

INDUSTRIES AND  
OCEANS, CITIZENS  
AND COASTS



A Report on the  
Massachusetts Institute of Technology  
Sea Grant Program

1 July 1974 to 30 June 1975

# CIRCULATING COPY

## Sea Grant Depository

INDUSTRIES AND OCEANS,  
CITIZENS AND COASTS



The Ocean's Future in America's Economy . . . . .	p. 2
A Generation Facing the Sea . . . . .	p. 6
Maintaining Marine and Coastal Environments . . . . .	p. 7
Making Public the Ocean's Potential . . . . .	p. 9

Report No. MITSG 76-2  
Index No. 76-002-Zay  
31 December 1975

## THE M.I.T. SEA GRANT PROGRAM 1974-1975

"Industry and oceans, citizens and coasts" conveys an image of the M.I.T. Sea Grant Program's twofold commitment — to the economic advancement of America's industry through new uses of the seas and marine resources, and to the preservation of rich ocean and coastal environments for future generations.

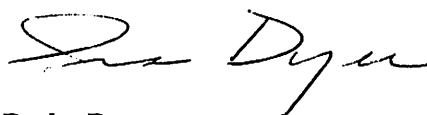
With this commitment, Sea Grant follows M.I.T.'s philosophy — to promote the creation and application of technology to opportunities for industrial growth, economic benefit, environmental safeguards, and social betterment. The Institute's participation in the National Sea Grant Program (a division of the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce) has brought this philosophy to bear on new opportunities in the oceans and coastal zones, and has furthered the development of marine resources and the seas' environment for human use.

"Industry and oceans, citizens and coasts" also reflects the M.I.T. Sea Grant Program's adherence to the goals of the National Sea Grant Program — to encourage the wise use of ocean and coastal resources and to develop the skills and technologies necessary to advance these uses.

Moreover, in its commitment to assist America in obtaining economic benefit from the seas and in protecting the ocean's environment, the Institute's Sea Grant Program is firmly aligned with national priorities. Sea Grant's goal of using more fully the oceans' contribution to our economic and industrial growth recognizes that living and mineral marine resources represent a reservoir of raw materials for industry, of energy for factories, homes, and transportation, and of food for generations to come. The Program's commitment to understanding society's effect on the marine environment acknowledges the global role that oceans and coasts play in biological, meteorological, and geological processes.

Sea Grant-sponsored research, education, and advisory services coalesce to make the Program's commitment reality. Sea Grant research focuses the strengths of several academic disciplines on a single investigation, producing pragmatic innovations and improvements for the benefit of ocean-related industries and the marine environment. Sea Grant-supported education provides students with practical, multidisciplinary experience in solving problems of ocean engineering, marine policy, and coastal zone land use management. Sea Grant advisory services reach industrial and civic constituencies with information and assistance on the use of seas and coasts, and transfer research results to those who can implement these data and derive new knowledge from them.

30 June 1975 saw the completion of M.I.T.'s third year as an Institutional Sea Grant Program. The dedication of Institute faculty, research staff, and students to Program goals, corresponding support from participating industries, organizations, and agencies, and the enthusiasm of Sea Grant's staff have ensured increasing success for the Program's efforts. In this annual report for 1974-1975, we present the accomplishments achieved through the M.I.T. Sea Grant Program's commitment to "industry and oceans, citizens and coasts."



Dr. Ira Dyer  
Director

## THE OCEAN'S FUTURE IN AMERICA'S ECONOMY

The M.I.T. Sea Grant Program's Marine Industry Advisory Service has established a working partnership between industry and academia to promote the application of new technologies to business opportunities in the oceans.

The oceans offer to American industry both a rich source of raw materials, and opportunities for new products, technologies, and innovative services aimed at marine markets. Through research on materials and methods, and through advisory services to industry, the M.I.T. Sea Grant Program helps to expand the ocean's role in national economic growth.

In April 1975, the M.I.T. Sea Grant Program inaugurated its Marine Industry Advisory Service (MIDAS) to bring about the Institute's closer collaboration with companies interested in the marine field. MIDAS builds upon M.I.T.'s tradition of working ties with business and industry, and seeks to encourage a mutually beneficial partnership to identify and exploit profitably marine business opportunities. Thirteen companies have set the pace for MIDAS's steady growth in size and services by electing to become charter members in this partnership.

MIDAS provides for two types of partnership between the M.I.T. Sea Grant Program and member companies. The M.I.T./Marine Industry Collegium will help to keep participating firms abreast of economically significant opportunities for new enterprise in marine-related areas, through regularly issued briefs on marine resource or product development, through current information service on important opportunities, and through personal advisory contact with members. The Collegium affords industry direct access to the experience and knowledge that companies can use to make sound, profitable decisions, and gives M.I.T. faculty and the M.I.T. Sea Grant Program a business perspective that will make the Institute's research projects even more responsive to industry's needs.

The second component of MIDAS partnership is the Marine Industries Business Strategy Program (Maribus), an intensive study of a selected marine resource, product, or service that has high economic potential for industry. Data generated through Maribus will be used by companies to formulate and begin implementing business strategies for the development of a particular ocean resource or a marine-related business venture.

Sea Grant research on the structure of chitin and chitosan will promote the application of these useful materials in numerous commercial products and processes.

Chitin, the natural polysaccharide related to cellulose, can be obtained in abundance from shellfish-processing wastes. Its derivative, chitosan, appears to have many promising applications in medicine, papermaking, adhesives, natural and synthetic fibers, pharmaceuticals, waste treatment and monitoring, agriculture, and food processing.

To foster these commercial uses for chitin and chitosan, continuing research sponsored by the M.I.T. Sea Grant Program has developed clear, flexible films cast of chitosan derived from several species of shellfish, and studies are underway on the structure of the chitosan and the strength of the films. Variations in chitosan's chemical structure depend primarily on the processing methods used to prepare chitin and to convert it into chitosan, rather than on the particular source of the chitin, and will influence chitosan's suitability for each of its potential industrial applications. Studies have also shown that chitosan can adsorb and release water readily, a characteristic important in the material's function as an ionic membrane or coagulant.

*Mr. Dean Horn, Sea Grant Program Executive Officer, Dr. Ira Dyer, Director of the Program, and Mr. Norman Doelling, MIDAS Manager, plan new marine advisory services for business and industry.*



*M.I.T. graduate student John Wall prepares to release the new Sea Grant hook-up block during field testing on board the Vincie N.*



**Innovative methods for underwater welding and cutting could make possible more efficient and economical repairs on metal structures in the sea.**

Following extensive research on fundamental processes in welding and cutting metals underwater, the M.I.T. Sea Grant Program initiated a new project in 1974-1975 to develop new and improved techniques and equipment for the construction and repair of pipelines, piers, and oil rigs in the oceans. Conceptual designs have been completed for several new underwater arc welding and cutting methods that accommodate the changes a seawater environment makes in the metallurgy of welds.

Researchers have also invented an underwater stud-welding gun to repair and construct materials for offshore drilling, to assist in salvage operations or rescue work at sea, and to join underwater the component parts of large offshore structures. The stud-welding gun prevents problems of brittleness and rapid cooling in the welded materials by removing seawater from the repair site and replacing it with an inert gas piped between stud and plate to be welded. The gun then forces the stud or bolt into the plate, and the metals are fused.

**Fiberglass boat hull design, construction techniques, and maintenance will be improved through Sea Grant findings on failure processes in fiberglass materials.**

The M.I.T. Sea Grant Program's research on the fracture mechanics of fiberglass-reinforced plastic (FRP) composite materials will provide the ship-building industry with data needed for the fabrication of increasingly larger FRP boat hulls. Fiberglass composites in plastic hulls can crack and break apart under rough conditions at sea, and the project's goal has been to determine analytical methods, composite constructions, and component materials that could prevent such rapid, catastrophic cracking in these plastics. Results of the study, completed this year, should also be useful to marine designers and materials manufacturers involved in the construction and safety of fiberglass boats.

During 1975, experiments demonstrated the effect of seawater on crack growth in several fiberglass plastic hull materials subjected to periodic stress, the type of loading that affects boats at sea. The presence of seawater appears to accelerate cracking under such cyclic loading, though under sustained, constant stress crack growth was slowed. Researchers have also studied the effects of time on crack stability and on the validity of fracture toughness tests.

**Criteria for multipurpose offshore platform design, developed through Sea Grant research, will help to expand effective use of ocean space.**

Platforms in the sea may be logical locations for a variety of industrial activities, such as offshore oil terminals, fish processing facilities, or power plants. The combination of several compatible functions on one platform would permit efficient use of a single offshore structure, and Sea Grant studies on design criteria for these types of platforms should be of benefit to the government agencies and industry engineers who will plan them. Working on multipurpose offshore platform design, ocean engineers at M.I.T. have completed pilot projects on the design of a platform for a nuclear power plant with a desalinization facility and oil storage terminal, and have finished preliminary research on the engineering analysis needed in the design of multipurpose offshore platforms.

**Sea Grant's new hook-up block design will result in safer trips to sea for crewmen on board New England's side trawling fishing boats.**

Attached to a fishing boat's side near the stern, the hook-up, or towing, block encircles the two heavily-loaded net tow cables, and guides them during the trawling run as the nets fill with fish. Because the old hook-up block now used on New England side trawlers has led to serious injuries under rough weather conditions on the Atlantic fishing grounds, concerned Massachusetts fishermen requested that the M.I.T. Sea Grant Program design an improved block.

Sea Grant's solution is a simpler, safer hook-up block that can easily replace those currently in use, and that makes possible fast securing and remote releasing of the net tow cables. Following laboratory testing, a prototype Sea Grant block went to sea in the autumn of 1974 on board a Gloucester trawler, the *Vincie N.*, and captain and crew found it very successful in their trawling runs. The block was presented in April 1975 to the New England Fisheries Steering Committee's Safety Advisory Service Committee, and another prototype block was successfully tested on one of New England's largest side trawlers, the *Massachusetts*. The Sea Grant Program has made available design data on the improved block as a first step in its distribution for use on board the region's other fishing vessels.

**If the federal government institutes a 200-mile limit for offshore waters, regulatory methods based on competitive bidding for quotas may be best for agencies that manage coastal fisheries resources.**

With the passage of a 200-mile economic zone at sea, the United States could gain unilateral control over the domestic continental shelf fisheries off its coasts. But such control will not solve the domestic fishing industry's problems. Regulations will be needed for efficient management of the fisheries to prevent overfishing, and a research project sponsored by the M.I.T. Sea Grant Program during the past year has analyzed alternative management schemes to guide regulatory agencies in setting up control mechanisms.

Researchers studied the effect of several management methods on real fishermen's income, fish consumers' income, and total national income, and described the economic interrelationship between the level of fishing effort, consequent yield, and prices received by fishermen and paid by consumers. Since private property rights, which would encourage fishermen to husband their stocks for long-term profit, cannot be established over portions of a fishery, controlled entry to the fisheries will have to be enforced in order to manage the resource for maximum national income. Among alternative management schemes proposed, such as gear restrictions, fixed landing payments, total take restrictions and quotas, and boat-by-boat quotas and licensing, the Sea Grant study designated competitive bidding for quotas as the method of regulation most likely to lead to efficient exploitation of the stocks and maximum national income.

**New England's depressed fishing industry could benefit from a federation of fisheries cooperatives.**

Under Sea Grant sponsorship, researchers at M.I.T. completed a study this year on the potential of fishermen's cooperatives for improving the economic outlook of New England's fishing industry. The project's primary conclusion is that a federation of cooperatives could provide more bargaining power in the marketplace for fishermen and could aid in ensuring a reliable supply of fish to meet consumer demand. However, social, political, and geographic impediments must be overcome to make the formation of such a federation practical for the three New England cooperatives considered in this study. To assist newly formed cooperatives, researchers also analyzed accounting systems for fisheries cooperatives, and developed a systems management methodology to assess the economic value of distant markets for New England seafood.

**Findings from Sea Grant research on the cholesterol content of fish and shellfish will be useful in preventive medicine and public health programs.**

Doctors and dieticians who prescribe dietary regimens for persons with high blood cholesterol levels, arteriosclerosis, and heart disease need detailed data on lipid components in commonly eaten seafoods. To meet this need, Institute food scientists supported by Sea Grant are investigating the content and composition of physiologically important lipids, such as cholesterol and certain fatty acids, in raw and processed finfish and shellfish. During 1974-1975, researchers tested and adapted analytical methods for lipid extraction and for cholesterol determination by color

Squid, an underutilized marine species, has positive potential as a new food resource.

The productivity of oyster aquacultural systems could be increased through the use of thermal effluents from power plants.

reactions and gas chromatography. The project's first experiment compared canned tunas with several popular meat products to demonstrate the suitability of test methods. M.I.T. scientists anticipate extensive applied use of the research results, both in the fields of medicine and nutrition, and by food processors who must quantify the nutritional values of seafood products to meet labeling requirements.

The reduction of harvestable stocks of edible finfish and shellfish, and their increased price, have made the nutritious, plentiful, and underutilized squid an attractive alternative to standard species. The M.I.T. Sea Grant Program's research on squid, completed this year, has studied the use of this cephalopod as a supplement for scarcer, more expensive seafoods. Marketing analyses showed that, at present, exporting squid caught by American fishermen to Mediterranean and Asiatic countries has greater potential for economic return than local marketing, for which new forms of processed squid are needed. Food scientists have determined the processing characteristics and functional properties of squid protein concentrates, have developed an improved process for extracting protein from squid muscle, and have studied questions of the concentrates' nonprotein nitrogen content and off-odors that may appear during storage. The project's final report will provide seafood processors with useful information on preliminary development of squid products and processing equipment and on marketing strategies.

The warmed water discharged from electric power plants could be useful in maintaining cultivated oysters' high summer growth rates year-round. Researchers investigating this possibility in a joint project of the M.I.T. Sea Grant Program and the University of Massachusetts Aquacultural Engineering Laboratory in Wareham, Massachusetts, have developed and operated a small-scale system to demonstrate the indirect use of thermal effluents from power plants for raising oysters in an aquacultural system, and are studying supplemental winter feeding needed to maintain adequate nutrient levels for the oysters' increased growth rates. The aquacultural engineers have performed a parametric economic analysis of a finishing plant for cultivated oysters, and are expanding the analysis to investigate several configurations of steel heat exchangers, and to take better account of maintenance costs, problems of power plant shut-down, and pumping costs.



*Graduate student Arlene Mathes of M.I.T.'s Department of Nutrition and Food Science tests seafood samples for their cholesterol content.*

## A GENERATION FACING THE SEA

Sea Grant's student summer laboratory helps Institute students benefit from the opportunity of creating solutions to real ocean engineering problems.

M.I.T. faculty revise and update selected ocean engineering subjects as part of fulfilling Sea Grant's goal of coherent educational programs in marine science and engineering.

Sea Grant's interdisciplinary systems design subject puts students to work on complex topical problems in coastal resources use.

Education on ocean resources and technology is designed to prepare today's students for tomorrow's wise uses of the seas. During 1974-1975, the M.I.T. Sea Grant Program's projects in marine education maintained strength in two directions, broadening the Institute's ocean-oriented curriculum, and providing opportunities for the practical application of students' classroom knowledge to marine and coastal zone problems.

Students from M.I.T. and from the Maine Maritime Academy join forces each summer to gain practical experience in developing equipment for and applying technology to marine activities. Following fall and spring terms spent in classrooms and in laboratories, where experimental equipment is designed and constructed, in the summer months course participants move to Castine, Maine, for field trials of instruments and techniques. Since 1973, the laboratory's major project has been the development of a free-swimming underwater robot that can be programmed to collect oceanographic and ocean engineering data. In July 1975, students successfully operated the robot under its own control, using a minicomputer on board to guide the submarine and to store the data collected by sensing instruments. Future work on the robot will improve its reliability; a collision avoidance mechanism and sonar communication system will be designed and installed.

A significant addition to Institute departmental offerings during academic year 1974-1975 was a new multidisciplinary, graduate-level subject on coastal zone management policy and on planning for the use and conservation of coastal resources. The Departments of Ocean Engineering, Civil Engineering, Architecture, and Urban Studies and Planning collaborated in teaching Coastal Zone Management; a course syllabus has been published. With Sea Grant support, the M.I.T. Department of Ocean Engineering has continued a joint experimental program, with Harvard Law School, on the interrelationships between ocean engineering and law.

Students from M.I.T. and Boston University Law School, participants in the 1975 interdisciplinary systems design subject supported by the M.I.T. Sea Grant Program, undertook a successful coastal planning study of four Massachusetts South Shore towns, Hull, Cohasset, Hingham, and Scituate. Faced with an estimated doubling of their populations over the next forty years, the towns asked the student group to analyze economic, technical, and land-use problems critical for the communities' futures; coordination of planning efforts with the state's coastal zone management program was another concern. Student researchers, following comprehensive surveys of available data and interviews with planning board members, recommended that towns use cluster zoning for residential development; that guidelines anticipating state regulations should be set for public access to local beaches; that planning capabilities be strengthened to meet future growth pressures; and that the communities undertake regional cooperation on schools, transportation, and planning. These and other study conclusions were presented in May 1975 to the towns' residents at a meeting held by the South Shore Chamber of Commerce.

*Professor A. Douglas Carmichael, left, and students Charles Mazel, Stuart Jessup, William Burke, Glenn Keller, and Deborah Hoover with the robot submarine developed in the Sea Grant-supported student summer laboratory.*





## MAINTAINING MARINE AND COASTAL ENVIRONMENTS

**Understanding physical processes in bays and making possible the rational use of coastal waters have been the goals of Sea Grant's major study on Massachusetts Bay.**

The continued human use of rich ocean and coastal zone resources depends on our ability to understand and hence maintain stable, productive environments in offshore waters and shorelands. The M.I.T. Sea Grant Program's research and advisory services promote the wise use of coastal lands and waters by advancing this understanding.

Through mathematical models that describe and predict the hydrodynamics of Massachusetts Bay, M.I.T. Sea Grant research will help Massachusetts preserve its fertile estuaries and bays while fostering the coastal zone development important for its economy. While natural decay and dispersion now maintain the bay's environmental stability, coastal zone planners and environmental engineers need to know the limits of these processes for handling fresh- and wastewater effluents, and the Sea Grant Program's major research project on the physical processes and seawater environment in Massachusetts Bay will provide such information.

During 1974-1975, the Massachusetts Bay project's fourth year, researchers from the Institute's Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics continued their work on the computer models developed from earlier field measurement programs on the bay's currents and chemical characteristics. Models that predict the bay's circulation and pollutant dispersion processes were verified by running the computer programs with tide and wind data obtained from observation, and comparing the bay's predicted and observed responses. A similar analysis was done on the results of a glass bead dispersion experiment originally carried out for 1973's New England Offshore Mining and Environmental Study. With techniques from estimation and optimization theory, researchers will expand the predictive numerical models for use in designing cost-effective water quality monitoring systems and sampling networks.

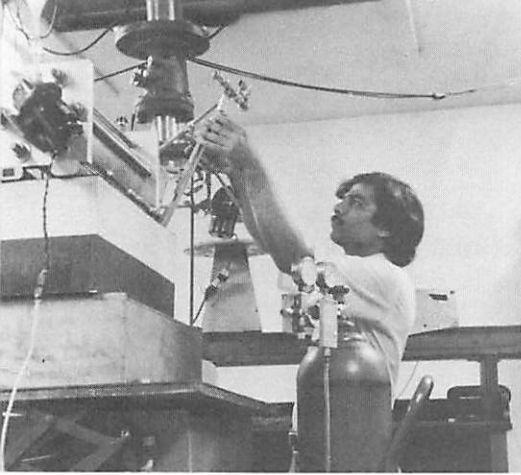
The Massachusetts Bay models will be applicable to hydrodynamic and dispersion processes in other offshore waters as well. They have been used in the past year not only for studying the thermal outfall at the Pilgrim Nuclear Power Plant in Plymouth, Massachusetts, but also in performing preliminary site evaluations of a potential power plant on Narragansett Bay in Rhode Island, and in making storm surge predictions for the Atlantic Generating Station off the New Jersey coast. In October 1974 a workshop introduced the models and their uses to interested industry and government representatives.

**A bioenergetic model for coastal waters will be useful in the prediction and monitoring of biological productivity in estuaries and bays.**

Professor Francois M. Morel, Sea Grant's first Henry L. Doherty Assistant Professor of Ocean Utilization (a chair endowed under Sea Grant administration through the generosity of the Henry L. and Grace Doherty Charitable Foundation, Inc.), is pursuing research on the development of a bioenergetic/biochemical model for coastal waters that, coupled with current hydrodynamic and chemical models, will predict nutrient concentrations, biomass, pH, or dissolved oxygen. While plotting the role of major factors in coastal waters' primary productivity, such as nutrients like phosphorus or nitrogen, energy sources, and temperature, Professor Morel has particularly studied the effect of trace metals, both as micronutrients and as toxic substances, on phytoplankton growth. Drawing upon his study of mechanisms that may cause the onset of destructive dinoflagellate blooms known as red tides, he and his colleagues have predicted the ranges within which trace copper will either be a limiting nutrient or a toxicant for marine phytoplankton.

**A major conference on toxic dinoflagellate blooms publicized current research on the red tides that disrupt the nation's shellfisheries.**

In November 1974 the First International Conference on Toxic Dinoflagellate Blooms, held jointly by the Massachusetts Science and Technology Foundation and the M.I.T. Sea Grant Program, provided presentations of current research on oceanographic conditions associated with the poisonous algal blooms, on the organisms' biology, toxin chemistry, and pharmacology, and on management of the paralytic shellfish poisoning that often results from the blooms. Over 230 scientists from around the world attended to learn about the blooms known as red tides that have



*Dineshchandra Shah, graduate student in nutrition and food science at M.I.T., prepares an experiment that will demonstrate the effect of electron irradiation on Salmonella.*

Irradiation with high-energy electrons could be an effective method for the disinfection of municipal sewage sludge and could change this waste into a usable resource.

Deployment of oil spill collection equipment and the siting of offshore petroleum facilities could be improved if mechanisms causing spill movement on the ocean's surface are better understood.

An M.I.T. Sea Grant advisory services project will test the usefulness of a new strain of American beach grass for preserving Massachusetts' barrier beaches.

closed shellfish beds and caused major economic losses for the shellfishing industry, particularly in New England, during the last several years.

The M.I.T. Sea Grant Program's study on wastewater and sewage treatment through high-energy electron irradiation has emphasized the application of this innovative process both to urban sewage treatment plants and to short-term uses in smaller, more specialized systems. Experiments on virus inactivation for nutrient wastewater in marine aquaculture systems have been done in cooperation with the Woods Hole Oceanographic Institution and the University of New Hampshire, and, for effluents from fish disease research, with the U.S. Department of the Interior's Eastern Fish Disease Laboratory. Viral inactivation is being determined as a function of electron dosage and dose rate, water temperature and oxygen content, and competing or sensitizing substances in the irradiated stream.

As a measure of Sea Grant's success, this research on high-energy electron irradiation as an effective, economical method for treating municipal sewage sludge was given major support for 1974-1976 through the National Science Foundation's Research Applied to National Needs program. This support will enable the research group to complete the laboratory work on the project and to build and operate a full-scale experimental facility at the Metropolitan District Commission's Deer Island Sewage Treatment Plant in Boston Harbor.

Continuing M.I.T. Sea Grant research on the economic and environmental impacts of continental shelf petroleum development, ocean engineers undertook during 1974-1975 a study on the transport of marine oil spills and surface films by waves. The researchers tested the hypothesis that surface oil films are moved over the sea-water because of momentum transfer from wind-generated waves rather than by the wind directly. An analytical model has been developed that accounts for the differing viscosities of oil and water and the boundary tension between them, and that explains spill transport as a function of motion passed on to the oil from attenuated waves attempting to pass beneath the spill. The model may also demonstrate the role of oil spill thickness in such wave-induced transport. By making possible more accurate understanding of oil spill transport mechanisms, this Sea Grant study should lead to better siting of offshore oil production platforms and deep water terminals, and improved use of spill containment and collection systems.

Along the Massachusetts coastline, barrier beaches that protect the rich ecologies of salt marshes and estuaries are continually assaulted by eroding waves and winds. American beach grass, holding the sands in place with deep, spreading roots, is the best defense against such erosion, and in April 1975 the M.I.T. Sea Grant Program and the Massachusetts Beach Buggy Association began a year-long demonstration project on the effectiveness of a new, vigorous strain of beach grass for stabilizing a washed-over section of Nauset Beach on Cape Cod. The U.S. Army Corps of Engineers, the Chatham (Massachusetts) Beach Patrol, and the Orleans (Massachusetts) Conservation Commission are also cooperating in the project. On a raw April day, volunteers set out 8000 culms of the new "Cape" strain, and 8000 of the older common variety of beach grass in two adjoining plots on Nauset Beach. Comparative photographs taken at regular intervals over the coming year will measure differing growth rates and the grasses' ability to hold the wind-swept sands in place.

## MAKING PUBLIC THE OCEAN'S POTENTIAL

Sea Grant symposia, short courses, and lectures provide the public with insights on society's future uses of the seas and coasts.

Aquacultural engineering advisory services are helping to boost the productivity of shellfisheries in Massachusetts and New England.

Through its advisory services, the M.I.T. Sea Grant Program has continued its successful interactions with local and regional constituencies.

Complementing its well-established research and education projects that make recognized contributions to society's wise use of the oceans and coasts, the M.I.T. Sea Grant Program's advisory services assist industry, through MIDAS, in the application of new technologies to business opportunities in the oceans, and transfer useful information on the oceans and coasts to individuals, local and regional government, organizations, and institutions, throughout Massachusetts and New England, whose vocations or interests are served by the seas.

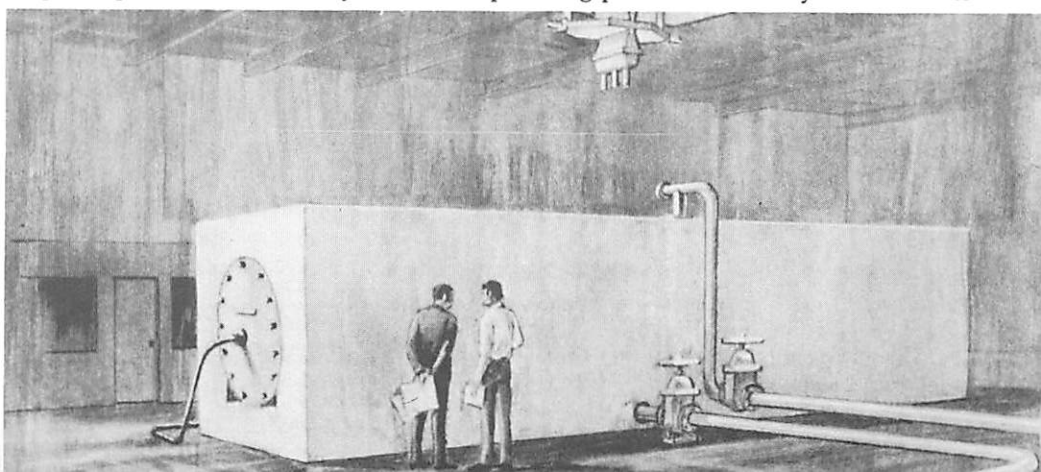
The M.I.T. Sea Grant Program's advisory services presented several well-attended symposia during the past year. The Third Annual Sea Grant Lecture featured Dr. Robert A. Frosch, Assistant Executive Director of the United Nations Environment Programme, speaking on "The Oceans: Planetary Engineering and International Management," with companion papers by Professor Judith T. Kildow of M.I.T.'s Department of Ocean Engineering and Professor Richard R. Baxter of Harvard Law School. Also in the fall of 1974, Sea Grant cosponsored with the New England Aquarium a series of five lectures supported by the Lowell Institute on "The New England Coastal Zone: Planning and Preservation." In April 1975, Mr. John Hutton, Development Officer of the North East Scotland Development Authority, spoke on his region's experience with the onshore impacts of offshore oil development. The year's symposium schedule was capped in June by the M.I.T. Sea Grant Program's participation as a cosponsor in "Boston Harbor: Who Cares?", a conference held at the University of Massachusetts Dorchester Campus by The Boston Harbor Associates, Inc.

During the summer of 1974, the Sea Grant Program cooperated with the M.I.T. Office of the Summer Session in offering to practicing professionals from industry and government four week-long subjects on Analysis and Design of Transportation Systems, Ship Structural Analysis and Design, Strategic Planning in the Energy Sector, and Ocean Resources Management.

Working with the University of Massachusetts Aquacultural Engineering Laboratory in Wareham, Sea Grant staff provided assistance to shellfishermen, aquacultural concerns, and local seacoast towns on technical and scientific problems in the shellfishing and aquacultural industries. Individual staff contacts, workshops, and special advisory projects for several towns formed the foundation of the innovative aquacultural engineering advisory services. In addition, a working model and film of last year's development of low-cost dams for alewife runs in shallow coastal streams were completed, and used to explain the concept to local officials and conservation groups.

Sea Grant is assisting state government on crucial issues facing Massachusetts. Professor Kildow is the Program's representative on the Governor's Task Force on Coastal Resources, a citizens' group appointed to advise the Commonwealth's Office of Coastal Zone Management on policy matters. For this office, established with Federal and state planning funds in July 1974, Sea Grant staff prepared a brochure that introduces coastal management to Massachusetts citizens and that asks for public participation in the three-year coastal planning process. Advisory services staff

Artist's conception of a million gallon per day pilot plant for water, wastewater, and sludge treatment with high energy electrons.



also sat on the Special Legislative Commission on Marine Resources and Boundaries and the Governor's Commission on Artificial Reefs, and worked with the New England Fisheries Steering Committee, the Massachusetts Department of Natural Resources and Executive Office of Environmental Affairs, and the Massachusetts Shellfish Wardens Association.

With the Program's assumption on 1 August 1974 of responsibility for the Institute's research vessel, the *R. R. Shrock*, Sea Grant's role as the focus for marine-related studies at M.I.T. was augmented. In June 1975 the *R. R. Shrock* was moved to a new, permanent mooring at the New England Aquarium on Boston's Central Wharf; responsibility for its operation, maintenance, and scheduling for use by local institutions for research in Massachusetts Bay has been delegated to Sea Grant's Marine Liaison Officer. During the past year, the Institute's Research Vessel Management Committee completed arrangements, through the Oceanographer of the Navy, for charter to M.I.T. of a U.S. Army T-Boat as a larger and more seaworthy replacement for the *R. R. Shrock*. The T-Boat's accommodations and equipment will be converted to meet Institute needs for a full-fledged research ship.

The M.I.T. Sea Grant Program has participated actively with other New England Sea Grant institutions in the founding of the New England Marine Advisory Service (NEMAS), headquartered in Durham, New Hampshire. NEMAS will respond to regional needs for information pertinent to ocean and coastal zone activities. Sea Grant's Advisory Services Officer is a member and Vice Chairman of the NEMAS Board of Directors.



*Volunteers from the Massachusetts Beach Buggy Association and the M.I.T. Sea Grant Program set out culms of the "Cape" beach grass on Nauset Beach.*

**FISCAL YEAR 1975  
INSTITUTIONAL PROGRAM  
SUMMARY**

For Year Beginning  
July 1, 1974

<b>Program Management</b>	Sea Grant Program Management; Dr. I. Dyer.	C
	Project Development Opportunities; Dr. Dyer and Mr. D. A. Horn	N
	Henry L. Doherty Professorships in Ocean Utilization; Dean A. A. H. Keil.	N
<b>Education and Training</b>	Interdisciplinary Systems Design Subject; Professor W. W. Seifert.	C
	Student Summer Laboratory; Professor A. D. Carmichael.	C
	Studies in Ocean Engineering/Law; Professor J. D. Nyhart.	C,T-3
	Ocean Engineering Curricula; Dr. Dyer.	C
<b>Advisory Services</b>	Advisory Services: Development, Operation, and Management; Dr. Dyer, Mr. Horn, and Mr. E. R. Pariser.	C
	Marine Resources Information Center; Mr. Pariser and Mr. J. M. Kyed.	C
	Symposia on Sea Grant Projects and Marine Resources Related Projects; Mr. Pariser.	C,T-2
	Public Education and Training Short Courses; Professor J. M. Austin.	C
	Annual Sea Grant Lectureship; Dean Keil.	C
	Aquaculture Engineering Advisory Services; Professor J. W. Zahradnik and Mr. A. B. Clifton.	N
<b>Research</b>	The Sea Environment of Massachusetts Bay and Adjacent Waters; Professor J. J. Connor.	C
	Sludge and Water Treatment with High Energy Electrons; Professor J. G. Trump.	C,T-2
	An Improved Hook-Up Block for Side Trawling; Professor S. P. Loutrel.	C,T-2
	Using Cooperatives to Aid the New England Fishing Industry; Professor H. S. Marcus.	C,T-2
	Evaluation of Potential of Heated Finishing Plant for Oysters; Professors Seifert and Zahradnik.	C
	Multipurpose Offshore Platform Design; Professor C. Chryssostomidis.	N
	Utilization of Squid for Processed Food Products; Professor S. A. Goldblith.	C,T-2
	Structure of Chitosan; Professor B. L. Averbach.	C
	Content, Composition, and Fate of Physiologically Important Lipid Components in Raw and Processed Shell- and Finfish; Professor Goldblith.	N
	Practitioner's Guide to the Law of the Sea Conference; Professors Nyhart, L. B. Sohn, R. R. Baxter, and J. T. Kildow.	N,T-2
	Resolution of the Oil Spill Transport Controversy; Professor J. W. Devanney, III.	N,T-2
	Fracture Toughness of Reinforced Plastic Hull Materials; Professor F. J. McGarry.	C,T-2
	Development of New, Improved Techniques for Underwater Welding and Cutting; Professor K. Masubuchi.	N
	Management of Fishery Resources Under the 200-Mile Limit; Professor Devanney	C,T-2

N New Project  
C Continued Project  
T Terminated Project; numerals indicate the following results:  
T-1 Work will be completed; book will be published  
T-2 Work will be completed; Sea Grant Report(s) will be published  
T-3 Work will be completed; new subject will be developed

## PUBLICATIONS

**The Ocean's Future in America's Economy**

- Averbach, B. L. *The Structure of Chitin and Chitosan*. MITSG 75-17. Massachusetts Institute of Technology, Cambridge, Mass. 10 pp.
- Averbach, B. L. "The Structure of Chitin and Chitosan." Ocean 75 Conference, San Diego, California, 22-25 September 1975.
- Brown, R. T., and K. Masubuchi. "Fundamental Research on Underwater Welding." *The Welding Journal*, 54:6(1975), Research Supplement: 178s-188s.
- Devanney, J. W., III. *Fisherman and Fish Consumer Income under the 200-Mile Limit*. MITSG 75-20. Massachusetts Institute of Technology, Cambridge, Mass. 35 pp.
- Devanney, J. W., III. *The OCS Petroleum Pie*. MITSG 75-10. Massachusetts Institute of Technology, Cambridge, Mass. 127 pp.
- Kahn, L. N., Z. Berk, S. Tong, E. R. Pariser, J. M. Flink, and S. A. Goldblith. "Squid Protein Concentrates: 1. Evaluation of Processes and Product Characteristics." *Lebensmittel-Wissenschaft und -Technologie*, 8(1975):64-69. Reprint MITSG 75-16.
- Mandell, J. F., and F. J. McGarry. *Fracture Behavior of Fiberglass Reinforced Plastics Suitable for Hull Materials*. MITSG 75-25. Massachusetts Institute of Technology, Cambridge, Mass. unpaginated.
- Mandell, J. F., F. J. McGarry, D. S. Barton, and R. P. Demchick. *Effect of Water on the Crack Propagation Rate in Fiberglass Laminates under Static and Dynamic Loading*. MITSG 75-18. Massachusetts Institute of Technology, Cambridge, Mass. 47 pp.
- Mandell, J. F., F. J. McGarry, W. D. Barton, and R. P. Demchick. "Effect of Water on the Crack Propagation Rate in Fiberglass Laminates under Static and Dynamic Loading." 31st Reinforced Plastics/Composites Institute, Society of the Plastics Industry, Washington, D.C., February 1976.
- Mandell, J. F., S. S. Wang, and F. J. McGarry. "The Extension of Crack Tip Damage Zones in Fiber Reinforced Plastic Laminates." *Journal of Composite Materials*, 9(July 1975):266.
- Marcus, H. S., J. R. Townley, A. J. Brown, and E. Lee. *Using Cooperatives to Aid the New England Fishing Industry*. MITSG 75-7. Massachusetts Institute of Technology, Cambridge, Mass. 435 pp.
- Masubuchi, K. "Underwater Welding and Cutting." *Marine Technology Society Journal*, 9:1(January 1975):32-37.
- McGarry, F. J., J. F. Mandell, and S. S. Wang. "Fracture of Fiber Reinforced Composites." 33rd Annual Technical Conference, Society of Plastics Engineers, Atlanta, Ga., May 1975.
- Moore, A. P., and K. Masubuchi. "Metals Joining in the Deep Ocean." Ocean 75 Conference, San Diego, California, 22-25 September 1975.
- Tong, S., J. M. Flink, and S. A. Goldblith. "Squid Protein Concentrates: 2. Evaluation of Functional Properties." *Lebensmittel-Wissenschaft und -Technologie*, 8(1975):70-74. Reprint MITSG 75-16.
- Wall, J. C. *An Improved Towing-Block for Side-Trawling*. S. B. and S. M. Thesis, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. June 1975.
- Wall, J. C., and S. P. Loutrel. "A New Towing-Block for Side-Trawling." Ocean 75 Conference, San Diego, California, 22-25 September 1975. Reprint MITSG 75-24.

## A Generation Facing the Sea

- Carmichael, A. D., and D. B. Wyman. *Ocean Engineering Summer Laboratory 1974; Massachusetts Institute of Technology and Maine Maritime Academy*. MITSG 75-12. Massachusetts Institute of Technology, Cambridge, Mass. 201 pp.
- Ducsik, D. W. *Teaching Coastal Zone Management; an Introductory Course Syllabus*. MITSG 75-1. Massachusetts Institute of Technology, Cambridge, Mass. 144 pp.
- Kennedy, Michael Bernard. *Alternative Employment of the Boston Navy Base*. MITSG 75-26. Massachusetts Institute of Technology, Cambridge, Mass. unpaginated.
- Seifert, W. W., and T. Engellener, eds. *Problems and Conflicts in the Coastal Zone South of Boston*. MITSG 75-23. Massachusetts Institute of Technology, Cambridge, Mass. unpaginated.

## Maintaining Marine and Coastal Environments

- Christodoulou, G. C. *Notes on Verification Studies of the Circulation Model in Massachusetts Bay*. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Cambridge, Mass., October 1974.
- Christodoulou, G. C., and B. R. Pearce. *Mathematical Modeling Relevant to the Glass Bead Study*. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Cambridge, Mass., January 1975.
- Devanney, J. W., III, G. Ashe, and B. Parkhurst. *Parable Beach: a Primer in Coastal Zone Economics*. MITSG 75-11. M.I.T. Press, Cambridge, Mass. Forthcoming.
- Leimkuhler, W. F. *A Two-Dimensional Finite Element Dispersion Model*. C.E. Thesis, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. September 1974.
- Lemke, H., and A. J. Sinskey. "Radiation Effect on Virus and Parasites Pertinent to Treatment of Wastes and Wastewater." International Atomic Energy Agency, IAEA-SM-194/503.
- The Massachusetts Coastline: Choice or Consequence*. Prepared for the Massachusetts Executive Office of Environmental Affairs and the Governor's Task Force on Coastal Resources by the M.I.T. Sea Grant Program. Massachusetts Institute of Technology, Cambridge, Mass., November 1974.
- Massachusetts Science and Technology Foundation, and M.I.T. Sea Grant Program. *Proceedings of the First International Conference on Toxic Dinoflagellate Blooms*. MITSG 75-8. Massachusetts Science and Technology Foundation, Wakefield, Mass. 541 pp.
- Pagenkopf, J. R., and B. R. Pearce. *Evaluation of Techniques for Numerical Calculation of Storm Surges*. Technical Report No. 199. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Cambridge, Mass.
- Parker, B. B., and B. R. Pearce. *The Response of Massachusetts Bay to Wind Stress*. MITSG 75-2. Massachusetts Institute of Technology, Cambridge, Mass. 107 pp.
- Passero, B., and M. J. Seale, compilers. *Coastal Zone Management: Focus on New England; an Annotated Selected Bibliography*. MITSG 75-21. Massachusetts Institute of Technology, Cambridge, Mass. 40 pp.
- Pearce, B. R., and J. R. Pagenkopf. "Numerical Calculation of Storm Surges: an Evaluation of Techniques." Offshore Technology Conference, Houston, Tex., May 1975.

- Pearce, B. R., and B. B. Parker. "An Investigation of the Response of Massachusetts Bay to Wind Stress." *Transport Mechanisms in the Nearshore Environment*, American Geophysical Union, Mystic, Conn., September 1974.
- Sinsky, A. J., D. Shah, K. A. Wright, E. W. Merrill, S. Sommer, and J. G. Trump. "Biological Effects of High Energy Electron Irradiation of Municipal Sludge." International Atomic Energy Agency, IAEA-SM-194/203.
- Smith, L. J., and J. E. Huguenin. "The Economics of Waste Water — Aquaculture Systems." *Ocean 75 Conference*, San Diego, California, 22-25 September 1975.
- Stewart, R. J. *The Interaction of Waves and Oil Spills*. MITSG 75-27. Massachusetts Institute of Technology, Cambridge, Mass. unpaginated.
- Trump, J. G., K. A. Wright, E. W. Merrill, A. J. Sinsky, D. Shah, and S. Sommer. "Prospects for High Energy Electron Irradiation of Wastewater Liquid Residuals." International Atomic Energy Agency, IAEA-SM-194/302. Reprint MITSG 75-19.
- Trump, J. G., K. A. Wright, A. J. Sinsky, E. W. Merrill, and D. Shah. "Feasibility of High Energy Electron Treatment of Municipal Sludge." *American Institute of Chemical Engineers*, Chicago, Ill., 6 May 1975.
- Wang, J. D., and J. J. Connor. *Mathematical Modeling of Near Coastal Circulation*. MITSG 75-13. Massachusetts Institute of Technology, Cambridge, Mass. 272 pp.
- Wang, J. D., and J. J. Connor. "Modelling of Circulation Induced by an Intake Outfall System." *Hydraulics Specialty Conference*, American Society of Civil Engineers, Knoxville, Tenn., August 1974.
- Wang, J. D., J. J. Connor, and B. R. Pearce. "Numerical Modelling of Sea Environment — Massachusetts Bay." *Convention*, American Society of Civil Engineers, Kansas City, Mo., October 1974.

#### Making Public the Ocean's Potential

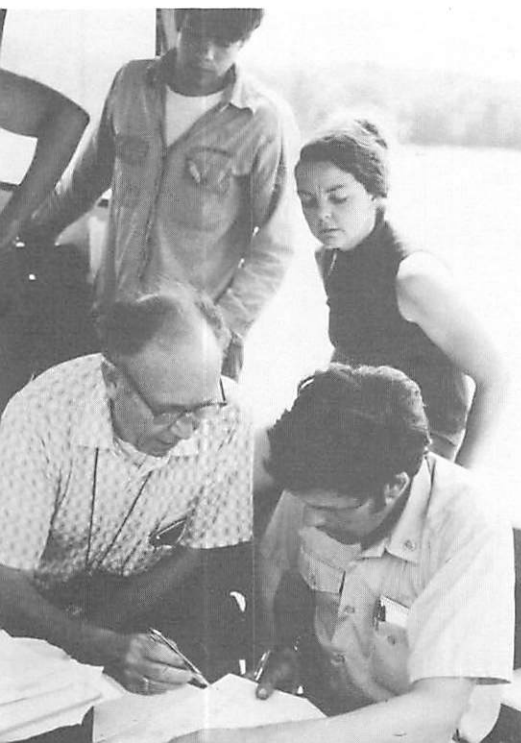
- Day, R. W., J. W. Zahradnik, and A. B. Clifton. *A Low-Cost Improvement for Alewife (Herring) Passageways*. MITSG 75-6-JUM. Massachusetts Institute of Technology, Cambridge, Mass. 12 pp.
- Frosch, R. A., J. T. Kildow, and R. R. Baxter. *The Oceans: Planetary Engineering and International Management; Third Annual Sea Grant Lecture and Symposium*. MITSG 75-3. Massachusetts Institute of Technology, Cambridge, Mass. unpaginated.
- Hutton, J. *Impacts of Offshore Oil on North East Scotland*. MITSG 75-15. Massachusetts Institute of Technology, Cambridge, Mass. 29 pp.
- Low-Cost Fish Ladders* (Film Report). MITSG 75-5-JUM. Massachusetts Institute of Technology, Cambridge, Mass.
- Pariser, E. R., and A. B. Clifton. *Marine Advisory Services in Massachusetts*. MITSG 75-22. Massachusetts Institute of Technology, Cambridge, Mass. unpaginated.
- Passero, B., and D. A. Horn, compilers. *Directory of M.I.T. Research Projects Related to Marine Resources, Ocean Utilization, and Coastal Zone Management*. MITSG 75-14. Massachusetts Institute of Technology, Cambridge, Mass. 51 pp.
- Publications 1970-1974; Sea Grant Program, Massachusetts Institute of Technology*. MITSG 75-9. Massachusetts Institute of Technology, Cambridge, Mass. 32 pp.
- Using the Seas to Serve People; a Report on the Massachusetts Institute of Technology Sea Grant Program: 1 July 1973 to 30 June 1974*. MITSG 75-4. Massachusetts Institute of Technology, Cambridge, Mass. 16 pp.



SUMMARY OF  
EXPENDITURES BY  
ACTIVITY

	NOAA Grant Funds	University Matching Funds
Program Management		
Program Administration	58,000	75,500
Program Development	40,000	37,300
Marine Education and Training		
College Level	64,600	85,400
Socio-Economic and Legal Studies		
Marine Economics	16,700	4,300
Ocean Law-International	9,900	9,100
Marine Technology Research and Development		
Ocean Engineering	81,000	51,700
Resources Recovery and Utilization	70,100	44,100
Transportation Systems	12,600	6,800
Pollution Studies	30,400	4,400
Marine Environmental Research		
Environmental Models	152,000	86,500
Advisory Services		
Extension Programs	136,800	48,500
Other Advisory Services	<u>47,300</u>	<u>89,600</u>
TOTAL	\$719,400	\$543,200

This summary is only approximate. In accordance with Federal grant requirements, the official financial report will be submitted by the M.I.T. Comptroller to the Office of Sea Grant.



*Dr. Harold E. Edgerton, Institute Professor Emeritus, instructs students in the M.I.T./Maine Maritime Academy student summer laboratory at Castine, Maine.*

## M.I.T. SEA GRANT PROGRAM ADMINISTRATION

Dr. Ira Dyer

*Director*

Head, M.I.T. Department of Ocean Engineering

Mr. Dean A. Horn

*Executive Officer*

Mr. E. R. Pariser

*Advisory Services Officer*

Senior Research Scientist, M.I.T. Department of Nutrition and Food Science

Mr. James E. Grayson

*Administrative Officer*

Dr. Alfred A. H. Keil

*Chairman, Sea Grant Policy Committee*

*Chairman, Sea Grant Faculty Council*

Dean, M.I.T. School of Engineering

Mr. James G. Kelso

*Chairman, Sea Grant State-Industry Advisory Council*

Vice President, Investors Bank & Trust Company

## PARTICIPANTS AND CONTRIBUTORS

Boston Edison Company

Boston Fisheries Association

Dow Chemical Company

Harvard Law School

Henry L. and Grace Doherty Charitable Foundation, Inc.

Ishikawajima-Harima Heavy Industries Co., Ltd.

Machlett Laboratories, Inc.

Maine Maritime Academy

Massachusetts Institute of Technology

National Fisheries Institute

New England Fisheries Association

Provincetown Co-operative Fishing Industries Inc.

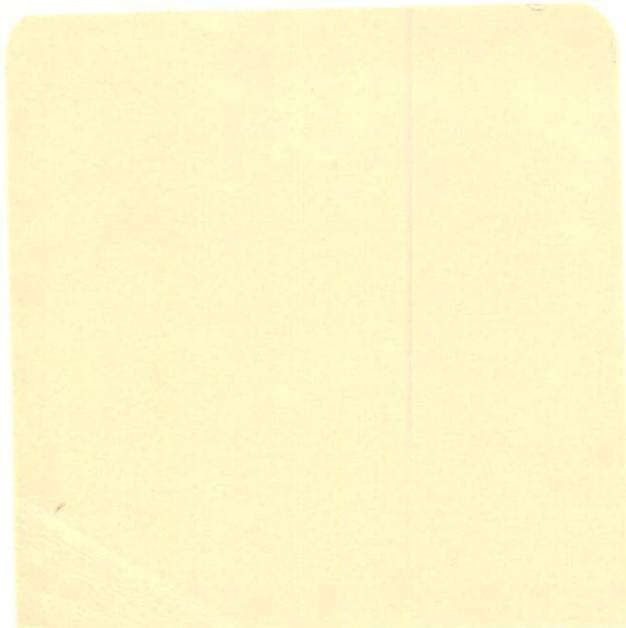
Sea Grant Lecture Endowment Funds

University of Massachusetts

Welding Research Council



*A cool, wet day gives newly planted beach grass a head start on root growth in Cape Cod's sands.*



---

Writer: S. Bronwyn Hurd  
Design: MIT Graphic Arts Service  
Photograph on page 6 by Calvin Campbell,  
M.I.T. News Office

**NATIONAL SEA GRANT DEPOSITORY  
PELL LIBRARY BUILDING  
URI, NARRAGANSETT BAY CAMPUS  
NARRAGANSETT, RI 02882**

**RECEIVED  
NATIONAL SEA GRANT DEPOSITORY,  
DATE: MAR 17 1976**

M.I.T. SEA GRANT PROGRAM  
ROOM 1-211  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
77 MASSACHUSETTS AVENUE  
CAMBRIDGE, MASSACHUSETTS 02139

Nonprofit Organization  
U.S. Postage  
PAID  
Boston, Massachusetts  
Permit Number 55293