A report on the University of Rhode Island Sea Grant program for July 1972 to June 1973

Stated simply, the goal of the University of Rhode Island Sea Grant program is to promote wise use of the coastal environment. During 1972-73, carrying out the Sea Grant objective has meant helping people in their ocean-oriented occupations—helping fishermen at Point Judith, Rhode Island, boost their herring catch six-fold over that of two years ago; providing experimental data necessary for construction of the first salmon aquaculture facility of its kind in New England; carrying out research at the request of the boating industry to determine if small boat marinas present a serious pollution problem, and providing a diagnostic service for fish hatcheries and commercial fish growers in and out of the state.

Wise use of the ocean, however, also means long-range planning and management. Sea Grant has become involved in this effort by providing local, state and federal governments and agencies with data and recommendations critical to the decision-making process. For example, the Coastal Resources Center completed an intensive study of Rhode Island barrier beaches and made management recommendations which are now state regulations.

Tools developed in other projects could also aid decision-makers. Sea Grant fisheries biologists have formulated a method of finding out if the intensive New England lobster fishing effort is actually reducing the catch by lobstermen. Resource economists have constructed an economic model of the Narragansett Bay area that can be used to predict the amount of increased waterborne wastes resulting from new economic activity.

Sea Grant activity has moved across geographical and political boundaries in projects like the development of a fish protein concentrate (FPC), which could improve diets in many areas of the world and use "trash" fish. Formal marine educational programs at the University continued to train students to fill a growing number of jobs in the fields of engineering, coastal zone management, marine economics, and commercial fisheries. And advisory programs last year helped get scientific information to growing numbers of user groups via publications, workshops, conferences, field specialists, an information center and the mass media.

Niels Rorholm
Sea Grant Coordinator

Environment

Thriving vacation communities, millions in beach-bound vehicles on Rhode Island's highways during the summer, and the many towns and factories using Narragansett Bay for waste disposal —these are just a few of the human pressures on the state coastal zone. Use of the coast now may be heavy enough to damage and perhaps even render useless portions of the very environment Rhode Islanders depend upon for a livelihood and recreation.

But an effort is under way to deal with this intensifying use of our coastal area. A state agency, the Coastal Resources Management Council, was created to formulate state policy that will allow wise use of the coastal environment and at the same time preserve it. The mission of the Coastal Council is critical. If it should fail, the very things that attracted people to Rhode Island—the excellent fishing, boating and swimming conditions and the beauty of the coastal environment—may slowly, but surely ebb. Sea Grant is involved in this effort through the University of Rhode Island Coastal Resources Center. As the Coastal Council's research arm, the URI Center gathers information which the Council must have in order to formulate policy.

Since formulating state policy for the entire coastal zone at once would be an impossible task for the Council, they tackled the most critical area first—the state's 27.4 miles of barrier beaches. In the last decade, a splurge of residential building in those areas left many people with the frightening thought that hurricanes, which periodically hammer the Rhode Island coast, could once again take a toll of human life and would most certainly destroy these homes. In fact, development seemed to be threatening the future of the beaches themselves. People walking or driving indiscriminately over the dunes are killing the stabilizing grass. Without the grass, the dunes might literally blow away.

Last winter, the Council placed a moratorium on all building on the barriers and asked the URI Coastal Center to make a comprehensive study of them. After completing the study, the Center made four crucial recommendations which the Council endorsed as state regulations: (1) Building should be prohibited on undeveloped barrier beaches; (2) on partially or wholly developed barrier beach areas, no new development of any kind should be allowed except on land behind dunes that is adequately protected from storms; (3) foot traffic should be highly controlled on the coastal dunes and permitted only over boardwalks and marked, stabilized trails, and (4) vehicles should be restricted to beaches and backdune roadways from October to May and prohibited from the barriers the rest of the year.

The Council adopted an even stricter regulation on vehicle use, prohibiting them from barrier beach areas at all times, except where roads exist or where it can be proven the vehicles do no damage.

Prohibiting building on the dunes clearly involves a complex issue of rights of private owners to develop land versus public rights to preserve and use rare, scenic coastal lands. The Sea Grant report takes this into consideration. Land owners affected by the regulations will need fair compensation for their loss in property value, the report states. It also recommends that funds for beach acquisition be acquired through user fees at all state recreational facilities and matched by federal funds. The state Council also adopted this recommendation.

Another Sea Grant study gives some indication of how a large oil find off the New England coast might affect the region's economy—and the possibility that offshore oil will be discovered and exploited there looks quite good. U.S. Geological Survey officials reportedly say the potential for oil in the Georges Bank region southeast of Cape Cod looks very promising. The thickness of the sedimentary deposits which could be expected to contain petroleum reservoirs is believed to compare favorably with those in the Gulf of Mexico.

The study is still under way; hence only tentative conclusions are available. The resource economist has said a large find of oil would probably not greatly lower high regional fuel prices, but might bring them more in line with prices in the rest of the country. And, finding a major deposit of natural gas could be an environmental boon, since it is the cheapest and least polluting of the fossil fuels.

But any offshore oil exploitation would probably not provide many jobs for New Englanders in the initial drilling phase, because of the need for specialized personnel. Support operations, such as marine transportation, supply, machinery and repair, would draw on New England facilities and personnel, but the actual impact would depend on the scale of operations. And, if oil is found, onshore refineries might draw heavily upon the New England work force.

In another project, Sea Grant researchers, using computers, are simulating various processes in Narragansett Bay. For example, ocean engineers have completed a physical model of tides and currents that has been used to predict water quality in the upper Bay after a storm sewer overload and oil slick movement from spills in the lower Bay. Resource economists have developed an economic-ecological model that can be used to predict the effect of economic growth on water pollution. A model that will characterize features such as animal and plant populations is being devised by marine biologists. Planned together, the various studies will eventually lead to a coordinated model that shows the interactions among physical, biological and economic aspects of man's use of the Bay—a significant tool for decision-making.

The physical model of the Bay is based on known, precise laws of fluid motion. It also takes into account the effects of tides, storms and the earth's rotation. Narragansett Bay water, the model indicates, is driven mostly by wind and tides. The model can predict water movement in the entire Bay or at any one of 320 points. So in one run of the computer, the equivalent of 320 separate current measurements can be obtained that are believed to have comparable accuracy.

The value of the physical Bay model is in its use as a predictive tool. For example, temperature profiles have been computed for the heated water discharge of a proposed nuclear power plant. The profiles indicate to what extent Bay water would be affected by the effluent and, thus, provide some clue to its potential effect on marine life.

The ability to accurately predict oil slick movement would be a great help to those responsible for the environmentally safe handling of petroleum resources. Using the physical model, Sea Grant scientists have been able to predict disper-

sion of past oil spills, knowing only their size and location. The results obtained from the computer were very close to actual dispersion. Use of such a predictive tool could help government agencies anticipate where a spill will spread after it occurs. Or the model could indicate where potential spills might spread, and give planners some idea of the merit of present contingency plans.

Another use of the physical model is a project aimed at predicting tidal heights at a number of locations in the Bay. In response to a request from the URI Marine Advisory Service, another Sea Grant program, the project was initiated for pleasure and commercial boat users. Tidal prediction lists have now been distributed to a sample of boat or marina owners to be checked for usefulness.

Any increase in the amount of additional Bay pollution which would result from new economic activity can be predicted using an economic model of the Bay area. Formulated by resource economists, the model could be used to alert coastal planners and managers to possible pollution problems from new industry. The calculations take into consideration waterborne wastes directly added to the Bay when one industry increases production as well as wastes added from other supplying industries.

Some of the data fed into the computer for the physical model have been obtained by ocean engineers through a program called "Bay Watch." Last year a sophisticated instrument buoy was launched to monitor currents, water temperature and other factors, and this Bay Watch Buoy System was kept on station for several months during which data were obtained. However, dissolved oxygen sensors on the buoy proved to be unreliable and, as a result, a program has been started to develop a sensor with increased long-term reliability.

In addition to research that examines the Bay from a broad perspective, other Sea Grant work has scrutinized small inlets to determine the environmental impact of small boat marinas. The conclusion: Marinas are just not the polluters that some people have assumed. But the researchers warned that further study is needed to determine if there is hydrocarbon or heavy metal pollution in marina areas, possible problems they did not study. They also recommended that new marinas be located in areas where tides or currents will flush water from the area frequently. Otherwise, dissolved oxygen could be dangerously depleted by the high density of plankton found in marina waters and might result in the death of fish and other marine life.

Both the marsh cove at Wickford, Rhode Island, and the five marinas studied supported thriving plant and animal life. Diversity of fish species in the marinas and the marsh was the same although greater numbers of the durable

fish species, such as mummichog, were found in the marina areas. Both environments had enough dissolved oxygen for animal life. Copper used in boat paint was found in higher concentrations in fouling communities, sea lettuce and sediments in the marina areas. Areas where this toxic chemical was concentrated were low in plankton and fish. Plankton in the marina area were not adversely affected by the facility itself.

Another related study that Sea Grant scientists have completed and reported is an intensive ecological study of a small salt marsh embayment on the west side of Narragansett Bay. It was the first major study of a New England salt marsh in about a decade.

Measurements of major populations, their metabolism, and seasonal patterns of the total salt marsh metabolism were made to ascertain energy flow within the embayment. Some conclusions: The studied salt marsh embayment depends greatly upon grasses as primary food producers; the efficiency of the marsh in producing grasses is lower than that in reports on southern salt marshes, and populations of shrimp and fish are largest in the fall.

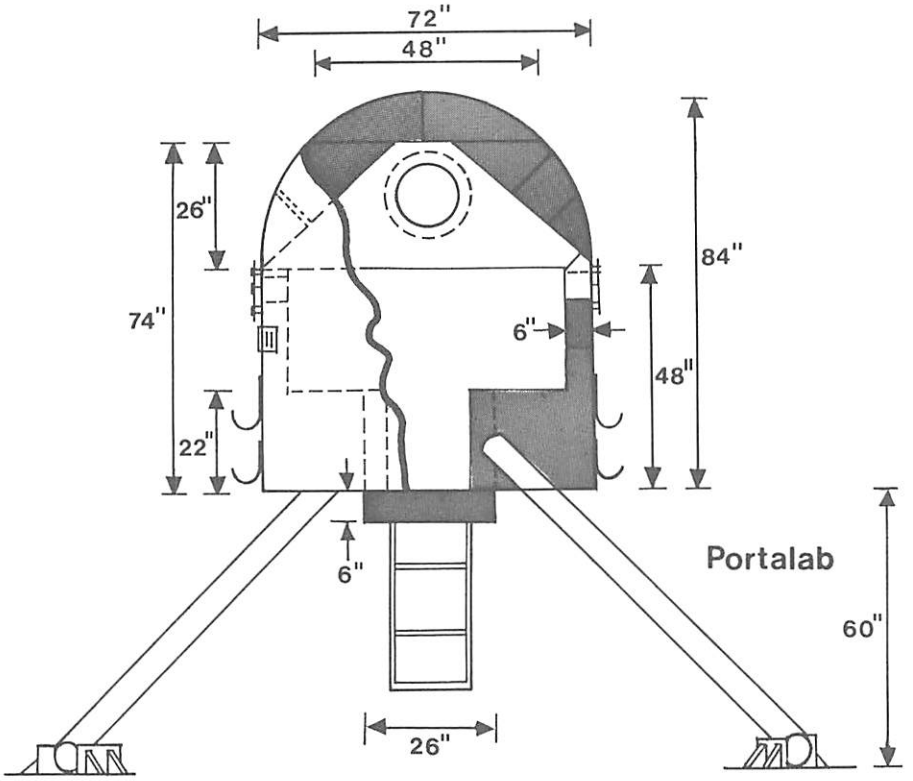
Sea Grant scientists simulated additions of sewage and of heated effluent water to the salt marsh inlet. Sewage added from a housing development around the salt marsh would lower dissolved oxygen and would produce anoxic conditions—total depletion of dissolved oxygen—in marsh waters. The simulated addition of heated power plant effluent water showed that small, but measurable lowerings of dissolved oxygen could be expected.

Sea Grant biochemists have finished experiments that indicate the nature and strength of the binding of organic material and bottom sediments. Information from this study should aid in predicting the immediate and long-term fate of waterborne pollutants such as petroleum hydrocarbons, chlorinated hydrocarbons and phthalete esters. The biochemists have also studied levels of organic matter—specifically fatty acids—in Bay sediments and have found levels higher near the Providence River and lower farther down the Bay. The variations are due either to the discharge of sewage from treatment plants into the river or to the synthesis of fatty acids by microscopic life found in the sediments. In yet another study, they found that microbial activity on decaying marsh grass is very important in the formation of natural organic detritus—tiny particles that serve as food for marine animals at the bottom of the food chain. They also have perfected a method of reconstructing the diet of filter-feeding animals by chemically analyzing gut contents.

Some other URI Sea Grant activities affecting the coastal environment follow.

Narragansett Bay's first underwater habitat, *Portalab*, has been successfully operated for more than a year since it was first reported in last year's *Annual Report*. *Portalab* was constructed by one Sea Grant researcher for $790, not counting labor costs. The red, nine-ton habitat, which rests in 37 feet of water in the West Passage near the URI Narragansett Bay Campus, has been used thus far for scuba diving and carbon dioxide experiments. Pressurized air and a phone communication system are maintained inside the habitat when it is in use through an "umbilical cord" to the pier.

As part of the systems ecology model of the Bay, a photosensitive device has been developed which can detect luminescence in the sea. In the estuary it is being used to ascertain the density of ctenophore feeding on zooplankton, an important step in the food chain.



The value of salt marshes as providers of fish food has often been a subject of speculation. Sea Grant research has now documented that one species—mummichog—has a diet that consists of five parts detrital material to one part live, invertebrate animals, such as plankton, and insects. Such information adds further knowledge on the role salt marshes play as a vital link in the marine food chain.

Research is under way to monitor pesticide and heavy metal pollutants in Bay water and sediments. It is not known whether levels of these pollutants are increasing or decreasing, and even more important, it is not known if levels are high enough to adversely affect finfish and shellfish industries.

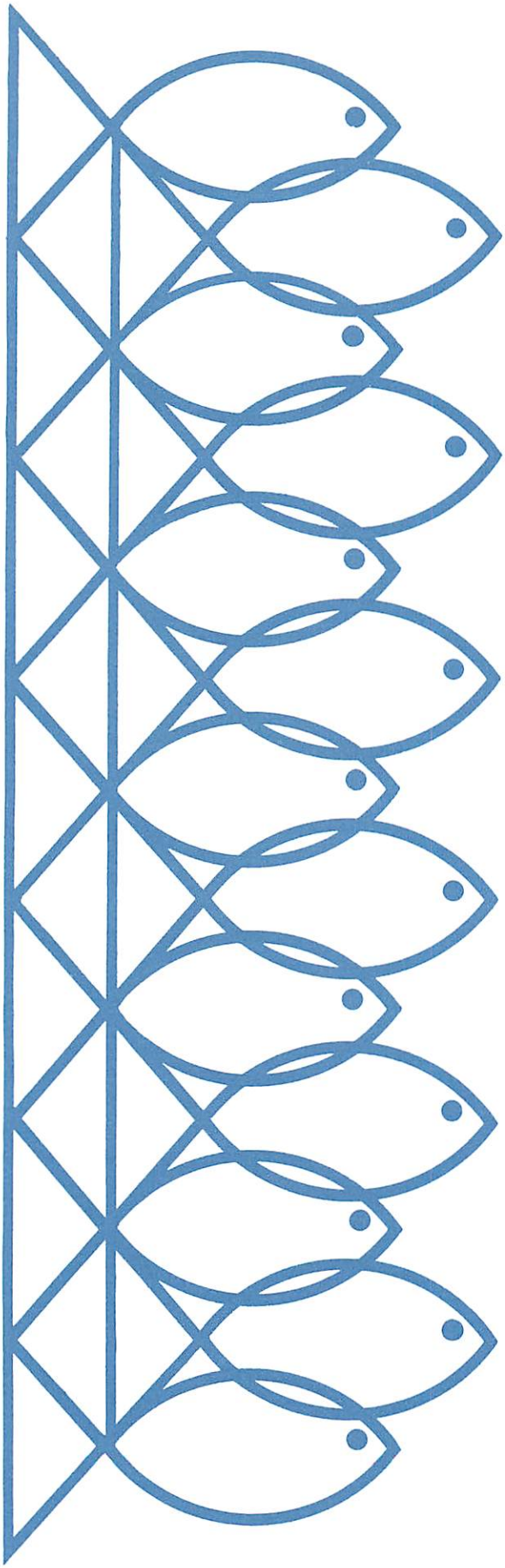
Sea Grant researchers working on the safe application of civilian scuba activity have assisted industries in the development of two products. For one company's waterproof paper, an entire new market area was identified by the URI researchers.

A study on the mortality rates for skin and scuba divers by URI Sea Grant researchers has shown that insurance rates are far too high for the slightly higher mortality rate—about 10 percent—found to result from diving activity. Many insurance companies are now being encouraged to reduce or eliminate their many high premium requirements for divers, and one California company has already established a normal premium coverage for diving instructors.

Analysis by URI researchers of diving fatalities indicated that new divers' early efforts are very dangerous. As the result of one URI Sea Grant diving expert's efforts, the recently-adopted standard on scuba instruction by the American National Standards Institute calls for several open-water dives rather than just one.

A project is under way to quantify liquid wastes now generated by Narragansett Bay coastal communities and to forecast waste disposal requirements to 1985. Alternatives for both waste disposal and prevention are being considered. The first part of the study, a water demand analysis, is nearing completion.

Sociologists are developing methods to evaluate personal benefits from marine-oriented recreational activities. Initially, people frequenting an ocean beach are being interviewed. Knowing the effect of ocean recreation upon people is important to the proper future use of our marine resources.



Resources

URI Sea Grant scientists have developed a prediction method capable of indicating if the intensive New England lobster fishing effort is depleting the inshore lobster population and reducing the catch.

This mathematical formula, which could greatly aid in the management of that fishery, works like this: If the local bottom water temperature of the first three months of the year is known, the scientists can predict the annual yield for that area. Bottom water temperature records from the lightship *Lurcher*, anchored off Nova Scotia until 1969, were used to test the formula. The scientists said that if the future yield estimates made to 1975 are consistently higher than observed yield, the effort may be so intensive it is detrimental to the fishery.

Also vital to both fish farming and the management of fisheries is the understanding and control of fish diseases. The URI Marine Pathology Laboratory is helping to fill that need by acting as a repository of fish tissue samples that have been affected by an identified disease. The laboratory also provides a monitoring service to the state's fish hatcheries and to commercial fish growers in and out of the state. Fish kills or disease are diagnosed upon request—a service valuable to fisheries biologists and fish farmers alike who must know very quickly what is injuring or killing the fish if damage is to be minimized. For example, when a large fish kill occurred near a nuclear power station in Massachusetts last spring, a Sea Grant scientist determined within hours that the kill was caused by nitrogen gas emboli, a condition similar to bends in divers. The condition occurs in fish when they move from cooler water saturated with nitrogen to warmer water. Nitrogen bubbles out of the blood, blocks proper blood circulation and causes death.

More than 1,000 tissue sections are preserved in paraffin blocks or in a wet preservative at the laboratory; these include many with examples of major fish diseases in North America and Great

Britain. Tissue cataloging is valuable because a fish disease may often be identified microscopically by its effect upon living fish tissue. Comparison with the cataloged tissue speeds diagnosis. The Marine Pathology Laboratory now attracts visiting scientists and inquiries concerning fish disease.

The laboratory is closer to finding a vaccine for vibriosis, a fish disease that could be a barrier to some aquaculture projects. Vibriosis causes fin rot and skin ulcers in winter flounder, salmon and other fishes, and more than 25 percent of the winter flounder landed on the East Coast may be affected. Sea Grant scientists have isolated the disease organism and they are now able to induce the disease in healthy fish. It is hoped the vaccine can be developed by killing and drying the isolated bacteria so they are less toxic. The dead organisms would be introduced into healthy fish so they could build up a natural resistance to vibriosis. A vaccine would probably be mixed with feed to inoculate salmon or winter flounder in aquaculture projects.

Another URI Sea Grant project has developed techniques to "farm" salmon or other fin fish in tanks and supplement East Coast landings. Sea Grant scientists have developed an operational aquaculture system consisting of four 1,750-gallon tanks, pumps, sophisticated water filters and other associated equipment, which has raised 900 Chinook salmon from fingerlings to two-pound size. When operating at full capacity, the system should be capable of raising 7,000 pounds of fish yearly.

Since the salmon aquaculture project has appeared to be successful, a commercial firm has begun building a salmon "farm" in Narragansett, Rhode Island—the first of its kind on the East Coast—and converting the Sea Grant experimental data to a commercial process. Its plan reportedly calls for a 6,000-square-foot building with adjacent outdoor tanks for raising fish. The Sea Grant scientist, who directed the URI experiments, has estimated that a commercial operation could raise salmon for about 70 cents a pound.

Key to the unique compact operation are water purification filters developed by a URI Sea Grant biological oceanographer. The filters allow the same water to be recycled over and over. With as little as 8,700 gallons of water, more than three tons of fish can be raised yearly. Other flow-through aquaculture systems, in comparison, require thousands-of-times more water in large ponds or enclosures to raise fish.

The biological filters consist of graded gravel beds which convert toxic ammonia, released by the fish, to nitrate, a less toxic form of nitrogen. The recirculating system has proven its worth in keeping nitrate at safe levels for fish—below 400 parts per million.

One of the big problems in aquaculture facilities—human error—has been minimized here. The system is largely automated and back-ups are available. If a pump quits circulating water for purification in one tank, the tank can be switched to one of three other pumping systems. If electricity fails, an emergency generating unit is on hand.

Developing a commercially feasible process for raising fish for the table is not the only purpose of the URI Sea Grant aquaculture facility. More than 500 one-pound salmon raised at the fish farm have been stocked in the Wood River in western Rhode Island to provide sport for fishermen and to see if a resident spawning population of Chinook can be established. The success of this venture will not be known until 1974 or 1975, when the salmon are expected to return from the sea to spawn.

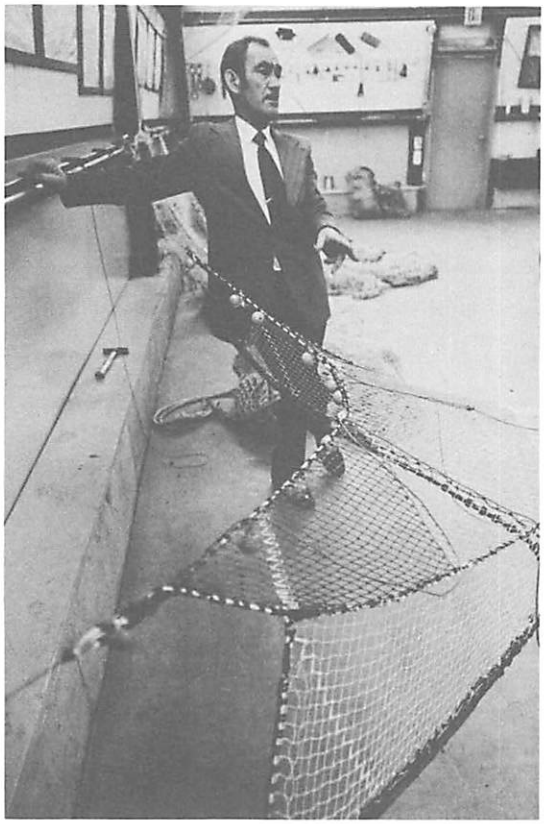
Knowledge gained from URI Sea Grant net evaluation studies has been used in the development of a bottom trawl that is boosting catches for the first eight East Coast fishermen who have used it. The net, called the URI 340, was funded by the National Marine Fisheries Service (NMFS) and developed in the URI Department of Fisheries and Marine Technology.

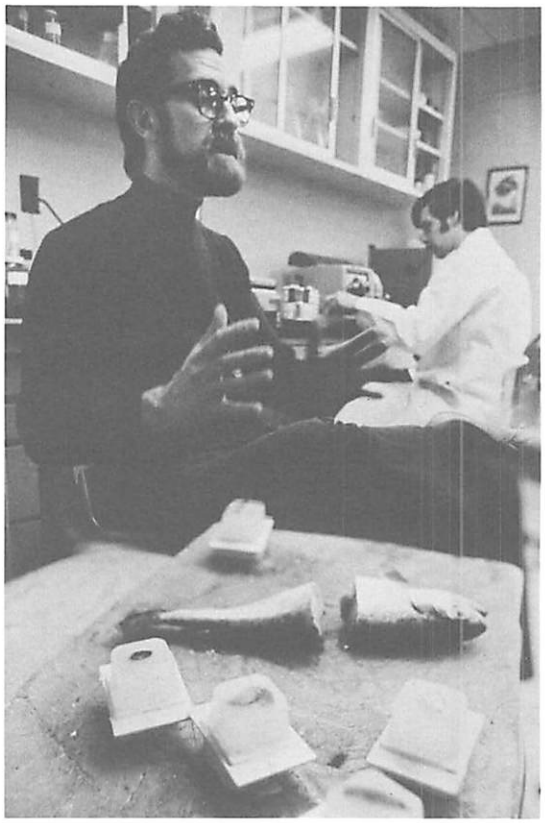
The URI 340 is presently being used by seven fishermen at Point Judith, Rhode Island, and one at a Virginia port. All report the net has substantially boosted their catches in comparison to the traditional Yankee bottom trawls formerly used. The URI 340 boosts catches because it attains greater headline height without sacrificing wingspread. In layman's terms, when under tow, the mouth of the URI 340 is larger than the mouths of Yankee trawls that have been used for decades. Furthermore, the URI 340 is as easy to maintain and handle as the traditional trawls.

Within months after Sea Grant publicized results of NMFS evaluation tests of the URI 340, about 80 requests for more information were received from Singapore, Peru, Alaska, Canada, and both coasts of the U.S. Sea Grant personnel are providing the inquirers with detailed plans and instructions on how the URI 340 may be constructed.

Another Sea Grant aquaculture project is aimed at finding a method to raise lobster to marketable size economically and on a large scale. The Sea Grant scientists do not believe it is feasible to raise lobster commercially yet, but they say that such operations may be economically viable in as little as five years.

To determine optimum conditions for growing marketable lobster, a pilot plant aquaculture system has been designed and constructed. Eggs are obtained from "berried" (egg-bearing) females at the laboratory. Two hundred juvenile lobsters are being raised to determine their molt-

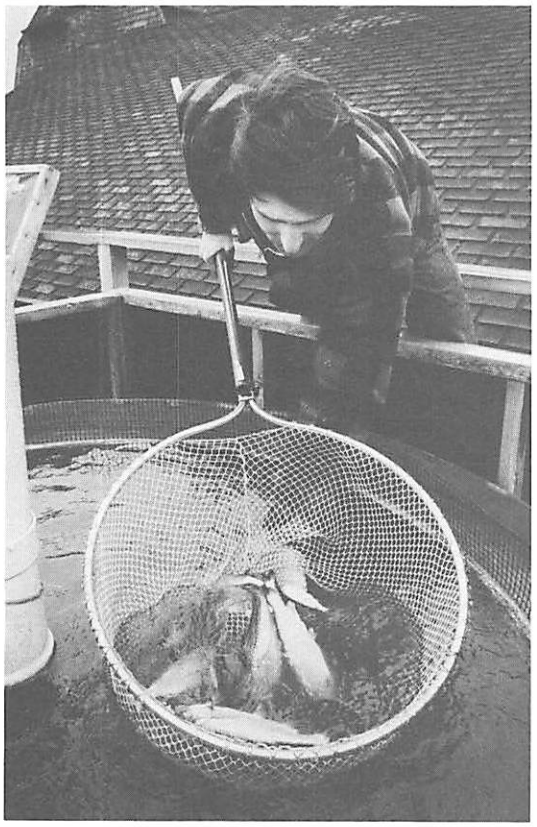




ing frequency, growth, weight gain, survival rate and minimum space requirements.

The main problem in raising lobsters is their aggressive nature. When crowded, they often pull off each other's claws. During the molting season, when they shed their protective shells in preparation for growth, the animals tend to eat one another.

Most likely, separating lobsters to prevent fighting would be too expensive in an aquaculture operation, so scientists are looking for ways to end lobster cannibalism. For example, Sea Grant researchers believe that there may be some sort of chemical communication between lobsters that triggers aggressive behavior. If this is true, lobsters might be "tricked" into thinking they are alone by manipulation of their environment. Another direction of research is aimed at constructing a shelter to enable weaker lobsters to fight off their more aggressive cousins. Still another possibility is controlling the lobsters' growth rate. If lobsters all molt at once, the cannibalizing problem may be solved because all of the animals would be equally vulnerable.



Of the many problems preventing full use of the world's fish resources, URI Sea Grant researchers have been working on more uses of "undesirable" species and the prevention of deterioration.

A process has been developed at URI which makes fish protein concentrate (FPC) at about two-thirds of the cost of present methods. Two American firms have shown interest in the process and want to try it. The process transforms "trash" fish into a floury, white substance that is 90 percent protein. FPC can be used as a protein supplement for animal or human food.

The Sea Grant study has found that FPC used as a supplement in bread is acceptable to people in Arabia and India. When 10 to 15 percent of the native bread flour was replaced by FPC, taste panel tests of the bread showed it to be palatable.

Seafood research at URI has resulted in processing methods that can preserve fish in granulated or filleted form up to one year. Preservatives, such as glycols and salt, have been tried with excellent results. Techniques used include freeze-drying and storage in sealed polyethylene bags.

Consumer preferences are an important problem of seafood marketing. One large foreign firm recently came to Sea Grant food and resource chemists with a problem in fish coloration. The firm hopes to market 120,000 Atlantic salmon in 1974, but they cannot get the consistent pink color that consumers prefer in the fish meat. If their problem is not solved, a potentially lucrative venture may have to be scrapped. URI scientists provided the company with information and suggestions based upon Sea Grant research to help them solve the problem.

In the area of drugs from the sea, research has been in two directions. One facet of work has been to study the metabolism of pesticides and other pollutants by various marine organisms to see if those organisms can tolerate some of the toxic substances entering the seas as a result of man's industrial and agricultural activity. For example, Sea Grant scientists in the Department of Pharmacology and Toxicology have been experimenting to determine how sensitive lobster is to the pesticide parathion. A second direction has been the search for drugs from the sea. Substances have been isolated from various species of marine life and tested for their therapeutic value.

Researchers in the Department of Pharmacognosy have begun a study of the poisonous red tide, which damaged the New England shellfish industry in the fall of 1972. It is known that the tide is caused by *Gonyaulax tamarensis* but the chemical nature of the toxic substance produced by this organism is unknown. More than 440 pounds of soft-shell clams containing the toxic substance have been collected. Partial fractionation and purification of the substance have been completed.

In the search for drugs from the sea, URI scientists have isolated and tested substances from the marine alga, *Eisenia bicyclis*, and found that the material has anti-inflammatory and antiparalytic effects. In addition, the nature of substances from the starfish, *Acanthaster planci* and *A. forbesi*, which were previously found to have antitumor, antiviral and animal-repellant properties, have been investigated.

The Third Food-Drugs from the Sea Conference was held at the University of Rhode Island in August 1972. The conference was sponsored jointly by the Marine Biological Resources Committee of the Marine Technology Society and the URI College of Pharmacy. About 150 persons attended including scientists from several nations.

Some other URI Sea Grant activities affecting the resources of the sea follow.

A bottom trawling experiment in which tows were made in relation to prevailing bottom current direction demonstrated that improvements of more than 25 percent in the catch could be achieved by towing *across* the bottom current.

A remote, self-contained and easily attached device has been developed which continuously records the fishing net headline height and wingspread, or the size of the trawl mouth in use. Such measurement is necessary for the evaluation of newly designed fishing trawls.

The fleet at Point Judith has been surveyed for vessel and trawling equipment. The results of the survey together with computer calculations have been used to produce graphs showing the compatibility of vessel, power plant and the type of trawl. Recommendations can now be given

regarding an improved match between the equipment and the vessel or the advisability of using new trawling equipment. Such a useful service could be extended to fleets at other New England ports.

Experiments are under way to determine the towing pull, vessel power requirement and the effect of changes in net construction and rigging on the towing pull. The information can be doubly useful; it can help fishermen rig nets and gear to the best advantage and help industry design more efficient nets, gear and vessels.

URI Sea Grant sociologists who have studied fishermen in a southern New England coastal town say that sons of fishermen often take up their fathers' occupation and, if access to fisheries is to be restricted to prevent depletion or extinction of fisheries, this traditional kinship interaction of fishing families may be disrupted. If access is to be restricted, social agencies should consider ways to reduce potential adverse effects upon families.

A study of the New England surf clam industry is under way to determine the most economic and efficient management system for it and to help implement that system by working with industry and the state and federal government. Conservation of the resource, economic efficiency of the industry, and the income and employment generated are all being considered. Thus far, information has been collected which, when analyzed, will reveal seasonal and annual demand.

Communication and Education

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In the tradition of the land-grant agricultural extension service, the URI Sea Grant program has two organizations with the primary responsibility of finding technical and scientific information, translating it, and distributing it to user groups. One is the Marine Advisory Service (MAS) responsible for programs and information dissemination primarily in Rhode Island. The other is the New England Marine Resources Information Program (NEMRIP), which functions as a marine information clearinghouse for the entire New England region. Publications, conferences and workshops originating from MAS and NEMRIP assist decision-making by persons concerned with the rational management and development of marine resources. Staffing of the programs overlaps.

More people took advantage of the Sea Grant marine information services over the past year than ever before. The mailing list for all NEMRIP-distributed periodicals grew by one-third to 17,-270 in 1972-73. *Information*, the monthly newsletter, was sent to 17,000 this year, up 3,000. Other publications included *Boating in New England* and updated versions of the *Marine Insurance Guide*, and *New FCC Marine Radio Regulations*. There were more than 14,000 publication requests, up 24 percent from the previous year. General information inquiries from visitors and by phone and mail reached 3,628, up 78 percent. Most inquiries concerned fisheries, educational opportunities, school projects and marine recreation. Nearly one-third of all requestors were associated with business or industry. Others were in government or education as either administrators, teachers or students.

How valuable are NEMRIP publications to people? A scientific survey by mail questionnaire of people who had received its publications resulted in several conclusions. Most respondents (1) read all of the received publication and read it carefully, (2) said the information contained was new to them, (3) found the publication useful, with most rating it as moderately useful, and (4) agreed that the publication increased their knowledge and interest in the subject while providing them with usable ideas.

In the past year, NEMRIP sponsored or co-sponsored a variety of regional programs on coastal management, recreation, marine business management, marine education and marine extension specialist training. The primary program was the Second Annual Marine Recreation Conference: Boating in New England, which was widely acclaimed by boating industry people. The fourth and fifth NEMRIP workshops for marine extension workers were held, featuring programs on commercial and sport fishing, and marine recreation.

Special NEMRIP projects included the initiation of a seven-state economic analysis of the marina industry in New England and New York. The study will provide information for those involved in public and private decision-making about the marina industry's developmental needs and constraints, and the boating public it serves.

Services provided by the University MAS include use of field specialists, publications, workshops and conferences, an information center, demonstrations and mass media reports. The MAS disseminates results of URI Sea Grant research for application by groups concerned with the state's coastal resources.

A project arranged and partly staffed by the MAS included two-boat midwater trawling at

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Point Judith. Begun early in 1972, the technique helped boost herring landings that year to 5.2 million pounds, more than three times the 1971 figure. And in 1973, the Point Judith fishermen again doubled their catch, landing 10 million pounds, an increase valued locally at $196,568. Cost to the MAS for providing some of the nets and advice was $2,500. Eight boats at Point Judith now have paired up for midwater trawling, and requests for information concerning the successful pair trawling are coming from other East and West Coast ports. A method now being introduced by MAS is Canadian pair seining; it may enable lobster fishermen and their vessels to fish for edible fin fish part of the year.

The MAS *modus operandi*—helping people identify problems of coastal zone use or management, then taking those problems to appropriate University scientists for solving—was demonstrated in a recent marina-marsh ecology study. Marinas have often been singled out as being major polluters of the marine environment. So the Rhode Island Marine Trade Association asked MAS personnel if a study could be made to find out if marinas harm the environment, and if so, how the situation could be corrected. The MAS took the problem to University scientists. The result is an intensive study of five Rhode Island marinas and a marsh near a marina. Results of the study are printed in the first section of this report (page 4).

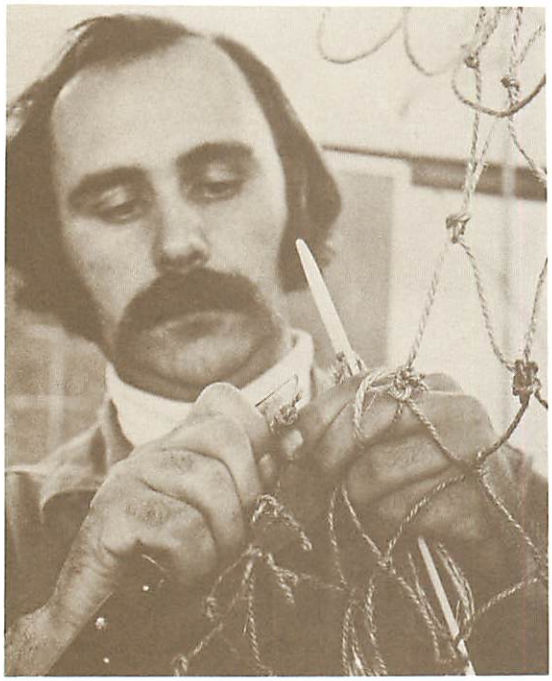
To reach an audience in a wide geographical area the MAS education specialist used television this last year. Sixteen weekly half-hour programs were produced by the MAS and aired by Channel 6, WTEV-TV, a commercial station located in New Bedford, Massachusetts. Also cooperating in the project were the Cooperative Extension Services of URI and the University of Massachusetts. The series, New England and the Sea, also inspired a three-day writers' workshop which produced a 58-page guide for teachers and students based on material covered in the TV series.

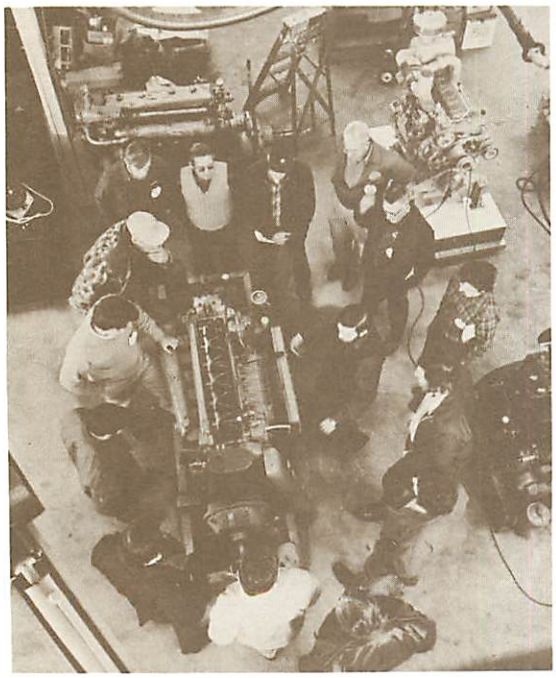
In addition to information support services to the URI Coastal Resources Center, the MAS prepared and published the *Rhode Island Marine Bibliography*, the first in a series of tools to be used for the development of a comprehensive coastal resources management plan for Rhode Island.

Activities of the MAS marine recreation specialist were highlighted last year when the second annual Rhode Island Boating Award was presented to him by the Rhode Island Marine Trade Association. Governor Philip Noel of Rhode Island presented the award "for substantial contributions to the boating industry through the Marine Advisory Service," during the winter boat show at the Providence Civic Center.

Of the many publications that have been prepared and distributed by the MAS, one that has attracted national attention is *Nuclear Power Plant Siting: A Handbook for the Layman*. Based on material from URI-sponsored public seminars and written by Dennis L. Meredith, a URI science editor, the publication has received two awards. A certificate of special recognition was awarded by the Atomic Industrial Forum. In addition, a series of newspaper articles based on the booklet won for the writer $1,000 for excellence in science writing from the American Association for the Advancement of Science and the Westinghouse Corporation.

Last year's *Sea Grant Annual Report, 71-72* also received national recognition from the American College Public Relations Association. As one



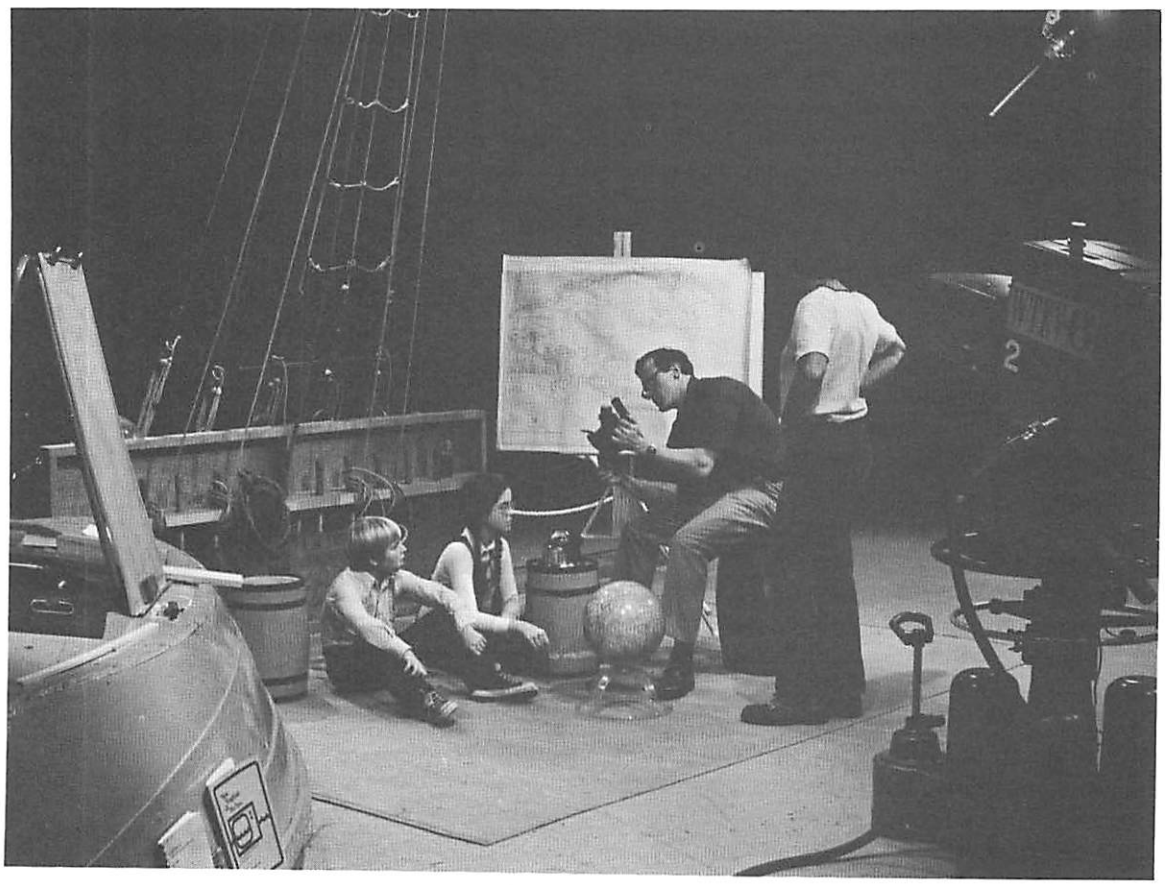


of some 1,300 college and university publications submitted, the URI Sea Grant publication was chosen among the best in the annual reports category.

MAS initiated and sponsored or co-sponsored a variety of conferences and workshops including the annual Fishermen's Forum which brought together local fishermen and one of the top fisheries policy-makers from the U.S. Department of State; a special program which brought representatives of the Icelandic fishing industry and that country's United Nations delegation together with local fishermen to discuss fisheries jurisdictions; four marina boating business management workshops in Rhode Island and Connecticut, the success of which is evident from requests for similar workshops in Maine and New Hampshire; four diesel engine repair short courses for marina and boatyard employees; the first New England Regional Marine Science Education Workshop at Point Judith, which emphasized using the marine environment itself for instruction; and a shoreline management seminar arranged as a forerunner of specific programs in the individual states for state and local interests.

The Law of the Sea Institute, based at the University, continued to provide a neutral communications medium through which a wide range of law of the sea issues can be discussed. With the United Nations Law of the Sea Conference scheduled to be held in late 1973 or early 1974, the activities of the Institute are receiving increased attention. If progress is to be made toward solution of the myriad of problems to be addressed to the UN conference, it will be necessary to reconcile many divergent interests; the Institute provides a forum where these conflicting interests can be aired.

A four-day conference held in June 1972 and sponsored by the Institute attracted more than 200 persons from around the world. The proceedings of the 1970 and 1971 summer Law of the Sea Conferences, six occasional papers and an



annotated *Marine Policy, Law and Economics Bibliography* were prepared and distributed. Topics of new publications issued during the last year include Canadian-U.S. maritime problems, law of the sea as it concerns Latin America, and continental shelf issues in the Yellow Sea and East China Sea. The Institute now supplies some 25 publications to users throughout the world.

Five URI education programs, supported partially by Sea Grant, enjoyed a productive year in terms of preparing students for marine-related jobs. One, the URI graduate program in ocean engineering, provides graduates with an adequate background for ocean research, particularly the development of ocean technology. Over the past several years, the department has grown to an enrollment of 92 students, and a survey of graduates since 1968 indicates *all* 40 are employed in marine-related positions with government, the military, industry and universities.

A joint degree program for undergraduates in ocean and mechanical engineering, instituted last year, immediately attracted 11 students. The curriculum, geared to prepare students for careers in marine-related industries requires 24 credit-hours of ocean courses with topics like underwater sound, oceanography, and water quality and pollution and laboratory projects based on boat operations.

One of the largest in the country, the ocean engineering department has laboratory facilities on the Kingston campus. In addition, nearby Navy and industrial laboratories have made many of their facilities available for joint research work. On the Narragansett Bay Campus, facilities include a new building to provide a permanent research station. Two vessels are now in almost continual use for research projects and laboratory classes.

To fill a nationwide need for marine-oriented economists, a program leading to a doctor of philosophy degree in economics with a marine resource option was begun in 1971. Graduates may be employed by private industry, state or federal agencies or by international agencies concerned with marine resource development. Six students have completed the program and are employed in government and academic institutions, and 11 other students are in various stages of the program.

The Master of Marine Affairs program is a one-year, interdisciplinary, graduate program that focuses on marine policy problems at all levels. Criteria for effective management in both the near-shore and deep-ocean environments are emphasized. Three courses on marine science policy and public law—International Pollution, Coastal Zone Law and Law and Politics of the Oceans—have been added to the program. The program has drawn much international interest. Inquiries have been received from 14 foreign countries and one student from Israel and one from Ethiopia have been enrolled.

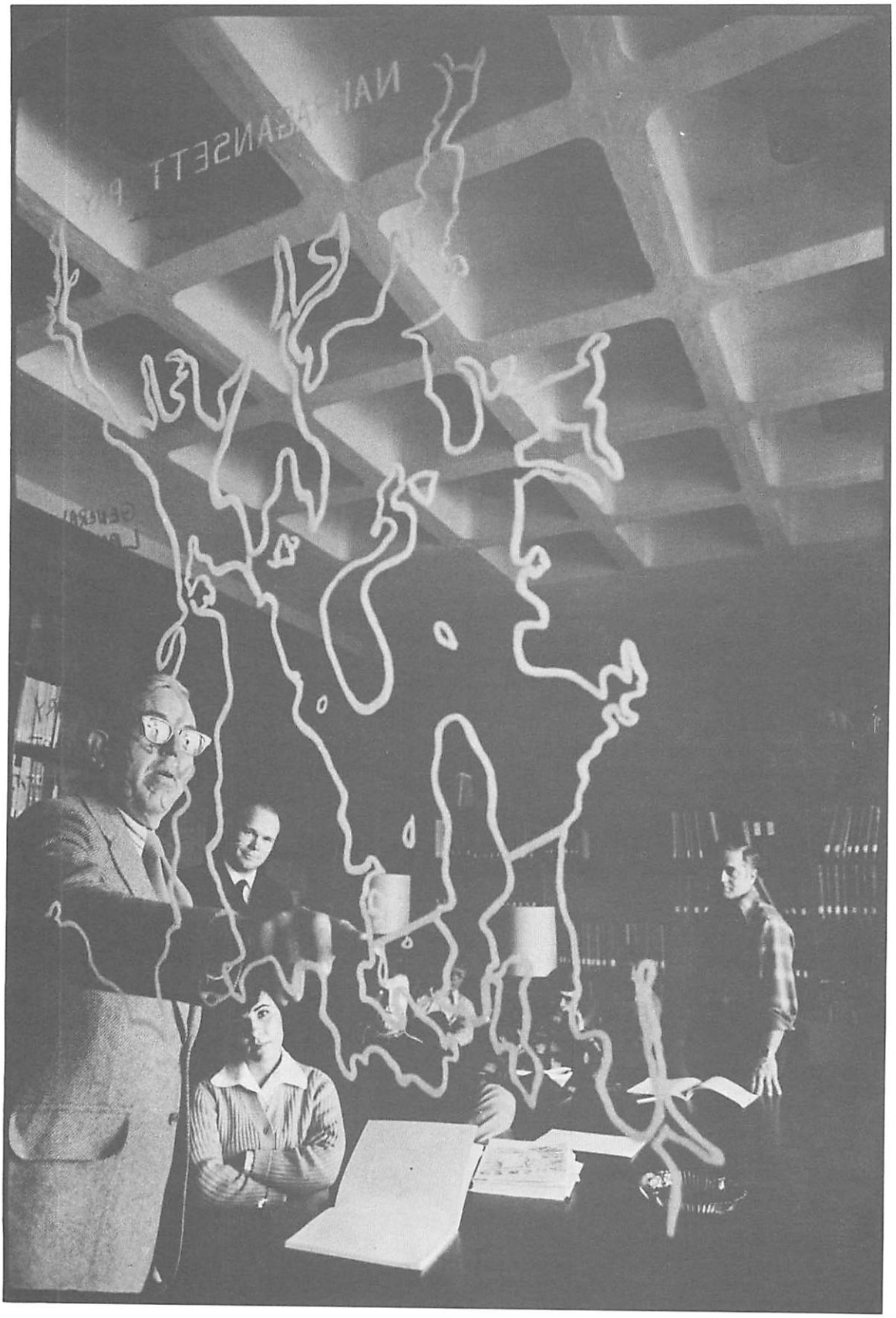
The majority of students who enter the program are in the middle of their careers and desire to broaden their knowledge of marine-related policy problems. They fall into three categories—those who take a leave of absence from government or from private institutions to gain a broader background on marine activities; others who go through the course and then seek employment in marine-related fields, and officers from the Naval War College who take the program in conjunction with their regular War College studies.

Employment of graduates from the Marine Affairs program speaks best for its success. In June through August, 1972, there were more employment offers than graduates to accept them. The entire 1972 class currently is employed in marine-related work. Of the 57 who have been graduated from the program since its beginning, more than 80 percent are employed in marine-related fields.

Young men who want to learn the trade of commercial fishing may take a two-year associate degree in the Department of Fisheries and Marine Technology. The vocationally-oriented program prepares the student for eventual command of fishing vessels and for other employment in the marine industry. New fishing techniques taught this past year include mid-water trawling and Scottish seining. Students can also receive a four-year bachelor of science degree in the natural resources curriculum where fisheries and marine technology is part of the marine resources concentration.

Facilities, which are located at Wickford, include an engineering laboratory, which has been constantly upgraded, and a new hydraulics laboratory. Other facilities and equipment include a seamanship laboratory, nets and gear laboratory, and an engineering laboratory with diesel engines common to the East Coast fishing fleet; electronic aids for fishing and navigation, and facilities for the teaching of pilotage and chartwork. Two training vessels are in regular use. One is a 47-foot trawler, the *Gail Ann*, and the other is a 21-foot diesel workboat.

Jobs taken typically by graduates include mate of an offshore fishing vessel, technician aboard an Antarctic research vessel, crewman aboard a dragger, and assistant fish plant manager. The seven 1972 graduates either entered the fishing industry, another marine industry or continued their education.



Project Status, Fiscal Year 1973

Project Number and Title		Planned Termination Date	Date of Initiation
Advisory Services			
A/AS-1	New England Marine Resources Information Program	None	1968
A/AS-2	Marine Advisory Service	None	1970
R/P-1	The Use and Impact of Marine Publications	1973 C*	1972
Education			
E/FT-1	Fisheries and Marine Technology	None	1968
E/M-1	Master of Marine Affairs	None	1969
E/ME-1	Marine Resources Economic Option	None R	1971
E/L-1	Law of the Sea Institute	None	1969
E/OE-1	Graduate Program in Ocean Engineering	None	1971
E/OE-2	Joint Program of Ocean and Mechanical Engineering	1974	1972
Coastal Resources			
R/ES-1	Analytical Physical Model	1975	1970
R/ES-2	Systems Ecology Studies of Narragansett Bay	1976	1970
R/ES-3	Economic-Ecological Model of the Narragansett Bay Basin	1975	1970
R/ES-4	Bay Watch	1974 R	1970
R/E-1	Biochemical Studies in Ecosystems	1973 C	1970
R/E-2	Estuarine Biogeochemistry	1974	1970
R/E-3	Geochemistry of Benthic Environments	1974 R	1968
R/CR-2	Economic Aspects of Multiple Use Coastal Zone Planning	1974	1970
R/CR-3	Petroleum in New England: Institutional and Economic Impacts	1974	1970
R/CR-5	Coastal Resources Center	None	1971
R/WP-1	Economics of Waste Disposal in Marine Environment	1975	1972
R/MR-1	Non-Economic Benefits from Marine Recreation	1974	1972
R/MS-1	Safe Application of Civilian SCUBA Activities	1973 C	1971
Fisheries			
R/F-1	Hydrodynamics of Fishing Gear	1974	1970
R/F-2	Towing Power of Bottom Trawls	1973 C	1969
R/F-3	Fishing Gear Development	1973 C	1968
R/F-5	Fisheries Population Dynamics—Biological Phase	1974	1968
R/F-7	Socio-Economic Study of Fishing Occupations	1974	1971
R/F-9	A Management System for Clam Resources in New England	1975	1972
R/F-10	The Merchant Marine Act and Fisheries	1974 T	1972
Aquaculture			
R/A-1	Management of Salmon in a Closed System	1976	1970
R/A-2	Aquaculture of American Lobster	1976	1968
R/A-3	Chemistry and Bacteriology of Biological Filters	1973 C	1970
R/A-4	Marine Pathology	1978	1970
Food and Drugs			
R/D-1	Marine Pharmacognosy	1974	1968
R/D-2	Marine Pharmacology	1974	1968
R/T-2	Preservation and Evaluation of Marine Foods—I	1975 T	1969
R/T-3	Preservation and Evaluation of Marine Foods—II	1975 R	1969
R/T-4	Process Development for Industrial Fish Products	1974	1969
R/T-5	Marine Fish Pigments	1974 C	1970
Management			
M/PM-1	Program Management	None	1971

** C indicates project was completed at the end of fiscal year 1973; T, that project was terminated; R, that support was reduced severely for lack of funds.*

Activity Sheet, Fiscal Year 1973

Research	*Sea Grant*	*Matching*
Aquaculture	$ 116,454	$ 17,942
Living Resources other than Aquaculture	61,911	13,717
Marine Biomedicinals	63,958	17,443
Marine Law and Socio-Economics	139,399	29,049
Ocean Engineering	130,393	90,553
Resource Recovery and Utilization	126,333	69,403
Direct Support for Coastal Management Decisions	36,920	23,696
Ecosystems Research	80,222	27,988
Pollution Studies	49,820	19,007
Environmental Models	21,935	6,526
Education and Training		
College Level	48,238	164,204
Vocational Marine Training	1,350	100,085
Advisory Services		
Extension Programs	150,681	12,150
Other Advisory Services	129,996	83,156
Program Management		
Program Administration	41,090	3,765
Total	$1,198,700	$678,684

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Biosynthesis of astaxanthin XVII intermediates in the conversion of B-carotene. Intern. J. Biochem. (in press). D. B. Rodriguez, K. L. Simpson and C. O. Chichester, Resource Chemistry. 1973.

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Marine Environment

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