SEA GRANT ANNUAL REPORT

UNIVERSITY OF RHODE ISLAND

The purposes of the University of Rhode Island's Sea Grant College Program are strongly reflected in the commitments of several of the University's eight colleges. It has achieved its ability to transcend traditional college and departmental lines through strong support on the part of the University's presidents and its governing boards, through imaginative administration under the Provost for Marine Affairs, and through faculty interest in the types of problems and potentials central to the Sea Grant ideal.

Three general conditions give focus to our Sea Grant efforts:

- The New England fisheries are in some respects a troubled industry, but in others, a very active and growing enterprise. The opportunities for industry-Sea Grant cooperation are tremendous and can prove beneficial to both industry and the nation.
- The southern New England coast – its embayments, beaches and marshes – is under uncommon pressure from its residents and from the millions of people who live within a day's drive. In this sea-land interface private and public property rights meet, and industry, natural areas, recreation, and commercial service firms must co-exist.
- The University of Rhode Island has a unique capability to train selected manpower needed to use the nation's marine resources efficiently and equitably.

The situation created by these three conditions leads naturally to education, research and advisory service programs in areas such as commercial fisheries, marine environmental problems, marine recreation, aquaculture, foods from the sea, and problems of mining in the sea.

This third *Annual Report* gives a general view of our Sea Grant activities in fiscal year 1974. Individuals interested in more detail on particular aspects of our work are invited to write to us for further information.

Niels Rorholm
Sea Grant Coordinator

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ew England's fishing industry has had its share of economic troubles. It has competed for depleted stocks with large foreign fleets, and has watched landings decline. It has seen profits for many fishermen remain marginal.

The URI Sea Grant Program, through its research and advisory services, has conducted a number of projects aimed at improving the industry's economic health. For example, the possibility of selling species for which there have been no traditional markets has been investigated, as have improvements in net and gear technology. In addition, fishing techniques never before tried in New England coastal waters have been introduced. Results have been promising.

For decades, New England fishermen have taken the traditionally-marketed species from their nets while throwing back into the sea "trash" species, which sometimes comprise up to two-thirds of the total catch. A Sea Grant resource economist has investigated the potential of both domestic and export markets for these rejected species as well as other species and has concluded that the possibilities are promising. Potential exists for processing and selling Jonah crab, monkfish, skate, ocean pout, dogfish, squid, ocean quahog and red crab. The export market for squid appears especially good in Italy and Spain.

Studies have been completed on calculating fishing net and gear drag and trawler-gear interaction. Results from the fishing net drag studies can be applied in the design of new netting and aquaculture fish pens. The trawling gear studies show how proposed changes in the trawl will affect drag. A means of matching a fishing vessel with the proper trawl is provided through the trawler-gear interaction studies. Sea Grant researchers also have found what changes in bottom trawl gear increase the size of the net opening, and thus increase the net's fishing capability. The results of this study have been published in a technical report and a popularized version for fishermen.

The Sea Grant net evaluation studies have resulted in the development of a new high opening bottom trawl, named the URI 340. Described in last year's *Annual Report,* it has since gained a good deal of recognition as one of the first major improvements in American net technology in a long while. The net project was funded by the National Marine Fisheries Service and carried out at the URI Department of Fisheries and Marine Technology with the help of research funded by Sea Grant. Since the initial development of the URI 340 was announced, more than four-hundred inquiries from fishermen, net manufacturers and others have been received from all parts of the globe. Sea Grant has provided these people with detailed drawings and instructions that tell how the net may be constructed. Word about the URI 340 has been spread farther with a feature article, complete with diagrams, in the 1973 edition of the *National Fisherman Yearbook.*

Catches by Rhode Island fishermen have been boosted as a result of two fishing techniques recently introduced by Sea Grant. The methods, midwater trawling for herring and Canadian pair seining, had never been tried in New England coastal waters. Both techniques were introduced by the commercial fisheries specialist of the Marine Advisory Service. Midwater trawling for herring, first reported last year, continues as an economically successful venture for five pairs of fishing vessels from the Point Judith, Rhode Island, fleet. More recently, the fisheries specialist introduced Canadian pair seining, and initial trials indicate that the

method can provide an adequate income in the off-season for medium-sized lobster vessels. An account of the latter project may be found in the third section of this report, which is about advisory services and education.

Sea Grant biological research is aimed at determining what causes variability in the numbers of certain fish stocks and at finding man's impact on these stocks. In one study, it was found that much of the variability in the yield of the New England yellowtail flounder fishery from 1944 to 1965 was probably caused by a general warming trend in the region. University scientists also studied dredge spoil dumping near Newport, Rhode Island, to see if the spoil had harmed a trap fishery nearby, as fishermen charged. Finding no evidence that dumping had caused the decline in catches, they said the lower catches were probably the result of a general decline in the scup fisheries — the most important trap fish — throughout its range.

Biologists have completed an evaluation of the incidence of parasitic infection in local populations of the ocean pout, a first step toward determining the possibility of marketing this species. Most of the infection in the 600 ocean pout examined was found in the lower, rear area of the fish where inexpensive removal may be feasible.

Three URI resource economists have studied the possible effects of limited entry legislation for two East Coast fisheries — surf clam and yellowtail flounder. They concluded that reduced fishing pressure would have the potential of bringing lower-cost fish to the consumer and increasing earnings of the fishermen who remain in the fishery. Fishing effort in the surf clam fishery is rapidly approaching the maximum sustainable yield (MSY) and probably will surpass it unless fishing effort is limited. In the case of yellowtail flounder, the annual harvest is already too high. If vessels are allowed to enter the fishery at will, the economists say a larger number of vessels will have lower catches at higher operating costs. The greatest economic gains for both fishermen and consumers could be attained if the fishing effort were restricted to a level slightly below that which would harvest the MSY. The economists emphasized, however, that rational management is not possible unless some means are found to regulate or eliminate foreign fishing pressure on many of our coastal species. Results of this study have been provided to a joint state-federal committee, charged with the formulation of management plans for the clam fishery.

An intensive sociological and historical study of human ecology of the Galilee, Rhode Island, fishing community, completed by a sociologist and an anthropologist, should help those involved in legislative and social programs predict their possible impacts upon coastal communities. In a book entitled *Fishermen of Galilee: The Human Ecology of a New England Coastal Community,* they outline the characteristics of the sub-culture of fishermen and explain the role of kinship in the community. The research provides an insight into the lives of Galilee fishermen and their economic success during the time when fishermen from other New England ports have suffered economically.

- Sea Grant aquaculture research is bringing us closer to the day when landings of one of the ocean's most expensive delicacies, the American lobster, may be supplemented with "farm-raised" lobster. The technical feasibility already has been proven. A pilot-plant-scale lobster aquaculture system, operating smoothly for the past two years, has sustained two-hundred juvenile lobsters through fifteen months of growth with a seventy percent survival rate. However, before lobster aquaculture can become a viable economic venture, production costs must be reduced, a problem that URI scientists are currently trying to resolve by increasing the growth rate of the cultured lobster. The researchers are trying to speed growth by removing

eye stalks and by selecting fast-growing animals. Among their other experiments are efforts to find the minimum space requirements at which the lobster can maintain a maximum growth rate. The scientists are also looking into the factors contributing to cannibalism, a major problem in lobster culture.

Culture of salmon and other species, using a water purification system developed at URI, looks very promising. Key to the compact URI fish farm, which was reported in last year's *Annual Report,* are the biological filters that convert ammonia to nitrate, a less toxic form of nitrogen. The filters make possible a closed recirculating water system, and with as little as 8,700 gallons of water, more than three tons of fish may be raised yearly. Hundreds of Chinook salmon have been raised at the URI facility from fingerlings to market size. Mortality and disease problems have been minimal.

In the last year, these aquaculturists have made a major improvement in the water treatment system. By making the brackish culture water slightly acidic, they found that salmon smolts can tolerate a higher level of ammonia. Under these conditions the biological filters operate much more efficiently. A West Coast firm, Domsea Farms, Inc., has already adapted the URI system for smolt production, and a number of firms in the South are adapting the system for catfish production. The URI fish farm continues to attract worldwide attention as evidenced by the visitors to it from China, Japan, Norway, Ireland, England and France.

- In research related to food from the sea, seafood scientists have developed a technique, similar to a Japanese process, to remove the fishy flavor from minced flesh and add artificial flavoring to make it taste like a meat product. Using the URI technique, flesh from underutilized species could be tailored to any consumer preference by modifying color and taste. The flavored "meat" product can be preserved for about fifteen days. The product, which has been cooked and flavored in a number of ways, has been tested by a tasting panel and proven quite acceptable.

  In another food-related project, scientists are recycling red crab waste from a processing plant as a fish food. Preliminary results indicate that fish that get the supplemented fish food show improved flesh color, an important consideration in marketing cultured fish.

- The URI Marine Pathology Laboratory continues working as a diagnostic center for private, commercial, state and federal organizations requesting assistance in finding the causes of fish disease. The laboratory routinely monitors salmon raised in aquaculture projects at URI and continues to search for a vaccine for *Vibriosis,* a fish disease that causes fin rot and skin ulcers in winter flounder, salmon and other species. This year, the laboratory added three hundred new samples of diseased and normal tissue from marine species to its collection, which is one of the largest in the eastern United States.

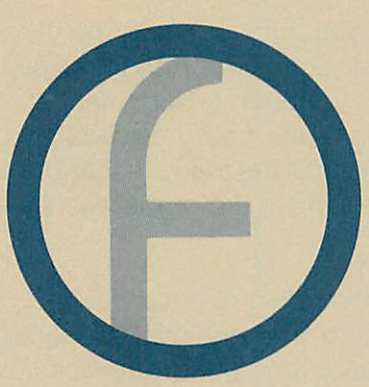
  This year, the laboratory diagnosed and reported the first case of a skin tumor, called *Papilloma,* in ocean pout, an Atlantic species. The disease has been found frequently in flathead sole off the California coast and there is intensive research on the West Coast to determine if the disease is related to pollution problems. This is the first time, however, that *Papilloma* has been found in an Atlantic species. The laboratory has also diagnosed the disease *Nocardiosis* in sixteen-month-old Chinook smolts, the first description of the disease in this species. Preliminary work has been completed to determine if the antibiotic Furanace is toxic to the bacteria that make biological filters used in aquaculture effective.

Red tide had a devastating effect upon the New England seafood industry in 1972. Toxin from the microscopic creature, *Gonyaulax tamarensis,* which causes the tide, poisoned shellfish over a wide area. Sea Grant researchers in pharmacognosy have been able to purify a small amount of the toxin and have concluded that the East Coast red tide toxin is not identical to that which causes shellfish poisoning on the West Coast, as had commonly been believed. Now that red tide toxin has been isolated, the search for preventive measures or antidotes should prove easier. In the spring of 1974, the scientists studied a red tide outbreak in Massachusetts and collected more than five hundred pounds of toxic clams.

- The Departments of Pharmacognosy, and Pharmacology and Toxicology are making a joint effort to seek new compounds from marine sources which have potential for use as drugs. In this work, new materials are isolated and characterized both chemically and pharmacologically, a first step in the development of new compounds which may find application as medicinals or diagnostic aids. The Department of Pharmacology and Toxicology also has investigated the ability of shellfish to metabolize certain foreign organic compounds. This work is important in determining how edible species take up and store a pollutant and whether the compound is changed into more or less toxic products.

Among the materials recently identified is a complex polymer from the seaweed, *Eisenia bicyclis,* collected from the Korean coast. The isolated substance possesses both anti-inflammatory and anti-curare properties. Another compound has been isolated from the starfish, *Asterias forbesii,* and has proven to have some anti-inflammatory properties as well as the ability to lower blood pressure in test animals.

The search continues for mechanisms that economically important shellfish use to detoxify pollutants. Pharmacologists have examined detoxification pathways in the quahog, *Mercenaria mercenaria.* And Sea Grant investigations have shown that the American lobster has the ability to metabolize the organophosphate insecticide parathion to inactive substances, although the rate is still unknown. The scientists also have found that lobsters can metabolize the chlorinated-hydrocarbon insecticide aldrin to dieldrin, an equally toxic substance which may have different storage characteristics than aldrin.



ostering the wise use of Rhode Island's coastal zone — the role of URI's Coastal Resources Center (CRC) — is crucial. The CRC provides the *only* major technical support for the state Coastal Resources Management Council. Established by the state legislature in 1971, the coastal council was given broad authority to implement coastal management to help insure prudent use of the state's coastal resources. In assisting the coastal council, the CRC inventories the state's coastal resources, analyzes the management alternatives and recommends policy.

As a tribute to the effectiveness of the URI center, the state of Rhode Island is awarding to it 114,000 dollars of the first coastal zone grant in the nation. The funds will be used to augment staff and step up the planning pace. But the center still receives some Sea Grant support, and it will remain a vital link in university, state, and federal government efforts in coastal management.

Rhode Island's approach to coastal planning is unusual. Normally, planners would complete a comprehensive study of coastal resources and then a coastal management plan would be formulated. However, this traditional approach provides no mechanism by which coastal resources may be managed during the time-consuming study. When the coastal council was established, it was felt that the pressure of human activities upon the state's four hundred and nineteen miles of shoreline was already so great that management was needed immediately. Thus, the coastal council was given instant management authority, and, at the same time, the URI Coastal Resources Center was established.

The coastal council has a general policy statement it is using as a basis for considering permit applications. Meanwhile, URI's coastal center is conducting a study and inventory of Rhode Island's coastal resources and recommending management policy. As each segment of the inventory is completed, management policy and regulations are adopted by the coastal council and added to a comprehensive management plan for the state.

Last year, the CRC completed a study of Rhode Island's 27.4 miles of barrier beaches, and the coastal council subsequently adopted the major management recommendations. This year, the CRC published a report on the sand and gravel resources under state jurisdiction. Anticipating mining of Rhode Island's ocean sand and gravel, the report provides basic information and recommendations for managing ocean mining, as well as model regulatory legislation. Other CRC projects in progress or nearing completion are inventories and analyses of Rhode Island commercial fisheries, unique natural coastal areas, and salt marshes. When completed, all of these studies will contain management recommendations.

Sea Grant-supported personnel in the CRC also have been assisting with a feasibility study of a Rhode Island Bay Islands Park System and an environmental evaluation of a potential nuclear power plant site in Charlestown, Rhode Island. Initiated at the request of the state Department of Natural Resources, the island park study is being supervised by the URI coastal center, in cooperation with state agencies' specialists, other university personnel and a citizen's advisory group. Work on this project is continuing, but a preliminary report submitted to the Governor's Office proposed a design philosophy and analyzed recreational demand. It also identified potential park components, examined transportation requirements and suggested a development strategy.

The CRC also is helping the Governor's Office respond to a proposal by

Narragansett Electric Company to build a 2400-megawatt nuclear power plant complex at the site of the former Charlestown Naval Air Station on Rhode Island's southern coast. The Governor's Office asked URI to conduct an environmental evaluation of the site to be used as part of the basis for state policy decisions. Coastal center personnel are helping coordinate the efforts of the many researchers at the University involved in this study and they are assisting in the preparation of a report for the Governor.

- Sea Grant studies also are providing planners with information needed to understand energy-related problems facing New England. The potential economic impact of oil field development in the Georges Bank area, one hundred miles southeast of Cape Cod, is the subject of a Sea Grant study by a resource economist. Geologists have speculated that the thick sedimentary strata underlying Georges Bank may contain rich deposits of both gas and oil.

Preliminary findings of the study reported last year were that development of an oil field would probably not provide many jobs for New Englanders. However, should a large oil find be made, the supporting operations and refineries probably would provide many jobs, improving New England's employment picture.

Further into the study, the economist testified last spring before the U.S. Senate's National Ocean Policy Committee that coastal zone planning clearly would be needed to deal with the impacts of oil exploitation. Refineries and other related developments sited along New England's coast would draw large numbers of people, putting intense pressure on local public services. The economist also explained that in certain coastal areas, prices on real estate, including housing, could be expected to rise.

The economist is nearing the end of the study and quantitative estimates of the economic impact can be made. A computer representation has been completed of the activities and costs associated with development of a single field. It may be used to estimate economic variables — such as oil input, unit costs, investments, lease and royalty payments by oil companies — as well as a number of others. The study is expected to give insight into both the potential national benefits and the regional impacts from offshore petroleum development.

As long as oil is required as fuel for our energy-demanding society, oil spills will probably remain an unavoidable consequence. Thus, Sea Grant ocean engineers are helping devise contingency plans to deal with spills that occur within Narragansett Bay. In helping the Rhode Island Petroleum Association, ocean engineers completed a statistical survey and analysis of spills that occurred in Rhode Island coastal waters from 1967 to 1971. Studies of oil spill barriers that might be used most successfully under conditions found in the Bay also have been completed. This work supplements research completed last year, using a computer model to predict the movement of a Bay oil spill.

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

This is how the method works. Light is shone through transparent material

containing a thin film of the oil sample. Because oil from different sources has slightly different molecular properties, each sample absorbs unlike portions of the light spectrum and produces a unique identification, recorded on a graph. A computer stores the fingerprint codes from different petroleum compounds so that if a fingerprint from the source of a mystery oil spill has been previously stored, the computer will match fingerprints from the spill and the source. The chemists envision a large computer reference "library" made up of fingerprints from oil shipped by tankers. If a spill were to occur, the source could be traced through the computer library. The oil fingerprinting technique has already been used to follow the fate of a large oil spill in Narragansett Bay and to point out the sources of several others to Coast Guard officials.

- Another Sea Grant study should aid local and state planners in the management of Rhode Island's domestic and industrial wastes. Resource economists examined existing municipal sewage treatment facilities in light of future sewage loads estimated by state agencies and water quality standards promulgated by the Environmental Protection Agency. They concluded that a substantial number of state municipalities already need larger facilities. Eight of the treatment facilities are capable only of primary treatment. And, in municipalities serviced by household septic systems, the capacity of the soil to assimilate sewage may soon be exceeded as populations around the Bay continue to grow. The Sea Grant economists are determining the best network of future sewage treatment centers, taking into consideration the trade-offs that are involved in system size, configuration, investment strategy, and effects of waste loadings on the marine environment.

- Other problems arise: A state agency needs to predict the effects of a proposed power generating facility on marine life in a major estuary. Regional planners want to know quickly the best possible coastal location for a sewage outfall pipe. A state planner would like to know how a new industry may affect water quality in a local bay

In the past, problems such as these have usually been solved by expensive, long-term studies, or they really haven't been solved at all. URI Sea Grant ocean engineers, resource economists, and ecologists have taken a new approach to these problems and have developed several "models" for Rhode Island's Narragansett Bay. These have the potential to help answer these kinds of questions, and many more, relatively quickly and inexpensively.

What is a "model"? In this case, it is a mathematical representation of a system that will indicate the effects of various changes within it. For example, the yield of a garden plot could be predicted with a simple mathematical model that accounted for such factors as available nutrients, light, temperature, and water. The URI Sea Grant models are a great deal more complex, and computers make them possible. Designed to simulate processes in Narragansett Bay, their greatest value lies in their ability to help predict the effects of man's activities on the Bay and their use as a basic research tool for studies of the Bay ecosystem.

The ecological model of the Bay, nearing completion, can be used to help predict the effects of sewage waste loadings upon marine life. It also can be used to indicate some of the likely effects of a coastal power generating plant on marine life. The ecological model accounts for waterborne nutrients and plankton —- tiny marine life that forms the base of the marine food chain. In addition, the ecological model responds to water temperature, light, water clarity, tidal mixing and sewage loadings.

Another new Sea Grant effort is the physical model of Narragansett Bay that

can help planners manage sewage wastes. The model is capable of predicting two important indicators of water quality — dissolved oxygen and biochemical oxygen demand — based on projections of sewage waste loads and their distribution around the Bay. Biochemical oxygen demand is a measure of the amount of oxygen-depleting substances that man adds to the Bay in sewage wastes. The importance of this model lies in its potential use by planners. For example, if alternative plans are proposed to handle future sewage wastes, the URI model can predict the water quality that would result from each scheme.

The water quality model has already predicted the Bay's water quality based on waste loadings projected to the year 1990. It also has been used to show how much time would be required for Bay water to become clean if present sewage loads were removed, and to predict how much time is required for Bay water to recover from storm sewage overflow, which frequently results in the closing of shellfishing areas.

The first physical model of Narragansett Bay, formulated two years ago by ocean engineers, continues to be developed as a management tool. This model simulates the physical flow characteristics of the Bay, divided into three hundred and twenty parts, and has the capability to predict, among other things, tide heights, currents, temperature, salinity and dissolved oxygen within each part. This year, it was used in a study of the movement of large ships in Narragansett Bay's East Passage to predict direction and variation of currents. Another application of the model was made at Millstone Point on the Connecticut coast. The model was adapted there to a study of water temperature variations resulting from the present and proposed heated water discharge from a nuclear power plant. It was also used to predict tidal motions in a large Rhode Island salt pond (Ninigret), where a large breachway may be constructed in the pond's barrier beach if a currently proposed nuclear power plant is installed near the pond. In addition, the physical model was used for a number of other purposes, including the following: computing hurricane surges and flooding in the Bay and predicting oil spill dispersion and convection in the lower Bay, and flushing times and trajectories of drifting particles in the Bay.

Ecological implications of economic growth have long been considered in terms of the effect of a single industry, taking into consideration its water supply and waste output and the waste treatment available. Sea Grant resource economists have developed an economic model of the Narragansett Bay area that shows not only the economic linkages between growth in a single industry and induced growth in other supplying industries, but also the waste products generated as a result of these interdependencies. The URI economic model can be used to alert coastal planners to the increases in various waterborne wastes that might occur with economic growth in any one of thirty-nine industrial sectors as well as the residential sector.

The economic model was used this year to demonstrate the interaction among economic activities and water effluent loadings for the Narragansett Bay area. It shows that waterborne wastes generated by the growth of a particular business or industry may be considerably less damaging and less extensive than those generated by companies from which the firm must obtain supplies and materials. This influence is known as the "waste multiplier effect." For example, the economic model shows that while waterborne wastes are increased about seventy-five pounds for each 1,000 dollars of production by the paperboard containers and boxes industry, an additional seven hundred pounds are added to the Bay from supplying industries.

One of the benefits of the models may be in using them collectively to study a

single problem. For example, if a state planner wanted to know whether or not a new industry will have an ecological impact on the Bay, Sea Grant resource economists could use the economic model to predict the additional wastes that could be expected to flow into the Bay, and provide this information to ocean engineers. Using the physical model, ocean engineers could then predict the probable changes in water quality. Ecologists could use these data to assess possible consequences for the Bay's marine life. Because these models are adaptable to other areas, they also show promise as prediction tools for planners elsewhere.

- While knowledge of the amounts of pollutants man is adding to coastal waters is useful, to fully assess their ecological impacts, other questions must be answered. Do toxic substances remain available to marine life in estuarine waters for long periods of time or are these substances flushed quickly and harmlessly out to sea? Do pollutants accumulate in sediments where they may contaminate shellfish? Investigations by Sea Grant chemists are providing insight into the mechanisms and rate of transportation of hydrocarbons, heavy metals and chlorinated hydrocarbons, such as the insecticide DDT. In one study, chemists found that organic substances from sewage effluent as well as natural sources are important agents in the transportation and deposition of the toxic heavy metals, byproducts of industry. The organic substances bind with heavy metals, with the end result that these metals are deposited in Bay sediments more quickly. In another study, it was found that suspended organic particles may be important agents for transporting DDT and concentrating it in sediments and detritus-feeding organisms.

  Sea Grant biochemists have determined that a major source of both suspended organic substances, called fatty acids, and hydrocarbons in the Providence and Taunton Rivers appears to be sewage effluents discharged into these areas. After analyzing water samples from a number of areas in Narragansett Bay, they concluded that there is a trend of decreasing concentration of suspended fatty acids and hydrocarbons from the Providence River to the lower Bay areas. The chemists also have found that the presence of dissolved organic material affects the solubility of petroleum hydrocarbons and thus their transportation, deposition and fate. The basic information supplied by this study can be applied in ecological and biochemical studies of marine systems. The techniques developed by the biochemists also could be used in the monitoring and control of pollution in Narragansett Bay as well as in other similar estuarine areas.

- How about the people who use our coastal resources? A Sea Grant sociologist has studied people who frequented a relatively isolated Rhode Island ocean beach to see what it was about the beach experience that drew them to it. The beach-goers most frequently said that experiencing the solitude of the setting and natural environment was the greatest benefit they obtained from the beach. If this is so, then high density use of such a beach might destroy its value as a recreational experience. This finding, along with a number of others, should prove useful to those making decisions about beach management.

- Among other Sea Grant projects dealing with the coastal environment are the following.

  The computer data bank developed through the Bay Watch project has been used to help the U.S. Coast Guard evaluate oil skimmers in tests conducted on the West Coast. The data bank also is being used in studies of the performance of oil barriers under Arctic conditions. Data processing techniques, developed for use in

seismic profiling, are being applied in marine geological research and could be useful to ocean mineral recovery systems.

Estimates of the future water quality of the Providence River have been made, taking into account changes in the amount of wastes dumped into the river and improvements in sewage treatment. The estimates were made using the Sea Grant water quality model and information from the Rhode Island Department of Health.

A sediment inspection around a number of Rhode Island bridges was completed for the Rhode Island Department of Transportation. It used profiling equipment from the Ocean Engineering Department and processing facilities from the Bay Watch project.

A fifty-foot square, floating scrap-tire breakwater was fabricated and tested in Narragansett Bay by Sea Grant ocean engineers. (A report on the URI floating breakwater and on the first international conference on floating breakwaters, co-sponsored by the URI Sea Grant Program, appears in the following section of this report.)

A new study was initiated to determine the role of wind in the circulation of Narragansett Bay waters. This work will help in predicting oil spill movement in the Bay and, thus, will be important in helping formulate plans for containing spills.

Using experience gained during an ecological study of small-boat marinas and salt marshes, Sea Grant ecologists responded to a request from North Kingstown, Rhode Island, for an environmental assessment of proposed marina construction in a marsh area.

Sea Grant ecologists have determined the rates of feeding, respiration, growth and nutrient regeneration by ctenophores (comb-jellyfish), the predators on summer zooplankton. Understanding the role of ctenophores brings us one step closer to a full understanding of the biological relationships which exist among Narragansett Bay marine life, and provides knowledge upon which management decisions must ultimately be built.

The Scuba safety program at URI has assisted two firms in appraising, testing and evaluating new diver flotation vest products and has aided the National Geographic Society in revising its book, *Underseas*.

Measurements of the annual cycle of production by the plankton community have been completed at a number of points within the Bay. Sea Grant ecologists are using the information from this study and a number of others to calculate an ecological energy budget for the area, another step in understanding Bay ecology.

pplying the results of applied research in the marine community is the job of the Marine Advisory Service (MAS). Extension specialists in such fields as commercial fisheries, seafood technology, marine economics, marine recreation and marine education work directly and intensively with industry and community groups, not only in transferring results of research but also in identifying problems and opportunities which could become the subjects of research. For example, among the research projects initiated by the MAS and completed by URI faculty this year were a study of the economic impact of the Newport International Sailboat Show and an analysis of marina insurance programs and costs.

Besides providing the link between researchers and various marine publics, in order to solve problems in the field, the MAS offers workshops, demonstrations and conferences which serve as forums where issues may be debated. And a second advisory service organization, the New England Marine Resources Information Program (NEMRIP), functions as a marine information clearinghouse for the region, distributing reports and periodicals and answering thousands of information requests.

• To solve some problems, however, the initiative of an MAS specialist may be all that's needed. For example, the commercial fisheries specialist recognized that lobster fishing vessels were frequently idle from January to May, when fishing is poor — a waste of manpower and costly equipment. He obtained the services of a consultant who introduced a fishing method never before tried in New England waters, Canadian pair seining, which enables lobstermen to fish for bottom fish during the off-season.

Skippers of the Rhode Island-based lobster vessels, *Atlantic Queen* and *Spartan,* tried Canadian pair seining during the spring of 1974, and the effort paid off. The two boats netted an average catch of nearly one and one-half tons of codfish, flounder and whiting each day, which provided an adequate economic return. The technique works like this. The two vessels lay out thousands of feet of cable in the shape of a crescent along the ocean floor. As both vessels conduct the tow, the movement of the line along the sand and mud bottom as it narrows to a "V" shape frightens the fish into the path of the oncoming bottom trawl. Two vessels may be modified for seining at a cost of 6,000 to 12,000 dollars, depending upon the type of equipment used, and they still may be used for lobstering. The Rhode Island skippers plan to demonstrate the method to other fishermen because it has potential for use by the scores of mid-sized lobster boats based at New England ports.

Two boat mid-water trawling for herring was introduced by the MAS to Point Judith fishermen two years ago, and the technique continues to be used by five pairs of fishing "draggers." This project has helped to increase the value of the local catch of herring by about 200,000 dollars a year. In the spring of 1974, the MAS specialist introduced the technique to fishermen in New Bedford, Massachusetts, largest of the New England fishing ports.

The efforts of the MAS commercial fisheries specialist have not gone unnoticed by industry. The Atlantic Offshore Fish and Lobster Association presented to him a special award for his contribution "to many practical innovations of significant benefit to the fishing industry."

The seafood technologist, hired this year by the MAS, has assisted in the formulation of plans for a quahog depuration plant on surplus Navy land at Quonset Point, Rhode Island. Using the plant, it is estimated that 9,500 acres of Narragansett Bay now marginally polluted could produce 200,000 bushels of quahogs annually with a total value of about six million dollars. The seafood specialist has also assisted Yankee Seafood, Inc. in getting underway a new plant which processes quahog for use in chowder, stuffing and patties. The firm was advised on the design, location and equipment for the plant's quality control laboratory, which is being initially monitored by the MAS during the staff training phase.

The MAS marine economist advised a number of fishermen on the financing and re-financing of vessels and a red crab plant on alternative facilities for its shucking and freezing operation, and chaired several meetings of fishermen on the subject of red crab harvesting and processing.

The MAS marine education specialist continued to promote environmental education by participating in various workshops and seminars for teachers, by conducting a class and by helping to establish policy for marine education at both regional and national levels. In addition, the education specialist helped prepare a proposal for a national 4-H television series about the marine environment.

The Rhode Island Department of Education was assisted in developing and carrying out a segment of the Narragansett Bay Heritage Project. As part of the study, seventh and eighth grade students from thirteen schools, their parents and teachers monitored the water quality of Narragansett Bay and participated in a historical study of man's use of the Bay.

The marine recreation specialist, in working with marina managers, learned of the need for inexpensive breakwater protection for small-boat marinas. Responding to this problem, Sea Grant ocean engineers at the University developed and tested floating scrap-tire breakwaters, which have proved to be both inexpensive and effective. The scrap-tire breakwaters are easy to fabricate, and efforts are being made to introduce them to marina managers throughout the New England area.

A fifty-foot square, scrap-tire breakwater was constructed, and it effectively dampened waves up to three feet high. New tire configurations and binding methods, and larger breakwaters are being tested. Use of scrap tires not only taps an inexpensive source of materials, compared to the metal or concrete usually used, but it also may prove to be one way to reuse a substantial number of the more than two-hundred million tires discarded annually in the United States.

- In helping foster floating breakwater technology, the MAS co-sponsored, with the URI Ocean Engineering Department and the University of Washington, the first gathering of floating breakwater experts since the 1940s. The International Conference on Floating Breakwaters attracted ninety participants from the United States, France and England to Newport, Rhode Island, where they pooled their knowledge of experiments with various breakwater designs and of field test results with prototype and commercially available floating breakwaters. A number of marina owners and fish farmers attended two panel discussions conducted for potential users.

The MAS also co-sponsored the annual Fishermen's Forum, a meeting that gives fishermen the opportunity to discuss common problems. For this year's Forum, two European fishing experts were part of the program, and consulted with the approximately one hundred and fifty New England fishermen and administrators who attended. One expert was a director of a major German net design and manufacturing company. The other was a consultant on fisheries gear and methods

from Scotland, who earlier had assisted with the Canadian pair seining trials. Nine small-group sessions were conducted during the Forum, giving fishermen an opportunity to participate in discussions on Canadian pair seining, squid resource development, vessel appraisals, financial assistance programs, lobster pot damage claims, legislative programs affecting fishermen, and development of the red crab resource.

More than one hundred participants gathered for the annual Marine Recreation Conference, organized and co-sponsored by the MAS. Shoreline planners, marine recreation developers, shipyard owners, educators, scientists and others met for two days to discuss coastal zone management issues that face the recreation industry. Among the topics debated at the conference: the politics of coastal planning, the federally funded coastal planning effort, and the impact of boating on the environment.

The MAS also co-sponsored a conference at Durham, New Hampshire, on coastal zone management as it relates to oil refineries and offshore unloading facilities, and co-sponsored the second Barrier Beach Field Day, at South Kingstown, Rhode Island.

- Among those who continued to take advantage of NEMRIP services last year were commercial fishermen, marina owners, planners and others affiliated with either a marine business or industry. For example, of the 4,200 individual inquiries processed during the past year (up sixteen percent from the previous year), more than one-quarter were from commercial fishermen, more than one-third from someone associated with a marine business and an equal number were from either students or teachers.

  This past year, 37,400 publications, excluding periodicals, were distributed to individuals upon request, and another 12,600 publications were distributed to specialized audiences. One book, *Handbook for Beach Strollers,* was turned over to a commercial distributor and was also accepted and promoted for sale by the *Providence Journal* Book Club, which devoted public service advertising for it worth 12,600 dollars.

  Newsletters published during the past year were *New England Marine Resources Information,* with a monthly circulation of 16,000; the MAS *Memorandum Series* with a monthly circulation of 900; and the *URI Commercial Fisheries Newsletter,* published bi-monthly for 1,200.

- The most important effort ever to produce a comprehensive law of the sea treaty is underway now through the United Nations Law of the Sea Conference. The one hundred and forty nations participating in its negotiations have begun formulating comprehensive sea law that may eventually govern, among other things, the exploitation of fish and mineral resources, navigation and ocean research. If a treaty is completed, its major impact upon New England could be the relief given fishermen with an international two-hundred mile "economic zone" within which the United States could regulate or prohibit foreign fishing.

  The URI Sea Grant program is involved in this treaty making effort with its support of the Law of the Sea Institute, based at the University, and with the planning of a coordinated research effort aimed at gaining knowledge for management of the sea. The Institute uses conferences, workshops and publications as media through which a wide range of sea law issues can be discussed. The Institute's conference held in June, 1973, attracted more than two hundred participants from forty countries to discuss the emerging regime of the oceans.

Reports published and distributed by the Institute over this past year covered topics of ocean use and law of the Soviet Union, the International Decade of Ocean Exploration, and fisheries management. In addition, reports were issued on two Law of the Sea workshops, and on the eighth Law of the Sea Institute Conference. The Institute has now begun a project to develop a comprehensive bibliography on the social sciences of the oceans.

- Four educational programs supported by the URI Sea Grant program continued to prepare students for marine-related careers. One of these, the Master of Marine Affairs Program, is a one-year graduate course of study designed to broaden knowledge of marine policy problems for people in mid-career.

Last year's students are fairly representative of the types of people attracted to the program. Of the twenty-nine enrolled, there were ten unsponsored civilians; three employees of the National Oceanic and Atmospheric Administration; seven senior military officers from the Newport Naval War College and four other officers; a staff member from the Office of the Oceanographer of the Navy, and four foreign students. This latter group consisted of an oceanographer from France, a professor of marine engineering from Ghana, a professor of marine biology from Chile and a zoologist from New Zealand.

Graduates from the Marine Affairs Program have been in high demand for marine-related jobs. The entire class of 1973 is currently employed with all but one graduate working in a marine-related field. And about eighty-five percent of the graduates of the four previous classes have found employment in marine career fields.

The program recently established a new library and a *Marine Affairs Journal.* A large number of publications covering state, regional, national and international marine affairs have been collected during the brief time of the library's existence. The first issue of the *Marine Affairs Journal* was published by students in the program.

The two-year commercial fisheries program, offered through the Department of Fisheries and Marine Technology, trains students for employment on fishing vessels and for other jobs in the marine industry. Those who complete the program receive an associate degree in commercial fisheries or they may opt to continue course work toward a four-year bachelor of science degree in natural resources.

Most graduates of the program — about fifteen a year — have enjoyed success in securing jobs. Eleven of the fourteen graduates from 1973 found employment in the commercial fishing industry and the other three are continuing studies toward a bachelor's degree. Among all the graduates of the program, about four out of five find employment in the fishing industry, and many others continue college studies or find employment in other marine-related fields.

Interest in the commercial fisheries program is at an all time high. Currently, there are twenty-four sophomores and the incoming freshman class is expected to number more than thirty. About two-thirds of the applicants are from either Rhode Island or other New England states. The remainder are attracted to the program from the West Coast and from foreign countries.

The fisheries school has facilities at Wickford, Rhode Island, including laboratories for teaching hydraulics, seamanship, nets and gear, and engine repair and maintenance. Five diesel engines of varying types and power have been donated by local industry. The program makes a strong effort to have available to students a wide range of gear and electronics equipment to make sure they can handle whatever problems they may encounter if they join the fleet.

Two programs of study in ocean engineering are currently being offered through the College of Engineering. One is an undergraduate joint program in ocean and mechanical engineering, and the other is the graduate program in ocean engineering.

In the undergraduate program, students are required to complete courses in underwater acoustics, marine pollution and other ocean-related subjects. A new course added to the curriculum is an introduction to ocean engineering. Seven students were graduated in 1973 and more continue to enroll in the study. In the graduate program, eleven students were graduated in 1973 and all have found employment in government or industry.

This year a new laboratory was completed for the Department of Ocean Engineering. Overlooking Narragansett Bay, it contains a large underwater acoustics research tank, complete diving facilities and an environmental data center. Two vessels are available for research purposes.

Activities, fiscal year 1974.

	Sea Grant	Matching
Marine Resources Development		
Aquaculture	$105,011	$12,451
Living Resources Other than Aquaculture	58,419	3,741
Marine Biomedicinals	41,620	21,962
Socio-Economic and Legal Studies		
Marine Economics	102,443	25,991
Socio-Political Studies	4,462	8,319
Marine Technology Research		
Ocean Engineering	76,170	49,282
Resource Recovery and Utilization	52,164	38,792
Marine Environmental Research		
Studies in Support of Coastal Management	32,628	38,857
Ecosystems Research	52,146	6,005
Pollution Studies	30,828	9,108
Environmental Models	15,691	12,813
Marine Education and Training		
College Level	26,339	119,125
Vocational Marine Technician Training	13,612	70,435
Advisory Services		
Extension Programs	159,261	30,000
Other Advisory Services	99,897	70,958
Program Management and Development		
Program Administration	48,165	—
Program Development	16,144	—
	$935,000	$517,839

Project status, fiscal year 1974.

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
A/L-1	Law of the Sea Institute	none	1969
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	1971
E/OE-1	Graduate Program in Ocean Engineering	none	1971
E/OE-2	Joint Program of Ocean and Mechanical Engineering	1974C*	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	1974T	1970
R/ES-5	Effect of Wind on Narragansett Bay Circulation	1974C	1973
R/E-2	Estuarine Biogeochemistry	1974C	1970
R/E-3	Geochemistry of Benthic Environments	1974C	1968
R/CR-2	Economic Aspects of Multiple Use Coastal Zone Planning	1974C	1970
R/CR-3	Petroleum in New England: Institutional and Economic Impacts	1974C	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	1975E	1972
R/MS-2	Continued Studies of Safe Application of Civilian Scuba Activities	1974C	1973
R/FB-1	Floating Breakwaters (formerly part of Bay Watch)	1975	1973
Fisheries			
R/F-1	Hydrodynamics of Fishing Gear	1974C	1970
R/F-5	Fisheries Population Dynamics — Biological Phase	1974C	1968
R/F-7	Socio-Economic Study of Fishing Occupations	1975E	1971
R/F-9	A Management System for Clam Resources in New England	1974C	1972
R/F-11	Bottom Trawl and Otter Board Performance	1976	1973
R/F-12	Export Potential for Underutilized Species	1974C	1973
Aquaculture			
R/A-1	Management of Salmon in a Closed System	1976	1970
R/A-2	Aquaculture of American Lobster	1976	1968
R/A-4	Marine Pathology	1978	1970
R/A-7	Water Purification in Closed System Aquaculture	1974C	1973
Food and Drugs			
R/D-1	Marine Pharmacognosy	1974C	1968
R/D-2	Marine Pharmacology	1974C	1968
R/T-3	Preservation and Evaluation of Marine Foods II	1975	1969
R/T-4	Process Development for Industrial Fish Products	1974C	1969
Management and Development			
M/PM-1	Program Management	none	1971
M/PD-1	Program Development	none	1973

C indicates project was completed at the end of Fiscal Year 1974; E that project was extended one year to year shown; and T that project was terminated.

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A Water Quality Problem in Lobster Holding Tanks. T. L. Meade, Marine Advisory Service, URI. 1973.

Living Resources, Other than Aquaculture

A Stress Syndrome in the Hard Clam, *Mercenaria mercenaria*. Journal of Invertebrate Pathology, 20(3):242-251 (November, 1972). 1973.

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The Biosynthesis of Astaxanthin-XV. The Carotenoids in Chidai, Red Sea Bream, *Evynnis japonica* Tanaka and [the Incorporation of Labelled Astaxanthin from the Diet of the Red Sea Bream] to their Body Astaxanthin. Bulletin of the Japanese Society of Scientific Fisheries, 40(1): 97-103 (1974). T. Katayama, T. Miyahara, Y. Tanaka, M. Sameshima, K. L. Simpson and C. O. Chichester, Food and Resource Chemistry, URI. 1974.

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Yankee 35 Bottom Trawl Performance Study. G. A. Motte, A. J. Hillier and R. D. Beckwith, Fisheries and Marine Technology and Agricultural Experiment Station, URI. 1973.

Socio-economic and Legal Studies

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Aquaculture in New England. J. M. Gates, G. C. Matthiessen and C. A. Griscom, Marine Advisory Service, URI. 1974.

The Benefits of Fisheries Regulation: A Case Study of the New England Yellowtail Flounder Fishery. J. M. Gates and V. J. Norton, Resource Economics, URI. 1974.

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Rhode Island Marina Insurance. C. H. Brainard, J. F. Fitzgerald and R. A. Hershbarger, Finance and Insurance, URI. 1974.

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Ocean Engineering

"Portalab," An Inexpensive Self-Ballasting Habitat. Marine Technology Society Journal, 8(2):39-44 (February, 1974). A. P. Davis, Jr. and H. V. Schenck, Jr., Ocean Engineering, URI. 1974.

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The Biosynthesis of Astaxanthin-VI. The Carotenoids in the Prawn, *Penaeus japonicus* Bate (Part II). Int. J. Biochem., 3:363-368 (1972). T. Katayama, T. Katama and C. O. Chichester, Food and Resource Chemistry, URI. 1974.

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Financing Fishing Vessels. A. A. Holmsen, Marine Advisory Service, URI. 1974.

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