyrene. One year of baseline data on standing stock has been obtained in preparation for an experimental spill. A major study, funded in a pass-through from the Department of Energy, at Texas A&M University will determine the potential and actual effects on the marine environment of the offshore discharge of brine; the brine would be produced as a result of the creation of a cavern in a salt dome into which imported oil would be pumped for storage. A related research effort at MIT is investigating and evaluating alternative discharge designs for disposal of the brine in the ocean, for use in a discharge structure and for the establishment of an environmental monitoring program.

The annual Underwater Mining Institute continues. It was organized many years ago by Dr. J. Robert Moore and offered through the University of Wisconsin Sea Grant Program. In October 1978, the ninth meeting was jointly sponsored by Sea Grant programs in California, Wisconsin, and Alaska, where Dr. Moore is Director of the Institute for Marine Science. The Institute celebrated its 10th anniversary in October 1979 in Galveston, sponsored by the University of Texas Marine Science Institute and Sea Grant Programs at Wisconsin and Texas A&M. The Institute continues to provide a forum for the dissemination of the current state of technology,

environmental and legal issues, and policy matters to academicians, special interest groups, and industry and government employees.

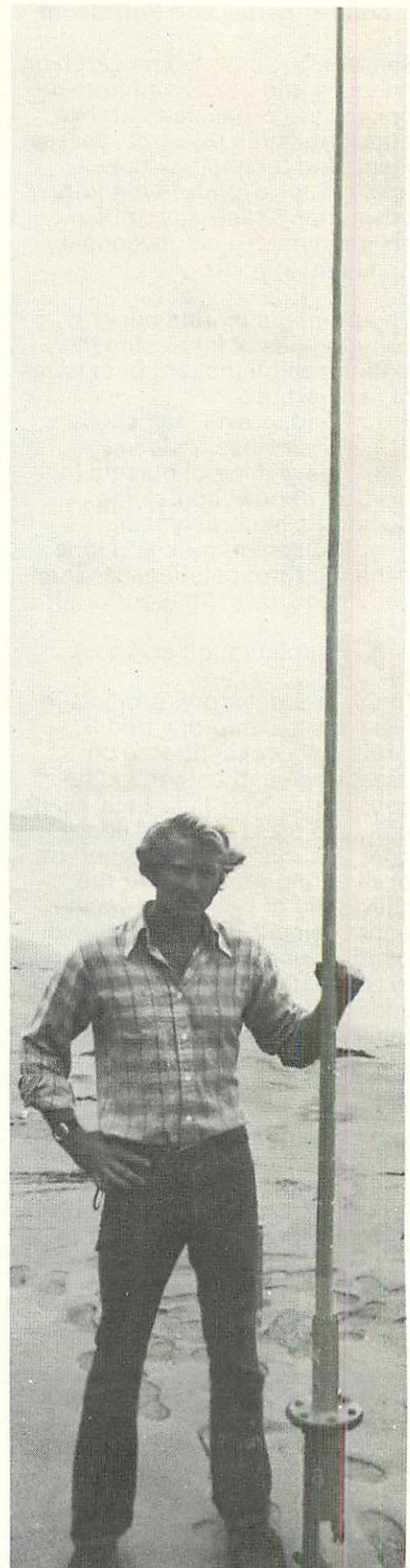
Energy

Sea Grant projects for energy-related research are concerned with exploration, production, transportation, storage, and social impacts. Sea Grant invests less than 2 percent of its grant funds on energy.

One current Sea Grant ocean-energy study exploits wave power in a pressure-activated, osmotic-membrane system to produce fresh water from sea water. A 1,500-gallon-per-day prototype system has been undergoing a series of field tests in Delaware Bay and off the coast of North Carolina. Tests of a modified system are scheduled to begin in the spring of 1980 off Puerto Rico. Another Sea Grant project for producing fresh water from the sea is aimed at significantly decreasing fuel consumption (per gallon of water produced) using an improved distillation process. Other Sea Grant investigations on ocean energy devices, involving salinity gradients, wave pressure, and tethered-buoy motion were completed in 1978.

A graduate-student scientist holds a wave resistance staff, used in the experiment at Torrey Pines, California, part of the Nearshore Sediment Transport Study. Measurements of many processes taking place in the surf were recorded in analog and digital form during a one-month period at the beach, for later assessment.

University of California Photo.



National Projects

Under legislation passed in 1976, the Secretary of Commerce was asked to "identify specific national needs and problems relative to ocean and coastal resources." As a Department of Commerce agency, the National Sea Grant College Program identified 15 national problems, ranging from protecting marine mammals to finding appropriate sites for waste disposal.

The first national project undertaken by Sea Grant was one involving "the development and the experimental verification of hydrodynamic laws governing the transport of marine sediments in the flow fields occurring in coastal waters." The project—called the Nearshore Sediment Transport Study (NSTS)—was designed to develop knowledge of how sand and mud move in response to wind, waves, tides, and other forces. This information is needed so that engineering decisions, such as where to build a pier or roadbed or where to establish an outfall for sewage or heated effluent, can be made with significantly higher confidence.

Beginning a "national" project represented a departure from the strictly localized programs that Sea Grant had pursued since its establishment in 1966. As a result, a new and experimental management plan was developed to bring the diverse scientific efforts of a number of widely distributed institutions into one program. The project marked the first time that Sea Grant would have scientists from many different institutions working together in experiments in the field.

Under the direction of Dr. Richard J. Seymour, oceanographer

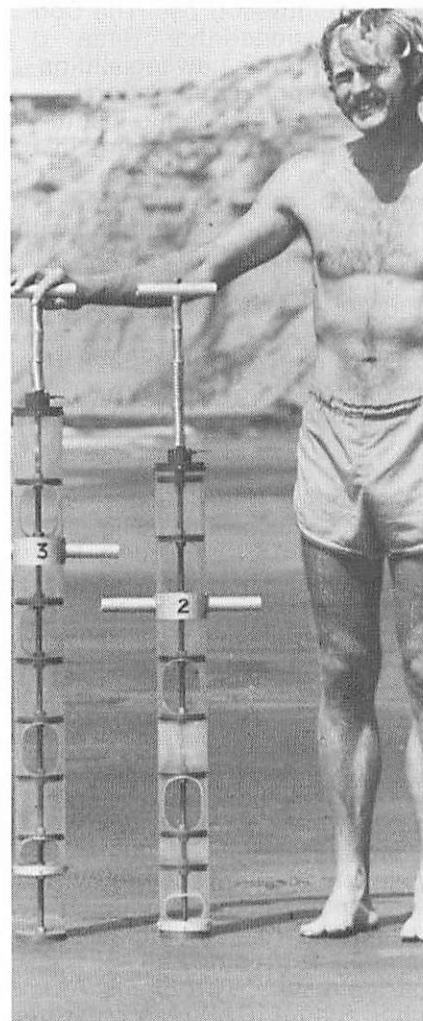
for the California Department of Navigation and Ocean Development, a steering committee of scientists with strong track records for experimental work in the laboratory and in the field was established. Early participants in the project included the Scripps Institution of Oceanography, the University of Washington, the University of Delaware, the State of California, and the U.S. Navy. Since then the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution have joined the project.

The first major field experiment took place in November 1978 at Torrey Pines Beach, just north of La Jolla, Calif. Principal investigators, their assistants, and scores of volunteers from nearby Scripps Institution of Oceanography spent nearly a month taking measurements of the surf zone. The result: the finest data collection ever made of the dynamics of the surf zone.

Since that time, an analysis of the data has been completed, and another major field experiment has been scheduled for Santa Barbara, Calif., in February 1980.

An additional national project, launched by Sea Grant in 1979, is investigating the settling of marine organisms on surfaces in the ocean and developing repellants to control fouling and boring organisms. The general problem of fouling on merchant vessels is one of continuing economic consequence to the shipping industry.

A scientist holds a suspended sediment sampler, an item of equipment used in the Nearshore Sediment Transport Study. The sampler cores a column of water, dividing it into discrete elements at specific depths. This sampler is especially designed for use in the surf.
University of California Photo.



International Cooperation Assistance Program (ICAP)

Section 3 of P.L. 94-461, signed by the President on October 8, 1976, established the International Cooperation Assistance Program (ICAP) within the Sea Grant College Program. Its goals are: (1) to enhance the research and development capabilities of developing foreign nations with respect to ocean and coastal resources; and (2) to promote the international exchange of information and data with respect to the assessment, development, use, and conservation of such resources. The Congress envisioned that grants made under this new legislation would promote cooperation between U.S. academic institutions and their counterparts in developing countries. Grants were to be made only to U.S. institutions, and consultation with the Secretary of State was required before grants were made.

Subsequently, in P.L. 95-428, the second stated goal of ICAP was altered to read:

“(2) promote the exchange among the United States and foreign nations (including, but not limited to, developing foreign nations) of information and data with respect to the assessment, development, utilization, and conservation of such resources.”

In establishing ICAP as part of the Sea Grant College Program, the Congress evidently wanted it to produce results of similar quality to those produced by Sea Grant in this country, building scientific and technological capacity to identify and solve marine resource problems. Another goal of ICAP is to contrib-

ute to the economic and social development of the developing world. ICAP should foster the development process by strengthening indigenous scientific and technological institutions and by supporting education and training programs.

Eighteen formal proposals were received by the Office of Sea Grant during FY 78, and 14 during FY 79. Of these, 11 have been funded for 1 or 2 years, for total Federal funding of \$1,820,400. Countries involved include Mexico, Chile, India, Egypt, Malaysia, Costa Rica, Israel, Colombia, and 11 South Pacific Nations—every area of the developing world except tropical Africa.

No project supported under ICAP has yet come to a conclusion, but examples of progress include:

Several faculty members from the University of Concepción spent short periods of time at the

John Day of the Louisiana Sea Grant College Program and a colleague from the University of Mexico check a litter trap in a mangrove swamp on Campeche Bay, Mexico. Day is working with counterparts in Mexico on an ecological study of the relatively undeveloped bay, in comparison with similar areas in Louisiana that have been significantly affected by man's activities.





A Malaysian scientist observes as a University of Rhode Island scientist positions a sieve and sluice box for sample collecting in one of Rhode Island's coastal ponds. The interdisciplinary study of the ponds is a prototype for ecosystem studies of marine and wetland areas, and the methods being developed in Rhode Island will be used for similar studies in Malaya.

Marine Sciences Research Center (Stony Brook) taking courses, attending seminars, and planning cooperative research endeavors. Faculty members from the Marine Science Research Center are now in Chile teaching short courses, improving the use of laboratory instrumentation, gathering data for a marine resources inventory, and planning a study of pollution processes in the Bay of Concepción. Chilean research capabilities have been strengthened, not only in technical matters but also in the planning and management of research.

The University of Delaware's research vessel *Skimmer* was transported to Costa Rica where a ship's crew and oceanographic technicians were trained, students and faculty carried out water quality and biological surveys in the Gulf of Nicoya during both wet and dry seasons, and an initial remote sensing study was done of currents in the Gulf.

Two Costa Rican students completed master's degree studies at the University of Delaware's College of Marine Studies. Training of the Costa Rica crew for R/V *Skimmer* progressed to the point where the vessel can be turned over to them for water quality work and light gear sampling as soon as an exchange agreement is ratified by the University of Costa Rica. Lectures and a workshop were conducted at the University of Costa Rica on remote sensing, coastal vegetation, and fisheries resources.

Professor Harlan Lampe of the University of Rhode Island worked with the Faculty of Economics and Agribusiness at Universiti Pertanian Malaysia in fisheries economics. Some of his work was not supported by Sea Grant, because the university asked him to stay additional time at its expense. Professors Marshall and Saila spent several months at two Malaysian universities helping with curriculum development and research planning in the field of fish population dynamics. Three fishery research projects were started under local funding, and several coastal ecology studies were carried out jointly by Rhode Island and Malaysian investigators.

Some specific tasks of the Oregon State project in Chile were a seminar on the results of recent research in Latin American waters, a workshop to train technicians in marine instrumentation and data collection, on-the-job experience for selected technicians, continuation of an oyster culture program, distribution of the newsletter *Exposure* which describes advances in instrumentation, and initial distribution of a basic oceanography text in Spanish. A major

effort was the "Inter-American Conference on Marine Science and Technology" at the Catholic University of Valparaiso. More than 100 scientists participated. While most of the attendees were from Chile, some also came from Costa Rica, Ecuador, Norway, and the United States. Topics included marine biology, marine chemistry, geology and geophysics, marine fisheries, instrumentation, and research vessel operation. The presentation related primarily to research done off the west coast of South America, but extending as far south as Antarctica.

Scientists from Israel and the Virginia Institute of Marine Science (VIMS) worked at each other's institutions, new information was gathered, and old data was analyzed. Because several of the Israeli investigators had previously worked in other fields, this was a training experience for them. A wave gauge was in-

stalled at Dado Beach south of Haifa as part of a cooperative project among the Israel National Oceanographic Institute, the Shore Processes Laboratory at Scripps, and VIMS. The results of this work are applicable to the planning and development of a proposed coal unloading facility at Hadera, a proposed Haifa marine and recreation complex, and an extension to Haifa harbor.

Campeche, the site of the Ixtoc I oil spill, is also the site for Dr. John Day's (Louisiana State University) project developing an "ecological program" for the Laguna de Terminos. Dr. Day was appointed a visiting professor at Universidad Nacional Autonoma de Mexico Center for Marine Sciences and Limnology so he could act as thesis advisor for students.

The investigators studied phytoplankton and mangrove productivity, paying special attention

A cooperative program between the Oregon Grant Sea College Program and universities in Chile has brought Chilean faculty and students to Oregon for technical training, and has sent Oregon personnel to Chile to observe marine research activities there.



to the effects of river discharge. Coupled with this effort was a study of fishery dynamics. To better understand the drainage basin of the lagoon, a hydrodynamic model was created. The model will be used to gain a better understanding of the lagoon circulation and to plan further research, as well as allowing for the study of pollutant dispersion, the fate of spilled oil, and the movement of larvae. All the information was packaged in a booklet on coastal planning.

During the past year, Dr. Day advised a number of students on thesis topics such as the distribution of oyster larvae in Laguna de Terminos, microbial damage on decaying mangroves, ecological and physical parameters in Estero Pargo, the ecology of blue crabs, and community dynamics of benthos associated with *Thalassia* beds. Students from the Universidad Autonoma Metropolitana in Mexico City came to the marine station for classes and extended field trips.

The initial training course by the University of Miami was held in April 1979, at the Colombian Navy's Center for Oceanographic and Hydrographic Research in Cartagena. Thirty-five students and 10 professors from 7 universities and 1 research group attended the seminars. Lectures

were given in the language of the instructor, with translation from English to Spanish when required. Colciencias (equivalent to the U.S. National Science Foundation) supported travel and per diem for students not within commuting distance of Cartagena. Formal presentations and less formal discussion groups covered topics as diverse as estuarine hydrodynamics, marine geology, and public health. The integrated study of Cartagena Bay began in June 1979. Students from Colombian universities, especially the two in Cartagena, are associated with all aspects of the work.



International cooperation in research is one goal of Sea Grant's International Program (ICAP). In an ICAP project at Oregon State, scientists from Oregon and Chile have worked together on field studies, sampling, and training students and technicians to conduct marine research.

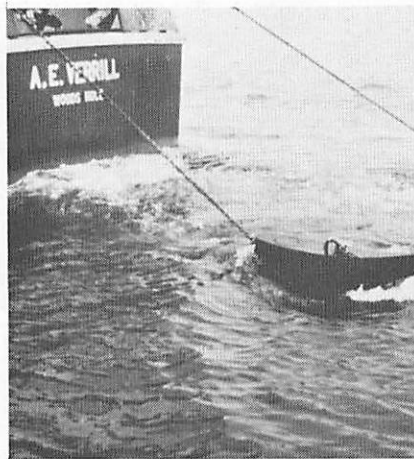


Technology and Commercial Development

Ocean Engineering

In FY 79, Sea Grant supported 106 ocean engineering projects in 21 programs, with total Federal funding of \$3,177,250. Sea Grant is, however, not a major source of funds for ocean engineering projects, except in the program at Massachusetts Institute of Technology (MIT) and in coastal engineering—sediment transport, erosion and deposition, and erosion control. The 106 projects include 9 supported by pass-through funds.

Offshore structures can cost hundreds of millions of dollars and must conform to environmental and safety regulations. To minimize construction and maintenance costs, engineers must be able to specify designs which account for the specific conditions of individual offshore locations. At MIT, Sea Grant researchers have adapted instrumentation to answer questions about marine soil stability, compressibility, and the loading that subsea sediments will tolerate. During the summer of 1979 these instruments were tested *in situ* at an oil exploration site off the coast of Venezuela. Currently, they are working to combine two instruments, the Dutch (Fugro) cone and a piezometer probe, to



Sea Grant supports engineering and technological research, part of its concern with wise use and development of our marine resources. Here an improved trawl door, developed by the Massachusetts Institute of Technology Sea Grant College, is demonstrated. The partially automated system promises significant safety and time-saving benefits and can be built or adapted for use by fishermen themselves using existing equipment.

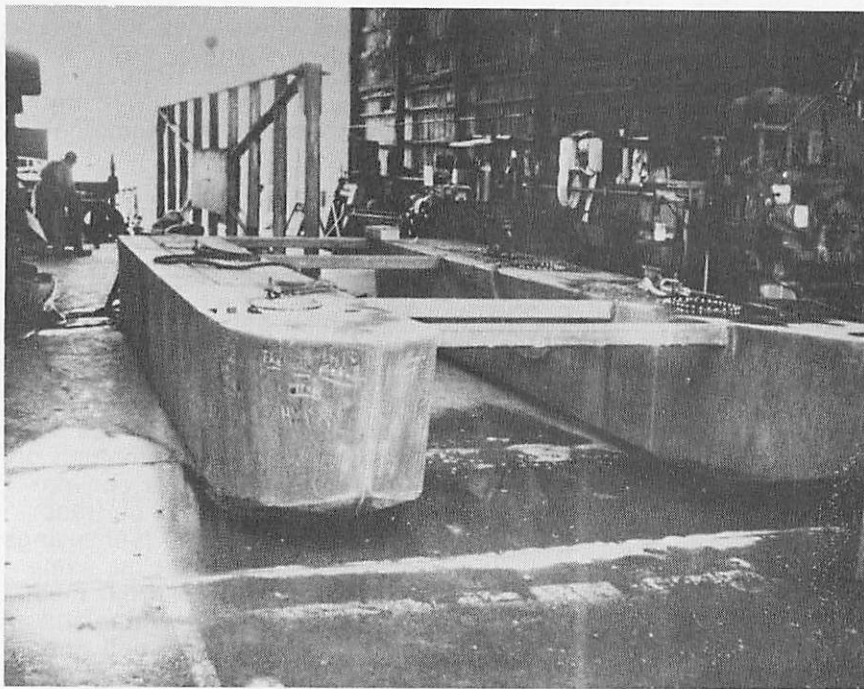
produce one device that will accurately, quickly, and economically provide regulators and structural designers with detailed descriptions of marine soils.

Also at MIT, Sea Grant researchers have produced an improved trawl door, the element of a fishing trawler's gear that holds the fishing net open as it is dragged behind the vessel. Because of its contoured shape, the new door spreads the net using hydrodynamic forces with an estimated drag reduction of 20 to 40 percent over conventional gear. This can be translated into significant fuel savings or larger catches for the same fuel costs. Support from members of the local New England fishing community aided Sea Grant researchers throughout construction and development, and, in 1979, MIT licensed the door to the Massachusetts manufacturer who contributed substantially to the full-scale testing of the door. Improved technology helps the entire industry to capitalize on the new economic opportunities opened to them with passage of the 200-mile limit legislation.

A prototype machine designed and developed at MIT to automatically skin the spiny dogfish shark (*Squalus acanthias*) could help turn an abundant, underutilized species into a desirable and marketable product. The new machine closely follows a series of steps used by hand skinners who now must perform this labor-intensive task.

The machine design was developed after a thorough investigation of the mechanical properties of spiny dogfish shark skin. In the search for a new or special process for skin removal, the researchers conferred with

An offshore sand recovery system is tested by personnel of the University of Hawaii Sea Grant College Program.
Photo by Fred Casclano.



A prototype oil spill recovery unit has been built by a researcher partly supported by the Florida Sea Grant College Program. A belt of foam soaks up oil from the water's surface and is wrung out. The separated oil is stored in two 500-gallon tanks located in the pontoons, and may be reused for some purposes.

seafood processors to learn from their experience in skinning the fish and discussed which features would have the greatest effect on successful marketing of the fish. In collaboration with the National Marine Fisheries Service, MIT Sea Grant is working with fishermen, processors, and machine manufacturers to make the machine an important New England fishery opportunity.

For several years, Sea Grant-supported researchers at the University of Washington have been investigating the application of hydroacoustics to the assessment of fish stocks. Sound penetrates readily through water and can be used directly to estimate the abundance of fish. Their techniques are now being used for assessment and management of many fish stocks, including herring. In fact, techniques were specifically developed for assessing and managing herring stocks using hydroacoustics, and this fishery

which had virtually collapsed now has an ex-vessel value in Washington and Alaska of about \$5 million annually. Also, some 21 State, Federal, and private agencies in the Pacific Northwest are supporting or conducting field investigations using the marine acoustic techniques developed under Sea Grant. The principal target species are the Pacific West Coast hake, Bering Sea pollock, and other pelagic stocks including West Coast and Bering Sea herring.

From 1968 through 1979, the total Sea Grant investment in marine acoustics (including matching) has been less than \$2 million, yet industry and other users on the West Coast alone are spending \$2-2½ million per year for acquiring acoustic data with techniques developed under Sea Grant. Sea Grant's contributions are not only research results, but also include trained personnel from graduates of the program.

The MIT Marine Industry Service (MIDAS) and its Collegium activities are a successful experiment in technology transfer between academia, industry, and government for mutual profit. More than 100 industries and 2 State and 6 Federal agencies participate in the program which provides workshops, conferences, working papers, and publications on MIT's marine-related research. The Collegium serves as a forum where industries convey their specific research needs to the scientists in the MIT Sea Grant community. Last year's meetings covered in-depth discussions of teleoperators for underwater work systems, advances in offshore geotechnical engineering, and wave power systems.

Marine Transportation

Sea Grant has not in the past devoted much of its resources to research in marine transportation systems. However, problems related to energy, supertankers, superports, increasing vessel traffic, hazardous cargoes, navigation, and recreational boating establish the importance of increased work in this field. Sea Grant personnel are working closely with other agencies—Maritime Administration, Coast Guard, Army Corps of Engineers—to assure a minimum both of gaps in research and of duplication of effort.

In FY 78, Sea Grant supported six marine transportation projects, with Federal funding of \$131,400 and matching funds of \$64,900; in FY 79, there were 11 projects with Federal funding of \$230,000 and matching funds of \$85,600. These projects were concerned with navigation, socioeconomic impacts, and cargo movement in the Snake-Columbia River systems; petroleum transport and international trade in the Great Lakes; harbors of refuge in Lake Superior; the port authority's public role; and a path control system for surface ships in channels.

A number of projects classified and discussed in other research categories also are related to marine transportation, including studies on oil spills, harbor management, ice loading of floating docks, erosion, and trade routes.

Examples of increased activity in this research area include: the planned establishment of a Center for Marine Transportation Studies at the University of Southern California's Institute for Marine and Coastal Studies,

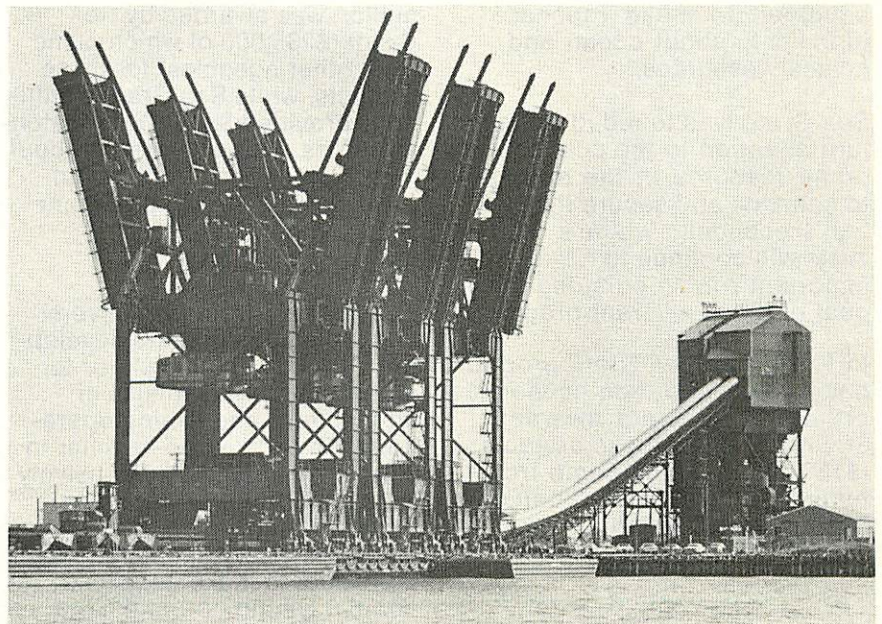
and MIT's 2-year Boston Harbor Management Study, in cooperation with NOAA's Office of Coastal Zone Management.

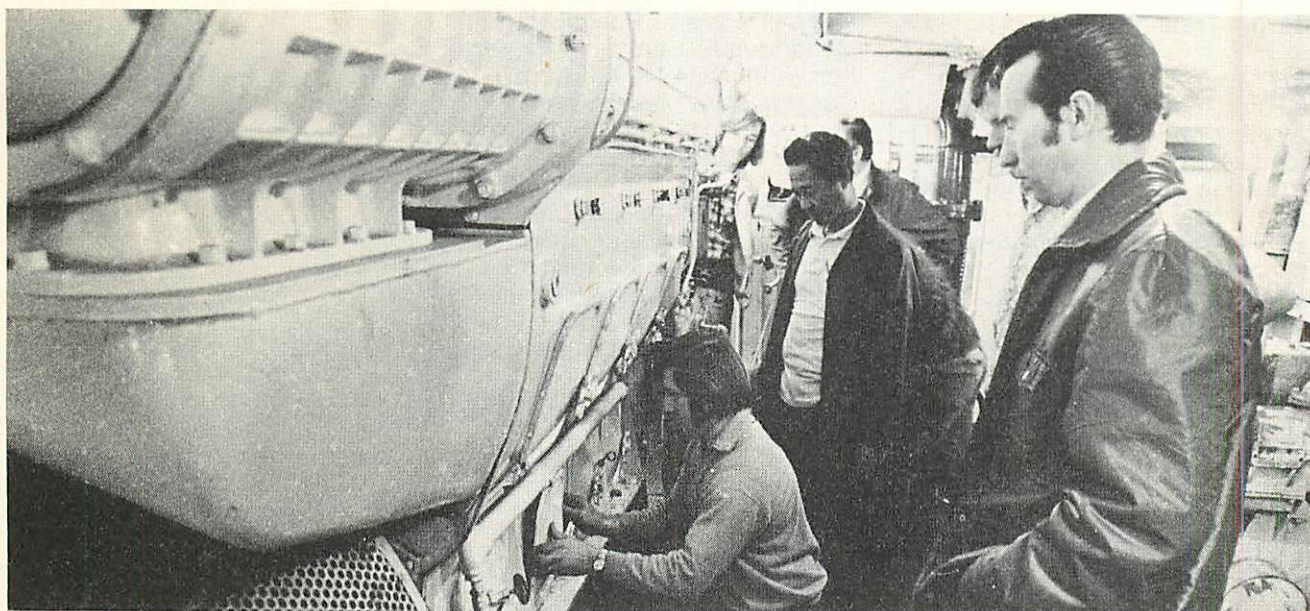
Marine Economics

Sea Grant economists, both in research and advisory services, are studying a wide range of issues in fisheries management and development, aquaculture, marine recreation, coastal zone resources, marine minerals, and marine pollution. From its beginning, Sea Grant has recognized and supported cooperation between economists, other social scientists, and natural scientists, who work together to solve problems of making efficient use of coastal and ocean resources. Using their traditional tools of analysis and developing new ones when needed, economists have made some progress toward understanding the part marine resources play in the economic activities of producing, consuming, and exchanging goods and of managing public resources.

Port development was the topic of discussion at the Sea Grant Association Annual Meeting in New Orleans in November 1977. Shown here is the coal loading facility of the N&W Railroad at Norfolk, Virginia—a major coal export terminal.

Photo by Dixie Galyean, VPI&SU.





Through the Sea Grant advisory service and many other outlets, this knowledge of economic conduct in a complex physical and social marine environment is given a practical value. By having economic information available, businesspeople, entrepreneurs, government leaders, and citizens are better equipped to make rational judgments about ocean and coastal resources.

Sea Grant was founded to help turn attention to the oceans as a prime resource in the struggle to enhance and secure the Nation's economic welfare. Economists will continue to have an important role in pursuing this goal of the Sea Grant program.

In FY 78, the Sea Grant program had 57 active marine economics projects. Sea Grant awarded \$1.74 million for these projects (\$160,000 of which came from other agencies), while Sea Grant institutions provided another

\$975,200 in matching funds. This represents about 5 percent of Sea Grant's total awards in FY 78 and 10 percent of the amount awarded for research projects.

In FY 79, the Sea Grant program supported 55 projects in marine economics. A total of \$1.67 million was awarded by Sea Grant (\$235,000 of which came from other agencies) for these projects, while Sea Grant institutions provided \$845,300 in matching funds. This represents about 4 percent of Sea Grant's total awards in FY 79 and 8 percent of the amount awarded for research projects.

Researchers from five universities are completing the development of a budget simulator for analyzing the economics of aquaculture and fishing operations. The simulator—similar in concept to that used extensively in agriculture—will aid many different users, such as the marine advisory agent helping an individual to make decisions about a fishing operation, the

economist seeking a data source in research, and the student learning the detailed framework of operating a business venture.

With the advent of extended fisheries jurisdiction, the character of international trade in seafoods is changing. Economists at Oregon State University are studying the factors affecting seafood demand in various foreign countries to estimate future trade patterns for Pacific salmon and groundfish. The research is cooperative with researchers in the trading countries under study.

Another change resulting from the extension of national fisheries jurisdiction is the formation of joint ventures between American and foreign fishermen. A study at the University of Washington is analyzing the benefits and constraints for domestic and foreign partners seeking access to economically underutilized species of the Northeastern Pacific fisheries. The study also will analyze joint ventures in world fisheries to identify the

Part of Sea Grant's mission is to train workers in the skills needed by modern marine industries. Here vocational students receive engine room training aboard a floating classroom moored in Seattle's Salmon Bay. The course is offered by Seattle Central Community College and is supported by Washington Sea Grant.

Photo by James O. Sneddon.

effects of these operations on the coastal nation's fishing industry.

The economics of small-scale commercial fishing, with its labor-intensive and geographically dispersed fleets of small vessels, is not well known. A study at Woods Hole Oceanographic Institution addresses the social and economic role of small-scale fishermen in New England, to determine what portion of the groundfish is caught by this group, how that fish is marketed compared to the fish caught by larger commercial operations, and whether these individuals have a substantial impact on the market.

Oregon State University is looking at the economic implications of salmon management policies affecting the mix of wild salmon stocks, stocks cultured in public hatcheries, and stocks released into the ocean from private aquaculture. The expected expansion of private aquaculture and public hatcheries for salmon,

resulting in increased competition for the ocean's carrying capacity, means that managers will be faced with identifying the value of and trade-offs among salmon-related activities.

When an ecosystem has been badly damaged by human activities, can economically feasible rehabilitation efforts be developed? The University of Wisconsin is seeking an answer to this question by examining the recovery of the Lake Michigan trout fishery, which was virtually destroyed in the early 1960's following the invasion of the sea lamprey.

At Oregon State University, scientists are examining how institutional arrangements affect the development of aquaculture. As an example, private salmon ocean ranching in Alaska takes place under a "non-profit" requirement while in Oregon it operates under "for profit" conditions. These different legal structures have stimulated quite dissimilar development with "cooperative" aquaculture firms emerging in Alaska and "corporate" firms in Oregon.

Researchers at Columbia University (New York City), in a cooperative effort with the Bureau of Economic Analysis, are studying the feasibility of constructing an ocean sector in the national income accounts. Initially, the methodology will be developed and used to prepare estimates for 1972, the year of the most recently available Economic Census. If successful, the project will result in a basic tool for measuring the value to the economy of the United States of the ocean sector as a whole and of its various subsectors.

Two projects jointly sponsored by Sea Grant and NOAA's Marine

Minerals Office are studying aspects of deep seabed mining. The development at MIT of a cost model of deep ocean mining will continue. This model is being used at the Law of the Sea Conference to evaluate negotiating positions on financial arrangements. Texas A&M will extend the MIT work by including the effects on the financial performance of mining firms of the primary and secondary costs associated with possible environmental regulations.

Control of discharges to several rivers in Wisconsin poses a difficult regulatory problem because some industries and municipalities need to increase pollution abatement beyond "best practicable technology" to meet water quality standards. A Sea Grant economist and an engineer from the University of Wisconsin are looking at alternative ways of achieving these water quality standards. Specifically, they are investigating the feasibility of implementing a system of transferable discharge permits. Their research suggests that abatement can be achieved at least cost if the additional abatement is undertaken by the most economically efficient treatment plants.

Almost 12 million gallons of oil were spilled accidentally by vessels on United States waters in 1977. The costs to society of small to moderate oil spills are being evaluated, including a look at the technical capabilities and costs of currently used and alternative cleanup systems. Estimates of the benefits of this technology, measured by damage averted, will be made. A survey also will be done of costs associated with actions which reduce the risks of oil spills occurring.



Manned Undersea Research

Major areas of focus in Sea Grant-funded underwater research are diver physiology and safety, resource research, undersea technology, and education. In FY 78, Federal funding totaled \$665,785, with \$348,024 in matching funds; in FY 79, Federal funds were \$989,637 with \$341,364 in matching funds. Twenty-one projects at eight Sea Grant institutions dealt with submersibles, remote sensors and vehicles, human diver physiology and technology, resource research, and education. In addition, either SCUBA or submersibles were used as research tools in approximately 38 projects at 13 institutions.

It is estimated that 100,000 women are currently involved in SCUBA activities, including scientific, sport, and instructional diving. The physiological risks faced by both pregnant and non-pregnant female divers are a major topic of interest in NOAA, the Navy, the commercial diving industry, academia, and others.



The Washington Sea Grant College Program sponsors a course in commercial diving, part of the technician training program at Highline Community College.

Photo by James O. Sneddon.

One study at Texas A&M has demonstrated that there is an increased susceptibility of the fetus to decompression sickness; another study is examining the effects of oral contraceptives on the nitrogen-saturated female diver. At Michigan, an extension of this work will determine the physiologic processes involved in nitrogen retention under hyperbaric conditions. Other physiological and medical aspects of underwater work, deep sea diving, and immersion hypothermia are under study at the Universities of Wisconsin and Minnesota, and critical information on the physics of exogenous gas bubble formation and elimination is being gathered at the University of Hawaii.

A submersible proved to be a unique and effective method of investigating the ecological role of tilefish and the longline gear used to catch them. The four hydroacoustic resource assessment projects at the University of Washington may be successful in assessing fish stocks, and provide considerable improvement in accuracy, timeliness, and efficiency (see section on Ocean Engineering for details).

A combined effort between the University of Minnesota and NOAA's Manned Undersea Science and Technology (MUS&T) Office has resulted in the development, testing, and evaluation of a high-resolution electronic/acoustic triangulation system that could greatly increase the efficiency of archaeological mapping and small scale surveys in other fields. Other technology projects include several at the Massachusetts Institute of Technology (MIT) that are studying communication systems for untethered vehicles and sensors and the application of the teleoperators to underseas tasks.

A diver for the Institute of Nautical Archaeology, Texas A&M University, enters the submersible decompression chamber after completing work on a fourth century wreck.

Photo by John A. Cassils.

Miniaturized underseas radiation detectors for manned submersible operations are being developed at the University of Washington, and a diver engineering study at Wisconsin is concerned with improving life support equipment for underwater breathing in shallow and deep water.

Several Sea Grant institutions have published pamphlets on diving, including "Diving and Fitness," "The Diver's Ear," and "Drugs and the Diver" by the University of Michigan, and "Diving and Smoking" by the Florida Marine Advisory Service.

Plans are underway for involving Sea Grant scientists in underwater habitat programs in FY 1980, as well as using the Marine Advisory Service to relay the latest information on safe diving procedures, decompression tables, and innovative use of mixed-gas.

Public Education and Awareness

The Sea Grant public affairs efforts have these primary objectives: to promote broader public understanding of Sea Grant research, educational, and marine advisory service activities; to improve liaison between the National Sea Grant Office and the Sea Grant Communications Network; and to establish more effective internal communications between the Sea Grant staff, the Sea Grant institutions, and the National Oceanic and Atmospheric Administration (NOAA). To meet these goals, a variety of public relations strategies have been used.

To promote broader public understanding, the office continued its program of grant and feature press releases. The number of

releases produced was increased and heavier concentration was given to feature articles. The most successful topics continue to be those on Dr. Martin J. Nemiroff and his cold water drowning rescue techniques and those on aquaculture, a subject of growing national and international interest. There was some success, too, with a release dealing with the work of Dr. William Fife at Texas A&M University. Dr. Fife is conducting research on pregnant sheep and relating his experiments to pregnant scuba divers. His findings have been supplemented by an international survey of women divers conducted by Margie Bolton in Florida.

Other releases that generated press interest included the vaccinator peg (use of the wooden peg to inoculate lobster against gaffkemia); desalination (wave-powered desalination system); chitin and chitosan studies; medicines from the sea; and International Cooperation Assistance programs.

Underwater researcher Fred Casciano observes a suction probe on the ocean bottom.





Necessary equipment for any diving program is the hyperbaric recompression chamber.

New publications during the year included *The First Ten Years*, an informational, historical accounting of Sea Grant's first decade of operation, and *University Curricula in the Marine Sciences and Related Fields*, a compilation of oceanographic study courses offered in approximately 300 colleges and universities across the Nation.

Following its move in spring 1978 from Texas A&M to Virginia Polytechnic Institute and State University, more than 2500 names and addresses have been added to the circulation list for *Sea Grant '70s*, the national magazine of the Sea Grant program. The new readers are predominantly legislators, teachers, journalists, and students at junior high and high schools, community colleges, and non-Sea Grant colleges and universities. Every

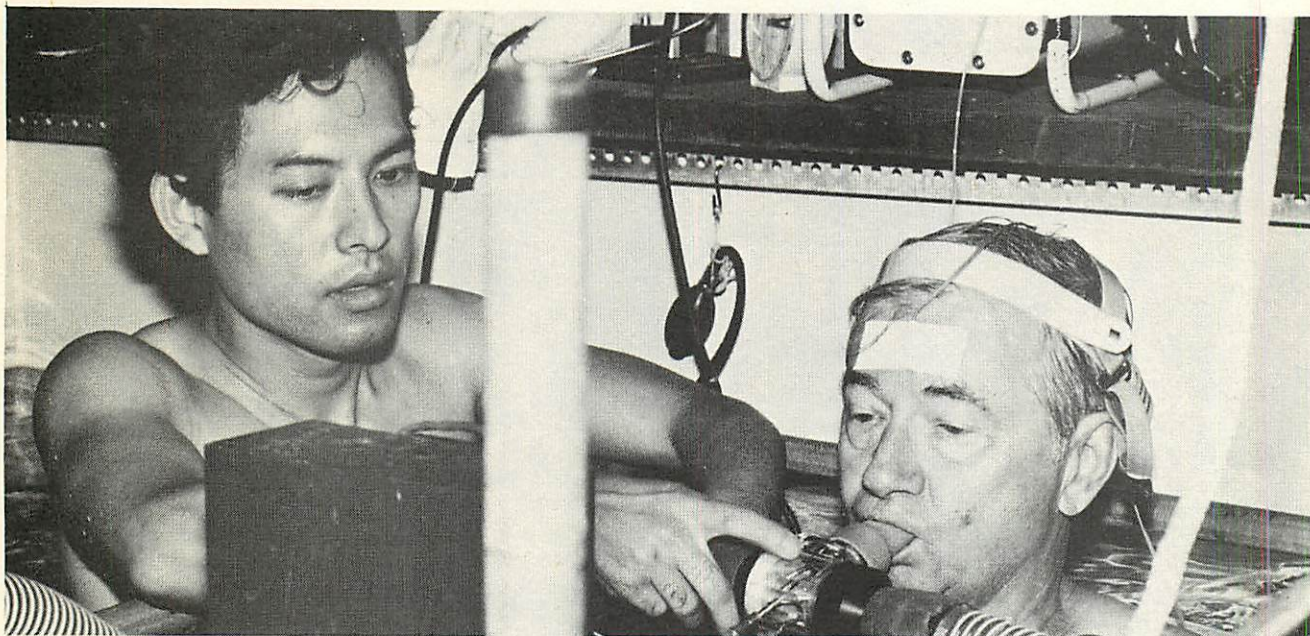
Sea Grant program, and nearly every project, was the subject of at least one feature article during these two years. In 1979, new guidelines for the magazine were distributed, and a redesigned publication titled *Sea Grant Today* will be produced beginning in January 1980.

The Sea Grant Public Affairs staff played a major role in planning and conducting the annual Sea Grant Communicators' Workshop, held at the Ramada Inn in Rosslyn, Va., in April 1979. Host institution for the 3-day event, entitled The Washington Connection, was the University of Maryland. This past year has seen improvements in *Communicators' Update*, a semiannual compilation of Sea Grant Communicators' activities, which was started in 1978. The format of the publication has been changed, and it is being produced more frequently.

Communications by the various Sea Grant institutions include a wide variety of publications, including technical reports, specialized advisory service papers, proceedings of conferences, books and monographs, newsletters, news or press releases—for print, radio, and TV—and audio-visual materials—films, video tapes, slide series.

Some special publication achievements during 1978-79 include:

1. *Alaska Tidelines*, published by the University of Alaska, a monthly publication for the junior high school grades. Each issue is built around a theme—whales, winter water, waterfowl—timed as closely as possible with Alaska's seasons to encourage classroom observation and



While volunteer Russell Stenarud (right) pedals a bicycle underwater, his air consumption, heart rate, and blood pressure are monitored by graduate student Akio Hashimoto. This activity is part of the diving physiology studies at the University of Wisconsin Sea Grant College Program.

activities. Some 30,000 students now receive this newsletter through their teachers.

2. The University of Wisconsin's two-minute *Earthwatch* series (radio) is distributed to the Great Lakes states for broadcast Monday through Friday. It is sent to 110 commercial and educational radio stations and reaches an estimated weekly audience of 2.5 million. Topics include scientific research, Great Lakes issues, land use, marine species, and environmental affairs.

3. The University of Michigan produces a biweekly, 5-minute radio series called *Surfbeat*, which is distributed to 30 affiliates. Topics include general Great Lakes and Michigan Sea Grant information. The University of North Carolina produces a series of 60-second announcements also known as *Surfbeat*. Their program deals with topics of interest to the marine and coastal communities of North Carolina and is distributed to radio stations throughout the State.

4. The University of Delaware has recently released the 19-minute film, "A Seafood Greenhouse," which describes a system for growing bivalve molluscs under controlled conditions. It was named one of the 10 best films of 45 shown during National Oceans Week, 1979.

5. The University of Maine produced "Marine Fisheries of Maine," a sound filmstrip series which describes the work, life styles, and equipment involved in six major New England fisheries: lobstering, gill netting, clamming, seining, scalloping, and trawling.

Sea Grant Depository

The National Sea Grant Depository, housed in the Pell Marine Science Library at the University of Rhode Island, maintains a complete archive of all publica-

tions of all Sea Grant programs. These include reprints, technical reports, conference proceedings, marine advisory reports, and general publications. During 1978-1979, 853 single documents were added to the collection, making a total of 6,379 single documents in the cumulative bibliography. Besides serving as an archive for the National Sea Grant College Program, the Depository functions as a circulating library. There are 19,137 documents in the complete collection, of which 12,758 are in the circulating collection. During 1978-1979, the Depository processed 6,744 requests for information, searches, loans, indexes, xeroxes of publications, referrals, and monthly acquisitions lists. During the biennium, 2,500 single publications were loaned.

Ocean and Coastal Law

In FY 78, Sea Grant supported 31 coastal and ocean law projects with \$724,200 in Federal funds and \$793,500 in matching funds. These projects covered such diverse topics as management of coastal storm water runoff, property rights in the ocean, onshore impact of offshore energy development, recreational access to the Great Lakes, urban waterfront policies, wetlands management, regulation and control of toxic substances, and, of course, Law of the Sea negotiations.

In FY 79, there were 36 projects with Federal funding of \$961,152 and matching funds of \$849,864. In 1979, additional topics of study included jurisdictional and management issues, marina siting, non-point-source pollution in Green Bay, the port authority,

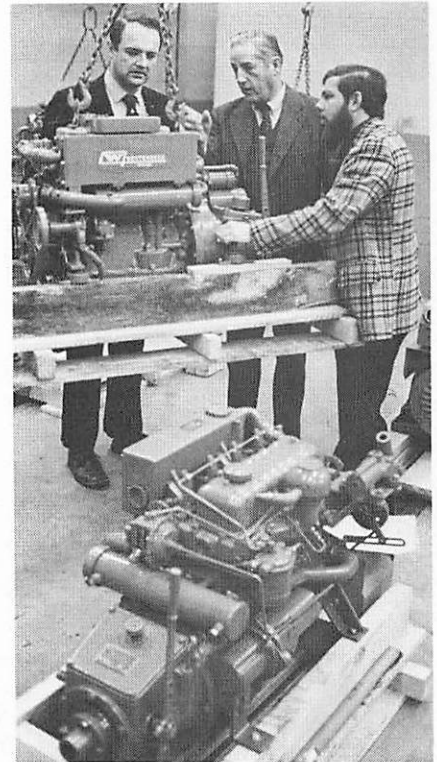
implementing the Toxic Substances Control Act.

In an effort to provide new and stimulating topics for legal research funded by Sea Grant as well as other functions, NOAA's Office of General Counsel (OGC) has expanded the role of the General Counsel's liaison to Sea Grant. In the past, the liaison function has been primarily passively reviewing incoming proposals for ocean and coastal legal projects and encouraging curriculum development in those fields. However, enough programs have developed to a point that they can provide a pool of people trained in such programs who can perform more sophisticated legal research projects, potentially funded by Sea Grant.

To help stimulate and monitor these potential researchers and their projects, the liaison role has been expanded to include active involvement in the entire process of Sea Grant proposal review, approval, and interim and post-project evaluation. This function includes soliciting worthwhile project topics, identifying those of particular interest to NOAA, and disseminating this information to potentially interested researchers. It would also include an effort to identify means of involving more minority persons and women in marine-oriented research.

Marine Recreation

The major emphasis of marine recreation-related research projects has continued to be on participation characteristics, resource and economic impacts



One popular course offered by the University of Rhode Island's Marine Advisory Service is the recreational boating diesel engine workshop, started by Marine Recreation specialist Neil Ross (left). Westerbeke Diesel donated this engine for use in the instruction. Photo by Robert J. Izzo, URI.



Dr. Rita Colwell (left), an internationally recognized marine microbiologist, became the first woman to be appointed a Sea Grant Director. Head of Maryland's Sea Grant Program, Dr. Colwell, who has continued her research activities while serving as Director, here discusses a project with faculty research assistant Tamar Barkay.

of sport fishing, and recreational boating. Although there remains a major emphasis on the resource aspect of recreation, additional effort has been directed to the sociopsychological aspects of recreation.

Due to the paucity of baseline information available for assessing marine recreation development potential and the relationship of recreation to other marine and coastal uses, Sea Grant research has been a major aid to public and private recreation developers and managers. In many instances, Sea Grant research has provided the information necessary for making recreation planning and development decisions.

Sea Grant-funded studies have looked at such varied topics as the impact of off-road vehicles on dunes, the relative impact of netting as compared to sport

fishing on estuarine species, tourism in the Great Lakes, movement patterns of salmonids, and even an assessment of an underwater park preserve in the Great Lakes.

Social Sciences

The social sciences have always been integral to the Sea Grant concept. Participants in planning and writing the legislation emphasized that prudent and orderly development of the Nation's water resources could not depend solely on the traditional natural and physical sciences, but also required the talents of economists, urban and rural planners, lawyers, political scientists, and anthropologists. In other words, the behavior and life history of the people who make their living in an industry based on fishing are of as much intrinsic scientific interest, and are as amenable to scientific analyses, as are the population dynamics or life history analyses of a migratory fish species to the fisheries biologist.

The social science community is primarily responsible to demonstrate specifically the ways in which quality marine-related social science research can clarify values, improve public policy on the oceans, and educate students in ocean affairs. The National Sea Grant Program has the responsibility to insure that the marine affairs community develops to a point where it effectively can fulfill its responsibilities. Sea Grant is the only Federal program specifically designated to support marine-related social science.

Affirmative Action

Because of its recognition that only a small number of minorities participate in marine and ocean related research, Sea Grant has pursued an active effort to develop a greater interest in marine-related professions among minorities, women, and the handicapped and to involve more minority participation in the management of the program. Major accomplishments during FY 78 included grants to the National Association for Equal Opportunity in Higher Education to support a conference of minority college officials, to the University of South Carolina to introduce several minority institutions to marine-related curricula, to the University of Maryland (Eastern Shore) to develop a fellowship program for minorities and women to enter the

marine sciences as professionals and technicians, and to Louisiana State University (Southern University)—a minority institution—for a production-oriented ecological study of commercial crawfish ponds.

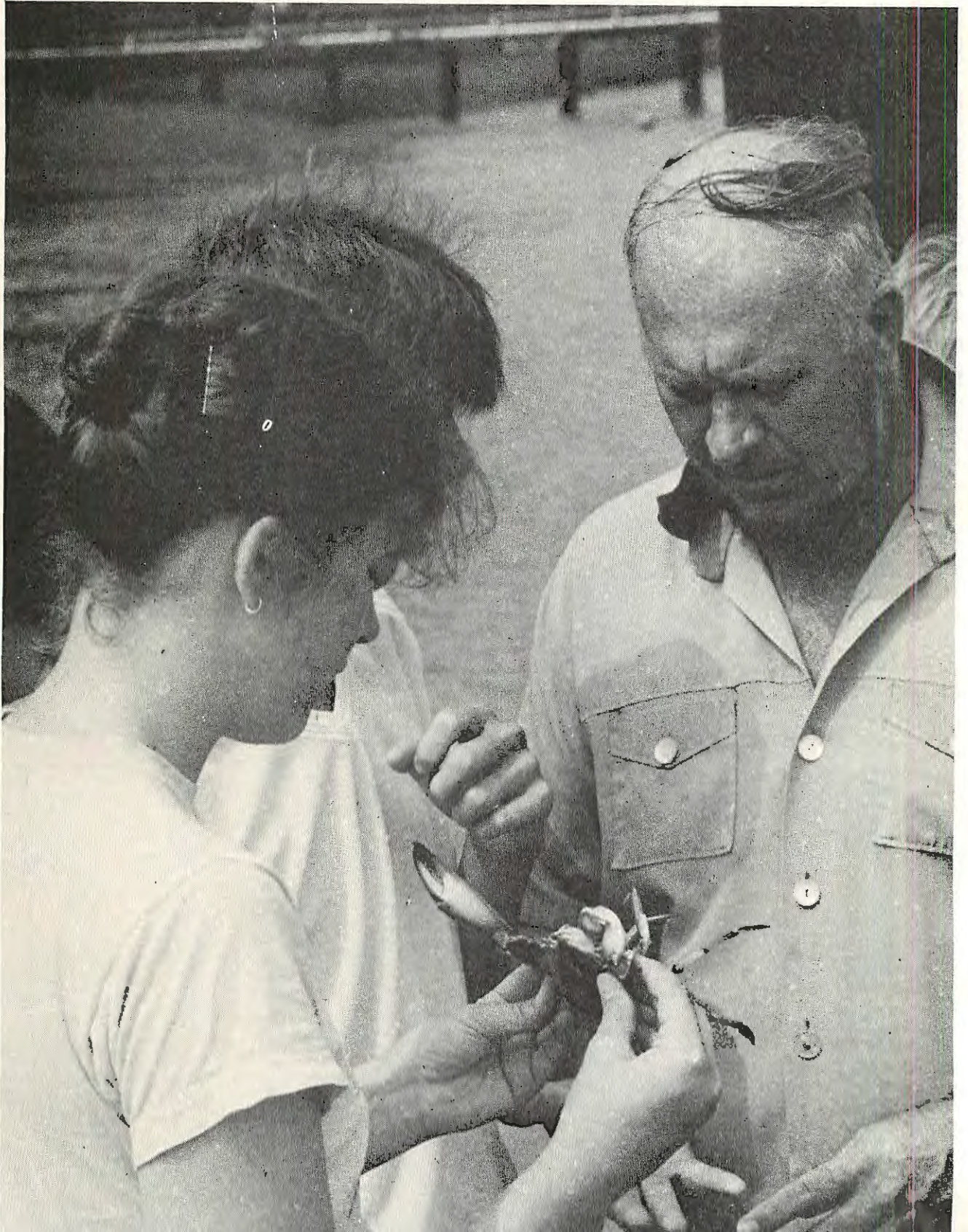
Two minorities and one woman were members of the Sea Grant Review Panel during this period, bringing to five the total representation on the 15-member panel.

In other activities, Sea Grant involvement included testing new teaching materials in Detroit public schools; preparing a Spanish glossary and teaching materials in Los Angeles, a familiarization project called "Please Go Near the Water" for minority youth in New York City, and other projects in Mississippi, South Carolina, and Wisconsin.

A minority high school student, supported by the New York Sea Grant Institute, entered the Nationwide Science Competition in Cleveland and was selected as grand prize winner at the Student Exposition on Energy Resources in New York.

During FY 79, the council of Sea Grant Directors formed an Ad Hoc Committee on Women and Minorities to provide leadership and to monitor progress in the development of these human resources. Among the directors, there are one minority (Asian-American) and two female Sea Grant Directors.

During FY 79, Jackson State College was admitted to membership in the Mississippi-Alabama Sea Grant Consortium. Its admission, along with that of Tuskegee Institute and Talladega College, marks the participation of three minority institutions in that program.



At its inception, the Sea Grant education and training program concentrated on developing specialists with skills to develop and manage marine resources. Emphasis was on graduate-level professional training, community college technician training, and occasional courses in specialized 4-year undergraduate areas.

The Marine Advisory Service education thrust followed with emphasis on translating research findings to the user community outside school and institutional settings. The target audiences were adults in marine-related business and industry, and school-age youngsters in groups such as 4-H clubs and Scouts.

The next education thrust was specific, funded material development projects for elementary and secondary levels. Thereafter, Sea Grant began deliberately to explore ways to provide general education about marine affairs to elementary and secondary level students in public schools as well as to undergraduate college students.

In FY 79, most of the Sea Grant education and training dollars continued to support the program area devoted to the development of specialists with skills



Milwaukee biology teacher James Williams, Bell Junior High School, helps a student with her fish respiration experiment, part of the Great Lakes Summer Education Project of the Wisconsin Sea Grant College Program, July 1978.

"Look out for those claws," advises Marine Education Specialist Will Hon as he explains the development and growth process of a blue crab to 4-H Club members participating in an oceanic education program at Skidaway Island, sponsored by the Georgia Sea Grant Program.

Photo by Jim Elliott.

for marine careers. Federal funding, excluding international projects, totaled \$2,884,917. In FY 78, excluding international projects, Federal funding totaled \$3,006,701.

The key activity for the Program Director for Education in the Office of Sea Grant for 1979 was to nurture general education through formal school systems (Kindergarten and grades 1-12) and related teacher training and to develop a closer working relationship with the U.S. Office of Education. To advance marine education, the goal for general education in schools was delineated, and a strategy to reach that goal was developed and pursued.

The goal of marine education in schools is the development of a marine-literate populace through the infusion of marine affairs in all discipline areas at all grade levels. Teachers would teach the same courses and concepts they currently teach, but they would have marine affairs woven in equal fashion to the land affairs that now dominate curricula.

The strategy to forward marine education in the schools has come to fruition, in that functional relationships now exist on three fronts: in Washington, D.C.; within the Sea Grant Network; and with professional educators' organizations. A sampling of the results of development of these relationships follows:

- Washington, D.C.: The United States Office of Education/Department of Education created a marine education unit. The Federal Interagency Committee on Education, Subcommittee on Environmental Education, created a Marine Education Task Force which Sea



One of the wonders of the deep—a starfish regenerating a foot—is carefully examined by a young student in an oceanic education class.

Grant chairs. Other funding agencies, such as the National Science Foundation and the United States Office of Education/Department of Education, are expected to increase the money they spend on marine education. However, Sea Grant will continue to play its role in catalyzing, developing, and piloting new and unique approaches to marine education throughout the educational continuum.

- Sea Grant Network: Communications have been increased significantly among educators within the Sea Grant programs and among educators and the advisory and research components of their Sea Grant Programs. Sharing of expertise and

mutual projects has been undertaken in the belief that when students become more marine-literate, they will become more aware of the potential for wise use of the marine environment in their daily lives. In addition, they will develop the ability and will be encouraged to make realistic assessments of the desirability of seeking training in skills that would prepare them for jobs in the marine field.

- Professional Educators' Organizations: The Council of Chief State School Officers (CCSSO) issued a policy state-

ment encouraging the States to engage in and promote marine education. The CCSSO created a network of Marine Education Coordinators from State education agencies across the Nation.

Sea Grant activities during 1979 have created an infrastructure in the American education system that is poised to respond to the need for marine education toward a literate populace. Federal and State agencies which fund education have been sensitized to the need for marine education. The structure exists to encourage local education agencies to engage in marine education. These groups are the ones to assume leadership in the continued growth and maintenance once Sea Grant initiates the activities. In addition to investing money in projects for use in school systems themselves, additional teacher training activities sponsored by school systems and by institu-

tions of higher learning are considered necessary. Pre-service and in-service teacher education needs attention, also.

These publications were produced by the Office of Sea Grant in the past year:

1. *The Sea Grant Education Initiative for K-12 and Related Teacher Training*
2. *Proceedings of the National Sea Grant College Program Marine Educators Leaders' Meeting, February 21-22, 1979*
3. *Conceptual Framework for Marine and Aquatic Education*
4. *Proceedings of the National Sea Grant College Program Marine Educators' Meeting, August 12-13, 1979*
5. *Outreach: Creating a Marine Literature Populace—The Sea Grant Marine Advisory Service and Marine Education Interface With The Community*
6. *Marine Education in the National Sea Grant College Program*

Nearly a quarter million visitors each year use the public wing of Oregon State University's Marine Science Center. Some experience the thrill of touching—and understanding—sea creatures like this spiny sea urchin. Others come for meetings, training sessions, and workshops. Don Giles (left), Oregon State Extension Marine Science Education specialist, conducts graded, programmed learning sessions for more than 13,000 school students annually.

Photo by Oregon State University.



A key factor in the success of the program was the program director's interaction with scores of people in professional educators' organizations. That activity involved 14 formal presentations to professional groups to emphasize the need for marine education, the sponsorship by Sea Grant of two intense workshops for educators from across the U.S. to assess the status of marine education and to develop methods to infuse that subject into U.S. school systems.

Fellowships

Guidelines for the Sea Grant Fellowship Program, mandated in the 1976 legislation (P.L. 94-416) were published in the April 11, 1978, *Federal Register*. The program provides educational assistance to qualified individuals at undergraduate and graduate levels in fields of study related to ocean and coastal resources, particularly to persons who would not otherwise be involved in marine resource activities, including women, minorities, and the handicapped. For example, a graduate student in biochemistry would, under this program, be encouraged to apply his or her biochemical knowledge and skills to work on a marine biochemical problem or question. Fellowships are not awarded directly to stu-

dents by the Office of Sea Grant; rather, the institutions that receive fellowship grants select the fellows and manage administration of the fellowships.

In FY 78, there were six such projects, with a funding total (Federal) of \$112,500; in FY 79, there were eight projects, with a Federal funding of \$147,880.

Marine Advisory Services

The Marine Advisory Service (MAS) is the outreach arm of the Sea Grant Program. The Marine Advisory Service function includes the informal education of marine audiences, providing technical advice and instruction, identifying and communicating user needs to researchers and managers, and disseminating research findings aimed at solving user problems. The methods used may include publications, conferences and seminars, mass media, and personalized extension services.

The Marine Advisory Services within Sea Grant closely cooperate with the Cooperative Extension Service of the Department of Agriculture; currently 19 Marine Advisory Service programs are closely aligned with the cooperative extension programs of 19 states.

Sea Grant supports 30 Marine Advisory Service programs. In FY 78 the Federal funding total was \$7,936,557, with matching funds of \$4,941,467; in FY 79 Federal funds totaled \$9,190,969, with matching funds of \$5,827,110.

There is a MAS in Puerto Rico and in every coastal and Great Lakes State except Indiana, Illinois, and Pennsylvania. Virginia and California each have two Sea Grant-supported advisory programs. Where two programs are present in a State, unique expertise and mutual communication and cooperation eliminate duplication of effort. There are also three regional programs—the Pacific Sea Grant Advisory Program (PASGAP), the New England Marine Advisory Service (NEMAS), and the Great Lakes Network. PASGAP is administered by a designated State advisory program which changes periodically. NEMAS is



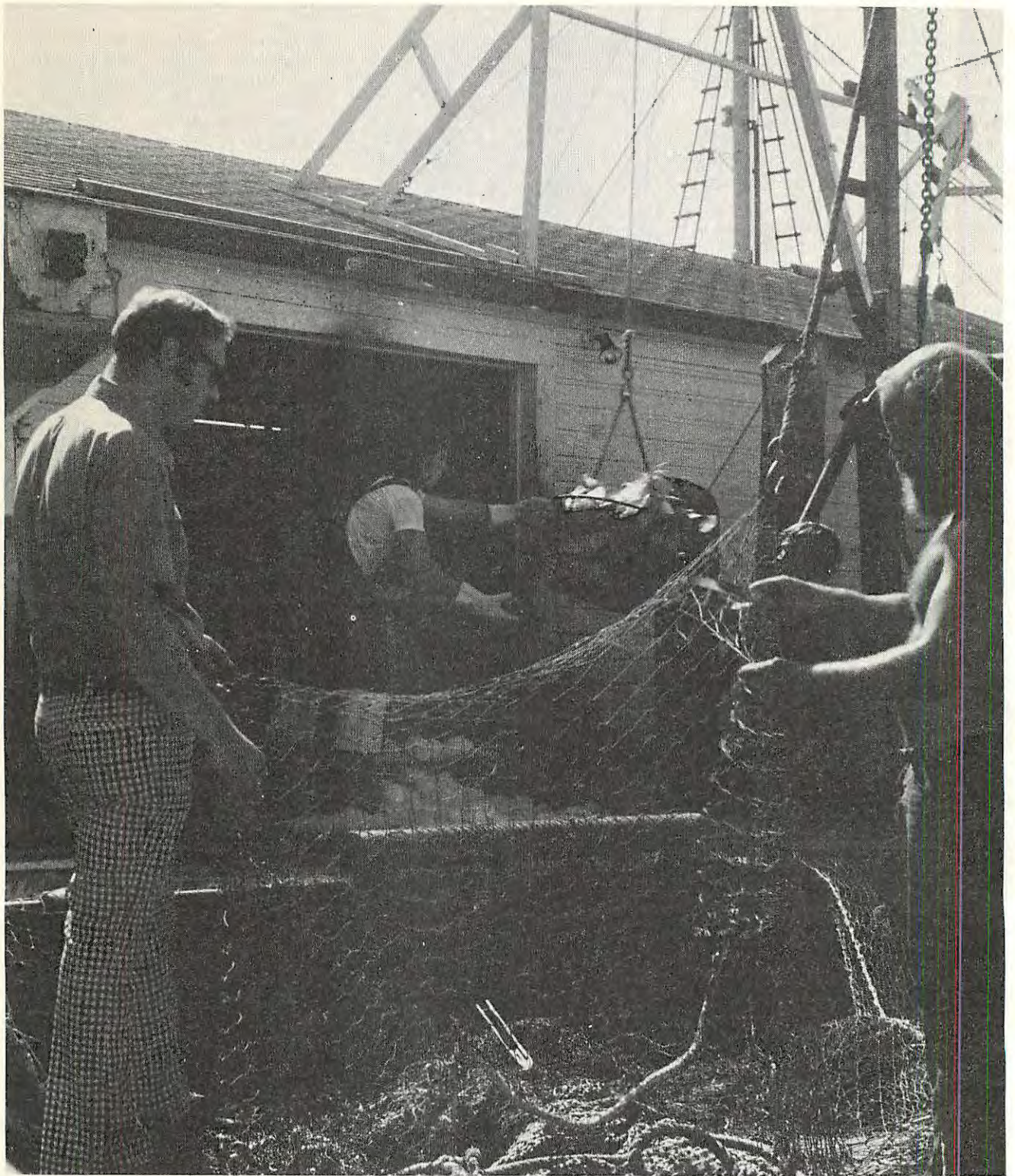
Florida Marine Advisory agent Leigh Taylor Johnson discusses Florida Sea Grant advisory bulletins with Cap'n Bob, who owns and operates a marina in Port Canaveral.

Photo by Victoria S. Howarth, VPI&SU.

administered by a fulltime individual who reports to a governing "Board of Directors" comprised of Sea Grant people and others from the region. The Great Lakes Network has been funded through each of the Great Lakes' institutions, but will change in FY 80 to the same administrative procedure as PASGAP. PASGAP, NEMAS, and the Great Lakes Network were created to marshal regional expertise for addressing identified regional needs and to provide support for accomplishing those projects through such means as talent exchange and regional training.

Although Advisory Service programs vary considerably in size, organization, and administration, they are similar in philosophy and methods of operation. The advisory programs address the needs of identified audiences with person-to-person (for example, on-the-waterfront) communication; their personnel include both specialists and field agents. Specialists tend to be responsible for particular subject areas Statewide, with varying degrees of field contact. Field agents have more diverse subject area responsibility, are primarily given geographic responsibility, are located in coastal communities, and work with specialists when particular expertise is needed. Both specialists and field agents are encouraged to use technical or informational resources, in or out of their parent organizations, to meet audience needs.

Nationally, advisory service programs are involved in many subject areas in which Sea Grant supports research as well as in areas outside the current realm



of Sea Grant research. Subject area diversity and emphasis varies from program to program. The broad subject areas emphasized nationwide are: commercial fishing and gear technology; seafood processing, marketing, and utilization; marine recreation; marine science education; aquaculture; marine transportation; coastal zone management; and marine mining.

In Alaska, the MAS helped develop a seafood processing sanitation system which was instituted in 10 Alaska plants, and also worked with industry to formulate the first hard shell clam fishery plan that was found acceptable by both industry and regulatory agencies.

For several years, Washington Sea Grant has supported Bellingham Vocational-Technical Institute (BVTI) in developing a prototype major evening program of marine short courses. "Marine Short Course: A Notebook" has just been published to make BVTI's "how to" information and lesson plans available to other Sea Grant programs.

At Oregon State University, MAS and NASA are involved in a 2-year joint effort to determine the best way to provide salmon and coastal fishermen with weather information that they may need to decide when and where to go

fishing. The sea level weather information is obtained from a satellite.

An unusual and far-reaching affirmative action effort at the University of California was the production in seven Asian languages of a summary of California regulations protecting tide-pool life, designed for the benefit of the many Asian immigrants now in the State who are accustomed to foraging beaches but unfamiliar with protective regulations for marine life. Translations were obtained from the Long Beach Asian Family Outreach Center, and 20,000 copies of the pamphlet were distributed through Asian Refugee Assistance Centers throughout California.

The University of Southern California Marine Advisory Service produced the first publicly available comprehensive review of the regulatory procedure of the California Coastal Commission. Intended for land developers, architects, lawyers, and public officials, the monograph contains extensive legal citations and a large removable flow diagram.

In addition, it is preparing a national directory of scientific personnel who may be consulted for information on specific topics, with the name and phone number of the Sea Grant communicator, to be used by media personnel either in pursuing general interest stories or in following up on marine-related news items.

The MAS program at Hawaii has a cooperative and highly successful program with the Department of Education to instruct teachers in drownproofing techniques, an improved method of staying afloat in open water.

The Texas Legislature appropriated \$300,000 to Texas Parks and Wildlife for an interagency contract with the Marine Advisory Program to conduct a seafood marketing program from commercial fishing license fees. In addition, the Marine Advisory staff has been monitoring movement of the Mexican oil spill.

A survey by Dr. Kenneth Roberts revealed that underwater obstructions in Louisiana waters cost shrimpers of the State almost \$4 million in lost trawls last year. Roberts' information figured prominently in testimony that contributed to passage of State gear compensation legislation. In addition, a MAS pilot project on location and mapping of underwater obstructions in St. Bernard Parish so impressed the State Office of Coastal Zone Management that it funded a Statewide mapping effort through the Louisiana Fisheries Federation.

A major activity which has drawn wide acclaim has been Mississippi's efforts to help with the indoctrination of Indochinese refugees coming to the United States. Training programs, offered to both Vietnamese and native American fishermen, have improved significantly relationships between people of the two vastly different cultures. In Texas, a special project also has begun to generate information on the numbers, location, and problems associated with resettlement of Indochinese refugees in Texas. The Marine Advisory Program staff has cooperated with Trans-Century Corporation, the consulting firm involved in developing a report for the Department of Commerce.

A University of Rhode Island Extension agent (left) lends a hand down on the Zaillee docks.

Photo by Seabrook Hull, URI.

In Alabama, the problem of disposal of seafood wastewater is a major concern of the residents of the City of Bayou La Batre and of its seafood processors. The advisory service began and coordinated a project to provide an alternative treatment system using spray irrigation techniques to spread shrimp wastewater over a salt marsh. The pilot system has been reviewed by the staff of the Alabama Office of State Planning and Federal Programs, and a formal project proposal is being presented to EPA for funding. This wastewater treatment project has national implications.

More than 120,000 people visited the University of Minnesota exhibit at the Minnesota State Fair, many of them learning about Sea Grant and Lake Superior from *Lawrence the Talking Lake Trout*. Lawrence is an animated, electronic fish whose mouth action is coordinated with the voice of a person coming over a tape recorder or a microphone in a live presentation.

Michigan's Expanded Nutrition Extension Program, designed to incorporate representatives of low-income households in demonstrating to their peers the advantages of family nutrition, cooperated in developing a MAS-supported project to educate and train teams of individuals in the nutritional preparation of underutilized species of fish from the Great Lakes. A human nutritionist developed materials and presented workshops in west, central, and southeast Michigan counties to train minority representatives in the use of underutilized species and to teach demonstration methods which the participants could use in their own neighborhoods. One of the specialties of this program was the use of an interpreter to

repeat the lessons in Spanish. The materials developed for these training experiences will now be used in training additional groups of householders in any county desiring the program.

In 1979, the Wisconsin Department of Natural Resources carried out the first stocking of 250,000 lake trout fingerlings on a natural spawning reef in Lake Michigan's Green Bay. Sea Grant Advisory Services had recommended the procedure based upon Sea Grant research on salmon homing and spawning habitats and the identification of important spawning sites. In addition, a marine agent joined University of Wisconsin researchers in underwater travels with a diver propulsion vehicle over Lake Michigan reefs in search of lake trout spawning sites.

The Ohio MAS formed a committee of sport and commercial fishermen, Sea Grant personnel, and personnel from the Ohio Division of Wildlife (ODW) to attempt to resolve conflicts between sport and commercial

Minnesota Sea Grant Extension Agent Thomas C. Mack is the voice for a radio broadcast of "Lake Superior Recreation Report," one of the kinds of information services provided by several Sea Grant programs for the general public.
Photo by Ryck Lydecker, U. Minnesota, Duluth.





Marine Advisory Program Leader for Mississippi, C. David Veal, discusses Gulf fisheries activities with a constituent.

fishermen, sport fishermen and ODW, and commercial fishermen and ODW.

The MAS "Hazards Awareness Project" at the University of Florida made considerable headway in promoting interagency cooperation and public awareness in disaster preparedness and public education.

Cleanup methods developed by Georgia advisory agents for a major shrimp processing plant saved that company approximately \$225,000. The procedures and principles were published in a bulletin which was purchased by the National Fisheries Institute for distribution to its member plants. It was also sent to plants on the inspection list of the U.S. Department of Commerce, National Marine Fisheries Service, and has been used by several Sea Grant programs.

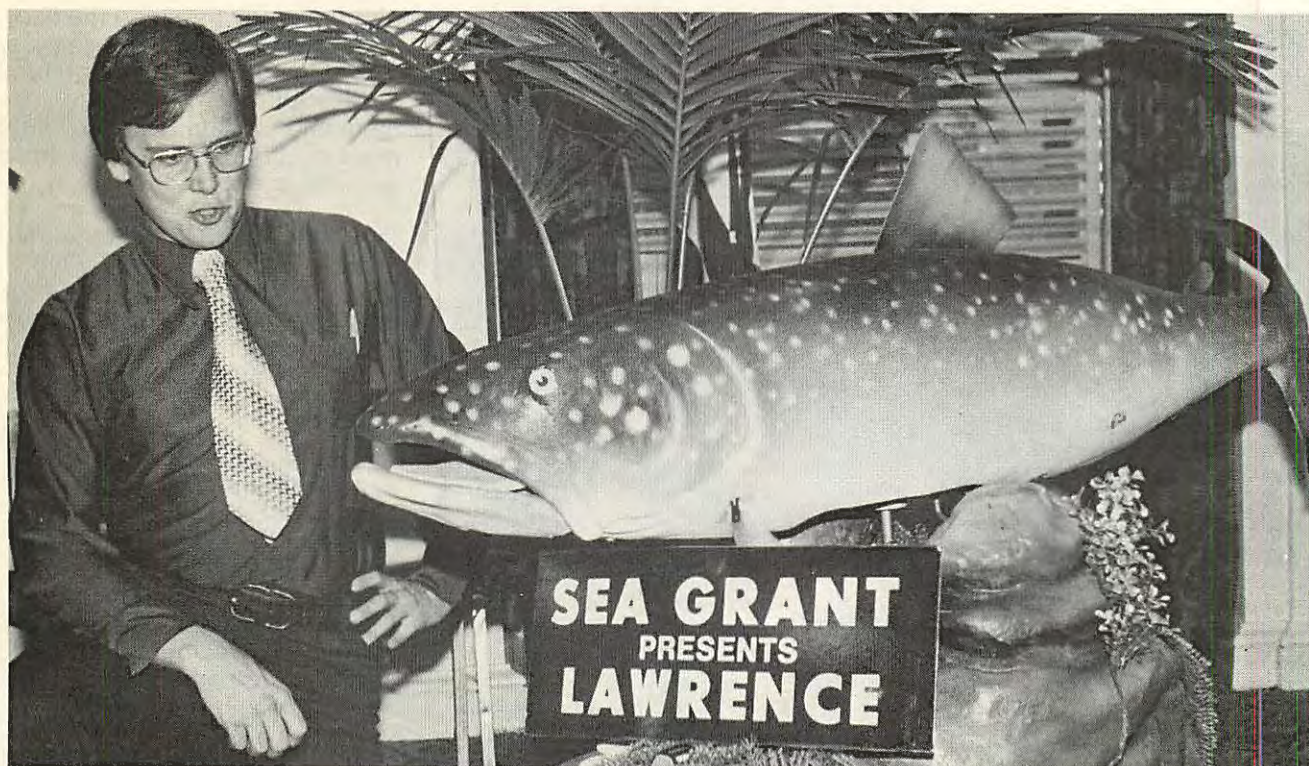
Virginia Institute of Marine Science (VIMS) has conducted a Mid-Atlantic pair-trawling demonstration designed to employ existing fishing vessels in offshore underutilized fisheries. In

addition, they provided the fishing industry, potential investors, city planning agencies, and funding institutions with an employment and economic impact statement of Virginia's offshore trawl and sea scallop fisheries.

The VIMS/MAS expanded its Sea Grant-sponsored Marine Education Materials System for national use. To date, there are 21 distribution centers throughout the country for marine-related educational material.

A national program developed by agricultural economists and food scientists at the Virginia Polytechnic Institute and State University, in cooperation with the National Association of Retail Grocers in the United States (NARGUS), was begun to train retail seafood managers. Three training programs were presented in Pennsylvania, and others will be added in the future. NARGUS is the largest association of independent food retail chains in the United States.

In addition, Virginia Polytechnic Institute and State University's MAS developed a training manual and series of consumer publications (approximately 50) for EFNEP (Expanded Food and Nutrition Education Program) technicians on the use of fish and shellfish by low-income families. The Department of Agriculture, which directs the program, had not been able to provide the appropriate support materials in this area.



Using his fishiest voice, Minnesota Sea Grant Extension agent Bruce Munson converses with LAWRENCE, The Lake Trout, who has been giving out finny secrets of the deep to students, state-fair attendees, and even Congressmen since his debut at the Minnesota State Fair in 1978.

Photo by Jim Elliott.

The "Strange Seafood Spectacular" was a coordinated extravaganza among Hampton Mariners Museum (Beaufort), North Carolina Marine Resources Centers, and the Sea Grant Advisory Services. Approximately 28,000 people participated and enjoyed unusual seafoods, such as rock shrimp, octopus, eels, and conch.

The South Carolina MAS acted as the link between commercial fishermen and the U.S. Public Health Service to establish contract facilities in Georgetown and Beaufort for free medical care for fishermen. The South Carolina Sea Grant Advisory Bulletin, "Q & A About Free Medical Care," is being considered for publication and national distribution as a joint Public Health Service, NMFS, and Sea Grant effort.

Major TV and newspaper coverage of New York's MAS demonstration on using underutilized fish resulted in an increasing demand for shark. With advisory service assistance, the Shinnecock Indians received a \$295,000 solar-heated hatchery grant.

The New Jersey MAS worked with a group of offshore fishermen to set up a telecomputer system that gives fishermen current isotherm charts from weather satellites. It also produced a report on the findings of the contaminants panel of a major symposium on the ecological stresses of the New York Bight area, which it co-sponsored with MESA (Marine Ecosystems Analysis Program) and New York Sea Grant.

The Delaware MAS sponsored "Coast Day" at the Marine Science Center in Lewes that highlighted Sea Grant research activities and attracted some 6,000 people from Maryland, Pennsylvania, and Virginia as well as Delaware.

A vocational-educational program aimed at watermen's children was developed in a cooperative effort between the University of Maryland MAS and the Talbot County School System. This program integrates formal education with hands-on technical courses that prepare students for careers as watermen.

Based on the success of a Scottish seining demonstration and the availability of followup information from the University of Rhode Island MAS program, an increasing number of East Coast fishermen are adapting the technique. In addition, a Red Tide poster and accompanying fact sheet was written for distribution throughout the New England MAS network. Designed to prevent panic among cruising boaters while still encouraging the eating of shellfish, the popularity and format of the poster and fact sheets have encouraged the Coast Guard to express an interest in having MAS produce a similar publication for it to print and distribute nationally.

The Massachusetts Institute of Technology MAS was involved in a Joint Marine Fisheries Education and Training Program with the Massachusetts Maritime Academy. More than 200 fishermen have taken courses with great success; as a result of the acceptance of this program, the State has budgeted \$92,000 as matching funds. The program is now being expanded to schools in other parts of the State. The advisory service is also taking the research results of the Red Tide project and getting the screening and identification procedures to the State Public Health Department and local shellfish wardens.

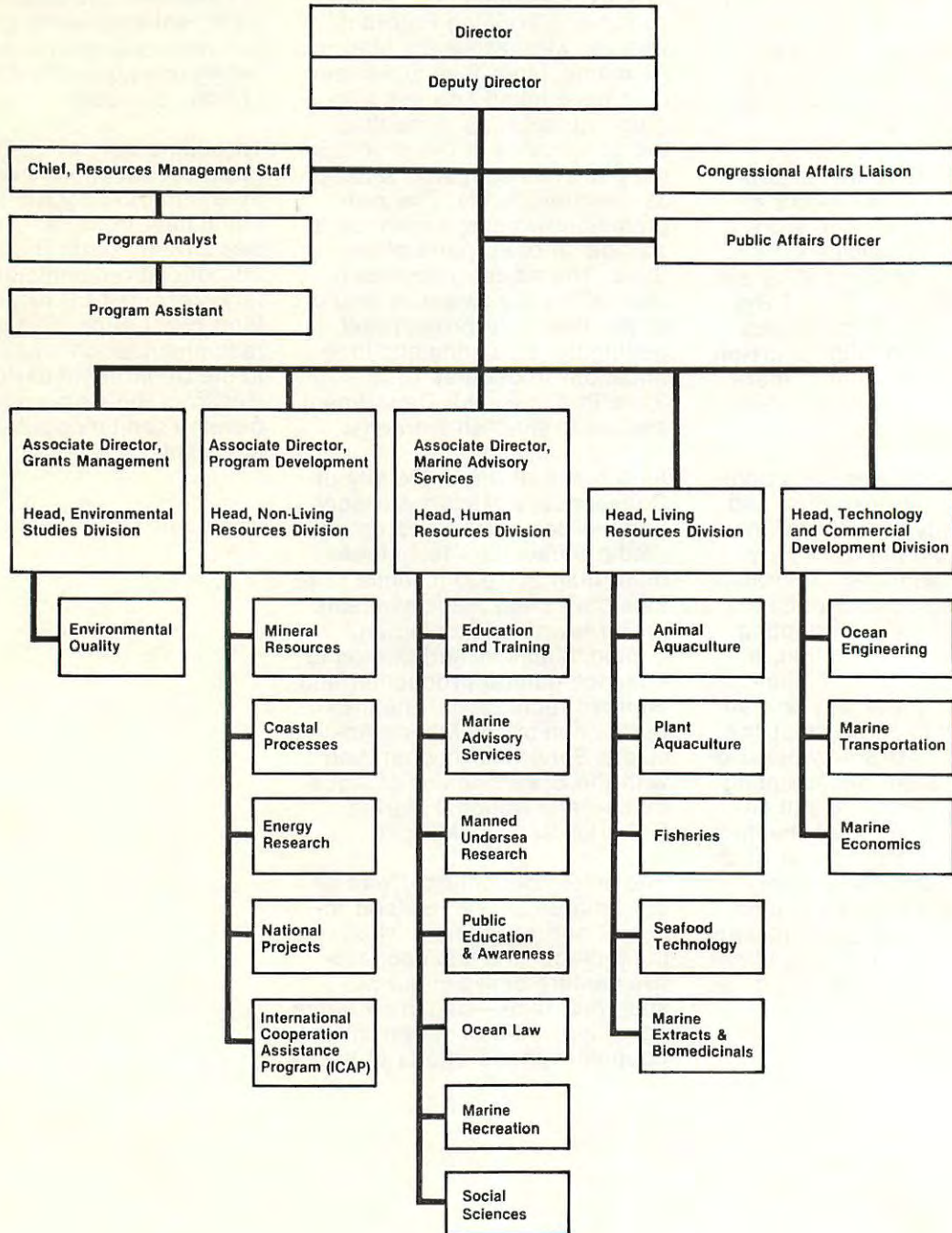
As a result of the University of Connecticut's Marine Advisory Service demonstrations on scientific aquaculture techniques, more than 200,000 juvenile scallops have been made available to the towns of Stonington, Groton, Madison, and Clinton to enhance natural production and improve recreational shellfish production by the Marine Advisory Service in cooperation with the State Division of Aquaculture and National Marine Fisheries Service, Milford.

The edible blue mussel was all but ignored by the seafood industry and consumers when the project—the first cooperative venture between the two state programs—began six years ago. Five years of research coupled with the efforts of the

New Hampshire-Maine MAS has resulted in a 20-fold increase in consumer demand, encouraging entrepreneurs to begin culturing, harvesting, and marketing this abundant and underutilized mollusc.

Through a very intensive program of education developed by the marine agents and with initial help from Texas A&M Sea Grant, Puerto Rico's MAS introduced recommended sanitary measures for fish and seafood processing plants. The recommendation was provided to the Department of Public Health of the Commonwealth to develop sanitary guidelines for the plants.

OFFICE OF SEA GRANT



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- Robert D. Wildman Deputy Director and Head, Living Resources Division
- Arthur G. Alexiou Associate Director, Program Development and Head, Non-Living Resources Division
- Richard C. Kolf Head, Technology and Commercial Development Division
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- George M. Knobl* National Marine Fisheries Service Liaison with Sea Grant
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** Part-time assignment to Sea Grant.*

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- Joyce Kinnard – Secretary to the Deputy Director
- Geraldine Taylor – Secretary, Environmental Studies Division
- Christine Thom – Secretary, Non-Living Resources Division
- Barbara Montgomery – Secretary, Non-Living Resources Division
- Jackie Turnage – Secretary, Human Resources Division
- Barbara Rotondi – Secretary, Human Resources Division
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Sea Grant**Review Panel 1978**

Dr. George S. Benton
Professor of Meteorology
Dept. of Earth & Planetary
Sciences
Johns Hopkins University

Dr. Lynton K. Caldwell
Department of Political Science
Indiana University

Honorable Alton A. Lennon
Wilmington, North Carolina

Dr. Randolph W. Bromery
Chancellor
University of Massachusetts

Dr. Joseph N. Busby
Gainesville, Florida

Dr. Bernard Le Mehaute
Senior Vice President
Tetra-Tech, Inc.
Pasadena, California

Dr. Lyle S. St. Amant
Assistant Director
Louisiana Wild Life & Fisheries
Commission

Dr. John D. Costlow, Jr.
Director, Duke University
Marine Laboratory

Ms. Marjorie Lass Vesley
Williamsville, New York

Sea Grant**Review Panel 1979**

Dr. Randolph W. Bromery
Commonwealth Professor of
Geophysics
University of Massachusetts
Amherst, Massachusetts

Dr. John Blair
Director of Research
Raytheon Corporation
Lexington, Massachusetts

Dr. Joseph N. Busby
Gainesville, Florida

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Chancellor, University of
Nebraska-Lincoln
Vice President, University of
Nebraska
Lincoln, Nebraska

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Madison, Wisconsin

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Umpqua Division—Bohemia, Inc.
Eugene, Oregon

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Chief, Illinois State Water Survey
Urbana, Illinois

Mr. Willard Bascom, Director
Southern California Coastal
Water Research Project
Long Beach, California

Dr. John D. Costlow, Jr.
Director, Duke University
Marine Laboratory
Beaufort, North Carolina

Ms. Marjorie L. Vesley
Williamsville, New York

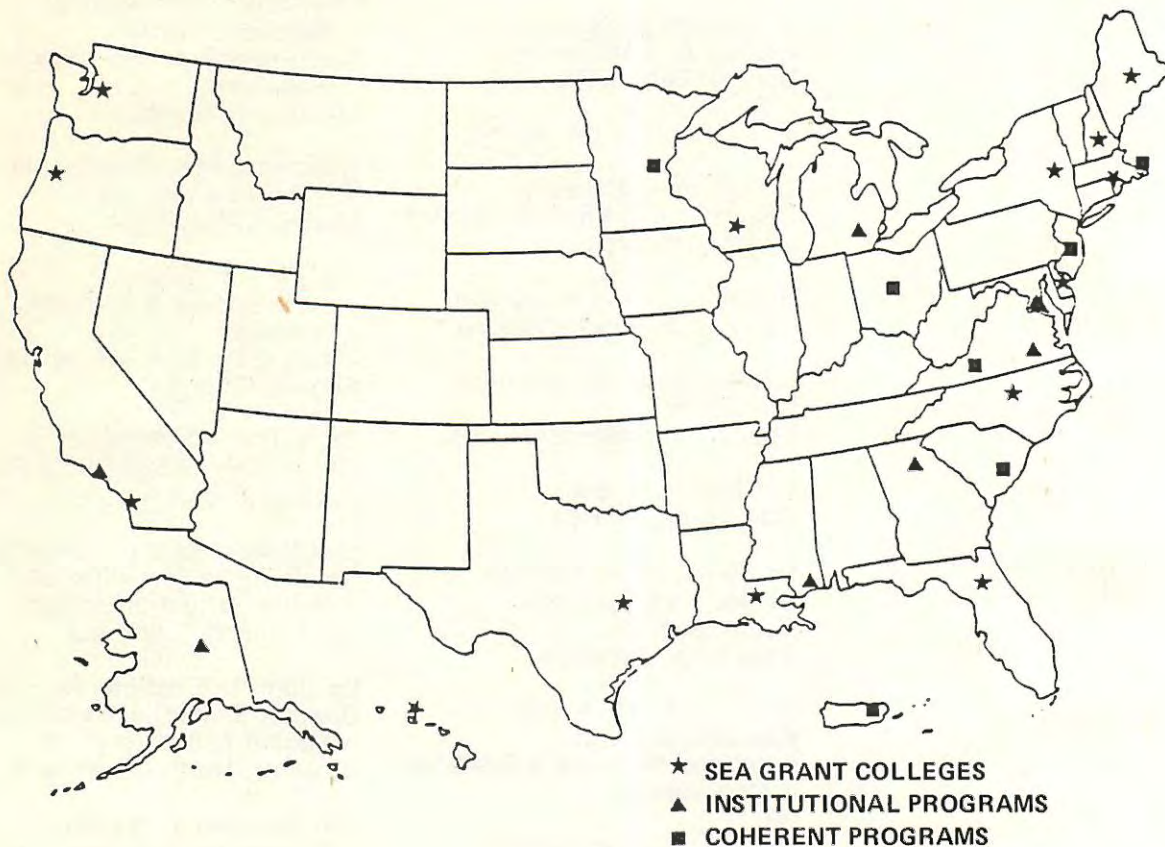
Professor Lloyd N. Ferguson
California State University
Los Angeles, California

Dr. Arturo Morales-Carrion
Executive Director
Puerto Rican Foundation for the
Humanities
San Juan, Puerto Rico

Mr. Christopher Weld
Sullivan & Worcester
Boston, Massachusetts

Dr. Charles L. Drake
Chairman, Department of
Earth Sciences
Dartmouth College
Hanover, New Hampshire

National Sea Grant College Program—1980



Sea Grant College Designations

1971
 Texas A&M University
 University of Washington
 Oregon State University
 University of Rhode Island

1972
 University of Wisconsin
 University of Hawaii

1973
 University of California System

1975
 State University of New York/
 Cornell

1976
 Massachusetts Institute of
 Technology
 University of North Carolina
 State University System of
 Florida
 University of Delaware

1978
 Louisiana State University

Program Directors for Sea Grant Institutional Support

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

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

Dr. Rita R. Colwell
Director, Sea Grant Program
University of Maryland
College Park, Maryland

Dr. B. J. Copeland
Director, UNC Sea Grant College Program
* North Carolina State University
Raleigh, North Carolina

Dr. Robert W. Corell
Director, UNH/UMO Joint Sea Grant Program
* University of New Hampshire
Durham, New Hampshire

Dr. Jack R. Davidson
Director, Sea Grant College Program
* University of Hawaii
Honolulu, Hawaii

Dr. William S. Gaither
Director, Sea Grant College Program
* University of Delaware
Newark, Delaware

Dr. Malvern Gilmartin
Associate Director,
UNH/UMO Joint Sea Grant Program
* University of Maine
Orono, Maine

Mr. Dean A. Horn
Director, Sea Grant College Program
* Massachusetts Institute of Technology
Cambridge, Massachusetts

Mr. Feenan D. Jennings
Director, Sea Grant College Program
* Texas A&M University
College Station, Texas

Dr. James Jones
Director, Mississippi-Alabama Sea Grant
Ocean Springs, Mississippi

Mr. Donald Keach
Director, Sea Grant Program
Institute for Marine and Coastal Studies
University of Southern California
Los Angeles, California

Dr. Maurice Lynch
Director, Sea Grant Program
Virginia Institute of Marine Science
Gloucester Point, Virginia

Dr. Stanley R. Murphy
Director, Sea Grant College Program
* University of Washington
Seattle, Washington

Dr. Hugh L. Popenoe
Director, Florida Sea Grant College Program
* University of Florida
Gainesville, Florida

Dr. Robert A. Ragotzkie
Director, Sea Grant Institute
* University of Wisconsin-Madison
Madison, Wisconsin

Dr. Niels R. Rorholm
Coordinator, Sea Grant College Program
* University of Rhode Island
Kingston, Rhode Island

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

Dr. Donald F. Squires
Director, SUNY/Cornell Sea Grant College Program
* State University of New York
Albany, New York

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

Dr. Jack R. Van Lopik
Director, Sea Grant College Program
* Louisiana State University
Baton Rouge, Louisiana

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

Total Institutional Programs:
21**

* Sea Grant Colleges: 14

** New Hampshire/Maine—single program

**Program Directors for
Sea Grant Coherent Support**

Dr. Robert B. Abel
Director, Sea Grant Program
New Jersey Marine Science
Consortium
Fort Hancock, New Jersey

Dr. John M. Armstrong
Director, South Carolina Sea
Grant Consortium
Charleston, South Carolina

Dr. E. Neal Boyd
Director, Sea Grant Program
Virginia Polytechnic Institute &
State University
Blacksburg, Virginia

Dr. Charles E. Herdendorf
Director, Sea Grant Program
Ohio State University
Columbus, Ohio

Mr. Donald C. McNaught
Director Designate, Sea Grant
Program
University of Minnesota
St. Paul, Minnesota

Dr. David A. Ross
Sea Grant Coordinator
Woods Hole Oceanographic
Institution
Woods Hole, Massachusetts

Marine Advisory Service Program Leaders

Warren McCord, Coordinator
Marine Advisory Program
Auburn University
Auburn, Alabama

John P. Doyle, Head
Marine Advisory Program
University of Alaska
Anchorage, Alaska

Maynard W. Cummings,
Coordinator
Marine Advisory Program
University of California
Davis, California

Stuart A. Ross, Director
Marine Advisory Service
University of Southern California
Los Angeles, California

George Geer, Coordinator
Marine Advisory Program
University of Connecticut
Wallingford, Connecticut

Carolyn Thoroughgood
Marine Advisory Program
University of Delaware
Newark, Delaware

Marion Clarke, Coordinator
Marine Advisory Program
University of Florida
Gainesville, Florida

Wayne Bough, Leader
Marine Advisory Program
University of Georgia
Brunswick, Georgia

Paul A. Pratte
Marine Advisory Program
University of Hawaii
Honolulu, Hawaii

Ronald Becker, Coordinator
Marine Advisory Program
Louisiana State University
Baton Rouge, Louisiana

Ronald Dearborn, Coordinator
Marine Advisory Program
UME/UNH Joint Program
University of Maine
Orono, Maine

Anthony Mazzaccaro
Marine Advisory Program
University of Maryland
College Park, Maryland

Arthur B. Clifton
Marine Liaison Officer
Massachusetts Institute of
Technology
Cambridge, Massachusetts

Eugene Dice
Recreation Resource Division
Michigan State University
East Lansing, Michigan

Dale R. Baker, Coordinator
Marine Advisory Program
University of Minnesota
Duluth, Minnesota

David Veal, Coordinator
Marine Advisory Program
Mississippi/Alabama Sea Grant
Consortium
Biloxi, Mississippi

Coordinator
Marine Advisory Service
University of New Hampshire
Durham, New Hampshire

John K. Hutchinson, Coordinator
New England Marine Advisory
Service
Durham, New Hampshire

Jim Murray, Director
New Jersey Marine Advisory
Service
Marmora, New Jersey

Bruce T. Wilkins, Coordinator
New York State Sea Grant
Marine Advisory Program
Cornell University
Ithaca, New York

J.C. Jones, Director
North Carolina Sea Grant
Program Advisory Services
North Carolina State University
Raleigh, North Carolina

Jeffrey M. Reutter
Ohio Sea Grant Extension
Program
Ohio State University
Columbus, Ohio

Kenneth Hilderbrand, Head
Marine Advisory Program
Oregon State University
Newport, Oregon

Manuel Hernandez-Avila
Director, Sea Grant Program
University of Puerto Rico
Mayaguez, Puerto Rico

Sara Callahan
University of Rhode Island
Marine Advisory Service
Narragansett Bay
Narragansett, Rhode Island

David C. Smith
Acting Marine Program Leader
Beaufort, South Carolina

Ranzell Nickelson
Marine Program Leader
Texas A&M University
College Station, Texas

William DuPaul, Coordinator
Marine Advisory Program
Virginia Institute of Marine
Science
Gloucester Point, Virginia

George J. Flick, Coordinator
Marine Advisory Program
Virginia Polytechnic Institute and
State University
Blacksburg, Virginia

Robert E. Harris, Manager
Marine Advisory Program
University of Washington
Seattle, Washington

Gene Woock
Coordinator of Field Agents
University of Wisconsin-
Extension
Madison, Wisconsin

Gregory D. Hedden, Coordinator
Sea Grant Marine Extension
Program
University of Wisconsin
Madison, Wisconsin

Sea Grant Communicators

Fran Sweet, Communications
Coordinator

Alaska Sea Grant Program
University of Alaska
Fairbanks, Alaska

Louise Eklund
Sea Grant College Program
University of California
La Jolla, California

Shirley Hudgins
Sea Grant
University of Southern California
Los Angeles, California

George Geer, Program Leader
University of Connecticut
Marine Advisory Service
Wallingford, Connecticut

Karin Danberg
University of Delaware
Newark, Delaware

Tom Leahy, Editor
Florida Sea Grant College
University of Florida
Gainesville, Florida

Reita Rivers
Sea Grant Editor
University of Georgia
Athens, Georgia

Rose Pfund, Information
Coordinator
Sea Grant College Program
University of Hawaii
Honolulu, Hawaii

Sally Kuzenski, Information
Specialist
Louisiana State University
Baton Rouge, Louisiana

Phyllis Coggins
Cooperative Extension Service
Rockland, Maine

Michael Fincham, Editor
University of Maryland
Sea Grant Program
College Park, Maryland

Elizabeth Harding
Sea Grant Program
Massachusetts Institute of
Technology
Cambridge, Massachusetts

Ellen Gately
Communications Coordinator
Woods Hole Oceanographic
Institution
Woods Hole, Massachusetts

Leslie Y. Lin
Michigan Sea Grant Program
University of Michigan
Ann Arbor, Michigan

Ryck Lydecker, Media Specialist
Sea Grant Extension Program
University of Minnesota-Duluth
Duluth, Minnesota

Dianne Jones
Mississippi/Alabama Sea Grant
Consortium
Ocean Springs, Mississippi

Nick Cowenhoven,
Communicator
UNH Marine Advisory Program
Durham, New Hampshire

Debbie Truitt
NEMAS/New England Center
Durham, New Hampshire

Susan Bonsall, Marine Advisory
Service
Cook College, Rutgers University
New Brunswick, New Jersey

Bruce Kantrowitz, Assistant
Director
Communications
SUNY/New York Sea Grant
Institute
Albany, New York

Sally Willson, Media Specialist
Sea Grant Extension Program
Cornell University
Ithaca, New York

Mary Day Mordecai
Sea Grant College Program
North Carolina State University
Raleigh, North Carolina

Laurie Fletcher, Communicator
Ohio Sea Grant Extension
Program
Columbus, Ohio

Jim Larison, Communications
Coordinator
Sea Grant Communications
Oregon State University
Corvallis, Oregon

Lesbia Carrasquillo
Humacao University College
Humacao, Puerto Rico

Betty Edel
Sea Grant Depository, Pell
Library
University of Rhode Island,
Bay Campus
Narragansett, Rhode Island

Christine Duerr Tarasevich
Marine Affairs Writer
URI Marine Advisory Service
Narragansett, Rhode Island

Laura Colunga
Sea Grant Program
Texas A&M University
College Station, Texas

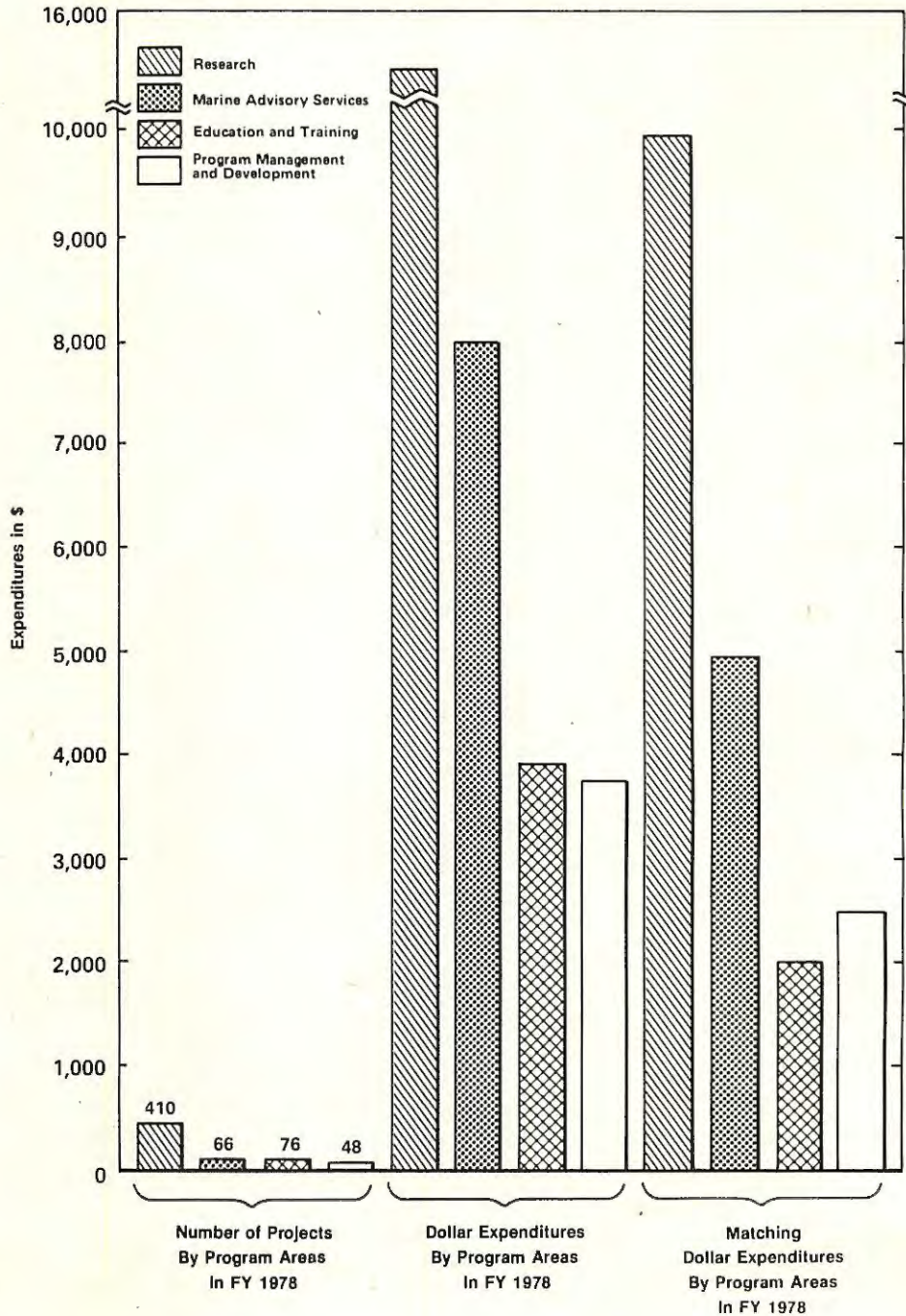
Dick Cook, Editor
Sea Grant Advisory Services
Virginia Institute of Marine
Science
Gloucester Point, Virginia

Chieko Hebard
Sea Grant Editor
Virginia Polytechnic Institute
and State University
Blacksburg, Virginia

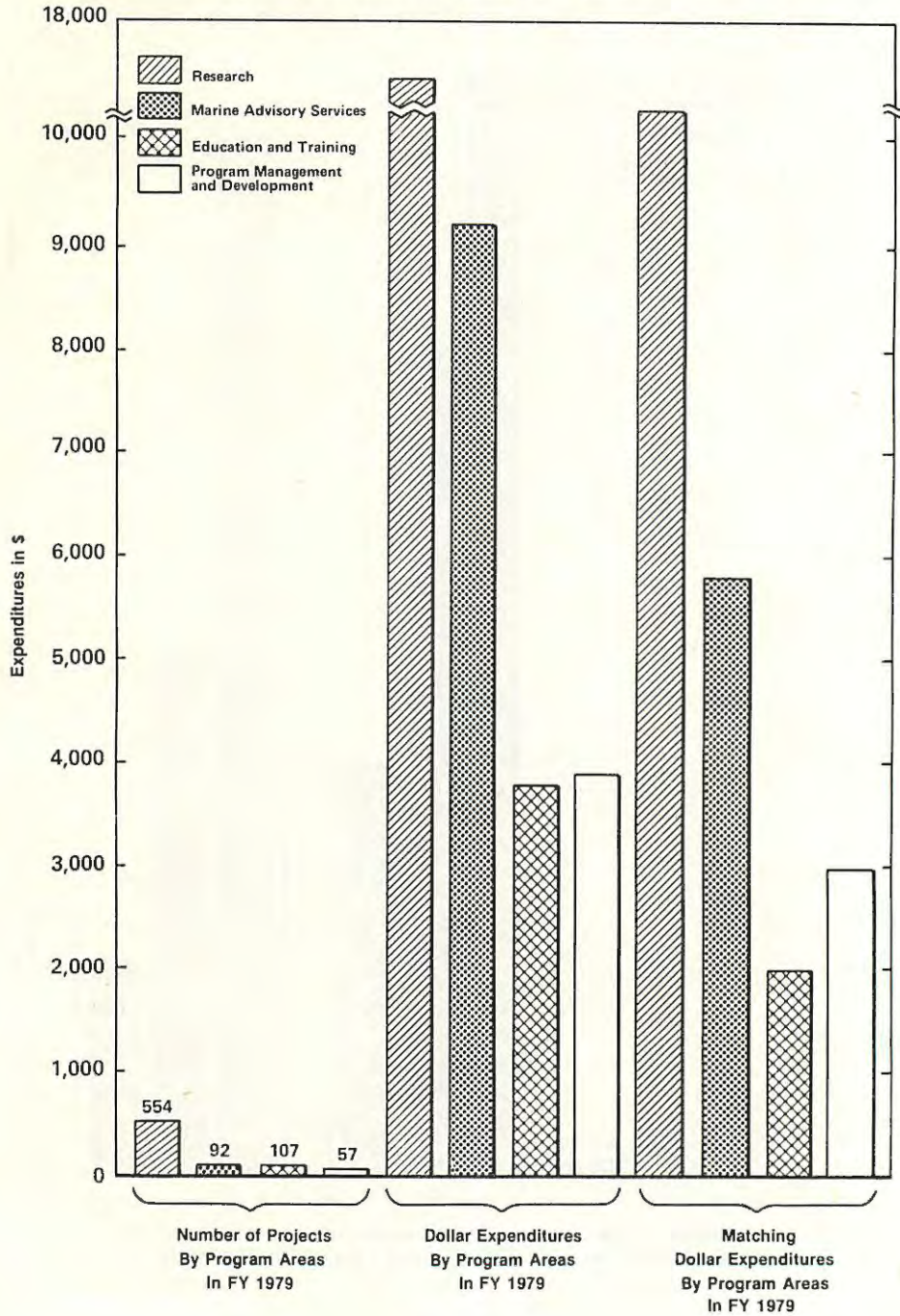
Patricia Peyton, Coordinator
Washington Sea Grant
Communications
University of Washington
Seattle, Washington

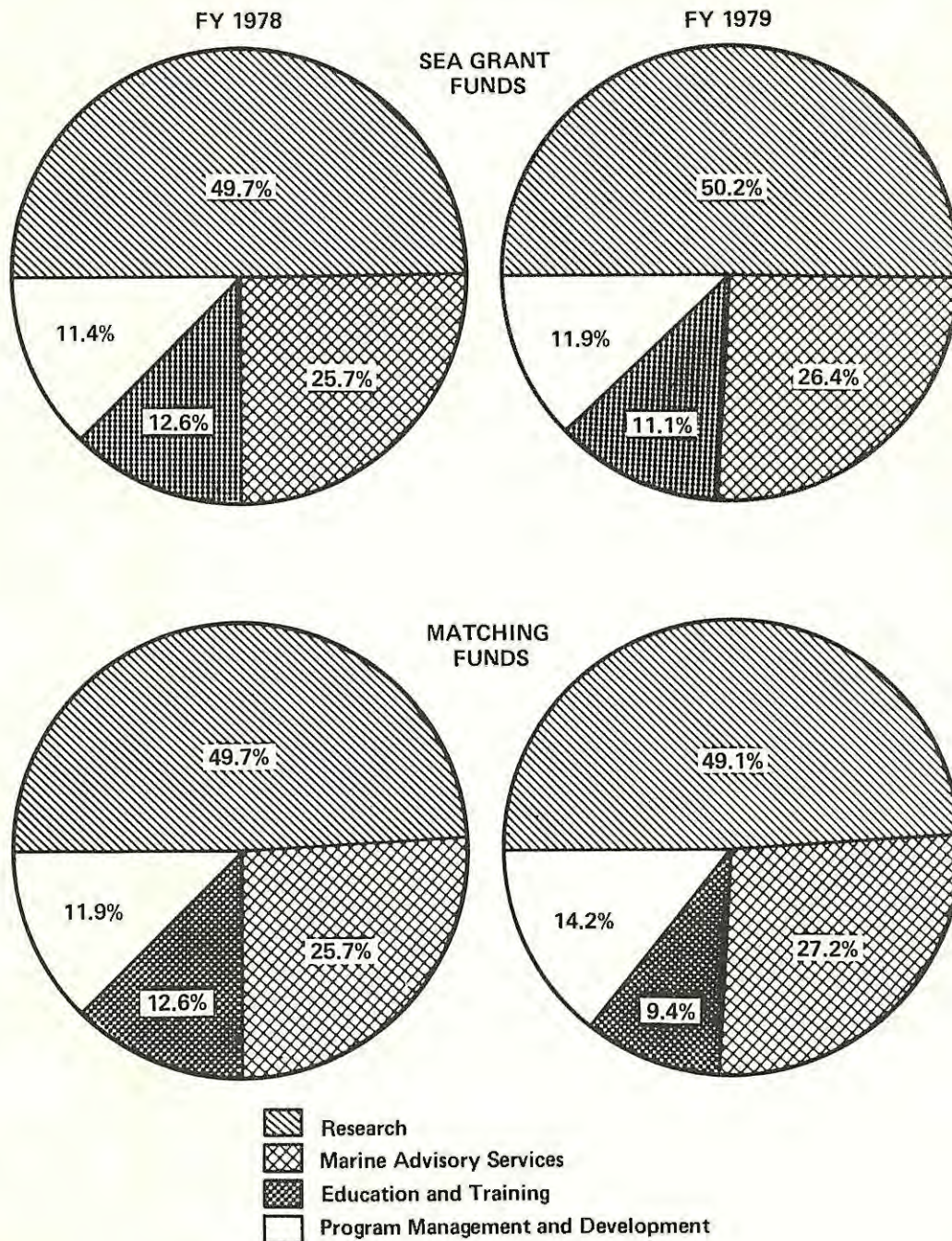
Linda Weimer
University of Wisconsin
Sea Grant Program
Madison, Wisconsin

Sea Grant Numbers of Projects, Dollar Expenditures, and Matching Dollar Expenditures by Program Areas in Fiscal Year 1978



Sea Grant Numbers of Projects, Dollar Expenditures, and Matching Dollar Expenditures by Program Areas in Fiscal Year 1979





Percentage of Sea Grant Funds and Matching Funds Expended by Program Area for Fiscal Years 1978 and 1979.

Grants Awarded, by Fiscal Year and State

	1978		1979	
	Sea Grant Dollars	Matching Dollars	Sea Grant Dollars	Matching Dollars
Alabama* (with Mississippi)				
Mississippi/Alabama Sea Grant Consortium	634,900*	328,207*	785,000*	429,404*
Alaska				
University of Alaska	2,024,000	1,653,523	1,208,500	834,852
Arizona				
University of Arizona	32,900	44,848	33,500	27,784
California				
University of California San Diego/ Davis	3,529,400	2,021,198	3,654,800	1,847,685
University of Southern California	589,000	483,628	575,000	533,195
Santa Barbara City College	20,700	11,393	—	—
Stanford University	255,300	128,302	—	—
California Institute of Technology	105,000	52,500	—	—
State Total	4,499,400	2,697,021	4,229,800	2,380,880
Colorado				
American Cancer Research Center and Hospital of Colorado	26,000	42,700	26,000	44,000
Connecticut				
University of Connecticut	94,000	62,742	93,900	47,300
Yale University	59,700	30,300	35,300	18,724
State Total	153,700	93,042	129,200	66,024
Delaware				
University of Delaware	1,429,600	790,101	1,125,300	768,507
District of Columbia				
National Association for Equal Op- portunity in Higher Education	9,000	—	—	—
National Fisheries Institute	24,000	12,000	—	—
American Geophysical Union	4,000	2,000	4,000	2,000
District Total	37,000	14,000	4,000	2,000
Florida				
State University System of Florida	1,260,000	943,400	1,489,000	1,134,500
University of Miami	292,900	51,200	—	—
State Total	1,552,900	994,600	1,489,000	1,134,500
Georgia				
University of Georgia	631,100	609,100	790,500	774,700

Grants Awarded, by Fiscal Year and State (Continued)

	1978		1979	
	Sea Grant Dollars	Matching Dollars	Sea Grant Dollars	Matching Dollars
Hawaii				
University of Hawaii	1,195,000	899,460	1,690,800	1,035,178
Oceanic Institute	70,000	35,000	65,000	32,500
Hawaii Department of Land and Natural Resources	—	—	100,000	100,000
State Total	1,265,000	934,460	1,855,800	1,167,678
Idaho				
University of Idaho	35,300	25,700	36,500	28,416
Louisiana				
Louisiana State University	1,071,600	610,547	1,194,300	715,392
Maine*				
University of Maine (with New Hampshire)	1,193,800*	606,360*	1,378,900*	699,519*
Maine Department of Maine Resources	26,750	13,375	—	—
State Total	1,220,550	619,735	1,378,900	699,519
Maryland				
University of Maryland	569,150	369,900	869,100	551,010
Undersea Medical Society	13,700	3,600	—	—
Council for National Cooperation in Aquatics	27,900	23,075	—	—
State Total	610,750	396,575	869,100	551,010
Massachusetts				
Massachusetts Institute of Technology	1,602,600	975,229	1,517,400	1,281,452
Woods Hole Oceanographic Institution	550,000	511,193	811,700	490,796
Harvard University	—	—	64,200	20,931
State Total	2,152,600	1,486,422	2,393,300	1,792,639
Michigan				
University of Michigan	911,000	470,300	1,020,600	520,892
Minnesota				
University of Minnesota	220,200	198,400	635,000	525,548
Mississippi* (with Alabama)				
Mississippi/Alabama Sea Grant Consortium	634,900*	328,207*	785,000*	429,404*

Grants Awarded, by Fiscal Year and State (Continued)

	1978		1979	
	Sea Grant Dollars	Matching Dollars	Sea Grant Dollars	Matching Dollars
New Hampshire* (with Maine)				
University of Maine/University of New Hampshire	1,193,800*	606,360*	1,378,900*	699,519*
University of New Hampshire	134,200**	68,300**	148,100**	86,023**
State Total	1,328,000	674,660	1,527,000	785,542
New Jersey				
New Jersey Marine Sciences Consortium	340,000	323,700	435,000	287,000
Fairleigh Dickinson University	52,000	26,983	121,200	58,585
Rutgers University	—	—	24,600	14,100
State Total	392,000	350,683	580,800	359,685
New York				
State University of New York/Cornell	1,583,670	832,497	1,656,700	865,223
Society of Naval Architects and Marine Engineers	24,000	42,000	24,000	42,000
State Total	1,607,670	874,497	1,680,700	907,223
North Carolina				
University of North Carolina	850,000	425,000	965,000	502,000
North Carolina State Department of Administration	—	—	5,500	3,864
State Total	850,000	425,000	970,500	505,864
Ohio				
Ohio State University Research Foundation	17,500	8,895	17,500	9,359
Ohio State University	121,800	67,816	180,000	101,400
State Total	139,300	76,711	197,500	110,759
Oklahoma				
University of Oklahoma	116,500	58,258	136,000	68,000
Oregon				
Oregon State University	1,831,000	938,900	2,340,000	1,658,800
Rhode Island				
University of Rhode Island	1,536,200	743,000	1,676,900	757,900
Gordon Research Conference	—	—	3,200	5,500
State Total	1,536,200	743,000	1,680,100	763,400
South Carolina				
University of South Carolina	3,911	2,483	—	—
South Carolina Sea Grant Consortium***	361,800	276,600	390,000	406,700
State Total	365,711	279,083	390,000	406,700

Grants Awarded, by Fiscal Year and State (Continued)

	1978		1979	
	Sea Grant Dollars	Matching Dollars	Sea Grant Dollars	Matching Dollars
Texas				
University of Texas at Austin	105,000	52,500	147,200	73,614
Texas A&M University	1,851,200	1,212,813	1,778,100	1,364,503
University of Texas Medical Branch	4,800	3,900	—	—
State Total	1,961,000	1,269,213	1,925,300	1,438,117
Virginia				
Virginia Polytechnic Institute and State University	207,100	86,000	191,850	86,500
University of Virginia	35,000	25,000	—	—
Virginia Institute of Marine Science	628,000	329,700	695,400	434,562
State Total	870,100	440,700	887,250	521,062
Washington				
University of Washington	2,129,300	1,033,947	2,119,026	1,136,076
Wisconsin				
University of Wisconsin	1,546,000	828,000	1,700,000	950,000
Puerto Rico				
University of Puerto Rico	88,500	55,100	109,100	70,540
Virgin Islands				
West Indies Lab/Fairleigh Dickinson University	55,000	27,548	—	—
National Total	30,850,531	19,242,723	34,068,676	21,445,994

* Mississippi/Alabama and Maine/New Hampshire operate joint Sea Grant programs; the funds listed are the total of the single grant award to each joint program.

** These grants to the University of New Hampshire are for the New England Marine Advisory Service (NEMAS) and for the Regional Coastal Information Center (RCIC).

*** Formerly the South Carolina Marine Resources Center.

Grants Awarded, by Sea Grant Classification

	1978			1979		
	No. of Projects	Sea Grant \$	Matching \$	No. of Projects	Sea Grant \$	Matching \$
Marine Resources Development						
A. Aquaculture						
01—Crustaceans	19	753,739	860,667	15	927,395	1,041,003
02—Finfish	23	795,047	531,927	23	671,167	581,565
03—Molluscs	29	703,605	550,524	16	479,561	607,165
04—Other Animals	6	253,495	230,278	7	230,137	202,742
05—Plants	11	353,871	247,659	8	292,647	205,799
Sub-Area Total	88	2,859,757	2,421,055	69	2,600,907	2,638,274
B. Living Resources Other Than Aquaculture						
06—Commercial Fisheries—						
Biology	43	1,283,394	858,481	61	1,904,633	1,073,094
07—Biological Oceanography	11	294,349	176,498	11	457,368	287,283
08—Pathology of Marine Organisms	16	519,775	306,647	13	428,221	394,304
Sub-Area Total	70	2,097,518	1,341,626	85	2,790,222	1,754,681
C. Mineral Resources						
09—Geological Oceanography	1	12,000	2,477	4	74,316	51,104
10—Mineral Resources—						
Other	9	157,201	142,908	4	176,394	101,847
Sub-Area Total	10	169,201	145,385	8	250,710	152,951
D. Marine Biomedicinals and Extracts						
11—Enzymes	1	25,000	13,400	2	31,571	7,992
12—Biomedicinals	15	400,543	235,128	11	425,946	249,920
13—Marine Extracts—Other	12	201,489	166,993	9	245,913	119,792
Sub-Area Total	28	627,032	415,521	22	703,430	377,704
Total Marine Resources Development	196	5,753,508	4,323,587	184	6,345,269	4,923,610
Marine Socio-Economics and Legal Research						
A. Marine Economics						
14—Marine Economics	26	843,104	462,550	29	878,307	438,116
B. Ocean Law						
15—Coastal	4	126,427	73,245	5	150,540	101,144
16—International	4	106,253	109,986	4	96,319	92,429
17—Other	3	104,680	53,492	4	110,343	70,242
Sub-Area Total	11	337,360	236,723	13	357,202	263,815
C. Marine Recreation						
18—Sports Fisheries	6	155,473	71,826	9	185,499	155,528
19—Other Recreation	5	101,608	65,591	7	114,075	124,785
Sub-Area Total	11	257,081	137,417	16	299,574	280,313
D. Socio-Political Studies						
20—Socio-Political Studies	14	325,457	513,464	14	341,661	453,486
Total, Marine Socio-Economics & Legal Research	62	1,763,002	1,350,154	72	1,876,744	1,435,730

Grants Awarded, by Sea Grant Classification (Continued)

	1978			1979		
	No. of Projects	Sea Grant \$	Matching \$	No. of Projects	Sea Grant \$	Matching \$
Marine Technology Research & Development						
A. Ocean Engineering						
21—Life Support Systems	1	28,867	13,890	1	29,033	29,656
22—Seafloor Engineering	5	107,580	72,494	5	144,777	125,851
23—Vehicles, Vessels, Platforms	6	94,580	81,778	4	81,291	73,689
24—Materials & Structures	13	319,240	178,016	12	468,486	212,418
25—Coastal Engineering	20	479,502	247,736	15	384,671	260,210
26—Engineering-Aquaculture	4	141,000	150,138	2	110,405	60,785
27—Dredging	3	68,386	31,431	3	82,258	21,688
28—Ocean Engineering— Other	11	324,579	174,328	11	364,909	119,482
Sub-Area Total	63	1,563,734	949,811	53	1,665,830	903,779
B. Resources Recovery & Utilization						
29—Behavioral Sciences	1	17,300	10,800	2	44,604	18,411
30—Commercial Fisheries Technology	15	296,147	223,544	11	178,878	117,551
31—Diver Engineering	1	17,675	24,873	1	32,029	19,431
32—Diver Physiology	4	157,804	83,621	4	230,739	101,541
33—Manned Submersibles	0	—	—	0	—	—
34—Man-In-the Sea	4	76,000	30,721	3	60,050	37,213
35—Seafood Science & Technology	34	929,199	482,667	33	841,053	478,954
Sub-Area Total	59	1,494,125	861,326	54	1,387,353	773,101
C. Transportation Systems						
36—Ports, Harbors & Offshore Terminals	0	—	—	3	30,549	23,585
37—Transportation Systems— Other	6	131,411	64,878	7	182,948	56,053
Sub-Area Total	6	131,411	64,878	10	213,497	79,638
Total Marine Technology Research & Development	128	3,189,270	1,876,015	117	3,266,680	1,756,518
Marine Environmental Research						
A. Research & Studies in Direct Support of Coastal Zone Management Decisions						
38—CZM—Social Sciences	13	282,975	173,614	12	338,074	173,737
39—CZM—Natural Sciences & Engineering	35	940,827	493,574	29	1,166,273	445,801
Sub-Area Total	48	1,223,802	667,188	41	1,504,347	619,538
B. Ecosystems Research						
40—Ecosystems Research	39	895,659	454,675	36	1,107,835	413,706

Grants Awarded, by Sea Grant Classification (Continued)

	1978			1979		
	No. of Projects	Sea Grant \$	Matching \$	No. of Projects	Sea Grant \$	Matching \$
C. Pollution Studies						
41—Oil Spills	3	79,251	21,431	5	165,670	90,527
42—Pesticides	2	35,667	26,200	4	62,045	59,789
43—Thermal and Radioactive	1	33,271	32,565	1	39,855	49,056
44—Metals	11	153,359	139,778	11	215,322	123,371
45—Pollution—Other	29	682,471	368,108	37	895,270	413,982
Sub-Area Total	46	984,019	588,082	58	1,378,162	736,725
D. Environmental Models						
46—Physical Processes	15	443,880	203,199	18	578,387	225,593
47—Biological Processes	5	257,907	97,851	9	303,218	188,942
48—Environmental Models— Other	2	137,113	47,813	4	90,372	49,601
Sub-Area Total	22	838,900	348,863	31	971,977	464,136
E. Applied Oceanography						
49—Applied Chemical Oceanography	1	18,800	20,500	2	76,767	50,183
50—Applied Physical Oceanography	13	673,319	138,281	13	666,668	139,577
Sub-Area Total	14	692,119	158,781	15	743,435	189,760
Total, Marine Environmental Research	169	4,634,499	2,217,589	181	5,705,756	2,423,865

Marine Education and Training

A. College Level, Course Development						
51—CD—Chemical Oceanog- raphy	0	—	—	1	59,900	26,983
52—CD—Geological Oceanography	0	—	—	1	13,000	6,500
53—CD—Physical Oceanog- raphy	0	—	—	0	—	—
54—CD—Economics	2	40,432	86,991	1	35,434	73,735
55—CD—Law	3	23,224	43,828	2	21,800	37,500
56—CD—Biology	0	—	—	1	9,500	7,052
57—CD—Pathology	0	—	—	0	—	—
58—CD—Seafood Tech- nology	0	—	—	0	—	—
59—CD—Fisheries	4	51,523	45,436	1	16,500	21,400
60—CD—Aquaculture	3	42,596	25,579	2	40,200	14,300
61—CD—Ocean Engineering	5	80,067	111,930	6	84,294	215,677
62—Course Development— Other	18	454,371	255,401	17	369,182	264,978
Sub-Area Total	35	692,213	569,165	32	649,810	668,125

Grants Awarded, by Sea Grant Classification (Continued)

	1978			1979		
	No. of Projects	Sea Grant \$	Matching \$	No. of Projects	Sea Grant \$	Matching \$
B. Vocational Marine						
Technician Training						
63—Commercial Diver Training	1	20,700	11,393	0	—	—
64—Oceanographic Technician Training	0	—	—	—	—	—
65—Aquaculture Technician Training	2	117,479	122,902	0	—	—
66—Commercial Fisheries Training	3	78,567	129,042	5	173,618	259,280
67—Technician Training— Other	2	61,997	6,200	3	107,000	90,253
Sub-Area Total	8	278,743	269,537	8	280,618	349,533
C. Retraining Program						
68—Engineering Retraining	0	—	—	0	—	—
69—Technician Retraining	0	—	—	0	—	—
D. Other Education						
70—Other Education	62	2,920,145	1,239,753	67	2,859,675	1,008,958
Total Marine Education & Training	105	3,891,101	2,078,455	107	3,790,103	2,026,616
Advisory Services						
A. Extension Programs						
71—Extension Agent Services	40	3,632,909	2,278,530	38	4,959,220	3,378,410
72—Extension Course Programs	2	374,000	179,634	1	29,080	15,964
73—Extension Programs— Other	9	979,089	918,703	8	989,664	638,304
Sub-Area Total	51	4,985,998	3,376,867	47	5,977,964	4,032,678
B. Other Advisory Services						
74—Conferences, Institutes, etc.	7	118,897	90,361	6	76,200	75,222
75—Public Education Programs	6	104,629	198,103	5	250,269	277,981
76—Publications, Audio Visuals, etc.	22	1,376,704	673,304	17	1,198,261	366,674
77—Advisory Services—Other	24	1,350,329	602,832	17	1,688,275	1,074,555
Sub Area Total	59	2,950,559	1,564,600	45	3,213,005	1,794,432
Total Advisory Services	110	7,936,557	4,941,467	92	9,190,969	5,827,110

Grants Awarded, by Sea Grant Classification (Continued)

	1978			1979		
	No. of Projects	Sea Grant \$	Matching \$	No. of Projects	Sea Grant \$	Matching \$
Program Management & Development						
A. Program Administration						
78—Program Planning	4	179,950	63,509	5	308,109	192,997
79—Program Administration	33	2,351,532	1,979,893	30	2,350,046	2,245,499
Sub-Area Total	37	2,531,482	2,043,402	35	2,658,155	2,438,496
B. Program Development						
80—Program Logistic Support	4	153,819	132,382	4	208,537	177,463
81—New Applications Development	19	997,293	279,672	18	1,026,463	436,586
Sub-Area Total	23	1,151,112	412,054	22	1,235,000	614,049
Total Program Management & Development	<u>60</u>	<u>3,682,594</u>	<u>2,455,456</u>	<u>57</u>	<u>3,893,155</u>	<u>3,052,545</u>
Grand Total	830	30,850,531	19,242,723	810	34,068,676	21,445,994

**The International Cooperation Assistance Program
(International Sea Grant)**

Developing Country	Grantee Institution	Cooperating Institution	Award
1978			
Mexico	Louisiana State U.	U. Nacional Autonoma de Mexico	\$21,600 (1 year)
Malaysia	U. Rhode Island	U. Malaya; U. Pertanian Malaysia	95,000 (1 year)
Israel	Virginia Institute of Marine Science	Israel Oceanographic Limnological Research, Inc.	131,400 (2 years)
Costa Rica	U. Delaware	U. Costa Rica	303,500 (2 years)
Colombia	U. Miami	Colombian Oceanographic Commission and universities	199,900 (2 years)
Chile	New York Sea Grant Institute	U. Concepcion	72,000 (2 years)
Chile & other Latin American countries	Oregon State U.	Catholic U. of Valparaiso, chiefly	90,000 (1 year)
1979			
Malaysia	U. Rhode Island	Three Malaysian universities	185,000 (2 years)
Mexico	U. California	Several Mexican universities	240,000 (2 years)
Mexico	Louisiana State U.	U. Nacional Autonoma de Mexico	46,800 (1 year)
India	U. Florida	Indian Institute of Technology	18,000 (1 year)
Egypt	Maryland Sea Grant Program	High Institute of Public Health, Alexandria	134,400 (2 years)
Chile and Mexico	Oregon State U.	Catholic U. of Valparaiso and other universities	190,000 (2 years)
Eleven South Pacific Nations	U. Hawaii	U. of the South Pacific, Institute of Marine Resources	92,800 (1 year)

Funds Managed for Other Agencies*

Agency	1978		1979	
	No. of Projects	Amount	No. of Projects	Amount
Marine Socio-Economic and Legal Research				
Department of Commerce	1	40,000	—	—
Department of Interior	—	—	1	5,000
Marine Resources (NOAA)	1	5,000	—	—
Maritime Administration (DOC)	—	—	1	5,000
National Marine Fisheries Service (NOAA)	1	17,000	2	41,400
Office of Marine Minerals (NOAA)	2	32,500	—	—
Office of Plans and Programs (NOAA)	—	—	1	50,000
State Department	—	—	1	30,000
Treasury Department	—	—	1	20,000
Marine Technology Research and Development				
Coast Guard (DOT)	—	—	2	155,000
Department of Defense—Navy	1	15,000	1	34,900
Manned Undersea Science and Technology (NOAA)	1	2,000	2	18,660
National Marine Fisheries Service (NOAA)	1	30,000	—	—
Office of Marine Minerals (NOAA)	1	25,000	—	—
Office of Ocean Engineering (NOAA)	1	6,450	1	7,000
Marine Environmental Research				
Department of Energy	2	348,600	—	—
Environmental Data Information Service (NOAA)	—	—	1	62,700
Manned Undersea Science and Technology (NOAA)	—	—	1	2,000
National Marine Fisheries Service (NOAA)	2	87,400	3	158,850
Office of Ocean Engineering (NOAA)	2	32,000	—	—
Marine Education and Training				
Coastal Zone Management (NOAA)	—	—	1	6,000
Environmental Protection Agency	1	29,000	—	—
General Counsel (NOAA)	—	—	1	1,814
United States/Spain (Department of State)	1	405,124	—	—

Funds Managed for Other Agencies* (Continued)

Agency	1978		1979	
	No. of Projects	Amount	No. of Projects	Amount
Marine Advisory Services				
Coast Guard (DOT)	1	34,900	—	—
Coastal Zone Management (NOAA)	2	50,000	3	133,000
Department of Interior	—	—	1	20,000
Environmental Data Information Service (NOAA)	1	10,000	4	17,400
Environmental Research Lab (NOAA)	3	207,484	1	225,700
Marine Ecosystems Analysis (NOAA)	—	—	1	57,800
National Marine Fisheries Service (NOAA)	—	—	3	73,000
National Ocean Survey (NOAA)	1	20,000	—	—
National Oceanographic Data Center (NOAA)	—	—	1	20,000
Office of Ocean Engineering (NOAA)	1	30,300	2	28,500
Program Management and Development				
Environmental Research Lab (NOAA)	2	19,916	—	—
Total	29	1,447,674	36	1,173,724

* Often referred to as "pass-through" funds.



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

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Honorable Philip M. Klutznick
Secretary of Commerce
Washington, D.C. 20230

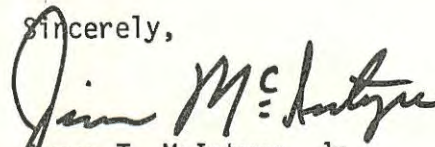
Dear Secretary Klutznick:

This is in response to your letter of March 17, 1980, transmitting for our review a final draft copy of the Biennial Report to the President and Congress on the National Sea Grant College program.

We have reviewed the draft report and have no comments other than that we are pleased that the program is completing the network of Sea Grant Colleges and striving toward improving the Sea Grant Colleges' effectiveness.

Thank you for the opportunity to provide our views.

Sincerely,


James T. McIntyre, Jr.
Director

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WASHINGTON, D.C. 20500

June 26, 1980

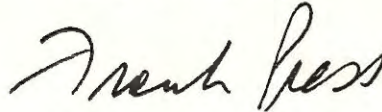
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Dear Mr. Secretary:

The Office of Science and Technology Policy is pleased to receive and approve the Biennial Report to the President and Congress on the National Sea Grant College Program. It has been effective in involving state and local communities in the development of projects that are responsive to their needs.

I have noted that this report develops coherent themes for research and development and their relationship to national research, development, and policy issues. Increasingly in the 1980's, the Sea Grant College Program will be viewed in this context.

Yours sincerely,



Frank Press
Director

Honorable Philip M. Klutznick
Secretary of Commerce
Washington, D.C. 20230