THE NATIONAL SEA GRANT COLLEGE PROGRAM

1985 • 1987

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section 1 of this book.

THE NATIONAL SEA GRANT COLLEGE PROGRAM

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Sea Grant Association

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Section 1. A National Capability

A range of important issues confronting the U.S. marine sector and a geographic listing of academic and non-profit institutions that conduct or actively participate in the work of the National Sea Grant College Program.

SEA GRANT: A NATIONAL CAPABILITY

The National Sea Grant College Program is a national, grassroots-based capability which is essential to the future of U.S. marine resources. Sea Grant is dedicated to the national goal of promoting the understanding, development, utilization, and conservation of ocean and coastal resources through university-based research, education, and advisory services.

Sea Grant Works

- The National Sea Grant College Program is a successful investment in the marine sector of the national economy. This investment has produced new ideas, economic benefits and skilled personnel.
- The National Sea Grant College Program has been studied and evaluated repeatedly. Congressional and other external evaluations have declared that the program is carrying out the intent of Congress. The program has been cited many times by Congressional committees as one of the most efficient, cost-effective programs of the federal government.
- The National Sea Grant College Program has become a model for university/private sector/government partnership on critical resource development opportunities and problems. Its broad-based, multidisciplinary, quality research--which emphasizes societal and industrial needs--makes the program a model which should be fostered and extended to other areas where there are national development needs.
- Sea Grant is the primary national university-based marine resource program. It is the only federal ocean program which couples research and the transfer of results to marine sector users.

Sea Grant Is Essential To National Ocean Policy

- New opportunities and demands for sustained Sea Grant effort are growing out of priority national policy areas such as the Exclusive Economic Zone, outer continental shelf resource development, and Great Lakes and ocean water quality questions, as well as from rapid scientific advances in such areas as genetic engineering and undersea technology.
- The country needs a stable and adequate base of support for the fundamental, long-term, high-risk Sea Grant research that is the basis for scientific advance in support of economic development. Continuity of support is also vital to sustain Sea Grant's educational and public service mission.
- Marine biotechnology, estuarine processes, fisheries recruitment and variability, waste assimiliation, and ocean technology have been cited repeatedly as areas fundamental to marine sector advancement and to sound environmental management. The Sea Grant network's proven capabilities for enlisting the talent of the universities--the main source of scientific expertise in our society--make it uniquely qualified to undertake these important new initiatives.

The following sections of this book describe the unique capabilities and achievements of this national program.

THE NATIONAL SEA GRANT NETWORK

Thirty Sea Grant colleges and institutions comprise the core of the National Sea Grant College Program. A unique Sea Grant creation, these programs function as the primary planning, goal-setting, management and accountability units of the national program, and they are the main source of continuity and long-term commitment to the purposes of the National Sea Grant College Program Act.

In 1982, the National Sea Grant Task Force surveyed the core Sea Grant institutions, asking for a list of other educational institutions participating in local programs since 1976. A "participant" was defined as (1) an administratively separate campus or system level entity and (2) a recipient of Sea Grant funds and/or a required signatory for a Sea Grant institutional proposal.

The Task Force also checked the annual listing of projects prepared by the National Sea Grant College Program Office. It should be noted, however, that this list does not show subcontractors or participants in multi-institutional projects.

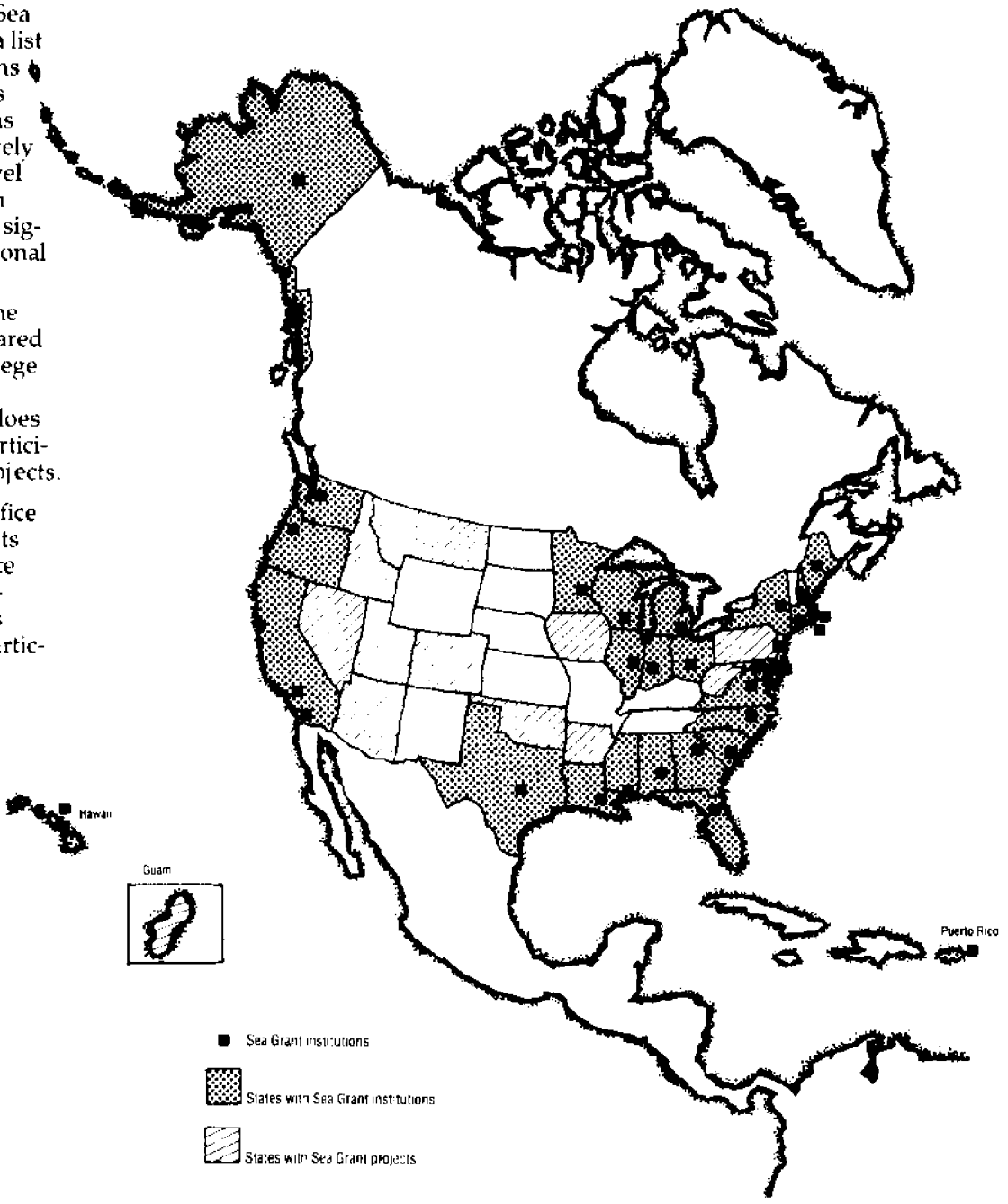
Over the years, the national office has awarded a number of grants for individual projects, separate from the core institutional programs. Records of these grants were checked for additional participants.

The survey results, which follow, show that more than three hundred institutions have participated actively in the program since the enactment of the Sea Grant Improvement Act of 1976:

- 254 institutions of post-secondary education
- 27 elementary and secondary schools or school systems
- 26 nonprofit institutions with marine-related educational and research missions

These institutions are located in 39 states (all 30 coastal states and 9 inland states), the District of Columbia, Puerto Rico, and Guam. The list does not include federal laboratories or agencies, state agencies other than those with special marine research and education functions, cooperative private sector enterprises, other cooperating groups that do not receive funds, or foreign universities.

Since the 1982 survey, a few additions and deletions have been made in this section to reflect known changes, but the map and list following are basically derived from data developed in 1982.



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Section 2. Regional Capabilities

Descriptions of regional projects conducted by Sea Grant programs in five regions:

- New England
- Mid-Atlantic
- Southeast
- Great Lakes
- Pacific Rim

NEW ENGLAND SEA GRANT NETWORK

The New England Sea Grant Network consists of the Sea Grant College Programs of the University of Maine, the University of New Hampshire, the Massachusetts Institute of Technology, the Woods Hole Oceanographic Institution, the University of Rhode Island, the University of Connecticut, and the New York Sea Grant Institute of the State University of New York and Cornell University.

Together, these programs focus on common marine interests and provide regional coordination and support for programs and activities in research, education, communications and advisory services. The goal is sound management and utilization of the marine resources of the northeast.

Some of the network's recent cooperative activities include:

EDUCATION AND COMMUNICATIONS

- **Training and technical workshops for fishermen and fisheries personnel** from the region. These workshops are run in cooperation with the Northeast Marine Advisory Council.
- **Increased consumer knowledge of seafood products** through development and dissemination of educational materials on purchase and preparation of popular fish species from the region.
- **Coordination of a media seminar and tour at Fish Expo '84** – the nation's largest commercial fishing and seafood processing trade show – by New England Sea Grant communicators. The seminar showcased Sea Grant research from the New England programs.

RESEARCH

- **Collaboration and cooperation on red tide and paralytic shellfish poisoning.** Researchers from throughout the region have been mapping the spreading distribution of the organism and have developed inexpensive identification techniques for use by academic researchers and state agency officials.
- **Development of hydrodynamic and dispersion computer models to trace the movement of pollutants within estuaries and harbors.** These models have been used in locating a sewage outfall pipe in New Haven, Conn. harbor, positioning offshore breakwaters in Bristol and Sconnet harbors in Rhode Island and locating spawning sanctuaries for the hard clam fishery in Great South Bay, New York.

ADVISORY

- **Establishment of the Northeast Marine Advisory Council** (NEMAC) in which Sea Grant and other institutions work cooperatively to coordinate and share marine information and research results and improve regional marine advisory services. In addition to Sea Grant institutions, NEMAC cooperators include the U.S. Coast Guard, National Weather Service, National Marine Fisheries Service, Massachusetts Division of Marine Fisheries, Maine Department of Marine Resources, Massachusetts Maritime Academy, Southern Maine Vocational Technical Institute, University of Massachusetts Cooperative Extension Service, and the New England Fisheries Development Foundation.
- **Creation of a position in seafood technology** to assist in bringing the results of research on seafood processing technology to the industry.
- **Production of two videotape programs** – one on hypothermia and one on cold water survival – for use by fishermen, boaters, emergency medical teams and rescue personnel in the region.

SEA GRANT MID-ATLANTIC ADVISORY SERVICES NETWORK

THE SEA GRANT MID-ATLANTIC ADVISORY SERVICES NETWORK, formerly the Mid-Atlantic States Advisory Services, was established in 1980. The network is comprised of the region's Sea Grant Programs from the six mid-Atlantic states (New York-North Carolina). The network was formed to serve several purposes. These include providing a structure to respond to regional issues as a group; to efficiently mobilize the expertise and skills of member programs to benefit the region; and to foster continued collaboration on cooperative projects that address regional marine resource issues. During 1984, a charter was adopted for the network that formally embodies these principles.

Member institutions are: New York Sea Grant Institute, New Jersey Marine Sciences Consortium Sea Grant Program, University of Delaware Sea Grant College Program, Maryland Sea Grant College Program, University of North Carolina Sea Grant College Program, and Virginia Sea Grant College Program.

The Sea Grant Mid-Atlantic Advisory Services Network has conducted a number of workshops, conferences, and cooperative demonstration projects. Representative accomplishments include:

WORKSHOPS

* The SGMAAS has sponsored several soft-shell crab workshops. Expertise from the states of Virginia, Maryland, and North Carolina has been shared throughout the region at various workshop locations. Workshop topics have ranged from facility designs to marketing and economics. Participation from both the business and academic communities during these sessions has resulted in the transfer of technical and practical information which has fostered a significant increase in the production of soft-shell blue crabs in the mid-Atlantic region. The economic impact of this industry is in the millions of dollars. Importantly, this impact is realized by all of the sectors of the industry which includes individual fishermen, shedders, and processors.

CONFERENCES

* "Striped Bass and Striped Bass Hybrids: Production and Potential" was a conference sponsored in cooperation with SGMAAS. This conference was a joint industry-government-university-planned effort designed to foster the exchange and discussion of current information on the topic. Issues discussed included aspects of culture and production, diseases and parasites, legal constraints, and marketing. Presently, several projects are underway ranging from site specific feasibility studies to the operation of prototype fish culture facilities.

DEMONSTRATION PROJECTS

* In cooperation with the National Weather Service (NWS), a cooperative computerized marine reporting (MAREP) collection center was established in Lewes, Delaware. At the site, radio reports are collected two scheduled times per day seven days per week and via microprocessor are sent to NWS. Discussions and meetings have been held with users to find ways of improving marine forecast services in the region. A slide/tape promoting and explaining the MAREP program has been cooperatively developed by the New York Sea Grant Institute in cooperation with NWS and distributed throughout the region.

By joining in this regional effort, the Sea Grant Programs of the mid-Atlantic states are able to more effectively apply the resources and expertise of the member institutions to problems associated with the development, conservation, and wise use of the marine resources of the mid-Atlantic region. For more information, contact: Dr. William DuPaul, SGMAAS, Virginia Sea Grant College Program, Virginia Institute of Marine Science, Gloucester Point, VA 23062.

THE SOUTHEAST MARINE ADVISORY SERVICE (SEMAS)

Using Resources Across The Region

The Southeast Marine Advisory Service (SEMAS) is a cooperative network of Sea Grant marine advisory programs in the coastal states from North Carolina to Texas and Puerto Rico. SEMAS serves as a medium for exchanging ideas, talents, and educational materials; it coordinates major regional educational programs for the public and training activities for the staffs of participating MAS programs; and it provides a structure through which business, industry, and government can work with the various Sea Grant programs. SEMAS is the vital mechanism through which regional needs and interests can be inserted into national programs.

Cooperation among the program leaders who compose the governing body of SEMAS is voluntary and the group has neither budget nor staff. Yet a number of important activities affecting marine and coastal matters throughout the Gulf and South Atlantic have resulted from this collaboration.

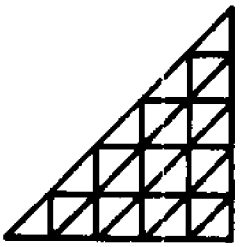
Conferences and Workshops. SEMAS cooperates with industry to promote educational programs for commercial fishermen, such as the three-day series of workshops, lectures, and films presented in conjunction with New Orleans' *Workboat Show '85*, and the symposia conducted at the *Commercial Boating and Fishing Exposition '83* in Miami. Specialty conferences and workshops, covering such topics as long-line fishing, energy conservation for fishing vessels, marine safety, and marine insurance, have attracted hundreds of fishermen and marine business people.

New Fishery Development. With the National Marine Fisheries Service and the Gulf and South Atlantic Fishery Development Foundation, SEMAS participated in efforts to develop new squid resources along the Atlantic and Gulf coasts. With the Mid-Atlantic Marine Advisory Service, SEMAS sponsored an interregional symposium on soft-shelled blue crab shedding research intended for scientists, marine advisory personnel, and ultimately, crab fishermen. SEMAS personnel have been active participants in the regional task force, composed of people from state and federal agencies, industry, and academia that developed the Marine Fisheries Research Initiative, intended to accelerate the economic development of Gulf of Mexico resources.

Educational Materials and Professional Training. With the National Marine Fisheries Service and the Georgia Marine Extension Service, SEMAS states participated in funding an important educational film on the dynamic behavior of shrimp trawls. The group has also sponsored a publication on soft-shelled crab shedding, a bibliography of coastal erosion, and a catalog of program resources. These materials are used in educational programs organized for a variety of audiences, including commercial fishermen, seafood processors, and coastal landowners.

Talent Sharing. Through SEMAS, researchers and marine advisory agents from one area share their knowledge and skills with those from another. A Louisiana crawfish specialist trained the marine agents of at least five other states in the pond cultivation of crawfish; a Georgia marine agent conducted seminars on twin trawling in the Gulf states; and researchers from Mississippi and Louisiana joined forces to conduct workshops on soft-shelled crab shedding in Alabama.

Coastal Weather. SEMAS has been instrumental in helping the National Weather Service to organize a southeast regional mariners' reporting system (MAREP), in which mariners radio their observations on offshore weather and sea conditions to a land-based operator and the information is relayed to the regional National Weather Service forecasting office. SEMAS personnel have been active in planning a 1985 national workshop on MAREP, involving personnel from the Sea Grant network and the National Weather Service.



THE GREAT LAKES SEA GRANT NETWORK

Enhancing and Safeguarding the Freshwater Fishery

The Great Lakes Sea Grant Network includes programs in New York, Ohio, Michigan, Wisconsin, Minnesota and Illinois-Indiana. One common aim of these programs is to foster wise use of the fish resources of the Great Lakes. Sea Grant's research and advisory services have played a major role in rehabilitating the Great Lakes fishery and in determining their size and economic value to the region.

THE FACTS

Nearly destroyed by overexploitation, the invasion of alien species and pollution in the first half of this century, the Great Lakes fishery has undergone a remarkable rebirth.

Virtually nonexistent just 20 years ago, the Great Lakes sport fishery today attracts about five million anglers, with a regional economic benefit of about $1.1 billion annually. The Great Lakes also support some 600 commercial fishermen, whose catch has a dockside value of about $48 million a year and a regional economic impact more than four times that. The rebirth of the fishery has been responsible for the economic revival of hundreds of Great Lakes coastal communities.

THE PROBLEMS

This billion-dollar resource could not exist at all without continuous control of the parasitic sea lamprey and continuous stocking of salmonid predators, including the once-native lake trout. Today, this resource is also imperiled by the destruction of spawning habitat and by contamination of the fish by toxic substances from both point and nonpoint sources, including the atmosphere.

Management of the fishery for maximum sustainable harvest is impeded by uncertainties about the size and potential of the lakes' forage fish populations, the maintenance of which is critical to sustaining the sport fishery. It is also frustrated by the fact that some 40 separate international, national, interstate and state governmental units have an influence on research, regulation, management and manipulation of the fish stocks and fisheries of the Great Lakes.

THE RECORD

Sea Grant researchers have analyzed the effects on the Great Lakes ecosystem of both the sea lamprey and the lampricide used to control it. They have identified and mapped for the first time the spawning grounds of various Great Lakes fish. They have traced the sources, pathways and fates of PCBs and other Great Lakes contaminants and analyzed the health effects of these contaminants on fish and people alike.

Sea Grant Great Lakes researchers have also provided state and federal management agencies with critical information about the life histories and interactions among the lakes' forage fish populations upon which to base stocking decisions.

Sea Grant institutions have taken and will continue to take the lead in establishing new directions for management of the fishery and in exploring new potentials for the continued development and maintenance of this Great Lakes resource by providing:

Comprehensive information about the Great Lakes Ecosystem. New York Sea Grant researchers are compiling new data on the population dynamics of both the Lake Ontario and eastern Lake Erie fisheries, while Minnesota and Michigan Sea Grant researchers are developing a means of exploiting and managing the relatively new pink salmon fishery in Lake Superior. Ohio Sea Grant scientists continue to provide valuable information on the spectacular walleye fishery that has arisen in western Lake Erie amid its vastly improved water quality. Wisconsin and Michigan's Sea Grant programs are currently cooperating with their state Departments of Natural Resources on a lake trout rehabilitation project in Lake Michigan that also involves a National Oceanic & Atmospheric Administration research vessel. Michigan and Wisconsin are also cooperating on an assessment of whitefish stocks in northern Lake Michigan, one of the most important fisheries in the lake.

New Tools for Fishery Management. Wisconsin Sea Grant researchers have developed a prototype model of Great Lakes predator-prey interactions that fishery managers throughout the region can use to make stocking decisions based on trends in the forage base and a variety of other factors. The predictive capacity of this modeling approach is now being tested in the Salmonid Diet Survey program involving the entire Great Lakes Sea Grant Network, the U.S. Fish & Wildlife Service, the Ontario Ministry of Natural Resources and several state agencies. Michigan Sea Grant researchers are developing a management model for Lake Superior herring stocks.

Pioneering Research on Contaminants in the Environment. The Great Lakes Sea Grant programs have been national leaders in providing information about the sources, environmental fates and health effects of PCBs, dioxin, toxaphene, mirex, lead and a host of other toxic contaminants. Wisconsin Sea Grant researchers were among the first in the world to study the human health effects of prolonged, low-level exposure to PCBs. Minnesota and Wisconsin Sea Grant scientists also determined that the atmosphere is a major source of many of the contaminants found in the Great Lakes.

Promoting Use of the Fishery and Its Products. The Sea Grant Great Lakes Network has played a major role in publicizing Great Lakes fishing and fish products. Recently, New York Sea Grant Extension helped private businesses create the Lake Erie Trail, now a part of the National Seaway Trail. Following the shore from the Eisenhower Locks on the St. Lawrence River to Lake Erie, a major attraction of the trail is its many excellent fishing sites, which were identified by New York Sea Grant agents. Minnesota, Michigan, New York and Wisconsin Sea Grant scientists have also developed better storage and packaging techniques for fresh fish.

The Great Lakes Sea Grant Network is the vehicle whereby—for the first time—research on the Great Lakes is being coordinated so that duplications of effort are avoided, methodologies are being standardized and results widely disseminated. Sea Grant researchers provide objective information for better understanding and resolving controversies among managers and users of the Great Lakes and the lakes' fisheries. Sea Grant advisory services field agents deliver research results to users and convey the research needs of users back to Sea Grant scientists.

Clearly, the future of the billion-dollar fishery of the Great Lakes is closely tied to continued, coordinated research on all facets of the Great Lakes ecosystem—the kind of research represented by the Great Lakes Sea Grant Network.

November 1984

Pacific Sea Grant College Program (PSGCP)

Five Sea Grant college programs in the Pacific states—Alaska, California, Hawaii, Oregon, and Washington—are working cooperatively to achieve sound management and utilization of the vast resources of the Pacific. The ocean area covered by their activities exceeds the landmass of the continental United States.

The formalized network organized by these programs, which is known as the Pacific Sea Grant College Program (PSGCP), grew out of earlier cooperative activities going back some 15 years. The present objective of PSGCP is to provide coordination and support for major regional activities in education, research, and advisory services.

Among recent activities are the following:

- In the autumn of 1983, over 300 people from 10 countries met in Seattle at the International Symposium on Salmonid Reproduction. This symposium, focused on the scientific basis for salmonid enhancement, was the major meeting of the past decade involving those scientists, industry, and government officials who are concerned with the enhancement of troubled salmon stocks. The meeting was organized by the University of Washington with support from the other PSGCP institutions and held in cooperation with the National Marine Fisheries Service and the Department of the Interior.
- In June of 1984, PSGCP sponsored a workshop on Guam on the taxonomy of selected economically important algae of the Pacific. A small group of leading taxonomists from the United States, Guam, the People's Republic of China, Australia, Taiwan, Chile, and Japan spent four days conducting comparative assessments of different specimens. A proceedings with photos and taxonomic keys will be produced as an aid to algae identification; the publication will also contain suggestions for needed follow-up activities. The California Sea Grant College Program planned and conducted this workshop.
- A workshop on Biological Interaction Among Marine Mammals and Commercial Fisheries in the southeastern Bering Sea was held in Anchorage, Alaska in October 1983. Sponsored by PSGCP, the Marine Mammal Commission, and the North Pacific Fishery Management Council, the workshop, which attracted 81 participants, consisted of 15 major presentations and four working sessions on marine mammals and groundfish, salmon, herring, and shellfish. Workshop proceedings were published by Alaska Sea Grant.
- The Oregon State University Sea Grant College Program organized a two-day conference for PSGCP on small boat fisheries as part of the seminar series at Fish Expo '83 in Seattle. Fish Expo involved 16 sections with 48 speakers and 3,000 participants.
- The markedly increased volume of debris in the world's oceans was the topic of concern at a workshop held in November 1984 in Honolulu for scientists, technicians, and members of the marine community. The presence of marine debris, such as lost fishing gear and nets, has created concern over entanglement of marine mammals, reptiles (turtles), seabirds, and fishes, and may result in fouling of vessel propulsion systems. The meeting was co-sponsored by the University of Hawaii in cooperation with other PSGCP institutions, the National Marine Fisheries Service, regional fishery management councils, and several other organizations.
- A five-day training workshop was held in December 1984 in Honolulu to bring together more than 60 marine advisors, specialists, and communicators from the Pacific Sea Grant colleges. The workshop addressed both highly focused topics, such as fisheries oceanography and seafood quality, and topics of broader scope, such as mediation and conflict resolution and long-range planning. The workshop also included a half-day session on computer systems.

Section 3. Statewide Capabilities

Descriptions of major Sea Grant programs conducted by 30 universities in coastal and Great Lakes states and Puerto Rico:

Alabama
Alaska
California (2)
Connecticut
Delaware
Florida
Georgia
Hawaii
Illinois
Indiana
Louisiana
Maine
Maryland
Massachusetts (2)
Michigan
Minnesota
Mississippi
New Hampshire
New Jersey
New York
North Carolina
Ohio
Oregon
Puerto Rico
Rhode Island
South Carolina
Texas
Virginia
Washington
Wisconsin

The University of Alaska Sea Grant College Program is a partnership between the university, the federal government, the state of Alaska, and industry encouraging the wise development, use, and conservation of Alaska's marine and coastal resources. The faculty and staff of the statewide university system advance their knowledge and skill in a program of marine research, education, and public service.

Alaska Sea Grant has been instrumental in promoting cooperative activities between governmental and industry organizations concerned with Alaska fisheries. Currently participating entities include:

—Alaska Department of Fish and Game—Alaska Trollers Association—
—Alaska Department of Transportation and Public Facilities—
—National Marine Fisheries Service—
—North Pacific Fishery Management Council—
—Northern Southeast Regional Aquaculture Association—
—United States Coast Guard—
—University of California—

Representative program achievements are:

Education

In 1978 Alaska Sea Grant undertook the revision of the Alaska Sea Week project to bring it from a kindergarten through sixth grade program developed by and for schools in southeast Alaska, to a program containing all aspects of the marine and coastal life found throughout Alaska for use statewide. This program has gained enormous momentum through a series of seven curriculum guides and teacher workshops. The Governor of Alaska proclaimed April 23 to May 11, 1982 as Sea Weeks. In 1984 the state of Alaska provided continuing support for the program through the university's College of Human and Rural Development.

Information

Alaska Sea Grant maintains a public information staff to provide information on fisheries and marine resources to Alaska residents, industry members, governmental agencies, and the university community. The past few years have averaged ten technical reports, four journal reprints, four marine advisory bulletins, and six informational brochures. In addition to printed materials, Alaska Sea Grant coordinates major conferences and symposia such as the Alaskan Marine Archeology Workshop, the International Sablefish Symposium, the Workshop on Biological Interactions between Marine Mammals and Commercial Fisheries in the Southeast Bering Sea, and the Symposium on Dungeness Crab Biology and Mangement. Proceedings of these meetings are published and have proved valuable for use as "source books" by resource biology and management personnel.

Research

Cooperative research between Alaska Sea Grant and the Alaska Department of Fish and Game has lead to a better understanding of the life history of the commercially important Tanner crab. Research results have allowed the harvest to be increased while still providing protection of the resource.

Paralytic shellfish poisoning (PSP) is a major public health and economic problem and a severe impediment to the development of major coastal clam and mussel fisheries resources in Alaska. Research supported over the past ten years by Alaska Sea Grant, the Food and Drug Administration, and others has identified the dinoflagellate *Protogonyaulax* as the source of the toxin, that the cells vary in toxicity, that there are at least 12 toxins involved, and that they are not necessarily detectable by conventional assay methods. Findings imply that management strategies will need to vary from one region to another, but the same strategy can be applied throughout a region.

For further information contact Alaska Sea Grant College Program, University of Alaska, 590 University Avenue, Suite 102, Fairbanks, Alaska 99701, (907) 474-7086, Donald H. Rosenberg, Director.

October, 1984

CALIFORNIA SEA GRANT

The California Sea Grant College Program—largest of the 29 Sea Grant programs in the United States and Puerto Rico—is a statewide partnership among government, industry, colleges and universities, and the public. Its mission is to promote wise development of our nation's marine resources through programs of responsive research, education, and advisory services. The National Sea Grant College Program is part of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

One aim of California Sea Grant is to support research that will result in practical applications. Among the programs funded by California Sea Grant are projects that have:

- Tested new pharmacological compounds derived from marine organisms. The compound manoalide, derived from a marine sponge, has for example been shown to be a potent anti-inflammatory and analgesic agent.
- Investigated tremie concrete for bridge piers and other massive underwater placements; this work later formed the basis for the massive concrete footing of the Hope Creek (New Jersey) Nuclear Power Plant intake.
- Developed a squid cleaning machine that does in seconds what used to take as long as 20 minutes. A prototype of the machine is being tested commercially. Estimates are that the machine could increase the value of the squid fishery fifty-fold, boosting the economic value of the fishery to $60 million annually.
- Discovered a correlation between the lunar cycle and smoltification-related thyroxin surge in salmonids. When coho salmon releases were timed on the new moon, ocean catch and hatchery returns improved by more than two-fold. In addition, the degree of the thyroxin surge can be enhanced by salt treatment.
- Developed storage techniques which keep fish fresh seven to nine days longer than conventional methods. Designed a free-moving fish fileting knife that runs on an air motor instead of an electric motor.
- Demonstrated that modern biochemical and genetic engineering techniques can be used to improve the production of abalone and other commercially valuable shellfish.
- Developed artificial propagation techniques for aquaculture of Pacific sturgeon. Commercial operations are being developed using techniques from this program.
- Provided information and advice on coastal wetlands to port districts, residential development organizations, planning agencies, and the federal government, with the aim of protecting marshlands for their environmental and economic benefits.
- Trained nearly 400 graduate students since 1972 in technical aspects of biology, chemistry, economics, engineering, geology, oceanography, and political science. Most of these students are now putting their skills and knowledge to work in government, industry, and university positions throughout the United States.
- Have shown that artificial elevation of intracellular pH increases hatchability of cysts of the brine shrimp *Artemia salina*. This result has particular applications in the aquaculture industry, which uses nauplii hatched from the cysts as feed for cultured shrimp, lobster, and fish.
- Educated more than 500,000 people annually through public displays, outreach programs, and consumer workshops on fisheries management and economics, salmon and abalone enhancement, trawling and gear development, alternative fisheries development, and the use of remote sensing data.

In addition to supporting application-oriented marine research, Sea Grant sponsors educational activities to communicate research results to government agencies, marine-related industries, scientists, fishermen, aquaculturists, and consumers—people who can translate research information into social and economic benefits for the coastal regions and the nation.

Since its inception in 1968, California Sea Grant has funded marine activities at more than 30 academic and marine institutions in California, including: California Institute of Technology; California State Universities at Humboldt, Long Beach, Northridge, San Diego, San Francisco, and San Jose; Claremont College; Loyola Marymount University; Moss Landing Marine Laboratories (a consortium of six state universities in northern California); Occidental College; Southern California Ocean Studies Consortium (comprising six state universities in southern California); Stanford University; University of California campuses at Berkeley, Davis, Irvine, Los Angeles, Riverside, San Diego, Santa Barbara, and Santa Cruz; University of San Diego; and University of Southern California.

In addition, the California Sea Grant College Program, in cooperation with the Pacific Sea Grant college programs in Alaska, Hawaii, Oregon, and Washington, is working to conserve and develop the vast resources of the Pacific Ocean. For more than a decade the Pacific Sea Grant college programs have provided advisory and education services regionally through the Pacific Area Sea Grant Advisory Program. This coordinated Sea Grant research base along the Pacific Rim has enhanced local marine advisory programs and allowed the development of regional educational workshops and research symposia.

Dr. James J. Sullivan, Program Manager, California Sea Grant College Program, University of California, San Diego A-032, La Jolla, CA 92093, (619) 452-4440

SEA GRANT'S HELPING MAKE THE U.S. #1 IN THE OCEANS . . .

And the USC Sea Grant Program is a part of that effort!!

Since the early 1900s, the University of Southern California has been involved in the areas of marine science, ocean engineering and marine policy. The USC Sea Grant Program, a part of the university's Institute for Marine and Coastal Studies (IMCS), is helping to carry on that tradition by linking university research with industry and user groups, which put research results into practice.

Virtually the entire population of Southern California is affected by the use and management of the ocean — for jobs, for goods and services, and for recreation. Therefore, the intelligent use and management of the ocean's scarce resources are of vital concern to all Southern Californians.

USC Sea Grant was established in 1969 and, since that time, has maintained its commitment to applying the expertise of specialists to solve special marine and coastal problems of the region through:

Research that spans coastal and marine resources, environmental problems, coastal management and ocean engineering.

Marine Education for elementary, secondary and adult classes.

Advisory Services for recreational activities, government agencies and private industry.

Recent accomplishments in these areas have included:

— Development of a new and inexpensive assay for the toxins that cause paralytic shellfish poisoning.

— Marine weather information for recreational boaters and commmercial fisheries, via radio, telephone and publications.

— Pollution studies in the Los Angeles and Long Beach harbors.

— Graduate courses and workshops on seaport management and related issues.

— Teacher guides for incorporating marine subjects into school curricula.

— Studies of nearshore fisheries.

— Models of wave effects on platforms.

— Tests on stress resistance of welds in sea waters.

Further information on USC Sea Grant's services and programs is available by contacting:

USC Sea Grant Program
Institute for Marine and Coastal Studies
University of Southern California
University Park
Los Angeles, CA 90089-0341
Phone: (213) 743-6068

CONNECTICUT SEA GRANT is a statewide program of marine research, education and advisory services.

CONNECTICUT SEA GRANT is part of a nationwide program of research that contributes to the growing body of knowledge about our coastal and oceanic resources and to the solution of contemporary problems in the marine sphere.

THE SEA GRANT MARINE ADVISORY SERVICE transfers the information and technology developed in the national research network to a wide community of users in Connecticut, the region and the nation.

Sea Grant also supports a broad range of educational programs for students at all levels, and for adults, so our coastal and oceanic resources may be understood and judiciously used by this and future generations.

The Sea Grant office, at The University of Connecticut's Avery Point Campus, has been designated the coordinating center for maritime activities and information in education and research for the State of Connecticut.

More than a dozen institutions are involved in the Connecticut Sea Grant Program, including The University of Connecticut, Fairfield University and Western Connecticut State University.

Connecticut has had a Marine Advisory Service, operating as part of the Cooperative Extension Service, since 1974. The Sea Grant program was established in 1980.

Sea Grant makes every effort to develop research interests in the major problems of the region. Current research centers on hard clams, soft clams, the behavior of dredge spoil mounds, growth regulators in crustacea, and the production of biomass in seaweed.

These are some of the ways Sea Grant is serving Connecticut:

- Researchers have identified techniques for raising hard clams that will insure increased survivorship of seed clams. Managing the conditions under which clams are grown can foil predators and permit greater numbers of clams to reach maturity, when they can be harvested for commercial or recreational purposes. In Connecticut, the potential for a sizeable industry exists as an acre of cultivated clam ground can yield $35,000 worth of clams. One commercial hatchery has already gone into operation as an outgrowth of the research.
- Advisory Service agents have worked with nine shoreline towns in developing shellfish management plans, in creating shellfish commissions, and were instrumental in establishment of a statewide Aquaculture Commission.
- Researchers studying behavior of mounds formed in disposal of material dredged from Connecticut's harbors expect to produce a handbook of dumping procedures that will result in stable mounds and procedures for covering or "capping" contaminated materials in the dredge spoil mounds. They estimate savings as high as $400,000, if the depth of capping material could be reduced by one yard on a mound 250 yards in diameter.
- Technical assistance provided by Advisory Service agents contributed materially to revitalization of the Port of Stonington, home of the State's sole commercial fishing fleet. That work paved the way for construction of a $300,000 dockside processing plant in 1984. Other cities which have benefited from technical assistance include New London, Norwalk and New Haven.
- Advisory Service agents work with fishermen and others in the marine trades to help them increase their income through better financial management and more efficient operations, and provide instruction through demonstrations and workshops on netmaking, specific fishing techniques and seafood quality.

The University of Connecticut is developing the Avery Point Campus into a major marine research center. Besides Sea Grant, the campus houses the UConn Marine Sciences Institute, NOAA's National Undersea Research Program, and Project Oceanology. The U.S. Coast Guard Research and Development Center, which is also on the Avery Point Campus, is one of a host of state and federal agencies with which Sea Grant has ties. Others include the U.S. Coast Guard Academy, the Naval Underwater Systems Center, the Naval Submarine Base, the Internal Revenue Service, and National Marine Fisheries Service Laboratory in Milford, as well as Connecticut's Departments of Environmental Protection, Agriculture and Transportation.

We believe that the total program in Connecticut — research, advisory services and education — closely matches the needs of the State as well as the goals of the National Sea Grant College Program.

For more information on Connecticut Sea Grant, contact:

Dr. Victor E. Scottron, Director
Connecticut Sea Grant
The University of Connecticut at Avery Point
Groton, CT 06340
(203) 445-5108

UNIVERSITY OF DELAWARE (UD) SEA GRANT COLLEGE PROGRAM

Now in its seventeenth year in Delaware, Sea Grant continues as a partnership in which the university, industry, and government pool their intellectual and financial resources to address coastal and marine issues. The primary objective of the UD Sea Grant College Program is

> *to stimulate practical marine resource development and use through application-oriented research, manpower education and training, and advisory services.*

Current emphasis in the Delaware program is in estuarine and coastal environmental assessments, marine biotechnology, geological and coastal dynamics, and marine programs outreach.

Research. Faculty members are conducting research that contributes information that can be used to solve identified coastal and marine problems and needs. These are some of UD Sea Grant's accomplishments through research:

- The corrosion of ships, offshore structures, and materials used in the marine environment annually results in billion-dollar losses to industry. A multi-institutional research program has verified that calcium-based deposits are more protective than magnesium-based deposits, making it possible to begin to manipulate the calcareous coating to get the best protection possible.
- To reduce feeding costs of controlled-environment maricultured oysters, scientists have found that the food costs of culturing juvenile oysters could be reduced by 56% using a 50% algal ration supplemented with yeast, rice starch, and kaolinite, instead of a 100% algal ration.
- Delaware and New Jersey are jointly involved in a comprehensive study of the Delaware Estuary, on which a large area depends for continued industrial and recreational growth. Defining how this system works, describing its health, and providing managers with predictive models to assess future trends could save potentially the loss or misuse of millions of dollars.
- Salt-tolerant plant research has identified several halophytes with potential use as grain, vegetable, and forage crops, which could grow in high salinity coastal and estuarine waters, where traditional crops cannot grow. One plant yields an oil similar to safflower oil and a crude protein content approaching that of the soybean.
- Chitin, a cellulose-like component of the shells of crab, shrimp, and other marine animals, is being investigated for its possible use in absorbable sutures. In recent calf-feeding trials, researchers have found that diets containing both chitin and whey, a cheese industry waste product, could reduce the cost of food production while reducing environmental waste, resulting in substantial economic savings.

Advisory Service. Marine Advisory Service (MAS) outreach activities serve the public, the users of our marine resources, by extending the knowledge gained by research:

- Through cooperation with the National Weather Service, MAS began a marine weather reporting system to improve the safety and reduce the losses to recreational and commercial fishermen, and other vessel operators.
- Focusing on shark as an underutilized species, specialists produced a videotape on "Shark Preparation and Cuisine" to help educate consumers on how to use this unfamiliar fish economically and nutritionally.
- A special series of *Delaware Estuary Situation Reports* was initiated to communicate and interpret the bistate Delaware Estuary research project findings. The series is designed to relate research on the Delaware Estuary to resource management concerns and practices of the region.
- A socio-economic analysis of the Delaware charter/head boat-industry indicated that per-trip expenditures by anglers contributed significantly to local economies. The findings are being used by several captains to target their marketing efforts.
- MAS cosponsored the Governor's Conference on the Inland Bays and one specialist served on the Inland Bays Task Force, charged with making recommendations to control future growth and development in the area surrounding the bay.

Education. As important as research and advice is the training of young professionals who, through their Sea Grant education, become aware of the importance of our marine resources and become prepared to deal with present and future marine issues. During the past year, 30 graduate and undergraduate students have received Sea Grant support and have been exposed to marine studies.

Sea Grant is a mechanism to identify and bring together all aspects of marine and coastal resources. As it provides answers to problems of the local, regional, and national coastal and marine environments, the program is relevant and of use to state agencies, legislative committees, industries, and individuals.

We would be pleased to provide you with further information on our program. Contact:

Dr. Carolyn A. Thoroughgood, Director
University of Delaware Sea Grant College Program
University of Delaware
Newark, Delaware 19716
(302) 451-8062

Florida Sea Grant College. . . .is a university program aimed at solving real problems. Faculty skills in research, education and extension services focus on the wise use, development and management of Florida's coastal and marine resources. Sea Grant relies on the knowledge and talent in the nine state and two private universities. These institutions are:

Florida A & M University • Florida Atlantic University • Florida Institute of Technology
Florida International University • Florida State University • University of Central Florida
University of Florida • University of Miami • University of North Florida
University of South Florida • University of West Florida

SCIENCE FOR THE PEOPLE

Research projects are funded in the universities as needs are identified. Non-federal sources of funding include matching industry, agency or citizen support. Projects are funded based on their rationale, scientific contribution and potential for application. A few of the more significant accomplishments during the past ten years are:

* Analyzed, labeled and experimented with vibrios to dispel some of the fear and mystery surrounding cholera and showed that no cases have resulted from eating commercially prepared seafood.
* Examined a promising surfactant as an inhibitor of marine biofouling-- a major problem with all vessels and structures in marine waters.
* Developed a method used by the state resource agency to estimate the amount of sand held in offshore bars to judge the feasibility of barrow sites for beach nourishment projects.
* Conducted research on corrosion fatigue of welded steel in seawater with results incorporated directly into the American Petroleum Institute practices on design of fixed offshore structures.
* Developed a methodology for data collection and evaluation of structures for use as hurricane shelters.
* Conducted research on barrier islands, their mobility since origin, response to storms and prediction of future barriers and mobility. This work has been used by Florida coastal cities in guiding coastal development.
* Evaluated the use of fiber and polymer-modified concrete for use in marine structures.

EXTENDING OUR KNOWLEDGE THROUGH APPLICATION

Sea Grant Marine Extension agents and specialists provide statewide coverage through eleven coastal county Extension offices and the Florida Cooperative Extension Service. Campus based specialists and agents utilizing faculty talent statewide identify research needs and develop educational programs. Some activities are:

* Demonstrated harvesting and processing techniques to show that a potential new deep-sea crab fishery exists in the Gulf of Mexico. Commercial companies are currently outfitting vessels to participate.
* Organized a symposium to bring technical information to decision makers and to identify priority research, education and management concerns for the 140-mile-long Indian River system on Florida's east coast. A similar effort is underway for Northeast Florida.
* Organized over 20 workshops for more than 500 participants in coastal engineering.
* Conducted a marina seminar to provide more than 200 owner/operators the latest research results and technology in economics and engineering.
* Transferred technology from the Chesapeake soft shell blue crab fishery to Florida with 20 firms now attempting soft crab production--an industry with a potential annual dockside value in excess of $1 million.

EDUCATION FOR OUR FUTURE

In addition to marine research and Extension activities, education efforts by Florida Sea Grant College have been effective in a number of areas, including:

* Participation of more than 300 students in Sea Grant projects at the state and private institutions. This includes undergraduate programs as well as advanced degrees in fields ranging from fisheries to philosophy with emphasis on the sciences.
* Provision of "seed money for start-up of courses to train professional divers and marine propulsion systems mechanics. Industry contributors have been Outboard Marine Corporation, Evinrude Motors, Johnson Motors and Mercury Marine.
* Assistance in funding a ship and yacht design course utilizing computer graphics aids in the design of both power and sail yachts. The course, the first of its kind to be offered at a U.S. university, has been taught three times. Students included those needing to upgrade current employable skills.

The combined effort of Sea Grant research faculty and Extension agents has built an effective framework that has created inter-institutional cooperation in solving Florida's critical coastal problems. In addition, bridges have been built to Sea Grant institutions who help form the National Sea Grant College Program, to industry, and to federal, state, and local agencies, and the coastal public--one large web of institutions and people cooperating with each other in the common task of responsible development and management of our marine resources.

For further information on the Florida Sea Grant College Program contact:

Dr. James C. Cato, Director
Florida Sea Grant College Program
Building 803, University of Florida
Gainesville, FL 32611
(904) 392-5870

GEORGIA SEA GRANT PROGRAM
UNIVERSITY SYSTEM OF GEORGIA

ECOLOGY BUILDING ATHENS, GEORGIA 30602 (404) 542-7671

In 1785, the Georgia legislature established the land grant concept by chartering the Nation's first state university. Almost a hundred years later, the University of Georgia, the first land grant institution, became the Nation's fifteenth Sea Grant College. President Fred C. Davison has said, "No program more clearly demonstrates this university's commitment to RESEARCH, EDUCATION, and SERVICE for the benefit of the state, region, and the nation through a strong state-federal partnership than the GEORGIA SEA GRANT COLLEGE PROGRAM."

Although strongly focused on the needs of Georgia's coastal and marine communities, the Georgia Sea Grant College Program has the potential for wider impact through a network of more than 30 Sea Grant universities bordering the oceans and the Great Lakes. These institutions make up a coordinated system which generates and disseminates information and technology to address the significant marine resources problems and opportunities which confront the United States today.

A few examples of current Sea Grant projects with significance and application beyond Georgia's boundaries include the following:

- In studies conducted to facilitate the development of an eel fishery in Georgia, eel behavior was studied by divers and recorded by underwater cameras. Based on these observations of eel movement and foraging habits, more efficient traps are being developed for the capture of eels.

- Biologists are isolating natural compounds from marine organisms in an effort to find prototypes for pesticides that are more selective and more easily biodegraded than man-made pesticides now used by agriculture.

- The performance characteristics of recently developed shrimp trawls were recorded on film in a project designed to demonstrate techniques for maximum trawling efficiency and for lowering the rate of fuel consumption in shrimping operations.

- Food scientists are searching for ways to use underutilized finfishes in products already a part of traditional foreign markets in an effort to diversify and expand the seafood industry and help to ease the U. S. trade deficit.

THE UNIVERSITY OF HAWAII SEA GRANT COLLEGE PROGRAM

Research, extension, and education – the tripartite mission of the University of Hawaii Sea Grant College Program – have dynamic, changing foci as projects are completed and new initiatives are begun. Highlights and major areas of emphasis include the following programs:

In aquaculture Sea Grant projects have developed both theoretical and applied approaches to increase prawn production

- a numerical model can predict harvestable population in ponds
- a new net design has improved the harvesting of prawns from mud-bottomed ponds

In tourism and recreation extension agents have worked with local individuals and groups on the island of Hawaii to develop

- a community action plan to enhance the attractiveness of and access to the island's unique marine resources for the use and enjoyment of residents and visitors alike

In fisheries scientists have made breakthrough discoveries in

- tracking the horizontal and vertical movements of tunas in an innovative capture-and-pursuit vessel
- developing preliminary mathematical models of the best sites for the deployment of fish aggregation buoys
- improving fish aggregation buoys to alleviate fish hook damage and to eliminate points with high corrosion potential

In educational programming Sea Grant funds have supported the initiation of

- professional-level summer educational programs, focusing on coral reef systems, for participants from Hawaii and other states and a number of foreign countries

In economics Sea Grant researchers studied the implications of fishery-related joint ventures on the economies of the host country in the western and South Pacific to enable

- Pacific island communities to negotiate better joint venture agreements with Asian rim nations

In law and public policy Sea Grant support enabled

- the convening of leading international law of the sea scholars and governmental officials to discuss customary international law governing Pacific Ocean activities
- a comparative study of legal, institutional, and economic factors expected to influence the siting of manganese nodule processing plants in six countries – Australia, Canada, Columbia, Ecuador, Fiji, and the Philippines – to provide public and private sectors with critical information needed for decisionmaking

For further information, please contact:

University of Hawaii Sea Grant College Program
Marine Science Building, Room 220
1000 Pope Road
Honolulu, HI 96822
Phone (808) 948-7031

Illinois-Indiana Sea Grant Program

Between 8 and 9 million people living in Illinois and Indiana live within an hour's drive of the shores of Lake Michigan. The tremendous impact of this midwest megalopolis on the 105 miles of this Lake's shoreline is staggering.

Focus

The Illinois-Indiana Sea Grant Program focuses on helping people get the most out of this precious marine resource. It points out resources and potential to businesses and private individuals in both Illinois and Indiana and provides the two states with an opportunity to further public understanding of the Great Lakes.

Initiated in April 1982, this Program is the most recent to be approved by the National Sea Grant College Program. The University of Illinois at Urbana-Champaign and Purdue University are the initiating institutions.

The Program consists of an Extension and a Research component to help meet the needs of its constituents. A formal education component may be added as the Program develops.

Through the Illinois-Indiana Sea Grant Program, those who study Great Lakes marine resources are linked to those who use the Lakes' resources -- industry, government and the general public. To reach a broad spectrum of users, information is transferred through meetings, conferences, publications, media projects and personal contacts by marine extension personnel.

The Extension Program

The Extension component of the Program works with identified resource user groups in Illinois and Indiana through an advisory council and other task groups to identify problems and needs. It then carries these concerns and needs back to academic institutions so available technical information can be identified and provided to these resource users. Research projects can also be designed to obtain additional needed information.

The marine extension element for the Program will be focusing this year's Extension component on the following subject areas:

*Coastal awareness and use
*Tourism and recreation
*4-H/youth marine science education
*Aquaculture
*Transportation
*Marine enterprises
*Charterboat operations.

The Research Program

We are hopeful that the research projects being undertaken this year will provide valuable information for area residents as well as for scientists who may be interested in our findings. The projects include:

*Food Habits of Salmonids in Lake Michigan
*Prey Handling Times for Lake Michigan Salmonds
*Specialization in Relation to the Management of the Southern Lake Michigan Sportfishery.

The Illinois-Indiana Sea Grant Program is working continually to address the problems posed by the dense human population so near Lake Michigan's shores. The staff periodically revises its plans and projects to meet the needs of this ever-increasing user group.

As this relatively new Sea Grant Program continues to expand, it will take its place with the other more comprehensive programs working to achieve the goals of the National Sea Grant College Program.

For further information about this Program, please contact Robert Espeseth, Coordinator, Illinois-Indiana Sea Grant Program, University of Illinois, 203 Huff Hall, 1206 S. Fourth Street, Champaign, IL 61820. Phone: 217/333-1824.

Louisiana Sea Grant
Benefits and Accomplishments

Since 1968, Louisiana Sea Grant has been at the forefront of the state's efforts to develop sound scientific principles and information for the management of marine resources. The great size, biological productivity, and mineral wealth of Louisiana's coastal zone make the region singularly important to both the state and national economies; its management has been Louisiana Sea Grant's dominant concern, for without effective management, vital long-term economic and social benefits will undoubtedly be lost.

Based at Louisiana State University's Center for Wetland Resources, the Sea Grant Program is committed to research, education, and advisory projects that lead to practical solutions for the problems of marine resources management and utilization.

The following are representative of recently completed or ongoing Sea Grant projects in research and advisory services that benefit the state of Louisiana and are in keeping with the goals of the National Sea Grant Program.

- Chemical spills and the discharges of industrial wastes into waterways cause serious concerns about the contamination of drinking water and the resulting public health problems. Present methods of removing or reducing toxic wastes are often inadequate and expensive, sometimes creating new combinations of chemicals that are more dangerous than the original toxicants. Using genetic manipulation, Sea Grant researchers have developed strains of bacteria that can destroy hazardous wastes—the first microorganisms tailor-made to feed on such toxicants as PCB, PCP, PAH, and creosote in brackish and saltwater environments as well as in fresh water.

- Louisiana's seafood processing industry discards enormous amounts of wastes, creating serious and costly disposal problems. Sea Grant researchers developed a process to recover the orange-red pigment astaxanthin from the waste products of shrimp and crawfish processing plants—thus turning the wastes into a vaulable resource. When added to the diets of commercially grown salmon and trout, astaxanthin gives these fish the rich color and flavor of wild populations, increasing their market value considerably.

- Sea Grant has recently concluded ten years of research on crawfish aquaculture, which virtually established and developed a thriving industry in Louisiana from what had once been just a traditional wild harvest. Though Sea Grant's investment over the decade was only $300,000, this industry has had an economic impact on Louisiana of over $70 million.

- Louisiana Sea Grant and the Mississippi-Alabama Sea Grant Consortium cooperatively built and tested a crab-shedding facility that uses a closed, recirculating water system. The information provided by this facility, disseminated through publications and annual workshops, has enabled soft-shelled blue crab producers to design and operate commercial facilities without the financial risk inherent in systems that use untreated water from natural systems.

- The dynamic forces fostering the growth of the evolving Atchafalaya delta and their extensive impacts on surrounding wetlands have affected many important activities in the region—commercial fishing, trapping, hunting, shell dredging, flood control, oil and gas production, and navigation. Louisiana Sea Grant's research program here has provided important information for governmental agencies and private industry in coastal management planning and resource-development projects.

- Louisiana's coastal marshes, which sustain the nation's most valuable commercial and recreational fisheries, are yielding to saltwater intrusion and erosion. Sea Grant sponsored research has been in the vanguard of state efforts to measure the rate of wetland loss, study the fundamental processes that control wetland growth and decline, and propose measures to reverse the declining trend. The results of Sea Grant research are also used by federal agencies like the U.S. Fish and Wildlife Service, the U.S. Corps of Engineers, and the National Marine Fisheries Service.

- Louisiana Sea Grant's Marine Advisory Program supports 20 marine agents and specialists who live and work throughout coastal Louisiana, providing information and practical assistance to their communities on a variety of topics such as aquaculture, seafood marketing, fisheries technology, mariculture, environmental management, recreation, and marine economics.

- Sea Grant marine advisory agents have been active in promoting new types of gear for Louisiana fishermen. One agent led shrimpers in the development and refinement of the aluminum trawl efficiency device (TED), which excludes jellyfish and other undesirable species from shrimp catches and has been adopted by the NMFS in its program to protect the sea turtle from accidental inclusion in fishing trawls. Other agents have worked to educate fishermen about special modifications that make bottom longlining for finfish more feasible in the northern Gulf, thus opening a new enterprise for Louisiana fishermen.

- Extensive workshops conducted by Sea Grant marine agents and specialists to teach retail seafood dealers how to increase their business—and, thus, profits—through more effective merchandising, greater product diversity, and more efficient quality control resulted in reports of sales increases from both large chain stores and independent dealers throughout the state.

- Sea Grant marine agents worked to establish state and federal programs for compensating fishermen who lose expensive gear on underwater obstructions in the northern Gulf, to assist fishermen in filing claims, and to aid the state in designating for removal some of Louisiana's most damaging underwater obstructions.

Louisiana Sea Grant College Program
Center for Wetland Resources Louisiana State University
Baton Rouge, Louisiana 70803

SEAGRANT

Sea Grant College Program

University of Maine

The Sea Grant College Program at the University of Maine is a cooperative program with the University of New Hampshire.

As part of the National Sea Grant College Program created by Congress in 1966, the University of Maine Sea Grant College Program is a statewide cooperative effort in marine research, education, and advisory service activities which focus on the coastal and marine opportunities of the Gulf of Maine.

Since its inception, the Sea Grant program in Maine has focused on these program areas: 1) Fisheries Development, 2) Fisheries Management, 3) Conflicting Demands for Marine Resources, 4) Education for the Development and Use of Marine Resources, and 5) Marine Environmental Research.

University of Maine Sea Grant projects in these program areas include:

FISHERIES DEVELOPMENT

- Development of **medicated diets for lobsters** to control gaffkemia, a bacterial disease which causes high mortalities among lobsters held in pounds, will significantly reduce the consequent, severe economic losses for Maine's highest value fishery.
- A Sea Grant researcher in economics, working with representatives from the Maine Fishermen's Cooperative and **Portland's pier operations** committee, is helping to establish sound operating rules for the auction on Portland's $25 million fish pier.

FISHERIES MANAGEMENT

- Over a decade of Sea Grant research on clam biology; clam seed-planting efforts in towns such as Jonesboro, Brunswick, and Freeport; and the economic impact of clam flat management have been compiled in the publication, ***Increasing Clam Harvests in Maine.*** This book will aid both the University and the Department of Marine Resources in assisting all coastal towns to manage their clam harvesting for optimal production.
- Sea Grant-supported studies on bottom-feeding flatfishes in conjunction with the Maine Department of Marine Resources and the National Undersea Research Program will lay the groundwork for new, **multispecies fisheries management** strategies in the Gulf of Maine.

CONFLICTING DEMANDS FOR MARINE RESOURCES

- Development of a model of the **circulation and tidal response of the Gulf of Maine** by Sea Grant researchers will provide an important contribution in evaluating the impact of tidal power development in the Bay of Fundy.
- Due to Sea Grant-supported studies on the structure of the Gulf of Maine fishery, a University of Maine economist has been selected as a special expert witness to the World Court proceedings at the Hague on the **maritime boundary dispute** between the United States and Canada.
- An annual conference on **East Coast Fisheries Law** is offered with Sea Grant support by the University's Marine Law Institute for those involved in managing New England's fisheries.

SHORELINE MANAGEMENT

- Sea Grant studies characterizing major **sandy beach systems** and suggesting guidelines for their future uses have led to the implementation of construction guidelines along Maine's sand dune areas and an amendment to an existing State of Maine law.

Joining with the many individuals and organizations in the state for guidance and knowledge, the Sea Grant College Program at the University of Maine is providing significant benefits in the development and management of Maine's marine and coastal resources.

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UNIVERSITY OF MARYLAND
Sea Grant College Program
H.J. Patterson Hall, University of Maryland, College Park, MD 20742

The Maryland Sea Grant College Program ...

Our mission: To improve and accelerate the development, use and management of the coastal, estuarine and marine resources of Maryland and the nation.

Our approach: To draw on the knowledge, talent and expertise in the universities, colleges and schools of Maryland and elsewhere for addressing marine resource problems and opportunities through a coordinated program of research, education and advisory services.

Through Research ..

To manage our resources wisely, we must understand them. Nowhere is this more evident than in our oceans, lakes and bays. To improve our understanding of an important natural resource, the Maryland Sea Grant College has focused its research efforts on the Chesapeake Bay—on estuarine biology and physiology. Furthering our understanding of estuaries and the seafood that comes from them, Sea Grant-supported researchers have:

- Studied the genetic make up of the striped bass or "rockfish," a much sought-after commercial and sport fish in grave decline. This research has told us more about the nature of striped bass migrations and has given us a highly improved method for the analysis of mitochondrial DNA from fish.
- Examined some of the important factors believed responsible for the decline of what has historically been the Chesapeake's most valuable fishery, the oyster. Researchers have analyzed oyster reproduction, nutrition and growth in an effort to identify weak links in oyster recruitment and production.
- Identified the role of a new bacterium, LST, in the metamorphosis and setting of oyster larvae—an important finding that could lead to the control of spat settlement and metamorphosis in oyster hatcheries or in the natural environment.
- Devised methods for examining nitrification and denitrification processes in the estuary.

Education ...

As part of Sea Grant's charter—and as an integral part of a large university—the Maryland Sea Grant College supports education, both informal and formal, focused on the Chesapeake Bay and the sea. In an active effort to promote both an appreciation and understanding of marine and estuarine resources, Sea Grant has:

- Supported outstanding undergraduate and graduate students pursuing marine-related courses of study.
- Worked with public school administrators and teachers to improve the presentation of marine-related course materials in the classroom.
- Produced films, slide shows, television and radio spots and publications informing selected publics about the problems, opportunities and potentials presented by the state's and the nation's abundant marine resources.
- Supplied timely information about striped bass, oysters and other commercially important fisheries to an interested public, including resource managers and planners.

Advisory Services ...

Louis Pasteur said that scientific research was most fulfilled when it found an outlet in practical application. In order to assure that new methods and insights find their way to relevant marine industries and public decision-making agencies (whether fisheries, seafood harvesting, processing, shipping, or recreation) the Maryland Sea Grant College works with the University's Cooperative Extension Service to deliver practical information and technical assistance. Marine advisory agents and specialists have:

- Improved methods for shedding of soft-shelled blue crabs—a growing business in Maryland.
- Worked closely with watermen who are interested in planting oysters on specially prepared plots in the Chesapeake Bay. Such work helps stimulate oyster production in the face of a declining wild fishery.
- Demonstrated, through the use of pond culture, how farmers and others can grow striped bass and hybrid stocks in closed farm ponds.
- Helped distribute information on navigation, fuel efficiency, collision avoidance, ship maintenance and marine safety to literally hundreds of thousands of boaters and fishermen.

MIT SEA GRANT PROGRAM

MIT Sea Grant is one of 29 programs in a nationwide network that carefully balances research, education, and advisory services to advance the use and management of ocean and coastal resources. MIT is collaborating with business, government agencies at all levels, and the public to find ways to:

- work more safely and economically in the oceans
- protect the productivity of the marine environment
- develop new, innovative uses of marine resources
- foster strong, efficient US ocean industries
- educate and train students for marine careers.

Sea Grant, A University-Based Program

The university base of the national Sea Grant program offers special help to marine industries who develop marine resources, to government agencies who manage marine uses, and to private citizens who benefit from marine products and a clean marine environment. Because the oceans are owned by everyone, many voices must be heard before decisions concerning resource development and management can be made. Universities provide an open forum, where groups with competing interests and conflicting viewpoints can meet with experts and initiate research that is mutually beneficial.

Academic institutions represent a large reservoir of talent and thus give Sea Grant the flexibility and ability to respond to the diverse needs of the marine community. Hundreds of researchers in the Sea Grant network have undertaken high risk studies and/or technology development that have had long-term payoffs. Unlike studies done for the benefit of a single organization, the results of Sea Grant's projects are made widely and freely available to anyone who has need of the information. Universities not only provide the free and open transfer of information, responsive and multi-disciplinary research, but they are also a superb training ground for young men and women who will work as managers, scientists, educators, and technologists in the marine field.

MIT, A Focus on Technology Development

For over a hundred years MIT has been a leader in marine engineering and technology development. In 1883 the Institute offered the first formal course leading to a degree in naval architecture and a year later established a department of sanitary chemistry, the first laboratory of its kind concerned with proper waste disposal and water pollution control. In 1970, MIT was the first private university asked to become a member of the network of Sea Grant institutions. Since then, faculty and students have made significant contributions to the development of new ocean technologies. For instance, the Program has:

- **been a pioneer in undersea robotics.** Robots are playing an increasingly important role in scientific and industrial operations offshore to increase diver safety. At MIT manufacturers and users of underwater robotic vehicles have collaborated with researchers from ocean, electrical and mechanical engineering departments to develop novel systems for new unmanned underwater vehicles. The systems include supervisory control for vehicles and manipulators, parallel linkage manipulators, tactile sensors, and sophisticated acoustic communication technology developed to meet industry needs. MIT faculty and students are combining and implementing these systems on an underwater vehicle, Sea Grant I.

- **created widely used modelling tools for assessing environmental effects of marine development.** An environmental and economic model was a critical tool for state, federal and private groups for assessing and negotiating oil and gas development on Georges Bank. A portion of the model, employed in response to the ARGO MERCHANT accident in 1976, is still being used by the US Coast Guard.

  To aid industries and government regulators, MIT Sea Grant created two hydrodynamic models that have been used to monitor environmental effects in large coastal bays throughout the US. Accurate information on the probable dispersion and circulation of particles and heat wastes has allowed local companies to engineer coastal power plants to specific conditions, thereby saving the companies and consumers millions of dollars while meeting clean water requirements of the Environmental Protection Agency.

- **fostered greater efficiency in the fishing industry.** Outdated technology has kept US fishermen from being competitive with foreign fleets in both domestic and international markets. The Center for Fishery Engineering Research at MIT has been given access to the large-scale and sophisticated National Ship and Research Development Center (NSRDC) in Bethesda, Maryland to work with industry and university researchers to improve the fuel and catch efficiency of widely used trawl nets.

- **converted wastes into beneficial pharmaceuticals through biotechnology.** To help turn millions of tons of fish wastes into profit centers for fishermen and beneficial pharmaceuticals for doctors and patients, Sea Grant sought out MIT's growing pool of biotechnology researchers. One project has shown that shark cartilage inhibits the spread of blood vessels that feed tumors. The results published in *Science* have attracted interest for their great promise in the control of vascular and some other kinds of cancer. In a companion project the viscera of flounder, cod, scallops and clams were found to be an abundant source of heparin, an anticoagulant that is critical in many kinds of surgery.

- **brought offshore companies together to make ocean operations safer and more economical.** MIT Sea Grant's advisory services, through the Collegium and the Communications/Information Office, have spurred collaboration among industry and university designers, hydrodynamicists, and structural engineers to address many of the long-term problems of recovering oil and gas supplies from deep waters. In one current geotechnical project, soil experts from MIT and a consortium of oil companies are correlating industry data with information gained from the application of a new procedure developed with MIT Sea Grant support. The result of this industry-university project will be the refinement of a cost effective, reliable technique for characterizing marine soils. This project, and the work leading to it, has also produced a well-trained cadre of geotechnical engineers—the dozens of students who have contributed significantly to research development.

For more information on MIT Sea Grant's education program, advisory service activities and its research in robotics, coastal processes, offshore facility engineering, living resource development, and other technology for ocean uses contact:

MIT Sea Grant Program Director,
Chryssostomos Chryssostomidis or
Executive Officer,
Norman Doelling
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Cambridge, MA 02139
(617) 253-7041

THE WOODS HOLE OCEANOGRAPHIC INSTITUTION SEA GRANT PROGRAM is a coherent effort that focuses most of its effort on research. Over the last several years emphasis has been on marine resources and related marine policy issues. Representative studies are:

* Paralytic shellfish poisoning (commonly known as *red tide*) study in the New England region, including possible methods for its control and pharmaceutical applications of the toxin.

* Stabilization of the bay scallop population in Massachusetts. The objective is to optimize the use of seed scallops from other areas or from hatcheries to compensate for natural losses of juvenile and to develop management techniques to optimize the harvest.

* A book and atlas on Georges Bank assessing existing knowledge of this important resource area and identifying areas for future studies.

* Study of the biogeochemistry and dispersion of PCB pollutants in the Buzzards Bay area, surrounding New Bedford, Massachusetts.

* Study of sediment bypassing of tidal inlets, in general, and sediment transport on Cape Cod.

* Polymetallic sulfide studies concerning policy and economic issues of this potential marine metals resource.

* Support of our International Marine Science and Policy Program that works with selected countries (Colombia, Ecuador, Brazil and Jordan) to assist them in the development of their marine resources and other marine opportunities.

Local and regional research and information projects also form an important part of our Program. Our Marine Assistance Service has worked to increase interactions with state and national shellfish agencies and associates as well as with selectmen and natural resource personnel in the local towns of Cape Cod. Our program at Woods Hole has also been involved with local teachers in several endeavors, including a marine studies lecture series for science/math teachers in the Town of Falmouth school system.

A joint doctoral program in oceanography exists between the Woods Hole Oceanographic Institution and the Massachusetts Institute of Technology; several of these students have been supported by Sea Grant.

The NATIONAL SEA GRANT COLLEGE PROGRAM plays a major role in the development of a responsive marine research effort for the United States by promoting the understanding, assessment, development, utilization and conservation of our Nation's ocean and coastal resources. The WHOI SEA GRANT PROGRAM has strived during the past decade to meet these ideals.

DR. DAVID A. ROSS - SEA GRANT COORDINATOR

Michigan Sea Grant College Program

ECONOMIC BENEFITS TO THE STATE, THE GREAT LAKES REGION, AND THE NATION

Michigan Sea Grant has contributed to the economic, environmental, and public welfare of the Great Lakes region. Through research, extension, and education, the program has helped to revitalize Michigan's economy and has broadly benefited the region and the nation.

GREAT LAKES FISHERIES

- Sea Grant research and extension activities are helping poorer, rural coastal counties in Michigan develop new practices and facilities to attract anglers, who bring much-needed revenue to these areas ($1 million in 1981 to Alcona County). Similar efforts are now being applied in other U.S. coastal counties.
- Sea Grant has developed highly efficient, low-cost nets for commercial fishers.
- Sea Grant research on ways to improve the natural reproduction of sport and commercial fish in the Great Lakes will reduce federal and state sport fish stocking costs, increase revenue from angler spending, and improve the commercial fishing industry.

COASTAL RESOURCES

- Sea Grant engineers have developed and tested effective, low-cost alternatives to expensive shore protection devices, lowering protection costs by up to 95%.

WATER SAFETY

- Sea Grant developed improved guidelines for divers which help prevent decompression sickness (the bends). Based on this research, a diver-carried device that tracks decompression status was recently developed and is manufactured by a Pennsylvania company. The device allows commercial divers much more time underwater, which translates into dollars saved.

TOXIC SUBSTANCES

- Sea Grant toxics research resulted in an economical laboratory method to identify potentially hazardous chemicals. The research has been used by major state and international agencies to develop critical hazards lists.

RECREATION AND TOURISM

- Sea Grant analysis of boater spending patterns is helping businesses and communities more profitably accommodate boating activity. In one city, Grand Haven, a Sea Grant agent helped develop a tax incremental financing plan to fund a marina expansion project.
- Sea Grant marketing research and extension efforts helped establish the first two underwater preserves in the U.S. waters of the Great Lakes. Michigan now has three preserves and a fourth is planned. The annual value of the diving tourist industry at an Alger County preserve is predicted to increase from $600,000 in 1980 to $5 million by 1990. A Sea Grant marine extension agent is helping the city of Munising establish and promote a land park and interpretive center next to this preserve.

TRANSPORTATION

- Sea Grant courses in ship and workboat production techniques helped U.S. shipbuilders compete in the international merchant marine construction market; led to a U.S. Navy contribution of $250,000 to The University of Michigan to develop a ship production curriculum; and resulted in the production of seven texts on advanced boatyard technologies for use in the industry.
- Sea Grant has studied cost-effective and environmentally sound ways to overcome constraints imposed by the narrow, icy St. Marys River at Sault Ste. Marie, such as a path control system that guides ships accurately through the narrow channels; and modifications to vessel design that would facilitate passage through ice without ship damage.

Michigan Sea Grant College Program

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Michigan State University - East Lansing - (517) 353-0647

Minnesota Sea Grant Institute

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MINNESOTA'S SEA

Sea Grant is a national program established in 1966 to promote the wise use of our marine resources. In Minnesota, Sea Grant is concerned with the country's largest inland sea: Lake Superior. As the largest, coldest, and northernmost of the Great Lakes, Superior has unique problems. Minnesota Sea Grant works toward solving those problems through research, extension, and education.

APPROACH

Research

Faculty at the University of Minnesota Twin Cities and Duluth campuses investigate a variety of issues, including: pollution of the lake, fish populations, the lake's ecosystem, water quality, prevention of hypothermia, and improving tourism and shipping in the region.

Extension

Area agents explain research results to the public and to organizations that can benefit from Sea Grant's work.

Education

Sea Grant supports and trains graduate students and American Indian undergraduates in the marine sciences.

RESULTS

°Northeastern Minnesota, including the region along Lake Superior, is the most depressed region in the state. But the region has great potential to build a strong tourism industry. Sea Grant economists, after completing a three year study, will be able to provide the state and private investors with options for developing new facilities and attractions to bring more people to the region.

°Sea lamprey have had a devastating effect on Lake Superior's trout populations. Recently, Sea Grant researchers suggested new methods to help management agencies deal with the parasitic lamprey. They showed that lamprey control should shift from chemical treatment of individual streams to control of areas with dense populations, minimizing the rate of lamprey reestablishment.

°Hypothermia is a contributing cause in 50 percent of the drowning fatalities in Minnesota. Sea Grant researchers studied how the body responds to cold water and the mechanisms it uses to protect itself. Sea Grant has researched this important field for six years, resulting in greater public awareness and scientific understanding of hypothermia and prevention of cold water drownings.

°The longer chemical herbicides are used, the greater the problem of plant resistance and environmental hazard. Sea Grant is working to create safer herbicides from naturally occurring lake algae. Researchers have already isolated a chemical which is toxic to some aquatic weeds and algae. The new products developed from that chemical could help solve resistance problems and would be plant-specific, killing only the intended plants while leaving fish and other plants unharmed.

°Sea Grant researchers found that management of nutrient inputs to Lake Superior must be changed to avoid long-term damage to the lake. A study of the three major nutrients entering the lake--phosphorous, nitrates, and silicates--showed that all three nutrients (not just phosphorous, as previously believed) must be controlled to maintain water quality and to keep areas with high nutrient input productive for the fishery.

°Chinook salmon are one of the major, non-native stocked fish in Minnesota. The timing of their release from the hatchery to the streams entering Lake Superior is crucial to their survival. Sea Grant researchers determined when chinook salmon reach smoltification, the time at which they should be released. Their findings show how salmon hatcheries may manipulate light to speed up smoltification, potentially decreasing hatchery expenses and improving the number of chinook salmon caught by Minnesota's fishermen.

°The United States exports more coal than any other country. Yet very little coal is shipped out the Midwest's Duluth/Superior port, even though the port is close to vast western coal reserves. Sea Grant economists are researching ways to improve the port's competitiveness with eastern ports.

°The number of boaters who want to launch on Lake Superior is increasing but the facilities to deal with them are not. Sea Grant extension helped the town of Two Harbors to organize, design, and get funding for a new boat launch, parking facilities, and a breakwall. The improved facilities are expected to bring more boaters and revenue to the area.

°The Duluth/Superior port wants to increase shipping to international ports. Sea Grant extension, by sponsoring a workshop on international trade, brought several business operators together to discuss ways to enhance the port's business. As a result of those discussions, a new processing facility and 500 new jobs were created in Duluth.

APPLICATIONS

Sea Grant is funded by the federal government, the University of Minnesota, the state legislature, and some small businesses. Because Sea Grant's research is of national as well as regional importance, many agencies are able to utilize Minnesota's results. Some of these include: the Great Lakes Fishery Commission, International Joint Commission (on the Great Lakes), Environmental Protection Agency, Minnesota Department of Natural Resources, and Port Authorities of Duluth and Superior.

Mississippi-Alabama Sea Grant Consortium

MEMBER INSTITUTIONS: Auburn University • Gulf Coast Research Laboratory • Jackson State University
Mississippi State University • University of Alabama • University of Alabama in Birmingham • University of Mississippi
University of South Alabama • University of Southern Mississippi

How Sea Grant works

The Sea Grant College Program in Mississippi and Alabama is administered through the Mississippi-Alabama Sea Grant Consortium, an organization of nine universities and research institutions contributing to marine research, education and public service.

The only functional two-state Sea Grant program that operates under a single director and a single board of directors, the Consortium's unique administrative structure has welded a broad cooperative base from which to solve problems and explore opportunities common to both states, the region and the nation.

Samples of success

When misplaced bridge rubble closed productive shrimping grounds south of Mobile Bay, the Consortium arranged a cooperative Sea Grant/NORDA side scan sonar survey of the 25-square mile area. The project produced precise locations of hazards to avoid, and shrimpers are once again trawling the area. Up to 80 boats fish the area, and the Sea Grant effort translates into an additional $5 to $10 million in Alabama shrimp landings per year. Sport fishermen are also using survey results to locate new fishing spots for game fish that gather at rubble sites.

More than a dozen new softshell crab businesses are operating in Mississippi and Alabama as the result of Sea Grant research into closed seawater systems for holding and shedding blue crabs. Previously existing businesses are increasing profits as operators apply research results to cut down on crab mortalities in holding systems. Source of supply of pre-molt crabs is the limiting factor in expansion of the softshell industry in northern Gulf states. Sea Grant is solving that problem with research on hormones to induce molting.

Even moderate fouling by barnacles and other organisms can increase fuel costs for a large cargo carrier by more than $1 million per year. Sea Grant research has developed new weapons against bio-fouling and mineral scaling using potent inhibitors of crystalline deposits. Four patent applications for environmentally compatible inhibitors have been filed. With the prospect of decreased fuel and maintenance costs and extended usefulness of affected surfaces, commercial interest in the inhibitors is high.

When public health care was eliminated for fishermen, Alabama Sea Grant Advisory personnel helped fishermen organize and secure group insurance for more than 550 families in Bayou La Batre, a major commercial fishing center. At a minimum savings of $50 per month per family, Alabama fishermen save $33,000 annually on insurance costs. The fishermen's association is one of the first to be organized by and for the small fisherman and one of the first to offer a group insurance program.

Mobile Bay is the front door for the Tennessee-Tombigbee Waterway that connects the Port of Mobile with 16,000 miles of navigable waterways in 23 states. Accurate assessments of change due to the Tenn-Tom and associated development depend on accurate baseline data. During the past five years, Sea Grant research has profiled the Bay's chemical and physical character. Sea Grant scientists have also developed effective methods using oysters and other bivalves to monitor the state of the Bay for fisheries and public health.

Predictions of the effects of Tenn-Tom on northern Gulf ports has led Sea Grant to an industrial engineering first—a simulation model for port expansion that bridges the gap between theoretical academic exercise and useable tool for port decision-makers. Port officials have worked closely with the principal investigator and have expressed keen interest in applications as the project nears completion. Workshops will introduce port personnel to the computer program and its uses.

Sea Grant in education

The Consortium's "Man and the Gulf of Mexico" (MGM) project has produced workbooks on the Gulf environment, has introduced 900 teachers to marine environments and MGM materials and has established a communications and resource network for more than 3,000 science teachers in Mississippi and Alabama. As a result of MGM workshops, more than 350 teachers have introduced marine topics into curricula that previously included little or no marine-related studies.

Educational efforts also include marine science development grants, fellowships and a cooperative NMFS marine research fellowship program for women and minorities. These efforts contribute expertise necessary to develop resources, explore economic solutions and train new scientists and decision-makers.

For more information contact
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(601) 875-9341

University of New Hampshire

The Sea Grant College Program at the University of New Hampshire is a cooperative program with the University of Maine.

As part of the National Sea Grant College Program, the University of New Hampshire Sea Grant Program works cooperatively with marine industries, state and federal agencies, organizations, and individuals to identify and solve problems associated with the development and conservation of northern New England's marine resources. At the same time, Sea Grant attempts to increase public awareness of important marine and coastal resources through its various marine information and education programs.

Examples of Sea Grant's work in New Hampshire—much of which also has national significance—include:

PROTECTION AND ENHANCEMENT OF MARINE RESOURCES

- Development of hydrodynamic and dispersion computer models to trace the **movement of pollutants within estuaries and harbors**. These models have been utilized in strategically locating a sewage outfall pipe in New Haven Harbor, Connecticut and in positioning offshore breakwaters in Bristol and Sconnet Harbors, Rhode Island.
- Refinement of laboratory techniques which can determine the degree of attachment of **toxic organic substances** to suspended sediment particles—an important parameter in determining the transport and ultimate fate of the pollutants along the coast.
- Technical assistance to the state, towns, and individuals on the proper design, location, and use of **shoreline erosion protection structures and techniques**.

FISHERIES MANAGEMENT AND DEVELOPMENT

- Development of an accurate and inexpensive method for detecting **toxins of the red tide organism** which sometimes contaminate New England shellfish.
- Determination of the impacts of sea urchin overpopulation on productive **kelp beds and lobster populations** along the coast of northern New England.
- Assistance in establishing the successful and profitable **Portsmouth Fishermen's Cooperative**. This Cooperative has resulted in reliable deliveries of fresh produce to the marketplace and timely payments to fishermen.

INDUSTRIAL AND COMMERCIAL DEVELOPMENT

- Discovery of a technique for predicting the stability of coastal and seafloor sands. This technique can help **avoid earthquake and storm-wave damage** to oil rigs and pier foundations.
- Development of a microbial fermentation process to produce **valuable chemicals from tropical agricultural products.** The new process is designed to generate industrial alcohols, chemical feedstocks, and antibiotics in a seawater medium in mobile shipboard units, or at fixed coastal facilities.
- Profiles of **visitor activity and spending patterns** within selected coastal communities. This information will be used by coastal tourism businesses in advertising and marketing strategies.
- Development of **emergency oil spill containment boom techniques** for high velocity current areas. These boom configurations are now required at all oil terminals along the Piscataqua River.

EDUCATION

- Production of a monthly marine education newsletter, *The Tidepool Times*, for students and educators. This has led to publication by Prentice-Hall of a 240-page, illustrated trade paperback, *The Seaside Naturalist*, based on the newsletter.
- Assistance in the development of the educational and research management components of the Great Bay Estuarine Sanctuary Plan.
- Coordination of a volunteer marine docent program which delivers marine education programs to more than 15,000 students, educators and members of the public each year.

The state of New Hampshire and northern New England have benefited significantly from Sea Grant's contribution to marine research, education, and advisory services. For further information, contact:

Robert W. Corell, Director
UNH Marine Program and
Sea Grant College Program
Marine Program Building
University of New Hampshire
Durham, New Hampshire 03824
(603) 862-2994

The National Sea Grant College Program, through the education, research and advisory service activities of the state Sea Grant programs, is a successful investment in the nation's marine resources. It is a model partnership involving the universities, the private sector and government at all levels. It is based on a national network involving strong local program input.

The New Jersey Sea Grant Institutional Program is managed by the New Jersey Marine Sciences Consortium, an alliance of 27 institutions of higher learning, a number of business and private entrepreneurial organizations, and individuals interested in marine affairs. New Jersey Sea Grant has recently entered its ninth year of activity in coastal and marine concerns.

Sea Grant has grown steadily in value to New Jersey by directing attention to the challenges and opportunities afforded by the state's extensive and invaluable marine resources. Emphasis on critical coastal problems dealing in fisheries, shoreline processes, and pollution continue to be at the forefront of Sea Grant activities under the New Jersey program.

These activities, highly sophisticated in academic terms, nevertheless possess a very real pragmatic interest in the economy of the state. Tourism is its second largest industry, accounting for over 5 billion dollars annually, most of it attracted by marine recreational activities. Its fishing industry alone generates almost 1 billion dollars each year!

Listed here are the results of a few of the most recent educational and research projects conducted under the Consortium's Sea Grant program. Each of these has been beneficial in providing knowledge essential to making correct decisions regarding use of our valuable marine resources:

- A three-dimensional, time dependent physical oceanographic model of circulation in the Hudson-Raritan estuary has been developed and tested. The Hudson-Raritan estuary is considered among the most polluted in the nation and the ability to apply this model to circulation within the estuary will allow environmental managers to predict pathways and fates of pollutants introduced into the system.
- Sea surface temperature charts and weather and wave condition forecasts have been two important services provided to commercial and recreational fishermen in the Mid-Atlantic region by a New Jersey Sea Grant Extension Agent. These programs aided in improved catches, reduced transit time, and conservation of fuel by fishermen. Both services have now been successfully transferred to the hands of private industry.
- The condition of the state's inlets, barrier beaches, and other coastal features are crucially important, both economically and culturally. The Sea Grant coastal systems program, in full cooperation with the NJ Department of Environmental Protection, has been successful in identifying barrier island hazard areas, analyzing the success of beach nourishment projects, and testing new techniques for maintaining inlet channels. Continued emphasis on the problems of shoreline changes will enable Sea Grant to contribute to coastal zone management in New Jersey.
- The New Jersey Sea Grant Extension Service, in cooperation with the National Oceanic and Atmospheric Administration's Ocean Assessment Division, held an Ocean Dumping Conference designed to bring together environmental managers, researchers, and the public to discuss the key issues regarding ocean dumping in the 1980's. The conference identified the status of ocean dumping activities and how they relate to pollution of the New York Bight, discussed ways to resolve the waste disposal problems of our region, and offered predictions on what can be expected in the future. The conference was well received and a Conference Proceedings has now been published.
- Two marine pollution educational module units, 'If Fish Could Talk' and 'The Great Garbage Chase' have been produced in cooperation with the New York State Sea Grant Institute, the NOAA Ocean Assessments Division, and the Cook College-Rutgers University Department of Education. Developed for use in secondary and elementary school curriculums respectively, these modules have been demonstrated by the Consortium's Pollution Specialist at dozens of schools and state and national teachers meetings, including the New Jersey Science Convention, the New Jersey Marine Education Association Annual Meeting, and the National Association of Biology Teachers Convention.

The Sea Grant Program is conducted nationally by the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. Created by Congress in 1966, the program takes its cue from the historically-proven Land Grant agricultural tradition, namely the integration and articulation of research, education and outreach. In New Jersey, the Sea Grant Program continues to achieve the goals and objectives established by the National Sea Grant Program.

From the shallows of the Delaware Bay to the offshore canyon depths of the Atlantic Ocean--from Sandy Hook to Cape May--New Jerseyans are, in ever-increasing numbers, associating themselves with the Consortium's leadership in the preservation and conservation of their irreplaceable marine resources.

Additional information may be obtained from:

Dr. Robert B. Abel, Director
New Jersey Sea Grant
New Jersey Marine Sciences Consortium
Building 22
Fort Hancock, NJ 07732
(201) 872-1300

New York Sea Grant Institute is. . . addressing diverse needs in a diverse state

New York is a coastal state of great diversity. Its 3200 miles of coast include:

- 578 miles of shoreline of the largest city in the nation--and the nation's busiest port
- 1040 miles of shoreline along Lakes Erie and Ontario and the St. Lawrence River, the corridor of commerce for the Great Lakes
- 1265 miles of shoreline of the nation's fourth largest island (largest of the contiguous 48 states), Long Island, most of whose 5.2 million residents often do not know that the bays surrounding the island produce many of the shellfish consumed in the nation
- 371 miles of shoreline along the Hudson River estuary, which includes New York's estuarine sanctuary

New York's coastal region is a critical part of the state and regional economy. Eighty-five percent of New Yorkers live in the 28 coastal counties. Metropolitan New York and the Port of New York and New Jersey constitute about 30 percent of the population and economy of the northeastern United States.

In 1974, the Trustees of Cornell University and the State University of New York system formed the New York Sea Grant Institute, as a cooperative activity, to help New Yorkers to appreciate their coastal resources and to make better and wiser use of them. The Sea Grant Institute coordinates New York's Sea Grant program in which faculty and students from many institutions in the state participate through their research. In collaboration with Cooperative Extension, Sea Grant Extension staff, located in nine coastal offices, help coastal users, businesses and industry to be aware of new ideas and technologies and to make better decisions on coastal matters.

Getting Results

- Restocking of salmon and trout in Lake Ontario has been a great success. Sea Grant, through research and extension, has helped communities and businesses along the Lake to develop a major sportfishery into a major economic asset--a $100 million a year industry. For example, when research found where salmon congregated in the Lake's waters, a charterboat fishing industry was able to develop. Five years ago there were no charterboats operating on Lake Ontario--today there are 125.

- New York's shellfish, from oysters and hard clams to bay scallops, have long been a national delicacy. Increasing production of these crops can be achieved only through aquaculture. Toward this end, the State's legislature and agencies turned to Sea Grant and asked it to create a plan for increasing investment in aquaculture business. Though only recently released, many of the plan's recommendations are being implemented. Significantly, the New York Legislature has appropriated $1 million to stimulate the aquaculture industry within the state

- Contractors building bulkheads and docks in the coastal region told Sea Grant Extension staff of their need for useful information on building materials and construction specifications. Most data sources available had been prepared for engineers--most coastal contractors don't have engineering degrees. Sea Grant had university engineers, working with the contractors, prepare new handbooks which are useful to the contractors and are helping them to do a better job.

- Sea Grant support of research in highly speculative areas can pay off handsomely. Two examples of "far-out" ideas which have worked are:

Ash and scrubber wastes produced by electrical generating plants burning coal are a major disposal headache. The idea of combining these wastes and compressing them into solid blocks was presented to Sea Grant. It was found that, although the blocks contain toxic materials, they do not leach these to the marine or freshwater environment and so can be used safely for various purposes. One of these is the construction of artificial fishing reefs. One midwest utility is now building a coal-waste block reef in Lake Michigan.

Fine harbor sediments are often badly contaminated with organic toxics and heavy metals. Disposal of these sediments, when they are dredged for channel maintainence, is a major problem for all ports. Sea Grant sponsored research exploring the possible burial of contaminated spoils in pits created by underwater sand mining and then covering them with clean sand. This disposal technique prevents the contaminants from re-entering the estuarine environment or from polluting groundwaters. Research is highly promising. Pilot scale projects have shown the feasibility and now several ports are considering the option for their spoil disposal problems.

- Sea Grant researchers have successfully farmed large seaweeds that occur naturally in New York's waters. At present the principal crop is a species called *Laminaria saccharina*, but researchers are also experimenting with another species, *Gracilaria tikhaviae*, as a summer crop. Using an oriental-style rope farm, the economic feasibility for growing large masses of seaweed for feedstock or for conversion to natural gas or to alcohol has been shown. One successful test of the concept was the weathering of the farm through a "100-year storm."

- Metropolitan New York is not where one would expect to find a big recreational fishery. But then, no one had looked! A Sea Grant funded project examined that question and found large numbers of shore-based fisherfolk. Although they are not boat owners, these recreational fishermen and women were not the subsistence fishermen expected. The study showed the average angler spent more than $250 on his or her equipment. Highly diverse ethnic and economic groups having many different fishing habits and utilizing their catch in many ways were also found. Some consumed most of what they caught--others threw the fish back! For the more than 100,000 shorebased fishermen the biggest problem is getting to the water's edge through fences, across highways, and along rock rubble riprapped shores. Several state and city agencies, which previously did not realize the need for beach access, are now planning for same. Among these is the Port of New York Authority which is including plans for fishing piers and wharves in it multi-purpose waterfront development.

- With Sea Grant support, the Webb Institute of Naval Architecture developed a computer program to match a fishing vessel's hull characteristics and engine performance with proper propeller design to maximize performance and reduce fuel costs. When their boats are hauled for maintainence, many commercial fishermen now arrange to have Sea Grant Extension agents help them check their vessels, using the computer program on the ways.

- Cod liver oil was a trusted remedy "for what ails you." As is the case with many other folk traditions, there is more than a little truth to the saying. A variety of studies have shown that certain polyunsaturated fatty acids occuring in fish lipids and fish oils reduce the tendency of blood platelets to form clots, the most frequent cause of death or debilitation from heart attack. New York Sea Grant has conducted nutritional studies to determine which fatty acid components of fish oils are responsible for the beneficial effects. That component, 20:5w3 eicosapentaenoic acid, which is most responsible for altering platelet aggregation in rats is now being assessed quantitatively to determine how much is needed. Research is also being conducted to determine which tissues are most sensitive to particular fatty acids. With this information will come the need to refine fish oils to extract that particular fraction desired. That research is also in progress.

The New York Sea Grant Institute of State University of New York and Cornell University, 37 Elk Street, Albany, New York 12246. (518/436-0701) or call your nearest Sea Grant Extension Office listed in the telephone directory.

UNC Sea Grant College Program

The UNC Sea Grant College Program is a federal-and-state partnership that draws on the talent from the 16 institutions of the University of North Carolina to solve marine and coastal problems. The program integrates research, extension, education and communication into programs and publications that answer to the state's coastal needs. Today, with over a decade of problem-solving experience to its credit, UNC Sea Grant is paying off for coastal North Carolina in several important ways.

Keeping seafood on the menu

Shrimp and oysters commonly adorn seafood platters n restaurants. But what about shark and squid? UNC Sea Grant advisory agents are working to expand the fisherman's repertoire of catchables and the public's acceptance of these once inedibles. And Sea Grant scientists molded a fertilizer fish into delicious seafood substitutes that cost the consumer less. Meanwhile, other Sea Grant researchers are ensuring that fishermen's nets always brim with bounty. They're studying the complexities of our estuaries where all valuable species spend a portion of their lives. And in the future, more seafood may have a cultivated flavor as Sea Grant scientists perfect the commercial culture of hybrid striped bass.

Striking a balance

To use the soggy soils of coastal North Carolina for agriculture, farmers flush fresh water from the land into the estuary, where fishermen believe the influx is reducing their catch. Can the estuary be used as a drainage outlet and as a fishing hole? A team of Sea Grant scientists are taking a multidiscipline approach to the conflict. On land, Sea Grant studies are testing how different agricultural practices and drainage methods can lessen freshwater flows from fields. In the estuary, Sea Grant scientists are tracing the impact of drainage on circulation patterns and learning how much fresh water a fish can tolerate. When the results are all in, Sea Grant may help to balance the scales between fishing and farming.

Letting science pay off for people

In many other ways, Sea Grant pays off for people. Sea Grant workshops about crab shedding spurred the construction of over 50 new shedding facilities, producing an estimated $2 million in additional gross sales of soft crabs. A commercial fishing show, organized by Sea Grant, grossed an estimated $750,000 for exhibitors selling nets, boats and gear. A weather relay program, begun by a Sea Grant marine advisory agent, helped the National Weather Service broadcast offshore conditions. The program helped fishermen make informed decisions at the docks, saving them fuel costs, time and personal risk. Sea Grant's coastal engineer helped toughen North Carolina coastal building codes against hurricanes, preventing thousands of dollars of damage when Diana blew ashore. These examples, and others, point out Sea Grant's ability to reach out with science and solutions.

Providing the facts

Thousands of North Carolinians look to UNC Sea Grant for information each year. People seek information from Sea Grant publications, workshops and demonstrations. And many ask Sea Grant agents and specialists for advice firsthand at the NCSU Seafood Laboratory in Morehead City, the Aquaculture Research Center in Aurora and at Sea Grant offices in the N.C. Marine Resources Centers. They use the information to get a better buy on fish, to interest students from kindergarten to college in marine science, to improve their fishing efficiency with a new piece of gear. People turn to Sea Grant for the facts. And more often than not, the facts are there waiting for them.

As Sea Grant closes the file on one coastal problem or works out the flaws in a fisherman's gear, another problem looms in the distance and another fisherman waits at the door. As long as people use our coastal and marine resources, conflicts and problems will continue to crop up. And Sea Grant will continue to assemble the state's best scientists to solve these problems and disseminate the results.

For more information, contact:

Dr. B.J. Copeland, Director
UNC Sea Grant College Program
105 1911 Building
Box 8605
North Carolina State University
Raleigh, North Carolina 27695-8605
919/737-2454

The Ohio Sea Grant Program is . . .

A unique partnership of Ohio colleges and universities, state agencies, private industry, the general public and the federal government, working to increase the utilization, development and wise management of our Lake Erie and marine resources. The program, housed within the Ohio State University's Center for Lake Erie Area Research (CLEAR) which also administers the Franz Theodore Stone Laboratory (the oldest freshwater field station in the country) on Lake Erie at Put-in-Bay, accomplishes its goals through research, education and advisory service or extension programs.

Research projects, some of which are funded at other Ohio colleges and universities, are designed to solve problems which are inhibiting the wise development and utilization of our Lake Erie resources.

Ohio Sea Grant's education program is viewed as a leader nationally, and is best known for the development of curriculum materials for grades 5-9, teacher training projects, the development of museum programs for informal public education, and innovative evaluation techniques to determine its effectiveness of educational programming.

The technology transfer aspect of Ohio Sea Grant is accomplished by the Advisory Service, its 3 Extension Specialists, and their Advisory Committees composed of influential and energetic citizens representing a diverse set of interests in Lake Erie. Committee members have many responsibilities including advising on program and area needs and assisting in prioritizing Sea Grant activities. consequently, Ohio Sea Grant provides for input from the private sector when university research priorities are established, and it provides a mechanism to coordinate and direct the capabilities and expertise of the private/public sector onto critical problems and issues relating to Lake Erie and Ohio's coastal resources.

Lake Erie: Assets and Problems

Surrounded by four states and two countries, Lake Erie is one of the most important lakes in the world and Ohio's most valuable natural resource. Since the start of Ohio Sea Grant, the number of charter fishing businesses has increased from 34 to over 600, and with the average sports enthusiast coming from 86 miles away and 10 percent coming from over 150 miles away, Lake Erie is truly at the heart of Ohio's developing tourist industry.

However, Lake Erie has economic values reaching far beyond its recreational assets. Each day 11 million people get their drinking water from Lake Erie. The lake is surrounded by well over 20 power plants, many of which use over 500,000 gallons/minute for cooling purposes, and annually ships almost as much coal from Ohio ports as is produced within the state. Lake Erie is also the most productive of the great lakes and produces more fish for human consumption than the other four combined.

Lake Erie is not without problems. It is the most organically enriched of the Great Lakes with tons of agricultural fertilizers and sewage pouring in daily. This fertilization has caused major portions of the bottom water in the central basin of the lake to become devoid of oxygen and fish life. Furthermore, fish from areas such as the Ashtabula River cannot be eaten because of contamination. Erosion is also a significant problem with $60 million of damage documented in Lake and Ashtabula counties from 1972-1976.

Sea Grant Accomplishments

The multiplicity of uses of Lake Erie provides many research, education and service opportunities. A few of our recent accomplishments are listed below.

1. With the assistance of the U.S. Army Corps of Engineers, sand dredged from the harbor at Fairport was returned to the littoral drift zone where it will reduce erosion. The success of this effort has been valued at $380,000/year.

2. The first "Congressional Day on Lake Erie" was held in June of 1982 and the second in June of 1983. These programs allowed our congressional delegation and their aides to learn of the value of Lake Erie and personally experience its beauty and richness. They now understand that Lake Erie is not only not dead, but one of the most productive and important lakes in the world. These programs were successfully followed by Ohio Sea Grant's first "State Legislature Day on Lake Erie" in June, 1984.

3. A market has been developed for gizzard shad, a heretofore valueless fish, valued in excess of $100,000/year.

4. The Marine Reports Program (MAREPS) has been developed and implemented with NOAA Weather Service to improve Lake Erie weather forecasts and make the lake a safer place to boat.

5. The artificial reef program has been developed and implemented for the central basin of Lake Erie which will serve as an economic stimulus for the region.

6. Economic value estimates have been developed for the various components of the Lake Erie economy to aid resource managers.

7. A storm-surge model has been developed to improve predictions of flooding in low-lying shore areas of western Lake Erie.

8. A strategy has been developed to determine suitable locations for large offshore structures.

9. New strategies have been developed to increase production in fish hatcheries.

10. Assistance has been provided to communities in planning shoreline and tourist development projects to avoid wasting valuable community dollars and to help them plan to maximize the impact of tourism dollars rather than simply increasing their number.

For further information about the Ohio Sea Grant Program contact:

Ohio Sea Grant Program
The Ohio State University
484 West 12th Avenue
Columbus, OH 43210
614 422-8949

Oregon State University
Sea Grant College Program

The Oregon State University Sea Grant College Program was established in 1968, a direct result of the National Sea Grant College and Program Act of 1966. In creating this marine program, Congress envisioned a system of universities parallel to the Land Grant College system. Eighteen years later Congress' desires are being met.

From its beginnings, the Oregon program has been dedicated to the maintenance, conservation, and wise use of the marine world and the coastal zone of Oregon, the Northwest, and the nation. We are helping to put the oceans to work through an integrated program of research, education, and advisory services.

Facilities:

Several academic institutions in addition to Oregon State University contribute to the program:

- University of Oregon
- Lewis and Clark College
- University of Idaho
- Washington State University
- University of Washington
- Clatsop Community College

In addition to the research undertaken at these institutions, Sea Grant work is carried out onboard oceanic vessels such as R/C *Wecoma* and at several satellite facilities including:

- the Oregon State University Seafoods Laboratory in Astoria
- the Mark O. Hatfield Marine Science Center in Newport

People:

The program is only as good as its people and fortunately, many outstanding individuals are involved. One hundred faculty members work at the above institutions on Sea Grant-sponsored work. More than 320 Sea Grant-supported students have received advanced degrees over the years.

Recent Successes:

Sea Grant-sponsored projects cover many marine areas and issues.

- Helping beleaguered salmon fishermen is one goal of innovative Sea Grant ocean research. How ocean conditions like the El Niño of 1983 contribute to the decline of salmon runs is being discovered through one pioneering project that, for the first time, is examining the behavior of young salmon in the ocean.

- A unique research institute headquartered at OSU and started with the assistance of Sea Grant offers new insights into international trade opportunities in seafoods. The research of the institute will help government and industry decision-makers improve their seafood marketing plans. The potential for U.S. producers would appear sizeable: Americans currently import 60 percent of the fish they eat.

- Mining of the deep-ocean seabed off the Oregon coast may offer new economic opportunities for Oregon coastal communities. Sea Grant-sponsored research will help evaluate the feasibility and environmental consequences of this mining activity so that wise use may be made of this potentially valuable resource.

- To give fishermen an added margin of safety against sudden changes of weather, OSU Extension Sea Grant agents introduced the use of timely weather information gathered by space satellite. But extreme variations in nearshore weather conditions remained a problem. Sea Grant agents helped establish a system in which fishermen at sea regularly report nearshore weather and ocean conditions that are then incorporated into daily National Weather Service forecasts to the marine community

- When shortened salmon seasons and dwindling catches of such traditional species as Dungeness crab and shrimp cut sharply into fishing income, OSU Extension Sea Grant agents organized a series of educational programs for small-boat fishermen in conjunction with Fish Expo in Seattle. More than 3,000 fishermen from all the West Coast states attended offerings on such topics as alternative fisheries, value-added processing, and direct sales to restaurants and the public.

- Marine mammalogists studied pinnipeds (sea mammals with flippers), developing techniques to track seal movements with radio transmitters. They discovered much about what seals eat and where they roam. A sound-producing device was subsequently developed to ward off seals and sea lions. It promises to save milions of dollars in damaged fishing gear and lost fish catches while saving marine mammals' lives. Radio tagging is being adopted for satellite use to study and track migrating whales traversing offshore oil-drilling areas.

- Sea Grant communicators, cooperating with other Sea Grant programs nationwide, and the public television station WGBH in Boston, produced *Farmers of the Sea*, which is to be broadcast as part of the highly acclaimed science series, NOVA.

For further information, contact: Sea Grant College Program • AdS 402 • Oregon State University • Corvallis, OR 97331 • (503) 754-2716

UNIVERSITY OF PUERTO RICO
Sea Grant Program

THE NATIONAL SEA GRANT COLLEGE PROGRAM IS ... UNIQUE!!

The Uniqueness, as in the Land Grant College Program in Agriculture, lies in a CONCEPT: the working partnership between universities, industry, government and the community; in the endeavor to promote and accelerate national development of marine and coastal resources, including their conservation, proper management, utilization and enjoyment by engaging the skills, talents and knowledge available at universities; in the pursuance of practical, quick-response solutions to coastal issues through the establishment of integrated programs of applied research, education and extension services . . .

Sea Grant is particularly unique for Puerto Rico. The University of Puerto Rico Sea Grant College Program (UPRSGCP) has generated new opportunities that provide:

- the incentives and funds for significant applied research;
- the information and guidance to achieve economic benefits which have not previously been available in the marine resources realm;
- the information and funds to increase the opportunities and capabilities for technological development, and for enhancing the ability of constituents to make decisions in marine issues;
- the means to disseminate information and results of highly sophisticated research performed in the 32 universities that comprise the National Sea Grant Network;
- the capability to place in perspective the importance of solving practical marine resources problems and needs of the island, the Caribbean and the nation.

With Sea Grant in Puerto Rico it has been possible to undertake projects that address meaningful issues:

IN RESEARCH

- the nature and origin of Ciguatera intoxication . . .
- the aggregation behavior, intensive fishing and annual spawning of a commercially important species of fish . . .
- the population dynamics of mangrove oysters in the southeast region of Puerto Rico . . .
- the possibility of obtaining medicinal and natural products from tropical marine flora and fauna . . .
- the socio-economic problems of fishing villages and fishermen . . .
- the extent and ecological effects of sewage pollution in coastal bays, lagoons and estuaries . . .
- the occurrence of sea level variations caused by seiches and internal waves and their effect on coastal circulation . . .
- the feasibility and probable value of trapping fish and shrimp at depths greater than 200 meters . . .

IN EDUCATION

- the Marine Education Section of the "Boletín Marino", our monthly newsletter, reaches hundreds of students from the elementary and secondary public and private schools system through 465 libraries and Sea Grant trained teachers . . .
- approximately 300,000 viewers are reached weekly through television programs . . .
- the thesis research of twelve graduate students has been funded, and the students themselves supported with assistanships . . .
- sponsored and offered the services of specialists, marine advisors, and researchers to present marine topics through lectures, seminars and hands-on training throughout the island's elementary and secondary education school system . . .
- instrumental in the plannification and organization of a Tropical School of Fisheries that looks forward to train people from the United States, Puerto Rico and the Caribbean Basin countries . . .

IN EXTENSION SERVICES

- held workshops on hygienic handling of seafood products directed at health officers, fishermen, fish-food wholesalers and retailers, and restaurant owners . . .
- increased the marketing potential of under-utilized species through demonstrations in shopping malls . . .
- offered workshops, lectures and demonstrations on: marketing concepts for fishermen; orientation on fisheries management plans; prevention of SCUBA diving accidents; orientation on taxes, social security, and insurance for fishermen; and development of new technologies for fisheries . . .
- promoted new legislation to remove boats from the list of tributable property; created an effective boat registry with provisions for recording mortgages; and reliable, confirmed statistics on recreational boating . . .
- surveys on sea food eating habits especially of under utilized species such as shark, tuna and molluscs . . .
- translations to Spanish of much needed literature from government agencies such as the U. S. Coast Guard and other Sea Grant programs . . .
- marine advisors have been mediators in agreements with the tuna canneries to buy some 6,000 lbs. of tuna a week from several fishing villages, thus providing the fishermen an added source of income . . .
- the "Boletín Marino" is distributed in twelve Latin American countries, Israel, Spain and Africa. We have also been instrumental in promoting Sea Grant throughout the U. S. Virgin Islands and the Caribbean through published information to appropriate audiences and user groups . . .

Sea Grant in Puerto Rico offers the National Sea Grant College Program an added dimension: increases Sea Grant's visibility and prestige extending its range of influence throughout Latin America and the Caribbean Basin region . . . We are the only fully bilingual program in the nation.

THERE IS NO DOUBT: SEA GRANT IN PUERTO RICO IS UNIQUE . . . AND NECESSARY!

UPRSG is specifically encouraging researchers to address the problems of management, development, conservation and utilization of marine and coastal resources in three programmatic areas: FISHERIES-AQUACULTURE, MARINE PHARMACOLOGY AND NATURAL PRODUCTS, and COASTAL PROCESSES.

For further information please contact:

Dr. Manuel L. Hernández-Avila, Director
Sea Grant Program
University of Puerto Rico
Mayagüez Campus
Mayagüez, P. R. 00708

SEA GRANT BENEFITS

UNIVERSITY OF RHODE ISLAND

The ocean shore of Rhode Island, like much of the Atlantic and Gulf coasts of the U.S., consists of shallow coastal lagoons or salt ponds lying behind barrier beaches and connected to the sea by narrow passes, inlets, or breachways. An integrated, multidisciplinary study of these coastal lagoons was developed by the University of Rhode Island Sea Grant program in response to requests for help from citizens groups, town governments and state regulatory agencies. As a result, a special area management plan has been developed, local zoning changed, dredging programs initiated, sewage inputs reduced, and a sense of stewardship and involvement invested in local residents.

Benefits

- Special Area Management Plan for the Salt Pond Region. Now in the process of being adopted into state law as part of the Coastal Program, the plan is based on findings of fact derived from the salt pond research project and identifies the salt ponds as ecosystems of special concern. The plan provides a common set of objectives for all agencies with authority in the region; creates a coordinated, streamlined permitting process to replace what is presently a fragmented, cumbersome and expensive system; establishes a permanent citizens' action committee to instill a sense of local responsibility for these resources; and provides a framework for balancing competing uses.

- Zoning Amendments. Two of the three coastal pond towns have adopted new zoning regulations which increased minimum lot size in critical areas to protect aquifer recharge areas and salt pond water quality to provide for future uses of the region.

- Fishery Management Guidance. Recommendations by the fishery scientists, including a simple computer model, were used by the Rhode Island Marine Fisheries Council and the DEM* in regulation changes.

- Dredging and Beach Nourishment. A sediment catchment basin is being dredged inside one breachway to a larger salt pond in order to stop the severe shoaling of the pond which is altering circulation and causing hazardous boating.

- Hydrodynamic Models. Computer models developed by the salt pond researchers to reflect the tidal circulation in shallow coastal embayments have been used to predict optimal channel design and breachway (inlet) management.

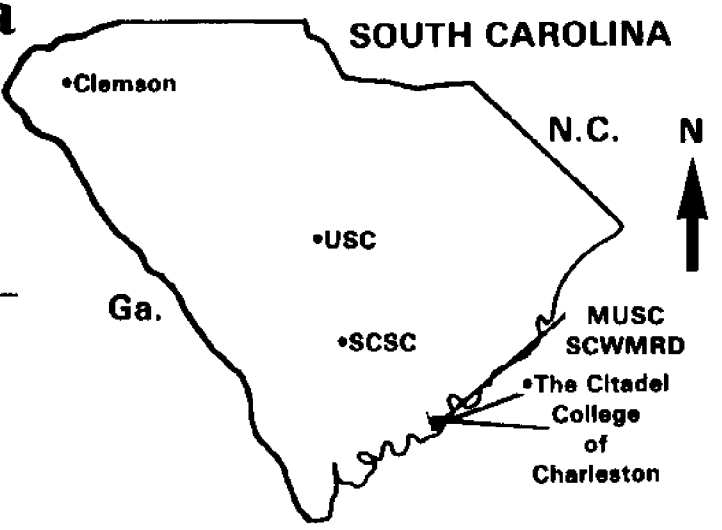
- A Tidegate for Inlet Management. The Department of Transportation has incorporated a tidegate in plans for bridge reconstruction over a tide inlet to one of the ponds. The tidegate is a flexible management tool for flood control and fishery enhancement.

- Septic System Maintenance Program. In response to information and recommendations generated by the salt pond project, DEM is presently clarifying and strengthening state septic system regulations and designating the salt pond region as an area of special concern.

*Department of Environmental Management

For further information: Scott Nixon (401) 792-6800 10/84

South Carolina Sea Grant Consortium



Addressing the Needs of a Growing State

Like many sunbelt states, South Carolina has grown as more people are drawn to warm temperatures, golden beaches, and vast natural resources. In the ten years between 1970 and 1980 the coastal counties have increased in population over 24%. Along the state's 187 mile coast, pressures from commercial, recreational, industrial and preservation interests continue to increase. The state's abundant coastal and marine resources are among her greatest assets.

A Partnership Of State Institutions

Recognizing the needs and opportunities presented by South Carolina's vast coastal and ocean resources, the State Legislature formed the South Carolina Sea Grant Consortium. The Consortium is designed to supply the knowledge and technology needed to develop and manage these resources. To accomplish this, the Consortium draws upon the talents and physical resources of its seven member institutions: The Citadel, Clemson University, the College of Charleston, the Medical University of South Carolina, South Carolina State College, South Carolina Wildlife and Marine Resources Department and the University of South Carolina. This consortial partnership encourages cooperative research, extension and education efforts in a variety of disciplines: it also offers access to a wide variety of facilities, including 30 laboratories and the new James M. Waddell, Jr. Aquaculture Research and Development Center.

Working With Other Organizations & Agencies

Sea Grant is an objective organization willing to work with diverse agencies and institutions to improve the quality of life on the coast. Sea Grant also consults private sector advisors about needed research projects. With broad input from a variety of sources, Sea Grant helps address the questions and concerns of people who live, work, and play on the coast. The Consortium is committed to improving the economic, social, and environmental potential of South Carolina's ocean and coastal resources.

Converting Ideas Into Action

• A group of businessmen had the idea to develop a commercial-scale hard clam "farm". Sea Grant structured a program combining research, industry, and government to look at the operational and economic potential of a hard clam farm. In this cooperative project, Trident Seafarms, Inc. provided all facilities and personnel and the South Carolina Wildlife and Marine Resources Department provided research and technical support. The Consortium provided the funding to develop mariculture protocols, systems, and equipment.

Today, Trident Seafarms, Inc. operates as a commercial-scale hard clam mariculture facility. Over 500 individuals have toured the farm including other commercial enterprises who have employed project-generated technology at their facilities.

• As Knobbed Whelk continued to appear in the shrimp harvest, several shrimpers had the idea to fish specifically for the large marine snails. The fishery is attractive to shrimpers since it requires little new gear. Harvesting also occurs at times different than the shrimp season; thereby extending but not interfering with the shrimp fishery. As the number of trawling boats has increased, there has also been increasing concern about management of the resource.

Sea Grant supported a study of the biology and population dynamics of the whelk to provide data to support fishery management regulations. On April 29, 1983 the South Carolina General Assembly passed special whelk resource legislation to preserve and manage this important new fishery. And today, Sea Grant research continues to be used by the agency managing and regulating the whelk fishery.

Providing Extension Assistance To Coastal Residents

The South Carolina Sea Grant Consortium also supports a marine extension program along with Clemson University's Cooperative Extension Service. Four marine specialists, located in Georgetown, Charleston, and Beaufort, offer extension assistance in: aquaculture, coastal development & management commercial fisheries, and recreation & tourism.

In the past year extension specialists have:

• helped coastal landowners grow crawfish in over 500 acres of ponds; up from 20 acres in 1980. Potential production for 1984 may exceed 400,000 lbs.

• helped to organize the South Carolina Marina Association, which represents fresh and salt water marinas and related marine trades. Through the Association, marinas can now access an insurance program that has already saved $25,000 in just 2 marinas.

• helped to produce a Recreation Guide to the Lowcountry that has been distributed to over 80,000 coastal residents and visitors. The guide features a map of historic sites and other points of interest.

• helped to develop alternative commercial fisheries. A recent workshop on squid introduced 100 fishermen to this potential fishery. Investigations of "golden" crab and "slipper" lobster fisheries are underway.

The South Carolina Sea Grant Consortium 221 Fort Johnson Road • Charleston, South Carolina 29412 • 803-795-9650

Sea Grant College Program

Texas A&M University

Texas A&M University is the Sea Grant College for Texas, providing leadership for research, education and extension activities to promote wise use of our marine resources. For more than a decade this effort has involved the knowledge, talent and skills of specialists from:

Texas A&M University • Texas Agricultural Extension Service • Texas Agricultural Experiment Station • Texas Engineering Experiment Station • Texas A&M University at Galveston • The University of Texas at Austin • The University of Texas at Tyler • University of Houston • University of Houston at Clear Lake City • Baylor College of Medicine • Texas Southern University • Lamar University • Brazosport College • Texas Southmost College • Pan American University

Recent Texas A&M Sea Grant research and advisory efforts have made direct contributions to the state's economy and to the safe use of the marine environment. For example:

- As a result of a Sea Grant effort to identify, catalog and disseminate information on bottom obstructions or "hangs," Gulf shrimp fishermen save an estimated $20 million annually that would be lost on damaged gear and missed fishing time. The Texas/Louisiana publication was updated recently with 3,860 new Loran C readings, and a similar book was prepared for the Mississippi-Alabama coast with help from the Mississippi-Alabama Sea Grant Consortium.
- Sea Grant researchers work closely with Mexico and U.S. government agencies on sea turtle conservation programs, since Texas is the site of important feeding grounds for the Kemp's Ridley, green and loggerhead species and hosts the U.S. portion of the Kemp's Ridley experimental conservation program. Recent data supporting the imprinting theory contributed to the decision to continue federal support of this type of research.
- Millions of people in the nation's coastal areas are threatened by hurricanes, and the principal means of preventing loss of life is through evacuation. Sea Grant provided seed money to analyze and encourage the use of computers, satellites and other forms of technology to develop guidelines for hurricane evacuation.
- Researchers at Baylor College of Medicine have determined that virus found in polluted waters often adhere to solid substances, which, in effect, form a virus reservoir when the solids settle to the bottom. Subsequent wind- and tide-induced movement of these substances probably explains outbreaks of infectious hepatitis among consumers of raw shellfish presumably harvested from safe waters.
- Marine Advisory Service specialists continue to explore the potential for a softshell blue crab fishery in Texas. Flow-through and closed recirculating system shedding operations have been built in three areas and provisions have been made to study improved harvesting techniques.
- Continuing Sea Grant-funded mariculture research has resulted in the development of information and technology required to artificially inseminate female marine shrimp. This increases the production of seedstock, which, in turn, makes shrimp farming more commercially feasible in the United States.

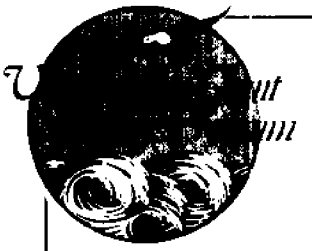
  Artificial insemination also aids genetic and domestication research by enabling selection of breeding pairs to produce more desirable offspring.
- As part of its efforts to educate seafood processors on the latest quality control efforts, Texas A&M's Marine Advisory Service equipped a mobile seafood quality laboratory that provides processors and fishing tournament officials with on-the-spot freshness tests or more detailed microbiological and processing information.

In addition to research and advisory service activities, education efforts by the Texas A&M Sea Grant Program provide increased understanding, appreciation and awareness of the coastal environment and resources.

- Public school teachers from throughout the country are given special inservice training in all aspects of marine education. More than 6,000 teachers in 20 states attended at least one workshop within a two-year period.
- An annual Marine Education Symposium attracts high school students and teachers from throughout the state, and introduces them to current scientific research, career opportunities, and marine-related aspects of social studies and the humanities.
- Texas youth ages 10 through 18 are involved in Sea Grant-sponsored Marine Adventure Camps each summer. The week-long sessions involve classroom study, beach and dune work, fishing, swimming and recreational activities.
- The Marine Advisory Service has organized a series of safety seminars for the offshore industry, which employs more than 28,000 workers in the Gulf of Mexico. Since the seminar began, the industry's accident rate per 100,000 people has dropped by more than 45 percent, a decrease attributed in part by industry safety officials to techniques demonstrated during these sessions.

For further information on the Texas A&M Sea Grant College Program, or for copies of recent publications, contact:

Feenan D. Jennings, Director
Sea Grant College Program
Texas A&M University
College Station, Texas 77843-4115
(409) 845-3854



VIRGINIA GRADUATE MARINE SCIENCE CONSORTIUM

Virginia Sea Grant was established in 1969. In 1981, the Virginia Graduate Marine Science Consortium was formed to strengthen and coordinate Sea Grant's activities in Virginia. Consortium members include the College of William and Mary, Old Dominion University, the University of Virginia, and Virginia Polytechnic Institute and State University. The Virginia Sea Grant College Program promotes high quality, objective research, education and public services related to marine resources as set forth in the National Sea Grant College and Program Act of 1966. As a member of the national Sea Grant network, the Virginia Sea Grant College Program is one of 30 Sea Grant programs throughout the nation which aid the coastal states, and the nation, in better use and management of the coastal environment and its resources.

Academic Resources

A tremendous reservoir of research, education and advisory talent within Virginia's universities forms the foundation of the Virginia Sea Grant College Program. Resources of Consortium member institutions include expertise in fisheries, seafood processing technology, environmental matters, marine law, and many other areas. In addition to Consortium members, Virginia Sea Grant has also supported projects at other educational institutions such as George Mason University, Hampton Institute, Norfolk State University and Virginia State University.

Cooperating Organizations

Central to the Sea Grant concept is a cooperative partnership between government, academia, and the private sector in addressing problems concerning state and national coastal resources. Through research, advisory and education projects, Virginia Sea Grant cooperates with business, industry, and federal and state agencies from the planning stages through project completion. Virginia Sea Grant has worked closely with the National Marine Fisheries Service, the National Weather Service, the Virginia Cooperative Extension Service, the National Fisheries Institute, the Mid-Atlantic Fisheries Development Foundation, Kroger Food Stores and many other organizations.

National Impact

In addition to providing leadership in the state of Virginia, the Virginia Sea Grant College Program is also involved with many regional and national efforts. For example, Virginia Sea Grant activities involving the Chesapeake Bay complement existing efforts by Maryland Sea Grant in a conscious effort to coordinate activities between the two programs. Research efforts focusing on fishery resources of the Bay are also being coordinated with similar activities in Maryland and Delaware in order to promote the continued availability of truly national resources such as the blue crab and the American oyster. Through the Mid-Atlantic States Marine Advisory Services organization, Virginia Sea Grant Marine Advisory Services works jointly with other Sea Grant programs to address common regional and national problems in an efficient and effective way.

Results

- Virginia Sea Grant's commercial fisheries gear specialist designed a multi-purpose "split winch-combination net reel" which allows the traditional Chesapeake Bay deadrise to both dredge and otter trawl, and thus take advantage of nearshore and bay fisheries year-round. In a demonstration project, the split winch was installed on a local fishing vessel and resulted in a twelve-fold increase in productivity, as measured by gross fish poundage and deck value. As a result of the success of the pilot project, several local fishermen have begun constructing and installing the innovative gear on their vessels.

- Virginia Sea Grant seafood technology specialists were credited with saving $70,000 worth of pasteurized crab meat which had been quarantined by the Food and Drug Administration because of canning defects. At the request of the industry, Sea Grant specialists designed and implemented a research plan that saved an entire season for a major seafood producer. Subsequent workshops sponsored by Virginia Sea Grant in cooperation with the FDA and the Virginia Department of Health alerted the rest of the industry to the problem and transferred the correct processing information.

- A major soft shell crab producer in Virginia, upon the advice of Virginia Sea Grant's commercial fisheries specialist, changed his flow-through crab shedding system to a closed recirculating system. The survival rate on crabs, from peeler through soft shell stage, increased from 35% to 65% in one season. Sea Grant outlay was 15 working days, and the shedder's outlay was $500 in material costs. In the past year alone, the specialist has provided in-depth consultation to five new closed system crab shedding firms, and over 30 individual crab shedding operations.

- Research sponsored by Virginia Sea Grant in hard clam culture has resulted in refinement of hatchery techniques, and production of a step-by-step instruction manual for growing the hard clam. Subsequent annual short courses for participants from 16 states, one territory and three foreign countries has seen the establishment of 21 commercial hard clam seed hatcheries, with four more under construction or in the planning stages.

- In an effort to address the interests and concerns of Virginia's recreational fishing community, Virginia Sea Grant annually sponsors the Virginia Sport Fisherman's Forum. The Forum provides an opportunity for communication between legislators, fishery management officials, scientists and fishermen concerning up-to-date fishery management and recreational fishery issues. Recent topics included the proposed saltwater fishing license in Virginia and regional management of striped bass in the Chesapeake Bay.

- In response to the need of the seafood industry for assistance in increasing consumer awareness of underutilized fish species, Virginia Sea Grant conducted a series of eight workshops for volunteers willing to be "demonstrators" in exchange for training in seafood promotion and marketing techniques. With this training, the volunteers exposed an estimated 2,200 consumers to a new line of surimi-based seafood during 28 hours of demonstrations in retail outlets. Retailers sold 4,500 pounds of product valued at $19,300 which they largely attributed to the volunteer efforts. Volunteer time was estimated at $950. These demonstration activities are continuing at seafood festivals and other functions.

For further information about the Virginia Sea Grant College Program, contact:

Dr. William L. Rickards, Director
Virginia Graduate Marine Science Consortium
203 Monroe Hill House
University of Virginia
Charlottesville, VA 22903

Washington Sea Grant--A University-based partnership with industry, government, and citizens that is providing innovative leadership for addressing problems and opportunities of marine resource conservation, development, and management . . .

To address the problems and opportunities of resource conservation, development, and management, the Washington Sea Grant Program undertook in 1968 a coordinated program of research, education, and advisory services. Through its advisory services and because of a one-third matching fund requirement, Sea Grant's customers have become active partners in the development of effective research and education activities. This user-university partnership has not only produced new ideas that combine academic theory and marketplace practicality, but it also has facilitated the evaluation of these ideas in the field.

The effectiveness of this partnership is amply demonstrated by the following projects in which Washington Sea Grant has provided regional and national leadership.

Testing for shellfish toxin Researchers at the University of Washington's Institute for Food Science and Technology have developed an automated test for paralytic shellfish poison(PSP). Run on an autoanalyzer (an instrument which automates a chemical test), it is faster and easier to use than the standard mouse bioassay. Consequently, the Washington Department of Social and Health Services, which is currently experimenting with the new test, should be able to process more shellfish samples than before. It is unlikely that the test will replace the mouse bioassay for determining when beaches should be closed or re-opened to shellfish harvesting; however, the test can be used for routine monitoring of closed beaches. Its introduction will permit monitoring a wider geographic area and more frequent monitoring of closed beaches.

Using shellfish wastes to protect wheat crops Washington State University plant pathologists, investigating agricultural uses for chitosan, a modified carbohydrate derived from shrimp and crab shells, have developed a winter wheat seed treatment that helps protect the crop against damage by soil fungus. In field trials in an eastern Washington area where fungal root rot is common, crop yield from treated seed was up to 20 percent higher than yield from untreated seed. Since chitosan occurs in nature, its use in agriculture should have none of the unexpected toxic or residual effects that sometimes occur with synthetic chemicals. Moreover, the treatment offers yet another commercial use for waste crabshell that is a disposal problem for seafood processors.

Deep ocean exploration In the late 1970s, discovery of hydrothermal vents on the ocean floor stirred great interest--not only in the new life forms found near them but also in the rich mineral deposits encrusting vent areas. None of the vents were observed for more than a few hours because submersibles can stay down for only short periods of time. However, during summer 1984, Sea Grant support enabled University of Washington oceanographers to place new monitoring devices on the ocean bottom. The instrument package contained a time lapse camera and electronic sensors to measure changes in seawater chemistry, temperature, flow rates and electrical conductivity. For the first time, repeated measurements of the chemistry and flow of superheated water issuing from ocean vents were made over a week's time. Further development will enable scientists to measure mineral and thermal outputs of the vents, will provide essential environmental information and will improve the quality of instruments used to measure deepwater phenomena.

Management planning for ports Most ports use financial reporting systems that are dictated by state auditors or other administrative entities. Frequently these systems do not provide port managers with the data needed to determine a port's financial performance--much less to formulate effective policies. In response to this problem, Washington Sea Grant's port industries specialist developed a simplified performance indicator system that is now being used by port managers worldwide to measure rapidly and accurately:

- the efficiency with which a port uses its resources such as land, labor, and capital
- the care with which a port controls its expenses
- the profitability of a port's investments

The monitoring system, described in a recent advisory report, enables port management to isolate significant data and to use them alone or in concert with other data to formulate policies. The ability to plan intelligently that is engendered by this system has been a boon to port managers who are faced with complexities of technological changes, scarce capital construction funds, high interest rates, and increased public pressure for services and benefits.

Seafood retailing A trend toward increased seafood consumption for health and nutritional reasons is evident in Washington State just as in other states. To help Washington seafood markets capitalize on this trend, Sea Grant advisory personnel have held seminars for retailers throughout the State to explain and demonstrate basics of seafood handling, merchandising, quality evaluation, and sanitation. Attendance has ranged from owners of "mom and pop" markets to employees of major food chains.

Among the results: A supermarket in Bellingham reassessed its philosophy about seafood, made dramatic physical renovations, and now boasts an attractive seafood section that features a wide variety of top quality seafood products. The largest chain in the state, Safeway Stores, Inc., is improving their ability to handle and display seafood. One food chain store executive reports that as a result of changes made, "volume and profitability are up."

To achieve results such as these has required many years, the dedicated efforts of hundreds of individuals, and the cooperation of a multitude of businesses, agencies, public institutions, and civic groups. This indeed is a partnership that has paid off for the users of Sea Grant efforts and has shown time and again that Sea Grant is a wise investment.

More information? In addition to the projects described here, the Washington Sea Grant Program has undertaken extensive research in diverse marine fields: from fisheries and oceanography to ocean law and public policy. The program supports several education and training projects at the University of Washington and institutions elsewhere in the State.

There is also a network of marine specialists and agents throughout Western Washington who provide businesses, agencies, and citizens with information and assistance needed to address marine problems and opportunities. For a directory of current projects and personnel, the latest biennial report of program accomplishments, or a catalog of Washington Sea Grant publications, write or call:

Washington Sea Grant Program
College of Ocean & Fishery Sciences
University of Washington
Seattle, WA 98195
(206) 543-6600

November 1984

UNIVERSITY OF WISCONSIN SEA GRANT COLLEGE PROGRAM

The University of Wisconsin Sea Grant Program was established in 1968—one of the first programs in what is now a nationwide network of 29 Sea Grant universities. In 1966, Congress established the National Sea Grant College and Program Act to promote research, education *and* public service *activities related to marine and Great Lakes resources. Congress challenged universities to do for the marine community what they had done for American farmers. Eighteen years later, the experiment is succeeding.*

THE INLAND SEAS

Wisconsin's "oceans" are the Great Lakes, and the Sea Grant program here focuses most of its attention on these inland seas. Headquartered in Madison, UW Sea Grant is a statewide program, with advisory services offices in Superior, Sister Bay, Green Bay and Milwaukee. More than 300 faculty, staff and students are involved in Sea Grant projects on campuses throughout the state—at UW-Green Bay, UW-Madison, UW-Milwaukee, UW-Parkside, UW-Stevens Point, UW-Superior, UW-Extension, Lawrence University and the Medical College of Wisconsin.

The Wisconsin Sea Grant Program represents a unique working partnership of federal, state, university and private sectors. With a combined annual budget of $3 million, UW Sea Grant supports a variety of research, education and public service activities. The program's major research areas include *fisheries, microcontaminants and water quality, seafood technology, diving physiology, aquaculture, policy studies* and a comprehensive *Green Bay research program.* The program's advisory services field agents provide a direct link between those who study the lakes and those who use or manage the resources—including commercial and sport fishermen, recreational businesses, industries and government agencies.

THE RECORD

The UW Sea Grant College Program is recognized as a national leader in research on microcontaminants and water quality, fishery and ecosystem dynamics, and diving medicine:

- **Microcontaminants.** Sea Grant scientists are identifying the sources and fates of toxic chemicals in the aquatic environment and predicting how long these compounds will remain a problem in the Great Lakes. The UW Sea Grant Institute sponsored a pioneer study of the health of infants exposed to PCBs in the mothers' blood while in the womb and in breast milk after birth. The study found that the benefits of breast-feeding outweigh the risks of low levels of PCBs in breast milk. The results of such projects have allowed industry and government to better manage and control the discharge of toxic compounds.

- **Groundwater.** Sea Grant researchers have discovered that groundwater may contribute 10 to 15 percent of the water in Lake Michigan—and possibly a significant amount of phosphorus and other nutrients. This information will be essential in assessing the impact of landfill waste disposal on both ground and lake water quality, and in considering strategies to control nutrients to protect the lake's water quality.

- **Diving.** The goal is to make scuba diving safer and easier, and more cost-effective for industry. UW Sea Grant researchers recently discovered that the short, deep "bounce dives" often made by sport divers hold greater risks of paralysis and death than previously believed. Spinoff medical benefits have included the discovery that exercising in water can be therapeutic for emphysema and other lung disease victims.

- **Fisheries.** Sea Grant researchers are working to restore native lake fish populations to enhance Wisconsin's sport and commercial fisheries, which have an estimated annual worth of $60 million and $4.2 million, respectively. Sea Grant researchers have also developed a model of predator-prey interactions and are now testing its predictive capability in a Great Lakes-wide survey of the diet of salmonids. The Wisconsin Department of Natural Resources is using this and other Sea Grant research to manage the trout and salmon sport fishery and to balance commercial and sport use of the fish resources of Lakes Michigan and Superior.

- **Engineering.** Each winter, lake ice causes hundreds of thousands of dollars in damages to marinas and harbor structures throughout the region. UW Sea Grant advisory services published the first comprehensive manual on how to design small-craft marinas and harbor structures to better withstand winter ice.

- **Education.** More than 250 students have received Master's and Ph.D. degrees as a result of UW Sea Grant support. Representing a broad range of disciplines, these students have gone on to work in academia, government, business and for major industries, including Bechtel Corporation, Exxon, General Motors and Bell Labs.

THE WISCONSIN IDEA IN ACTION

"The Wisconsin Idea"—that the boundaries of the university are the boundaries of the state—is a tradition that has grown strong since it began in the early 1900s. The UW Sea Grant College Program embodies this philosophy by devoting more than 25 percent of its resources to education and service programs outside the classroom.

Sea Grant emphasizes public service. It helps the university work for the people of Wisconsin—by sponsoring workshops for commercial and sport fishermen, helping marina owners minimize ice damage, advising the Port of Milwaukee on dredge spoil disposal, and producing the popular Earthwatch Radio series.

THE GOAL

The resources of Lakes Superior and Michigan are extremely valuable to the people of Wisconsin. The lakes provide high quality water for coastal residents and industry and offer abundant recreational opportunities—fishing, boating, swimming and scuba diving. But the lakes also mean jobs for Wisconsin shipbuilders, dockworkers, sailors, tourist businesses, commercial and charter fishermen, and many others.

The University of Wisconsin Sea Grant College Program is dedicated to protecting and enhancing these resources, which are of vital importance to the economy and quality of life in Wisconsin.

For more information:
Sea Grant Institute
University of Wisconsin
1800 University Avenue
Madison, WI 53705
(608) 262-0905

November 1984

Section 4. Recent Achievements

Recent benefits and accomplishments of the 30 Sea Grant college and institutional programs conducted in coastal and Great Lakes states and Puerto Rico.

Alabama
Alaska
California (2)
Connecticut
Delaware
Florida
Georgia
Hawaii
Illinois
Indiana
Louisiana
Maine
Maryland
Massachusetts (2)
Michigan
Minnesota
Mississippi
New Hampshire
New Jersey
New York
North Carolina
Ohio
Oregon
Puerto Rico
Rhode Island
South Carolina
Texas
Virginia
Washington
Wisconsin

University of Alaska Sea Grant College Program
Increased Revenues in Alaska's Trawl Fishery

The commercial king crab industry began in Alaska in the 1920s but until after World War II, there was no major domestic king crab fishery. Japan did have a fishery off Alaska in the 1930s and both Japan and the Soviet Union exploited king crab in these waters between the late 1940s and mid-1960s when limits were set on their catches. By 1975 the king crab fishery became a solely domestic fishery; the catch almost tripled form 108,998 mt in 1975 to 293,749 mt in 1980. Thereafter the king crab fishery began a remarkable decline; the 1982 harvest was 71,575 mt. As a result of the decline, the major king crab fishing areas were closed in 1983 and estimates are that they may be closed until 1990.

The majority of Alaska's king crab fishermen reside in Kodiak and until 1981 contributed largely to Alaska's and especially Kodiak's economic well-being. With the rising harvests experienced during the mid- and late 1970s, crab fishermen were able to buy larger vessels and more sophisticated gear. Now only the payments remain.

In order to alleviate the effects of the decline, Alaska Sea Grant sponsored a training program to assist these fishermen in diversifying and entering the developing groundfish fisheries.

Ten Kodiak fishermen, paying their own way, took advantage of a two-week course offered by the university's Fishery Industrial Technology Center at the British Sea Fish Authority facilities in Hull, England during April 1984. The fishermen were able to program the computer-linked trawl simulator for any specific bottom-type, vessel horsepower, net design, rigging and fish behavior. Although the full benefit of the training received by the fishermen will not be known for some time, some very significant results have already been observed.

One Kodiak vessel, averaging $60,000 gross per month before its captain took the course, is now averaging between $90,000 and $120,000 a month. As the vessel owner put it, "before the class, they were hanging up all the time; now they are fishing on the bottom." While no figures are yet available on the savings in gear and lost fishing time, they are said to be "considerable."

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October, 1984

Improved Production of Abalone Using Biochemical and Genetic Engineering

Modern biochemical and genetic techniques are being used to improve control over biological processes that limit the production of commercially valuable shellfish, such as abalone. These processes include several stages of reproduction, larval development and metamorphosis, and survival of the cultivated animals.

Experiments conducted by Daniel E. Morse, Marine Science Institute, University of California, Santa Barbara, with funding provided by the California Sea Grant College Program (National Oceanic and Atmospheric Administration, Department of Commerce), have concentrated on the Red Abalone, a major commercial resource in California.

Dr. Morse and his research associates initially sought to improve control over reproduction. They found that they could induce abalones to spawn by adding a small amount of the hormone prostaglandin to the surrounding seawater. A search for a less expensive procedure led to the discovery that hydrogen peroxide stimulates production of prostaglandins, and thus also induces spawning.

A second research problem arose from the fact that the larvae that hatch from fertilized abalone eggs frequently exhibit high mortality—a problem that had been plaguing efforts at industrial cultivation for years. Dr. Morse found that the swimming larvae are normally induced to settle and undergo metamorphosis to their juvenile form at the surfaces of specific red algae. In subsequent work, Dr. Morse was able to isolate the substances in these algae that are responsible for the induction of settlement and metamorphosis. Of these, the most potent and least expensive proved to be a simple amino acid known as GABA (for gamma-amino-butyric acid). Use of this chemical provides a safe and inexpensive method for inducing rapid metamorphosis with high efficiency and survival. Most exciting perhaps is the potential application of GABA to human medicine, since the amino acid is known to be a potent neurotransmitter that controls nearly one-half of the cells in the human brain. New compounds have been discovered by this research group in marine algae and bacteria that mimic the action of GABA; these are now being explored for their usefulness as diagnostic and therapeutic agents.

One of the major problems remaining in the commercial production of abalone is the animal's relatively slow growth. To attack this problem, Dr. Morse has begun to clone and amplify the genes that code for growth-accelerating hormones, thereby applying the techniques of genetic engineering to mariculture.

By far the greatest application of Dr. Morse's work has been in the area of marine aquaculture. The methods developed are simple, inexpensive, reliable, and applicable to a large number of species. Procedures developed by Dr. Morse have been applied to a large number of mollusc species under cultivation or harvest in Mexico, Europe, Africa, New Zealand, Australia, Japan, and China.

One valuable spinoff of this research relates to the control of marine fouling. Having identified the mechanism that controls settlement of larvae and their attachment to surfaces immersed in the ocean (such as ships, pilings, piers, and platforms), Morse and his colleagues are investigating means for blocking these processes with a new generation of nontoxic inhibitors; this work is being supported by the U.S. Navy and the offshore industry.

For this work, Dr. Morse and his research specialists have been twice recognized by the World Mariculture Society. In 1982, a Sea Grant trainee working with Dr. Morse, Andrea J. Baloun, received the prestigious Predoctoral Research Award from the Association for Women in Science Education Foundation.

Dr. James J. Sullivan, Program Manager
California Sea Grant College Program
University of California, San Diego A-032
La Jolla, CA 92093

USC SEA GRANT'S "HOUSE-FLY ASSAY" ATTACKS PROBLEM OF PARALYTIC SHELLFISH POISONING

STATEMENT OF THE PROBLEM

When the presence of Paralytic Shellfish Poisoning is discovered, regulators close large sections of coastline thereby quarantining uncontaminated as well as hazardous shellfish populations. This practice reduces the credibility of the quarantines among recreational divers and strikes a severe economic blow to the fishing industry.

SEA GRANT RESPONSE

Regular toxin monitoring in commercially harvested shellfish is mandated in several states, including by the State of California Department of Health. The only assay approved by the U.S. Food and Drug Administration (FDA) tests whether laboratory mice are affected by extracts of shellfish meat. This test, however, is costly and is too complex and cumbersome to be used in the field.

Research by the University of Southern California Sea Grant Program has developed a bioassay that eliminates the many disadvantages of the present mouse bioassay. The new test animal is the common house fly, Musca domestica. A typical mouse bioassay costs $100 or more, whereas a fly bioassay costs only about $50. The new assay method is being tested nationally and the USC Sea Grant Program will seek government certification of the process.

RESULTS

* The fly assay has been shown to be inexpensive, simple to teach and highly reliable.

* Several laboratories and governmental agencies have expressed interest in the results of the research.

* The fly assay is significantly more sensitive at lower levels of toxin than is the official mouse method. This will prove useful in research and perhaps in forecasting the occurrence of dangerous levels of toxin.

* Two USC doctoral candidates have won national honors for their work on the USC Sea Grant research project.

* Research also has established that certain crab larvae can feed on the toxic dinoflaggellates and accumulate the toxin without being affected by it. This result defines another pathway by which the toxin can enter the marine food web.

FURTHER INFORMATION: USC Sea Grant Program
Institute for Marine and Coastal Studies
University of Southern California
University Park
Los Angeles, CA 90089-0341

1984

CONNECTICUT SEA GRANT

A century ago, Connecticut was a leading oyster-producing state, and her waters yielded a significant harvest of oysters and hard and soft clams.

Around the turn of the century, shellfish harvests went into decline. Water pollution, overharvesting and neglect of natural beds were among the factors cited as reasons for the decline. Annual oyster production peaked at 10,000,000 bushels in 1898. It was 40,000 bushels in 1967. Hard and soft clam harvests went from 200,000 bushels to none.

In the last 15 years, Connecticut has mounted an effort to rejuvenate her shellfisheries. And, since its inception in 1974, the Connecticut Sea Grant Marine Advisory Service has been in the forefront of the effort to return shellfishing to a viable industry. Sea Grant joined the effort with the initiation of its first research project, "The Life History and Resource Management of the Hard Clam," in 1981.

Marine Advisory Service specialists have worked with nearly half of the 25 shoreline municipalities to develop shellfish management plans or assist in establishment of municipal shellfish commissions. Their efforts included guiding commissions through the procedures for shellfish surveys to identify near-shore areas with potentially harvestable shellfish resources, and assisting with demonstration plots and other projects.

The Marine Advisory Service specialists played a key role in the state legislature's decision to establish a state Aquaculture Commission, and the program leader has been appointed by the Governor to serve on the commission. In addition, the specialists assisted with formation of a regional shellfish officers' association to provide a formal network for distribution of information as it contributes to a revitalized shellfish industry.

Workshops sponsored by the Marine Advisory Service on aquaculture regulations and techniques provided a vehicle for Sea Grant researchers to present their initial findings on techniques to achieve maximum survival of seed clams. That project involves studies of natural populations, larval settlement and recruitment, and growth and survivorship of juvenile and adult clams. A portion of the research was conducted with a $43,220 industry match.

Aquaculture is only one area of involvement for Connecticut's Marine Advisory Service. Others include fisheries, including seafood processing and marketing, marine economics, coastal development, marine recreation, and marine education.

For additional information about Connecticut Sea Grant's Marine Advisory Service, contact:

Victor E. Scottron, Director
Connecticut Sea Grant
The University of Connecticut at Avery Point
Groton, CT 06340
(203) 445-5108

UNIVERSITY OF DELAWARE
SEA GRANT COLLEGE PROGRAM
HALOPHYTES: SALT-TOLERANT PLANT RESEARCH

Salt-tolerant plant research continues toward the goal of developing improved cultivars of a grain, a vegetable, and several forages from wild halophytes that will thrive when exposed to salinities characteristic of coastal and estuarine waters.

Having selected the first generation of the leafy, spinach-like *Atriplex triangularis*, researchers are beginning to increase the seed of this strain. Selected cultivars are being tested both in a saline desert and in a coastal site with high humidity, which offers an opportunity to compare plant performance in two distinctly different types of environments.

The research emphasis is now focused on using somaclonal variations in tissue culture as the basis for selecting plants with specific desirable genetic traits. Although the reasons are not completely understood, cells in tissue culture undergo more changes than they would in the whole plant. By subjecting these cultures to temperature extremes, the cells that survive will have endurance to these extremes. Selection of cell lines which can subsequently be regenerated into whole plants that can withstand low temperatures will make it possible to grow certain salt-tolerant plants in Delaware and other locations that ordinarily could not withstand our winter temperatures.

Researchers are also evaluating the nutritional content of halophytes. Several salt-tolerant plants have been identified that have value for use as food, feed, or forage crops. *Kosteletzkya*, seashore mallow, yields seeds whose oil is very high in linoleic acid, an essential fatty acid, and is similar to that of safflower; its crude protein is almost 25%, compared with the 30 to 40% found in soybeans. Feed made with *Kosteletzkya* seeds has a higher protein efficiency ratio than those made with corn, wheat, or rice, indicating that *Kosteletzkya* seed protein is used effectively in the body. Researchers are now evaluating how the nutritional value of *Atriplex* withstands cooking and freezing. They are also testing possible use of *Kosteletzkya* in cereals, poultry feed, breads, and commercial gums.

The ability to grow a crop where none could grow previously and the ability to irrigate a crop with salt water while saving precious fresh water will have a real economic impact. Supplying high-quality seed sources of halophytes with specific characteristics could be a new source of income. Using halophytes in the food and feed industries also could have a significant economic benefit.

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DEVELOPING VALUABLE NEW FISHERIES: BURGEONING HARVEST OF CALICO SCALLOPS IS AIDED BY FLORIDA SEA GRANT R & D

In just the last few years, the fishery for calico scallops has grown from mir or status to become one of Florida's most valuable. Questions concerning seafood product quality, processing technology, vessel operations, and education of the incustry and regulatory interests all have been addressed by Florida Sea Grant. Work to help establish and sustain a fishery also has provided new economic opportunities for other sectors of the fishing industry, which were overcapitalized.

Situation

Prior to 1980, annual production of the shellfish, calico scallops, never exceeded 2.5 million pounds in Florida. In recent years, harvests have increased dramatically, with forecasts of over 26 million pounds for 1984. This amounts to a wholesale value of over $60 million dollars, making it the second most valuable in the state and of great economic impact locally due to its concentration geographically in the Cape Canaveral area along the Atlantic coast.

Development of the fishery has been accompanied both by normal growing pains and by unique circumstances that threaten its well-being, the quality of its seafood product, and even the safety of its participants on the high seas. Specific concerns have included:

- consumer attitudes toward product appearance affected by scallop parasites
- regulatory limits affecting disposal of processing wastes
- safety and stabil ty of vessels never designed for scallop fishing
- information for potential entrants into the fishery
- industry concern for sustained levels of harvest of scallops

Sea Grant Response

Florida Sea Grant has melded five faculty and additional support personnel from three universities into a research, extension, and technology transfer team that has provided both leadership and support in various phases of a cooperative academic, agency and industry response to the needs of those involved with this remarkable fishery.

As fishery expansion began a few years ago, naturally occurring parasites in the adductor muscle of the scallops taken in the principal fishing grounds off Cape Canaveral raised concern for the quality and aesthetics of the product. In one instance regulatory action forced the destruction of 13,000 pounds of scallops valued at over $30,000. A Sea Grant pilot study culminating in a longer project due to end in 1984 has developed initial descriptions of parasite burdens in scallops.

From this work has grown a related but broader study, jointly funded with industrial development support, to assess how quality control is influenced by current harvest, processing, and storage practice. Generic industry needs such as onboard handling, cleansing, shucking, processing, and yield are being scientifically analyzed in this newer project. This work includes assessments for methods to kill and remove any parasite infestation to within regulatory guidelines. All work is due to culminate in a final industry/regulatory workshop on quality control where Sea Grant published operation manuals will be distributed.

In response to problems with the volume and content of viscera and shell wastes generated by shoreside processing facilities located in a limited geographic area, Sea Grant's seafood technologist has addressed treatment procedures and options. Further work has been proposed to address water conservation in processing, and waste utilization as livestock feeds.

In addition to addressing onboard handling, and especially the length of time that scallops are stored on deck, Sea Grant also is determining vessel loading capabilities, which are of intense interest because shrimp vessels are being used in a situation for which they were not originally designed. In other words, vessels built to trawl nets through the water and store catch below deck are now storing scallops (and the weight of the shell) above deck. This creates a top-heavy situation and vessels have capsized, with loss of equipment and casualties. A current Sea Grant project is assessing hull design and construction parameters to improve stability and safety.

Results

Information about the burgeoning fishery is sought by many interests, and Sea Grant extension personnel have played a key role in supplying it. For example, at a workshop dealing with fishing industry expansion to the north of the historical Florida scallop ports, Sea Grant personnel provided facts that demonstrated the economic potential and benefits to be realized from start-up of the fishery. State regulatory agency, industry, and local governmental voices were heard in an objective forum that also addressed the general issue of waterfront development.

Research, meanwhile, has demonstrated that the parasites do not constitute a human health hazard. Even if they did, the effectiveness of processing to kill them has been established with data from the Sea Grant research.

Preliminary engineering studies have characterized and called attention to the vessel stability situation. Public workshops to disseminate practical guidelines for vessel operation are planned. Interestingly, one of the graduate students involved with the project won a national research award from the Sea Grant Association for the excellence of his study.

Communications with regulatory state and federal agencies has built bridges of understanding and provided a data base for rational evaluation of this industry. Sea Grant studies that have established the compliance of processing standards to acceptable norms have built credibility for the industry in dealing with remaining needs.

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Although Georgia has over 1,000 miles of fishable rivers, eel fishing had long been prohibited west of Interstate 95, a highway which runs roughly parallel to the coast approximately eight miles west of it. The widely held perception was that eel traps would also capture young game fish, shad, and catfish, and that this, in time, would adversely affect both sportsfishing and commercial catfish and shad fishing.

Sea Grant researchers, however, saw potential advantages to the coastal counties, to the state, and to the nation in an expanded eel fishery. They pointed out that the trapping methods and the seasonality of eel fishing could complement other part-time fisheries, such as crabbing, and offer the possibility of full-time employment. Since the market for eels historically has been an export market primarily to Europe and Japan, increased exports of eels would also help to ease an increasingly unfavorable balance of trade.

In an investigation designed to assess the impact of expanded, legalized eeling, the Department of Natural Resources was persuaded to open the commercial trap fishery for yellow American eels in Georgia rivers on a provisional, one-year basis in March 1980.

Data gathered during that year showed conclusively that a very small incidental catch of other economically important fishes occurred in eeling. This information provided the basis for management's decision to open the rivers to eeling permanently.

As more fishermen became involved, new studies were conducted to facilitate the development of the Georgia eel fishery. Baseline populations were determined as a basis for recruitment studies, and it was found that eels in Georgia grow faster and may be more capable of sustaining greater fishing pressure than populations farther north. Commonly used eel traps were tested for efficiency. Eel behavior was studied by divers and underwater cameras to determine eel movement and foraging habits. These observations contributed to the development of more efficient traps.

Commercial landings of eels have increased to the point that they are the fourth largest fishery in the state after shrimp, crabs, and shad.

The information generated by four years of Sea Grant research and disseminated by the Sea Grant advisory staff has resulted not only in increased catches, but will continue to form the framework for future management decisions in the fishery.

Edward Chin, Director

RESOURCE ASSESSMENT OF THE NORTHWESTERN HAWAIIAN ISLANDS

The 200-mile exclusive economic zone placed vast expanses of marine real estate off the Hawaiian Archipelago and particularly off the remote Northwestern Hawaiian Islands under federal jurisdiction. The fishery resources have only been sporadically exploited because of the great distance from the populated islands. Until a tripartite-Sea Grant assessment of the fisheries and wildlife resources was completed in 1984, very little was known about the extent of the fishery resources of this region. Participants of this major interagency research program included the University of Hawaii Sea Grant College Program, Hawaii Division of Aquatic Resources, National Marine Fisheries Service, and U.S. Fish and Wildlife Service.

The resource assessment established the existence of commercially exploitable shrimp, precious corals, lobster, and bottomfish fisheries. It also confirmed the difference between standing stocks on continental and insular shelf environments, the former region has great populations of limited number of species, whereas the latter has great diversity of species with smaller populations of each species.

The Western Pacific Regional Fishery Management Council used this data to develop its management plan for spring lobsters and is currently using this data base to develop the fishery management plan for bottomfish. Other uses are being made of the data by the state and federal governments to develop management plans for threatened and endangered species and fishery resources in waters off the Northwestern Hawaiian Islands.

More than 200 researchers from the three state and federal agencies and the University of Hawaii participated in this multidisciplinary research program. Thirty-eight research reports have been produced and more than 50 articles and papers published in professional journals. Two symposia were held to disseminate the results of research to scientists, fishery administrators, fishermen, and other interested individuals. These papers have been published in three volumes by the University of Hawaii Sea Grant College Program.

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CHARTERBOAT FISHING INDUSTRY PROVIDES SIGNIFICANT ECONOMIC RETURN TO THE REGION

The charterboat industry is represented in the Illinois-Indiana region by six charterboat associations plus many independent charterboat operators. Charterboat operations are an important part of the tourism industry in Illinois and Indiana for several reasons:

(1) Lake Michigan provides a unique and outstanding fishery to destination fishermen;

(2) Conference-goers and out-of-town businessmen pouring into the Chicago area every day frequently take advantage of the charterboat fishing experience; and

(3) Many vacationers are attracted to the Indiana shoreline to enjoy charterboat fishing as a part of their vacation experience.

The Illinois-Indiana Sea Grant Program is helping this industry bring in and retain more tourism dollars by educating charterboat operators in fisheries resources, improved business practice and by informing commerce-related sectors and local governments about the economic importance of the charterboat industry.

The Program has provided assistance through the following activities:

* Workshops which offer information ranging from stocking program updates to charterboat liability insurance.

* Preparation of the Directory of Illinois Licensed Boat Charter and Livery Services, a comprehensive directory listing all types of charters from sportfishing to scuba-diving. This was printed in cooperation with the Illinois Department of Conservation and the Illinois Department of Commerce and Community Affairs.

* The institution of the Marine Reporting Program (MAREP), which is a system for obtaining timely localized weather forecasts for sportfishermen. A central location has been established by the Chicago office of the National Weather Service for receiving and transmitting this weather information. Through the coordination of the Illinois-Indiana Sea Grant Program, ten volunteers from the Chicago Sportfishing Association have been trained in reporting weather data for this system.

* Involvement in the Salmonid Diet Study, a research project that is being done to provide a better understanding of salmonid food habits in Lake Michigan. This study is part of a project being cooperatively investigated by the other Programs in the Great Lakes Sea Grant Network. The information gained will be used by the resource managers charged with the maintenance and utilization of the fisheries resource of Lake Michigan. A long range result of this study will be to sustain the economic return and enjoyment of sportfishing in the region.

For further information about this program, please contact Robert Espeseth, Coordinator, Illinois-Indiana Sea Grant Program, University of Illinois, 203 Huff Hall, 1206 S. Fourth Street, Champaign, Ill. 61820. Phone: 217/333-1824.

Seafood Wastes—A Valuable Resource

Louisiana Sea Grant

Thanks to a decade of Sea Grant-supported research, the cultivation of crawfish (Procambarus clarkii) in south Louisiana represents the most extensive concentrated farming of crustacea in the United States, with an economic impact on the state of over $70 million.

Disposing of the enormous amounts of proteinaceous wastes discarded by crawfish processing plants, however, has become a serious environmental and economic problem. In St. Martin Parish alone, where there are at least 20 crawfish processing plants, over 15 million pounds of waste are produced each year and the annual cost of disposal has reached several hundred thousand dollars. Thousands of tons of wastes have been buried in landfills throughout the state, but in 1985 stringent federal laws will make that practice illegal.

Supported by Louisiana Sea Grant through ten years of research into the nutritional value of seafood wastes, Dr. Samuel P. Meyers has developed a process that can turn the wastes from an expensive nuisance into a valuable resource. The wastes contain astaxanthin, an orange-red pigment that imparts a desirable pink tint and greater flavor to the flesh of farm-raised trout and salmon when used as a dietary additive. Dr. Meyers has perfected a method of extracting the astaxanthin from the wastes, a process that provides an important use for crawfish shells and gives seafood processors a new source of profit.

A pound of the extracted pigment, a carotenoid in the vitamin A family, can sell for about $600. The U.S. salmon industry has found that this substance gives commercially grown trout and salmon the rich color and flavor of wild populations. Interest is also keen in other countries with active aquaculture programs, like Japan, Canada, and Sweden.

St. Martin Parish, in the heart of Louisiana's "crawfish belt," has enthusiastically supported Dr. Meyers' work with funds for building the first crustacean waste processing facility in the country. The plant opened during the summer of 1984. At present, Dr. Meyers is working to improve the commercial efficiency of the process and to develop other commercial applications for astaxanthin.

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Sea Grant College Program
University of Maine

Increasing Clam Harvests in Maine:
From the Campus to the Clam Flats

Where Have All the Clams Gone?

That's what clam diggers, wholesalers, town clam committees, clam wardens, and researchers all wanted to know when clam landings started decreasing drastically in the mid-1950's. The soft-shelled clam, *Mya arenaria,* is Maine's third most important commercial fishery, after lobsters and groundfish, and the principal means of income for many people in the small, coastal towns in Downeast Maine. In 1976 clam harvesters and local shellfish committees of these coastal towns, which are responsible for their own tidal flats, came to the University of Maine and its Marine Advisory Service for help in managing the resource.

What's Sea Grant Doing About It?

After the problem of a decline in stocks was identified and a clam survey of the flats was undertaken by Marine Advisory staff in the Washington County area, a Sea Grant research program, known as the "Mya Project," was initiated in 1979 to generate information needed for the improved management of the clam flats.

The research team, consisting of a sedimentologist, a biologist, a geochemist, and an aquaculturist, designed the proposal in conjunction with Maine's Marine Advisory Service which had instigated the project in direct response to coastal community needs.

A study of soft-shelled clams and their mudflat environment was carried out in Jonesboro, Maine during 1980 and 1981 to determine what could be done to increase the recruitment of young clams onto the flats. Meanwhile, the aquaculture facility at the Ira C. Darling Center of the University of Maine at Orono, located at Walpole, was the site of hatchery-rearing activities where clam broodstock were induced to spawn before being shipped to nursery sites in various coastal towns up and down the state.

In addition, Sea Grant researchers were also studying the biology of the clam through clam feeding and growth experiments in the laboratory, while sedimentologists were conducting field and lab experiments to determine the grain size characteristics and nutritional quality of the clam flats.

The Results: Hope for a Better Harvest

Already clam diggers in Freeport, Jonesboro, and four other communities have begun to harvest clams spawned three years ago in the University's Darling Center hatchery. In Brunswick, an inexpensive new clam seed dredge, developed by the University's Agriculture Engineering Department with Sea Grant support, now makes it possible to transplant natural clam seed from overcrowded areas to areas depleted by the elements or man.

Over a decade of Sea Grant research on basic clam biology, clam seed-planting efforts in coastal towns, and the economic impact of clam flat management have recently been compiled in a Sea Grant publication, ***Increasing Clam Harvests in Maine.*** Along with this manual, the development of aquaculture techniques, the mechanical seed harvester, and an innovative 4-H program in raising clams from seed in a hatchery built and maintained by the youths themselves will assist all coastal towns to manage their clam harvesting for optimal production.

Cooperating with the many individuals and organizations in the state interested in the wise management of the clam resource, the Sea Grant College Program at the University of Maine has provided significant benefits to the local clam management committees in coastal towns, clam dealers, and the clam harvesters themselves.

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UNIVERSITY OF MARYLAND

Sea Grant College Program

MARYLAND SEA GRANT AND THE OYSTER FISHERY

THE PROBLEM: The oyster fishery--traditionally the Chesapeake Bay's most valuable fishery resource--is in serious decline, harvests dropping to less than half of their recent average.

THE RESPONSE: The Maryland Sea Grant College has moved to help revitalize the oyster industry through research, education and advisory services.

The decline of the oyster industry results from both man-made and natural perturbations. To help explain how the oyster responds to changes in its environment, researchers have used Sea Grant support to study:

- The way in which oysters metamorphose and settle. This research has led to the discovery of a patented bacterium, designated LST, which appears to trigger an oyster's change from free-floating larva to permanently settled oyster. Substances associated with this bacterium also hold potential as marine glues and adhesives.
- The distribution and availability of food for the oyster.
- The quality and nature of that food, with an eye toward subtle changes in the Chesapeake Bay's flora and fauna.
- How an oyster feeds and reproduces--through an analysis of molluscan "bioenergetics."

To help those who are trying to come up with innovative methods, Sea Grant has supported several practical projects. Marine Advisory agents and specialists have:

- Worked with watermen to plant young oysters (or "spat") on specially prepared bay bottom to increase future harvests and production.
- Cooperated with aquaculturists to improve the spawning, setting and feeding of hatchery-reared oysters.
- Shared information with commercial aquaculturists in other parts of the country --especially in the Pacific Northwest--and brought new aquaculture methodologies to the Chesapeake region.

BENEFITS: The decline of the Maryland oyster industry is a large-scale problem which admits of no easy solution. But the research and education now underway at Maryland Sea Grant has offered up some interesting benefits. The newly patented bacterium, LST, has been distributed to a commercial hatchery, which is experimenting with the substance to improve oyster spat set and survival. Methods for year-round algae culture are being employed by oyster hatcheries to feed cultured oysters. Recommendations have been made to state management agencies about the best places to plant oyster shell and young "seed" oysters. And thanks to Marine Advisory efforts, some watermen now have young oysters growing--and nearing market size--on specially prepared plots. This combination of scientific and practical expertise offers our best hope for reversing the oyster industry's deep decline.

MIT SEA GRANT PROGRAM

Computer Tools for Predicting the Effects of Change

Problem

Decisions to make changes in coastal communities often pit group against group, even neighbor against neighbor. One of the inherent problems of change has been the difficulty of assessing residual and synergistic effects on the marine environment. For some towns a new marina could mean more and much needed jobs, revenues and boating facilities. But how to tell whether dredging the harbor entry or mooring areas will change circulation patterns? Will the changes make flushing of municipal wastes less efficient? Could spilled oil and gas or bacterial contamination from shipboard wastes get trapped in the bay or harbor, ruining swimming beaches or recreational fishing areas? If the tides and currents do carry the pollutants safely out to sea, will they pass over and taint economically important shellfish flats?

Solution

In recent years, computer models have provided communities, government regulators, and industry with a kind of crystal ball - a way of looking into the future to understand consequences and mitigate those that might be adverse. Through MIT Sea Grant, in the mid 1970s, faculty and students created a unique and powerful hydrodynamic model for predicting the transport and dispersion of natural and manmade substances in large harbors and bays.

Originally, the model was part of a planned, multi million dollar National Ocean Mining Environmental Study (NOMES) to assess the environmental and ecological impact of massive dredging of offshore sand and gravel resources for use by the construction industry. Later in 1973 and 1976 Boston Edison used the model, divided into two parts —CAFE for looking at water circulation and DISPER for looking at particle dispersion —to win a license for a second generator at their Pilgrim Nuclear Plant. The company saved for themselves, and ultimately for consumers, between $29-54 million dollars by proving that their cooling water channel, increased flow rate and the projected heat flux could be handled by existing facilities within the environmental requirements of state and federal regulations. These models have been used in almost 40 applications to predict the effect of waste dispersal, sediment transport, hurricane surge, and power plant sitings in Massachusetts Bay, Great Egg Harbor, New Jersey, San Francisco Bay, Miami's Biscayne Bay, Long Island Sound, the Mississippi River, and harbor areas in Alaska and Australia.

Future Applications

CAFE and DISPER offered information that had previously been available only through extremely expensive and time consuming measurement programs. They have worked especially well for communities located on large, regularly shaped bays. However, for smaller towns and cities tucked into irregular coastlines with craggy embayments, the application of these models has required extensive, costly computation.

So two years ago, Jerome Connor, one of the creators of CAFE and DISPER, and Keith Stolzenbach, a respected hydrodynamicist, began to adapt the models to develop a new, faster, and simpler tool to be known as TEA (Tidal Embayment Analysis). A new mathematical approach has increased the speed of execution, with a concomitant reduction in the cost. The improvements have been dramatic. A program that took two hours to run now takes two minutes.

At present TEA is being applied to three case studies in New England: two are power generating plants and one is a pond on Cape Cod which is implicated as a source of red tide organisms. In the near future, TEA and its accompanying users' manual will give small communities well founded insights into the effects of changing or expanding the uses of local bays and harbors. MIT Sea Grant, which has already had one major meeting to introduce TEA to potential users, will further disseminate this valuable information through it's well coordinated and publicized report series. In addition, the new knowledge gained from creating TEA as well as CAFE and DISPER will be hand carried to the marine community by some of Sea Grant's most effective disseminators—the scores of students who have worked with MIT faculty members to bring these new technologies to life.

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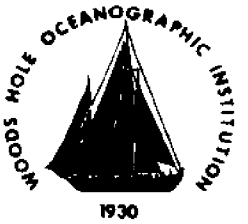

Red Tide

Red tide, the cause of paralytic shellfish poisoning (PSP) in humans, threatens a shellfish industry worth more than $48.5 million in New England and more than $263 million nationally. Consumer reaction to news coverage of red tide outbreaks is known to extend to lobsters and finfish species not directly affected by red tide and to areas far removed from New England. At Woods Hole, Sea Grant research on red tides has identified life cycle stages responsible for initiating red tide outbreaks as well as associated environmental factors. Recent effort focuses on factors responsible for aspects of the bloom dynamics and termination and their implications for artificial control of red tides. Finally, a new research project here is examining how the powerful red tide toxin might be used pharmaceutically for beneficial applications.

Red tide, caused by a microscopic marine alga or phytoplankter, first occurred in southern New England in 1972, although it was earlier known in Canadian waters for many years. The southern extension of red tide may be continuing, as in more recent years the organism has been found in Long Island Sound. A similar southward spread of red tide has been found on the West Coast in waters of the state of Washington.

In early Sea Grant research, Dr. Donald Anderson identified the key role played by a resting stage, or "cyst", in overwintering of the red tide organism in estuarine sediments and in the distribution, timing and initiation of the red tide bloom in late spring. Subsequent research, including that of Dr. Patricia Glibert, has focused on factors determining the severity of the bloom and its duration. More recently, Dr. Anderson has focused on the role of a natural parasitic microorganism in termining red tides and its potential use in artificially controlling these blooms. A second potential control mechanism under investigation involves cross-breeding with less toxic algal strains to reduce overall toxicity of the bloom.

The potency of red tide saxitoxins and their reversible effects suggest they may serve as a source of anesthetics, possibly safer and more long-lasting than those presently available. Dr. Sherwood Hall is currently researching the pharmaceutical potential of this class of toxins or their derivatives.

The primary impact of PSP is the threat of its presence. Most shellfish are probably safe to eat most of the time, but the possibility they are not results in costly monitoring programs and stifles the development of otherwise viable shellfisheries in terms of natural harvest as well as aquaculture. Sea Grant research at Woods Hole has made significant progress in the prediction, control and understanding of red tides and in the possibility of turning their poison into a useful pharmaceutical product for the benefit of mankind.

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Michigan Sea Grant College Program

SEA GRANT SAVES LIVES: Cold Water Drowning Research

Hundreds of lives are saved worldwide per year as a result of Sea Grant research and education on cold water drowning and revival techniques.

Research - Until 1976, drowning victims submerged underwater for longer than four minutes were generally presumed dead and efforts were not made to resuscitate them. However, based on medical knowledge and first-hand experience, Sea Grant researcher and physician Martin Nemiroff had developed a theory that people submerged for even longer periods of time underwater, especially cold water, could survive with little or no after effects. In 1976, Michigan Sea Grant funded Dr. Nemiroff to further document his theory. His research activities revealed that cold water drowning victims could survive after submersion for as long as an hour if properly resuscitated.

Outreach - Through the efforts of Dr. Nemiroff, the U.S. Coast Guard, and Michigan State Police, Michigan Sea Grant began a widespread public education program to promote awareness of the nature of cold water near-drowning and resuscitation techniques. Sea Grant communicators assisted in developing and disseminating informational materials through national and international media and other outlets. Sea Grant field agents began extensive training and education to train first responders (such as firemen, sheriffs, water rescue personnel) and those in charge of hospital emergency room treatment of cold water accident victims. Agents also help those already trained to train others.

Results -

- The U.S. Coast Guard estimates a 25% drop in drowning fatalities. It has been training its personnel and has carried out a wide-reaching campaign to teach boaters about cold water near-drowning and revival measures. The Coast Guard estimates a 50% drop in boating fatalities with continuing public education efforts.
- Hospitals across the nation have set up emergency teams to handle near-drownings and have obtained special equipment to handle these cases. National and international medical personnel have been trained in cold water near-drowning revival techniques.
- Water safety manuals used by the Coast Guard, hospitals, and Red Cross have been rewritten to incorporate information on cold water near-drowning rescue techniques.
- Sea Grant field agents have informed, educated, and/or trained over 8200 first responders, emergency medical personnel, and others about near-drowning and rescue procedures. Many of these have received state-approved EMT course credit and have trained thousands of others.
- Agents and Communicators have prepared publications on emergency treatment of near-drowning victims which are now distributed by the Coast Guard, Departments of Natural Resources, and other organizations.

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IMPROVING LAKE SUPERIOR'S WATER QUALITY AND FISHERY

PROBLEM

The Duluth-Superior region of Lake Superior is among the lake's most productive areas. It is also a heavily used recreational area and receives high nutrient input from runoff and sewage effluents. High rates of long-term nutrient input have the potential to harm the fishery by enhancing growth of undesirable algal species, altering the forage base, and leading to changes in the fishery. Because algal production is one of the best predictors of maximum sustainable fish yields, greater knowledge of the nutrient-algal interaction is needed.

SEA GRANT APPROACH

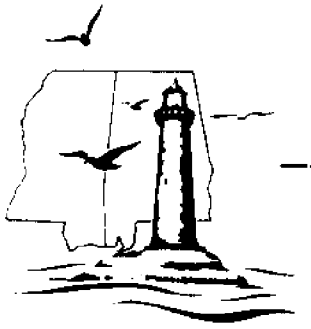
Of the three most common nutrients entering the lake--phosphorous, silicates, and nitrates--only phosphorous is regulated by treatment plants; the other nutrients have been considered less critical to water quality. Ecology Professor G. David Tilman's research shows that the ratio of all three nutrients, along with water temperature, affect water quality and the type of algae that will thrive.

Tilman found that the undesirable blue-green algae thrive in the warmer waters of Lake Superior, with low nitrate to phosphorous ratios. They are generally indictors of poor water quality and may be toxic to zooplankton. Diatoms, on the other hand, are indicators of good water quality, are a good food for fish, and they dominate in cooler water with a low phosphorous to silicate ratio.

Tilman's results show that water quality management should be changed to include regulation of all three nutrients since they all affect the growth of undesirable algal species.

BENEFITS

Sea Grant-sponsored research has uncovered a major mechanism that determines the quality of algal production in Lake Superior, providing scientific data for future research on the link between algal growth and fish production. It has also revealed a relationship between nutrients that could maximize the yield of desirable algae without leading to an abundunce of harmful species.



Mississippi-Alabama Sea Grant Consortium

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MAJOR ACHIEVEMENT--ONE EXAMPLE

The softshell crab industry in the Gulf is faced with continuing decline in the quality of coastal waters and with limited supply of premolt (peeler) crabs.

The development of closed, commercial-scale recirculating seawater systems to hold and shed peeler crabs has allowed for expansion of the industry independent of coastal water quality. The solution to the problem of limited supply of peelers is also under development through Sea Grant research involving hormones that induce molting in blue crabs.

A network of advisory agents and scientists is identifying other problems and filling needs with applied research. Sea Grant scientists, advisory service agents and industry representatives work closely together to provide the latest information to interested individuals, business people and other marine agents from Maryland to Texas. More than 300 Mississippi and Alabama residents have participated in softshell crab workshops and dozens have set up their own shedding systems.

The result of Sea Grant efforts: grassroots entrepreneurs are starting new enterprises; operators of existing crab shedding businesses are applying Sea Grant guidelines for more efficient and economical operations. At a price ten times higher than the hard shell crab, the softshell offers the potential for substantial supplemental income; and the fledgling industry is attracting investment from a broad spectrum of coastal residents.

University of New Hampshire

The economy and life of northern New England are intimately tied to the marine environment. Fish landings in Maine and New Hampshire are worth over $125 million annually and generate another $320 million in related income. Tourism and recreation bring in another $2 billion in revenue as Maine and New Hampshire attract 11 million visitors each year, more than half of them to the coastal region. On an average summer week-end, an estimated 500,000 people pack Maine and New Hampshire's 60 miles of sandy beaches.

Increased growth and development within the coastal zone present serious challenges to the marine resources which form the basis of these industries. New Hampshire has had a population increase of 24.8% since 1970, making it the fastest growing state east of the Mississippi. The bulk of that increase took place within 50 miles of the coast, and more than 30% of the region's population now lives in the coastal zone.

Because of these pressures on a fragile and finite resource, Sea Grant research at the University of New Hampshire is particularly focused on the protection and enhancement of valuable marine resources. These are some examples.

- The dynamics of interaction between estuarine nutrient cycles and New England's multi-million dollar coastal fisheries have not been explored adequately. Working with the pristine Parker River estuary at Plum Island, Mass., a multi-disciplinary Sea Grant team from UNH has begun a project to study the internal processing mechanisms and complex water movements of this ecosystem.
- The Atlantic Salmon, once the king of sport and commercial fisheries, is now rare in northern New England waters, but an agressive stocking and restoration program could restore it to its former glory. The success of this restoration project will depend upon suitable water quality, and a UNH Sea Grant research project is investigating the effect of acid precipitation on the migration patterns of this valuable salmonid.
- The ports of Portsmouth, N.H. and Portland, Maine, annually receive about 23 million short tons of crude oil by sea. In either port, a major oil spill could be disastrous. Working with the New Hampshire Water Supply and Pollution Control Commission, a UNH Sea Grant team designed and field tested oil spill boom configurations for spill containment in high velocity currents. As a result, these boom systems are now required at all oil terminals along the Piscataqua River. A similar program is being considered for Searsport, Me.
- Sewage, industrial discharges, and runoff can have very negative impacts on water quality. Recognizing the need to predict what happens to a pollutant once it's been discharged into coastal waters, UNH Sea Grant researchers have developed hydrodynamic and dispersion computer models to trace the movement of pollutants within estuaries and harbors. These models have been used in strategically locating a sewage outfall pipe in New Haven (Conn.) Harbor and positioning offshore breakwaters in Bristol and Sconnet Harbors, Rhode Island.
- Northern New England estuarine sediments serve as major sinks for certain toxic trace metals associated with industrial and municipal discharges. One UNH Sea Grant project has refined laboratory techniques which can determine the degree of attachment of toxic organic substances to suspended sediment particles—an important parameter in determining the transport and ultimate fate of pollutants. These same researchers have been studying PAH's—polyaromatic hydrocarbons—which may cause tumors in bottom-dwelling fish. Their research considers both chemical and biological processes to determine how these PAH's may be affecting the food chain and, ultimately, seafood consumers.

The state of New Hampshire and northern New England have benefited significantly from Sea Grant's contribution to marine research, education, and advisory services. For further information, contact:

Robert W. Corell, Director
UNH Marine Program and
Sea Grant College Program
Marine Program Building
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(603) 862-2994

University of New Hampshire University of Maine Sea Grant College Program 10/84

NEW JERSEY SEA GRANT INSTITUTIONAL PROGRAM

THE OBJECTIVE OF THIS SEA GRANT STUDY IS TO PROVIDE A BIOLOGICAL BASIS FOR MANAGEMENT OF TILEFISH STOCKS.

Tilefish are an important fishery resource in several Mid-Atlantic and southern New England states, with an annual dockside of about $8 million. In New Jersey, over four million pounds were landed in one year, primarily at Barnegat Light, dubbed "the tilefish capital of the world." New Jersey Sea Grant sponsored research on the life history and population dynamics of tilefish has provided valuable information for the enhancement of this commercial fishery and for the rational management of this tilefish resource.

Tilefish occur along a relatively narrow portion of the outer continental shelf and in submarine canyon walls at depths of 120 to 240 meters where temperatures are fairly uniform. In situ observations with submersibles revealed that they live around boulders and in vertical burrows in clay substrates. These burrows can be up to 4-5 meters in diameter and 2 meters deep. Tilefish reach a maximum size of 60 pounds in weight and 120 cm in length. Their habitat extends from Nova Scotia south to Florida and throughout the Gulf of Mexico, being most abundant in the North Atlantic from Cape Cod to New Jersey and less abundant in the South Atlantic between Cape Hatteras and Cape Kennedy. Small commercial fisheries occur off the southeast coast of Florida and in the Gulf of Mexico.

With the full cooperation of the commercial fishing industry, investigators of a five-year New Jersey Sea Grant project amassed data on stock separation of tilefish on the east coast of the United States, catch and fishing effort, age, growth, mortality, age/size structure of the fishery, and reproductive biology. Techniques were developed for tagging tilefish to determine migration or movement patterns and for advancing the catch ratio of longline fishermen. Results of these studies have been utilized by the Mid-Atlantic Fishery Management Council/National Marine Fisheries Service for incorporation in a tilefish management plan. In addition, they have transferred to the east coast of Florida to enhance that area's tilefish fishery, and plans are being formulated to continue these studies in the Gulf of Mexico.

The success of this project is attributed to the cooperative efforts of academe, NOAA's Sea Grant College and Undersea Research Programs, the U.S. Geological Survey, the New Jersey Sea Grant Program and the Harbor Branch Foundation.

Additional information may be obtained from:

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New Jersey Sea Grant
New Jersey Marine Sciences Consortium
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Fort Hancock, NJ 07732
(201) 872-1300

Savings for New York's Commercial Fishing Fleet

Problem

Increasing fuel costs and relatively stable fish prices have placed commercial fishermen, particularly those using trawling gear, in a financial bind. A survey of New York's Long Island based commercial fishing fleet indicated that 20 percent of the existing vessels could significantly increase their catch or reduce their fuel costs by improving their propulsion systems.

Approach

The survey of fishing vessels, undertaken by New York Sea Grant extension specialists working with researchers from Webb Institute of Naval Architecture, provided information for the design of needed research. Research included:

- Evaluation of various techniques of fuel conservation available to commercial fishermen including: sail assisted power, effective matching of propeller to hull design and engine capacity, gear reduction and two-speed gear boxes as well as the use of nozzles, variable pitch propellers and other propeller configurations.
- An analysis of the relationship between various types of fishing gear and fuel economy.
- Based on the evaluation and the analysis, a propeller design program was developed for use on a portable computer, which matched propeller and hull design configuration for greatest efficiency.
- Field trials of the computer program were undertaken, in cooperation with a propeller manufacturer, to determine if commercial fishermen found it useful.

Output

A series of technical reports detail criteria for selecting the proper propeller for a fishing trawler and show how to match hull, engine, reduction gear and propeller for maximum efficiency. Ways to increase the efficiency of trawling gear in concert with vessel capability are illustrated.

The computer program, which describes alternative vessel/propeller combinations and the towing power characteristics which result, can easily be taken into the field by an extension specialist. New York's Sea Grant extension specialists have field tested the computer program and found that commercial fishermen want to use it in deciding on vessel modifications.

To help fishermen further understand all factors involved in increasing efficiency of their vessels, a 14-minute video-tape was produced by Sea Grant Extension. The video-tape demonstrates propeller design, construction and effects on fuel economy of vessels.

Now that the project has been shown to be effective in New York, steps are being taken to broaden the use of this research. Sea Grant Extension specialists in northeast and middle Atlantic states are being trained in the use of this information, particularly, the computer program.

Benefits

Although the research has been completed only recently, some benefits can be demonstrated. One New York commercial fisherman, after studying the output of the computer program, invested $20,000 in a nozzle system for propelling his fishing vessel. Since that investment, he has increased his catch by a third and will pay back conversion costs in less than six months.

The New York Sea Grant Institute of State University of New York and Cornell University, 37 Elk Street, Albany, New York 12246. (518/436-0701) or call your nearest Sea Grant Extension Office listed in the telephone directory.

UNC SEA GRANT COLLEGE PROGRAM

Surimi: A New Use For An Underutilized Species

Too many of our fish are either wasted or sold for pennies because the market for them is weak. As a result, fishermen and seafood processors suffer, and a lot of good food never reaches the consumer.

Over the past decade, UNC Sea Grant researchers developed food uses for underutilized species of fish from the Atlantic Ocean and the Gulf of Mexico. Most of these food uses involved surimi, a minced fish product developed by the Japanese Sea Grant researchers worked out the details of the texture, chemical structure, binders and waste reduction for surimi. And scientists shared their findings with the seafood industry.

Sea Grant researcher Tyre Lanier currently is evaluating the Atlantic and Gulf menhaden as possible candidates for use in surimi. While the menhaden fishery is the nation's largest in terms of volume, its value per pound ranks well below other species. But Lanier predicts menhaden may become "the soybean of the sea." At the turn of the century, soybeans were used mainly for animal feed. Now, the protein from soybeans can be found in many items on the grocer's shelves.

The surimi process transforms the bony, fatty menhaden into an edible fish. A mechanical deboner removes the bones, and the washing process removes all but 2 percent of the fat. Along with the fat goes the strong, fishy taste characteristic of menhaden. Since the surimi process uses only 20 percent of the fish, the remainder can still be processed for fish meal and fish oil.

As a result of past and ongoing research, UNC Sea Grant scientists developed one of the most extensive banks of surimi research information in the country. And that's why Kibun Products International, Inc., the world's largest processor of surimi-based food products, recently constructed a plant in Raleigh, N.C. Kibun's Raleigh location will provide an opportunity for industry/academic cooperation that could lead to better utilization of domestic fish resources and to improved quality of surimi-based foods at reduced costs.

For more information, contact:

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919/737-2454

ARTIFICIAL REEFS: A REALITY IN LAKE ERIE

Lake Erie is the southernmost, the shallowest, the warmest, the most organically enriched and consequently the most biologically productive of the Great Lakes. In fact, Lake Erie produces more fish annually for human consumption than the other 4 Great Lakes combined. Between 1976 and 1984 the walleye harvest increased from 111,000 to 3,000,000, and the number of charter boats increased from 34 to over 600. However, most of this fishery production, harvest and recreational development is associated with the western basin of the lake with its many natural reefs which are used for spawning by many of the lake's most desired sport species.

Lake Erie is traditionally divided into 3 basins: a small shallow western basin (average depth 24 feet), a large moderately deep central basin (average depth 60 feet), and a deep eastern basin (maximum depth 210 feet). Compared to the western basin, the central basin is a flat-bottomed pan. This lack of relief inhibits sport fishing success because there is nothing to congregate fish or fishermen.

To alleviate this problem and improve the sport fishery in the central basin of Lake Erie, the Sea Grant Program, at the request of and with the assistance of our Sea Grant Advisory Committees, developed an Artificial Reef Program for Lake Erie.

First, Sea Grant researchers evaluated bottom types, water quality patterns, thermocline locations, ice flow patterns, points of angler access, and fish population data to determine suitable sites for artificial reefs. Five sites were identified. Researchers also determined the suitability of various material types for reef construction. Then, in cooperation with the Ohio Department of Natural Resources (ODNR), a permit application was developed and sent to the U.S. Army Corps of Engineers. The permit was put in the name of the ODNR so that contributions to the program would be tax deductable.

At this point, our Sea Grant Advisory Committees went to work to obtain donations of materials, supplies, labor and dollars for the program. To start the program, O'Brian Stone Company of Warrensville Heights, Ohio donated 3,000 tons of sandstone rubble. The Ford Motor Company donated a storage facility on the Cuyahoga River. The Cuyahoga County Commissioners first donated county dump trucks to haul the material to the Ford Motor Company site, and then donated $62,500 to the Sea Grant Artificial Reef Program in The Ohio State University Development Fund to construct the reefs.

Sea Grant researchers working with the contractor, developed dumping techniques and patterns which would turn the artificial reef into an underwater research laboratory suitable for testing hypotheses regarding the effectiveness of the reef in congregating sport fish.

On August 9, 1984, the first of the artificial reefs was constructed in Lake Erie. Several research efforts are already underway to evaluate the reefs and aid in future reef construction, but sportsmen are already flocking to the area and meeting with a great deal of success.

For further information about the Ohio Sea Grant Program contact:

Ohio Sea Grant Program
The Ohio State University
484 West 12th Avenue
Columbus, OH 43210
614/422-8949

Oregon State University Sea Grant College Program

A Long-term Commitment to Salmon

The goal of the Sea Grant College Program at Oregon State University is to advance the understanding, wise use, and development of ocean resources. Towards this end, Sea Grant supports research, education, and advisory services and coordinates its efforts with those of government and private industry. In Oregon, the salmon industry has been a key element of our coastal economics, and Sea Grant has had a long and deep commitment to the maintenance and enhancement of the salmon fishery. Perhaps none of the work supported by Sea Grant illustrates this commitment better than the pioneering research which has been done at sea since 1979.

Abstract: The Sea Grant research of Oregon State University fishery oceanographer Bill Pearcy is contributing to the solution of Oregon's most pressing fishery problem, the steady decline since 1977 in the catch of coho salmon. The decrease in the harvest of coho, the state's commercially most important fish, has spelled trouble for fishermen and fishery managers alike. By gathering previously unavailable data which show how ocean conditions affect juvenile salmon, Pearcy has both provided an important new management tool and helped set the agenda for other ocean-going research.

Background: Since the early 1900s a combination of factors associated with the development of the Northwest—poor logging practices, dam building, and overfishing—have contributed to the decline of many stocks of Pacific salmon. In the period following World War II, significant gains were made in restoring some stocks to near-historic levels through increased production at hatcheries. Sea Grant has been and continues to be an important contributor to these freshwater strategies to increase salmon populations, but by the late 1970s it was becoming clear that these efforts were not enough. There was a blind spot.

The Problem: While the number of juvenile salmon released from the freshwater environments into the ocean was increasing, the number of salmon adults returning from the ocean to spawn was beginning to decline. Commercial fishermen began to suffer economic hardship, a situation which was to become extreme in 1983, when several coastal counties in Oregon would be declared disaster areas in the wake of the traumatic ocean phenomenon known as El Niño.

The Approach: The blind spot in salmon management was the ocean. Oceanographer Bill Pearcy proposed to shed some light on how ocean conditions affect juvenile cohos' migration, distribution, growth, and survival. Starting in the summer of 1979 and continuing for each summer since, Pearcy has used purse seine nets to sample juvenile salmon populations at regular intervals along the coasts of Oregon and southern Washington.

The Results: Pearcy and his associates have found several distinct patterns in the behavior of Oregon juvenile coho. They tend to be located within about 20 miles of shore in 9°-15°C water; different stocks typically migrate first south of their river of ocean entry and then move north; there is a strong correlation between ocean upwelling and the next year's coho production. Using Pearcy's data, fishery managers have increasingly come to understand that ocean conditions—more than hatchery practices— determine adult salmon abundance, and they are taking steps to enhance the young fishes' chances for survival. For example, salmon stocks are now released into the ocean at different places and times, so that in the event of unfavorable ocean conditions, the young fish don't all compete for the same food and suffer heavy mortalities.

Pearcy's pioneering investigation in the ocean has increased the awareness of other agencies of the need for such research, and in 1983 Pearcy himself was named the director of the new Cooperative Institute for Marine Resources Studies. This joint program of the National Oceanic and Atmospheric Administration and Oregon State University is intended to foster research cooperation between the federal agency and universities in the Northwest.

For further information, contact Sea Grant College Program • AdS 402 • Oregon State University • Corvallis, OR 97331 • (503) 754-2716

FISH TRAPPING IN DEEP WATERS...

Problem

Feasibility and value of trapping fishes and shrimp at depths greater than 200 m around Puerto Rico have never been determined.

Description

Original objectives of this UPR Sea Grant project were to 1) determine what finfishes are present which can be trapped, using inexpensive gear, at depths of 200-1000 m; 2) test the feasibility and value of fishing these depths; and 3) to examine certain biological parameters of the species caught. To date six transects are nearly completed, with a total of 24 stations sampled. For logistic reasons most stations sampled have been at the deeper end (i.e. 500-1000m) of the proposed sampling range.

Early results of this project clearly indicated that shrimp resources were significant and had harvest potential. In particular, several species of pandalid shrimps, most significantly Heterocarpus ensifer and Plesionika edwardsi, were caught a commercial fishery using traps for pandalid shrimps has been recently developed in Hawaii. Due to these considerations, the original finfish project was expanded, under UPR Sea Grant, to include shrimp sampling using specially designed shrimp traps. To date 10 stations have been sampled using this gear.

A potential problem with trap fishing these depths became apparent during the early phases of this study, which UPR Sea Grant personnel hope to be able to investigate further. This involves the large numbers of the giant isopod (Bathynomus giganteus) and bagfishes, both considered major deepwater scavengers, which enter fish and shrimp traps. Future plans include possible use of a deepwater submersible to observe effects these scavengers are having on attraction of target species to the traps and on target species within the traps. The goal of these observations will be to determine if any modifications of gear or its deployment will reduce the negative effects these scavengers may have on catch.

Results

To date this project has shown that 1) snappers are present and can be trapped using inexpensive methods at depths of ca. 200-4000 m off Puerto Rico and Mona Island; 2) several species of pandalid shrimps are present at depths of ca. 500-1000 m in significant quantities and have harvest potential, and 3) that a potential problem exists in using traps at deeper depths (ca. 500-1000 m) in the form of scavengers (i.e. giant isopods and bagfishes), which may feed on target species in traps or deter them from entering traps.

Results ancillary to the goals of this project have been the discovery of one, and possibly two, new species of bagfishes and several new records for Puerto Rico of deepwater fishes.

THE RED HIND FISHERIES...

Problem

What effect does intensive fishing over annual spawning aggregations of the red hind have on future population sizes?

Solution

Sea Grant is sponsoring a major research effort to produce the basic biological information needed to answer this question. The potential effect, on future reproductive potential of the population, of intensive fishing over grouper aggregations will depend on four factors.

(1) The proportion of the total annual spawning in the population that generally occurs in and during the aggregation. Bimonthly analysis of gonadal histology of commercially-caught specimens over a 24-month period demonstrate that gonadal ripeness coincides with the one-week period in January during which the fish aggregate. Red hinds rarely spawn outside of that period.

(2) The selectivity of aggregation fishing, i.e. whether the fish caught over an aggregation tend to be disproportionately of particular sizes or sexes. Intensive diving over a spawning aggregation at the edge of the insular Puerto Rican shelf enabled us to spear a representative sample of fish to compare by handlining from a boat. The sex ratio of the speared sample was 5.6 females per male, not significantly different from the sex ratio of hand-caught fish. Size distribution was also the same between the two sets of samples. Thus, commercial fishing techniques remove males and females randomly from the aggregation.

(3) The causes of female-to-male sex change in this hermaphroditic fish. Study is now underway to determine whether sex change is controlled socially, as it is in other fishes in the grouper family.

(4) The nature of the social system before and after the spawning aggregation. The social system was described by mapping the locations of tagged fish on a grid at a shallow reef. All individuals maintained fixed home ranges that overlapped heavily with the home ranges of neighboring fish. Home range size did not correlate with the size of the individual fish, nor with its sex. In fact, all fish on the grid, and in two other shallow inshore reefs that were studied, were females. It appears that inshore populations are predominately female. Females probably move to the insular shelf at particular sizes or times of the year where they associate with males and become capable of sex change.

Practical Significance

The study has produced interesting practical results. First, the data demonstrate that local fishing techniques adequately sample both sex ratio and size distribution of the underlying population. Thus, future fisheries work can rely upon commercial catches to provide unbiased samples of these measures. Second, the study has begun to influence the development of new yield models, particularly models being developed at CIMAS and the University of Miami that consider the influence of a protogynous (i.e. female-to-male sex change) life history strategy. Third, the study is serving as a model for how to conduct other studies of this kind, particularly for studies planned on groupers in the U.S. Virgin Islands and in Belize.

For further information please contact
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Mayagüez, PR 00708

FISHERIES AND COASTAL RESOURCE MANAGEMENT
continue to be the major thrusts for the pioneering
UNIVERSITY OF RHODE ISLAND SEA GRANT COLLEGE PROGRAM.
As one of the first four Sea Grant Colleges, URI has developed a successful research, education, and advisory service combination which responds to local and national needs in marine resource use and management.

URI research in marine business management, seafood science, marine resource economics, ocean engineering, oceanography, and other areas provides understanding of the marine environment so that resources such as fisheries and coastal lands can be used and managed more profitably with minimal negative impacts. As the need for trained personnel arises in industry and government, short courses and academic curriculums are developed; examples include financial planning for marinas and marine management. Many URI advisory projects including demonstrations on floating breakwater technology and the fishing vessel weather-reporting system have been adapted for use by out-of-state programs and by foreign countries. Cooperation with other programs and agencies in solving regional or national problems is fostered through the national Sea Grant network.

FISHERIES. Through joint projects with Rhode Island and Massachusetts fishermen, URI's program in fishing technology transfer has helped the Northeast industry to adopt more efficient fishing gear and methods. It has also worked closely with the National Weather Service to improve weather products and delivery systems and has provided guidance to fishermen in the areas of vessel safety and marine insurance.

. **URI High Rise 340 Trawl.** By using this trawl design, vessel owners have increased their fish catches; at least 25 fishermen have reported annual net benefits of $125,000. High-rise trawls are now commonly produced by U.S. netmakers.

. Pair Demersal Trawling. Initial trials begun in 1982 with two Point Judith vessels indicate that this gear has potential for reducing by 25 percent or more the cost per ton of fish caught.

COASTAL RESOURCE MANAGEMENT. Interpreting environmental and economic research for coastal planners and assisting in the development of strategies for managing coastal areas have been substantial contributions of the URI program. The close working relationship that has evolved between URI and state agencies and citizen organizations is a factor in the success of Rhode Island's coastal management.

. **Coastal Ecosystem Productivity.** An understanding has been gained of the importance of bottom-dwelling organisms to enhancement of coastal productivity. Highly susceptible to pollution, coastal bottom communities are now known to be major regulators of nutrients.

. **Coastal Lagoon Studies.** This interdisciplinary study resulted from urgent community questions on the impact of increased development on the state's highly productive coastal ponds. The state has adopted a plan for preserving and improving these areas based upon this study and URI coastal planners are being consulted by the towns on which measures to adopt to preserve these areas.

For further information: Scott Nixon (401)792-6800 10/84

THE PROBLEM

The Atlantic Swordfish is ranked as the highest dollar value finfish landed in South Carolina; for the last two years, harvest values have exceeded $2,000,000. Analysis of recent landings has revealed a decline in the average size of swordfish landed locally and regionally; a possible indication of over-fishing. As such, commercial longliners and Fishery Management Councils have become aware of the urgent need for a resource management plan. However, insufficient data on the age structure of the fishery made development of a base management plan difficult.

THE RESEARCH

Investigators at the University of South Carolina assembled a three-year project to estimate the age structure of swordfish landed in South Carolina. Age estimation can be accomplished through the observation of annuli in various hard parts of fish (ie., scales, vertebrate, spines), but this research showed that the aging techniques using the otoliths of swordfish were most effective.

Based on analysis of data and age estimates, the investigators showed that the decline in the average size of swordfish landed was due largely to over-fishing. Sixty-five percent of the fish landed during the study period were four years old or younger. In terms of their reproductive state, females were almost all pre-reproductive and only a few of the males were capable of reproduction. The South Atlantic Fishery Management Council and the investigators applied these data to South Carolina landings and showed that, in 1978, 33% of fish landed were 4 years old or less; by 1983, this figure rose to 66%. Based on these results, the investigators concluded that commercial fishing has been removing an increasing percentage of pre-reproductive females from the population. As a result of stock over-fishing, future year-class strength, recruitment and health of the fishery have been affected.

RESULTS

The South Atlantic Fishery Management Council has incorporated these data into its existing Swordfish Source Document and Draft Swordfish Management Plan for the Atlantic, Gulf, and Caribbean. Provisions to protect the stock from overfishing have been modified. Before these data were available, the proposed regulations sought to reduce total allowable catch per fisherman (per boat). As a direct result of Sea Grant research, the Plan now proposes a management scheme to reduce the allowable catch of swordfish under 50 pounds, thus protecting pre-reproductive fish. Public hearings on the Swordfish Management Plan are now being held with the expectation that it will be implemented by the end of 1984.

For more information contact: The South Carolina Sea Grant Consortium
221 Fort Johnson Road • Charleston, South Carolina 29412 • 803-795-9650

Sea Grant College Program
Texas A&M University • College Station, Texas 77843-4115

Nearly the entire population of the Kemp's Ridley sea turtle nests on a short stretch of beach in Rancho Nuevo, Mexico, that has exposed them to such extensive harvests by man that their continued existence is endangered. To reverse this trend, Texas A&M University Sea Grant researchers Dr. David Owens and Mark Grassman have joined with scientists from the National Marine Fisheries Service, U.S. Fish and Wildlife, National Parks Service and Mexico's Instituto Nacional de Pesca in an international conservation effort.

All species of sea turtles found near the United States are considered either endangered or threatened with extinction. Texas is the site of important feeding grounds for the Kemp's Ridley, green and loggerhead species. Since the state hosts the U.S. portion of the Kemp's Ridley experimental conservation program, much of the work has concentrated on determining whether young turtles can be imprinted to return to a second nesting beach on the Padre Island National Seashore. Imprinting is an experimental technique to condition the senses of young animals so that they will return to the source of the imprinting once they reach maturity.

Several laboratory experiments have been conducted with automated behavior monitoring equipment, each of which indicates that young turtles rapidly learn cues about the chemical nature of their environment that they use at a later time for orientation and directed movements. Because marine turtles may require decades to reach sexual maturity, these data supporting the imprinting theory have been important in the recent decision to continue federal support of this type of conservation research.

Owens' and Grassman's laboratory experiments have demonstrated that both sexes of turtles are being produced in the Kemp's Ridley experiment, an important consideration due to the recent discovery of temperature-dependent sex determination in sea turtles. There had been some concern that moving the eggs from Rancho Nuevo to Padre Island for hatching might affect the natural male-female ratio because of temperature fluctuations.

They also designed, organized and assisted with the U.S. captive breeding program for the Kemp's Ridley that is centered at the Miami Sea Aquarium, and have evaluated the reproductive status of all captive adult Kemp's Ridleys in this country. In related work, the researchers developed the first sex ratio for a large sub-adult population of wild loggerheads, an important component of the population ecology model for this species.

Finally, the researchers have continued an active public education and research publication program on the worldwide sea turtle conservation efforts. They assisted in the production of a documentary film, **The Heartbreak Turtle**, produced by the Houston public broadcasting station, work closely with HEART (Help Endangered Animals--Ridley Turtles), a conservation organization begun by schoolchildren that helps underwrite the feeding of the young turtles, and conduct tours of the sea turtle laboratory for area students. In addition, Owens developed and distributed an instructional unit on sea turtles to the 4,000 teachers receiving the Sea Grant Program's quarterly educational newsletter.

For more information on the sea turtle conservation program, contact:

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VIRGINIA GRADUATE MARINE SCIENCE CONSORTIUM

ASSISTING VIRGINIA'S BLUE CRAB SHEDDING INDUSTRY

Background

Virginia has long been a leading producer of blue crabs. For example, in 1982 hard crab landings in Virginia totaled 44,057,437 pounds worth $9,128,196 dockside. Now, the soft shell blue crab, in demand as a gourmet food item, is also increasing in popularity. In 1982 this specialized fishing industry was estimated to be worth $6.5 million in Virginia and Maryland.

The Problem

As the market for this product continues to grow, so does demand. Yet a great many blue crab shedders still use methods dating back to the earliest days of the industry. Consequently, excessive mortality of crabs frequently occurs during the shedding process. Many of these mortalities can be traced to poor water quality. In some cases, mortality can exceed 65-70 percent.

Virginia Sea Grant Response

At the request of industry, Virginia Sea Grant initiated a program to increase the production capabilities of the soft shell blue crab industry through information transfer, diagnostic services and improved shedding facility design/construction.

Information transfer occurs through workshops, publications and individual contact. An on-request diagnostic service was begun in 1982 which provides on-site determination of water temperature, salinity and dissolved oxygen in shedding facilities, as well as consultation on mortality problems. Considerable effort has been devoted to facility design and construction. These efforts occur at two levels: services to those individuals desiring to update their current systems, and services to individuals desiring to enter the industry.

Results

- One crab shedder in Reedville, VA explained his problem of excessive peeler crab mortality to Virginia Sea Grant's commercial fisheries specialist. The specialist assessed the situation with regarc to water quality and system operation. Since the shedding operation could not be relocated and the water source could not be up-graded, the only option available was to convert from an open system to a closed system in which the water was filtered, conditioned and recirculated. The specialist provided consultation and schematics for component parts that could be incorporated into the existing facility design. As a result, the shedder's survival rate on crabs, from peeler through soft shell stage, increased from 35% to 65% in one season. Sea Grant outlay was 15 working days, and the shedder's outlay was $500 in material costs. This case study is just one example of the results of this program.

- Virginia Sea Grant's commercial fisheries specialist is a nationally recognized expert in crab shedding and has cooperated with other Sea Grant programs throughout the nation including Maryland, North Carolina, South Carolina, Georgia and Louisiana. This cooperation has involved providing written information regarding shedding, giving presentations at workshops n other states, and acting as an advisor to other Sea Grant programs in the network. This regional and national interest is testimony to the emerging value of this program to the industry.

- A comprehensive publication, entitled "Manual for Handling and Shedding Blue Crabs *(Callinectes sapidus)*" has been produced by Virginia Sea Grant. This 76 page document is serving as the authoritative source for information regarding blue crab shedding.

- Within the past year alone, the specialist aided in the design and construction of five new closed-system shedding facilities and has provided technical advice and consultation to over 30 crab shedding operations.

For further information about the Virginia Sea Grant College Program, contact:

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SALMON ENHANCEMENT: Renewing a Resource

It was a series of unrelated and inadvertent human steps that led, over many decades, to a decline in salmon resources in Washington and many parts of the nation. The building of dams, deteriorating water quality, losses of spawning habitat, changes in fishing techniques and effort--all these combined to undermine the security of once-self-maintaining stocks. To stem the decline of this resource similarly requires human intervention--this time deliberate--along several different fronts.

ECOSYSTEM RESEARCH

West Coast estuaries are subject to increasing development. Yet their importance in providing food and temporary habitat to juvenile salmon migrating seaward is not well understood. Sea Grant researchers have determined that chum and pink salmon food sources in estuaries are derived from the productivity of tideflat and eelgrass areas rather than saltmarsh or riverine-based habitat. To determine the limits of such estuarine areas to support these juvenile salmon, the researchers are conducting experiments which will reveal whether competition for food occurs when the fish occupy the same habitat. If such competition occurs and proves deleterious to one or both species, then certain parts of estuaries may need to be protected to avoid further damage to salmon stocks.

HATCHERY MANAGEMENT

Computer-aided hatchery production Now being evaluated at six Washington Department of Game trout hatcheries is a Sea Grant-developed computer program to assist at every decision point in fish production. The personal computer program requires detailed input: physical and chemical characteristics of hatchery waters; size, weight, numbers and species of trout or salmon being reared; and food type used. The output is equally detailed: a hatchery manager can project weights of fish and number of days to reach a certain size; when a pond of fish should be split to maximize weight gain; costs of rearing, food requirements; and probable final number of fish. The hatchery manager can also track and evaluate the progress of fish during rearing.

Detecting smoltification The inability to determine when juvenile hatchery salmon are in condition for transfer from freshwater to seawater has frustrated managers for years. It also reduces production, since fish released to streams before they are ready for seaward migration suffer increased mortality. Researchers have been unable to find a simple, unambiguous indicator of smoltification, the physiological change juvenile salmon undergo to be able to live in seawater. A technique now viewed with some optimism, however, is measuring thyroid hormone levels over time in a population of juvenile salmon. A pulse of thyroid hormone seems to occur in the blood of smolting coho salmon. Experiments now underway will test whether salmon released after the thyroid pulse survive in greater numbers than those released at other times.

NET PEN PRODUCTION

Coho strain selection Rearing Pacific salmon in net pens is a relatively new approach in salmon production. One goal is to develop a coho salmon stock suited to pen culture using selective breeding techniques. Desired traits include rapid growth in freshwater and seawater, good survival to maturity, high fecundity, and high yields at processing.

Working with two coho "families" at a commercial net-pen operation in Puget Sound, researchers mate fish with high fecundity, high offspring viability and large egg size as well as good growth characteristics. The progeny are grown under commercial production conditions. Three generations of selection, combined with improvements in husbandry, have resulted in increased freshwater and seawater growth rates, greater success in smoltification, and better adult survival. These improvements led for the first time in 1982 and 1983 to more-than-adequate egg production for the facility's needs, ensuring continued genetic improvements.

Broodstock nutrition A second goal of net-pen salmon research is to put the vitamin supplements fed to female broodfish on a scientific basis. Working at a commercial net-pen facility, researchers have determined that increasing vitamin levels in the females' feed can result in higher levels of some vitamins in the eggs and higher egg production. To determine optimum vitamin levels, the researchers supplement broodstock feed with varying amounts of vitamins and then measure the activity of vitamin-dependent enzymes of the females as well as the numbers of eggs produced and egg vitamin content. In contrast to the current practice of simply doubling the juvenile vitamin supplement when feeding adult broodstock, this approach avoids unnecessary and costly increases in vitamin supplements.

DISEASE RESEARCH

Disease control If unchecked, bacterial kidney disease (BKD) may kill up to 40 percent of spawners and reduce the production of young fish at hatcheries. It is a particularly difficult disease to eradicate from hatcheries because BKD, although usually fatal in the long run, can be carried by fish for years and can be transmitted directly to offspring via the egg. Sea Grant researchers have developed an effective treatment for BKD--adult fish are injected with the antibiotic erythromycin, while eggs are immersed in a solution of the antibiotic. The treatment eliminates BKD-causing bacteria from apparently healthy "carrier" fish and so prevents disease transmission after the fish have been released. Use of the treatment at hatcheries has reduced BKD-caused losses of adults to five percent or less.

Disease prevention A new approach to vaccine development is to employ the tools of genetic engineering where traditional techniques have failed to develop effective vaccines. Using as a model the disease-causing bacterium *Vibrio anguillarum*, researchers have identified a protein in the surface structure of one strain of the bacterium which is a determinant of the strain's high virulence. They have shown that the genetic material coding for this protein can be manipulated in the laboratory. This suggests the possibility, one which researchers are now pursuing, that a strain can be "engineered" so that this surface protein component is amplified significantly. Such a strain should be much more likely than the original to provoke the strong antibody response needed to confer immunity on fish. If this approach succeeds, then it will be used to develop vaccines for such intractable fish diseases as furunculosis.

INFORMATION EXCHANGE AND PUBLICATION

Efforts by its Marine Advisory Services have resulted in Washington Sea Grant-sponsored workshops on salmonid broodstock maturation in 1980 and 1981 and a full-scale international symposium on salmonid reproduction in 1985. At the earlier workshops, researchers and resource managers identified critical research needs and exchanged information leading to direct improvements in husbandry. The symposium on salmonid reproduction was held at a time when researchers around the world had developed a variety of techniques permitting unprecedented degree of control over salmon and trout life cycles. That this research area was ripe for discussion, evaluation and comparison of results was amply confirmed in the numbers attending, the quality of papers presented, and the participation by scientists from many parts of the world. Publications resulting from both efforts are further ensuring worldwide appreciation and understanding of progress in these areas of research.

The realization that concerted effort could halt the decline in salmon stocks came early in the Northwest and is evident in the building of the first hatchery in Washington state on the Kalama River in 1895. Yet incomplete understanding of salmon biology and continued habitat loss limited the success of the early efforts. With increased information on both the biological requirements and genetic plasticity of Pacific salmon have come improvements in traditional culture methods, new culture methods, and even the realization that new strains of salmon can be developed for particular uses. Progress in some research areas is slow, its rate limited by the growth and maturation rates of the fish themselves. Yet the strides made thus far suggest that this multiple-front effort is a productive, even essential approach to securing salmon resources in the region.

To obtain a directory of current projects, a publications catalog, or the most recent biennial report of the Washington Sea Grant Program, please write:

Washington Sea Grant Communications
College of Ocean and Fishery Sciences
University of Washington
Seattle, WA 98195

UNIVERSITY OF WISCONSIN SEA GRANT COLLEGE PROGRAM

Helping to Keep the Great Lakes Clean

The total value of Wisconsin's Great Lakes resources is almost impossible to calculate, but they are easily worth more than $100 million annually to the state's economy—and their value is increasing. Sport and commercial fishing in Wisconsin waters of Lakes Michigan and Superior alone have net benefits to the state totaling nearly $65 million a year. The lakes provide a practically limitless supply of high quality water for residential and industrial use—an asset that should not be underestimated with the increasingly severe problems in water-poor states. They also provide multimillion-dollar shipping and recreational industries.

THE PROBLEM

Wisconsin's economic stake in its Great Lakes resources is imperiled by an emerging, insidious threat—contamination of the lakes' water, sediments and fish by a variety of toxic chemicals. First it was DDT, then PCBs, now it's toxaphene, dieldrin and dioxins.

Contamination of the fish has caused restrictions on the commercial fishery and large, continuing economic losses for the state's fishermen and related industries. It has also cast a cloud over Wisconsin's Great Lakes sport fishery—the economic lifeblood of many coastal communities. Contaminants in the sediments of shipping channels threaten the state's shipping industry—the PCB levels in Milwaukee Harbor sediments were so high a few years ago that the dredged material almost qualified as hazardous waste which would have cost $7.5 million for disposal.

Relatively little is known about the actual human health risks these contaminants pose. The problem is compounded by the fact that there are hundreds of chemicals in the discharges of the industries and cities around the Great Lakes. And now it appears that many of the contaminants entering the lakes come from the air and from sources far beyond Wisconsin's borders.

Tracking down these contaminants is extremely complex and time-consuming. It is also expensive—testing the PCB level in just one fish costs around $200; for dioxins, it costs more than $1,000. New and more economical methods for identifying and controlling these contaminants are urgently needed not only in Wisconsin, but nationwide.

THE RECORD

The University of Wisconsin Sea Grant College Program is a national leader in determining the sources, environmental pathways and health effects of toxic contaminants and in assessing how much and how long they will be a problem, especially in fish. This effort combines many scientific disciplines—chemistry, biology, toxicology, ecology, medicine and others. UW Sea Grant's recent achievements include:

Identifying the Atmosphere as a Major Carrier of Contaminants. Sea Grant researchers recently determined that the atmosphere is the source of at least half and perhaps as much as 90 percent of the PCBs, toxaphene, lead and other toxic contaminants entering the Great Lakes. For instance, though little was used here, toxaphene has been found in Great Lakes fish at levels as high as those in the Cotton Belt, where the now-banned insecticide was most heavily used. Such information is critically important in helping the state, the region and the nation determine the true nature and magnitude of the contaminants problem.

Determining How Long Contaminants Remain in the Great Lakes. UW Sea Grant scientists have found that some toxic metals like lead and zinc remain in Lake Michigan's water as little as two years, while others like copper and cadmium may remain as long as 30 years. PCBs have been estimated to take up to 50 years to pass out of the lake ecosystem, although recent observations on fish suggest that the residence time is much shorter. This information is being used by resource management agencies, industry, fishery managers and public health officials alike for taking immediate actions and making long-term plans to control these contaminants.

Identifying the Structure-Activity Relationships of Toxic Chemicals. Sea Grant scientists are building models for predicting the specific environmental pathways of whole classes of compounds according to their basic chemical structure. They are testing the idea that the similarities of the molecular structure of a chemical to PCBs is a measure of its toxicity and biochemical behavior. With 55,000 different compounds manufactured in the U.S., such models could be very valuable as a means of screening and regulating whole classes of compounds without the considerable time and expense of testing each and every chemical.

Conducting One of the First Studies of the Human Health Effects of PCBs. A recent UW Sea Grant study in Sheboygan, Wisconsin, was one of the first in the U.S. to examine the effects of low-level PCB exposure on infant health. The Sheboygan study showed that fetal PCB exposure was linked to an increase in the number of minor infectious illnesses to age four months, but early infant development and growth was normal. The study also showed that the benefits of breast-feeding an infant outweigh the risks of PCB exposure from the mother's milk. In addition, eating fish and exposure to PCBs in the workplace seemed to be only minor factors in the women's total PCB body burden.

THE BENEFITS

The transfer of research information to those who need it is a hallmark of the Sea Grant program. UW Sea Grant scientists deliver their findings through scientific journals, professional conferences and directly to managers in state and federal agencies and in industry. The UW Sea Grant Institute keeps the public informed as well with understandable publications and by public presentations by advisory services personnel.

Wisconsin residents have long recognized that clean, uncontaminated water is a valuable resource. With increased scientific knowledge and public understanding, both industry and government are better able to manage and control the discharge of toxic compounds. The state is one of the few in the nation in which nearly all of its waters met the "fishable and swimmable by 1983" goal of the U.S. Clean Water Act of 1970. The University of Wisconsin Sea Grant College Program has played and will continue to play a key role in providing the scientific information needed to protect and enhance the water resources of Wisconsin, the Great Lakes and the nation.

For more information:
Sea Grant Institute
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Madison, WI 53705
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November 1984

Section 5. Economic Effects

A reprint of a 1981 report documenting $230 million in annual gross revenue or savings (cost avoidance) resulting from or stimulated by selected Sea Grant projects.

ECONOMIC EFFECTS OF SEA GRANT

Reprinted from a report prepared by the Sea Grant Task Force, Washington, D.C., March 26, 1981, on behalf of the Marine Affairs Committee of The National Association of State Universities and Land-Grant Colleges in conjunction with the Sea Grant Association.

Sea Grant Task Force - 1981

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ECONOMIC EFFECTS OF SEA GRANT

EXECUTIVE SUMMARY

- Examples for this economic appraisal came from Sea Grant programs nationwide
- Economic effects on industry, business and commerce, derived from 57 projects stimulated by federal investment through Sea Grant, showed:

A.	Fish harvesting	$ 37,552,000
B.	Seafood processing and marketing	17,500,000
C.	Aquaculture	21,752,000
D.	Marine construction	126,896,000
E.	Marine transportation	2,890,000
F.	Marine-related retail trade	19,400,000
G.	Marine-related real estate	3,000,000
H.	Marine service industry	813,000
	Total	$229,803,000

- This *annual* figure ($230 million) approaches the *total* federal investment in the Sea Grant program over its thirteen-year history.

PARTIAL LISTING OF ECONOMIC EFFECTS OF THE NATIONAL SEA GRANT COLLEGE PROGRAM

Summary: Estimates and analyses of *parts* of the Sea Grant program indicate it has led to or stimulated over $230 million in annual gross revenue or savings (cost avoidance) leading to fuller utilization and greater efficiency in marine or coastal resource based industries.* Not accounted for are contributions to better management of these resources. Neither do we attempt to place a monetary value on the manpower development role of Sea Grant. The latter is a major contribution to the nation's ability to use its coasts and water productively whether for commerce, food, or for recreation.

Twenty-six Sea Grant programs participated in developing the data for an analysis of economic effects. A substantial volume of background data was prepared as source information on the economic stimulation to industry, business, and commerce. The data obtained (based on fifty-seven projects) represent a few percent of the total project activity within Sea Grant. Each program selected only a few examples of documented economic effect from its research and educational efforts. The intent of this report is to provide, from a nationwide point of view, a partial assessment of economic effects of Sea Grant's work. A summary (Table 1) of the findings for eight major categories of Sea Grant research and educational activity indicates the aggregated annual effects.

The material that follows provides summary information on each of the fifty-seven projects in eight major categories outlined in Table 1.

* Production costs have not been subtracted. Later analysis will attempt more detailed net benefit studies of selected parts. The partial nature of this analysis should also be stressed. It is based on examples from individual programs rather than on total coverage. Hence, it is conservative.

Table 1. Selected set of economic effects from the National Sea Grant College Program.

A. FISH HARVESTING Increase the economic productivity of commercial shellfish, groundfish, and mid-water fisheries.	$ 37,552,300
B. FISH PROCESSING AND MARKETING Expand the economic base of the seafood processing industry.	$ 17,500,465
C. AQUACULTURE Provide new commercial opportunities by developing the science, technology, and economic potential of aquaculture of marine species.	$ 21,752,000
D. MARINE CONSTRUCTION Facilitate improvements in environmentally sound, economical, and safe waste disposal and offshore construction activities.	$126,895,771
E. MARINE TRANSPORTATION Increase the efficiency and safety of the U.S. shipping fleet and the competitiveness of U.S. boat manufacturers in the foreign market.	$ 2,890,000
F. MARINE-RELATED RETAIL TRADE Promote the growth of precious coral and pet turtle industries and reduce the loss of lives from cold-water drownings.	$ 19,400,000
G. MARINE-RELATED REAL ESTATE Develop new technologies for shoreline stabilization, flood control, and alternative methods of sewage treatment.	$ 3,000,000
H. MARINE SERVICE INDUSTRY Reduce wave damage to marinas and find an economically feasible alternative to breakwater construction for small marinas.	$ 812,760
TOTAL	$229,803,296

SEA GRANT AND THE ECONOMY

The economic development potential of the marine and coastal resources of the United States has attracted much attention in recent decades. The magnitude of 1972 economic activity within the coastal and ocean sectors only recently has been assessed (*Science*, Vol. 208, 30 May 1980). This analysis of the ocean economic sector in the National Income Accounting System (NIAS) places the ocean sector value at $30.6 billion in 1972 which is comparable to agriculture ($35.4 billion), mining ($18.9 billion), construction ($58 billion), transportation ($46.2 billion), and communications ($29.4 billion). The NIAS is an analysis technique that indicates the contribution of various economic sectors to national income and, hence, provides a way of understanding the composition of the economy. The NIAS assessment is based upon nine major subsectors, with the percentage indicated:

1. Commercial Fishing (1%)
   Harvesting, processing, and aquaculture
2. Marine Mining (7%)
   Oil and gas, sand and gravel, and limestone
3. Marine Construction (1%)
4. Manufacturing (4%)
   Ship and boat building
5. Marine Transportation and Communications (8%)
   Shipping, cargo handling, and warehousing, transportation, services, and marine-related communications
6. Marine-related Retail Trade (24%)
   Marine-related merchandising and retailing
7. Marine Financing, Insurance, and Real Estate (15%)
8. Marine Services (3%)
   Hotels, marine recreation, educational services, museums, and marine organizations
9. Public Administration--State and Local (37%)
   Federal government, ocean-related activities

These data provided the first major overview of the oceans' economic importance. A more recent assessment of the magnitude of the private marine sector has been conducted by the Sea Grant Association Budget Committee. Considering all aspects of fishing, marine-related manufacturing, marine transportation and marine-related tourism, it was found that total sales exceeded $58 billion in 1978, with employment in these industries at nearly 1.4 million. Further, Department of Commerce figures indicate that sales within these industries increased 21.4% from 1977 to 1978 with an increase of 8% in employment, for a productivity increase of 14% in sales or shipment per person before adjustment for inflation.

Understanding the structure and characteristics of the industrial, business and commerce components of the ocean sector is important. A preliminary analysis suggests, that with some exceptions such as the oil and gas industry, most of the components within the private marine sector are disaggregated and evolving in nature. The fisheries component, for example, is comprised mainly of small independent businesses that have been shown to be the most viable economic force in the catching sector.

Most observers agree that the university/industry commitment to research and extension was the key Federal policy that contributed so significantly to the productivity of our agricultural industry. In 1966, the Federal Government established the policy and structure for similar activities aimed at marine resources through the National Sea Grant College Program Act. Fortunately, like the agricultural sector, the oceans sector has access to universities and industry. Primarily, the focus is on fisheries and aquaculture, seafood processing, marine construction and transportation, and marine-related trade, real estate, service industries, recreation, and tourism.

The Sea Grant College and Program Act of 1966 (P.L. 89-688) was passed "to accelerate national development of marine resources, including their conservation, proper management, and maximum social and economic utilization." More specifically, the program was directed to "achieve the gainful use of marine resources" (Sec 202(d)) through a partnership between the Federal and State Governments, universities, and the private sector. The term "Sea Grant" was chosen to emphasize the agricultural parallel in meeting present needs of the nation by developing the economic potential of our marine resources.

Since 1966, the United States has laid claim to a 200-mile economic zone, including all resources in the water column, on and under the ocean floor. By this single action, the United States almost doubled the territory under sovereign jurisdiction. When developed wisely, these vast new areas offer the nation economic opportunities equal to or greater than the agricultural sector of the nation's economy.

The factors that contribute to the productivity of the Sea Grant Program are:

1. The partnership of universities, industry, and government.
2. Sea Grant is the only Federally stimulated program focused on developing the resources of the ocean on a broad economic front.
3. Economic analyses of the Sea Grant Program, such as the following, clearly demonstrate an unusually good return on investment.
4. The Sea Grant Program is identifying and developing new resources for the nation in such areas as biomedicinals, aquaculture, ocean energy, conversion, diverse waste conversion, reduction of marine corrosion and biofouling.
5. Several independent assessments of the Sea Grant Program have been made in the past. The productivity of the program is generally recognized. The most recent assessment was made by the Heritage Foundation, which reviewed all Federal programs in 1980 and reported the following on Sea Grant:

> It has an impressive record of success . . . . It operates in partnership with state and local governments, private industry, universities, organizations and individuals concerned with or affected by ocean and coastal resources . . . A key element of Sea Grant is its outreach mechanism whereby results of research are provided to users in industry, government agencies, and the general public.

This appraisal demonstrates the economic effects of the Sea Grant Program. The sections that follow were based on data supplied by 26 Sea Grant Programs. However, this report must be seen as a partial assessment, prepared on relatively short notice. The Sea Grant Program will continue to improve its means of assessing benefits and documentation of program accomplishments.

ECONOMIC EXAMPLES

A. Fish Harvesting

Sea Grant's assistance in increasing the productivity of the commercial shellfish, groundfish, and mid-water fisheries resulted in annual economic effects of $37,552,300 on industry, from sixteen projects on which data are readily available.

Examples of annual economic effects	
1. Eel fishery	$ 148,000
2. Herring fishery	1,250,000
3. Commercial fish	6,500,000
4. Shrimp trawl obstruction	3,500,000
5. Side trawler operations	494,000
6. Soft blue crab production	1,000,000
7. Oyster fishery	98,100
8. Black cod fishery	321,000
9. Net damage by underwater obstructions	600,000
10. Offshore fishery	11,210
11. Alaska commercial fishery	1,055,000
12. Swordfish and blackfin tuna fisheries	2,600,000
13. Finfishery	475,000
14. Herring fishery	1,500,000
15. Great Lakes commercial fishery	6,000,000
16. Crab fishery	12,000,000
TOTAL	$37,552,300

A1. Challenge Develop the eel fishery in North Carolina.

Solution Provide research to improve fishing and handling techniques and development of export market for fresh frozen eels to Europe and Japan.

Benefit Growth of eel fishing industry from $16,000 in 1972 to $1,200,000 of foreign exports in 1980, an average annual growth of $148,000.

Source North Carolina

A2. Challenge Assist ground fishing fleet changeover to deep water species.

Solution Development of midwater fishing gear for herring export catch.

Benefit Has led to annual gross increases of $1,250,000, or net increases of $431,000 of exportable fish from 18 vessels. Technology is still spreading.

Source Rhode Island

A3. Challenge Improve the efficiency of harvesting by commercial fishermen.

Solution Assisted the fishermen to develop new and improved technology for handling nets, crab pots, and other fishing gear. Cost-effective hydraulic gear is now being used on 60 medium-sized boats.

Benefit $6,500,000 per year increased income for fishing industry.

Source North Carolina

A4. Challenge Reduce loss and damage to shrimp trawls (subject to federal compensation by law) from bottom obstructions.

Solution Collected data on obstruction locations from personal contacts with boat captains and the historical record, assembled their data with LORAN navigation coordinates, and disseminated the information to the shrimping fleet.

Benefit $3,500,000 per year.

Source Texas

A5.	**Challenge**	Improve the safety of side trawler operations; the attachment of towing cables to the stern of a side trawler is extremely hazardous, sometimes causing serious injury or death to fishermen.
	Solution	Developed and introduced to New England fishermen a quick-acting, remote-releasing hook-up block. Modification of this unique device has adapted it for use by U.S. Coast Guard for life boat handling. A commercial concern is studying use of the block as an anchor release.
	Benefit	Increased one fishing captain's earnings by at least $3,000 per year. When fully implemented, a modified block for successfully handling its new RHI lifeboat will save the Coast Guard an estimated $3,500,000 or $491,000 annually over 15 years.
	Source	Massachusetts
A6.	**Challenge**	Revitalize declining soft blue crab production.
	Solution	Provided technical, economic feasibility analysis and marketing assistance to the industry.
	Benefit	$1,000,000 per year.
	Source	Florida
A7.	**Challenge**	Reduce threat to Chesapeake Bay oyster industry of the widespread occurrence of pink coloration in oysters.
	Solution	Showed the pink coloration had no effect on the oysters' wholesomeness or palatability, publicized these findings, and convinced a Federal purchasing agent to reverse an earlier shipment rejection.
	Benefit	This one incident had a $500,000 benefit but the aggregate value to the Chesapeake Bay oyster fishery is hard to calculate. Over 15 years this amounts to an annual amount of $ 98,100.
	Source	Virginia
A8.	**Challenge**	Re-establish black cod fishing catch.
	Solution	Provided research and developed new design traps.
	Benefit	Landings increased by a factor of 8 (poundage) from 1973 to 1975 with an average annual value of $321,000.
	Source	California
A9.	**Challenge**	Prevent net damage by underwater obstructions (reimbursable by the Federal Government by law).
	Solution	Collected information on such obstacles from individual fishermen and published the descriptions and locations in a log book.
	Benefit	Saved fishermen $600,000 per year in net costs plus unaccounted reduction of losses in fishing time.
	Source	North Carolina
A10.	**Challenge**	Locate offshore fishing grounds and disseminate new sonar tracking techniques.
	Solution	Provided offshore research and training in advance fish travel, radar and navigation.
	Benefit	$80,000 in one harvest involving 5 boats (otherwise idle due to failure of inshore fishery). This amounts to $11,210 annually over 15 years.
	Source	Georgia
A11.	**Challenge**	Enhance income of native Alaskan fishermen from commercial fishing.
	Solution	Designed program to improve effectiveness of native Alaskan fishermen in commercial herring fishery.
	Benefit	Earnings increased by $1,055,000 in first year after program started.
	Source	Alaska

A12.	**Challenge**	Develop a winter catch supplement for the seasonal Gulf coast shrimp fishery to provide year-round employment and capital utilization.
	Solution	Developed new swordfish and blackfin tuna fisheries.
	Benefit	$2,600,000 per year.
	Source	Texas
A13.	**Challenge**	Find alternative fisheries for shrimpers in South Carolina.
	Solution	Helped shrimp fishermen adapt their vessels to fish for previously unexploited finfish and instructed fishermen in new techniques.
	Benefit	$475,000 annual gross income from finfish over past 5 years.
	Source	South Carolina
A14.	**Challenge**	Accurately determine the herring fish stock, to increase harvesting efficiency while protecting against over fishing.
	Solution	Successfully applied acoustic techniques for more accurately estimating fish populations for the Pacific herring fishery. Data are used in establishing the Regional Fisheries Management Plan for Pacific herring.
	Benefit	Increased the allowable harvest from approximately 30 percent resulting in an annual landed value increase of approximately $1,500,000.
	Source	Washington
A15.	**Challenge**	Rebuild the Wisconsin Great Lakes Fishing Industry.
	Solution	Identified historical spawning reefs in Lake Michigan, developed new processing and new marketing techniques for under-utilized sucker fish, developed canned pack for improved marketing of under-utilized alewives, and provided research data and technical assistance to the industry.
	Benefit	Recovery of Wisconsin commercial fishing industry from brink of collapse to $6,000,000 annual dockside sales.
	Source	Wisconsin
A16.	**Challenge**	Increase number of crab species harvested by U.S. fishermen.
	Solution	Carried out a marketing study in conjunction with North Pacific Fishery Management Council which successfully showed that Japanese Tanner Crab fishing fleets should be removed from U.S. waters.
	Benefit	Tanner Crabs now totally harvested by domestic fishing industries with a value of $18,000,000 per year to date. The U.S. industry was $6,000,000 prior to 1977.
	Source	Alaska

B. Seafood Processing and Marketing

Through Sea Grant's efforts to expand the economic base of the seafood processing industry, the annual aggregate economic effects from eleven projects on which data are readily available was $16,500,456.

Examples of annual economic effects	
1. Salmon canneries	$ 4,615,465
2. Seafood quality	150,000
3. Storage of fresh fish	454,000
4. Clam-mincing by-products	500,000
5. Oyster industry	1,000,000
6. Crab-processing wastes	2,500,000
7. Oyster-cleansing system	1,000,000
8. New domestic seafood markets	100,000
9. Shrimp processing	5,600,000
10. Fish processors	1,231,000
11. Frozen seafood packaging	350,000
TOTAL	$17,500,465

B1. Challenge Help prevent closing of Alaska salmon canneries that would result from proposed environmental regulations on disposal of salmon-processing waste requiring modification of equipment.

Solution Studied economic impact of proposed regulations and revealed serious errors in the contractor data and analysis report supporting the regulations. As a result of the Sea Grant study, EPA regulations were modified.

Benefit The requirement for modifications to waste processing equipment was rescinded with the resulting saving of $22,500,000 to the Alaskan salmon processors in 1979. This amounts to $4,615,465 annually over a 15-year period.

Source Washington

B2. Challenge Improve seafood quality by insulating boat holds.

Solution Promoted engineering and research to develop insulation requirements and handling techniques for improved quality of catch and increased income to fishermen for higher quality products.

Benefit $150,000 per year increased revenue for fishermen.

Source North Carolina

B3. Challenge Extend storage time in transportation of fresh fish.

Solution Developed CO2-modified atmosphere containers.

Benefit Estimated savings of $454,000 per year for transporting Alaskan salmon into California as well as saving one-third of energy costs.

Source California

B4. Challenge Recover and utilize protein and other nutrients from surf clam processing waste.

Solution Development of marketable clam broth and freeze-dried clam flavor ingredient.

Benefit Clam broth - $500,000 per year in sales and reduced waste treatment cost for one firm. Flavor ingredient - one firm estimates potential annual sales of $750,000.

Source New York

B5.	**Challenge**	Sustain Apalachicola Bay oyster industry threatened with shutdown due to water-quality problem.
	Solution	Through technical assistance in sanitation and processing procedures and cooperation with the state Oyster Task Force, sustained and enlarged continued production of safe oysters, even under newly strengthened sanitation requirement.
	Benefit	Not only was disaster to the industry averted, but oyster production was increased from 5,784,930 pounds in 1979 to 6,395,778 pounds in 1980 equaling a landing value of $5,800,000.
	Source	Florida
B6.	**Challenge**	Reduce the cost of disposal of crab processing wastes (many processors faced shutdown due to increased cost of waste disposal).
	Solution	Demonstrated crab-meal production, using 20-30 million pounds of hard-crab processing scrap.
	Benefit	A gross benefit of $2,500,000 per year, through reduction of waste disposal costs and sale of crab meal, has been achieved in the Middle Atlantic region.
	Source	Virginia
B7.	**Challenge**	Develop an off-bottom oyster cleansing system.
	Solution	Developed mechanization system for depuration process and performed biological studies enabling lifting of some regulatory restrictions.
	Benefit	Productive and economically feasible depuration process resulting in $1,000,000 of oysters.
	Source	Mississippi
B8.	**Challenge**	Find new seafood markets (domestic).
	Solution	Perform market research and provide technical assistance.
	Benefit	$100,000 per year to *one* company in Tennessee.
	Source	Georgia
B9.	**Challenge**	Prevent waste of edible portion of shrimp that is lost during processing.
	Solution	Developed and introduced to industry improved handling and processing techniques to reduce waste by increasing yield and saving energy.
	Benefit	Annual yield region was increased by 4 percent; the equivalent of $5,600,000 per year direct return to processors.
	Source	Oregon
B10.	**Challenge**	Assist fish processors to cope with environmental regulation problems.
	Solution	Studied operations of fish meal plants and developed a procedure to increase productivity simultaneously with reduction of problems from effluent pollution.
	Benefit	Prevented closure of fish processor allowing continuance of industry amounting to $1,231,000 gross annual income to processor and commercial fishermen.
	Source	Wisconsin
B11.	**Challenge**	Develop new convenience seafood products from under-utilized species of fish.
	Solution	Develop and market test a number of new frozen products, several eventually adopted by commercial processors.
	Benefit	Additional annual sales revenues to fish wholesalers and processors of at least $350,000.
	Source	New York

C. Aquaculture

Aquaculture of marine species provided new commercial opportunities by developing the science, technology, and economic potential. $21,752,000 represents the annual aggregate economic effects on industry from projects on which data are readily available.

Examples of annual economic effects	
1. Crawfish aquaculture	$ 8,450,000
2. Pen-reared salmon	192,000
3. Oyster beds	160,000
4. Net-pen fishery	3,000,000
5. Land clam and oyster spawn	400,000
6. Seafood production	6,000,000
7. Maine fishing industry	1,000,000
8. Ocean ranching	2,300,000
9. Salmonid mortality	250,000
TOTAL	$21,752,000

C1. Challenge Develop crawfish aquaculture as an industry in Louisiana.

Solution Since 1969, introduced research on crawfish aquaculture to pond operators and to rice farmers where crawfish are now being stocked in rice paddies.

Benefit Increased pond acreage from 12,000 acres in 1969 to 62,000 acres in 1980 with associated increased income for crawfish farmers of $8,450,000 per year.

Source Louisiana

C2. Challenge Reduce mortality rate (50 to 80 percent) of pen-reared salmon when smolt are transferred from freshwater to saltwater.

Solution Through genetic research (similar to that applied to the poultry industry), developed a strain of Coho salmon specifically adapted to pen-rearing with one-half the mortality rate of natural stock.

Benefit One commercial salmon grower realized a net saving of $192,000 per year raising this new strain.

Source Washington

C3. Challenge Help prevent continual reduction of the size of natural oyster beds due to development and pollution.

Solution Develop pilot closed-system oyster culture facility.

Benefit Understanding in oyster spawning, spot setting, nutrition, and water quality control are already contributing an estimated $160,000 per year benefit to the natural bed fisheries. The ultimate goal of commercial sized closed-system aquaculture facilities will be a major industry and conservation breakthrough.

Source Delaware

C4. Challenge Develop a net-pen fishery.

Solution Provided research and demonstrated projects that resulted in several companies in the Pacific Northwest going into commercial production of salmon using this technology.

Benefit DomSea Farms, now a subsidiary of Campbell Soup, is harvesting over $3,000,000 of salmon per year.

Source Washington

C5.	**Challenge**	Reduce disease-related mortalities in New York shellfish hatcheries.
	Solution	Research/extension program to identify diseases of New York shellfish, develop disease-control procedures and train hatchery operators in these procedures.
	Benefit	Doubling of effective hatchery production on Long Island should produce annual market sales increases of $400,000.
	Source	New York
C6.	**Challenge**	Increase the production of seafood through aquaculture.
	Solution	Conducted research to identify and select the most promising plant and animal species for aquaculture, developed the supporting technology and marine science for commercial expansion, and provided advisory assistance to the developing industry.
	Benefit	Aquaculture in Hawaii now produces a wholesale value of over $6,000,000 (1980) and is projected to increase to over $32,000,000 in 1985.
	Source	Hawaii
C7.	**Challenge**	Bring greater economic stability to the Maine fishing industry.
	Solution	Stimulated the formation of a new shellfish aquaculture industry.
	Benefit	This still young industry's last year's sales exceeded $1,000,000 with a projected five-fold increase over the next five years.
	Source	Maine
C8.	**Challenge**	Develop ocean ranching in Alaska.
	Solution	Assisted development of private non-profit aquaculture corporation and hatchery to stock salmon in geographic areas where salmon fisheries do not exist.
	Benefit	New salmon fishery where salmon stocks had not existed with a catch in 1980 valued at $2,300,000.
	Source	Alaska
C9.	**Challenge**	Excessive mortality in smoltification of salmonids.
	Solution	By demonstrating the role of ammonia in oxygen transport in fish, investigators have helped the Dworshak National Fish Hatchery to reduce salmonid mortality during smoltification from 35,000 per day to 300 per day.
	Benefit	An annual savings of $250,000.
	Source	Rhode Island

D. Marine Construction

Facilitating improvements in environmentally sound, economical and safe coastal and offshore construction activities has resulted in $126,895,771 annualized cost avoidance or savings aggregated from projects on which data are available.

Examples of annual economic effects	
1. Mathematical modeling	$ 80,645,771
2. Construction aggregates	45,000,000
3. Sand and dredging industry	250,000
4. Wave-tracking buoy	1,000,000
TOTAL	$126,895,771

D1. Challenge Assess impacts on marine environment of offshore construction and disposal permitting.

Solution Developed finite element mathematical models to accurately assess impacts and successfully predict transport and disposal of materials in semi-enclosed water bodies.

Benefit Saved $29,000,000 to $54,000,000 in estimated circulating-water channel modifications or new construction costs. An annual saving of $5,417,779 over 15 years. Using the minimum estimate amortized over an assumed 10-year construction period, this represents a $2,900,000 annualized cost avoidance. Demonstrated environmental acceptability of sewage outflow led to EPA approval of a waiver request and will result in construction cost avoidance of $400,000,000 ($300,000,000 is federal subsidy). Amortizing this saving over a 10-year construction period, this represents a $74,727,992 annualized cost avoidance. Contractor reports savings of $15,000 to $80,000 for each application of the model over conventional techniques and estimates total savings of up to $500,000 per year.

Source Massachusetts

D2. Challenge Assure availability of reasonably-priced supply of construction aggregate to New York Metropolitan Area.

Solution Econometric models capable of predicting net cost reductions from aggregate mining in New York Harbor.

Benefit Development of most cost-effective mining scenario would produce annual cost savings of $20,000,000 to sand suppliers and $45,000,000 to building industry.

Source New York

D3. Challenge Revitalize sand and dredging industry in Toledo, closed because of environmental concerns.

Solution Showed that the sand and gravel used for construction aggregate could be dredged without harming the environment.

Benefit $250,000 worth of sand and gravel now dredged annually.

Source Ohio

D4. Challenge Obtain accurate wave-spectra data for design and construction of offshore facilities and structures.

Solution Developed wave-tracking buoy to directly measure and record wave directional spectra.

Benefit New wave-tracking buoy has been added to a small business product line with projected annual sales of $1,000,000.

Source Massachusetts

E. Marine Transportation

The result of increasing the efficiency and safety of the U.S. shipping fleet and the competitiveness of U.S. boat manufacturers in the Mexican market meant an annual aggregate economic benefit to industry of $2,890,000 from four projects on which data are readily available.

Examples of annual economic effects	
1. Satellite information	$1,560,000
2. Shrimp boat manufacturing	700,000
3. Fishing vessel replacement	40,000
4. Offshore tanker mooring	590,000
TOTAL	$2,890,000

E1.	**Challenge**	Disseminate NOAA's satellite information on Gulf Stream dynamics to disaggregated user industries.
	Solution	Worked with NOAA satellite and weather service personnel to locate and establish communication linkages to a broad-base user clientele.
	Benefit	One shipping company estimates $1,560,000 annual savings in fuel costs.
	Source	Florida
E2.	**Challenge**	Increase competitiveness of U.S. shrimp boat manufacturing (for international markets).
	Solution	Trained international boat operators for maximum vessel usage (on site) (e.g., Mexican fishermen).
	Benefit	Continued gross sales of U.S.-built vessels amounted to $700,000 in a year.
	Source	Georgia
E3.	**Challenge**	Replace worn out fishing vessels for individual fishermen.
	Solution	Instructed fishermen how to build their own fiberglass boats.
	Benefit	Sixteen boats built resulted in total net saving of $40,000.
	Source	South Carolina
E4.	**Challenge**	Improve the safety of offshore tanker mooring operations.
	Solution	Developed prototype talking current spar buoy that reports ocean currents to ship operators making offshore moorings.
	Benefit	A new talking current spar buoy instrument has been added to a small business product line with projected annual gross sales of $590,000.
	Source	Massachusetts

F. Marine-related Retail Trade

Sea Grant helped promote the growth of precious coral and pet turtle industries and helped reduce the loss of lives from cold-water drownings. $19,400,000 represents the annual aggregate economic effects on industry from only three projects on which data are readily available.

Examples of annual economic effects	
1. Cold-water drowning	$10,000,000
2. Pet turtle industry	2,100,000
3. Precious coral industry	7,300,000
TOTAL	$19,400,000

F1. **Challenge** Reduce loss of lives resulting from cold-water drownings.

Solution Studied temperature regulation of humans in cold-water environments and, in partnership with industry, designed new kinds of personal flotation devices that minimize body temperature loss.

Benefit Stimulated production in three new lines of personal flotation devices and thermal suits grossing $10,000,000 in 1980.

Source Minnesota

F2. **Challenge** Help prevent collapse of pet turtle industry threatened due to FDA ban on interstate shipment of carriers of salmonella.

Solution Developed antibiotic treatment of turtle eggs in vacuum chamber that eliminated the salmonella transmission problem.

Benefit Industry expanded in business to $2,100,000 yearly production.

Source Louisiana

F3. **Challenge** Develop a precious coral industry while husbanding rare stocks of coral.

Solution Promoted research and application of undersea technologies.

Benefit The industry grew from 50 employees and gross sales of $500,000 to 214 employees and gross sales of $7,800,000.

Source Hawaii

G. Marine-related Real Estate

The economic importance of coastal real estate has motivated the development of new technologies for shoreline stabilization, flood control, and alternative methods of sewage treatment. This represents $3,000,000 aggregated annual economic effects on industry from four projects on which data are available.

Examples of annual economic effects	
1. Shoreline erosion	$1,000,000
2. Flood control	750,000
3. Waste disposal	850,000
4. Irradiation of sewage sludge	400,000
TOTAL	$3,000,000

G1. Challenge Reduce economic losses to coastal property owners from shoreline erosion.

Solution Performed research on vegetation to stabilize shorelines, studies of cement-asbestos bulkhead failure, and research on erosion in local communities, providing information to adjust building setbacks.

Benefit $1,000,000 saved from property damages and remedial actions.

Source North Carolina

G2. Challenge Improve flood control techniques.

Solution Developed and demonstrated new design concepts.

Benefit Reduction in federal flood insurance payments (e.g., $750,000 per flood) and reduced flooding.

Source New York

G3. Challenge Reduce the impact of waste disposal on the economic development of coastal land and water.

Solution Provide research on environmental distribution of sewage waste and developed alternative, cost-effective disposal system which has been approved and adopted by coastal communities.

Benefit $850,000 per year increase in shellfish harvest and the lifting of building restrictions to allow $4,000,000 of new building during 1980.

Source North Carolina

G4. Challenge Provide a new method of sewage sludge treatment that is less capital and energy intensive.

Solution Developed and had approved by EPA an electron irradiation process for pasteurizing sewage sludge.

Benefit Miami-Dade Water and Sewage Authority is now constructing the first facility based on this process which is projected to perform at an annual savings of $400,000.

Source Massachusetts

H. Marine Service Industry

Reducing wave damage to marinas and finding an economically feasible alternative to breakwater construction for small marinas resulted in annual aggregate economic effects on industry of $812,760 from just three projects. These savings have been replicated numerous times in many regions of the United States.

Examples of annual economic effects	
1. Small-marina operators	$ 176,760
2. Wave damage reduction	500,000
3. Marine trade seminars	136,000
TOTAL	$ 812,760

H1. Challenge Find an economically feasible alternative to traditional breakwater constructions for small-marina operators.

Solution Introduced marina operators to the concept of floating tire breakwaters and floating tire docks, gave the needed design and construction information, and advised on the construction and installation of an expanded marina facility.

Benefit Saved $176,760 in annual facilities costs.

Source Michigan

H2. Challenge Develop low-cost, effective shore protection technologies.

Solution With Rhode Island, design, construct, and field test several floating tire breakwaters.

Benefit Annual savings to shorefront property owners of $500,000 through reduced wave and storm related damage.

Source New York

H3. Challenge Improve efficiency of marine recreational firms.

Solution Formulated and conducted ten marine trade management seminars along the U.S. East Coast involving 680 firms.

Benefit $136,000 in immediate savings.

Source Rhode Island

Section 6. External Evaluations

Evaluations of the National Sea Grant College Program by these federal, academic, and private sector organizations.

- National Advisory Committee on Oceans & Atmosphere
- Department of Commerce, Office of Program Evaluation
- General Accounting Office
- University of Connecticut, Institute for Social Inquiry
- National Oceanic & Atmospheric Administration, Office of Policy & Planning
- Massachusetts Institute of Technology, Center for Policy Alternatives
- Heritage Foundation

EXTERNAL EVALUATIONS OF THE NATIONAL SEA GRANT COLLEGE PROGRAM

Although funding for Sea Grant represents a mere fraction of the billion dollar federal ocean program, it has been the subject of continuous scrutiny and evaluation for more than a decade. Studies have focused on:

- The general effectiveness of the program
- Sea Grant's relationship to the National Oceanic and Atmospheric Administration
- Contributions of individual research projects
- Attitudes and perceptions of academic marine scientists toward Sea Grant

Several themes emerge in these assessments:

- Sea Grant plays a unique and important role in the nation's marine program.
- The program's strengths reside in its ability to promote interdisciplinary marine research, education, and advisory activities responsive to both local and national needs. Its biggest limitation in fulfilling its promise has been insufficient funding.
- Perceptions about the quality of Sea Grant research and administrative effectiveness depend largely on whether researchers are interested primarily in basic or applied research.
- A variety of administrative changes would improve the effectiveness of the program.
- The relationship between Sea Grant and its parent agency, the National Oceanic and Atmospheric Administration, can and should be clarified in a manner that would enable each to draw on the strengths and resources of the other.

The following sections summarize, with a minimum of commentary, the major points made in these reports. Although many of the recommendations made have been addressed by the National Sea Grant Office and the Sea Grant directors, no effort is made here to trace these actions or to summarize the evaluations of the Sea Grant programs made as a regular part of the congressional oversight or budget process. All of these forms of oversight and review have been useful in helping lead to the program's accomplishments cited in other sections of this book.

National Advisory Committee On Oceans and Atmosphere, 1976

During the fall of 1975, the members and staff of the National Advisory Committee on Oceans and Atmosphere (NACOA), embarked on a year-long evaluation of the Sea Grant program. Based on extensive interviews, site visits, panel reviews, attendance at directors' meetings and a review of the extensive documentation about the program, the Committee concluded:

> Sea Grant plays an important role in the national effort to develop and conserve our marine resources. Its ability to draw on the pool of talent in our universities and other research institutions, and its close contacts with users and potential users of marine information and technology, enable it to complement the activities of the numerous other Federal agencies and programs also concerned with marine resource development. Its most significant contributions have stemmed from its sensitivity to regional and local perceptions of issues which, while collectively important to the Nation, may be individually too small or too new to have attracted attention at the Federal level.
>
> *The National Sea Grant Program: A Review*
> A Report for the Secretary of Commerce
> Washington, D.C., November 3, 1976

Sea Grant plays an important role in the national effort to develop and conserve our marine resources. Its ability to draw on the pool of talent in our universities and other research institutions, and its close contacts with users and potential users of marine information and technology, enable it to complement the activities of the numerous other Federal agencies and programs.

In strongly recommending that the program be continued, NACOA noted that Sea Grant had been "responsive to its legislative charter", had "contributed significantly to the Nation's marine effort," and that there was "a continuing need for the kind of service it provides." To strengthen the program, the Committee made recommendations on policy, management and funding.

With respect to policy, NACOA urged the Administator of NOAA to "clarify the goals and role of Sea Grant in relation to NOAA's overall mission", to make more extensive use of the Sea Grant Advisory Panel for advice on broad policy issues, and to develop and implement procedures for improved coordination between other agencies, other parts of NOAA, and Sea Grant.

The Office of Sea Grant was encouraged to clarify its guidelines; aid participating institutions in establishing priorities; expedite its proposal review process; ensure that engineering is incorporated into research projects where appropriate; and, for projects with commercial potential, consider economic as well as technical feasibility.

NACOA concluded that federal funding was "inadequate for the task assigned to the program," hence should be increased to a minimum of $40 million per year over the next several years.

Department of Commerce Office of Program Evaluation, 1976

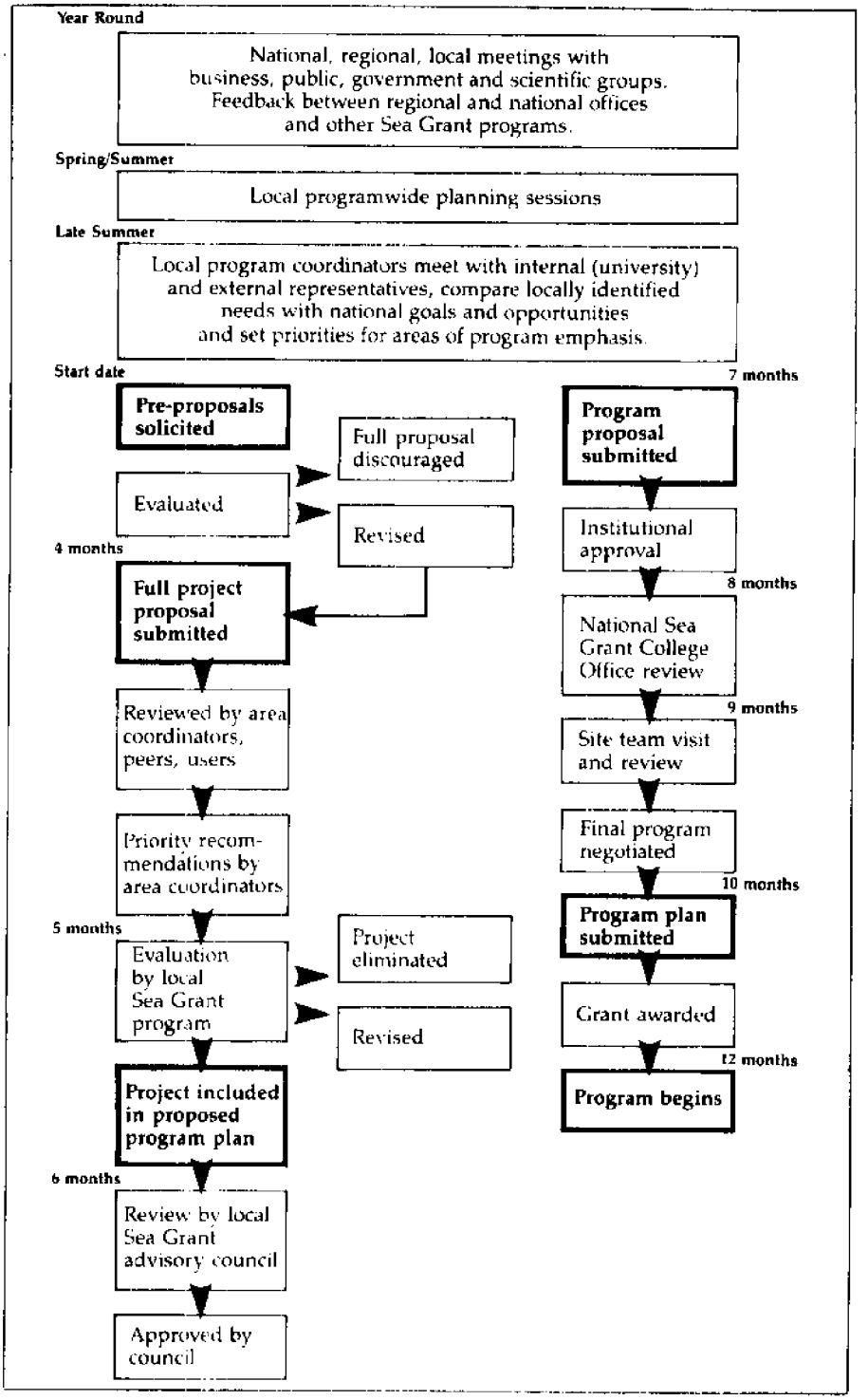
In a staff study, Department of Commerce evaluation specialists addressed two questions raised initially by the Office of Management and Budget. These were whether Sea Grant was a "capacity-building program" or a conduit for grants, and whether or not these grants duplicated work supported by other agencies. The report noted that Sea Grant represented only a fraction of the total funding for federal marine programs but endorsed Sea Grant's role in developing institutional capabilities (e.g., "capacity-building").

They concluded that Sea Grant research was funded by a variety of public and private sources; provided a mechanism for passing funds from other agencies which reduced administrative costs and duplication; and employed an effective six-stage (see figure) review process which assured project quality. They also noted that peer reviews of the Sea Grant approach and program administration had been favorable and that "the local

initiative model" was preferred to a model which sought to impose national criteria for requesting and selecting research proposals.

With respect to "capacity-building", however, there was no common understanding of the goals, objectives, and procedures for developing the kinds of institutions and resources required to fulfill government mission. It did seem possible, however, that a model of "capacity-building could be developed and tested which would have pay-offs in Sea Grant's resource management and program structure." The evaluators recommended that the Office of Management and Budget develop a "capacity-building model" for application throughout the government.

Sea Grant Programs
Planning, Proposal and Review Process



This diagram outlines the planning, proposal and review process at major Sea Grant institutions. Though details will vary from institution to institution, the process is typical. The diagram, which does not appear in the 1976 report from the Department of Commerce, is included here for information purposes.

General Accounting Office 1974 and 1979

The General Accounting Office (GAO) has conducted two assessments of Sea Grant. The first and most extensive was conveyed by letter to the Office of Sea Grant on March 16, 1974, and the second, far more limited in scope, was summarized in a letter dated October 15, 1979.

The 1974 observations were directed primarily at issues of program management and reporting. Recommendations included more explicit attention to relating efforts to accomplishments and benefits; increased suggestions for program development by local advisory groups; more attention by Sea Grant to matching costs; development of procedures that would, before final approval of a proposal, resolve and document actions taken as a result of peer reviews; and creation of a NOAA-wide advisory service. Additional suggestions concerned establishing guidelines and procedures for the management of Sea Grant programs in the universities.

The 1979 letter was based on an examination of the administration of Sea Grant to identify areas needing further review and analysis. On the basis of visits to Sea Grant programs in six states, personal contacts in four others, and discussions with NOAA personnel, the reviewers concluded that: (1) "Many Sea Grant projects appear to have only limited application and to be of little benefit to the identified user community," and (2) "A followup evaluation appears to be needed to determine if the federally supported Sea Grant projects are meeting expected goals and objectives."

The first observation was based on a strictly literal interpretation of the relationship between research, advisory services and users, a point made with great clarity and force in the Office of Sea Grant's explanation of why it could not accept that statement as valid. The second statement involved evaluation of completed projects, procedures for which were well established in Sea Grant administrative practices.

University of Connecticut Institute for Social Inquiry, 1977-79

W. Wayne Shannon and David D. Palmer of the Institute for Social Inquiry at the University of Connecticut undertook an extensive study of the relationship between federal funding agencies and university marine scientists. Their report, *The Federal Funding of Academic Marine Science*, is the only report that examines Sea Grant in the context of the broader pattern of federal support for academic marine programs.

Data were compiled between 1977 and 1979 from mail questionnaires received from 793 academic marine scientists, 918 questionnaires from recent graduates of marine programs, and 153 interviews with federal agency and university administrators.

The researchers noted that Sea Grant, along with the National Science Foundation's Oceanography Section and Office for the International Decade of Ocean Exploration (since 1980 merged in the Division of Ocean Sciences), and the Navy's Office of Naval Research have the most extensive linkages to the university ocean research community of all federal agencies.

Interviews and survey data revealed several areas of dissatisfaction on the part of university marine scientists:

- That the national Sea Grant office had not followed a consistent program
- That site visit review teams assigned to various institutions were often comprised of individuals who were deemed insufficiently familiar with the programs to evaluate them "in a professional and consistent manner over time"

- That Sea Grant was "too sensitive to political winds" and the wants of different users, "too prone to 'target' various desired areas of research, too much concerned with relevance and too anxious to cite accomplishments in the real world."
- That there was an "excessively arduous review process" for Sea Grant proposals and too little money to support and sustain those who were interested in doing Sea Grant research

At the heart of many of these concerns was the tension between Sea Grant's emphasis on applied research and university scientists' desire to pursue basic problems of their own choosing.

The authors observed, however, that often after such critical comments were made, persons expressing them would quickly reaffirm interest in and devotion to the "Sea Grant idea." They concluded:

> While it is surely not everyone's enthusiasm, a broad range of individuals in the academic marine science community see Sea Grant as a highly important part of the federal funding system. Recognition is widespread that Sea Grant is the most durable and institutionally committed program supporting academic marine science research beyond the disciplines of oceanography, proper. Its importance as a catalyst for interdisciplinary activity, marine-related engineering, and social science is widely recognized. Generally, however, there is a pervasive sentiment in the academic community, even among some of Sea Grant's strongest supporters, that the Sea Grant idea--a creative partnership between the federal government, the university, and the governmental and private users of marine technology--needs continuing assessment and perfected implementation.

Recognition is widespread that Sea Grant is the most durable and institutionally committed program supporting academic marine science research beyond the disciplines of oceanography, proper.

National Oceanic and Atmospheric Administration Office of Policy and Planning, 1980

This internal staff report reviewed the legislative origins of Sea Grant, its administrative practices, and funding history as a basis for improving Sea Grant's relationships with other parts of NOAA. The basic questions included: (1) the responsiveness of Sea Grant to NOAA's needs and (2) ways in which cooperation between Sea Grant and other parts of NOAA might be improved.

Sea Grant, noted the report, fills a number of roles for NOAA. It is NOAA's largest "marine outreach arm, through its advisory services, educational activities and university research," and thus is able to maintain close contact with marine specialists in the universities. Sea Grant with its constituency base and attention to local needs, is able to respond to local issues and concerns, as well as serve as an effective early warning system for emerging national problems. Sea Grant had not, however, "been used adequately to enhance NOAA's stature and image."

The report recommended improved communication between Sea Grant and other parts of NOAA, more participation in the Sea Grant review process by other NOAA specialists, and improved understanding of the roles, mission, and priorities by those in Sea Grant and NOAA in order to improve the performance of each.

Massachusetts Institute of Technology Center for Policy Alternatives, 1977

A study of program development procedures and transfer mechanisms in the National Sea Grant Program was undertaken by the Center for Policy Alternatives at Massachusetts Institute of Technology. This study evolved from an earlier MIT evaluation of the commercial and foreign trade impact of the Sea Grant program, and it sought to suggest ways Sea Grant could increase the speed and frequency of economic benefits without sacrificing other benefits of Sea Grant support, or "distorting the fundamental characteristics of participating institutions."

The analysis reviewed the conditions that influenced commercially successful Sea Grant projects, program orientation, and development procedures and transfer mechanisms, with particular emphasis on the strengths and deficiencies of each of these aspects of the program. Inadequate funding was a key problem. "Many imaginative initiatives" had been rejected and Sea Grant institutions had few incentives to promote new ideas in the face of limited funding. A more fundamental problem, however, was the failure of Sea Grant "to project itself forcefully and prove its usefulness."

The researchers concluded that "the objective which it established for itself during its first ten years--the construction of a forceful and balanced network of institutions to implement the Sea Grant concept--has been achieved, and in the opinion of the authors, with highly superior marks."

They urged that attention turn to defining those areas where Sea Grant wished to make an impact, to promote a network of diverse institutions, each with its own special strengths and capabilities, and continue to play a "forceful catalyst role, linking university and community together in research on relevant and highly present" marine resource issues.

In addition, Sea Grant should make a "more unabashed effort to 'sell' itself", and to continually emphasize the close working relationship between advisory services and research projects which "remain Sea Grant's strongest asset."

To pursue these goals, the analysts called for a more active role in program development by the national Sea Grant office, the review panel, and the directors, in particular in setting priorities and identifying clusters ("portfolios") of research projects, and the use of site visits to review past performance.

They also recommended greater latitude for high-risk proposals (which the earlier MIT study found produced the greatest pay-offs), and active pursuit of more cooperation with the private sector, including joint university-industry programs.

Massachusetts Institute of Technology Center for Policy Alternatives, 1981-82

The National Sea Grant College Program has many goals and activities that are important to the nation and to the individual states. Given the nature of marine problems and opportunities and of universities, not all activities can or should lead to readily quantifiable results. However, the work of the Sea Grant institutions has led to a number of demonstrable economic benefits.

In 1981, annual sales in the range of $44-62 million resulted from the 19 projects surveyed that have led to commercial developments. Thus, even with the most conservative figure, annual sales from this small sample exceed the highest annual federal appropriation ($41.8 million in FY81) to the National Sea Grant College Program.

One class of economic benefits can be measured by commercial product developments that result in sales. In 1976, the Massachusetts Institute of Technology's Center for Policy Alternatives (CPA) looked at a sample (77) of Sea Grant projects funded in 1975 that might lead to new commercial products and tried to predict future sales.

In 1981-82, a team at the Center headed by Professor James Utterback and Margaret Linskey reviewed developments in 59 of the 77 projects over the intervening six years. Results were published in a CPA report entitled, *A Reevaluation in 1981 of the Commercial Use of Sea Grant Projects Funded in 1975.* Highlights of the report include:

- In 1981, annual sales in the range of $44-62 million resulted from the 19 projects surveyed that have led to commercial developments. Thus, even with the most conservative figure, annual sales from this small sample exceed the highest annual federal appropriation ($41.8 million in FY81) to the National Sea Grant College Program.
- Eleven new products have resulted as a direct consequence of the Sea Grant projects studied.
- Ten new companies have been formed primarily as a direct result of Sea Grant efforts to introduce the projects' results commercially.

- There have been approximately 25 secondary companies that have started producing products similar to those of the 10 primary companies.
- High risk, broadly based research projects have actually produced more of the values reported than have those that were seemingly less risky and more specific at the outset.
- The more successful projects often go in directions other than their originally stated objectives, exhibiting Sea Grant flexibility to accommodate emerging industrial and market needs.
- At least 15 additional projects from the sample which have not yet produced commercial results are thought still to have potential. This underlines the long-term nature of research and development.
- Sea Grant has built a stable and reliable marine research base.
- Graduate students from Sea Grant programs are particularly effective in transferring Sea Grant research results to industry and government agencies.
- There have been many indirect or social returns from Sea Grant work, such as increased personal safety at sea, increased quality and availability of seafood products, and the introduction of new production methods and new uses for products originating in the oceans.

It should be reemphasized that the report, like the 1981 *Economic Effects of Sea Grant*, studied only a small sample of Sea Grant work and only a specifically prescribed set of benefits. Even in the circumscribed area of economic benefits, it did not look at all projects or at the many other kinds of economic benefits, such as cost savings or jobs preserved. In that light, the results are even more impressive.

Heritage Foundation, 1981

Sea Grant funding should be increased by 10 percent per year in real terms for the next five years.

Prior to President Ronald Reagan's first inauguration, teams of knowledgable individuals, under the auspices of the Heritage Foundation, surveyed the role and performance of programs throughout the federal government. The group that evaluated the Department of Commerce found that:

> The Sea Grant Program has an impressive record of success, primarily because it is based largely on local priorities and needs. It operates in partnership with State and local governments, private industry, universities, organizations and individuals concerned with or affected by ocean and coastal resources. The Congress makes regular requests of Sea Grant for information.
>
> A key element of Sea Grant is its outreach mechanism whereby results of research are provided to users in industry, government agencies and the general public.
>
> Sea Grant funding should be increased by 10 percent per year in real terms for the next five years.

Mandate for Leadership
Charles L. Heatherly, editor
Heritage Foundation, Washington, DC, 1981

Section 7. Legislation

The Sea Grant Program Improvement Act of 1976 (P.L. 94-461) and Amendments of 1978, 1980, and 1984.

Public Law 94-461
94th Congress

An Act

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

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

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

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

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

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

"TITLE II—NATIONAL SEA GRANT PROGRAM

National Sea Grant Program Act.
33 USC 1121 note.

"SEC. 201. SHORT TITLE.

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

33 USC 1121.

"SEC. 202. DECLARATION OF POLICY.

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

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

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

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

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

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

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the title heading of title II of the Marine Resources and Engineering Development Act of 1966 (33 U.S.C. 1101 et seq.) is amended to read as follows:

National sea grant program, appropriation authorization.

1978

"TITLE II—NATIONAL SEA GRANT COLLEGE PROGRAM".

Section 201 of the National Sea Grant Program Act (33 U.S.C. 1121) is amended by inserting "College" immediately before "Program".

33 USC 1121 note.

1978

Sections 202(a)(3), 203(3), 204, and 211 are each amended by striking out "national sea grant program" each place it appears therein and inserting in lieu thereof "national sea grant college program".

33 USC 1121-1123, 1130.

1978

* 1978 = 1978 Amendments
Public Law 95-428-Oct. 7, 1978(92 Stat. 999)
1980 = 1980 Amendments
Public Law 96-289-June 28, 1980(94 Stat. 605)
1984 = 1984 Amendments
Public Law 98-623—November 8, 1984

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

33 USC 1122. "SEC. 203. DEFINITIONS.

"As used in this title—

"(1) The term 'Administration' means the National Oceanic and Atmospheric Administration.

"(2) The term 'Administrator' means the Administrator of the National Oceanic and Atmospheric Administration.

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

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

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

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

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

"(8) The term 'panel' means the sea grant review panel established under section 209.

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

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

"(11) The term 'sea grant program' means any program which—

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

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

Sec. 203(3): See amendment (1978) at Sec. 202(a)(3)

in section 203(6) by inserting "Great Lakes and the" immediately before "territorial sea"; 33 USC 1121 note. 1980

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

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

"(13) The term 'Secretary' means the Secretary of Commerce.

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

"SEC. 204. NATIONAL SEA GRANT PROGRAM. 33 USC 1123.

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

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

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

"(B) appropriate administrative experience.

"(2) The Director shall be appointed and compensated, without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, at a rate not in excess of the maximum rate for GS-18 of the General Schedule under section 5332 of such title. 5 USC 3301 *et seq.* 5 USC 5332 note.

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

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

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

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

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

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

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

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

The section heading of such section 204 is amended to read as follows: 1978

"SEC. 204. NATIONAL SEA GRANT COLLEGE PROGRAM."

Sec. 204(all parts): See amendment (1978) at Sec. 202(a)(3)

in section 204(c) by redesignating paragraphs (5) and (6) as paragraphs (6) and (7), respectively, and by inserting immediately after paragraph (4) the following new paragraph: 33 USC 1122. 33 USC 1123. 1980

"(5) encourage cooperation and coordination with other Federal programs concerned with ocean and coastal resource conservation and usage;".

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

5 USC 3301 et seq.

5 USC 5332 note.

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

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

Publication.

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

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

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

Rules and regulations.

33 USC 1124.

"SEC. 205. CONTRACTS AND GRANTS.

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

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

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

The total amount paid pursuant to any such grant or contract may equal 66⅔ percent, or any lesser percent, of the total cost of the sea grant program or project involved.

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

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

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

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

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

Application.

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

by amending section 204(d)— 33 USC 1123 1978

(A) by striking out "and" at the end of paragraph (5),

(B) by redesignating paragraph (6) as paragraph (7), and

(C) by inserting immediately after paragraph (5) the following new paragraph:

"(6) accept funds from other Federal departments, agencies (including agencies within the Administration), and instrumentalities to pay for grants made, and contracts entered into, by the Secretary under section 205(a); and"; 33 USC 1124.

by striking out the period at the end of the last sentence of section 205(a) and inserting in lieu thereof the following: "; except that this limitation shall not apply in the case of grants or contracts paid for with funds accepted by the Secretary under section 204(d)(6)."; 1978 33 USC 1123.

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

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

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

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

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

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

Record retention. Regulation.

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

Audit.

"SEC. 206. NATIONAL PROJECTS.

33 USC 1125.

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

Grants and contracts.

Application.

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

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

in section 205(d)(2) by inserting "may be applied to the short-term rental of buildings or facilities for meetings which are in direct support of any sea grant program or project and" immediately after "contract" the second time it appears therein; 33 USC 1124. 1980

by amending the first sentence of section 206(c) to read as follows: 33 USC 1125. 1978

"There are authorized to be appropriated for purposes of carrying this section not to exceed the following amounts:

"(1) $5,000,000 for each of fiscal years 1977, 1978, and 1979.

"(2) $7,000,000 for fiscal year 1980.";

in section 206(c) by inserting "out" immediately after "carrying", and by inserting the following new paragraph immediately after paragraph (2): 33 USC 1125. 1980

Not to exceed $5,000,000 for fiscal year 1981, not to exceed $6,000,000 for fiscal year 1982, and not to exceed $7,000,000 for fiscal year 1983.";

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

33 USC 1126.

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

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

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

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

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

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

33 USC 1124, 1123.

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

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

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

33 USC 1121 note.

Ante, p. 1961.

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

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

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

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

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

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

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

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

Hearing.

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

33 USC 1127.

"SEC. 208. SEA GRANT FELLOWSHIPS.

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

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

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

"SEC. 209. SEA GRANT REVIEW PANEL. 33 USC 1128.

"(a) ESTABLISHMENT.—There shall be established an independent committee to be known as the sea grant review panel. The panel shall, on the 60th day after the date of the enactment of the Sea Grant Program Improvement Act of 1976, supersede the sea grant advisory panel in existence before such date of enactment. *Ante*, p. 1961.

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

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

"(2) the sea grant fellowship program;

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

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

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

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

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

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

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

in section 209(c)(3) by striking the first two sentences and inserting in lieu thereof the following: "Any individual appointed to a partial or full term may be reappointed for one additional full term." 33 USC 1128. 1980

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

Chairman, Vice Chairman.

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

Compensation. 5 USC 5332 note.

"(5) Voting members of the panel shall—

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

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

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

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

33 USC 1129.

"SEC. 210. INTERAGENCY COOPERATION.

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

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

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

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

33 USC 1130.

"SEC. 211. ANNUAL REPORT AND EVALUATION.

Submittal to Congress and President.

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

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

33 USC 1131.

"SEC. 212. AUTHORIZATION FOR APPROPRIATIONS.

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

Sec. 211(all parts): See amendment (1978) at Sec. 202(a)(3)

by amending section 211— 33 USC 1130. 1978

(A) by striking out "ANNUAL" in the section heading and inserting in lieu thereof "BIENNIAL",

(B) by amending subsection (a) to read as follows:

"(a) BIENNIAL REPORT.—The Secretary shall submit to the Congress and the President, not later than February 15, 1980, and not later than February 15 of every even-numbered year thereafter, a report on the activities of, and the outlook for, the national sea grant program."; and

Report to Congress and the President.

(C) by amending the last sentence of subsection (b) to read as follows: "Such material shall be submitted to the Secretary not later than February 1 of the year in which the report concerned is to be submitted under subsection (a), and the Secretary shall cause it to be published as a separate section in such report."

by amending the first sentence in section 212 to read as follows: 33 USC 1131. 1978

"There are authorized to be appropriated for purposes of carrying out the provisions of this title (other than section 206) not to exceed the following amounts: 33 USC 1125.

"(1) $50,000,000 for each of fiscal years 1977 and 1978.

"(2) $55,000,000 for each of fiscal years 1979 and 1980.".

in section 212 by inserting the following new paragraph immediately after paragraph (2): 33 USC 1131. 1980

"(3) Not to exceed $50,000,000 for fiscal year 1981, not to exceed $58,000,000 for fiscal year 1982, and not to exceed $65,000,000 for fiscal year 1983.".

"(4) Not to exceed $39,000,000 for fiscal year 1985, not to exceed $42,000,000 for fiscal year 1986, and not to exceed $44,000,000 for fiscal year 1987.". 1984

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

SEC. 3. INTERNATIONAL COOPERATION ASSISTANCE. 33 USC 1124a.

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

(1) enhance the research and development capability of developing foreign nations with respect to ocean and coastal resources, as such term is defined in section 203 of the National Sea Grant Program Act; and

(2) promote the international exchange of information and data with respect to the assessment, development, utilization, and conservation of such resources.

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

Regulation.

Consultation.

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

SEC. 4. CONFORMING AND MISCELLANEOUS PROVISIONS.

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

"(65) Administrator, National Oceanic and Atmospheric Administration.".

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

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

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

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

5 USC app. II; 15 USC 1511 note.

The section heading of section 3 of the Sea Grant Program Improvement Act of 1976 (33 U.S.C. 1124a) is amended to read as follows: 1980

"SEC. 3. SEA GRANT INTERNATIONAL PROGRAM.".

Section 3 of the Sea Grant Program Improvement Act of 1976 (33 U.S.C. 1124a) is amended— 1978

(1) by striking out "National Sea Grant Program Act" each place it appears therein and inserting in lieu therof "National Sea Grant College Program Act";

(2) by amending subsection (a) (2) to read as follows:

"(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."; and

(3) by amending the first sentence of subsection (c) to read as follows:

"There are authorized to be appropriated for purposes of carrying out this section not to exceed the following amounts:

"(1) $3,000,000 for each of fiscal years 1977, 1978, and 1979.

"(2) $5,000,000 for fiscal year 1980.".

Section 3(c) of the Sea Grant Program Improvement Act of 1976 (33 U.S.C. 1124a(c)) is amended by inserting the following new paragraph immediately after paragraph (2): 1980

"(3) Not to exceed $5,000,000 for fiscal year 1981, not to exceed $5,000,000 for fiscal year 1982, and not to exceed $5,000,000 for fiscal year 1983.".

"(4) For fiscal years 1985, 1986, and 1987, not to exceed $1,000,000, appropriated in each fiscal year pursuant to section 212 of the National Sea Grant Program Act, may be available to carry out this section.". 1984

5 USC app. II.

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

Approved October 8, 1976.

LEGISLATIVE HISTORY:

HOUSE REPORTS No. 94-1048 (Comm. on Merchant Marine and Fisheries) and No. 94-1556 (Comm. of Conference).
SENATE REPORTS No. 94-848 accompanying S. 3165 (Committees on Labor and Public Welfare and Commerce).
CONGRESSIONAL RECORD, Vol. 122 (1976):
May 3, considered and passed House.
June 14, considered and passed Senate, amended, in lieu of S. 3165.
Sept. 17, Senate agreed to conference report.
Sept. 23, House agreed to conference report.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 12, No. 42:
Oct. 10, Presidential statement.

LEGISLATIVE HISTORY: 1978 Amendments

HOUSE REPORT No. 95-1011 (Comm. on Merchant Marine and Fisheries).
SENATE REPORT No. 95-887 (Comm. on Commerce, Science, and Transportation) and (Comm. on Human Resources).
CONGRESSIONAL RECORD, Vol. 124 (1978):
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June 29, House concurred in Senate amendment with amendments.
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LEGISLATIVE HISTORY: 1980 Amendments

HOUSE REPORT No. 96-844 (Comm. on Merchant Marine and Fisheries).
SENATE REPORT No. 96-723 (Comm. on Commerce, Science, and Transportation and Comm. on Labor and Human Resources).
CONGRESSIONAL RECORD, Vol. 126 (1980):
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June 9, Senate concurred in House amendments with an amendment.
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LEGISLATIVE HISTORY: 1984 Amendments

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Section 8. Index

A keyword index to Sea Grant projects described in Sections 2, 3, 4, and 5 of this book.

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A National Capability

For Marine

- Research
- Education
- Advisory Services