Division of Marine Resources
University of Washington HG–30
Seattle, Washington 98195

WASHINGTON SEA GRANT

A Report on Activities During 76/77/78

The Washington Sea Grant Progam is now beginning its eleventh year. Like other Sea Grant programs throughout the country, its primary concern is the wise use and protection of our valuable marine resources through coordinated efforts in research and development, education and training, advisory services, and communication. This report documents these efforts for the period January 1, 1976 through December 31, 1978. The report is by no means an exhaustive picture of all the activities, projects or accomplishments but rather an overview, a distillation as it were, of the program. Those wishing a more detailed picture are referred to the Sea Grant proposals for the years involved, to the Project Directory just completed, and to the budget summary sheet and list of publications at the end of this report.

Washington Sea Grant Program

Stanley R. Murphy
Director, Division of Marine Resources

Alyn C. Duxbury
Assistant Director for New Programs

Richard Trowbridge
Assistant Director for Operations

Robert E. Harris
Manager, Marine Advisory Program

Defining the Population

Puget Sound . . . the Strait of Juan de Fuca . . . the Pacific Ocean. These three bodies of water define the 2,337 miles of marine coastline in Washington State and they play a significant role in the lives of the state's citizens. It is in the western half of the state that the population is concentrated, with nearly 70% living within the Puget Sound region.

People in the area own more boats per capita than those of any other population center in the United States—some twelve times the national average. The largest ferry system in the world serves commuters, tourists, and recreationists alike. Commercial fishing is a major industry, and over half a million sports fishermen enjoy the resources each year. Shipping via the Sound and coastal waterways is essential to area industry as goods from all over the world arrive by cargo ship and Washington products are exported in the same way.

Almost 30% of the population is in school, with a large percentage enrolled in colleges and universities. Impressive numbers participate in varying forms of continuing education. A recent study reveals that residents of Seattle, the state's largest city, buy more books per capita than residents of any other U.S. city. Per capita annual income is above the national average and is

continuing to rise, while the unemployment rate is declining. The Boeing Company, a major factor in the region's economy, is experiencing record sales with announced orders reaching the $11 billion mark in 1978 alone.

Clearly, a population so closely associated with the marine environment has great need for information about that environment. Current areas of concern include protection of natural resources, rights of Indians and non-Indians to fish for salmon, a growing need for small craft marinas, repercussions of oil transportation and other hazardous products, and conflicts over shoreline uses. The people of Washington also want information on how and when to catch local fish and shellfish as well as how to preserve and prepare them. Boaters want to be kept up to date on technological advances and new regulations. They also want information about marina siting, tide patterns, and safety precautions. In short, the need for current, reliable information on all sorts of marine-related matters is intense.

In These Pages . . .

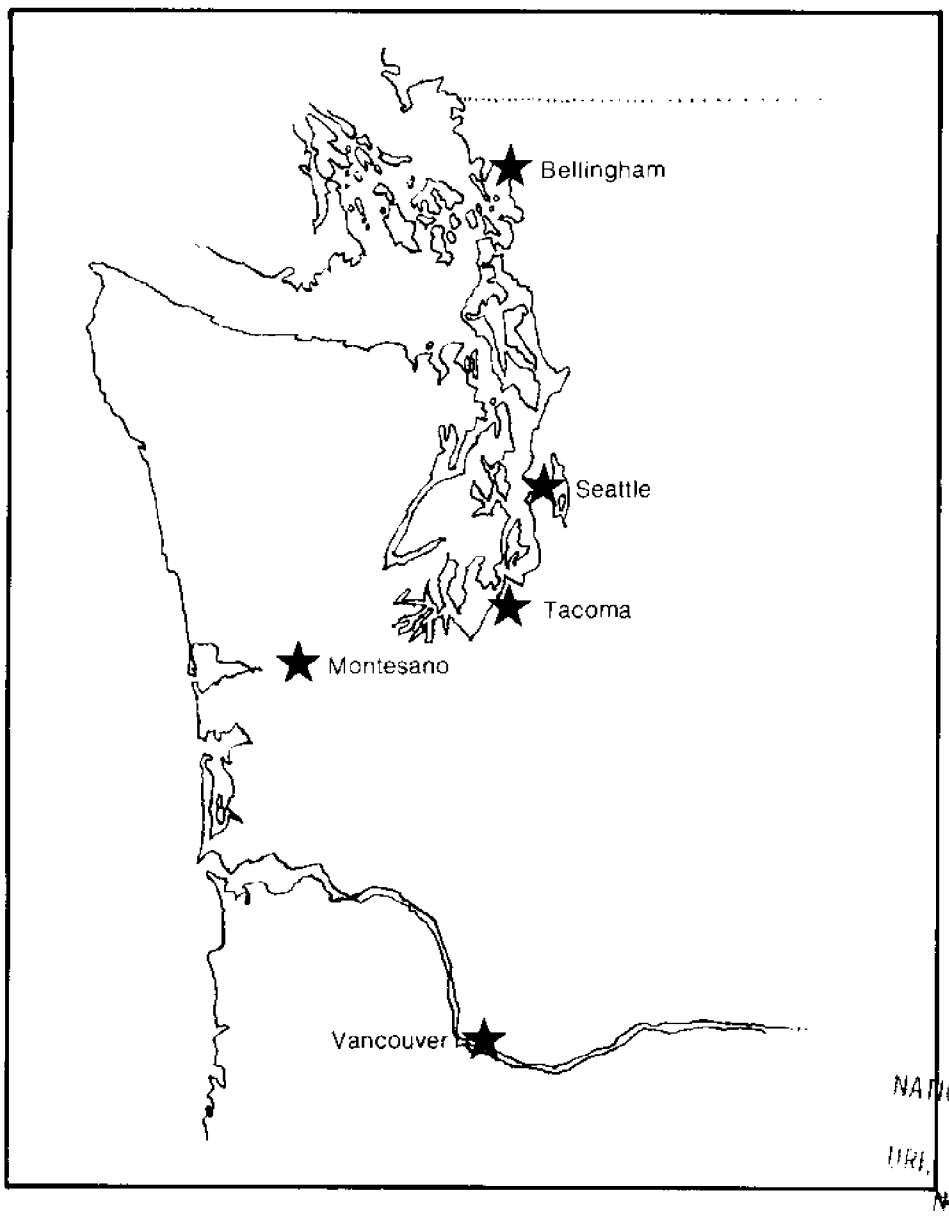
Assessing the Needs

To ascertain the current information needs of its various constituencies, the Marine Advisory Program (MAP) functions, in a sense, as the eyes and ears of Washington Sea Grant. MAP agents and specialists may then respond directly themselves to these information needs or they may relay them back to the program to define research areas in need of study. MAP also disseminates research results through publications, workshops, and other appropriate avenues to those who will benefit from these results.

The Marine Advisory Program has identified eight primary constituencies that it serves:

- Commercial fishing
- Aquaculture
- Seafood Processing and Marketing
- Ports, Harbors, and Marinas
- Marine Recreation
- Marine Trades
- Government Agencies and Institutions
- General Public

During 1976-78, MAP increased its capability of serving these constituencies in several ways. Two new field agents were hired to serve the Columbia River and Northern Puget Sound region. This action places field personnel in five geographic areas in western Washington (see map). Since such a large number of commercial fishermen are concentrated in Seattle, an office was opened at Fishermen's Terminal and manned several days a week.



Commercial Fishing

Although fishing is a multifaceted business in the Northwest, over the years salmon has been the mainstay of the industry, accounting for some 60% of the cash value at landing (1976). Financial and resource management problems have resulted, however, from the 1974 U.S. District Court ruling that treaty Indians are entitled to catch half the harvestable salmon, thus markedly reallocating the available commercial harvest. The MAP economist conducted an economic study of the troll and recreational salmon fisheries, and the analyses are being used on a continuing basis by the Pacific Fisheries Management Council in development of a salmon management plan for the ocean fishery.

MAP agents and specialists also worked with volunteer groups to establish a viable and economically sound small-scale program for installing streamside egg-box incubators in small creek rehabilitation projects. Several creeks in Puget Sound and a river at Grays Harbor have had working installations that have contributed over a million salmon fry to the environment.

Additional assistance in the commercial fishing area has been given on gear problems, navigation, and weather report coverage. MAP personnel are constantly working with individuals or groups through workshops and classes, or on a personal basis to help solve problems, disseminate information, or to act as facilitators. In addition, newsletters, calendars, and brochures have been circulated to keep the constituency advised of relevant events and activities.

Assessing the Needs (continued from Front Page)

Aquaculture

The aquaculture specialist has not only assisted in the stream enhancement projects already mentioned, but has also been involved in helping oyster growers by studying predator control and the possible immunization of oyster larvae against *Vibrio*. No reliable domestic or hatchery seed source has yet been developed on the Pacific Coast and more research into areas of disease and predator control is urgently needed if the industry is to remain healthy.

Literature reviews are also being assembled so that those interested in artificial propagation of salmon, trout, Pacific sturgeon, and minor fisheries may gain access to pertinent literature through available bibliographies.

Seafood Processing and Marketing

In the area of seafood processing and marketing, Sea Grant joined forces with the Institute for Food Science and Technology at the University of Washington to enhance the ability of both programs to respond to needs of the industry. Assistance was given in several ways. Dungeness crab processors were threatened with additional regulatory action until MAP specialists aided them in solving a potential public health safety problem. An investigation of the economic impact of federal wastewater treatment requirements for seafood processors resulted in the withdrawal of proposed regulations that had been based on ill-founded assumptions not applicable to the industry. The MAP economist recently assisted shellfish processors and the Environmental Protection Agency (EPA) by providing a feasibility study designed to select a rational waste treatment from several alternatives.

There are more than 200 seafood processing plants in the state of Washington, ranging in size from tiny 15- by 20-foot buildings equipped with household freezers to mammoth structures with 100,000 pounds of cold storage capacity. Most companies operate without technical help of any kind. Often marketing techniques lack sophistication. In short, this specialized industry faces problems of many kinds and any technical help available from MAP specialists is normally greatly appreciated.

Under the concept of total utilization, shrimp wastes were tested as a fertilizer, and it was found that they significantly increased production when they were mixed with steer manure. Scientific arguments were also marshalled for relaxing the restrictions regarding mercury in seafoods. This was of particular importance to the halibut industry since it led to raising of the action level guidelines.

In 1976-77, Washington Sea Grant was supported by grant number 04-5-158-48 from the National Oceanic and Atmospheric Administration and by matching funds from state of Washington sources. In 1977-78, support was by grant number 04-7-158-44021 from NOAA and by matching funds from state of Washington sources.

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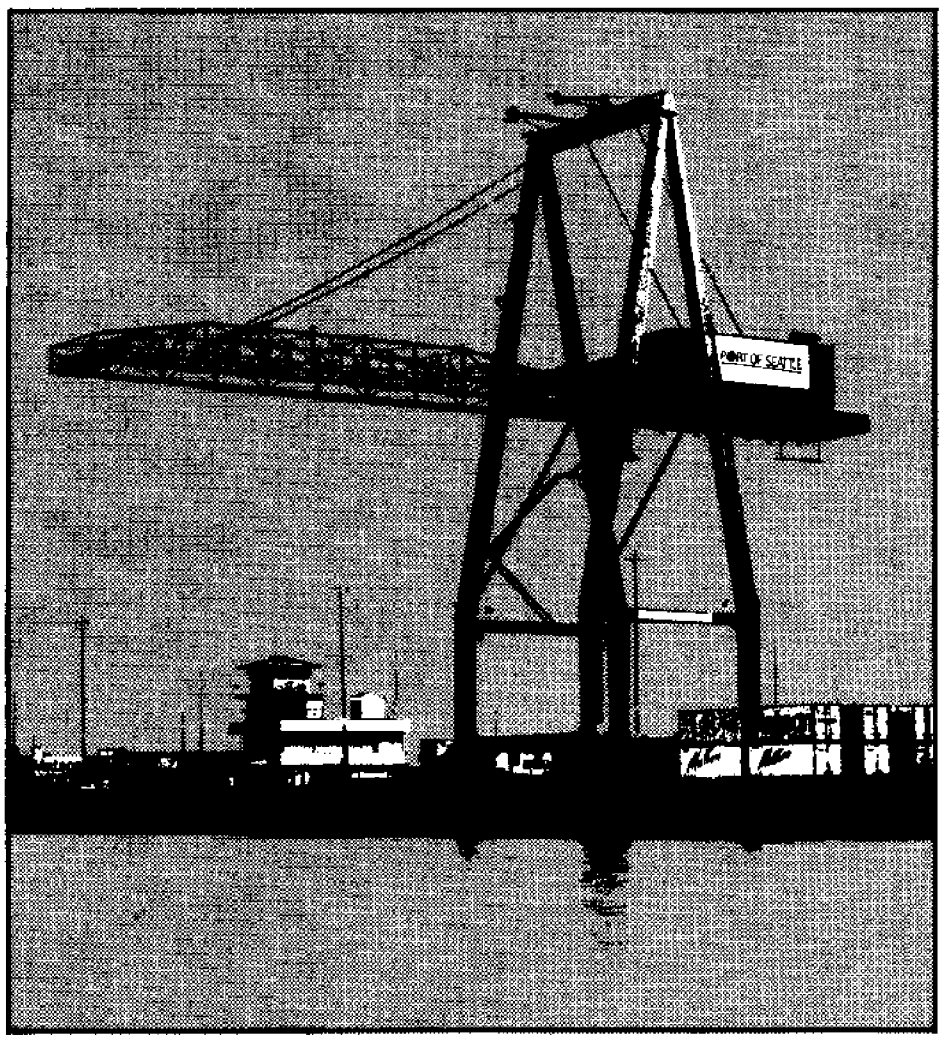


Ports, Harbors and Marinas

As already indicated, Washington's waterborne commerce is of considerable importance to the state. There are 73 public port districts located in 31 counties, and Seattle ranks second nationally in container cargo handled. Furthermore, the Puget Sound region has an extremely high ratio of boat owners per capita, resulting in a serious shortage of moorage and marina space. MAP specialists helped potential developers thread their way through the permit process and policies of the agencies involved by cosponsoring with the Northwest Marine Trade Association a moorage workshop that brought together both developers and agency personnel. Proceedings of this workshop were published and are available from Washington Sea Grant. Developers have also been invited to state-of-the-art marina design presentations, and they now have access to findings of a Small Craft Harbors Research Advisory Group formed by MAP (see section Government Agencies and Institutions).

Because the general public is of critical significance in the small craft moorage problem, MAP cooperated with the Sea Search television series on a documentary dealing with problems of recreational boating and moorage. This program was aired on PBS channel 13 and reached an estimated 100,000 viewers. It has also been made available to government agencies, schools, and private citizen groups, as have other documentaries produced in the series. The program on the 200-mile limit, also aired in 1978, was scheduled to be shown at a two-day conference with an expected attendance of 800.

The waters and shorelines of Washington, both on the open coast and within the protected confines of Puget Sound, offer a superb recreational resource for citizens and tourists alike. Cruising and sailing, marine sportfishing, SCUBA diving, beachcombing, picnicking, and harvesting of shellfish from public lands are but a few of the activities attracting an ever-growing number of recreationists. MAP has worked to make these pastimes safer and more enjoyable. The increased frequency and expanded coverage of marine weather reports keyed to specific areas have benefited the pleasure boater as well as the commercial fisherman. Information on the proper handling and care of catch disseminated through MAP has helped the recreationing public return home with seafood that is in good condition and thus less likely to be wasted.

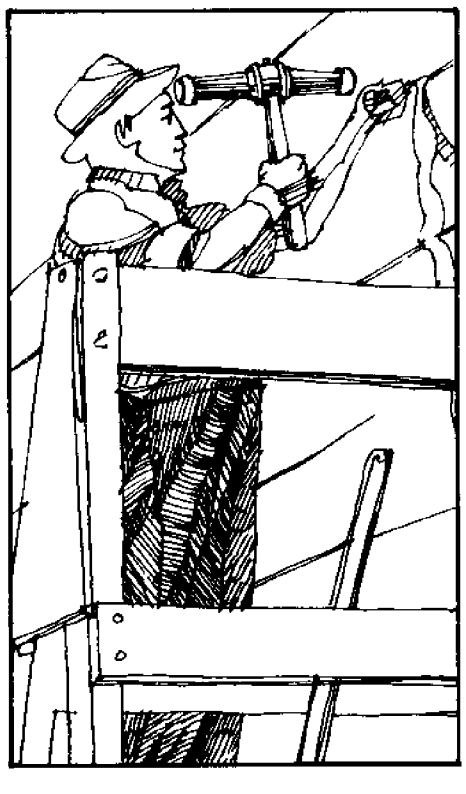
Through the Recreation '76 and Shorelines '77 workshops, the public were made aware of their access rights to public or private beaches, streams, and lakes in the state. They were also given information on the controversial Boldt decision, recent legislation protecting coastal environments, and trends in campground business. This kind of information helps forestall trouble and disappointment for those endeavoring to enjoy the state's resources.

Marine Recreation

Washington's open coastal and inshore water areas are a mecca for sports fishermen seeking salmon, shellfish, and other fish. On weekends, especially during the summer months, there is a mass migration of sportsmen, often with their families, to these areas to use their own boats or charter boats. This frequently leaves large numbers of people on shore, waiting for other family members to return. In one such location, MAP assisted in operating a visitor information center staffed by specialists who conducted field trips, workshops, general education projects, and seafood preparation demonstrations. During 1978, this center at Ocean Shores attracted over 3,000 drop-in visitors who found a place to while away the time in a constructive manner. A similar center was available in Westport in 1977.

Marine Trades

Located on or near the more than two thousand miles of coastline in western Washington are upwards of one thousand business enterprises that build ships and marine equipment, that service ports and harbors, commercial fishing fleets, and recreational boaters. Most of these businesses belong to the member-supported Northwest Marine Trades Association, which acts as a regional industry representative. A dynamic and innovative organization, the association offers its members insurance programs, a credit union, education and management seminars, advertising services, representation before government agencies, and a host of other activities. Sea Grant works closely with this established and effective organization to help meet the needs of the marine industry. The moorage workshop already mentioned is but one example.



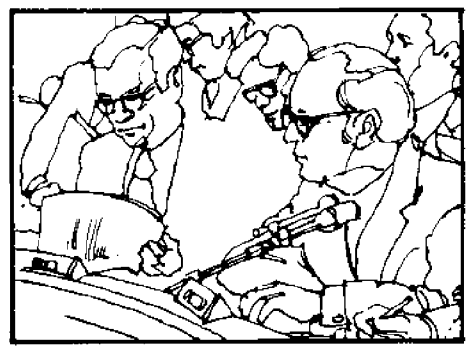
Government Agencies and Institutions

Government agencies and institutions represent another constituency with which Washington Sea Grant actively cooperates. Frequently, cooperation involves working with several agencies at the same time. For example, MAP cooperated with the National Weather Service and the Washington State Department of Fisheries in producing surface temperature charts of coastal waters for use by fishermen. Ground truth information in the form of sea surface temperatures was collected to calibrate satellite imagery so that thermal front charts could be prepared to help in the location of salmon and albacore.

Economic analyses described earlier involved working with the Pacific Fisheries Management Council, the troll and recreational fisheries, the U.S. Department of Commerce, EPA, and various seafood industries. The assistance to crab processors in solving the health problem in packaging required working with the Departments of Agriculture of both Washington and Oregon.

The previously mentioned Small Craft Harbors Research Advisory Group established by MAP specialists currently advises and shares information with all agencies that become involved in overseeing, evaluating, and issuing permits for marine facilities in the area. Formation of this group involved bringing together individuals from federal and state resource management/planning agencies, industry, and academic research projects for a common cause effort.

Various agencies and institutions at the local, state, and federal level often use Sea Grant as a facilitator for cooperative projects or as a partner in troubleshooting specific problems. There are also opportunities for Sea Grant to benefit these groups directly. MAP personnel are sometimes called upon to testify at hearings as expert witnesses and in this capacity are considered as the nonvested interest. Conferences such as Shorelines '77, put together by MAP, presented to agency personnel current developments in shorelines management and assisted those in the Office of Coastal Zone Management in evaluating Washington State's CZMP. The national Sea Grant program itself has been a recipient of MAP expertise—one instance being a review of the Sea Grant benefit analysis program, by Washington Sea Grant's marine economist. Other Sea Grant programs throughout the country also benefit through the exchange of publications and research information.



General Public

The MAP communications staff published a bimonthly marine events calendar to advise all constituencies of meetings and public events of general interest on a local, national, and international scale. An information sheet (Current Marine Research and Activities), carrying brief summaries of research and advisory activities, was initiated for distribution to the media. In addition, the staff embarked on a 14-volume Puget Sound Publication Series in conjunction with NOAA's Puget Sound Marine EcoSystem Analysis (MESA) project.

Local newsletters were widely circulated in both the Grays Harbor and North Sound regions. Brochures were also developed and distributed on such topics as shaking crab, marine sanitation devices for small boats, and caring for seafood once it has been caught.

MAP personnel also set up and manned booths at county and regional fairs to dispense literature and information and to acquaint the public with projects and publications associated with Sea Grant. MAP specialists attended marine science youth camps to cooperate with county extension agents and the 4-H program in conducting field trips and disseminating educational materials. Personnel also cooperated in several public lecture series offered by the Seattle Aquarium, the Pacific Science Center, and Continuing Education at the University of Washington.

Sharpening the Skills

Educational activities of Washington Sea Grant are varied, to meet the differing needs of its many constituencies. In addition to the public information efforts described above, educational activities may include workshops for specific public sectors offered in response to needs expressed by these sectors. These workshops may be organized and presented by MAP personnel drawing a diversified audience from throughout the state to a central location or they may be offered in the field at vocational-educational centers associated with MAP, in response to the needs of certain local constituencies. Topics covered at these workshops are of significant interest to those in marine-related industries or professions. In North Sound, Bellingham Vocational-Technical Institute hosted 600 fishermen in 1977 and 800 in 1978 in such sessions. Clover Park Vocational-Technical Institute and Grays Harbor College have engaged in similar efforts.

K-12 Curriculum

Somewhat more formal than these workshops are short courses offered for credit at educational centers associated with Sea Grant. One example is the short course offered each summer for K-12 teachers. This is typically an intensive two-week session in which teachers study marine subjects, their application in the classroom, and the creation of curriculum materials for later use.

Recognizing the importance of this K-12 sector in education, Sea Grant has begun development of K-12 curriculum materials and activity packets with the Pacific Science Center. Part of this effort involved testing of the materials developed, appropriate revision, and teacher education. At the close of 1978, two activity packets had been printed, and five more were ready for the press. Since no money was allocated for printing, the project sought and received assistance from the state's office of the Superintendent of Public Instruction, both in personnel time and printing support. The next activity packets are due out in early 1979. The K-12 project in conjunction with the Superintendent's office is also documenting statewide the marine education that now exists so that areas needing strengthening can be identified.

Vocational Courses

Sea Grant is also involved in vocational courses at community colleges and vocational-technical schools that can be taken for credit over a full school term for in-depth training. In some cases, combinations of these courses are assembled into full curriculum programs leading to a two-year A.A. degree having a marine emphasis.

Sea Grant has funded both course development and equipment needs for these programs. Their success record has been excellent, as witnessed by their viability, their national reputation, and their ability to place students in jobs related to their training. The reporting period saw the phasing out of Sea Grant support as these programs have matured sufficiently to survive on their own.

The marine trades program at Seattle Central Community College has completed development of a personnel training course in petroleum transportation and handling that complements other courses in marine fire fighting, safety, diesel engine repair, marine refrigeration, and hydraulics. Industry is now cooperating with this program and is using the available courses to train industry personnel.

Shoreline Community College used Sea Grant support to develop two-year programs for oceanographic marine technicians and marine biological technicians. These programs have developed to such an extent that they have been able to secure contractual support from federal and state agencies using students in training to execute needed field studies. Data collected through this program were used to develop habitat descriptions for Puget Sound and to construct charts portraying benthic animal and sediment characteristics throughout a large portion of Puget Sound.

At Grays Harbor College, Sea Grant funded both an MAP office and an educational effort in the fisheries technician program. An important benefit from Sea Grant was the development of an initial effort allowing students to become involved in field studies in the local area. These studies gradually accumulated a data base and level of expertise enabling instructors and students to secure contractual funding from other agencies.

The commercial fisherman program at Clover Park Vocational-Technical Institute has continued to grow, adding peripheral areas with Sea Grant assistance. The program offers special courses in marine refrigeration and hydraulic systems for fishing boats, and the course in marine mechanics is off to a strong start.

University Courses

At the university level, Sea Grant supports the development of innovative classes for expanding studies in the interdisciplinary marine areas. This support extends not only to single class development, but also to new curricula leading to new degree programs in marine studies.

Educational and curricula development begins with the process of contemplating the skills and academic background needed by students moving into a broad versus a specific role in society. Thus academic insight tends to direct the course of events rather than a specific need being brought to the attention of the campus.

At the University of Washington, there has been an extensive history of marine education that predates Sea Grant by many years. Yet the Sea Grant program arrived in time to help establish a new area of graduate marine education and to add some specialized programs to ongoing educational efforts.

In particular, the development of the Institute for Marine Studies has proceeded with Sea Grant support. This institute formed the backdrop for developing new curricula at the graduate level, using specially tailored courses in law, economics, policy and management, and resource use—all of them applicable to the marine environment. The curriculum and course development for students wishing to study in the area of resource management achieved its primary goal during the reporting period—the program was recognized by deans at the University and granted the right to award its own master's degree as a fully accredited program. The variety of course offerings available to students has been generated almost exclusively with Sea Grant support.

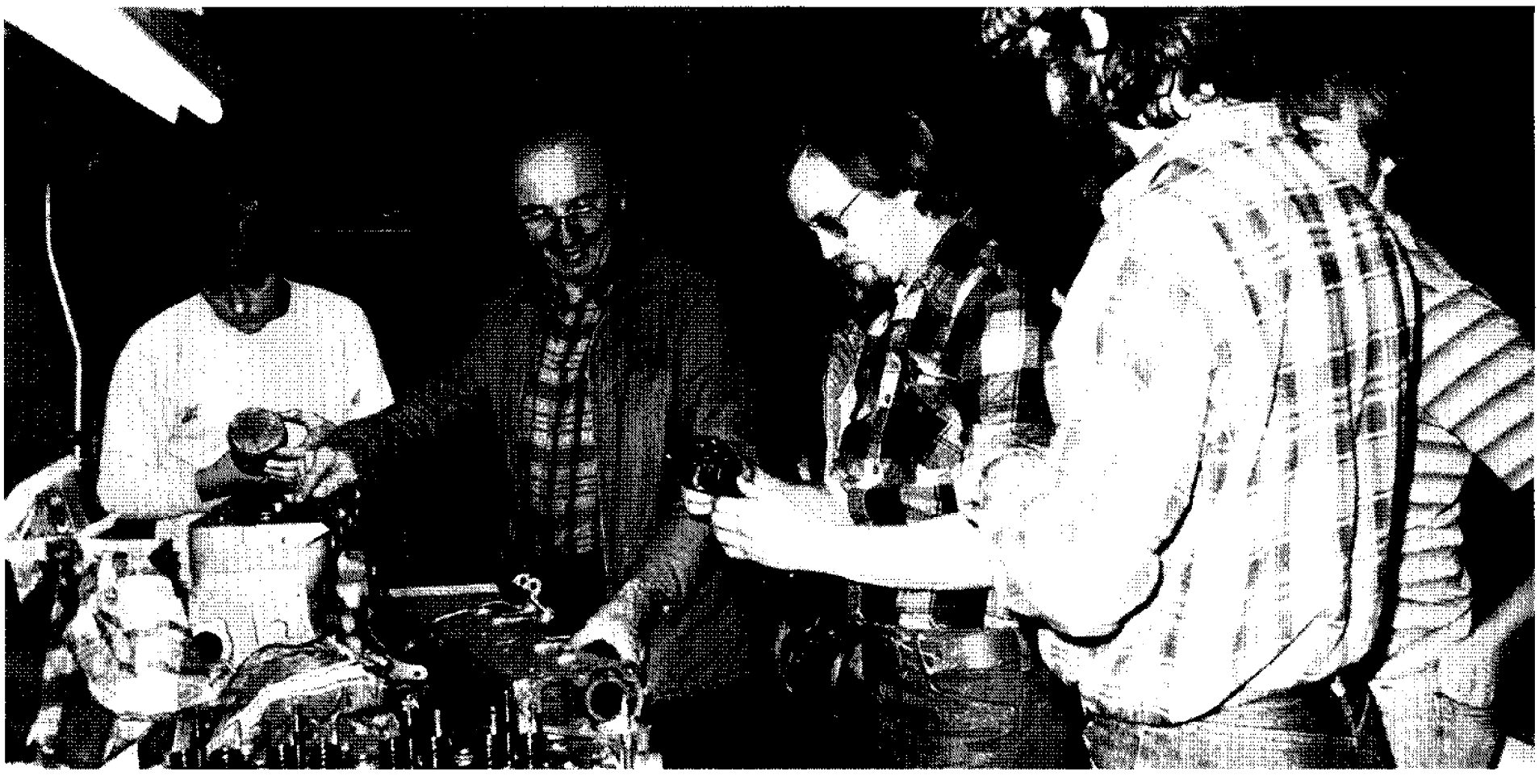
Associated with the Institute for Marine Studies is the Coastal Resources Program, also developed with Sea Grant support. This program embraces research, education, and advisory services, with all three components complementing each other. Research was completed in analyzing public and private rights to beaches, streams and lakes in Washington State. Treaty rights for Indians involved in commercial fishing were examined, as was the use of mitigation as a tool in coastal zone management. Of particular importance was the application of mitigation to marine development, which led to reducing the uncertainty of proposed marinas by private developers.

A study of port development and its relation to coastal zone management was conducted using seaports in six coastal and Great Lakes states. Findings of this study are reported in a book entitled *Under New Management: Port Growth and Emerging Coastal Management Programs* that is just off the press. The economics of marine recreation was examined to clarify the need for organization and location of facilities for the recreational boater.

Ocean Engineering is developing as a graduate program at the University of Washington. Sea Grant has supported its early growth, and the subject area now offers sufficient diversity in courses to move toward a viable option in engineering studies.

The College of Fisheries has, for several years, offered a series of lectures by internationally known experts for students, faculty, and others both within and without the University. These lectures have been well received, and Sea Grant has published books based on these lectures. Those published during the reporting period include *Aquaculture in Southeast Asia: A Historical Overview*, by Shao-Wen Ling; and *A Balanced Science of Renewable Resources, with Particular Reference to Fisheries*, by Henry A. Regier.

Thus it is obvious that the educational spectrum of Washington Sea Grant during the reporting period was broad and touched on many areas.



Finding the Solutions

Research conducted by Sea Grant is usually applied research—it strives to solve problems that have clear and immediate applicability to the marine area. Research is fostered to answer needs of the advisory program in their efforts to assist their respective constituencies. Research is also required as a component of academic programs at the graduate level, especially when these programs are dealing with immediate issues. Furthermore, research on its own merit is warranted in the areas of living marine resources, their management, harvesting, and processing; industries associated with these living resources; and development of new products.

Fish Stock Assessments

From 1976–78, research projects associated with the techniques of acoustically assessing fish populations were carried forward on three fronts: techniques of stock assessment, actual estimations of fish stocks, and engineering aspects of acoustical equipment and acoustical techniques. The objective was to develop a total system that could give accurate counts of numbers of fish, delineate the size of a school of fish, determine the average individual size, and identify the type of fish being observed. In addition, the system was to be readily usable from any vessel in any situation, capable of looking up or down in the water column, and usable in a remote operation.

Sea Grant research in hydroacoustic techniques has drawn considerable national and international attention. In the Puget Sound herring fishery alone, it is estimated that acoustic techniques have resulted in benefits of half a million dollars per year. It is clear that a scheme of enhancing stock assessment is a valuable tool for management of that stock.

Investigations were also carried out on local fish populations involved in both commercial and recreational fisheries. In Northern Puget Sound, recreational fishing for non-salmonids is intense and has the potential of causing stock depletions. Studies of these stocks by tagging or by fish counts will help to determine whether observed fluctuations are natural or are due to sport fishing pressures.

Salt marshes have long been known as valuable nursery grounds for marine species, but their specific value to the Pacific Coast salmon has not been well documented. Sea Grant studies in the Skagit salt marsh revealed that chum and chinook salmon use these areas and that documentation of food resources and marsh stream counts of juveniles could be of help in predicting adult run sizes and scheduling releases of hatchery-reared fish into the marine system.

NORFISH, another research program with Sea Grant support, is being conducted in cooperation with the National Marine Fisheries Service. It is a joint effort at developing management tools for regional fisheries in the Northeast Pacific and Alaskan waters. Specifically, the project has provided economic parameters to NMFS and the North Pacific Fisheries Council to determine the potential of the Alaska ground fishery. NORFISH has provided an analysis of capital fund distribution in the Alaska shellfish fleet, developed with NMFS an on-line information system for foreign fishery catches, and provided techniques for estimating nonlinear parameters in fishery models applied to Pacific halibut and yellowfin tuna.

Aquaculture

All aspects of salmon and shellfish aquaculture are areas of extensive research. Investigations are proceeding in the areas of stock development for growth, genetic traits, diseases, artificial foods, and hatchery technique reviews. Faculty and staff at the College of Fisheries at the University are leaders in these efforts and have had a long history in stock development.

Faculty and students have been studying the total problem of hatchery rearing of salmonids, including the importance of stock genetics, fish behavior, pathology and nutrition. Project investigations are comparing salmonid production and survival of stocks reared naturally with those reared under artificial techniques. This effort, carried out in cooperation with state and federal agencies, helps to establish changes in hatchery practices in both state and federal hatchery systems. In addition, the model ocean ranching project being conducted will be used as a demonstration project when an ocean ranching bill is considered by the state legislature.

Penculturing of salmonids developed in Washington as a cooperative effort between industry, the National Marine Fisheries Service, and Sea Grant has revealed much about the problems of growing salmonids in high-density rearing pens. Survival of the fledgling industry will require development of special stocks with improved growth rates, high feed conversion to flesh, and natural resistance to disease. Special stock development is under way to create a suitable genetic strain. At the same time, research has been devoted to the methodology of innoculating fish against the primary disease, *Vibrio anguillarum*, of pen-reared salmonids. Studies are focusing on the specific mechanisms of pathogenesis of the marine Vibrio to determine its genetic basis. Early results indicate that it is the plasmids of the Vibrio that have the capacity to produce the disease. If it can be shown that the virulence is plasmid-mediated, further steps can be taken in disease control.

Shellfish are also marine crops. Oysters raised locally are primarily the Japanese Pacific oyster. Twenty years ago, the annual harvest was 13,000,000 pounds, but the yield is now down to about 5,000,000 pounds. Genetic crosses are being tried on commercial beds to see if new strains can bring the yields back. The development of genetic crosses and the raising of oyster spawn have permitted the transfer of new technology to oyster seed producers both in Washington State and elsewhere.

Seaweeds, especially those macroalgae having a high carrageenan content, are valuable for the polymers they contain. These polymers have wide application in industry as emulsifying agents. The algae in Puget Sound grow very well whenever there is a substrate suitable for attachment, but frequently there is a lack of such substrate. There is, however, the potential for seeding an artificial substrate and raising the algae in a way convenient to harvest. There is also the possibility of enhancing the growth rate by nutrient enrichment with sewage effluent in tank or pond culture. This has the added benefit of having the algae act as a nutrient scrubber for discharged effluent.

New Marine Products

Sea Grant also encourages development of marine products that have a potential for creating new markets and uses or for utilizing waste products. The shells of crabs and shrimp previously discarded as waste now have the potential for refinement into chitin and chitosan with promising applications in industry. Sea Grant has obtained excellent results in the introduction of chitin as a bonding agent in the production of paper, nonwoven fabrics, and glass fiber assemblages. Chitosan also serves as a clarifier by helping to remove small particles from aqueous suspension. A self-supporting industry could well result, with the added advantage of contributing to total utilization and the reduction of wastes in processing.

Other polymers from marine sources also show potential industrial applications. Marine plants and animals contain enzyme systems that produce polymers, and Sea Grant has been investigating the bromination systems in these plants and animals since

brominated polymers are in wide use as flame-retardants in the clothing industry. Investigation of these natural bromides could lead to new methods of synthesizing or to new classes of polymers or monomers with industrial potential.

Ocean Engineering

Another aspect of research is that geared to technology in marine industry. In Washington Sea Grant, ocean engineering has played a significant role. The marine acoustics program already referred to has a hardware development aspect involving engineering and equipment design. In hatchery operations, there are also engineering needs associated with design of the system and hardware used in egg incubation and production of food compatible with the stock being raised. Thus engineering has a direct input into better utilization and management of living resources.

Washington Sea Grant has mounted an engineering effort to develop pilot plant facilities to produce economical food products that will be both nutritionally balanced and capable of meeting the physical needs of handfed stocks. This feed must satisfy a range of parameters for diverse species going from the postlarval stage to the adult stage. Each group at various life stages has specific demands regarding water solubility, density of food, size and shape of food particles and nutritional value. Tests are under way to determine if manufacturing techniques can solve the requirements of test species.

Other technological problems are involved in processing fish once they are harvested. More and more, this is becoming a mechanized process to assure a high-grade uniform product efficiently and rapidly produced. Furthermore, more types of fish are being considered for processing to prevent wastage of resources. In some cases, this processing must be done, at least partially, on board the fishing vessel for reasons of economics, quality control, or space limitation. Engineering expertise associated with food processing is being brought to bear on this problem to develop inexpensive techniques for improving the production of palatable hydrolized fish tissue and also techniques of concentrating solution of heat-sensitive materials using submerged combustion.

In many cases, fishing vessels encounter safety problems—problems that affect not only personnel and equipment but also regulations and insurance costs. Washington Sea Grant is cooperating with the fishing industry, the U.S. Coast Guard, and insurance underwriters to analyze accidents in terms of vessel types, geographical location, and probable causes. These data are being gathered in a Fishing Vessel Safety Analysis Center, which will also examine engineering aspects of vessels and their operation to create a base for rational safety requirements, more realistic insurance rates, and recommendations for hardware changes to help ameliorate problem areas.

Other resources available from the sea are also truly within the technological purview of engineers. Within this reporting period, a guest lecturer was sponsored by Sea Grant to examine the potential for deriving energy from the sea. As a class project, his students produced a book that gave engineering details for extracting energy from waves, tides, current, and thermal gradients—material notably absent from more popular treatments of the subject.

Publishing the Results 76/77/78

Aquaculture

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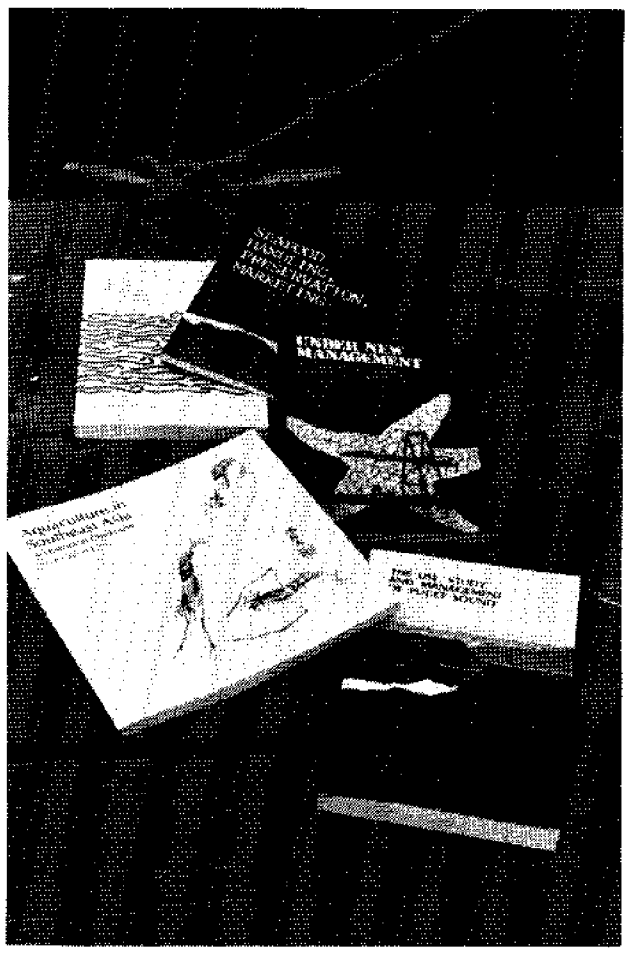

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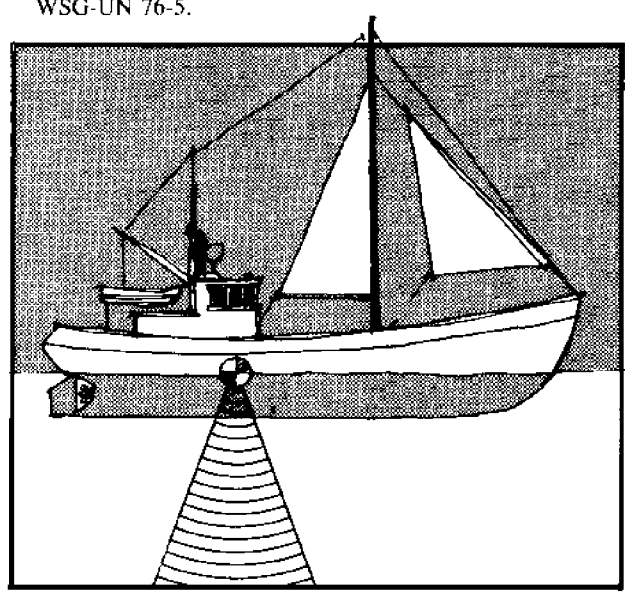

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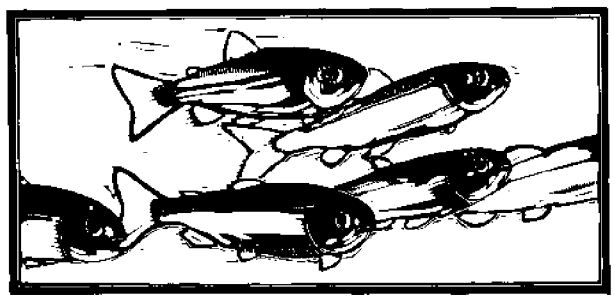

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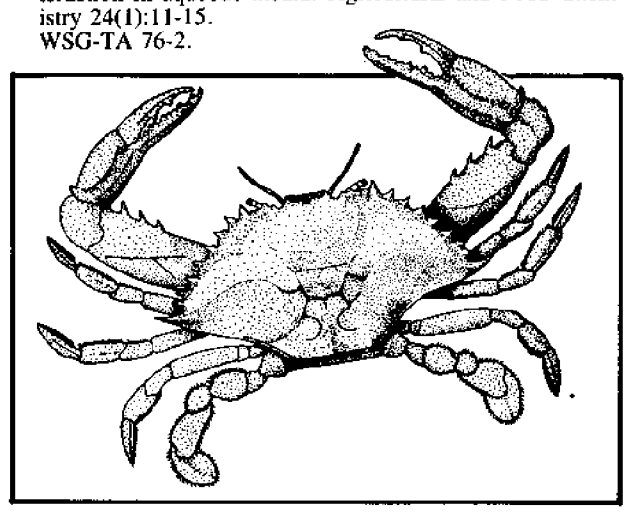

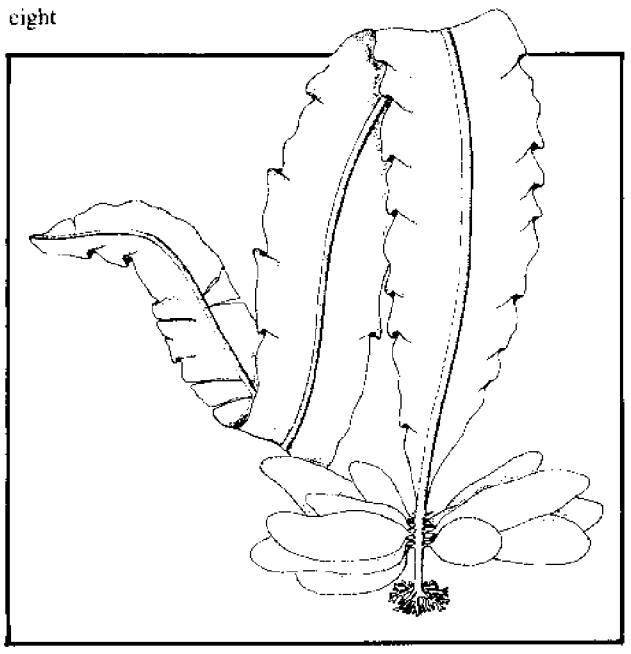

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Accounting for the Dollars

This summary is only approximate. The official financial report will be submitted to NOAA's Office of Sea Grant Programs in accordance with the federal grant requirements.

	1976		1977		1978	
	Sea Grant	Matching	Sea Grant	Matching	Sea Grant	Matching
ADVISORY SERVICES						
Field Advisory Services	$ 302,100	$107,600	$ 342,000	$114,000	$ 407,800	$ 141,700
Program Communications	106,500	14,600	130,500	34,100	150,000	43,600
EDUCATION AND TRAINING						
Education/University	159,400	116,300	180,100	152,300	151,300	135,300
Education/Other Institutions	32,700	125,700	35,000	52,900	24,100	27,700
RESEARCH AND DEVELOPMENT						
Research in Fisheries Management	93,900	50,100	65,700	54,400	187,400	78,400
Aquaculture	288,700	127,800	313,100	262,500	364,600	231,400
Marine Product Development	129,900	58,700	50,100	24,100	50,700	24,300
Coastal Resources Program	112,500	54,400	93,600	33,200	122,400	54,500
Ocean Engineering	132,600	61,600	141,600	72,200	168,100	89,900
Marine Studies Program					19,200	34,000
PROGRAM MANAGEMENT	101,700	98,700	123,300	159,700	134,400	164,200
TOTAL	$1,460,000	$815,500	$1,475,000	$959,400	$1,780,000	$1,025,000