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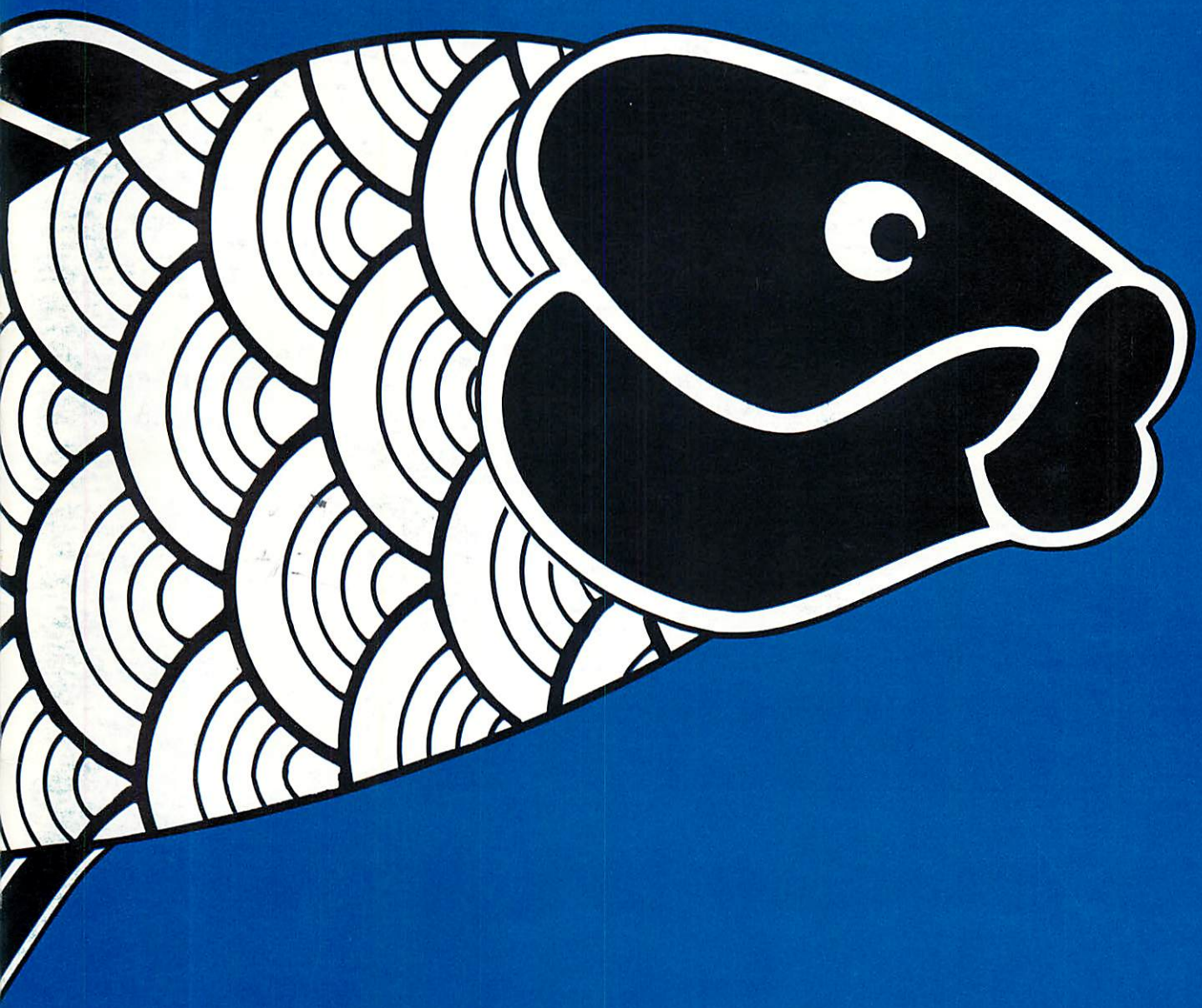


A Report on the University of Rhode Island's Sea Grant Program, July 1975 to June 1976.

Foreword

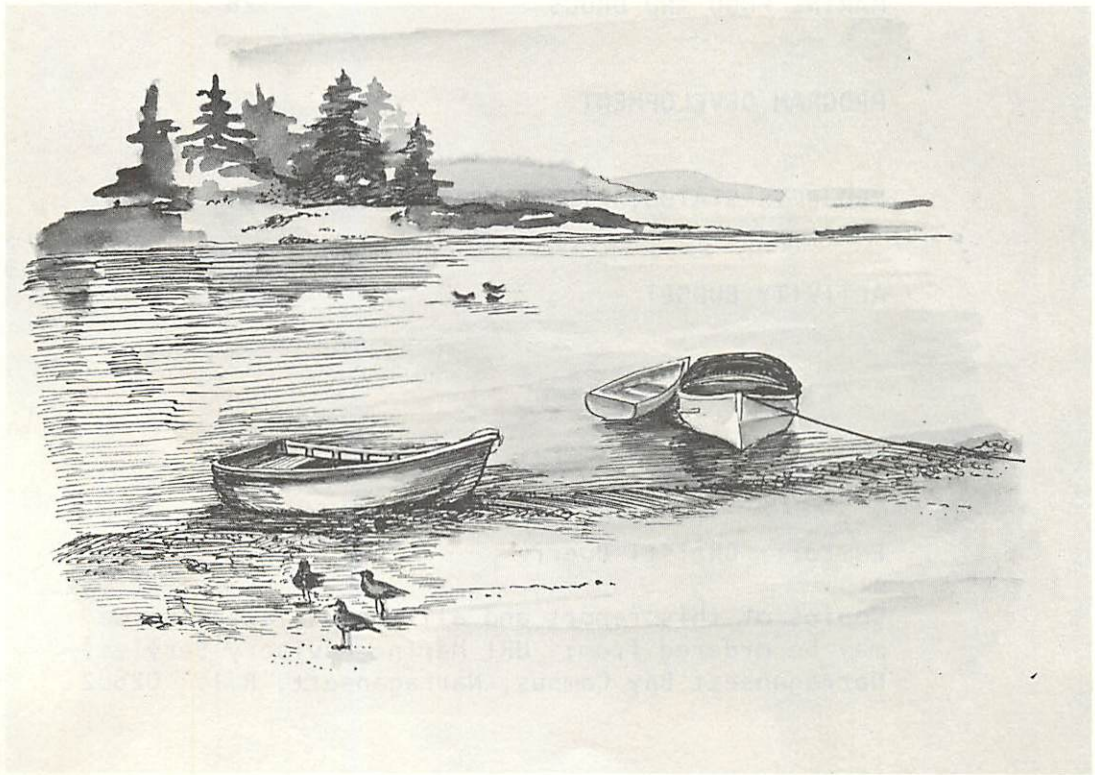
In October of 1965, speaking before an audience of marine scientists and administrators convened to discuss the concept of a Sea Grant University, United States Senator Claiborne Pell of Rhode Island said:

> "Rhode Island has had a long and historic association with the sea. Eighty-eight years ago, Alexander Agassiz - - a resident of this very city of Newport - - organized the three cruises of the Coast Guard vessel, BLAKE. These voyages marked the first major effort of the United States in oceanographic exploration. Until the end of the last century, the Alexander Agassiz laboratory in Newport, stemming from a concept originated by his father, Louis, was our nation's historic center of early research into the mysteries of the marine environment.
>
> "Thus Rhode Island can lay rightful claim to the beginnings of oceanographic studies which this University has so well expanded. History combines fittingly in this respect with continuing and improving purpose. A great deal more needs to be done, however, if we are to make full use of our potentials and develop the skills and understandings we will need for the future."

True to Senator Pell's observation that "a great deal more needs to be done", the URI Sea Grant Program has sought to expand its concerns with research, education and public service projects responsive to problems and opportunities in the marine sector.

This report for the year 1975-76 describes the activities undertaken at URI which, hopefully, reflect the high purposes envisioned by our senior senator when he shepherded passage of the Sea Grant College and Program Act of 1966

Niels Rorholm
Coordinator
URI Sea Grant Program



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Editor: Christi Duerr

Copies of this report and all those listed inside may be ordered from: URI Marine Advisory Service, Narragansett Bay Campus, Narragansett, R.I. 02882

Introduction

Ted Blount had a mountain of protein-rich, but unmarketable, clam pieces left over from processing operations at the Blount Seafood Company in Warren, R.I. He also had a desire to add a sideline venture to the business.

This desire surfaced one day in 1975 during a discussion Blount had with Jeffrey L. Howe, seafood technologist with the University of Rhode Island's Marine Advisory Service, the extension arm of the Sea Grant Program. Out of their talk came the suggestion that the company try aquaculture. How URI Sea Grant personnel helped the company develop its new venture illustrates the role Sea Grant, with its research, educational, and advisory services, can play in supporting new enterprises.

Aquaculture came under consideration by Howe and Blount because the company has two assets that could be used in such an endeavor. One is the presence of two saltwater wells on Blount's property that deliver 300 gallons a minute of 55-degree water to the surface. This water is disease-free, and so the possibility of contaminating fish through the water supply - a possibility present in natural seawater systems - is eliminated. The other asset is the daily plant production of 200 pounds of clam pieces, or slurry. If this could be used in a feed ration, feed costs (a major outlay for an aquaculture system) could be significantly reduced.

Once the decision to try aquaculture was made, the next step was to select an animal species. Howe went back to the University and consulted Dr. Thomas Meade, URI professor of animal science, who, with Sea Grant support, has been experimenting on the aquaculture of trout and salmon for several years. Meade advised Howe that the temperature and salinity of Blount's saltwater wells would be optimum for raising coho salmon and rainbow trout. And because these fish command good prices in the seafood market, their sale should make the venture economically feasible. If the company were interested in trying to raise these fish, he told the seafood technologist, he would donate 2000 fingerlings from his system for the new venture.

Blount and George Richardson, the vice president of Blount Seafood, liked the idea and began reading about fish aquaculture. The system they decided to use would hold the fish in two silos. Water from the wells would be circulated through the silos and then discharged.

By using secondhand materials, the two men kept the initial costs of the system below $2,000. A 3000-gallon oil tank, cut in half and mounted vertically just outside the plant, became the silos. Pumps to circulate 20 gallons of salt water a minute through the tank from the wells were installed to oxygenate the well water.

Howe arranged to have Gerald Levine, a graduate student of Dr. Meade's, work with Blount under MAS support to aid in the initial set-up and to formulate the food ration.

By November, 1975, the fish silo system was ready, and the URI fingerlings were transferred to their new home at Blount Seafood. Throughout the following months, the fish grew rapidly, promising to reach the harvest size of a pound much sooner than had been expected. The salmon were also receptive to the moist pellet diet which was developed by Levine. This diet, devoured by the salmon much faster than commercial feeds, incorporated the clam slurry into a nutritional feed which also offered the most significant savings.

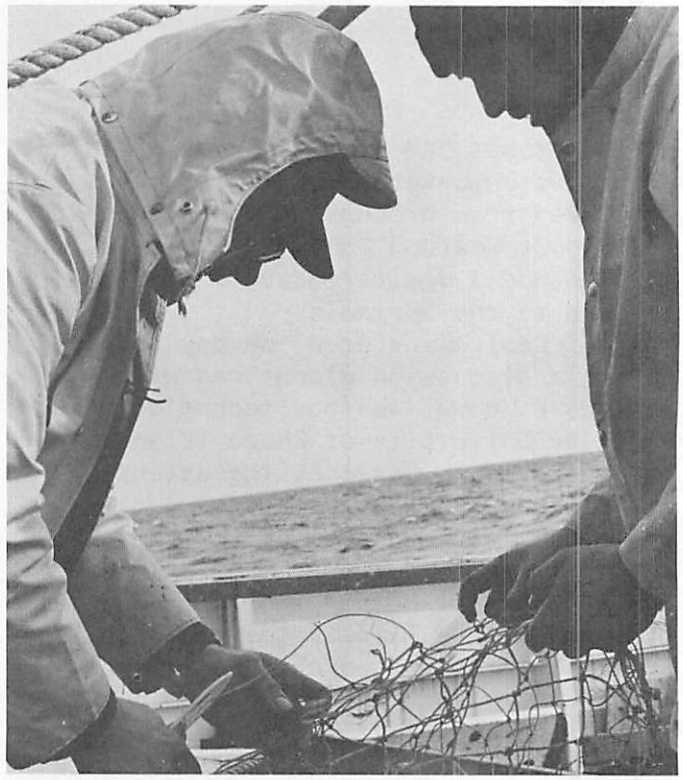
Blount and Richardson continued to make improvements in their system, consulting with Howe and with aquaculture experts around the country. Convinced that the venture would succeed, they hired Levine full-time. They also changed from using silos to a tank 18 feet in diameter and four feet high. This new tank appeared to further reduce

operating costs and raise output.

The success of the salmon system started the group wondering whether the system might not be applicable for other species, even though there were still problems with which to contend. Around this same time the Southern New England Fisheries Development Program was created through the efforts of former Senator John O. Pastore, of Rhode Island. This program, which is administered through the National Marine Fisheries Service, offers funds for research of immediate benefit to the region.

Howe and Blount Corporation officials felt the aquaculture system they had developed held great potential for southern New England, so they requested funds for further research from the new agency. The request was granted, and they are now cooperating in a project to study waste discharges from the system, to refine the system's design, to test its suitability for other species, and to compare feed rations.

Not all Sea Grant projects involve all phases of the program--research, education, and advisory services--as did the Blount salmon aquaculture venture. However, all the program's resources in these areas are available for improving the management, protection, and development of Rhode Island's marine resources. Once problems are identified--either by a citizen, an agency, or the University--researchers are approached to handle the projects. The results are disseminated through publications or communicated directly to user groups by Marine Advisory Service personnel. When the recommendations are applied, feedback from users aids in further refinements and in faster identification of new questions. The program also looks towards future needs of Rhode Island in its continual training of new specialists in its educational programs and its support of student assistants in Sea Grant research.



Advisory Services

In the ever-increasing complexity of today's world, new discoveries and accomplishments are being made every year. But much of that information may be inaccessible to the average user, who is unaware of how to obtain it or how to use it. The marine advisory staff transmits information of marine and coastal interest to individuals, groups, and businessmen who may need it. The staff members also respond to requests for assistance from marine resource users.

MARINE ADVISORY SERVICE

Commercial Fishing. As costs increase for boats, gear and labor, and as stocks of favored fish are depleted, the fishing industry is discovering that fishing is profitable when skippers carry a variety of gear for fishing whatever stock they find.

As an aid to increasing this versatility of New England fishing skippers, Robert E. Taber, commercial fisheries specialist, has been assisting fishermen in experiments with new gear and European fishing techniques. Three such projects were undertaken by Taber in 1975-76 with the funding support from the Southern New England Fisheries Development Program. One project, which had begun with Sea Grant funds, involved construction of a skiff and underwater camera apparatus for videotaping fishing nets in action. The other two projects involve the transfer of European fishing techniques to New England: Danish seining and bottom pair trawling.

The experiments with bottom pair trawling were initiated at the request of several Point Judith fishing skippers, who had had good success with midwater pair trawling and were eager to try the same method for bottom species such as scup, mackerel, butterfish, and squid. Taber obtained a European net and two tow boats, the Susan and Lori (Peter Sprague, Capt.) and the Karen Sue (Dave Roebuck, Capt.) and experimented with the techniques in early 1976.

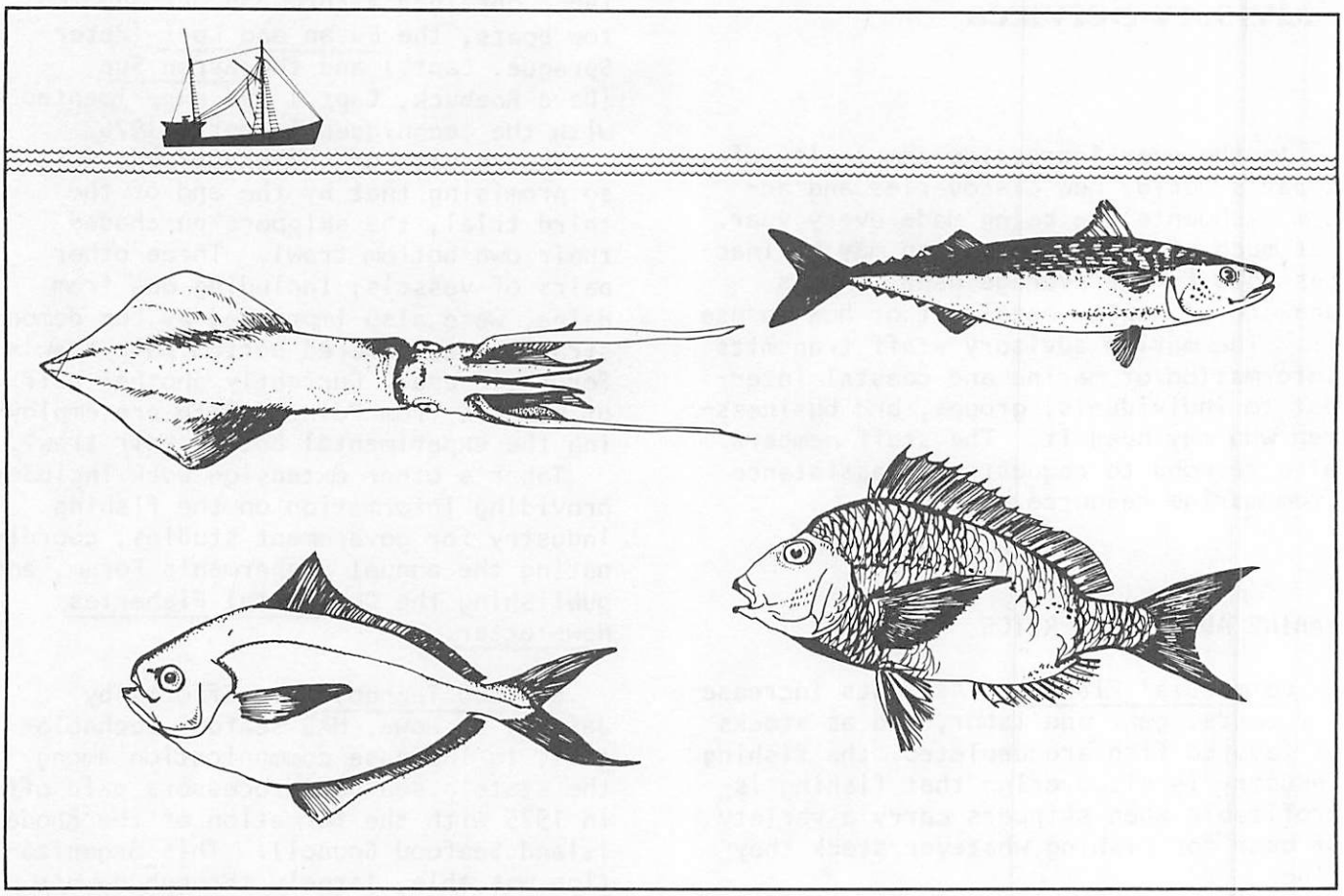
The results of the experiment were so promising that by the end of the third trial, the skippers purchased their own bottom trawl. Three other pairs of vessels, including one from Maine, were also impressed by the demonstration and ordered bottom pair trawls for their use. Currently another pair of vessels from Point Judith are employing the experimental bottom pair trawl.

Taber's other extension work includes providing information on the fishing industry for government studies, coordinating the annual Fishermen's Forum, and publishing the Commercial Fisheries Newsletter.

Seafood Technology. Efforts by Jeffrey L. Howe, MAS seafood technologist, to increase communication among the state's seafood processors paid off in 1975 with the formation of the Rhode Island Seafood Council. This organization was able, largely through Howe's assistance, to secure a $75,000 grant from the Southern New England Fisheries Development Program for a consumer education program promoting consumption of Southern New England seafood products.

In connection with Howe's interest in marketing underutilized species, he began plans for a demonstration, multi-purpose processing plant to be operated in conjunction with Amoriggi Seafood, Inc., of Johnston. The plant will have one basic processing line which will be easily adapted to the handling of seafood species such as conch, channel whelk, Jonah crabs, and squid. Initially, these species will be partially processed and then sold for further processing.

Other activities in which Howe was involved included planning for a clam depuration plant in Rhode Island, serving on the Governor's Fisheries Task Force, and teaching seafood processing and handling to URI commercial fisheries students.



Howe also served as president for the Atlantic Fisheries Technologist, and in this capacity arranged its 21st annual meeting in Newport.

The technologist's advisory work with Blount Seafood Company in their salmon aquaculture venture is detailed in the introduction.

Resource Economics. Added in 1975-76 to the usual large number of inquiries for assistance which resource economist Dr.Andreas Holmsen receives, were requests for advice on the labor and capital needs of the fishing industry. Interest was expressed in both the harvesting and processing sectors, in light of the expansion to 200 miles of U.S. control over its coastal fishing grounds. Dr. Holmsen met with many government and industry representatives doing studies on the fishing industry, such as the New England Regional Commission and the Congressional Research Service, to discuss their needs. These studies were touched upon in presentations Dr. Holmsen made to fishermen at the Maine and Rhode Island Fishermen's Forums.

Dr. Holmsen also provided financial advice to a wide range of clientele. Firms in Rhode Island and elsewhere received input on the economic feasibility of new ventures. Firms in Chicago, Spain, and the Canary Islands sought advice on the legal and financial issues involved in the squid export business. Fishermen met with the specialist over tax problems and vessel leasing. The specialist also prepared a marine memorandum on the procedures, costs and merits of incorporating

fishing vessels in Rhode Island, and statements of typical cases of vessel finance for use by banks.

As a regular contributor to the MAS "Commercial Fisheries Newsletter," he provided such information as descriptions of fisheries bills in the General Assembly and a discussion of state fisheries laws.

Marine Recreation. The close ties of Rhode Islanders to the sea can be seen in the many historic sites located within a mile of the shoreline. As a Bicentennial project, marine recreation specialist Neil Ross prepared a guide to these spots for boat owners and other tourists. He and local writer Norris Randolph checked sites along the entire Rhode Island coastline to select those which can be most easily viewed or visited by boat. In the Cruising Guide, which is about the size of a state road map, these sites are marked on a map of the state's coast. The guide provides descriptions of the sites, as well as short essays about Roger Williams, Rhode Island's role in the Revolutionary War, the Indians, and Colonial farming practices. On the back of the Guide is a reproduction of a chart of Narragansett Bay that was drawn in 1777.

Ross also became involved in another Bicentennial project, the Tall Ships' visit to Newport. He assisted the committee which planned for the ships' stay.

The marine recreation specialist continued his work on floating tire breakwaters. As an outgrowth of that work, he planned a workshop on the uses of scrap tires. Held at the Goodyear Tire and Rubber Company plant in Akron, Ohio, the workshop focused on using tires as protection against shoreline erosion and as artificial reefs, in addition to their use in floating breakwaters. Several other Sea Grant programs involved in finding uses for scrap tires participated in the workshop.

Also this year, Ross laid the groundwork for the first student internship in marine recreation ever to be offered by a marine trades group. The Connecticut Marine Trades Association provided support to a Connecticut student attending Texas A&M University for three months of field work in indentifying problems of marine recreation in Rhode Island, Connecticut, and Massachusetts. The student also compared the different approaches of the advisory services and trade associations in the three states.

Marine Education. Marine education should expand from just offering students scientific knowledge to include marine-oriented art, history, and music. This is the philosophy of a newly created group, Rhode Island Marine Educators. Formation of the organization was spearheaded by education specialist Prentice K. Stout, who joined MAS during the fall of 1975. RIME's purpose is to spread information and curriculum materials concerning the marine environment among elementary and secondary level teachers, and to keep them informed of marine-education seminars, workshops, and meetings throughout New England. Group meetings emphasize classroom activities and background information useful to the teachers.

In addition to his work with RIME, Stout also worked closely with marine educators throughout New England through the creation of the New England Marine Educators.

Revisions of two publications useful to teachers were completed during 1975-76. One is an update of the Environmental Education Guide for the state, which lists the facilities to which teachers can take their classes to study the environment. The other is a booklet aimed at high school students. It describes job opportunities in marine-related fields, from boating trades to marine sciences and support service for shipping and recreation.

Much of the specialist's time during the late spring and early summer was devoted to planning a symposium held during the Tall Ships' visit to Newport. This symposium concerned how to increase

the marine awareness of the crews of sail training vessels, and the role these ships can play in monitoring global oceanic conditions. It was sponsored by MAS, the Oceanic Society, and the American Sail Training Association. Participating in the symposium were Tall Ships captains and representatives, university scientists, employees from governmental pollution-and-ocean-monitoring agencies, and members of sail training associations. Dr. Thor Heyerdahl, Norwegian explorer and ethnologist, also spoke. Heyerdahl, who was Stout's guest during his visit, spoke to students and faculty of the Graduate School of Oceanography in a special seminar arranged by Stout.

Marine Public Education. The MAS gained the services of a part-time specialist in marine public education this year, when Sara S. Callaghan was hired to assist Prentice Stout in his work with schools, to conduct special educational programs, and to aid the Coastal Resources Center in its public education projects.

One of Callaghan's projects was to tell the story of Sea Grant and its accomplishments through public service TV spots. Working with WJAR-TV, a Providence television station, Callaghan developed a series of 30-second spots about Sea Grant projects. These spots were aired during the spring and summer on the three local television stations.

Another project Callaghan conducted was an open house at URI's Jerusalem Marine Field Station. The station is available for use by university researchers and students as well as by organized school programs. Exhibits at the two-day event featured past and present research work into fish communication, striped bass, fishing gear and lobster habitats.

Currently, Callaghan is helping the museum in Providence's Roger Williams Park plan a large exhibit about Narragansett Bay. Because the majority of the state's children go to school near the park, the museum is an excellent, easy-to-reach facility for educating children about the state's most important resource, the Bay. URI Sea Grant is also providing some funds to help in the construction of the exhibit.

In her work for the Coastal Resources Center, Callaghan developed a combination summer calendar and tide chart. She also wrote an activity book entitled "Down Where The Water Is: A Coastal Awareness Activity Book," which is designed to inform youngsters about the importance and use of coastal resources. It is accompanied by a teacher's guide.

Callaghan assisted in editing publications on lobsters and the CRC's Bay Islands Park proposal, and prepared a number of inexpensive posters for use by teachers.

Information. An information specialist, a writer, and an editor help to make the marine information gathered by researchers and advisory service personnel more accessible to the public. This year, over 33,000 copies of publications were distributed through the Marine Advisory Service. Among these were some 37 publications released during 1975-76. One of them, "Tides and Tidal Currents of Narragansett Bay," received an honorable mention boating safety award from the New England Marine Trades Association. These tides and current charts are formulated entirely from computer models developed by ocean engineers in Sea Grant research projects.

Three periodicals are published through MAS to keep people up to date on marine activities. The Marine Advisory Newsletter, distributed bimonthly to 1,073 subscribers, provides information about campus projects. The bimonthly Commercial Fisheries Newsletter, disseminates needed information to 1,564 fishermen through the Northeast. Information, which has been under the auspices of the New England Marine Resources Information Program, was transferred in December to the New England Marine Advisory Service. URI, however, continues to provide the service of writer Elisabeth Keiffer and

distribution facilities. There are 11,697 subscribers to the newsletter, which describes marine projects of interest in the region.

Fifty-five news articles on various Sea Grant and marine-related subjects were prepared for the local media in addition to exclusive articles for National Fisherman and the Marine Technology Journal. Also, speakers on marine topics were scheduled on Providence and Boston television interview shows.

Requests for information, processed by information specialist William Bivona and the MAS staff, numbered over 2,000. Clients ranged from scientists wanting specific information on research projects to fishermen needing to know how to keep lobsters alive during transport to school children studying "all about the ocean."

Reorganization. In July of 1975, several of URI's marine departments underwent reorganization. The Division of Marine Resources was created, combining the Marine Advisory Service, the Coastal Resources Center,and the Applied Marine Research Group. Walter Gray, who heads MAS, was appointed to head DMR. Dr. Saul B. Saila, URI professor of oceanography, acts as chief scientist. Also in the division is the Jerusalem Marine Field Station.

COASTAL RESOURCES CENTER

Principal Investigator: Walter J. Gray

The Coastal Resources Center, funded by Sea Grant, the federal Office of Coastal Zone Management, and the state, acts as the technical arm of the Coastal Resources Management Council. Its major task this past year was the development of a management plan for Rhode Island. In response to public comments on the management program and to changes on the federal level, the CRC is currently revising management guidelines and incorporating public comments into its program.

During 1975-76, CRC entered into a contract with the New England Regional Commission (NERCOM) to coordinate a study of the impact of offshore oil and gas development on the commercial fishing industry in the Georges Bank area. Another NERCOM project undertaken by CRC was the coordination of a two-year market feasibility study for an underutilized fish species, the ocean pout. A team of URI specialists in biology, processing, and marketing worked to introduce ocean pout to the consumer market. The result was that more than one million pounds of pout were moved through markets, in sharp contrast to an almost negligible amount the year before.

Also completed by the center was a report on the feasibility of establishing an island park system in Narragansett Bay.

At the request of the Governor's office, the CRC formed an Outer Continental Shelf Task Force. This task force, composed of URI faculty from various disciplines, advises the Governor on issues related to OCS oil and gas exploration and development.

Another Governor's task force was formed for fisheries, as a result of a two-year study completed by CRC on the state's commercial fishes and fishing activities. This task force developed several pieces of legislation which it recommended be introduced into the General Assembly.

Stuart O. Hale, founding director of CRC, retired in July, and was succeeded by Walter J. Gray when the center was incorporated into the DMR. In December, Stephen B. Olsen, a resource specialist with the center, was designated as coordinator.

LAW OF THE SEA INSTITUTE

Principal investigator:
John K. Gamble, Jr.

As the international negotiators prepared for another session of the United Nations Law of the Sea Conference, the

Law of the Sea Institute continued its publication of papers and bibliographies on ocean policy issues for the use of decision makers and other interested parties. These publications included proceedings from the Institute's 9th annual conference held in Miami, Florida, and four other papers: Report of the Ocean Policy Research Workshop; the Greek-Turkish Dispute Over the Aegean Continental Shelf; Contemporary Law of the Sea: Transportation, Communication and Flight; and Canada at the Third Law of the Sea Conference: Policy, Role and Prospects. Responding to the interest of agencies in the management of the 200-mile economic resource zone, two bibliographies in law of the sea and marine policy were published. One contains annotations of some 400 articles printed in the periodical literature of the 1970s. The other is a regional bibliography focusing on Latin American contributions to law of the sea.

Planning was also conducted for the institute's 10th annual conference, which followed the close of the third session of the UN Law of the Sea Conference in New York. The conference, the theme of which was Law of the Sea; Outcome and Problems of Implementation, examined many aspects of extended coastal state jurisdiction including modes of establishing economic zones and economic zone management. This well-attended conference at URI drew substantial representation from the delegates to the UN's Law of the Sea Conference session in New York.

CORROSION OF ALUMINUM ALLOY SCUBA TANKS

Co-Principal Investigators:
Dr. Hilbert Van N. Schenck, Jr.
John J. McAniff
Graduate Student: Fran Cichy

Nationwide, about two deaths occur every three years by scuba tanks exploding while they are being filled with air at dive shops. These explosions result from corrosion of the tank caused by seawater trapped inside the cylinder. Concerned about this problem, the URI diving safety researchers earlier had studied the problem of corrosion in steel tanks and had recommended that aluminum tanks be allowed on the market. Manufacturers of an aluminum tank soon became interested in having URI researchers perform the same corrosion tests on the aluminum tanks to evaluate their potential for corrosion.

During 1975-76, the researchers performed these tests on the aluminum tanks. They found that the tanks, under extreme corrosion exposure, proved much more resistant than steel tanks. As a result they are recommending that the industry phase out steel tanks and replace them with aluminum alloy cylinders.

Additional tests were also run by the researchers to test the galvanic coupling effects of the aluminum tanks with chrome-plated brass valves, a problem which exists only when the brass extender is exposed at the gas/water interface. They suggested that the brass extender on the tank valve be replaced with aluminum, or be treated to reduce corrosion.

ADVISORY SERVICE PUBLICATIONS

Cruising Guide to Historic Rhode Island. N.W. Ross, M. Hanft, N. Randolph, Marine Advisory Service, URI, 1976. P480

How to Build a Floating Scrap Tire Breakwater. T. Kowalski, Ocean Engineering, and N. Ross, Marine Advisory Service, URI, 1975. Second printing, 1976. P455

How to Build and Save Beaches and Dunes. J.A. Jagschitz and R.C. Wakefield, Plant and Soil Science, URI, 1971. Third printing. P 44

Marine Career Series: Marine Related Occupations: A Primer for High School Students. P.K. Stout and S. S. Callaghan, Marine Advisory Service, URI, 1976. P 486

Sea Grant Annual Report, University of Rhode Island, 1975. B. Cole, Marine Advisory Service, URI, 1976. P 473

Some Northeastern State Regulations for Non-resident Fishermen. A. Holmsen, Marine Advisory Service, URI. P 443

Education

The marine environment is becoming increasingly more important as a source of resources, many of which are being rapidly depleted on land, as a center for valuable commercial activities, and for its other benefits such as recreation. As the demands on the marine environment increase, need grows for more men and women who can wisely manage marine resources. To provide this personnel, URI has been a pioneer in the development of training programs for specialists to deal with such problems as marine resource management, marine economics, and ocean engineering. In addition, it has recognized the need to increase the sophistication and technology of traditional marine occupations such as commercial fishing to meet the demand for increased efficiency.

MASTER OF MARINE AFFAIRS PROGRAM

Principal Investigator:
Dr. Lewis M. Alexander

Bringing together specialists in a broad range of fields, the marine affairs program tries to provide its

students with an appreciation of diverse perspectives on the problems of marine resource development. In its seventh year of operation, the program graduated 20 students whose backgrounds included economics, military service, fisheries, science, computer science and law. Among speakers offered in 1975-76 were experts from the National Maine Fisheries Service and the Soviet-U.S. Fisheries Claims Board. Students visited with delegates and technical experts to the third session of the United Nations Law of the Sea Conference on a field trip to New York.

Some of the positions accepted by marine affairs graduates are with a variety of departments within the U.S. National Oceanic and Atmospheric Administration, the National Fisheries Company of Trinidad, the Massachusetts Maritime Academy, the Norfolk, VA Port Authority, the New England Fisheries Steering Committee, and the marine affairs program.

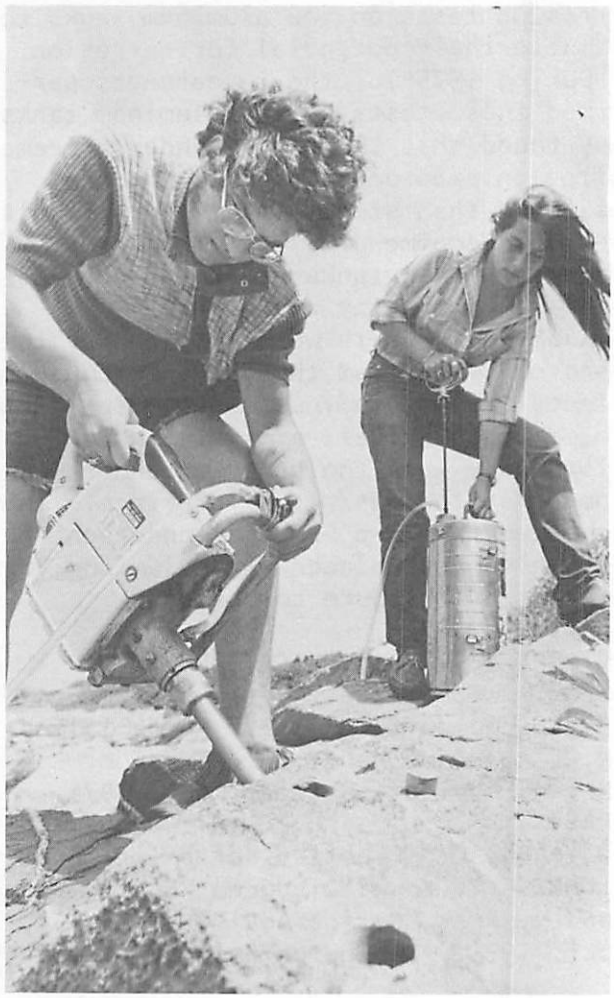
Recently, a program allowing a marine affairs graduate to also obtain a certificate in commercial fisheries was instituted in cooperation with the URI Department of Fisheries and Marine Technology. This was adopted so that fisheries students, especially those from developing countries, may receive training in resource management skills. Also instituted was a cooperative effort with the URI Graduate Program in Community Planning and Area Development which allows planning students to receive training in coastal zone management.

OCEAN ENGINEERING

Principal Investigator:
Dr. Herman E. Sheets

The recent boom in offshore oil development and other commercial activities in the marine environment has generated a need for engineers trained to deal with the special problems of working in the marine environment. Consequently, the employment picture for the growing number of URI's ocean engineering students is extremely bright. Of last year's graduates - three doctorates, ten masters, and five combination bachelors in mechanical and ocean engineering - most were employed by private industry. The rest have entered university, government, or military service.

Currently, over 100 graduate and and undergraduate students are enrolled, many of whom are part-time students who work with nearby industries or military installations. Research projects by ocean engineering students range from ship propulsion devices to



underwater archeological excavation techniques and numerical modeling of water circulation.

ECONOMICS-MARINE RESOURCES OPTION

Principal Investigator:
Dr. Darrell L. Hueth

This doctoral program is designed to fill a nationwide need for professional economists familiar with marine economic problems, a growing need now because of the growth of commercial activities in the marine environment. Offshore oil development and the extension of the U.S. economic zone to 200 miles have heightened this need. Three doctoral degrees were awarded in 1975-76.

FISHERIES AND MARINE TECHNOLOGY

Principal Investigator:
Geoffrey A. Motte

With the extension of the United States' economic control out to 200 miles, and the accompanying restrictions on foreign fishing within this zone, U.S. fishermen will need to expand their capabilities to efficiently harvest the resources available to them. Helping to prepare fishermen for this task are graduates from URI's two-year associate degree program in fisheries and marine technology. The department also offers a four-year bachelor's degree in commercial fishing or natural resources, which includes the two-year fishing certificate, and, in conjunction with the marine affairs program, a graduate certificate.

In 1976 there were 23 students, including the first woman graduated from the program. Four additional students received their bachelor's degrees.

EDUCATION PUBLICATIONS

How to Plan and Cut Nets. A.J. Hillier, Fisheries and Marine Technology, URI, 1972. Fourth Printing. P133

Marine Affairs Journal #3, M. Betty et al., Master of Marine Affairs Program, URI, 1975. P464

When a state the size of Rhode Island possesses over 400 miles of shoreline, the resources of these waters become extremely important. Increasing pressures of development on the marine resources in the coastal zone make it imperative that the state have the knowledge it needs about these resources and sectors of the population dependent on them. This is necessary so that proper actions can be taken when possible threats to the survival of coastal resources arise. Sea Grant researchers have attempted to provide information about the movement of Rhode Island's coastal waters, the ecology of natural systems, the effects of man's activities on natural systems, and the non-economic benefits resulting from the use of marine resources.

Coastal Resources

ECOSYSTEM ANALYSIS - APPLICATION IN A COASTAL TOWN

Principal Investigator:
Dr. Candace A. Oviatt

Associate Investigator:
Dr. Scott W. Nixon

Graduate Student: Virginia Lee

From the hundreds of years of interactions between man-made and natural systems in South Kingstown and Narragansett, a unique ecological unit

has been formed. In this unit, man's economic development has put stress on the natural ecosystem, and in return, the natural ecosystem has imposed constraints on man's development. To examine and quantify these interactions, URI researchers Dr. Candace A. Oviatt, research associate, and Dr. Scott W. Nixon, associate professor of oceanography, applied techniques of ecological systems analysis which they have been developing to the coastal ecosystem. Their goal has been to generate a "macromodel" of this coastal area so that the general consequences of long-range management strategies proposed for it can be predicted.

A large amount of data on the human ecological systems were collected. They include present and past land use and ownership, water supply, resources, housing, population structure, types of soil and vegetation, agriculture, fishing, tourism, public services, transportation, and energy uses. These data are being analyzed to develop budgets, flow diagrams and models of the whole ecological unit. An initial model analysis conducted by the researchers was an examination of the stress boundaries between natural and human systems to see when natural resources would begin to limit human development.

The information and models developed by the researchers will be presented to the town councils of South Kingstown and Narragansett and to citizen groups, to be used as a basis for discussion of the effects of various kinds of coastal zone development.

EFFECT OF DREDGE SPOIL DISPOSAL ON BENTHIC ANIMALS

Co-Principal Investigators:
Sheldon D. Pratt, Dr. Saul B. Saila

Dredge operations needed to keep waterways and ports open are vital to shipping interests and to boat traffic. These operations have often been delayed because of concern over the effects on fauna and flora at the sites used for deposit of dredge spoil. Many studies have been launched to examine the biological effects of disposal so that wiser selection of sites can be made. The spoil site's recovery rate is important to this area of study.

Sheldon Pratt, research associate, and Dr. Saul B. Saila, professor of oceanography, investigated the recovery rate of one abandoned spoil site by monitoring the geological, chemical, and biological changes that have occurred after abandonment.

The site chosen by Pratt and Saila is in Rhode Island Sound, where close to one million cubic yards of sediment were deposited between 1967 to 1970. In their observations of the site, they followed the pattern of recolonization and found three different types of assemblages would successively occur: those organisms found in silt, unstable sand, and in stable fine sand. The researchers found that even after five years of recovery, the spoil site had fewer species and lower biomass than the area's natural bottom.

In addition to observations made at the site, laboratory studies were conducted on the burrowing and feeding behavior of important benthic species, and also on the growth rate of the ocean quahog.

All of the information on the spoil site recently collected by the scientists has been transmitted to governmental agencies to aid in the choice of a regional disposal site for Rhode Island and southern Massachusetts.

MONITORING HYDROCARBONS ON AND IN SEA WATER

Principal Investigator:
Dr. Christopher W. Brown

Graduate Student: Wai Ping Lee

Research Assistants:
Mark Ahmadjian, Patricia Lynch

Narragansett Bay is the state's major resource, essential to the commercial and recreational activities that are vital to the state's economy. Because of the Bay's importance, investigations were conducted into the levels of hydrocarbons now existing in the Bay, its major rivers, and its beaches by Dr. Christopher W. Brown, assistant professor of chemistry. The locations monitored included the Providence and Seekonk rivers, waters off Rocky Point, Jamestown, and Point Judith, and beaches in the Bay and Rhode Island Sound. In addition, a major pleasure-craft harbor, Wickford, was sampled for its level of hydrocarbons.

The results of the team's 114 samples showed that the greatest petroleum pollution occurred in the Providence and Seekonk rivers. In Wickford Harbor, researchers discovered higher levels of hydrocarbons during the winter. These hydrocarbons are from diesel or home heating fuels, not from the gasoline or lubricating oils used by most pleasure craft. The chemists also detected the presence of a hazardous chemical called phthalic acid ester in Wickford and the Seekonk River. This chemical is used in making plastics and is also produced by degradation of some petroleum compounds in sea water.

Techniques used by the researchers in their analyses were infrared spectroscopy and gas chromatography. Both of these, however, require sample preparation. In order to cut down the time needed to identify contaminants, the researchers began exploring other methods. The most promising of these has been Raman spectroscopy, which involves beaming a laser into a sample. From the scattering of the light, contaminants are identified, because no two contaminants scatter the laser light in the same way.

SYSTEMS ECOLOGY STUDIES OF NARRAGANSETT BAY

Principal Investigator:
Dr. Scott W. Nixon

Associate Investigator:
Dr. Candace A. Oviatt

Graduate Student: Wendell Hahm

What would happen if all the plankton in a section of Narragansett Bay were killed by a spill of hazardous chemicals? What would be the effect on the life and water quality of the Bay if sewer outfalls were relocated? Once questions like these could only be answered with reasonable guesses. Now, however, URI researchers have been gathering data to prepare a numerical model of Narragansett Bay which they hope can more accurately predict how this ecosystem will respond to perturbations caused by human actions. Dr. Scott W. Nixon, associate professor of oceanography, and Dr. Candace A. Oviatt, research associate with the Graduate School of Oceanography, have been involved for six years in developing their ecosystem model, which provides realistic simulations of the interactions and roles of phytoplankton, zooplankton and five nutrients in the Bay. The model is divided into eight sections, which allows monitoring of the effects of a change in one section on the other seven.

During 1975-76, researchers conducted several field and laboratory experiments to expand the data base for their model. The researchers also tested its responses to changes in its ecosystem. Currently, they are using the model to determine possible effects of relocating sewage outfalls

in the Bay, in response to a request from the Rhode Island Department of Health. Because the time, money, expertise, and facilities for modeling do not exist in many places where increasing pressures are affecting ecosystems, the scientists are continuing to investigate the general applicability of their Narragansett Bay model for predicting the responses of other systems.

DEVELOPMENT OF AN INTEGRATED THREE DIMENSIONAL HYDRODYNAMIC, SALINITY AND TEMPERATURE MODEL

Principal Investigator:
Dr. Malcolm L. Spaulding

Graduate Student: Robert Gordon

Building on past experience with numerical modeling of water circulation, Dr. Malcolm L. Spaulding, assistant professor of ocean engineering, and his assistant derived equations for a new three-dimensional numerical model to simulate water circulation and salinity distribution for estuarine and coastal applications. The modeling technique developed is a novel method for decreasing computational difficulties. This model is presently ready for application in cases where vertical circulation is important, such as in water quality predictions.

To test the accuracy of the model,

ten cases were run in which analytical solutions were also computed for comparison. Following these tests, a model for the Providence River was developed which describes the effects of wind and salinity gradients on the water circulation.

CAUSES OF PHYTOPLANKTON BLOOMS IN NARRAGANSETT BAY

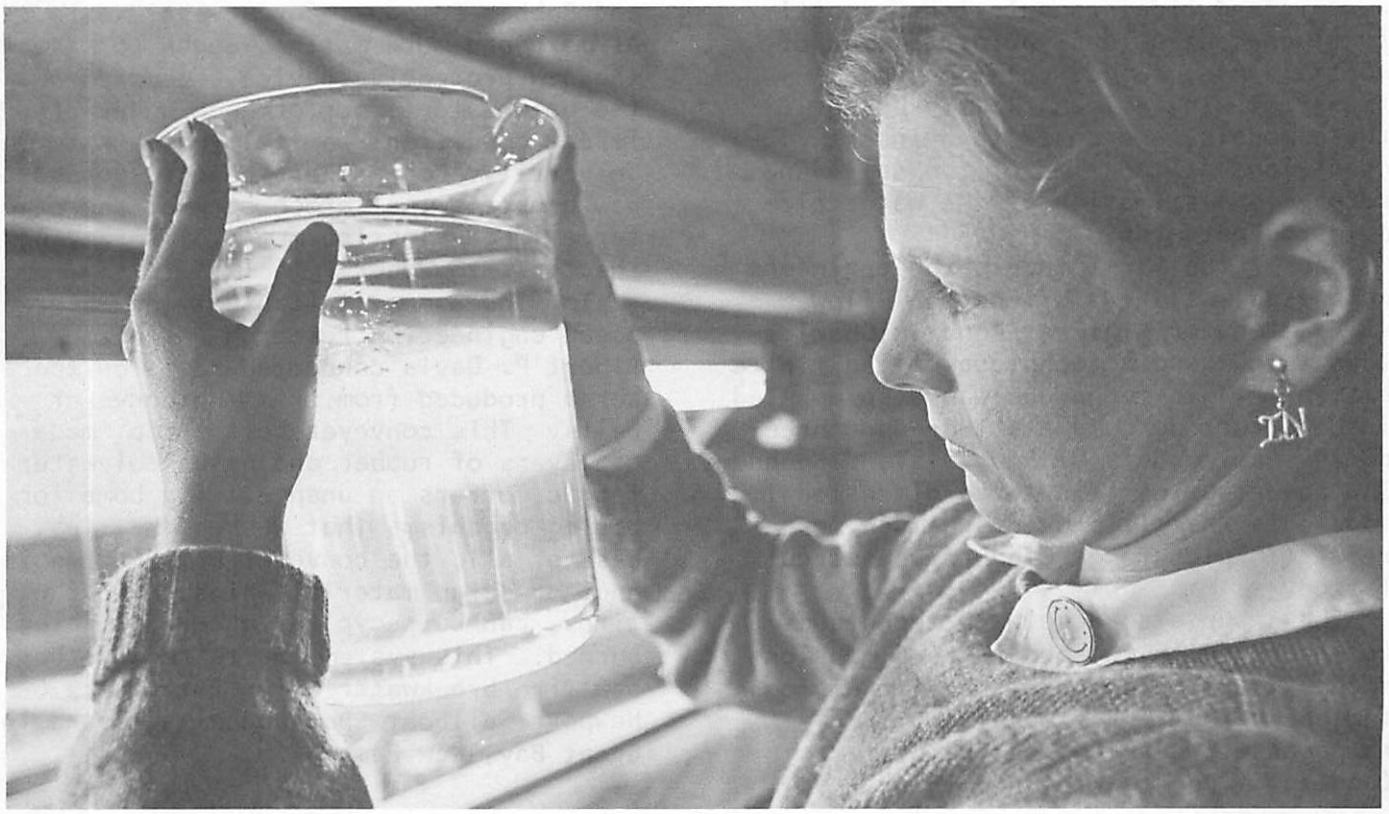
Principal Investigator:
Dr. Theodore J. Smayda

Graduate Student: Gary Hitchcock

Research Assistant: Carmelo Thomas

Phytoplankton are essential as the basic producers of food and oxygen for life in the sea and on land. In studies of phytoplankton in Narragansett Bay, Dr. Theodore J. Smayda, professor of oceanography and botany, noticed during four of the past six years an unusual phenomenon regarding these tiny plants. The largest bloom, or population explosion, of the plants (the majority being the diatom Skeletonema costatum,) occurred in August, and not at the usual late-winter/spring time. A series of studies was launched to clarify the reasons for the late summer bloom.

One of the studies examined the role of nitrogen in regulating the natural phytoplankton population. Phytoplankton were concentrated, provided with nutrients, and observed for their rate of nitrogen uptake. The daily nitrogen requirements calculated from this experiment were then compared to the amount of nitrogen excreted from zooplankton and benthos to see if their excretion rates would supply this daily phytoplankton need. It was found that the zooplankton and benthos were not the only source for the required nitrogen, nor were pollutants, runoff, or rainfall. Research to find the remaining sources is continuing.



The scientists also investigated the possibility of extensive grazing of phytoplankton by ctenophores as a population regulation mechanism. However the experiment showed no evidence of this extensive grazing.

ANALYTICAL MODELING OF COASTAL ZONE AREAS

Co-Principal Investigators:
Dr. Frank M. White,
Dr. Malcolm L. Spaulding

Graduate Student: Hsin-pang Wang

If a ship sank and began to release a cargo of oil or a hazardous chemical into the waters around Rhode Island, clean-up crews could be one step ahead if they knew in what directions the contaminants would travel. One way URI ocean engineers are trying to help is by developing numerical models, in two and three dimensions, of coastal water movement over the shelf off southern Rhode Island. These models provide for hydrodynamic and tidal computations, constituent concentrations, point release of contaminants, net circulation, and transient wind driven flows. Using these models, one could then insert conditions at the time of the spill and receive an estimation of the water circulation patterns.

One of the first models the engineers completed was a two dimensional flow simulation for Ninigret Pond in Charlestown which used a technique called finite element. This technique was also applied in constructing complete two- and three-dimensional models of Block Island Sound. The advantage of this three-dimensional model, is that it provides a much more realistic picture of wind-driven circulation.

The group also developed techniques for modeling in two and three dimensions the point release and dispersion of contaminants from three locations in Narragansett Bay--Quonset Point, Coggeshall Point, Fields Point--and just offshore of Charlestown Beach.

These preliminary studies on nutrient uptake and grazing provided important insights and guidance, which have helped in designing more extensive physiological-ecological studies now on-going. The group is also planning to establish growth kinetic constants for the phytoplankton species dominant in the bloom, and to investigate why a minimum of phytoplankton occurs when conditions would appear to be favorable to growth.

FLOATING BREAKWATERS

Principal Investigator:
Dr. Tadeusz Kowalski

Associate investigator:
Albert P. Davis Jr.

Refinement of the inexpensive and effective floating-tire breakwater has been a continuing Sea Grant project, supported in part by the Goodyear Tire and Rubber Company, for several years. As more and more marinas began to install the new protective device, feedback on the breakwater's performance under different conditions was relayed back to the University. Researchers have responded to new problems that arose such as the need for a longer-lasting material for tying the tires together.

To find a more suitable tying material, ocean engineering research associate Albert P. Davis conducted tests on the scrap produced from trimming conveyer belts. This conveyer belt scrap, made of layers of rubber and nylon-polyester fabric, offers an unappetizing home for boring organisms that weaken the ties. Best of all, the conveyor belt edging is another scrap material which, like the tires, can be recycled instead of being burned. This system was tested in the new tire breakwater built for the 1976 Newport Sailboat Show and at a marina in Great Bay, New Hampshire.

Another finding from the field tests of the breakwater was that, not unexpectedly, they began to accumulate marine organisms. An investigation into the amounts and types of marine organisms settling on the tires was completed by a group of high school students. Their findings of such organisms as softshell clams and blue mussels raises the possibility that the tires could someday serve double duty as aquaculture reefs. The tires may also prove a source of shelter and food for fish, thus creating new grounds for fishermen.

Also undergoing investigation was the use of tires as breakwaters for offshore areas. Dr. Tadeusz Kowalski, professor of ocean engineering, experimented with their use in these areas while spending a year at the University of Glasgow. Models of different configurations were tested in tanks for their response to varying wave heights.

AN ECONOMIC EVALUATION OF MARINE RECREATION IN RHODE ISLAND

Principal Investigator:
Dr. Kenneth E. McConnell

Graduate Student: Lester Nicholson

Rhode Island's 419 miles of shoreline is an important recreational resource to the state, used heavily by both in-state and out-of-state residents. The shoreline is also important economically. To guard this important resource, state planners need to know what types of activities occur along the coastline, what are the predicted future use demands, and what is the optimum carrying capacity of the facilities the state now has.

In this project, three surveys of marine recreational activity were compiled. From this data, provisional forecasts of the use of marine recreational facilities in the state for the next 20 years were completed. Lastly, a study of the carrying capacities of Rhode Island's beaches was determined. The results of these studies, giving an insight into the socio-economic characteristics of the users of marine recreational facilities and the demands on these facilities were conveyed to state planners. This information will also become an integral part of the Rhode Island Comprehensive Outdoor Recreation Plan.

INPUT, TRANSPORT, AND FATE OF PETROLEUM HYDROCARBONS IN SEWAGE EFFLUENTS

Principal Investigator:
Dr. James G. Quinn

Graduate Student: Edward S. Van Fleet

Each year the Field's Point sewage treatment plant, the largest in the state, discharges about 40 percent of the sewage that ultimately enters Narragansett Bay. This sewage, which is first released into the Providence River, carries approximately 300 metric tons of hydrocarbons a year. For the past two years, the transportation and fate of these sewage hydrocarbons has been the subject of research by Dr. James G. Quinn, associate professor of oceanography.

His team first performed analyses of 21 composite samples of sewage effluent from the plant. Hydrocarbons, in general, were associated with the suspended material in the effluent. Only five percent were found to be dissolved in the effluent. Similar analyses were conducted on water samples taken from four locations in the Providence River. The results showed that the river hydrocarbon concentration decreased significantly from the plant outfall to the river mouth. As with the effluent, most of the hydrocarbons were present as suspended material rather than being dissolved. The pattern of hydrocarbon abundance and distribution in surface sediments of the Providence River at the same four river locations also showed a significant decrease from the sewage outfall to the river mouth. Sediment core samples were examined for

the vertical distribution of the hydrocarbons.

From these studies, Dr. Quinn suggests that most hydrocarbons introduced into the Providence River associate with suspended material rather than being dissolved into the water column. Some of these suspended hydrocarbons are then rapidly deposited in the river sediments. The remaining fraction is transported down the Bay via tidal currents, and is gradually deposited in the Bay sediments. The amount of hydrocarbons existing now in the Bay sediments is currently being investigated.

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Natural Fisheries

Despite the significant drop in the numbers of the most important commercial fish species, Rhode Island's fisheries have been thriving. A major reason has been the versatility of its fleet, which is seeking out new species for harvesting and adopting new gear and techniques. The state's fishermen are standing at the threshold of a new age. The creation of U.S. jurisdiction over fish stocks out to 200 miles may mean that, with proper management, over-exploited stocks may eventually make a recovery. However, this bright prospect for the future depends on costly and time-consuming experimentation with gear and development of managment schemes. To aid the fishing industry in this experimentation, the URI Sea Grant Program has committed its expertise and facilities to help refine fishing gear, provide fishermen with needed information about changes in navigational systems, discover the population dynamics of important fish species, and determine the economic impacts of extended jurisdiction.

BOTTOM TRAWL AND OTTERBOARD PERFORMANCE STUDY

Principal Investigator:
Geoffrey A. Motte

If there's a good way to catch fish, it might just be possible to improve it. That was the goal of fisheries gear researcher Geoffrey A. Motte this past year. Using statistical procedures, theoretical studies, and field experiments, he tested the effectiveness of fishing gear modifications that he and others designed and evaluated the performance of trawling gear.

One of the fishing gear modifications involved otterboard weight and size variation. A statistical model previously developed from instrumented field trials on the Yankee 35 trawl was expanded to include factors representing the effect on the angle of trawl mouth of these variations. In another experiment, a full scale set of high aspect ration trawl doors was fabricated and tested to see if the present instability of the doors could be eliminated. Initial sea tests were promising, but further modifications were continued.

As an alternative method for evaluating trawl performance, one which would not require field tests, Motte identified the existing statistical procedures and techniques available for analyzing catch data as an indication of how well a trawl performs. In preparation for the completion of a towing tank for testing scale

net and door models, Motte also developed techniques for determining and evaluating hydrodynamic interactions between trawl doors and trawl gear. These techniques will allow fishing gear researchers to examine trawl door stability and hydrodynamic characteristics prior to further full scale development.

To improve the results of field testing, changes were made in the acoustical instrumentation now used by URI gear researchers. New instrumentation using omnidirectional sound was designed and constructed which not only improves the reliability of measurements but also reduces the time necessary for data acquisition.

TRANSITION FROM LORAN-A TO LORAN-C

Principal Investigator:
Thomas M. Stout

Associate Investigator:
Albert P. Davis

Transitions from old to new systems often present difficulties. In the changeover in navigational systems from Loran-A to Loran-C, Thomas A. Stout, instructor in fisheries and marine technology, found this to be especially true. In this case, however, the difficulties encountered during the transition period can be extremely hazardous to boat crews because navigational systems are essential for determining a boat's location. To identify the problems which are arising in the change to Loran-C, Stout occupied 200 survey stations and steamed 500 survey miles. The data he obtained was analyzed and published in the form of two smooth data sheets and three charts which were made available to fishermen and boat operators. Also prepared from these surveys was a marine advisory bulletin which discusses the accuracy, repeatability, and general usefulness of the system's performance. Stout found that the engineering of the new system was very good overall, but that certain design improvements could be made. These suggestions for improving receiver design were passed on to the manufacturer, who concurred with them. Suggestions for improving the Loran-C system were conveyed to the Coast Guard.

THE ECONOMIC IMPACTS OF EXTENDED FISHERIES JURISDICTION UNDER ALTERNATIVE INSTITUTIONAL AND FISHERIES MANAGEMENT POLICIES

Principal Investigator:
Dr. Virgil J. Norton

During the first year of this project, Dr. Virgil J. Norton, professor of resource economics, concentrated his efforts on formulating a framework for evaluation of the economic impact of extended fisheries jurisdiction and on gathering data and information relating to various aspects of the domestic and foreign fishing industry. The information collected was designed to accomplish the following objectives for the first year: (1) to identify the amount of domestic investment in the harvesting and processing sectors required to utilize the fish stocks available under extended jurisdiction; (2) to develop economic criteria for determining the appropriate rate of reducing foreign fishing effort within the zone; and, (3) to identify the economic effects of potential increases in the domestic share of coastal fish resources and probable decrease of imports on the prices of fish products available to U.S. consumers and on general world fishery trade patterns.

Some of the information collected to accomplish these objectives included a survey of the New England groundfish industry; the catch and effort of U.S. and foreign vessels in the ICNAF area for the years 1954-1973; data on the European fishing industry; and data by geographic and product basis of the retail, wholesale, and processing sectors of the U.S. fishing industry.

In the project's second year, Norton will analyze the data, primarily with the objective of examining alternative entry limit schemes and also of analyzing

potential effects of certain institutional aspects such as antipollution laws, and new onboard handling requirements on the fishing industry.

ECONOMICS OF GROUNDFISH TRAWLERS

Principal Investigator:
Dr. Andreas A. Holmsen

In comparing the economics of groundfish trawling in Norway, Iceland, and the United States, Dr. Andreas Holmsen, professor of resource economics, found the best money for a fishermen was on a U.S. boat and the most return to an investor was from a Norwegian vessel. These findings were based on Dr. Holmsen's analysis of 1974 data he collected in each country on the operations of groundfish trawlers measuring 65 to 90 feet in length. In his comparisons, fishermens' earnings were 50 percent higher in the U.S. than in Norway, and 100 percent higher than in Iceland. On the other hand, return on capital was considerably higher in Norway than in the U.S. In Iceland the return on capital was negative.

The report, detailing comparisons of the three countries' trawlers, includes data on vessel characteristics, fishing effort, landing, and price and cost breakdowns. It contains descriptions of the underlying reasons for many of the cost items which need explanation, such as insurance and finance costs; the share systems on the vessels in each country, and the effects of transfer payments and subsidies that affect costs or prices. In addition, it discusses problems associated with international comparisons of cost and return data from fishing vessels.

REGIONAL FISHERIES POPULATION MANAGEMENT

Principal Investigator:
Dr. Saul B. Saila

Graduate Students:
Michael Sissenwine, David Bearse

Research Associate:
Daniel Sheehy

During the 1940's the yellowtail flounder began to become an important resource not only to otter trawlers from Massachusetts and Rhode Island but, increasingly, to boats from New York and foreign countries. The fishery prospered during the 1940's, declined during the 1950's, and suddenly recovered during the 1960's. To find out what caused this decline and sudden recovery, URI professor of oceanography Dr. Saul B. Saila investigated the population dynamics of the fish.

The aspects of the population dynamics chosen for study were the average growth per fish, the equilibrium catch (the maximum amount of fish which can be harvested without detrimental effect on the stock), and the number of recruits, that is, of yellowtails reaching harvestable size. Methods were developed to estimate values for these aspects during the period 1944-1965.

The investigators found that 43 to 75 percent of the annual equilibrium catch of the fishery resulted from recruitment, and that the temperature three years before the fish were recruited affected the catch size more than the size of the spawning stock. The effect of warmer temperatures than average for a season was negative on harvests three years later while cooler temperatures would be reflected in a better harvest after that same period. Temperature increases were also found to slow growth rates of the fish. The reason for the detrimental effect of warmer temperature, the scientists feel, is that the yellowtail flounder in southern New England waters is at the southern limit of its range.

In order to demonstrate that these relationships determined for the yellowtail flounder fishery were realistic, and to illustrate the usefulness of models for managing a fishery, a compartmentalized simulation model was developed. The model was found to adequately explain major trends in the fishery between 1943-1972, the years for which data were available.

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Aquaculture

Salmon and lobsters are both highly prized items in the seafood market. As such, they hold a great attraction as animals for "sea farming" or aquaculture. However, before profitable farming of these two species can take place, many questions about the basic physiology of these animals and how they react under differing culture conditions must be answered. Because private industry is hard pressed to devote the capital and time needed to find out if aquaculture ventures with these animals would be feasible, Sea Grant scientists at URI are studying the suitability of these animals for aquaculture.

MANAGEMENT OF SALMONIDS IN A CLOSED CIRCULATING CONTROLLED ENVIRONMENT SYSTEM

Principal Investigator:
Dr. Thomas L. Meade

Research Assistant:
David Wilson

The salmon which once graced the waters and provided delectable fare to the early settlers has long since left the East Coast. For several years, URI scientist Dr. Thomas L. Meade, professor of animal science, has tried to bring back salmon to the East through development of closed system aquaculture. With the system design completed, research focused on possible disease and nitrification problems that can arise in the system, and on feed formulation for coho salmon fingerlings.

The most significant accomplishments occurred in the studies on diseases. A technique for rapidly screening therapeutic agents for their effect on nitrification was developed, so that safe levels for a wide range of these agents could be established.

Significant progress was also made in the area of ammonia and nitrate toxicity. One notable result has been the establishment of the specific reaction for the ligand bondings of ammonia to hemoglobin, a reaction which effectively reduces the oxygen transport capability of blood. This discovery holds obvious implications for humans if the reaction occurs with their blood. Studies are now being extended to mammalian blood.

In regard to nitrite toxicity, experiments revealed that the increasing chloride ion concentrate in a fresh water supply may eliminate nitrite toxicity, a chronic problem in some Western hatcheries. Another major problem in hatcheries, the capital costs of the closed aquaculture system, may be reduced by 30 percent per installation because of observations made on the nitrification capability of suspended microcolonies of nitrifying organisms. These could replace the more expensive, fixed-media aerobic filters.

Another major cost of the aquacultural system may be lessened by utilizing diets developed by the scientists which use fish sold for industrial purposes. Several diets were tested with good results.

SELECTED PROBLEMS IN AQUACULTURE OF AMERICAN LOBSTER, Homarus americanus

Principal Investigator:
Dr. Akella N. Sastry

Graduate Students:
Lynn Zeitlin-Hale, John Laczak,
Carol Milligan

Research Assistant:
Doug Wilcox

For several years Dr. Akella N. Sastry, associate professor of oceanography, has been directing research into aquaculture of the commercially important East Coast lobster. The efforts of his research team during 1975-76 were concentrated on determining the techniques and optimal conditions for culturing lobsters as larvae, juveniles and adults; the effects of environmental conditions on communal rearing of juvenile and adults, and physiological studies of egg production and larval development.

During the studies of juvenile lobster growth rates, it was discovered that initial differences in weight and frequency of molting found among animals seem to establish a pattern for slow or fast growth. Therefore, it is now possible to select animals which will grow fast.

Other studies conducted on space requirements for growth showed that space has a definite effect on growth, with severe space limitations affecting survival. From the data gathered, it is now possible to calculate the optimal space requirements for maximum growth and survival of lobsters during each of the molt stages.

From analysis of all the data collected on growth rates, two observations resulted. The first is that lobsters could reach a market size of one pound within three to four years if kept in a partially recirculating seawater system at 20 degrees Centigrade and fed a diet of live blue mussels. The second is that weight gain per molt is an innate characteristic of each lobster, while the molting frequency is dependent upon environmental conditions.

SELECTED PROBLEMS IN THE CULTURE OF THE LOBSTER, *Homarus americanus*

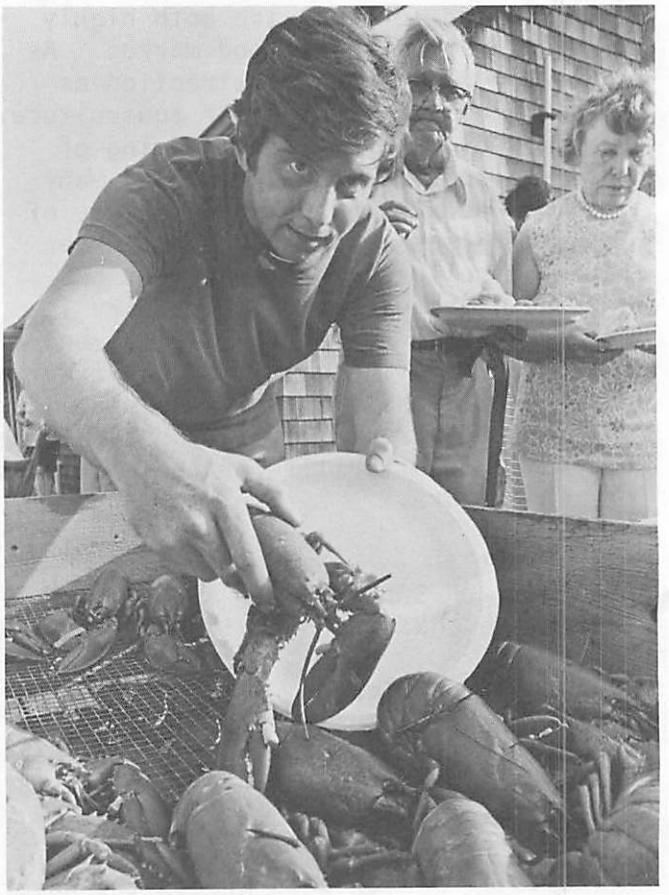
Principal Investigator:
Dr. J. Stanley Cobb

Research Assistant:
George R. Tamm

Graduate Student:
Anne David

Students:
Christopher Ordzi, Mike Solon

When two lobsters are held together in a tank, they form a dominant/subordinate relationship. It has been shown that one effect of this relationship is that the molting of the subordinate lobster is



delayed. To understand more about the mechanisms of molt delay and of dominance hierarchies, a number of different experiments was conducted by Dr. J. Stanley Cobb, professor of zoology.

In one of these studies, lobsters in the ninth stage of development were paired together to see if there were chemical and visual signals which mediate molt delay. The results indicated that actual physical contact was required to effect the delay. This suggests that when lobsters are held in the same water, molt delay phenomena should be taken into account.

Dominance in lobster groups, proved earlier in experiments at URI, came under scrutiny in another series of experiments interrelating dominance rank, its induced molt delay, and the underlying behavioral, physiological, and morphological mechanisms. Tanks were stocked at three different densities and the locomotive and agonistic behaviors of the lobsters were observed. It was found that at all densities there would be periodic bursts of activity, although activity decreased as the density increased. The subordinate animals were also found to have reduced activity patterns. Agonistic behavior, on the other hand, increased with the stocking density until, at the highest level, the animals displayed constant threat postures.

MARINE PATHOLOGY

Principal Investigator:
Dr. Richard E. Wolke

Graduate Student:
James Fontaine

Lab Technician:
Dennis Mesko

For several years Dr. Richard E. Wolke, associate professor of animal pathology, and his staff have been working continuously with both salmon and lobster aquaculturists at URI. During 1975-76, they noticed in their monitoring of the salmon system that the incidence of the disease Nocardiosis was increasing in the salmon. In order to further study the disease, Wolke and his staff conducted an investigation on the organism responsible.

In the lab's work on diseases in wild marine fish populations, the staff examined tissue samples from striped bass collected in New England and mid-Atlantic coastal waters. This study will result in a monograph on striped bass diseases.

From studies of diseases in domestic and wild fish, lab personnel have built up an extensive collection of tissues from marine invertebrates, fish, birds and mammals. Because of this collection, the Sea Grant lab was chosen by the Armed Forces Institute of Pathology to prepare study sets and syllabi on fish diseases. These will be made available to scientists throughout the world.

In providing extension services, the lab's personnel serve a wide clientele, from health departments to commercial aquarium owners. One such extension activity this past year benefited Narragansett Bay bait dealers whose eels were dying in great numbers shortly after capture. Dr. Wolke determined that there was an outbreak of the fish bacterial disease vibriosis among the bait eels and suggested several procedures to the dealers for reducing their bait loss. The dealers followed the suggestions and were able to provide the needed bait eels to sports fishermen for their chance at the annual bluefish and striped bass runs.

ECONOMICS OF SALMONID CULTURE IN NEW ENGLAND

Principal Investigator:
Dr. John M. Gates

Working in conjunction with the salmon aquaculturists at URI, economist Dr. J.M. Gates completed and published a cost analysis for a pilot scale smolt rearing system. He also formulated a system optimization model which was used to

optimize the growth and marketing of silver salmon. In an attempt to place rates of return for salmon into perspective with rates of return in other sectors of the U.S. economy, a financial analysis of the grow-out phase was done. This indicated rates of return comparable to those in other sectors.

THE POTENTIAL OF MARINE MACROALGAE IN SILO CULTURE

Principal Investigator:
Dr. Marilyn M. Harlin

Associate Investigators:
Dr. Thomas L. Meade, Jon Lindbergh

Research Assistants:
Boyce Thorne Miller, Louis A. Ventura

One of the problems in a closed aquaculture system is how to remove from the recirculating water nitrogenous wastes generated by the culture animal. A far-from-exotic method, which lets nature do all the work and also promises to pay for its own keep, has been experimented with by a group headed by Dr. Marilyn M. Harlin, associate professor of botany. She is investigating using a commercially valuable red algae, Gracilaria verrucosa, to remove the ammonium, nitrite, and nitrate from water coming from a fish silo so that the water can be reused without need for further nitrification and dentrification processing. A saleable product, the seaweed, can be recovered in addition to the culture animal.

In order to demonstrate the potential for use of a silo culture, Dr. Harlin's group first grew, in a pilot system, a low density of killy fish with sea lettuce Ulva as the only biological filter. This pilot system worked well with the ammonia from the fish removed by an actively grown crop of sea lettuce. However, the Ulva has no commercial value. For this reason, Dr. Harlin has been trying to determine the physiology and requirements of the commercially valuable Gracilaria for its suitability for silo culture. One promising thing about the red algae which Dr. Harlin's group discovered was that the temperature and salinity for a salmonid silo culture and removal of the wastes by the algae were compatible. This means that no expensive adjustments for the algal tank would be necessary to keep the Gracilaria happy and growing well.

Based on the above studies, a pilot system has been diagrammed for combining salmonids and Gracilaria cultures.

AQUACULTURE

Closed System Salmonid Culture in the United States. T.L. Meade, Animal Science, URI, 1976. P 483.

Dominance Status and Molt Order in Lobster Homarus americanus. Marine Behavior and Physiology 3:119-124 (1975). J.S. Cobb and G.R. Tamm, Zoology, URI, (1976). P 476.

In Situ Morphology of Nitrifying-Like Bacteria in Aquaculture Systems. Applied and Environmental Microbiology 31(3): 423-432 (1976). P.W. Johnson and J.M. Sieburth. Graduate School of Oceanography, URI, 1976. P 492.

Optimizing the Growth and Marketing of Fish in a Controlled Environment. J.M. Gates and J.J. Mueller, Resource Economics, URI. P 459.

A Production Cost Analysis of Closed System Culture of Salmonids. C.R. MacDonald, T.L. Meade, J.M. Gates, Animal Science, Resource Economics, URI, 1975. P 456.

Marine Food and Drugs

Rhode Island has depended heavily upon food from the sea as sustenance and as a trade product for centuries. For the state to continue this heritage, the availability of healthy seafood species is essential. To help insure the continuation of this dependence upon this marine resource, Sea Grant researchers are studying outbreaks of red tide, which

prohibits shellfish harvesting and developing methods for determining the freshness of seafood products. They are also investigating ways to make maximum use of seafood catches by finding outlets for seafood processing wastes.

STUDY OF EAST COAST PARALYTIC SHELLFISH POISON

Principal Investigator:
Dr. Yuzuru Shimizu

Co-Investigator:
Yasukatsu Oshima

Graduate Student:
William E. Fallon

Wreaking havoc on commercial fishing and seafood sales are the periodic invasions of the New England coast by red tide, a phenomenon caused by a "population explosion" of tiny reddish plants which give sea water a characteristic red color. When shellfish eat the tiny plants, a paralytic poison from the organism is transmitted to them. Even after the bloom disappears, the toxicity of the poison decreases so slowly that a ban on shellfish collecting must be prolonged, causing considerable economic loss to fishermen.

In order to help alleviate these economic losses, URI investigator Dr. Yuzuru Shimizu, associate professor of pharmacognosy, has been studying the toxins found in the East Coast red tide organisms and developing ways for destroying or removing these toxins from tainted seafood.

Shimizu's work brought significant results as he discovered a process to easily extract red tide toxins from clams without affecting the quality of the clam meat. He also set to rest long-standing arguments about the number and nature of the toxins found in the East Coast red tide poison. He and his team have currently identified six new toxins, plus a seventh known one, saxitoxin, which is found in the West Coast red tide organisms. These toxins were first isolated from clams contaminated by the East Coast red tide organism, Gonyaulax tamarensis, and then from a culture of the organism. The results indicated that the toxins isolated from the clams were not secondary products of the shellfish but were originally produced by the red tide organism.

In further study the team determined the chemical structure of two of the new toxins. They also developed a fast analysis technique for the toxins by using high speed liquid chromatography and electrophoresis.

UTILIZATION OF RED CRAB WASTE IN SALMONID AQUACULTURE

Co-Principal Investigators:
Dr. Kenneth L. Simpson
Dr. Tung-Ching Lee
Dr. Clinton O. Chichester

Graduate Student:
M.J. Cyronak

Research Assistant:
K.L. Bonatti

No matter how delectable and nutritious a salmon may be, its marketability rapidly diminishes if it lacks the distinctive pink coloring. When salmon are raised in an aquaculture facility, a major problem is to provide in its diet the pigment astaxanthin, the protein which is responsible for the pink coloring. There presently exists no commercial source for natural or synthetic astaxanthin, meaning that growers often resort to adding artificial colorings, a practice met with increasing disfavor by consumers and regulatory agencies.

URI food and resource chemists investigating the economic uses of red crab processing wastes may have found an answer. They have discovered that the pigment astaxanthin is present in the shells of deep sea red crabs, a species now beginning to be harvested and processed in southern New England. It was

discovered that the needed pigment can be extracted from the shells using hot soybean oil.

In continuing to investigate pigmentation, the researchers looked at the protein composition of pigmented and unpigmented trout and salmon from aquaculture operations and fish markets. From this work they determined that recognized species of salmon would show different protein patterns.

The researchers also examined protein recovery from a shrimp wastes. This process they developed involved adjusting the pH of the wash water to separate out the astaxanthin protein.

In the coming year chemists are planning to continue dietary uses of crab and shrimp wastes; to conduct feedings tests with the pigment extract; and to develop further refinements in the technology of protein recovery from seafood processing plants.

DEVELOPMENT OF A SIMPLIFIED METHOD FOR THE ASSESSMENT OF MARINE FOOD QUALITY

Principal Investigator:
Dr. Arthur G. Rand, Jr.

Associate Investigators:
Federick D. Jahns, Jeffrey L. Howe, Richard J. Coduri, Jr.

There currently exists no inexpensive and fast commercial method for testing the point at which frozen fish ceases to be fresh and marketable. URI food and resource chemists believe they have found

such a method in the development of an enzyme-coated strip which indicates by color change the freshness of fish.

This strip contains a dye and an enzyme (xanthine oxidase) which are immobilized with gelatin onto a piece of filter paper and attached to a small plastic stick. The strip works by the reaction of the enzyme with hypoxanthine, a compound which increases in concentration after a fish is caught. If a fish is freshly caught, its juices placed on the strip will not change the strip's initial blue color. As the fish ages, and the concentration of hypoxanthine increases, however, the strip turns pink from the enzyme reaction.

The validity of the immobilized enzyme strip for estimating hypoxanthine was verified by the scientists with two storage trials of iced winter flounder.

Several non-university groups are cooperating in application and implementation studies of the strips. These include the U.S. Food and Drug Administration in Seattle, Howard Johnson's restaurant chain, Daylin Laboratories, Abandoned Farms, Boggess Fish Packer, and Mystic Marine Life Aquarium.

Currently under investigation are conditions for processing and storage of the enzyme test strip as well as the effects of various additives in the strip formulation.

Further work planned by the investigators will be to produce an immobilized enzyme test strip which can quantitate hypoxanthine levels as well as indicate the presence of spoilage compounds such as amines. This test would also be a dye-coupled visual reaction.

MARINE FOOD AND DRUGS

Anti-Inflammation Mechanism of Extract from Eisenia bicyclis (Kjellman) Setchell. Journal of Pharmaceutical Sciences, 64 (7):1258-1259 (1975). D.M. Whitaker and G.P. Carlson, Pharmacology/Toxicology, URI, 1975. P 465.

The Biology of Astaxanthin-XVIII The Metabolism of the Carotenoids in the Prawn, Penaeus japonicus Bate Bulletin of the Japanese Society of Scientific Fisheries, 42 (2):197-202 (1976). Y. Tanaka, H. Matsuguchi, T. Katayama, K.L. Simpson and C.O. Chichester, Food and Resource Chemistry, URI, 1976. P 491.

Presence of Four Toxins in Red Tide Infested Clams and Cultured Gonyaulax Tamarensis Cells. Biochemical and Biophysical Research Communications, 66 (2) 1975. Y. Shimizu, M. Alam, Y. Oshima, and W.E. Fallon, Pharmacognosy, URI, 1976. P 478.

Program Development

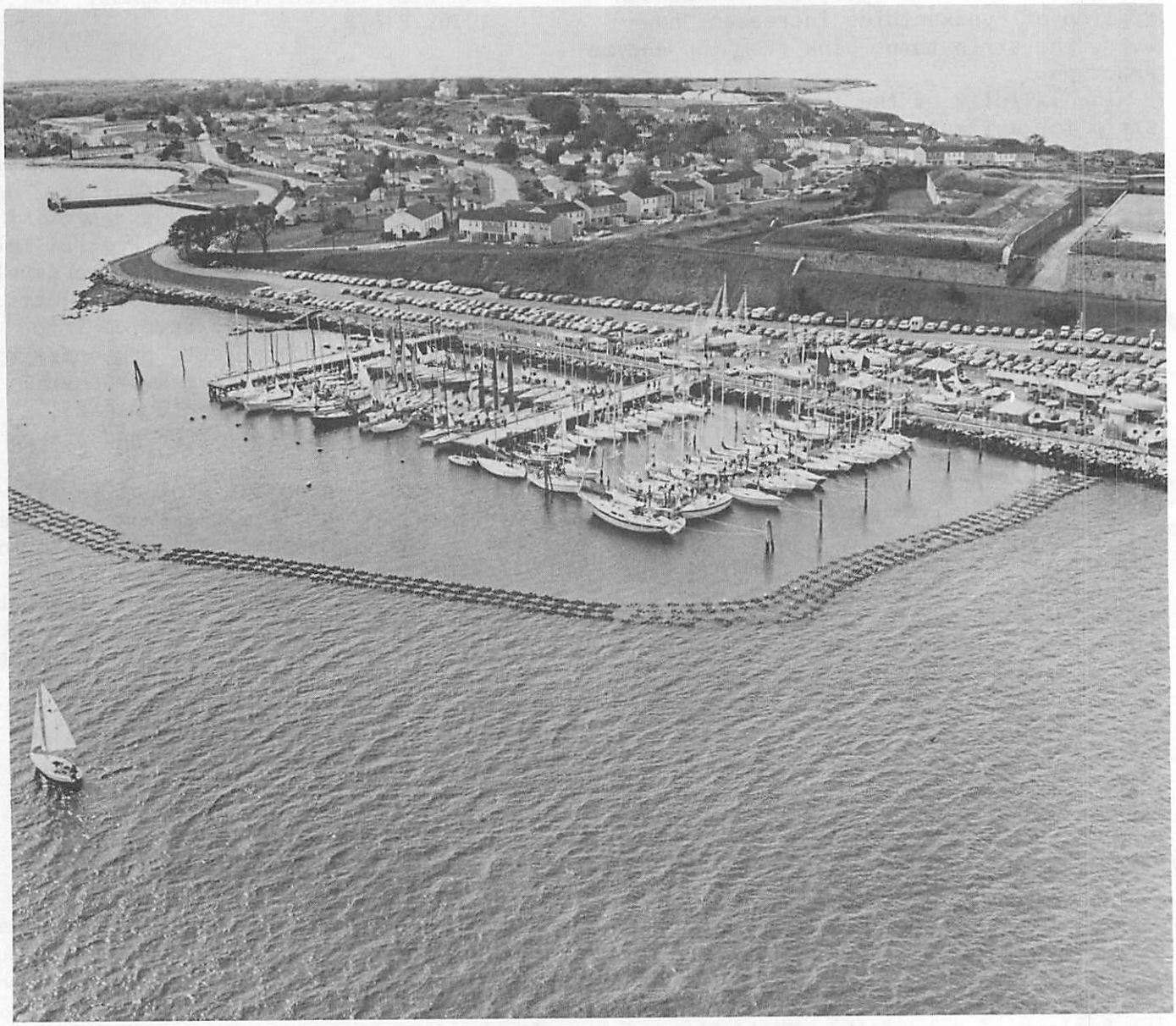
In order to remain responsive to needs of Rhode Islanders, to encourage new ideas, and to follow up unexpected and promising discoveries, URI's Sea Grant Program maintains a fund which can support the development of unanticipated research projects. These projects sometimes develop into full-scale research efforts presented for formal funding the next year. Others, mounted to answer an immediate need, provide required information and are concluded.

One such development project in 1975-76 was an initial investigation into the interaction of menhaden and sportfish in Narragansett Bay by Dr. Candace Oviatt and Bruce Rogers, both research associates with the Graduate School of Oceanography. They were responding to a claim by sportsfishermen that possible comercial overfishing of menhaden, a food species for bluefish and striped bass, caused a decline in the number of the important gamefish. To determine the role which menhaden play in the diet of these gamefish, the researchers collected during the summer approximately 100 stomachs from sportsfishermen in the Bay and off Rhode Island's southern shore and analyzed the contents. Preliminary results of the study were that the striped bass and bluefish will feed on whatever food species is abundant.

The researchers also conducted a series of feeding experiments on large striped bass and bluefish. These gave the first estimates ever made on the rates of food consumption of these large fish under known conditions.

In order to obtain more conclusive data, Dr. Oviatt and Rogers are now continuing the project on a larger scale as a fully funded Sea Grant project for 1976-77.

Another URI Sea Grant project initiated by an outside request was a survey of tidal currents in the Barrington River Yacht Basin for the Harbor Commission of that basin. Dr. Malcolm Spaulding, assistant professor of ocean engineering, conducted three surveys determining the circulation patterns and recording the tidal heights and currents at the Barrington Bridge. This information, besides being supplied to the commission, is being used to numerically model the circulation of the region.



Projects Status, Fiscal Year 1976

Project Number and Title		Planned Termination Date	Date Initiated
Advisory Services			
A/AS-3	Marine Advisory Service and New England Marine Resources Information Program	None	1975
A/CR-5	Coastal Resources Center	None	1971
A/L-1	Law of the Sea Institute	1976	1969
A/SS-2	Corrosion of Aluminum Alloy Scuba Tanks	1976C	1975
Education			
E/FT-1	Fisheries & Marine Technology	None	1968
E/M-1	Master of Marine Affairs	None	1969
E/ME-1	Marine Resources Economics Option	1978	1971
E/OE-1	Graduate Program Ocean Engineering	1980	1971
Coastal Resources			
R/E-4	Ecosystem Analysis-Application in a Coastal Town	1976C	1974
R/E-5	Effect of Dredge Spoil on Benthic Animals	1976C	1974
R/E-8	Identifying and Monitoring Oil Spills	1977	1974
R/ES-2	Systems Ecology Studies of Narragansett Bay	1976C	1970
R/ES-6	Development of an Integrated Three-Dimensional Hydrodynamic, Salinity and Temperature Model	1977	1974
R/ES-8	Causes of Phytoplankton Blooms in Narragansett Bay	1978	1975
R/ES-9	Analytical Modeling of Coastal Zone Areas	1978	1975
R/FB-1	Floating Breakwaters	1976C	1973

R/MR-2	An Economic Evaluation of Marine Recreation in Rhode Island	1976C	1974
R/WP-2	Input, Transport and Fate of Petroleum Hydrocarbons in Sewage Effluents	1976C	1974
Fisheries			
R/F-11	Bottom Trawl and Other Board Performance Study	1976C	1973
R/F-16	Regional Fisheries Population Management	1977	1974
R/F-19	Transition From Loran-A to Loran-C	1976T	1975
R/F-20	The Economic Impacts of Extended U.S. Fishery Jurisdiction Under Alternative Institutional and Fisheries Management Policies	1977	1975
R/F-21	Economics of Groundfish Trawlers	1976C	1975
Aquaculture			
R/A-1	Management of Salmonids in a Closed Circulating Controlled Environment System	1976C	1970
R/A-2	Aquaculture of American Lobster	1976C	1968
R/A-4	Marine Pathology	1978	1970
R/A-8	Economics of Salmonid Culture in New England	1976C	1974
R/A-9	Potential of Macroalgae in Silo Culture	1976E2	1975
Food and Drugs			
R/D-3	Toxicity of Gonyaulax tamarensis	1976C	1974
R/T-5	Utilization of Red Crab Waste in Salmonid Aquaculture	1977	1974
R/T-6	Simplified Method of Assessing Marine Food Quality	1977	1975
Management and Development			
M/PM-1	Program Management	None	1971
M/PD-1	Program Development	None	1973

C--indicates project was completed in 1976
T--indicates project was terminated in 1976
E2--extended for two years

Activity Budget

	NOAA Grant Funds	University Matching Funds
Marine Resources Development		
Aquaculture	$ 130,580	$ 22,069
Living Resources, other than aquaculture	54,726	10,348
Marine Biomedicinals & Extracts	13,411	-0-
Soci-Economic & Legal Studies		
Marine Economics	106,167	36,127
Ocean Law	18,964	45,704
Marine Recreation	34,700	-0-
Marine Technology Research & Development		
Ocean Engineering	37,400	9,594
Resources Recovery & Utilization	66,006	39,952
Marine Environmental Research		
Research & Studies in Direct Support of Coastal Management Decisions	20,835	10,734
Ecosystems Research	100,497	19,309
Pollution Studies	34,715	5,334
Environmental Models	52,763	28,052
Marine Education & Training		
College Level	12,426	204,625
Vocational Marine Technician Training	26,907	115,763
Advisory Services		
Marine Advisory Services	278,685	51,000
Program Management & Development		
Program Administration	57,127	5,138
Program Development	84,091	-0-
	$1,130,000	$603,749