

WASHINGTON
SEA
GRANT
AN
INVESTMENT
IN
ENVIRONMENTAL,
ECONOMIC
AND
EDUCATIONAL
ENHANCEMENT



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WASHINGTON SEA GRANT
AN INVESTMENT IN ENVIRONMENTAL, ECONOMIC
& EDUCATIONAL ENHANCEMENT

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LOOKING BACK

AFTER A PROMISING YOUTH AND A VIGOROUS ADOLESCENCE, THE WASHINGTON SEA GRANT PROGRAM AT THE UNIVERSITY OF WASHINGTON HAS MATURED AND IS POISED TO ENTER ADULTHOOD.

WASHINGTON WAS AMONG THE FIRST STATES SELECTED TO HOST A SEA GRANT PROGRAM. THE NATIONAL SEA GRANT COLLEGE PROGRAM WAS SIGNED INTO LAW BY PRESIDENT JOHNSON ON OCTOBER 15, 1966. THE FIRST GRANTS CAME TO UW IN THE FALL OF 1969 AND WINTER OF 1970. UW WAS OFFICIALLY DESIGNATED ONE OF THE FIRST FOUR SEA GRANT COLLEGES ON SEPTEMBER 17, 1971, ALONG WITH THE UNIVERSITY OF RHODE ISLAND, TEXAS A&M, AND OREGON STATE.

DURING THIS FORMATIVE STAGE, FEDERAL RESPONSIBILITY FOR SEA GRANT WAS TRANSFERRED FROM THE NATIONAL SCI-

ENCE FOUNDATION TO THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), PART OF THE U.S. DEPARTMENT OF COMMERCE, UPON NOAA'S CREATION IN OCTOBER, 1970. DURING THE NEXT TWO DECADES, ACADEMIC INSTITUTIONS FROM ALL COASTAL AND GREAT LAKES STATES AND SEVERAL TERRITORIES FORMED A NATION-WIDE NETWORK, THE PARTNERSHIP AMONG UNIVERSITIES, GOVERNMENTS, BUSINESSES, AND THE PUBLIC THAT IS SEA GRANT TODAY.

SEA GRANT WAS SENT INTO THE WORLD WITH A BROAD MANDATE FROM ITS VISIONARY FOUNDERS, WHO SAW IT AS THE AQUATIC EQUIVALENT OF THE "LAND GRANT" COLLEGE SYSTEM. THE LAND GRANT SYSTEM HAD BEEN CREATED IN 1862 FOR FOSTERING AGRICULTURAL RESEARCH, AND HAS HELPED MAKE THE U.S. THE WORLD'S GREATEST AGRICULTURAL NATION. WITH THIS MODEL AS A PARTIAL START-

ING POINT, CONGRESS DIRECTED THE SEA GRANT PROGRAM TO ENLIST THE NATION'S UNIVERSITIES IN A BROAD-BASED PROGRAM OF RESEARCH, EDUCATION, AND ADVISORY SERVICES (OUT-REACH AND TECHNOLOGY TRANSFER) DEDICATED TO THE WISE USE AND ENHANCEMENT OF MARINE RESOURCES.

RESEARCH. ENLIST ALL APPROPRIATE DISCIPLINES IN A COORDINATED EFFORT TO BETTER UNDERSTAND THE MARINE ENVIRONMENT, TO ADDRESS PROBLEMS AND OPPORTUNITIES IN MANAGING MARINE RESOURCES, AND TO DEVELOP NEW PRODUCTS FROM THE SEA AND NEW INDUSTRY TO WORK ON AND IN THE OCEANS.

EDUCATION. TRAIN SKILLED PERSONNEL WHO CAN MANAGE, DEVELOP, AND STUDY THE OCEANS; AND PROVIDE BETTER UNDERSTANDING OF THE MARINE ENVIRONMENT AMONG THE PUBLIC AT LARGE IN ORDER TO PROMOTE PUBLIC STEWARDSHIP OF THE OCEAN AND COASTS.

ADVISORY SERVICES.

BRING KNOWLEDGE TO THE PEOPLE—INCLUDING INDUSTRY, AGENCY MANAGERS, AND THE PUBLIC—WHO BOTH USE THE COASTS AND OCEANS AND MUST DECIDE AMONG COMPETING USES AND POLICIES.

OTHER AGENCIES SPONSOR SIGNIFICANT MARINE ACTIVITIES, OF COURSE. THE COAST GUARD IS RESPONSIBLE FOR SAFE VESSEL TRAVEL AND POLICING OF THE COASTS, THE ARMY CORPS OF ENGINEERS MAINTAINS OUR WATERWAYS AND SHORES. THE ENVIRONMENTAL PROTECTION AGENCY (EPA), NOAA, AND STATE AGENCIES MONITOR WATER QUALITY, MANAGE FISH STOCKS, AND ENFORCE REGULATIONS. THE NATIONAL SCIENCE FOUNDATION (NSF), EPA, ARMY CORPS OF ENGINEERS, NAVY, AND OTHER BRANCHES OF NOAA CONDUCT AND FINANCE MARINE RESEARCH. THE PRIVATE SECTOR ALSO PLAYS A CRUCIAL ROLE IN DEVELOPMENT OF NEW

TECHNOLOGY IN MARINE ELECTRONICS, FISHERIES, AND SEAFOOD TECHNOLOGY.

BUT ONLY SEA GRANT IS GIVEN THE MANDATE BOTH TO APPLY QUALITY SCIENCE TO SPECIFIC PROBLEMS AND TO INTEGRATE RESEARCH, EDUCATION, AND OUTREACH IN A SUSTAINED ACTIVITY INVOLVING A NUMBER OF PARTNERS. ONLY SEA GRANT IS CHARGED TO STUDY THE SEA, TO HELP MANAGE IT WISELY, AND TO PROVIDE AN UNDERPINNING FOR MARINE INDUSTRY. AND ONLY SEA GRANT IS LEGISLATIVELY MANDATED TO HAVE A BROAD PUBLIC OUTREACH EFFORT.

IN ITS FIRST TWENTY YEARS, THE WASHINGTON SEA GRANT PROGRAM HAS MOSTLY KEPT A LOW PROFILE IN THE AWARENESS OF THE GENERAL PUBLIC AND STATE GOVERNMENT. BUT ANYONE IN THE MARINE SECTOR—PUBLIC OR PRIVATE—WILL INSTANTLY RECOGNIZE THE NAME OF SEA GRANT. WHETHER THEY KNOW IT OR

NOT, SEA GRANT TOUCHES UPON THE DAILY LIFE OF ALMOST EVERYONE IN THIS STATE:

- THE FISHING INDUSTRY AND SEAFOOD PROCESSORS, RETAILERS, AND CONSUMERS
- SHELLFISH GROWERS, MANAGERS, AND PUBLIC HEALTH OFFICIALS
- HYDROPOWER MANAGERS, ELECTRICITY USERS, OIL AND GAS USERS
- WATERFRONT PROPERTY OWNERS, SHORELINE PLANNERS, RECREATIONAL AND COMMERCIAL USERS
- BOATERS, SHIPPERS, PORTS, CONSUMERS OF IMPORTED GOODS, MAKERS OF GOODS FOR EXPORT
- ANYONE WHO USES OR VIEWS PUGET SOUND OR THE PACIFIC COAST

WASHINGTON SEA GRANT TODAY COMPRISES THREE INTERACTING AND MUTUALLY SUPPORTIVE COMPONENTS DERIVED FROM THE THREE GOALS OF ITS ORIGINAL MANDATE. IT SPONSORS RESEARCH IN NUMEROUS PRODUCTIVE

AREAS OF MARINE SCIENCE AND EDUCATION. IT SUPPORTS AN EXTENSIVE NETWORK OF **MARINE ADVISORY SERVICES**. AND IT CONDUCTS A VIGOROUS PROGRAM OF **PUBLIC INFORMATION** AMONG RESEARCHERS AND ADVISORY SPECIALISTS AND THEIR PUBLIC AND PRIVATE CONSTITUENCIES.

IN THE FOLLOWING PAGES, WASHINGTON SEA GRANT'S ACTIVITIES AND CAPABILITIES ARE COMPARED IN MORE DETAIL WITH ITS ORIGINAL MANDATE. FROM THIS COMPARISON, IT IS CLEAR THAT:

- WASHINGTON SEA GRANT PROVIDES THE UNIVERSITY WITH AN ONGOING, COST-EFFECTIVE, AND HIGHLY VISIBLE OUTREACH MECHANISM THAT BENEFITS UW'S RESEARCH AND EDUCATIONAL MISSIONS.
- WASHINGTON SEA GRANT HAS A DEMONSTRATED TRACK RECORD FOR HELPING START NEW BUSINESSES AND INDUSTRIES AND PROVIDING

NEEDED TECHNICAL ASSISTANCE TO FIRMS AND INDIVIDUALS.

- WASHINGTON SEA GRANT HAS A PROVEN RECORD OF PROVIDING GOVERNMENT, INDUSTRY, AND THE PUBLIC WITH THE FACTUAL INFORMATION NEEDED FOR WISE CONSERVATION AND PUBLIC STEWARDSHIP OF THE STATE'S SENSITIVE MARINE RESOURCES.
- WASHINGTON SEA GRANT IS A WISE INVESTMENT IN THE HUMAN AND NATURAL RESOURCES OF WASHINGTON STATE.



THE SPARTINA INVASION

An alien species has taken root in Washington's Willapa Bay, home to half the state's commercial oysters, worth \$11 million dollars annually, and to young-of-the-year Dungeness crab that mature to provide a substantial portion of the \$16 million dollar annual catch. The alien is *Spartina*, or cordgrass, introduced to the bay in 1894 and now found from northern California to British Columbia. *Spartina* destroys the habitat for the native inhabitants of the tideflats, including eelgrass, oysters, and juvenile salmon, lingcod, herring, and crab.

In its first 90 years, *Spartina* colonized only about 430 acres of the bay. But in the last six years, the affected area has doubled, and it is predicted to cover 30,000 acres—most of the intertidal zone—by 2030. The state currently has no means of eradicating it or even limiting its spread. An interagency federal/state task force has been examining possible responses. Now, with Sea Grant support, Marine Advisory Services coastal field agent Steve Harbell, Thomas Mumford of the Washington Department of Natural Resources, and Pacific County planner James Sayce will convene a workshop in fall, 1990, bringing together experts from around the world to begin the search for possible solutions.

RESPONSES TO STATE ENVIRONMENTAL NEEDS WETLANDS AND HABITAT

THE DISAPPEARANCE of wetlands and the critical habitat they provide for fish and other wildlife is one of most serious issues facing coastal resource managers in this state. Yet it is only recently that scientific research has revealed the importance of these habitats and has provided both basic scientific understanding of their ecology and information that is useful for their management.

- Sea Grant researchers **Charles Simenstad** and **Ronald Thom** at the University of Washington School of Fisheries are local pioneers in nearshore and wetland research. The research began in the 1970s with studies that revealed how juvenile salmon feed in certain shallow

nearshore waters near estuaries during their vulnerable first days in salt water. Additional studies with professor **Robert Wissmar** revealed the vital roles of nearshore plants in supporting the food webs of these habitats.

This group has now teamed up to form WET, the Wetland Ecosystem Team, building on earlier efforts by Sea Grant and others to establish a strong multi-agency estuarine habitat activity in the Northwest. One of its early accomplishments is an experimental restoration of the Lincoln Street Marsh, a wetland in the Tacoma tideflats, with funding from the Army Corps of Engineers. Thom is documenting an apparent widespread increase in the amount of kelp in Puget Sound, possibly a result of increased nutrients due to sewage disposal. Sea Grant is now supporting a broad effort to select natural wetlands to serve as

reference sites. These sites will be useful for observing long-term trends in wetland ecology and for comparing with artificially restored wetlands to test the success of mitigation efforts, especially for supporting juvenile salmon.

- Long-term Sea Grant studies by UW fisheries professor **David Armstrong** and **Donald Gunderson** have demonstrated the importance of coastal estuaries habitat for rearing of Dungeness crab and English sole. As a spinoff of this research, they have used Army Corps of Engineers funding to develop an experimental method for mitigating the mortality of crab during dredging of Grays Harbor by spreading oyster shell on areas of tideflats, where it creates refuge and increases juvenile crab survival. A study of the same refuge phenomenon in Willapa Bay led them to the conclusion that the oyster industry

was a net benefit to crab populations despite its use of the pesticide carbaryl, which kills juvenile crab, to control infestations of the pest ghost shrimp. Sea Grant is sponsoring additional research on nonchemical methods for controlling ghost shrimp.

The same group, including biologist **Paul Dinnel**, also studied Dungeness crab populations in Puget Sound for the Army Corps, and found dense concentrations of spawning female crab at certain times of year near the proposed Navy home port at Everett. As a result, the Corps modified its dredging plans to avoid harming the crab population.

OFFSHORE OIL AND GAS DEVELOPMENT

IN 1987, the U.S. Interior Department's Minerals Management Service issued a new Five-Year Plan for expanding offshore oil production along the nation's coast. The plan included Washington state for the first time in more than 20 years. Reactions were strong on all points of the political spectrum, as some foresaw a mighty flow of dollars to the coastal economy and others envisioned a horrifying flow of spilled oil. The state legislature, convinced of the need for more information to formulate wise responses, turned to Washington Sea Grant.

Sea Grant created the Ocean Resources Assessment Program (ORAP) and managed several groups of workers who attacked various aspects of the offshore oil issue. The result was an unprecedented series of

books, a series in demand by scholars and resource managers in other coastal states and acclaimed as the nation's most comprehensive set of studies of offshore oil's regional implications. They are being used, for example, to plan for the Washington coastal marine sanctuary recently created by Congress, and to revise the estimates of oil reserves on the outer continental shelf. As such, they reflect the unique capabilities of the Sea Grant Program for treating difficult subjects in an efficient, unbiased, and professional manner.

The completed series reached the market just days before the worst oil spill in American history, the *Exxon Valdez*, and for months afterward Sea Grant and its authors were in close touch supplying information to officials from Alaska, the federal government, the National Academy of Sciences, professional

societies, and other states facing oil development, such as California, Oregon, and North Carolina.

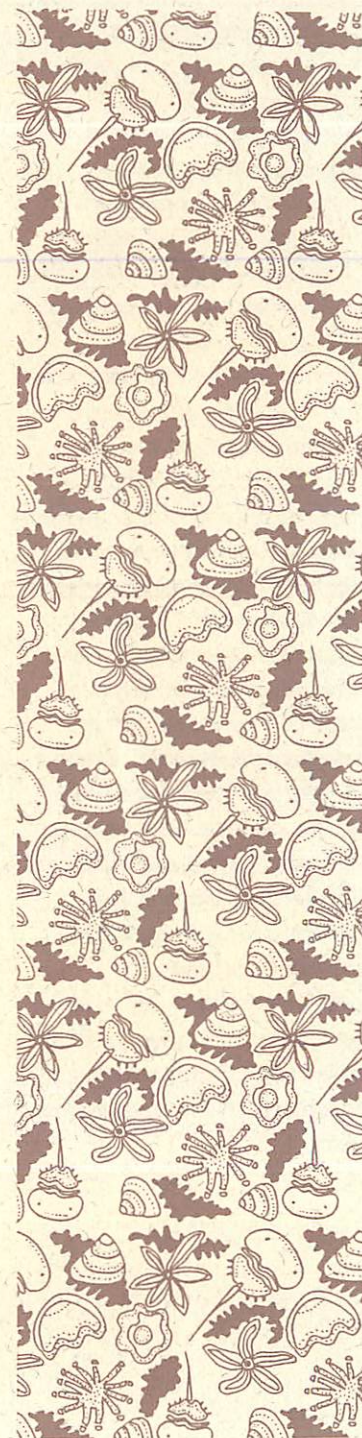
The series, collectively titled Washington State and Offshore Oil and Gas, comprises five books:

- *State & Local Influence over Offshore Oil Decisions*, by Sea Grant researchers **Marc Hershman, David Fluharty**, and **Scott Powell** of the UW Institute for Marine Studies, deals with how states can maximize their say in the federal government's offshore oil decision process.
- *Coastal Washington, A Synthesis of Information*, by Sea Grant science writer **Richard Strickland** and freelance business and environmental journalist **Daniel Jack Chasan**, reviews the natural and human resources of the Washington coast and how they might be affected by offshore oil.

- *An Assessment of the Oil & Gas Potential of the Washington Outer Continental Shelf*, by **William Lingley** and **Stephen Palmer** of the Washington Department of Natural Resources, examines and reinterprets existing public domain geologic data and concludes that the oil potential off the Washington coast appears significantly greater than previously believed.

- *Information Priorities, Final Report of the Advisory Committee*, summarizes the findings of a panel of state and tribal officials, environmentalists, and representatives of oil, fishing, and shipping interests on what the state needs to learn to cope with the advent of offshore oil.

- *Toward a Conceptual Framework for Guiding Future OCS Research*, by **Roger Kaspersen** of Clark University (Worcester, Massachusetts), principal author,



OIL AND FISHERIES MIGHT MIX

One of the more troublesome aspects of offshore oil development is interference with fishing operations by seismic exploration and other petroleum-related activities. Relations between geophysical surveyors and fishermen in Washington have been sour since 1980, when the geophysical vessel *Geco Alpha* snagged the lines of more than a thousand crab pots, worth over \$100,000, and dragged them away. When it appeared that such conflicts might re-emerge, the state legislature asked Sea Grant to bring the parties together to discuss their differences. In 1988-89, as part of ORAP, Marine Advisory Services coastal field agent Steve Harbell organized several meetings of representatives from federal and state agencies, various commercial and recreational fishing groups, and the petroleum industry. He drew on the experience of California Sea Grant MAS field agent John Richards, who performs a similar service in Santa Barbara. Oil development pressures have now eased along the Washington coast, but Harbell's efforts laid the groundwork for future discussions the issue arises again.

summarizes a workshop that discussed how best to guide scientific research to facilitate the OCS decision process.

- In addition, ORAP funds helped complete a sixth book, *Coastal Oceanography of Washington and Oregon*, edited by **Michael Landry** (a former UW oceanographer now at the University of Hawaii) and UW oceanography professor **Barbara Hickey**. This volume, published by Elsevier, compiled the existing scientific knowledge in a series of papers by the experts in this area.

PUGET SOUND ENVIRONMENT

PUGET SOUND is one of Washington's most precious resources, and one that received a lot of public and governmental attention during the 1980s. Considerable effort continues to be expended by Washington Sea Grant, as well as others, trying to understand the Sound's problems, both natural and human-caused, and to remedy them or prevent their spread.

PUGET SOUND BOOKS

Well before the flurry of interest in Puget Sound in the 1980s, Washington Sea Grant recognized the need among researchers, industry specialists, resource managers, and the general public for reliable reference works on the subject. The result was the timely Puget Sound Books series, which has been acclaimed by readers at all levels and become widely used in the marine

community. For example:

- After reading the first volume, business journalist **Daniel Jack Chasan's** *The Water Link*, a history of Puget Sound as a resource, one reviewer called on readers to "take notice of this series," and another predicted it would tell the public "a great deal about the Sound and its resources" and would "facilitate planning for conservation and development."

- *The Coast of Puget Sound*, by geologist **John Downing**, now at the Battelle Marine Laboratory in Sequim, Washington, was termed "an excellent reference" offering practical assistance to coastal engineers and landowners. It provides ample descriptions of shoreline processes, as well as a step-by-step guide to obtaining shoreline permits in this state.

- *Shellfish and Seaweed Harvests of Puget Sound*,

by aquaculture consultant **Daniel Cheney** and **Thomas Mumford** of the Washington Department of Natural Resources, has been called "fascinating and highly informative."

- The series as a whole was termed "a priceless resource for citizens of the Puget lowlands" and for "all those who live on estuarine watersheds." "Had this kind of series been available in time for eastern estuaries," said one reviewer, "it might have saved Chesapeake Bay."

TOXIC PLANKTON

Paralytic shellfish poisoning (PSP) is a toxic condition that infests clams, mussels, and other bivalve shellfish when a certain species of plankton, *Protogonyaulax catenella*, blooms in the water. The condition can cause paralysis and death in humans and other animals that ingest the shellfish. PSP has been present along the Washington coast as long

as anyone knows, but it invaded Puget Sound for the first time in 1978 and has been spreading ever since.

- Years of study by Sea Grant fishery researchers **Kenneth Chew** and **Louisa Nishitani** provided tantalizing clues but no clear answers to the causes of PSP outbreaks. They did unearth some connections to water temperature; the toxic plankton does not bloom below 14° Celsius, and outbreaks are more frequent during warm "El Niño" episodes. They also determined that "breeding bays," such as Quartermaster Harbor on Vashon Island, may export toxicity to other areas in the Sound, and that fish kills can occur during severe PSP outbreaks.

- Considerable progress has been made in research to help prevent humans from being poisoned by toxic shellfish. Researchers supervised by food science

professor **John Liston** perfected a chemical technique for measuring the types and amounts of PSP toxins in plankton and in shellfish tissues. The technique has great research value, but its most valuable application will be in reducing the need to sacrifice live mice to test toxicity levels present at shellfish gathering beaches.

In addition, Liston has supervised experimental work on methods to remove toxins from shellfish meat and so make it safely edible. So far, his group has been able to remove as much as 92% of the toxicity by prolonged rinsing with highly purified water. Unfortunately, this acceleration of shellfishes' natural cleansing process works only in the laboratory, and is not safe to try at home. But Liston colleague **Barbara Rasco** has also found that PSP toxins can be broken down by strains of bacteria in the sediment, raising the hope that

biochemical methods might be developed to completely detoxify shellfish for human consumption.

- There are additional bright prospects for an improved system to give early warning of PSP outbreaks. Professor **Mary Jane Perry** of the UW Oceanography School is developing antibodies that react to the presence of *Protogonyaulax* cells. This immunological approach should yield a simple, rapid, and sensitive method for identifying the earliest stages of plankton blooms that cause PSP. This advance notice would aid public health officials and commercial growers in monitoring outbreaks and keeping unsafe shellfish from reaching consumers.

MARINE DEBRIS

THE ISSUE of waste in the oceans is washing over the national consciousness, as seaborne trash repeatedly fouls our shores and kills thousands of marine birds, mammals, fish, and turtles annually. The remedy for this situation is a combination of legal action and community education.

- Washington Sea Grant Marine Advisory Services responded in 1988 by publishing *Plastic in the Ocean: What are we Doing to Clean it Up?* It informs the marine community and the general public about stiff new controls implemented by the Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 on ocean dumping of plastic and other waste.

Written by **Xanthippe Augerot**, assistant to the director of Washington Sea Grant, the publication

GENETIC FINGERPRINTING OF PUGET SOUND BACTERIA

Fecal contamination of nearshore waters, as indicated by coliform bacteria, is one of the most pervasive and most intractable pollution problems facing Puget Sound today. More shellfish beds are being closed because of this problem every year. Bacterial contamination can arise from such sources as sewage treatment plants, wild and farm animal waste, faulty septic tanks, and urban surface runoff. In most cases, however, the contamination is hard to control because of the difficulty of pinpointing its source.

Professor Jerry Ongerth and postdoctoral fellow Mansour Samadpour of the UW Department of Environmental Health are applying an innovative new biotechnological tool, called ribosomal RNA typing (ribotyping), to track down sources of these bacteria. Ribotyping is analogous to the DNA fingerprinting method now being introduced as evidence in some courts. Dr. Samadpour developed the technique

while a graduate student in food microbiology at the UW Fisheries School.

Ribotyping enables the scientists to match chromosomal markers in bacteria isolated from shellfish, sediments, and water in Puget Sound to those from various suspected sources by comparison of ribotyping profiles. The technique is being tested first in northern Port Susan, a large Puget Sound bay whose potential production of 500,000 pounds of shellfish per year is currently restricted because of bacterial contamination. The Tulalip Tribe, which manages some of the affected shorelines in Port Susan, is assisting.

describes how various types of trash (including paper, glass, metal, and food waste as well as plastic) should be handled and summarizes the potential impacts of the new law on recreational boaters, fishermen, beachgoers, public and merchant vessels, ports and marinas, and offshore platforms. It also lists other resource materials on the subject and summarizes current state and regional cleanup activities from around the country. Author Augerot and MAS staffers also served on a statewide Marine Plastic Debris Task Force created by the Washington Department of Natural Resources (DNR) to mitigate debris problems, enforce the MPPRCA, and educate the public.

- Responding to the need to reduce marine debris in Puget Sound, Washington Sea Grant Marine Advisory Services North Sound Office created a Marine Debris Pilot

Project in debris collection and boater education at Squalicum Harbor in Bellingham. Modeled after a similar project in Newport, Oregon, the startup was supported in part by Public Involvement and Education Funds from the Puget Sound Water Quality Authority. Coordinator **Patti Mullin** and former marine field agent **Jim Humphreys** issued three publications and a poster which were distributed to boaters and recreational and commercial fishermen in Squalicum and other marinas around Washington and other states.

The Port now collects cardboard, wood, metal, and netting and other plastics from fishermen and recreational boaters for recycling. Despite some initial skepticism, the Bellingham program received considerable media attention and is being used as a guide for similar programs at

marinas in Seattle, Port Townsend, Port Angeles, and Sequim; across the nation in Texas, New York, and Maine; and even as far away as Taiwan. MAS has also been consulted on debris disposal at the ports of Grays Harbor and Ilwaco. Sea Grant's poster and its logo were adopted by the Washington State Task Force on Marine Debris, and the poster also is riding the high seas aboard the vessels of the American President Lines and the U.S. Navy.

RESPONSES TO STATE ECONOMIC NEEDS HIGH SEAS FISHERIES

WASHINGTON STATE has the nation's largest fishing fleet. Accordingly, Washington Sea Grant supports some of the nation's top fishery researchers, whose analyses are vital for the development, safety, and prudent management of the state's fish resources and its burgeoning fishing industry.

- Sea Grant researcher **Robert Francis**, director of UW's Fisheries Research Institute, has been studying two fisheries that are extremely valuable to Washington. He and co-workers found new evidence that salmon runs from California to Alaska are affected by large-scale conditions in the open Pacific Ocean. These conditions complicate enhancement measures

taken on land, such as hatchery releases. Francis also published outspoken views on the need to preserve vanishing wild stocks of salmon.

In addition, Francis supervised postdoctoral associate **Timothy Mulligan** (now at Humboldt State University in California), who analyzed the bone chemistry of Bering Sea pollock. This species supports the world's largest fishery and forms the backbone of Washington's groundfishing industry. Mulligan's results showed that pollock stocks spawning in U.S. waters are fished by Japan and other nations in the international waters of the "Donut Hole," and therefore could require international conservation efforts.

• UW Fisheries professor **David Armstrong** began surveying the Dungeness crab populations of the Washington coast with Sea Grant

support in 1983. At that time, the crab fishery was in a prolonged slump for unknown reasons. Armstrong and his co-workers quickly discovered that the population appeared to be sustained in these lean years by juvenile crab that matured in the sheltered waters of the Grays Harbor and Willapa Bay estuaries. When the fishery staged a dramatic recovery in 1988, the researchers were able to link it to their data that showed a high survival rate of juveniles on the outer coast, as well as in the estuaries, in 1984. The search continues for the ocean conditions that may promote juvenile crab survival.

• The tragic 1990 sinking of the Seattle-based factory vessel *Aleutian Enterprise* in Alaskan waters reminds us of the never-ending dangers of high-seas fishing. Many may recall, as well, when the Washington-based sister crab boats, *Altair* and *Americus*, capsized

and sank in the frigid Bering Sea in February, 1983, with their crew and full loads of king crab. Then as now, probing questions were raised: What caused the accidents? Could they happen again?

During its 1983 investigation, the Coast Guard sought help from mechanical engineer **Bruce Adee**, director of UW's Fishing Vessel Safety Center, who had been studying fishing vessel stability with Sea Grant support. Adee used electronically monitored scale models of the ships, together with pre-accident photos and specifications from sister ships. He determined that the ships were carrying 50 tons of extra weight, which contributed to their instability. This finding changed the course of the investigation and resulted in improved safety measures for the fishing industry as a whole. Issues of unstable loading also appear to be involved

in the capsizing of the *Aleutian Enterprise*, a fact that reveals the unfortunately continuing relevance of Adee's research.

Washington Sea Grant Marine Advisory Services also plays an active role in fishing vessel safety. MAS staff participated in a West Coast regional assessment of fishing vessel safety for the National Research Council Marine Board.

HIGH-TECH INNOVATION

Washington Sea Grant has helped sponsor some of the most technologically audacious research in marine science, helping build a "center of excellence" on the UW campus.

• Oceanographer **John Delaney** is one of a cadre of researchers from around the world who founded RIDGE (Ridge Interdisciplinary Global Experiment). UW is national headquarters for

WATER QUALITY SPECIALISTS

9

Suburban and rural water quality are proving to be stubborn problems in Puget Sound management, since they are affected by the dispersed, small-scale activities of numerous individuals. Washington Sea Grant Marine Advisory Services and Washington State University Cooperative Extension, with funding from the state legislature, have begun a pilot education project to address water quality issues in Mason, Kitsap, and Jefferson counties.

Sea Grant has created two new positions for water quality specialists, having primary responsibility to address Puget Sound water quality issues and to assist commercial and recreational shellfish growers. They will complement two Cooperative Extension specialists who focus on upland and freshwater activities affecting Puget Sound water quality and local watersheds.

Serving southern Puget Sound as water quality specialist from an office in Shelton is Paula Cullenberg, who most recently was Marine Advisory Services field agent for Alaska Sea Grant in the Bristol Bay and Aleutian Islands regions. Paula also has experience as a water quality specialist for Indian tribes and the Alaska legislature, and earned her M.S. in fisheries at UW.

Sea Grant newcomer James Bolger will cover the western Sound from a base at Port Orchard. Bolger, former senior marine interpreter and

volunteer coordinator at the Monterey Bay Aquarium in California, returns to Washington, where he was an instructor with the Seattle Aquarium and Pacific Marine Research, as well as being a staff oceanographer and earning his M.S. at UW.

The four specialists will work as a team to develop educational activities to help resolve local water quality problems in the three-county area. If successful, this regional, two-university approach will be extended to all the counties in the Puget Sound basin.

WORKSHOPS AT FISHERMEN'S TERMINAL

The Fishermen's Terminal office in Seattle is a cooperative effort of Washington Sea Grant Marine Advisory Services and the Marine Technology Branch of Seattle Central Community College. It is located in the heart of the largest concentration of fishing vessels in the state.

Scott Harrington is a veteran Marine Advisory Services commercial fisheries field agent at the Fishermen's Terminal Office in Seattle. He works on an eight-month Sea Grant assignment, then works for himself fishing during summer. As a result, he "knows the ropes" of commercial fishing, and during the off season he shares the fruits of his years of experience with other fishermen. He fields a steady stream of "How-To" questions that range from finding jobs

this program to coordinate global research on the mid-ocean ridge system, a submerged mountain chain that is the longest on Earth. Delaney and co-workers **Russell McDuff** and **Adam Schultz** study the Juan de Fuca Ridge off the Washington coast. There they are pioneering the technology for monitoring the harsh hydrothermal vent environment two miles below the sea surface.

• Engineer **John Hart** of UW's Applied Physics Laboratory (APL) oversaw production of *Seashuttle*, a free-swimming undersea research probe. Four feet long and weighing just sixteen pounds, *Seashuttle* gathers data on seawater temperature and salinity as it follows a programmed course and returns to its mother ship. It was tested successfully by APL oceanographer **Jamie Morison** under the Arctic pack ice in spring, 1989.

• In July, 1990, UW oceanographer **Paul Johnson** and the Seattle engineering firm **Williamson & Associates** conducted successful Puget Sound testing of a new undersea geologic drill. It is designed to be the world's only "over-the-side" deep-sea drill that can be shared and operated by standard oceanographic research vessels. Small and relatively inexpensive, it is intended to answer a pent-up demand among oceanographers worldwide. Even before the final design was finished, Johnson was flooded with calls from scientists as far away as Australia and Germany.

Additional tests in the deep ocean are planned for fall, 1990. The drill is then scheduled to go on a 1991 expedition aboard the West German icebreaker *Polar Stern* to the Arctic Ocean, whose rock bottom has never been drilled. The results could be of immense value for

understanding global plate tectonics and climatic change, and should have naval applications as well.

BOOSTING THE BIOLOGICAL BOUNTY

WASHINGTON SEA Grant has been a proud sponsor of a number of young enterprises that are expanding the uses of marine living resources, sometimes in surprising ways. The accomplishments of these enterprises range from turning waste material into high-value products to reducing die-offs and improving the genetic stock of fish and shellfish. Together, these projects help sustain Washington's position as having the most diverse set of aquacultural enterprises in the country.

CHITIN IS EXCITIN'

Once just a pesky waste product of the shellfish processing industry, chitin today is a

hot commodity with a growing spectrum of uses. Chitin is a structural carbohydrate, similar to cellulose, and is a major component of the shells of crustaceans such as crabs and shrimp. When converted to chitosan by a simple chemical process, chitin's marvelous properties are liberated for human use. It has applications as a filtration material, fabric, and animal feed. Its biodegradability and nonallergenic, antifungal, and wound-healing properties make it a valuable medical material for sutures, artificial skin, dressings and ointments, and even contact lenses.

• Washington Sea Grant has been in the forefront of supporting research on purification and uses of chitin. As an outgrowth of early research, the **Protan Company** now processes chitin from crab and shrimp shells at a plant in Raymond, Washington, and markets chitosan from

Woodinville for treating wounds and for filtering wine and beer, swimming pool water, and other liquids. The **Vanson Chemical Co.** of Redmond, Washington, has developed and now markets chitin derivatives for waste water treatment, and **Polychite**, also of Redmond, markets a chemical for cleaning swimming pools and spas. Plant Pathology professor **Lee Hadwiger** at Washington State University is investigating the genetic mechanism that enables chitosan to confer resistance to fungal pests on wheat and pea seeds. This valuable property increases wheat yields as much as 20 percent and has led to its commercial marketing by the **Bentech Corporation** of Clackamas, Oregon.

- One of the Sea Grant pioneers of chitin chemistry was Forest Resources and Chemical Engineering professor **Graham Allan** of the University of

Washington. Currently he is studying how to bond chitosan to various types of fibers to impart special qualities to fabrics. He also is investigating the ability to chitosan to promote nerve regeneration. For the future, Allan foresees a day when chitosan will be manufactured through bioengineering to relieve the shortage of raw high-grade chitin that is expected to emerge as commercial applications expand.

DESIGNER SALMON

After years of research on producing larger, longer-lived, and hardier Pacific salmon, scientists are perfecting methods for creating new breeds of salmon that combine the best traits of different existing species and stocks. The resulting hybrid fish should benefit both salmon growers and consumers. Two different approaches are under study.

- Professor **Gary Thorgaard** of Washington State University in

Pullman and professor **James Seeb**, now at Southern Illinois University, have successfully created hybrid "chumook" salmon. These fish can adapt to salt water at an early age, like their chum mothers, but have meat quality resembling that of their chinook fathers. This combination should increase the yield from salmon net pens. In the past such hybrids usually died. But when specially treated as eggs to transform them into triploids, with an extra set of chromosomes, the hybrids survive well and show promising growth in captivity.

The second and separate approach involved more than ten years of classic selective breeding in salmon by UW fisheries professor **William Hershberger** and co-workers, including graduate student James Meyers. Starting in 1977, they developed coho salmon strains that grew 30% faster in the

hatchery and 60% faster in salt water net-pens. As a result, juvenile fish could enter salt water earlier, and adults reached market size 30% sooner.

The triploid technique was developed in the early 1980s by Thorgaard, Hershberger, and **Fred Utter** and **Orlay Johnson** of the NOAA Northwest Fisheries Center. Its original purpose, and still a source of great promise, was to eliminate spawning and subsequent death, thus potentially granting net-pen salmon increased size and life span, and preventing the flesh deterioration that normally occurs before spawning.

- Fisheries professor **Walton Dickhoff** also can produce sterile salmon using the male hormone testosterone, administered to embryos in a bath and in their feed. Released to Puget Sound in a joint program with the Washington Department of Fisheries,

to fixing and maintaining engines and other gear, preparing business tax forms, and obtaining proper licenses and safety certification.

Sarah Fiske, who also fishes, is a program assistant with Harrington at Fishermen's Terminal, and works part-time at a satellite office in Port Angeles. Together, they call upon a broad network of experts in responding to inquiries. In addition, a primary activity is to coordinate and teach workshops on practically any topic that pertains to the fishing industry: use of radar, practical navigation, net mending, outboard motor maintenance, battery maintenance, diesel engine troubleshooting, water safety training, corrosion control, first aid at sea, hypothermia, marine meteorology, hydraulics, rules of the road, fiberglass maintenance, seafood handling, wood maintenance and repair, and how to catch bottomfish. These workshops center around the Puget Sound area, but have been extended to the Washington coast and Columbia River areas as well. A similar set of topics was also covered by former MAS North Sound agent Jim Humphreys in classes cosponsored by the Bellingham Vocational-Technical Institute during winter, 1989.

BIOSONICS

A modest former bakery in the Wallingford district of Seattle houses one of the world's leading developers and manufacturers of hydroacoustic, navigational, and image-processing

technology for fisheries and environmental assessment applications. Biosonics, Inc., began by making instruments for locating, identifying, counting, and tracking fish using ultrasonic sound waves, or sonar.

Founded in 1978, Biosonics now employs 35 people and grosses more than \$3 million in annual sales, dollars that flow back into the state economy from customers from around the world. Their technology has become the worldwide standard and is indispensable for managing Columbia River salmon and Washington and Alaska herring populations. Bioacoustic techniques are estimated to have increased catches of these species by several million dollars annually in good fishing years. More importantly, they give salmonid managers better estimates of quantities such as returns and escapements, which are critical to effective management in years when populations are low.

The company commercialized bioacoustic technology that was developed with support from Washington Sea Grant during the 1970s. Sea Grant was instrumental in funding UW engineering professor John Ehrenberg and fisheries professors Richard Thorne and Ole

the resulting fish have been found to live longer and grow larger. What's more, the fish remain at sea to be caught by fishermen instead of returning to spawn.

- **Ronald Hardy** of the Northwest Fisheries Center in Seattle has developed methods for boosting the amounts of heart-healthy fish oils in farmed salmon. The results raise the possibility of custom-growing salmon in net pens as a tasty and economical source of fish oil for people who need to reduce their cholesterol levels. Someday fishery scientists, doctors, and dieticians might help consumers hand-pick their fish, like varietals of wine, to gain health as well as taste benefits.

By adding extra oils extracted from fish-processing waste to normal salmon feed, Hardy can raise the level of vital omega-three (Ω -3) fatty acids in farmed Atlantic salmon meat, usually fairly low in oils,

to levels as high as those in almost any wild salmon. Hardy stresses that he is not ready to recommend which fish people should buy for specific dietary benefits, because individual people respond very differently to the same treatments. But medical specialists agree that eating fish is superior to taking capsules as a way of adding fish oil to the diet.

WHY DO THEY DIE?

Each year, from spring through fall, up to 90% of yearling salmon, especially Atlantics, die after being transferred from freshwater hatcheries into saltwater net-pens in Puget Sound. The losses cost local growers millions of dollars every year. The exact causes of death are a mystery. Researchers at the University of Washington School of Fisheries, with funding from the Washington Sea Grant Program, are spearheading attacks on this problem, which also afflicts net-pen salmon

growers from British Columbia and as far away as Chile, Scotland, and Norway.

- *Conditioning and Stress* —A group led by professor **Walton Dickhoff** is measuring salmon's resistance to physiological stresses such as the transition from fresh to salt water. Simple exhaustion may be a cause, but stress may increase susceptibility to disease and harmful plankton. Observing such properties as growth hormones and enzymes, Dickhoff has found that most fry are transferred to salt water too early in spring, and many survive better if kept in fresh water until the fall. Fry also survive better if they are kept cool in the winter, and if lights are used to simulate the longer days of spring during this period.

- *Kidney Disease* — Professor **Marsha Landolt** is leading a team using biotechnology to develop a vaccine against Bacterial Kidney

Disease (BKD), the most common and serious disease affecting salmon and trout worldwide. It is difficult to find a stock of fish anywhere in the U.S. that is free of the disease, and BKD is a particular problem now in British Columbia and Chile. A preventative vaccine could save growers millions of dollars, but currently there is no vaccine, nor even any antibiotics approved for use in food fish, that can control the disease. Landolt and her co-workers plan to locate the BKD gene and splice it into common laboratory bacteria to mass-produce antigens, the raw materials for large-scale immunization of fish in water baths.

SHELLFISH AND SEAWEED CULTURE

Over its short life, Washington Sea Grant has helped revolutionize shellfish culture in Washington State. The values of selective breeding and genetic research

has been demonstrated, new breeds have been developed, and technology transfer has fostered a variety of shellfish enterprises and a nascent seaweed industry as well.

• *Shellfish*. The leader of the transformation in shellfish culture has been fisheries Professor **Kenneth Chew**, who has guided numerous talented students. Research conducted through his laboratory, in conjunction with commercial growers, has virtually created two shellfisheries where none existed before.

The Manila clam (*Venerupis japonica*) was introduced unintentionally into Northwest waters from Japan in shipments of oyster seed during the 1930s and '40s. Popular as a "steamer" clam, it is an excellent clam for sport and commercial production because of its high survival rate, rapid growth, and ease of digging and culturing artificially. Nevertheless, Manila clam fisheries

essentially did not exist before 1970, when only 500,000 pounds were harvested. During the 1970s, Chew and his associates conducted research on the natural characteristics of the species and on methods for supplementing stocks through mariculture.

As a result, Washington is now the world's largest producer and exporter of Manila clams, yielding 4-5 million pounds per year. The estimated market demand for this species would support even double this production level. With funding from the state legislature, Chew, Doug Thompson of the Washington Department of Fisheries, and Washington Sea Grant Communications are currently updating a popular 1982 publication, *A Guide to Manila Clam Aquaculture in Puget Sound*, intended for commercial growers, public beach managers, and private beach owners.

A similar line of research during the same period has led to the appearance of the blue mussel (*Mytilus edulis*) at fish counters and on restaurant menus. This delicacy, long popular among Europeans, is now vying for the attention of U.S. consumers.

Chew's crowning research achievements, however, have been in oyster culture. From difficult times 20 years ago, Washington's growers have built up their industry until they now produce 30 to 50% of the nation's oyster crop. Chew's Sea Grant research on hatchery techniques and selective breeding has been instrumental in this phenomenal success.

In Chew's most recent and most spectacular accomplishment in oyster culture, graduate students **Standish Allen** (now at Rutgers University) and **Sandra Downing** perfected a chemical technique for creating triploid oysters.

Like similarly treated salmon, triploid oysters have an extra set of chromosomes and are essentially sexually sterile. Thus, they remain firm, meaty, and sweet during the spawning season from May through August (the months with no "R"). The result is the potential to offset the 70% drop in state oyster sales during summer.

Although they were denied a patent for their technique, Chew, Allen, and Downing's application stimulated the U.S. Patent Board's historic 1987 decision that animal life is patentable. Patent or no, at least two commercial hatcheries and several growers in Washington are now geared up to produce triploids in commercial quantities, and thereby to change the face of the global shellfish marketplace for both consumers and growers.

Mathisen, who founded the marine acoustics program at the UW School of Fisheries. As the program drew in many other benefactors and workers, Sea Grant always played a very important part. It provided graduate support for Alan Wirtz, designer of the basic echo sounder and co-founder of Biosonics with his advisor, UW electrical engineering professor William Acker.

DIETARY FISH OIL

Dr. Robert Knopp of the UW Department of Medicine and nutritional sciences professor Marian Childs have been investigating the effectiveness of dietary fish oil supplements. They find that large doses of Ω -3 fatty acids (nine grams per day) can cut levels of dangerous blood triglycerides in half, reducing the risk of pancreatitis. The responses they observed in blood cholesterol were more complex, however, and appeared to depend on family history. Their results suggest that fish oil helps some people lower their total cholesterol levels, but may actually raise levels of harmful low-density (LDL) cholesterol in sensitive subjects. They are continuing to study how to identify appropriate patients for fish oil treatment.

TERRY NOSHO AND THE NOXIOUS PLANKTON

In September, 1989, a multimillion dollar tide of death swept through salmon farms in the San Juan Islands and the Strait of Juan de Fuca. The tiny but lethal agent of this plague, which cost some growers nearly their entire fish production, was a bloom of a single-celled species of plankton called *Heterosigma*.

Washington Sea Grant Marines Advisory Services aquaculture specialist Terry Noshio works closely with salmon growers, as well as with other aquaculture enterprises. He saw the financial losses and recognized the need to help the industry. Although there is no known way to prevent the outbreaks, Noshio knew that there was a body of knowledge among scientists, including some from British Columbia where this problem had existed for years. Noshio quickly organized a two-day workshop for growers, held in February, 1990, on the UW campus. He invited managers and researchers from the U.S. and Canada to speak about how they respond to noxious plankton blooms. A summary of this workshop is now available.

In addition, Sea Grant had just initiated a project by professors Karl Banse and Frieda Taub to monitor salmon mortalities in Puget Sound and try to learn more about how *Heterosigma* causes them. As part of the workshop, graduate student Jack Rensel and UW oceanographers Rita Horner and James Postel conducted a

• *Seaweed*. UW Botany professor **J. Robert Waaland**, working with **Thomas Mumford** of the Washington Department of Natural Resources, helped pioneer Puget Sound farming of *nori*, the edible seaweed used in the Japanese dish sushi. *Nori*, made from the red seaweed *Porphyra*, is the world's most valuable aquacultural crop, worth more than one billion dollars annually. With Waaland working in the laboratory and Mumford in the field, and the participation of local farmers, several native species have been domesticated. They should offer a wide range of tastes, textures, and growth conditions, and should have greater resistance to local pests. Waaland also has made substantial progress at propagating plants vegetatively, instead of sexually—a process analogous to rooting cuttings in land plants. This ability has immediate applications for

research, and in the future could greatly simplify nori farming.

Puget Sound nori also has biotechnological uses. A pigment from *Porphyra* is marketed and used as a fluorescent label for antibodies in medical research by **Cyanotech**, a Woodinville firm. Commercial growers are studying other possible edible seaweed crops such as kelp pickles. Discussions are under way with the Port Gamble Klallam tribe, which has an aquaculture site. Another possibility is a land-based culture system for nori, either locally or alongside OTEC (Ocean Thermal Energy Conversion) facilities, large-scale renewable energy projects currently proposed off Hawaii.

Waaland notes that seaweed farming had the potential to reverse the usual flow of technology across the Pacific: it originated in Japan, but Puget Sound-

ers have copied and improved upon it. Domestic seaweed was already beginning to supplant Japanese products in the small but growing local marketplace. Local nori growing is encountering public opposition, however, mostly from owners of upland property overlooking potential nori farms and from fishermen who fear being displaced from accustomed waters. So Waaland's findings may instead benefit growers in other countries such as China, England, New Zealand, Canada, and Japan.

MARINE ADVISORY SPECIALISTS HELP BUSINESSES AND CONSUMERS

SOME OF Washington Sea Grant's greatest benefits come not just from the research it sponsors but also from its special role in disseminating research knowledge to those who need it. Marine Advisory specialists, based on the UW campus but ranging far afield in their professional rounds, provide a valuable linkage between the ivory tower and the rest of the marine community.

• **John Peters**, seafood specialist with Washington Sea Grant's Marine Advisory Service, is dedicated to enhancing the quality, consistency, and safety of seafood products sold in American markets. He assists the local seafood industry by making personal

contacts, writing publications, and conducting workshops and short courses in which fishermen, processors, wholesalers, and retailers learn to upgrade their skills.

Despite recent public concern about pollution and safety, Peters is confident that the majority of seafoods produced and marketed in the United States—and especially in the Northwest—are clean, safe, and healthful. He says recent studies show that seafoods are responsible for a very low percentage of food-borne disease outbreaks in this country. About 90% of seafood-borne illness, Peters estimates, is self-imposed among people who consume:

- recreationally harvested fish and shellfish
- illegally harvested shellfish bootlegged to market
- raw or undercooked seafoods
- some imported products that undergo less inspec-

tion than domestic products

· a few species of tropical and subtropical fishes that feed on toxic algae, or that have been carelessly harvested and handled.

Peters says voluntary industry safeguards, local, state, and federal regulations and inspections, and other practices help assure consumers of a safe and wholesome seafood supply. But, he adds, these precautions do not address an underlying problem, the decline in water quality. "Unless we stop polluting," he warns, "the problem will continue. Inspection alone won't maintain our supplies of clean and healthful seafood."

Peters advises consumers to shop for seafood as they would any other food: pay attention to the appearance, texture, consistency, and smell. Buy from reputable dealers, trust their advice, and give them feedback on

how well you liked their products. He also says consumers can maximize their eating pleasure by following the Golden Rule of seafood handling—keeping it cold and clean—between purchase and preparation.

• Washington State boasts one of the nation's longest saltwater coastlines. It extends 2,656 miles and includes the 1,411 miles of Puget Sound shoreline, the Pacific coast, and the marine reaches of the Columbia River and its estuary. These coastal resources are among our most valuable assets. Protecting these assets, while still permitting their judicious use and development, is a challenge indeed.

Robert F. Goodwin, an urban geographer, has served as coastal resources specialist for the Washington Sea Grant Marine Advisory services for the past 15 years. He assists coastal resource users

and managers by providing information, technical assistance, workshops, and publications so that the problems and needs of various user groups such as local government, waterfront industries, public interest groups, and concerned citizens may be better understood and wise decisions made on how these resources are managed. He is in constant demand for review of waterfront project plans and for networking among coastal resource users.

Goodwin's name is found on numerous publications that are useful for shoreline planners. In 1987, he organized a conference that brought together planners from around the Northwest to share experiences, and he edited its proceedings to publish *Waterfront Revitalization for Smaller Communities*. He did likewise with the proceedings of a conference of marina officials and recreational boating

laboratory session to train the growers on the types of situations when the noxious plankton can develop, how to recognize it, and possible measures to mitigate losses. The investigators have also produced a written identification guide to Puget Sound plankton. They are now forging close cooperative links with UW Botany professor Rose Ann Cattolico, whose plant molecular biology laboratory is the main local source of expertise on *Heterosigma*.

These effort have been timely, as *Heterosigma* struck Puget Sound again and caused additional widespread salmon mortalities in July, 1990. This time, however, with advance notice, some farms were able to take the preventive action of moving their pens, thus avoiding catastrophic losses of fish.

MAS NORTH PUGET SOUND OFFICE

Salmon enhancement efforts are conducted in conjunction with the WSG Marine Advisory Services North Puget Sound field office in Bellingham, a cooperative project with the Bellingham Vocational-Technical Institute. Fisheries adviser Robert Suggs has worked with the Whatcom County Fish Enhancement Council to obtain \$22,000 from the Port of Bellingham commissioners for volunteer salmon enhancement projects. Those local volunteer citizens and school groups were able to release more than a million salmon fry and 75,000 smolts during 1989-90.

Edward Melvin, MAS Bellingham field agent, took over from Jim Humphreys in June, 1990. Melvin came to Washington from Santa Cruz, California, where he was MAS agent for 10 years. He comes with broad experience in teaching, research, and technical assistance relating to commercial fisheries, salmon and wetlands enhancement, aquaculture, water quality, and coastal resource management. He is currently funded by the National Marine Fisheries Service and California Sea Grant to investigate the potential of hagfish as a new commercial fishery for the West Coast. He also serves as vice president of the Pacific Coast section of the National Shellfisheries Association.

specialists, producing *Boating and Moorage in the 90s*. He also co-authored, with James Good of Oregon Sea Grant, *Waterfront Revitalization for Small Cities*, a practical handbook for urban shoreline planning. In a report to be issued in fall, 1990, Goodwin will reveal results of a current survey of the need for marinas and moorage space in the state.

- Washington's strategic location in the northwest corner of the U.S. fosters the state's active trade with Alaska and the Far East. Washington boasts 12 major deep-draft ports for ocean commerce and 12 slack-water barge ports on the Columbia/Snake River system. It also has many smaller ports that contribute to the economic well-being of their communities. Development of capital-intensive port facilities, shrinking funds for construction and expansion, and increasing public scrutiny make it

imperative for ports to analyze current practices and plan for the future.

Thomas J.

Dowd is port industries specialist for Washington Sea Grant Marine Advisory Services and affiliate professor of port and marine transportation in the University of Washington Institute for Marine Studies. He works with ports and other maritime industries to help them solve problems and make better managerial and operational decisions. He conducts research in the field, provides data, and has written a series of practical guides for port managers. His scope covers ports nationwide, as well as in Canada and around the world. At Dowd's urging, the university set up the only graduate-level port and marine transportation management program in the U.S. and one of only three in the world.

In 1990 Dowd was named a one of nine distinguished North

American transportation professors at International Intermodal Expo '90, a prestigious exposition for the shipping trades. He also serves on the marine transportation task force of the Transportation Research Board of the National Research Council, the most prestigious body of its kind in the nation, which addresses critical maritime transportation issues facing government and industry.

RESPONSES TO STATE EDUCATIONAL NEEDS

K-12 EDUCATION

A RECENT survey by the Seattle Aquarium found that 75% of science teachers taught marine science, even in eastern Washington, and 85% said they needed more training and teaching materials to do the job right. Two recent activities illustrate the pioneering role Washington Sea Grant has played in meeting these needs and stimulating innovation in marine science education.

- "Water on Wheels," the Pacific Science Center's traveling van, brought marine science lessons to nearly 200,000 students and teachers throughout Washington from 1986 to 1989. The van operated on the principle of hands-on participation. **Andrea Marrett**, teacher education manager for

the Pacific Science Center, quotes Dr. Gerald Krockover of Purdue as saying that people remember “10% of what we hear, 15% of what we see, 40% of what we discuss with others, and 80% of what we practice or experience directly.”

The van contained such student activities as a darkened “Feely Box and Touch Board” in which creatures were felt but not seen; a model fish that rose and sank in a tank as students adjusted its swim bladder pressure; and a computer model that showed a fish responding when its fins moved. Following the visit, the van would leave each school a Salmon Curriculum Kit, which provided a complete two-week lesson plan of activities centered around salmon survival and integrating science, mathematics, and computer skills.

Sea Grant’s educational support can be traced back to 1971,

when it funded construction of a working physical model of Puget Sound at the Science Center. Sea Grant then helped promote curriculum development in the 1970s with Ocean Related Curriculum Materials (ORCA), recently revised, and in the 1980s with Salmon Curriculum Kits. Both are now in use nationwide.

- The Aquarium now has its own traveling exhibit, “Puget Sound on Wheels,” and circulates its own set of portable displays, called “Get Wet” kits, to state schools. In 1986-87, together with the Poulsbo Marine Science Center, it also offered teacher training workshops sponsored by Sea Grant. The workshops attracted about 300 teachers at 12 locations in eastern and western Washington.

The Aquarium’s “Get Wet” kits, loaned to schools statewide, cover the topics of Marine Mammals, Pacific Salmon, Fish Adaptation,

and Washington Seashores. They consist of three boxes: a tabletop display; interactive items such as whale sounds and homing scents; and an activity box with a slide show, life-size marine mammal banners, and life-size models and pictures of salmon life cycle stages.

VOCATIONAL EDUCATION

EARLY IN its history, Washington Sea Grant provided early support for course development and equipment to set up marine vocational training programs in western Washington. Today, most of these programs have grown to operate independently.

- Shoreline Community College developed two-year programs for oceanographic and marine biological technicians.

- Grays Harbor College broadened its fisheries technician program, and Clover Park Vocational-

Technical Institute added courses in marine refrigeration, hydraulic systems, and mechanics for fishing boats.

- Highline Community College established a hard-hat diving program that trained maintenance crews for *Tektite II*, an experimental manned underwater habitat in the early 1970s. The program has since trained commercial divers for numerous applications such as working on the underwater structures of offshore oil rigs.

- The marine trades program at Seattle Central Community College developed a personnel training course in petroleum transportation and handling that complemented other courses in fire fighting, safety, diesel engine repair, and related topics.

The Sea Grant Marine Advisory Services office at Fishermen’s Terminal retains ties with this program as it



SEA GRANT FELLOWS FROM UNIVERSITY OF WASHINGTON

The John A. Knauss National Sea Grant Fellowship program gives marine policy graduate students from UW and other universities a year of first-hand experience with a congressional staff or executive agency in Washington, D.C. The fellowships are named for a long-time academic supporter of Sea Grant who is currently director of its parent agency, the National Oceanic and Atmospheric Administration (NOAA). Fellows are selected on the basis of academic achievement, scientific background, and policy experience and skills. As one of the primary centers for marine science and policy studies in the nation, UW has sent at least one fellow every year since the program began in 1979, and more fellows than any other Sea Grant program. In 1990, Jean Flemma became the 23rd Sea Grant Fellow from UW in the 12 years of the program.

adapts to a changing world. The U.S. merchant marine fleet is shrinking in the face of competition from low-salaried, foreign flag vessels, and demand for many of the maritime courses is dropping. There appears to be growth potential in marine safety instruction for the fishing industry, however, one of Sea Grant's strengths.

- Marine Advisory Service field offices also currently operate in cooperation with Bellingham Vocational-Technical Institute and Peninsula Community College in Port Angeles.

UNIVERSITY EDUCATION

PERHAPS SEA Grant's most important "product" is the graduate students it supports and the expertise they develop with Sea Grant support. Sea Grant offers university students the opportunity to participate in the state-of-the-art research it sponsors. In addition, the program has also supported the development of whole new academic programs which create teaching positions as well as different avenues for research.

- Sea Grant support during the 1970s was crucial to the creation of UW's Institute for Marine Studies (IMS), now one of the premier marine policy research and education centers in the world. The Institute has turned out so many successful students, produced so much important work, and become so integral to discussions of marine affairs locally,

nationally, and internationally that it seems to transcend its age of only 15 years. The Institute closed a critical gap in the University's and the community's ability to analyze and prepare students for legal, administrative, and economic trends taking place in the marine sector.

These abilities were extremely valuable, for example, when the Magnuson Fishery Conservation and Management Act of 1976 imposed U.S. authority to regulate fisheries within 200 miles of its shores. This move prompted an international reshuffling and a badly needed conservation of high seas fisheries. It then led to the groundfishing boom that brought prosperity to Washington fishermen during the 1980s, just in time to help those retooling from the Boldt decisions of the 1970s. The effects of the Magnuson Act have now come full circle in the form of domestic user conflicts

and competition in a fully exploited and mature fishery.

Over the same period, the states have asserted increasing power and responsibility over their shorelines. Washington was the first state in the nation, in 1971, to obtain federal approval of its shoreline management program, and scholars at the Institute for Marine Studies, with support from Washington Sea Grant, have been leaders in monitoring the program's subsequent performance. Their continuing studies on shoreline issues enabled **Marc Hershman** and his students, for example, to write a pioneering book summarizing the regional effects of shoreline management. IMS researchers **David Fluharty** and **Tom Leschine** also have been important players in marine resource management in this state. They have led their students into participation in offshore oil studies and

analysis of the workings of the Puget Sound Water Quality Authority, which was created in the mid-1980s to coordinate and promote effective management and cleanup of Puget Sound.

• Washington Sea Grant also played a useful role in the creation of two other strong marine-related programs at UW. One is the Ocean Engineering program, of which researcher **Bruce Adee's** fishing vessel safety program, described elsewhere in this report, is an example. Another is the Ocean Law program, headed by professor **William Burke** in the School of Law. Burke is an internationally recognized expert on subjects such as the Law of the Sea Convention. He also spends considerable time supervising students in his other specialties, legal issues with great local relevance, such as the 200-mile limit on fisheries and regulation of oil tanker traffic in Puget Sound.

Student/Internship	Status as of August 1990	Student/Internship	Status as of August 1990
Dan Ashe 1982—House Merchant Marine & Fisheries Committee	House Merchant Marine & Fisheries Committee, Washington DC	James H. Rendall 1979—NOAA National Marine Fisheries Service	Deceased
Xan Augerot 1986—Senate Commerce Committee	Assistant to the Director, Washington Sea Grant Program, Seattle WA	Vernon Ross 1988—National Science Foundation	Office of Budget & Control, National Science Foundation, Washington DC
Darrell Brown 1980—House Merchant Marine & Fisheries Committee	Environmental Protection Agency, Washington DC	Monique Trainor Rutledge 1983—NOAA Office of Marine Pollution Assessment)	NOAA National Marine Fisheries Service, Portland OR
James Buizer 1984—NOAA Office of Atmospheric Research International	NOAA Office of Climate & Atmospheric Research, Silver Spring MD	Gary Shigenaka 1986—Coastal & Estuarine Assessments Branch, Ocean Assessments Division	NOAA National Ocean Survey, Hazardous Materials Response Branch, Seattle WA
Christine L. Dawson 1979—National Ocean Policy Study, Senate Commerce Committee	Policy & Planning Staff, U.S. State Department, Washington DC	Allen Stayman 1979—Staff of Senator Lowell P. Weicker (R-CT)	Senate Energy & Natural Resources Committee, Washington DC
Gina Deferrari 1981—House Merchant Marine & Fisheries Committee	House Merchant Marine & Fisheries Committee, Washington DC	Erik Stromberg 1982—Staff of Congressman Glenn Anderson (D-CA)	President, American Association of Port Authorities, Washington DC
Jean Flemma 1990—House Merchant Marine & Fisheries Committee	Now serving internship	Deborah Trefts 1985—House Merchant Marine & Fisheries Committee	Office of Offshore Development, Sacramento CA
Laura Geselbracht 1987—NOAA Strategic Assessments Branch, Ocean Assessments Division	Shapiro & Associates, Seattle WA	Paul Vincent 1981—Senate Commerce, Science & Transportation Committee	Eagle Pet Supply, St. Paul MN
Wendy Graham 1989—House Science & Technology Committee	PTI, Inc., Bellevue WA	Susan O'Malley Wade 1983—House Merchant Marine & Fisheries Committee	Office of Offshore Development, Sacramento CA
Dan Grosse 1989—Office of Oceanographer of the Navy	NOAA National Marine Fisheries Service, Silver Spring MD	Matthew Wells 1987—Staff of former Senator Lowell Weicker (R-CT)	Attending School of Law, University of Washington, Seattle WA
Karen Holtz 1989—NOAA Marine & Estuarine Management Division	NOAA National Marine Fisheries Service, Silver Spring MD	Dolores Wesson 1988—House Merchant Marine & Fisheries Committee	California Sea Grant College Program, San Diego CA
Kevin McManus 1983—NOAA National Marine Fisheries Service	NOAA National Marine Fisheries Service, Washington, DC		



WASHINGTON SEA GRANT PROGRAM ADMINISTRATION

THE MANAGEMENT of Washington Sea Grant provides coordination and direction for the program. It integrates the program functions, defines program priorities and directions, and secures sources of funding. The staff also manages funds for program development projects and cooperative agency programs. These activities make Sea Grant an active partner and guiding force in the new frontiers of local marine research.

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MARINE ADVISORY SERVICES

WASHINGTON SEA Grant

Marine Advisory Services provides information and skills to citizens, business, industry, and government, to foster effective use and wise management of marine resources. The program works with public and private resource users and managers in a wide range of topical areas through a system of specialists and agents with defined duties. Their functions include developing new information through original research; gathering existing information for user needs; transmitting information and skills

through pamphlets, courses, workshops, lectures, and meetings; providing technical review of research and policies generated elsewhere; and stimulating new research to meet perceived needs.

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Washington Sea Grant
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3716 Brooklyn Ave. NE
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FAX (206) 685-0380

Expertise: program administration, publications, public policy education, water resources management

FIELD OFFICES

Marine Advisory Services operates four full-time field offices and two part-time satellite offices, and jointly operates two Water Quality regional project offices with Washington State University Cooperative Extension, to

serve western Washington and the Columbia/Snake River system. For general information or assistance in their areas of expertise, contact the nearest field agent.

Seattle and Central Puget Sound Office, Fishermen's Terminal

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Expertise: commercial fisheries, gear design and utilization, Central and South Puget Sound

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Edward F. Melvin,

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Robert Suggs, Fisheries Advisor

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Expertise: fisheries management, shellfish, habitat, North Puget Sound

Coast Office, Montesano

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Expertise: aquaculture, fisheries, seafood, Washington coast

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Specialists at the
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transmits information on
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government, the press,
and the general public
through a variety of
outlets. The program
publishes books and
technical reports, docu-
ments program accom-
plishments, and gener-
ates news releases and
features. It also works
closely with investigators
to plan training work-
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conferences. In addition,
the staff offers a public
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LOOKING AHEAD

OVER ITS TWO DECADES OF LIFE, SEA GRANT HAS BEEN A RELIABLE AND PRODUCTIVE INVESTMENT. AS WE ENTER THE 1990S AND MOVE TOWARD A NEW CENTURY, SEA GRANT'S EXPERTISE WILL BE IN DEMAND FOR NEW PROBLEMS AND OPPORTUNITIES, EVEN AS ITS CURRENT PRIORITY EFFORTS CONTINUE:

- THE PRESSURES OF POPULATION AND ECONOMIC GROWTH WILL ACCENTUATE THE NEED FOR BETTER UNDERSTANDING OF MAN'S IMPACTS ON COASTAL WATER QUALITY AND ON CRITICAL WETLAND HABITATS.
- A REVIVAL OF OCEAN TECHNOLOGY INDUSTRIES, WITH AN INCREASED NEED FOR INDUSTRIAL AND ENVIRONMENTAL MANAGEMENT OF TECHNOLOGY, WILL CREATE NEW DEMANDS FOR RESEARCH AND EDUCATION.
- THE REVOLUTIONARY GROWTH IN BIOLOGICAL KNOWLEDGE OVER THE PAST

30 YEARS HAS OPENED NEW OPPORTUNITIES IN THE COLLECTIVE FIELD OF MARINE BIOTECHNOLOGY. THIS FIELD PROMISES MAJOR NEW ADVANCES IN OUR ABILITIES TO PRESERVE AND SUSTAIN THREATENED FISH GENE POOLS, TO IMPROVE FISH AND SHELLFISH CULTURE, AND TO PROMOTE NEW APPROACHES TO THE DETECTION AND CLEANUP OF HUMAN WASTES AND CONTAMINATED SEDIMENTS.

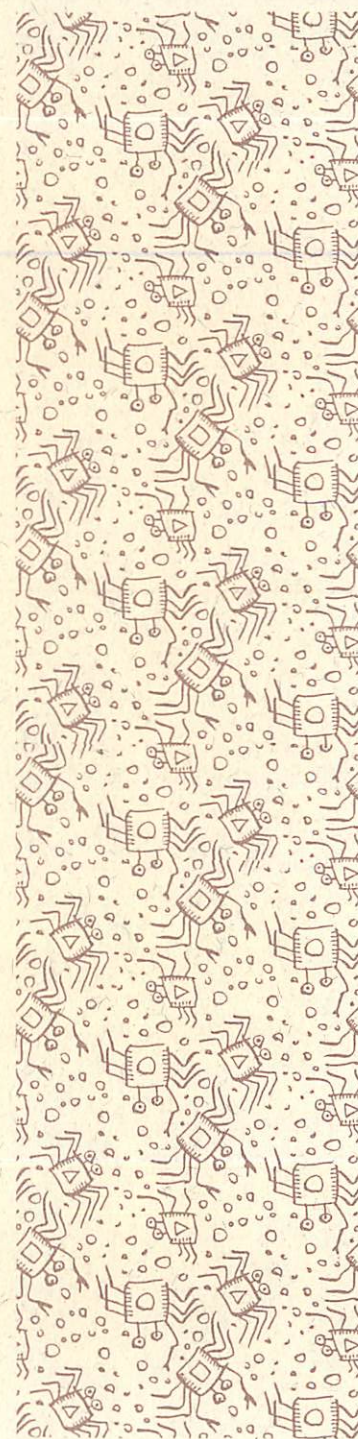
- WHILE THE WEST COAST—PARTICULARLY THE NORTHEAST PACIFIC—REMAINS ONE OF THE FEW BRIGHT SPOTS IN U.S. FISHERIES, BETTER UNDERSTANDING AND ESPECIALLY IMPROVED USE OF SCIENTIFIC KNOWLEDGE WILL BE NECESSARY TO MAINTAIN A HEALTHY FISHERY. THERE IS ALSO A GROWING AWARENESS OF THE NEED FOR RESEARCH IN THE COASTAL ZONE, WHERE HUMAN ACTIVITIES THREATEN CRITICAL FISHERY AND LIVING RESOURCE

HABITATS IN NEARSHORE WATERS, ESTUARIES, WETLANDS, AND STREAMS.

- COMPETITION AMONG HUMAN USES OF THE COASTS AND OCEAN—FOR RECREATION, FOOD, LIVELIHOOD, WASTE DISPOSAL, AND AESTHETIC ENJOYMENT—ARE CERTAIN TO INTENSIFY IN COMING YEARS. THE DEMAND FOR GUIDANCE FROM NATURAL AND SOCIAL SCIENTISTS ALIKE WILL GROW, AS BETTER CONFLICT RESOLUTION, IMPROVED DECISION-MAKING, AND WISER STEWARDSHIP OF OUR RESOURCES BECOME PARAMOUNT NEEDS.

OUR ASPIRATIONS FOR IMPROVING THE HUMAN CONDITION CAN REACH THEIR FULLEST FRUITION ONLY IN A HEALTHY NATURAL ENVIRONMENT. WASHINGTON'S MARINE ENVIRONMENT AND THE ECONOMIC GROWTH IT SUPPORTS ONCE APPEARED INFINITE, BUT WE KNOW TODAY THEY ARE LIMITED AND SOMETIMES FRAGILE. WASHINGTON SEA GRANT

HAS AN IMPORTANT ROLE TO PLAY, THROUGH RESEARCH, EDUCATION, AND ADVISORY SERVICES, IN FOSTERING USE OF MARINE RESOURCES IN A PRUDENT AND SUSTAINABLE MANNER. THE CHALLENGE FOR SEA GRANT IS TO EMPOWER WASHINGTON CITIZENS WITH KNOWLEDGE IN THEIR QUEST TO BALANCE THE DEMANDS FOR ECONOMIC AND ENVIRONMENTAL HEALTH.





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