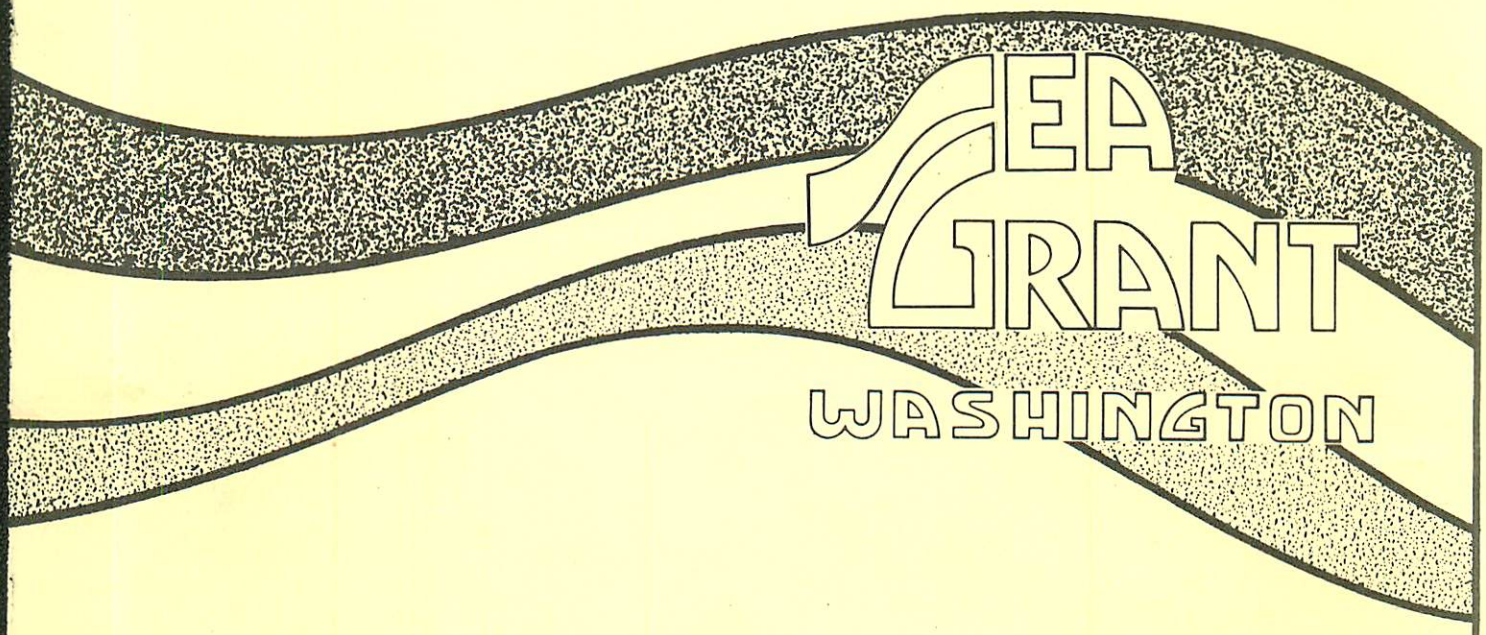

A REPORT ON THE WASHINGTON SEA GRANT PROGRAM

January 1, 1975 - December 31, 1975

Division of Marine Resources, University of Washington, Seattle 98195

WASHINGTON SEA GRANT PROGRAM

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THE UNIVERSITY AND THE MARINE COMMUNITY

With its passage of the National Sea Grant College and Program Act of 1966, Congress initiated a united effort to develop the nation's marine resources by establishing a unique partnership involving educational institutions, federal and state governments, and industry. Provisions of the Act called for the creation of Sea Grant colleges, and in September 1971, the University of Washington was designated one of the first four Sea Grant Colleges in the nation.

In Washington, a state-wide Sea Grant program administered by the University serves the marine community through programs in research and development, education and training, and advisory services. As a recipient of Sea Grant support, the Washington Sea Grant Program must match federal funds it receives from the National Oceanic and Atmospheric Administration on a one for two basis. This calls for coordination with other programs on state, academic, and industrial levels, and requires the active involvement of many people in the planning and operational processes.

The resulting combination of effort is one of the unique aspects of Sea Grant and is an approach to marine resource development which is making a significant impact upon the needs of the marine community. In the chapters which follow, those needs which were addressed by Washington Sea Grant in 1975 are outlined and results reported.

CONTENTS

PROVIDING INFORMATION AND SERVICES

. . .to the Marine Community

To Coastal Communities

Pressures on the sensitive coastal zone have been increasing since the earliest days of seafaring trade. Today, Washington Sea Grant's coastal resources program provides a vital advisory and information link to people attempting wise management of our shorelines.

In October 1975, Robert Goodwin joined the Sea Grant marine advisory program as its coastal management specialist. One of his first priorities was to establish a coastal resources technical reference collection. The core of this collection has been catalogued under a unique system tailored to the needs of coastal zone management. A User's Guide to Coastal Resource Literature in the University of Washington library system is almost complete and, along with the reference collection, will improve access to the burgeoning literature in this field.

Coastal zone management legislation in Washington State, as with many environmental issues, is constantly under fire (the Shorelines Management Act of 1971, in particular). One complaint by developers about the Shorelines Act has been the time it takes to gain permit approval, or denial, for substantial shorelines development. Goodwin helped the Shorelines Subcommittee of the House Ecology Committee quickly gather information on this problem by surveying six representative local governments regarding permit processing and the time taken to issue or deny permits. He relayed his findings to the subcommittee in December 1975, in time to be used in the January legislative session. Up until this time, there had been no data available on length of time necessary to process shoreline development permits.

On several occasions in 1975, local planners asked the coastal resources program for comment on the adequacy and accuracy of environmental impact statements. The consequences of marina construction, dredge spoil disposal, and clam dredging on water quality and marine biota, for example, require technical expertise rarely available in local planning agencies. For such developments, the coastal resources program provides a neutral forum within which permit applicants, local planners, and academic experts in marine fields can meet to weigh the consequences, and perhaps suggest alternatives.

Timely transfer of information by the coastal resources program helped Puget

Sound commercial fishermen retain the right to berth at Seattle's Shilshole marina. The controversy resulted from a draft of Seattle's shoreline master plan that would have prohibited use of the marina by commercial fishing vessels. As a result of this draft, the Puget Sound Gillnetters Association sought help from the coastal resources program. Program personnel found that such a prohibition would violate the "open to all on an equal basis" provision of the U.S. Army Corps of Engineers, which had partially funded the marina. The end result was that the final version of the Seattle shoreline plan does not keep fishermen out of Shilshole.

To Fish Farmers

Terry Nosho, aquaculture field specialist, continued a diversified program in 1975 that has been of great value to Northwest fish and shellfish farmers. In past years he has been instrumental in transferring information to those who need it on topics ranging from stocking rates and diets to disease reduction and prevention. It has been a two-way street; Nosho's close liaison with the fish farmers provides a direct means for getting their problems back to researchers for resolution.

In 1975, Nosho focused on providing ocean ranching information to commercial fishermen, sportsmen, and potential investors. The ocean-ranching concept involves releasing juvenile salmon and then waiting until the salmon's natural homing instinct brings it back full grown and ready for harvest. Nosho's presentations on this controversial issue have helped clear the air of misunderstanding by providing hard technical and scientific information to all people concerned. Throughout the year he discussed ocean ranching in numerous speaking engagements and informal meetings with groups varying in size from two to 85 people.

Another program involved participating in the planning and field work necessary to assess soft-shell clam stocks in Port Susan and Skagit Bay. The work is crucial to wise management of the stocks and represents a continuing joint effort by Sea Grant, the Washington Department of Fisheries and Department of Game, clam harvesters, and county planners.

In still another area, Nosho continued his participation in studies that are evaluating various aspects of the Pacific Northwest oyster industry. Much of this work has been in cooperation with researchers at Oregon State University.

Nosho rounded out the year by completing two useful publications for those who want to farm the sea: Salmonid Diseases: A Workshop Summary and Oyster Growing Techniques for Puget Sound Beach Owners.

To Home Canners and Seafood Processors

At the research end of things is Dr. John Liston, Director of the Institute for Food Science and Technology within the College of Fisheries at the University of Washington. At the liaison-communication-coordination and advisory end is John Peters, Sea Grant seafood specialist. Between the two of them, Peters and Liston provide valuable services to commercial and domestic seafood processors in many ways.

One of these ways lies in the area of home canning. There has been a dramatic increase in home canning in recent years. This is a particularly economical way to preserve food, but is also potentially quite hazardous. The hazard is generally greatest with low-acid foods—such as seafood—because these foods can provide excellent growth conditions for *Clostridium* botulinum, the organism responsible for botulism.

With this in mind, researchers working with Dr. Liston began reviews, tests, and detailed studies of home seafood canning processes. The critical objective is to help the public protect itself. Their work is continuing in 1976, and as Dr. Liston's researchers develop the facts, John Peters coordinates the flow of this crucial information to the public.

Efforts continue at providing professional and technical expertise to the smaller seafood processors who cannot afford a staff of researchers and process developers. To this end, John Peters spends considerable time contacting and visiting Washington seafood plants. An added benefit to these contacts lies in getting information back from the processors on their problems and needs. This feedback helps ensure the relevance of present and future research.

Work concluded in 1975 on a preliminary collection of methods for analyzing and testing fishery products. The plan now is to develop a list of selected methods, tested for suitability with west coast fish species. The previous major reference book in this area is obsolete and has been out of print for many years.

Other work concerned U.S. Environmental Protection Agency regulations governing seafood processing plant effluents. John Peters' first step has been to become familiar with equipment capabilities and manufacturers, and with previous research done by the National Marine Fisheries Service. His findings are being presented to an industry committee formed to study guidelines proposed by the Environmental Protection Agency concerning effluents from seafood processing plants.

To Marine Industries and Agencies

Scientific and technical data do not alone secure a stable position for a marine industry. Among other crucial elements needed is sound economic information and analysis. Sea Grant's marine economics advisory effort is intended to fill this need.

Staff economist, Dr. James Bray, divides his efforts among a number of Sea Grant projects and continues to collect and analyze economic data on Washington's marine industries. Some of Bray's 1975 advisory activities included helping to organize and present a workshop on fisheries cooperatives, analyzing the economic viability of rafted oyster production, and evaluating the economic implications of various means for ex-vessel pricing of king crab.

In addition, Dr. Bray spent a considerable part of 1975 evaluating the National Sea Grant system of determining costs and benefits for the entire Sea Grant program. He developed a proposal for an alternative reporting program that is under consideration for implementation by the national office. If adopted, the plan would provide an improved tool for management and a more effective method of determining Sea Grant's benefits to society.

To Northern Puget Sound

In the fall of 1975, Sea Grant established a new field office for northern Puget Sound marine communities. The office, located on the waterfront in Bellingham, is now under the auspices of the Bellingham Vocational-Technical Institute and the University of Washington to serve five counties: Whatcom, San Juan, Island, Skagit, and northern Snohomish.

Head of the program is Samuel Leathers of BVTI, and Peter Granger came on in September as the marine field agent. Together with educational coordinator Bob Suggs, Granger quickly surveyed the needs of local commercial fishermen and set up an advisory committee of representatives from marine industry.

One of the specific problems Granger identified was a need for cooperation between towboaters and crab fishermen to prevent gear interference. Granger organized a well attended discussion meeting, setting the two groups on the path toward a workable solution. Such liaison is often the necessary key that Sea Grant advisory programs can provide.

Already, BVTI has geared up to present a wide variety of practical short courses in marine fields. Granger plans technical workshops for the winter months, the traditional off-season for area fishermen. Among topics Granger plans to investigate are local stream enhancement projects, a weather service report for the San Juan Islands, and markets for under utilized species such as dogfish.

Not the least among the new program's accomplishments was publication of the first issue of North Soundings, a marine affairs newsletter for commercial fishermen and recreational boaters.

To the Washington Coast

Advisory services were initiated at Grays Harbor College in 1972. Under the guidance of Dr. John Smith, director of the Grays Harbor program, this Sea Grant effort now meets the three basic advisory services aims of transferring information from a source to a user, solving problems, and educating user groups.

Donald Samuelson, marine field agent at Grays Harbor, has steadily sought to broaden the range of marine users who benefit from the coastal advisory program while continuing to offer special short courses modeled to fit commercial fishing needs. In 1975, he also reached out to the charter boat fleet with classes in navigation, boating safety, business management, marine hydraulics and weather forecasting. Several of these classes were the result of cooperation between Sea Grant and other federal agencies, including the National Weather Service, U.S. Coast Guard, Small Business Administration, and the National Marine Fisheries Service.

Samuelson also established a marine information center at Westport during the summer of 1975. The center, called Seaquest '75, served the tourists and sport salmon fishermen who turn the Westport fishing community into a summer resort every year. More than 5,000 people visited the center, enjoying displays, movies, lectures, and field trips that dealt with the local marine world. So successful was this center, that a similar effort was planned for the summer of 1976 by citizens of nearby Ocean Shores.

Information specialist Pansy Bray continued to publish Harbor Tides, a newsletter that keeps coastal fishermen abreast of a number of useful topics including new laws and regulations, catch statistics, new publications, and meetings and workshops. Mrs. Bray worked with 4-H youths on marine science projects and displayed a marine handling aquarium at the Grays Harbor County Fair. She also participated in a number of seafood cookery demonstrations which drew an attendance of more than 1,000 homemakers.

To Southern Puget Sound

The Sea Grant program at Clover Park Education Center in Lakewood (near Tacoma) is directly aimed at providing support to Puget Sound commercial fishermen. In response to needs expressed by the fishermen, William Mohler, head of the Sea Grant program at Clover Park, and Scott Harrington, commercial fisherman field instructor, conducted a series of eight workshops in 1975. Topics ranged from financial management and battery care and maintenance to diesel fuel systems and fire prevention and control. A total of 173 fishermen actively participated in these workshops.

A total of 218 people attended another series of meetings Clover Park Sea Grant organized in Port Angeles, Bellingham, and Seattle. The meetings were requested by the National Marine Fisheries Service to review and obtain local input for the National Fisheries Plan.

Harrington also worked with Gig Harbor fishermen and the Peninsula Kiwanis Boy's Club in preparing to plant 650,000 chum salmon eggs in streams. The idea is to re-establish depleted salmon runs in known chum streams. Over 500,000 fry were released—150,000 directly into streams and 350,000 after they were held in rearing ponds for six weeks.

Since recent Federal Court decisions on fishing rights, the Clover Park program has been actively searching for alternative Puget Sound fisheries. By the end of 1975, two special projects had begun.

A bottomfish pot-fishing project is intended to find out whether this method of bottom fishing can benefit Northwest fishermen. So far, the method has indeed caught fish, but not in great enough numbers to measure validity. Tests go on, along with attempts to overcome problems associated with gear loss, type of bait, and fish concentrations.

For the second project, Washington Sea Grant borrowed a Danish Pair Seine from Oregon Sea Grant. This type of net is designed for bottom fishing. It is used by two boats that can be of low horsepower, and the partner boats can keep the cost-per-boat down by sharing expenses. The Clover Park investigators are working with local fishermen to determine if this net can be used advantageously in Puget Sound. The project was not completed in 1975, but initial test results are encouraging.

To Commercial Fishermen

To help make commercial fishing a safer and therefore more productive pursuit, a Sea Grant advisory project is centered on writing a set of voluntary safety standards for the king crab fishing fleet. Through the application of such standards, the fisherman could reduce the chances of losing his catch, his boat, and even his life.

Chapters on wet tanks, fire fighting and prevention, marine propulsion, and auxiliary equipment are already in draft form or nearly complete. One area given highest priority by an advisory committee from the North Pacific Fishing Vessels Owners Association is vessel stability. The chapter on this topic was in outline form by the end of 1975 and it addresses both static and dynamic stability.

Dr. Bruce Adee, of the Department of Mechanical Engineering at the University of Washington, is developing important new information in the area of dynamic stability. His research on the dynamic stability of short, squat hulls has reached the stage of putting specific vessel data into a computer program. When the program is refined, it will be available to naval architects at minimal cost.

As a result of this program, engineering students, seeking a practical class design project, were encouraged to find some way to reduce the height of stacked crab pots carried on the decks of transisting vessels. Their design of a "nesting" pot was given to the king crab industry association, and that group is actively seeking avenues for converting the design into a marketable product.

DEVELOPING MANPOWER TO MEET NATIONAL NEEDS

. . .through courses at the University of Washington

Law and Marine Affairs

Preserving the marine environment while developing marine resources requires a substantial legal framework. To do this requires lawyers trained in relevant legal topics who also have a knowledge of the marine environment. It is this need for specially trained lawyers that is met by the Law and Marine Affairs course of study at the University of Washington's School of Law.

Five students received LL.M. degrees through the program in June of 1975. Three of them had Sea Grant support. Of these graduates, three are now in private practice in Tallahassee, Honolulu, and Anchorage; one accepted a military commission; and one joined a Tokyo firm specializing in marine affairs. The next fall, 13 students registered in the program for the 1975-76 school year.

Two research projects, with partial support from Sea Grant, were completed in 1975. The first, a book entitled National and International Law Enforcement in the Ocean, has been published by Sea Grant and is being marketed by the University of Washington Press.

Because of the world-wide attention focused on this and related topics, sales have been made to legal scholars all over North and South America and in Europe, Asia, Africa, and Australia.

A second project deals with international legal problems of transportation. The results have already appeared as an occasional paper of the Law of the Sea Institute. More formal publication is planned for Yale Studies in World Public Order, Spring, 1976 and a shorter version will appear in International Organization, Fall, 1976.

Professor Burke also teaches a course on international law of the sea, and with Sea Grant support continuously revises and updates the course material in response to world events. For this purpose, he attended both the 1974 Caracas session of the UN Law of the Sea Conference and the 1975 Geneva Session. He plans a final revision after the conference closes in 1976 or 1977.

The 1973 edition of his course materials has now been authorized for use in a number of other law schools including the University of Miami, College of William and Mary, Gonzaga University, and the University of California at Berkeley.

Professor Ralph Johnson's Sea Grant supported class on the law of the coastal zone had 35 students enrolled in 1975--the first year it was offered. The course, created under Professor Johnson's careful guidance, addresses the legal background of the increasingly important topic of coastal zone management.

The areas of coastal zone management to which Professor Johnson and his four research assistants gave their attention in 1975 are diverse and numerous. Among the many projects were:

1) a second edition of the casebooks used in the class on law of the coastal zone

2) a study of the Trident nuclear submarine base project, concentrating on community related impacts

3) presentations on local strategies for coastal zone management and on pending legislation affecting public lands

4) a paper on aspects of limiting the damage award in a suit for biological harm to living resources

5) a study on federal-state relationships in the marine transport of oil

6) a memorandum on the constitutionality of proposed legislation relating to port development and tanker safety measures.

The classroom is not the only place where coastal zone matters receive Professor Johnson's attention. Since May 1974, he has chaired the Sea Grant Coastal Zone Management planning committee that provides direction and coordination to coastal zone research projects throughout the University.

Economic Studies

Economic issues play an important role in the rational management and development of marine resources. Robert Stoke's course in the Institute for Marine Studies gives students an understanding of both this role and the issues themselves.

Nine graduate students from backgrounds in economics, law, fisheries, and oceanography took the course in 1975. They surveyed the basic principles of natural resource economics first. Then, drawing on their diverse backgrounds, they applied these principles to management problems in fisheries, offshore oil development, and coastal zone use. The result was that the students added another important piece to their expanding picture of resource management.

Ocean Systems Design

There are three primary goals in Dr. Karl Vesper's ocean systems design course in the Mechanical Engineering Department at the University. Dr. Vesper ranks these goals in order of importance:

1) to increase the student's ability to work with people of different backgrounds, accomplishing common design objectives that require simultaneous application of a number of disciplines

2) to create a specific plan for a new ocean system of practical significance and value

3) to impart knowledge of ocean technology.

That first objective is quite a mouthful--and it is an especially important one. Specialists cooperating on a team to develop projects for industry and government are no longer the exception--they are the rule.

Appropriate to this team approach, the 16 graduate students in the 1975 course came from the fields of engineering, business administration, fisheries, physics, oceanography, and architecture. They split into specialized subteams to design an integrated system that would have nuclear energy, seawater, sewage, and food organisms as inputs. . . and electrical energy, food, and clean water as outputs. Moreover they designed each subsystem to utilize the waste of the preceding subsystem.

The students produced a detailed report on the design of a modular system adaptable to many potential sites. The agriculture-aquaculture part of the system would produce algae, brine shrimp, oysters, pink salmon, seaweed, and strawberries. The electrical output of the system would be 117 megawatts. The system would utilize one million gallons of sewage each day and dissipate 179 megawatts of thermal energy. To top it off, the students estimated that, based on an investment of $9-12 million, it would be possible to get profits from the plant of about $2 million per year.

It is easy to imagine the complexities involved in designing a marine system like this one. In our complex technological world, it is also easy to imagine how valuable the students must find this classroom experience.

Marine Technology Affairs

Dr. Edward Wenk, Jr., director of the University's Program in the Social Management of Technology, offers a two-quarter Sea Grant supported seminar for graduate students on marine technology affairs. In this seminar, he guides study and analysis of policy assessments--typically made by marine resource planning and management agencies--that require a basic understanding of related technologies.

The primary aim of the seminar is an educational one, but student analyses and critiques also result in some important public service contributions that can be used by public planning agencies. In 1975, individual students produced in-depth, policy oriented research reports on marine issues of their choice. The students presented their findings on these issues at a public meeting attended by commercial fishermen, potential investors, resource managers, and the press.

These students completed two major reports in 1975, "Petroleum Development on the U.S. Outer Continental Shelf: Policy Options in Leasing and Federal-State Relationships" and "Washington State Shoreline Management: An Interim Assessment". Both SMT program reports were distributed to the many public agencies concerned with these vital issues.

Outside the seminar, Professor Wenk presented an analysis of ocean technology assessments, "Oceans and the Predicament of Humankind", at the International Conference on Technology Assessment held in Monaco in October 1975. He also did a substantial amount of public service consulting for congressional committees dealing with marine affairs, and he reviewed numerous ocean studies at the request of the National Academy of Engineering and the staff of the Office of Technology Assessment.

Marine Policy

Marine policies are established within a context that is broad and often complicated. It is this context, itself, that is the subject of a two-quarter introductory course offered by the Institute for Marine Studies at the University. Professor Donald McKernan, director of the Institute, coordinates this far-reaching course sequence.

Thirty-three graduate students enrolled in the 1975 course. They came from a wide variety of backgrounds including oceanography, fisheries, political science, public administration, economics, and law. This diversity poses a teaching challenge, but suits quite well the interdisciplinary nature and philosophy of the Institute's program in marine studies.

To reach the course objective of understanding the context of marine policy problems, the students concentrated on four basic areas:

1) the range of activities occurring on or in the world's oceans, the allocation of authority at different levels, and the dynamics of trends in a variety of ocean uses and their regulations

2) analysis of conflicts occurring in ocean space

3) identification and analysis of policy problems relating to ocean use

4) design, evaluation, and ranking of alternative policies aimed at solving particular problems.

Students enrolled in the Institute's "Survey of Living Marine Resources" course examine the direct and indirect impact of human activities on the ocean's living resources. This course aims particularly at non-fisheries graduate students, providing these students fundamental fisheries science concepts and their application to decision-making processes.

Interests of the 15 students enrolled for the winter 1976 course ranged from maritime law, fisheries management and planning, coastal zone management, and international relations. The students examined the broad objectives of living resources management--such as conservation, allocation, research, and enforcement--along with descriptions and case studies of institutions designed to facilitate reaching these objectives.

The course puts special emphasis on data requirements for sound management--factors such as growth, recruitment, natural mortality and fish mortality. As still another important part of the course, the students discuss and analyze biological and economic bases for renewable resource management, the conflicts between user groups, and conflicts regarding "theories" of the use of living marine resources.

International Organizations and Ocean Management

In this course taught by Professor Edward Miles, Institute of Marine Studies, students are introduced to the ways in which international organizations attempt to manage and regulate the utilization of the world oceans. The course emphasizes:

1) analyzing processes which support and/or constrain these organizations in the performance of their tasks

2) searching for alternative policies which might increase their effectiveness.

Because the present time is one of rapid change in the law of the sea, substantial attention is also paid to assessing the implications of such changes for organizations dealing with fisheries management, marine science, marine pollution and ocean transportation.

During Winter quarter, 1975, six graduate students registered for the course. Their backgrounds were in fisheries biology and management; geography; ocean trans-

portation and port development; law; and oceanography.

Of the six students, three have completed their courses of study and are currently employed: one is acting director of the Southwest Fisheries Research Center, National Marine Fisheries Service, and now serves on U.S. delegations to certain international organizations involved in fisheries management; one is a member of a Japanese firm of research consultants in marine affairs; and one is an attorney who specializes in marine affairs.

DEVELOPING MANPOWER TO MEET NATIONAL NEEDS

. . .through courses in Washington's community colleges and vocational schools

Grays Harbor College

At Grays Harbor College, the Fish and Game Technician Program has an annual enrollment of around 50 students. Each spring, about 15 graduate from this two-year program coordinated by Dr. John Smith.

The average age of the fish and game tech students is 24—a mature and highly motivated group. Many of these students change their goal from a two-year vocational program to a bachelor's degree program at a university. Of the thirteen 1975 graduates, seven found jobs related to their training and six are continuing their education at universities.

One important aspect of the program is the opportunity for students to learn to conduct scientific programs by becoming involved in actual field work. During the 1974 and 1975 school years, about 60 students worked on such studies as the Eastpoint seafood pollution study, Willapa Harbor oyster mortality study, Grays Harbor dredge spoil study, and the Grays Harbor baseline studies.

An increasing number of groups in the Washington region are involved in fish rearing. A coho salmon rearing facility at Grays Harbor, including a gravel incubation facility and a floating rearing pen, gives students valuable training to meet the growing need for technicians experienced in fish rearing.

Another special project at Grays Harbor is a summer class for teachers called "Washington and the Sea". The 1975 class equipped 19 elementary and secondary school teachers with marine science materials and methods they can use in their own classrooms.

Shoreline Community College

Shoreline Community College graduated 26 marine science technicians in 1975. Program coordinator John Serwold reports that 24 of these graduates found work related to their training and two transferred for additional university training. Another year of 100% placement for Shoreline's marine technicians.

In addition to regular classroom efforts, extensive field work conducted by the students forms a vital part of their training. This field work resulted in the completion of four reports sponsored jointly by Sea Grant and other agencies during 1975. One on microbiogenic sediments

was presented to a major conference on estuaries at Oregon State University.

This on-the-job training in subjects ranging from field sampling and sample preparation techniques to data preparation, drafting, and photography makes students especially valuable as potential employees. At the same time, the students make a significant contribution to studies conducted by a variety of agencies. As a result of the success of past projects, the students have gained further opportunities to do baseline sediment and benthic (bottom) assemblage studies for the U.S. Army Corps of Engineers, Seattle's METRO, and the Washington State Department of Ecology (DOE). Another project, for the National Oceanic and Atmospheric Administration, deals with benthic assemblages in Elliott Bay.

The 1976 summer will be spent on a sediment and benthic analysis in Port Susan and Everett Harbor. On top of this, the DOE project has been extended to include producing charts that depict Central Puget Sound's benthic assemblages, sediments, and oceanography.

Clover Park Vocational-Technical Institute

The marine mechanics program at Clover Park Vocational-Technical Institute began in September 1974. Nineteen students completed the opening year under the direction of William Mohler, program coordinator.

The program's first graduates will appear in June of 1976. An early sign of the program's success has been the favorable response by industry in placing eight students on board vessels for on-the-job training.

Sea Grant support in 1975 made possible the purchase of a 1200-horsepower diesel engine for rebuilding to meet part of the program's basic equipment needs. This engine is a typical example of what the students will encounter in industry after graduation and provides an excellent technology tool.

Another simple and effective part of the program also gives students direct experience. Customers bring in gas and diesel engines for repair, and the students make the repairs under the supervision of the course instructor. Parts and supply costs, along with a shop fee, are passed along to the customer. In this way, the students are assured of a steady supply of engines to work, and the shop fee lowers the cost of training.

Seattle Central Community College

In 1975, the marine technology program coordinated by Donald Smith and Henry Dahlgren at Seattle Central Community College focused on developing a curriculum for training people involved in petroleum transfer on Puget Sound and coastal waters. The results have been accepted by both the Coast Guard and industry.

A total of 60 people have successfully passed the Coast Guard "Tankerman's" examination as a direct result of participating in the tankerman's classes. In yet another facet of the program, over 100 people have completed the program's course in shipboard fire prevention and fire fighting.

As a result of the program's success, top training officials of the Coast Guard and U.S. Maritime Administration have become interested, and they will very likely use the program as a model for other training efforts. In addition, the Alyeska Pipeline Service Company is considering the program as a model for training Alaska oil pipeline operators.

Toward that end, Dahlgren presented a paper on training crews to operate vessels at the Symposium on Science and Natural Resources in the Gulf of Alaska, in October, in Anchorage.

For 1976, efforts will be directed toward expanding the curriculum, developing new training aids and facilities, and, in general, looking for ways to improve an already highly successful program.

ASSESSING LIVING MARINE RESOURCES

Marine Acoustics

The goal of Dr. John Ehrenberg's research in the Applied Physics Laboratory of the University of Washington is to develop hardware and techniques for acoustically assessing fisheries resources. The research is a joint effort of the faculty, staff, and students of the Electrical Engineering Department, Division of Marine Resources, the Applied Physics Laboratory and the Fisheries Research Institute.

Under the joint sponsorship of Sea Grant and the National Marine Fisheries Service, one major research activity of 1975 involved developing an acoustic system that measures the acoustic target strength of fish in their natural environment. As techniques for using the system in the field are developed, the accuracy of acoustic abundance estimates is improved. In addition to abundance estimates, the system will provide information on the size distribution of the fish surveyed. Both these steps are essential to the wise management of our fisheries.

Dr. Ehrenberg and a graduate student also explored some new techniques for getting fish abundance estimates by processing the acoustic signal scattered off fish, and they also developed a statistical description of the acoustic signal that may provide the basis for future techniques.

Dr. Dean Lytle of the Electrical Engineering Department and a graduate student conducted experiments and analyses of the acoustic scattering from high density fish populations. The objective of this research is to extend the acoustic range over which fish abundance estimates are effective.

Target Strength Studies

Dr. Richard Thorne's group is evaluating the method of assessing the target strength of fish, using a dual-beam echo sounding system developed by APL. The target strength, or relative amount of the transmitted sound energy that is reflected by the fish, must be known in order to estimate fish stocks by acoustic means. Target strength varies with the size of individual fish and from species to species, so its determination is complex--usually accomplished indirectly in the past. Now it appears that comparing the echo returns to two separate transducers, investigators can calculate directly the target strength. If this new method is

successful, it will be possible to calibrate relative fish density estimates directly from integration of the echoes. In many cases, it will also be possible to estimate a fish's size and possibly species from its sound reflectivity.

North Puget Sound Recreational Fisheries

Sportsmen's hook-and-line, scuba divers, and commercial fishermen all levy a toll on recreational bottom fish. Investigators directed by Dr. Stephen Mathews of the Fisheries Research Institute began in 1975 to determine the effects of this fishing on a number of important species. Using methods such as tagging, age frequency analysis, experimental fishing, and underwater observation, the investigators hope to explain how the bottom fish populations react to different types of exploitation.

Initially, they tagged more than 200 fish, including quillback, yellowtail, black and copper rockfish, lingcod and other greenlings in seven areas of northern Puget Sound.

As part of these tagging experiments, they studied tag retention and behavior of tagged fish. They found that both a tagged group and a control group, that was handled but not tagged, went through a period of sulking. The tagging itself seems to have no effect on the length of time the fish sulk. The tag retention part of the study was still in progress at the end of 1975, but after six weeks no tags had been lost due to shedding or breakage.

Besides the tagging work, the researchers collected about 500 pairs of otoliths (ear bones) to conduct age and growth analyses. The otoliths show growth rings, in much the same way as do trees.

Understanding the mechanisms involved in the repopulation of a heavily exploited area can lead to improved management of the recreational bottom fishery. To achieve this objective, the research group selected sites for studying repopulation of a restricted area which will purposely be "fished out" in 1976. The investigators will then monitor and evaluate the area's recovery.

Lake Washington Sockeye Salmon Studies

The sockeye salmon run in Lake Washington is fairly small and erratic—typically varying from about 150,000 to 300,000 fish each year. However, this run still provides significant catches for sport fishermen and Indian gillnetters. Not only that, but study procedures and techniques developed here are applicable to runs in other areas.

With this in mind, Dr. Robert Burgner, Director of the Fisheries Research Institute, Dr. Stephen Mathews, and Dr. Richard Thorne are directing assessment and monitoring studies of the run. Their work with the juvenile sockeye population enables them to forecast the size of the run two years in advance. This forecast provides the Washington Department of Fisheries with an important tool for resource management.

Supported by the National Science Foundation and Washington Department of Fisheries, in addition to Sea Grant, the studies combine acoustic surveys with midwater trawls to estimate juvenile abundance. Investigators also use the trawl samples in conjunction with zooplankton samples to study growth and food habits.

Most sockeye lakes are ice-covered in winter. Lake Washington is not, and this advantage allows year-round sampling to trace growth and eating patterns. Among other findings, the study has shown that the juvenile sockeye are highly selective

about which of the microscopic animals they eat and that they have consistent, seasonal diet patterns. The nature of this selectivity is the subject of continuing study.

The researchers have found that, although the population has been increasing since 1960, the average weight of the sockeye smolts has gone down. The workers are attempting to find out why—whether it is caused by the buildup in numbers itself or perhaps by nutritional changes that occurred in the mid-1960's after Seattle's METRO diverted treated sewage from the lake. As part of this, they are checking to see if there have been size or species changes among the zooplankton that could account for the smolt size decrease.

In other work conducted in 1975, a Ph.D. thesis modeled the feeding behavior of the juvenile sockeye, and work continued on an over-all management model for allocation of the harvest.

Puget Sound Herring Studies

About two years ago, the Puget Sound herring fishery blossomed in response to Japanese demand for herring roe. The result has been a harvest value of over $2 million each year, and accurate estimates of the Puget Sound herring abundance are critical to wise management of this resource. For example, overfishing of the herring could adversely affect the multi-million dollar salmon industry, since herring form a sizeable part of the salmon diet.

To provide the important information on abundance, Dr. Richard Thorne and his associates of the Fisheries Research Institute continued their weekly acoustic surveys of prespawning herring stock in 1975. The estimates that come from their work form a principal basis for herring-fishing quotas set by the Washington Department of Fisheries. In 1975, their efforts concentrated on the Gulf of Georgia (estimated herring biomass of 25 million pounds) and southern Puget Sound (15 million pounds).

Dogfish are found in company with herring concentrations. For this reason, the acoustic surveys have been able to document a steady increase in the Puget Sound population of this nuisance shark. In southern Puget Sound (Carr Inlet), for example, the surveys have indicated a four-fold increase in the percentage of dogfish relative to the total population in a period of three years. The impact of this increase on the herring and other fisheries is not yet known.

Juvenile Salmon Studies

The Kvichak River system runs of sockeye salmon in Alaska make up 60-80% of the Bristol Bay sockeye fishery, or about 60-65 million fish over a five-year period. Through necessity, the system is managed as a single unit, but it does not behave that way.

Lake Clark empties into Iliamna Lake via the Newhalen River. Illiamna Lake, which is about 90 miles long, empties in turn into the ocean via the Kvichak River. Both lakes serve as salmon nurseries, with Lake Clark making up about 10% of the combined nursery area. However, studies begun in 1961 indicate the lakes do not behave the same way in the relative production of fry. Apparently there are two mixed runs to the Kvichak system, possibly with different time cycles.

To further our understanding of this system so it may be managed more efficiently, a survey team directed by Dr. Ole Mathisen of the Fisheries Research Institute continued acoustic and net surveys in 1975. They found the relative abundance of fry in Lake Clark to be the

highest observed since survey operations began in 1962. Politics and labor disputes resulted in a lack of early season fishing in 1974, and this apparently favored the escape of fish to Lake Clark. This high escapement in turn apparently led to the large number of fry for 1975. If this is indeed the cause, then the same thing should occur in 1976 as well, since the 1975 run was not subjected to early fishing, either. The 1976 surveys will tell the story.

However, this theory still will not provide a complete picture of how the cyclic pattern of returns or of survival in Lake Clark differs from that in Lake Iliamna. Better estimates of the returns to Lake Clark are needed. Until we know whether Lake Clark stocks do in fact appear in the commercial fishery at different times than the Iliamna stocks during certain years of historic five-year Kvichak cycle, fishery managers must continue to treat the system as a whole.

Iliamna Lake

For the past several summers surveys of the fish population in Iliamna Lake have uncovered some interesting behavior among the juvenile sockeye salmon there. This behavior has limited the effectiveness of present acoustic techniques for assessing fry abundance there and probably in other Alaskan lakes.

The juveniles form small, dense schools at depths between 20 and 50 meters during the day. The schools are so dense and scattered over such an area, that meaningful acoustic assessment is not presently possible. At night, the fish migrate to feed very near the surface, but Dr. Mathisen's group found many of them swim too near it for echo-sounder detection. By comparison, the juvenile salmon in British Columbia and Washington lakes seldom approach closer than 10 meters, though they do form schools in the daytime. The investigators believe this behavior difference is related to the higher surface temperatures here and in Canada than in Alaska. One possible way under consideration to overcome this sampling problem in Alaskan lakes is to tow a submerged acoustic transducer, using it to "look up" a the near-surface fish.

Lake Quinault

There are workable methods for estimating the abundance of juvenile sockeye salmon feeding in Lake Quinault, Washington, and for estimating the abundance of maturing adults prior to their swim upstream to the spawning grounds. But good management of a salmon run needs an accurate estimate of the run's abundance while fishing is actually in progress. To get this essential information for the Lake Quinault run, the Quinault Indian Tribe and I.T.T.Rayonier joined with Sea Grant to sponsor acoustic surveys. In 1975, a survey team directed by Dr. Mathisen combined catch statistics from the gillnet fishery and acoustic survey estimates of the salmon escaping into the lake in an initial effort to come up with the needed information. Present plans call for the work to continue in 1976.

Juvenile Salmon Studies in Hood Canal

The U.S. Navy is constructing the Trident submarine base on the shores of Hood Canal. The Canal is an important passageway for chum, chinook, coho, and pink salmon, and for steelhead and cutthroat trout. For this reason, investigators under the direction of Dr. Ernest Salo are studying the effects of piers and Trident pier construction on the migrations of juvenile salmon. Dr. Salo's team is determining the timing, daily movement, and abundance of the

migrations, evaluating effects of the piers on them, and measuring environmental conditions.

With the cooperation and support of the Navy, the first phase of this five-year study took place in 1975. Researchers found that chum salmon smolts were the most abundant of the salmonids, and the migration peak of these young fish hit about mid to late May. In addition, the investigators found concentrations of salmon around existing piers, so an intensive study of this apparent attraction to piers will begin in the spring of 1976.

Construction at the Trident base is at an early stage, so the long process of data collection has just begun.

DESCRIBING PUGET SOUND RESOURCES AND ENVIRONMENTS

Ecology and Distribution of Puget Sound Fishes

A major reference work on the "Fishes of Puget Sound" came another step nearer to completion in 1975. This book will combine in a single publication detailed information on the identification, distribution, relative abundance, life history, and importance of each of the more than 200 Puget Sound fish species.

The lengthy and painstaking process of completing this work is being guided by Dr. Allan DeLacy, Professor Emeritus of Fisheries, with the invaluable assistance of Dr. Bruce Miller. Their efforts will result in a major reference work useful to educational, state, and federal agencies, commercial and sport fishermen, shoreline managers, industry, environmental groups, and others with an interest in Puget Sound marine life.

The researchers currently expect to complete their work by the end of 1978. In the meantime, much of the information they have been gathering has already been made available to the public. For example, in 1972, the researchers prepared a "Checklist of Puget Sound Fishes" which Sea Grant then published. In 1973-74, they completed a detailed atlas of Puget Sound fishes. This 680-page atlas includes a geographical distribution map for each species.

The initial distribution of this atlas was limited to state agencies and the University library. In 1975, work began on transcribing the information to magnetic cards for formal publication and, perhaps even more important, for easy and frequent updating. At the same time, the investigators continued the massive task of compiling the rest of the information that will appear in "Fishes of Puget Sound".

Population Dynamics of Clams

Dr. Vincent Galluci's investigations of the patterns of change and growth in the clam population of Garrison Bay, San Juan Island, have already helped a partial recovery of clam stocks depleted by unrestricted public use.

He is currently placing major emphasis on the dynamics problem of how settlement, growth, mortality, and predation rates may be used to predict population size and age distributions. Other essential aspects of his work involve studying the interactions of sediment, clam species,

and predators, and the food, feeding, and growth rates of individual clams. Experiments in 1975 uncovered new data regarding the relationship between growth rate and feeding.

From all the information gathered so far, investigators are devising a management plan for the Garrison Bay clams, a plan to achieve a sustainable yield harvest pattern. This will hopefully result in a more satisfying controlled recreational shellfishery, without the fear of exhausting the resource.

To be successful, the recovery efforts need public cooperation. So,through the San Juan Island newspaper, Dr. Galluci and his associate have given people information on the clams, including life history, proper digging techniques, and reasons why regulated beach closings are necessary. In addition, the investigators have helped the National Park Service prepare a leaflet on Garrison Bay clams and proper ways to dig them.

Artificial Reefs

Artificial reefs have been used throughout the world to enhance the productivity of barren and relatively unproductive areas. Investigators of the Washington Cooperative Fishery Research Unit are studying reef designs made of old automobile tires. They are placing various designs in five test areas near a public fishing pier at Edmonds, Washington, to study just what happens. The use of the tire reefs, if as successful as expected, will give fishery managers an effective and inexpensive tool for developing more abundant public pier fisheries in Washington and around the country.

Puget Sound Marine Environment

Investigators directed by Eugene Collias of the University of Washington's Department of Oceanography are preparing an atlas of surface currents in Puget Sound. The information will be especially useful to other researchers, boaters, and commercial and recreational fishermen.

To obtain the information needed for the atlas, investigators injected dye into the University's tidal model of Puget Sound, dusted the surface with polystyrene particles, and then photographed the effect. The photographs were taken at eight stages of the tidal cycle. From them, the investigators are developing charts that will show in detail the location and approximate strength of surface currents at eight stages in the tidal cycle. Each chart will represent calm conditions only, since wind effects cannot be duplicated in the model.

Studies also continue on Puget Sound's material budget. For example, Seattle's METRO asked the Department of Oceanorgraphy to make a one-year survey of the nutrient balance in the main Puget Sound basin. The researchers will combine these new data with historical data to complete the study in 1976.

In reviewing existing data on tide heights and winds, investigators found that, under certain conditions, the water level in Puget Sound may be as much as 2½ feet higher than the predicted tide height. This happens when a strong southerly wind moves over the Sound during a time of low barometric pressure. The effect is most pronounced in Saratoga Passage and Port Susan.

Among other things, predicted tidal height is important to the design of effective shoreline erosion defense structures. Since a number of activities such as this use predicted heights, what the combined effect of wind and low pressure does in Puget Sound takes on special significance.

DEVELOPING COMMERCIAL AND CLINICAL USES

. . .for marine resources

Mussel Adhesive

Sea mussels, *Mytilus californianus*, attach themselves to rocks and pilings in a way that withstands saltwater, action of marine bacteria, extremes in temperature, and the pounding of waves. The chemical nature of the adhesive involved is presently unknown--but of considerable interest to physicians and dentists in their quest for a similarly resistant bioadhesive. How this adhesive substance is synthesized and secreted, is the object of research directed by Dr. Patricia Keller. She is a professor of oral biology at the University of Washington.

The byssus, a tuft of strong filaments that the mussels use to attach themselves, is made up of distinct parts. It is the terminal plates or adhesive discs that attach the byssus threads to the substrate. In 1975, the researchers were able to extract collagen from tiny granules in the terminus of the byssus. Collagen is a fibrous protein that is the chief constituent of connective tissue fibrils in vertebrates. It yields gelatin and glue when it is heated with water for a long time.

Dr. Keller's group found that the mussel collagen is similar to vertebrate collagen and to the composition of the byssus threads. However, the researchers feel that recent studies by Dr. Arnold Tamarin indicate that collagen does not contribute to the mussel's actual adhesion to the substrate. It looks as though bonding might result from interactions of a phenolic material and mucoid material contained in granules found near the tip of the byssus. So experimental efforts for 1976 will focus on isolating the phenol granules and mucous granules in order to find out the chemical nature of their contents and the interactions that might be involved in forming the adhesive disc.

The work of isolating the mussel's amazing adhesive is painstaking. But the potential benefits could make it all worthwhile.

Marine Polymers

Professor Graham Allan and his colleagues in the University of Washington's College of Forest Resources and at the University of Puget Sound are attempting to find or develop polymer sources primarily capable of meeting the needs of the vast Pacific Northwest paper industry. Polymers are used by that industry to increase the wet and dry strengths of paper and non-woven

materials. But this is not the only use for polymers. Presently, Professor Allan sees the following range of polymer uses and appropriate sources:

Diatoms are tiny, culturable marine organisms that can produce a premium product. From them, very pure forms of polymer can be extracted. Although extraction is an expensive process, the resulting products are suitable for formulating specialty foods and pharmaceuticals.

Crab shells discarded by seafood processing plants presently pose a severe pollution problem but these shells could provide up to 100 million pounds of chitin/chitosan annually. Cost to process this source of polymers is "intermediate" but it is currently the basis for two commercial plant operations. In the long run, however, this source is incapable of providing the multi-million pounds of polymer annually required by paper and other industries.

Fungi are therefore the source that Professor Allan is turning to in order to find a source of low-cost fibrous material that is capable of meeting the bulk needs of the paper-making industry.

Aequorin

A great many people view jellyfish as a nuisance, at best. But, regarding some species, at least, this view is changing. Here in Puget Sound, a small, non-poisonous jellyfish named *Aequorea aequorea* flourishes in great abundance. At night, you can see a faint green glow around the edges of *Aequorea*, and it is this glow that has resulted in a use for this jellyfish.

The substance producing the bioluminescence is a protein called aequorin. Aequorin glows in the presence of calcium. Not only that, the measurable amount of light emitted is proportional to the amount of calcium present. One way this fact can be used is to detect small changes in calcium concentrations in human blood cells. This is important clinically because the changes are often early signs of cell destruction and can indicate the onset of certain diseases.

Dr. Samuel Felton and his investigators in the Fisheries Research Institute have been working with Sea Grant support since 1971 to develop aequorin both as a detection tool and as a research product for market testing. In 1975, the Oceanographic Commission of Washington joined with Sea Grant to support the continuing work.

Efforts to perfect a simple and rapid blood calcium assay test, and test marketing through the Sigma Chemical Company, ran on through 1975. The product appeared on the market in mid-year, but it will take about a year to determine the demand in clinical laboratories around the country.

One interesting observation made by the investigators was that the aequorin obtained from jellyfish at two different locations in the Sound in two different years didn't yield the same results. Investigators feel there was either a difference in the processing or in the jellyfish themselves, and will continue to study this phenomenon in 1976.

Total Utilization Concept

The Total Utilization Concept (TUC) for fish catches is just that. Fostered by Dr. George Pigott of the Institute for Food Science and Technology, the TUC project was initiated to find a use for the tons of fish waste and incidentally caught fish

that go unused every year. Dr. Pigott's goals are two-fold:

1) to provide the fishing industry with an efficient, economical, and possibly shipboard process for extracting concentrated proteins from "trash" fish and fish wastes

2) to develop salable products that use these proteins.

Dr. Pigott and his student researchers redirected their focus in 1975 from developing the extraction processes to applying the techniques to commercial production. Specifically, they concentrated in four areas:

1) Shipboard operation of a deboner and predigestion of non-utilized fish species

2) Continuous recycling of digest products to prevent oil emulsification in the digester tanks

3) Continuous ion exchange procedures for neutralizing digested protein and reducing the salt (NaCl) content

4) Submerged combustion evaporation of hydrolysate to concentrate solution from approximately 10% solids to that required for spray drying.

Each of these engineering applications represents a graduate thesis program. Having developed sound industrial processes, the investigators are applying themselves to industry production problems.

Dr. Pigott expects the final phase of the total utilization program as presently conceived will see completion in 1976, with the engineering steps uniting to form a continuous pilot plant operation. He and his investigators are confident that the program will result in a viable commercial process that can produce value where before there has been only waste. This program is valuable in making the mixed catches useful on shipboard and to prevent the wastage of these catches by dumping at sea.

Seafood Technology

The Institute for Food Science and Technology provides laboratory backup and some research support for the Sea Grant marine advisory service. Last year, Institute investigators concentrated in two areas:

1) studying the use of ratfish as human food

2) evaluating the adequacy of home canning procedures.

Though quite edible, the ratfish is a singularly unpleasant looking fish, with a name that produces equally unpleasant mental associations. The critter also has a ratio of flesh to head, skin, and bones that is too low for economic processing in traditional ways. Combine these factors, and it is not difficult to understand why this species is not presently fished--on purpose, at least--by just about anyone.

However, ratfish are an abundant inhabitant of the waters of Puget Sound and the Washington Coast and, in a world of increasing protein needs, developing this resource would be an important and useful accomplishment. The present investigation involves using deboning machines to obtain minced flesh and then preparing and testing fish-patties and other products. The work is still in progress. Maybe somewhere along the line someone will even try to change the ratfish's name to enhance market potential.

The increasing cost of processed foods and the environmental movement have resulted in increased home canning. Incidents of food poisoning from home-canned products have occured, and the possibility of more has spurred a re-evaluation of the seafood canning processes recommended by manufacturers and public agencies to ensure a safe product. Since failing to follow recommended processes could be a primary source of unfortunate incidents, the work includes studying what effects procedural changes have on the safety of the product.

Presently, investigators are evaluating the processes recommended for seafoods common in the Pacific Northwest such as salmon, crab, shrimp, tuna, and clams. They have found, for example, that all recommended processes for salmon offer a good margin of safety if venting instructions are followed. They also found that processes adequate for canning salmon in pint containers are often grossly inadequate for larger containers--manufacturers rightly do not recommend using a home pressure cooker to can salmon in larger than pint containers.

As noted earlier, the findings of this research are being carried to those who are involved in home canning through the efforts of the Marine Advisory Seafood Specialist.

DEVELOPING MANAGEMENT SYSTEMS

. . .for marine and coastal resources

NORFISH

The wise management of marine resources must include the gathering and sorting of environmental data. But these are only the first steps. There must also be efficient and sound methods for analyzing and interpreting data. Project NORFISH is aimed at developing such methods.

Directed by Dr. Lewis Bledsoe and Dr. Stephen Mathews, NORFISH investigators are developing computer methods to increase the efficiency of monitoring and managing Northeast Pacific fisheries and other coastal zone resources. Their goal is to provide managing biologists easier access to useful environmental data and the means for interpreting. This, in turn, can produce a substantial savings in time and money. For example, in 1974 the investigators reduced the time for a typical Washington trawl fishery data retrieval from five man-hours to one man-hour and the computer cost from $20 to $1.

A computer simulator framework, developed by NORFISH researchers, has been tested and is now the major research tool in the NORFISH study of northeastern Pacific fisheries. Researchers are filling in the simulator framework with large amounts of information about the fishing capability and economics of foreign and domestic fleets, Alaskan processing capacity, current regulations, and stock dynamics for present and possible future commercial stocks. The aim is to make it possible for researchers to come up with reasonable, objective predictions of effects of different management systems--a much sounder approach than the more traditional ones of seat-of-the-pants and after-the-fact. At the close of 1975, investigators were well into the process of putting information in the simulator, and they expect to make preliminary analyses during 1976. These initial efforts are expected to reveal just how good the computer predictions are.

For several years, NORFISH has helped the groundfish committee of the Pacific Marine Fisheries Commission in efforts to improve data handling and processing related to West Coast trawl fisheries. A lot of data have been generated over the years, but until recently there was no satisfactory way of gaining useful access to or manipulating it. Now, managers in Washington and British Columbia can find out such information as how many fish and of what kinds are caught, how many fishermen are involved, and how much effort has been put into catching the fish.

As of 1974 and 1975, Oregon and California are being added to this picture with compatible data collection and handling systems. When this is accomplished, the entire coastal trawl fishery can be managed as a whole--a distinct advantage from the viewpoint of resource management.

Investigators began a major effort during 1975 to develop an automated data-processing procedure for the Oregon Fish and Wildlife Commission and the California Department of Fish and Game. NORFISH personnel have been working hand in hand with biologists, systems analysts, and programmers from these agencies so revised procedures can be implemented in the two states early in 1976. Representatives of the Alaska Department of Fish and Game have also studied the system for use should a domestic Alaskan trawl fishery become a reality.

Dr. J.G. Sutinen and Dr. Gardner Brown completed a long-term economic study in 1975. They used mathematical economic methods to study the social desirability of the "share system" of pay for fishermen compared to a system based on a wage structure. Under the share system, the boat captain and crew receive proportional shares of the gross proceeds from their fishing efforts, rather than a set wage. This system has been around for a long time. It used to be called the "lay" system, and mention of it even appears in Moby Dick.

The investigators' emphatic conclusion is that fishing investors are better off under the share system, though this system has been criticized as a deterrent to investment in fish-harvesting systems. Critics have said that the potential returns on their investment are too low under the share system. What the researchers found offset this low return: the risk is spread over all individuals involved in high risk associated with fishing ventures. The investor must share the profits, all right, but he also gets to share the risks rather than carry the entire burden himself. This tips the scales in favor of the share system. As for the individual fishermen, the study shows they are neither better nor worse off under either system. However, the study does conclude that, should the share system be abolished in favor of a wage system, the total number of fishermen and their income would decline.

Terminal Salmon Harvest Model

A new NORFISH project in 1975 was the development of a way to predict salmon run size and timing from catch statistics gathered early in the season. The method has the advantage of using a series of preconstructed tables that by-pass complex calculations. Based on a probability model of salmon development, the method assumes that some aspects of this model are constant from one season to the next. Investigators are now evaluating the technique's validity by analyzing Puget Sound coho net fishery data covering the past 25 years.

Potential for Chum Salmon Hatcheries

Salmon hatchery efforts in North America have largely concentrated on coho and chinook because of their high value and the success of rearing techniques. Now, a 1975 NORFISH analysis of the hatchery rearing systems of chum slamon along with chinook and coho indicates that chum slamon would make a substantial addition to the depressed commercial salmon fisheries. Though highly successful on a commercial basis in Japan, experimental rearing of chums in the United States has not been very promising until recently. With current rearing successes, an upturn in the commercial value of chum, and the

ever increasing need for enhanced salmon fisheries, more and more attention is swinging to chum salmon.

The present study involves using a computer program (HATCH, written by Dr. Fred Johnson for the Washington Department of Fisheries) to simulate hatchery operations at Hoodsport, where chums, chinook, and coho are now being raised. The investigators analyzed the benefit-cost ratios of various combinations of such multi-species rearing and found that, by manipulating the number of each species on hand at any one time, the ratio of the entire hatchery could be increased over the one-or-two species operation. They found that, if we can attain success similar to the Japanese, chums would be an important addition regardless of the split of fish between the United States and Canada.

Coastal Zone Management Program

Past efforts supporting the implementation of the Washington State Shoreline Management Act and the Federal Coastal Zone Management Act developed into a major research project in 1975. The Washington Department of Ecology asked for help in developing inventory procedures for the state's salt-water shoreline resources. DOE also wanted assistance in using this inventory to develop shoreline management policies. Increased pressures on the shorelines make this type of information of great importance to the sensible regulating and planning of shoreline development.

Dr. Bledsoe and investigators at the Center for Quantitative Science worked successfully at developing a computer automated method of retrieving information from a shoreline resources inventory, and picturing the information on computer-produced maps. The researchers also investigated methods for predicting future shoreline land use patterns based on existing and historical patterns.

The researchers used Snohomish County's shoreline for the study, gathering data on ownership, natural and physical characteristics, vegetation, land use, assessed value, and types of development. They broke this information down to each .02 mile of the entire county shoreline.

Now a complete summary for any part of the county shoreline can be displayed on a computer map, brought forth by the simple use of tax assessor's account numbers for the region of interest. The shoreline manager thus can have an immediate cross reference from an account number to a variety of economic, social and ecological information.

Aquaculture Research Management System

With the myriad possibilities in aquaculture, research managers need a systematic way to determine where to place research emphasis and money. Investigators directed by Dr. Bledsoe are developing just such a method at the request of the National Marine Fisheries Service. NMFS is formulating a national fisheries plan for management of aquaculture research.

In 1975, the investigators began experimenting with simulation models for existing and potential aquaculture systems. The intended first step of the approach was to predict the net economic benefit of a given aquaculture project. Next, the investigators would determine what happens to this benefit when various factors change that are associated with the rearing of the particular animals. These factors include such things as probability of disease, the ability to get reproduction to occur, and the availability and cost of food.

Once they know in what ways the benefits are sensitive, the investigators would be able to pinpoint the most likely areas for research that would enhance the aquaculture project. The approaches used in 1976, as the investigation continues, will largely depend on what the researchers glean from this 1975 work.

FARMING THE SEAS

Pen-Rearing Studies

For the past three years, Dr. Ernest Salo of the Fisheries Research Institute has directed salmon pen-rearing studies at Henderson Inlet in southern Puget Sound. The work has been supported by the Weyerhaeuser Company, which has a salmon aquaculture project adjacent to its log dump in the Inlet. There, the Company raised about 1½ million chinook and coho salmon to pan size, about 3/4 pound, from May 1974 to October 1975. Results of this project which was completed in the fall of 1975 show that a moderately sized fish farm is compatible with the Henderson Inlet environment and that this area is particularly suited to fish farming.

In these studies investigators looked at the effects of fish respiration and excretion, and excess fish food on water quality and on benthic (bottom) plant and animal communities. Researchers found that the presence of the salmon did not significantly affect water quality. Rather, it is seasonal phytoplankton (microscopic plant) abundance and major hydrographic conditions in the area that dominate larger scale water quality fluctuations.

The investigators did find, as expected, that organic-enriching material accumulates on the bottom under the pens, which cover an area of about 100 feet by 400 feet. Rich in carbon and nitrogen, this material was found to be related to a decrease in the diversity of benthic species. Diversity is generally taken as a rough measure of the community's health. The material was also related to an increase in the abundance of certain organisms that serve as indicators of environmental change such as *Capitella capitata*. *Capitella* is a little red worm that is well-known example of such "transgressive indicator species". The researchers did find that the area recovered quite rapidly when the pens were moved.

Disease Control

The expansion of salmon husbandry to pen-rearing production of pan-sized fish has presented new problems in disease control. Vibriosis, caused by the bacterium *Vibrio anguillarum*, is a particularly serious problem because of its capability for producing large scale salmon deaths in the pens. Work by Dr. Salo's group on evaluating vaccine

effectiveness against vibriosis continued into 1975 as results of previous years' work have been very promising. In 1975, the investigators compared an intraperitoneal injection (into the abdominal cavity) method they had been using with a new method called "vacuum infiltration". This new vaccination method was developed by Wildlife Vaccines, Inc., and the Western Fish Disease Laboratory of the U.S. Bureau of Sport Fisheries and Wildlife. With this method, young fish are placed in a low pressure environment and then placed in an innoculating solution at normal pressure where their bodies absorb a vaccine. If it proves effective, this new technique would be cheaper and lend itself to vaccinating larger numbers of fish than the intraperitoneal method.

The researchers found that the number of deaths due to vibriosis among the vacuum infiltrated groups of coho salmon was slightly higher than in the intraperitoneally injected groups (8.8% as compared to 7.1%).

However, both groups did much better than the control groups (handled but not vaccinated) in which almost half the fish died. Interestingly, the vacuum infiltrated fish survived the vaccination process itself better than the intraperitoneally injected fish (1.1% deaths as compared to 10.3% deaths). This was expected and hoped for, since the fish undergo less handling stress with the infiltration method.

Since this initial work, the researchers have found they can do away with the "vacuum" part of the new method. The fish are still in their freshwater development stage when vaccinated. If they are placed in a salt solution with the vaccine, the osmotic pressure difference causes the vaccine to be absorbed by the fish.

Synthetic Turf Substrate Incubation Studies

Synthetic turf may be finding a useful place other than on the athletic field. Dr. Salo's group at the Fisheries Research Institute's Big Beef Creek research station on Hood Canal have been testing the turf's use as an artificial substrate (underlayer) for hatching salmon fry. Nature uses an ideal substrate in the wild—gravel. But for hatchery use gravel is heavy, awkward to handle, hard to clean . . . it just isn't very useable. So researchers are looking for substitutes that result in fry of the same high quality as does gravel, but without gravel's drawbacks.

The investigators conducted experiments to compare synthetic turf with gravel as a substrate in incubation trays. The emerging fry had similar weights and lengths from both substrates. They showed no significant differences in growth rates over an additional five-week rearing period. By comparison, bare trays resulted in smaller fry, and these fry remained smaller over the rearing period.

In tests of the effects of egg density, the investigators found no significant effect, even when the synthetic turf-lined trays were filled to their physical limit (about 26 eggs per square inch).

Salmonid Aquaculture Studies

The rearing and release of salmonids to enhance the sport and commercial fisheries are firmly established and successful practices. Yet, the process demands continuous change and development to keep up with increasing demand. Sea Grant research at the College of Fisheries responds to this challenge with emphasis in the areas of management, genetics, nutrition, and

behavior. Directed by such people as Dr. Ernest Brannon, Dr. William Hershberger, and others, the goal of all the 1975 interrelated projects is the same: improve the fishery.

Selective Breeding

One method that can be used to change the biological characteristics of fish stocks is genetic selection through selective breeding. Work in this area continued in 1975 with chinook and coho salmon and rainbow trout.

With chinook, the investigators are studying the effects of genetic selection on increasing growth rate, survival and contribution to the fishery, and on changing the migration characteristics of the stock. Recent work indicates that some dramatic changes in the population returning to the rearing ponds can be accomplished by varying the age of the adult fish used in genetic crossing. For instance, use of younger male parents seems to result in a higher percentage of return, but smaller adult fish as compared to use of older male parents.

The work with coho salmon centers on two factors related to the existing accelerated rearing and early release program. First, since accelerated rearing doesn't match the natural life cycle of the coho, researchers are looking for stocks that will do well under different temperature conditions (e.g., seasonal). Second, researchers are studying an apparent division in the coho population, based on migration distance into saltwater.

Investigators directed the 1975 selection program with rainbow trout toward three major areas:

1) establishing family lines to develop pedigrees and analyze to a high degree the performance variability within the Donaldson strain (developed by Dr. Lauren Donaldson in research begun more than 40 years ago at the College of Fisheries)

2) improving the present Donaldson strain trait of lower zygote survival and rearing difficulty

3) evaluating the use of hybrids with another strain in a stocking and commercial production program.

Development of Salmon Brood Stock for Pen Rearing

Investigators began a cooperative program in 1973 with the National Marine Fisheries Service to develop suitable chinook and coho brood stock for successful saltwater pen-rearing of salmon. The major emphasis of the program is to develop a stock that will yield rapid growing, high quality offspring for use in a production facility.

Comparing growth data of chinook and coho, the researchers have found that coho grow more rapidly, but there is less variance in the chinook growth rates. Since low variability in growth rate is desirable from a commercial production standpoint, the chinook may be the more desirable fish, particularly if selective breeding can increase the average growth rate.

Two related studies of chinook salmon involve the age of the parents. One study is intended to find out what effect parental age-class (2, 3, and 4-year olds) has on the chinook contribution to the Washington fishery. Recoveries of tagged fish are providing information to determine if parental age-class affects survival, growth rate, time of entry into the fishery, and distribution in Washington waters.

The second study is determining how parental age and size affect the early development of chinook. After crossing numerous combinations of ages, and different sized individuals among the 4-year olds, the investigators are monitoring factors such as mortality, time from fertilization to hatching, rate of yolk absorption, yolk conversion efficiency, and early growth.

Water Reuse System for Fish Hatchery

Investigators are evaluating different models of fish hatchery water reuse systems. Recycling of the water is an aid to water conservation and can be a big help to private fish farms that may have access to limited amounts of fresh water. Moreover, the Environmental Protection Agency defines untreated hatchery effluent as a pollutant, and one way to reduce this problem is recycling.

The first phase of the study is focused on nitrification performance of biological filters and the second phase is directed at the effect water reuse has on the growth of fingerlings.

Quality of Rainbow Brood Stock

Groups of pre-spawning rainbow trout were fed diets with different amounts of protein for eight months to find out just how much protein trout brood stocks need. Gamete viability and egg hatchability have been a problem with some hatchery trout brood stocks, and the researchers are investigating diet as a possible cause.

The researchers found that, at least in the environmental conditions used, a 35-45% protein diet resulted in maximum growth and egg production. They also discovered a significant delay in the spawning time of trout receiving both less and more protein and further found that the amount of protein did not appear to affect gamete viability or egg hatchability.

Because the 1973 brood showed an overall poor egg hatchability, investigators are also conducting diet and water temperature experiments on the 1974 brood to study effects on fecundity, gamete viability and egg hatchability.

Alternative Protein Sources to Supplement Chinook Diets

In another protein study, investigators substituted varying amounts of candida yeast, brewer's yeast, and feather meal for the fishmeal portion of the standard chinook salmon hatchery diet. Feather meal is much what it sounds like—cooked and ground chicken feathers, which are a rich source of protein.

The aim is to find less expensive but effective diets. The cost of fishmeal is expected to continue going up and the availability of fishmeal down, so researchers are looking for alternate protein sources that are stable and, if possible, cheaper.

The researchers conducted a ten-week feeding trial with six different protein mixtures. None of the supplements by itself contains sufficient percentages of all ten amino acids necessary for chinook salmon growth. After examining length, weight, and mortalities bi-weekly, the investigators found that none of the mixtures quite measured up to the standard diet. The possibilities are far from exhausted, however, and, as fish meal finds its way more and more into human foods, similar work must continue.

Effect of Anesthesia on Sperm Viability of Rainbow Trout

For ease of handling and therefore less stress on the animal, fish are often anesthetized before eggs or sperm are taken. Investigators have been studying the effects of anesthesia on the viability of rainbow trout sperm. They observed that anesthetizing the male does decrease

observable sperm motility, semen pH (acidity-alkalinity), and egg survival. The investigators therefore recommend evaluating the benefits of male anesthesia versus the possibility of egg loss. Experiments are continuing in order to substantiate these initial findings.

Relation between Growth and Population Density, Fern Lake Sockeye

The growth potential of salmon fry as related to population density is the subject of a study of Fern Lake sockeye salmon. Two possible production strategies are involved. One is that sockeye stocks could be planted in such numbers that there is an optimum combination of maximum growth and the most fish possible. The other strategy could be to plant a high density population that would have poor growth but would serve also as food for larger fish, such as rainbow trout. Which strategy is used would depend on the objective of the fishery managers. However, both approaches need answers to the questions surrounding growth and population density.

The work is in progress, with investigators monitoring growth and other factors in four groups of different densities. As a side light, the researchers are looking for possible variations in the type of natural food the fish eat as associated with population density.

Shellfish Studies

As in 1974, Dr. Kenneth Chew's 1975 shellfish research focused on studies of molluscan culture and oyster disease and genetics.

Manila Clam Seed Planting

Investigators under Dr. Chew's direction continued studies of the Manila clam, *Venerupis japonica,* in conjunction with the Washington Department of Fisheries and Department of Natural Resources. Placing this work in perspective, the 1974 Washington clam harvest was worth over $400,000, overall.

With the cooperation of the Washington Department of Parks and Recreation and the National Marine Fisheries Service, the researchers considerably expanded the work, which involves planting hatchery-spawned seed clams on Puget Sound beaches. The goal is to find out if this method can increase production on clam beaches where there are not presently commercial clam densities and also repopulate heavily dug public beaches. Present indications are that beaches can recover from recreational digging.

Mussel Raft Culture

In Europe, fresh mussels have found a ready market for a great many years, and on the east coast of the United States, mussels are being marketed on a regular basis. But in the Northwest the mussel market is still only at the "potential" stage--though Puget Sound certainly has a great capacity for growing this shellfish.

Research in 1974 established the possibility of culturing *Mytilus edulis* through the testing of various types of substrate for mussel seed setting and growth. There is a problem in that mussel setting does not occur at the same time each year, yet predicting this time can be critical. If the substrate is placed in the water too early, it becomes fouled and doesn't catch much in the way of mussel seed. If placed too late, the culturist may miss the set.

This problem was the focus of 1975 research. Investigators found that mussel larvae are present in the water prior to setting, so it may be possible to use this information to predict the setting time and work will continue in this area. In the meantime, efforts continue by many people to develop mussel culture as a profitable Northwest industry.

Oyster Disease Studies

Disease can result in serious losses for the commercial oyster industry, an industry that had a 1974 harvest value in Washington of over $4.5 million. With warm summer water temperatures, the count of various bacteria increases along with the number of oyster deaths. Studies continued into 1975 investigating the relationships between water temperature, bacteria build-up, and oyster mortalities.

The likely culprit appears to be virulent strains of *Vibrio* bacteria, but the process of infection and the events leading to death are still not well understood. However, researchers were able to apparently answer one persistent question—whether bacteria cause the oyster deaths or if the presence of bacteria is merely incidental to the effects of exhaustion and physiological collapse due to spawning and the stress of high temperatures. Experiments with antibiotics that successfully protect oysters show that bacteria are a necessary part of the system leading to oyster deaths in high temperature conditions.

Oyster Genetic Studies

The major emphasis in genetics investigations of the Pacific oyster, *Cassostrea gigas*, is to increase the oyster's resistance to death associated with Vibrio bacteria species. Initial studies indicated a fairly high genetic variability in the oysters, and the breeding program began in the search for disease-resistant stocks.

Basically, virulent *Vibro* are introduced to oysters and the surviving individual shellfish are crossed. Their offspring are again tested to find out if there has been an increase in resistance. In connection with this work, the investigators are analyzing the "families" of resistant oysters for single gene differences.

The overall program has just begun. The two-pronged approach of bacteriological investigations and genetics studies will hopefully provide preventive measures to counteract disease losses.

Seaweed Aquaculture

Seaweeds are marine plants that capture solar energy. They convert this energy into a variety of products such as food for marine animals, food for man, and certain useful chemicals for which no synthetic substitute is known.

Developing the knowledge and techniques to support a domestic seaweed farming industry is the goal of Dr. J. Robert Waaland and his research associates in the Botany Department of the University of Washington. The application of their research will provide the basis for a new, renewable-resource based industry in the Pacific Northwest, a reliable domestic supply of high quality seaweed chemicals, and the biological and technical know-how for farming a variety of seaweed species.

The seaweed research represents a cooperative effort by Sea Grant, Seattle's METRO, Marine Colloids, Inc., and the National Marine Fisheries Service. Present emphasis is on local seaweed species that are sources of the marine colloid, carrageenan. Industry uses carrageenan in a variety of ways, especially as a natural suspending agent in

foods, as a clarifying agent in liquids, and in controlling crystal growth in frozen confections like ice cream.

Taken as a whole, the researchers worked in six primary areas during 1975:

1) studies of growth rate in semi-enclosed culture

2) studies of vegetative propagation

3) development and application of a strain selection method

4) expansion of the cultivation research facility, relocating to a site adjacent to the METRO sewage treatment plant at West Point in Seattle

5) test-growth of the agar producers *Gracilaria* and *Gelidium*

6) growth of microalgae that produce useful polymers, and evaluation of promising new polymers that were discovered.

Research in previous years centered on Iridaea cordata, while 1975 research emphasized study of *Gigartina exasperata*. Both produce carrageenan. Researchers found that vegetative propagation of *Gigartina* is feasible and easily accomplished, making it easier to culture than *Iridaea* in this respect.

The researchers also discovered a fast-growing strain of *Gigartina* that grows at twice the 2%-per-day rate of the average *Gigartina* plant.

Investigators at the Washington State Department of Natural Resources are now applying results of the earlier research on *Iridaea*. They are attempting to scale up the cultivation methods so seaweed farms can be planted in state-owned waters. Revenues from these farms would benefit all the state's citizens, much in the way timber revenues do today.

Floating Breakwaters

Floating breakwaters make it possible to expand moorage space for small vessels with a minimum of ecological disruption. In deep water, floating breakwaters are also cheaper than traditional rubble mound breakwaters. So it is not surprising that communities and developers are turning more and more to floating breakwaters in the face of increasing demand for small boat moorages.

One result of the keen interest in floating breakwaters is a need for sound design guidance. Dr. Bruce Adee, Dr. Eugene Richey, and their associates at the University of Washington are helping meet this need. Their work is a combined effort in the Mechanical and Civil Engineering Departments and the Ocean Engineering Research Laboratory. Model testing, prototype performance monitoring, and developing a mathematical model to predict performance—the researchers are using all of these approaches to find out what doesn't work,what does, and how well.

During 1975, the investigators placed monitoring instruments on the floating breakwater at Sitka, Alaska. Now, they have data available on the performance of both the Sitka breakwater and the one at Tenakee in Alaska.

The investigators have also developed a theoretical model to a high degree. By comparing the performance of actual breakwaters with theoretical results, the investigators have found that the model does an excellent job of predicting motions, wave energy transmission properties, and mooring line performance.

PROVIDING PUBLICATIONS AND AUDIO-VISUAL MATERIALS

. . . for the Marine Community

Most federally funded university programs require grant recipients to report results of their work to their funding agency and usually to publish research findings in professional journals. The men and women who receive Sea Grant support are expected to do this kind of reporting also, but additionally and just as important, they are expected to go one step further and to see that information is made available to the public--to its businesses and industries, to its resource planning and management agencies, to its schools and libraries, and to individuals.

The Washington Sea Grant projects described on the preceding pages--as well as earlier projects--resulted in a significant amount of information that has been disseminated in the form of books, bulletins, technical articles in journals, special reports for public agencies, student theses and papers, and even television documentaries.

To ensure that this information reaches the audiences for which it is intended, the Washington Sea Grant Program has made special arrangements for distribution. Among these is an arrangement with the University of Washington Press which actively markets Sea Grant books worldwide. Arrangements have also been made for 18 distribution centers including county extension offices, community colleges, and NOAA offices in western Washington.

Besides these outlets, the program also publishes a catalog of available materials and routinely notifies interested citizens of new literature and upcoming marine events through specialized mailings. People or agencies who are interested in receiving the catalog or notices should write: Washington Sea Grant Communications, Division of Marine Resources HG-30, University of Washington, Seattle, WA 98195.

The following list includes the various publications and audio-visual materials which were developed by the Washington Sea Grant Program in 1975. The list also includes information about how specific items may be located or obtained.

PUBLICATIONS

Single copies of the following publications are free if picked up at the Washington Sea Grant communications office at the University of Washington or at one of its 18 distribution centers in western Washington. If publications are ordered by mail, a single copy of each of these titles will be sent for a 50 cent handling charge. Bulk copy rates are available upon request.

Bray, Pansy. 1975. Recipe cards—Hallelujah hake, schooner skate, rapturous rex sole, oriental octopus, and marvelous mussels. WSG-UN 75-6.

Chaves, Linda. 1975. Experimental culture of mussels at Seabeck Bay. WSG-TA 75-14

Chew, Kenneth K. 1975. Prospects for successful manila clam seeding. WSG-TA 75-15

Dahlgren, H.K. 1975. Crew training: A comprehensive program. WSG-TA 75-13.

Dunn, Charlotte. 1975. Fish filleting leaflet. (Reprinted from public information report #117, Wisconsin Sea Grant College Program.) WSG-AS 75-1

Duxbury, Alyn C. 1975. Tracing ocean currents. (Reprinted from PACIFIC SEARCH, May, 1975.) WSG-AS 75-2

Duxbury, Alyn C., and Robert E. Williams. 1975. Washington tides. (Reprinted from PACIFIC SEARCH, 1975.) WSG-AS 75-3

Kyte, Michael A., and Kenneth K. Chew. 1975. A review of the hydraulic escalator shellfish harvester and its know effects in relation to the soft-shell clam, *Mya arenaria*, in Washington State. WSG 75-2

Mathews, Steve, and Harry G. Senn. 1975. Chum salmon hatchery rearing in Japan, in Washington. WSG-TA 75-3

Nosho, Terry Y., Ernest O. Salo, and Jennifer Dee. 1975. Ocean ranching in Washington: A workshop summary. WSG-WO 75-1

Nosho, Terry Y. 1975. Salmonid diseases: A workshop summary. WSG-WO 75-2

Nosho, Terry Y. 1975. Oyster stocking techniques for Puget Sound beach owners. WSG-TA 75-16

The following bulletins are available for the price indicated. To obtain a copy, please write: Washington Sea Grant Communications, Division of Marine Resources HG-30, University of Washington, Seattle, WA 98195.

Goodwin, Robert F., and Barbara J. Miller. 1975. Legal and economic strategies for shorelines management. WSG-WO 75-3. $1.50. (Washington residents, please include 5.3% sales tax.)

Nunnallee, Edmund P. 1975. An operators' manual for the hydroacoustic data collection system. WSG-TA 75-1. $2.00. (Washington residents, please include 5.3% sales tax.)

The following books published by Washington Sea Grant are marketed by the University of Washington Press. They may be obtained through local booksellers. Orders should cite the International Standard Book Number preceding the price.

Bish, Robert L., Robert Warren, Louis F. Weschler, James A. Crutchfield, and Peter Harrison. 1975. Coastal resource use: Decisions on Puget Sound. ISBN 0-295-95348-9. $10.95. (Washington residents, please include 5.3% sales tax.)

Burke, William T., Richard Legatski, and William W. Woodhead. 1975. National and international law enforcement in the ocean. ISBN 0-295-95489-2. $7.50. (Washington residents, please include 5.3% sales tax.)

JOURNAL ARTICLES AND TECHNICAL REPORTS

The following reports of Sea Grant supported research appear in the journals cited or in the proceedings of the scientific or engineering societies indicated. Please contact your local library for assistance in locating these articles and reports.

Adee, Bruce H. 1975. Analysis of floating breakwater performance. Proceedings of the Symposium on Modeling Techniques, American Society of Chemical Engineers, San Francisco, California, September 3-5, 1975. WSG-TA 75-22

Adee, Bruce H. 1975. Analysis of floating breakwater mooring forces. Ocean Engineering Mechanics OED1:77-92. WSG-TA 75-31

Adee, Bruce H. 1975. Floating breakwaters: An idea whose time has returned. Proceedings of Ocean '75, Institute of Electrical and Electronic Engineering, 707-715, San Diego, California, September 22-25, 1975. WSG-TA 75-27

Allan, G.G., G.D. Crosby, and K.V. Sarkanen. 1975. Marine polymer 6. Evaluation of chitosan as a strength additive for α-cellulose and unbleached sulfite papers. Proceedings of the 1975 International Paper Physics Conference, Ellenville, New York, September 21-25, 1975. WSG-TA 75-10

Angell, Charles L., Bruce S. Miller, and S.R. Wellings. 1975. Epizootiology of tumors in a population of juvenile english sole *(Parophrys vetulus)* from Puget Sound, Washington. Journal of the Fisheries Research Board of Canada. 32(10) :1723-1732. WSG-TA 75-17

Beyer, Donald L., Roy E. Nakatani, and Craig P. Straude. 1975. Effects of salmon cannery wastes on water quality and marine organisms. Journal of Water Pollution Control Federation, 47(7) :1857-1869. WSG-TA 75-11

Buroker, Norman E., William K. Hershberger, and Kenneth K. Chew. 1975. Genetic variation in the Pacific oyster, *Crassostrea gigas.* Journal of the Fisheries Research Board of Canada, 32(12) :2471-2477. WSG-TA 75-24

Ehrenberg, John E., and George M. Pigott. 1975. Lipid-protein interaction during aqueous extraction of fish protein: Fish actin preparation and purification. Journal of the Acoustic Society of America, Vol. 57, No. 4, 961-963. WSG-TA 75-7

Gallucci, Vincent F., and Robert K. Kawaratani. 1975. Mortality of *Transennella tantilla* due to burial. Journal of the Fisheries Research Board of Canada, 32(9) :1637-1640. WSG TA-75-25

Hruby, Thomas. 1975. Seasonal changes in two algal populations from the coastal waters of Washington State. Journal of Ecology, 63:881-890. WSG-TA 75-32

Hylleberg, J., and V.F. Gallucci. 1975. Selectivity in feeding by the deposit-feeding bivalve *Macoma nasuta.* Marine Biology, 32:167-178. WSG-TA 75-29

Mathisen, Ole A. 1975. Three decades of hydroacoustic fish stock assessment. Marine Technology Society Journal, 9(6) :31-34. WSG-TA 75-28

Medcalf, Darrell G., Trudy Lionel, J.H. Brannon, and J.R. Scott. 1975. Seasonable variation in the mucilaginous polysaccharides from *Ulva lactuca.* Botanica Marina, XVIII:67-70. WSG-TA 75-21

Medcalf, Darrell G., Jeff R. Scott, James H. Brannon, Glenn A. Hemerick, Ronald L. Cunningham, James H. Chessen, and Jitu Sha. 1975. Some structural features and viscometric properties of the extracellular polysaccharide from *Porphyridum cruentum.* Carbohydrate Research 44:87-96. WSG-TA 75-23

Merchant, Howard C., and Walton A. Orr. 1975. Model testing in the natural environment. Ocean Engineering Mechanics OED-1:93-110. WSG-TA 75-30

Moulton, Lawrence L. 1975. Life history observations on the Puget Sound rockfish, *Sebastes emphaeus* (Starks, 1911). Journal of the Fisheries Research Board of Canada, 32(8) :1439-1442. WSG-TA 75-12

Nichols, Frederic H. 1975. Dynamics and energetics of three deposit-feeding benthic invertebrate populations in Puget Sound, Washington. Ecological Monographs 45(1) :57-82. WSG-TA 75-8

Nickelson, Sally, and Steve B. Mathews. 1975. Energy efficiency in the Pacific oyster industry. Proceedings of the Pacific Coast Section Meeting of the National Shellfisheries Association, September, 1974. WSG-TA 75-4

Palmer, Fred E., Kathleen A. Ballard, and Frieda B. Taub. 1975. A continuous culture apparatus for the mass production of algae. Aquaculture 6:319-331. WSG-TA 75-19

Satia, Benedict, and Ernest L. Brannon. 1975. The value of certain fish-processing wastes and dogfish *(Squalus suckleyi)* as food for coho salmon *(Oncorhynchus kisutch)* fry. The Progressive Fish-Culturist 37(2) :76-80. WSG-TA 75-20

Shenouda, Soliman Y., and George M. Pigott. 1975. Lipid-protein interaction during aqueous extraction of fish protein: Actin-lipid interaction. Journal of Food Science 40:523-532. WSG-TA 75-6

Shenouda, Soliman Y., and George M. Pigott. 1975. Lipid-protein interaction during aqueous extraction of fish protein: Fish actin preparation and purification. Journal of Food Science 40:520-522. WSG-TA 75-7

Taub, Frieda B. 1975. Continuous algal culture. American Society of Agricultural Engineers. Paper No. After 75-5015. WSG-TA 75-9

Waaland, J. Robert. 1975. Differences in carrageenan in gametophytes and tetrasporophytes of red algae. Phytochemistry, 14:1352-1362. WSG-TA 75-18

Weimer, R.T., and J.E. Ehrenberg. 1975. Analysis of threshold-induced bias inherent in acoustic scattering cross-section estimates of individual fish. Journal of Fisheries Research Board of Canada 32(12) :2547-2551. WSG-TA 75-26

Winter, D.F., K. Banse, and G.C. Anderson. 1975. The dynamics of phytoplankton blooms in Puget Sound, a fjord in the northwestern United States. Marine Biology 29:139-176. WSG-TA 75-2

SPECIAL REPORTS

The following unpublished reports were compiled or written by Washington Sea Grant personnel for the agency or institution specified. File copies of these reports may be examined during business hours in the Washington Sea Grant communications office at the University of Washington.

Ehrhardt, N.M., and L.J. Bledsoe. 1975. A comparative study of the statistical areas in the North Pacific fisheries. NORFISH 75-60

Grays Harbor Community College, Washington Sea Grant. 1975. Grays Harbor fish toxicity studies, 1974. (Special report published by the Washington State Department of Ecology.) WSG-MR 75-5

Goodwin, Robert F. 1975. Washington State shorelines management act: Substantial development permits, processing time study. (Special report to the House Shorelines Subcommittee of the Washington State Legislature.) WSG-MR 75-6

Hongskul, Veravat. 1975. Fishery dynamics of the Northeastern Pacific groundfish resources. NORFISH 75-59

Huppert, Daniel. 1975. Economics of a multi-species fishery: Theoretical and empirical results for the Washington coastal trawl fleet. NORFISH 75-20

Jaeger, Sig. 1975. A limited entry collage: Some published aspects, 1974/75. (Special report published by North Pacific Vessel Owners.) WSG-UN 75-9

Nosho, Terry Y. 1975. Oral testimony to House Natural Resources Committee of the Washington State Legislature; a statement on ocean ranching. WSG-TE 75-1

Parks, Wesley. 1975. A Pacific salmon fisheries model for the study of gear regulation: An application to the Washington troll fishery. NORFISH 75-58

THESES AND DISSERTATIONS

The following theses and dissertations were supported in whole or in part by the Washington Sea Grant Program. Copies of Ph.D. dissertations are available at cost to reproduce and may be ordered from Xerox University Microfilms, Dissertation Copies, P.O. Box 1764, Ann Arbor, Michigan 48106. Master's theses may be obtained through your local library on inter-library loan from Suzzallo Library, University of Washington, Seattle, WA 98195.

Buroker, Norman E. 1975. A survey of protein variation in populations of the Pacific oyster, *Crassostrea gigas*. M.S. thesis, University of Washington. WSG-TH 75-7

Erickson, Jr., Carl Arthur. 1975. Envelope and level crossing statistics of volume reverberation signals. M.S. thesis in electrical engineering, University of Washington. WSG-TH 75-4

Hopley, Jr., Charles Wilfred. 1975. The effect of parental age-class on the early life history of hatchery-reared chinook salmon, *Oncorhynchus tshawytscha*. M.S. thesis, University of Washington. WSG-TH 75-8

Kong, Norman. 1975. A feasibility study of new routes to the marine polymers chitin and chitosan. M.S. thesis in chemical engineering, University of Washington. WSG-TH 75-9

Preston, Elaine Anne. 1975. The responses of the flatworm, *Pseudostylochus ostrephagus* (Hyman) to electric current. M.S. thesis, University of Washington. WSG-TH 75-2

Stokes, Robert Lloyd. 1975. Petroleum facilities in Washington: A regional benefit cost analysis. Ph.D. dissertation in economics, University of Washington. WSG-TH 75-3 75-3

Swan, David Aitken. 1975. Mining deep ocean nodules: An examination of technological development process. M.S. thesis in engineering, University of Washington. WSG-TH 75-5

Weimer, Robert Thomas. 1975. Analysis of three related problems encountered in the acoustic estimation of the target strength distribution and its mean value for individual fish. M.S. thesis in electrical engineering, Univesity of Washington. WSG-TH 75-6

Wirtz, Alan Richard. 1975. A dual sonar receiver for use in target strength estimation. M.S. thesis in electrical engineering, University of Washington. WSG-TH 75-1

STUDENT REPORTS

The following unpublished reports were compiled or written by students enrolled in courses supported in part by Washington Sea Grant. File copies of these reports may be examined during business hours in the Washington Sea Grant communications office at the University of Washington. Photo copies of these reports are available for cost to reproduce, and reproduction costs are available upon request to Washington Sea Grant Communications, Division of Marine Resources HG-30, University of Washington, Seattle, WA 98195.

Cartmell, James Samuel. 1975. Impact of the Boldt decision upon the Fidalgo Island salmon industry. (An MBA research report prepared under the direction of Professor Karl H. Vesper.) WSG-MR 75-4

Cook, Jr., Harold Thomas. 1975. Commercial fishing hardware innovation of the 70's. (An MBA research report prepared under the direction of Professor Karl. H. Vesper.) WSG-MR 75-2

James, Daniel William. 1975. Sewage sludge disposal alternatives. (An MBA research report prepared under the direction of Professor Karl H. Vesper.) WSG-MR 75-3

Tobolski, Jeff, editor. 1975. Integrated mariculture-agriculture system utilizing sewage effluent and waste heat. (Student report from Ocean Engineering 552, Ocean Systems Design, directed by Professor Karl H. Vesper.) WSG-MR 75-1

TELEVISION DOCUMENTARIES

These 60-minute television documentaries were produced for broadcast at KCTS-TV or KING-TV with support from Washington Sea Grant. 3/4-inch video-cassettes of these programs are available from Washington Sea Grant Communications, Division of Marine Resources HG-30, University of Washington, Seattle, WA 98195, for a rental fee of $10.00.

Ovens, Carol B. and Lucille Fuller, producers. 1975. Oil on Washington waters. A television documentary produced in cooperation with KCTS-TV. WSG-AV 75-1

Ovens, Carol B. and Lucille Fuller, producers. 1975. Ocean land grab. A television documentary produced in cooperation with KCTS-TV. WSG AV 75-2

Ovens, Carol B. and Lucille Fuller, producers. 1975. Troubled waters—it's no fish story. A television documentary produced in cooperation with KING-TV. WSG AV 75-3

WASHINGTON SEA GRANT PROGRAM

January 1, 1975 - December 31, 1975

Expenditures by type of effort*

	Sea Grant	Regional Contributions
Advisory Services		
Providing information and advisory services	$ 341,300	$ 172,900
Education and Training		
University of Washington courses	154,500	138,700
Technical training	46,200	107,700
Research and Development		
Assessing living marine resources	135,100	73,100
Describing Puget Sound resources and environments	39,700	36,000
Developing commercial and clinical uses for marine resources	146,400	69,800
Developing management systems for marine and coastal resources	134,800	48,400
Farming the seas	282,000	124,500
Engineering in the ocean environment	30,100	20,600
Program Management	112,700	103,800
TOTAL	$ 1,422,800	$ 895,500

**This summary is only approximate and represents funds granted for the first year of a two-year grant. The official financial report will be submitted to NOAA's office of Sea Grant Programs in accordance with the federal grant requirements.*