have you got a moment? come on inside. there's some interesting stuff in here. some stuff about oregon's ocean. sea grant is helping people put oregon's ocean to work and now is your big chance to find out all about it, so why not take a look at this report on the oregon state university sea grant college program for 1976–1977

sea grant

Introduction

The name Oregon State University creates a mental image for the many thousands of us that have been or are a part of the university's tradition, history, programs and promise.

Some of us have studied at OSU. Many others of us use the results of research in homes and businesses through educational interaction with OSU's Extension Service.

A quite recent addition to the university's tradition and history is OSU's emergence as a major marine research, training and Extension center. This emergence has a dramatic effect on the university's programs today, and promises to be even more important in the last two decades of the 20th century.

The beginnings of OSU's interest in things marine stretch back to the early part of this century. The 1930s, however, brought focused effort on the farming of oysters and studies of water quality in a small laboratory on Yaquina Bay. Professor R. E. Dimick, who started OSU's Department of Fish and Game Management (now the Department of Fisheries and Wildlife), provided the pioneering enthusiasm for this effort.

The opening of the OSU Seafoods Laboratory in Astoria in 1940 formalized cooperative research and training with the seafood industry. Dr. Ed Harvey, first director of the laboratory, combined research and Extension activities to bring new forms of seafood to Oregon tables. Substantial impetus to increasing harvests of soles and rockfishes stemmed from mink nutrition research for mink farmers during and after World War II. First conducted in the Department of Fish and Game Management, the mink operation was later moved to the Department of Animal Science.

Increased work in basic marine biology and parasitology was linked to the late Dr. Ivan Pratt's studies at Charleston in the late 1940s.

Dr. Wayne Burt's arrival in 1954 brought the word "oceanography" to OSU's campus. First came course work and small-scale estuarine research, then a Department of Oceanography in the College of Science in 1959, and on to a School of Oceanography in 1969. An exciting story by itself, but only a part of how OSU has become a marine university.

With oceanographic ships, the **Acona** in 1962 and the **Yaquina** in 1964, to serve the burgeoning interest in marine research and education, a major coastal base was needed. The OSU Marine Science Center, a partnership between the people of Lincoln County, the federal government and the university, opened as our coastal campus in June 1965.

Marine advisory projects became part of the OSU Extension Service in the early 1960s. Early segments of this educational effort were aided by a short-lived federal agency called the State Technical Services Program.

Enactment of the National Sea Grant College and Program Act of 1966 by Congress provided another opportunity to focus major efforts of Oregon State University toward a program of research, education and training, and advisory service activities to help put Oregon's ocean to work. With support from Oregon's legislature, citizens and industries, OSU was successful in obtaining one of the first institutional (large-scale) grants in this national match-funding program. Three years later, in 1971, we were chosen as one of the first four Sea Grant Colleges in the nation. There are now 12 colleges.

Through these formative years, the leadership of Dean Roy Young, Dean John Byrne, Dean Fred Burgess, Director Joe Cox and Dr. Herb Frolander was pivotal.

Sea Grant funding provided us with the opportunity to organize a marine development program that can gear our entire talent base to the purposes of education, research and application of research results for the benefit of Oregon and the nation.

Through Sea Grant support, for example, new programs in ocean engineering, marine economics and the marine aspects of the humanities have been innovated at OSU. Vocational training of fishermen and marine technicians began at Clatsop Community College. Concentrations in marine and maritime law were commenced at the University of Oregon. Columbia River concerns on intermodal shipping and socioeconomic impacts of slack water navigation are being studied in a partnership with the University of Idaho and Washington State University.

Oregon State University has maintained an important position among the 30 or so universities involved as partners in the Sea Grant network. Currently, we are second in funding (to the University of California), and accepted as among the leaders in the development and implementation of the Sea Grant concept.

The OSU Sea Grant College Program is a sizable segment of the university's marine program, about 33 percent. Further, Sea Grant-supported work makes up about 10 percent of the total OSU research budget.

The OSU Sea Grant College Program is a region-wide attempt to address citizens' needs for knowledge on conservation and development of marine resources. We team the talents of professors and researchers, Extension agents and specialists, and students to help find action answers. The current program involves faculty from 11 departments, six schools and colleges, four universities and one community college.

An advisory council, composed of some of Oregon's leading citizens, provides counsel and guidance on policy and problem identification.

This annual report, required by Sea Grant legislation, is a departure from the more formal, corporate-style reports we have used in the past. It will reach 55,000 alumni, 12,000 parents of students, and more than 8,000 other friends of Oregon State University. The report to you on our active projects will attempt to show how education, research and advisory functions of Sea Grant are interwoven to provide action education that will benefit all of us.

We hope that this report will be of value to you. If, after reading the report, you have some advice or a question or two, please let me know.

William Q. Wick
Director, Sea Grant College Program
Oregon State University AdS 320
Corvallis, Oregon 97331

Fish for the future

An age-old question with new importance to a growing world: how many fishes in the sea?

Modern scientists add their own queries: how do these fishes breed, feed and interact in Oregon's ocean?

Sea Grant scientists study fish stocks to answer these questions. What will their answers mean?

For commercial and recreational fishermen, an assurance of healthy stocks of Oregon's valuable fish and shellfish; for the consumer, continued supplies of nutritious fish in local supermarkets; and for the world, high-quality protein to stave off a hungry future.

More Than Meets the Eye

On a summer Sunday, people with pails, rakes and shovels throng intertidal mudflats in Oregon's bays, seeking cockles, butter clams . . . and gaper clams.

What these clam diggers don't see are the dense clam beds found in regions beyond the tide's ebb. For the past three years, these subtidal areas have been the province of Danil Hancock, leader of a Sea Grant research project on subtidal clam populations.

"Because of growing consumer demand for clams, commercial harvesters are interested in the subtidal clam beds," says Hancock, instructor in oceanography at OSU. "Gaper clams, for instance, are far more numerous in subtidal beds than in intertidal areas where recreatonal clammers dig. The subtidal gapers also grow larger and have heavier shells than the intertidal clams."

The Oregon Department of Fish and Wildlife (ODFW), a participant in the Sea Grant study, has granted five commercial permits for experimental harvest of clams in Yaquina Bay. Since most of the clams will be gapers, Hancock and research associate Gail Breed have focused their recent research on the ecology and management of this clam.

Subtidal Sex Lives

The OSU researchers believe that before large-scale harvesting begins, we need to know how subtidal populations contribute to intertidal and total numbers of gaper clams, and what harvesting techniques are soundest from a management viewpoint. The two are studying the gapers' spawning characteristics to determine how intertidal clam beds depend on subtidal populations.

In Oregon, gaper clams spawn during January and February. As a winter-spawning clam, gapers probably contribute numerous larvae to the plankton that is food for other estuarine organisms during a critical season of the year.

"Because it's free-swimming or floating, a gaper larva can go anywhere in the bay. Since the greater numbers of subtidal gapers will produce more larvae, these clams could play a major role in replenishing intertidal beds," says Breed.

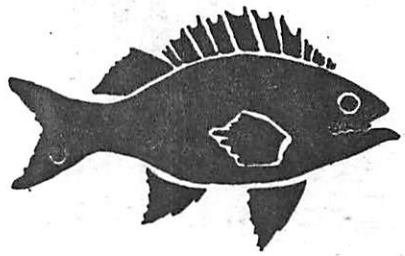
"Besides determining the numbers of larvae present in Yaquina Bay at different times of year, we will also dissect gaper clams to find out at what age they become reproductively mature."

Breed will measure the volume of gonads, or reproductive organs, as a percentage of each clam's body weight. She will correlate this percentage with the clam's age.

"Young gaper clams have little gonad tissue, but during the second or third year there's a rapid increase in the size of the reproductive organs. After this spurt of gonad growth evens off, the gapers will continue reproducing until they're about nine years old."

Combine the gapers' active spawning age with the subtidal clams' role in replenishing intertidal beds, and a possible management strategy appears. According to Breed: "Give the gapers two or three years to spawn; after they've finished their rapid gonadal growth, then they're fair game for fishing."

Since ripe clams yield more meat, harvesting techniques should ideally select ripe clams aged five years or more. But the experimental methods, such as jet stream and suction dredge, that harvesters are testing under ODFW's permits are not age selective. They may also disrupt the clam beds, killing gapers that aren't taken.



Because of these problems, the experimental harvests are being monitored to check what happens to the subtidal beds, what size of clams are being taken, and how much area should be opened to fishing.

And to Hancock, this Sea Grant study isn't just an important step in gauging the wisest management strategy for a new resource. "It also illustrates why we need scientific studies before we rush headlong into harvest."

Crabs on the Range

You wouldn't expect to find a Western-style roundup taking place in a small boat bobbing about on Yaquina Bay.

But substitute scuttling Dungeness crabs for bawling calves, as Richard Stroud, an OSU Sea Grant researcher, is doing, and you'll see the roundup's time-honored technique of branding given a new twist.

Dungeness crabs bring in about $15 million to West Coast commercial fishermen. Sportfishermen also harvest fair numbers of the shellfish. Because of the market demand for the tasty crabs, those who manage fishery resources need scientific management studies to guard against overfishing.

Scientific management requires population studies to keep tabs on the number of crabs inhabiting Oregon's bays and offshore waters. And population studies depend on tagging, or branding, individual shellfish.

"These studies assume that you can calculate a total population by marking a known number of animals. Say that you brand 1000 crabs and put them back into the bay. These marked animals will be reported by fishermen and processors. If 10 out of every 100 animals caught bears a brand, you can calculate a total population of 10 times the number originally tagged, or 10,000 crabs," says Stroud, research associate in veterinary medicine at OSU.

"Git Along, Little. . ."

Because crabs molt in order to grow, they will shed with their old shells any metal or plastic tag that has been attached. Thus through his Sea Grant research Stroud has sought new techniques that would permanently mark significant numbers of crabs cheaply and rapidly. Changing the colored pattern in the crabs' shells by freeze branding or laser marking seems to do the trick.

According to Stroud, "A membrane beneath the crab's calcified carapace, or outer shell, contains melanocytes, cells that supply the characteristic pigment to the carapace as the crab grows a new shell after molting. Destroying these cells in a certain spot leaves a white mark, or brand, that will last through successive molts."

Stroud worked with Keith Farrell, an Agricultural Research Service scientist at Washington State University, who had originally discovered freeze branding as a method for marking wildlife, and is now working with laser branding techniques.

"In freeze branding, we touch the crab's shell for five to 10 seconds with a small sponge that's been dipped in liquid freon, a supercooled gas that's about the temperature of dry ice. The freon creates ice crystals in the melanocytes, which absorb the cold faster than the surrounding tissues. As the ice crystals thaw, they rupture and destroy the pigmented cells," Stroud explains. Lasers also destroy melanocytes, but with light energy that is selectively absorbed by the pigment-bearing cells.

Stroud has found laser marking a more controllable technique. But freeze branding doesn't require the sophisticated, sensitive equipment that lasers do, and so is a simpler method for wildlife biologists working with large numbers of crabs on small boats at sea.

"Freon's the right temperature for easy, rapid branding, it's commercially available at low cost, and there's room for some variation in application time."

Turning 'Em Loose

Stroud points out that in branding animals for population studies it's important that the marked animals survive; if more branded than unmarked crabs die, resulting population estimates will be skewed. Freeze branding on the back edge of the carapace offers a smooth, flat surface for the sponge, and no major organs or nerves that might be shocked with cold lie under this part of the shell.

Freeze branding also means lower mortality from the shock of handling, Stroud indicates; it's a fast enough technique to get crabs back into seawater quickly before they dry out.

At ODFW's research facility in Newport, crabs taken from Yaquina Bay were held in seawater tanks and cared for by Laimons Osis, ODFW fisheries biologist, while Stroud watched his brands last through several moltings.

"We just worked in Yaquina Bay, since bays are the source of young crabs that join offshore stocks. Though proving the technique was our main goal, we did mark, release and recover some crabs from the bay."

Stroud expects to hand off the freeze-branding methods to ODFW and to other fisheries agencies on both coasts that must manage crab fisheries.

Fish on the Rocks

The charterboat Hyak churns out of Depoe Bay into the Pacific's swells, bearing a group of eager anglers who will set their lines for rockfish and lingcod over the underwater reefs just offshore.

Chugging in the Hyak's wake, the dory Tooshqua also heads for the offshore reefs. Candia Coombs and Rick Steiner, the two OSU graduate students who pilot the dory, are also seeking rockfish, but the fish they catch are for statistics, not supper.

The fishes that inhabit Oregon's offshore reefs are a popular target for increasing numbers of sportfishermen, and are also caught by commercial fishermen. Thus these stocks represent yet another of Oregon's resources that face heavy fishing pressure.

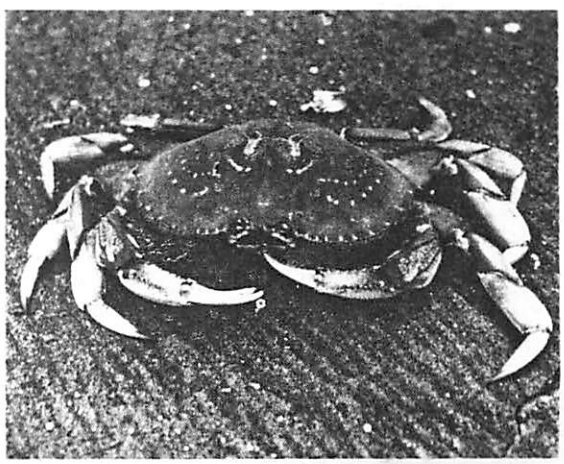
Seeking data for measures to conserve the stocks, Howard Horton, professor of fisheries at OSU, is taking the pulse of the reef fish populations through a Sea Grant project that is also supported by the Oregon Agricultural Experiment Station.

"We're concentrating on Siletz Reef, which lies between Government Point and Cascade Head, because it's one of the most heavily fished reefs. Many private boats and all the charterboats from Depoe Bay spend a good deal of time there, and the fishing goes on all year round," says Horton.

Lookout for Anglers

To describe the fishing effort, Horton scheduled shore-based observations along the coast overlooking Siletz Reef. Graduate student observers determined the number and types of fishing vessels over the reef and counted the number of anglers in each boat.

"Roughly 65 percent of the boats were private vessels, and we found from dockside sampling that on the average each angler was catching one



fish for each hour spent fishing. Charterboats, whose passengers caught an average of one and one-half fish per hour, accounted for the other 35 percent of boats plying the reef," according to Horton.

These figures translate into statistics on catch per unit of fishing effort, a tool fisheries biologists use to judge whether a species of fish is holding its own. ODFW is gathering similar data in a coordinated effort.

Dockside observations also revealed that about half of the fish caught were black rockfish. Yelloweye rockfish and lingcod represented about 15 percent each of the total catch, and fish from other species appeared in smaller numbers. The Sea Grant researchers will collate their observations to evaluate the sex, size and age of the fish.

Equally important to the Sea Grant scientists' goals are tagging and fish sampling. Steiner and Coombs have taken the Tooshqua out to Siletz Reef in all kinds of weather to catch and tag reef fish specimens.

So far, they have tagged 1300 fish, and have had 21 tags returned. Using the ratio of returns to the number tagged, they can estimate total populations of fish on the reef. For instance, out of 916 black rockfish tagged, 6 have been recovered, apparently indicating a reasonably healthy population.

"But," Horton explains, "we tagged only 33 yelloweye rockfish, and have recovered 7 tags, one of them twice, a very high percentage in comparison. This indicates that these fish are being heavily exploited, and that the population is small and probably vulnerable."

Fins on the Move

From data on tagging and return locations, Coombs is looking for evidence of reef fish migration. So far, the only evidence has been the recapture, by trawl fisherman Barry Fisher, of a lingcod that had travelled 20 miles south and 12 miles west from its original capture site.

"We suspect that lingcod are territorial fishes; they'll come onto the reefs in winter for reproduction, since their eggs must be laid on rocks. Afterward, when available habitat on the reefs has been staked out, the remaining lingcod head for deeper water offshore to find their own territories. Since the heaviest fishing pressure occurs on the reefs, even if lingcod numbers are fished down in a given year we believe that during the breeding season the reefs will be repopulated as the deep water fish move in to spawn," Horton explains.

"The rockfishes school, however, and probably spend their entire life cycle on the reefs. Knowing this, fisheries managers also know that you can't rebuild populations by recruitment from deeper water."

Rick Steiner has collected over 411 fish, of 12 different species, for analysis of stomach contents; depth of water and the nature of the seafloor were noted for each fish taken. Questions Steiner seeks to answer include how all the reef fish species inhabit the same area, what ecological niches they occupy and whether they compete for the same sorts of food. The ultimate puzzle is how overharvesting of one species affects other stocks with which it may interact.

Undersea Gardens in Newport is maintaining in its seawater tanks several of the fishes Steiner and Coombs have caught and tagged, so that the Sea Grant researchers can describe the fishes' behavioral patterns and determine how well the tags are retained on the fish.

ODFW, reflecting concern for the reef fish stocks, has changed catch regulations for the coming year. Only 10 fish per day may be caught, of which only three can be lingcod, and anglers may have no more than 20 fish in their possession. And, as resource managers balance the level of fishing pressure, the Tooshqua continues its voyages to find the statistics behind the angler's catch.

Anchovies – In Oregon's Ocean, Too

Though you may know anchovies as tidbits on top of pizzas, fishermen annually harvest millions of metric tons of the small fish off the coasts of Peru, Chile, Mexico and southern California. Processors convert most of this harvest into fish meal for domestic animal diets.

Anchovies also occur off Oregon's coast, but fishermen tap this northern stock only as a source of bait. Thus little scientific work had addressed the question of this stock's size and usefulness until Sally Richardson, associate professor of oceanography at OSU, began Sea Grant-supported research on Oregon's anchovies.

"We'd like to know what the potential yield of this northern stock could be," says Richardson. "It's possible that the anchovies are present in enough numbers to support commercial harvest. Also, this anchovy is a major source of food for tuna, salmon and at least four species of marine birds."

Anchovies, though found offshore along the coast of North and South America between British Columbia and central Chile, fall into subpopulations within their North American range. The northern subpopulation extends from Cape Mendocino, California, to British Columbia. Preliminary estimates of the northern subpopulation's biomass hover between 500,000 and one million metric tons.

Counting Little Fishes

During July, the peak period for anchovy spawning, Richardson went to sea in 1975 and 1976 to survey the ichthyoplankton, the minute floating egg and larval stages of fishes, in 60,000 square miles of ocean off Oregon. Samples of seawater taken from survey points within this area were examined under the microscope for numbers and species of planktonic organisms.

Richardson's figures for 1976 put a rough census of the number of anchovy larvae as four trillion. To estimate the number of adult fish that gave birth to this vast number of larvae, she is using data and a computer model the California Cooperative Fisheries Investigation developed.

"The whole question of larval feeding is of intense interest too: is there enough food for the larvae, can they seek out concentrations of food, and how these factors relate to their survival and the size of a particular year's crop of anchovies."

Another key to estimating anchovy biomass is the fecundity, or reproductive potential, of adult fish. An essential component of life history information, fecundity is the number of eggs produced per gram of female fish. Also important is determining the ratio of males to females. In July of this year, Richardson obtained 670 anchovies in spawning condition that were captured off northern Oregon and Washington, and has dissected them to refine her estimates of fecundity and sex ratios.

In July 1977, the National Marine Fisheries Service cooperated with the Sea Grant researcher in conducting an acoustic population survey covering 40,000 square miles. Survey results indicated for the third year in a row that a major spawning stock of anchovy occurs off Oregon and Washington.

According to Richardson, "Anchovies are pelagic, or open ocean, fish. They'll move 90 miles or more offshore, beyond the edge of the continental shelf, in summer to spawn. They avoid the zone of upwelling along the coast, where the water at 45 degrees Fahrenheit is too cold for eggs to survive. We've found that spawning adults stay near the seawater's surface, though at different times of year they have been taken by fishermen in bottom trawls."

Richardson has found the greatest concentration of spawning anchovies off the mouth of the Columbia River.

"The plume of river water flowing out into the ocean may create ideal feeding conditions for larvae, and may provide the warmer water the anchovies need for spawning success."

Larvae from the Columbia plume spawning grounds are gradually transported south along the coast by prevailing currents; juvenile anchovies are found in Oregon's bays during the spring and fall.

Richardson will put her estimates of stock size and potential yield to work in evaluating whether a commercial anchovy fishery on the northern stock is economically and environmentally feasible.

It's a fish's life

Life in the briny deep can become suddenly exciting, if you're a lingcod or rockfish hooked by OSU Sea Grant researchers and hauled up from the dark offshore reefs you call home. Gentle hands quickly measure, weigh and tag you on board a rocking platform. Then it's back over the side into the sea, and you begin a dazed descent to your rocky underwater home.

Tracking the habits and populations of fishes that dwell in Oregon's offshore reefs, the researchers have caught and tagged 1300 fish. Here Candia Coombs, graduate student on the project fisheries professor Dr. Howard Horton leads, weighs a black rockfish before tagging and releasing it.

When a commercial or sport fisherman catches the fish again, its tag will tell Candia and her colleagues much about the fish and its fellows.

Catch One, Catch All

The sun sets over Oregon's ocean. A commercial fisherman heads toward home port, his trawler's holds filled with iced Dover, English and petrale soles.

In the valley, a homemaker fills the family's plates with sautéed fillet of sole.

And an OSU fisheries biologist wraps up the day's work on a Sea Grant project that is putting innovative ideas in fisheries science to work for both trawl fisherman and homemaker.

Numerous species of flatfishes, or soles and flounders, dwell on the deeper terraces of Oregon's outer continental shelf or on the sandy shallow seafloor closer to shore. Commercial trawlers landed last year more than 10 million pounds of flatfishes; almost half of this figure comprises Dover sole.

Albert V. Tyler, associate professor of fisheries at OSU, explains the Sea Grant research team's interest in the flatfishes.

"Though this fishery isn't a large one on a worldwide basis – New England's landings are 10 times Oregon's – it is significant for our regional social structure and coastal economy. The current dockside value of the fleet's landings is about 2.5 million dollars."

"There are only 30 to 35 permanent, full-time dragger vessels operating in Oregon, but we're looking at the fishery's potential – there could be 60 to 100. Current landings don't reflect what we suspect could be harvested. The main factor that's preventing full use of the fishery is marketing. Right now the sole end up as fresh fillets in West Coast supermarkets or restaurants – a limited market."

With the fishery's potential come questions of managing a large and complex resource, especially so since enactment of 200-mile limit legislation and institution of regional fisheries management councils around the nation. In this, and in the nature of flatfish exploitation, the Sea Grant researchers find ample reasons for large-scale scientific investigation of sole stocks and other species associated with them.

As Tyler points out, "The fishery is not selective. The otter trawl takes any sizable fish and invertebrates in its path as it drags along the ocean floor. This fishing technique means that fishermen are taking not just a species, but an ecological subsystem. Thus, from a fisheries science standpoint, we have to be concerned about the entire assemblage of fishes in an ocean region, not just the marketable species fishermen aim for."

Participants in the Sea Grant project, drawn from OSU's Department of Fisheries and Wildlife and School of Oceanography and from ODFW, seek to assess the flatfishery's potential by addressing scientific and management problems in innovative ways.

How Much is Too Much

Fisheries management agencies look for estimates of how many fish of a single species may be landed per year without overfishing the stock. Sustained yield over time is their goal, in order to protect the economic health of the fishing fleet and to maintain fish populations.

Since Oregon's trawlers land a complex mix of species, traditional methods of calculating stock yields, on a species-by-species basis, would require a vast body of data unattainable except for the dozen most important species. Also, traditional yield models don't take into account the probable interactions among flatfishes, other groundfishes and invertebrates in the continental shelf ecosystem, and don't reflect recent changes in fishing effort that have disrupted some species' stable populations.

"Because of this, our main objective is to describe and map the assemblages of species on Oregon's continental shelf trawling grounds, and to discover factors that affect the productivity of the larval and adult phases of the flatfish. We'll attempt to find out how the target species fit into the multispecies groundfish scenario, and then aim for management methods to achieve stability for the assemblages themselves," says Tyler, who is coordinating the project.

Using ODFW records, he has plotted and analyzed the distribution of flatfish and associated species on the northern 100 miles of Oregon's continental shelf. Over a two-year period, William G. Pearcy, professor of oceanography at OSU, has sampled demersal, or bottom-dwelling, fishes at seven stations located inshore from Heceta Bank.

"We've found an offshore and an inshore assemblage, northern and southern subassemblages, and an intermediate area," Tyler explains. "The main change in the composition of the catch happens between the shallow sandy seafloor closer to shore and the deeper continental shelf areas. Once we've analyzed our data we'll look for the relationships among the assemblages."

The Tender Years

Related project work concentrates on the flatfishes' two life stages, as larvae that swim or float among the plankton near the sea's surface and as juveniles and adults that live on the seafloor. Studying spawning grounds, larvae distribution and survival, and the relation between the size of each year's production of fish and oceanographic conditions, Sally Richardson, Pearcy and Tyler see the pelagic larval phase as an important key to understanding year-to-year fluctuations in flatfish populations. Bob Hayman, a graduate student working with Tyler, is completing his thesis correlating oceanographic conditions with the yearly population strength of Dover and English soles.

"When a stock is fished heavily, you expect a corresponding leap in reproduction rate as the stock recovers. However, we haven't seen this over the limited range of fishing pressure that these stocks have experienced, because storms, upwelling and other factors can cut survival rates of eggs or larvae, especially if these factors disrupt breeding or hatching. But we're betting that last year's weather should bring about larger than average landings of Dover sole eight years from now," Tyler remarks.

Pearcy, Richardson, Andrew G. Carey, Jr., associate professor of oceanography, and several research assistants and graduate students are piecing together data on the juvenile and adult stages of flatfish life. Tasks they are tackling include mapping nursery areas for juveniles, and identifying and describing the types of invertebrates the flatfishes seek out as food. Keith Kreuz, a graduate student of Tyler's, is undertaking related research on variations in annual growth rates for Dover and English soles.

Modeling the Future

From information on species assemblages and flatfish life history, the Sea Grant researchers will develop mathematical models that can be used by appropriate agencies to manage the fishery. Tyler explains:

"There are two approaches to modeling a fishery this complex. You can make a multispecies model, and factor in data on the productivity of each species and the interactions between species. But this sort of model requires enormous amounts of data that are likely to be unattainable. You may be able to account for some species interaction, but the demersal ecosystem is so complex that it may not be possible to piece together even the main influences on each species individually."

"Right now fisheries managers are generally working with the traditional concepts of maximum sustainable yield and optimum sustainable yield for commercially desirable species. Maximum sustainable yield, the largest weight of fish harvestable each year over time, is a biological concept that represents the steady state balance point between rate of natural production and rate of mortality. Optimum sustainable yield is a corollary idea that tries to account for social and economic factors."

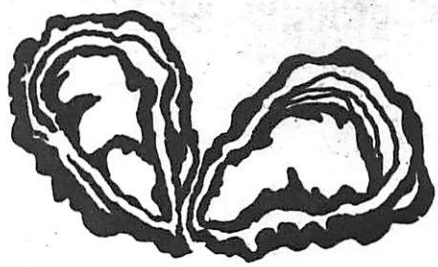
Tyler points out that the trouble with these concepts comes because sustainable yields can't occur simultaneously for all species in an ecosystem. Suppose that arrowtooth flounders prey on young Dover sole. Catching the maximum sustainable yield of the arrowtooth flounders means maximizing productivity of the flounders, and hence rate of predation on young Dover sole, thus cutting into the quantities of Dover sole available to the fishing fleet.

"These are the kinds of problems you run into when you're interested in target species. That's why we're looking at a second approach to modeling in considering assemblage properties rather than individual species. We're dealing with an unconventional idea, that there should be a sustainability of assemblages as well as of target species. That way you can take into account the interactions among species, not just the population dynamics of a single species. Interactions may show us that sustained yield is an unworkable management concept for some target species, and that perhaps pulse fishing, hitting different stocks hard one year and then letting them recover, is better."

"There's some controversy in these ideas. It's difficult to get across the idea that we have to account for the consequences of exploiting a whole part of an ecosystem. Disregarding the fate of species taken incidentally and discarded, or simplifying the ecosystem by reducing these fish to boost growth of target species, might bring instability into the ecosystem or flip it into another species assemblage pattern that is substantially less usable by man. Often less numerous species have influence out of proportion to their numbers, and overexploiting them may lead to a scarcity of the species you want to build up."

Tyler sees the complex Sea Grant project as an example of the far-reaching research universities can do best: "We're taking some of the deeper problems facing the fishery and working them through to set the stage for the industry's future."

Farming the seas



From hunters to farmers, 10,000 years ago, mankind made this transition on land.

These days, as fishermen leave harbor to hunt fish on the high seas, aquaculturists stay behind to tend their fish and shellfish.

Sea Grant scientists apply agricultural techniques to aquaculture. Selective breeding, engineered rations and planned production help them accomplish their research goals.

The payoff -- increasing the harvest of commercially profitable fish and shellfish for aquacultural entrepreneurs. The added fishery resource boosts stocks to meet the world's growing demand for protein.

Working for a Bumper Crop

Quick. In the future, what species of salmon might you find in a can next to tuna on grocers' shelves?

Would you believe Oncorhynchus keta, or chum salmon, produced by ocean ranchers willing to invest in a new industry?

A Sea Grant project is laying the foundation for chum ranching in an experimental hatchery nestled on the banks of Whiskey Creek. The murky green ribbon of water cascades down the coastal mountains and empties into Netarts Bay near Tillamook.

Jim Lannan, assistant professor of fisheries at OSU, along with Earl Pulford and others from the Oregon Department of Fish and Wildlife (ODFW) are assessing the biological and economic feasibility of chum salmon ranching. Establishing a brood stock the state can use in its salmon management program is also one of their goals.

The research team had some success generating surplus eggs for use in Oregon salmon management programs. They have also developed a simple production system for producing chum fry and harvesting mature salmon when they return from the sea to spawn.

Breaking ground on the chum ranch

The hatchery crew traps the returning salmon, which weigh about 12 pounds on the average, in a weir that spans the width of the stream. The workers divert the anadromous fish from the obstacle into holding tanks.

Other tanks Lannan describes as incubating tanks, where eggs and sperm (also called milt) from this year's returns will become next year's releases. Each tank, with gravel strewn along its bottom, provides habitat for incubating chum eggs.

"We have consistently high survival, and put out a good quality fry at a minimal cost per pound of salmon produced," Lannan states.

Perils at sea

In the safe hatchery environment, incubating eggs and chum fry live an easy life. But when the crew at the hatchery scoots the young fish out of the pens toward the ocean, the chum must fend for themselves.

Many don't make it.

Returns from the hatchery releases have ranged from 0.1 to 0.5 percent.

"For chum, that's a good return," Lannan explains. "That's comparable to what you'd find in nature."

A half of one percent return doesn't satisfy Lannan and Pulford, however. Returns must increase to make chum ranching an economically feasible enterprise for private entrepreneurs.

"We think we lose about half or more of our releases to predation during the first two weeks after they leave the hatchery," the experimental aquaculturist states. "We can work around that problem, and maybe increase returns, without substantially modifying the hatchery."

Keeping chum fry in the hatchery an additional 30 days is one way the researchers will try to cut losses. Although chum fry adapt to salt water shortly after emerging from their egg sacs, letting the fish grow for a month in the freshwater hatchery will make them less vulnerable to sea-run cutthroat trout and other predators.

"We'll have to feed the young fish, of course," Lannan adds. "But if we can double returns, the cost of feeding them will be insignificant."

Salmon ranching -- enhancing the resource

If salmon ranching blooms as an Oregon industry, Lannan feels that aquaculturists will benefit commercial and sport fishermen.

"When the fish go to sea, they're public property," the Sea Grant researcher states.

"We have to go more and more to artificial propagation to enhance salmon resources. There just aren't that many places left for wild salmon to spawn successfully."

As the Oregon salmon ranching in-

dustry develops, not only professional and sport fishermen stand to benefit, but you, as a consumer, do too.

You'll find a steady supply of salmon at grocery stores. And if you notice canned chum salmon perched next to the tuna, you'll know that technology, and eggs, from an experimental chum hatchery on Whiskey Creek made rearing this fish possible.

New Menu for Salmon

It's a well known fact. Big fish eat little fish.

In a laboratory experiment at OSU, however, salmon and trout also eat animal fats. The fats will save aquaculturists who rear these fish a considerable amount of money.

Russell Sinnhuber, professor of food science and technology, and T.C. Yu, associate professor, the scientists conducting the experiment, say animal fats cost about a nickel a pound. Compared to feeding trout and salmon foods that the fish would find at sea -- scarce marine fats such as salmon or herring oil that cost about 30 cents a pound -- substituting animal fats in a ration makes good economic sense.

Sinnhuber and Yu pelleted lard, some proteinaceous fish meal and fish oil into a prototype feed they call the Oregon Test Diet. The ration incorporates sound principles of trout and salmon nutrition that commercial aquaculturists can use to develop other rations.

Formulating the test ration began with an intensive study of trout and salmon nutrition.

"We tried to come as close to their natural diets as possible," Sinnhuber says about their Sea Grant project.

Wild ocean-run salmon devour small fish. Those fish make a salmon's diet half protein and half marine fats.

Duplicating a natural trout or salmon diet for hatchery-reared fish simply costs too much money. A salmon and herring oil shortage sent prices skyrocketing up to the 30-cent per pound mark recently. Feeding fish protein in a protein-starved world doesn't set well with the researchers either.

The pair decided to scrimp on the expensive energy foods, and establish the absolute minimum amount of protein and marine fats the fish require for growth and survival. They began a series of feeding trials, varying the amount of protein and marine fats in the test ration.

Results showed trout and salmon need a diet that is a third protein, not half. Sinnhuber and Yu conclude that wild trout and salmon burn as energy protein they don't need for growth and bodily maintenance.

The pair also found that trout and salmon survive well on a ration with 10 percent marine fats, not 50 percent. This small amount of herring or salmon oil, they discovered, provides fish with an essential fatty acid called omega 3. Omega 3, highly concentrated in fish oil, insures optimum growth and survival in salmonids.

Alternative energy

A search began for an alternative energy source, low in cost and readily available, for the test ration to replace all but 10 percent of the marine fats containing the essential omega 3.

Attention turned to vegetable oils. Tests showed that many oils contained high quantities of a fatty acid Sinnhuber and Yu call omega 6. Heavy concentrations of omega 6, in the presence of omega 3, mask the beneficial aspects of omega 3. The researchers call this competitive inhibition.

Interest turned to animal fats. Low in omega 6, low in cost and readily available, animal fats supply energy hatchery-reared trout and salmon require.

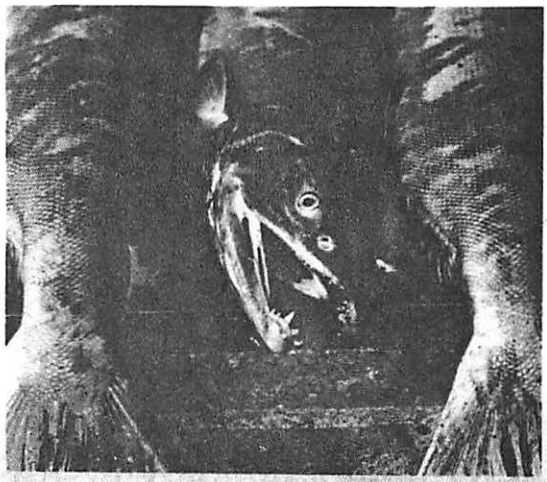
Fish fed the Oregon Test Diet containing 10 percent animal lard and 10 percent marine fats grew as well as fish fed 20 percent marine fats. Both rations contained the same amount of protein and dextrin -- a carbohydrate.

Animal fats may solve another problem Sinnhuber and Yu face. Storage stability.

Sinnhuber points out that fish oil in rations quickly turns rancid. It is his hope that making a cube-shaped fish pellet and surrounding the pellet with stabilized animal fat retards spoilage.

Although the pair have formulated a prototype test ration, they still have numerous questions they want to answer about trout and salmon nutrition.

Trout and salmon contain enzymes necessary to reap the energy carbohydrates provide, but they eat little of this high energy food in their natural



environment. Sinnhuber and Yu plan to explore the role of carbohydrates in fish as an alternative energy source.

Vitamins and minerals also interest the pair. Few have studied the role of these dietary components in trout and salmon nutrition.

Sinnhuber and Yu will also search for sources of protein other than fish meal. They feel that they can find a protein more suited for fish, and less desirable for humans, than valuable fish meal.

There is partial truth in the "big fish eat little fish" axiom of ecology. Although the axiom is nature's strict way with trout and salmon preying on smaller fish in the ocean, Sinnhuber and Yu found that they can also feed animal fats to hatchery-reared salmonids.

Animal fats work to the benefit of aquaculturists fulfilling a consumer demand for trout and salmon in the marketplace. So, the old axiom has a new twist: big fish eat bigger animals.

All the little oysters

Remember curling up with your copy of Lewis Carroll's **Through the Looking Glass?**

" 'O Oysters, come and walk with us!'
The Walrus did beseech.
'A pleasant walk, a pleasant talk,
Along the briny beach:
We cannot do with more than four
To give a hand to each.'

The Walrus and the Carpenter
Walked on a mile or so,
And then they rested on a rock
Conveniently low:
And all the little Oysters stood
And waited in a row.

'A loaf of bread,' the Walrus said,
'Is what we chiefly need:
Pepper and vinegar besides
Are very good indeed--
Now, if you're ready, Oysters dear,
We can begin to feed.' "

People interested in commercially rearing oysters might get off on the wrong foot if they only read the rather crude technique the walrus and carpenter relied on for their feast. They'd get better advice from Wilbur Breese, associate professor of fisheries at OSU, who is stationed at the Marine Science Center in Newport.

Breese studies oysters. Finding better ways for oyster farmers to grow this delicious mollusk guides his Sea Grant project.

If interested growers stop by the Marine Science Center, Breese would tell them about three techniques commonly used for rearing the mollusks -- raft culture, rack culture and out-bay culture.

In describing his work, Breese would first explain that oyster growers traditionally plant their seed on mucky bay bottoms. The oyster seed is attached to broken oyster shell that growers call cultch. In three to four years, the oysters mature on the cultch and growers harvest them.

Breese can quickly outline the alternatives growers use to increase productivity, especially in marginal waters.

Rack culturists build a frame and set it at the bottom of a bay. They place their cultch on the structure.

Raft culturists, on the other hand, string their cultch and dangle it from a floating structure they build. They can also insert trays containing oyster seed, with or without cultch, into the raft.

Breese has spent a considerable amount of time studying the third alternative -- out-bay culture.

The researcher literally grows oysters out of the bay and at the Marine Science Center. He keeps the cold-blooded animals in specially designed tanks.

Pumps push foamy seawater slowly through the concrete and fiberglass tanks. Breese carefully regulates water flow and temperature.

"Yes, you can improve oyster growth by carefully handling water in an out-bay system," the oyster researcher explains. Contrast that to an in-bay oyster grower having no control over water flow or temperature, and the advantages of an out-bay system become apparent.

Pumping seawater slowly through the tanks keeps the microscopic plankton, which oysters eat, in the tank long enough to reproduce exponentially, or bloom. A bloom in a tank is a cheap source of oyster food.

Regulating water temperature optimizes food utilization. At 59 degrees Fahrenheit oysters convert a maximum amount of the plankton they ingest into energy for growth. This doesn't mean they grow fastest at 59 degrees Fahrenheit, Breese explains. They just get more mileage out of their food.

Out-bay culture can give growers using the system other advantages. No longer does an oysterman stay up nights fretting over intense storms that can wipe out an oyster bed in a bay. He doesn't need to worry about getting legal permits to use part of a bay for an oyster bed, either.

Not Just Any Spot Will Do

Interested oyster growers often ask Breese what part of a particular bay might be best for starting an oyster operation.

A simple question, but the answer doesn't roll off Breese's tongue easily, for one reason. No one knows exactly what oysters eat.

The animals pour seawater over their gills, selecting preferred species of microscopic plankton suspended in the briny broth. A variety of plankton species inhabit the water. As of yet, the ones oysters prefer have not been identified. Researchers have shown, however, that oysters will eat certain types of plankton fed to them.

Not knowing what an oyster eats makes finding a spot rich with the right nutrients difficult. But Breese is working on a method to spot the best oyster haunts.

Analyzing carbon nitrogen ratios in the water may indicate an abundance of planktonic life in estuaries and bays. Breese believes that water high in organic particulate carbon, and nitrogen contains enough of the right types of plankton for oysters to feed on and grow.

A talk with Breese leaves no doubt that there is more to growing, and harvesting, oysters than luring them out of the water with sweet words as the walrus and carpenter did. Those talking with the oyster researcher also understand that his innovative project provides new ways for Oregon's oyster aquaculturists to put bays and estuaries to work.

Super oyster?

Since the dawn of modern animal science, super cow, super pig and super chicken have been on the minds of animal geneticists striving to produce the optimum domestic animal. But super oyster?

"Perhaps," says Jim Lannan. Selecting disease resistant, meaty oysters that gain rapidly on their planktonic diet is one goal of his Sea Grant project.

"We've made good progress on the breeding program here," Lannan exclaims about his work at the experimental oyster seed hatchery at the Marine Science Center in Newport. The oyster geneticist has bred over 100 lines of oysters from seed, or larvae, and duplicated over 60 of the lines.

The ultimate oyster isn't a farfetched idea, but an oyster that grows well in Yaquina Bay might not be a super oyster in another bay. A good breeding program accounts for the environmental peculiarities of this mollusk's habitat.

The long hours Lannan spent breeding 100 lines of oysters adapted to Yaquina Bay established the rudiments of a good selective breeding program applicable to any oyster seed hatchery. Picking superior oysters, however, can be expensive.

"If you look at a good beef herd, you'll see ear tags," Lannan says. "If you follow this up, you'll see an elaborate record-keeping system documenting each cow's performance. That costs money, but that's what an oyster breeder must do too."

To demonstrate the applicability and practicality of an oyster breeding program to the oyster seed industry, Lannan will help a private hatchery set up its own breeding program. He will show the producer how to keep records, mark oysters and evaluate performance.

Lannan's research may not produce a super oyster adaptable to every bay on the West Coast. But his efforts will help the oyster seed industry bolster supplies of the seed to satisfy a strong grower demand. That could put more of a meatier, tastier oyster on consumers' tables faster.

Medical progress for salmon and shrimp

In the fish hatchery's raceways, millions of salmon fingerlings flourish. If all goes well, these fish, released to the sea via a nearby stream or river, will found a new generation of salmon sought by commercial and recreational fishermen.

Unless disease strikes.

Scientists, specialists in fish diseases, seek cures for fatal infections caused by bacteria and viruses that can also thrive among the crowded fish.

Fish Clinics

To a hatchery manager, there's nothing quite so satisfying as seeing millions of healthy salmon or trout fry striking greedily at the day's rations.

And there's nothing as worrisome as seeing these same fish sluggish or belly up in the raceway's flowing water. Such symptoms may be evidence that disease is spreading among the young fish.

Aquaculturists rearing salmon fingerlings for release and recapture as adults also face potential catastrophic losses from disease. Commercial and recreational fishermen feel the pinch if salmon stocks are decimated by bacterial or viral infections.

But hatchery managers, aquaculturists and fishermen can take comfort in the medical progress that OSU, and Sea Grant, are making. Under the direction of Dr. John Fryer, chairman of OSU's Department of Microbiology, a team of microbiologists, parasitologists and pathologists seeks to cure and prevent the major diseases that limit successful rearing of salmonid fishes.

"Sea Grant support, added to that of the Oregon Department of Fish and Wildlife (ODFW) and the Oregon Agricultural Experiment Station, has helped us continue research on the organisms that cause diseases, fishes' response to infection and methods of prevention. We've also been able to respond to fish growers' needs for diagnosis and treatment, and to inspect and certify as disease-free the fish eggs and fry that are shipped between states," says Fryer. He stresses that the OSU work on fish diseases aims at problems faced by an emerging industry.

Under hatchery conditions, where the stress of crowding increases the fishes' susceptibility, bacterial and viral infections can destroy a high percentage of a year's crop of fingerlings.

Especially hazardous for salmonids is vibriosis, a virulent bacterial disease of saltwater fish. Fryer and his associates have developed both oral and injected vaccines against vibriosis, and have witnessed vaccinated fish successfully resist infection in both laboratory and field studies. Two commercial firms are now producing the vibriosis bacterin.

During the past year, Fryer, Robert Olson, research associate in zoology, and graduate assistant David Ransom have explored methods of improving the bacterin's effectiveness. The researchers have also studied methods of vaccinating large numbers of fish with the bacterin. In addition to feeding or injecting, spray administration appears useful.

How fishes develop immunity to disease is not completely understood. But the Sea Grant investigators have begun to examine some of the roles of different natural defense mechanisms fish, as all animals, have against disease, either bacteria-eating white blood cells or antibodies carried in the blood or lymph fluid.

Fryer's research dovetails with the advisory efforts he and his associates have undertaken on behalf of the Northwest hatcheries and fish culturists. They have established a diagnostic laboratory, at OSU's Marine Science Center at Newport, that identifies pathogens causing fresh and saltwater fish diseases and recommends treatments.

In the last year Ransom and Olson have examined more than 2000 fishes, which came to them from 10 private aquaculturists and the Marine Science Center, and have identified 16 pathogens infecting the fish they received.

Diagnoses discovered through Ransom's and Olson's work often result in prescriptions for appropriate treatment with antibiotics or chemicals to cure the infections. They also have recommended, for a commercial saltwater aquaculture site, a design that could eliminate stresses predisposing returning adult salmon to bacterial infections.

The demand for salmon and trout has spurred the development of private hatcheries that provide fish eggs and fry for release throughout the Northwest. Government agencies have realized that a disease organism introduced with the fry can spread throughout a river or watershed and attack native fish populations that have not built up natural immunity to the introduced pathogen. Thus all Northwest states require that fish slated for interstate transport be inspected and certified as disease-free.

Responding to hatcheries' needs for disease clearances, the Sea Grant team continues to conduct a certification service, and inspected numerous groups of fish from 12 private hatcheries during the past year.

Through their work on fish pathogens, the OSU researchers are helping Oregon's hatcheries and fish culturists curb destructive outbreaks of salmonid diseases, for sustained harvest and economic success in one of Oregon's major industries, the salmon fishery.

"Since we began sampling two years ago, parasite incidence has been very low among shrimp taken from Oregon waters, though it's higher in shrimp caught off Washington and British Columbia. This past season, 1977, witnessed a record year of shrimp landings in Oregon, yet the percentage of parasite incidence has remained about the same."

Olson is searching for the possibility of a relationship between shrimp population levels and parasite incidence, and wonders about the effect of fishing pressure. One could assume that recent high shrimp populations would allow the parasites to infect greater numbers of shrimp, so that shrimp population levels could fall. But, he points out, even in a year of record landings the parasite is still present at very low levels, so that its impact on the shrimp is unclear.

Olson is anticipating study of shrimp landings for 1978; because of 1977's unusually high population, 1978's figures may provide a clue to the relationship between population level and parasites.

As for haplosporidan parasites on clams, their biology and pathology (the effect of infection) are just as mysterious.

Olson's sampling has uncovered parasites on clams in Yaquina Bay, Coos Bay, Siuslaw estuary, Netarts Bay and Tillamook Bay, and ODFW is using this data when evaluating potential harvesting areas and appropriate harvesting levels for the emerging gaper clam fishery. The agency has opened for harvest only areas with very low parasite incidence, if any, so that clams taken are of high quality.

"We sampled at five areas in Yaquina Bay, and found the worst infection in clams taken from Sally's Bend," says Olson. "We've looked at possible environmental factors that might single out this area for intense infection, but haven't found anything."

"We assume that this organism is not a normal parasite of clams, since the clam's tissue forms cysts around the parasites and apparently kills them."

"When we looked at the pea crabs that often live within the gaper clam shell, we discovered an unidentified protozoan parasite. This parasite might be transmitted to the clam and cause the cysts we've seen in the infected clam tissue."

Closing areas to harvest is the method for managing infected clam beds at this point, just as varying fishing pressure may allow management of shrimp microsporidans. And Olson continues to probe the nature of the tiny parasites and their commercially valuable hosts.

Microsporan Mysteries

Pink shrimp and clams, like salmon, are seafood delicacies prized by consumers.

Like salmon, too, the shrimp and clams can fall prey to disease. And though they never reach your table, infected shrimp or clams can represent economic losses to the seafood processor or commercial harvester.

In September 1974, a seafood processor in Astoria, Oregon, had to cull and discard much of a fresh load of pink shrimp he'd already paid for. The shrimp were infected with a tiny parasite, a microsporidan, that turned their flesh soft and milky-white.

Clams are susceptible to similar parasites, called haplosporidans. In planning commercial harvests of gaper clams, ODFW faced the need to know more about the distribution and pathology of this potentially lethal parasite. With these problems at hand, the stage was set for an OSU Sea Grant project.

According to Robert Olson, project investigator, "There's very little historical data, or information in the scientific literature, on these parasites, either their incidence or their biology. We worked, with ODFW's help, to fill in some of the gaps."

Freeing fish disease-free

A.J. Demaris liberates fish -- about a million coho a year from the Oregon Department of Fish and Wildlife Hatchery near Alsea.

"I'm here to raise fish. I have production goals," the hatchery manager insists while throwing handfuls of fish feed to excited coho fingerlings swimming in concrete tanks.

Some of those hungry coho Demaris sets loose will give sport anglers a thrill. Others will put paychecks in salmon trollers' wallets.

Some, however, die of vibriosis.

"If we want to increase returns and improve fishing, we must work on vaccines, especially a vibriosis vaccine to protect fish from the disease while they move through estuaries," Demaris explains. Only 1.13 percent of the fish released from the hatchery in the past 10 years have returned.

Returns could increase some, the hatchery manager feels, if John Fryer's Sea Grant work with vaccines succeeds.

Says Demaris, "You know, I do my best to get a good quality fry out, but once the fish leave the hatchery, that's where a vaccine could really pay off."

New ways in an ancient craft

Fishing – a skill nomadic people developed long ago as they roamed the ancient world, hunting for food with crude tools.

Today, commercial fishermen roam coastal waters with modern gear. As changing times bring new demand for their catches, they regard their profession with new interest.

Sea Grant responds, seeking innovations to help fishermen sharpen modern skills in this ancient craft.

Working for Progress

Ask fishermen from Astoria to Brookings to compare their way of life today to 50, 20 or just one year ago. Their answer? Different!

New laws, new marine fishery management schemes, new interest in underutilized fisheries and new gear have profound economic and social impacts that move fishermen from the past into the present and future.

OSU's Sea Grant Marine Advisory Program (MAP) brings useful knowledge to Oregon's fishermen confronting change. Working within the OSU Extension Service, MAP agents and specialists talk with fishermen, hold workshops and short courses, write usable publications, assist agencies in charting the future of fish stocks, and help fishermen speak up for their interests.

Pairing up for Hake

Paul Heikkila, MAP agent in Coos, Curry and Douglas counties, works closely with south coast fishermen fishing in a time of change.

Hake, an underutilized fish species, is part of that change. Heikkila, a member of the Port of Coos Bay Hake Committee, says, "Our purpose was to draw up a plan for the port to go after a viable hake industry."

"If we could harvest and fillet a third of the hake that Russian and Polish vessels take off the Oregon coast each year, we would bring in 30 million dollars at today's prices. That would have a great impact on our local economy."

Although a strong demand for hake doesn't exist yet, Heikkila hopes that fishermen will be ready to capitalize on the new market when it does develop. To help fishermen ready themselves, he works closely with Joe Easley and Bob Jackson, two Coos Bay bottom trawlers experimenting with pair trawling.

"The traditional bottom trawler doesn't have the sheer horsepower to pull a mid-water trawl for hake. Using two boats instead of one – pair trawling – musters up enough power," the MAP agent explains.

MAP agent Bob Jacobson listens to the fishermen in Lincoln and Lane

counties. But last year he worked with the newly created Pacific Fishery Management Council to make sure all fishermen in the state were kept posted on the council's activities.

The council, established by the Fishery Conservation and Management Act of 1976, has the responsibility of managing marine fisheries in the 200-mile zone off California and the Pacific Northwest.

Jacobson attended most of the early council meetings, and kept fishermen informed. The **Oregon Commercial Fisheries Newsletter**, which the MAP agent writes and publishes, helped him accomplish this task.

Organizing for Change

John Faudskar covers Tillamook County for MAP.

"One involvement I had last year was helping Tillamook County fishermen form the Ocean Harvesters," Faudskar explains. "The fishermen thought that they could be more effective in stating their views about new laws if they organized."

Oyster growers' need for a summer oyster sent Faudskar to seek help from a researcher last year.

"The quality of oysters in Tillamook and Netarts bays, as well as any other bay, can deteriorate in summer when the water warms up," the MAP agent points out. "The market really declines then, and that's why I decided to call Willy Breese."

Breese, an oyster researcher at the Marine Science Center in Newport, will study the Suminoe – an oyster found in the Yellow Sea. This oyster reportedly maintains its quality during the summer months.

"What's neat about this is that the industry needed something, and asked us to help," Faudskar says. "We're really doing something they want."

North Coast Ways

MAP agent Jim Bergeron offers a helping hand to fishermen in Clatsop County. Last year, he worked with Susi Jones of the Oregon Arts Commission to help fishermen tell their story in a new way – the Folk Life Festival.

"To 2,000 to 3,000 people who attended the festival at Clatsop fairgrounds, we (fishermen) presented fishing as not just a way to make a living, but as a way of life," the agent explains. Fishermen demonstrated a variety of skills their craft requires.

"Part of the Sea Grant mission is to educate the public on issues that deal with the sea. Because of changes in fishing, and the fisheries, the better the general public is educated, the better off we'll be at making decisions about the resources. That's why I became involved with the festival."

Confronting change has changed fishermen, according to Ken Hilderbrand, head of MAP and Sea Grant's assistant director for advisory services.

"One of the changes we've seen among fishermen is better organization. I feel we're partially responsible for this as we've helped fishermen help themselves."

Hilderbrand believes fishermen will continue to seek MAP's help as they face change.

"One thing is for sure," he explains, "fishermen are quite adaptable. They'll use MAP, or anyone else they can get information from, to seek new ways to catch fish efficiently!"

Finance on the High Seas

Forging across the bar to sea as a commercial fishermen isn't the life of security it may appear to be. Ask Fred Smith.

Smith, Extension marine economist for MAP for the past 10 years, has helped fishermen and marine industries stand firmly on their business legs.

"Fishermen often cite a good catch and being their own boss as the rewards for their efforts," Smith says. But environmental factors – weather and fish stocks – make a fisherman's self-employed lifestyle financially insecure.

When he began his job, Smith realized that these factors kept fishermen lagging behind businesses not dependent on a good catch from the sea. He set out to bring fishermen the business knowledge they needed.

Smith, also professor of agricultural and resource economics, wrote several MAP publications for Oregon's professional fishermen to help them learn how to analyze finances, form a corporation, borrow money, calculate profit, analyze efficiency and even form a cooperative.

Workshops give Smith a chance to work with fishermen face to face. He also advises individual fishermen who ask for help.

Has the effort paid off?

Smith thinks so. "During the past 10 years, I've seen tremendous change at Newport and Coos Bay," the economist says.

Part of that change has expressed itself as leadership. Fishermen running their operations on sound business principles gain managerial confidence and a willingness to lead the industry, Smith believes.

A sense of confidence and leadership give fishermen more control over their future. Ask Fred Smith, MAP economist. He knows, because he has spent the past 10 years watching fishermen become leaders as he helped them become better businessmen.

The Engineer and the Fishermen

Ed Kolbe spends long hours at his desk scribbling away on scratch paper with his mechanical pencil. Big deal.

For Oregon's professional fishermen, and for Kolbe, it is a big deal. As assistant professor of agricultural engineering stationed at the Marine Science Center in Newport, Kolbe studies a variety of fishing gear improvements that will help fishermen catch more fish, store their catch on boats better, and make fishing safer.

Kolbe spends a quarter of his time as MAP fisheries engineer; he brings his research results, and other useful information, directly to the fishermen.

Mention radar to Kolbe, and he'll probably start talking about reflectors.

Concerned about fishermen's safe navigation at night or in fog, the marine engineer, MAP oceanographer Ed Condon and Bill Snook, a student, began testing radar reflectors. The reflectors make a 30-foot fishing boat show up as 80 feet long on a radar screen.

He helped Condon draw up plans for the reflector, which are included in an Extension bulletin Condon wrote. Fishermen acquiring the bulletin can build their own reflectors.

Pursuing a notion that puzzles salmon trollers, Kolbe studied electrolytic charges on stainless steel trolling lines in salt water.

No scientific studies were done, but after reviewing the literature, and talking with a marine electronics expert, Kolbe says it appears that a half-volt positive charge on the trolling line may encourage salmon to strike on days when few fish bite.

Kolbe compiled his findings into a MAP report for fishermen.

Kolbe's work with refrigerated seawater spray may keep shrimp catches fresher in boat holds. For fishermen, finding ice for shrimp storage at sea can sometimes be a chore, and that spurred interest in this new chilling system.

"Sprayed shrimp," Kolbe says, "keep well for three days. After that time, bacteria in the recirculated water attack the catch. Some processors report that the shrimp are hard to peel, too."

The engineer enlisted help from other Sea Grant researchers to work on the refrigeration problem.

Kolbe's colleagues, and fishermen, have given him more ideas that will send him back to his desk, to plot more solutions on the pile of scratch paper he keeps within arm's reach.

School for Seafarers

Oregon's professional fishermen need help – skilled help. A 1971 survey of 238 working fishermen spotted a shortage of deckhands well versed in fishing gear and methods, boat handling and boat maintenance. A 1975 follow-up showed that fishermen's demand still exceeded supply.

Clatsop Community College in Astoria responded to the shortage. With Sea Grant help, the community college upgraded its Commercial Fishing Technology Program and Marine Technology Program.

At the helm of the commercial fishing program, housed in the old Astoria Yacht Club building, stands Ward Nichols, a fisherman of 42 years.

Two days every month, students file up the gangway of the **Forerunner**, a 55-foot steel-hulled boat equipped with the latest fishing gear and electronic equipment, and go fishing with Nichols.

"The **Forerunner** is THE classroom," Nichols stresses. But students also sit in a real classroom, listening to Nichols lecture in detail about trawl fishing, gill netting, crabbing, salmon trolling, tuna fishing and long lining.

Marine diesel, electricity and refrigeration courses complement Nichols' year-long commercial fishing course.

A summer at sea ties together students' classroom knowledge and experience from the handful of fishing trips on the **Forerunner** during the regular school year. Students either find jobs with fishermen or sign up as crewmen on the **Forerunner**.

While Nichols trains fishermen, Pat Killion, head of the Marine Technology Program, teaches his students skills they'll need as captains or deckhands on charter boats, towboats and other commercial vessels.

Killion points out that many experienced, and inexperienced, mariners take his year-long seamanship course – the core of the two-year Marine Technology Program, and a required course for commercial fishing students. Complementary courses train students in diesel mechanics, electronics, marine electricity and welding.

A future in fishing

Why would anyone pack his bags, move from an obscure Atlantic fishing port, and head west for Clatsop Community College in rainy Astoria?

"To be a good commercial fisherman," answers Wig Bisbee, a lanky young man from Florida. His buddy and classmate, Ray Glynn, a stocky New Yorker, agrees.

By coincidence, both read the same article in **National Fisherman** describing the Commercial Fishing Technology Program at Clatsop. Ray read the story in the cabin of his dad's boat. Wig can't remember where he saw the piece, but he did. That's the important thing, he stresses with a southerner's drawl.

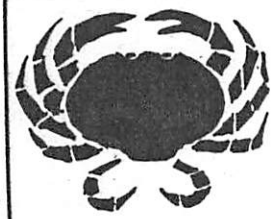
The newspaper story sent both young men west to the college. Both are glad they came.

"The program is good," says Wig while mending a piece of net for practice. "Real gooood!"

Both student fishermen talk fondly of fishing with Ward on the **Forerunner** – the program's own commercial boat outfitted with the latest gear. The **Forerunner** gives them experience no book can provide.

Any student dreams of graduation – especially Wig and Ray. With a diploma in commercial fishing from Clatsop Community College, both feel that they may be able to win a banker's trust, and a loan, to fulfill the goal for which they left Atlantic shores – to become productive, self-employed professional fishermen skippering their own boats.

From trawler to table



Catching that salmon, sole or Dungeness crab is only the first step in seafood's journey to Oregon's dinner table. From a fishboat's hold to fresh or frozen fillets, cans or gleaming glass jars -- the seafood processor brings the harvest of Oregon's ocean to readiness for the consumer's kitchen.

Diner's Delight

High in protein, low in fats. Most people know these facts about seafood.

But Dennis Gordon wants to know more. Gordon, research associate in food science and technology at the OSU Seafoods Laboratory in Astoria, says that many questions remain unanswered about the nutritional value of seafood in our diets.

Although all essential nutrients in seafoods interest Gordon, last year he studied iron as part of his Sea Grant research. How much iron seafoods contain, and how much of that iron is available for absorption into our digestive systems were research questions he addressed.

How much iron?

"Previous research indicated that seafoods were a moderate source of iron in our diets," Gordon explains. "But when we got to looking closely at seafoods in the lab, we found they were extremely low in iron."

Of the small amount of iron in seafoods, only 15 percent is available for the digestive system to absorb.

Although low in iron, the protein in seafood enhances iron uptake from other foods containing the mineral -- especially vegetables.

Seafood has plenty of protein to encourage iron uptake, Gordon says. But the fats in seafood -- mostly polyunsaturated fats that many believe reduce the chance of atherosclerosis, or hardening of the arteries -- may inhibit iron uptake.

"Polyunsaturated fats oxidize," Gordon points out. "This is detrimental."

An antioxidant may retard oxidation. This would encourage iron absorption from seafoods and other foods containing the mineral when eaten with seafoods.

"I've had some success with three antioxidants -- BHT, vitamin C and vitamin E -- in my lab tests with rats," Gordon explains. "These chemicals may be effective by themselves, or work synergistically as a triad to promote maximum iron uptake."

To Gordon, his work with iron leads to an interesting point.

"Just because a food has a certain level of a mineral in it doesn't mean much. The question is, how much of the mineral can the body take up?"

Most people know seafoods have plenty of protein and little fat. But Dennis Gordon will tell people more about seafoods as he studies the minerals they contain, and discovers how the seafoods work with other foods to supply the essential elements of life.

Progress in Processing

Oregon's ocean offers a rich harvest to fishermen.

The harvest will become even richer as seafood processors adopt innovative production methods and seek markets for both traditional and unexploited species of fish and shellfish.

Helping processors take advantage of opportunities to improve their techniques and expand their markets is the job David Crawford and Jerry Babbitt, professor and associate professor of food science and technology at OSU, have undertaken.

Situated at OSU's Seafoods Laboratory in Astoria, Oregon, Crawford and Babbitt have been in an ideal position to work hand-in-hand with the seafood industry. Sea Grant support has enabled them to carry their laboratory research accomplishments directly into production-scale advisory work within the processing plants.

According to Crawford, who is director of the laboratory, "We've concentrated on three major areas in our Sea Grant research and advisory efforts -- developing new products from fish that are currently discarded at sea, solving processing problems that limit yields from the catch fishermen bring to the plants, and finding uses for scrap fish and processing wastes."

Crawford points to hake as an example of the lab's Sea Grant work with underutilized species.

"It's a fair fish, and good eating, but it brings a lower price than other species, which cuts industry's interest in it. But we helped in an experiment on new hake markets last summer. The Oregon Otter Trawl Commission put up money to buy hake from fishermen, the fish were filleted, battered and breaded by Pacific Shrimp, Inc., a local processor, and the Pig and Pancake restaurants in Astoria and Seaside offered the hake as a menu item. They're still selling 50 pounds a week to customers."

Babbitt and Crawford listen to the seafood industry's concerns, translate these into research, and then work with processors to demonstrate in plant the new techniques developed through their studies. Recently they've attacked the problem of peeling the succulent pink shrimp that are a major market item for fishermen and processors.

Says Crawford, "Fresh shrimp don't peel well, and you can lose 25 to 30 percent of the flesh in the process. Three-day-old shrimp peel better, but of course the quality, while still high, isn't like that of one-day-old shrimp. "We've been looking for new methods for peeling fresh shrimp. We've experimented with various fresh shrimp pretreatment baths, adjusting temperature and acidity levels, and have found one that works very well, at reasonable cost, for the two types of mechanical peelers processors use."

The two researchers, with colleagues Dennis Gordon and Duncan Law, professor of food science and technology, are also investigating the effect of storage time and method on shrimp quality; and are taking their findings on shrimp peelability to industry for proving.

Seafood processors and salmon hatcheries have a common opportunity that Babbitt and Crawford have explored. Hatchery managers continuously seek improvements in the rations fed to fingerlings before the young fish head for sea. Processors are interested in potential markets for processing wastes, the scraps of fish or shrimp left after filleting or peeling.

The Sea Grant food scientists have been using different types of scraps and industrial fish to formulate various high-energy feeds that could promote salmon growth and strength, and have worked with Oregon Aqua-Foods, Inc., to improve ration manufacturing efficiency in that company's feed mill.

At the Seafoods Laboratory, Babbitt and Crawford are taking other problems the seafood industry wrestles with, such as discoloration of canned tuna and fresh rockfish fillets, and searching for solutions.

Their work is helping seafood processors in Oregon and throughout the Northwest take better advantage of the ocean's rich harvest.

Attack on Microbes

When Jong Lee set out in 1974 to profile the unwanted microorganisms that thrive on seafoods during various stages of processing, the seafood industry welcomed him.

"You know, a microbiologist being welcomed to a food processing plant is like a fox being welcomed to the chicken coop," the OSU Sea Grant researcher spouts.

Why the welcome?

It's simple. Lee, professor of food science and technology, solves the microbial problems he finds in processing plants. Most regulatory agencies, on the other hand, find problems and demand that the processor correct the situation, or halt production. Rarely do they have the resources needed to show processors how to solve the problem.

Another reason for Lee's reception at processing plants is Sea Grant's Marine Advisory Program.

"I go to plants hanging on MAP's coattails," the microbiologist points out. "The agents do it for me because they know how sincere I am in wanting to help processors solve problems and upgrade the image of seafood in consumers' eyes."

Last year, Lee completed a microbial profile of Pacific shrimp. The study identified the danger points microbes pose for shrimp as the product moves through processing plants.

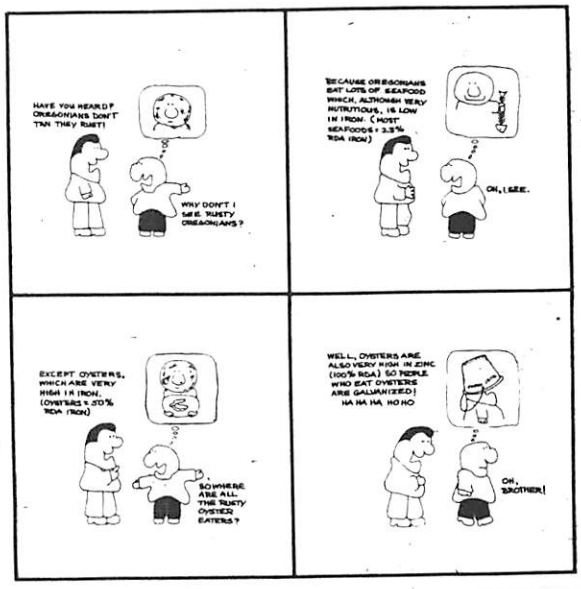
The study also showed why processors should spray the shrimp with brine instead of dipping them in brine vats. This significantly reduces the microbial contamination level.

The shrimp microbial profile, coupled with a previously completed Dungeness crab microbial profile, gives processors thorough instructions on what to do and what not to do with these two important shellfish.

"People often ask me why I emphasize shrimp and crabs so much," the microbiologist remarks. "It's because these seafoods are usually eaten without further cooking, and thus require more stringent microbial control."

"Any research, especially in the Sea Grant Program, must address a need -- not only the needs of today but also those of tomorrow. We need data to gain insight into the unique problems Oregon's seafood processors face so that we can solve the problems in the best way possible."

Yes, Jong Lee receives a welcome when he visits seafood processing plants. Instead of the farmer with the fox in his chicken coop, processors realize that this Sea Grant microbiologist has a sincere commitment to help processors solve problems. That will help the industry deliver a better seafood product to consumers.



Canning Seafood at Home

Seafood processors aren't the only ones preparing fish and shellfish for storage and later consumption. That sleek salmon, and those succulent clams and crabs you've brought home from the shore can be easily canned and stored for midwinter dinners.

New guidelines for canning seafoods, developed through OSU Sea Grant research, specify reliable processing times and procedures for putting up clams, crabs and fish such as salmon, carp and northern pike at home.

Carolyn Raab, OSU Extension food and nutrition specialist, describes the seafood canning research as a response to consumers' needs identified by county Extension home economists in coastal communities.

"Coastal residents have asked us for up-to-date recommendations on canning their catches. With Sea Grant support we've been able to find out what procedures are best."

Actual canning experiments, using favorite Oregon seafoods, were carried out at the University of Minnesota by Dr. Edmund Zottola, Extension food microbiologist, as part of his ongoing research project on home canning.

According to Raab, home-canned seafoods make possible year-round consumption of fish and shellfish, which retain their value as a good source of B vitamins and protein, are conveniently stored, and are low in cost, "especially if you've caught the fish, clams or crabs yourself."

Raab reminds homemakers that processing in a pressure canner, following reliable instructions, is essential. "Also," she advises, "make sure you're canning a high-quality

product: pack your seafoods in ice for the trip home from the coast."

If you'd like to eat next summer's catches during February's snows, just drop Sea Grant a line requesting the forthcoming revised Extension fact sheet on home canning of seafoods.

Sea Grant
Extension Communications
AdS 422
Oregon State University
Corvallis, OR 97331

A Source of Advice

Crabs and shrimp everywhere – in the sea, in boat holds and on the docks.

Last year's monstrous surplus of these delicious crustaceans exceeded production capacity for many Oregon seafood processors. That started Bill Davidson thinking.

Davidson, Extension meat, poultry and seafood specialist and MAP troubleshooter, pursued the idea of sending any future supplies to mid-American consumers hungry for shellfish.

Davidson acted as a liaison between a Midwest seafood wholesaler, an airline shipper, and several Oregon seafood processors. They discussed the possibility of shipping live and cooked crabs by air to new, and to some extent undeveloped, markets.

At the moment, an Oregon seafood processor and the Midwest wholesaler are negotiating an agreement for shipping the crab and shrimp.

Last year, Davidson's creative thinking tackled several other problems perishable seafood products face on their journey from capture to consumption. That was his job.

Take another look at that crab and shrimp surplus. The surplus contributed to a demand for a fresh product rather than the traditionally canned frozen product. For that reason distributors and processors wanted to sell fresh crab and shrimp in vacuum-sealed No. 10 tins.

Canning the fresh products concerned the State of Oregon Department of Agriculture, which regulates the Oregon seafood industry.

"People tend to think foods in cans keep forever," Davidson explains. "Fresh crabs and shrimp certainly don't."

The Department of Agriculture, thinking of a potential food poisoning problem, proposed banning the sale of fresh crab and shrimp in cans.

Oregon processors and distributors did not receive the proposal well. The ban would have placed them at an unfair competitive advantage with firms in states where selling the fresh crustaceans in vacuum-sealed tins is permitted.

Davidson and his MAP colleagues recognized the differences of opinion and organized a meeting to discuss the situation. The meeting at the OSU Marine Science Center in Newport drew together seafood processors, representatives of the Department of Agriculture and other government agencies, Sea Grant scientists and MAP personnel.

A temporary solution was ultimately reached that minimized the possibility of mishandling the product, but still allowed Oregon processors to remain competitive in the marketplace.

Processors agreed to label each container of fresh crab and shrimp with a caution notice that advises consumers how to handle the product properly.

"I was pleased with the outcome," the MAP seafood scientist says. "The label not only helps people handle seafood products properly, but it will help maintain the high quality of these seafoods."

Fresh or fresh frozen? This question currently runs through the minds of many Oregon salmon trollers.

Fishermen deliver most troll-caught salmon fresh to Oregon processors. Mishandling, or extended fishing trips, can lower the eating quality of the catch.

On-board freezing of salmon immediately after capture can minimize the deteriorative changes. But fresh freezing troll-caught salmon is not without technical and legal complications.

In workshops MAP coastal agents organized for salmon trollers, Davidson was able to discuss the advantages of fresh freezing as well as some of the responsibilities that accompany the process. To some extent, he explains, fishermen become the primary processors of the product, and with this goes the responsibility of proper handling and freezing techniques.

Fishermen and seafood processors can properly handle a product, but that doesn't exclude seafoods from other perils in retail stores -- mishandling and temperature abuse.

Temperatures above 40 degrees Fahrenheit cause seafoods to deteriorate rapidly. Last year Davidson helped many independent stores, local chains and national chains maintain correct temperatures in their display cases.

Davidson even worried about seafood products once they left the store and headed for a consumer's kitchen. He was concerned about proper handling and preparation at home.

"I think there is a mystique to seafoods," the MAP specialist explains. "Most love it, but many actually hesitate to serve seafood because they don't know how to prepare it."

Statistics support the point. The average American consumes 12 pounds of seafood yearly. Half is canned, and two-thirds of the remainder is served in restaurants.

Davidson met with several groups of consumers last year to explain not only the nutritional value and proper handling of seafoods, but also ways to prepare the products.

From a consumer's kitchen to a crab and shrimp surplus piling up on Oregon's docks, MAP seafood specialist Bill Davidson tackled a variety of seafood handling problems last year. His efforts helped deliver a high-quality meal to consumers' tables.

But that was his job.

Down on the Farm

What do crab and shrimp processors have in common with coastal farmers?

Not much until Bob Costa found a way to utilize crab and shrimp processing wastes, and farmers an alternative source of nitrogen and phosphorus fertilizer.

Oregon seafood processors faced a July 1, 1977, ban on dumping crab and shrimp processing wastes in navigable waters. That's why they asked MAP to help find a new place to dump up to 30 million pounds of the crustacean by-products annually.

MAP director Ken Hilderbrand called OSU Extension soil scientist Hugh Gardner, who is stationed in Corvallis.

"I remember that call," Gardner says. "They (MAP) were really concerned about what the processors were going to do with all this waste material."

"I told them seafood products have been used for centuries as fertilizer. We've been sticking dead fish under rosebushes a long, long time."

According to Gardner, there is a good reason for sticking fish under rosebushes. The creatures of the deep contain nutrients plants require for growth. The Indians taught this principle to the Pilgrims struggling with their corn. Even Oregon's coastal farmers used to spread crab and shrimp processing wastes on their land long ago. They did, that is, until inexpensive sources of inorganic nitrogen and phosphorus fertilizers were developed.

Today, however, inorganic fertilizers aren't as cheap. During the 1973 gas crisis, nitrogen costs skyrocketed from about 12 cents to 25 cents a pound. Today, the price stands at about 15 cents a pound, but farmers still worry that another shortage will boost prices in the future. That's why agriculturalists express continuing interest in finding alternative sources of fertilizer.

"But MAP wanted specific answers to some specific questions about using the wastes as fertilizer," Gardner asserts. "I just didn't have them."

Realizing something had to be done with the wastes before the July 1977 ban, the experienced soil scientist interested Bob Costa, one of his graduate students, in developing a Sea Grant research project to answer MAP's questions.

Costa carefully outlined the topics his research addressed. They included:

--the best ways to apply the shrimp and crab processing wastes;

--the effect of the wastes on plant and soil chemical composition;

--the value of shrimp and crab wastes compared to conventional fertilizers;

--reasonable application rates;

--whether for best results the waste should be pulverized prior to application; and

--whether incorporating the waste into the soil is better than spreading it on the surface.

In a greenhouse experiment, Costa studied the response of two common coastal pasture crops, orchardgrass and New Zealand white clover, grown in two common coastal soils. A field trial on John Dickenson's farm near Toledo also answered many of the soil scientist's questions.

His results?

A stand of orchardgrass on Dickenson's farm, fertilized with three tons of the processing wastes containing 77 pounds of nitrogen and a considerable amount of phosphorus, yielded 6.1 tons of hay to the acre. A similar stand on the farm fertilized with a 16-10-0 inorganic fertilizer at a rate which supplied 64 pounds of nitrogen, 80 of phosphate, and 60 pounds of sulfur yielded 5.6 tons to the acre.

The results of the greenhouse experiment confirmed information obtained in the field.

Yes, the crustacean processing wastes are a nitrogen and phosphorus fertilizer.

True, it's a lot easier spreading 400 pounds of conventional fertilizer on a pasture than three to eight tons of shrimp and crab processing wastes, but use of the waste material solves an important environmental problem and can provide farmers with an economical source of plant food.

The OSU Extension Service held field days and short courses to acquaint farmers with the wastes and their nutrient value as well as their economic value. Currently, farmers near most major crab and shrimp processing plants spread the wastes over their land.

Lincoln County farmers, because of Costa's research, and with the help of Lincoln County Extension agent John Fitzpatrick, formed a cooperative and negotiated an agreement in which the processors agreed to pay the agriculturalists $7 a ton to haul the wastes away.

And for Costa, the satisfaction of successfully completing a research project that pulled seafood processing plants out of a pinch and helped coastal farmers was rewarded in a very special way.

The Sea Grant Association awarded the soil scientist one of three awards that honored outstanding student researchers at its annual meeting in New Orleans, Louisiana, last November. Over 70 students submitted papers for judging.

Now that seafood processors and coastal farmers can work together to benefit each other, both realize they have something in common. A processing plant's wastes have become a farmer's fertilizer.

Mouth watering meals

Cod, petrale sole, crab, oyster, clam, shrimp. It's all there, behind the two dark-stained knotty pine doors – each adorned with a porthole for a window – at the Sea Boy's Market in Corvallis.

Pam and Bob Knight make it their business to present a variety of seafood to satisfy customers' appetites for a nutritious meal. So do numerous other seafood stores in Oregon.

The pair opened this particular store three years ago to supply what they felt was a growing demand for delicious, fresh seafood. They were right.

The number of steady customers has increased by 40 percent since they rang up the first dollar on the cash register, Pam estimates.

Why?

"Seafood is certainly more expensive than beef, so I guess people eat it for nutritional reasons," Pam hypothesizes.

"There are a lot of people buying seafood now because they're in a weight-watching group, or their doctors put them on a high-protein diet."

Red snapper and sole make up the bulk of customers' requests. But some patrons are getting brave, say the Knights. More and more ask for octopus, shark steaks, squid and a Hawaiian fish, mahimahi.

Whatever customers prefer, they will find a wide assortment of fresh, delicious, nutritious seafood products at this store, and at others in business in the state to supply a growing demand for high-protein, low-fat foods from the sea.

Where buyer meets seller

Fishing and ocean ranching isn't an eight to five job. That's one reason why seafood prices, quality and supply vary.

Seafood market structure also accounts for some of the variability consumers notice as they stroll down supermarket aisles or look at menus in restaurants.

Before consumers make their choice, they look closely at what seafood costs. So do producers.

Producers' concerns? Acquiring information describing the economic feasibility of catching, or rearing, the fish they sell to processors.

Bringing Home the Seafood

You fought through the traffic snarl in the parking lot, and battled the automatic door. Finally, you're inside.

Spirited music waltzes you to the grocery cart corral. You pick one, and begin the trek down the supermarket's aisles.

Time to make a choice.

You stop and scan the variety of canned salmon, shrimp and oysters on the shelf before you. You look at the fresh and frozen fillets in the meat cases too.

You make your selection and complete the last link of an intricate marketing chain between seafood producers, processors and consumers. The seafood industry will respond to your choice, but that response may be an inconsistent one.

Even without facts, many consumers picking seafood notice that the price, quality and supply of the products from the briny deep vary. Fishermen and ocean ranchers would tell you that the price they receive for their catch fluctuates even more.

Weather and the seasons account for some of the variation. So do the number of fishermen and ocean ranchers on certain fisheries, and competition between fish buyers for a catch. So do processing efficiency, the type of fish canners process, and the distance from the port of landing to the retailer.

Price quality and supply variability concern Dick Johnston, associate professor in OSU's Department of Agricultural and Resource Economics, and Fred Smith, professor, as well as the seafood industry.

The two Sea Grant researchers study why the seafood market ticks the way it does from producers to processors, and finally to consumers. The pair will also develop measures to monitor the market's performance.

Johnston and Smith have set out to examine one product in particular in the seafood marketplace -- salmon. They have gathered price and landing information at various coastal ports in the Northwest by interviewing processors and salmon fishermen. They used the information to generate hypotheses that may explain the salmon market's variability. Further work will either confirm, or reject, the hypotheses.

The pair also collects salmon processing cost information. This data allows them to analyze the effect of processing efficiency on pricing.

Studies of the Northwest seafood market will give the industry, and the researchers, a regional perspective. A national outlook, however, would provide the industry a better idea of its position and help develop new marketing strategies. To provide that point of view, Smith and Johnston say they will pool their data and results with other Sea Grant programs in the nation. Ultimately, the findings will be available for public use.

Aquaculture and Economics

Any business takes a calculated risk supplying consumers with goods or services. A new business, however, takes extra risks attracting a market for its products and anticipating consumer demand.

"If you're working with a product, but you don't understand the economic relationships, you take a real gamble," claims Johnston. He and his associates in the Department of Agricultural and Resource Economics, associate professor Don Langmo, graduate student Jerry Clark, and Smith, study the economic feasibility of the Northwest's infant aquaculture industry. They also look at the economic impact of changing technology on more established aquaculture operations.

Recently, the economists looked closely at the costs of raising oyster seed in hatcheries. Prior to the study, no production cost research had been completed for this aspect of aquaculture in the Northwest.

Oyster seed farmers, Johnston explains, sell the seed they rear in bayside hatcheries to oyster growers. The growers tend the tiny mollusks in bay water until they grow to a marketable size.

Don Langmo and Kwang Im, currently an economist for the Alaska Department of Fish and Game, estimated variable and fixed costs of operating various-sized oyster seed hatcheries, speculated on hatchery profit potential, compared investment alternatives and investigated short-run and long-run cost functions. With help from the University of Washington Sea Grant Program, Johnston followed up with an oyster seed market survey, and determined the effect of consumer demand for oysters on growers' demand for hatchery seed.

Johnston points out that his associate Fred Smith has begun gathering data for a similar analysis of growing oysters. Smith will calculate production costs of rearing to market size the hatchery-produced oyster seed growers buy.

Ocean ranching of salmon by private firms has generated much interest in Oregon, Johnston says. Already the state has issued 16 permits to firms wanting to raise fish in modern hatcheries, release them to sea and wait for their return as mature adults three or four years later.

Johnston and his associates are studying the economic feasibility of the salmon ranching business. They use many of the same tools they worked with in the oyster seed project.

The OSU economists will cooperate with the University of Alaska Sea Grant Program to broaden the scope of the study and give a more complete picture of the salmon ranching industry on the West Coast.

To have and to hold

There's a mighty stir seaward these days as industry, government and citizens realize the ocean's value as a source of food, energy, raw materials and recreation.

With this growing interest in the marine frontier comes the need to manage wisely and balance uses. For future managers of the seas and coasts, this means foresight in fostering development and a commitment to conservation.

Seals and Salmon

When Congress passed the Marine Mammal Protection Act in 1972, resource managers added another law to their legal toolboxes. But few guessed that the law would radically change seal and sea lion behavior as well.

Indeed it has, says Bruce Mate, assistant professor of oceanography at OSU and a Sea Grant researcher, who is collecting facts about the animals' new habits to assist marine resource agencies.

The 1972 law protecting the fish-eating pinnipeds (as seals and sea lions are also called) has resulted in a change in their distribution. They are now found far up Oregon's rivers on feeding forays.

All this "bold" pinniped behavior irks Oregon's salmon fishermen, who are convinced that the animals deplete salmon runs.

Fishermen swallowed the 1972 law reluctantly. Prior to the legislation, fishermen could shoot the pinnipeds around river mouths. Overnight, that became illegal. The about-face, Mate believes, has frustrated fishermen, who view the seals' river presence as "proof" of their negative attitudes about the animals.

While the majority of fishermen obey the law, a handful violate it and shoot the pinnipeds. This raises the ire of those who want to protect marine mammals, and is also downright illegal.

Demonstrations, petitions, and even interference with foreign whaling ships and seal hunters have stressed the protectionist point of view. Letters demanding a stop to any marine mammal harassment flood into Washington, D.C., and foreign capitols.

Another less verbal interest is involved in the debate: Oregon's coastal tourist industry is large, and depends on tourists and tourist attractions. Seals and sea lions simply attract people.

"They're neat to look at," Mate explains.

Sorting out Seal Facts

The marine mammalogist readily concludes that the law has squared off sides. When confrontations occur, arguments are based on emotion, not fact.

Realizing this, Mate gathers facts in the Rogue River near Gold Beach -- an area abundant with pinnipeds -- to assess the animals' impact on the salmon run there.

Part of Mate's work will estimate the population of two pinniped species; he will use regular surveys to estimate the number of animals seasonally using the river.

Mate's project will also determine what the pinnipeds eat. Mate stresses that he has documented the fact that seals and sea lions eat salmon. How much salmon and what else is the critical issue, because no one knows for sure if the animals seriously deplete salmon runs.

"Pinnipeds eat opportunistically," the mammalogist explains. "They eat anything."

Observers have seen seals and sea lions eating other fish, as well as lampreys. Lampreys prey on salmon. Mate suggests the possibility that pinnipeds may eat more of this salmon predator than salmon, thus ultimately benefitting the fishery. However, if fish don't bite for the sportfisherman because pinnipeds are present in the river, conflict will remain.

Examining pinnipeds' stomach contents will tell the Sea Grant researcher what seals and sea lions eat, and in what amounts. From that information, he can calculate the percentage of salmon in the animals' diets.

Knowing how much salmon a pinniped may eat, and how many pinnipeds swim the Rogue River, will allow Mate to assess the impact of seals and sea lions on the river's salmon run.

"We'll have facts to work with," Mate says.

Facts will give people the necessary information they need to support, or to change, their attitudes. Facts will also further marine resource managers' understanding of marine mammals relative to the Protection Act of 1972, to benefit both people and pinnipeds.

Lawyers at Sea

The drone of several voices becomes a crescendo, then hushes as the jury files into the courtroom to deliver its decision.

Lawyers from an ocean oil drilling firm and a fishermen's organization protesting oil exploitation in prime fishing grounds await the verdict.

The judge asks the jury foreman, "Have you reached a decision?"

What the jury decided in this hypothetical case doesn't really matter. The point is that as more people

turn to the oceans and coasts for a livelihood, user conflicts increase.

Many marine resource managers need legal help in understanding the intent of the laws passed to protect users' and the nation's interests. The Fishery Conservation and Management Act of 1976 illustrates the point.

Certain U.S. companies propose to fish cooperatively with foreign nations within the 200-mile fisheries management zone. Would delivery of a U.S. company's catch to a foreign processing vessel constitute fishing on the foreigner's part? Could the foreign ship fly the U.S. flag and fish in domestic waters? If so, would the foreign fishermen violate U.S. immigration laws?

Tough questions that marine resource managers must ponder as they seek the best ways to sustain yields of U.S. fishery stocks.

Advising Lawyers

The Ocean Resources Law Program at the University of Oregon School of Law willingly takes on the task of researching such intricate legal questions for managers.

Jon Jacobson, professor of law, who heads the program, keeps pace with current developments in ocean and coastal law to fulfill the program's research and advisory roles, and keeps managers up-to-date by publishing his

findings in **Ocean Law Memo**, the program's newsletter.

Jacobson enlists the aid of two or three graduate students in the law school each year.

Bill Dials is studying the questions joint fishing ventures raise, as well as legal points concerning a state's right to manage fisheries within its boundaries.

One part of the Fishery Conservation and Management Act of 1976 implies that the Secretary of Commerce has the authority to overturn a state's management system. This could cause havoc for fishermen, and for the managers who chart the future of salmon runs up the Columbia, Suislaw and other Oregon rivers.

The Global Ocean

The United Nations Law of the Sea (LOS) Conference, a gathering of more than 150 nations to chart, by treaty, a worldwide "constitution" for the oceans, considers all marine resources, both biological and mineral, from a global perspective.

The LOS outlook conflicts somewhat with the U.S. fisheries act of 1976, as well as with domestic ocean mineral development interests. Jacobson and Bill Ecklund study the legal issues involved.

Several LOS nations disagree with the U.S. claim to manage anadromous fishes, particularly salmon, beyond the 200-mile zone, as the 1976 law stipulates.

"If the LOS treaty comes to a vote, and we become party to it, what happens to the 1976 act?", Jacobson asks. "The answer is not clear yet."

Mining the oceans looms as an even bigger source of debate at the conference. Developing nations want insurance of a fair share of valuable ocean minerals, especially manganese nodules strewn on the seafloor in deep, midocean waters.

The outcome of the debate, which Ecklund is researching, will affect U.S. investors' willingness to develop the resources as well as any legislation Congress makes to regulate companies tapping the minerals.

Oil and Fish

Peter Swan, a faculty colleague of Jacobson's, is on a Fulbright lectureship in Norway this year. He plans to spend some time studying Norwegian laws regulating offshore oil drilling.

When Swan returns, he will compare U.S. laws to the Norwegian rules, and will suggest aspects of the Norwegian laws U.S. legislators may want to consider.

Offshore oil has also attracted the attention of Oregon's Land Conservation and Development Commission (LCDC), the agency responsible for charting Oregon's future growth based on public consensus.

LCDC has enlisted the aid of a recent law school graduate and three law students to study potential legal conflicts between fishermen and oil companies that may drill in prime fishing grounds.

Aquaculture doesn't escape the attention of the Ocean Resources Law Program. Last year the program sponsored an aquaculture symposium. A private aquaculturist explained that

he had to wander through a maze of red tape to acquire 18 permits before he could legally start his hatchery. He pled for an easier way to enter the industry.

"We'll try to find out what a person has to do to get started in ocean ranching, and we'll set up a blueprint to help people through all legal steps of obtaining the permits," Jacobson says. Greg Cook, another research assistant, has begun work on that project.

The Third Mission

Research and advise -- two primary responsibilities of the Ocean Resources Law Program. But Jacobson accepts a third responsibility as an equally vital part of his mission -- education.

He guides about 20 students a year into either coastal or ocean law.

Jacobson picks two or three graduate students from each year's group to fill research assistantships. The chance to work on ocean-related legal issues with the law professor is an opportunity many students seek.

The Ocean Resources Law Program, and its graduates, fulfill a legal advisory role marine resource managers need. As new students join Jacobson in the legal niche he occupies, resource managers have competent advice at their disposal to balance peoples' uses of the oceans and coasts.

Planning Fishing's Future

Fishery biologists spend days at sea sampling fish stocks. Their purpose -- calculating the extent of fishery resources deep among the rocky ocean terraces of the outer continental shelf, or closer to shore along the sandy seafloor.

Critical questions surface as biologists funnel their data to marine resource managers developing strategies to exploit the stocks wisely.

Who harvests what, and in what amounts to ensure catches for future fishermen?

The Fishery Conservation and Management Act of 1976 created eight regional fishery management councils to address these questions. The Pacific Fishery Management Council, responsible for the 200-mile economic zone off the California and the Pacific Northwest, is one of them.

Before President Ford signed the bill, Bruce Rettig, supported by Sea Grant, was asking questions he knew the newly created council would soon ponder, and seeking answers.

"Public administration of fishery resources has been under increasing stress, and the Fishery Conservation and Management Act of 1976 was the first step toward a new institutional arrangement," says Rettig, associate professor of agricultural and resource economics at OSU.

"I'm trying to see where this is leading us."

Rettig, also a member of the Pacific Fishery Management Council's Scientific and Statistical Committee, is currently exploring two vital concepts in fishery management -- expected harvest and optimum yield.

Tools for Management

The economist and graduate student Chris Carter realize that fishermen move from fishery to fishery as the season progresses. Several salmon trollers become crabbers in winter. Many draggers that seek bottom fish in winter turn to shrimp in spring.

The management council needs a method to predict the fishing pressure on each stock before making a management plan. Using expected harvest, the council can determine the amount of fish they expect U.S. fishermen to land. Any residual can be more accurately allocated to foreign fishermen.

"We're looking at landings and activities of Oregon fishermen engaged in multiple harvesting of shrimp, groundfish and crab," Rettig explains. "We're trying to understand the impact of prices and associated economic conditions influencing the choice among these fisheries."

Rettig's research with the second concept -- optimum yield -- helps the Pacific Fishery Management Council allocate fishery resources among conflicting interests.

"For practical purposes, you can think of making a fishery management plan in three stages," the economist suggests.

The first stage describes the fishery in detail, including the problems a stock faces. The second part of making the plan sets new objectives if current conditions prove unsatisfactory. Managers also pose alternatives to meet the new objectives during the process.

Managers evaluate the alternatives, and select appropriate ones to attain the new objectives in the third stage. Then they consider regulations that reflect the best trade-off between economic, social and biological considerations.

"That's optimum yield," Rettig remarks about the planning process.

Rettig's work on refining the optimum yield concept is partly empirical and partly conceptual.

"I'm trying to see whether there should be standardized criteria for evaluating alternatives. Currently the objectives and alternatives selected vary widely from fishery to fishery."

Fishery biologists spend days at sea assessing the extent of fishery resources. Bruce Rettig and his graduate assistant spend days at their desks, grappling with the questions of who harvests what, and in what amounts, with the tools of expected harvest and optimum yield. Their work will help the Pacific Fishery Management Council balance all fishery users' needs.

The Young Managers

Stars are born, but marine resource managers are trained.

The Marine Resources Management Program in OSU's School of Oceanography does just that. Students with strong backgrounds in fisheries, political science, economics, and other disciplines learn how to manage ocean and coastal resources based on sound, scientific information.

Victor Neal, head of the program and director of the school's instructional programs, stresses the need for facts in the decision-making process. He demands that his students get "hands-on" experience at making decisions.

True, students in the program learn biological, chemical and physical oceanography as well as management methods and estuarine processes. But, when a port commission calls Neal with a problem, his students tackle it with the knowledge they have acquired.

Bandon asked for help in mapping its port's future recently, and the Tillamook Port Commission requested assistance in finding a suitable site for a new marina.

Working with port commissions gives students a valuable group training experience. The group situation helps each young manager see how others perceive a problem, and what facts others consider pertinent. Thus, when students land their first job, Neal explains, they know how to consider all resource users' needs.

Going it alone

An internship is the highlight of each student's academic training. The apprentice managers usually serve with government agencies. One intern recently studied the need for Columbia River marinas for the Oregon State Marine Board. Another investigated ports' impacts on Oregon's economy for the state's Department of Economic Development.

Finding internships that match a student's needs, interests and goals keeps Neal busy. Counseling each student in the Marine Resources Management Program consumes an enormous amount of time too.

The time Neal spends with students, however, ensures that properly trained managers will graduate from the program with a nose for finding facts about any issue they confront on the job.

Managers with that skill, Neal states, know how to make decisions that will promote the wise use of coastal and ocean resources.

The ocean for everyone

Oceans affect us culturally and aesthetically. Yet from the scientist's point of view, and from the perspective of humanists, writers and artists, much needs to be understood of the salty waters that cover 70 percent of the earth.

To foster that integrated understanding, Sea Grant helped initiate the Marine and Maritime Studies Program at OSU. The program offers students a solid core of interdisciplinary courses that have the sea as a central topic. The departments of anthropology, English, history, psychology, modern languages and art as well as the School of Oceanography participate in the program.

A speaker's forum, film series, workshops and short courses extend the Marine and Maritime Studies Program into several Oregon communities. Collaboration with other colleges and universities in the nation has established a coast-to-coast network of humanities and marine education programs as well.

Fostering an understanding of marine resources among Oregonians -- that's one goal of the Marine Advisory Program.

Both MAP Extension marine education specialists, Don Giles and Vicki Osis, extend an invitation to anyone wanting to learn about the marine environment. Here's how to take them up on the offer.

--Displays at the Marine Science Center in Newport help visitors, some 400,000 annually, learn about ocean and estuarine processes as well as the animals that live in the sea and fly above it.

--Seatauqua, a summer marine education program, offers a variety of courses ranging from nature walks to naivgation workshops at the Marine Science Center for all age groups.

--4-H, for which MAP provides leaders with handbooks on marine subjects. MAP has helped 4-H form marine science clubs, and has even conducted a marine-oriented summer camp.

--Other educational activities, such as publications MAP Extension communications specialist Charlie Jackson and Jim Leadon, MAP editor, help marine Extension agents and specialists write, as well as radio and television shows, promote an understanding of the marine environment.

As the river meets the sea

The earth's most productive environment -- the estuary, where a river meets the sea.

In the rich mixing of fresh and salt water, new generations of fish and shellfish grow, feeding on abundant plankton in the nutrient-rich waters.

Human settlements crowd the estuary's shores with fishing piers, shipping docks and waterfront industry.

Modeling Estuarine Productivity

Using estuaries wisely challenges our ability to understand, predict and hence forestall undesirable changes that would harm the estuarine environment.

Charles Miller, associate professor of oceanography at OSU, has worked to modify a computer model that will help estuarine planners assess accurately the affect of construction, dredging and other modifications in estuaries.

Miller and the graduate students working with him on the Sea Grant project collected data for the model by sampling two species of zooplankton in Yaquina Bay -- **Acartia tonsa** and **Acartia clausi.**

Zooplankton are primary links in the estuarine food chain. Disruption of the food chain could alter an estuary's production of fish and shellfish.

The model that Miller is using analyzes disturbances in the zooplankton population, and how those disturbances affect the estuary's total productivity.

The researchers took samples of zooplankton once a week for six years in the lower reaches of Yaquina Bay. They also collected a concurrent two-year data set in the upper bay.

From that data, Miller charted seasonal population fluctuations of **Acartia tonsa** and **Acartia clausi** over the six-year period for various portions of the bay.

Miller attempted to determine why Acartia populations oscillate, realizing that the answers must be included as variables in the model. He discovered several growth rules for the two species, and found that environmental factors such as water flow and temperature, salinity, volume of water in the estuary at various tide stages, and the bay's substrate affect zooplankton densities and distribution.

Plugging into the model numerical values for the environmental factors and growth rules may lead to successful prediction of the population of these two zooplankton species in the estuary. This will give planners a method to assess the impact of engineering modifications on estuaries before construction begins.

Protecting the Waterfront

Although plankton and fish thrive in estuaries, destructive organisms also call this productive environment home.

Gribbles, shipworms and certain types of wood-decaying fungi destroy wooden waterfront structures around the world. In the U.S., a conservative estimate places the damage they cause to wooden boats, pilings and piers at $500 million annually.

Just this year, gribble attack sent a section of a bridge at Isthmus Slough in Coos Bay tumbling into the water. Nearby, a pile driver also fell through a gribble-weakened dock.

Robert Graham, professor of forest products at OSU's Forest Research Laboratory, isn't one to downplay the destructive powers of marine wood borers and decay fungi. He points out that the use of pressure-creosoted piles could have prevented the damage in Coos Bay.

Graham and his research assistants, Guy Helsing and Bob Inwards, as well as several students broke ground on a Sea Grant project in 1974 to find ways of stopping wood decay and insect attack in wooden waterfront structures. Malcolm Corden, professor of botany and plant pathology, is helping Graham identify the wood-decaying fungi.

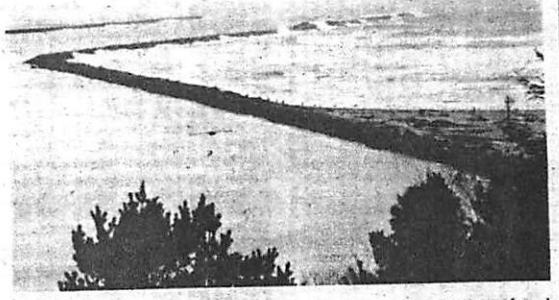
"In the moist coastal environment, airborne fungal spores land on wood, germinate and extend thread-like fungal strands deep into wood," Graham points out. "As the strands penetrate, they feed on cellulose and lignin that give wood its strength."

Gribbles burrow just beneath the surface of wood, and can reduce stout pilings to hourglass-shaped remnants. Shipworms, a species of clam, tunnel deep into heartwood, making pilings look like Swiss cheese.

Graham and his associates pit antifungal fumigants against these three destructive organisms. Initial results indicate that wood-decaying fungi, shipworms and, possibly, gribbles should start looking for a new source of food or shelter.

Graham's student assistants found 36 pressure-creosoted wooden piles infested with wood-decaying fungi in a bulkhead at Florence. He directed them to inject liquid fumigants into the piles just below the exposed tops. The fumigants, injected in liquid form, turn into a toxic gas inside the pole.

"The technique saves utility companies millions of dollars annually by stopping decay inside poles," Graham states. "It may be equally important for saving piles and timbers in waterfront structures."



One year later, Graham and his students found that the fumigants had killed the fungi in all but four of the 36 piles. After another year, none of the bulkhead piles contained decay fungi.

The research team also wondered if fumigants would control wood-decaying fungi plaguing waterfront structures built of untreated wood. Fumigants injected in 12-year-old untreated piles at Florence virtually eliminated wood-decaying fungi.

On what Graham calls a long shot, they decided to explore the ability of fumigants to prevent marine borer attack. The researchers placed Douglas-fir test panels in Yaquina Bay at Newport, San Francisco Bay and Los Angeles Harbor two years ago.

Recently, they discovered that the fumigants prevented, or reduced, gribble and shipworm attack in Yaquina Bay. In the bays to the south, however, the fumigants did not deter gribbles; there was little or no shipworm attack of untreated panels. Graham concludes that warmer water temperatures in San Francisco Bay and Los Angeles Harbor may increase gribble activity to a point at which fumigants provide little control.

Finding a protective cap for piling tops occupies some of the research team's time. The treated tops of creosoted pilings frequently are cut off, leaving untreated wood exposed. Prompt application of caps is necessary to prevent quick infestation of decay fungi, and also reduces the amount of gaseous fumigant seeping out of the piles.

Wooden boats do not escape wood-decaying fungi either. To help owners of wooden boats maintain their vessels, Graham and Ed Condon, OSU Extension oceanographer, wrote a publication describing the decay fungi, and how boat owners can solve fungi problems.

Graham has also written and produced two slide-tapes to teach port managers and workers the types of wood-destroying organisms and the kinds of treatments that can extend the life of wooden waterfront structures.

Getting the Team Together

Estuary research resembles opening day on a crowded trout stream. Fishermen line up elbow to elbow, catching each others lines.

Tangled communication lines plague many researchers studying Oregon's 22 estuaries.

Seventeen state, regional and federal agencies realize this, and in 1975 banded together. Their goals -- exchanging research results and coordinating future research activities to facilitate the understanding of each Oregon estuary as a complete ecosystem.

To promote coordination, they created the Oregon Estuarine Research Council (OERC). Sea Grant partially supported OERC's executive office, located at OSU's School of Oceanography.

Running OERC keeps executive director Bob Holton, assistant professor of oceanography at OSU, and his administrative assistant John Morgan busy.

"Numerous projects are underway in Oregon's estuaries," Holton explains. "Believe me, keeping track of who does what for whom, and who could benefit from knowing what another agency does, can be confusing. But someone needs to do it."

Holton emphasizes the need for OERC. An abundance of separate agencies gathering information impedes knowledge of each estuary as a complete ecosystem. OERC may help agencies to share their progress.

Since its inception in 1975, OERC has compiled a bibliography of completed research projects in Oregon estuaries, an invaluable tool for any estuarine researcher in the state. Holton and Morgan are now working on a catalogue of current estuarine research.

Twice a year, OERC members have regular business meetings to present research project updates, exchange research ideas and priorities, and set OERC goals.

OERC has also established a library that concentrates pertinent estuarine research literature, saving investigators long hours of looking for bits and pieces of relevant information.

OERC's bibliography of past research, catalogue of current work, and library all focus on working together and keeping lines of communication among agencies tangle-free.

THE GRIBBLES ARE COMING

Sea Grant changed Paul Coyne's visual landscape.

When Coyne used to look at the 300 pilings in the docks he manages for the Port of Siuslaw, he saw dollars going down the drain. He didn't know it then, but wood-rotting fungi, gribbles and shipworms were devouring the pilings -- each worth about $900 at today's prices.

Now Coyne sees dollars saved when he looks at the pilings. Bob Graham, a Sea Grant researcher who knows how to prevent wood deterioration in waterfront structures, acquainted Coyne with the destructive organisms, and helped the manager put a halt to them.

"Graham and his crew showed us what to look for," the port manager says. "They even explained it so any guy can understand the problem and make you want to follow through."

Coyne spread the word. Now Graham helps port managers up and down the coast.

Bob Graham and Sea Grant changed Paul Coyne's visual landscape. Other port managers are getting a better view too.

Mariners make way

The mariner wants to put to sea. How's the weather?

An ongoing Sea Grant project develops new methods for accurate forecasts of harbor and open sea conditions.

The mariner is at sea. But where?

Sea Grant informs mariners about the new Loran-C navigational system.

The mariner is back in port. Is moorage space available?

Sea Grant helps marina operators determine guidelines for planning and financing their facility's future.

Watching the Waves

Beachside wave watching is a fascinating hobby for many Oregonians who make the pilgrimage west for vacations or weekends.

Waves fascinate Bill Quinn too, but it's his profession.

Quinn, an associate professor of oceanography at OSU, worked closely with the National Weather Service and the U.S. Coast Guard to develop a suitable wave observing and forecasting system. Mariners rely on sea condition forecasts, and the oceanographer's work may improve predictions.

Early in their Sea Grant project, Quinn and his two colleagues, research assistants Dave Zopf and Clayton Creech, tested a seismometer. Instead of evaluating earthquake shocks on the Richter scale, they calibrated the instrument to measure ocean waves near the coast. They called the instrument a wavemeter.

Satisfied with the wavemeter, Quinn, Zopf and Creech installed seven of the instruments in Coast Guard stations from Humboldt Bay in California to Westport, Washington.

The Coast Guard routinely records wavemeter readings and sends the information, via teletype, to National Weather Service forecasters in Portland and Seattle. The forecasters use the data to monitor wave conditions and verify previous sea condition forecasts.

"This land-based wavemeter system is highly reliable and economical," Quinn points out.

Warm or Cold?

For the brave, a toe in the chilly surf tells them the swimming conditions are far from ideal. Quinn, Zopf and Creech also test the water temperature, but with a thermal sensing device.

The researchers installed the temperature measuring equipment on the bottom of bays near the Coast Guard stations. The Coast Guard relays the temperature readings, via teletype, to the National Weather Service where forecasters use the data to predict coastal fog and cloud conditions. The readings also help the Coast Guard calculate how long a person can survive in the chilly ocean water before dying from hypothermia, or exposure.

A call to the National Weather Service gives the up-to-date forecast. But for mariners in Westport and Newport, the television gives the same information.

At these seaports, the wave and sea temperature data are now transmitted via a phone line to local cable television stations. On the station's weather channels, wave height and sea temperature gauges are included with traditional weather meters.

The sea condition information helps others too. The National Environmental Satellite Service double checks satellite sea temperature observations with the data. The National Data Buoy Office compares wave height observations with the seismometer readings. Sea Grant researchers and other scientists have access to the information as well.

While beachside wave watching is a hobby for many, Quinn, a professional wave watcher, looks at the phenomenon from a different perspective that can make weather and sea condition forecasts mariners depend on more exact.

Staying on Track

You've spent a foggy morning on your boat mending crab pots. The sun is out now, and you're checking your Loran-A receiver anticipating the start of a good season next week.

You ignore shrieking gulls and the groaning dock. Then the sound of steps on the wooden wharf catches your ear. A voice speaks.

"Hi, I'm Dan Panshin and I'm studying Loran users. Do you plan to switch to Loran-C when the Coast Guard terminates Loran-A in July, 1979?"

Panshin, Extension oceanographer for MAP and associate professor of oceanography at OSU, spent almost a year asking commercial fishermen from Oregon to Maine, and others who depend on Loran as a navigational aid, that question. He also carefully explained what Loran is, and how it works.

Loran stands for LOng RAnge Navigation. Many fishermen, merchant mariners and other navigators in U.S. coastal waters use radio-transmitted Loran-A signals to pinpoint their position with extreme accuracy. They will, that is, until the Coast Guard, authorized by the U.S. Department of Transportation, converts to Loran-C.

There's a good reason behind all this. A chain of Loran-A transmitters was established along U.S. coastlines during and after World War II. A primary Loran-A transmitter sends a radio signal, which Loran receivers on boats and ships pick up.

Another Loran-A transmitter, a slave transmitter, sends a secondary signal shortly after the primary signal. Loran receivers calculate the time lag between the two signals in microseconds and navigators can determine their position on Loran nautical charts within 500 to 1,500 feet. None of this accurate navigational system depends on weather, as celestial navigation does.

Loran-C operates the same way, but better, pinpointing a position within 50 to 500 feet. Those few feet can make the difference navigating through shallow shoals and around rocky headlands, especially for captains of huge oil tankers.

In 1976, the U.S. Department of Transportation, considering the benefits of Loran-C, instructed the Coast Guard to phase out Loran-A and implement the new system. On the West Coast, Loran-A is scheduled for termination during July 1979.

That's where Panshin and the Sea Grant College Program at OSU fit in.

"They're very competent engineers and technologists," Panshin says of the Coast Guard. But the oceanographer adds that the Coast Guard had little idea how the conversion to Loran-C would affect Loran users. They funded his year-long Sea Grant project to find out.

Panshin, and his associates Charles Vars, professor of economics, and research assistant Rebecca Roberts surveyed Loran users nationwide. From that research, they made these recommendations to the Coast Guard:

- To delay Loran-A's termination date in Oregon, Washington and California by one year. Loran-C sets will cost users between $3,000 and $4,000. Extending the termination date an extra year will give users more time to make their investment. The cost of the sets will probably come down as manufacturers put more receivers on the market.
- To terminate Loran-A in November instead of July on the West Coast. November is a slack period for marine activity, and Panshin believes conversion then would have less of an impact than during the peak season in July.
- To place greater emphasis on making accurate Loran-C nautical charts.
- To conduct an educational campaign to inform Loran users of the change. Some people still buy Loran-A receivers unaware of the upcoming switch to Loran-C.

The Coast Guard has responded to the recommendations, and has already begun an educational program. More emphasis is being placed on Loran-C nautical charts. Panshin says officials are seriously considering extending Loran-A's termination date until November 1980.

Panshin points out that this Loran project sums up Sea Grant philosophy.

"Sea Grant provided the missing link between a highly technical organization, the Coast Guard, and the working mariners who rely on the navigational services that organization provides," the oceanographer explains.

Is There Room to Grow?

Marina managers are expanding their moorage and storage facilities to make room up and down the coast for an increasing number of recreational boaters, says Charles Vars, professor of economics at OSU and a Sea Grant principal investigator studying the demand for additional marina space.

The Port of Newport recently began constructing 250 more moorage spaces at South Beach on Yaquina Bay. Salmon Harbor's port plans to expand to 2,000 spaces as demand grows, and Bay City has blueprints on the drafting table for an expanded moorage and storage area.

Although moorage and storage facilities have grown successfully in the past, no attempt has been made in Oregon to estimate the demand for these services in a comprehensive and systematic manner.

Just recently, Vars explains, an individual interested in starting a marina quizzed him about the demand for storage and moorage facilities, and the services boaters prefer at marinas.

Vars admits he didn't know the answers to the investor's questions, but within the year he'll have a better idea. He recently mailed a survey to 6,000 registered boaters in Oregon. The information the boaters mail back will provide data to analyze the demand for moorage and storage locations on the coast, as well as the impact of higher moorage fees on that demand. Vars explains that new moorage facilities are so costly to construct that fees may increase as much as 100 percent above current rates.

Vars adds that the survey will also identify marina services boaters prefer, as well as what boaters like and dislike about marinas.

"We're asking questions that have never been asked before in a boating survey, at least in the Pacific Northwest," Vars explains.

While the survey will not give precise information about boaters at particular marina facilities, the economist believes that the information will help investors estimate and evaluate their business and its future.

THE FIRST GEAR ON THE BOAT

Salmon trollers depend on Loran -- the electronic navigational system the Coast Guard manages for mariners.

"Loran is the first piece of equipment you put on your boat," insists Ken Butler, skipper of the **Pescedero** out of Bandon. "There wouldn't be nearly as many people in the business if all they had to navigate with was a fathometer and compass."

"That's right," exclaims Glenn McCasland, captain of the **Sea Trout**, who also calls Bandon home port. "Loran can make the difference between a $1,000 day and a $10 day. If you get off a good fishing spot without Loran, you won't get back on."

"It doesn't take too many of that kind of day to blow your whole season," Butler asserts.

Both trollers feel satisfied with the existing Loran-A system. They wouldn't mind the switch to Loran-C in July 1979 if the Coast Guard can show them how the new signal will benefit salmon trollers' needs. The accuracy of Loran-C charts also concerns them.

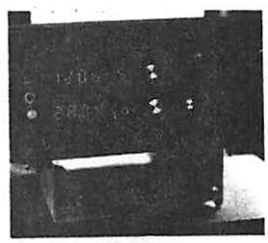
Their apprehension about the switch to Loran-C is why they think Dan Panshin's Sea Grant study of Loran users nationwide will inform the Coast Guard of their uneasiness.

"When he gets Loran-C set up so it does benefit us, then he'll make a very valuable contribution," Butler explains.

One thing's for certain: these two salmon trollers, and others, depend on Loran. When the Coast Guard makes the switch, Butler, and many other fishermen, will add a $3,000 to $4,000 Loran-C receiver to the $30,000 to $40,000 they already have invested in their boats.

McCasland just bought his new Loran-C receiver.

"Son of a gun, it cost $4,000. But you have to have it!"



Building on sea and shore

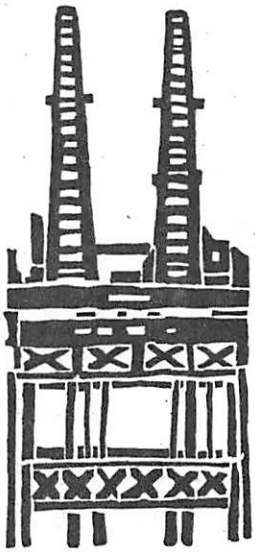
Man the builder.

Building on the coast. A desirable homesite could be the next candidate for a quick trip into the sea. Understanding and preventing causes of erosion on Oregon's coast can help.

Building in coastal waters. Innovative engineering can design marinas to complement an estuary's natural flushing and cleansing processes.

Building at sea. The search for offshore energy expands the technology of construction at sea, but new design techniques that account for ocean wave forces are needed.

Sea Grant -- helping the builders and doers in the marine environment.



A House Upon the Sand

Bayocean Spit and Siletz Spit. Two victims of destructive erosion on Oregon's coast.

But Bayocean and Siletz spits are also witness to the curiosity of Paul Komar, a Sea Grant researcher at OSU who wants to know how Oregon's coastal erosion happens and how to prevent its devastating effects.

Komar, associate professor of oceanography, had studied the fate of Bayocean, watching the spit's changing shape through historical records and photographs, and of Siletz Spit using old surveys and aerial photographs, through two previous Sea Grant projects.

Seeking more clues to erosion processes, he embarked on a new study, which he completed this year. He began his research with the intention of using Netarts Spit, un undeveloped strip of sand, as an ideal spot to investigate the natural forces of erosion.

Storms from the Sea

But the forces of nature took a hand midway through Komar's first year of research. In February 1976 a major storm slammed into Oregon's coast. Once more Siletz Spit suffered renewed erosion, and several homes were threatened as the sand beneath them washed toward the sea.

The storm and its aftermath presented Komar with an opportunity to document a new instance of severe erosion, and to correlate the changes in dune and beach with the storm-driven wave and tide conditions.

Oregon's coastal erosion occurs mainly during winter months, when bad weather augments the power of Pacific waves. Komar contrasted the characteristics of the waves generated during the storms of 1972 and 1976, and found that though the 1976 storm had smaller waves than 1972's, it coincided with high spring tides that drove shoreline water levels higher. Added to this were the near-hurricane force wind speeds of the 1976 storm that brought the first washover of Siletz Spit dunes Komar had observed.

Once Komar had described and analyzed this new incident of erosion on Siletz Spit, he turned his attention to Netarts Spit and the question of natural sand spit erosion.

According to the scientist, "I found that Netarts was not as useful in demonstrating this process as I originally thought it would be. It turns out that the dunes there are much higher than on Siletz Spit, and so do not erode in the same fashion. Also, the erosion occurs along a much longer stretch of dunes, and is not as localized as it is on Siletz Spit."

Waves contribute to continuing erosion processes on Oregon's coast primarily when their path is interrupted by jetties, as happened at Bayocean. Waves arriving from offshore tend to come from the north in summer and south in winter, so that sands swept away at one time of year can be redeposited when the seasonal reversal of wave direction occurs. Komar calls Netarts Spit the best example of zero net sand transport, because it is tucked away between two large headlands that do not permit the sand's escape from the beach during the seasonal cycle.

Komar points out that beaches are the best buffers to protect coastal property from the sea. His work on sand spits, Bayocean, Siletz and Netarts, has shown that a zone of dunes closest to the beach are subject to rapid erosion.

"These dunes will restore themselves naturally following an episode of erosion if they are allowed to do so. On Siletz houses were unfortunately built on this zone of rapid erosion. I worked with Oregon's Land Conservation and Development Commission to formulate guidelines for coastal construction, and recommended that erosion zones be avoided. This recommendation was accepted, and the last I heard the commission's statewide planning standards recommend that no more construction be permitted on the seaward portions of Siletz Spit or other Oregon spits."

Cozy Boats and Clean Water

The booming demand for recreational boating is putting pressure on Oregon's waterfronts.

There's an increasingly short supply of marina berths for pleasure and commercial boats along the state's coastline. Some local port authorities are responding by planning expansions of existing marinas or creating new ones.

At the same time state and federal agencies are drafting regulations to guarantee water quality in the nation's rivers, lakes and estuaries.

Here's where the conflict comes, according to Larry Slotta, a Sea Grant principal investigator who has been seeking innovative methods for designing marinas to maintain water quality.

"The boat owners and the marina operators want to protect the boats, to give them a snug harbor. Since marinas are set up to shield boats from waves and storms, they create calm water that does not mix freely within the basin or with the river outside. Often there is little exchange of water except by tidal action that generally is not enough to flush the basin completely."

Without regular flushing, the marina can trap pollutants, which can accumulate in sediments at the bottom of the basin in undesirable and possibly toxic quantities. Regulatory agencies, concerned about the possible ecological consequences of pollutant buildup, have been reluctant to grant permits for construction of new marinas or moorage areas unless their designs guaranteed maintenance of acceptable water quality.

Thus Slotta, professor of civil engineering at OSU, and his graduate students embarked on a two-year Sea Grant research project that was supported in part also by the Environmental Protection Agency, the National Science Foundation's Research Applied to National Needs program, and the Port of Brookings; other Oregon ports also assisted.

"No one had developed guidelines to specify marina siting and design criteria that could assure preservation of water quality. We felt that by describing the effects of marina shape and estuarine circulation patterns on the flushing characteristics of planned marinas, and by developing predictive computer programs to model these processes, we could contribute to sound guidelines for future marinas," says Slotta.

The daily rise and fall of tides within the estuary will play the largest role in moving what little water flows into and out of the marina basin. However, the river's eddies and currents flowing past the marina's entrance can also affect its flushing properties. Siting the entrance to gain maximum benefit from the estuarine circulation patterns was a question worked on by Slotta's colleagues at the Danish Hydraulic Institute in Copenhagen last year.

The design of the basin itself will also determine how well water can circulate within a marina. David Askren, a graduate student on the Sea Grant project, worked on numerical simulation of marina configuration and circulation patterns. He recently completed his thesis, which spells out methods for making marina design decisions.

Another graduate student, Scott Noble, studied existing marinas on Oregon's coast to determine flushing characteristics of differently shaped small boat basins. Using samples of the chemical and organic pollutants contained in sediments at each marina, Noble was able to compare the influences of basin design on adequate flushing and to create a predictive model to aid marina planners.

Slotta indicates that the regulatory agencies continue to be interested in the results of his Sea Grant work. Information from the project is currently being reviewed by an ad hoc committee of Washington, Oregon, and federal representatives that is working to develop criteria for marina siting.

Platforms for Power

The North Sea, and the Gulf of Alaska -- frontiers companies are exploring in their search for new petroleum resources.

Bob Hudspeth, an OSU ocean engineer, is also exploring frontiers -- new technologies that can make offshore oil platforms safe and cost-efficient.

Ocean regions petroleum companies now work in are known for brutal weather and waves, and engineers must design offshore platforms to withstand the force of winds and high seas.

However, Hudspeth, assistant professor of civil engineering at OSU, suspects that many of these platforms may be overdesigned for the environments in which they are placed.

"If we continue to design in this way, offshore platforms will end up costing several hundred million dollars each," he says. "At this rate the costs of offshore oil exploitation will become prohibitive, and we won't be able to keep gasoline costs under $1.00 a gallon. If we're going to be conservative designers, then we should have sound reason."

Sound reasons for cost-efficient platforms that maintain essential safety standards are what Hudspeth has been seeking through Sea Grant research. His goal has been to model the actual wave forces an offshore structure faces and the structure's response to those forces.

Three heads better than one

As rivers of commerce, the Columbia and Snake are vital to the economies of Oregon, Washington and Idaho.

Besides hosting towboats pulling barges full of wheat, lumber and other agricultural products, and ships with valuable cargos in their holds, a salmon run worth $300 million annually thrives in the rivers.

Recognizing that the development of the Columbia and Snake rivers concerns all three states, Washington State University, the University of Washington, University of Idaho and Oregon State University formed the Columbia Regional Sea Grant Program.

Funds from the program currently support projects at the University of Idaho and Washington State University. Agricultural economists at the University of Idaho are studying the economies of new shipping technology that enables products to be transported from Lewiston, Idaho to the sea -- a distance of over 400 miles.

At Washington State University, researchers are studying the socio-economic impact of the new 14-foot deep slack water channel that extends from Bonneville Dam to Lewiston.

Future Columbia River Sea Grant Program projects will address other critical needs concerning the development of the rivers in the tri-state region.

"Platform designers have been taking the sea's irregular surface and treating it as very regular and periodic. For an offshore region, you predict the highest wave and pick a regular time interval, or period, for its reoccurrence. This method predicts very high forces. But it's more realistic to represent waves as random in period, height and direction, since the structural stresses that a 70-foot wave repeating every 10 seconds creates are greater than those from the same-sized wave in the midst of an irregular series of smaller waves."

Using OSU's Wave Research Facility, Hudspeth has been able to simulate linear waves (coming from a single direction) that vary randomly in time sequence and height, and to model them and the forces they represent mathematically. The simulation can be correlated to wave extremes that could be expected in particular ocean regions. A Continental Oil Company grant for additional research has resulted from the Sea Grant project's development of this capability at the Wave Research Facility.

Responding Structures

Michael Grecco, a graduate student working with Hudspeth, developed a computer program to plot the dynamic responses offshore structures will have to random waves calculated from actual or simulated measurements. The model, used in the platform planning process, can lead to designs that match actual environmental conditions while meeting standards for structural safety, and thus save on construction costs.

Hudspeth remarks that the project has generated considerable interest

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This report was produced by:
Dan Himsworth,
writer/photographer
Bronwyn Hurd,
writer/photographer
Connie Morehouse,
designer