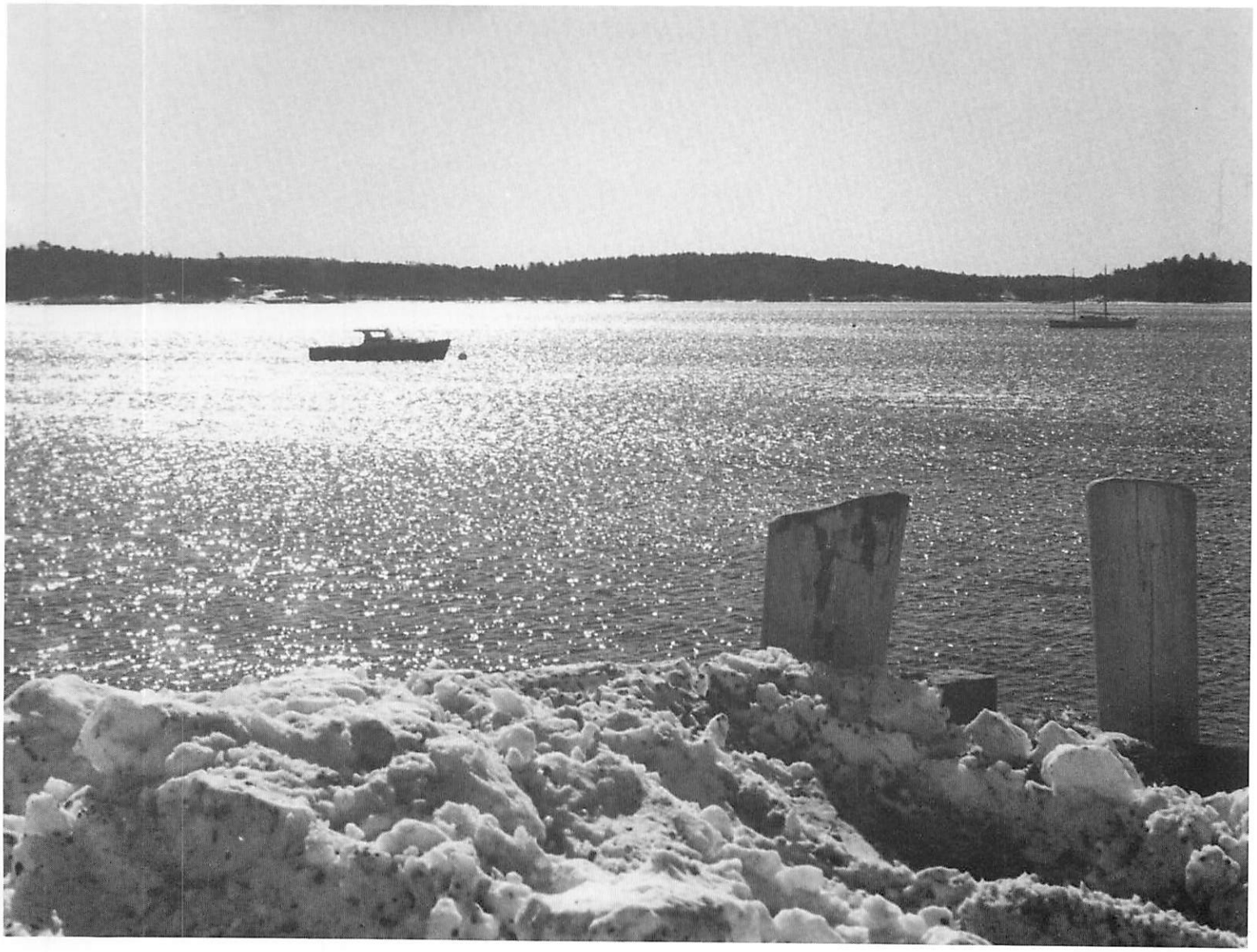
[redacted]

[redacted]



MAINE/NEW HAMPSHIRE
SEA GRANT COLLEGE PROGRAM

Making a difference: a decade of marine research, education & service

1976 - 1986

PREFACE

In any enterprise with identifiable goals and objectives, it is important on occasion to step back from the normal schedule of activity and take stock of past achievements and developments. Re-evaluation is particularly valuable when the enterprise is part of a larger and even more complex system and attempts to break new administrative ground.

The University of Maine/University of New Hampshire Sea Grant College Program represents such an enterprise, and this report examines the achievements and developments of the past ten years (1976-1986), with specific focus on the following:

- the regional context within which the program has evolved **(sections 1 & 2)**
- the management and organization of the program **(section 3)**
- the leadership exercised by the program and its impact at many levels **(section 4)**
- the important role played by the program's Policy Advisory Committee in long range planning to maintain research relevance **(section 5)**
- the productivity of this research program **(section 6)**
- the Marine Advisory Program and its structure and accomplishments **(section 7)**
- the formal educational programs that have been offered and a survey of the graduate students who have participated in Sea Grant research **(section 8)**
- a look at the future direction of the Maine/New Hampshire Sea Grant Program **(section 9)**

All of these considerations are dynamic and evolving. The changing and interactive nature of these several components indicates the importance of overall integration within the program and between the program and the external world.

This interactive nature also leads to some redundancy, which is always the case in any attempt such as this to describe component parts of an integrated whole. Thus, for example, many of the research achievements in the Productivity section are also included in and expanded upon in the Marine Advisory Program section. Their inclusion is appropriate to both, but from differing perspectives.

Individually and collectively, the sections of this document, along with its appendices, are responsive to the evaluative criteria for recertification by the National Sea Grant Office. We believe they provide a good representation of the quality and effectiveness of the Maine/New Hampshire Sea Grant College Program, the extent to which it exemplifies and furthers the Sea Grant concept, and ***the difference it has made.***

SEA GRANT IN MAINE AND NEW HAMPSHIRE: *MAKING A DIFFERENCE*—1

The joint University of Maine/University of New Hampshire (UM/UNH) Sea Grant College Program is part of a national effort of *research*, *education*, and *advisory* (extension) services, whose primary goal is to promote the wise use, conservation, and development of our marine resources. Conceived by Athelstan Spillhaus, science popularizer and academician, who felt that the United States was devoting too much attention to the race for space and not enough to the exploration of the oceans, the National Sea Grant College Program was formally established by Congress in 1966. Twenty years later, a $39 million Sea Grant Program at 300 academic and nonprofit institutions around the United States and Puerto Rico now returns an estimated $230 million annually in gross revenues and savings to marine industries.

Through a unique partnership of our two state universities, the federal government represented by the National Oceanic and Atmospheric Administration, and our various marine clientele, the UM/UNH Sea Grant Program has had a significant impact on marine resource use and development in northern New England. In the ten short years since Maine and New Hampshire merged their separate programs to form a single, stronger, more balanced Sea Grant Program in 1976, our cohesive undertakings in marine research, education, and advisory services have produced many far-reaching results.

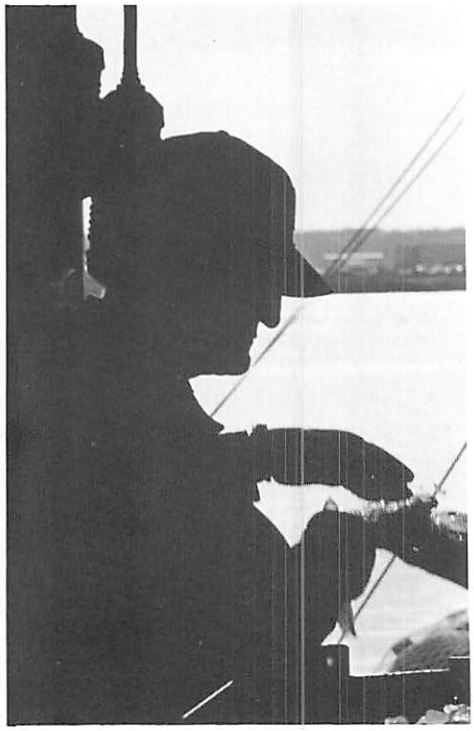
Marine science pervades nearly every aspect of modern life in northern New England. Increasingly, science and technology are invoked to address issues in political, economic, and social policy, while the general public is frequently asked to make scientific judgments. Decisions about pollution control, shoreline development, fisheries management, oil exploration, and even national boundaries rely on input from marine user groups and coastal residents. Those who live inland are equally involved in establishing marine policy by voting on bond issues for cargo ports and fish piers and deciding referendum questions on coastal uses. These responsibilities demand a scientifically literate constituency who base their decisions on current knowledge.

The purpose of this publication and its various appendices is to highlight the new knowledge about the Gulf of Maine, New England's "own" ocean, generated through Sea Grant investments over the past ten years, and to provide insight as to how this knowledge has been used by residents of northern New England to make a difference in their lives.

Impacts on our various academic institutions and programs will also be identified. Some results directly attributable to Sea Grant investments include the evolution of our blue mussel aquaculture industry; the development of medicated lobster feeds which have improved nutrition and controlled disease in lobster pounds; policy shifts within our various communities and state regulatory agencies such as the required oil spill containment boom procedures on the Piscataqua River; and the increasing emphasis certain school districts are placing upon marine science education. Still others represent the possibilities when Sea Grant investments are used to seed promising efforts or leverage suport for larger projects — such as the establishment of the Marine Law Institute, the establishment of the fish auction in Portland, and development of the highly unique, but very successful, cooperators network within our Sea Grant Marine Advisory Program.

In order for the Maine/New Hampshire Sea Grant College Program to be successful it must *make a difference*. It must make a difference within our respective universities, within our region and the nation, and most importantly to the thousands of people for whom this program was established originally by Congress to assist — those who must make wise choices concerning the allocation, conservation, management, and development of our key marine/coastal resources.

The Gulf of Maine is a living laboratory in our own backyard. Tapping its full potential is more than reaping profits from fish and oil. As Athelstan Spillhaus expressed it two decades ago, "The oceans offer us military, recreational, economical, artistic, and intellectual outlets of unlimited scope. They'll offer us more space than space in which to remain human."



PROGRAM CONTEXT 2

The context within which the Maine/New Hampshire Sea Grant College Program operates is as unique and varied as the structure of the program itself. Our 4,000-mile coastline borders one of the richest marine environments in the world, the Gulf of Maine. Famous for its many seafood products, the Gulf of Maine supports a highly productive fishery, exploited by both commercial and sport fishermen.

In 1984, over 185 million pounds of fish, shellfish, and other species were landed in northern New England (Maine and New Hampshire) ports at a total ex-vessel value of about $120 million. Lobsters, clams, scallops, and groundfish (primarily cod, haddock, and flounder) account for nearly 95 percent of this landed value. Much of this product is sold to dealers in the Portland, New York, and Boston fresh fish markets, but an increasing amount is now being processed locally and shipped to other markets in fresh or frozen form. Some 10,000 individuals are engaged full-time in the commercial fishing industry, and another 5,000 either dig clams and seaworms or fish for other species part-time.

Today, both fishermen and managers in the Gulf of Maine region are concerned that most stocks of commercially-valuable fish are at unsatisfactory low levels. Finding acceptable management schemes is hampered by two major factors. The first is a social factor of allocating the fish stocks to a tremendously varied fleet. The second is a lack of adequate knowledge of fish population ecology coupled with a lack of confidence by fishermen in the factors which *are* known.

Traditional fish stocks are heavily fished, and increased profits from these fish will not come, in the short term, from increased landings. The cost of fishing remains high, even though interest rates and fuel costs have eased somewhat. Profits are not likely to increase because of decreasing costs. Therefore, the fishery of the Gulf of Maine will depend on landing high quality (and, therefore, high-priced) fish, maintaining and/or enhancing the value of the product, and competing in the market with a quality product. Even with the identification and subsequent landing of species not now fully utilized, quality, not volume, is the arena in which Gulf of Maine fish will compete successfully. As Canadian competition is likely to be a major factor with respect to fisheries management considerations in the Gulf of Maine over the next five years, Canada will also be a factor in fisheries development considerations.

While early aquaculture ventures in Maine and New Hampshire were viewed as an industry separate from fishing, aquaculture is now seen by many as one segment of a continuum of fishing practices. Virtually nonexistent fifteen years ago, aquaculture in northern New England has evolved into a major growth industry, with blue mussels, European and American oysters, clams, and Pacific/Atlantic salmon, the major species.

There are 120 coastal communities in northern New England which are home to 40 percent (800,000 persons) of the region's population. Nearly one-half of these people live in towns with populations under 5000. Development densities vary enormously along the coast. The southern coast from Seabrook, New Hampshire, to Freeport, Maine, is under great development pressure, while the remainder is still relatively undeveloped.

Although much of the coastline is still undeveloped, the predominant trends indicate a changing situation. Small coastal towns are developing at a much more rapid rate than large towns and cities. Those with populations under 5,000 in 1970 grew by nearly 50 percent over the last fifteen years. Taxable valuations in those same small towns grew at a much faster rate (174 percent) than population increases. Such growth reflects expansion of tourism and great increases in land values. The number of visitors to the coastal zone has doubled in the past twelve years. In 1985, some 7 million tourists with an economic impact of $1.4 billion visited the coastal areas in northern New England making tourism the second leading industry in both Maine and New Hampshire. Population projections for both states indicate that growth in the coastal zone will continue to be considerably greater over the next five years than in inland regions.

The Gulf of Maine also provides a water transportation system for shipping oil, gas, coal, forest products, and agricultural products. Indeed, deep-water harbors comparable to those along the northern New England coast, such as Eastport, Bath, Portland, and Portsmouth, are not found elsewhere along the entire eastern seaboard.

But the more than 100 ports and harbors along our coastline are feeling the burden of increased populations primarily in the form of conflicting demands on limited facilities and resources. Residential and recreational uses are squeezing out the more traditional commercial and fisheries users who cannot afford the high prices created by supply and demand.

Portland, the region's largest port, has typified this scenario over the past six years. Its waterfront has changed from a fishing and shipping center to a mix of condominiums, restaurants, working wharves, and small boutiques. Only a capital investment from the private and

public sector allowed for development of a new commercial fishing pier with the long awaited Portland Fish Auction. Many of the region's ports and harbors, including Portsmouth, Bar Harbor, Eastport, Boothbay Harbor, Islesboro, and Searsport are now recognizing the need to manage harbor resources and growth, and are seeking skilled technical and professional management expertise to assist them.

With billions of dollars, thousands of jobs, and a quality of life at stake, the Sea Grant College Program in northern New England has helped to play a critical role during this period of major and lasting change. There are problems, needs, and complicating factors underlying every issue discussed in this report. The generation of new knowledge, the identification of existing knowledge, and its delivery to those who can use it to make sound, factual decisions, are the heartbeat of the UM/UNH Sea Grant College Program.

MANAGEMENT, ORGANIZATION, AND EFFECTIVENESS 3

The primary thrust of the University of Maine/University of New Hampshire Sea Grant College Program management effort is to provide an appropriate focus and coherence to our diverse range of marine research, education, and extension activities. To ensure that Gulf of Maine waters are wisely used requires a full understanding of the ocean, its processes, and resources. As a Sea Grant College Program, the Universities of Maine and New Hampshire have an obligation to achieve the highest level of excellence by responding to continually changing priority issues affecting our coastlines and also by stimulating the academic community to collaborate on multidisciplinary projects necessary to gain new information on the complex problems in the marine environment.

Consequently, our management program is built on the following objectives:

- to focus on priority concerns and issues of the northern New England coastal region;
- to maintain close liaison with the region's research community in order to apply its talents to priority concerns consistent with the academic mission of the institutions;
- to ensure that the program's marine advisory professionals identify priority concerns and develop and deliver responsive informal educational programs to key marine clientele;
- to maintain liaison with state agencies, industrial and business interests, and community organizations in order to understand and integrate their needs and goals into the program;
- to foster new program initiatives in response to the priority needs of the region in order to ensure a stimulated and dynamic program; and
- to execute the functional and operational responsibilities of the program consistent with the NOAA Office of Sea Grant objectives.

Management oversight is provided primarily by two bodies: the joint Maine/New Hampshire **Sea Grant Policy Advisory Committee** (PAC) and the Sea Grant executive committee. The latter group is composed of the two Sea Grant directors, associate directors, and Advisory Program leaders from both the University of New Hampshire and University of Maine. In addition, a communications coordinator from one of the lead institutions sits on the committee on a rotating basis. The seven-member executive committee meets regularly and is responsible for all program development and management activities related to the UM/UNH Sea Grant College Program. In conjunction with the PAC, it sets and implements all policy of the joint program to ensure the continual development of a coherent, regional program.

Prior to 1976 when the two states and universities merged to form a joint Sea Grant Program, there were three distinct Sea Grant-supported efforts in northern New England — the University of Maine, (UM) the University of New Hampshire, (UNH) and the Maine Department of Marine Resources (DMR). Each had their own funding cycle, submitted separate grant proposals to the National Sea Grant Office, and individually set their own program priorities and directions. While UM and UNH were traditional, university-based Sea Grant Programs that supported marine research, education, and advisory services activities, Sea Grant funds provided to the Maine DMR, a state agency, were used exclusively for extension work in commercial fisheries.

UM and UNH formed a joint program in 1976, and the Maine DMR was gradually brought into the partnership over the next few years. To this day, DMR remains an active participant in our marine advisory program, performing the bulk of our work in the commercial fisheries area.

The Sea Grant Program and its executive committee are governed by a twenty-two member external Policy Advisory Committee (PAC). This group of faculty (six), administrators (four), and marine clientele (twelve) provides general oversight and counsel to the program. Its members are appointed by the presidents of our respective institutions for two-year terms. Over the years, the PAC has been closely involved in the development of our ***Long Range Plans*** and in various program reviews, including site visits and program component reviews.

Internally, the Sea Grant College Program at both institutions is a component of larger marine organizations. The two Sea Grant directors are also directors of the **Center for Marine Studies** (CMS) and the **Institute of Marine Science and Ocean Engineering** (IMSOE) at the University of Maine and University of New Hampshire respectively. Within this academic structure, the Sea Grant directors report to the vice president for academic affairs at UNH and the vice president for research at UM.

Although Sea Grant's place within the CMS and IMSOE (formerly the Marine Program) has remained constant for the past eleven years, important organiza-

tional changes within both the CMS and IMSOE, as well as within the Sea Grant Program itself, have strengthened our management ability. To encourage greater coordination and communication between the advisory and research components at UNH, the Marine Advisory Program leader's responsibilities were broadened in 1981 to include half-time duties as the associate Sea Grant director. This change has allowed the UNH Sea Grant director to devote a much greater portion of his time to national and legislative initiatives and to promoting greater interaction between the research and extension staff.

In recognition of the important strides made by the marine sciences at UNH, the Marine Program, which was established in 1974 by the New Hampshire Legislature, was replaced by the Institute of Marine Science and Ocean Engineering in 1986. This reorganization will provide increased university funding for marine activities, including Sea Grant, and facilitate greater cooperation among academic departments with a marine emphasis.

At UM, the organization and administration of marine programs, including the Sea Grant program, have also undergone some important changes. The Center for Marine Studies was established in 1977 to provide an organizational focus for the various campus marine programs in existence at that time. The center's responsibilities include administering the Sea Grant College Program and the university's marine field station, the **Ira C. Darling Center.** It also provides overall leadership for the planning and development of marine programs throughout the university. This assures an excellent home for the Sea Grant Program by connecting that program and its diverse responsibilities with the similarly diverse marine interests and capabilities of the university system.

The successful melding of two public universities in different states into a single Sea Grant College Program is perhaps the best example of our management philosophy. We realized early in our history that in order for Sea Grant-supported research, education, and advisory service efforts to have a significant impact, we would have to build linkages. Thus, wherever possible, we have seized opportunities to use Sea Grant funds to either leverage other funding or to seed projects with reasonable chances of continuing when Sea Grant funding is discontinued.

Consequently, we have actively encouraged and supported programs such as the cooperators network within our **Marine Advisory Program.** This network combines under the Sea Grant aegis more than thirty individuals from ten different institutions/ organizations with marine outreach programs. Likewise, the fifty marine docents (volunteers), who are trained and coordinated through the Sea Grant Program, serve as extensions of our core advisory staff. With this pool of extraordinary talent available, we can enhance the variety and extent of our program capabilities.

Linkages like those developed between the New Hampshire Division of Parks and the New Hampshire Audubon Society have enabled us to build an outstanding marine education field effort at Odiorne Point State Park over the past ten years. This has led to overwhelming community support and approval of funds by the state government to continue this effort. Similarly, the cooperative nature of the Maine Fishermen's Forum, where Sea Grant joined with several segments of the fishing community to develop this project over the past ten years, has ensured its continued success after Sea Grant involvement necessarily decreased.

On the research side, Sea Grant has been closely involved in the establishment of the **Association for Research on the Gulf of Maine (ARGO-Maine).** This group consists of the Bigelow Laboratory for Ocean Sciences, the Maine Department of Marine Resources, the Maine Maritime Academy, the Maine Geological Survey, and the University of Maine. Its primary purpose is to devise and implement multidisciplinary research efforts aimed at gaining a clearer understanding of the Gulf of Maine. More recently, with the support and encouragement of Sea Grant, UM has assumed the leadership in the Northeast for development of successful proposals to the National Undersea Research Program, (NURP) which frequently build upon work supported by Sea Grant.

As the Sea Grant Program in northern New England has matured there has been a noticeable change in how we have approached and attempted to solve marine-related problems. Early research projects, for example, tended to have a heavy emphasis on obtaining baseline data. We encouraged and supported research which was primarily oriented by academic discipline (i.e., ocean engineering, estuarine science, marine biology) and was generally site-specific. We even organized our program around these academic disciplines. A significant step forward was taken when we decided to build multi-project efforts on major marine resource questions or problems. Projects concerning the development of a sustainable blue mussel industry, hatchery operations related to New Hampshire's coho salmon fishery, and the effects of digging on mud flats and soft-shell

clam populations are representative of this era.

Recently, the Sea Grant management team has begun to explore an exciting new phase of program evolution. By examining various marine environments, such as the Gulf of Maine and northern New England estuaries, from a systems level, we hope to begin the difficult process of integrating existing information from all pertinent marine disciplines and identifying major gaps in our knowledge. The prevailing feeling is that in order to solve the remaining key marine resources problems, a thorough understanding of the processes operating within and between these major systems must be gained.

As our program focus and management philosophy have evolved over the past eleven years, the manner in which proposals and projects are judged has also changed. The present method of reviewing new research and education proposals is a three-step process. First, short summary proposals are solicited by the executive committee. Proposals which address marine and coastal issues identified in the *Long Range Plan* are accorded highest priority, but other creative and rigorously conceived proposals in areas not mentioned in the *Long Range Plan* are also welcomed. The executive committee reviews the summary proposals using several criteria including relevance, scope, perceived potential success, and relationship to past or current Sea Grant projects.

Investigators with summary proposals meeting the criteria are then invited to submit full proposals. These are peer-reviewed by three to six scientists who judge technical merit, and by three marine clientele. These reviews are used as the primary basis for the Sea Grant executive committee to make decisions on which projects are included in the omnibus proposal submitted biennially to the National Sea Grant Office. The final step in the selection process occurs in consultation with our program monitor after each project has been thoroughly reviewed at the site visit and by National Sea Grant staff.


MEDIUM
SMALL
YELLOW TAILS
CC'S
LARGE
HADDOCK
SMALL
LARGE
HAKE
SCROD
LARGE
HALIBUT
EX. LARGE
LARGE
MEDIUM
CHICK
SNAP
MONK TAILS
POLLACK
LARGE
MEDIUM
SMALL
SKATE WINGS
OTHER/SEASONAL
A CATFISH
B REDFISH
C CUSK
TOTAL POUNDS

LEADERSHIP 4

At both the University of Maine and the University of New Hampshire, the Sea Grant directors also serve as directors of the major marine academic units — the **Institute of Marine Science and Ocean Engineering** at UNH and the **Center for Marine Studies** at UM. These academic units have missions in marine research, education, and outreach which closely parallel those of Sea Grant's. They receive significant university support ($550,000 - $700,000/yr.) and coordinate nearly all of the marine activities on the campuses, including management of the principal marine research laboratories such as the **Jackson Estuarine Laboratory** (UNH) and the **Ira C. Darling Center** (UM).

At the Universities of Maine and New Hampshire, where the emphasis on building a comprehensive research program in the marine sciences and ocean engineering areas has been a major consideration for a relatively short time, the provision of adequate research facilities to parallel the growth in human resources is important. Stimulated by sizeable Sea Grant investments in researchers studying salmon aquaculture, sea urchins, and commercial fisheries, the University of New Hampshire has nearly completed two new marine research facilities which will aid Sea Grant research and increase opportunities for other investigators. The **Coastal Marine Laboratory** at Fort Constitution in New Castle will provide running seawater systems for studies on coastal and oceanic organisms, while the **Anadromous Fish and Aquatic Invertebrate Research Building** in Durham allows for hatchery-related research on Atlantic and Pacific salmon, as well as lamprey eels. In addition, the Marine Programs Building at UNH, completed in 1978, contains 3,000 square feet of student office and laboratory space designed to support the needs of more than thirty undergraduate students who participate annually in the Sea Grant-supported Ocean Projects course. More recently, a new **Science and Engineering Research Building** has opened at UNH, housing many marine researchers. This $15 million, 100,000 square-foot facility was the brainchild of then Sea Grant Director Robert W. Corell who, with other UNH administrators, successfully orchestrated the proposal through the federal appropriations process.

Sea Grant has had a similar impact on the development of marine research facilities at the University of Maine. The aquaculture building at the Ira C. Darling Center in Walpole, was designed and built by the university as a direct outgrowth of Sea Grant investments in early aquaculture research. This facility continues to grow in importance to researchers and aquaculturists as the university and Sea Grant attempt to meet the needs of our ever-expanding aquaculture industry.

Through its leadership, Sea Grant has also had an impact within various academic units and departments at our universities. In 1980, with initial Sea Grant encouragement and support, the University of Southern Maine in Portland established the **Marine Law Institute** with primary focus on the investigation of legal developments in the management of interjurisdictional marine resources. The institute quickly gained national recognition and is now an integral part of the UM Law School. Its staff of five are involved with innovative, opportunistic research on coastal and marine-related legal issues, and they maintain an active outreach component through its regular newsletter, ***Territorial Sea,*** short courses for policy makers, and its status as a formal cooperator within the Sea Grant Marine Advisory Program network.

When the development of the **1980 UM/UNH Sea Grant Long Range Plan** identified marine recreation and tourism as an important issue, the UNH Department of Leisure Management and Tourism decided to increase its efforts in that area. Through a cooperative arrangement with Sea Grant, a new faculty member was hired with major commitments in both marine recreation/tourism research and extension. That individual was later asked by the Governor to head the N. H. Division of State Parks. His replacement continues to carry a strong marine focus, including not only extension work but a formal course in marine interpretive education and a continuing $60,000/year state-funded research project in tourism.

Due to the impetus and leadership from the Sea Grant Marine Advisory Program, the **Maine Maritime Academy** (MMA) and the two vocational technical institutes at South Portland and Eastport, Maine have instituted a series of innovative programs. Over the past four years, the MMA has developed an extensive array of marine-related outreach efforts, including K-12 teacher training, an eleven-course Summer Sea Institute, ocean survival workshops for fishermen and yachters, as well as marine fire fighting short courses. Similarly, the two vocational technical institutes have reorganized their commercial fisheries curriculum which now emphasizes short, traveling modules, as opposed to the more traditional in-residence instruction.

Over the past few years our Sea Grant Program staff have played major roles within our two states, the New England region, and

on the national level. UNH Sea Grant Director Robert W. Corell, served as a trustee on the Governor's Committee for the New Hampshire Oceanographic Foundation and as a member of the New Hampshire Coastal Management Advisory Council, the latter during crucial periods of program development. He also served as chair of the Board of Directors of the New Hampshire College and University Council Marine Studies Program for several years.

In Maine, UM Sea Grant Director Ronald Dearborn served on the executive committee of the Maine Aquaculture Association and helped develop key sections of the **Maine State Aquaculture Plan,** which recommended the University of Maine and Sea Grant assume leadership for its implementation. Since that time, Ronald Dearborn has become the Alaska Sea Grant director.

Within the Sea Grant network both directors have served terms as chair of the New England Sea Grant Directors, while each has been on the executive committee of the Sea Grant Association in a number of leadership posts, including president. In addition, Robert Corell has served as chair of the National Sea Grant Task Force, and has been a member of the Board of Directors of the Marine Division of the National Association of State University and Land Grant Colleges for the past six years. He has also been active on the ALVIN review committee (chair for ten years), the UNOLS Advisory Council (vice-chair), and the NSF Ocean Science Division Advisory Committee (chair for three years). Most recently, he has taken a two-year leave of absence from UNH to head the Geosciences Directorate at the National Science Foundation.

The two Marine Advisory Program leaders, Brian Doyle (UNH) and David Dow (UM), have served a total of four years as chair of the eighteen-member Northeast Marine Advisory Council, while the communications director at UNH served as chair of the New England Sea Grant Communicators. The SGMAP Program Leader at UNH is currently providing leadership as a co-chair on the joint Northeast Sea Grant/ National Marine Fisheries Service recreational fishing sub-committee, established as a result of a 1986 Sea Grant/NMFS retreat in Woods Hole, Massachusetts.

Particularly noteworthy are results of Sea Grant leadership within our states that have occurred over relatively long periods. Three prime examples are the **Maine Fishermen's Forum,** the **Maine Lobster Institute,** and the **Odiorne Point Marine Education Program.** Initiated twelve years ago, at the suggestion of a Sea Grant researcher, James Wilson (UM) and a handful of commercial fishermen, the annual Maine Fishermen's Forum is the largest and most successful of its kind in the country. Planned, organized, and funded almost exclusively by the Sea Grant Marine Advisory Program (SGMAP) for the first eight years, the opportunities offered by this three-day event with 1000 participants eventually attracted industry sponsorship for nearly total responsibility of the program, including cash contributions of close to $50,000 last year.

Similarly, our more than ten years of Sea Grant research and extension involvement in issues related to the lobster fishery were rewarded with the recent establishment of the Maine Lobster Institute (MLI). Headed by Executive Director David Dow, this institute, a partnership between the lobster industry and the University of Maine, will support cooperative projects in lobster research and extension with major funding provided by the industry itself.

Another long-term effort coordinated through our SGMAP involves marine science education programs offered at Odiorne Point State Park in Rye, New Hampshire. Supported jointly by Sea Grant, the New Hampshire Division of State Parks, and the New Hampshire Audubon Society, the field-oriented programs were initiated in 1977 to help train K-12 students and teachers and the general public in basic marine science and ecology. Community involvement and support at Odiorne resulted in the formation of the Friends of Odiorne Point, Inc. in 1985. The primary goal of this group is to raise funds to augment the ongoing marine science education programs at Odiorne Point. They have successfully raised more than $35,000 to this point. As the result of this overwhelming community support, the New Hampshire State Legislature recently approved a bill to provide $50,000/year to continue and expand the marine science education programs at Odiorne. In addition, $600,000 was appropriated (to be matched by $400,000 in private funds) to construct a new marine science education center on site.

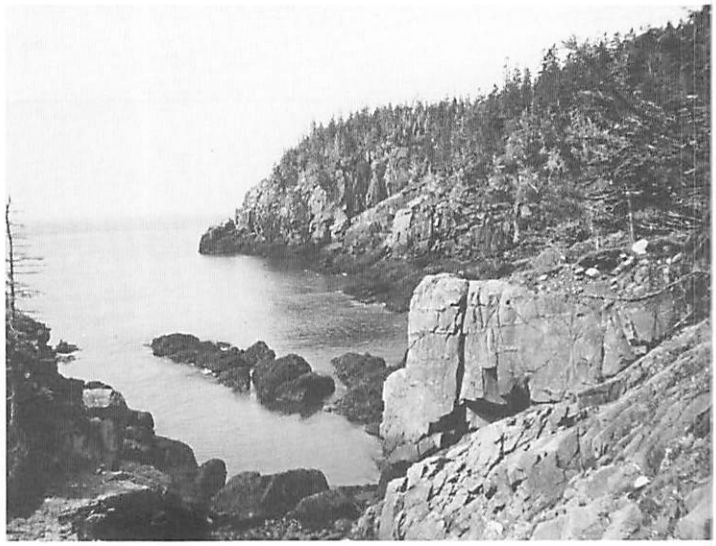
Nationally, the Maine/New Hampshire Sea Grant College Program has exercised leadership in several research areas and built a reputation on a willingness to experiment with novel and creative approaches to carry out its comprehensive marine research, education, and extension activities. Our faculty have made major scientific contributions in the fields of fish disease, fisheries economics, marine pollution, and aquaculture.

The ability of two institutions in two different states to work together cooperatively and effectively is the foundation of our Sea Grant philosophy. This part-

nership makes each of the institutions stronger and is a model for multi-institutional arrangements. The cooperators network within our Sea Grant Marine Advisory Program is another experiment unique to UNH/UM Sea Grant which is paying huge dividends and is now being carefully considered as a model by other programs around the country.

Our marine docent program, which attracts scores of talented community volunteers, is yet another creative method of extending our resources beyond what we could achieve alone. The process of long range planning is a fourth area in which the Maine/New Hampshire Sea Grant College Program has excelled. Every four or five years this process culminates in a comprehensive document providing a programmatic, issues-oriented context for our activities.

These four areas: *a tightly coordinated bi-state effort, a cooperators network within the Sea Grant Marine Advisory Program, the use of volunteers,* and *long-range planning,* are collectively the trademark of the Maine/New Hampshire Sea Grant Program. They reflect our management philosophy and the areas where we have provided leadership to the Sea Grant network.



RELEVANCE 5

In Maine and New Hampshire there is a strong interest in the opportunities created by our proximity to the Gulf of Maine, one of the world's richest marine environments. Whether the region's marine resources are commercial, recreational, or aesthetic, a university-based program such as Sea Grant must foster an understanding of the relevant issues surrounding those resources in order to constructively influence their management and development. Because of the federal partnership built into the Sea Grant concept, we must also strive for a balanced emphasis on national issues and priorities within the context of our regional program.

The primary mechanism we use to meet these goals is our long range planning process, which was incorporated formally into our Sea Grant program some ten years ago.

The original plan, developed in 1977, was generated primarily in-house with substantial faculty input. In the development of our last two long range plans, however, marine resource users have played a significant leadership role. Our **Sea Grant Policy Advisory Committee** has provided critical oversight and dedicated countless hours in the planning, drafting, and reviewing of our long range plans. Combined with their advice has been input from dozens of other key representatives of academic, government, and industrial marine communities.

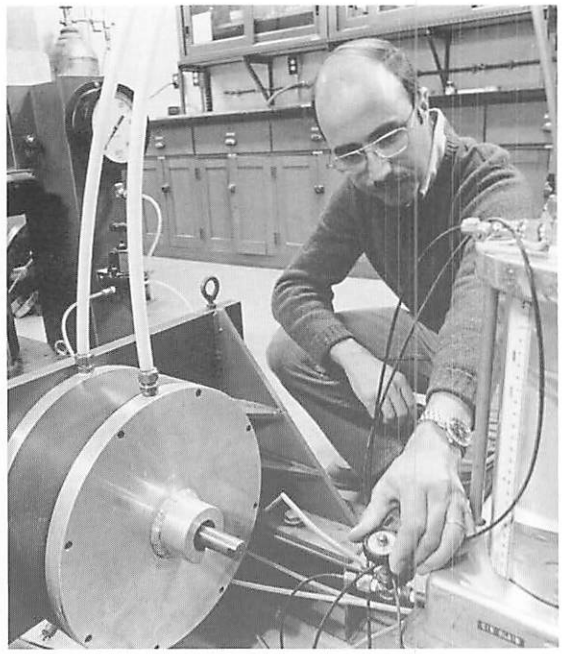
Our current plan covers three areas of major importance to both northern New England and the nation. They are: *industrial and commercial development; changes in the coastal environment;* and *fisheries management and development.*

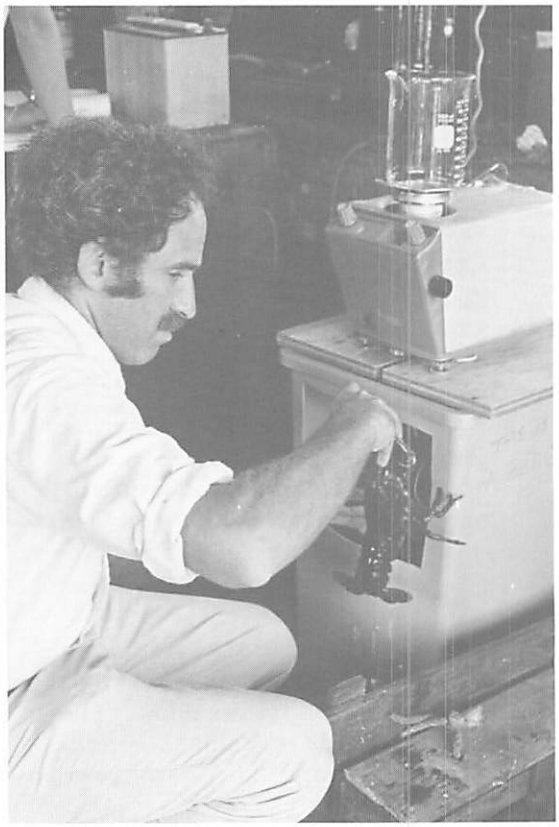
Within the written plan, each area offers "Background" and "Opportunities" statements. The "Background" statement briefly outlines the importance of the issue and provides a rationale for Sea Grant involvement. The "Opportunities" statement provides examples of the types of research, education and extension projects which could make a contribution to the resolution of a specific issue.

Identified issues do not always match well with traditional academic units or departments. Our approach reflects a planning process which is issue-oriented. In many instances, a multi-disciplinary approach is called for, even encouraged, in order to make a meaningful contribution to a particular marine resource issue.

The written document which results from the planning process identifies the region's key marine issues and investigates ways in which the academic resources of Maine and New Hampshire can be brought to bear through the Sea Grant Program. The plan provides a context for our involvement and serves as a creative stimulus to the faculty and staff on our respective campuses. It provides guidance for the allocation of limited resources, and, retroactively, provides a yardstick for measuring the contribution of Sea Grant to the region and the nation. While we view it as a flexible document that will need constant revision and updating to meet changing needs, we feel it is a framework within which our program can operate for three to five years.


D





PRODUCTIVITY 6

The driving force behind the Maine/New Hampshire Sea Grant College Program is the investment in projects which have the potential for *making a difference in northern New England.* By matching traditional strengths within the university network with well-defined problems, we have stimulated new ideas, added critical pieces of technology, and provided an important bridge between theory and application. Through close coordination and/or joint ventures with commercial and industrial interests, the program serves as the link between the marine community and the university to help solve problems related to marine resource use.

That's what we call *the Sea Grant difference.* It's a difference which has been made with a relatively small amount of money within the larger marine context of Maine and New Hampshire. Consider, for example, just a few statistics which highlight the relative magnitude of expenditures within northern New England's marine environment.

Fisheries landings in Maine and New Hampshire are worth over $125 million annually and generate another $320 million in related income.

Tourism and recreation bring over $2 billion in revenue through the 12 million visitors Maine and New Hampshire attract each year, more than half of them to the coastal region.

Tens of millions of dollars have been spent in Maine and New Hampshire over the past few years for new public docking facilities along the coast.

In a recent year, the Maine Department of Marine Resources spent more than $1.6 million for marine enforcement alone.

A single fishing vessel was launched recently in the Gulf of Maine at a cost of $2.3 million.

In contrast to these large expenditures, the federal investment in the Maine/New Hampshire Sea Grant College Program for the decade 1976-86 was $13.6 million. The following are but a few examples of how the program has leveraged an annual investment of about $1.5 million into something considerably larger, thereby making a difference in northern New England.

INDUSTRIAL AND COMMERCIAL DEVELOPMENT

Background

An abundance of deep-water ports, a relatively pristine coastline, a thriving tourism industry, and the availability of marine products, such as seaweeds, are the cornerstones for most industrial and commercial marine development in our region. Because of Sea Grant's university-based structure, there is a useful role it can play in stimulating and assisting these key development activities.

Full utilization of our **marine transportation and port facilities** is often hindered by problems of safety, economics, lagging technologies, changing markets, and environmental concerns. Competition for limited port and harbor space from non-maritime uses, as well as public policy issues dealing with planned growth and access, are also affecting the way port-related and marine transportation investment decisions are being made.

As the region's second leading industry, **marine recreation and tourism** is comprised primarily of small, disaggregated businesses which often suffer high failure rates. The challenge is to assist these fragmented businesses to develop expertise to compete successfully. Policy questions concerning state and local government actions and the environmental impacts of further expansion of the recreation and tourism industry have also been important.

Research and development of marine products, though still a relatively small component of northern New England's industrial and commercial base, is nonetheless an area of great potential. In particular, we have focused on opportunities to evaluate the medicinal, agricultural, and energy-development applications. Seaweeds are an obvious candidate for this type of work, and fish by-products is another fertile area.

Within this section on **Industrial and Commercial Development,** then, there are three issues which have been the focus of Sea Grant efforts: *marine transportation and port development; biotechnology;* and *marine recreation and tourism.*

Program Goals

To develop or refine appropriate technology which will help development-oriented marine industries use key marine resources safely and economically.

To evaluate the potential of utilizing abundantly available marine products and marine product extracts for commercial, medicinal, agricultural or energy development application.

To assist the region in capitalizing fully on the benefits offered by a strong and healthy commercial marine recreation and tourism sector.

Achievements

- The ports of Portsmouth, New Hampshire, and Portland, Maine annually receive about 23 million short tons of crude oil by sea. In either port, a major oil spill could be disastrous. Working with the New Hampshire Water Supply

A PILING THAT'S BETTER BY DESIGN

In 1985, 874 markers were lost in the Houston-Galveston shipping channel, accidentally snapped off at the mudline by unwieldly freight barges. Each lost marker cost $5,000 to be replaced, for a total replacement cost of over $4 million.

In any given year, several thousand navigation aids are destroyed nationwide by barge and ship traffic, costing the federal government millions of dollars in replacement costs and resulting in navigational hazards for our nation's shipping.

Two members of the mechanical engineering department and the ocean engineering program at the University of New Hampshire have developed an **alternative navigation aid, a collision-tolerant pile** which would outlive ordinary channel-markers by at least a factor of five.

Funded by Sea Grant and the Coast Guard, **M. Robinson Swift** and **Kenneth Baldwin** have designed a compliant piling that will resist tilting under strong currents or storms but will yield when a passing vessel hits it and forces it under the water. When the vessel passes, the piling has the resiliency to return to upright from any position.

In the Swift/Baldwin design, the appropriate degree of resistance is provided by an elastic member which is pre-stressed to a known load. This allows the piling to remain vertical under normal operating conditions and return to vertical after a knockdown collision.

A quarter-scale collision-tolerant pile was built in 1984-85 by a student team working in the **Sea Grant-sponsored Ocean Projects course.** Tested in Great Bay, that piling was successful most of the time, but "most" wasn't good enough for Swift and Baldwin.

"The original design called for a hinge that was like a car's universal joint. It had two axes of rotation, and at some oblique angles, the hinge stuck," says Baldwin. "Now we've gone to what is basically a ball and socket with a central stay for the restoring mechanism."

Tests in Great Bay showed the modified quarter-scale model to be 100% successful in popping back to its original position. The researchers also put the piling in the ocean off Odiorne Point in Rye last summer to see if it would withstand wave action. Subjected to the quarter-scale equivalent of a hurricane, the piling maintained its verticality.

Working drawings of a full-size piling have been delivered to the Coast Guard, and three steel prototypes, each eighteen inches in diameter by thirty-seven feet high, will be fabricated shortly and tested in some busy shipping channels. The U. S. Army Corps of Engineers is also interested in the piling design for possible use on a southern river where buoys have been wiped out from spring cresting of the river's floodwaters.

Baldwin says the researchers are still working on the development of a software package that will answer questions about environmental parameters. "Designs can vary slightly depending on local wave and wind action, bottom sediments, water depth, and whether a piling is going to be in a sheltered spot or near the mouth of a channel."

and Pollution Control Commission, a Sea Grant team designed and field tested **oil spill boom configurations for spill containment** in high velocity currents. As a result, these boom systems are now required at all oil terminals along the Piscataqua River. A similar system has also been instituted at Searsport, Maine.

- Liquefaction is the process that results when sand is overloaded due to earthquakes and violent wave action. Eventually, sand grains are forced apart, and whatever has been resting on that sand no longer has anything to support it. Sea Grant researchers have developed a way to **identify the acoustical signature of sand samples** and estimate their liquefaction potential. Such information could be used by engineers siting oil rigs and pier foundations on the continental shelf and slope.

- Using a patented technology for microbial fermentation that lent itself to a compact unit with a high throughput rate, a Sea Grant team gave the process a marine twist. The result was a 100-gallon a week **seawater-based fermentation unit** which produced potentially valuable chemicals from yeast. The process is designed to generate industrial alcohols, chem-

BREWING UP A SWEET SOLUTION

It's harvest time in the Caribbean, and workers are busily loading an offshore barge with molasses, the sweet residue of the island's sugar cane crop. Fresh water is at a premium here, but that's no problem for the technicians running the fermentation plant aboard the barge. Seawater abounds. Quickly, they combine the molasses and salt water in a microbiological process developed by a Sea Grant researcher in New Hampshire. The result is an inexpensive alcohol that could end up as the base of a Japanese whiskey or, given another oil crisis, an alternative fuel for American automobiles.

The scene described is not yet a reality, but someday it may be. The biotechnology, refined by University of New Hampshire microbiologist **William Chesbro,** exists. The next step is to transfer that knowledge to the private sector or find a government agency to fund a pilot plant.

Chesbro's Sea Grant project might be attributed to scientific serendipity. Chesbro and his students had developed and patented **technology for microbial fermentation** that lent itself to a compact unit with a high throughput rate. It had nothing to do with seawater specifically since it could use any kind of water, but it allowed the fermentation volumes to be shrunk down to a size that allowed plant mobility. Since water transportation costs the least, the technology seemed ideal for a shipboard unit traveling from port to port.

Chesbro could see the potential for all these factors to be gathered together in a complementary project. He applied for and received Sea Grant funding to investigate the potential of **seawater-based fermentation to provide industrial alcohols and feedstocks from sugar-rich plants.** His goal was to explore not only the techniques of doing so, but the economic feasibility as well.

Common commercial yeast was chosen as the demonstration organism, in part because Chesbro knew enormous amounts of water had to be used with yeast in the fermentation process. "A significant portion of the start-up costs of an alcohol distillation plant comes from the need to drill wells or to buy water or dispose of water." If yeast could grow well in seawater, the potential for cost savings was immense. Using seawater, they need only be located coastally where they would have access to the ocean's billions of gallons of water.

According to Chesbro, what's been achieved so far is the easy part. The best strains of yeast and the best nutrient mixes to use with seawater have been established. What is essentially a lab prototype in vials has been scaled up to a moderate 100-gallon a week recycling fermentation system. The next step is to find private or industrial support to build and operate a pilot plant.

Part of Chesbro's grant was also used to explore the economic feasibility of the project. He now feels that the biggest potential for his fermentation technology is in markets outside the United States.

The UNH researcher has found in other parts of the world the cost of fermentation alcohol is competitive with or lower than that of the synthetic alcohols. The regulations governing purity and process are also considerably less stringent.

So while the U. S. market for his fermentation technology is economically marginal (or at least until the next petroleum shortage comes around), attractive markets elsewhere do exist and merit further exploration. That's why it all comes back to that pilot plant, built full-size and operating, to demonstrate to the industry that this is a commercially viable approach. Chesbro sums it up in two sentences as compact as his fermentation unit. "The problems at this point are ones of technical scale-up. The do-ability is there."

ical feedstocks, and antibiotics from tropical plants such as sugar cane and to do so aboard mobile shipboard units or at fixed coastal facilities.

- The design and field testing of a quarter-scale, hinged, **collision-tolerant navigation aid** could save the Coast Guard millions of dollars per year in piling replacement costs. The Coast Guard is currently constructing full-scale piles for placement this year.

- To facilitate **seaweed extract studies,** Sea Grant researchers developed a new radioisotope technique for determining rapid growth indexes using ^{35}S. This method is widely recognized as an accurate way of screening fast-

growing strains for mariculture.

• Through continued collaboration with Marine Colloids, Inc., the world's largest producer of carrageenans, and through other research, Sea Grant has had a major effort directed toward the **exploration of commercial, medicinal, and agricultural uses for seaweeds.** One project demonstrated that carrageenan can significantly alter the growth and metabolism of fibroplast cells in tissue culture. That research resulted in a National Institutes of Health-funded project dealing with the potential use of carrageenan in reducing the growth of malignant cells. Another investigation identified techniques to produce high yield seed stocks of the carrageenan source *Chondrus crispus*, while yet another Sea Grant researcher determined the harvest potential of *Ascophyllum nodosum* along the northern New England coast.

• To more fully understand coastal processes and establish design criteria for offshore oil rigs and shorefront structures, Sea Grant researchers successfully modeled the wave climate of the Gulf of Maine and associated coastal regions by the **prediction of maximum wave heights through a computer model.** The civil engineering doctoral student involved in the project was selected as the 1983 recipient of the American Oceanic Organization award.

• Stagnant water, weed blooms, and a flushing system that was eroding an adjacent causeway were just a few of the problems at Spinney Creek in Eliot, Maine. Sea Grant-development funds supported the **construction and testing of a new tide gate** which allows for maximum flushing on a continuous basis, while maintaining acceptable water levels in ponds and creeks. The gate has reduced weed populations dramatically, facilitated a successful clam aquaculture enterprise, and eliminated hazardous currents produced by the old gate system.

• **Profiles of visitor activity and spending patterns** within selected New Hampshire coastal communities were developed. This information has been used by coastal tourism organizations in advertising and marketing strategies.

• In a New England-wide regional Sea Grant project, UM/UNH Sea Grant researchers assisted in the **development of a model for planners** to use to predict and compare the economic outcomes of alternative tourism product mixes on coastal communities.

• **Atlantic salmon restoration efforts** have been plagued by the difficulty of maintaining an adequate egg supply to the hatcheries. A Sea Grant researcher has been working on endocrine methods to accelerate and synchronize Atlantic salmon ovulation. She has also discovered the presence of the sex steroid hormone, testosterone, in seven commercial diets for salmon. This hormone has been linked to diminished fitness of hatchery-reared salmon and may reduce potential of survival to adulthood, thus hindering salmon restoration projects and aquaculture ventures.

• Successful restoration of the Atlantic salmon, once king of sport and commercial fisheries, to its historic habitat will be dependent upon suitable water quality. Sea Grant research has discovered that **acid rain** in New England rivers **may be interfering with the Atlantic salmon's ability to return to its homestream to spawn,** thus jeopardizing attempts to restore this prized species to New England.

CHANGES IN THE COASTAL ENVIRONMENT

Background

Northern New England's economy and lifestyle are intimately tied to the marine environment. Two of the region's major industries and largest employers, commercial fishing and tourism/recreation, are heavily dependent upon a high quality marine environment for their continued viability. But, as in most coastal areas around this country, a steadily increasing population is threatening some of our most valued resources with **demands for additional residential and commercial development along the coast.** More shoreline protection devices will be a likely outgrowth as more permanent structures are built.

Closely related to this growth is the issue of incremental development. Over a period of time, there is a **cumulative impact** of small, disconnected events which can result in significant degradation or serious depletion of coastal resources. Effects of this growth are manifested in changes in the distinct character of many small coastal towns, impacts on groundwater, destruction of wildlife habitat and important farmlands, and a strain on local capital facilities such as sewers and solid waste disposal sites.

Also damaging to marine resources, is the **discharge of pollutants into the coastal zone.** Many waste materials are currently entering the oceans by direct discharge through pipelines or from barges. They are also entering indirectly from surface runoff, river inputs or atmospheric precipitation, or from recreation activities. These wastes include domestic and industrial wastewaters and waste-

ON THE TRAIL OF TOXICS

In 1979 there was a major oil spill in New Hampshire's Great Bay estuary. In response, a group of Sea Grant researchers at the University of New Hampshire began a cooperative, multi-disciplinary project to determine just what happened to toxic substances such as polyaromatic hydrocarbons (PAHs) and trace metals when they entered an estuarine environment.

As Project Coordinator **C. L. "Tiny" Grant** puts it, "With toxic inputs, we need to be able to predict where they will go, how long they will persist, and by what methods they will degrade or be otherwise altered." He says, "Simplistically, one might think that if you have a paint spill or a boat develops a leak, all you need to know is where the water goes. Boy, is it ever more complicated than that."

Grant and fellow chemist **W. Rudolf Seitz** finally determined that the vast majority of very hydrophobic compounds are bound on the surface of suspended particulates in the water and sediment, rather than being dissolved in the water. "This is the case often times as much as 98-99 percent," says Grant. They were able to make this determination thanks to a new technique they developed, called **"fluorescence quenching."**

They had noticed that when PAHs associated with natural organic matter, their fluorescence was quenched. By starting with a known amount of PAHs free in solution, then gradually adding organics, the difference in fluorescence could be measured and the percentage of "what goes where" determined.

The development of this new analytical measurement of partition coefficients was not the only major breakthrough made. The team was also able to prove that organics with a land derivation bind PAHs more readily and more strongly than particles of marine origin. This had previously been speculated but the UNH researchers provided the first published documentation.

Exploring another aspect of PAHs, microbiologists **Galen Jones** and **William Guerin** explored factors that influenced the biodegradation of these toxic substances. They found that there is a strong seasonal variation, that **higher salinity waters may retard biodegradation,** and that a low nutrient situation such as that found in open ocean waters is similarly inhibiting to the process. Accumulating sediments can also bury PAHs at the bottom of an estuary where lack of oxygen can leave all but the top layer impervious to bacterial attack. This build-up can be a problem when bottom sediments are disturbed by dredging or construction.

For an effective biodegradation process to take place, Guerin says the bacteria also require more than an hors d'oeuvre of hydrocarbons. "Energetically, it's very expensive for bacteria to work on PAHs. They need to be exposed to hydrocarbons and they need to be assured of a constant supply before they'll turn away from the dissolved organics they seem to prefer."

The researchers made two other important discoveries. One was that **Tweens** (which are soap-like compounds or surfactants) increased the water solubility, and thus the degradation, of the hydrocarbons. The second was that they were able to isolate an organism that could degrade the PAH phenanthrene completely, all the way to CO2 and water. Previously-known phenanthrene-degrading bacteria could only accomplish a partial breakdown.

While other members of the team concentrated on PAHs, chemist **James Weber** looked at organotins and leads. One of his particular concerns was the possible presence in the estuary of tributyltins, or TBTs. These are particularly controversial because they are contained in anti-fouling paints and, until recently, no reliable test existed that would measure its presence in the tin that leaches out of the paint.

The problem is particularly acute because a Navy shipyard near a prime Chesapeake oyster and crab spawning ground wants to use a paint formula containing TBTs. At issue is whether the anti-fouling biocides will continue down the water column after they kill seaweeds and barnacles attached to ship hulls and also harm non-target organisms such as mussels, clams, crabs, and oysters.

Jim Weber has developed a test to make

just such a determination. The system can assess the presence in shellfish of tiny, but lethal amounts of TBT and do it in fewer steps than previously needed.

"Other techniques require a great deal of sample manipulation," Weber says, noting that the more times a sample is handled, the more chance there is for contamination or loss of material. "All we do is take our estuarine water, add one chemical to it, and measure butyltins."

Grant sums up the impact of the multidisciplinary project by noting:

"The ultimate significance of such measurements relates to the health and well being of all sea-dwelling organisms and to humans. The application of data we have generated is not restricted to Great Bay or even New England. It could be used throughout the world."

water sludges, chemical and hazardous wastes, dredge spoils, petroleum hydrocarbons, and biocides from ship hulls.

While the short-term effects of various spills and discharges can be catastropic and highly visible (i.e., fish kills, shellfish bed closures, seaweed foulings), the problem of longer term impacts of low level discharges and the ultimate fate of these materials is of more interest.

Within this section, five major issues have been the primary focus of Sea Grant efforts over the last ten years: *construction in the coastal zone; coastal energy development; marine pollution; cumulative impacts; access.*

Program Goals

To develop an increased understanding of nearshore physical processes, particularly the natural behavior of tidal inlet/sandy beach systems, coastal wave phenomena, and sediment transport.

To determine the behavior and fate of pollutants discharged into estuarine and coastal environments and identify acceptable alternative disposal strategies.

To identify effective ways of managing growth in coastal areas with particular emphasis on public access and incremental development.

Achievements

- Northern New England estuarine sediments serve as major sinks for certain toxic trace metals associated with industrial and municipal discharges. Sea Grant researchers have refined new laboratory **techniques which can determine the degree of attachment of toxic organic substances** to suspended sediment particles — an important parameter in determining the transport and ultimate fate of pollutants.

- In tracing what happens to polycyclic aromatic hydrocarbons (PAHs) that enter an estuary from oil spills or other sources, Sea Grant researchers have discovered **a surfactant which makes these toxic hydrocarbons more susceptible to breakdown** by naturally-occurring bacteria. Besides increasing hydrocarbon solubility, these *Tweens*, as they are called, are not harmful to the bacteria necessary for the PAH breakdown process, and therefore, have the potential for speeding up environmental cleanups.

- A single, reliable technique for assessing minute, but lethal, amounts of tributyltin in shellfish has been developed. This technique was used by the French government in testing certain coastal waters and should prove critical in assisting regulators to assess the **impacts of antifouling paints on shellfish stocks** in the Chesapeake Bay region. The Sea Grant chemist involved was also asked to present this technique, which requires less sample manipulation than in previous tests, at a symposium on organotin compounds at Oceans '86.

- The electroplating and electric circuit board industries contribute some 35 percent of New England's hazardous waste, including copper, cadmium, chromium, lead, and arsenic. Now, two Sea Grant researchers have developed a **new technique to solidify/stabilize this inorganic hazardous waste in a cement mixture.** Ocean disposal may prove feasible as leaching rates for these solidified blocks are considerably slower in the ocean than on land. Land-based disposal of similar blocks is also prone to freezing and thawing, an action which cracks the blocks and leaves more surface exposed from which the metals can leach into groundwater.

- A **new technology,** which has been adopted by the Environmental Protection Agency, has been developed to **measure leaching rates of toxic substances from soils.**

- Sewage, industrial discharges, and runoff can have very negative impacts on water quality. Recognizing the need to predict what happens to a pollutant once it's been discharged into coastal waters, Sea Grant researchers de-

SEA GRANT GOES TO THE BEACH

In the wake of winter storms in 1978 which caused over $47 million in property damage on the Maine coast, the public began to listen to Sea Grant oceanographer **L. Kenneth Fink,** who had initiated a series of profiles to determine rates of change along Maine's thirty-seven miles of sandy beaches.

Alarmed by rapid commercial and residential development in these fragile ecosystems and alerted to the possible harmful effects of documented sea-level rise, Fink began a series of scientific investigations designed to understand sediment transport along Maine's beaches. He and co-researcher **Duncan Fitzgerald** of Boston University have studied beach processes as well as associated tidal inlet systems for nearly ten years.

The system itself is one that is little understood. "There is little information here in the United States on the 'indented shoreline system'," says Fink. "Most information is derived from the barrier island system. Here in Maine, we have a glaciated coastline with 'pocket' beaches or barrier-split type beaches. 'Bay mouth barrier spits' is what we call them."

"But these are very restricted sand systems we're dealing with. They're sediment starved, with very little re-supply. There's no source of sand that we've identified so far that can supply the system." Fortunately, he adds, while the system's sand has "been obviously affected by human activities," the transport has been mainly within the system, without any permanent loss.

Classically, when a river meets the sea the result is a delta reaching out into the ocean. There, ebb tides deposit enormous quantities of sand onto a broad, flat coastal plain.

In Maine, however, in small to moderate size tidal inlets just the opposite is happening. Fink and Fitzgerald discovered that the currents in these mesotidal inlets are flood-dominated, so that large volumes of sand are being transported into the intertidal areas behind the barrier beaches. The net result is a landward movement of sediment, with more infilling and less open water behind these inlets than elsewhere.

The implications of these findings bear directly on dredging and maintenance policies for Maine harbors. To offset this continual shoaling in estuaries and salt marshes, dredging has to take place more frequently than in other parts of the country where ebb tide currents dominate. Dredging is expensive, poses the dilemma of where to dump the dredge spoils, and, ultimately, says Fink, is fated to be unsuccessful. He foresees that, **"Our research will eventually mandate a completely new approach to dredging policies in Maine, because there are places where it is not going to be cost-effective."**

Ken Fink's passionate concern for Maine beaches takes him not only to the shore but to town meetings and Board of Environmental Protection hearings. An article in *Downeast Magazine* stated that, "Many credit him with being the one person most responsible for educating the Maine public and government officials on the dynamics of sand beaches."

His research and his testimony figured prominently in the passage of the **Maine Sand Dunes Law,** a 1978 amendment to the state's wetlands protection act. It severely limits new construction on beaches and dunes and the reconstruction of storm-damaged buildings or seawalls.

veloped **hydrodynamic and dispersion computer models to trace the movement of pollutants within estuaries and harbors.** These models have been used in strategically locating a sewage outfall pipe in New Haven Harbor, Connecticut, and positioning offshore breakwaters in Bristol and Sconnett Harbors, Rhode Island. Additionally, a major environmental consulting firm generated $250,000 in new consulting contracts using these models.

- Information on the **effects of thermal discharges from nuclear power plants on worms and clams** allowed regulators to reopen previously closed shellfish beds around a nuclear plant in Wiscasset, Maine.
- A Sea Grant sedimentologist has proved that waves and tidal currents aren't the only natural mechanisms for moving fine-grained sediments in a shallow estuary. Raindrops can create vortex rings, pulses that enter the water column, hit the bottom with significant force, and stir up the sedi-

ments. The resuspended sediments can then be carried away, even by weak tides. The discovery has implications for studying the path of toxics which are often bound to sediments. **Artificial raindrops** could also be used to **transport oxygen into sewage lagoons, to inject nutrients into aquaculture facilities, or to dislodge silt buildup around boat ramps and piers.**

• Increased growth and development within the coastal zone presents serious challenges to the relatively undisturbed marine resources of Maine and New Hampshire. Because issues surrounding jurisdictional conflicts and management authorities often involve complex legal questions, Sea Grant stimulated the **development of the Marine Law Institute,** at the University of Southern Maine, which is recognized as a national resource and provides an ongoing forum for research, information, and analysis of conflicting uses of coastal and marine resources.

• In cooperation with the U. S. Army Cold Regions Research and Engineering Laboratory (CRREL), Sea Grant researchers determined that coastal ice such as found in Great Bay, N.H. is structurally an analog for Arctic sea ice. This finding offers the potential for a readily accessible, more hospitable site for **expanded study of ice formation and possible testing of equipment destined for use in polar latitudes.**

• A **circulation and tidal model** was developed to predict the response **of the Gulf of Maine** to the proposed Bay of Fundy tidal power development project.

• Only sixty miles of Maine and New Hampshire's 4000-mile coastline consist of sandy beaches, yet on an average summer weekend, more than 500,000 people use them. Obviously, the recreational value of these beaches is enormous, and their protection of prime importance. Sea Grant research on beach dynamics has provided the basis for important local and state regulatory efforts. It has also resulted in **management guidelines, local zoning ordinances, legislation regulating development on sand dunes,** and strict rules prohibiting the construction or replacement of all shore hardening devices such as bulkheads, revetments, and seawalls.

• Contributing to effective policy-making for regulating development on the coast, Sea Grant sedimentologists have correlated changes to the coast with sedimentary processes, biological communities, and human activities. Through bottom core sampling, seismic surveys, aerial photography, and bluff erosion profiles, they are **documenting the migration of the coast across geologic, historic, and contemporary time frames.** Knowledge of these physical and biological processes at work in the coastal zone is imperative to proper management and conservation of the shoreline.

• Facing the critical problem of **growth management in many coastal communities,** Sea Grant projects have addressed the problems of public access to the waterfront, water-dependent uses, and cumulative impacts of incremental development. Results of these **legal studies** are being used by state and local officials, private citizens, and maritime industries in assessing effective models of state-local coordination and basic legal questions.

FISHERIES MANAGEMENT AND DEVELOPMENT

Background

In a two-state region with a population of about 2 million, 15,000 fishermen hold commercial fishing licenses. They contribute $320 million to the area economy, and tens of millions of dollars have been spent over the last seven years for new docking facilities.

In 1976, the declaration of a 200-mile economic zone and passage of the Magnuson Fisheries Conservation and Management Act (MFCMA) changed the character of the fishery in the United States. Nowhere was the change more dramatic or troublesome than in the Gulf of Maine. Much of the trouble arose out of the adjustments in jurisdictional responsibility prompted by MFCMA, and was exacerbated by the inadequacy of the existing tools to meet the new demands placed on management.

A major expansion of the New England fishery further complicated the management process. This expansion, capitalized primarily by the private sector, made plans for allocation of the resource all but unworkable.

The New England fleet may be capable of harvesting certain species to levels below which an economic fishery can continue to exist. While the MFCMA requires the protection of fishery stocks, it also requires consideration of the economic and social health of the fishery. Federal, regional, and state managers now find themselves with possible low fish stocks to be allocated to an over-capitalized fishery. New management techniques are necessary.

As for the fisheries development areas, the majority of our work has focused on aquaculture. The first mariculture ventures in northern New England were estab-

lished in the early 1970 s. Today, Maine and New Hampshire have more than fifty individual aquaculture ventures which vary greatly in scale.

The Sea Grant program is also beginning to become more involved in development projects related to harvesting, marketing, and processing, particularly as they focus on quality and similar value-added efforts.

Within this section on **Fisheries Management and Development,** then, five issues have been the primary focus of Sea Grant efforts over the past ten years: *scientific basis for management; the social context of management; lobster resources and the industry; marketing, harvesting, and processing;* and *aquaculture.*

Program Goals

To enhance understanding of commercial and sportfishing stocks in the Gulf of Maine and the factors which affect the levels of those stocks.

To develop predictive tools which will further the new multi-fishery management conceptual approach to include species interaction.

To develop and aid the adoption of harvesting technologies which reduce fuel consumption, increase the quality of target species taken, reflect the needs of fisheries management and conservation, and increase the safety of fishermen.

To facilitate the continued development of the aquaculture industry with special emphasis on issues relating to disease, genetics, diet, and seed stock.

Achievements

• In the early 1970 s, wild mussel landings in Maine and New Hampshire totalled about 150,000 pounds with a value of $35,000. There was no mussel culture industry in the region. After a five-year research and marketing effort by our Sea Grant Program, landings increased to over 2 million pounds at a value of nearly $700,000. Today, largely **as a result of those Sea Grant efforts, the mussel industry continues its rapid growth** and is now the largest aquaculture industry in the region, with sales approaching $3.5 million.

• Over a **decade of Sea Grant research on the bacterial disease, gaffkemia,** which often causes high mortalities among lobsters held in pounds or lobster cars in Maine and in the Canadian Maritime Provinces, has resulted in the first drug approved by the Federal Drug Administration (FDA) for any crustacean species *(Federal Register,* Vol. 51, 1986, p. 1441). At present, about fifty of the eighty lobster pound owners in Maine use the new medicated feed for lobsters, with a conservative estimate of reduced gaffkemia mortality representing about $2 million annually.

• A Sea Grant researcher developed such a thorough knowledge of the structure of the fishery in the Gulf of Maine that he was selected by the United States legal team as the only non-government and non-lawyer expert witness to present **testimony** before the World Court at the Hague during proceedings **on the United States-Canadian Gulf of Maine boundary dispute.**

• Sea Grant investigators found a powerful, new **chemical assay technique for delineating Atlantic herring stocks** during non-spawning periods. Identification of different populations will assist the New England Fisheries Management Council with development of more effective management plans.

• **Mechanized shellfish processing and cleaning equipment** has been developed and has received wide use at many shellfish aquaculture ventures in the region.

• A population explosion among **sea urchins** has been extensively studied to determine the **impact on productive kelp beds and lobster populations** along the coast of northern New England. In addition, a **possible new fishery for sea urchins** has been facilitated through harvesting and marketing studies which suggest such a fishery could be relatively profitable. To date, twenty-five individuals have requested this report and are considering pursuing these suggestions. A follow-up study will be supported with Saltonstall-Kennedy funds this year.

• Sea Grant researchers discovered that fin rot disease is a major factor in determining return rates for hatchery-reared Atlantic salmon released in the wild. For caudal fin rot the mortality at sea is near 100 percent, presumably due to loss of speed and maneuverability. As a result of this and other Sea Grant-supported work (particularly in infectious pancreatic necrosis, a virus which can bring 90-95 percent mortality in affected hatcheries), the **Aquatic Animal Health Laboratory** was established to meet the aquaculture industry's need for answers relating to disease and nutrition issues.

• Researchers in the program have collaborated with several other Sea Grant programs on the **development and production of a bivalve larvae identification manual** for use by aquaculturists and fisheries biologists. Initial identification was made by using scanning electron microscopy to analyze larval hinge-tooth structure, but the manual will allow field workers to identify wild bivalve larvae through routine

MAINTAINING THE MATCHLESS MAINE LOBSTER

The Maine lobster — no other words evoke such a powerful image of a rugged Yankee tradition so closely identified with the state of Maine.

The lobster fishery is big business in Maine. The 1986 catch was worth nearly $46 million, which comprises almost half of the total landed value of Maine's commercial fish catch. The lobster industry continues to be one of the state's largest employers.

Because of its unique cultural value and significant economic importance, the lobster *(Homarus americanus)* has been the focus of a wide variety of Sea Grant research at the University of Maine. Under the direction of **Robert C. Bayer,** professor of animal and veterinary sciences, several accomplishments have been achieved that benefit not only the lobster industry in Maine but also throughout the northeastern United States and maritime Canada.

In the mid-1970s, Bayer and his students tackled the most serious disease of lobster held in pounds, **gaffkemia.** Known commonly as "red tail," this fatal bacterial disease was **responsible for over 50 percent of annual losses in pounds.** Early phases of Bayer's efforts were aimed at teaching pound owners to detect the presence of the disease through simple microscopic techniques so that spread of the disease could be limited by removing diseased individuals.

After isolating the bacterium *(Aerococcus viridans)* which cause the disease, the research team turned its attention to controlling the disease, and in the mid 1970s the University of Maine received a patent for a vaccine which can prevent red tail in healthy lobsters.

As Bayer and his students trooped along the Maine coast showing pound owners how to innoculate each lobster, they began to formulate plans for a quicker, cheaper means of achieving the same goal. After all, the individual innoculation of the thousands of lobsters held annually in lobster pounds throughout the state was a staggering prospect.

At about the same time, related studies were being conducted under Bayer's guidance to develop a balanced **artificial diet suitable for pound feeding.** The goal was to come up with a product comparable in price to the regular diet of fish cuttings, but without the associated problems of quality and availability. Based on nutritional analysis of the contents of lobster stomachs and after rigorous field-testing, a dry, pelleted feed was produced. It did not take long for Bayer to hit upon the idea of including the medication against red tail in the artificial diet, thus addressing **aquaculture's two main concerns, nutrition and disease,** with one overall solution. Preliminary field trials in lobster pounds in 1982, 1983, and 1984 showed a very low incidence of gaffkemia (3 percent) in lobster fed the pelleted diet fortified with Terramycin® (oxytetracycline). January, 1986, marked the Food and Drug Administration's approval of this, the first medication for use in lobsters.

Bayer has also worked on other lobster research projects in conjunction with the Maine Lobstermen's Association and the Maine Department of Marine Resources. Several **cooperative tagging studies** have resulted in a better understanding of lobster migration patterns in the Gulf of Maine. And results from a recently completed study on the **size distribution of V-notched lobsters** have been used in the development of the federal management plan for the American lobster.

optical microscope examination.

• A Sea Grant study determined that mortality rates for undersized commercial fish species of flounder discarded at sea when caught incidentally in shrimp trawls can run up to 95 percent. The Fisheries Technology Service (a SGMAP cooperator) developed a **shrimp separator trawl** which is expected to save the industry $10 million annually through conservation of juvenile flatfish and decreased labor costs related to culling and discarding.

• Researchers funded by Sea Grant developed an accurate and inexpensive **method for detecting toxins of the red tide organism** which sometimes contaminate New England shellfish.

• The soft-shell clam is the most valuable commercial bivalve in the region, with landed value of

SHELLFISH AS A CASH CROP

The cold, clean waters of northern New England's more than 4,000 miles of coastline provide an ideal setting for the development of aquaculture, or "farming the sea." But up until fifteen years ago, aquaculture was still considered an anomaly and the wave of the future. Today due to innovative bottom-culture techniques and stepped-up marketing efforts, aquaculture is enjoying the growth that its promoters have long predicted.

Although the volume of aquaculture production in New England is still small compared to commercial fishing, it accounts for 10 percent of the worldwide aquatic production of seaweeds, fish, and shellfish. As of 1986, there were more than fifty commercial aquaculture operations in Maine and New Hampshire.

In northern New England, the value of wild mussel landings has risen from almost nothing only a few years back to $3.5 million annually. In fact, **mussel businesses in Maine supply 90 percent of all the mussels harvested in New England.** With substantial capital investment in the late 1970s, the slow-to-begin mussel culture industry now employs over 100 people to meet an increasing demand for the popular, gourmet cuisine.

Due primarily to Sea Grant-funded research in mussel growth rates, culture techniques, and the development of pearl-free mussels, Maine's mussel culture production has increased ten-fold to its present level of more than 3 million pounds annually. Sea Grant's latest effort in this area is the development of a scientific and engineering base necessary for improved mussel seed procurement which involves understanding seed mussel recruitment and developing cost-effective methods to enhance this recruitment.

While researchers and aquaculturists are actively farming mussels in many coves along the coast, others are involved with developing new methods for enhancing the oyster, soft-shell clam, and lobster resources.

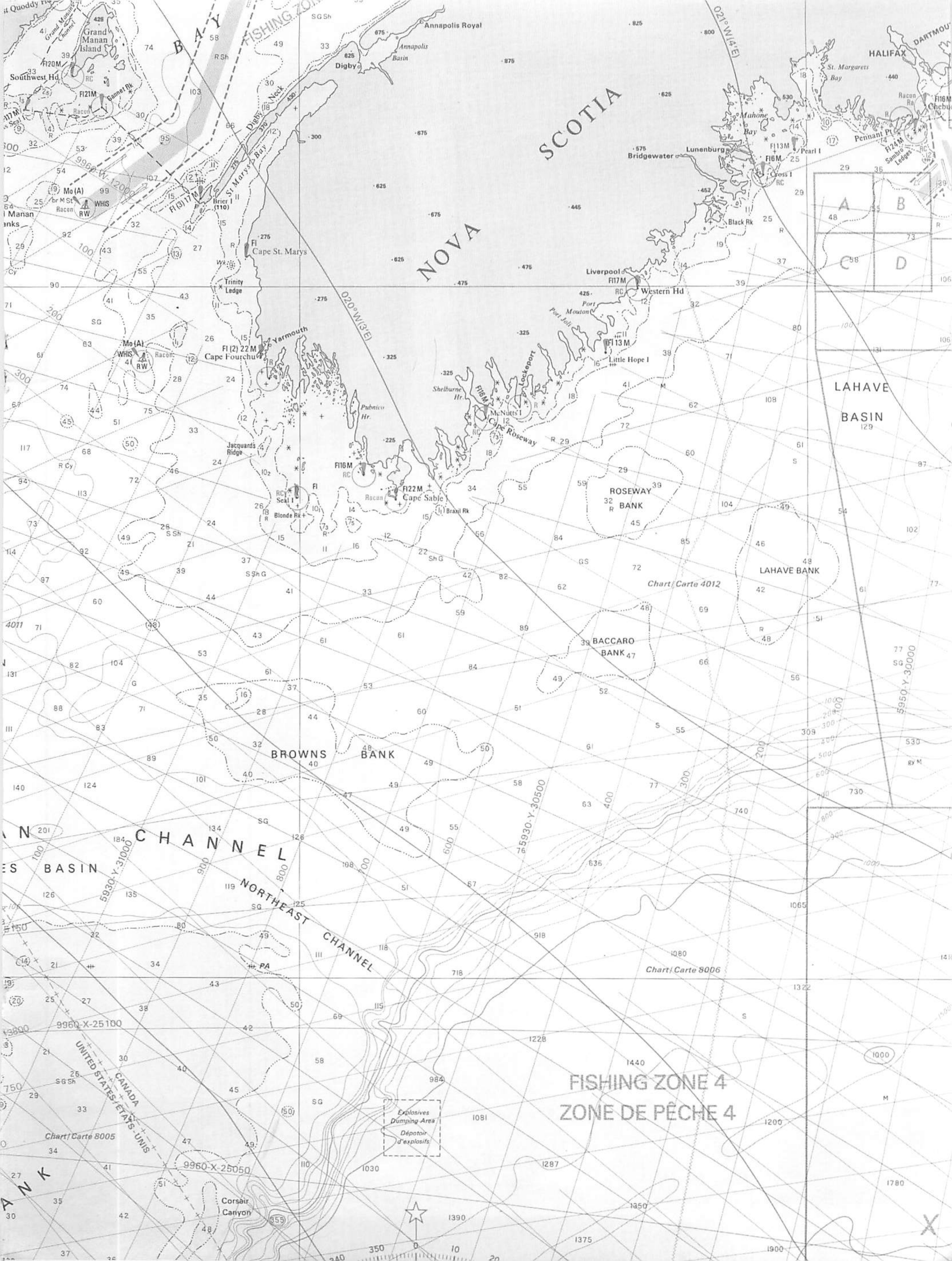
Working out of the basement of the Cutler town office building way Downeast, Sea Grant Marine Advisory Program cooperators **Brian Beal** and **Sam Chapman** are assisting townspeople and commercial fishermen there in raising egg-bearing lobsters in a hatchery until the females release their eggs. The two University of Maine marine biologists monitor the planktonic creatures as they hatch, molt, and metamorphose into tiny lobsters with all the characteristics of larger lobsters. At an inch and a half, the tiny lobsters, so vital to Maine's fishing industry, are released to the wild where they will hopefully reach the commercial fisheries within five or six years.

Lobsters, which were believed three years ago to be too cannibalistic for aquaculture, are now being successfully raised in cages at the Ira C. Darling Center, the University of Maine's marine research facility in Walpole. The highest value seafood product in Maine, lobster landings of 20 million pounds annually bring a wholesale price of $50 million. By applying aquaculture techniques to the lobster industry, the depleting resource may be enhanced as the fishing effort steadily increases.

$12 million annually. It is also the principal means of income for several thousand people in Downeast Maine. A decade of Sea Grant work has helped dozens of towns assess their clam resources and develop new management techniques. A six-community **clam hatchery** has sprung up, **seeding experiments** have been successfully carried out, a **mechanical seed harvestor** has been developed, and the effects of digging on clam flats determined. Sea Grant staff and cooperators also initiated the annual **Downeast Clam Forum.**

• In conjunction with the New Hampshire Fish and Game Department, Sea Grant researchers collaborated on a five-year project which developed successful **hatchery techniques for rearing coho salmon** to be released for recreational anglers.


MAINE
GULF OF MAINE
JORDAN BASIN
CROWELL BASIN
FUNDIA
GEORG
JEFFREYS LEDGE
STELLWAGEN BANK
MASSACHUSETTS
MASSACHUSETTS BAY
CAPE COD BAY
CAPE COD
NANTUCKET SOUND
USN-W104
Chart/Carte US 13006
Chart/Carte
Bangor
Penobscot River
Ellsworth
Belfast
Penobscot Bay
Rockland
Bar Harbor
Blue Hill Bay
Isle au Haut
Jonesport
Machias Bay
Petit Manan I
Mount Desert Rk
Matinicus Rk
Monhegan I
Portland
Cape Elizabeth
Cape Small
Seguin I
Halfway Rk
Saco
Boon I
Boon Island Ledge
Portsmouth
Isles of Shoals
Platts Bank
Cashes Ledge
Fippennies Ledge
Ammen Rk
Gloucester
Cape Ann
Eastern Pt
BOSTON
Plymouth
Race Pt
Chatham
Buzzards Bay
Woods Hole
Martha's Vineyard
Gay Hd
Nomans Land
Nantucket Island
Great Pt
Sankaty Hd
DAVIS BANK
Georges Shoal
Cultivator Shoal
Tide Rips
Rides de marée
DANGER
Unexploded ordnance
Explosifs non éclatés
Repd 1969
DANGER
Unexploded depth charges
Grenades sous-marines non éclatées
Repd 1956
Unexploded depth charges (Repd 1982)
Grenades sous-marine non éclatées (Repd 1982)
DANGER
Unexploded depth charge
Grenade sous-marine non éclatée
Repd 1957
Obst (Crib / Caisson)
(Nauset Beach)
(Highland)
Subm Obstr
019° W (1E)
018° W
017° W
016° W (1W)
5930-X-13500
5930-X-13000
5930-X-12500
5930-X-12000
5930-X-11500
5930-Y-31500
9960-X-25700
9960-X-25600
9960-X-25800
9960-X-25400
9960-X-25300
9960-X-25200
9960-Y-44400
9960-Y-44300
9960-Y-44200
9960-Y-44100
9960-Y-44000
9960-W-12500
9960-W-13000
9960-W-13500



NOVA SCOTIA
BAY
Grand Manan Island
Southwest Hd
Annapolis Royal
Annapolis Basin
Digby
Digby Neck
St Marys Bay
Brier I
Cape St. Marys
Trinity Ledge
Yarmouth
Cape Fourchu
Pubnico Hr.
Jacquards Ridge
Seal I
Blonde Rk
Cape Sable
Brazil Rk
Shelburne Hr.
McNutts I
Cape Roseway
Lockeport
Little Hope I
Port Joli
Port Mouton
Liverpool
Western Hd
Bridgewater
Lunenburg
Mahone Bay
Cross I
Pearl I
Black Rk
St. Margarets Bay
HALIFAX
DARTMOUTH
Pennant Pt
Sambro Ledges
Chebucto
020°W(3'E)
021°W(4'E)
ROSEWAY BANK
BACCARO BANK
LAHAVE BANK
LAHAVE BASIN
BROWNS BANK
CHANNEL
NORTHEAST CHANNEL
BASIN
Chart/Carte 4012
Chart/Carte 8006
Chart/Carte 8005
5930-Y-30500
5930-Y-31000
5950-Y-30000
9960-X-25100
9960-X-25050
9960-W-12000
UNITED STATES/ETATS-UNIS
CANADA
Corsair Canyon
Explosives Dumping Area
Dépotoir d'explosifs
FISHING ZONE 4
ZONE DE PÊCHE 4
A
B
C
D


SPENCER

SEA GRANT MARINE ADVISORY PROGRAM 7

PROGRAM STRUCTURE AND MANAGEMENT

Prior to the Maine/New Hampshire Sea Grant Program's achievement of college status in 1980, the Marine Advisory Program functioned primarily as a loose confederation of three distinct groups: 1) the Marine Extension and Public Education Program at the University of New Hampshire, 2) the Marine Advisory Service at the University of Maine, and 3) the Fisheries Technology Service of the Maine Department of Marine Resources. Each had its own staff, identified priorities independently of the other organizations, and developed educational programs for a restricted locale or audience.

But in 1980 that all changed with the creation of a single Sea Grant Marine Advisory Program (SGMAP) to represent the bi-state region. **The Fisheries Technology Service** continues to be a part of our SGMAP through a formal contractual agreement with the University of Maine. However, while we are a single overall program unit, the Maine/New Hampshire Sea Grant Marine Advisory Program consists of two major components, one at UNH in Durham, New Hampshire and one at UM in Orono, Maine. It is co-administered by program leaders at each institution, and central administrative support is provided through these offices for the network of advisory service staff and cooperators throughout the region. The two leaders are responsible for assuring that programs within the Maine and New Hampshire components are planned and coordinated jointly, whenever possible.

Since the establishment of a Sea Grant Marine Advisory Program at the University of New Hampshire in 1976, it has been affiliated with the UNH Institute of Marine Science and Ocean Engineering (formerly called the Marine Program). In 1986 a formal linkage between the SGMAP at UNH and the Cooperative Extension Service (CES) was established. The name of the program was changed to the Sea Grant Extension Program. It became a fifth program element within the CES, equal with the existing program elements of 4-H, home economics, agriculture, and forestry. The Sea Grant program leader was appointed the CES program leader for the newly established Sea Grant Extension Program. All current and future Sea Grant field staff at UNH will be given CES appointments. The Sea Grant Extension program leader is administratively responsible to both the director of the Cooperative Extension Service and the UNH Sea Grant director (see Figure 1). Consistent with UNH/CES policy all Sea Grant state specialists and county staff report directly to the Sea Grant Extension program leader.

At the University of Maine, the Sea Grant College Program is part of the Center for Marine Studies (CMS), which is responsible for system-wide leadership (seven campuses) in marine science. The CMS director also serves as the Sea Grant director. In a full-time role, the SGMAP leader at the University of Maine also serves as the Center for Marine Studies director of marine outreach and reports to the CMS director (see Figure 2).

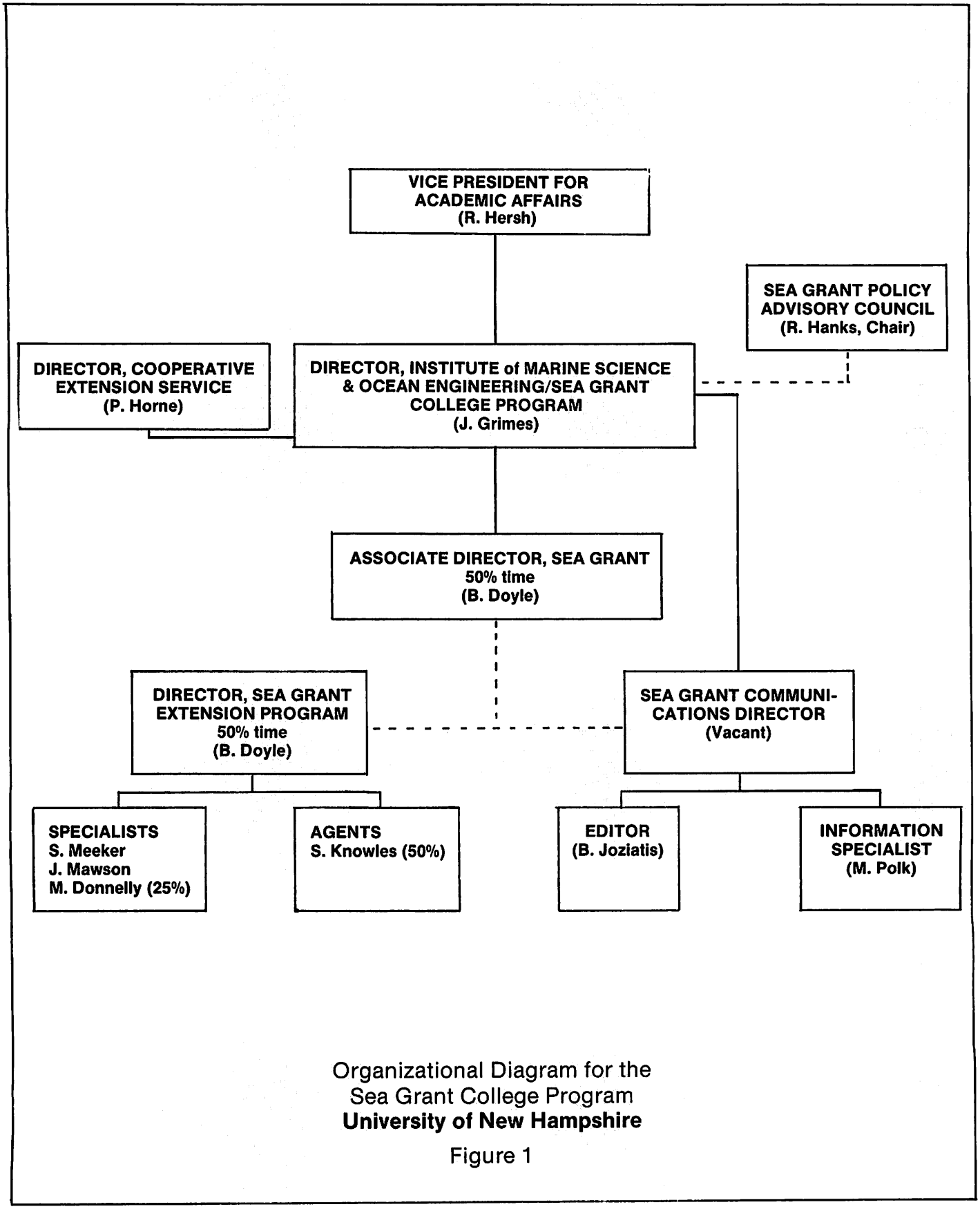
Rather than rely exclusively on our relatively small Sea Grant marine advisory core staff to provide quality informal education to the marine clientele in northern New England, we consciously chose to augment our program, and hence dramatically extend our outreach capabilities, by developing three highly effective and unique arrangements involving: **1) the cooperation of other institutions, agencies, and programs** with similar or parallel missions; **2) university research faculty;** and **3) volunteers (marine docents).**

COOPERATORS

Our cooperators network grew out of the realization that a number of other public institutions and agencies within northern New England shared our goals in marine outreach education. Thus, six years ago we attempted to establish a framework within which Sea Grant could play a central role to help focus and coordinate these diverse outreach activities. Under the administrative supervision of the two program leaders, we have developed an organizational structure that maximizes the impact of Sea Grant's investment through formal collaboration and talent-sharing with these institutions. The result was the establishment of the **Sea Grant Cooperators Network.**

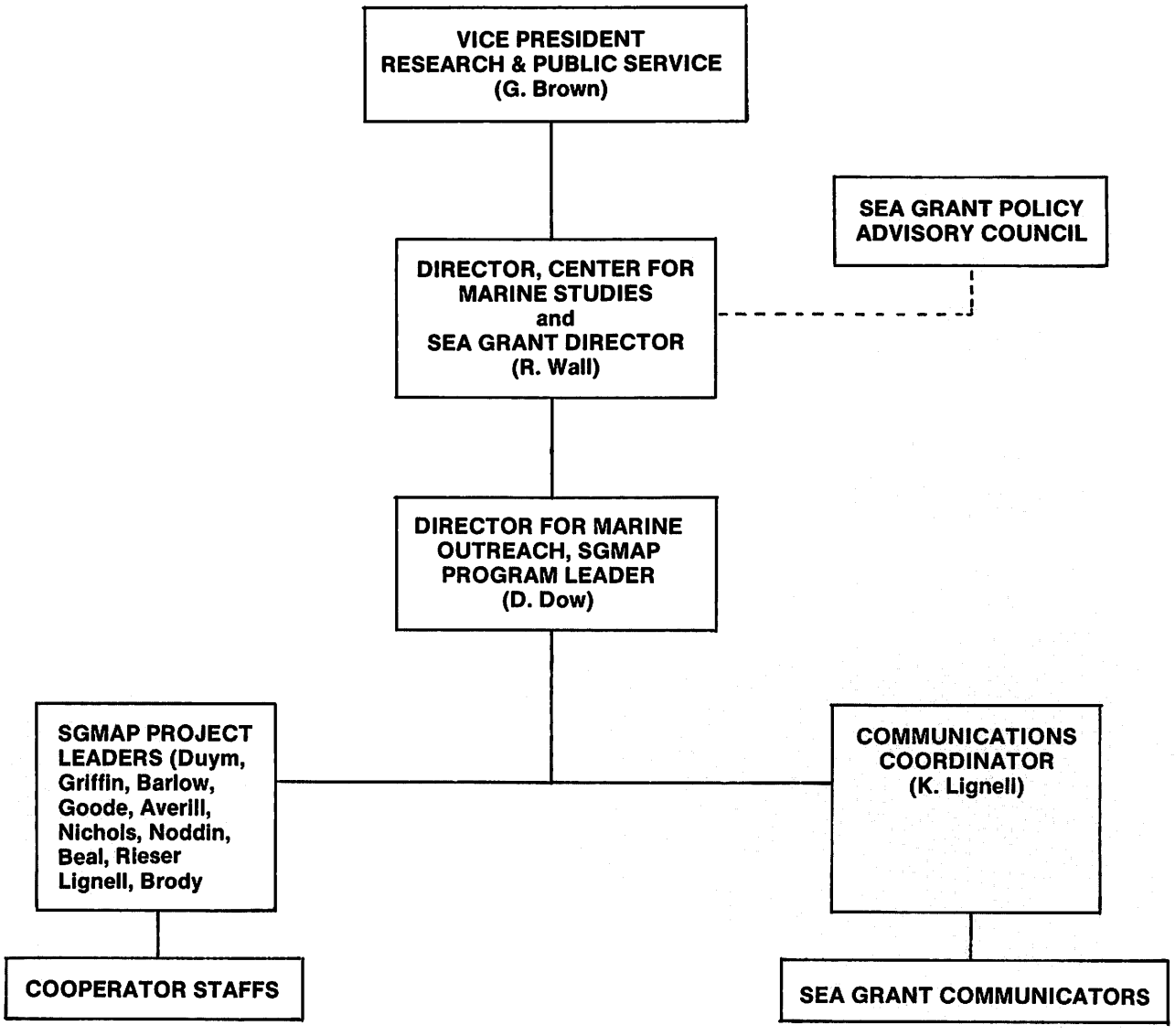
This network has grown during these six years and now formally includes ten institutions, agencies, and programs:

- Fisheries Technology Service of the Maine Department of Marine Resources
- Maine Maritime Academy
- Southern Maine Vocational Technical Institute
- Washington County Vocational Technical Institute
- College of the Atlantic
- University of Maine at Machias
- Marine Law Institute of the University of Maine School of Law at the University of Southern Maine
- Cooperative Extension Service at the University of Maine
- Northeast Marine Education Program of the College of



Organizational Diagram for the
Sea Grant College Program
University of New Hampshire

Figure 1



Organizational Diagram for the
Sea Grant College Program
University of Maine

Figure 2

Education at the University of Maine
- Technical Services Program of the College of Engineering and Science at the University of Maine

Individuals within the cooperators network participate fully in the planning, design, implementation, and evaluation of SGMAP outreach efforts. The network is also supported by a variety of administrative arrangements utilized according to the needs and particular circumstances of the educational task to be undertaken. They include:

Fiscal
- memorandums of agreement
- contracts of services
- joint funding and budgeting
- cost sharing
- fund transfer

Planning and Programming
- shared planning and priority setting
- shared programs and visibility
- joint evaluation

Personnel
- shared use of staff resources
- co-location of staff

Central Administrative Services
- communications/publications
- grants management, reporting evaluation

Although the cooperators network has existed for less than six years, there is ample evidence to suggest that Sea Grant investments in the network are already paying handsome dividends in the form of increased financial and personnel commitment to marine outreach by cooperating institutions. For example, in 1984 the **Fisheries Technology Service** (FTS), within the Maine Department of Marine Resources, employed three full-time fisheries extension agents. Due to increased state support, there are now six full-time staff who actively participate in Sea Grant Marine Advisory programs, and during this period Sea Grant Marine Advisory Program support to FTS has decreased slightly.

Likewise the **UM Cooperative Extension Service** has increased its commitment to marine extension programming since we initiated funding support ($10,000 per year) four years ago. Starting with one full-time employee (FTE), they now have three FTEs who regularly coordinate and plan their outreach programs with other SGMAP staff and cooperators. We have also experienced similar increases in non-Sea Grant-supported staff commitment at both the **Maine Maritime Academy** and the two state vocational technical institutes. Collectively, they have grown to nearly two FTEs.

In terms of program impact, the cooperator network accounts for over thirty individuals contributing no less than sixteen FTEs.

RESEARCH FACULTY CONNECTIONS

A concerted effort is made to involve Sea Grant research faculty in our marine advisory program. Their talents are utilized in a number of ways to enhance the Sea Grant Marine Advisory Program's outreach capabilities. In some instances they are provided modest support and given appointments as staff or cooperators within the SGMAP. Such is the case with Maureen Donnelly of the UNH department of leisure management and tourism, as well as Mike Brody and Warren Tomkiewicz of the UM College of Education.

Each of these faculty have assigned marine advisory functions which are an outgrowth of their externally-funded research efforts. For Donnelly, this is in the marine recreation and tourism area. Brody and Tomkiewicz, co-directors of the **Northeast Marine Education Program** have been involved in teacher training, curriculum development, and research into the program development and evaluation process for advisory programs.

A similar arrangement has been finalized with Alison Rieser, executive director of the **Marine Law Institute** (MLI) at the University of Southern Maine, which became a formal SGMAP Cooperator in 1986. While we have utilized the special academic talents in law and policy at the MLI for many years, their formal participation in our outreach network provides both SGMAP and the MLI with new opportunities such as the East Coast Fisheries Law Conference, the *Territorial Sea* newsletter, and the Institute's involvement with law and policy relative to coastal development.

Our involvement with the **Maine Maritime Academy** faculty as a cooperator allows SGMAP access to all aspects of maritime management and transportation. As our ports and harbors continue to develop more fully, this resource should become even more productive.

The University of Maine **Aquatic Animal Health Laboratory** cooperates closely with SGMAP on health-related issues of fish and shellfish in both culture (aquaculture) and commercial fisheries. SGMAP is a key liaison between this important academic research team and the aquaculture industry. The health lab has assisted industry with disease diagnosis, certification, and therapy, and conducts workshops with SGMAP on behalf of the industry.

In 1985, the **Fisheries and Aquaculture Research Group** was established at the Agricultural Experiment Station at the University of Maine. This brought together faculty in various departments to address industry problems in a quick-response fashion.

With salary contributions of over $100,000 from the Experiment Station to these faculty, the College of Life Sciences and Agriculture has acknowledged fisheries research as a priority. These faculty have been SGMAP's "bread and butter" research support group for many years and have made significant contributions to our outreach efforts. In 1986 alone, these faculty and their graduate students conducted or participated in no less than twenty-seven SGMAP-sponsored industry workshops, forums, or projects.

Also in 1985 the **Engineering and Technology Center** in the University of Maine's College of Engineering was established. The "tech center" is the College of Engineering Experiment Station, and assists industry via the problem-solving capability of its faculty and students. Our connection with this new cooperator should be of great value to SGMAP in providing technical engineering support to our staff and to the fishing industry.

In addition, the faculty of the University of Maine's oceanography program are an important resource for Sea Grant staff. These faculty, although often involved in research of a basic nature, have special knowledge and skills that are frequently used in outreach programs. Oceanography faculty have conducted seminars for community and state planners on beach erosion and protection, lobster behavior in relation to traps, and the identification of a chemical substance generated from mussel dragging.

Similarly, at the University of New Hampshire, marine faculty from all disciplines have contributed to public outreach programs. Some of these include involvement in the Great Bay Estuarine Research Reserve effort, presentations at the Odiorne Point Nature Center, consultation on coastal erosion and marine pollution problems, and working with such state agencies as New Hampshire Fish and Game.

MARINE DOCENTS (VOLUNTEERS)

The third program-enhancing function utilized by the SGMAP is the marine docent program. Our cadre of marine docents, which in a given year ranges in size from twenty-five to fifty, are trained volunteers who give freely of their time to assist SGMAP staff in nearly all aspects of program development, coordination, and delivery. Under the guidance of one of our marine education specialists, docents undergo an intensive six-month training program which includes sessions on marine science, coastal issues, Sea Grant research, classroom teaching techniques, and program development.

Docents not only assist staff with program development and organization but also do actual teaching themselves on subjects ranging from aquaculture to salt marshes to tides and currents. Their primary audiences are K-12 school children and teachers, and the general public. Upon entering the program, each marine docent makes a minimum commitment of four hours per week for two years. Their impact on our region and program is significant, as evidenced by the more than 2000 programs/lectures they gave to nearly 100,000 individuals during the past ten years. In addition, one of these marine docents, Persis Plaisted won the 1984 Northeast Marine Advisory Council (NEMAC) Outstanding Achievement Award.

At the 1986 Sea Grant site review, we estimated that for an annual Sea Grant budget of $358,002, we are receiving in excess of $1 million worth of Marine Advisory Program effort from the individuals included in our cooperator network, research faculty, and marine docents.

PROGRAM EMPHASIS AND ACHIEVEMENTS

The UM/UNH Sea Grant Marine Advisory Program presently concentrates on educational efforts within four major areas:

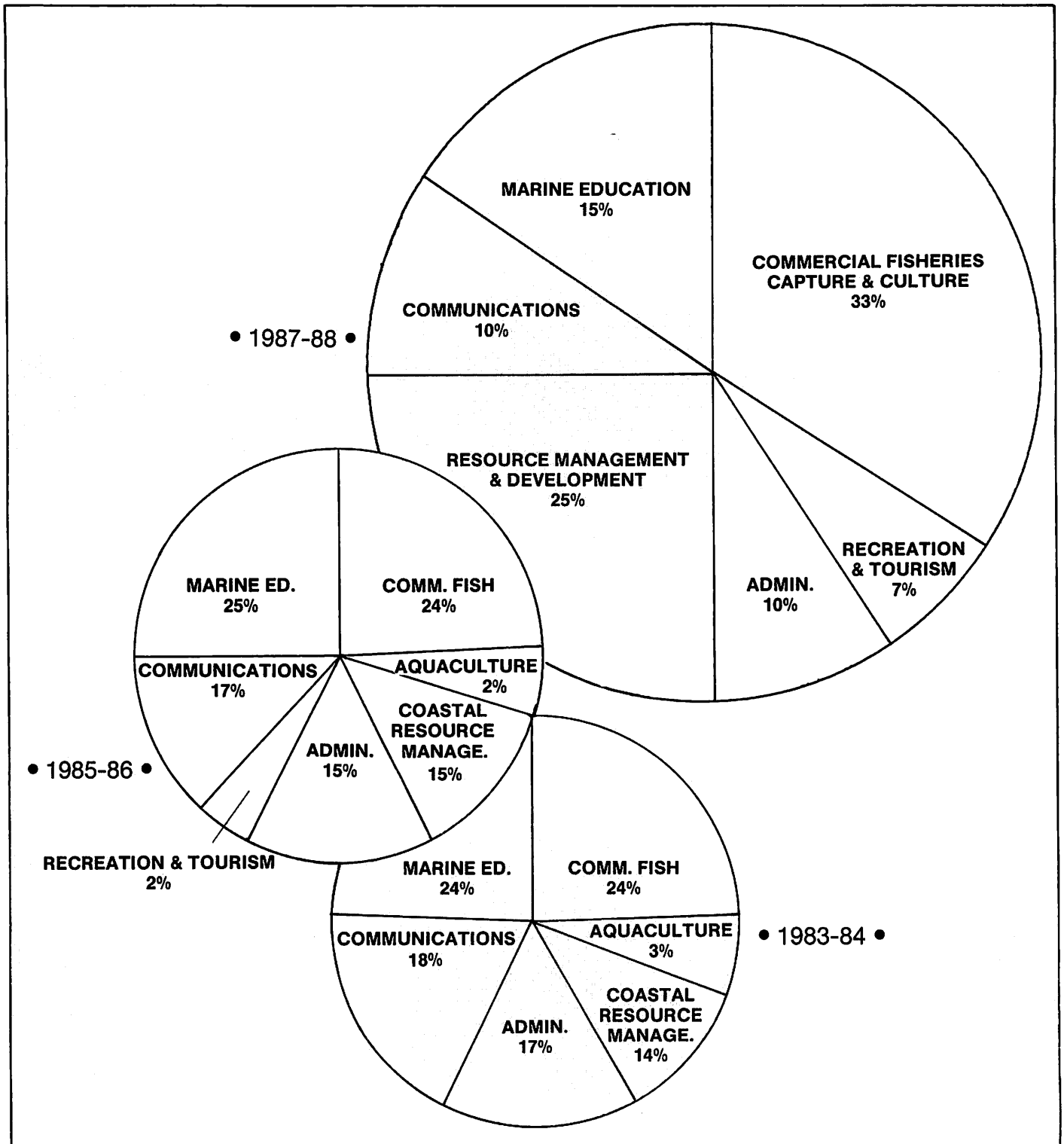
- Commercial Fisheries
- Coastal Resource Management and Development
- Marine Science Education
- Marine Recreation and Tourism

While marine recreation and tourism has only been considered a major program element for the past four years, the others have been a focus for SGMAP efforts since 1976. In response to identified needs and changing program priorities, distribution of advisory service effort has modified over time, particularly during the last five years. (Figure 3).

COMMERCIAL FISHERIES

Situation

Northern New England's commercial fishing industry generates over $300 million annually to the region's economy and employs nearly 15,000 individuals. Its health and vitality are of critical importance to the region. Maine and New Hampshire's fishing industries prospered and experienced unprecedented growth during the late 1970s and early 1980s, (catching nearly one third of New England landings and establishing itself as a "center" for both traditional and commercial fishing and aquaculture). However, a combination of events including the loss of the northeast portion of Georges Bank to the Canadians, a leveling off of landings, and the rising costs of doing business, have created new challenges for the industry. It is clear that increased profits will not



DISTRIBUTION of EFFORT ACROSS PROGRAM AREAS for the UM/UNH SEA GRANT MARINE ADVISORY PROGRAM
FIGURE 3

come from increased landings of traditional fish stocks, at least in the short term. The fishery will depend on landing a high quality product that enhances its value and status in a competitive marketplace.

There is constant concern about the viability of the region's most valuable fishery resource, the American lobster ($50 million landed value/year). The full impact of human activity on this resource (dragging, dredging, pollution, potential overfishing) has never been adequately addressed. Interest has been renewed in the possibility of supplementing or enhancing the lobster resources with hatch and release programs, and many contend that this may contribute additional seed stock to the existing resource and is now occurring along the Maine coast on a pilot scale.

Virtually non-existent fifteen years ago, aquaculture has evolved into a major industry with blue mussels, European and American oysters, Pacific/Atlantic salmon, and clams leading the way. Crabs and sea scallops are prime contenders on the new culture candidate list. Blue mussels alone, with half of the harvest of 300,000 bushels being cultured, accounted for $3.5 million in sales in 1985. Competition and concern over lease sites and the effects of culture fisheries on traditional fisheries have been and will continue to be major issues along northern New England coasts.

Achievements

• Sea Grant cooperators from the Fisheries Technology Service (FTS) have worked with fishermen since the early 1970s to **develop a sustainable ocean quahog harvest.** Efficient hydraulic gear was adapted to Maine's vessels and bottom type while markets were investigated and promoted, and in 1982 the first market opened up for little neck ocean quahogs. Sea Grant-supported research is underway to determine quahog population dynamics as well as resource harvest sustainability. The development of this new fishery involves fifty-five vessels landing 1.2 million pounds of product valued at $1.9 million annually.

• In 1985 SGMAP provided the leadership and support for the creation of the **Maine Lobster Pound Association.** (MLPA). This association boasts thirty members (there are fifty pounds in the region) and expects 100 percent participation in the near future. They have conducted several educational workshops on disease and marketing, are involved in the governmental process, and are establishing new association marketing initiatives.

• The cooperative **lobster tagging project** initiated several years ago between Sea Grant, the Maine Lobstermen's Association, and the Maine Department of Marine Resources was the largest study of its kind ever conducted, with over 4,000 lobsters tagged. It has also paved the way for an exciting new partnership between academic research and industry; the establishment of the Maine Lobster Institute in April 1987. It will provide hard dollar support for projects in lobster ecology at the University of Maine.

• Clammers in Downeast Maine earn $5 million annually from the harvest of these mollusks. In conjunction with Sea Grant researchers and the Maine DMR, SGMAP staff have developed a sixty-page **clam management manual,** and they have also assisted towns in developing **hatchery-rearing techniques** to produce potential new seed sources. This effort has resulted in the establishment of a **six-community, soft-shell clam hatchery** in Downeast Washington County designed to produce at least 5 million seed clams per year for use in reseeding several thousands of acres of clam flats.

• During the past five years SGMAP cooperators from the Fisheries Technology Service (FTS) evaluated several **nets designed to separate fish from shrimp** in order to reduce the great numbers of juvenile groundfish destroyed incidentally in the catching of shrimp. FTS cooperators modified a Newfoundland separator trawl to peform in New England waters, with assistance of the MIT Sea Grant Program in securing the use of the David Taylor Naval Testing Facility in Maryland. The first full size (seventy-foot) separator trawl was placed aboard a commercial vessel in December, 1985 with remarkably consistent results — a 90 percent separation rate coupled with over 95 percent shrimp retention. Savings in reduced fish mortality and deck labor is conservatively estimated at $10 million annually.

• For many years all fish landed in Portsmouth, NH, were sent to market in Boston via independent trucking companies. Spurred by lack of adequate trucking facilities and late payments, a group of commercial fishermen decided to explore the possibility of setting up their own fisheries cooperative with the help of SGMAP staff. Fourteen commercial fishermen contributed $1000 each to establish the **Portsmouth Fishermen's Cooperative** in 1979, which has grown steadily since then to twenty-two members and now handles 4 million pounds of fish annually.

• The annual **Maine Fishermen's Forum,** initiated and organized by SGMAP in 1976, attracts nearly 1000 fishermen each year to the largest educational event of its kind in the nation. Recognizing the success and importance of this event, the commercial fishing industry assumed primary responsi-

WHERE THE ACTION IS: MAINE'S NEW FISH AUCTION

Although the temperature hovers near the freezing mark and a bone-chilling cold emanates from the damp building on the Portland waterfront, the seafood buyers and sellers clad in down parkas and insulated boots all agree that the action on the floor of the year-old **Portland Fish Exchange** is hot enough to keep them warm.

According to the general manager of the Exchange, the current level of activity at the auction has gone "way beyond expectations with boats getting better prices for their catch and buyers having better access to fish," which means higher quality fish for consumers.

The promise of making quality pay is exactly why **Jim Wilson,** Sea Grant researcher in economics at the University of Maine, first proposed this type of economic exchange for Maine's groundfish industry just a decade ago. As a consultant to the city of Portland during its development of a $25 million Fish Pier facility, Wilson promoted the display auction as a way to "introduce a price differential for higher quality fish and insure a predictable supply with twenty-five boats landing fish directly and, perhaps, the equivalent number of trucks trucking in fish."

The reality has already doubled Wilson's predictions. A typical day has nearly fifty boats unloading and 100,000 to 150,000 pounds of fish on display, with truck deliveries accounting for between 30,000 and 40,000 pounds. Unloading usually begins before dawn. All fish are weighed, culled by size, species, and quality, then placed in iced boxes before going on display.

In traditional fish auctions, a buyer usually purchases an entire "trip," or boatload, sight unseen. Fish that were iced and boxed at sea usually command the same price as fish that were shoveled into the hold. In the display auction *all* the fish are exhibited in the refrigerated auction building. In countries where display auctions are common, as in Japan and northern Europe, buyers consistently bid higher for the higher quality product.

Wilson first proposed the concept of a display auction in a 1976 Sea Grant report on the potential impact of the 200-mile limit on the Maine fishing industry. He and **Robin Peters,** editor/publisher of *Commercial Fisheries News* and then a fisheries specialist with Sea Grant, developed the idea further in subsequent studies for the State Planning Office and the City of Portland. Wilson was later contracted by the city's Fish Pier Operations Committee to design the rules of operation for the fish auction and, more importantly, to strike a balance between the demands of the harvesters and the dealers/processors.

Wilson's contribution to the successful development of the Portland Fish Exchange has also earned him the 1987 President's Public Service Achievement Award at the University of Maine.

bility for sponsoring and organizing the forum in 1983. It continues successfully with industry providing some $43,000 to the 1987 forum.

• With the current focus on quality in the fishing business and because of the highly perishable nature of seafood, the role of bacteria is of constant concern. In response to industry interest in conducting in-house microbiological assessment of their product, SGMAP staff, in conjunction with UM Department of Food Sciences faculty, conducted the first **quality control workshop for seafood processors,** seafood handlers, and boat captains to introduce and train them in the use of simple assessment tests. Of the fifty-one participants, a majority indicated they would install microbiological techniques in their own work environments.

• Realizing the tremendous growth-related disease problems in culture fisheries in the region in this last decade, SGMAP staff, working with Paul Reno of the University of Maine's microbiology department, developed the idea of creating a disease "clearinghouse" for the industry. Established in 1985, the **Aquatic Animal Health Laboratory** diagnoses and monitors the health status of cultivated species. The lab specializes in performing tests for the certification of seed stocks required by the federal government, Canada, and the New England states.

COASTAL RESOURCE MANAGEMENT AND DEVELOPMENT

Situation

There are 120 coastal communities along Maine and New Hampshire's 4,000 miles of coastline. Although diversity among the

towns is great, from a bustling commercial port such as Portsmouth to the pristine fishing villages of Downeast Maine, they share one thing in common — increasing pressures of a growing population and the subsequent demands on facilities and resources.

This burgeoning growth threatens to change the basic character of northern New England's coastline and harbors. In the past decade, boating traffic has doubled, boat mooring space has become scarce, and there is a significant increase in on-shore demands being placed upon the scarce resource of our harbors and our coastline.

Most of the region now agree that the alternative to planned growth, allowing random factors to determine direction, is no longer acceptable. Public and private investments in marine resource development projects in places like Portsmouth, Portland, Searsport, and Eastport have forced coastal communities to be aware of trends in land use and port volumes in relation to jobs, revenue, and compatibility with other uses.

Achievements

• SGMAP staff and cooperators played an active role in assisting local communities and state agencies to establish **national estuarine sanctuaries** in both Wells, Maine and Great Bay, New Hampshire. After a meeting cosponsored by Sea Grant and attended by some forty local officials, state representatives, and federal Office of Coastal Zone Management staff, the New Hampshire Office of State Planning initiated the application process which led to the designation of Great Bay as an Estuarine Research Reserve seven years later.

• When a local developer unveiled plans to build a 200-unit condominium/recreation complex on a pristine, 100-acre New Hampshire coastal site, controversy ensued. The affected township, along with the local conservation group and the builder, agreed to ask Sea Grant for assistance in settling certain issues. Drawing together marine faculty and Sea Grant researchers from a variety of disciplines, SGMAP staff assisted the group in making a series of recommendations pertaining to access points, location of wildlife populations, buffer zones, and boat launch/docking area which the developer accepted.

• The UM Cooperative Extension Service, a Sea Grant Marine Advisory Program cooperator, has provided assistance over the last three years to area harbor masters. Educational workshops and a forty-nine page **Guide to Harbor Management Manual,** were the catalysts in leading to the establishment of the Maine Harbor Master's Association in early 1986. The association provides harbor masters the opportunity to focus on common concerns, exchange ideas, and to "speak with one voice" in order to cope with the increasing use and competition for harbor resources.

• Culminating nearly seven years of marine advisory involvement with issues related to cold water survival, SGMAP staff with support from the Northeast Marine Advisory Council (NEMAC) and the U. S. Coast Guard produced two commercial quality, thirty-minute, color **videotapes on hypothermia.** Nearly 300 of the videotapes have been distributed both nationally and internationally.

• Marinas and boatyards along the east coast are experiencing difficulties in gaining trained, entry-level staff and providing for their on-going exposure to new technologies. On Long Island, administrators and staff at the State University of New York (Farmingdale) recognized the need but lacked information for alternate ways to meet the challenge. Staff from Maine/New Hampshire SGMAP and N.Y. Sea Grant guided representatives from the Long Island campus to Maine's vocational technical institute where a Marine Trades Center provides such education. As a result of this tour, SUNY at Farmingdale has developed a series of technical workshops for industry personnel and is considering the establishment of an Associate's Degree Program in marine trades technology.

• The Maine Maritime Academy (MMA), a SGMAP cooperator, has provided leadership in both maritime transportation and marine education issues for the region. Four series of workshops on ocean survival have been offered to nearly 750 fishermen, yachtsmen, and public safety personnel, as have **diving safety symposiums** and **marine firefighting programs.** Recently, the academy has targeted their ocean survival workshops at high school seniors, with about 100 student participants to date. Last winter, five students successfully escaped from an automobile which skidded off a causeway and overturned in the water. They attributed their escape and survival to techniques learned in the MMA workshops they had recently completed.

• The soft-shell clam industry is Maine's second most valuable fishery ($5 million/ 5.2 million pounds landed). Seventy percent of these landings occur in Maine's easternmost counties (Hancock and Washington). SGMAP staff and cooperators organized two regional shellfish workshops and the first **"Maine Shellfish Conference"** in fall, 1985, attended by 300 harvestors, local clam committee members, academics, and state management officials. This activity has led to the hiring of a CES

marine extension assistant to serve the Downeast area and the establishment of the Maine Shellfish Dealers Association.

• Tonnage shipped through Eastport has increased dramatically over the past five years with continued growth and facilities expansion expected. The Sea Grant Marine Advisory Program, upon request of the Eastport Port Authority, provided assistance in organizing and publishing educational material highlighting the port's potential. Our work has led to a variety of activities including the development of a training program for dock workers by staff at the Marine Trades Center, and the commitment of $1 million of state funds for port improvement.

• Over the past ten years Sea Grant has supported several research projects in the field of marine pollution. SGMAP staff organized a forum for ten Sea Grant researchers to present the results of their work to participants from industry, government, and academe. One researcher subsequently presented his work on coastal modeling to the MIT Sea Grant Industry Advisory Service — a group of about 100 marine industry representatives. Based upon his presentation, another researcher received support from the NH Bureau of Hazardous Waste to carry out a project complementing his ongoing Sea Grant-supported research on marine disposal of hazardous waste.

• Impressed with the Sea Grant project which developed successful oil boom diversion techniques for the Piscataqua River, a high velocity current area, the Maine Department of Environmental Protection subsequently required these techniques in the port of Searsport, Maine, where similar conditions exist.

MARINE SCIENCE EDUCATION

Situation

Addressing issues related to marine science education in the bi-state region can be complex. Both states operate and make decisions mainly at the local level, and both states rank low in state aid to education. In New Hampshire for example, 95 percent or more of all school budgets is raised by local property taxes. The result is a large fluctuation in the quality of K-12 education.

There exists a real concern over the quality of science education in this country. Summarizing the situation, Mayer (1985) notes that, "A series of reports issued over the past several years, including that entitled, *A Nation At Risk*, and the more considered report by the National Science Board Commission entitled *Educating Americans for the 21st Century*, have highlighted the need for improved sciences and mathematics education."

For New Hampshire and Maine, this national concern is also reflected at the local level. Studies of the frequency of science teaching indicate a substantial drop between 1973 and 1978. Preliminary indications are that this frequency is even lower now. When asked what could best help to rectify the situation, a survey of principals and superintendents ranked the development of better in-service and pre-service training as top priority.

A recent study of 226 Maine public school students in grades four, eight, and eleven further emphasizes this point. It found that the overwhelming majority of those students understood relatively few marine science and natural resource concepts, with only slight improvement through the grades.

Despite the diminished effort in science education, interest in marine science education is escalating. There is an increasing demand for and participation of area educators in Sea Grant marine education efforts such as those outlined below.

Achievements

• *The Seaside Naturalist*, a 240-page book released by Prentice-Hall Publishing Company, is based on *The Tidepool Times*, a marine education newsletter originally produced by the SGMAP staff and now published by the Friends of Odiorne Point, Inc. Prentice-Hall provided the working capital, as well as publishing, advertising, and distribution services. The Sea Grant Marine Advisory Program and the author are sharing in 10 percent of the royalties generated from the sales of the book. Nearly 4,000 copies have been sold since the book's public release in 1983.

• Marine docents not only help to staff field programs at **Odiorne Point Nature Center** and on the **Floating Lab** but also provide SEATREK lectures to schools, clubs, organizations, and community celebrations. Averaging 300 presentations each year, **SEATREK** reaches about 15,000 people in New Hampshire, southern Maine, and northern Massachusetts, 75 percent of whom are students and educators. During the ten-year period the docent program has been in existence, marine docents have presented more than 2000 lectures to approximately 100,000 individuals.

• The marine docent program has served as a model for other institutions establishing volunteer programs. Recently, for example, the Society for the Protection of New Hampshire Forests designed a docent program very much like that at UNH and received a three-year private grant of $60,000 to establish it.

• Several years ago a New Hampshire seacoast community group raised money to build and

launch a gundalow, an early workboat used extensively on Great Bay, and SGMAP staff organized a gundalow education committee to draft a marine education program for use as the gundalow moves to various coastal sites. The staff also helped develop a gundalow education proposal, which the National Endowment for the Humanities funded at $60,660.

• In Jonesboro, Maine, where clamming employs two-thirds of the town's population, SGMAP staff and cooperators helped thirty 4-H youths develop an experimental shellfish hatchery. Assisted by local fishermen, the program included the spawning of 200,000 clams and the planting of 1 million European oysters. Five other such clubs are now in place. The project also led to the development of a six-town Community Clam Hatchery on Beals Island, with broodstock produced by the Jonesboro 4-H'ers.

• Each year, eighty-five to ninety-five classes with 200 teachers/parents and 3000 students take part in spring field programs at Odiorne Point State Park in Rye, New Hampshire, with dozens more schools on a waiting list. The program includes a mandatory workshop for teachers/parents, curriculum material, and a pre-trip SEATREK lecture by a marine docent.

• Designed to increase the public's knowledge of marine resources and their relationship to our environment, the summer programs at Odiorne Point currently attract some 8,000 people each year. Since 1980, participation has increased 15-20 percent per year.

• Careful use and management of a limited coastline is a critical issue in New Hampshire. With an $8,000 grant from the New Hampshire Coastal Program in 1984-85, a high school curriculum, **N.H.'s Coastal Issues: A Wave of Concern,** was developed by SGMAP. A second grant of $9,000 from the same source helped to modify, disseminate, and evaluate the material. In addition, ten marine docents were given in-depth training on the coastal issues curriculum and will integrate it into existing docent outreach programs.

• Within a formal, one-semester course offered by SGMAP and the UNH department of leisure management and tourism, twenty-five students have learned marine science education techniques, assisted with teacher training, and functioned as staff assistants at Odiorne Point. Former interns are now at such places as Long Island's Rose Environmental Education Center, the University of Rhode Island's Environmental Educational Center, Florida's Harborside Marine Institute, the Chesapeake Education Center, the National Park Service, the Appalachian Mountain Club, and a county park system in Scotland.

• The Floating Lab, a mini-oceanographic cruise for junior and senior high school classes, offers twenty, four-hour programs each year aboard a seventy-foot charter boat. There are pre-cruise training sessions for teachers and a 180-page **Floating Lab Resource Manual,** developed by SGMAP staff, to help integrate the Floating Lab into a broader marine science curriculum. During the past ten years 300 teachers and parent chaperones, and 2,500 students have participated in this program.

• The Floating Lab has served as a stimulus for school districts to increase their commitment to marine science. For example, Exeter Area Junior High School has incorporated marine students as a strong part of its eighth grade curriculum after participating in the Floating Lab program. Another school, Goffstown High School, received a federal "Excellence in Education" grant to initiate their own version of the Floating Lab based on prior exposure to the SGMAP program.

• The **Northeast Marine Education Program** (NEMEP) at the University of Maine has developed numerous marine science education curriculum units for educators and the general public. NEMEP recently received a $70,000 grant from the Maine Department of Education and Cultural Services to design a two-week program with a heavy marine science focus for thirty science and math teachers. In addition, NEMEP continues to offer the twelve-day **Summer Marine Education Institutes** for teachers.

• SGMAP staff and cooperators helped northern New England educators form their own professional organization, the **Gulf of Maine Marine Education Association** (GOMMEA), in the late 1970s. SGMAP continues to work cooperatively with GOMMEA on common-interest projects which include sponsoring an annual conference, supporting the National Marine Education Association, and creating programs that act as resources for educators.

• During the past ten years, a number of students, teachers, and staff involved in Sea Grant marine education activities have been recognized with competitive awards. In 1984 and 1985, a marine docent from New Hampshire and a Sea Grant aquaculture specialist in Maine received Outstanding Achievement Awards from the Northeast Marine Advisory Council (NEMAC). Two Maine high school seniors won the Governor's Science Award for research on the relationship of oyster aquaculture to technological development. The initial recipients of President Reagan's Science Teacher of the Year Award in both New Hamp-

THE ABSeas AT ODIORNE POINT

Odiorne Point State Park in Rye is the site of New Hampshire's first settlement, Pannaway Plantation, established in 1623. The last remaining undeveloped segment of the state's eighteen-mile coastline, this 230-acre preserve offers a variety of habitats, from a rocky shore to salt and freshwater marshes.

Since 1976, the Sea Grant Marine Advisory Program at the University of New Hampshire has been instrumental in developing interpretative programs that help visitors understand and appreciate Odiorne's marine resources. Working with Odiorne co-sponsors, the New Hampshire Division of Parks, the Audubon Society of New Hampshire, and the Friends of Odiorne Point, Inc., SGMAP produces marine awareness programs that annually serve some 10,000 individuals.

One such program is **Through The Looking Glass,** a field program offered each spring for K-12 students and their teachers. Students get a hands-on look at marine life in the Touch Tank. They then have a chance to see how sea urchins, sea stars, and other creatures they've just met, live in the wild along the rocky intertidal and adapt to the changing environment that results from tidal cycles and wave action. In 1987, schools from Massachusetts, New Hampshire, and Vermont took part in the twenty three-hour programs and ninety half-hour programs.

In a recent evaluation, 85 percent of the participating teachers during a two-year period had seen evidence of cognitive growth in their students as a result of their experience at Odiorne. Seventy-nine percent felt their students' attitudes about the marine environment have changed.

Equally successful are the **Summer By The Sea** science education programs targeted primarily at the general public. These activities include topics such as coastal issues, marine geology, estuaries, seaweeds, tidepools, fisheries, and salt marshes, and currently attract some 8,000 people each year. In 1985, 160 selected participants were surveyed to gain their reaction to the summer programs; 92 percent ranked them as "very high" to "exceptional" in quality and content.

To assist Sea Grant with the financial and administrative challenges presented by a comprehensive field marine science program such as is offered at Odiorne Point, a community support group, Friends of Odiorne Point, was formed in 1985. These individuals are committed to maintaining marine science education programs at Odiorne and have developed private fundraising strategies to assure adequate financial resources. In addition, they are involved in the upkeep and repair of the Visitor Center facility, and perform various other tasks. To date, they have raised nearly $35,000 — including a recent gift of a $15,000 endowment. They have targeted and expect to raise an additional $100,000 for the program by the end of 1988.

Perhaps the most dramatic indication of how successful this program has been was exemplified by the support given to it by the New Hampshire Legislature this year. Spearheaded by the Friends of Odiorne Point, individuals from the community, and the other program sponsors, the state legislature appropriated $100,000 to support year-round marine education programs at Odiorne and $600,000 (to be matched by $400,000 in private funds) to construct a new marine science education center on the site.

shire and Maine were involved in Sea Grant marine education programs.

MARINE RECREATION AND TOURISM

Situation

In 1986, tourism was the second leading industry in New Hampshire and Maine, generating approximately $2.2 billion in gross revenues. More than half of our 12 million yearly visitors are attracted to the coast. The Travel Industry Association estimates that if growth of the recreation and **tourism industry** continues at current rates, **by the year 2000 it will be the largest industry in the nation.**

Marine recreational fishing is an important industry in its own right. Sport Fishing Institute statistics show that nearly $4 billion was spent in 1980 on retail sales related to recreational fishing. Some 17 million individuals participate in salt-water fishing annually. In northern New England an estimated 250,000 anglers accounted for more than 1 million fishing trips in 1982. Both Maine and New Hampshire have active sportfishing stocking programs for such species

as Atlantic salmon, coho salmon, and shad. There is a sizeable charter/party boat industry in the region with over 300 boats regularly carrying anglers offshore for cod, haddock, flounder, pollock, bluefish, and tuna.

Not surprisingly, state and local officials, as well as a host of businesses, have recognized the opportunities for economic development and profit-making associated with a strong recreation and tourism industry. In the last four years, for example, gross tourism expenditures in northern New England jumped more than 20 percent. The coastal share of those expenditures is at least $1.4 billion.

Although both marine sportfishing and tourism are welcome industries to most coastal communities, they are not without problems. Most of the businesses are small, independently owned, and loosely organized at best. They are traditionally high-risk ventures with high failure rates. Uncontrolled tourism produces strains on community resources and can generate an unwanted backlash among residents. Sportfishing is in direct competition for many of the desirable commercial species such as haddock and cod. Dwindling stocks and a growing presence of sportfishing interests on management councils have accelerated conflicts between the commercial and recreational sectors.

About three years ago, marine recreation and tourism became the newest SGMAP element. The initial focus was to develop a communications network of tourism professionals, recreation business managers, state tourism staff, and SGMAP staff, and to identify specific problems inherent to tourism and recreation businesses.

Achievements

• Working with researchers and using Sea Grant development funds, SGMAP staff provided the New Hampshire Seacoast Council on Tourism (SCT) with information on visitor activity and spending patterns within coastal New Hampshire. This data was an important consideration in subsequent advertising/marketing strategies. In addition, the study developed and verified a data collection methodology which is both affordable and easily used by local officials.

• During 1983, the **Maine Marine Industry Association,** (MMIA) representing 200 boatbuilders, marina operators, and marine products/services dealers, was formed. Working with Sea Grant researchers from both the University of Maine and the University of Rhode Island, SGMAP assisted MMIA in completing a survey showing the industry employed nearly 10,000 individuals annually and generated some $179 million in sales in 1982. This information was valuable in MMIA efforts to alter the Maine Boat Tax (Fall 1984 referendum) and in gaining new membership.

• Sea Grant staff, supported by a $5,600 grant, helped the N.H. Seacoast Council on Tourism to redesign their radio strategy to reach intended audiences most effectively. The following year, SCT appropriated an additional $3,500 to support a follow-up evaluation on broadcast effectiveness.

• To assist the State of New Hampshire in gathering and analyzing important data, a SGMAP staff member obtained a $65,000 grant from the Office of Vacation Travel to establish the **Travel Research and Statistics Service** (TRASS) at UNH. TRASS' primary purpose is to design and implement research methodologies for measuring the effectiveness of the state's matching-grants promotion program. In addition, TRASS has set up a system to identify, retrieve, store, and process data to measure the economic impact of tourism in the state. This project has received state funding at the same level for three years now.

• The **demand for safe mooring space** continues to grow despite the fact that many harbors are already at maximum. In New Hampshire, where there are nearly 1000 boaters on the waiting list, SGMAP staff assisted the State Port Authority in determining the most efficient layout and anchoring systems for Little Harbor in New Castle. Staff linked the Port Authority with officials from Mt. Desert Island, Maine, which had done a similar study.

• With SGMAP encouragement (a staffer served on the planning committee) the 1985 National Outdoor Recreation Trends II Symposium included special sessions on marine/coastal issues. Our marine recreation specialist also presented several papers, served as chair of a session on coastal tourism, and has been involved with the Sea Grant committee formed to develop an issues paper on marine recreation and tourism opportunities.

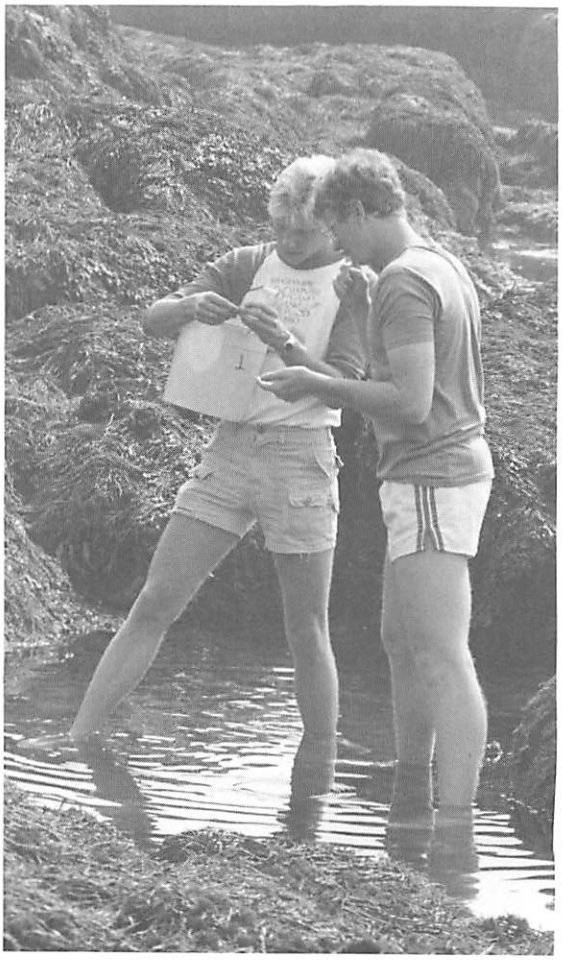
• Along with New York Sea Grant Extension, SGMAP staff held a workshop for marine recreation and tourism businesses. This **Northeast Marine Advisory Council** (NEMAC)-sponsored workshop focused on bringing together thirty New England charter boat operators, marina/boatyard owners, and tourism business managers/owners to identify specific management problems for which New England SGMAP assistance might be provided. A subsequent publication identified pertinent research topics and summarized business and management needs for which extension programs will be developed.

• With New Hampshire CES and SGMAP support, a half-time

marine business agent has been hired for coastal New Hampshire in a two-year pilot project. He will address some of the priority extension needs identified in the NEMAC strategic planning workshop. Several other NEMAC members, most notably New York Sea Grant Extension and Maine Cooperative Extension Service, have also beefed-up marine business management extension programs after participation in the workshop.

- Our first **Sea Grant marine recreation and tourism specialist,** now director of the N. H. Division of Parks and a member of our Maine/New Hampshire Sea Grant Policy Advisory Committee, is one of fifteen commissioners on the Presidential Commission on Americans Outdoors (PCAO). This group is to review outdoor recreation trends and issues and ultimately will develop a blueprint for a partnership between the federal government and private sector.

- As part of the Presidential Commission on Americans Outdoors, a special session on marine recreation and tourism was held at UNH. SGMAP staff led discussions that focused on access, marinas, the boating industry, charter boats, coastal tourism, and sport angling. The staff also provided pertinent Sea Grant reports and publications from around the country. The Commission used much of this information in their final report.



FORMAL EDUCATIONAL PROGRAMS—8

In addition to the informal education activities developed through the Marine Advisory Program, the Maine/New Hampshire Sea Grant Program recognizes the benefits of formal marine education and seeks to develop programs at post-secondary institutions.

One such program is the **Ocean Projects Course** at the University of New Hampshire (UNH). Now in its fifteenth year, this course allows undergraduate students to experience both the excitement and frustration of true research. It provides an opportunity for students from various disciplines to work as members of a team to solve contemporary problems in the ocean and coastal zone.

One student project that grew into a fully-funded Sea Grant research project was a study of how deeply raindrops penetrate water. Students designed a "rainmaking machine" that could vary the speed and size of manufactured raindrops. Their UNH advisor, an oceanographer who specializes in estuarine research, expanded on their work and showed how important rainfall may be in moving sediments in shallow water and in intertidal areas.

Another curriculum-oriented Sea Grant project drew upon the resources of many institutions of higher education. The New Hampshire College and University Council consists of UNH and thirteen colleges in New Hampshire. Having recognized the need for marine education at the post-secondary level, the **NHCUC Marine Studies Program** was initiated in 1979 to increase the marine-related studies opportunities for its 31,000 undergraduates and to share resources and information among all participating institutions.

Mr. and Mrs. Fish, who combine theater and marine education in a northern New England program called, **"The Sea Comes Alive,"** have probably reached a wider audience than any other marine education activity in New England. With Sea Grant support from 1978 through 1982, the team worked out of the Southern Maine Vocational Technical Institute, and in 1981 their program received the Jefferson Award for Outstanding Public Service in Environment for the State of Maine. Now self-supporting, in an average year Mr. and Mrs. Fish provide 150 creative drama class presentations to Portland area school children; eighty school Ocean Day assemblies; ten special needs programs for the elderly, hospitalized, gifted, and retarded; twenty-five evening and weekend programs for civic and community organizations; twenty in-service training workshops for teachers, and ten creative education workshops for college students and future educators.

At UM, the **Northeast Marine Education Program** (NEMEP) has developed numerous marine science education curriculum units for educators and the general public, in addition to the production of videotapes by graduate students to teach the general public about marine issues and conflicts. The first film, "The Gulf of Maine: A Sea Beside the Sea," has reached over 50,000 people. NEMEP recently was awarded a $70,000 grant from the Maine Department of Education and Cultural Services to design a two-week program with a heavy marine science focus for thirty science and math teachers. Meanwhile, NEMEP continues to offer the twelve-day Summer Marine Education Institutes for teachers.

Now a permanent feature of the Marine Law Institute curriculum at the UM Law School in Portland, the Sea Grant-funded **ocean and coastal law course** is unique in that it combines both international and domestic law. In response to the passage of the Magnuson Fishery Conservation and Management Act in the late 1970s, the course informs practicing and future lawyers on historical analysis of international laws of the sea; the evolution of zones of jurisdiction; the Gulf of Maine/Georges Bank boundary dispute with Canada; and principles of maritime boundary delimitation. Recently, the curriculum has widened to include examination of state and local laws as they pertain to land use control in the coastal zone.

The following case studies indicate the extent to which formal education is an integral part of the UM/UNH Sea Grant Program.

OCEAN PROJECTS: A TASTE OF THE REAL WORLD

To combat what seems a declining interest in the sciences, the National Science Foundation and other agencies are increasing funding to projects that encourage undergraduate research. With the help of Sea Grant funding, the University of New Hampshire has been accomplishing just that since 1972.

Formally, the mechanism is "Opportunities for Undergraduate Research and Development in Marine Science and Engineering," known colloquially as **Ocean Projects.** Since its inception fifteen years ago, the emphasis has been on putting together interdisciplinary teams of undergraduates (usually juniors and seniors) who will then attempt to solve real, and frequently complex, research and engineering problems.

Faculty advisors see the Ocean Projects course as a critically needed supplement to more traditional academic approaches. As one advisor put it, "Students are craving hands-on experience at this point in their careers. They need a taste of the real world." A former student wholeheartedly agrees, noting, "You don't learn just by reading in a book — you learn by making mistakes."

The course is a year-long one, and a former Ocean Projects coordinator **D. Allan Waterfield** describes it this way: "Each student team defines its problem; prepares and submits a budget; engages in dialogue with experts in the ocean community; designs, builds and tests prototype models or gathers scientific, historical or attitudinal data; makes interim oral reports; prepares a comprehensive final written report; and defends its results before a jury of experts drawn from the ocean community."

Often, the jury is made up of former Ocean Projects students. The University of New Hampshire does not offer an undergraduate marine major, instead stressing the need to acquire solid grounding in the basic sciences. In many cases, exposure to the marine world via Ocean Projects participation has encouraged students to continue their graduate work in a marine discipline and eventually go on to careers with marine-related organizations. Ocean Projects alumnae now work for such groups as Seaward International, Exxon, the Portsmouth Naval Shipyard, Martin Marietta, Ocean Research Equipment, the U. S. Navy, Woods Hole Oceanographic Institution, Honeywell, General Dynamics, Perry Submarine, and others.

A typical Ocean Projects alum is **Ed Garcia** who, as a junior worked on the development of an unmanned, untethered submersible vehicle called EAVE. As a result, he continued as an electrical engineering graduate student at UNH and was chosen to work with the Marine Systems Engineering Lab on further development of EAVE. After receiving his master's, he worked with the Harris Corporation in Plattsburg, New York, and is now with Sea Data Corporation — a marine instrumentation company — in Marion, Massachusetts.

Describing his experiences as an Ocean Projects student, Garcia calls them invaluable, saying they gave him the opportunity to learn that "something that works on paper and something that *works* may be two different things."

In 1972-73, the initial year of the course, only two projects were organized, with a total of eight students participating. In 1986-87, eight projects were funded, with topics ranging from the bioconversion of seaweed to methane in a three-phase fluidized bed to a fiber optic telemetry operations network that may eventually be used by Woods Hole submersibles. Thirty-five students participated.

THE INLAND MARINE SCENE

The New Hampshire College and University Council (NHCUC) is an association of fourteen four-year, accredited public and private higher education institutions in New Hampshire. Since its inception, the Council has concentrated on forging joint programs in academic and management areas and on efficiently sharing resources.

One such cooperative effort was a **Marine Studies Program** initiated in 1979. Coordinated through the NHCUC and funded by Sea Grant, the program helped increase marine literacy among the 31,000 students enrolled in NHCUC member institutions, most of them at inland sites away from the coast.

Headed by **Richard Fralick** of Plymouth State College, the Marine Studies Program developed a resource information manual for NHCUC marine faculty, implemented a model marine studies minor at Plymouth, and provided marine career information for students.

One major project was sponsorship of an annual marine symposium for faculty and students, which included guest speakers from outside the consortium as well as NHCUC marine faculty discussing their research. The day-long programs, which were also open to the public, covered a broad range of marine-related topics during the three years in which they were presented.

Among the subjects explored were marine archaeological projects in the Piscataqua River Basin, Law of the Sea issues, nudibranch research, K-12 marine education projects in New Hampshire, saline wastewater treatments for coastal communities, the future of the New England fishing industry, advances in oceanography, and the role of shipboring mollusks in breaking down the hundreds of tons of wood washed into the ocean daily.

The symposia also provided students with an opportunity to learn about alternative marine education programs for college students, such as the Shoals Marine Laboratory in the Gulf of Maine and the *R/V Regina Maris*, and to hear from faculty who had studied or done marine research in locales as remote as Hawaii and China.

Members of the NHCUC include: Colby-Sawyer College, Daniel Webster College, Dartmouth College, Franklin Pierce College, Nathaniel Hawthorne College, Keene State College, New England College, New Hampshire College, Notre Dame College, Plymouth State College, Rivier College, Saint Anselm College, the School for Lifelong Learning, and the University of New Hampshire.

BRINGING THE OCEAN INTO THE CLASSROOM

What Are the ABC's of Marine Education? Is Our Food Future in the Sea? Do You Know Our Marine Fishes? Have You Been to the Shore Before? Especially designed for young people in the fifth through ninth grades, these questions are also the titles of a stimulating series of resource guides to excite students to learn about the coastal regions of Northern New England. The marine resource guides, along with videotapes exploring the Gulf of Maine, were produced with Sea Grant support by the **Northeast Marine Education Program** (NEMEP) from its base at the University of Maine's College of Education.

The videotapes, which give visual impact to the themes of the unique resources and conflicting uses of the Gulf of Maine and its boundaries, have reached over 80,000 people — from high school students to adults. NEMEP has focused on the diverse coastal environments and offshore waters of the Gulf of Maine, in both their resource guides and videotapes, in order to acquaint teachers, students, and the voting public with important concepts about these resources so they will be better informed when making decisions concerning the use of marine resources.

NEMEP also provides leadership for teachers by helping to plan annual conferences and by publishing a quarterly newsletter, *The Gulf Stream*, which focuses on marine-related topics particularly emphasizing the Gulf of Maine.

In addition, multidisciplinary marine education courses for teachers, extension educators, and others are offered each summer for both graduate and undergraduate credit. The innovative course combines coastal field experiences with classroom work, with stress on developing marine education instruction strategies.

MARINE LAW STAFF UNRAVEL TANGLED RESOURCE ISSUES

What are the ramifications of the World Court boundary decisions on Canadian and U. S. fisheries management? How adequate are Maine's current laws for effectively managing the state's growing coastal development pressures? Can a developer be legally required to guarantee public access at a newly developed site in exchange for the right to develop that site? These and other legal and policy issues in the marine resource field are the concerns of the **Marine Law Institute,** a component of both the University of Maine School of Law and the Center for Research and Advanced Study at the University of Southern Maine.

As a cooperator in the Sea Grant Marine Advisory Program, the Marine Law Institute joins with other universities, agencies, and institutions to disseminate information to the public. One of the institute's keen interests is examining how best to manage public access to Maine's coastline. **Public access to the shoreline** is especially sensitive in Maine, because nearly 97 percent of the state's coastline is privately owned.

The results of the Marine Law Institute's research is made available to the public through its quarterly publication, *Territorial Sea,* which analyzes both fisheries management and other areas of natural resource law.

In 1983 and 1986, the Marine Law Institute sponsored conferences on East Coast Fisheries Law and Policy. Proceedings from these conferences include papers on a variety of fisheries topics, including U. S.-Canadian developments, the scientific basis for management, marine insurance, habitat degradation, and tax considerations.

The Marine Law Institute staff also frequently contributes to workshops for coastal resource managers and educators, answering legal questions on clam flat management, aquaculture leasing, coastal access, and other resource issues.

"WHO PUT THE HOLES IN THE CLAM SHELL?"

In real life, Mr. and Mrs. Fish are **Jeff Sandler** and **Deb Hall** who work out of the Southern Maine Vocational Technical Institute/ Gulf of Maine Aquarium in Portland. But to thousands of school children, they are denizens of the deep who make learning about marine creatures entertaining as well as educational.

The two teamed up in 1978 to combine theater and marine education in a northern New England program called, **"The Sea Comes Alive."** Initially funded by Sea Grant, they are now self-supporting and have performed from the Bahamas to British Columbia.

In a typical Mr. and Mrs. Fish program for school assemblies, the duo "find" some empty clam shells washed up on the beach and bearing small holes. Mr. and Mrs. Fish interview several suspects, including the starfish, crab, snail, and gull, and enlist the audience's help in solving the mystery. In doing so, students learn eating habits and characteristics of each of these animals and are introduced to such concepts as molting, scavenging and regeneration.

The second half of the program brings selected students on stage to help Mr. and Mrs. Fish identify the most frequently used forms of protection in the ocean. Mr. Fish as Big Fish tries to make a meal out of the students, but because Mrs. Fish has given them the effective protection devices real sea creatures use, the Big Fish is foiled.

In addition to performing for school children, Mr. and Mrs. Fish have given special programs at the Smithsonian, the Baltimore Aquarium, the Shedd Aquarium in Chicago, Boston's New England Aquarium, and Ocean World in Fort Lauderdale.

Sandler and Hall estimated once that in a typical year, they provided approximately:

- One hundred and fifty "creative drama" class presentations to Portland area school children,
- Eighty school Ocean Day assemblies,
- Ten special needs programs for the elderly, hospitalized, gifted, retarded, emotionally handicapped and disturbed,

- Twenty-five evening and weekend programs for civic organizations, scout groups, community service programs, church and social organizations,
- Twenty in-service training workshops for teachers,
- Twenty other special presentations, and
- Fifty opportunities for participation by volunteers.

Like "The Twelve Days of Christmas" listing, Mr. and Mrs. Fish's accomplishments could probably go on. And on. But one indicator of the esteem in which their program is held is their receipt of the 1981 Jefferson Award for Outstanding Public Service in Environment for the State of Maine. Additional awards have come from the Charles Lowery Foundation and the Levey Foundation.

Jeff Sandler has become the president of the National Marine Education Association, and both he and Deb are past presidents and are still active in the Gulf of Maine Marine Education Association. In 1983, they hosted the National Marine Education Association Conference in Portland, Maine.

The "Fish" have also published teacher guides complete with lesson ideas and still do workshops for teachers and college students.

GRADUATE EDUCATION

Graduate education is a vital part of our program. Since 1976, the University of New Hampshire/ University of Maine Sea Grant Program has provided research assistantships to 153 students in agricultural and resource economics, animal and veterinary sciences, biochemistry, botany, chemistry, civil engineering, earth sciences, economics, education, electrical engineering, food science, forestry, geology, history, law, mathematics, mechanical engineering, microbiology, oceanography, physics, plant and soil sciences, and zoology.

Sixty percent of the graduate students supported by Sea Grant funds studied in the following departments: oceanography (19 percent), zoology (13 percent), and botany, civil engineering, and microbiology (7 percent each).

These students have earned twenty-two Ph.D.'s; three Ed.D.'s; eighty-three M.S. degrees; seven M.A. degrees; one Master's in Education. The seven Sea Grant-supported students at the University of Maine School of Law and at Franklin Pierce Law School were awarded J.D. degrees.

Eight students are currently working toward their doctorates and six toward Master's degrees. Fourteen Master's degrees were not completed, and two Ph.D. students are on leave of absence.

We have included in the appendices a complete listing of these students. The following are examples of some of our outstanding alumnae:

Vijay Panchang

If you were at the University of Poona, India in 1980, you might have seen **Vijay Panchang** leading his team out on the cricket field between civil engineering exams.

On the University of Maine Orono campus, Panchang (M.A. 1983, Ph.D. 1985) was also an outstanding and personable graduate student in civil engineering. His graduate research, which earned him numerous awards including a Sea Grant Association Award for Student Research, focused on **storm-generated waves in the Gulf of Maine.** Analysis of his wave data could have practical application for the Gulf's oil and fishing industry.

During the 1986-87 academic year, Panchang and his family lived in Tallahassee, Florida, where he was a research associate with the Mesoscale Air-Sea Interaction Group at Florida State University, the world-renowned group in ocean modeling research. In fall 1987, Panchang returned to join the faculty of the University of Maine as associate professor of civil engineering.

Jane Arbuckle

A few years back, **Jane Arbuckle** (M.S. 1982, zoology) was a familiar sight to the residents of Jonesboro, Maine, as she tromped through the mudflats in hip-waisters.

Arbuckle's Sea Grant-sponsored **study of the soft-shell clam and its mudflat environment** examined various methods to increase the recruitment of young clams onto the flats. Local clam diggers joined her on the mudflats and assisted her in such tasks as digging furrows and erecting snow fences. Improving clam production is crucial in towns like Jonesboro which rely on the soft-shell clam as a principal means of income.

Arbuckle currently serves as

wildlife director at the Maine Audubon Society and is involved in marine wildlife detanglement efforts. The management and conservation techniques she developed during her Sea Grant research at the University of Maine continue to assist her as she becomes more involved in preserving the region's wildlife and marine resources.

Carter Newell

While studying aquaculture at the University of Maine Ira C. Darling Center, **Carter Newell** (M.S. 1982, oceanography) focused on the **growth rates of the soft-shell clam.** His research has important implications for management of the fishery and will allow more accurate assessment of clam growth in a wide variety of environments.

Today, Newell can be found busily punching out new ideas and data on his computer at the Great Eastern Mussel Farms (GEM) in Tenants Harbor. As biologist in charge of quality control at GEM, Newell applies his background in aquaculture to produce quality mussels, making Maine the biggest producer of mussels in the country. Newell also has his fingers in a number of other fisheries-related projects, many of which involve his former university professors.

According to Newell, "The training that I received through my Sea Grant research assistantship gave me the tools of the trade of a shellfish biologist, which I can now apply towards two important shellfish species in Maine — the soft-shell clam and the blue mussel."

Steven Bogdanowicz

In 1985, **Steven Bogdanowicz** (M.S. 1986, zoology) received a prestigious National Sea Grant Student Award for outstanding achievement in marine-related research during his graduate studies at the University of Maine.

Bogdanowicz' project involved **testing for reproductive isolation among well-defined groups of Atlantic herring** using a new and powerful chemical assay.

According to Bogdanowicz, "Effective management of a migratory species like the herring can only be properly implemented with knowledge of the biological characteristics of the species."

Bogdanowicz and his wife, Chris, also a Sea Grant-supported student in zoology, currently live in Ithaca, New York, where he is continuing his graduate studies at Cornell.

Richard Lutz

University of Maine professor of animal and veterinary sciences, Herb Hidu, first met University of Maine alumnus, **Richard Lutz** (Ph.D. 1975, oceanography) at the University of Maryland where Lutz was completing a National Science Foundation fellowship on shellfish. A few years later, Hidu and Lutz were working together again on the preliminary coordination of the University of Maine Sea Grant Program. Lutz organized the initial cooperative research efforts that launched the UM/UNH joint college program. **Focusing on blue mussels,** Lutz' research served as a basis for the expanding mussel culture industry that has blossomed in Maine in the last decade.

Lutz' studies led to his current position of professor of marine sciences at Rutgers University, where he also serves as the director of both the Fisheries and Aquaculture Technological Extension Center and the Rutgers Shellfish Research Laboratory.

"Lutz' coordination of the first dual university program between the University of Maine and University of New Hampshire was outstanding," says Hidu. "He is a natural organizer and continues to publish and expand on issues important to marine sciences."

Leslie Linkkila

When **Leslie Linkkila** (M.S. 1983, microbiology) was a graduate student at the University of New Hampshire, she worked on a Sea Grant project that investigated the **potential of seawater-based fermentation to provide industrial alcohols and feed stocks from sugar-rich plants.** The trick, she noted at the time, was to combine a patented, continuous fermentation technology and seawater so that certain yeast cells would have a healthy environment to produce lots of a desired product without growing too much themselves. Too good an environment would result in the microorganisms "overeating" and clogging the filters through which the product (in this case, alcohol) was supposed to pass.

Linkkila is still concerned with filters but now she's on the other side of the fence, working with Schleicher and Schuell of Keene, New Hampshire. Her company sells supplies, among them filtration devices, for research in molecular biology and for clinical diagnostic kits. As manager of technical information and training, she is responsible for providing technical support to both customers and sales staff.

The company sells primarily to academic researchers, and Linkkila says she gets "an onslaught" of calls the first few months of each new semester. But they also sell to private biotechnology firms, including companies putting together kits in which filtration or retention of organisms is necessary. Many of the uses are directly related to the fermentation techniques she mastered during her Sea Grant research at UNH.

"Each customer has unique needs so you're constantly problem-solving on a number of different levels," says Linkkila.

"It's just like being a graduate student again."

Michael Josselyn

In some ways, **Michael Josselyn's** life hasn't changed that much since he was a Ph.D. candidate at the University of New Hampshire in 1979. At the time, he was involved in a Sea Grant research project looking into **nutrient processes in the Great Bay estuary** and, as a botany major, was investigating the role of marine macrophytes in the estuarine detrital pool.

Today, Josselyn directs a California laboratory that conducts estuarine research in San Francisco Bay, and his own research effort is still focused on estuarine seaweeds and salt marsh ecology. He also holds a joint appointment as professor of biology at San Francisco State University.

As director of the Romberg Tiburon Center for Environmental Studies, Josselyn heads a staff of eight scientists, ten students, and six technicians, and administers a budget that includes some $1 million annually in external funding. In the fall, his laboratory will begin a two-year project on eelgrass physiology. The funding agency? The National Sea Grant College Program.

Patricia Glibert

Patricia Glibert (M.S. 1976, earth sciences) credits Sea Grant with helping her get her first job. "In 1976, I worked on a Sea Grant project at UNH that concerned **spatial and temporal variability and nutrient distribution patterns in Great Bay.** When I got my master's degree, Woods Hole hired me, based on my Sea Grant work, to set up a nutrient facilities lab for them."

While at Woods Hole Oceanographic Institution in Massachusetts, Glibert received Sea Grant funding to study *Gonyaulax tamarensis*, the toxic dinoflagellate responsible for red tide. At the same time, she continued her academic career and received her Ph.D. in biology from Harvard, where she specialized in nutrient dynamics and phytoplankton production.

Since 1986, Glibert has been an assistant research scientist at the University of Maryland's Horn Point Environmental Laboratory. She says the lab's research interests range from wetlands and marsh work to oceanography, and that her own field of concentration continues to be nutrient cycling and plankton dynamics. She is currently funded by the National Science Foundation to investigate nutrient dynamics and microbial production in the plume of Chesapeake Bay.

Thomas Shevenell

While a doctoral student at the University of New Hampshire, **Thomas Shevenell** (Ph.D. 1986, earth sciences) was noted for his ingenious, low-cost solutions to research problems. An article in *Windward*, the Sea Grant Program newsletter, noted that he and UNH sedimentologist Franz Anderson "have **conducted artificial raindrop experiments** in pizza pans ... have trapped fine sediments in mini-ice cube trays ... and turned a plastic Dunkin Donuts jelly bucket into an on-site rain chamber on the mud flats of Great Bay."

His academic abilities were also respected. In 1986, the New England Estuarine Research Society gave him their annual Ketchum Award for his paper on "Rain and Its Importance to Intertidal Sedimentation."

Shevenell is presently putting this combination of ingenuity and research expertise to good use in his own company. After receiving his degree, he joined forces with Michael Gallen, formerly of the New Hampshire Water Supply and Pollution Control Commission, to start Shevenell, Gallen and Associates, Inc. He is treasurer of the Portsmouth firm, which specializes in environmental site-assessment on commercial properties, and says the bulk of their work is to make sure that the property in question won't be subject to the state's hazardous waste clean-up law in the future.

Recently, the company expanded beyond the seacoast area to open a second office in Concord, the state capital.

Lawrence Buckley

Now an employee of the National Marine Fisheries Service, **Lawrence Buckley** (Ph.D. 1975, biochemistry) is the resident biochemist at the National Marine Fisheries Services federal laboratory in Narragansett, Rhode Island. The lab looks at ocean conditions and the marine resources off the northeast coast of the United States, from northern Maine to Cape Hatteras, and has studied a wide range of commercial and sportfish species, from flounder to striped bass.

Although Buckley **investigated red tide** while a doctoral candidate at the University of New Hampshire and as a post-doc at the University of Rhode Island, his research emphasis is now on young fish, both at the larval and juvenile stages. This summer, he participated in a research cruise to look at the abundance of juvenile cod and haddock in the Georges Bank region of the Gulf of Maine. More typically, however, his work takes place in the estuarine area or in the lab where he is studying both the effect of contaminants and of environmental variabilities, such as water temperature, on various species.

Buckley is also responsible for the lab's research aquarium. "We

buy adult spawning stock from fishermen," he says, "induce spawning, raise the eggs and look at the development rates as they go into the larval, then the juvenile stages. My biochemistry background fits in because I also have to develop techniques to measure field conditions."

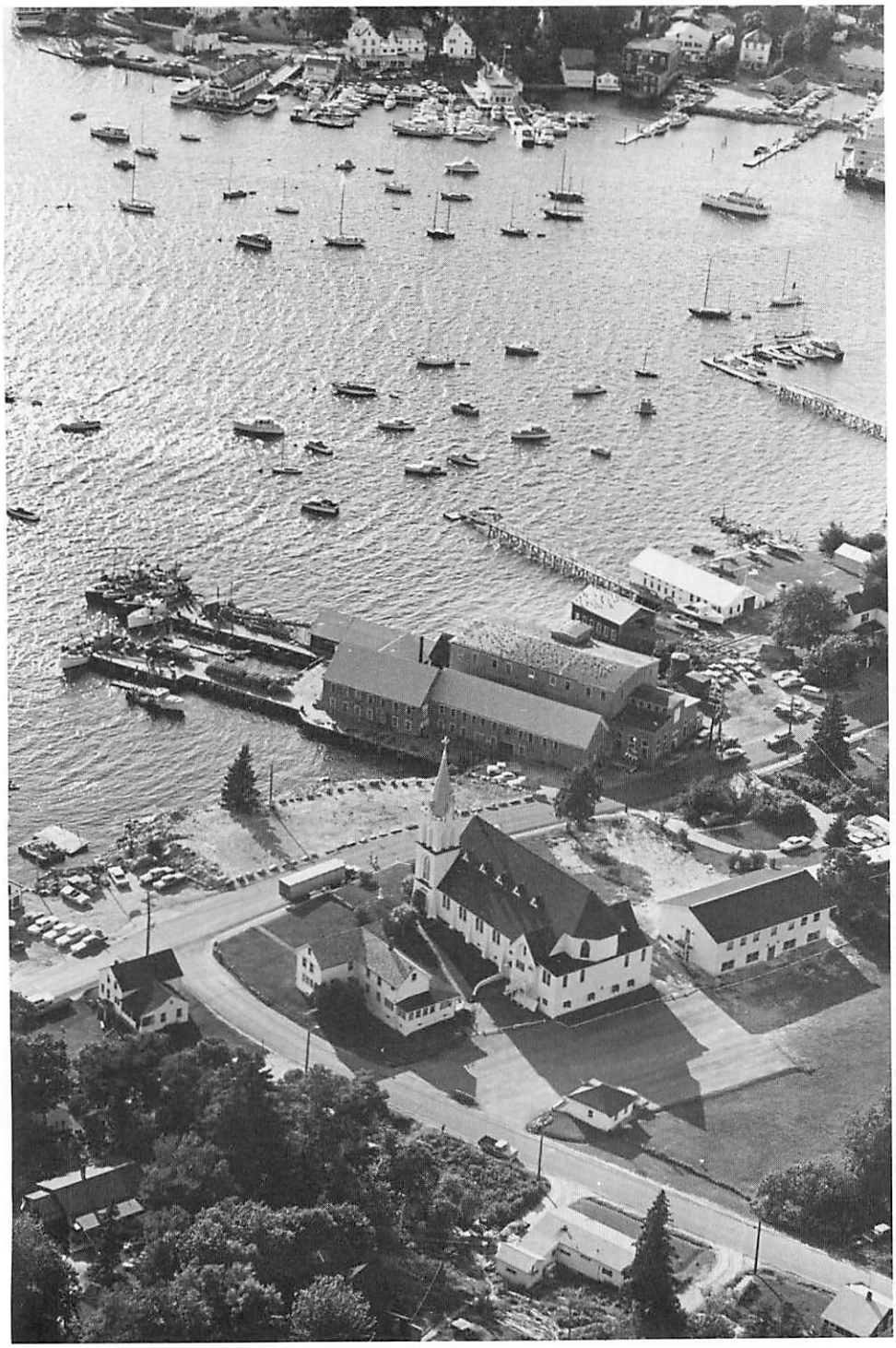
"Fish are highly fecund, but only a few survive to a marketable size. We're trying to find out why."

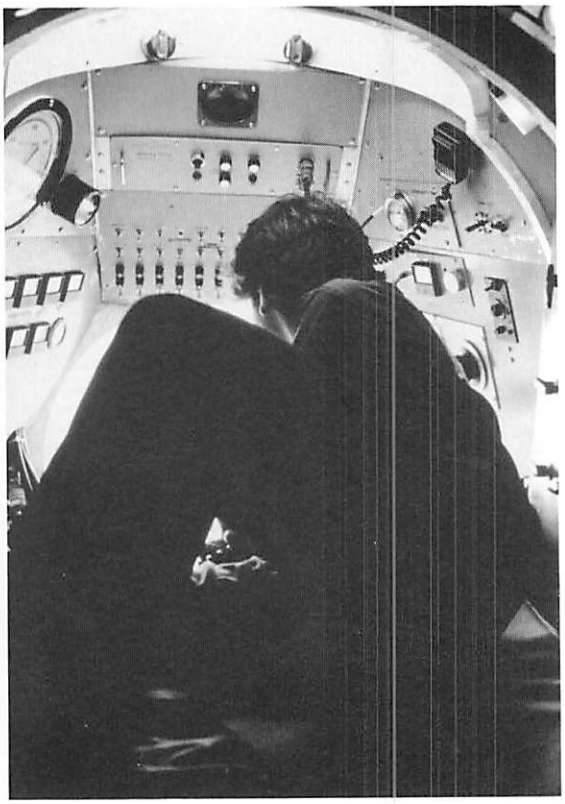
William Herr

As a UNH graduate student, **William Herr** (M.S. 1983, electrical engineering) was involved in a Sea Grant project to **design a non-dispersive, infrared carbon dioxide analyzer to study the expired breath of divers.** Herr is still concerned with underwater devices but his emphasis now is on the design of systems for submersibles.

After graduation, Herr joined Perry Offshore in Riviera Beach, Florida. One of his responsibilities was field engineering support of a manned, one-atmosphere tethered manipulator bell and involved operations at 2000 feet in the Mediterranean. Another project was a microprocessor-based circuit design. Just before he left Perry in 1985, Herr was project engineer on a custom application, remotely operated underwater vehicle system.

Herr joined Martin Marietta Baltimore Aerospace as a senior engineer to help develop advanced high-level control and sensory systems that would permit an underwater vehicle to perform its mission without human supervision. After establishing this multi-year AUV (Autonomous Underwater Vehicles) research program, he became program manager in charge of developing a pre-emptive underwater vehicle system that Martin Marietta will use to test and demonstrate the technology being developed by their internal research projects. This system, the Mobile Undersea Systems Test (MUST) laboratory will be operational by January 1988.





WHERE DO WE GO FROM HERE?
Furthering the Sea Grant Concept 9

The first ten years of the UM/UNH Sea Grant College Program have been challenging, exciting, and productive. We have grown and matured during this period, as we sought to meet the 1966 goals established for the National Sea Grant College Program by Congress.

This first decade of college status has allowed us to gain a better sense of where Sea Grant can make its most effective contributions. We have accomplished this through constant interactions with our federal partner, the national office of Sea Grant; with our marine faculty, students, and university administrators; with the advisory service staff; and, most importantly, with our many marine clientele. Continued communication with these same components is critical to our success during the next phase of the program's evolution.

One of our program's major strengths, long-range planning, will be a key element in this evolution. In *Looking Ahead,* the most recent long-range plan of the UM/UNH Sea Grant College Program, we identified three major, interrelated areas for our program to address: **fisheries management and development; changes in the coastal environment;** and **industrial/commercial development.**

These concepts provide a legitimate framework for our Sea Grant program during the next five years. Based on contributions from our twenty-two Policy Advisory Committee members and from representatives of academic, governmental, and industrial communities, the plan was designed to be interdisciplinary and inter-institutional. It was also recognized that it would undergo constant revision.

Nearly a year since its initial publication, the programmatic concepts and directions contained in the most recent plan are still substantially intact. However, there clearly exist new developments, and we also anticipate new initiatives. To fully understand the complex processes occurring in the marine environment in general, and in the Gulf of Maine in particular, future scientific endeavors need to be approached from a systems level. Specifically, our program will encourage investigation of the offshore, nearshore, and estuarine systems.

The rich fishery of the Gulf of Maine will comprise a major focus of such programs. For example, we have recently initiated support for a group of scientists (spearheaded by physical oceanographers and geochemists) to investigate the current circulation and chemical fluxes in the offshore areas. This is basic oceanographic data needed by biological oceanographers to understand why productivity is so high in the gulf.

In the nearshore area, we anticipate a majority of our investigators will continue concentrating on coastal processes and the rich living resources of this habitat, including lobsters, clams, oysters, mussels, and seaweeds. Joint efforts with the newly established Maine Lobster Institute will be particularly helpful here.

A new initiative in estuaries should complete our composite study of the Gulf of Maine. The number of estuaries along our northern New England coast and the important environmental processes occurring within them is simply too large to fund extensive and comprehensive studies in all of these systems. Consequently, investigators will be encouraged to focus on representative systems in multi-faceted, coordinated programs that will multiply the benefits of any one study. With that in mind, we have supported designation of Great Bay as a National Estuarine Research Reserve with NOAA. For over ten years, we have also supported UNH researchers in building up a data base on nutrient and hydrographic variations in the system. Within this estuary, unique in some features yet having the commonality of all estuaries, we will continue to encourage individual projects as well as multidisciplinary Sea Grant research.

Given the reality of present and anticipated funding levels for the National Sea Grant College Program, it is clear that investigating the complex scientific questions associated with our offshore, nearshore, and estuarine systems will require extensive cooperation among our academic institutions, state agencies, and private research laboratories. Sea Grant will play a central role in stimulating and fostering this kind of cooperation.

Due to geographic accessibility, our program has focused much of its attention on the Gulf of Maine. However, regional and national projects in identified strategic research initiatives will gain greater importance for the Maine/New Hampshire Sea Grant Program over the next ten years. With some experience already in these multi-state, multi-investigator projects, we anticipate assuming a major role in a number of such national initiatives, particularly those that relate to fisheries oceanography, estuarine systems, and perhaps, marine biotechnology.

Fostering and furthering the Sea Grant concept among our academic institutions and state legislatures will also be a key ingredient to our future success. Our program has steadily broadened its base of support among the marine communities of northern New England. Some of our efforts, such as in marine education and lobster research/extension, have generated significant new support from industry

and/or the state government. With these solid inroads, a renewed emphasis will be placed upon seeking additional non-federal support for Sea Grant efforts in Maine and New Hampshire.

The plentiful existence of marine resources in our region leads to disparate aspirations for their use, and differing viewpoints often result in conflict. The U. S.-Canadian boundary dispute off the coast of Maine, controversy over construction of the Seabrook Nuclear Power Plant in the Hampton estuary, lawsuits pitting fishing interests against those promoting offshore oil exploration, offshore disposal of wastes, shoreline access, and the complex management schemes for the New England fishery, all illustrate this clash of conflicting interests.

To use the Gulf of Maine waters wisely requires a full understanding of the ocean, its processes and resources. Our increasing reliance on the ocean and its resources will ultimately require broad public knowledge and understanding of this environment. As a Sea Grant College Program, the Universities of Maine and New Hampshire have an obligation to contribute their expertise towards this public knowledge and understanding.

The challenge is an exciting one, and the prospects for development of various marine resources are equally exciting.

- Three quarters of the sun's energy reaching the earth, rains on the oceans. Can it be harnessed from conversion waves, currents, thermal difference, salinity differences, or from the biomasses?
- Over 99 percent of the globe's water is in the oceans and thin ice caps. Can it be made economically available to reduce the world's critical water supply problems?
- Are the ocean basins or the deep ocean geological structures stable enough to accept the 13,000 cubic meters of nuclear waste the world will generate in the year 2000?
- By the year 2000, demographers estimate that 80 percent of the U. S. population will live within fifty miles of a coast. Will we be able to accommodate the people, their desire for property, their right to use the sea, their waste products?
- Can we truly farm the sea as we now hunt it? Can we domesticate its species as we have terrestrial counterparts?
- What of pharmaceuticals? Some now come from the sea; will more follow?

The possibilities go on and on. The educational milieu provided by this environment and the opportunities for collaboration that exist between disciplines are unique. Cooperative research, the interconnecting of fundamental science to enhance understanding of complex problems in the ocean, and the embracing of the totality of the "new oceanography" augers well for the future of the marine science programs at the Universities of Maine and New Hampshire.

A statement prepared by the National Association of State Universities and Land Grant Colleges on the role of marine programs in higher education sums it up well:

Using the oceans ... intelligently, is one of the greatest challenges of this age. Marine food, energy, minerals, transportation, and recreation as well as the preservation of the marine environment are increasingly accepted as a necessary part of our future, but we need to educate ourselves if we are to derive maximum benefits of the sea.

Photo Credits:
Alicia Anstead
John Brooks
Tom Carbone
Rita Carey
Concord Monitor
MaJo Keleshian
Kathleen Lignell
Jim Mullins
Paul Pelletier
Quoddy Tides
Brenda Roth
George Sylvester
UNH Media Services
Joanna Young

This publication is made possible by Grant #NA86-D-SG-047 from the National Oceanic and Atmospheric Administration to the Maine/New Hampshire Sea Grant College Program.

Prepared by the Maine/New Hampshire Sea Grant Communications Staff. Designed by MaJo Keleshian.

500 10/87 RF-MSG-87-6 UNHMP-AR-SG-87-13