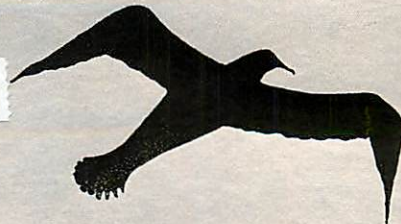


ORESU-Q-75-001



# sea grant

A Report on the Oregon State University Sea Grant College Program 1974-1975

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# interview with the director

*Everyone has talents, but most people don't have the opportunity to use them. The OSU Sea Grant College Program can do something about that. It's a people-oriented program and it can give people the opportunity to use their talents.*

—WILLIAM Q. WICK.

**Oregon State University is designated a Sea Grant College. What is a Sea Grant College Program?**

The OSU Sea Grant College Program is a partnership among government, industry and education which is helping to understand and develop ocean resources.

It is a people-oriented ocean program—this tends to set it apart from all others. We emphasize the interaction among people, the marine environment and marine resources.

Sea Grant also has a mandate, through the National Sea Grant Program and College Act of 1966, to generate new knowledge, to train students and to put knowledge to work for the benefit of everyone.

**Why is it necessary to maintain a national ocean program?**

Because the ocean is there and we have an obligation to develop and use our marine resources in the best possible way.

America was originally an oceanic nation, but we seem to have turned our back on the sea. We haven't taken our oceans seriously for the last hundred years—except for defense and limited fisheries. This neglect shows up when we compare our national use of the ocean with increasing ocean use by other countries.

We don't have to fall behind.

Sea Grant provides the opportunity to turn America's focus back toward the ocean. Without that focus, our marine resources will develop in a topsy-turvy manner—if at all.

Sea Grant's three-fold, functional approach—research, education and advisory—also provides the opportunity to do the job right. Through one program, students can be trained, knowledge generated and put to use.

Finally, Sea Grant provides the opportunity to benefit all of us—even those people who don't care about the ocean.

**Who doesn't care about the ocean?**

People who don't live along the ocean usually don't care about ocean development. They like to visit the ocean, but when it's out of sight, it's out of mind.

For example, I wasn't very successful selling the importance of the sea to people in Eastern Oregon when I visited there last fall. They showed some interest in our steelhead trout work since some of them like to fish for steelhead. But it was difficult to explain the idea that "land is just an island" and that the sea physically dominates the earth. People there were reluctant to buy that. Cattle, ducks, deer and forests were more central to their interests.

**Why should the ocean be important to inland people?**

For some very fundamental reasons. The ocean stores heat and moderates the earth's temperature—this makes our planet habitable.

Much of our weather is controlled by the ocean.

Although the oceans will not feed the world, an important percentage of human protein food comes from living marine resources.

**How do you explain the interest some inlanders show in Oregon's coastal zone?**

Perhaps they feel that the ocean and its coastline belong to all of us and they want to have something to say about how the shore areas are managed.

Others may be curious about the overall management scheme. If we are successful in developing plans leading to zoning in the coastal area, we can use the same techniques for managing our other land areas.

**Do you think inlanders and coastal residents will take an interest in planning?**

As an optimist, I believe that all people should want to plan their destiny. In the final analysis, they don't. The people who participate in coastal planning are probably the same small percentage who participate in other community decisions—whether it's school curricula or highway siting.

**Who plans the OSU Sea Grant College Program?**

We attempt to involve all who may have an interest in ocean resources. Our marine agents and specialists are continuously in contact with people in the marine community. These include fishermen, recreationists, port managers, small coastal businesses, educators, and the many local, state and federal agencies with marine responsibilities.

In reality, our program is planned probably by a small core group of people who have enough interest to make the effort.

Part of that core group is a mature and helpful Sea Grant Advisory Council composed of established decision-makers from several Oregon

communities. We hold conferences and establish local, special-interest advisory committees. We also use the mass media to develop awareness and request input to the program.

Our yearly program is a balance of four factors: the needs of the people of Oregon and the Northwest who are active users of the marine resources, the talent base of the university, available funding and our best estimates of future trends.

**Why are Sea Grant programs placed in universities?**

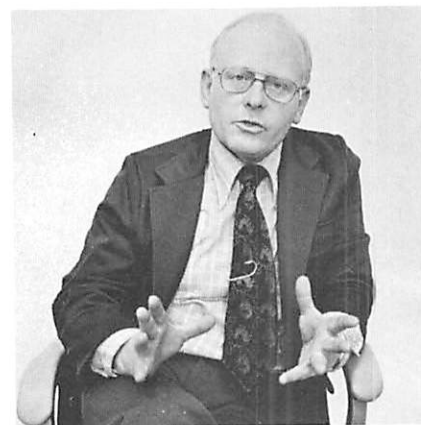
That's the only place where they could possibly succeed. Sea Grant's main product is the trained mind—the obvious product of a university. The university provides a multidisciplinary approach that can't be duplicated anywhere else. It is the only structure where three activities occur almost simultaneously: while you study, you can be training manpower, and putting both the new information and the trained person to work.

**Is Sea Grant research basic or applied?**

Both. Sea Grant is aimed at problem solving. Problem solving implies short focus and quick results. Before some quick results can be obtained, basic information is needed. That means a share of our research effort must be long-term and basic in nature.

At the same time, Sea Grant research must be planned with milestones to show progress toward the desired goal.

Longer-range planning and longer-range research projects are producing results both in new knowledge and in trained manpower. Here's an example. I was analyzing some proj-





ects that were basic in focus and had been difficult to justify for Sea Grant support. I found that students who had been involved in these projects had also obtained good jobs. They were readily marketable as employees and were doing good work. Why? Because they had received excellent training in the basics of their profession.

#### **What per cent of the Sea Grant budget goes toward education?**

About 16 per cent. We're supporting six per cent in curriculum and course development, and another six per cent on graduate research assistantships and the remaining four per cent in educational segments of research and advisory projects. Our advisory project, "Marine Science Public Education" (A/Ed-7), is a good example of the latter. That project affects 350,000 people at the Marine Science Center in Newport each year and provides short courses, teacher training and 4-H assistance. Yet, we call it advisory rather than education.

#### **Where have students made the greatest contributions?**

Nearly everywhere. In the natural sciences, food technology, nutrition, disease work, aquaculture and fisheries. We've made contributions in law, economics, engineering, oceanography and even anthropology.

#### **Are Sea Grant projects restricted to Oregon State University?**

By no means. We are the Sea Grant College Program for the State of Oregon. Work is centered at Oregon State University, but includes impor-

tant work in ocean law at the University of Oregon, technician training at Clatsop Community College and some new interesting research in farming shrimp in geothermal waters at the Oregon Institute of Technology. In addition, five of our 50 projects are cooperative in funding and manpower with the Oregon Department of Fish and Wildlife.

On a regional basis, we helped organize the Pacific Sea Grant Advisory Program (PASGAP) in 1969. Through PASGAP we are allied with all Sea Grant programs in the Pacific, from Guam and Samoa to Alaska, British Columbia, Hawaii, California and the National Marine Fisheries Service. Through this cooperation, we share talent, publish jointly and conduct workshops on important marine resource questions.

Beyond the region, we are part of the National Sea Grant system which is active in 30 states—and we even work internationally with counterparts in Japan, Australia and New Zealand.

#### **What's the impact of inflation on Sea Grant's federal funding?**

The National Sea Grant program is operating now on 74 per cent as much money as it had in 1972—even though the federal appropriation is several million dollars more than in 1972.

Since Sea Grant is largely a people program (students, professors, researchers, advisory agents and specialists), the real impact of reduced effective funding has been on people involvement. About three-fourths as many people are involved in Sea Grant now as in 1972.

In some ways, we may have oversold the concept of what Sea Grant is and what it can do in relation to the funds available to follow through with

our ideas. More and more people are becoming aware of Sea Grant. At the same time, inflation is reducing our funds to respond to this increased interest.

Fortunately, the people of Oregon have provided an important funding base for Sea Grant operations through support in the legislature, coastal county commissions, and, increasingly, Oregon industry.

#### **Are Americans getting their money's worth from Sea Grant?**

Without question. Beyond the obvious contributions of new knowledge and trained students, Sea Grant results are counter-inflationary.

Consumers are becoming better informed on how and why to purchase and prepare nutritious seafoods. Under-exploited and unexploited forms of seafood, such as squid, are reaching the market in larger quantities.

Fishing boats are being designed to be more energy efficient and to be safer working platforms.

Seafood processing methods are being changed to increase their efficiency and sanitation. Processing wastes are receiving new use as animal foods and fertilizers.

Sea farming is moving closer to economic stability.

Coastal homeowners are learning how to live more securely in a beautiful, but sometimes harsh, environment. The clashes between coastal economic and environmental concerns are being softened through new knowledge on the timing and methodology of dredging.

Valid answers to these tough questions are not easy to come by. But one thing is sure. Sea Grant is committed to the important task of helping to put Oregon's and America's oceans to work.

# food from the sea

## AQUACULTURE

### **Reviving chum salmon runs: a new industry**

Sea Grant may help create a new Oregon industry from an old Oregon fishery.

The chum salmon fishery—crippled by spoiled spawning grounds and extensive exploitation—is being revived by two Sea Grant researchers involved in a five-year project.

Principal investigator James E. Lannan, assistant professor of fisheries and wildlife, and Richard Caldwell, assistant professor of fisheries, are experimenting with a substitute for natural spawning grounds: a stream-side gravel incubator.

First used in 1969 at the Netarts Bay Fisheries Culture Station on Whiskey Creek, the gravel incubator consists of nylon mesh to hold the eggs and a gravel bed where new fry rest and develop. When ready, chum fry swim from the incubator into Whiskey Creek and then out to sea.

According to Lannan, the stream-side gravel incubator evolved over the past six years by a process of serial evaluations each season, followed by design improvements and

modification. It is a very efficient, economical approach to the production of Pacific salmon fry. Whether the fry are of sufficient quality to result in reasonable returns remains to be demonstrated—but results are encouraging.

More than three million chum salmon have been hatched in gravel incubators and released into Whiskey Creek since the 1969-70 season. The number of fry released each season was: 1969-70, 225,000 fry; 1970-71, 480,000 fry; 1971-72, 225,000 fry; 1972-73, 570,080 fry; 1973-74, 800,000 fry; and 1974-75, 900,000 fry.

Hatching and releasing chum fry is only half the story. On their way out to sea, they must swim past coastal trout and other predators which feed on chum fry.

Of the fry that get past predators, only about one per cent survive in the ocean and return to their spawning ground as three- or four-year-old adults.

So far, returns of chum salmon to Whiskey Creek during the three years in which hatchery produced fish could be included were: 1972, 1,200 fish; 1973, 1,500 fish; and 1974, 3,000 fish. Because 3,000 fish returned to Whiskey Creek in 1974, Lannan be-

lieves the project has had an impact on the Whiskey Creek stock.

According to Lannan, surplus eggs were available from the Whiskey Creek stock. The Oregon Department of Fish and Wildlife distributed these eggs to private hatcheries. Total egg distribution included: 1972, 200,000 eggs; 1973, 300,000 eggs; and 1974, 2,007,550 eggs.

The operation of private chum hatcheries was made possible by laws enacted by the 1971 Oregon Legislature. To date, there are four private chum hatcheries and more than 15 parties have applied for a license.

Lannan predicts that if fish production continues at the same rate that it has at the Netarts pilot hatchery, private chum hatcheries in Oregon can expect returns of two to three million pounds of fish annually by 1980.

Economic predictions are also promising. Chum salmon can be sold for from 25 cents to \$1 per pound, depending on quality and market conditions. The average weight of a returning chum salmon is 12 pounds and females carry an average of 2,500 eggs. At first, most of these

eggs will be sold to start new hatcheries.

Eventually, a multi-million dollar chum salmon industry may be created from a fishery that almost went belly-up. (R/AQ-6)

### **Aquaculture-0, Disease-1**

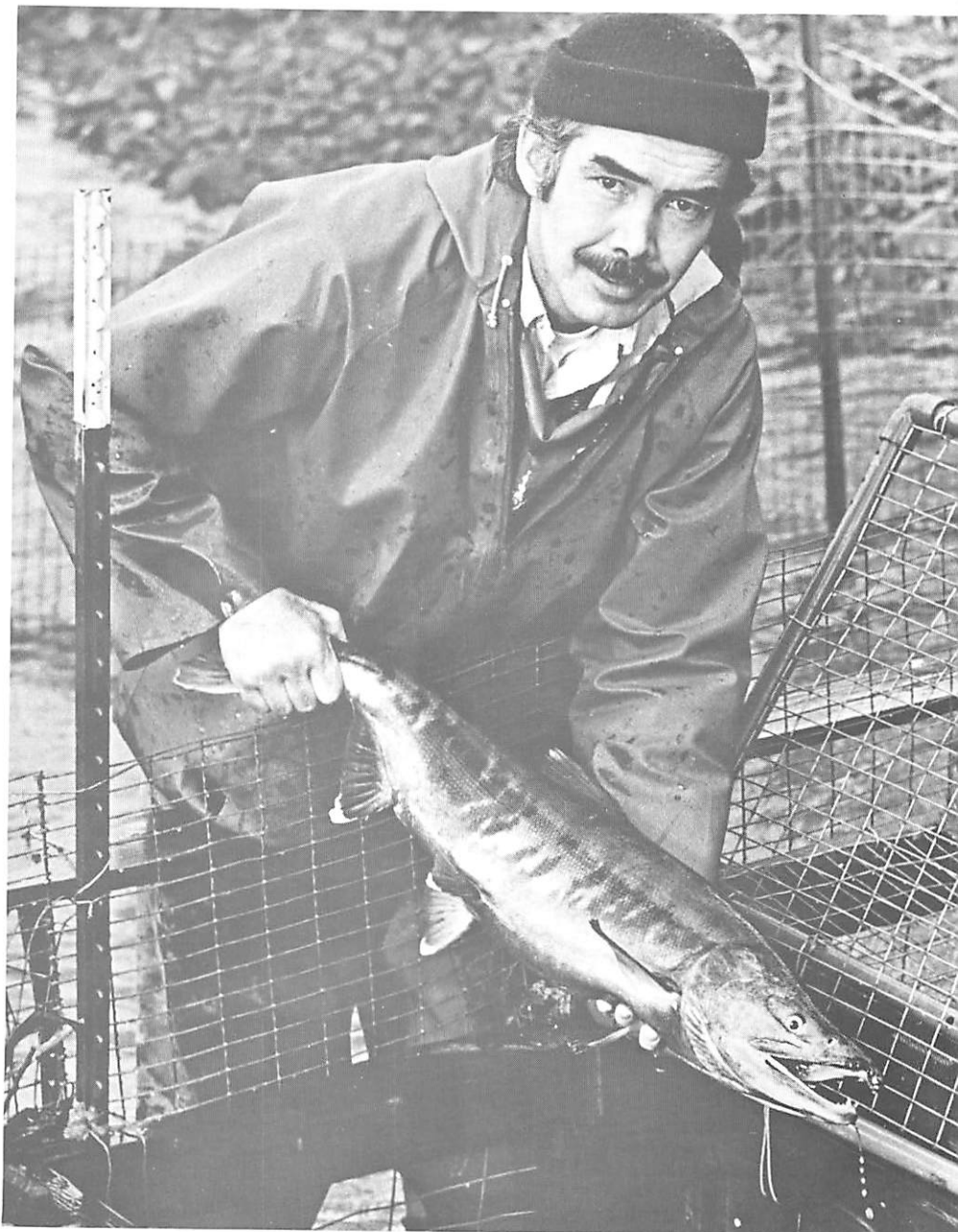
Pink and chum salmon seem like good candidates for aquaculture. They grow rapidly, adapt quickly to seawater and don't need much care.

Gerald E. Davis, associate professor of fisheries, decided to find out just how suitable these candidates were before people began investing in aquaculture. He initiated a three-year project to investigate the biological factors required to determine if rearing pink and chum salmon is economically feasible.

Three electric companies, Pacific Power and Light, Portland General Electric and the Eugene Water and Electric Board, requested this information. These utilities are considering the development of generating stations at coastal sites, and are exploring aquaculture as a potential use for cooling water discharges. For example, the water discharged from generating stations warms the seawater and may accelerate pink and chum salmon growth rates.

This information was also requested by firms already engaged in commercial salmon production (such as Oregon Aqua-Foods in Newport) who are interested in exploiting the rapid growth rates and early adaptability to seawater characteristic of chum and pink salmon.

The results of growth experiments indicate that chum salmon production may be enhanced by rearing the animals in sea water heated to tem-



James E. Lannan (Photo by Jim Vincent, the Oregonian)

peratures slightly above ambient, according to Davis. But, he added, this generalization is valid only if the animals are protected against vibriosis, an infectious disease caused by *Vibrio anguillarum*. It turned out to be an important qualification. Despite repeated efforts, Davis' research team was not able to protect chum salmon against infection by *V. anguillarum*.

Some of these efforts were directed by John Fryer, professor of microbiology, who has successfully vaccinated other salmonids—specifically coho, chinook and rainbow trout—against vibriosis. Although Fryer believes that pink and chum salmon are highly susceptible to vibriosis, he recently discovered that vibriosis contains two serotypes—not just one. In past projects, Fryer only vaccinated against one; if he is able to vaccinate against both serotypes, the vibrio problem in chum and pink salmon may be reduced.

Davis did attempt to protect juvenile chum salmon against vibriosis by oral immunization. Several different methods were employed in administering the vaccine. They included administering the vaccine after introducing the fish to seawater, before introducing the fish to seawater, in the starter mash and in pelletized rations. All this work was done with vaccine based solely on the single vibrio serotype known at the time.

Davis also attempted to determine whether any of the variability in the response to infection by *V. anguillarum* had a genetic base. He thought there was a heritable component in the variance of resistance to vibriosis.

Davis concluded that one long-term solution to the vibrio problem may be found by selectively breeding vibrio-resistant brood stocks.

In order for the seawater culture of pink and chum salmon to become economically feasible, positive means of preventing losses by vibriosis must be discovered, according to Davis. Despite their rapid growth and early adaptation to seawater, said Davis, pink and chum salmon culture using heated effluents is at present a high risk venture at best. (R/AQ-7)

### Fatty acids improve fish rations

Fish culturists and feed manufacturers are now adding a high percentage of fish oil to fish rations, say professors T. C. Yu and Russell O. Sinnhuber of food science and technology.

Fish oil increases the energy level of the ration and enables the fish to utilize dietary protein more efficiently for growth.

That's one result from a completed two-year project to study the nutritional requirements of salmon and trout, two important food and recreational species of the Pacific Northwest.

Trout feeding trials conducted during the project have proved the value and essentiality of  $\omega$ 3 fatty acids for maximum growth, feed efficiency and low mortality, according to Yu and Sinnhuber.

Until recently, similar data for salmon was nonexistent.

But last year, they tested 12 diets containing varying levels of  $\omega$ 3 and  $\omega$ 6 fatty acids for salmon. Each diet was fed to duplicate groups of salmon fry for 14 weeks. The fish growth rate, feed conversion and accumulated mortality were recorded.

The optimum dietary  $\omega$ 3 fatty acid was 1 to 2.5 per cent and dietary  $\omega$ 6 fatty acid greater than one per cent retarded fish growth.



Russell O. Sinnhuber and T. C. Yu





At the end of the experiment, the fatty acid composition of the fish from each group was determined; Yu divided the results into three areas.

The metabolism of dietary lipids in salmon is similar in one respect to that of rainbow trout. The 18:2 $\omega$ 6 was converted into 22:5 $\omega$ 6 through carbon chain length elongation and desaturation reactions. Dietary 18:3 $\omega$ 3 was similarly converted into 22:6 $\omega$ 3.

Yu also found that the incorporation of  $\omega$ 6 fatty acids into phospholipids of salmon (also trout) was inhibited markedly by increasing the levels of dietary 18:3 $\omega$ 3.

Finally, Yu and Sinnhuber discovered that the incorporation of  $\omega$ 3 fatty acids into phospholipids of salmon was not significantly inhibited by the increased dietary 18:2 $\omega$ 6. On the contrary, the increased dietary 18:2 $\omega$ 6 significantly inhibited the incorporation of  $\omega$ 3 fatty acids in phospholipids of trout.

These results indicate a species difference in lipid metabolism.

Thanks to the research of Yu and Sinnhuber, fish culturists now know that a little fish oil goes a long way toward maximum growth, feed efficiency and low mortality in rainbow trout. (R/AQ-8)

### **Omega-3: the fatty acid for rainbow trout**

Rainbow trout—which fatty acid do they need to mature and reproduce?

They can be reared to maturity with a diet containing  $\omega$ 3 fatty acid as the sole source of dietary lipid, according to professors T. C. Yu and Russell O. Sinnhuber of food science and technology.

Yu and Sinnhuber completed a three-year project to determine if a diet containing only  $\omega$ 3 fatty acid (without the addition of  $\omega$ 6 fatty acid)

can support the fish to maturity, including reproduction to yield a healthy second generation.

To answer this question, Yu and Sinnhuber fed a group of trout a semi-purified diet (Diet A) containing one per cent linolenic acid ( $18:3\omega3$ ) as the sole source of dietary lipid for 36 months. A second group of fish were fed the same diet except that 1.5 per cent of linoleic acid ( $18:2\omega2$ ) was supplemented (Diet B).

At the end of the experiment, Yu analyzed the fatty acid composition of the mature fish and the eggs they produced. He also measured the growth and mortality of the young second-generation fish.

Yu and Sinnhuber observed reproductive cycles during the 36-month period. The young fish hatched were fed a hatchery control diet containing ten per cent fish oil for three months.

According to Yu, the result from these experiments can be divided into three areas.

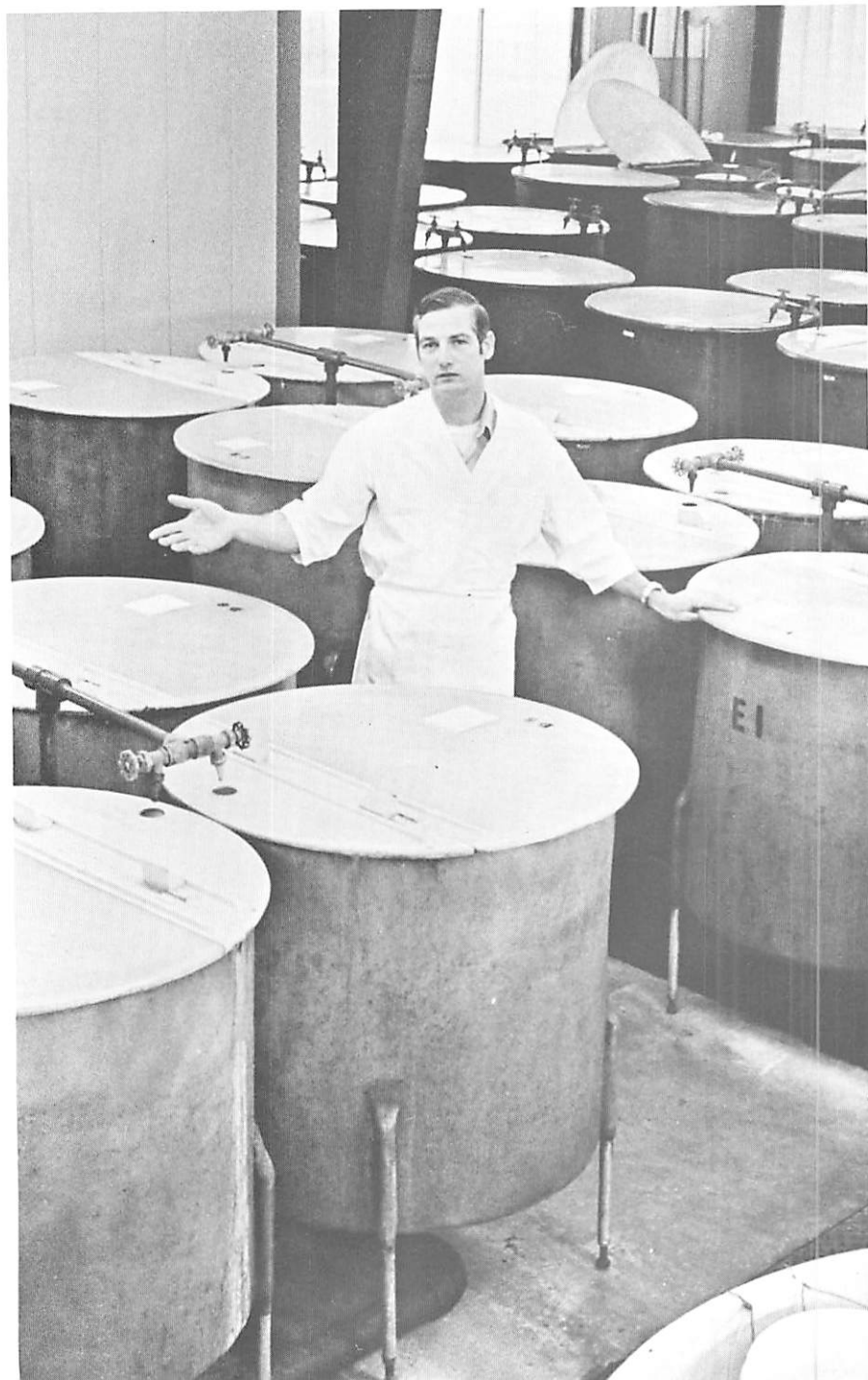
The lipids extracted from carcasses showed that the Diet A fish contained 42.8 per cent and 33.9 per cent total  $\omega3$  fatty acids in the phospholipids of the female and male fish, respectively. No  $\omega6$  fatty acids were found in these lipids.

By contrast, Diet B fish contained 25.3 per cent and 18.0 per cent total  $\omega3$  fatty acids and 26.5 and 24.9 per cent total  $\omega6$  fatty acids in female and male phospholipids, respectively.

Yu also found that egg phospholipids from Diet A fish contained 28.9 per cent  $\omega3$  fatty acid and was devoid of  $\omega6$  fatty acid. The egg phospholipids from Diet B fish contained 25.1 per cent  $\omega3$  and 20.5 per cent  $\omega6$  fatty acids.

To conclude his experiment, Yu fed fry from both groups a control diet for three months.

George Putnam



The fish weight gain and accumulated mortality were compared with control fry produced by the brood stock of our laboratory. Both weight gain and fish mortality were normal.

He adds that histological examination results showed no abnormality in liver, heart and kidney tissues.

This study proved that rainbow trout can be reared to maturity with a diet containing  $\omega$ 3 fatty acids as the sole source of dietary lipid.

As a result, fish culturists are adding fish oils, a rich source of  $\omega$ 3 fatty acids, to fish diets. (R/AQ-10)

### **Shellfish waste: disposal problem or fish food?**

Solving a diet problem for salmonid fishes may also solve a disposal problem for seafood processors.

That's the hope of George Putnam, instructor in food science and technology, and principal investigator for a three-year project on the protein/energy relationships and mineral requirements of rainbow trout.

How does research on rainbow trout relate to seafood processors?

Fish growers need to formulate the most economically productive diets from existing raw materials. Existing raw materials include seafood processing wastes such as shrimp and crab. Although processors have been dumping these wastes into bays, alternate means of disposal are being sought. Adding shrimp and crab wastes to the diet of salmonid fishes may provide a solution to the disposal problem, and provide an inexpensive source of protein. However, the requirements for these potential nutrients and salmonid tolerance to them is presently unknown.

According to Putnam, the initial phase of this project emphasized the

influence of various dietary protein levels on the utilization of fat for energy.

During the past year, Putnam conducted a 12-week feeding trial at the Food Toxicology and Nutrition Laboratory to understand the effects of dietary calcium/phosphorus on the growth, feed conversion and kidney histology in rainbow trout. The experiment involved the feeding of two levels (0.75 and 1.25 per cent) of phosphorus each with four levels (0.025, 0.5, 1.25 and 2.00 per cent) of calcium to triplicate lots of 4-month-old rainbow trout. Preliminary results indicated that these different dietary levels of calcium/phosphorus did not significantly affect the growth or the feed conversion during the 12-week period. However, kidney histology was markedly affected. At each level of phosphorus tested, those diets with low calcium (0.025 and 0.5 per cent) showed a high incidence of kidney stones (nephrocalcinosis).

According to Putnam, these findings indicated that the mineral metabolism of rainbow trout is quite complex and that dietary mineral balance is an important consideration. He adds that further understanding is needed to clarify this problem.

The Sea Grant scientist also conducted a pilot feeding trial to further the understanding of protein/energy relationships in salmonids. Putnam had observed in earlier related studies that trout would not grow well on a test diet of low protein casein/gelatin (32.8 per cent), but grew very well on a test diet of low fish protein concentrate (FPC)/gelatin (32 per cent).

He found that the growth rate of the trout was restored to that of the low FPC/gelatin-fed trout when the low casein/gelatin diet was supple-

mented with the amino acids arginine (0.06 per cent), cysteine (0.02), methionine (0.04) and tryptophane (0.03).

These findings indicated that FPC or amino acid supplementation of low quality or low quantity protein diets may be feasible on a production basis where protein shortages exist.

If Putnam's work is successful, shellfish wastes will no longer be a problem for fish processors. They will be a bonus for fish growers looking for an inexpensive source of protein. (R/AQ-11)

### **Hatchery seed: a step closer to the domestic oyster**

When Wilbur Breese decided to develop techniques for producing oyster seed in a hatchery, he had one thing in mind: he wanted Oregon to be able to produce its own oyster seed.

Oregon's oystermen presently depend on Japan, Washington and Canada for the annual seed supply that sustains their industry.

But something else is happening.

Breese is providing one of the essential tools needed to domesticate the oyster.

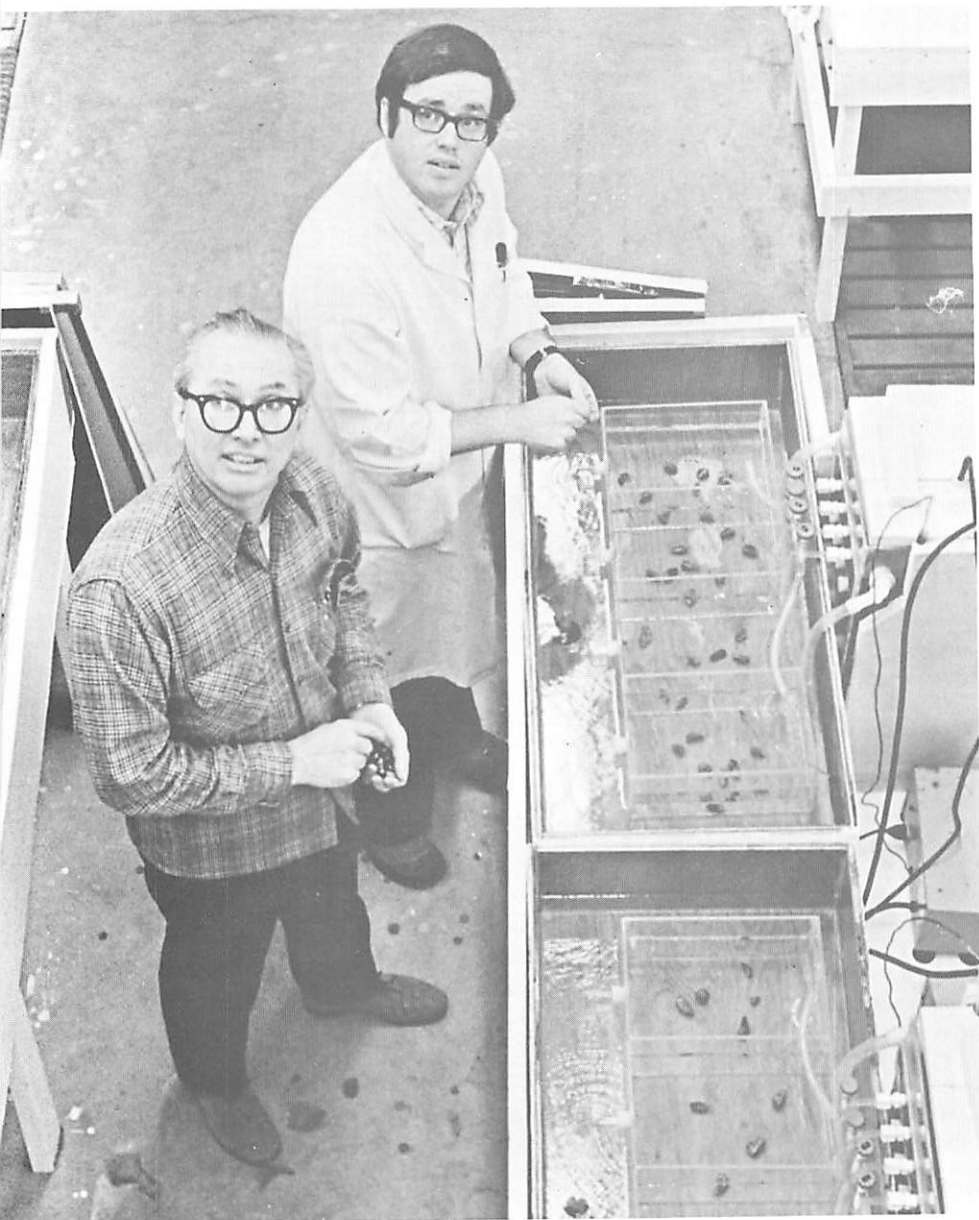
If oyster seed can be produced in a hatchery, it can be genetically controlled to produce the kind of oyster that consumers want.

That's good news for Oregon's oyster industry. The ability to control oysters genetically may make Oregon's hatchery-produced oyster seed a unique product—not simply a last resort when seed from other places is unavailable.

How did the new hatchery system evolve?

Breese, associate professor of fisheries, conducted a two-year

Wilbur Breese and Robert Malouf



project designed to operate a flow-through oyster seed pilot hatchery for a sufficient period of time to allow for evaluation. The evaluation included engineering, economic and biological assessment of both the hatchery and its operation.

Breese also prepared a manual for the operation of an oyster seed hatchery.

According to Breese, there are now at least five new hatcheries in the Pacific Northwest and he predicts that the manual will stimulate the development of more oyster seed hatcheries.

The Sea Grant project produced information on the cost of operation in dollars or hours of labor, the cost of material used and capital expenses for seed production. The cost of seed production was also estimated.

Breese also defined culture criteria for specific algal species used in oyster hatcheries and demonstrated the use of ozone as a sterilizing agent in algal production.

Finally, Breese described future research that may be needed for the commercial application of both the batch and flow-through systems of producing oyster seed.

Thanks to Breese, things may be looking up for Oregon's oyster industry. Oregon may soon be producing and genetically controlling its own seed. That could mean a better product for the consumer and steadier work for the industry. (R/AQ-15)

### **Oysters: some like it hot**

Heated waste water discharged by power plants may provide a good growing environment for oysters, according to Wilbur Breese, associate professor of fisheries.



Breese initiated a four-year project to determine if oysters could be reared in seawater heated by power plants. Preliminary studies indicated that oysters could grow in open coastal seawater and that their growth rate could be accelerated by increased temperatures.

The Sea Grant researcher also wanted to provide information on designing and evaluating facilities for the "factory production" of oysters in heated water. Emphasis was placed on the development and evaluation of methods of supplemental feeding in case natural seawater was nutritionally inadequate to sustain maximum oyster growth under intensive culture conditions. Research to date revealed that the capacity of seawater-borne nutrients to support the growth of oysters undergoes considerable seasonal variation. Data indicated that during the winter months nutrients were inadequate to support the growth of larger oysters (about two inches in diameter). This was especially true at elevated temperatures. Nutrients available during the winter months may satisfy the maintenance requirements of the larger oysters at ambient temperatures, but weight loss may occur at elevated temperatures.

Breese discovered that seed oysters, up to three-fourths of an inch, exhibited good growth during winter months when the larger oysters showed no growth. Under elevated temperatures seed-oyster growth increased during periods of the year when larger oysters showed little if any growth at any temperature.

Early experiments showed a need for monitoring the variations in nutrient levels that occur in seawater in order to account for variations in oyster growth. As a result, various meth-

ods were considered for measuring nutrient levels, and three were selected for use:

- chlorophyll
- total particulate material
- dissolved and particulate organic carbon.

Efforts were made to determine the influence of nutrient levels on oyster growth both by lowering natural nutrient levels by filtration and by also increasing nutrient levels by the addition of cultured algae.

According to Breese, recent activities included the testing of the closed system apparatus. This gear will give Breese the control necessary to conduct energy budget research for oysters.

Breese also discovered that the total organic carbon in seawater fluctuated from 1 to 3 mg/l. Unless the amount of organic carbon available to the oyster is known, feeding studies will be difficult to control.

Some parameters for out-bay culture were also established.

Breese's research was prompted by an anticipated increase in the number of power plants along Oregon's coast. Three Oregon power companies already expressed interest in the potential uses of heated effluents in the culture of commercially-valuable fish and shellfish.

According to Breese, this project was terminated two years early due to de-emphasis on heated seawater research and the need for better understanding of oyster culture in general. Some of its objectives, however, were transferred to a new project, R/AQ-26.

From that project may come the improved understanding of oyster nutrition and culture that will make it

feasible once again to consider raising oysters in heated waste water from power plants. (R/AQ-16)

### Better food for faster growth

Feeding oysters can be tricky.

Oysters raised in hatcheries are usually fed living algae. Thus oyster farmers must also be algae farmers.

Harry Phinney, professor of botany, thought there might be an easier way. Phinney, working with graduate student James deBoer, recently completed a five-year Sea Grant project to determine if young oysters could be fed non-living organic materials. If so, the food algae could be grown, frozen, stored and transported. That way the oyster farmer wouldn't have to be in the algae farming business. It would also mean oyster hatchery operators would no longer have to synchronize two biological systems—oyster cultures and algal cultures.

Can it be done?

To find out, Phinney took the two algal species most commonly used to feed larval oysters, *Isochrysis galbana* and *Pseudoisochrysis paradoxa*, and labeled them with radioactive carbon ( $^{14}\text{C}$ ). Then some of the algal cells were broken up and separated into fractions by centrifugation and micropore filtration. In addition, a portion of the supernatant from centrifugation was used to produce organic aggregates by bubbling; these aggregates are similar to the organic material found in surf foam along the coast.

Separate batches of larval oysters were fed labeled algae in one of the three forms: living algal cells, dissolved organic material or organic aggregates. By measuring the

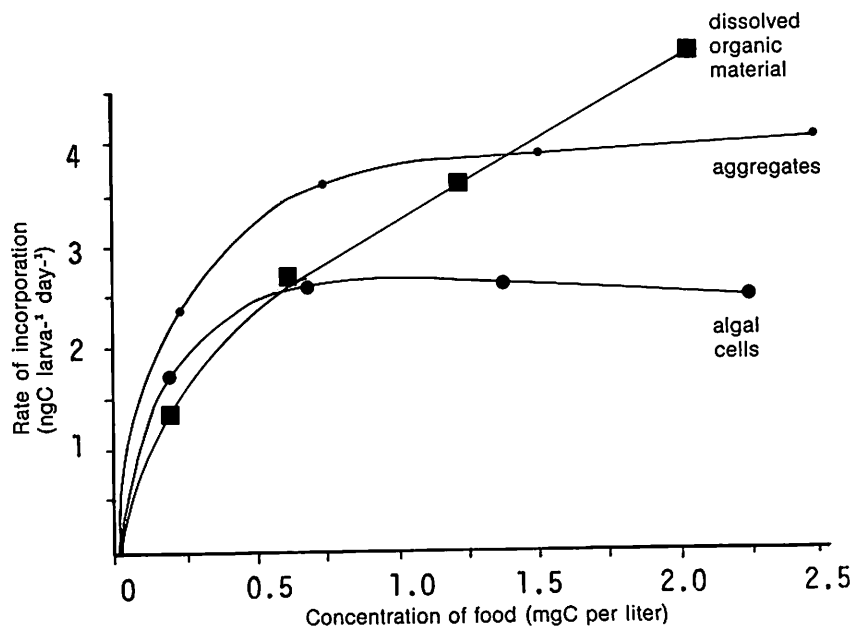
amount of radioactive carbon in the oysters, Phinney could determine how quickly the larval oysters incorporated the various forms of organic material.

It turned out that larvae 80-90 microns long incorporated living algal cells most quickly at cell densities equivalent to 0.5 milligrams of carbon per liter. At food concentrations above 0.5 milligrams of carbon per liter, larvae incorporated dissolved organic material faster than they did living algal cells. Larvae incorporated organic aggregates slower or faster than living algal cells depending on the biochemical composition, size and concentration of the aggregates. (See figure.)

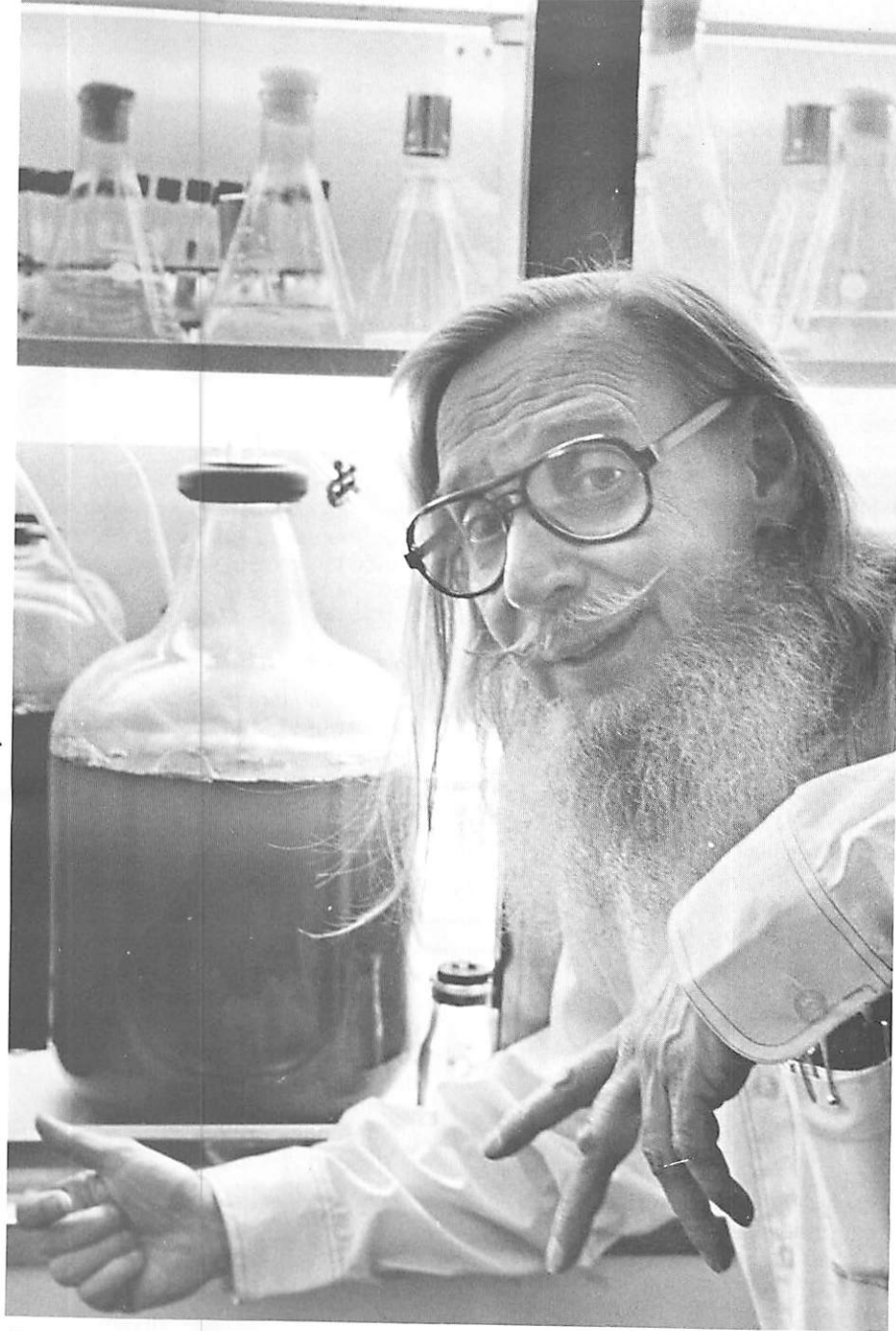
Oyster larvae 120-140 microns long possessed a greatly increased capacity to incorporate living algal cells, suggesting a change had occurred in their feeding habits or in their digestive systems. Although these larvae incorporated dissolved organic material and organic aggregates at high rates, the rate of incorporation of algal cells was even higher.

Phinney concluded that it is entirely feasible to feed larval oysters a diet of dissolved organic material instead of live algal cells. He recommends that the dissolved organic material be prepared from several species of algal food organisms. And he warns that there may be practical problems in maintaining oyster larvae in static cultures since this type of food will require a daily water change to dilute out any developing bacterial populations.

Not only would dissolved organic material be a more convenient way to feed larval oysters, it may actually



Relationship between concentration of food (algal cells, DOM, and organic aggregates) and the rate of incorporation ( $I_r$ ) by small oyster larvae (Experiment 8)



Harry K. Phinney

be better for the larval oysters, according to Phinney. Oysters in the wild usually grow to setting size about twice as fast as they do under artificial conditions. Phinney believes this difference may be due to the fact that in a hatchery the larvae do not receive dissolved organic material even though they can incorporate it faster than living algal cells.

Evidently, the easiest way to feed larval oysters is also the best. Feeding oysters may turn out not to be so tricky after all. (R/AQ-18)

### Improving the oyster

Oyster growers—and oyster eaters—can expect bigger and better oysters if Sea Grant's research on the selective breeding of oysters continues to be successful.

That's the hope of James Lannan, assistant professor of fisheries and wildlife, who initiated a three-year project in the selective breeding of oysters.

The primary aim was to increase yields of oysters by providing selected lines of larger, faster-growing animals. In addition, Lannan wanted to make oyster hatcheries commercially feasible by increasing the quantity and quality of the oyster seed they produce.

Lannan's project was divided into two sequential phases. The first phase was completed in 1972. It involved studying oyster heritability using statistical genetic methods to separate the variation in several economically important oyster characteristics into genetic and non-genetic components.

This procedure provided an efficient method for evaluating the potential economic gains of selective breeding. It also facilitated the design

of breeding schemes to realize these potential gains.

According to Lannan, the information derived from the oyster heritability study will be used to generate lines of selected oysters which exhibit superior performance for each of several growing areas.

The second phase of the project is now in process. Lannan has begun testing progeny and started analyzing selected lines of oysters using the diallel method. He is selecting attributes which include survival of larvae to metamorphosis under hatchery conditions, rapid growth to market size and stress tolerance.

Although data are not complete enough to evaluate the field performance attributes, generalizations about larval survival can be made. Selective breeding can improve the average survival in commercial hatcheries.

His studies also demonstrated how best to manage the oyster mating system. Preliminary estimates of the repeatability of the response to selection indicate that the methods proposed are suitable for industrial application. A reproducible three-fold increase in larval survival has been accomplished in the experimental breeding program.

Finally, Lannan demonstrated that brood stock management is essential to establish sustained production. Many of the often encountered but seldom explained failures in oyster hatcheries may be eliminated by careful management of the brood stock.

Oyster fans should look forward to Lannan's results. If oyster hatcheries become commercially feasible and selective breeding is successful, there may be a constant supply of improved, Oregon-grown oysters. (R/AQ-19)

### **Substituting animal fat for fish oil**

Recent Sea Grant studies have established the fatty acid requirements for salmon and trout and have shown that fish oil is an excellent source of these fatty acids.

But adding fish oil to fish rations can create a problem.

The production of feed-grade fish oil by the fish industry is marginal and the supply is often quite limited.

That's why Russell O. Sinnhuber and T. C. Yu, both investigators in the department of food science and technology, decided to look into the possible use of the more readily available animal fats as a source of lipid for energy in fish rations.

During the past year, the researchers conducted a feeding experiment using rainbow trout as a test animal. The control diet contained 22 per cent salmon oil and 30 per cent protein. They also used two test diets in which one-third and one-half of the salmon oil were replaced by lard. Each diet was fed to duplicate groups of fish for 14 weeks.

The results?

No significant differences were found in fish weight gain and feed efficiency among these groups. The experiment was repeated by increasing the dietary protein to 35 and 40 per cent. Similar results were obtained.

According to Sinnhuber and Yu, the proximate analysis of the nine fish samples showed that the protein content in the whole fish was lowest (14.9 per cent) in the group of fish fed with the diet containing 30 per cent protein. The body protein increased to 15.4 per cent in the groups fed on diets containing 35 and 40 per cent protein. There was little difference in moisture, ash and lipid contents in the nine groups of fish;

however, the fish liver weight did increase as the dietary carbohydrate was increased. The fatty acid composition of the fish samples is also being determined.

The results of this feeding experiment indicated that trout utilized both salmon oil and lard equally well as a source of energy. The dietary salmon oil at 10 per cent provided an adequate quantity of the  $\omega$ 3 fatty acids required by the fish.

That means that aquaculturists and fish feed producers won't have to rely solely on fish oils as a source of energy: they can use animal fats which are cheaper and more available. The use of animal fats will also reduce the level of expensive protein feed. (R/AQ-21)

### **How many fish can live in a pond?**

Many fish farmers want to know the answer to what seems like a simple question.

How many fish can be reared in a single saltwater pond?

The accumulation of ammonia (a fish excretory product) in seawater is a factor which limits stocking densities in rearing ponds.

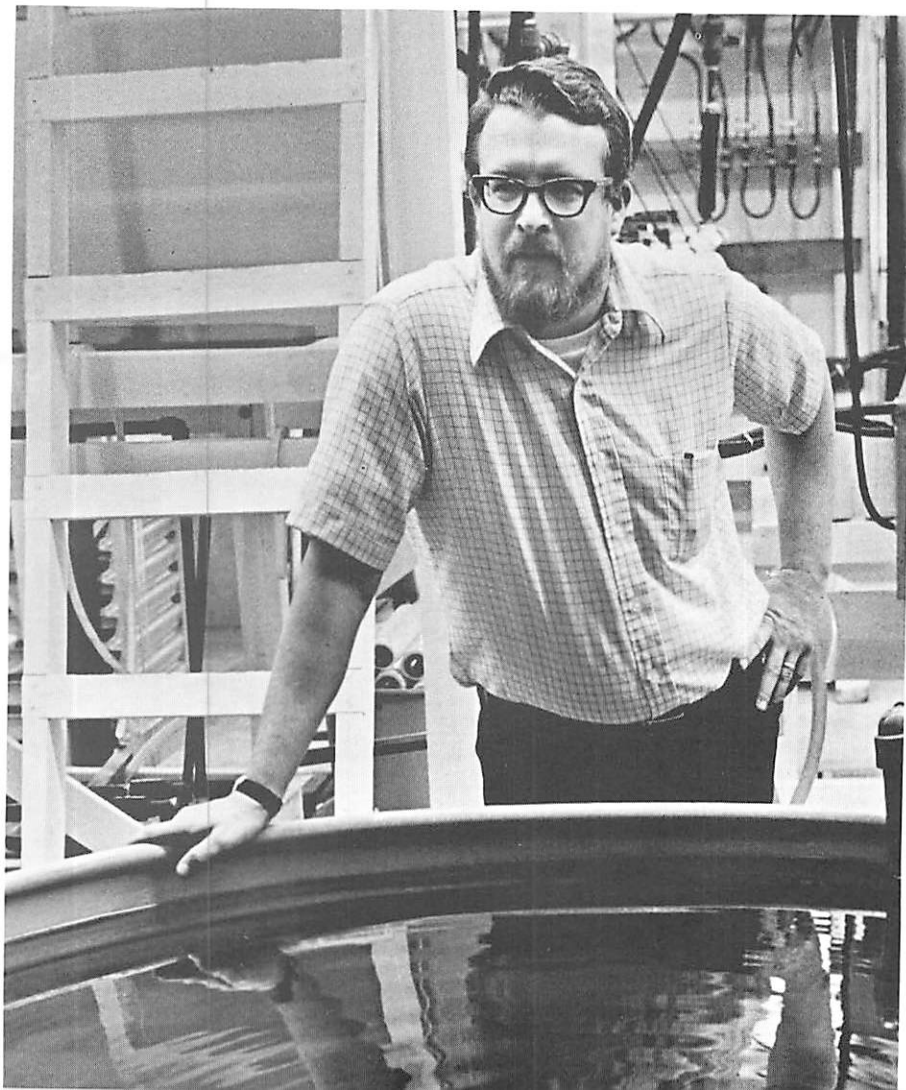
One aquaculture firm, Oregon Aqua Foods, Inc., decided to increase stocking densities to maximize production. They requested assistance from Sea Grant to determine the effect of seawater on ammonia toxicity in seawater-cultured rainbow trout.

Richard S. Caldwell, assistant professor of fisheries, initiated a four-month project to study two aspects of ammonia toxicity in seawater.

One aspect involved the relationships between stocking densities and survival, or an



Richard S. Caldwell



appropriate sublethal indication of ammonia toxicity. The experiment was conducted under two conditions: controlled seawater replacement rates and steady-state seawater ammonia.

The other involved the effect of sublethal ammonia intoxication on blood osmotic concentrations of rainbow trout as a function of salinity.

The results?

Caldwell placed seawater-cultured rainbow trout in 387 gallon circular tanks at stocking densities from 1.0 to 3.0 pounds per cubic foot. The equilibrium levels of total ammonia in seawater were determined as a function of seawater flow rates (6 to 30 gallons per minute) into the tanks. Equilibrium levels of ammonia in seawater were directly proportional to stocking densities and were inversely proportional at each stocking density to seawater flow rates.

At the highest stocking density (310 pounds per cubic foot) and lowest seawater flow rate (6 gallons per minute), the equilibrium level of total ammonia for unfed fish was 0.56 milligrams per liter, according to Caldwell. At all stocking density-flow rate combinations, ammonia concentrations increased within one hour after feeding and returned to unfed equilibrium levels within about 12 to 18 hours.

Feeding approximately doubled the concentration of ammonia in tank seawater over equilibrium concentrations at all stocking density-flow rate combinations. The highest ammonia concentration (1.8 milligrams per liter) was found three hours after feeding in tanks stocked at 3.0 pounds per cubic foot and supplied with 6 gallons per minute of seawater.

Ammonia production rates were approximately equivalent to those reported for freshwater-reared rainbow trout. At 3 pounds per cubic foot stocking densities, the ammonia production rate of fish averaged 358 micrograms per gram per day.

Varying seawater flow rates, thereby altering the level of ammonia buildup in seawater, did not influence the ammonia production rate of fish, according to the Sea Grant scientist.

To solve the second part of the problem, Caldwell exposed seawater-cultured trout for up to 48 hours to the following combinations: approximately 19 milligrams per liter of total ammonia (as the chloride salt) in freshwater, 10 parts per thousand seawater and 31 parts per thousand seawater. The median concentration of ammonia in control tanks at the same salinities was approximately 1 milligram per liter (derived from fish excretion).

At 4, 24 and 48 hours, blood was sampled from each of the six treatment groups and the osmotic pressure of plasma was determined. In control fish the osmotic pressure of plasma ranged from a low of  $288 \pm 26$  milliOsmoles per kilogram (for fish exposed to fresh water for four hours) to a high of  $342 \pm 14$  milliOsmoles per kilogram (for fish exposed for 48 hours to seawater at 31 parts per thousand). The mean difference in plasma osmotic pressure between seawater and freshwater fish was approximately 30 milliOsmoles per kilogram.

No statistically significant differences were found between control and exposed fish at any salinity or period of exposure.

Caldwell concluded that osmotic regulation was unaffected at seawater

ammonia concentrations near the lethal level.

These results were communicated to Oregon Aqua Foods and applied to their culture system. (R/AQ-23[D])

### Improving oyster diets

Oysters grown domestically require the same food as oysters grown in the wild.

They need food algae.

Unfortunately, algal foods for domestic oysters are currently grown in large tanks with little concern for efficiency of the operation or quality of the food for oyster growth.

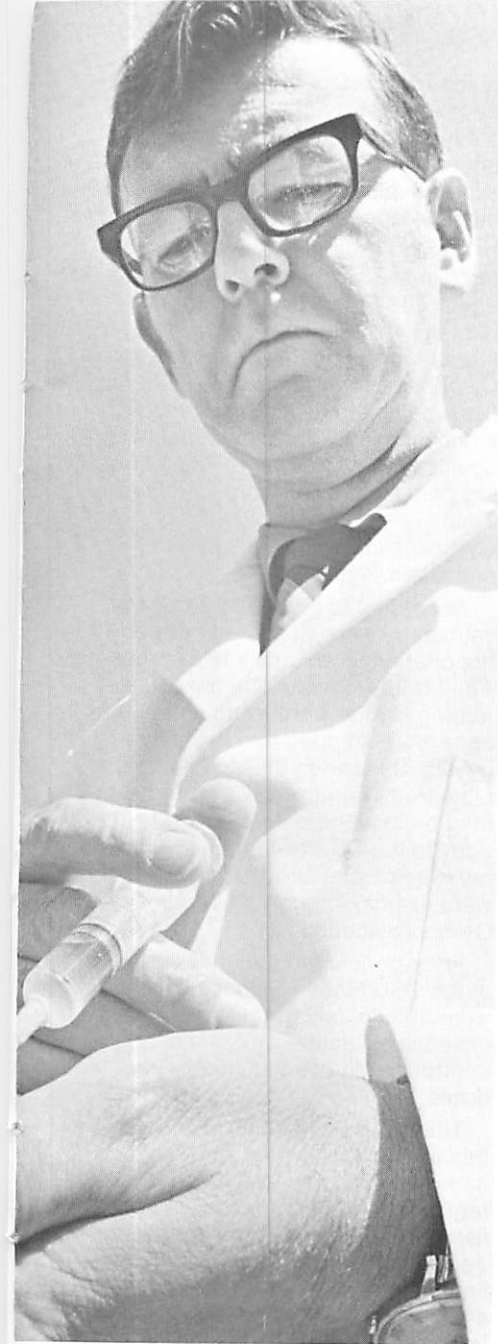
In response to inefficient algal production, Lawrence F. Small, professor of oceanography, initiated a one-year project to determine optimal growth and nutritional response spectra for common food algae.

He also planned to develop (in conjunction with another Sea Grant project) continuous-flow systems to deliver algal food on a systematic, sustained, characterized basis to oyster larvae to promote maximum larval growth. The current means of oyster larval rearing was largely guesswork, with no process control and little background data to substantiate the effectiveness of the feeding program relative to oyster larval growth, according to Small.

To determine optimal growth, Small set up controlled light-temperature grids and monitored algal growth and other population criteria in each light-temperature combination. Light-temperature regimes of optimum algal growth and "quality" (carbon/nitrogen ratio, cell size, algal excretion levels) were determined, and these criteria were used as a basis for growing algae in continuous-flow cultures to feed oyster larvae. Small



John L. Fryer



also added carbon dioxide as a variable of interest, to try to improve algal growth and "quality" even further.

To develop continuous-flow systems, Small encountered multiple problems. He had to design a system to continually meter good-quality algae into oyster tanks at appropriate cell concentrations, and keep out contaminants which would jeopardize the long-term running of the continuous-flow system. He experimented successfully with ozonization and carbon treatment of baseline water (water with a uniform response), using a commercial ozonizer, and developed the methodology with respect to long-term sterilization and detoxification of the water. He also designed the continuous-flow system constructed and now in final check stages at the Marine Science Center in Newport.

According to Small, experiments are being repeated on growth and nutritional response spectra of *Isochrysis* (food algae). Experiments are also in progress on carbon and nitrogen budgets of *Isochrysis* and *Skeletonema*, and carbon dioxide effects in algal food organisms.

As a result of Small's project, better food algae will be available to domestic oysters—possibly better than what they would eat living in the wild. (R/AQ-22[D])

## FISH AND SHELLFISH DISEASES

### Vaccinations help save salmon

*Vibrio anguillarum*. It's the bacterium that causes vibriosis, a disease which can kill up to 90 per cent of salmonid fish reared in salt-water facilities.

The control of *V. anguillarum* may determine the success of salt-water rearing of salmonid fish on the Pacific Coast.

A vaccine for the control of *V. anguillarum* has already been laboratory tested by John Fryer, professor of microbiology and investigator for a Sea Grant project to develop methods for the immunization of fish against vibriosis.

The results are encouraging for specific salmonids.

Fryer's results indicate that survival can be significantly increased in coho, chinook and rainbow trout by the use of bacterins; however, using bacterins to reduce loss from vibriosis in selected production lots in the Pacific Northwest has met with varying success. Further investigations are required to improve the effectiveness of this immunization process.

Fryer also discovered that bacterin boosters may affect the level of protection resulting from immunization. Experiments conducted at the Marine Science Center in 1974 examined this possibility. However, the occurrence of *V. anguillarum* did not reach the epizootic levels necessary for conclusive results to be obtained. Similar booster experiments are currently in progress.

In the marine environment, *V. anguillarum* is widespread and environmental conditions are known to contribute to outbreaks of infectious dis-

eases of salmonid fish. For example, temperature and salinity affect the growth of bacteria. These and other environmental factors play an important role in vibriosis outbreaks in estuarine environments.

Knowledge of the conditions associated with epizootics may enable preventive measures to be taken. These parameters are being monitored at the Marine Science Center to determine if specific correlations exist between certain environmental conditions and epizootics of vibriosis.

The mechanism of immunity conferred by the oral vibrio bacterin is not known, according to Fryer. Humoral antibody is not produced and therefore it is likely that the immunity is cellular (phagocytic) in nature. Determining the distribution of antigens in immunized fish may enable the immune process to be explained. This in turn will provide insight into ways by which the effectiveness of immunization may be enhanced.

If Fryer's results continue to be encouraging, some species of salmonids may be protected against vibriosis. Without that protection, it may be difficult to successfully rear salmonid fish on the West Coast. (R/FSD-1)

### **What do you do with a sick salmon?**

Doctors. Everyone needs them.

Even fish need them—especially fish artificially reared in large populations.

And the need for fish doctors increases as more people invest in fish farming.

In response to this need, the OSU Sea Grant College Program initiated a two-year project to help fish farmers detect, prevent and control infectious diseases in fish. Under the direction of John L. Fryer, professor of

microbiology, the project was designed to meet three objectives.

- to provide a diagnostic service to detect infectious diseases among populations of fish and shellfish in aquaculture and in studies at the OSU Marine Science Center.

- to recommend therapeutic and prophylactic procedures for control of infectious diseases of propagated fishes.

- to assist aquaculturists in disease prevention by certifying disease-free stocks of fish used in propagation. Fryer also planned to develop sanitation procedures for handling eggs, fish and larvae.

Last year, results were obtained in each area.

According to Fryer, diseased fish were examined in the laboratory as well as on location at aquaculture facilities. Bacterial and viral pathogens were identified through use of microscopy, *in vitro* culture, biochemical tests and deactivation by specific antisera. Mycotic and protozoan diseases were also identified by using microscopy.

After pathogens were identified, recommendations were made for the appropriate choice and level of antimicrobial agent to be used in treatment. Additional examinations were made after treatment to insure irradiation of disease. Fish without disease symptoms were also examined prior to ocean release or interstate transport of fry or eggs.

Diagnostic services were provided to various projects at the OSU Marine Science Center and to six private aquaculture facilities. Fish were certified as disease free (as required by the Oregon Department of Fish and Wildlife) for ocean liberation and interstate transport of fry and eggs. Various sanitation procedures were

recommended for reducing the incidence and spread of fish diseases.

Fryer prescribed terramycin, erythromycin, Hyamine, Diquat, formalin and malachite green for treatment as appropriate.

He also examined 749 fish exhibiting disease symptoms for infectious agents. The following pathogenic bacteria were identified: *Vibrio anguillarum*, *Vibrio* sp., *Pseudomonas* sp., *Cytophaga psychrophila*, *Aeromonas hydrophila*, the causative agent of kidney diseases, and an unidentified species of myxobacteria. The following parasites of fish were identified: *Tricodina* sp., *Nanophyetus* sp., *Gyrodactylus* sp., *Costia pyrriformis* and *Saprolegnia* sp.

According to Fryer, ten groups of salmon fry were examined before importation to aquaculture facilities. Adult trout from one Oregon fish rearing station were examined before eggs were shipped to out-of-state buyers. Sixty adult pink salmon from Little Port Walter, Alaska, were examined on location before importing eggs to the OSU Netarts Bay Hatchery. Samples of large groups of fish were examined prior to liberation into Oregon estuaries.

Fryer concluded that investigators at the OSU Marine Science Center were able to successfully treat diseased fish, sanitize equipment and control conditions to minimize diseases.

Thanks to Sea Grant's fish doctor, private aquaculture facilities have been able to comply with Oregon regulations requiring examinations of fish prior to interstate transport of eggs and fry or ocean release of fingerlings. Private facilities were also able to avoid large losses of fish from disease, thus enhancing production. (R/AQ-9)

## A natural enemy of English sole

A Yaquina Bay parasite is potentially lethal to young English sole, according to Robert E. Olson, a research associate in zoology based at the Marine Science Center.

The parasite, *Glugea stephani*, can infect the entire intestine and reduce the sole's capacity to absorb nutrients. Under these circumstances, starvation is probably the direct or indirect cause of death.

Olson has completed a two-year project to study the impact of this parasite on English sole, a commercially important flatfish which uses Yaquina Bay as a nursery ground.

He examined 3,118 English sole for infection and conducted laboratory experiments on parasite development and parasite-host specificity.

The results of the study indicated that fish became infected only in the upper areas of the estuarine nursery ground where summer temperatures were above 15 C. The incidence of infection reached 79.8 per cent in the late fall.

In the laboratory, infections developed and parasite growth occurred only at or above 15 C.

According to Olson, the parasite was successfully transmitted to juvenile English sole by shrimp and amphipod vectors as well as by direct ingestion of parasite spores by the host.

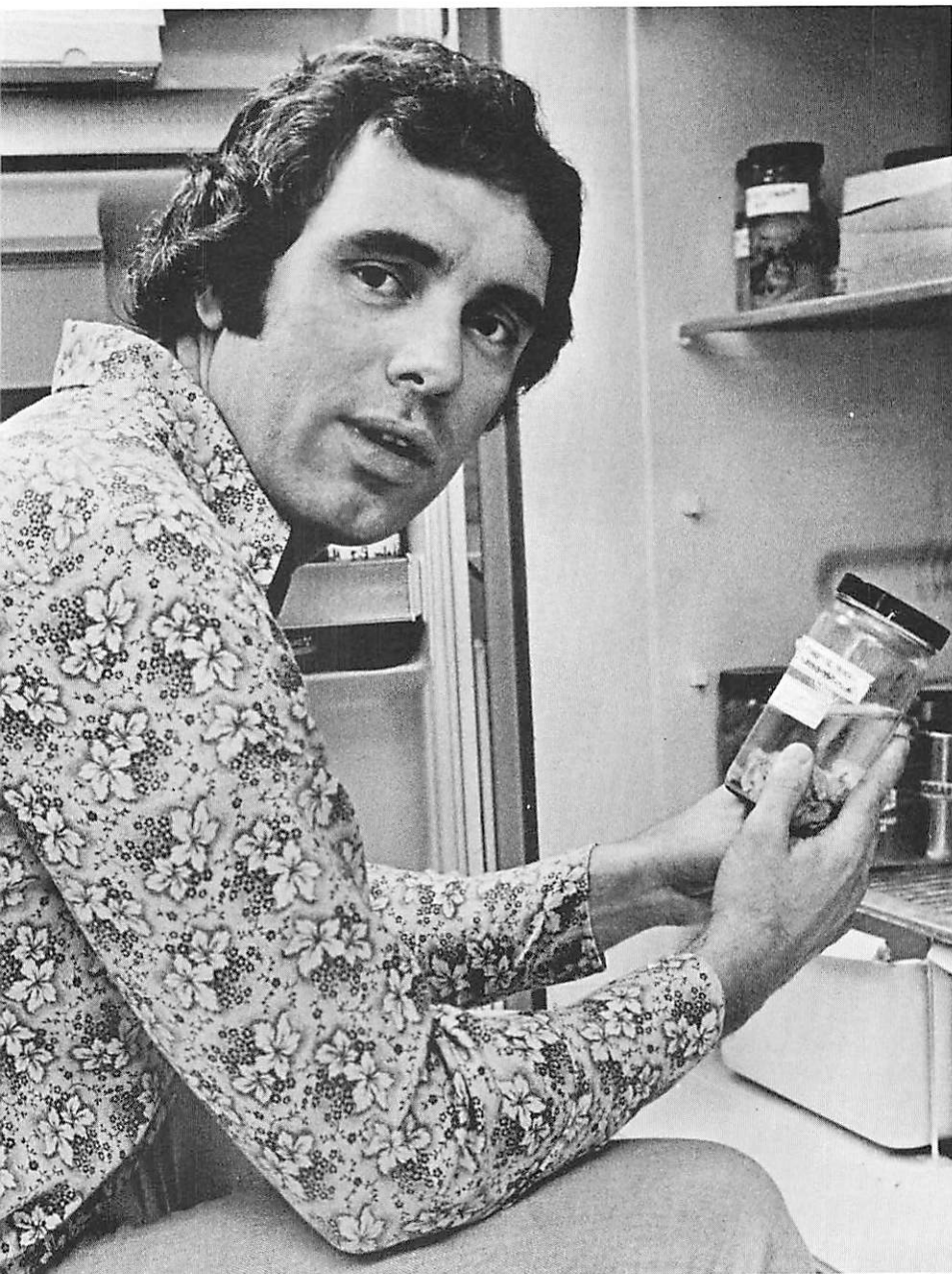
Infections that resulted from ingestion of spore-carrying vectors were much more intense than those resulting from the direct ingestion of spores.

Olson also tried to determine the potential for the parasite to infect other host species, especially salmonids reared in aquaculture. He tested speckled sanddab, a non-



Robert E. Olson





pleuronectid flatfish, and chum salmon; both resisted infection from the parasite.

The information from this project will be useful to those managing fisheries and to those engaged in aquaculture, according to Olson.

English sole isn't the only fish infected by parasites and *Glugea stephani* isn't the only parasite that infects fish. But a better understanding of *Glugea stephani* will provide insight into the biology of other similar parasite-host relationships in both fishes and shrimp. (R/AQ-13)

#### **Oyster "tumors": closer to an answer**

A disease with possibly serious implications has been reported in several species of economically important bivalve mollusks from Yaquina Bay, Oregon.

Many scientists, including researchers at the National Cancer Institute, consider the disease a tumor-like neoplastic growth.

The presence of such a cellular proliferative disorder in shellfish from Yaquina Bay is significant for several reasons, according to Michael C. Mix, associate professor of biology, who became involved in a Sea Grant project to study the neoplastic disease in Yaquina Bay in 1972.

Why is the disease significant?

Mix explains that affected bivalves are utilized as food by man and the exact nature of the disease is not completely understood. He adds that nothing is known about the origin of the disorders, but their presence in native species of shellfish suggests



that environmental oncogens (viruses and cancer-causing chemicals) may be present in bays where shellfish are utilized as food. The effects of the disease on shellfish populations are also unknown.

Mix has attempted to characterize the exact nature of the disease to determine if the condition is in fact analogous or homologous to malignant neoplasia, and to determine the origin of the disease if it is found to represent neoplasia.

During the past three years, Mix employed a variety of sophisticated methods never before used to characterize and understand such diseases in invertebrates. The methods included autoradiography, histochemistry, electron microscopy and fluorescent antibody techniques.

To determine the cause of these disorders, Mix placed samples of experimental *Ostrea lurida* in trays at several sites in Yaquina Bay and analyzed them bimonthly. Native *O. lurida* were also sampled and analyzed. Abnormal cells which characterize the disease are being studied with the electron microscope to determine if viruses or infectious disease agents are present.

Mix reports that he has just begun to analyze oyster and mussel tissues for the presence of chemical carcinogens.

According to Mix, the evidence accumulated from the histochemical and autoradiographic studies and preliminary electron microscopic examination of the abnormal cells suggests that the cells have many of the characteristics of neoplastic cells associated with vertebrate malignant

tumors. They have basophilic cytoplasm, have abundant cytoplasmic RNA, have no cytoplasmic granules, possess nuclear irregularities, have high nuclear-to-cytoplasmic ratios, have Feulgen-negative nucleoli, are large in size and are pleomorphic.

Perhaps most significantly, data from the autoradiographic study strongly indicate that the atypical cells proliferate at a much greater rate than normal oyster cells. If the fluorescent antibody studies demonstrate beyond doubt that the abnormal cells are oyster cells, it will generally be accepted that this condition represents neoplasia. It will then be imperative to determine the cause of these abnormal proliferative disorders because of the public health consideration.

Mix is presently studying the abnormal cells with the electron microscope to determine if any microbial agent is present, and is analyzing shellfish tissues for the presence of chemical carcinogens. The sampling data have revealed that the condition, to date, has been found only in a small number of native oysters taken from the commercial oyster growing areas of Yaquina Bay. The causal implications of this finding are not yet understood.

Mix has made significant progress toward understanding the nature of this tumor-like disease in oysters. Soon, he hopes to determine what causes it. (R/BR-9)

## BIOLOGICAL RESOURCES

### Big fish eat little fish, etc.

The concept is simple.

Big fishes eat little fishes, little fishes eat tiny fishes and tiny fishes eat plankton and copepods.

But the factors affecting food chain dynamics in Oregon's ocean are extraordinarily complex, according to Herbert Curl, William Percy and Lawrence Small, professors of oceanography.

They recently completed a seven-year project to study the food chain dynamics within the pelagic fisheries environment off Oregon. Much of their work concerned the highly productive areas of coastal upwelling.

The purpose of the project was to develop an environmental profiling system to obtain simultaneous measurements of variables affecting primary and secondary production on regions of significant fisheries activity.

This information will be used to obtain long-term correlations among measured variables for predicting the distribution and abundance of commercial and sports fishes, according to Small. Information will also be used to predict the trophic (or food chain) levels leading to the production of these fishes.

The researchers selected areas of manageable size important from a fisheries standpoint (bays, nearshore areas), and determined changes of significant environmental variables through time.

Each environment was looked at in a holistic manner, and in a proper time framework to measure the time variation in the important variables. Such an approach afforded a

reasonable chance to estimate fluxes, which was the type of information needed to allow comparisons between one area and another in relation to ability to support a fishery.

The newly developed profiling system allowed simultaneous estimates of water temperature, salinity, water density, light penetration, four nutrients, dissolved oxygen, chlorophyll *a*, and particulate carbon and nitrogen.

Proper cruise planning enabled the researchers to cover a reasonable area of Oregon coastline, the fertile Inland Passage area of Alaska around Auke Bay and the rich Hood Canal. The areas were observed during different seasons and in such time that major changes were easily seen and measured.

The Sea Grant oceanographers also gained knowledge of the seasonal changes in basic fertility of the Auke Bay area and Hood Canal; these findings are being reported in journals. Data from off Oregon's coast are being analyzed with particular reference to upwelling events in the spring-summer seasons.

According to Small, the profiling system idea and the holistic approach to looking at a selected environment have come into wide acceptance. He expects the Inland Passage, Hood Canal and Oregon Coast data to provide the most precise background yet available on which to base certain fishing, off-shore dumping and power station location decisions.

Thanks to Curl, Percy and Small, data are now available to understand some of the complexities of the food chain for pelagic fisheries. That should help insure food for fish—and fish for fishermen. (R/BR-4)

## **A crucial link in the food chain**

Plankton and copepods.

These tiny marine plants and animals play a big role in Oregon's ocean.

They are the first link in the food chain for fish which live in the open ocean.

Three oceanographers have been studying plankton and copepods in an effort to understand the food chain processes in the ocean.

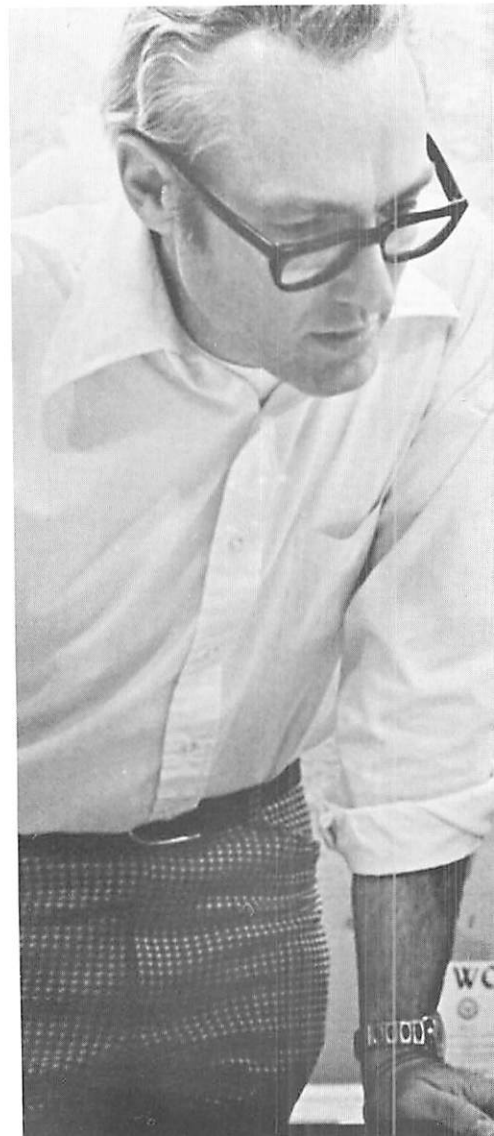
Charles B. Miller, associate professor of oceanography, research assistant Joan Flynn and graduate student William T. Peterson, developed three objectives for a two-year Sea Grant project.

The first objective was to determine the distribution of zooplankton species and biomass in the ocean very close to the Oregon coast.

The opportunity to tackle this objective was provided by another research team, according to Miller. The IDOE-CUEA (International Decade of Ocean Exploration-Coastal Upwelling Ecosystem Analysis) program was conducting a refined study of the Oregon upwelling current system with arrays of moored current meters during the summer of 1973. However, no biological studies were planned by CUEA to complement this sophisticated current data.

That was Miller's cue. He collected zooplankton samples along six transects perpendicular to the Oregon coast and parallel to the current meter arrays. These samples enabled the researchers to determine where planktonic animals live with respect to both water movements and water characteristics.

The six transects were taken under a range of hydrographic conditions from fully developed upwelling to the



Lawrence F. Smali and William G. Percy



relaxed condition which develops between upwelling episodes.

Upwelling divides the coastal ocean into two faunistic zones parallel to the shore. Inshore of the upwelling front (12 kilometers from shore at Newport), there was a zone dominated by the copepods *Acartia clausi*, *Centropages abdominalis* and *Pseudocalanus* sp. Offshore of the front, there was a zone dominated by *A. longiremis*, *Calanus marshallae* and *Pseudocalanus* sp. No animals were present in the frontal zone, except for the surface dwelling *A. longiremis*.

When upwelling stopped, the offshore faunal group was spread shoreward through the zone previously occupied by the front. The very nearshore assemblage was spread seaward, but remained restricted to water within about 10 kilometers from shore.

Peterson evaluated each species for differences in distribution among its life cycle stages. For the offshore assemblage, Peterson found that copepods do indeed live in different places during different stages.

The second project objective involved developing a commercial harvest of zooplankton based on a concentration of euphausiids (krill) reliably occurring off the Oregon coast over the 100 kilometer contour. Sampling by the project indicated that catches of 0.2 to 0.9 kilograms (dry weight) per thousand cubic meters of water filtered should be possible during summer season. The variation was due to patchy distribution of the krill.

The third and final project objective was to study an isolated population of *A. tonsa* (a copepod) in upper Yaquina Bay, Oregon. Miller planned to develop a quantitative model of



the interaction of estuarine hydraulics and copepod population dynamics. The existence of such models will help coastal zone planners evaluate proposed modifications for bays.

The population of another copepod *A. clausi*, was also analyzed.

Results for this objective are incomplete. Plankton were sampled biweekly over a period of three summers and samples for 1973 were analyzed. Samples for 1974 are being analyzed under a new Sea Grant project.

According to Miller, the most important discovery was learning that resting eggs play a vital role in the life cycles of estuarine plankters. The eggs reside in the mud of the tidal flats and slow-water zones during the cold, low salinity winter months.

An experimental analysis of the conditions which induced hatching of these eggs was also conducted. Three conditions necessary for hatching were identified: the temperature must be greater than 7 C, salinity must be greater than 10 parts per thousand (with increasing hatching rates at increasing salinities) and at least some light must be available. Without these conditions, hatching would be delayed until summer conditions became established in the bay. A given egg must also be at the surface of the mud.

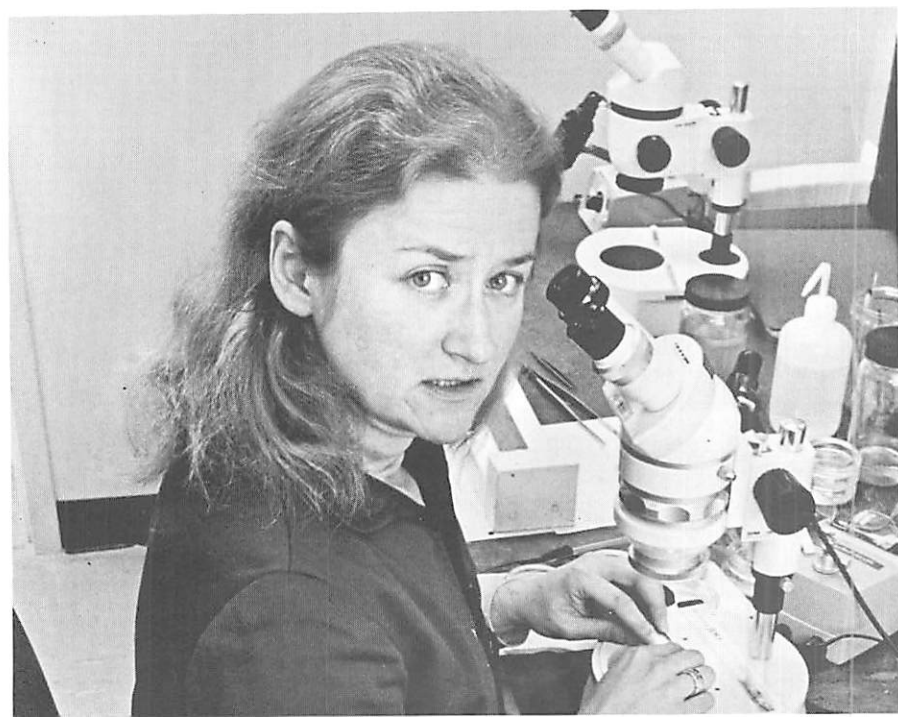
From these results, Miller concluded that the health of the bay as a habitat for plankton-eating fish requires retention of a good deal of muddy bottom.

Identifying a copepod's requirement for a muddy bottom is an important step in understanding the food chain processes in Oregon's



William Peterson, Charles Miller and Joan Flynn

Sally Richardson



ocean. If a copepod's habitat is destroyed by dredging, its eggs may not be able to hatch. Eliminating a copepod population also eliminates a food supply for small fishes. And if small fishes can't find food, the first link in the food chain for Oregon's ocean may be broken. (R/BR-5)

### **Early life of the English sole, et al**

More than two million pounds of English sole (*Parophrys vetulus*) were landed in Oregon in 1973. English sole make up about one tenth of total Oregon trawl landings.

Studies by Sally Richardson, School of Oceanography, have led to a better understanding of the life history of English sole. The results of her study, completing this year, should prove valuable to agencies involved in evaluation and management of fish stocks.

During the past year fish larvae were sorted and identified from more than 200 plankton samples. This completed a sampling series which included more than 110,000 fish larvae from more than 1,200 samples taken off the Oregon coast from 1969 to 1975. Data analysis is about 90 per cent complete. Three publications have resulted thus far and five additional publications are in preparation.

Two major distribution assemblages of fish larvae were distinguished off Yaquina Bay, Oregon. A "coastal" group is consistently found from 1 to 15 miles offshore while an "oceanic" group occurs from 20 to 60 miles offshore. Thus, drift out to sea may not be a major mortality factor for larvae in the "coastal" assemblage, such as English sole.

Abundance of larvae (especially English sole, butter sole, tomcod and smelt) in the coastal zone (1 to 10

miles offshore) off Yaquina Bay, Oregon fluctuated greatly from 1969 to 1972. Correlations between larval abundance and oceanographic and environmental factors (e.g., currents, upwelling, wind patterns) are being made to understand factors affecting larval survival.

Spring surveys of fish larvae in coastal waters from the Columbia River to Cape Blanco have shown species composition to be relatively uniform along the coast. However, a large concentration of English sole larvae was found south of Yaquina Head within 15 miles of the coast in early spring 1973. Abundance of English sole larvae in that year exceeded values for the same period in 1972 and 1974 by two and three orders of magnitude respectively. Possible causes of such great fluctuations in larval abundance are being analyzed. Data from 1975 will be included in the analysis.

Preliminary sampling was conducted in the upper 15 cm (6 in) of coastal waters (neuston) at monthly intervals throughout the year. Larvae of lingcod, cabezon, sablefish and Irish lord are highly concentrated there as opposed to deeper in the water column. However, English sole and other flatfishes were not found in abundance at the surface, as anticipated. Still, pollution of the surface waters may have serious effects on future populations of the fishes that are concentrated there in larval stages.

Richardson's data on the life history of English sole should be useful to agencies which manage fish stocks. They know that English sole is important to Oregon's trawl fishery—and that it's important to keep it that way. (R/BR-6)

## **EXPLOITATION OF STOCKS**

### **New net guards may net safety and savings**

Gillnetters on the Columbia River, Puget Sound and in Alaska are using more powerful boats to obtain higher production at higher speeds.

Unfortunately, the guards used to keep nets out of propellers rob fishermen of some of that additional power. Existing net guards result in net-guard failures and increased fuel consumption due to drag.

An improved net guard design could increase operating safety and lower operating costs for about 6,000 gillnetters, according to John R. Kinney, assistant professor of mechanical engineering.

Kinney is completing a two-year project to develop effective and efficient net guards for gillnet propellers. The effort has been pursued along two paths: he has studied a ring-type guard on a small boat (8.75-inch propeller) and he has evaluated a streamlined basket-type guard on a full-size fishing boat (20-inch propeller).

The ring-guard study compared a commercially available weed guard to a flow-accelerating nozzle guard with and without streamlined radial vanes. Using the unguarded propeller as a reference, the commercial weed guard, the nozzle with vanes and the nozzle without vanes developed apparent thrust coefficients of 75 per cent, 90 per cent and 100 per cent respectively, and torque coefficients of 100 per cent, 112 per cent and 123 per cent respectively at an advance ratio of 0.75.

These data show a significant advantage for the nozzle without vanes. However, the higher cost of

the nozzle, its installation requirement (small propeller tip clearance), its suspected tendency to catch a net float at some crossing angles, the lack of structure to shed the net web (without vanes), and its unconventional design hinder its use by fishermen. Kinney also developed a computer model of planing hull-propeller-guard performance. The model prediction was within five per cent of the small boat performance in most of the planing region. The model can be used to compare guard designs and to match propeller-engine-planing hull combinations.

Because of the limitations in applying the nozzle guard, the computer model was used to study a streamlined guard of conventional basket shape. For a reference boat with an 8.77-foot beam, twin screws and 11,000 pound displacement at 13 knots, the model predicts an increased thrust requirement of eight per cent with a streamlined basket guard and 28 per cent with a conventional basket guard.

A pair of streamlined baskets were installed on a similar boat and operated in the salmon fisheries for 10 weeks. Elements in conventional guards had failed and fallen off during the first week of fishing on this boat. After the streamlined guards were removed cracks were noticed on some elements—but all elements were in place. A minor design change is expected to correct the crack problem. Measurement of boat performance at 13 knots (nominal operation speed) indicated that the addition of the streamlined basket guard required an increase of four per cent in propeller speed and nine per cent in power.

Good cost/benefit estimates require a more comprehensive model for engine performance than was available during the project extension. Some unsponsored work on an engine model is planned. The redesigned netguard will be reinstalled on the same boat to obtain further experience by fishing with it.

The computer program model is the most broadly applicable result of the project, according to Kinney. He believes it could be put to further use. It could be adapted to the trawler studies conducted by Ed Kolbe, another Sea Grant researcher. The model could also be structured to reveal preferred operating conditions for small fishing vessels with a minimum of readily available boat data.

The successful results from the computer program model bring Kinney and 6,000 gillnetters one step closer to the desired product: a netguard which increases operating safety and decreases operating costs. (R/ES-2)

### **Bait your hook with a battery**

Commercial fishing—it ain't what it used to be.

Today's commercial fisherman can rely on new electronic fishing gear and new methods to help him land his catch.

Unfortunately, not all of Oregon's commercial fishermen have access to information on new gear or know how to interpret some of the engineering data on new methods.

That's why Sea Grant got involved. Under the direction of Edward Kolbe, fishing gear development specialist and marine extension agent Robert Jacobson, a two-year Sea Grant project is helping to demonstrate new commercial fishing

gear and methods to the Oregon fishing fleet. Kolbe also assisted commercial fishermen in evaluating existing fishing gear and methods and provided training for fishermen.

According to Kolbe, the project was aided by coastal agents from the Marine Advisory Program. These agents made major contributions toward identifying needs and reporting results.

This past year, Kolbe conducted seminars on new gear. For example, two representatives of a German electronics company presented a seminar on echo-sounders used for depth recording, fish finding and mid-water trawl operation. A set of notes from that seminar was prepared to include additional information from a list of books and articles currently available. The notes were made available to fishermen through Oregon's four marine extension agents.

Another seminar involved the effects of voltage on stainless steel fishing lines. A voltage drop between lines and boat occurs when the two are electrically insulated; it is a result of dissimilar metals immersed in salt water. The experiences of a Canadian electronics expert has shown that during periods of light fishing, a positive voltage on the line will increase the catch, and a negative voltage will decrease the catch.

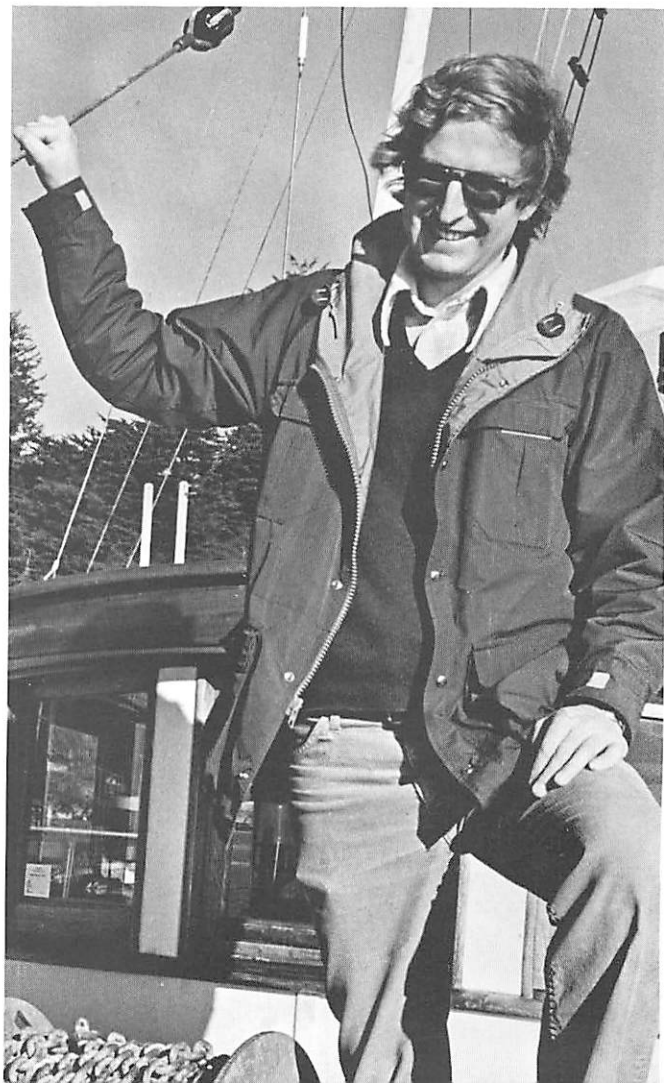
At the invitation of a MAP agent, the electronics expert visited two ports in Oregon to relate his experiences. The seminars generated a great amount of interest, not only in trolling wire voltages, but in troubleshooting boat electrical problems, cathodic protection and electrical bonding of boats. Kolbe prepared a report dealing with bonding and troll wire voltage and is preparing another

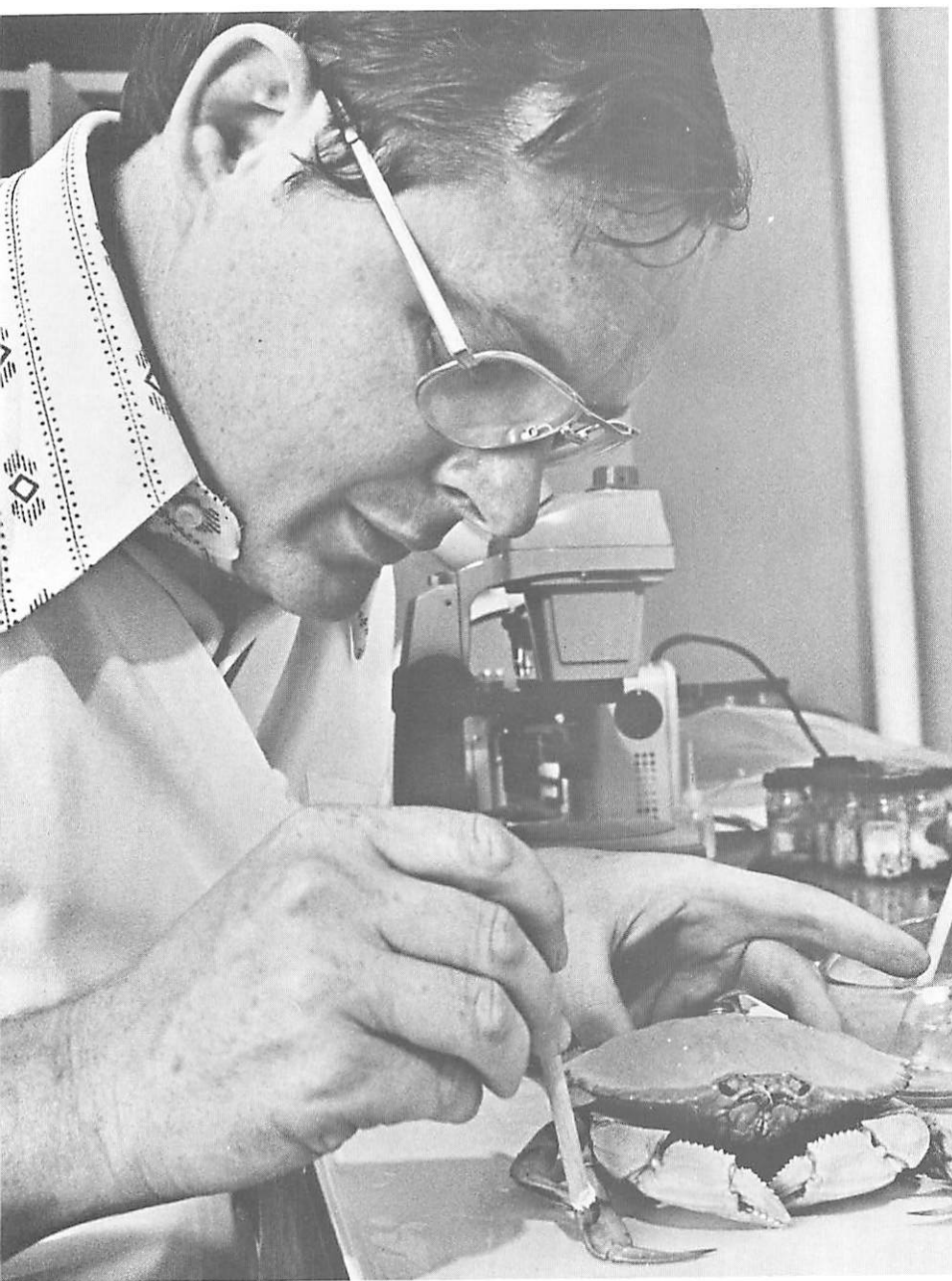




John R. Kinney

Edward Kolbe





Richard Stroud

report describing the use of volt-ohmmeters.

According to Kolbe, a field study on the cause and effects of underwater boat noises was initiated. Equipment was collected and assembled, contacts with fishermen were established and measurements begun—both in Oregon and California.

No, commercial fishing ain't what it used to be. But that's all right. Most fishermen won't complain about new gear and methods that result in increased catches and profits. (R/ES-4)

### **Branding crabs with laser beams**

Branding a crab. Sound easy? It isn't.

Crabs and other crustaceans periodically molt, or shed their shell. This makes conventional methods of tagging unsatisfactory because the tag is shed, interferes with molting or is difficult to apply. Proper tagging enables fisheries management agencies to study growth, migration, population dynamics and other aspects of the biology of crabs, shrimp and lobster species.

According to Richard K. Stroud, research associate in veterinary medicine, new methods now being developed may produce a permanent mark.

Stroud is involved in a three-year project to investigate the use of freeze branding and laser branding techniques to produce a mark on the back of the shell of Dungeness crabs (*Cancer magister*) that will be reproduced with each succeeding molt cycle. Both techniques involve altering normal pigmentation at the mark site by selectively destroying the pigment-producing cells. Stroud explains this can be done with minimal damage to the surrounding integumental tissue because of the differential uptake of energy from the laser

or the sensitivity of pigment-producing cells to freezing and thawing.

According to Stroud, this concept has been used extensively to mark cattle, snakes, horses, fish and many other species. It should work for crabs also because a crab's pigment-producing cells are located in the membranes which produce the exoskeleton. As a result, any alteration of pigment-producing cells in these membranes will be reflected in each succeeding exoskeleton produced.

To develop freeze branding and laser branding into useable management tools, many variables in the marking process are being investigated. Variables in freeze marking include temperature, contact time, location on shell and type of "branding iron." Type of laser and power levels are the factors being tested for laser marking.

In order to test the crab-marking concept, sea water facilities were constructed at the Oregon Department of Fish and Wildlife Laboratory in Newport, Oregon, to hold experimental Dungeness crabs so that long term observations could be made. Associate investigator Dale Snow, from the Oregon Department of Fish and Wildlife, directed the feeding and care of the crabs.

So far, Stroud and Snow placed 671 marks on 130 crabs using various laser and freeze marking techniques. In addition, 40 crabs were laser marked, sacrificed at various intervals and the shell-forming membrane examined to determine the pathological changes caused by the laser. All crabs were collected from Yaquina Bay and were from 9-13 cm carapace width.

Stroud used Freon 12, Freon 22 and liquid nitrogen as coolants for freeze branding experiments con-

ducted at Newport. He branded crabs on the carapace using sponge or copper super-cooled "branding irons" applied from 5 to 20 seconds. After branding, crabs were maintained and periodic observations were made both prior to and after molting.

Of the freeze marking techniques attempted, the best preliminary results were achieved by using Freon 12 as a coolant, a rubber medium-density sponge as a "branding iron" and contact times of from 5 to 15 seconds. A ruby laser, a neodymium laser and an infrared laser were also used. The ruby laser firing at a level of 0.3-0.4 j/cm<sup>2</sup> produced the best laser marks.

Stroud plans further experimentation with larger numbers of crabs during 1976-77 fiscal year to further refine the most promising techniques. Because of the limited availability of crabs of 3-5 cm carapace width, most work will be done on crabs in the 10-13 cm range. Histological studies are currently underway to evaluate tissue changes produced by the marking techniques.

Crab branding may never be easy, but it appears that it will be an effective and reliable tool for the marine biologist. The result should be improved understanding and better management of crab populations, and possibly shrimp and lobster populations as well. (R/ES-5)

### **Where the groundfish are**

Groundfish. You can find them in any seafood market along Oregon's coast. Take your pick of petrale sole, English sole or Pacific Ocean perch.

Or you can probably catch two or three groundfish yourself if you go charter boat fishing.

Although they seem abundant, no one knows the size of the groundfish

stocks in the northeast Pacific. And no efficient methods for assessing groundfish stocks have been developed.

Without a knowledge of fish species, numbers and locations, it's hard to manage stocks. And it's hard to interpret the impact of the commercial fishing fleet on these stocks.

That's why Al Tyler, associate professor of fisheries and wildlife, got involved in a one-year Sea Grant project.

According to Tyler, interpretation of the impacts of the fishing fleet on fish stocks depends on landing records expressed in catch-per-effort units. Correctly based, catch-per-effort data give a direct indication of the relative abundance of fish stocks. The units must be in terms of boat-time spent in making the catch from identified species stocks.

However, consultation with the Oregon Department of Fish and Wildlife revealed that stock-specific catch-per-effort interpretations could not be made from present landing data because quantities landed were recorded by trip. A boat trip could include many areas of the continental shelf. If catches were recorded by tow or statistical catch areas that were small enough to be stock-specific, then data on catch of each species per boat-hour would be useful in following stock trends.

The basic problem, as Tyler saw it, was to find the optimum size of the statistical areas and determine whether the areas should follow a grid pattern or bottom contours.

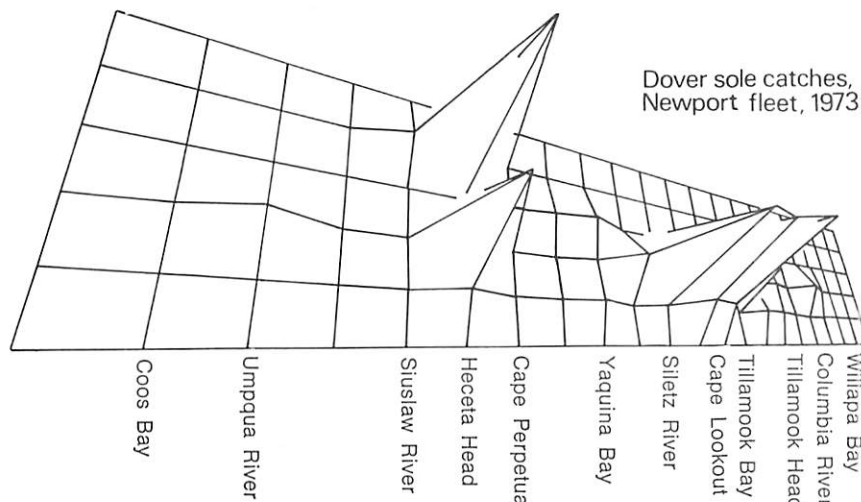
To solve the problem, Tyler aimed his project at developing methods for assessing northeast Pacific groundfish stocks.

During the year, he reviewed fishermen's log-book records on file

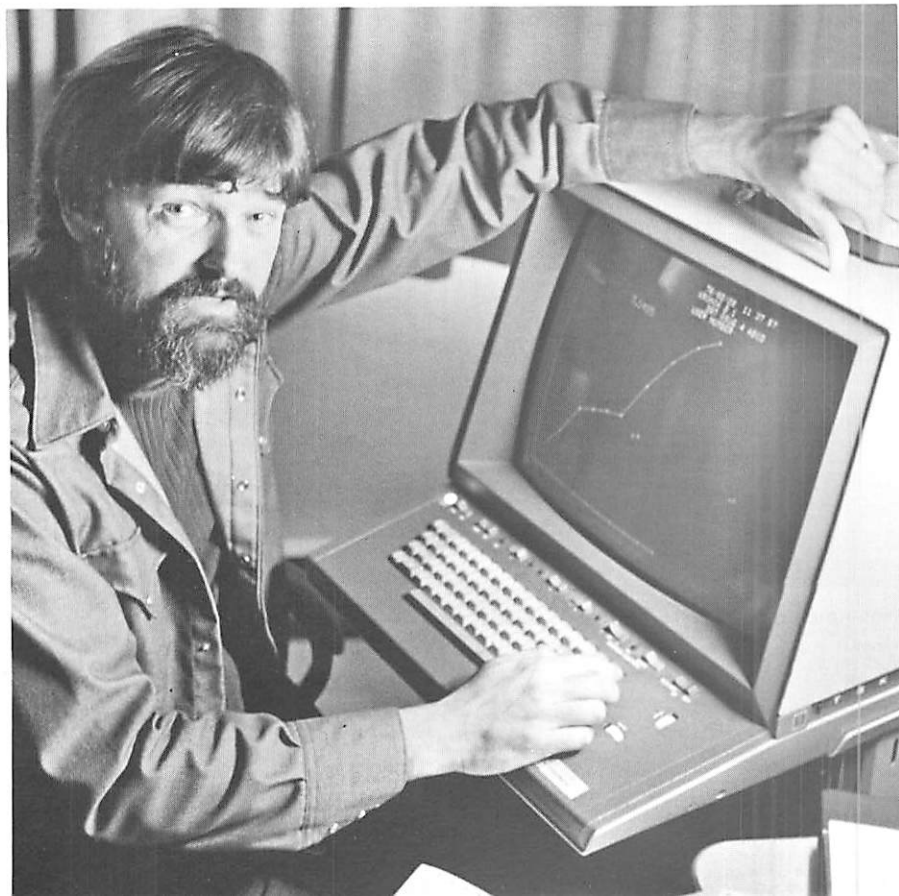
with the Oregon Department of Fish and Wildlife. They indicated that trends in stock abundance could be obtained from some target species if the catch and effort records were computerized. The records included data on petrale sole, English sole, rex sole, Dover sole, Pacific Ocean perch and pink shrimp. Catch distribution maps could also be generated from these data. Log-book records of groundfish and shrimp landings for 1973 were keypunched for a pilot study of commercial catch mapping.

To date, catch and effort of the Newport, Oregon fleet is the most fully analyzed. Fishing effort by this fleet is distributed largely between Cape Lookout and Heceta Head, and within 20 miles of shore. The major exception is the trawling that occurs on Heceta Bank (about 30 miles off Heceta Head). About twice as much effort was expended in the 10-mile square area adjacent to Newport as in any other 10-mile square area. Catches of rockfish, ocean perch, petrale sole and English sole echo the general effort distribution; catches of Dover sole and rex sole do not. This indicates a more specialized fishery for these species. Dover sole was taken in deeper water (50-100 fathoms), 20 miles off shore in areas north of Newport, and also on Heceta Bank. Most rex sole were taken 10 miles off shore, and in four areas between Tillamook Head and the Siuslaw River.

A tentative new statistical area map for reporting Oregon commercial landings was proposed jointly with representatives from the Oregon Department of Fish and Wildlife at the June 23, 1975, meeting of the Pacific Marine Fish Commission. The proposal was made partially on the basis of physical characteristics of the sea bottom.



Albert V. Tyler



This project was terminated early in order to combine Tyler's interest in better statistical data with the efforts of several other scientists interested in reaching a better understanding of the pleuronectid (flatfish) production system and associated fisheries (R/OPF-1). Tyler's earlier work is already beginning to show results. A preliminary figure showing Dover sole catches in 10-square-mile increments has been drafted.

Clear, graphic information like this will make possible improved management of Oregon's flatfish stocks. Over 20 million pounds of flatfish are landed every year in Oregon. Fishermen, managers and consumers want to make sure that will always be the case. (R/ES-7)

#### **Tanner crab: no substitute for Dungeness**

A fishery based on the Tanner crab (*Chionoecetes tanneri* Rathbun) is not feasible at this time.

That's the conclusion of Andrew G. Carey, associate professor of oceanography, and graduate students Brian Oliver and Patricia Tester, who completed a two-year study on the Tanner crab.

Carey, Oliver and Tester conducted eleven cruises off Oregon's continental shelf from Coos Bay southward to Cape Blanco to determine the distribution and abundance of the Tanner crab. Between April 1973 and March 1975 they collected 273 trawl samples with a three-meter quantitative beam trawl and a seven-meter otter trawl.

Oliver found that adult crabs were distributed over a depth range of 400-2,149 meters. Adult males ranged from 521-1,528 meters, adult females from 439-904 meters and juveniles from 402-1,500 meters.



Andrew Carey



No strong correlation was found between the Tanner crab distributions and any measured aspect of the physical benthic environment, according to Oliver.

Tester defined nine size classes for juvenile males, eight size classes for juvenile females and determined crab age maturity to be from five to six years. The sex ratio was 2.41 females per 1 male.

This Sea Grant project was initiated with the hope that a Tanner fishery would help supplement fluctuating Dungeness crab catches. That won't be possible at this time, according to these three oceanographers. Relatively low population densities and the depressed crab market on the West Coast will prevent the Tanner fishery from being established. (R/BR-1)

### A crystal ball for crab

Fishermen and processors need a reliable way to predict the size of next year's crab harvest a year in advance of the commercial fishing season. This prediction would help them allocate both time and equipment prior to the season.

Conservation agencies would be able to use the same information in formulating short-range management decisions concerning Oregon's crab resource.

Are such predictions possible?

Howard Horton thinks they are.

Horton, professor of fisheries, is involved in a project designed to predict the abundance of harvestable Dungeness crab. His work is based on the assumption that next year's catch can be predicted from the ratio of sub-legal-size crab to legal-size crab during the current season.



Howard Horton

Season <sup>1</sup>	Predicted landings (kg)	Actual harvest (kg)	Error
1973-74	1,405,092	1,550,126	- 9.4%
1974-75	1,306,901	1,600,000	-18.3%

<sup>1</sup> Crab seasons begin in December of one year and last through August-September the following year.

Predicted and actual crab landings in Oregon for 1973-74 and 1974-75.



To gather data, he and his students sampled crabs in experimental pots fished alongside conventional gear from commercial fishing boats based in the ports of Newport and Astoria, Oregon.

In all, 7,227 crabs were captured during three fishing seasons. Of this total, 1,283 were legal-size males, 2,516 were sub-legal-size males and 3,428 were females (all of which are illegal regardless of size). Horton and graduate research assistant Jerome Stefferud developed a statistical procedure which yielded the predictions shown in the table below. The predictions were within 10-20 per cent of actual landings.

The Sea Grant investigators are now concentrating on increasing the sample size and refining the statistical procedures. They are also investigating the effects of possibly harvesting large female crabs and the merits of sampling before the start of the fishing season.

What will be the size of the crab harvest in 1977?

Ask Horton in June, 1976, after he's completed his two-year project to predict the size of the crab harvest a year in advance of the fishing season. (R/ES-6)

## MARINE PRODUCT DEVELOPMENT

### The 28.8-second fillet

Filleting a fish is easy, right?

Then how long does it take you to fillet a petrale sole?

Two minutes? (Better sharpen your knife.)

One minute?

If it takes longer than 28.8 seconds, you're too slow, according to engineered time standards developed by William F. Engesser.

Engesser, professor of industrial engineering, developed time standards to identify and improve seafood processing productivity. Productivity includes yields, safety, quality, production rates, sanitation and packaging. Improved productivity from time standards benefits processors, fishermen and consumers. Processors gain directly by more efficient operation and both fishermen and consumers benefit from enhanced fish yields and quality.

Determining these time standards was one aspect of a seven-year project designed to study industrial engineering systems for shrimp, crab and bottomfish processing. Engesser also developed longer-range value-analysis procedures and product-mix standards which included activities in the fields of resource management, harvesting, processing, marketing and employment stabilization.

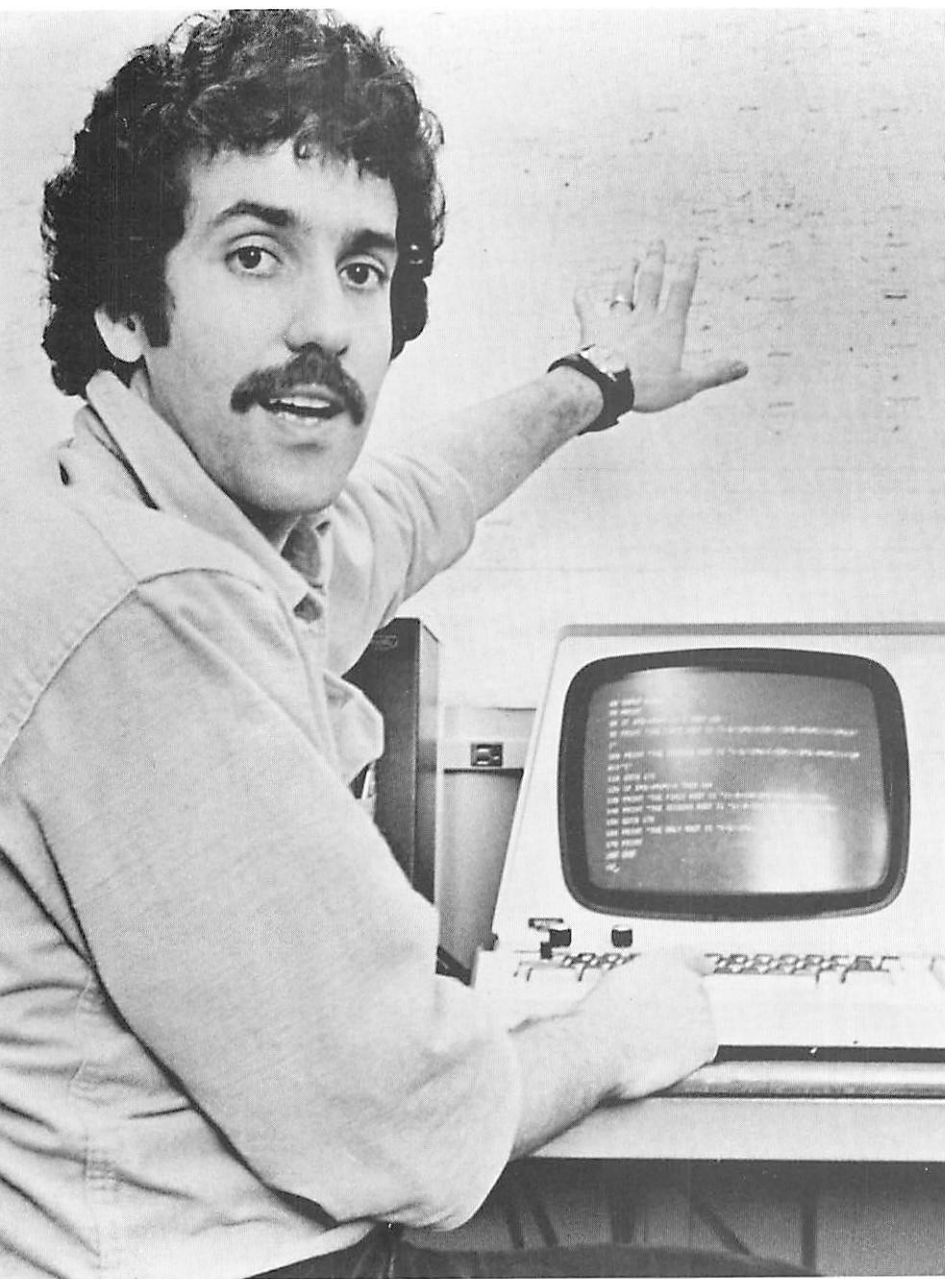
To implement time standards, Engesser determined that formal and informal training was necessary at all operating levels including the activities before and after seafoods were processed. To meet this need, three quantitative measures of productivity were developed. They included MAP (master achievement

programming), SAP (supervisor and staff achievement programming) and CAP (chief achievement programming).

MAP made use of an achievement chart with pictures illustrating desirable motion patterns plus the detailed steps and performance time of high-skill workers. Motion picture and video-tape cassettes were used to supplement the achievement charts. In test runs in two plants, both workers and their supervisors gained a deeper insight of desirable skill traits. A chart on filleting petrale sole which included time/motion patterns was published.

The second measure, SAP, used equations to compare the performances of two plants. The results of last year's study showed a 30 per cent filleting productivity rate difference even though the petrale filleting methods were identical. Some possible causes for the difference were identified, but further investigations are necessary for firmer conclusions and improved performances.

Although equations were important management tools, Engesser found that analyzing large productivity differences between normal and standard times was more important. For example, when differences between normal and standard times were high, Engesser felt that immediate self-improvement steps should be taken to avoid such repetitions in the future. Some possible assignable causes of productivity differences included personal time, yields, set-up time, fish condition, thefts, avoidable delays, unavoidable delays, safety, sanitation, skill levels, tool and equipment condition, consumer



William Mercer

acceptance, fish size and errors in production data.

The third measure, CAP, involved product-mix standards. Engesser found that CAP was improved when complete product-mix standards were included in a future plan and schedule chart. Effective use of the chart enables top-level executives to quickly evaluate the effects of mechanization, alternate marketing decisions, imperfect operations and the complexity of the input-output relationships among the various activities and resources.

One of Engesser's graduate students, Willie Mercer, completed his graduate thesis which analyzed the processing of both vegetables and seafood. Mercer used the plan, schedule and evaluation chart to not only validate alleged savings, but to illustrate how resource planning and management (RPM) charts can be used to predict future results and to adjust rapidly to appropriate changes when the unexpected occurs. His thesis won second place in the 1975 national graduate student research competition sponsored by the American Institute of Industrial Engineers.

According to Engesser, the cooperating processing manager said that the processing of seafood (crab and shrimp) along with their traditional vegetables, shows a net profit (before taxes) of approximately \$35,000. He mentioned that the seafood processing alone did not result in a direct profit, but that by augmenting their entire production with seafood processing, the savings resulted from providing a means to keep people working during slack periods.

Resource planning and management (RPM) and engineered time

standards lead to increased incomes and yields. That's good for processors.

But the efforts of Engesser and Mercer also benefit people. Improved planning and management enables employees to remain employed and time standards contribute to a better and less costly product for the consumers. (R/PD-18)

### Starfish pills?

Starfish, sea cucumbers and sea worms. They may end up on your drug store shelf.

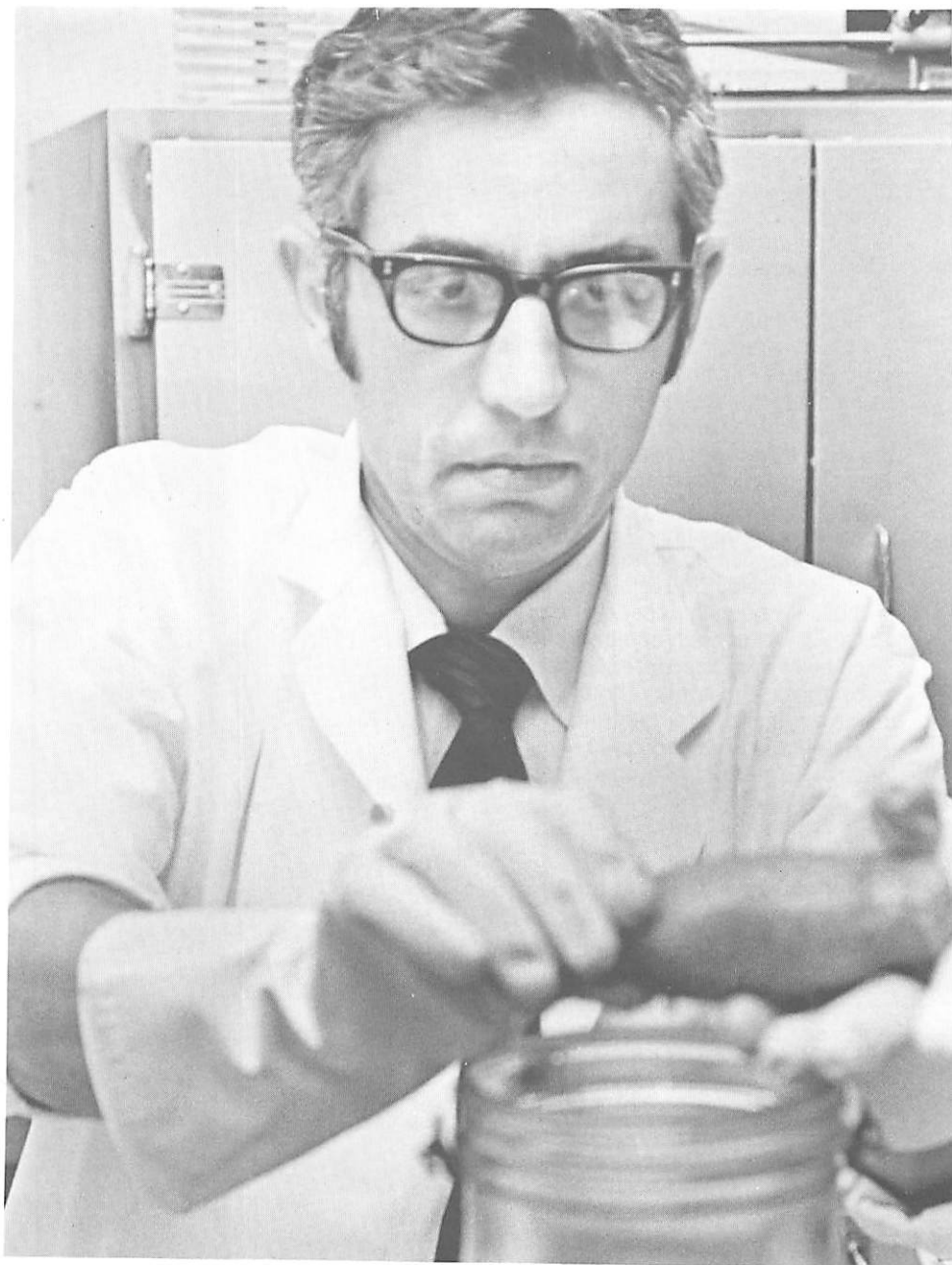
Chemical compounds in starfish and other marine invertebrates may help prevent or control human diseases such as cancer. These compounds may also prevent fish diseases and be of value as insecticides.

George Constantine, associate professor of pharmacology, has analyzed marine invertebrates (annelids, chordates, coelenterates, echinoderms and molluscs) and higher marine fungi (Ascomycetes and Fungi Imperfecti) during a four-year Sea Grant project. He also examined what role these substances play in marine ecosystems.

Now he is evaluating these substances biologically for pharmacologic, anticancer, antibacterial/antifungal and insecticidal activities.

The results from the past year's work fall into three areas: isolation and structure elucidation, biological assay and fungal metabolites.

According to Constantine, more than 20 biologically active crude extracts were fractionated (divided by chemical and physical methods) to determine the compounds responsible for their activity. Twelve compounds were isolated; these are now undergoing structural analysis at



George Constantine

Stanford University, Iowa State and the University of California at Berkeley.

Regarding biological assays, Constantine reported that 33 marine invertebrate extracts are in the process of being evaluated for insecticidal activity by Zoecon, Inc., Palo Alto, California. Preliminary results on several extracts have been encouraging.

Eight extracts exhibiting significant activity against microorganisms which infect Pacific Northwest salmon, steelhead and trout have received further attention. Several students have been involved in isolating new chemical extracts from marine fungi.

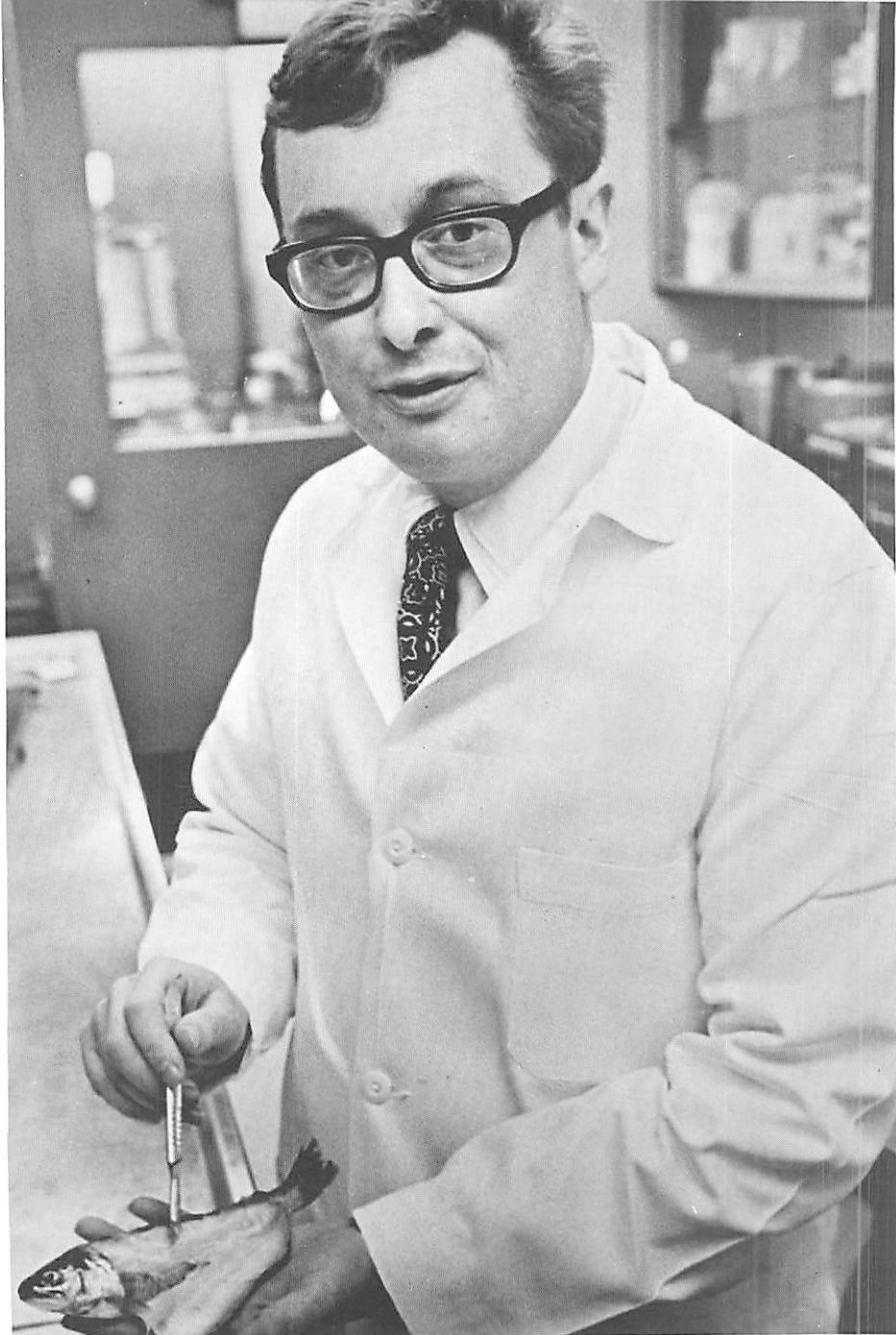
There is no certainty that Constantine's work will lead to new drugs, pesticides, or other useful chemicals—it usually takes a decade or more to fully develop such compounds once activity is discovered in natural substances. But some of tomorrow's miracle drugs may come from the sea, perhaps from such unlikely candidates as starfish, sea cucumbers or sea worms. (R/PD-2)

#### **Wanted: a yardstick for shrimp quality**

Shrimp quality is important to both fisherman and processor; however, not all shrimp is of equal quality.

An accurate chemical index of shrimp quality would be valuable for establishing raw product quality, scheduling optimum processing sequence and possibly predicting potential frozen shelf-life.

One method of monitoring shrimp quality may include determining the levels and rate of decomposition of trimethylamine oxide (TMAO) in shrimp.



David Crawford

Trimethylamine oxide decomposes enzymatically to dimethylamine (DMA) and formaldehyde (FA) during the ice storage of whole shrimp, according to David L. Crawford, associate professor of food science and technology. Directly related levels remain in separated cooked meat after processing.

Crawford, principal investigator for a one-year project on the decomposition of trimethylamine oxide in Pacific Shrimp, believes that DMA and/or FA levels in whole raw shrimp and cooked meat offer a potential quality control index.

Efforts are being directed toward establishing the ranges of TMAO, DMA and FA in landed whole shrimp, the rate of DMA and FA formation during iced and frozen storage and the correlation of expert flavor panel scores with chemical indices.

Crawford reports that TMAO in whole shrimp varied by individual shrimp, on-board handling practices and/or storage time/temperature relationships which were reflected by levels in separated cooked meat.

Continuing research reveals that the decomposition of TMAO to DMA and FA in frozen (0 F) storage of cooked meat in vacuum is not occurring. This indicates that the proposed enzymatic system is inactivated by precooking procedures.

Correlation of these indices with flavor panel scores is improving with storage time. This suggests that the index level has a relationship to shelf-life potential, according to Crawford. (R/PD-20)

## **Testing new seafood combinations**

What happens when you mix minced fish flesh with vegetable and cereal products?

You get a new seafood product low in cost and high in nutrition. Such a product would have a wide application in low cost institutional feeding programs, according to David L. Crawford, associate professor of food science and technology.

Crawford recently completed a two-year project to develop new seafood product concepts involving the extension of machine-separated minced flesh from finfish with vegetable and cereal products.

Crawford investigated minced flesh-extender fabrication and combinations methodology, determined the shelf-life of the product and the effect of minced flesh source. He also determined comparative commercial and concept acceptance.

During the past year, the processing parameters for the machine extrusion of minced fish flesh in combination with potato, rice and yellow and white corn grit extenders in ratios ranging from 0:100 to 80:20 were established at 10 per cent increment levels.

Flavor panel evaluations used expert judges under controlled conditions. Results showed ratios ranging from 40:60 to 50:50 (minced fish:extenders) to yield a slight optimum preference for the deep-fat fried product, but minced fish levels greater than 20 per cent did not significantly enhance or detract from panel scores.

Flavor panels ranked minced fish extenders in various combinations in the following order: potatoes, rice

and white and yellow grits (the grits ranked equally).

Crawford described the magnitude of student panel scores as good, with values for overall desirability ranging from 5.95 to 6.70 on a nine point scale. (Nine is the highest affirmative value; one is the lowest value.) The lowered scores for the concepts including corn products probably reflect a regional food type preference.

Crawford also discovered that minced flesh from rockfish and cod-like species, including Pacific hake, yielded comparable product quality and acceptance.

The four product concepts (50:50 true cod:extender ratios), each packaged in air and in vacuum, were stored 12 months at 0 F and evaluated by expert flavor panels at three-month intervals. Potato and rice concepts showed excellent shelf-life stability under both packaging systems. The acceptance of the two forms of grits deteriorated after six months regardless of packaging system.

Making a product nutritional is only one part of preparing a new product. It also needs to be tasty and have a long shelf life.

Crawford's new product—minced fish flesh with cereal or vegetables—meets those requirements. Soon, consumers may be eating Crawford's product—and judging for themselves. (R/PD-12)

## **Getting a fresher taste from frozen seafoods**

Fact: the majority of fish destined for human consumption is handled and sold as a frozen product.

Until recently, knowledge of what happens to fish muscle when it's frozen was unavailable.

But this year, David L. Crawford, associate professor of food science and technology, completed a three-year Sea Grant project on the parameters influencing the utility of fish muscle in frozen portions and further processed items.

The results of his research will enable processors, consumers and retailers to select the proper conditions for frozen storage and better utilize a frozen product.

According to Crawford, the previous year's objectives centered on the qualitative and quantitative measurements of fish myofibrillar protein subjected to frozen storage. Myofibrillar protein isolation, various solubilization techniques, polyacrylamide gel electrophoresis separation and quantitation by visible desitometry and evaluating different dyes were used to study the proteins.

Initial observations indicated mass changes took place in the protein actin and those of molecular weight less than 45,000 (seven proteins). This lends support to the concept that these myofibrillar proteins are most affected by frozen storage. Since that time, additional work was accomplished on the separation of molecular weight (MW) components greater than 45,000 and up to myosin, MW 222,000 (seventeen proteins).

Previous work, however, indicated that formaldehyde, a breakdown product of trimethylamine oxide, and free fatty acids, resulting from lipolytic activity, contributed to the decrease in solubilization of myofibrillar proteins.

Crawford found that various chemicals could be used to retard these degradation steps, but their addition must be beneficial to the

problem and safe. Experiments are being conducted to see if increased, or possibly decreased, levels of phosphorous (phosphates) and calcium may be employed to preserve the quality of frozen fish.

While the quality of fish for individual consumption may be reduced by frozen storage, other work indicated that freezing provides advantageous textural and physical properties to fish muscle when used in fabricated foods. The emulsification capacity of frozen fish muscle does not deteriorate with frozen storage, according to Crawford.

The technique of assessing frozen storage quality by decreasing salt (NaCl) extractability with storage time as a quality control index is continually being evaluated. Although this phenomena has been demonstrated for other species, Crawford found that it did not hold true for ling cod (*Ophiodon elongatus*) subjected to 0 C.

This work should indicate to the industry the importance of rapid product handling, constant temperature during frozen storage and possibly the need for improved moisture retardant packaging material to preserve quality during frozen storage.

Fact: the quality of frozen seafood products can be maintained.

Thanks to Crawford, processors and retailers now have some guidelines to follow to maintain that quality. (R/PD-10)

### **Quick handling: it keeps the blues away**

Blue-colored crab—decoration or disaster?

Disaster.

Blueing ranging from a light blue-

gray to a dark blue-black discoloration of fresh crab meat, frozen whole cooked crab and crab sections, and canned retorted crab meat can result in large monetary losses for the crab industry and is a serious quality control problem.

How serious?

In 1973 one Astoria fisherman discarded an entire Dungeness crab catch due to blueing. Again in 1973, several thousand pounds of frozen sections of queen crab shipped from Alaska to be processed in Oregon were discarded because blueing developed after the sections were thawed. Furthermore, one local processor discontinued marketing whole cooked crab as well as canned meat for the retail market because of blueing discoloration.

Because of these problems, Jerry Babbitt, associate professor of food science and technology, began investigating blueing discoloration in Dungeness crab. He felt that information relating the seasonal effects on condition of the crab and the use of various chemicals (acids, antioxidants and reducing agents) on blueing might enable the crab industry to modify handling and processing methods to reduce blueing.

After completing his one-year Sea Grant project, he found that the handling and condition of the crab when received by the processor were much more important than seasonal effects on quality and incidence of blueing in frozen crab and canned crab meat. (His samplings ranged from December through April.) Regarding experiments with various chemicals, he learned that there was no advantage in using sodium metabisulfite to prevent blueing in



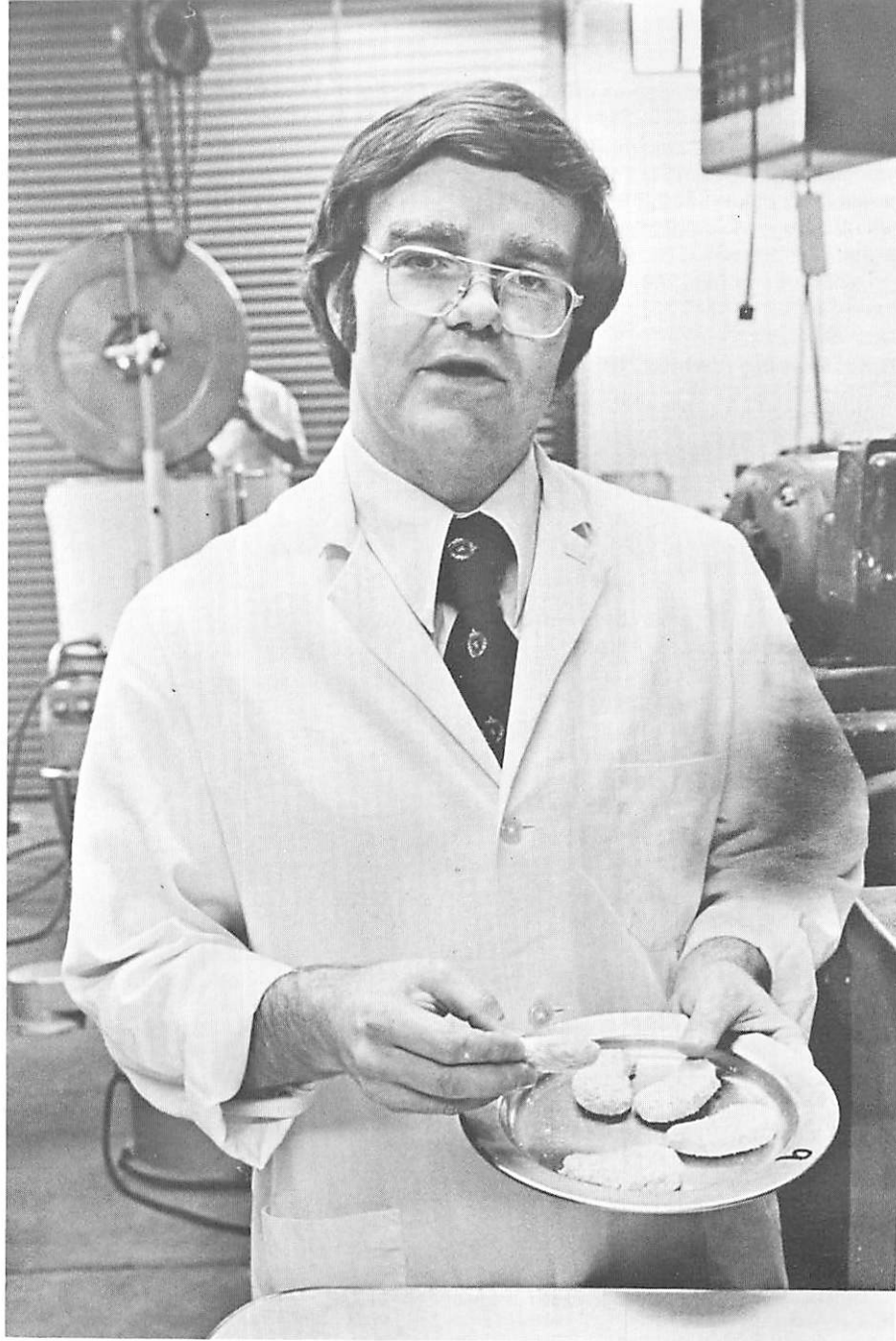
properly cooked and frozen crab sections. Dip-treatments with a combination of ascorbic acid and citric acid caused a slight yellowish-brown discoloration in the frozen crab sections. This was also discernible when the crab meat was canned.

Blueing of canned crab meat was reduced when cooked crab sections were cooled in a metabisulfite (5 grams per liter) solution for 30 seconds. The use of a citric acid-ascorbic acid dip and the addition of sodium acid pyrophosphate did not reduce the incidence of blueing in the canned crab meat. The addition of citric acid was as effective in reducing the blueing of canned crab meat as the metabisulfite dip treatment.

When freshly caught crab were held two days at 33-35 F before processing, extensive blueing occurred in the canned crab meat even if properly cooked. The blueing was even more pronounced if the cooked crab sections were frozen prior to canning. Although little blueing was detected after thawing the sections, the blueing of the canned meat was extensive even when citric acid was added and a metabisulfite dip treatment used.

According to Babbitt, blueing of canned crab meat is not simply related to the presence of the crab blood in the meat, although the copper present in the blood plays an important catalytic role in the reactions. The blueing is the result of biochemical and chemical reactions involving the polymerization and condensation of phenolic and/or other compounds.

The results of the study indicate that the chemical prevention of blueing is very difficult.



Jerry K. Babbitt

What's the easiest way to prevent blueing?

Handling and processing the freshly caught crab as quickly as possible. Quick handling helps prevent the poor meat quality and monetary losses that occur when crab meat turns blue. (R/PD-19)

### **Tuna: keeping it whiter, brighter**

Tuna. It isn't always white and flaky.

Occasionally, during the canning process, tuna flesh will turn from a desirable white color to an orange or green discoloration after cooking and prior to retorting.

The green and orange discoloration of tuna can be a serious problem. Last year one Astoria processing plant rejected \$70,000 worth of albacore tuna just on the basis of discoloration: green (60 per cent) and orange (30 per cent).

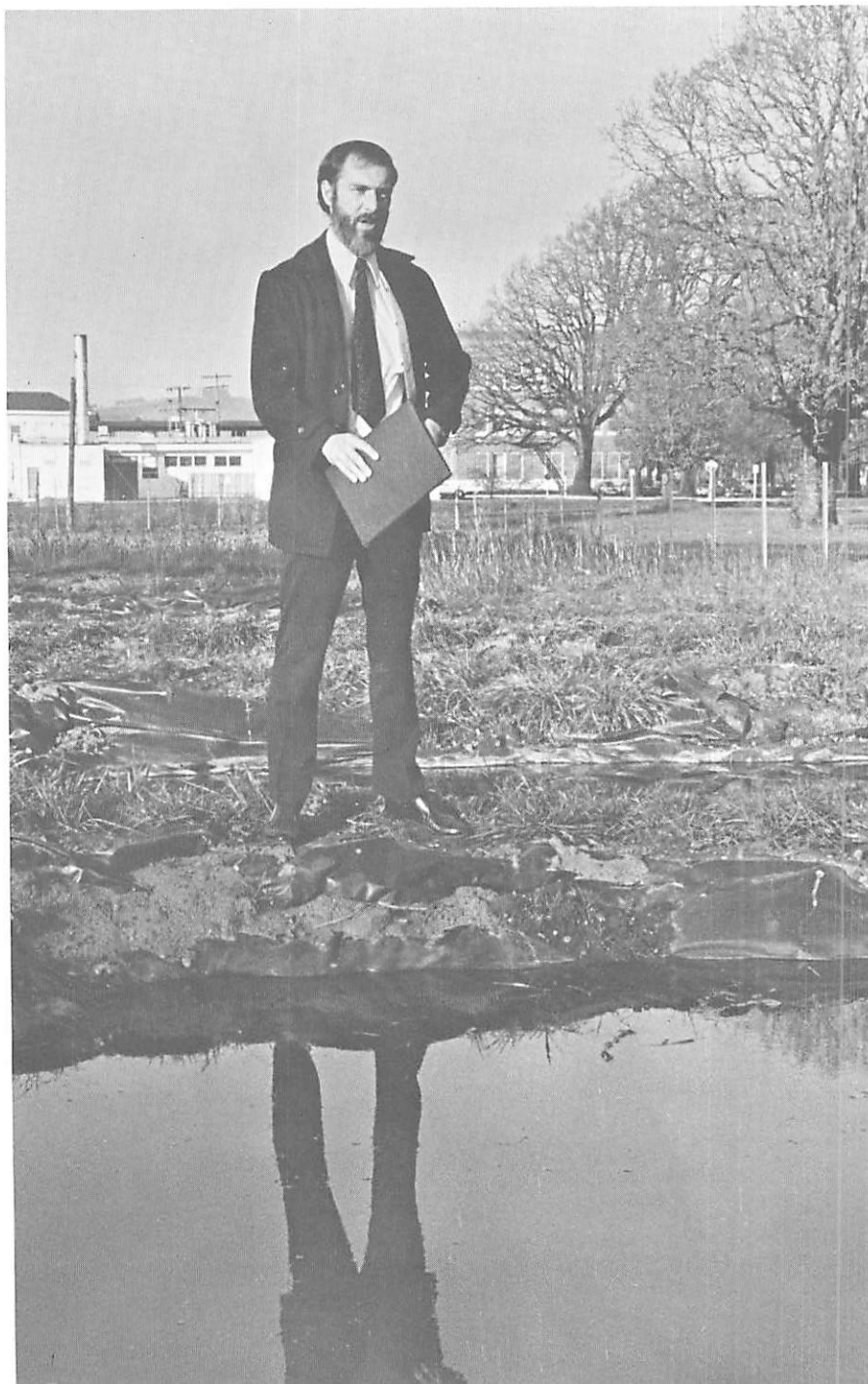
Coincidentally, the increase in the incidence of greening in albacore tuna has been accompanied by increased use of brine systems to freeze the tuna at sea subsequently allowing them to fish for longer periods of time between deliveries.

Could brine freezing lead to green and orange discoloration?

That's what Jerry Babbitt wanted to find out. Babbitt, associate professor of food science and technology, began a two-year project to find out if the chemical parameters associated with greening were related to the types of systems the fishermen were using to handle the tuna as well as the processing procedures used in the plant.

He began by tagging tuna from different boats (iced, air-blast freezer, spray-brine freezer and a combination brine immersion/air-

Richard Johnston



blast freezer) when the tuna were delivered to the plants. Some tuna were immediately processed and the degree of discoloration noted. The other tuna were frozen; after thawing, lots of these tuna were processed at monthly intervals and the degree of discoloration noted.

According to Babbitt, the results from the now completed project demonstrated that there was very little difference in the chemical parameters associated with the green discoloration among the different types of systems used by the fishermen. However, if the brine systems used by the fishermen were not properly controlled, the salt content could reach levels as high as one to two per cent in the tuna muscle.

Babbitt also discovered that there was little difference in the chemical parameters associated with the green discoloration among the tuna held frozen for three months before processing.

Through coordinating laboratory work with in-plant processing procedures, Babbitt found that by altering the cooking time the greening discoloration can be controlled.

By extending other laboratory findings with yellowfin tuna, Babbitt confirmed that trimethylamine oxide (TMAO) content is correlated with the greening discoloration of albacore tuna. Again, by carefully monitoring cooking procedures, it is possible to control greening. This finding explains why some research teams have not been able to relate high TMAO levels in tuna to the incidence of greening.

Thanks to Babbitt, the costly problem of green discoloration in tuna can be avoided. If cooking

procedures are carefully monitored, tuna can be white and flaky. (R/PD-8)

### **The salmon industry: supply and demand**

The salmon industry is always changing.

For example, various management programs such as limited entry or production augmentation are being considered or have been implemented in the U.S. and Canada.

Changes also include salmon products themselves. Some of the salmon formerly canned is being sold fresh both domestically and abroad.

Even the structure of the industry is changing. All these changes affect and are affected by salmon supply and demand.

To understand these changes, Richard S. Johnston, associate professor of agricultural and resource economics, began a two-year project focused on the processed salmon market in the U.S. and Canada. His objectives included analyzing the factors affecting the structural changes in the industry and the supply and demand for salmon. Johnston felt this information would help policy makers predict the economic impacts of government management programs on the salmon industry.

Johnston was assisted by Der-Hsing (Stanley) Wang and Christopher Carter, graduate students, and William Jensen, professor of administration at Willamette University.

The study, which was completed this year, involved statistically estimating the relationships between prices of canned red, pink and chum salmon and the variables determining

those prices. (Variables include salmon landings, consumer incomes and the market for fresh and frozen salmon.)

Johnston also compared the determinants of prices paid by canners to fishermen between the U.S. and Canada, and explored the impact of Canada's limited-entry program in the salmon fishery on sockeye salmon prices and income in that fishery.

Finally, he examined the relationships between changes in the structure of the salmon market and salmon prices.

In analyzing recent data pertaining to the wholesale demand for canned red salmon, Johnston found a decrease in the estimated price elasticity (sensitivity of quantities purchased to price changes) and an increase in the estimated income elasticity (the sensitivity of quantities purchased to income changes). He also analyzed the market structure data for the State of Washington. The results suggested that changes in the relative shares of salmon purchased by the largest processors may be associated with biological phenomena determining the mix of salmon species being harvested. To a large extent, this is beyond the control of the processors.

Johnston shared these results with a number of interested parties, including the Federal Trade Commission and the Washington State Department of Fisheries.

According to Johnston, results of the analysis of data for the Canadian industry were reviewed by members of the industry, including government economists. He reports that the reaction to the analysis was favorable.

Of particular interest was the finding that increased salmon landings (through limited entry or salmon enhancement programs) would likely be associated with increased industry total returns because of relatively small price-depressing effects. Johnston observes, however, that if the price-elasticity of demand in the U.S. is, in fact, considerably lower than that in Canada, a similar result may not prevail here.

There are a lot of "ifs" in the conditions which affect the supply and demand of salmon. Analyzing these "ifs" may help predict the economic impacts of management programs on the salmon industry. (R/PD-16)

### **Helping fishermen land a profit**

You're a fisherman.

Years of experience have taught you how to land a lot of fish, but not how to make a lot of money.

What's the problem?

Ask Frederick J. Smith, professor of agricultural and resource economics.

Smith recently completed a four-year project to gather and analyze data on fishermen and commercial fishing firms.

His objective was to determine the variables in commercial fishing firms which are the most important determinants of profitability and efficiency.

During the past four years, Smith published Marine Economics Data Sheets (MEDS). MEDS contain the results of surveys on fishermen and fishing industries and were used in business analysis. They were also used to obtain credit and to give a realistic financial preview to those entering the fishing business.

All MEDS were revised to provide more descriptive information on each vessel and other marine businesses, costs and returns for a range of production levels, data on effort and prices in a new format which clarified opportunity costs.

A solid seafood waste study was initiated and completed in five months. It identified the nature of seafood waste being generated from Newport to Brookings. Ten alternatives to existing disposal methods were examined and analyzed. As a direct result of the study, a development corporation began its own economic feasibility study of a fish-meal plant. Two other firms began expansion of existing rendering operations.

Shrimp marketing was also studied. Processing-cost, marketing-cost and product-volume data for shrimp were obtained from state agencies, processors, brokers and warehouses.

Seafood brokers and distributors in the San Francisco area were interviewed concerning their handling of Oregon shrimp. Export requirements and quantities were determined for local shrimp.

During 1975, the costs, earnings efficiency and social characteristics for 210 sample fishing firms were tabulated and analyzed. Publications are not yet available, but numerous Oregon fishermen have used results in deciding which fishery to enter and what size boat to use.

Smith's work doesn't directly help fishermen catch more fish. But the information from his study should make it possible for fishermen to turn their fish into higher profits. (R/PD-17)

### **Seafood processing: getting the bugs out**

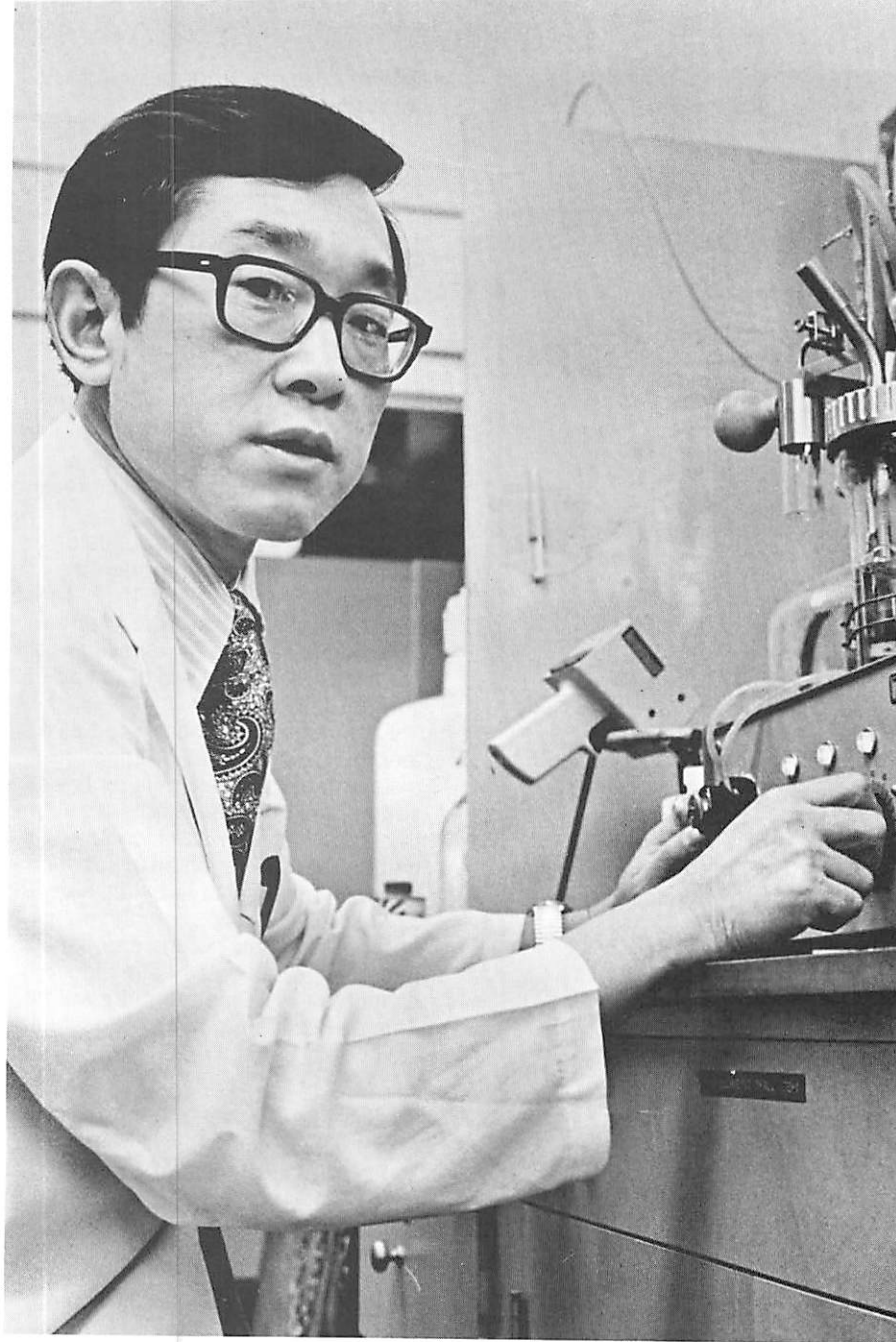
Variations in seafood processing techniques can make the difference between high and low quality products. Seafood processing is subject to federal good manufacturing practices regulations (GMP's), now in various stages of development. Microorganisms associated with seafoods are determined primarily by geographical environment. GMP's, however, are formulated along species lines, irrespective of geography. Many are based on East and Gulf Coast research and reflect their respective environment and microbial flora.

If Oregon's processors want GMP's which reflect the needs of Oregon and the West Coast, they must make their unique requirements known before the federal GMP's are formally adopted.

J. S. Lee is studying these needs.

Lee, associate professor of food science and technology, is involved in a four-year project to evaluate the influence of seafood processing practices on the microbiological quality of Oregon seafoods and to find means to optimize the processing methods.

Lee's initial emphasis was placed on seafoods consumed without further cooking, such as crab meat and cooked shrimp. His studies on crab meat were completed during fiscal year 1973-1974. Last year he studied processing practices for shrimp. The study included quantitatively identifying the microorganisms isolated from each step of processing, from the raw to the finished product. Some processing steps were identified to be inherent to the system, but many were unique to the individual processor.



Jong S. Lee

After evaluating the current processing methods, Lee sent letters of recommended improvements to individual processors. The effects of the recommended changes are being assessed.

Lee's work showed the accumulation of *Arthrobacter* sp. in processing plants employing elaborate duct-works to transport the shrimp. Little is known about the role of *Arthrobacter* in seafoods. The microbial species primarily originate from soil and mud. Lee is investigating ways to reduce the *Arthrobacter* load by speeding up the shrimp transport and by increasing the frequency of cleaning up. Concurrently, Lee is determining the heat inactivation kinetics of *Arthrobacter* sp. to learn if lengthening the cooking time could also reduce the *Arthrobacter* load.

Another example of Lee's follow-up study involves the relationship between the volume of wash water used and the microbial quality of shrimp. An apparatus was constructed to wash the shrimp with a measured volume of water. Lee found that the maximum microbial removal of 70 per cent could be attained by wash water ratios from 5:1 to 20:1 (water to shrimp). This, however, was only applicable with the freshly peeled shrimp—even a volume of water in excess of 20 times that of the shrimp could not dislodge the bacteria that had multiplied in shrimp.

According to Lee, the investigation dealing with shrimp processing will be completed during the current fiscal year and the findings will be published in technical papers and information letters to the processors. Personal contact with the seafood industry, in conjunction with the





James E. Oldfield and John Adair

Marine Advisory Program, will also be made.

The systematic evaluation of the microbial characteristics of Oregon seafoods will eventually be expanded to oysters, clams, soles, rockfish, tuna and salmon. And with Lee's help, the developing federal GMP's will reflect the needs of Oregon and the West Coast. (R/PD-21)

### **Shellfish wastes: possible protein source?**

Processing seafood gives us a product for human consumption—and a lot of waste besides.

More than 21 million pounds of seafood wastes were reported by southern Oregon ports in 1972. These materials include mainly fish frames (after fillets have been removed) and the shells and entrails of crab and shrimp.

Fish frames have been used as a feed ingredient for fur-bearing animals and carnivorous pets, but shrimp and crab shells are less attractive. Shellfish wastes contain a high percentage of chitin, a substance practically indigestible by animals.

But these wastes shouldn't be ignored: they contain considerable protein—some estimates have placed it as high as 30-50 per cent dry weight. This makes them potentially useful

as feed ingredients for domestic animals.

That's why James E. Oldfield, professor of animal science, became involved with the Sea Grant College Program. He initiated a project to determine if marine by-products can be used as alternate protein sources for domestic animals. He chose mink as an experimental animal because they are sensitive test animals. Mink produce fur which is largely protein; they grow rapidly in body size; their body size is small and they are economical to use.

To determine if shellfish wastes can be used as a source of protein, two more researchers based at the OSU Experimental Fur Farm got involved. John Adair, senior instructor of animal science, and graduate student Bruce Watkins fed two similar groups (50 mink each) diets where shrimp waste provided 25 per cent of the total protein.

One of these groups received the shrimp waste as it came from the processing plant; the other received shrimp waste after treatment with mild heat and a commercial enzyme preparation used in an effort to improve its digestibility.

Performance of the animals in terms of growth and fur production was measured against that of a further group of mink fed the same type

of diet without the addition of the shrimp waste.

The results showed that while growth was lower on the two diets containing shrimp waste than on the control diet, the pelt values were similar. This suggests that the waste (at the level fed) can be a useful ingredient in mink feed. The results also showed that there was no difference in performance of the mink fed the treated or untreated waste, suggesting that the cost of this particular treatment was not justified.

The research team is studying crab wastes this year. They have attempted to separate the protein from the indigestible chitin by drying, fine grinding and sieving, and by chemical treatment. Once chitin is separated, it can be used for preparation of chitosans which are useful in water purification processes.

The Sea Grant scientists have also contacted a commercial chemical laboratory in Seattle to collaborate with them on a dual-use project for the by-products from crab and shrimp wastes.

Soon the waste produced by seafood processing may no longer be a problem. The millions of pounds of seafood wastes traditionally dumped in coastal waters may provide a source of protein for domestic livestock. (R/PD-22)

# coastal zone environments

## COASTAL MANAGEMENT

### **Sand budgets help beach balance**

Coastal erosion. It can be a costly problem.

Paul Komar, associate professor of oceanography has been studying this problem for the past five years.

He looked at Bayocean Spit, a vacation community destroyed by erosion in 1952.

He looked at Siletz Spit, a residential area endangered by erosion in 1972-73.

He learned that jetties can influence coastal sand transport and that sand dunes can erode and be re-established in predictable cycles.

For example, jetty construction at Bayocean in 1914-17 led to erosion of the spit and culminated in complete breaching of the spit in 1952.

According to Komar, erosion occurred in spite of the area being one of zero net beach sand transport, a condition that usually does not cause erosion. Studying this area provided information on problems of coastal development as well as causes of coastal erosion.

At Siletz Spit erosion in 1972-73 destroyed one house; several others

were saved only by immediate placement of riprap. Komar learned that erosion also endangered an estimated \$4.5 million in coastal homes and property.

Studying Siletz Spit showed that there had been repeated episodes of erosion prior to development of the spit. Erosion of the dunes was followed by a period of natural dune rebuilding.

Komar found that homes were constructed on areas of dunes that had been eroded away and re-established within the last century.

A sand budget was completed for the northern half of the Oregon coast, according to Komar.

This budget evaluates the sources and losses of sand to the beach. It is useful in understanding the causes of existing beach and coastal property erosion and in anticipating critical areas of future erosion.

The budget also considers the generation of nearshore currents and the resulting longshore sand transport.

Komar says the results of these studies can be applied to all coastal areas, not just Oregon beaches.

That makes his results useful to anyone who wants to build along

any coast. His information can help people avoid critical areas of erosion—and its costs and dangers.  
(R/CM-1)

### **Solutions that cause problems**

It happens sometimes.

Structures created to solve a problem end up causing another problem.

Groins—beach protective structures built approximately perpendicular to the shoreline—are a good example. They are supposed to trap the longshore movement of sand and thus retard erosion of the beach.

But they can also cause rip currents which are hazardous to bathers and cause beach sands to be washed offshore. At the present there is no rational basis by which the coastal engineer can select a particular groin spacing for a given beach.

That's why Paul Komar got involved.

Komar, associate professor of oceanography, has completed a one-year project to determine what groin spacings produce rip currents. That involved determining what

spacings produced resonant interactions with possible edge wave modes on the beach.

Komar initially expected that the edge waves and the normal water waves would have the same periods and thus generate rip currents. This should have been the case according to the now-prevalent hypothesis on the origin of rip currents.

Instead, Komar discovered that the edge wave period was twice that of the incoming waves so that rip currents were not formed by the interactions of the edge waves and incoming waves. Rips were present in the wave basin but their origin was uncertain.

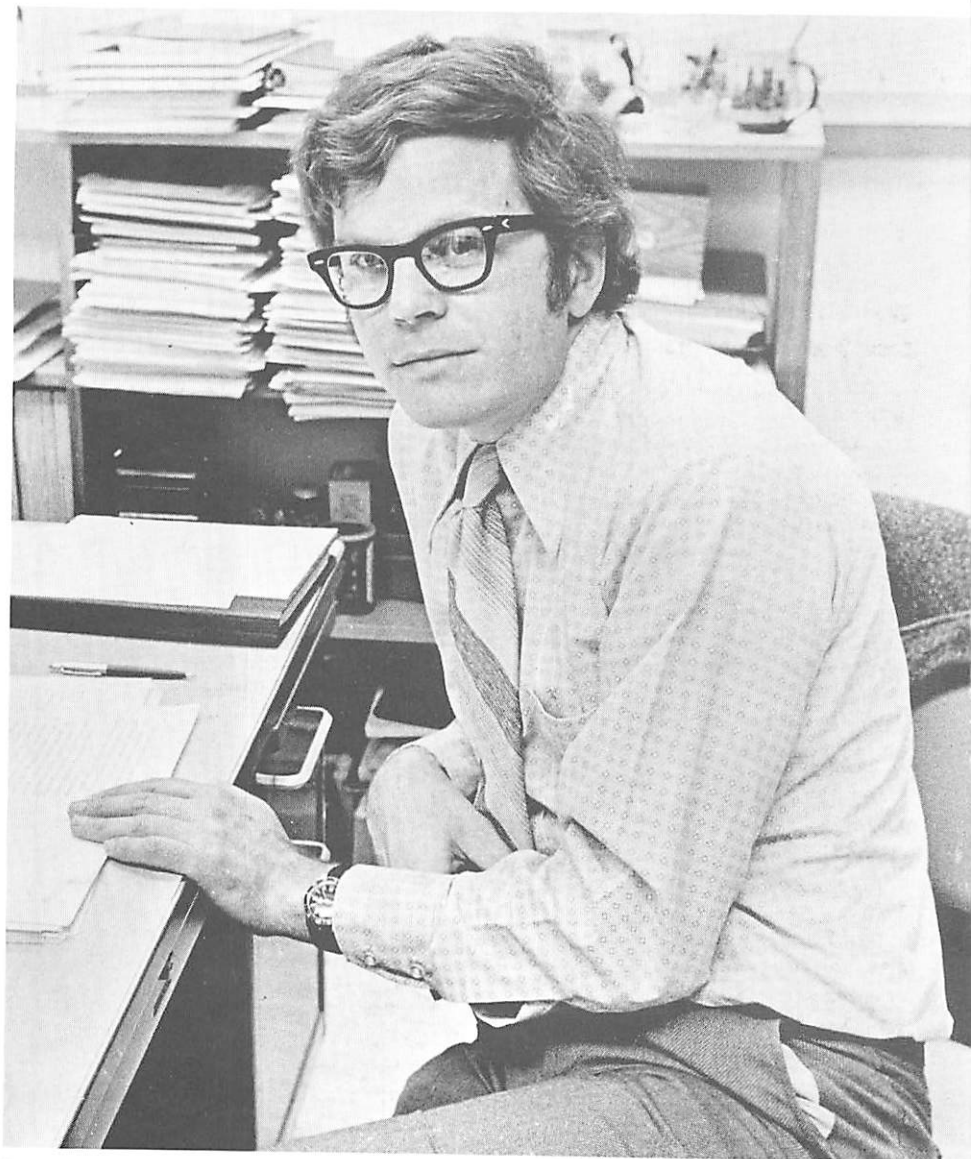
Komar also learned that the effectiveness of groins in stopping beach erosion was related to the strength of the edge waves that were generated. Their effects on the wash were sufficient to erode the beach in some places and cause deposition in other places. The strong sub-harmonic edge waves therefore caused major rearrangements of the sand on the beach. However, major erosion of the beach under resonant conditions was not achieved as had been anticipated when the study began.

The study did provide some basic information on nearshore processes such as the generation of edge waves and the configuration of equilibrium shorelines.

And thanks to Komar, the first step toward more rational designs for groin fields has been taken. These structures may eventually retard beach erosion—and not complicate it. (R/CM-8)

### **Reducing the risks of going to sea**

How can boating accidents be reduced?



Paul D. Komar

With a 24-hour, all weather wave report.

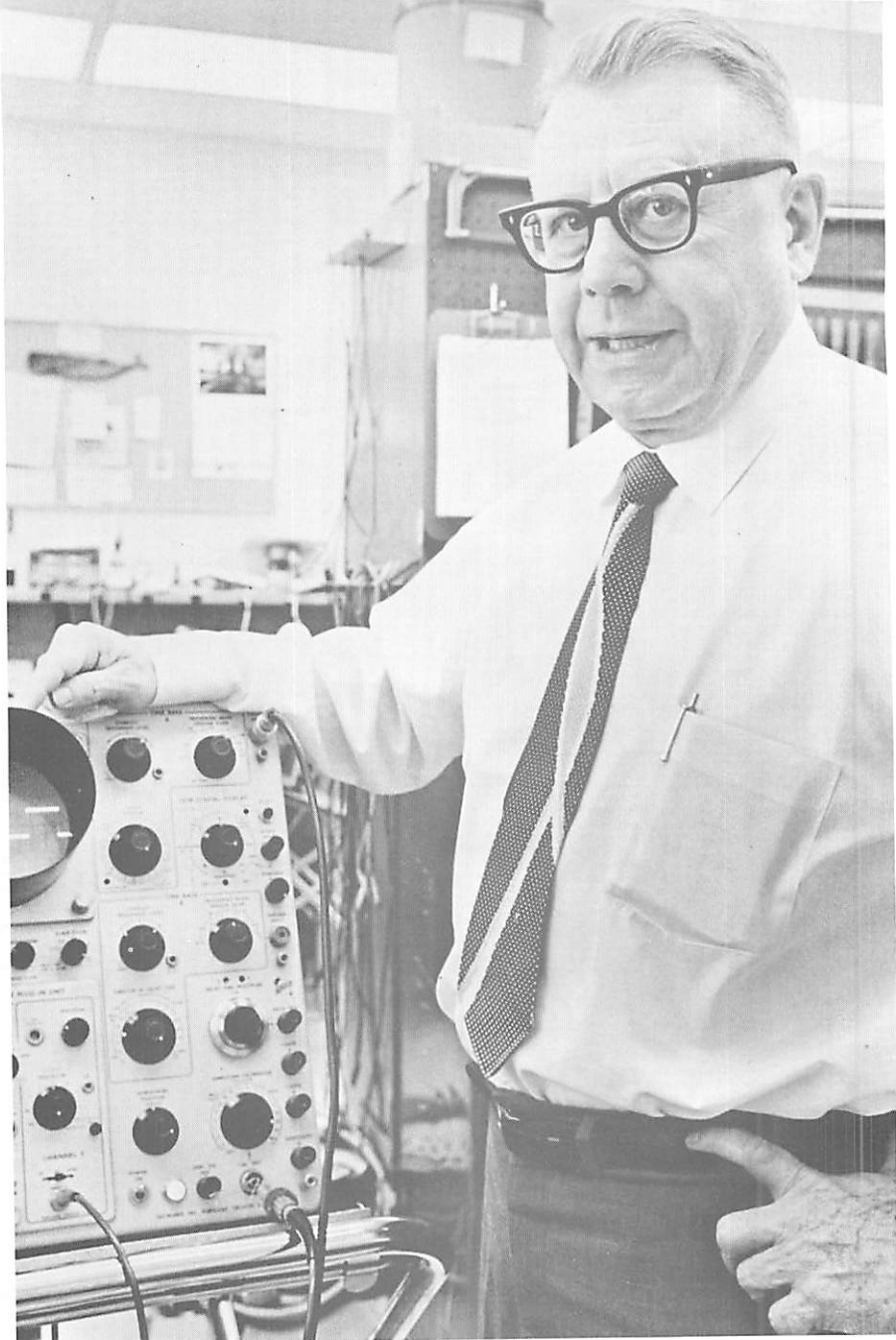
Twenty-four hour, all-weather wave reports and improved wave forecasts should also improve user operating efficiency in Oregon and reduce the calls for assistance received by Coast Guard stations, according to William Quinn, research associate in Oceanography.

Quinn is principal investigator for a Sea Grant project on operational wave observing and reporting. If his project is successful, 24-hour, all-weather wave reports will become available to the public from six Pacific-Northwest locations in 1976.

This proposed network of wave observing instruments at Coast Guard stations on the Oregon and Washington coast will be of direct operational use to the Coast Guard and public, and provide wave and precursor-swell data to the National Weather Service (NWS) as a means to improve wave forecasts for the Northwest coast. Other plans include improving the semi-automated wave forecasting system previously developed for NWS in terms of accuracy, through application of verification findings.

So far, Quinn has installed and tested wavemeters at four Coast Guard stations: Cape Disappointment, Westport, Newport and Coos Bay. The stations began to report wavemeter readings to users via radio and teletype in May 1975. A one-month test of remote operation to NWS in Portland, Oregon was also completed successfully.

Two additional installations—Chetco and LaPush—are scheduled for August 1975 and will complete the Northwest network. The National Weather Service receives the wave observations via the Coast Guard



William H. Quinn



teletype network for use in wave forecasting.

The Sea Grant oceanographer also tested a swellmeter instrument at Newport. These instruments detect the long-period waves that precede peak wave heights at the coast. The swellmeter has now been modified to give direct wave and swell period readouts. After tests during winter 1975, it will be permanently remoted to Portland.

According to Quinn the wave and swell information will be used by NWS forecasters (in conjunction with the semi-automated forecasting technique developed by a predecessor Sea Grant project) to improve operational wave forecasts disseminated to users by teletype, VHF radio and public media.

Twenty-four hour all-weather wave reports and improved techniques to get this information out will soon be available to all ocean users—from boaters to beachcombers.

In addition to improving user operating efficiency and reducing calls for help to the Coast Guard, wave forecasts will make it safer for those who go to sea. (R/CM-2)

### **Coastal land: absentee ownership and higher prices**

More money, more leisure time and more recreational opportunities.

This combination has led to a higher demand for property in Oregon's coastal zone in recent years.

Unfortunately, land ownership and land use change along Oregon's coast have created numerous prob-

lems, according to Ray M. Northam, professor of geography, and colleagues Thomas J. Maresh and Mary Lee Nolan.

Anticipating new problems due to the demand for coastal land, Northam completed a one-year study to investigate the magnitude, nature and locations of recent changes in land ownership, use and value in Oregon's coastal zone.

The first major task was to obtain a data base for the study area. Data were obtained on land ownership, parcel size, parcel value and parcel location and were put on computer tapes.

Another task involved obtaining land use information for 1967, the initial year of the study period, and for 1973, the terminal year of the

Ray M. Northam, Mary Lee Nolan and Thomas J. Maresh



study period. Data for 1967 and 1973 were obtained from large-scale air photos and from field investigations.

Northam found that the largest share of land parcels were vacant or idle in both 1967 and 1973. The proportion of idle or vacant parcels increased during the period as a result of agricultural parcels, with or without residences becoming idle during the period.

Northam also found that in 1967, slightly less than one-half of the land parcels were owned by absentee owners, while in 1973, more than one-half of the parcels were owned by persons not residing in the study area. The dominant area of residence of absentee owners of coastal zone land parcels was the Willamette Valley, especially the three-county Portland metropolitan area. The incidence of absentee ownership of coastal zone land parcels was determined on a county basis for all counties in the state. In addition, the distribution of absentee ownership of sample land parcels was established for other states in the county, with California and Washington dominant in this regard. Trends in the incidence of absentee ownership were established in all cases where non-local ownership occurred.

The Sea Grant geographer reported that land values in the study area appreciated at a greater rate than for most other sections of the state. Land values, as opposed to improvement values in the Tillamook County section appreciated more than those in the Lincoln County section. This is probably the result of greater proximity to absentee owners in the Portland metropolitan area.

Average parcel size decreased in the study area, regardless of the land type involved: agricultural, forest, de-

velopmental, or coastal mix. This likely resulted from more land parcels being subdivided and converted to some type of development, especially for single-family residences. Many of the latter, however, consisted of mobile home units placed on small idle parcels of land that were formerly parts of larger land parcels.

In addition to providing information to local, regional and state land management and land planning groups, the findings of this project should be valuable to citizens and private organizations in the coastal zone. It may come as a surprise to them that most of their neighbors don't live next door after all. (R/CM-12)

### **Predicting forces on ocean floor pipelines**

Pipes and cables installed along the ocean floor are too often broken by ocean forces. Breakage interrupts service and is extremely expensive to repair.

Unfortunately, preventing pipe breakage is a difficult problem. Ocean floor currents are hard to predict and hard to design for.

Further, the basic fluid dynamics in flow around pipes and cables lying on the ocean floor is not well understood.

The challenge to understand these problems was accepted by two ocean engineers.

Tokuo Yamamoto, assistant professor in civil engineering, and John H. Nath, professor of mechanical engineering and oceanography, recently completed a one-year project to develop design criteria for marine structures, such as fixed and moored offshore structures and pipelines

through the surf zone and across estuaries subjected to waves and currents.

How did they do it?

Past theoretical findings concerning the influence of a nearby plane boundary on the hydrodynamic forces on a cylinder were put to the test with nearly full-scale experiments at the Oregon State University Wave Research Facility. The Reynolds number (the ratio between inertia forces and viscous forces) was varied up to  $2.0 \times 10^5$  and the fluid displacement-to-pipe-diameter ratio was varied up to five. In addition, lift and drag forces were measured at Reynolds numbers between  $2 \times 10^4$  and  $8 \times 10^4$  at the OSU wind tunnel. Also, flow visualization, using hydrogen bubble techniques was made in a water channel at a Reynolds number of 5800 in order to determine qualitative cause-effect mechanisms.

The researchers obtained the following results:

- For both steady and oscillating flows, the drag force parallel to the foundation increased by 20 to 100 per cent when a cylinder was near a foundation boundary. The same increase was obtained from calculations based on the free streamline theory and vortex frequency measurements made in the water channel.

- They found that the lift force was always in a direction away from the foundation for steady real flow where a significant wake was formed behind the cylinder. The same was true for a cylinder in an oscillating flow when the relative water particle displacement was large. However, for small relative displacements, the lift coefficient was always negative, as predicted by the theoretical mathematical derivation.



Tokuo Yamamoto and John Nath

- The inertia coefficient contribution to the horizontal forces increased from 2.0 to 3.3 as the cylinder approached and touched the boundary. This, too, was in excellent agreement with the theoretical mathematical development.

Finally, they photographed the flow configuration for flow around pipes near a plane boundary with hydrogen bubble techniques.

The variation of forces on the pipe, as influenced by the boundary, is nearly predictable, according to Yamamoto and Nath. This information should lead to more economical and safer designs for submerged pipelines—and fewer repair bills. (R/CM-9)

#### **The 200-mile limit: a coast to coast concern**

The 200-mile fishing limit.

It's dominated two international conferences on the Law of the Sea.

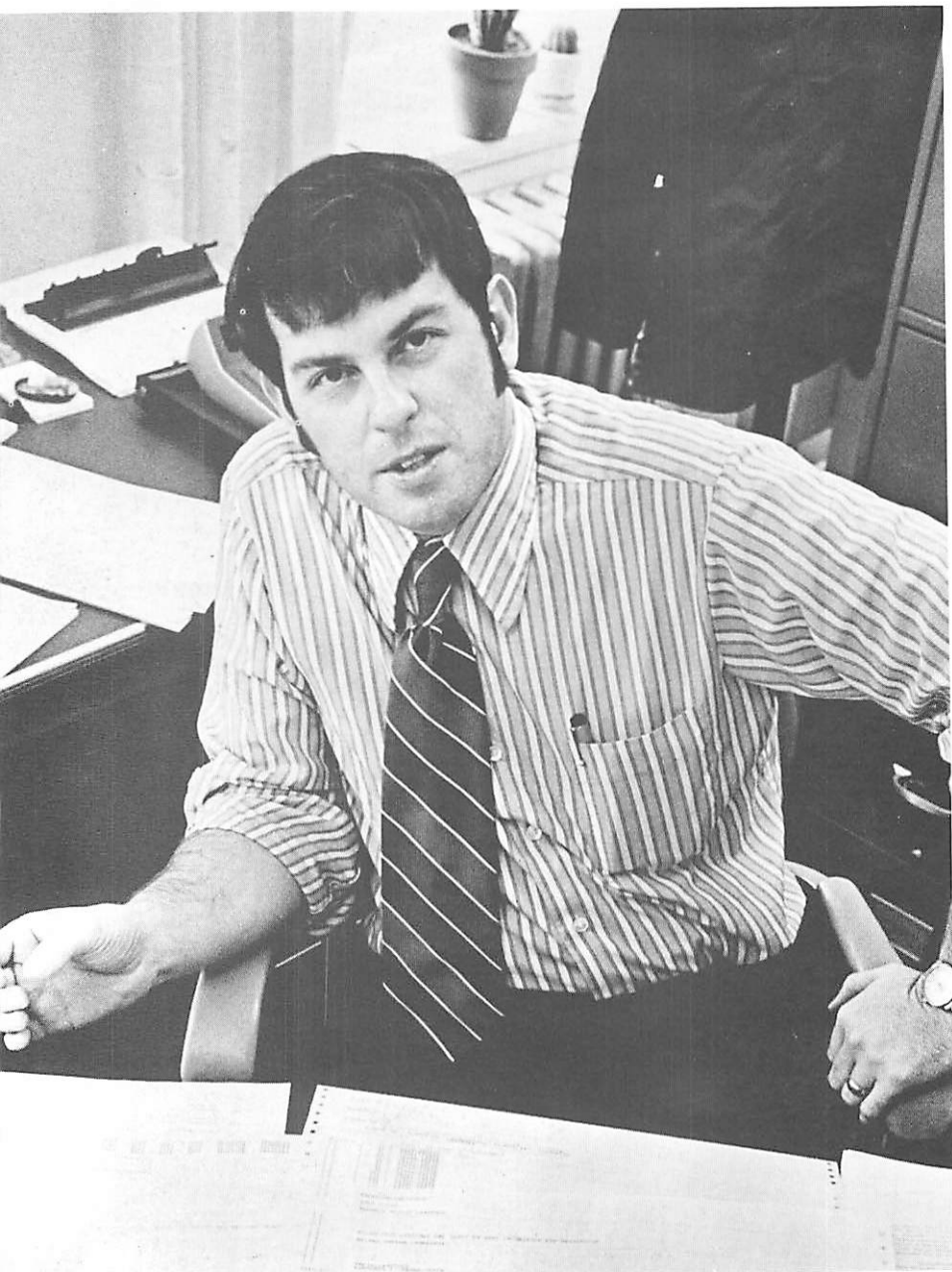
It's also caused an economist to redirect his two-year Sea Grant project.

Why?

The issue of extended jurisdiction needs to be studied now, according to R. Bruce Rettig, associate professor of agricultural and resource economics.

Several forces came together in 1974 to push the issue of extended fishery jurisdiction forward rapidly, according to Rettig. These forces included widespread agreement at the U.N. Law of the Sea conferences on extended jurisdiction and passage of a 200-mile bill by the U.S. Senate.

By December 1974, economists at Oregon State University and the University of Rhode Island had submitted coordinated Sea Grant



Bruce Rettig

proposals to study extended jurisdiction.

Rettig was one of those economists.

He helped develop specific research plans between OSU and the University of Rhode Island during the first half of 1975. Related research projects emerged at several other institutions.

In response to this, the National Sea Grant office and the National Marine Fisheries Service co-sponsored a meeting of economists, anthropologists and government scientists at the Woods Hole Oceanographic Institution during June, 1975.

One of the products of the conference was a firm plan for cooperation among OSU, the University of Rhode Island, Woods Hole Oceanographic Institution, Columbia University, the University of Delaware, the Virginia Institute of Marine Sciences and the National Marine Fisheries Service on projects funded by Sea Grant, NMFS and NFS-RANN.

Rettig's original project involved studying the economic benefits from coastal developments. The cost of coastal developments—including recreational developments—is usually shouldered by coastal residents. Rettig wanted to determine if the cost of these developments could be shared by people who benefit from them.

The Sea Grant economist chose Tillamook Bay on Oregon's coast as his study area.

Six months after he began the study, Tillamook's economy was severely affected by the national economic decline in 1974. The Tillamook study was shifted to sponsorship by the Rural



Development Act, while the Sea Grant funds were redirected to work on the 200-mile limit.

Redirecting Rettig's project left one Sea Grant effort incomplete.

But, more importantly, the redirected project will produce new information on an issue of international significance that can't wait. (R/CM-10)

### **Camping out: who pays the price?**

Campers using state-operated campgrounds pay less than 50 per cent of the annual costs of providing campsite facilities, according to Herbert Stoevener, professor of agricultural and resource economics.

User fees currently range from \$1 to \$4. When this revenue is totaled, it amounts to less than half of the cost needed to provide campsites.

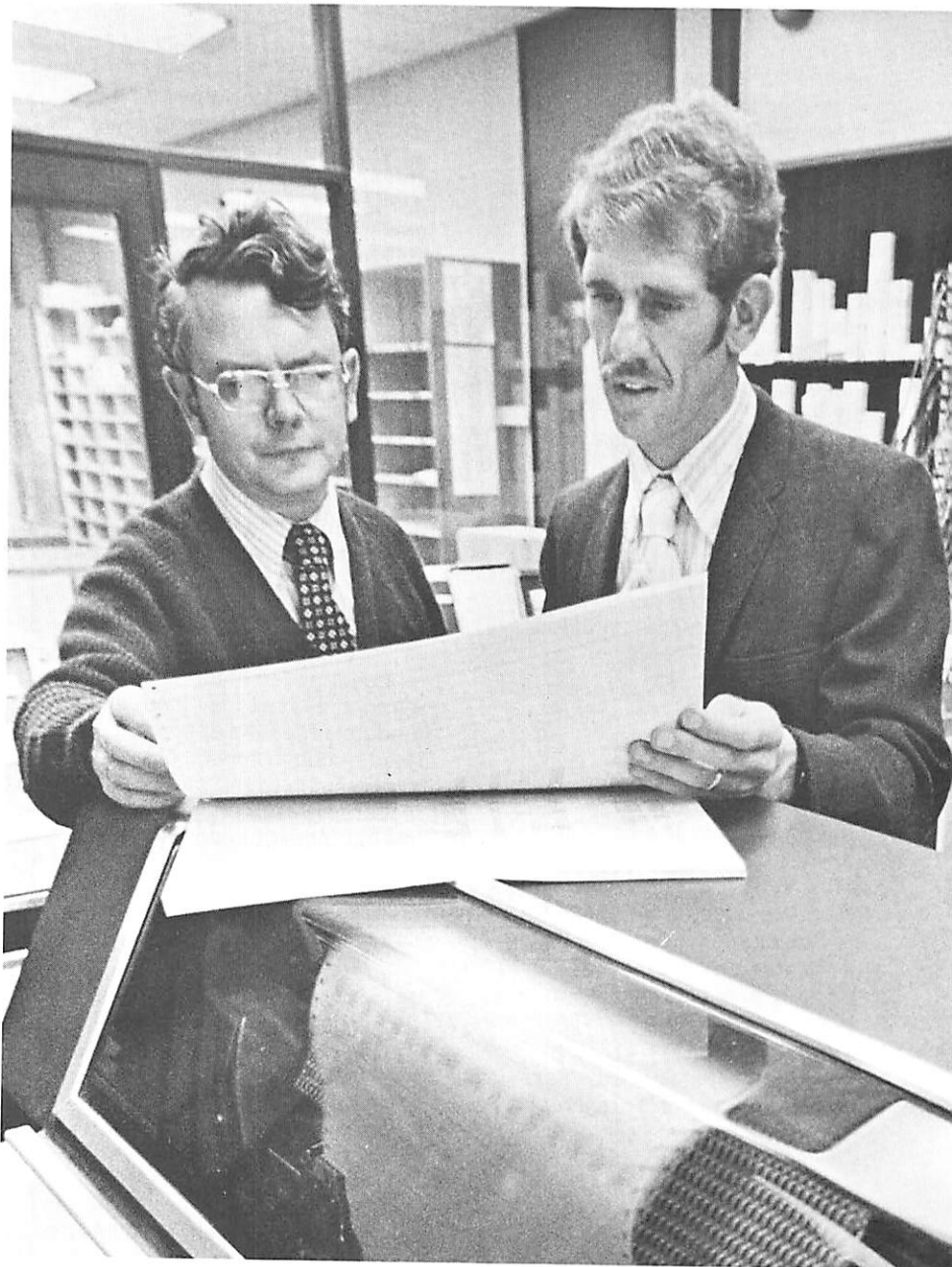
Costs associated with providing camping facilities include operation and maintenance costs, depreciation on capital improvements and the opportunity cost of the capital used to construct the public facilities.

Stoevener has been working on an 18-month project to determine if it is economically feasible for private industry to provide a larger portion of the camping facilities along Oregon's coast.

So far, most of his efforts have focused on analyzing the cost of publicly provided camping facilities. These facilities include about 40 campgrounds along Oregon's coast with about 4,000 campsites.

Stoevener has gathered data from the U.S. Forest Service and the State Parks and Recreation Section of the State Highway Division.

Analysis of the data indicates that it currently costs about \$3,400 to construct a U.S. Forest Service



Herbert Stoevener and Steven Reiling



campsite and the annual cost of providing a campsite is about \$550. Given the current use rate for the campgrounds, the average cost per camping party is \$8 per day.

The situation is much the same in state-operated campgrounds. The average construction cost per campsite is about \$4,300 and the average annual cost of providing a campsite is about \$700. Only 50 per cent of this cost (\$700) is paid directly by users through user fees.

Stoevener is also investigating some of the effects created by pricing public facilities below actual cost. Low user fees make it possible for more people to afford to use the facilities. Low fees also stimulate economic activity in the sectors of the economy which supply camping equipment and other goods and services required by the camping public.

On the other hand, low user fees also contribute to the crowding problem at public facilities.

The emerging private campground industry is another aspect of Stoevener's study. The Sea Grant economist is gathering data to determine the types of facilities and services provided by the private campground industry. The data will also provide information concerning total revenue, occupancy rates, pricing methods and problems facing private operators.

Stoevener will collect cost data from operators to compare the cost structure in the private sector with the cost structure in the public sector. A financial analysis of firms in the industry will be conducted to determine the economic feasibility of privately providing overnight camping facilities.

Efforts will be made to determine how the private sector might respond to higher user fees. Higher fees may encourage further development in the private sector and decrease the crowding problems at publicly provided facilities.

Stoevener plans to distribute the results of the study to those governmental agencies which provide camping facilities, to private campground operators and to persons interested in entering the campground industry.

The results of this study may lead to user fees which more accurately reflect the costs of providing public campsites. That would benefit the private campground industry, the taxpayer and the camper who doesn't like crowded conditions. (R/CM-11)

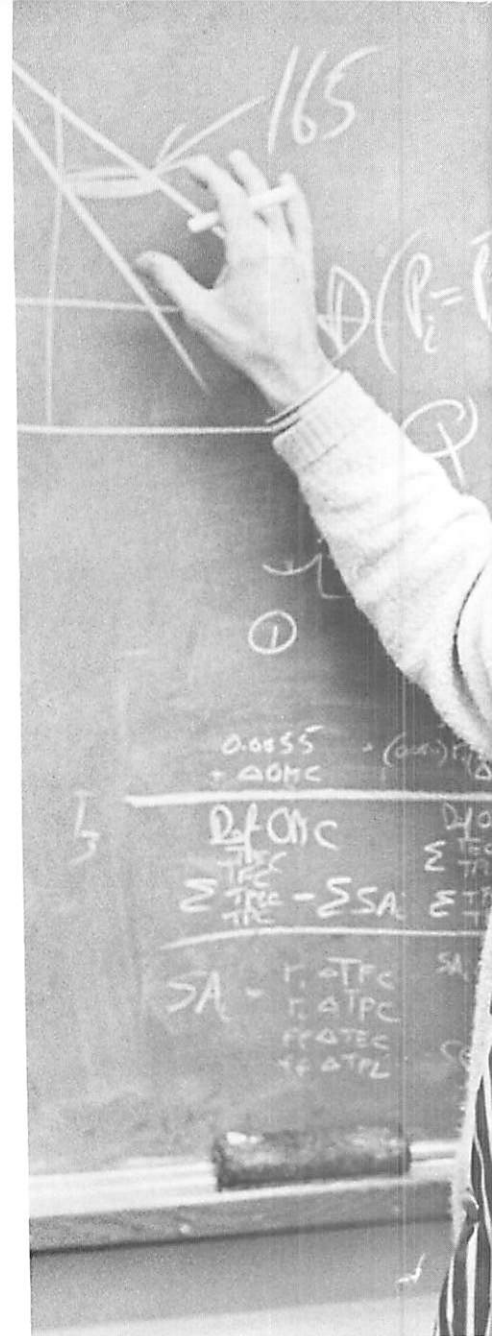
### Who should pay for public services?

Local government officials along Oregon's coast may inadequately understand—and appreciate—the impact of public service pricing policy on community and port development, according to R. Charles Vars, associate professor of economics.

Local government officials do not have policy analyses readily available to evaluate alternative pricing systems. Further, they rarely ask their consultants the appropriate questions to learn the consequences of different pricing schemes for local government finances, land use, community growth and so forth.

In response to this, Vars began a one-year project to study public service pricing and Oregon coastal development.

He investigated various Oregon coastal development situations to determine how pricing decisions can affect the user/taxpayer distribution



R. Charles Vars, Jr.



of public service costs and contribute toward achieving public policy objectives related to the use and development of coastal lands and ports.

Specifically, Vars surveyed and prepared a report on moorage rates at Northwest coastal boat basins. He recommended changes in the level and structure of moorage rates on the north side of Yaquina Bay and at the Town of Hammond Boat Basin. These reports were presented to the Port of Newport Commission and the Town of Hammond Parks and Recreation Commission, respectively. Consultations continue with the Port of Newport concerning the effects of alternative user/charge policies on the ability of the Port to achieve the objectives expressed in the Yaquina Bay Marine Development Plan.

Another study included two coastal sewer projects. At the request of the Clatsop County Board of Commissioners, Vars analyzed a proposed sewer plan. He presented oral and written reports critical of the proposed system to the Board of Commissioners during June 1975. In addition, a graduate student supported by this project is nearing completion of a master's thesis on pricing aspects of a proposed sewer extension north of Tillamook's city limits. A report to the City of Tillamook and the North 101 Sanitary District was prepared during the summer of 1975 to summarize thesis findings for local decision-makers. A second report will be prepared.

Vars is also working on a project in Bay City, Oregon. According to Vars, Bay City and a group of small water districts north of Tillamook are presently considering consolidation into one large district to exploit a newly discovered large water source. Total

and incremental costs for alternative consolidation plans have been estimated with an appropriate linear programming routine. User charges by district and by consolidation plan have been estimated and will be presented to local officials during January 1976.

Vars reports that a group of undergraduate students in a Regional Economics course studied past and contemplated activities the Port Umpqua used to attract new industry to Port property at Reedsport. The students' report made recommendations that the Port make certain changes in its activities; they also presented considerable data on the impact a new industry would have on Reedsport.

A second student report was prepared for the Yaquina Bay Shipping Council on past and prospective export shipping developments at the Port of Newport. This paper provides necessary background data and perspective for the benefit-cost evaluation of maintaining the Newport channel that will be undertaken by other students during the fall 1975.

Finally, a graduate student under the direction of Vars has undertaken a master's thesis on systems-development-type charges in Oregon and elsewhere in the U.S. This thesis, together with the other studies, will provide illustrative analyses and data for a handbook now in preparation. The handbook will reflect the year's activities, and will include policy analyses, methodologies and tools to assist local officials and their staffs in the evaluation of pricing policies.

Thanks to Vars, local officials may have a better understanding of the impact of public service pricing systems on their communities.

And if they're able to evaluate pricing policies effectively, local offi-

cials may be able to increase the benefit of the service while keeping down the cost of the service to the taxpayer. (R/CM-13)

### **Who plans Oregon's coastal zone?**

All those meetings to get citizens involved in creating a master plan for Oregon's coast. Who came to them? Were they effective?

That's what political scientists D. Jay Doubleday, R. Kenneth Godwin and Kathleen Orange set out to discover.

They found, for instance, that more highly educated people were more likely to attend the meetings. They also found that about half of those who attended were satisfied with their participation.

Public participation in coastal planning is required both by the federal Coastal Zone Management Act and by Oregon's guidelines for its Land Conservation and Development Commission (LCDC). Prior to the creation of LCDC, the Oregon Coastal Conservation and Development Commission (OCC&DC) designed and implemented a program for citizen participation in planning for the management of Oregon's coastal zone. The OSU Sea Grant College Program decided to analyze and evaluate that participation program to see if similar future programs could be made even more effective.

Doubleday and his colleagues found that public workshops were effectively used by OCC&DC early in the policy formulation process to obtain citizen concerns about coastal resource management. They employed personal interviews and a structured questionnaire to compare 74 workshop participants with a sample of 240 nonparticipants. They

Kathleen Orange, D. Jay Doubleday and R. Kenneth Godwin



found, not surprisingly, that participants were more involved in community and political organization than non-participants, that participants had more education and higher occupational status and a stronger sense of political efficacy.

Only eight per cent of the non-participants, however, had even heard of the workshops before they were held, the investigators discovered. They recommended more extensive publicity to foster more widespread participation in such programs. Three-fourths of the participants found out about the workshops either through mailed invitation (43 per cent) or newspapers (31 per cent).

Fifty per cent of the participants were satisfied with the workshops, 26 per cent were dissatisfied and 24 per cent gave mixed evaluations.

Participants, commissioners and staff made many specific evaluative statements about the strengths and weaknesses of the workshops with respect to representatives of the participants, organization and planning for the meetings, participant and leader conduct at the meetings, location and timing, follow-up, preparation of participants, and content. Their comments are being passed to LCDR and to local government officials and planners through a Marine Report and a planned technical report.

Yes—in the judgment of many participants, staff and commissioners—all those planning workshops did make a difference. And, thanks to the investigators' analysis and evaluation, future citizen participation in coastal planning should be even more effective. (R/CM-14)

## ESTUARINE MANAGEMENT

### Wood rot: a million dollar menace

Annual damage to wooden waterfront structures in the United States by marine borers, decay fungi and insects is about \$500 million. Much of that damage is caused by decay fungi, according to Robert Graham, Forest Research Laboratory.

Part of Graham's work involves inspecting West Coast waterfront structures to survey the type and extent of biological damage. Structures were inspected at six Oregon ports as well as Seattle, Oakland and Pearl Harbor.

It turned out that creosoted Douglas-fir piles are providing long service (20-40 years) along the Oregon-Washington coast. In southern latitudes, concrete and polyvinylchloride jackets are used to prolong their service. At all sites, Graham reports, decay was accelerated by inadequate protection of pile cut-offs, use of large timbers (which tend to crack and provide pathways for decay-causing organisms), and construction practices that trap water.

Untreated Douglas-fir is performing well along the Oregon coast as decking and stringers and as untreated piles in waters without marine borers. Relatively simple on-site treatments, wisely used, can do much to prevent deterioration, according to Graham. He recommends they be substituted where economics precludes the purchase of pressure-treated wood.

Five decay fungi and eleven "nondecay" fungi, also commonly found in Douglas-fir poles in western

Oregon, were identified in the waterfront structures inspected (see figure).

At the request of personnel at Port Orford, where dock repairs were underway, Graham developed recommendations on construction and on-site preservative treating practices to improve the performance of wood. These recommendations will be published after revision and review with representatives of the construction industry.

Besides finding out where decay problems exist and what causes them, Graham is also looking for ways to prevent or retard decay in wooden waterfront structures. The most promising approach appears to be to inject the wood with liquid chemicals that diffuse as gasses, killing fungi along the way.

Four-year-old creosoted bulkhead piles, all with internal decay, were treated with Vapam, Vorlex and chloropicrin, all anti-fungal agents. Then, the tops were cut off horizontally and covered with a coal-tar cement and fiberglass cloth cap. The piles will be bioassayed annually to follow changes in fungal population.

Twelve-year-old untreated decaying Douglas-fir free-standing piles were bioassayed and selected for treatment with the same chemicals. Results of these tests should be directly applicable to fender piles with fumigants when the opportunity arises. He has found that fumigants move as much as 8 feet below the site of treatment in poles; thus piles could be treated by drilling holes from the tops, applying the chemicals and capping the pile.

To determine if fumigants will prevent marine borer attack, 2 x 4 x



18-inch Douglas-fir heartwood panels are being prepared for treatment with fumigants. They will be installed at Newport, Los Angeles and San Francisco.

Moisture content determinations of the interior of piles that have been standing in water up to 40 years show that beyond a depth of about 2 inches, there is sufficient void space for movement of fumigants. Moisture contents in the intertidal zone were low: about 30-40 per cent.

The scope of Graham's research activities will expand during the next year to consider deterioration of wooden boats.

In addition, Graham is completing work on a slide-tape presentation, "Wood Destroyers in a Marine Environment." The slide-tape, intended for port maintenance personnel and port managers, will show how marine borers attack wood below the splash zone in salt water and how decay fungi and insects destroy wood above the water and on land. Awareness of the problem and more wide-spread application of existing techniques would significantly cut losses due to decay, according to Graham.

Even a fractional reduction on a price tag of a half billion dollars a year would be a significant savings. (R/EM-3)

### A new design to cut steel costs

What happens if engineers don't build a model before they build a full-scale structure?

Their designs may be too conservative.

And conservative designs mean extra cost, according to W. Lee Schroeder, assistant dean of engineering.



Robert Graham

#### Decay fungi\*

*Poria placenta*  
*Poria carbonica* Overh.  
*Poria xantha*  
*Poria sericomollis*  
*Fomitopsis cajanderi*

#### "Nondecay" fungi

*Alternaria alternata*  
*Cladosporium cladosporoides*  
*Hyalodendron lignicola*  
*Pachnocybe terrugina*  
*Paecilomyces varioti*  
*Penicillium* spp.  
*Rhinocladiella mansonii*  
*Scytalidium lignicola*  
*Trichoderma viridae*

\*Listed in order of decreasing frequency.

Fungi identified from waterfront structures along the Oregon and Washington coasts.



For example, \$2.5 million was recently spent to construct two cellular bulkhead wharves along Portland's waterfront. These wharves, built to serve as ship berths, consisted of steel cells filled with sand. One wharf, on the Columbia River, was formed by 23 adjacent circular cells; the other, on the Willamette, was formed by 12 adjacent cells. Each cell was 65 feet in diameter and contained sheet piling 90 feet long.

The design for these wharves was based on current theories and empirical knowledge. Schroeder believes more realistic designs could cut steel costs for these structures by up to 30 per cent.

Schroeder is involved in a two-

year project to study design methods for cellular bulkhead wharves, structures used increasingly in waterfront development in Oregon and throughout the world. His project will relate construction and service conditions to forces and deformations in a circular cell bulkhead by study and experiments on a large-scale model. He hopes to demonstrate that the wharf requires less steel—and less expense—than present designs indicate.

Schroeder and graduate student James K. Maitland have already constructed an instrumented physical model 4 feet in diameter and 6 feet high. The model sits in a structure 12 feet by 16 feet by 8 feet high; this structure contains 40 tons of sand.

Schroeder also initiated analytical studies of the structure by the finite element method.

So far, the Sea Grant engineers completed a stress/deformation analysis of the free-standing cell. The computer program for analysis of the back-filled cell was also completed.

Schroeder plans to compare experimental data with analytical studies and earlier field studies on the Portland structures. Eventually, an analytical method will be proposed.

And eventually—with the help of a model—more realistic designs which will cut steel costs will replace the conservative designs currently used for cellular structures. (R/EM-5)

William L. Schroeder



## Scale effects in hydraulic models

Bridges. Offshore nuclear power plants. Breakwaters. Deep water super-ports. Mariculture facilities.

In the future, these structures may be floating instead of fixed.

Moored floating structures are receiving increased consideration as alternatives to fixed structures. They are often more economical and may be preferable when engineers want to maintain free circulation in the adjacent marine environment.

Unfortunately, they are difficult to design.

The interaction between floating structures and waves is complex. Engineers must rely on hydraulic models to predict forces, structure response and induced changes in the wave field.

Reliance on hydraulic models leads to other problems. Small scale hydraulic models tend to distort the anticipated behavior of the prototype due to scale effects. Scale effects include the following three conditions:

- wall effects in two-dimensional models
- nonlinear response in mooring line tension and transmitted wave height due to turbulent drag and flow expansion losses
- finite amplitude wave effects.

In response to these problems, Charles K. Sollitt, assistant professor of civil engineering, initiated a one-year project to enumerate the scale effects encountered in hydraulic modeling. He also hoped to improve the predictive capabilities of this common analysis and design technique.

To specify scale effects, Sollitt used the Oregon State University Wave Facility to study two structures. One structure, a two-dimensional

rectangular cross-section constrained with symmetric mooring lines, was studied to simulate conditions at near-prototype scale. (This type of structure is the most widely used in contemporary applications.) The results were compared to measurements made on a much smaller model to quantify the magnitude of scale distortion.

According to Sollitt, this project is important for designing future model tests: either a need for large scale models will be demonstrated or the validity of small scale model results will be substantiated.

So far, large scale model tests at the OSU Wave Research Facility utilized monochromatic wave excitation. The large model was a rectangular parallelepiped—four feet high, eight feet long (longitudinal dimension) and 12 feet wide (lateral dimension). It was constrained with symmetric inelastic mooring lines. Controlled extension of the moorings was provided by springs at the anchor attachments. Incident, reflected and transmitted waves, as well as model displacement, were measured with sonic profilers. Heave and surge accelerations were measured with variable capacitance sensing accelerometers. Pitch angle was measured with an inertial gyroscope. Mooring line tensions were measured with strain gages on load rings at the anchors. Wave frequency and height, water depth, mooring line tension and scope were varied in the experiment. The experiment was repeated at approximately one-tenth of the large scale. (Plans to make measurements at full scale were abandoned since two-dimensional monochromatic wave loading could not be reproduced in the field.)

Sollitt's initial results indicated a significant dependence on wall effects. This effect was minimized at the large scale with spring loaded omnidirectional rollers and close wall tolerances. Reducing this effect at small scale was more difficult due to the inherent finite resistance of any roller system. Finite amplitude wave effects demonstrated a nonlinear response in wave transmission and mooring line tension. Thus, the hypothesized scale effects appeared to be borne out by initial experiments.

Many engineers believe that floating structures have economic and environmental advantages over fixed structures under certain conditions.

Sollitt's studies may lead to increased confidence in the predictive capabilities of hydraulic models. (R/EM-4)

## Wise decisions for estuaries

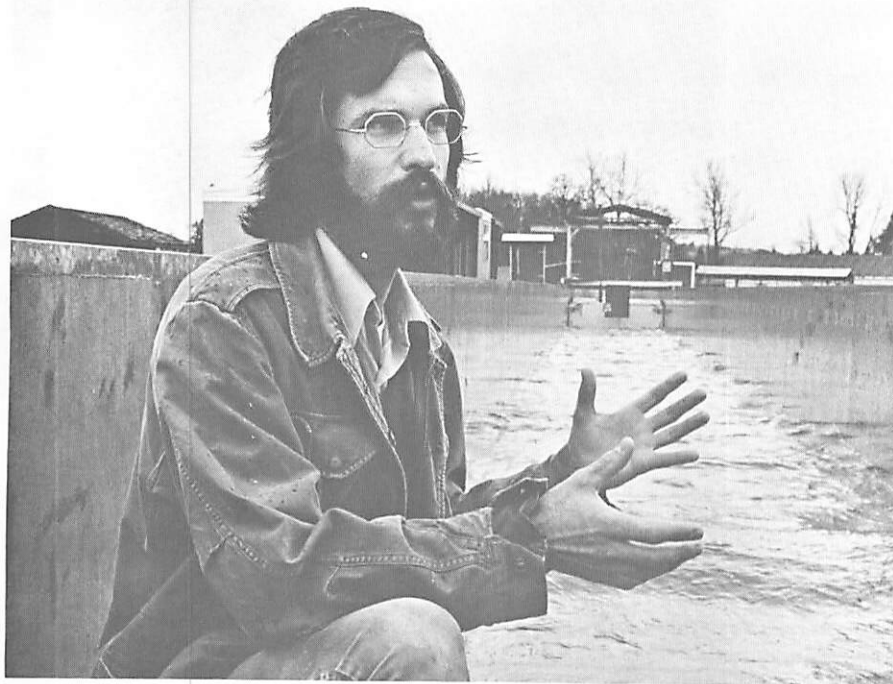
Coastal planners have a big job on their hands.

They are responsible for the wise development of Oregon's estuaries.

Wise development requires an understanding of the dynamics of the interacting physical, chemical and biological processes of an estuary.

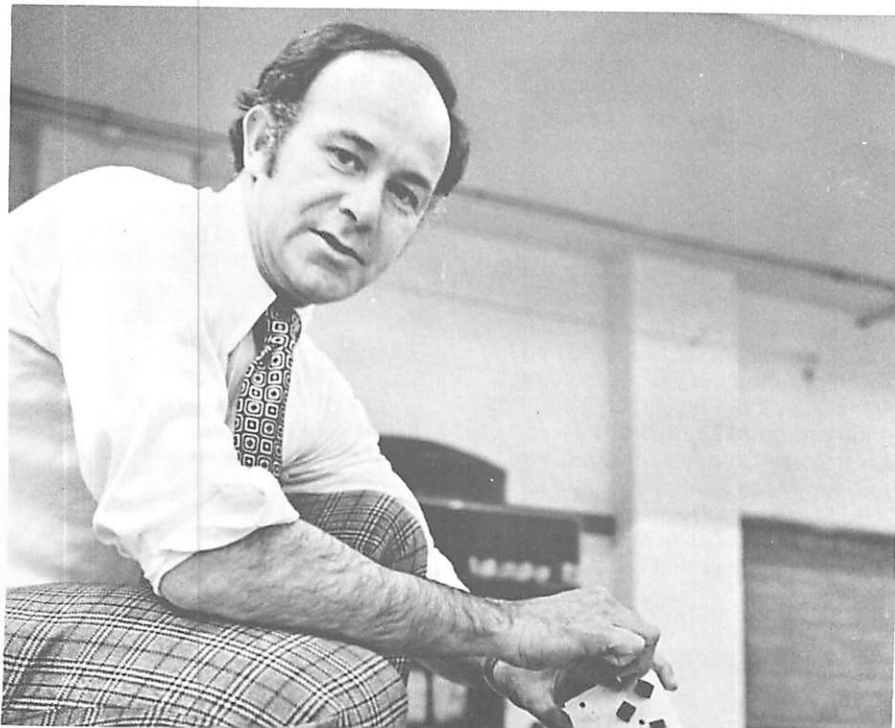
Larry S. Slotta is helping to provide that understanding. Slotta, professor of civil engineering, completed a seven-year project to study the physical and chemical processes of Oregon's estuaries.

Objectives included providing quantitative information on the seasonal variation of several important hydraulic, chemical and physical estuarine characteristics such as tidal elevations and currents,



Charles K. Sollitt

Larry S. Slotta



fresh-water inflows, salinity, temperature, dissolved oxygen, turbidity, suspended sediments, bottom sediments and hydrographic features.

This information should help planners select shipping channel alignment and depth, and locations for outfall, aquaculture production, in-bay and shortline spoiling and log rafting.

Slotta's recent activities range from evaluation to assistance to planners along Oregon's coast.

For example, he evaluated various sewage treatment and discharge alternatives in Siletz Bay for a possible savings of \$40,000 in construction costs for Lincoln City. He researched dredge spoil distribution and estuarine effects on Coos Bay. Research results of a study in Alsea Bay were used by the U.S. Attorney's office in preparing a legal action concerning unauthorized construction in the bay.

Assistance went to the following agencies:

- Oregon Department of Fish and Wildlife to aid in siting artificial reefs in Tillamook Bay.
- Oregon's Highway Commission State Parks Division on proper design of a bathing beach at the New Lost Creek Dam.
- Governor Straub and Oregon's Department of Environmental Quality on siting Alumax's aluminum reduction plant at Astoria, Oregon.
- the Army Corps of Engineers on long-range dredge disposal considerations in Oregon's estuaries.

Thanks to Slotta, the big job for coastal planners is more manageable. His results are helping them make wiser decisions about Oregon's estuaries. (R/EM-1)

# human resources

## PROFESSIONAL AND TECHNICAL EDUCATION

### **Training fishermen: practical experience and new technology**

There was a time when a professional fisherman's son would follow in his father's footsteps.

But times are changing.

The number of sons and close relatives of practicing professional fishermen entering the trade is rapidly decreasing.

Tomorrow's professional fishermen will probably come from outside the field.

To prepare persons with few professional fishing skills for entry level employment in the fishing industry, Sea Grant initiated a commercial fishing technician training program. The program also provides opportunities for working professional fishermen to update their present skills. Under the direction of Ward Nichols, instructor of commercial fishing at Clatsop Community College, the six-year program also allows new fishing gear and methods to be tested.

To train new and old fishermen, courses in commercial fishing were offered all year. Summer term consisted of practical navigation and

paid work experience aboard the college's M/V *Forerunner*, a fishing vessel purchased in May 1974. During the regular school year, students learned about professional fishing through lectures and laboratory courses. Evening classes in gillnet mending, crab pot construction and repair, net construction and repair and marine refrigeration were also offered.

In addition to regularly scheduled classes, the college offered workshops, both on its own and in cooperation with the Marine Advisory Program. This year's workshops concerned wire rope, loran and economics.

Nichols also held survival workshops at the YMCA. Nearly 50 persons, mostly fishermen, attended and participated by trying survival suits and life rafts in the YMCA swimming pool. Euthusiasm for the workshops doubled during the year. According to Nichols, 31 full-time students enrolled in the program during the 1974-75 school year. Students included two from American Samoa and one from Truk. Eighteen were employed in the industry in June 1975. Most were employed on commercial fishing vessels

as deckhands. Thirteen students dropped the program by changing majors or leaving school.

One student graduated with an Associate of Science degree. He is currently fishing but plans to attend a merchant marine academy on the East Coast next year.

Some of the program's graduates are now in the industry, successfully applying modern gear and techniques. Their success has led in turn to their acceptance by the older, experienced fishermen. Although these older fishermen responded to the educational endeavors of both Clatsop Community College and the Marine Advisory Program, greater emphasis needs to be placed on convincing the practicing professional fisherman that education and training are for his benefit and economic survival.

And if a fisherman's son should follow in his father's footsteps, he'll have the best of both worlds: his father's experience as well as training from Sea Grant's commercial fishing technician training program. (T/T-2)

## **An ocean speciality for future lawyers**

Future lawyers who practice in the ocean-oriented Pacific Northwest will need a legal background in the elements of ocean law.

That's why the Ocean Resources Law Program, under Sea Grant sponsorship, has introduced two new ocean-related seminars into the Oregon Law School curriculum. One seminar is on Ocean Resources Law; it is open to 12 to 20 students. Another seminar on Coastal Law is designed to prepare future lawyers for legal activity in the field of coastal zone management.

Part of Sea Grant's involvement in the Ocean Resource Law Program is through an eleven year project aimed at professional training in ocean law. According to Jon Jacobson, principal investigator for the project and professor of law at the University of Oregon, changes in the law, and new legal approaches to old problems, require legal education to adapt. He adds that new uses for and pressures on oceanic and coastal resources call for new and different management approaches and people to plan and implement them.

The OSU Master of Marine Resource Management curriculum is a response to this need. Jacobson reports that three Oregon Law School faculty members participated in this program by presenting a course in ocean and coastal law to the degree candidates.

According to Jacobson, each year the Ocean Resources Law Program selects a small number of upper-class law students for more intensive training in ocean law and coastal law. In May 1975, three of the selected researcher/trainees were graduated.

Other law students, not part of the research team but still interested in

Ward Nichols





ocean-law educational opportunities, performed research as part of courses or seminars or as independent research, under the supervision of the investigators.

According to Jacobson, the prestigious 1975 Jessup International Moot Court Competition, on the topic of pollution of coastal boundary waters, interested five such students. In the process of winning the Northwest Regional meet in Seattle and placing at the national finals in Washington, D.C., these five students immeasurably enhanced their knowledge and skills in several ocean- and coastal-law areas. The Ocean Resources Law Program sponsored this effort in part.

This year, the Coastal Law seminar will be repeated. A new team of researcher/trainees will investigate the legal problems inherent in aquaculture operations and in management of the coastal and oceanic environment.

New problems in coastal zone management and new ocean-related activities such as aquaculture will continue to arise. To prepare for the legal activity surrounding these issues, future lawyers need to study the elements of ocean law—now. (E/L-1)

### **Making it easier to land a waterfront job**

It's like any other field. If you have experience, you can get a better job.

The marine industry is no exception.

They want people trained in seamanship, piloting, boat handling and navigation.

Seven years ago there was no way to get that training except on a boat.

Then Sea Grant stepped in. They initiated a marine technician training program to provide persons with

fundamental skills for marine employment. The program also provided a way for experienced workers to upgrade their job skills in commercial fishing, fish processing, oceanography, harbor patrol and marine insurance investigation.

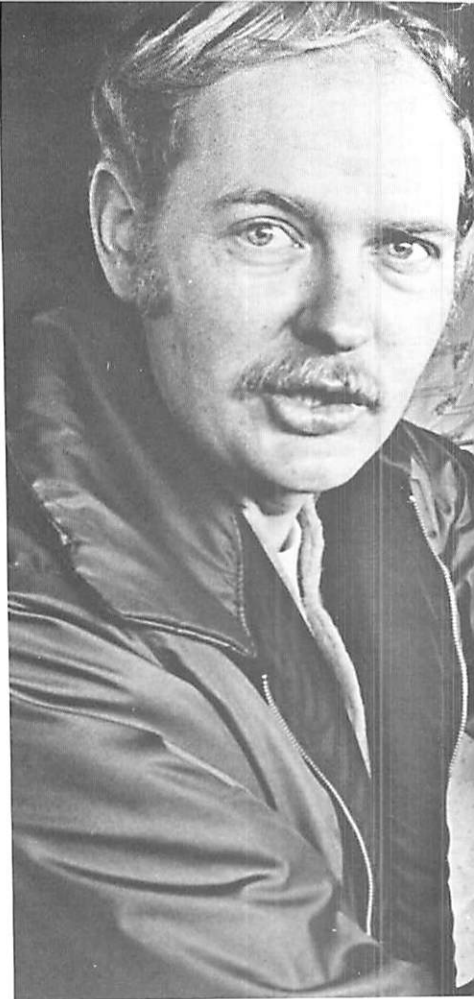
Under the direction of Patrick J. Killion, instructor in seamanship at Clatsop Community College, the program offered marine-technology courses and workshops throughout the year. The Marine Advisory Program was also involved. The Marine Advisory Program conducted a navigation workshop and the college offered boat handling classes.

During the 1974-75 school year, 20 first-year and 8 second-year students were enrolled full-time. Five first-year students dropped the program to change majors or leave school.

A curriculum to meet student and industry needs was developed and response to course offerings was good. With the passage of Bill 46 USC 405, which required boat operator licensing, the marine operators license preparation course had growing enrollments. Courses in navigation, diesel engines and refrigeration also increased in enrollment.

More than 50 part-time students were enrolled. They took classes such as navigation, marine operators license preparation, diesel engines, refrigeration and marine electricity. Participation by part-time students increased but is expected to level off in the near future.

According to Killion, participation by part-time students increased when the entire marine program was moved to the old Astoria Yacht Club building on Youngs Bay. He found that students interested primarily in marine industry—not higher education—felt



Patrick J. Killion



more at ease in a waterfront classroom.

Accurate employment data is not available at this time. Six students graduated with an Associate Degree. Most were employed in the marine industry. Of both first and second-year students, some operated charter boats, some worked as deckhands, some fished and others were employed outside the industry.

Now—thanks to the marine technician program—persons wanting jobs in the marine industry can get job experience before looking for a job. (T/T-3)

### **The little bugs on the rocks**

"Nothing gives me more pleasure than the little bugs on the rocks," said John Steinbeck of his nature walks along the beach near Pacific Grove, California.

Steinbeck, besides being a Nobel prize winning novelist, was also something of an accomplished marine biologist.

His close friendship with Edward F. Ricketts, a marine biologist who owned and operated the Pacific Biological Laboratory in Pacific Grove, led to their jointly authored *Sea of Cortez*, a philosophical account of a specimen collecting trip in the Gulf of California.

Steinbeck's interest in marine biology was a well-known fact to Richard Astro, associate professor of English and Joel Hedgpeth, then professor of oceanography. But it also intrigued them.

To explore the relationship between Steinbeck and the sea, they organized a one-day conference in May, 1974. The program brought together humanists and scientists—those who knew Steinbeck personally and those who knew him only from

his writings—to discuss how the sea can influence and shape an artist's imagination.

The conference, sponsored by the OSU Sea Grant College Program, attracted a large and attentive audience; the university's Marine Science Center had standing-room-only for the day's discussions.

The intense interest led Astro and Hedgpeth to issue a proceedings. After only three months, the proceedings were nearly sold out at \$1 per copy.

In addition, the interest, both by those from technical fields and by those from humanistic fields, led to Sea Grant support for a project to develop a course concerned with literature and the sea.

The course will culminate in another conference, this time dealing more broadly with literature and the sea.

Both Steinbecks—the novelist and the marine biologist—would probably approve. It will explore man's attitudes about nature and his relationship with it, including his fascination with the sea and “the little bugs on the rocks.” (E/LS-1[D])

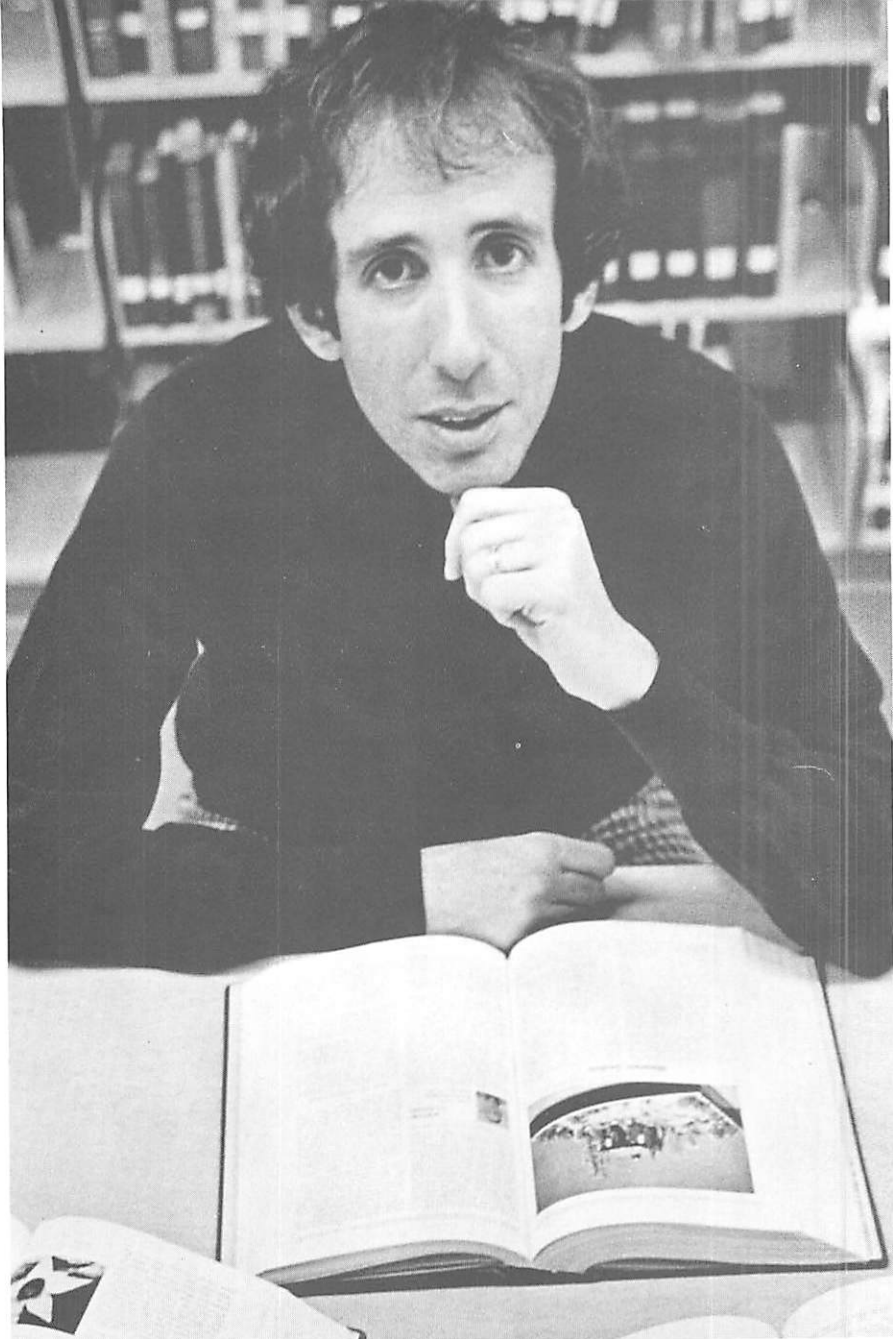
### **Training managers for the coastal zone**

Last year Oregon State University took a big step toward the proper management of environmental conditions in the coastal zone and maintaining them at an acceptable level.

The university approved a program in marine resource management.

Sea Grant became involved in the new program with a project aimed at professional training in marine resource management.

Under the direction of Victor T. Neal, the three-year project was



Richard Astro

designed to prepare graduate students for careers in marine resource management.

Specifically, Neal planned to develop a graduate level course on the complete oceanography of estuaries and develop an internship program.

So far, it's worked.

Six students were admitted to the program fall term 1974-75. Of these, two were graduated and one is now working for Lawrence-Livermore Laboratories, Livermore, California. His job is to develop a full model and impact study for power plant developments in San Francisco Bay and the California Coast. The other student returned to his management position with the Environmental Protection Agency.

According to Neal, two students served internships during summer 1975. One student was with the Columbia River and Estuarine Study Team in Astoria, Oregon and one was with the Environmental Protection Agency in Corvallis, Oregon. These internship experiences will be evaluated during the coming year.

Neal also developed and taught the course in estuaries; the results are now being evaluated. Based on the experiences of the estuarine course, the core requirements for marine resource management students may be restructured.

The material covered in the estuarine course will be reorganized during the coming year; only the

physical process will be covered in a course offered winter term.

During spring term, Neal will teach a course in marine resources which should be valuable to marine resource management students as well as students involved in other disciplines such as liberal arts, fisheries and engineering.

Neal reports that six new students were accepted for fall term 1975-76; four of them enrolled.

If interest in the new marine resource management program continues to grow, Oregon's coastal zone will receive professional attention from persons trained to properly manage and maintain coastal environments. (E/MRM-1)

Victor T. Neal



## PUBLIC POLICY ANALYSIS

### Ocean law: facing a challenge

Laws. And more laws. The ocean and coastal zone are being flooded by new and proposed laws.

To determine the long-range effects of these new laws, much research and analysis—and tools for research and analysis—are needed.

The Ocean Resources Law Program at the Oregon Law School is performing part of that task.

Since 1968, Jon L. Jacobson, professor of law at the University of Oregon Law School, has been involved in a Sea Grant project aimed at research and publication in ocean law.

In previous years, Jacobson completed research for publication on several topics. For example, research on the 1972 Marine Mammal Protection Act was published in law/journal format in 1974, research on "Future Fisheries Technology and the Third Law of the Sea Conference" was published by the American Society of International Law in 1974, research was completed on the future impact of aquaculture on fish management laws; and additional coastal law research was published in the *Oregon Law Review* in 1975.

Jacobson also conducted research on miscellaneous ocean-law topics. They include coastal water and the public trust doctrine, scope of authority of Oregon Port Districts and Oregon beach law. Two major articles on control of ocean pollution by state legislation were published in law journals (January 1973 and October 1973).

An article on the Coast Guard's new airborne oilspill surveillance system was published in *Ocean Science News* in 1975.

This past year, Jacobson concentrated on the international and national implications of the new directions in the international Law of the Sea. Drawing on the insights gained from attending portions of the first two substantive sessions (1974-75) of the U.N. Law of the Sea Conference, he researched and analyzed the coming regime of ocean fisheries management and other new LOS directions.

He also published some of the results of his research on LOS. They include contributions to a book, *The Future of International Fisheries Management*, published under the auspices of the American Society of International Law and a monograph published under the same auspices on *The U.S. and the Law of the Sea: Interim Resource Management Options*. He also presented a major address on the interaction of fisheries technology and ocean law at the 1975 Law of the Sea Institute meeting.

This year, the Sea Grant law professor continues to monitor and analyze the Law of the Sea Conference as it proceeds—this time, from a different perspective.

From November 1975 through June 1976, he will be on sabbatical in Norway teaching and researching at the University of Oslo. Norway is a key country for the law of the sea; its concerns for its coastal fishing industry and the new development of offshore oil are similar to concerns in the U.S.

While in Norway, Jacobson will monitor the response of Norwegian institutions to the new laws of the sea and analyze the Norwegian response for the benefit of audiences in the U.S. He anticipates that this project will result in a publication,

probably entitled, *Norway and the New Laws of the Sea: Lessons for the United States*.

In the coastal-law area, Jacobson published a special issue of the *Oregon Law Review* on the management of the Oregon coast. In addition, members of the Ocean Resources Law Program team assisted the Oregon Coastal Conservation and Development Commission (OCC & DC) in forming management policies; a similar relationship with the Land Development and Conservation Commission (LCDC), the state body now developing management policies, is planned for the current year.

Publication of a recently completed thesaurus for a model Ocean Law Library is also planned for this year. The thesaurus is the first of its kind and should prove a valuable addition to the several ocean-law collections throughout the country.

The increase in ocean and coastal laws has created a challenge for lawyers.

Jacobson is facing that challenge. He is researching these new laws to gain a perspective on ocean law developments, and he is helping people who need to understand them. (R/PPA-1)

### Managing the Dungeness crab fishery

Too many crab pots may be creating serious problems for the Dungeness crab fishery.

The rapid increase in the amount of vessels and gear along the Pacific Coast has caused management agencies to identify the Dungeness fishery as one where steps can and should be taken to control overall effort.



For example, the National Marine Fisheries Service and the States of Oregon, Washington and California (through the Pacific Marine Fisheries Commission) formed a State-Federal Dungeness Crab Study team to identify what changes are needed to improve the economic and biological viability of the fishery.

One step which may be considered is a moratorium on additional entry to prevent the present economic situation from deteriorating.

To determine the economic impact of such a moratorium, Joe B. Stevens, associate professor of agricultural and resource economics, completed a two-year project sponsored by Sea Grant.

The project objectives included the following:

- to derive estimates of supply and demand for new property rights which would be created if a moratorium on entry into the Dungeness Crab fishery were declared.
- to estimate the equilibrium price of such rights and the allocation of fishermen and vessels among the crab fishery, other fisheries and the non-fishing sector.
- to evaluate the extent to which effort in related fisheries may need to be controlled if the objectives sought by limiting entry into the crab fishery are to be met.

Stevens' initial strategy of simulating a "market approach" to resource allocation in crabbing had to be altered substantially because of difficulties in simulating the willingness of fishermen to sell their vessels and leave the fishery. He described two problems in particular. First, his survey of crabbers revealed that very few skippers leave this particular fishery; hence, he had limited data



Joe Stevens

on which to make inferences about occupational mobility, particularly exits from the fishery. Second, nearly all of Oregon's crabbers combined crabbing with other fishing enterprises. Crabbing activity occurred largely when other fisheries were not active. Hence, crabbing was complementary to other fishing enterprises, rather than competitive with them.

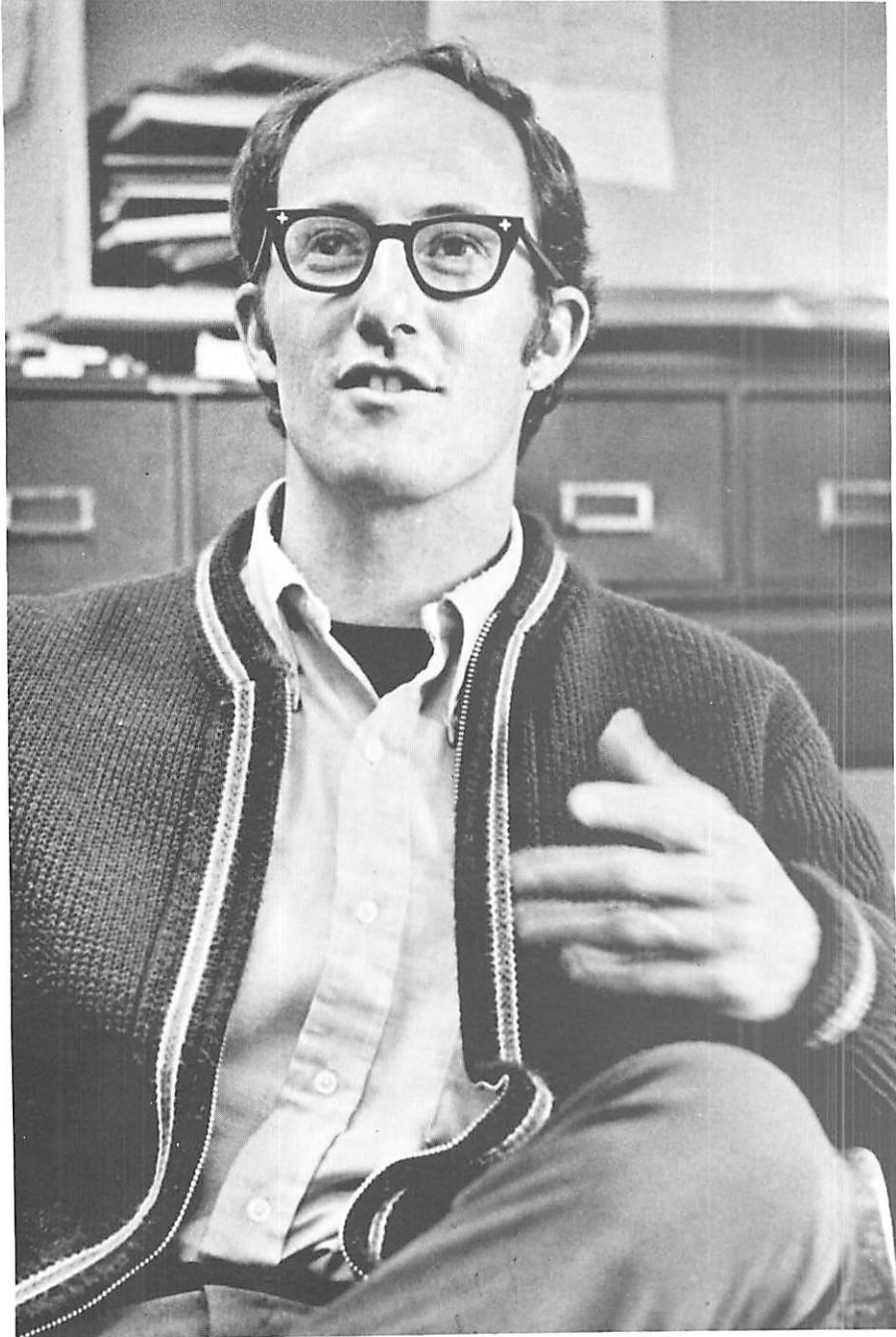
As a result, Stevens turned his attention to two new questions: would existing crabbers be better off financially if no more pots were used than were needed to harvest a maximum sustainable yield? And if so, would voluntary and/or coercive action be required to hold the number of pots at the desired level?

To answer these questions, Stevens used two data sources. He relied on his detailed survey of 37 crabbing enterprises in 1972, and a long-term yield-effort relationship estimated from time-series data (1952-1972).

According to Stevens, the research is still in progress, but some findings can be reported.

Baseline economic data for three types of crab fishermen were analyzed. Stevens found that the average net return in 1972, by type of fishermen, varied from \$8,959 to \$35,227. The most profitable crabbers were those who also fished for shrimp and/or bottomfish. Very few Oregon crabbers supplemented their fishing incomes from work outside the fishery. Economies of size exist in crabbing operations, and the productivity of all inputs exceeded their costs in 1972.

Stevens also derived estimates of long-term yield functions for Oregon's Dungeness crab fishery. He found that no more than 50,000 crab pots would be needed under existing



Courtland Smith

technology to harvest the maximum sustainable yield. (There are now about 60,000 pots in the fishery.)

According to Stevens, if the number of crab pots had been limited to 1971 levels, 1972 catches would have increased by 30 pounds per pot.

The Sea Grant economist is now using linear programming techniques to determine whether net returns from crabbing could have been increased in 1972 if the number of pots had been held constant at 1971 levels. If so, Stevens will know that a financial incentive exists for limiting numbers of crab pots.

And if there is a financial incentive for gear limitation on the part of individual crabbers, then the next step will be to determine whether a policy on gear limitation might best be implemented by voluntary action by individuals, by voluntary action by groups of crabbers or by government restrictions which would be binding on all crabbers.

Stevens will communicate these results to the State-Federal Dungeness Crab Study team through periodic joint meetings. When Stevens completes his research, the study team should be able to determine if the serious problems in the Dungeness crab industry are, in fact, created by too many crab pots.  
(R/PPA-4)

### **Fisheries management: what went wrong?**

It's been going on for a hundred years.

Fisheries managers, Oregon fishermen, and the general public have been trying to conserve fish resources.

But they haven't met with much success.

Why?

That's what Courtland L. Smith wanted to find out.

Smith, associate professor of anthropology, conducted a one-year study to determine why conservation of fisheries failed to achieve long-term importance and stability, and what impacts management regulations and external factors had on the fishing industry.

A system of evaluation, which compared the change over time in the shape of a social well-being frequency distribution, was developed for this study.

According to Smith, open-ended interviews were completed with 150 Oregon fishermen, fisheries managers, fish processors and others related to the fishing industry. These interviews and review of documents provided data on fishermen's concerns, fishing patterns, relations of fishing to other activities and the nature of the fish harvest system.

To provide time depth, intensive analysis was made of historical data. Synthesis was completed of more than 100 years of Columbia River pack price, landings, price to fishermen, market conditions, regulations, organizational configurations, sports-commercial relations and activities of fishermen's and packing organizations.

Smith also prepared income distributions. They included Columbia

River Packers Association gillnetter's income, 1916-26; halibut vessel landings and income, odd years 1911-39; Oregon otter trawl income, 1965-72; salmon landings by Oregon sports anglers, 1971-73; salmon pack of Columbia River Canneries, 1876-92, and Southeastern Alaskan canneries, 1911-23; and world fish harvest by country 1961 and 1971. The shape of these distributions was correlated with economic conditions, management rules and intergroup relations to determine the impacts of various types of changes on fishing and fish processing activities.

What did Smith discover?

The single most important finding was that institutions which manage fisheries were too narrowly conceived and too limited in authority to have significant impacts on preserving fish resources. In addition, managers did not understand the nature of fishing activities, citizens did not understand their role in making management decisions and the relations between the fishing industry and other social activities was not well understood.

The Sea Grant anthropologist presented this information in a nine-session film and lecture series to an audience totalling 1,500. More than 500 undergraduate students received a unit on economic change based on this research. Several seminars were presented to other scientists, resource managers and advanced graduate students. Public information displays highlighting research findings are in preparation. (R/PPA-5)



Ken Hilderbrand, Sea Grant Assistant Director for Advisory Services

## MARINE ADVISORY PROGRAM

"Helping people to help themselves."

That's the job and philosophy of Sea Grant's Marine Advisory Program (MAP).

Ken Hilderbrand, Assistant Sea Grant Director for Advisory Services, leads a team of four coastal Agents and eight subject-matter Specialists who work within the OSU Extension Service to help people help themselves. The MAP staff provides three kinds of help:

- it provides knowledge for public understanding of marine resources.
- it develops techniques to improve public education on marine resources.
- it provides feedback from marine users to Sea Grant researchers.

Take, for instance, the Public Education Program conducted at the OSU Marine Science Center. Over 352,000 people attended Marine Science Center educational programs in fiscal year 75. The programs included the summer "Seatauqua 75" which offered 11 lectures, 10 two- or three-day workshops, 10 nature hikes, a host of special events and a continuous showing of films. Included were lectures on coastal weather, geologic hazards, native Americans and fisheries; workshops on boat safety, coastal vegetation, intertidal and estuarine ecology. Other special education tours and programs at the Marine Science Center and Yaquina Head Station were attended by over 540 groups with 20,000 students.

Other Marine Education programs included a series of ten 15-minute video tapes played on statewide educational television, a series of publications ("Marine Education Tips") intended for use by teachers in public schools and "leader's

guides" for use by 4-H leaders throughout the state.

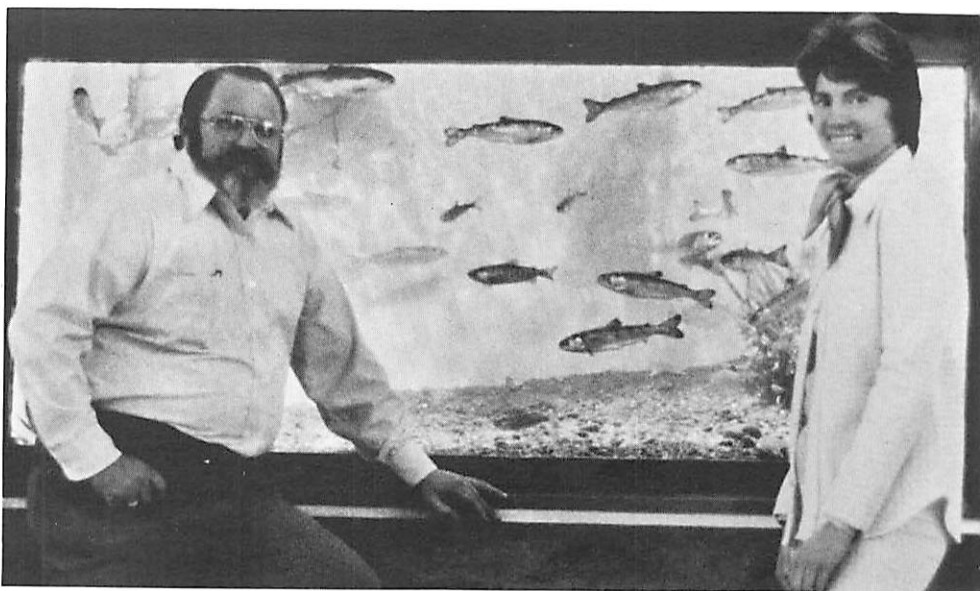
All these programs were done in cooperation with many state and local agencies, school districts, community colleges and university schools and relied heavily on citizens who contributed generously of their time to make Oregonians better aware of the importance of their marine environment and its resources.

The year's activities also included student training through an intern program for future "resource recreation managers," career awareness in a two-day symposium for career counselors and appreciation for esthetic values through lectures and displays of marine topics in literature and photography.

### **A team approach**

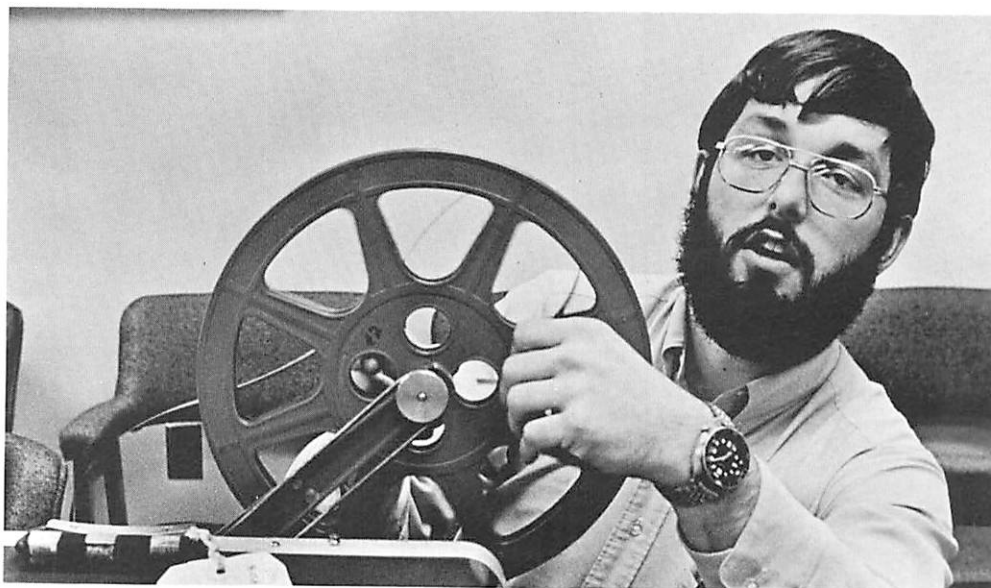
The Marine Advisory Program staff operated as a team on most projects. When the National Marine Fisheries Service requested help in getting user input for developing a National Fisheries Plan (at the request of the National Advisory Council on Oceans and Atmosphere) the team responded. Guidance in design of the project was provided in four regional meetings. Oregon input was obtained in 11 sessions covering the entire state—both coastal and interior. Over 700 sport and commercial fishermen, seafood processors, elected officials, agency representatives and concerned citizens had a chance to design fisheries policy for the nation. Over 30 per cent of all such meetings held nationally were held in Oregon.

The Marine Advisory Program staff saw the completion of several

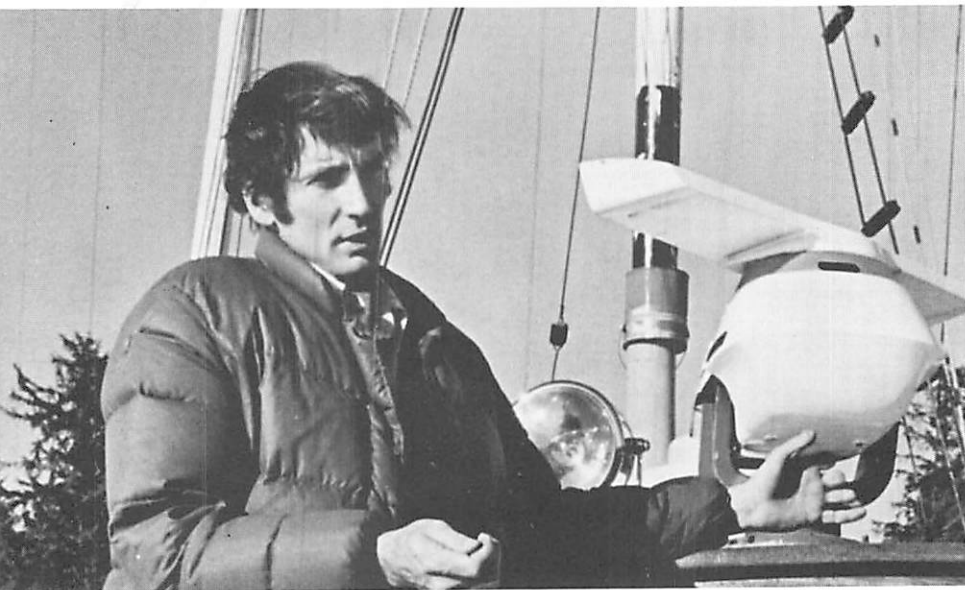


**Don Giles and Vickie Osis, MAP Marine Education Specialists**

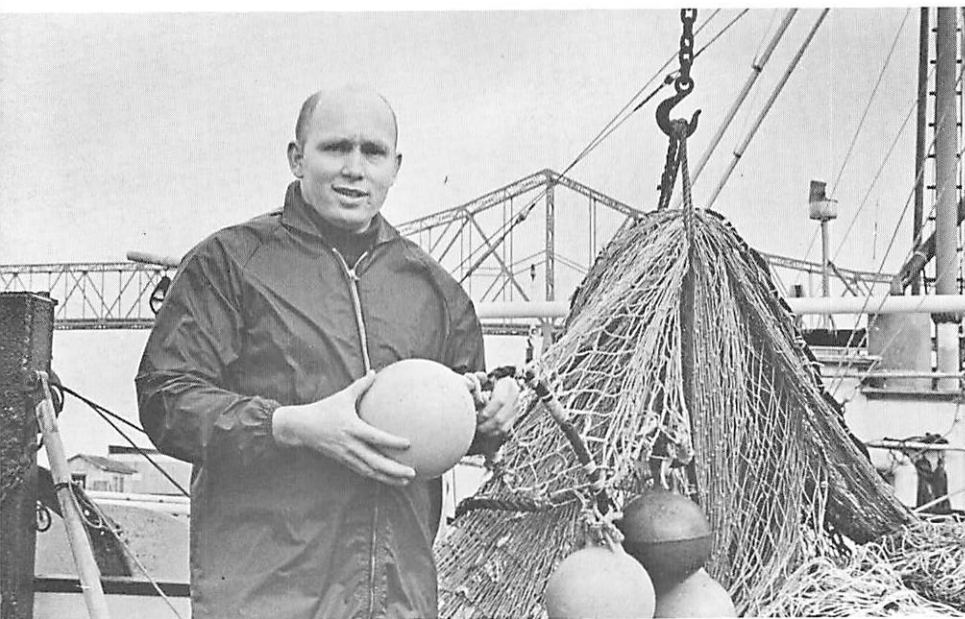
**Bruce Mate, MAP Agent**







Robert Jacobson, MAP Agent



Jim Bergeron, MAP Agent

projects in fiscal year 75. A MAP initiated OSU land use planning study in Clatsop County put the county planning staff well on their way to completion of a comprehensive land/water use plan. The research staff gained useful knowledge of citizen participation techniques and the county planning staff learned many of the newer skills and techniques of modern day planners.

A detailed study of the Youngs Bay estuary was completed by OSU researchers. It was funded by a private company at the urging of a MAP-led citizen advisory committee when it became obvious that it was a critical concern involving the location of a \$15 million aluminum mill near the bay. Although the mill will locate elsewhere, the knowledge gained will be invaluable in the efforts to understand the Columbia River system—a project now under the leadership of CREST (Columbia River Estuary Study Task Force). Sea Grant Extension agents helped to develop the concept, organize the task force, and now continue to supply technical assistance and even talent in the form of Sea Grant trained and funded Marine Resource Management trainees.

Marine Extension Agents and Specialists helped to develop the Marine Resource Management program at OSU, continue to teach various subjects during the course, and direct the energies of its students to solutions of real problems of critical concern to coastal residents.

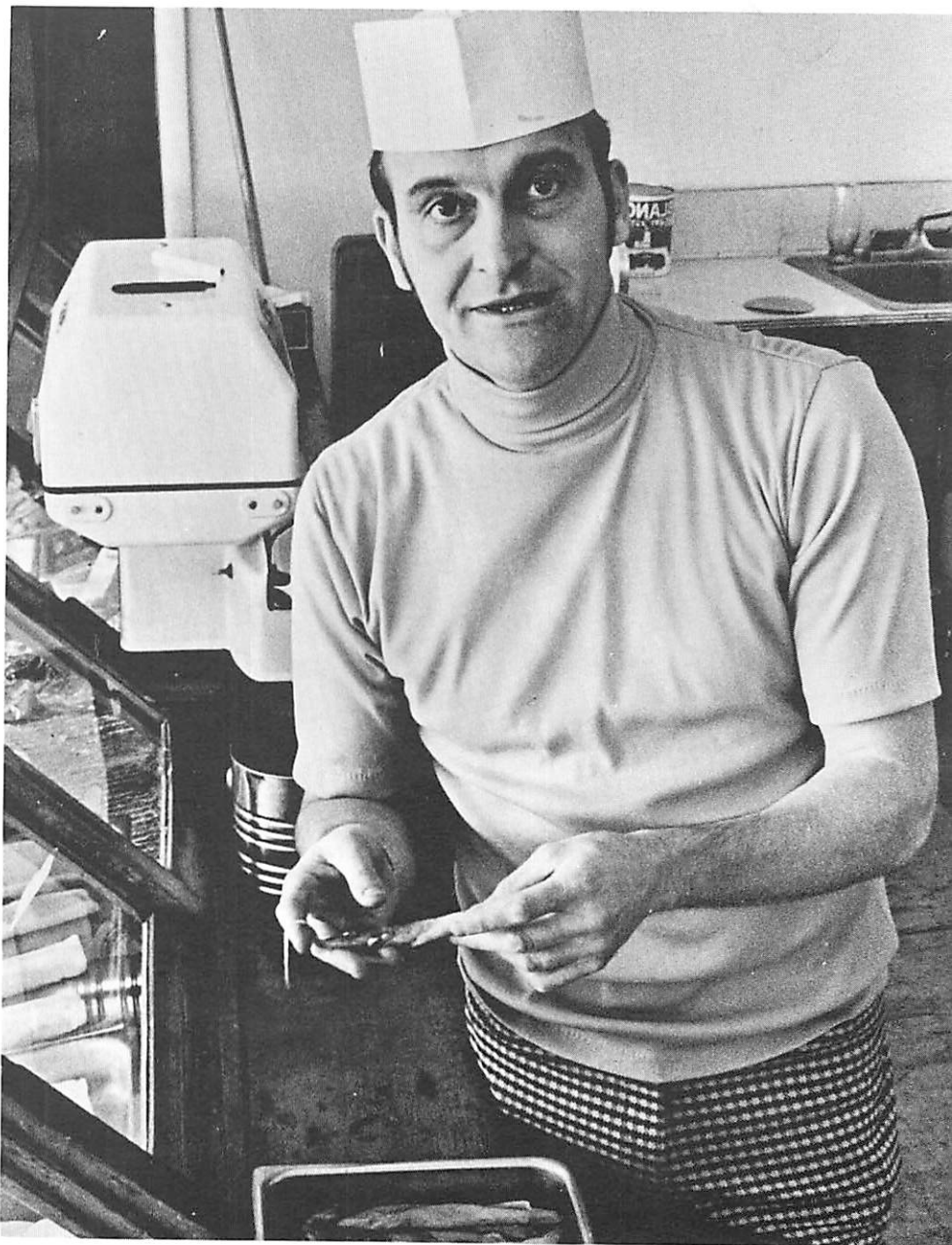
As a citizen planning group, CREST is new to the Oregon scene. Even the three-year-old Tillamook Bay Force is predated by the group

which planned Yaquina Bay, in the late 1960s and early 1970s.

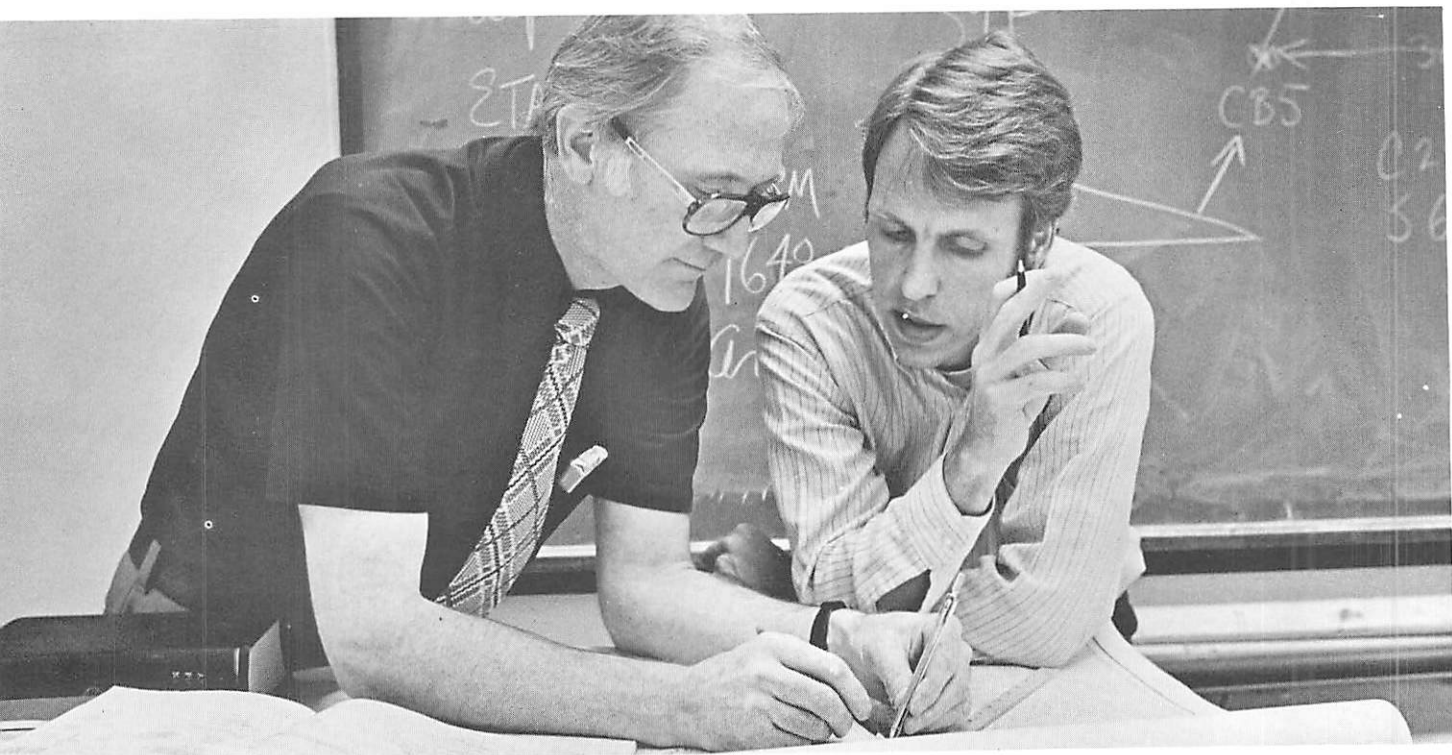
The citizens of Yaquina Bay recently passed a \$2.5 million bond issue to guarantee loans on a \$5 million marine/convention center project—it was part of the Yaquina Bay Task Force's "Yaquina Bay Plan." The community voted for it, the community planned it and the community formed the task force which caused it to happen. However, close inspection will show Sea Grant Marine Advisory Program influence at every step through leadership development, estuarine research, technical advice and hours of dedicated work.

#### **The portable classroom**

MAP helped get coastal "custom cannery" certified as retort operators under Food and Drug Administration regulations. They taught navigation and boating safety to hundreds of mariners in dozens of workshops. They put on survival suits and jumped in the bay to demonstrate the suit's value to the fishing fleet. They developed a program on tax management and taught it to over 300 fishermen in five ports—in fiscal year 75 alone. The interest generated spread all the way to Washington, D.C. where the Internal Revenue Service (as a direct result of this interest) is now completing a "Tax Guide for Fishermen." This five-year-old program in tax management will not be offered in fiscal year 76. Not because the subject is no longer useful, but because the role played by advisory services is now complete. The IRS and local tax consultants (with some continued logistical support) will carry it on. The program has found a home and that is the ultimate mark of success for advisory education.



William Davidson, MAP Seafood Technology Specialist



Ed Condon and Dan Panshin, MAP Oceanographic Specialists

Programs to improve the management skills of marine firms were extended regionally to the states of Washington and Alaska. Seven professional fisherman's workshops involving over 130 students were taken "where the action is" in Kodiak, Alaska and Ilwaco, Aberdeen, Seattle, Bellingham, Port Angeles and Gig Harbor, Washington—this, in addition to four locations in Oregon with over 100 students.

A major working conference on estuarine research and management brought together scientists, managers and leaders from all over the Pacific Northwest. A workshop on

management of Oregon's clam resource accomplished the same thing on a more specific subject, but both were part of a new educational thrust which will attempt to bring better coordination between the multitude of interests and activities in estuarine research, development and management.

Not all advisory accomplishment lends itself to description by time, place, audience and numbers. Thousands of personal letters were written in response to questions about hundreds of varying problems—legislators asking for technical advice on a new bill, a 4th grade student trying to find out about

seaweed, a fisherman wanting advice on rigging tuna trolling lines or a housewife canning a 25 pound Chinook. Other assistance was given to Extension agents in inland counties wanting answers to marine questions asked by inland mariners and Extension specialists wanting marine participation in statewide educational programs in nutrition, forest management, youth education and marketing.

Special educational programs were developed in reaction to user demand—a demonstration of shrimp/trash fish separators, radar and sonar and temperature profiling of seafood in market channels from processing

to consumption. MAP agents demonstrated how to can salmon, how to catch flounder from the jetty and how to pickle herring.

Not all advisory activities have immediate benefits or easily relate directly to local needs. Over two years of activity related to the changeover of offshore navigational systems from Loran A to Loran C have yet to affect a single user—the payoff may be a better system in another two or three years if there is any payoff at all. A regional conference on fishermen's coops has yet to see the formation of a single Oregon coop; yet the demonstration of "Canadian technique" for controlling electrical charges on salmon trolling lines has changed practices throughout the fleet and sold out stores full of voltmeters.

### **Talent imports and exports**

The OSU Sea Grant Marine Advisory Program has talents useful to other states. Through the Pacific Sea Grant Advisory Program (PASGAP) our talent has been exported to every state in the Pacific Rim—marine economics to Washington, California and Alaska; seafood technology to Alaska and California; marine education to the same places. OSU marine agents and specialists have served the nation on site visits to other universities, and through leadership and participation in national committees on marine education, communication, economics, coastal zone management and seafood technology. These "talent loans" have been paid for by exchange of fishing vessel electronics experts from Canada and Alaska, communication specialists from



John Faudskar, MAP Agent

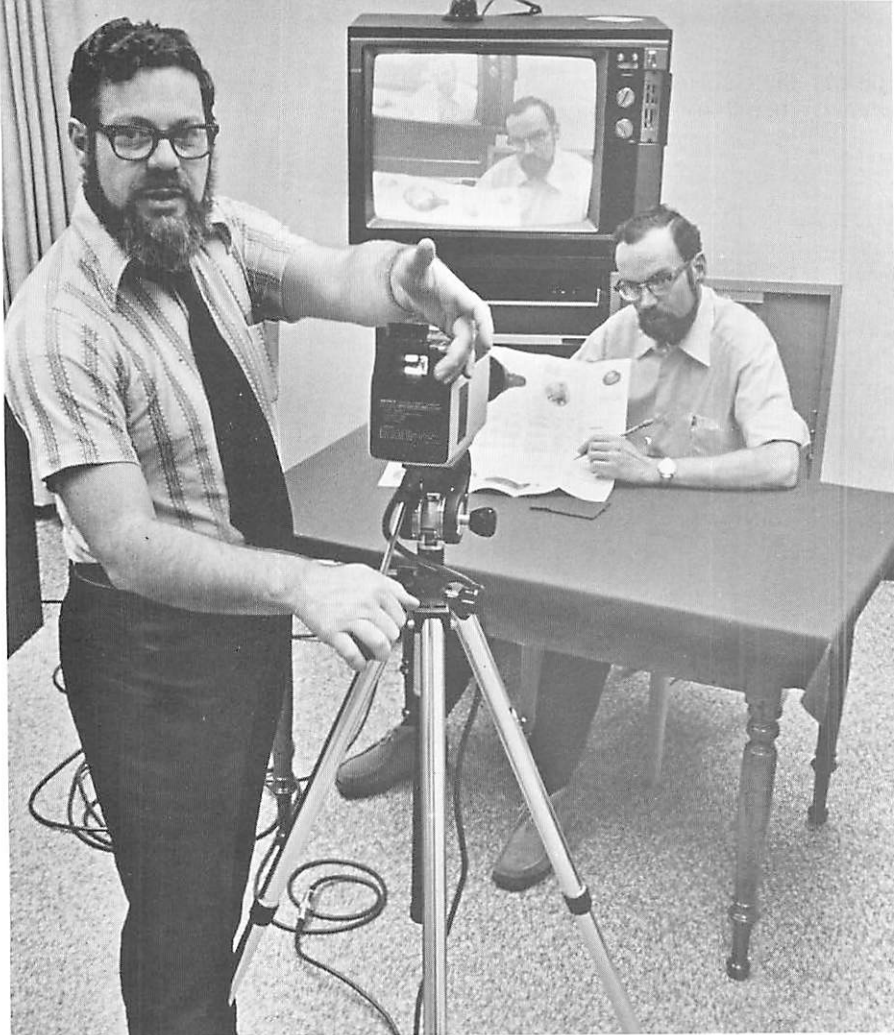


California and process engineers from Washington.

MAP's ability to provide feedback from users to researchers greatly improved in fiscal year 75. Through MAP-sponsored planning meetings and personal contacts, the research community came into contact with a variety of user groups. Among the results are new research projects in use of shellfish waste as a fertilizer (thereby getting rid of the waste) and the effect of boat noise on the fishing capability of individual vessels. Sea Grant agents identified an opportunity to obtain 5,000 to 10,000 horsepower of "free" refrigeration from a liquified natural gas revaporization plant on the Oregon coast and assisted in obtaining over \$50,000 to study the unique capabilities of its 260 degree-below-zero potential.

The Marine Advisory Program staff explain again and again that the program can not be "all things to all people" but they continue to touch all aspects of the conservation and development of Oregon's marine resources—including perhaps our most valuable resource, the people we call "mariners."

Opportunities to document the value of these educational programs through benefit/cost analysis are few and far between. Perhaps for this reason the focus is on people, and programs are designed to solve problems people perceive as important. The fact that thousands of dollars worth of crab pots were saved by devising "safe" tow boat lanes through active fishing grounds may not be nearly as important as the fact that a resource-use conflict—important in the eyes of the users—was resolved!



Charles Jackson, MAP Communications Specialist, and Jim Leadon, MAP Editor



### **The difficulties of measuring advisory benefits**

All program leaders have at least one task in common: they need to measure the benefits of their programs.

The task turns into a problem for Sea Grant advisory services.

Many of the benefits provided by advisory services are hard to measure. They may involve listening to fishermen, assessing problems or gathering information.

Program leaders need a new management tool—they need a method to assess intangible benefits.

A Sea Grant communicator tried to provide that tool.

Charles Jackson, an extension marine communication specialist, initiated a one-year project supported by program management funds to investigate and develop audio-visual documentation of effective methods for assessing the performance of marine advisory services.

His objective was to produce an audio-visual program which could be used to introduce administrative personnel, marine advisory staffs and concerned citizens to ways to assess the benefits of marine advisory services.

Jackson interviewed leaders of advisory services and university

extension services at both private institutions and Land Grant colleges. Different methods for assessing benefits were discussed.

The results of the project were somewhat frustrating, according to Jackson. The project did not identify any one or two widely acceptable, effective methods of assessing advisory service, or lead to an audio-visual program documenting these methods.

Why?

It turned out that one or two evaluation methods weren't enough to cover all local and national advisory service programs.

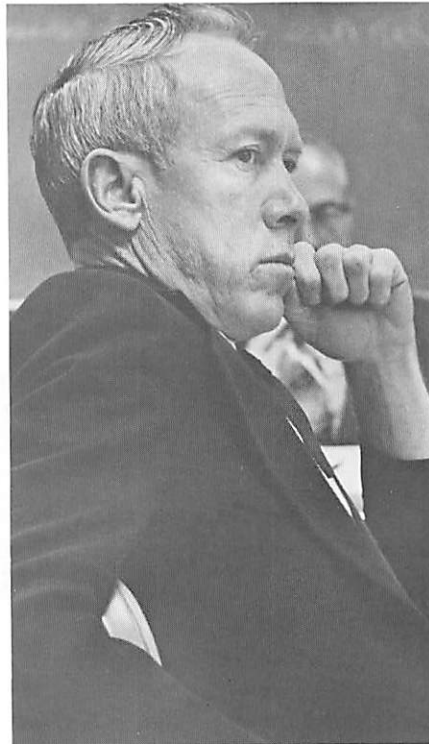
For example, local and national administrations of advisory services don't necessarily agree on effective measurements. Measurements differ according to each administration's management objectives, its need to know, its working environment and individual staff members' backgrounds and pre-conditioning.

Jackson also concluded that audio-visual documentation of benefits of advisory services was not effective for general application at multiple administrative levels.

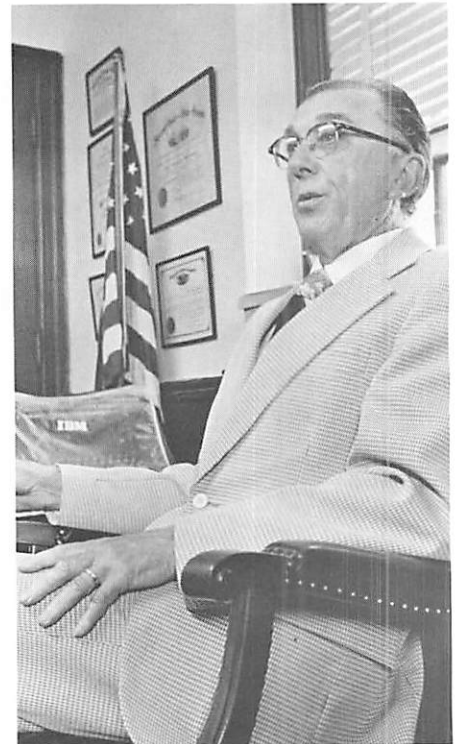
He does believe that a method to assess benefits can be an important tool—if it concentrates on a specific program at a local level. (M/A-3)

# program policy and management

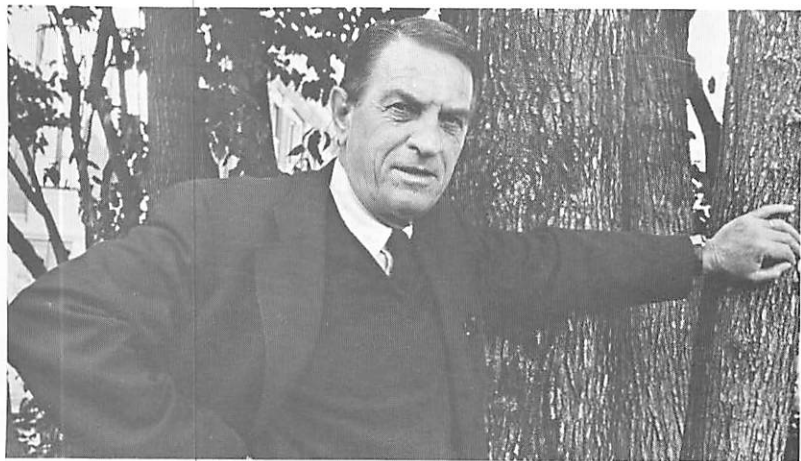
## ADVISORY COUNCIL



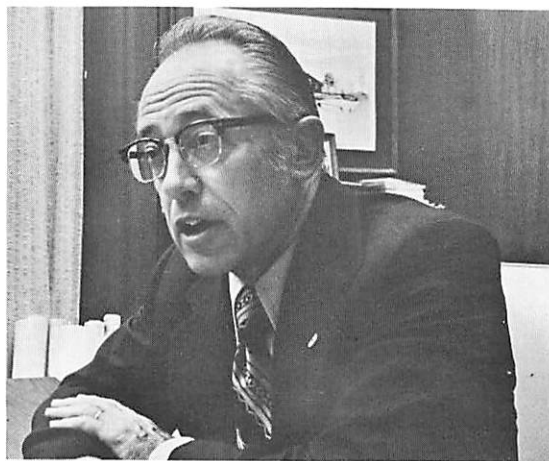
Paul Triem, Vice-President,  
Bohemia Inc., Eugene



J. S. Bohannon, Circuit Court  
Judge, Tillamook



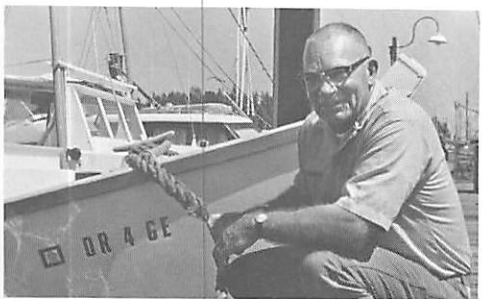
**Phil W. Schneider, Regional Executive, National Wildlife Federation, Portland**



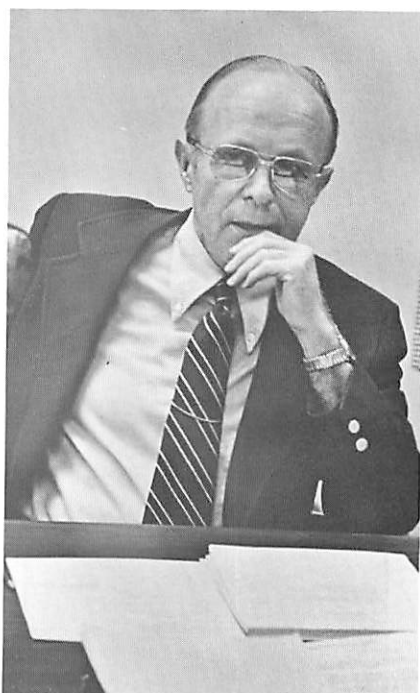
**Alden Toevs, President, Citizen's Bank, Corvallis**



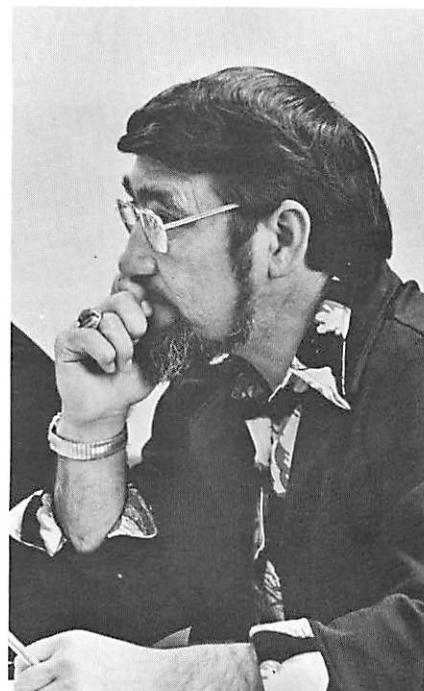
**Don Jackson, Central Lincoln Public Utilities District, Newport**



**H. Cecil Buckingham, Professional Fisherman, Newport**

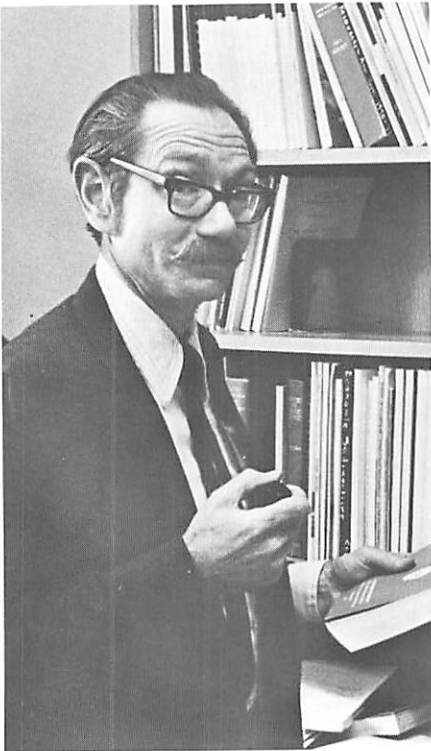


**Gilbert Bowe, Consulting Forester, Portland**

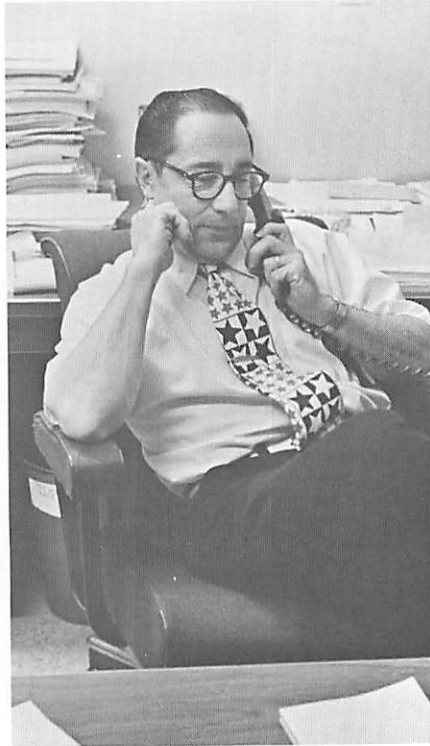


**Robert Younker, Port of Coos Bay**

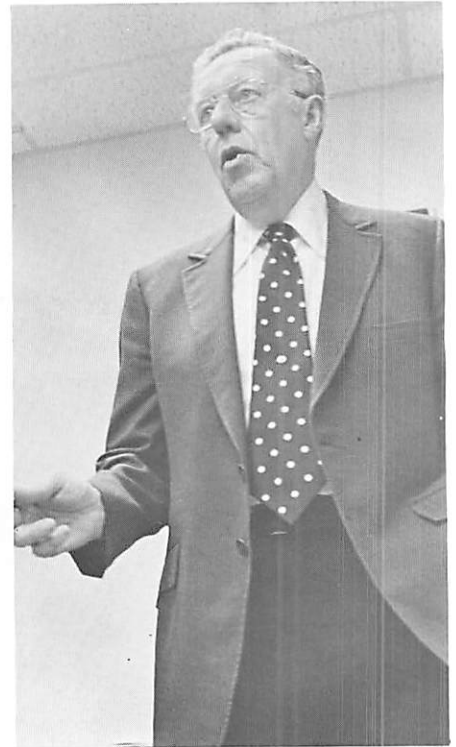
EXECUTIVE COMMITTEE



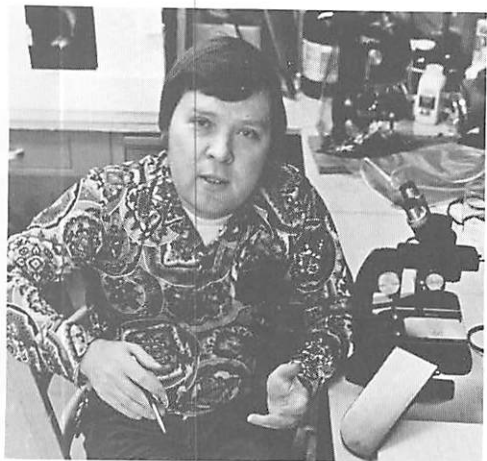
Charles E. Warren, Professor  
of Fisheries



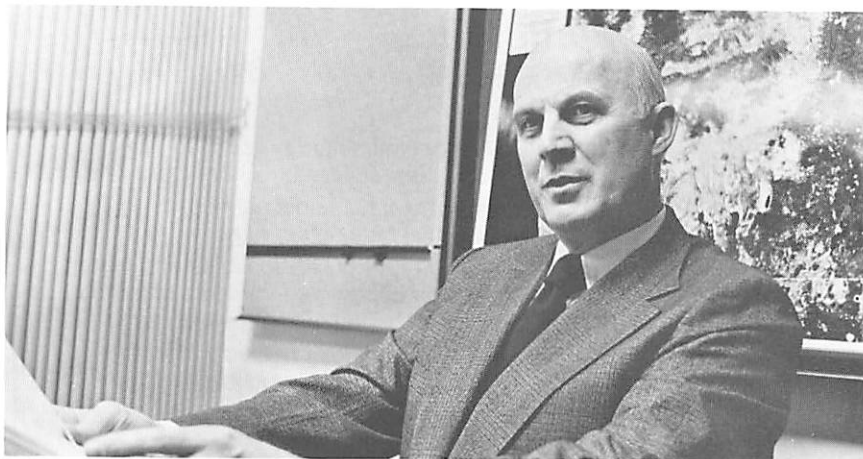
Fredrick J. Burgess, Dean, School  
of Engineering



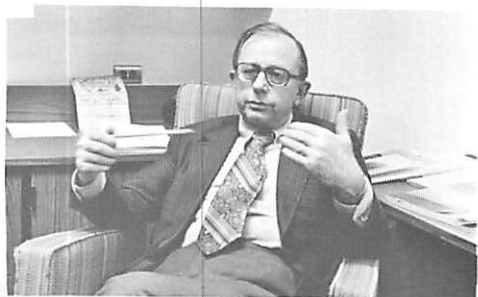
Joseph R. Cox, Director, Extension  
Service



C. David McIntire, Associate  
Professor of Botany



Roy A. Young, Vice President for Research and Graduate Studies



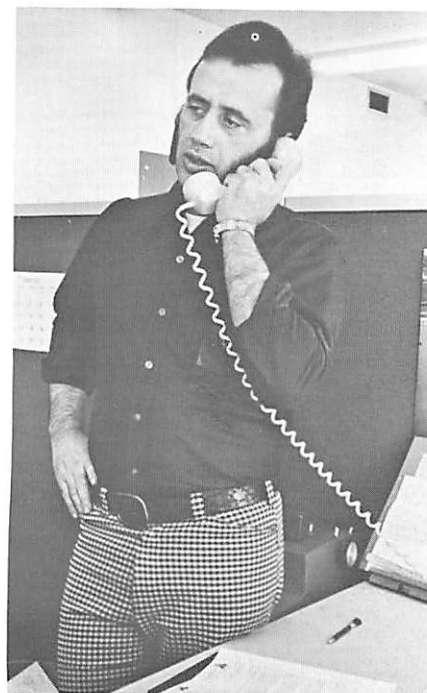
Emery N. Castle, Dean, Graduate  
School



William Q. Wick, Chairman,  
Executive Committee



John V. Byrne, Dean, School of  
Oceanography



Kenneth S. Hilderbrand, Assistant  
Director for Advisory Services



## STATUS OF PROJECTS

### FOOD FROM THE SEA

N—New, C—Continuing, R—Redirected, F—Finished

#### Aquaculture

		FY 73	FY 74	FY 75
R/AQ-6	Pilot chum salmon production		N	C
R/AQ-7	Sea-water culture of salmonids		N	T
R/AQ-8	Essential fatty acids: salmon		N	F
R/AQ-10	Essential fatty acids: rainbow trout		N	F
R/AQ-11	Protein-energy relationships and mineral metabolism requirements of rainbow trout		N	C
R/AQ-15	Hatchery techniques for oyster seed		N	F
R/AQ-16	Raising oysters in heated water		N	R
R/AQ-18	Culture of algae for molluscs	C	C	F
R/AQ-19	Selective breeding of oysters		N	C
R/AQ-21	Animal fats in fish rations			N
R/AQ-22 (D)	Algal foods for molluscs			N/F
R/AQ-23 (D)	Ammonia toxicity in rainbow trout			N/F

#### Fish and Shellfish Diseases

R/FSD-1	Immunization of fish against vibriosis			N
R/AQ-9	Infectious diseases in fish		N	F
R/AQ-13	Glugea disease of fish in Oregon estuaries		N	F
R/BR-9	Neoplastic disease of bivalve molluscs	N	C	C

#### Biological Resources

R/BR-4	Pelagic fisheries environment off Oregon	C	C	F
R/BR-5	Pelagic food chain processes		N	F
R/BR-6	Early life of boreal food fish	C	C	R

#### Exploitation of Stocks

R/ES-2	Gillnet boat propeller shroud		N	F
R/ES-4	Fishing gear and methods development			N/R
R/ES-5	Branding and marking of Dungeness crabs			N
R/ES-6	Prediction of harvestable Dungeness crab			N
R/ES-7	Groundfish stock assessment			N
R/BR-1	Tanner crab as a potential fishery		N	F

#### Marine Product Development

R/PD-2	Marine biomedicinals	C	T	
R/PD-8	Discoloration of albacore tuna		N	F
R/PD-10	Utility of fish muscle	N	C	C
R/PD-12	New seafood product concepts		N	F
R/PD-16	Processed salmon markets: U.S. and Canada		N	F
R/PD-17	Economics of marine firms	C	C	F
R/PD-18	Industrial engineering system study	C	C	C

		FY 73	FY 74	FY 75
R/PD-19	Blueing discoloration in Dungeness crab			N/F
R/PD-20	Trimethylamine oxide in Pacific shrimp			N/F
R/PD-21	Microbial evaluation of seafood processing			N
R/PD-22	Marine by-products as protein sources			N
<b>COASTAL ZONE ENVIRONMENT</b>				
<b>Coastal Management Program</b>				
R/CM-1	Coastal sand transport	C	C	F
R/CM-2	Operational wave observing and forecasting			N
R/CM-8	Groin spacings on beaches			N/F
R/CM-9	Ocean and nearshore structure design			N/F
R/CM-10	Economic benefits from environmental improvement			N/R
R/CM-11	Public and private outdoor recreation			N/F
R/CM-12	Oregon coastal zone land			N/F
R/CM-13	Public service pricing			N/F
R/CM-14	Citizen participation in planning			N/F
<b>Estuarine Management Program</b>				
R/EM-1	Estuarine hydraulics	C	C	F
R/EM-3	Wooden water-front structures			N
R/EM-4	Wave interaction with moored structures			N/F
R/EM-5	Cellular bulkhead wharves			N
R/EM-6	Economic information: marine industry			N/F
<b>HUMAN RESOURCES</b>				
<b>Professional and Technical Education Program</b>				
T/T-2	Commercial fishing technician training	C	C	C
T/T-3	Marine technician training	C	C	C
E/L-1	Professional training in ocean law	C	C	C
E/MRM-1	Professional training in marine resource management			N
E/LS-1 (D)	Literature and the sea: Steinbeck			N
<b>Marine Advisory Program</b>				
		C	C	C
<b>Public Policy Analysis Program</b>				
R/PPA-1	Research and publication in ocean law	C	C	C
R/PPA-4	Economic impact of a crab moratorium		N	F
R/PPA-5	Social well-being distributions			N/F
<b>PROGRAM ADMINISTRATION AND DEVELOPMENT</b>				
M/A-1	Program administration	C	C	C
M/A-2	Program development	C	C	C
M/A-3	Assessing benefits of advisory services		N	F

## FINANCIAL SUMMARY

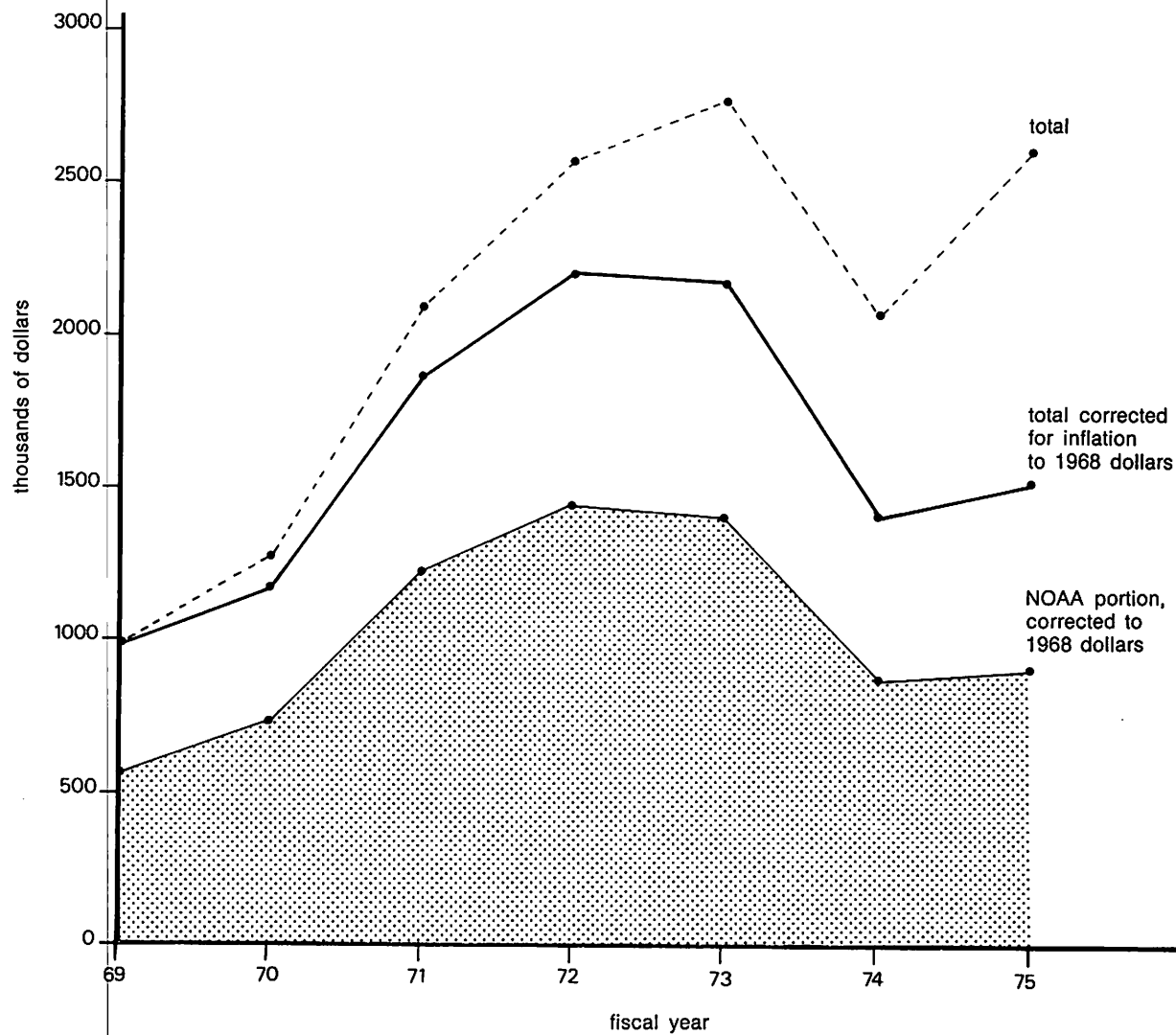
### BUDGET SUMMARY

by type of activity  
July 1, 1974—June 30, 1975  
expenditures

	NOAA	University
<b>Research</b>		
Marine Resources Development		
Aquaculture	205,185	116,895
Living Resources other than Aquaculture	338,080	160,068
Socio-Economic and Legal Studies		
Marine Economics	117,125	54,540
Ocean Law	15,280	8,863
Socio-Political Studies	10,845	7,822
Marine Technology Research and Development		
Ocean Engineering	181,501	127,329
Resources Recovery and Utilization	154,815	95,664
Marine Environmental Research		
Research and Studies in Direct Support of Coastal		
Management Decisions	44,135	22,309
Applied Oceanography	64,750	3,251
<b>Education</b>		
Marine Education and Training		
College Level	10,732	5,822
Vocational Marine Technician Training	39,471	137,280
<b>Advisory</b>		
Advisory Services		
Extension Programs	216,157	144,498
Other Advisory Services	48,160	51,881
<b>Program Management</b>		
Program Management and Development		
Program Administration	102,378	99,545
Program Development	1,386	16,217
<b>Totals</b>	<b>\$1,550,000</b>	<b>\$1,051,984</b>

This budget summary is not a final fiscal report. Expenditure figures are only approximate.

Oregon State University  
Sea Grant College Program  
Funding Level



## FOOD FROM THE SEA

### AQUACULTURE PROGRAM

DeBoer, James A. 1975. The utilization of nonliving algal products by larval oysters. Ph.D. Thesis Abstract. [X1-75-001].

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