

WASHINGTON SEA GRANT PROGRAM



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A REPORT ON THE WASHINGTON SEA GRANT PROGRAM
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PREFACE

In 1966, Congress passed the National Sea Grant College and Program Act authorizing establishment of a program devoted to developing and conserving this Nation's marine resources. The program was intended to parallel the century-old land grant program created by the Morrill Act, which was aimed at developing the Nation's agricultural resources.

Under provisions of the Sea Grant act, grants were first made in 1968 to the University of Washington, University of Rhode Island, and Oregon State University to initiate programs in marine resource research, education, and advisory services. During the years between 1968 and 1972, the national program expanded to include similar programs at 15 universities and colleges in the Gulf of Mexico and the Great Lakes regions, as well as on the Atlantic and Pacific coasts, and each of these programs has, in turn, expanded and matured.

This report summarizes activities of one of these sea grant programs--that of the University of Washington--from January 1, 1972, through December 31, 1972, under grant number NG-1-72 from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Sea Grant requires a one-third non-federal matching fund. During 1972 matching funds were provided to Washington Sea Grant by the University of Washington, six other institutions of higher education in Washington, two state resource agencies, and numerous regional marine businesses, industries, and agencies.

In this report, highlights of the 1972 program are summarized and published by the University of Washington's Division of Marine Resources, administrative unit for Washington Sea Grant, not only in fulfillment of contract requirements but also in furtherance of its goal to provide useful information to the marine community. Further details about the program are available from the Division which is located at 3716 Brooklyn Avenue N.E., Seattle, Washington, 98195.

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PROGRAM MANAGEMENT

The Washington Sea Grant Program is appropriately instituted at the University of Washington where over the years marine programs have consistently produced leaders in the development of marine resources. Since its inception in 1968, the Washington Sea Grant Program has been able to draw upon a wide array of talent available within the University and to develop improved mechanisms to amalgamate University talent with that of other institutions and agencies to meet needs of the statewide marine community.

In recognition of the results obtained, the Secretary of Commerce designated the University of Washington one of the nation's four initial Sea Grant colleges in September 1971. That designation reinforced the determination of University and Sea Grant program administrators to continue to improve the quality of the program.

As a first step, the Office of Vice President for Research, at the request of Program Director Stanley R. Murphy, appointed in October 1971 a Washington Sea Grant Steering Committee to consider responsibilities implicit in the Sea Grant College designation and to assess local resources available for meeting new responsibilities. This seven-man committee drawn from as many disciplines immediately began an ongoing series of meetings to review the status of the program and to find improved ways of assessing priorities and for achieving well-defined goals. With the committee's advice and counsel, the Program Director successfully coalesced several groups of small, essentially isolated efforts into focused sub-programs.

It was in the spring of 1972 that the value of the steering committee became abundantly clear. At this time, hints of tightening federal funding began to reach a university administration operating within the constraints of limited state support--the inevitable result of a depressed state economy. The steering committee spent numerous hours working with the program director in developing criteria for evaluating projects, in suggesting alternative methods, and in tightening and refining project goals. As a result, local investigators began 1973 with the assurance that, despite a less than optimistic economic outlook, Washington Sea Grant had planned a solid, viable program capable of maintaining essential services and program elements necessary for continuation.

Later in 1972, a second step was taken by program administrators to meet the higher commitments of a Sea Grant college and to further augment program maturity. Responding to needs outlined by the national Sea Grant director, the local program retained a consultant, Robert F. Goodwin, to explore evaluating selected projects in terms of profits derived from the taxpayers' investment. As 1972 ended, Mr. Goodwin's initial study of the WSG marine acoustics program was nearing completion, and preliminary results documented a magnitude of benefits previously only guessed at by project investigators. From Mr. Goodwin's reports, program administrators could demonstrate that an innovation for investigating stock abundance developed by WSG researchers had been adopted by outside agencies and thereby generated between 1969 and 1972 a sevenfold increased investment of non-Sea Grant dollars in regional marine acoustics research.

Prior to 1972, achievement of explicit project goals had been the sole measure by which administrators could determine Washington Sea Grant program successes. With the advent of analytic approaches introduced by Mr. Goodwin, the program's managers now recognized that the associated benefits to society derived from program achievements must also be demonstrated in mature program evaluation. Thus, in 1973 continued attention will be directed toward these self-appraisal efforts begun in 1972.

Realistically, a program's direction is shaped by many forces--both internal and external. Thus far this report has considered only directions generated internally during 1972. Washington Sea Grant, like similar organizations, operates within a larger framework--that of the University of Washington--and during 1972 a major realignment of the University's marine-related programs occurred. In the fall, President Charles E. Odegaard named a seven-member Marine Affairs Board with university-wide responsibility in the marine areas for planning, assessment of priorities, and supervision of operations. (Figure 1 shows how the University is now organized in the marine area and the relationship of the Washington Sea Grant program within the University.)

Concurrent with Dr. Odegaard's appointments, the University regents established an Institute for Marine Studies to foster broad interdisciplinary education and research in the marine area. Both the Marine Affairs Board and the new Institute appear to have broad implications for Washington Sea Grant, but what the implications are likely to be will not be known until the Board and the Institute become cohesive entities and relationships with Sea Grant are explored.

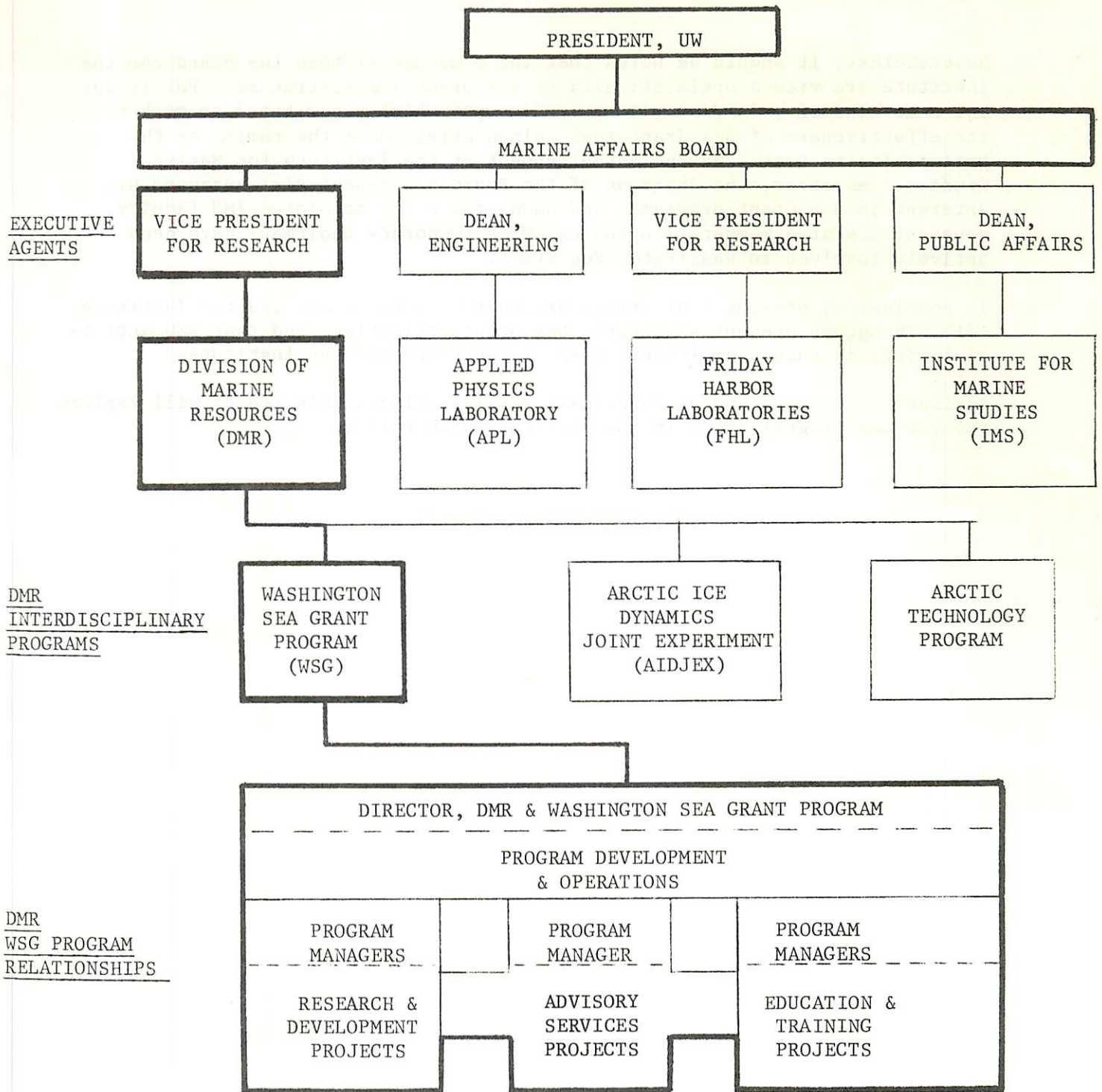


Figure 1. ORGANIZATION OF MARINE COMPONENTS WITHIN THE UNIVERSITY OF WASHINGTON 1972

Nevertheless, it should be noted that the presence of both the Board and the Institute are viewed optimistically by Sea Grant administrators. For it was the same kind of multidisciplinary philosophy which contributed so much to the effectiveness of Sea Grant that helped bring about the naming of the Marine Affairs Board and the establishment of the Institute for Marine Studies. Moreover, the chairman of the Board has repeatedly expressed his interest in Sea Grant programs, and among the newly appointed IMS faculty, seven of its nine members (including IMS's temporary chairman) have been actively involved in Washington Sea Grant.

In conclusion, present indications are that both the Board and the Institute will strengthen present Washington Sea Grant activities, and that WSG activities will, in turn, complement those of the Board and the Institute.

Against this background of management considerations, this report will explore the various program areas in the sections which follow.

ADVISORY SERVICES

1972 was a year of consolidation and preparation for widening Washington Sea Grant's advisory activities within two general areas:

- Distilling and disseminating marine resource information resulting from scientific research and engineering developments to marine businesses and industries, federal and state agencies, local governments, and the general public
- Identifying regional needs for marine resource information and initiating appropriate responses to those needs

ADVISORY PROGRAM MANAGEMENT

To implement these goals the following steps were taken during 1972:

- An additional field position was established to initiate program expertise in finfish and shellfish aquaculture and to complement existing staff expertise in commercial fishing and seafood processing
- A coastal field office was established at Grays Harbor College to serve Washington's Pacific coastal counties
- A memorandum of agreement was drawn up and approved by University of Washington and Washington State University officials authorizing cooperative efforts between advisory service and cooperative extension personnel

- A conference with coastal county extension personnel, in cooperation with National Marine Fisheries Service, Washington State Department of Fisheries, and the WSU Cooperative Extension Service was sponsored to exchange information on local community concerns for the marine environment and possible sources of expertise available to respond to those concerns
- Staff participation in the Pacific Sea Grant Advisory Program was encouraged and was manifested by
 1. Staff organization and sponsorship of one of five PASGAP marine industry input conferences, Olympia, January 1972
 2. Manager's active participation in the Anchorage input conference
 3. Manager's role as recording secretary for PASGAP coordination committee
 4. Field specialist's leadership in organizing and holding PASGAP-sponsored smoked fish workshops in Oregon and Washington
 5. Editor's continued chairmanship of PASGAP publications committee
 6. Editor's production of two PASGAP publications
 7. Editor's provision of three days' talent-sharing with Alaska Sea Grant program in Anchorage
- An agreement was concluded with the University of Washington Press to facilitate and expand distribution and to permit sales of selected program publications
- An editorial committee was established to advise on program publications of a technical nature and to recommend and approve publication policies
- Staffing of a telephone reference service for general marine information assistance was continued
- Support was provided for the initiation of a Sea Grant collection in the University's Fisheries-Oceanography Library

FIELD PROGRAMS

Seafood Processing

During the year under review, the program's seafood specialist, with the assistance of UW's Institute for Food Science and Technology, directed his efforts toward helping the seafood processing industry solve quality control problems associated with smoked fish products. Working closely with seafood specialists at Oregon State University and National Marine Fisheries Service, he helped develop and teach a series of workshops in Oregon and Washington for regional smoked fish processors. Sponsored by PASGAP, the workshops were designed to inform processors about recently issued federal regulations concerning smoked fish products and to help the processors comply with these new standards. Besides providing the industry with useful information, the

workshops also stimulated formation of the Puget Sound Smoked Fish Producers Association, and this industry group has provided a convenient mechanism for subsequent advisory work in this area.

Building upon the foundation laid during the workshops, the specialist devoted the balance of 1972 to personally visiting smoked fish processors in Washington in order to learn what their individual problems were and to help find solutions. By midyear, the specialist had discerned a pattern of needs common within the industry--in order to comply with the new regulations, most plants would need to redesign and restructure physical facilities, and the expertise needed to do so was not readily available.

Therefore, he returned to the University and approached the faculty of the Department of Architecture with industry's appeal for help. In response, the Department recommended one of its fifth-year students for summer employment with Advisory Services and selected the problem for subsequent advanced design courses.

The student employee devoted the summer to charting various plants' product flow--from receiving to shipping--and diagramming how that flow was controlled by plant structure. In the fall, this information was shared with the design classes, and students devoted their efforts to developing models incorporating recommended improvements. By the end of the year, these recommendations were nearing completion and presentation by the class to the industry was scheduled for 1973.

Commercial Fishing

Annually, the State of Washington licenses nearly 10,000 commercial fishing vessels and to serve this viable marine industry during 1972, Washington Sea Grant supported advisory activities of two commercial fishing specialists. The first of these men to join the program was employed from mid-1970 until mid-1972 by Clover Park Education Center to assist with instruction in the Center's marine technician programs and to implement its commercial fishing advisory project--both supported by Sea Grant. The second specialist was hired in November 1971 by the Marine Advisory Program at the University of Washington to provide staff expertise on commercial fishing to Sea Grant research scientists and liaison between research programs and the field staff.

In October 1972, this second specialist resigned to accept an offer to head the fisheries technology program at Kodiak Community College. Simultaneously, a strong interest in having an area marine agent was expressed by the coastal and fishing communities around Aberdeen-Grays Harbor and this led program management to begin refocusing field services along geographic rather than subject specialty lines. Thus, in late 1972 the first specialist was reassigned to a billet at Grays Harbor College, as an employee of the University's Marine Advisory Program, to help implement a coastal advisory service. For the time, support remained at Clover Park for its traditional commercial fishing advisory activities such as short courses and workshops. And the feasibility of shifting other field staff assignments from specialty to geographic areas remained under consideration.

Prior to this reorientation of field effort, the commercial fishing industry of Washington was served by the following activities of the two specialists during 1972. During off-season months, a series of Town Hall meetings were held in three Washington ports so fishermen could have an opportunity to collectively voice their concerns and to hear representatives from agencies with research and regulatory responsibilities for the industry. Additionally, seminars and workshops were conducted in various ports on long-lining techniques, shipboard first aid, salmon dressing and icing, operation of inflatable life rafts, and potfishing and artificial baits for bottom fish.

One of the specialists, working with project NORFISH investigators, helped identify areas for potential research on fisheries problems such as the need for correlating skipper capabilities with catch-per-unit of effort, marketing restraints on vessel catch, share system on vessel investment, and losses on fixed and mobile gear conflicts. And research needs uncovered and relayed to program managers by the other specialist resulted in field operations on the feasibility of using gillnets to catch albacore tuna.

Further efforts by these men resulted in three advisory publications. A 1971 survey of the Whatcom County fishing industry was published in early 1972 and attracted wide attention because it demonstrated for the first time that commercial fishing alone (not related industries such as seafood processing and boat building) was second only to the oil industry in impact upon the county's economy. Proceedings of a workshop on life raft demonstrations and a pot fishing/artificial bait symposium were also published and distributed widely.

Aquaculture

In October 1972, another specialist joined the marine advisory staff to concentrate on services for Washington's rapidly expanding aquaculture interests and for its sizable shellfish industry. Because this addition came so late in the year, achievements in the aquaculture/shellfish program cannot be reported. However, it should be noted that selection of the individual for this post was based primarily upon his performance as a graduate student and subsequently as a research biologist on shellfish culture projects conducted by the University's College of Fisheries and supported by Sea Grant. In the latter capacity, he worked closely with the field staff in the assessment of Washington's various programs in shellfish aquaculture and in the performance of a feasibility study on potential of geoduck clams for Dungeness crab pot bait.

COMMUNICATION SERVICES

The capability to publish is vital to all Sea Grant programs, and the titles published and/or distributed during 1972 appear at the end of this report. In addition to editing, distributing, and documenting these titles, the program's full-time and part-time editors also produced a wide variety of feature and news articles which appeared in both local and regional press. Moreover, the full-time editor wrote and produced a monthly staff newsletter, Washington Sea Grant Items, which is designed as an informal internal communication device and which costs the program less than \$120 annually for printing and distribution.

In addition to these routine projects, she initiated a small feasibility study on the effectiveness of a recipe-card format as a means of promoting seafood sales. The study was undertaken in cooperation with members of the Puget Sound Gillnet Association Auxiliary and thirty Puget Sound markets and with counsel from the regional marketing director of the National Marine Fisheries Service. Scheduled for completion in 1973, the initial success of the project was demonstrated when careful format planning resulted in a printing bill of less than \$500 for 100,000 recipes.

Besides this recipe project, efforts of the editor also resulted in the conclusion of a distribution agreement with the University of Washington Press to facilitate distribution and enable sales of selected program publications as well as in the documentation and recommendation of publication policies adopted by the editorial committee on which she also serves. Further, in her capacity as chairman of the PASGAP Publications Committee she has coordinated production of seven regional advisory publications and, of these, written one and edited two. Her PASGAP activities also included a three-day visit to the Alaska Sea Grant office where, by invitation, she provided assistance to a then recently instituted editorial program.

Although the other editor worked only part-time for the program, she, too, contributed significantly to these program highlights. Early in the year, she worked closely with Mr. John Gulland of FAO to edit transcriptions of tapes of lectures he delivered at the College of Fisheries and to produce the volume, Population Dynamics of World Fisheries, which is now being widely marketed by the University of Washington Press.

Additionally, it was at the suggestion of and on the basis of research done by her that Athelstan Spilhaus was selected by the University's Graduate School as a lecturer for its highly respected John Danz lecture series during 1972-73. And at her instigation, a local educational television station produced and broadcasted an hour-long documentary on various aspects of the forthcoming Law of the Sea Conference and the UW Office of Continuing Education developed and scheduled for February 1973 a weekend seminar, Puget Sound: Oil on Troubled Waters?, with faculty drawn from among Sea Grant investigators.

OCEANOGRAPHIC MODEL OF PUGET SOUND

Every year, more than one-third million people visit the Pacific Science Center located in a civic complex inherited by the City of Seattle from its World's Fair of 1962. Because of these large crowds attracted by the Center's international reputation for popularizing science, Washington Sea Grant determined some years ago that there could be no more effective repository for a hydraulically operated and mechanically controlled model of Puget Sound and its tidal system. Thus, a senior oceanographer of the University's Department of Oceanography was asked by Sea Grant administrators to design and supervise the building of a working model of Puget Sound that would demonstrate to the public the tidal action and river runoff of this unique estuary.

Previously, he had executed a similar model for the Department of Oceanography. So from departmental storage, he unearthed his original hand-carved, layered, wooden molds; and these he presented to a Seattle boat builder for the basis of a cast fiber-glass model of Puget Sound.

By the end of 1972, the model had been installed in the Center and the computer-driven components which would generate the tides and currents of Puget Sound had been completed. In cooperation with the Center's exhibit designers and builders, the first phase of painting the model had been completed, and the Center's preliminary plan for a total oceanographic display, of which the model was to be a keystone, had been finished.

EDUCATION AND TRAINING

NEW COURSES AT THE UNIVERSITY OF WASHINGTON

By 1972, increasing interest in the oceans on the part of industry and government had created a demand for professional engineers, scientists, social scientists, and legal scholars--all with knowledge and skills which could be applied toward conservation and development of the marine environment. To meet this demand, Sea Grant has aided in establishing new courses at the University of Washington that provide students with education and training needed to pursue careers in marine research and maritime industries. Sea Grant support for educational projects is used by the University in a number of ways, including developing curriculum materials for new marine-oriented courses and undertaking feasibility studies which demonstrate areas of research of technological or economic value to industry.

Ocean Engineering

Foremost among these educational projects has been the establishment of an ocean engineering program at the University accomplished through the initiation of new courses and modification of existing courses to encompass ocean engineering problems. In the winter of 1972, a course in coastal engineering, "The Interlocking Role of Engineering and Oceanography," was added to the University's engineering curriculum, and a course on corrosion for mechanical engineers was modified to include marine corrosion problem-solving. The latter

course modification was a spin-off of earlier Sea Grant feasibility studies directed toward such topics as corrosion, small boat fishing operations, and instrumentation for measuring sea states.

Besides providing instruction through the University's regular curriculum, ocean engineering project investigators offered an intensive short course designed to acquaint practicing engineers with regional coastal problems. Attended by engineers from private firms, city and state agencies, and port commissions, the course was convened on three separate dates in 1972 to meet registration demands.

In 1970, an interdisciplinary, ocean engineering systems design course was instituted for both seniors and graduate students. The purpose of this course was to provide a vehicle for encouraging interdisciplinary marine studies among students and faculty, and its success can be measured by the output of the 1971 class--a 630-page report detailing implications of water-borne oil transport on Puget Sound. In 1972, the class's investigations and conclusions were published by Washington Sea Grant program in a book entitled Oil on Puget Sound and distributed widely by the University of Washington Press.

Subsequently, the 1972 class developed a comprehensive plan addressing the methods by which Washington's harvest of food from the sea could be increased ten-fold over the next 10 years. The class's long-range projections included considerations of physical, technical, organic, ecological, legal, economic, and marketing problems. In these considerations, the students recognized a number of potential industrial opportunities and, thus, made recommendations which, if implemented, would not only increase seafood output and quality while reducing expenses, but would also increase revenues to the State of Washington.

Fisheries

Within the College of Fisheries, courses have been implemented to introduce students to the technology of U.S. commercial fisheries. These courses include:

- "Principles of Fishing Gear and Fishing Vessel Development," which covers commercial gear and methods of harvesting marine animals for food and industrial use;
- "Principles of Fisheries Technology," which encompasses the science and technology associated with harvesting, preserving, and marketing seafood; and
- "Environment, Food and Technology," which delineates the problems of waste disposal and treatment associated with seafood processing.

A total of 62 students have enrolled in these three courses, which are to be phased from the Sea Grant program in 1973-74.

The University is also pioneering courses in management techniques for the purpose of training biologists qualified to deal with the stresses placed upon the environment and its resources by the increasing population and rapid progress of technology. These courses include "Management of Exploited Animal Populations," "Ecological Models," and "Fisheries Management."

These courses have emphasized the interplay between quantitative sciences and fisheries biology and a major output of the course sequence has been the successful development of a computerized management scheme for a salmon fishery. Moreover, the program has offered two short courses oriented toward the mid-career biologist and resource manager, and interest in the courses attracted 34 participants from throughout the United States. A third project activity is annual sponsorship of a series of lectures by internationally known fisheries biologists. During 1972, John Gulland of FAO presented this series, and Washington Sea Grant has compiled and published his lectures under the title, Population Dynamics of World Fisheries. Widespread distribution of the Gulland book has been possible through the marketing division of the University of Washington Press.

Ocean Law

In managing any resources, particularly resources of the ocean, the most pertinent problems are usually ones of legislation or law. Thus, with Sea Grant support, the University of Washington School of Law has recently augmented its collection of teaching materials for existing courses on international law of the sea and for new courses on coastal zone management and international utilization and management of world fisheries. Results include preliminary edition of a book on North Pacific fisheries which has been completed and is available in mimeograph format and a revised and enlarged edition of an index to U.N. marine treaties which has been published under the Sea Grant imprint and again distributed by the University of Washington Press.

To date, four students have been awarded degrees in the second year LL.M. program, and they have assumed positions in marine-related fields on the staffs of Scripps Institution of Oceanography, the U.S. Senate Commerce Committee, the Chevron Marine Transport Company, and in private practice.

Marine Affairs

To further accommodate growing problems of ocean matters, the University has developed a broad program in marine affairs, and its curriculum emphasizes the impact and effect which man's activities have on the marine environment and marine resources. Instruction in this program concentrates on coastal management, international management of ocean space, and incentives in institutional arrangements for public/private collaboration in the advancement of marine technology. Seminars in the field of marine affairs have drawn students from a wide range of disciplines. Students in oceanography, engineering, law, public affairs, geosciences, and political science have found from these seminars that they were able to communicate effectively with one another to further their knowledge and interest in the affairs of the marine world.

TECHNICIAN TRAINING

Beside sponsoring new courses at the University of Washington, the local program has also fostered new courses and curricula improvements at various community colleges and vocational-technical schools in the state. These educational programs were developed in response to anticipated needs for marine technicians and were designed to bring students into contact with

actual day-to-day problem situations in order to give them opportunities to apply learned skills to solving real problems. The emphasis has been to increase the quality of these programs with Sea Grant help in providing specialized equipment and support in generating good class materials, rather than enlarging or proliferating technical programs.

Seattle Central Community College has received support from Washington Sea Grant for equipment needed to train personnel for maintenance and repair of hydraulic, diesel, and refrigeration systems aboard vessels. The commercial fishing industry, the towboat industry, and the ferry systems in both Washington and Alaska already are employing graduates of SCCC's program, and the school reports that all students seriously interested in pursuing sea-going careers have found either part-time or full-time employment on the waterfront.

In addition, those already engaged in marine operations may take advantage of the program to update their professional skills and capabilities through short courses, workshops, and other offerings.

Grays Harbor College, Aberdeen, offers a 2-year program for fish and game technicians, and Sea Grant has helped augment this program by sponsoring courses which emphasize practical methods for solving problems encountered by both the commercial and sports-fishing industries in Washington. Results of several course studies have been compiled into locally useful reports and maps. To help assess their commercial potential as bait for the Dungeness crab fishery, one such study delineated the location and density of Eastern Bay clam beds; another described destructive ghost shrimp populations in Grays Harbor. The college has also developed and published a fish and game technician's curriculum manual to assist students in planning course work and to describe their academic background to potential employers. A considerable number of students in this program transfer to 4-year schools to continue their education in the fisheries field.

Shoreline Community College, Seattle, conducts a continuing program to help fulfill the need for oceanographic and marine biology technicians. Emphasis is "on-the-job" experience with such institutions and agencies as the University of Washington, Seattle METRO, National Ocean Survey, National Oceanographic Instrumentation Center, and the Environmental Protection Agency, and according to these and other employers, students from this program have proved to be competent lab and field technicians. Equipment and supplies provided to the program by Sea Grant have helped strengthen attendant instruction in electronics, chemistry, lab and field instrumentation and techniques, data collection and processing.

Program results include preparation of two technician manuals for publication and potential use by similar training programs throughout the nation. Moreover, the college's placement center reports that graduates of the marine technology program have experienced little difficulty in finding related employment.

Peninsula College, Port Angeles, provides instruction to students interested in becoming technicians in fish hatcheries or in industries or agencies concerned with water quality, and through Sea Grant the college has had the means to purchase laboratory equipment needed for fisheries biology and water chemistry courses.

In the course of their studies, Peninsula students have engaged in a number of projects which have drawn widespread interest both locally and statewide. One of these projects resulted in a series of color photographs recording the embryological development of coho salmon. Representative photos from the series appeared in the summer 1972 issue of Pacific Search, a magazine recording natural history of the Pacific Northwest, and both NMFS and FAO have expressed interest in securing a similar series on chinook salmon. Although Peninsula College will not participate in WSG beyond 1972, accomplishments of this program will be remembered by residents of Washington's Olympic Peninsula.

Highline Community College, south of Seattle in Midway, has two main objectives for its underseas technician program: to inculcate students with skills needed to become competent commercial divers with engineering skills and to extend instruction in diving techniques and safety procedures to Northwest educational institutions, government agencies, and private businesses. Toward this end, Sea Grant has provided Highline with a decompression chamber and assorted diving gear and was instrumental in helping Highline secure a diving bell from the Department of Commerce. Possession of this equipment has enabled Highline to function as a specialized training center for instructing special groups such as law enforcement and fire-fighting personnel.

Because of locally depressed conditions, employment opportunities for commercial divers in the Puget Sound region are virtually nonexistent. Nonetheless, nearly all of last year's graduates from this program who actively sought related employment found jobs with oil companies and major marine construction firms along the Gulf Coast.

During 1972, Highline diving instructors offered a series of lectures on the operations and purposes of the decompression chamber to 144 representatives of area agencies and institutions. Of those participating in the series, 31 were qualified in basic scuba, 30 later enrolled in an intensive course entitled "Introduction to Commercial Diving Functions and Equipment," and 33 subsequently were actively involved in a seminar offered in cooperation with the professional association of diving instructors.

Clover Park Education Center, located in Lakewood Center near Tacoma, offers short courses and vocational training for the people who man the nearly 10,000 commercial fishing vessels licensed in Washington. With Sea Grant support, the Center provides basic training in such areas as gear handling techniques, navigation, and net mending through its regular curriculum and in special short courses. This effort is to encourage new entries into the fishery work force and to update commercial fishermen in the use of new techniques and gear.

In 1972, 15 students received Associate of Applied Science degrees from Clover Park's marine program and five more completed technical requirements for that degree. Of these 20 men, all those interested in commercial fishing careers were hired aboard Washington and Alaska vessels. In the first-year courses of Clover Park's marine program, more than 25 students were enrolled during 1972.

RESEARCH AND DEVELOPMENT

NORFISH

NORFISH is the acronym for a major Washington Sea Grant research program oriented toward a total system quantitative approach to the management of oceanic and coastal zone resources in the North Pacific--with a primary emphasis upon its fishery resources. The immediate program objective is development of a set of quantitative tools (e.g., simulation models, data storage, and information display techniques) that eventually will provide policy makers in both government and private industry with effective techniques for management of coastal zone fishery resources. To achieve its goals and objectives, NORFISH administrators have assembled an interdisciplinary team of biological and quantitative scientists, economists, engineers, and legal scholars; and although this team was dealt considerable blows during 1972 by the death of one and the departure of two of its original project leaders, ongoing support is being provided by remaining investigators.

Major development activities for NORFISH information systems and graphic output capabilities came to a close in 1972, and a system called MARS VI

became the standard for storing and retrieving the large data sets of NORFISH. Moreover, NORPLOT and related systems became the standard graphic output system for MARS VI and other information search and retrieval systems. To complement these software products, NORFISH acquired a graphic remote terminal facility which is the first of its kind to be utilized on line to the University computer.

Simulation activities for the year included development of a multispecies, multigear, population dynamics and harvesting simulator which appears to have immediate applicability for investigating various management strategies in the groundfish trawl fishery. The design and implementation of an economic sector for the multispecies model were also completed and will permit evaluation of economic as well as physical yield of the fishery.

Additional work in the economics of fisheries included an analysis of variability in fishing power for the trawl fishery with respect to weather conditions and boat skippers and an investigation of the economics of the crew share system that is yielding new insights into probable effects of alternative distribution systems in fisheries.

In cooperation with the Pacific Marine Fisheries Commission, NORFISH has completed a project to automate and standardize reporting of catch information for the trawl fishery of the several coastal states. Future efforts of NORFISH and the PMFC will involve evaluation of the effects of foreign vessels on the American trawl fishery, and results of earlier simulation projects will be utilized in this analysis.

NORFISH also maintains a liaison with the Northwest Fisheries Center of NMFS, and project analyses of landbased fisheries of the Japanese were utilized by the Center in presentations to the International North Pacific Fisheries Commission during the fall of 1972. Another international project is an analysis of the Japanese catch of pollock, a high-yield trawl species in the Bering Sea. This analysis will continue into 1973 as will a study of underutilized and nonutilized marine species that will aid in evaluating future productivity of the oceans.

Considerable progress was made in 1972 on two salmon management simulation models, HATCH and GAMES, both developed as joint projects between the University and the Washington State Department of Fisheries. HATCH is being developed to help optimize the value of salmon from hatchery production. All the variables that the hatchery manager can control such as water temperature, feeding schedules, release dates and sizes, species composition, and pond flow are included in the model. Simulating various combinations of these will show how salmon hatcheries should be operated to maximize their benefit/cost ratios.

GAMES is a model of the existing salmon runs that contribute to major salmon fisheries in Washington and adjacent areas of Oregon and British Columbia, and the many sport and commercial fisheries that operate jointly and competitively on these. The purpose of GAMES is to ultimately determine the optimum harvest strategy in terms of the proper balance of seasons, size limits, catch quotas, fishing vessel quotas and harvest rates for the many fisheries, and thus promote a management scheme that would maximize total benefits from the runs.

In a localized study, modeling and simulation expertise within NORFISH was used to construct a model to predict trends of land use on Orcas Island in the San Juans. This model was intended as a pilot for Sea Grant activities in the management of nearshore environmental resources, but will also serve as a prototype for NOAA's Marine Ecosystem Analysis (MESA) program which has been provisionally programmed for a Puget Sound study.

Finally, in 1972, a series of papers dealing with international institutional arrangements for fisheries management were completed. Discussions in this series, scheduled for publication as a book, yield valuable insight into the possible results of the forthcoming Law of the Sea Conference and during the past winter served as the basis for a seminar in international arrangements held at NMFS's Northwest Fisheries Center.

NORFISH anticipates future useful research into fisheries and fisheries related problems during 1973, and plans for a macroscale simulation of all major fisheries of the northeastern Pacific (NEPAC) are underway. NEPAC will include both economic and population dynamics sectors and will be used to analyze the interfishery effect of possible entry limitations as well as the effect of foreign fishing on the North American industry.

ANIMAL AQUACULTURE

Finfish Aquaculture

Fish farming is a relatively recent commercial enterprise in the United States when compared to its agricultural counterparts. However, this form of aquaculture has received increasing interest in recent years, since it may hold promise for assisting in reversing depletion of natural fish stocks and for providing an additional source of animal protein. At the University of Washington, scientists have conducted studies on the selective breeding and nutrition of salmon and trout for more than 40 years, and more recently the University's researchers have experimented with various pen-rearing techniques in marine waters to find more efficient means of producing market-size salmon and trout.

In the breeding program, a select stock of rainbow trout has been developed which reaches sexual maturity within 2 years and displays improved temperature tolerance, fecundity, color, disease resistance, and other desired characteristics. In the 1972 spawning, these trout produced an average of 11,000 eggs of about 4.8 mm in diameter. In contrast, a wild trout may produce less than a thousand eggs. Eggs taken in excess of research needs are made available to the Washington Department of Fisheries and other hatchery programs. Surplus rainbow fingerlings, yearlings, and brood fish are released into Lake Washington and other lakes as a continuing program for sport fishing enhancement. By crossing the select rainbow trout with steelhead stock, scientists have produced a hybrid which is especially useful for marine aquaculture. These fish grow rapidly and are available for transfer to salt water within 6 months.

In the past, chinook salmon runs returning to the University's pond have been used mainly for chronic irradiation studies; however, these are being

phased out in favor of genetic studies. Select fingerlings resulting from genetic programs are being marked before being released to the sea so that upon their return, project scientists can assess effects of the interyear crosses.

Each spring, starting with the 1967 brood year, young coho reared in warm water and fed diets which produce rapid growth have been released as 6-month smolts instead of the usual full year residence in freshwater. Most of the adults from those released return as 2-year-olds after spending the usual 18 months in the sea. A few, however, come back in the first year as jacks, and some return as 3-year adults. The number of adult survivals in this program has shown a marked increase each year, and by the end of 1972, nearly 1,000 marked fish of the 1970 brood year had returned as 2-year-old adults. This return of adults represents a survival of 1.46 percent of the smolts released in the spring of 1971. A return of adults greater than 0.5% is highly satisfactory. Breeding hearty and fast-growing stocks is but one facet of this program. Good nutrition for fish in culture is also essential. So in the spring of 1972, studies were begun to evaluate effects of two commercial diets and two standard University diets on the growth rate, fecundity, and fertility of rainbow trout. Over the years, results of this study will provide a basis for decisions by managers of the Pacific Northwest's growing number of fish farms.

Another study of interest to area aquaculture enterprises is a 2-year program being conducted by the Fisheries Research Institute at the University on the feasibility of pen-rearing chinook salmon at several marine sites in Puget Sound. General objectives of this study include the following:

- To explore the possibilities of new areas of Puget Sound as future sites for commercial mariculture ventures
- To compare the growth rates of salmon reared in study sites under essentially standardized feeding and rearing methods
- To analyze the effects of certain environmental conditions on growth rates
- To correlate the optimal ranges of these environmental factors with past oceanographic records of Puget Sound in order to identify potentially favorable aquaculture sites
- To study the movements of released pen-reared fish

Study objectives are being achieved by holding fish in identically sized floating pens at four sites, by feeding a standard diet, and by recording daily environmental factors such as temperature, salinity, flow, dissolved oxygen, barometric pressure, vertical visibility, and sea conditions. The only major deterrent to the program so far has been disease. Vibrio outbreaks caused significant losses at all four sites in 1972--greater than in the previous year--and control of this disease remains a major objective for success of future fish-farming operations.

Shellfish Aquaculture

In the College of Fisheries, Sea Grant helped initiate research on oyster mortality, a specific problem of the large oyster industry in Washington. Additional ongoing research includes the study of algae as food for oysters and experiments with floating culture of oysters and mussels.

Laboratory investigation of oyster mortality continued in 1972. Researchers found that temperature and nutrient enrichment of the seawater were critical factors in abating or initiating a laboratory die-off of adult Pacific oysters. By manipulating these two factors, control of mortality was achieved in the laboratory. But control of temperature and nutrients is not feasible in a natural environment, so additional studies are underway to isolate and identify a suspected pathogenic bacterium and also, hopefully, to develop a disease resistant strain of oysters.

Presently, algal cultures provide the only practical method for mass feeding of oysters, but this method is limited in that little is known about the nutritional requirements of oysters. Therefore, research has been directed toward developing an efficient means for culturing algal feeds and studying effects of various algal feeds upon growth and survival of young oysters.

In other research, shellfish scientists are studying alternatives to bottom culture by growing oysters and mussels on strings of shell suspended from rafts. Preliminary observations indicate that heavy fouling may be a problem, but final results await further data collection and final analysis in 1973. Further, preliminary studies to determine the feasibility of developing new Manila clam producing areas have been initiated, and seed clams have been planted for observations.

POPULATION ASSESSMENT

Although estimates vary, it is generally agreed that the value of both commercial and sports fisheries to the Pacific Northwest economy is substantial. Therefore, Washington Sea Grant is supporting a variety of projects in the University's College of Fisheries aimed at the assessment of regional fish populations so that these resources can be efficiently and accurately described and the information used by fishery related industries and management agencies.

In 1972, research emphasis was placed upon improvement of field sampling and surveying techniques in cooperation with the Washington Sea Grant marine acoustics program (see related report on page 26) and upon provision of biological data to the National Marine Fisheries Service, the Washington Department of Fisheries, the International Biological Program, and other resource management agencies. Field testing was concerned mainly with attempts to verify and to help reduce variance of acoustical survey data, and shipboard units were used to study herring stocks in Alaska and Puget Sound, hake in Puget Sound, and sockeye salmon in lakes of Washington and Alaska.

By correlating data acquired through acoustic transects of sampling areas to net haul data acquired simultaneously in the same areas, project scientists were able to demonstrate that spatial distribution of sockeye populations during lake residence varied seasonally and to describe that distribution within Lake Washington for the first time. Resulting data were also used to update an information bank on Lake Washington's sockeye smolt abundance versus its adult returns so that eventually spawner-recruit models and marine survival rates for the Lake could be formulated. Similar surveys were made of sockeye populations in Lake Iliamna, Alaska; in Lake Quinault; and, for the first time, in Lake Wenatchee.

A technique for estimating the number of adult returns to Lake Washington had been developed in 1971 but was considerably improved in 1972. By studying sockeye distribution patterns revealed through echo soundings, scientists were able to establish a counting threshold, above which only adults were counted and by which a direct estimate of adults could be made at any time. Because of this 1972 achievement, it is probable that the Lake Washington sockeye fishery will be open to greater harvesting by sportsmen in 1973.

Since 1969, the spawning population of hake in Port Susan has been surveyed each year by acoustic means, and similar surveys were conducted again during 1972. Additionally, acoustic surveys of the commercially important herring populations in Puget Sound were initiated. Because results of this new effort were promising, continuation and expansion of herring monitoring surveys are planned for 1973. Acoustic surveys off southeastern Alaska in cooperation with the State of Alaska Department of Fish and Game located large herring stocks in Carroll Inlet, Deer Island-Sunny Bay, Katlian Bay, and Auke Bay, where the largest stock was found.

In addition to the acoustic surveys of major regional stocks, the College of Fisheries also conducted nearshore net sampling of Puget Sound fishes in areas where such work previously had been either incomplete or nonexistent. Particular attention was given to sites where information was especially needed, such as in waters adjacent to environmentally controversial Nisqually Flats, Gig Harbor, and Cherry Point. Data derived from each sampling station included identity of all captured species, length measurements by depth of capture, life history notes such as the occurrence of ripe or spawning fish, and incidence of tumor-bearing flatfish.

Various agencies and citizen groups continuously ask for this type information, and as it becomes available, it is provided to interested parties. However, to facilitate information transfer, project investigators in 1972 summarized all reported occurrences of the 211 fish species found in 12 designated sub-areas of Puget Sound, compiled an extensive (183 papers) bibliography citing these occurrences, and published a Washington Sea Grant report entitled, Checklist of Puget Sound Fishes. The report has been widely distributed to regional agencies and citizens, and users have been requested to help expand the present checklist by submitting additional verifiable records of the capture of any species of fish within Puget Sound.

A second information storage and retrieval system related to Northwest fisheries was significantly upgraded during 1972, when the Bristol Bay sockeye salmon data file was organized and placed on computer-compatible magnetic tape. This file, a joint undertaking of the Alaska Department of Fish and Game and the University's Fisheries Research Institute, contains data pertaining to the commercial fishery on and management of the Bristol Bay sockeye salmon run since 1955. The Fisheries Research Institute is the current repository for the tape and the prototype of the data bank, a file presently containing about 18,000 cards.

APPLICATIONS OF NEW MARINE MATERIALS

In late 1972, a pilot plant operation for the total utilization of fish and shellfish wastes was opened by the Oceanographic Institute of Washington in cooperation with a Seattle firm, Food, Chemical & Research Laboratories. Located in Tukwila, south of Seattle, initial costs of this experimental plant were partially underwritten by the Washington Sea Grant Program.

In the plant, protein from fish wastes is extracted for use in animal feeds and eventually, perhaps, for prepared human foods. Formerly wasted shellfish exoskeletons are reduced chemically to chitin and chitosan--polymers of potential value to a number of industries.

It is hoped that experience gained from this pilot operation will provide the business community an impetus for developing economical products from fish and shellfish wastes as well as viable markets for these products. In addition to economic benefits, the project may also help abate the seafood processing industry's current pollution problem caused by casual disposal of processing wastes.

The total utilization concept behind the pilot plant dates back to 1969, when Washington Sea Grant initiated two projects aimed at more complete utilization of marine products. One of these was started in the University's Institute for Food Sciences and was directed toward complete recovery of protein remaining in fish-processing wastes. Two methods for extracting this protein have been developed: one, using a brine solution and the other, enzyme hydrolysis.

The second project was a cooperative endeavor between the University's College of Forest Resources and the Department of Chemistry at the University of Puget Sound. This work centered around investigations of marine polymers including chitosan, a deacetylated derivative from the chitinous material of shellfish exoskeletons.

The latter studies showed that chitosan contained binding properties of potential value to the paper industry because it reduces hydrodynamic drag and thus improves wet strength during processing. Full-scale testing depended upon the availability of sufficient quantities of deproteinated shellfish wastes from which chitosan could be derived. Therefore, it was soon recognized that a conjunction of the two projects would provide cleaned shellfish for preparing chitosan as well as an effective means for further using shellfish wastes.

Concurrently, the marine advisory program's seafood specialist learned that Food, Chemical & Research Laboratories was seeking assistance in establishing a semi-works scale pilot plant for producing chitin and chitosan from shellfish wastes. Seattle Rendering Works had provided the firm with a building and daily deliveries of shellfish wastes; however, the specialist reported that additional facilities for cleaning and deproteinating the incoming shell were required.

As a result, a mutually advantageous arrangement for combined pilot testing of the protein and polymer extraction operations was set up at the rendering works in 1972. These combined operations allow student involvement in actual

operation of a pilot plant, and they permit interruptible operation since the rendering plant is capable of taking any and all aborted batches of material--thereby removing the pressure often found in a processing plant working with experimental equipment or processes. Moreover, as operations get into full swing in 1973, the plant will supply chitosan through the National Sea Grant Office to scientists nationwide for further research and market development.

Animals from the sea are not the only marine life with industrial potential. Marine plants, especially seaweeds, are also being considered for their untapped economic value, and in the University's Department of Botany particular emphasis is being given to mass cultivation of carrageen-producing red algae. Carrageen is an emulsifier commonly used in such products as ice cream, toothpaste, and cosmetics; and Pillsbury Foods and Marine Colloids, Inc. are but two firms currently using results from this research.

During 1972 field studies, seaweed scientists successfully transplanted more than 1,000 plants to habitats in which they had not grown previously and thereby established, on an experimental scale, a seaweed "farm". Additionally, they determined the optimum depth for most rapid growth of two species of red algae. In the laboratory, an incubator for determining optimum lights and temperatures for growing these same species was developed and tested. Finally, conditions under which a third species yields high levels of valuable marine polymers were observed.

Although marine industries such as food processors and marine manufacturers are prime users of new products from the sea, there is another group of users whose reliance upon these products is also significant--medical researchers. Throughout the world, scientific teams are examining a wide variety of marine plants and animals for their potential as preventives or cures for disease. One such team is conducting its research at the University of Washington where studies are currently concentrated upon a unique protein, aequorin, obtained from a Puget Sound jellyfish, Aequorea aequorea.

Aequorin is unique because in the presence of ionic calcium it emits a glow--similar to that of the jellyfish from which it is extracted. Because of this curious property, the aequorin protein can be used to measure minuscule changes in calcium concentrations in a person's body fluids or cells. Such changes frequently are early signals of cellular destruction in the body and point to the onset of diseases such as metastatic carcinoma, bone dysplasia, cardiac dysrhythmias, parathyroid disorder, and others.

The value of such a clinical indicator has created a large demand for aequorin for use by a host of researchers across the country, so during 1972 Washington Sea Grant supported work necessary to develop a procedure whereby the extracted jellyfish protein could be efficiently purified and produced on a large scale. Having established a high-yield purification procedure, the scientists are now concentrating upon using aequorin to determine the role of the calcium ion in regulation of cell function.

MANAGING THE NEARSHORE ENVIRONMENT

What are the best uses of a state's shorelines and nearshore waters? More and more frequently that is a question being asked by citizens of coastal states--and the answers can be complex because pressures for use of a limited space are intense. Conservationists are pushing for preservation of these coastal areas as refuges for native fish and wildlife. Recreationalists want beaches set aside for swimming, boating, and other water sports. And businessmen put forth impressive arguments for the need for waterfront locations for industrial parks with outlets to shipping lanes.

With respect to coastal zone management, Sea Grant does not try to resolve issues, but it does try to provide sound data on the resource to policy makers who must provide the answers. In Washington, Sea Grant has supported three efforts directed toward development of information that can be used by those responsible for coastal management decisions.

Socio-economic, Institutional, and Legal Considerations in the Management of Puget Sound

By the end of 1972, a team of researchers from the University's Departments of Economics, Oceanography, Political Science, and Graduate School of Public Affairs had completed documentation of a series of case studies surrounding public controversies over potential uses of Puget Sound shorelines. These studies included analyses of disputes between proponents of an aluminum plant on Guemes Island and recreation groups, between an oil corporation planning to build a refinery at Port Susan and recreation/fishing interests, and between a railroad proposing an industrial park for the Nisqually Flats near Olympia and wildlife conservationists.

In documenting each of these controversies, the team recorded the information used by all parties in each dispute and, if settled, the basis on which each issue was resolved. The individual studies are now being compiled into a reference work dealing with the overall demands placed on Puget Sound's shoreline resources and the processes through which uses of these resources are determined. Beyond this, the team is examining possible consequences of alternative legal and administrative frameworks which have been proposed for future management of the area's resources.

The final version of the study, to be published in 1974, will be designed for immediate use by Puget Sound's public policy makers at federal, state, and local levels. As a major study of the management of a large estuarine-inland waterway system, it will be of interest to researchers and policy makers elsewhere in the United States.

Biological Production Model for Puget Sound

Since 1966, the municipality of metropolitan Seattle (METRO) has daily discharged about 45 metric tons of treated sewage-sludge from its West Point plant into Puget Sound. This activity inevitably raised questions about its effects upon the biological production of the Sound.

Responding to these questions, an investigation was initiated to identify the environmental and physiological factors which govern the biological production of this marine environment. Taking historic hydrographic and biological data supplied by the University's oceanographers, Sea Grant

scientists have constructed a mathematical model that describes effects of environmental factors upon phytoplankton growth in Puget Sound.

By employing techniques of similarity analysis, workers developed, with support from the Environmental Protection Agency, a quantitative description of the main features of mid-channel circulation in the central basin of Puget Sound. These results were then used in the calculations of the algal population dynamics in the Sound. Good agreement was achieved with observed time and space distributions of phytoplankton as measured in the field during the springs of 1966 and 1967 and because of this, workers have been able to identify and describe environmental factors which control algal growth in the central basin of the Sound.

Although this study deals primarily with Puget Sound, it is broad enough in scope to be adapted to studies of plankton dynamics in many stratified fjord-like estuarine systems.

Marine Environment of Puget Sound

For more than 40 years, oceanographers at the University of Washington have been collecting data on the marine environment of Puget Sound. Believing this information to be of inestimable value to regional resource planners, Sea Grant has supported organization and publication of these data into readily accessible and useable formats.

Two major publications have resulted: Index to Physical and Chemical Oceanographic Data of Puget Sound and Its Approaches, 1932-1966 and Bibliography of Literature: Puget Sound Marine Environment. Published jointly by Washington Sea Grant and the Washington Department of Natural Resources, the two volumes have been widely circulated to environmental planning and resource management agencies. Because contents of both publications have been computerized, updating for subsequent editions should be relatively simple.

Work on a third volume in the series is now underway, and publication is anticipated in 1974. Entitled Atlas of Physical and Chemical Properties of Puget Sound and Its Approaches, the upcoming publication will display graphically seven water quality characteristics recorded over time at sampling stations along eight longitudinal profiles of Puget Sound. Besides Sea Grant, the Washington Department of Ecology is providing support for preparation and publication of the atlas.

In other investigations, oceanographic data gathered between 1934 and 1971 were used to determine long-term trends in chemical parameters for Puget Sound in order to delineate the impact of treated waste discharges into this estuarine system. Resulting water budget studies established flushing characteristics for the Sound and, significantly, neither an increase in nutrients nor decrease in oxygen was detected. These efforts contributed useful information to the Puget Sound modeling project as well as toward a broader base of information about the Puget Sound system.

SUPPORTING SCIENCE AND ENGINEERING

With the growing recognition of the marine environment as a valuable national resource, it is important to develop more efficient means for exploiting the ocean's potential for public and commercial use. Two Washington Sea Grant projects were directed toward these objectives in 1972. The first was an engineering effort aimed at investigating Puget Sound waters as a natural environment laboratory for engineering test purposes; the second project involved development of acoustic hardware and techniques that would provide more accurate assessments of aquatic populations.

Natural Environment Demonstration Project

Naval architects and marine engineers find that existing model-testing basins cannot duplicate completely the complex dynamics of the ocean, so University engineers have been gathering data on Puget Sound waters that will eventually describe the wave climate of those waters and their scale relationship to the waves of the open sea. Two Seattle naval architect and marine engineering firms actively cooperated on two associated tasks.

As part of the first task, a vessel motion monitoring system consisting of accelerometers, gyroscopes, and signal conditioning equipment was built to measure the motions of vessels in a seaway. Data on the roll, pitch, heave, yaw, surge, and sway of vessels are outputs of the system which can be tape recorded for subsequent computer analysis. Experimental data have been gathered on tug-barge runs in the Sound and await analysis. It is hoped that these data will contribute to development of criteria for determining optimum towline lengths as well as cargo loadings for barges in specific sea states.

Task two of the project involves obtaining a description of the sea surface which contributes to the motion of a marine platform--for example, a barge under tow or a floating breakwater--as sensed by the monitoring system. For this purpose, a wave probe for determining the directional wave spectra from wave height measurements has been designed, and during 1972, this instrumentation was loaned to the University of Hawaii's ocean engineering program for use in stability tests for its floating city model.

Completion of data gathering by these two systems and subsequent analysis is anticipated during 1973; then thrust of Washington Sea Grant's engineering research will be turned toward developing more efficient and effective floating breakwater systems.

Marine Acoustics

In the past, a great deal of marine acoustic research has been conducted by the University's Applied Physics Laboratory under auspices of the U.S. Navy, and the Washington Sea Grant program has taken advantage of this long-standing expertise to develop technology which can be applied toward the acoustic assessment of aquatic populations. Working with scientists at the National Marine Fisheries Service and the Washington Department of Fisheries, researchers in the WSG marine acoustics program have consistently achieved project objectives through theoretical work in statistical estimation, signal processing, and equipment design. Field testing of project developments is conducted in

cooperation with biological assessment programs--one of which was described in the section of this report on population assessment.

Through this program a digital data acquisition and processing system (DDAPS) was developed in 1971 to calculate fish abundance from echo voltages of fish targets. In 1972, a digital tape drive to read programs in rapidly was installed, a CRT terminal was added, and a program for assessment of the size of fish from echo strengths was developed. Additionally, the echo sounder data acquisition system was improved with the installation of a device that automatically calibrates the gain of the echo sounder receiver and tape recorder.

Moreover, a portable hydroacoustic tape recording system was designed and built to record acoustic signals aboard ships and boats for subsequent processing in landbased laboratories. As a result, acoustic surveys of lakes and streams accessible only by small boats are now possible.

A major new thrust in 1972 involved Sea Grant cooperation with researchers from the National Marine Fisheries Service and from the University's Fisheries Research Institute and Applied Physics Laboratory on a project whose principal funding was provided by NASA and NMFS. This effort involved evaluation of sonar buoys along the Aleutians as a means of increasing accuracy of salmon abundance estimates in the ocean, with particular emphasis upon assessing sockeye runs entering Bristol Bay. Launch and retrieval during moderately severe sea conditions presented no problems, and the radio data link and the storing of data on magnetic tapes and on paper tape proved satisfactory. Although some variability and inconsistencies developed in some of the instruments, results of the summer's work appear extremely promising, since the sonar buoys offer advantages not possible with seining. Specifically, the system permits simultaneous counts at a number of locations across the path of fish migration; continuous monitoring throughout the day and night; information on depth of swimming and manner of dispersion; and sampling when sea conditions are too rough for purse seine fishing. For the time, it will still be necessary to sample with purse seine in order to determine species, size, and age composition of salmon being monitored.

Beside the National Marine Fisheries Service and the Washington Department of Fisheries, an increasing number of agencies and groups are benefitting from this research. They include the Alaska Department of Fish and Game, the Quinault Indian Tribe, Seattle City Light, Chelan County Public Utility District, and Argonne National Laboratories, and the International Pacific Salmon Commission. Benefits are derived both from marine resource information gathered in field tests and from expertise provided in development of acoustic equipment and techniques. And preliminary results of a management study of this program indicate that the sharing of one innovative technique alone has resulted in a seven-fold increased investment in regional marine acoustic research.

APPENDIXES

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| 28 | Expenditures by Category of Effort - 1972 |
| 29 | Washington Sea Grant Reports - 1972 |

EXPENDITURES BY CATEGORY OF EFFORT

ACTIVITY SHEET*

Washington Sea Grant Program - 1972

	<u>Sea Grant Funds</u>	<u>University Matching Funds</u>
PROGRAM MANAGEMENT	\$97,229	\$53,058
ADVISORY SERVICES	224,883	89,490
EDUCATION AND TRAINING		
New Courses at the University of Washington	138,193	131,936
Technician Training	45,906	53,595
 **RESEARCH AND DEVELOPMENT		
Pacific Northwest Fisheries Management (NORFISH and partial support for Population Assessment)	195,034	84,262
Aquaculture (Finfish and Shellfish)	244,399	78,510
New Resource Utilization (Applications of New Marine Materials)	185,769	126,647
Management of Puget Sound (Managing the Nearshore Environment)	89,017	31,778
Ocean Engineering (Natural Environment Demonstration Project)	18,547	7,847
Marine Acoustics (Marine Acoustics and partial support for Population Assessment)	113,023	36,016
TOTAL	\$1,352,000	\$693,139

*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.

**Where budget category titles differ from titles used in describing program areas, the latter titles are indicated in parentheses.

2/22/74

WASHINGTON SEA GRANT REPORTS
January 1, 1972 - December 31, 1972

	Primary Series	Available from these sources*	No. of Pages
Book 72	Vagners, Juris, and Paul Mar, eds. Oil on Puget Sound.	UWP, \$10.00	629
WSG 72-1	Gulland, John. March 1972. Population dynamics of world fisheries. \$7.50	UWP, \$7.50	336
WSG 72-2	Gamble, John King, Jr. June 1972. Index to marine treaties. \$7.50.	UWP, \$7.50	438
WSG 72-3	DeLacy, Allan C., Bruce S. Miller, and Steven F. Borton. July 1972. Checklist of Puget Sound fishes.	DMR, NTIS No. COM-73-10072	43
WSG 72-4	Thorne, Richard E., Edmund P. Nunnallee, and James H. Green. December 1972. A portable hydroacoustic data acquisition system for fish stock assessment.	DMR, NTIS No. COM-73-10194	14
Miscellaneous Publications			
WSG-MP 72-1	Borland, Stewart, and Martha Oliver. October 1972. Port expansion in the Puget Sound region, 1970-2000.	DMR, NTIS No. COM-73-10618	80
Advisory Reports			
WSG-AS 72-1	Johnson, Eugene. March 1972. Economic contribution of the commercial fishing industry to Whatcom County.	DMR, NTIS No. COM-72-10901	6
WSG-AS 72-2	Jaeger, Sig. May 1972. Potfishing and artificial baits symposium. Proceedings of a symposium held March 13, 1972 at the College of Fisheries, University of Washington.	DMR, NTIS No. COM-72-10834	32
WSG-AS 72-3	Moore, Ray. May 1972. Indian liaison work.	DMR, NTIS No. COM-72-10690	5

*Key to sources on page 37

Advisory Reports		Available from these sources*	No. of Pages
WSG-AS 72-4	Jaeger, Sig. August 1972. A format for demonstrating the inflatable life raft.	DMR, NTIS No. COM-72-11286	6
WSG-AS 72-5	Peyton, Patricia, and Katherine Mosness. April 1972. Seafood marketing pilot program. Unpublished.	Unpublished	
Technical and Journal Articles			
WSG-TA 72-1	Duxbury, Alyn C. February 1972. Effects of aquaculture on other uses of Puget Sound. Talk delivered at First Annual Conference Marine Technology Society, Pacific Rim, held in Seattle, February 25-26, 1972. Unpublished.	Unpublished	5
WSG-TA 72-2	Izutsu, K. T., and S. P. Felton. 1971. Plasma calcium assay, with use of the jellyfish protein, aequorin as a reagent. Clinical Chemistry 18-77-79.	NTIS No. COM-72-10710	2
WSG-TA 72-3	Collias, Eugene. February 1972. The salt water system of Washington State. Prepared for the Washington State Department of Ecology and the Planning and Community Affairs Agency--Educational seminars held in Spokane, Yakima, Everett, and Chehalis in February 1972. Unpublished.	Unpublished	24
WSG-TA 72-4	Abbott, Robert Riley. 1972. Induced aggregation of pond-reared rainbow trout (<i>Salmo gairdneri</i>) through acoustic conditioning. American Fisheries 101(1):35-43.	NTIS No. COM-72-10836	9
WSG-TA 72-5	Ehrenberg, John E. 1972. A method for extracting the fish target strength distribution from acoustic echoes. Proceedings OCEAN 72 IEEE Conference on Engineering and Ocean Environment:61-64.	Proceedings	4
WSG-TA 72-6	Kasahara, Hiroshi. 1972. Japanese distant-water fisheries: A review. Fishery Bulletin 70(2):227-282. \$1.25.	GPO, \$1.25	56

*Key to sources on page 37

	Technical and Journal Articles	Available from these sources*	No. of Pages
WSG-TA 72-7	Kasahara, Hiroshi, and William Burke. May 1972. International fishery management in the North Pacific: Present and future. Unpublished.	Unpublished	248
WSG-TA 72-8	Harris, Colin, Kenneth K. Chew, and Vincent Price. 1972. Relation of egg number to carapace length of sidestripe shrimp (<i>Pandalopsis dispar</i>) from Dabob Bay, Washington. J. Fisheries Research Board of Canada 29:464-465.	NTIS No. COM-72-11105	2
WSG-TA 72-9	Young, R. A., K. F. Sarkanen, P. G. Johnson, and G. G. Allan. 1972. Marine plant polymers Part III. A kinetic analysis of the alkaline degradation of polysaccharides with specific reference to (1→3)-β-D-Glucans. Carbohydrate Research 21:111-122.	NTIS No. COM-73-10077	12
WSG-TA 72-10	Allan, G. G., J. Lewin, and P. G. Johnson. 1972. Marine polymers. IV Diatom polysaccharides. Botanica Marinae 15:102-108.	NTIS No. COM-73-10054	7
WSG-TA 72-11	Price, Vincent A., and Kenneth K. Chew. 1972. Laboratory rearing of spot shrimp larvae (<i>Pandalus platyceros</i>) and descriptions of stages. J. Fisheries Research Board of Canada 29(4):413-422.	NTIS No. COM-72-11104	10
WSG-TA 72-12	Winter, Donald F. August 1972. A similarity solution for circulation in stratified fjords. Presented at the International Symposium on Stratified Flows in Novosibirsk, U.S.S.R. in August 1972.	NTIS No. COM-73-10022	9
WSG-TA 72-13	Winter, Donald F., and Karl Banse. March 1972. A strategy for modeling primary production in stratified fjords. Presented at the Second Technical Conference on Estuaries of the Pacific Northwest, Corvallis, Oregon, March 16-17, 1972.	Proceedings	28

*Key to sources on page 37

	Technical and Journal Articles	Available from these sources*	No. of Pages
WSG-TA 72-14	Duxbury, Alyn C., and Mark Friebertshauser. May 1972. Orthophosphate and dissolved oxygen in Puget Sound. Presented at the Puget Sound Water Quality Symposium sponsored by the University of Washington and Metro, Seattle, May 18-19, 1972.	Unpublished	7
WSG-TA 72-15	Oceanographic study of water quality in Port Gardner. Unpublished data report covering three cruises in Everett Harbor to measure S%, T°C, O ₂ , pH, and PBI in the area, by University of Washington Oceanography 460 class under direction of Alyn C. Duxbury.	Unpublished	46
WSG-TA 72-16	Lipovsky, Vance P., and Kenneth K. Chew. 1972. Mortality of Pacific oysters (<i>Crassostrea gigas</i>): The influence of temperature and enriched seawater on oyster survival. Proceedings of the National Shellfisheries Association 62:72-82.	NTIS No. COM-72-11430	10
WSG-TA 72-17	Nosho, Terry Y., and Kenneth K. Chew. 1972. The setting and growth of the Manila clam, <i>Venerupis japonica</i> (Deshayes), in Hood Canal, Washington. Proceedings of the National Shellfisheries Association 62:50-58.	NTIS No. COM-72-11429	9
WSG-TA 72-18	Khanna, Karun, and A. D. C. Holden. August 1972. A large scale information retrieval system. University of Washington Department of Electrical Engineering Technical Report 156.	EE/UW	95
WSG-TA 72-19	Waaland, J. Robert, and Clifford I. Kamp. 1972. Observations on the life history of <i>Membranoptera multiramosa</i> Gardner (<i>Rhodophyceae ceramiales</i>) in culture. Phycologia 11(1):15-18.	NTIS Number requested	4
WSG-TA 72-20	Waaland, J. R. 1972. Field and laboratory studies on the growth of <i>Iridaea</i> and <i>Gigartina</i> . J. Phycology 8(supplement): 9-10. (Abstract).	DMR	1
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WSG-TA 72-23	Crutchfield, James A. 1972. Economics and politics of estuarine management: The Puget Sound case. Paper presented to Annual Meeting of Marine Technology Society, Washington, D.C., September, 1972.	Proceedings	17
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WSG-TA 72-25	Pigott, George M. 1972. Total utilization concept in fish processing. Paper presented at Annual Meeting of the Association of Sea Grant Institutions, Houston, Texas, October 10-12, 1972.	Proceedings	11
WSG-TA 72-26	Norris, Richard E., and Dong Ho Kim. 1972. Development of thalli in some Gigartinaeae. Japanese Society of Phycology July (1972):265-280.	NTIS No. COM-73-10537	16
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WSG-TA 72-29	Flajser, Steven, and Edward Wenk. October 1972. The impact of Alaskan oil transport on Puget Sound. The Trend in Engineering 24(4):10-23.	DMR, NTIS Number requested	13
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WSG-CC 72-2	Grinols, Richard B., and Philip L. Churchley. April 1972. Environmental chemistry and distribution of fauna in Port Angeles and Dungeness embayments (1971). Unpublished progress report.	Unpublished	29

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WSG-TH 72-2	Sergev, Stephen Sergius. July 1972. Rigid body acceleration of an ocean-going towed barge. M.S. Thesis, Univ. Wash.	UWL	103
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WSG-TH 72-4	True, Earl Halberg. December 1972. The potential for producing feed for salmonid culture in the Puget Sound area. M.B.A. Thesis, Univ. Wash.	UWL	102

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KEY TO SOURCES FOR OBTAINING WASHINGTON SEA GRANT REPORTS

January 1, 1972 - December 31, 1972

AA/UW	Department of Aeronautics and Astronautics University of Washington Seattle, Washington 98195	NTIS	U.S. Department of Commerce National Technical Information Service Springfield, Virginia 22151
ADFG	Alaska Department of Fish and Game Support Building Juneau, Alaska 99801	PCC	Peninsula Community College Port Angeles, Washington 98362
CPEC	Clover Park Education Center 4500 Steilacoom Blvd. S.W. Lakewood Center, Washington 98499	SCC	Shoreline Community College 16101 Greenwood Avenue North Seattle, Washington 98133
DMR	Division of Marine Resources University of Washington 3716 Brooklyn Avenue N.E. Seattle, Washington 98195	UWL	Suzzallo Library Interlibrary Loan Office University of Washington Seattle, Washington 98195
DNR	Department of Natural Resources Public Lands Building Olympia, Washington 98504	UWP	University of Washington Press 1416 N.E. 41st JI-50 Seattle, Washington 98195
EE/UW	Department of Electrical Engineering University of Washington Seattle, Washington 98195	Journal Submission	Manuscript submitted to journal listed. Publication pending.
GHC	Grays Harbor College Aberdeen, Washington 98520	Proceedings	Proceedings published by society listed, but reprints were not made available.
GPO	Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20402	Unpublished	Raw data and other materials resulting from significant program effort.
IER/UW	Institute for Economic Research University of Washington Seattle, Washington 98195		
EES/OSU	Engineering Experiment Station Oregon State University Corvallis, Oregon 97331		

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