A look at Sea Grant in North Carolina 1977

Contents

Maurice Ballance had his shoes off, his head thrown back and his eyes closed. Stomping out a steady rhythm, he picked a well-worn guitar.

The tune was "Patty's Holler," a favorite of Ballance and the other three men who meet with him for regular jam sessions. It's a song about the old days on Ocracoke—one of the tunes that helps him remember a lifestyle that is rapidly passing into history.

Like the other musicians Ballance was born and raised on Ocracoke. In fact his ancestors settled on the island in the late 1700s. His father was a professional fisherman in an era when almost all of the island's residents depended upon the plenty of the sea for their livelihoods.

Times were different then. Wild ponies ran in groups of 200 and 300 across the dunes and down the sound side of the narrow island. Fishermen and their families clustered in a tiny village protected from the sea by a maritime forest. Their distinctive Outer Banks accent, a vestige from English colonists, attested to generations of isolation from the mainland.

"You know, fishing is like farming. You have good years and bad years," Ballance remembers. Even in the good years, finances were tight. Occasionally the islanders tried their hands at farming in the sandy soil or raising cattle on marsh grass. If the potato patch didn't get washed out by a hurricane, it was worth the effort. But mostly they traded with mainland farmers for the vegetables they needed: a keg of salted mullets for a couple of bushels of corn.

The isolation also meant that modern conveniences came late to the island. When Ballance was growing up in the 1930s, there was no electricity or run-

ning water. The mail boat made one round trip between Atlantic and the island daily. And about twice a week another boat brought supplies from Little Washington.

After World War II, things began to change. The first ferry system was installed. Gradually the island's pristine beaches and quaint fishing village were discovered by tourists. In the late 1950s the National Park Service bought up most of the island to be included in the Cape Hatteras National Seashore.

"Yankee dollar"

But Ballance recalls that it wasn't until the 1960s that the influence of tourists and the "Yankee dollar" began to have far-reaching effects. Now in the summertime the narrow road running through desolate dunes is clogged with traffic. The herds of wild ponies have dwindled to a few half domesticated, fenced-in ponies. Ferries running several times daily connect the island with three locations on the mainland.

The changes have meant increased prosperity for the islanders. It used to be that young people who chose not to fish commercially were forced to move away from Ocracoke to find work. Now many of them stay to take jobs with the park service or in the growing number of motels, restaurants and gift shops.

But increased prosperity also has meant giving up some of the old ways. And tradition dies hard on this rugged little island where fierce independence, stamina and strong community bonds were the keys to survival for so many generations.

Ballance's life has been touched by the island's changes. Like his ancestors he is a commercial fisherman. He used to fish full-time until it got too hard to make a decent living that way. After retiring from the Coast Guard in 1965, he began to work for the state's ferry system. But fishing is in his blood. Whenever he gets the chance, he's out fishing with his brothers and cousins, in the tradition of his ancestors.

Most of Ballance's friends are also bending with the winds of change on Ocracoke. They're turning from full-time fishing to more reliable employment. Many small time fishermen have been replaced by a few large trawlers. Gradually the traditional Ocracoke fishing village is evolving into a tourist center.

"Some people like the tourists. Some don't. But I guess they're a necessity around here now," says Ballance.

Sea Grant

Maurice Ballance's tale is the story of much of coastal North Carolina today. Perhaps more than any other area of the state, the coast is caught in the cross currents of change brought on by advanced technology, increased development and tourism. It is an area ripe for conflicts over the use of increasingly valuable land and water.

It was in the light of these sweeping pressures on coastal sections of the United States that Congress established the National Sea Grant program in 1966. Modeled after the tried and true land grant college concept, it was designed to help communities come to grips with some of their problems.

North Carolina

Sea Grant has been working in North Carolina since 1970. It started as a small program funded by federal and state monies to do applied research. Today it is a unique blend of research, advisory services and education. One of 26 similar programs in the nation, it achieved the distinction of Sea Grant College status in 1976 for excellence in all three areas.

Working with faculty members on four campuses of the University of North Carolina and other scientists throughout the state, Sea Grant has access to a variety of talents and expertise. Over the years the program has grown. In 1977 UNC Sea Grant sponsored 16 full fledged research projects, 16 advisory staff members and several educational programs. Researchers tackled a variety of problems such as waste disposal, erosion, beach access and seafood safety.

Sometimes the regular funding cycle for the Sea Grant program is a little too slow to meet certain pressing needs. Rather than let the opportunity for good research pass, the Sea Grant director allocates mini-grants and project initiation funds. In 1977 that's how researchers began to look at the potential for a new cownosed ray fishery, the

effects of freshwater runoff on shrimp populations and the use of Japanese black pine to slow erosion.

But there's another important aspect of the Sea Grant program. People like Maurice Ballance sometimes need help in dealing with their changing world. Sea Grant's team of 16 advisory agents and specialists is always ready to lend a hand. Often the agents turn to researchers for the answers to pressing questions raised by the coastal public.

In 1977 three agents living in different sections of the coast worked primarily with the commercial fishing industry. Among other things, they introduced commercial fishermen to labor saving gear and helped them find new markets for their catches. One of the fisheries agents joined the staff early in the year, extending help to fishermen in the southern section of the state for the first time.

Another specialist worked with government agencies and individuals interested in solving some of the sticky difficulties of land use management on the coast. And, since recreation is a booming business in the coastal area, it claims a growing portion of Sea Grant's advisory services effort. In 1977 a recreation agent joined the recreation specialist on the Sea Grant team. Together they worked with marina operators, charter boat owners, sport fishermen and a variety of others.

With its research and advisory service program well in hand, Sea Grant placed a new emphasis on education in 1977. Several new projects were aimed at improving marine education in the public schools and universities.

Research, education and advisory services ... they all work together to form the Sea Grant program. And just to make sure that the people who need information and help get it, Sea Grant has a team of communications specialists. They use the mass media and a variety of publications geared to special groups of people to do their job.

Fishing

Murray Bridges fishes for a living, mostly for blue crabs. His is a one-man operation that gets underway before dawn on any halfway decent day between April and September. He shoves off from the dock near his house in Collington and heads out in the Albemarle Sound to check on 150 crab pots he keeps out most of the season.

Bridges and his wife Brady also run one of the more sophisticated peeler crab operations in the state. Peelers are delicate creatures. "Just like newborn babies," according to Bridges. If you don't want to lose any, you have to check on them like clockwork every three hours. That makes for a demanding schedule, so it's important for Bridges to cut corners wherever he can.

That's why Bridges is more than willing to try out the hydraulic equipment Sea Grant fisheries agent Hughes Tillett recommends to him. Tillett believes that the gear can save fishermen valuable time, energy and money. In 1977 he helped Bridges install a pot puller on one boat and a hydraulic reel on another.

Bridges figures he can pull 30 pots an hour by hand on a pretty day. With the hydraulic pot puller he can do 45. "You can fish a third more pots and then you're still not as tired as you would be if you pulled by hand," he says.

Bridges is one of several fishermen Tillett relies on to show off new

Photo: Murray Bridges

hydraulic equipment. "It's hard to sell new techniques to fishermen," admits Bridges. "It's more or less got to be a proven fact." Tillet feels that he is making progress, though. When he joined the Sea Grant staff in 1974 hydraulic gear wasn't being used in the northern section of the state. Now it is becoming more and more common.

Like most commercial fishermen, Murray Bridges is part of a large business community. It includes net makers, boat builders, fish processors, gear dealers and sometimes the owners of retail fish markets. Tillett, like Sea Grant's other two fisheries agents, deals with people in all aspects of that community at one time or another. His interest is in making the fisherman's business more efficient and profitable.

Tillett is always calling on his own past experience as a commercial fisherman to help others out. In 1977 he taught shrimp net construction, adjustment and operation to about 35 local fishermen. He also continued his work with several fishermen on the Outer Banks who now farm oysters and clams to supplement their incomes. And he answered hundreds of questions about everything from fishing seasons to eel pots.

In 1977 Sea Grant added another pair of hands to its fisheries staff. Jim Bahen set up shop in the Marine Resources Center at Ft. Fisher. Almost before he had his feet firmly on the ground, Bahen was called on to lend a hand to a struggling new seafood company in Carolina Beach. Saddled with a green captain and crew and inadequate rigging, the business' main fishing boat was floundering. Bahen helped the ow-

ner find an experienced captain and more functional rigging.

Then in October he helped to organize a trip to Alabama for six North Carolina boat builders. The trip opened the lines of communication between boat builders in the two states and exposed the North Carolina boat builders to techniques for building steel-hulled boats and rigging for stern trawling. Most North Carolina fishermen still use side trawling rigs and wooden boats. In addition the trip sparked at least one cooperative building venture between two North Carolina companies.

Skipper Crow is Sea Grant's fisheries agent in the central section of the coast. His headquarters is the North Carolina Marine Resources Center at Bogue Banks. Among other talents Crow has a flair for business management. That makes him a real asset to fishermen who need help in tapping new markets for their catches.

Crow knows that North Carolina fishermen are sometimes forced to take rock bottom prices for their fish simply because the markets are so limited. So in 1977 he began working with the Gulf and South Atlantic Fisheries Foundation to open up new markets in the Midwest. Crow visited five midwestern states and discussed marketing potential with food distributors, supermarket chains and food editors.

After he returned home Crow visited North Carolina fish processors to give them information on midwestern markets that might be opening up. The processors were interested in packaging and handling requirements for the new markets.

Eeling

It was the biggest haul any of the Pamlico River fishermen could remember. In nine days during the fall of 1977, J. C. Morgan and his son pulled in 5,400 pounds of eels.

You might say that Morgan comes by that sort of fishing skill naturally. Though he's been fishing for eels only three years, he learned to make eel pots from his father, who plyed the waters of the Pamlico 25 years ago.

The eel pots Morgan makes now aren't very different from those his father fashioned. But there is a big difference in their businesses. Morgan's father used to sell his catch for a piddling 18¢ a pound to crab fishermen who used them as bait on trot lines. Now Morgan gets 50¢ a pound from a buyer in Maine who ships them overseas. The eels wind up on dinner tables in Europe, where they are considered delicacies.

Morgan can thank Sea Grant advisory agents for his access to that overseas market. It all started back in 1972 when the agents were casting about for ways to make life a little easier for North Carolina's part-time fishermen. They hit upon the idea of converting the state's waning bait eel fishery into a full-fledged, profitable food industry. As eels were plentiful in rivers and sounds, the agents needed only a reliable market and good techniques for catching and storing them.

Five years later North Carolina's coastal area boasted about 300 part-time eel fishermen, many of them trained by Sea Grant agents. Seven in- and out-of-state buyers offered a steady price of 50¢ a pound for eels and North Carolina was responsible for seven to 15 percent of the nation's eel export. The agents' work had paid off.

By 1977 the eel fishery had stabilized so that agent Skipper Crow no longer had to drum up business. But on request from fishermen he and recreation specialist Leon Abbas taught six workshops on eel harvesting techniques in several coastal towns.

The more sophisticated industry increased the need for a serious analysis of the potential worldwide market for North Carolina eels. With mini-grant funds North Carolina State University economist Ed Leonard sent questionnaires to brokers and major eel consuming countries all over the world. Once the results are in Leonard thinks that they'll help potential eel fishermen and aquaculturists make solid decisions about how much and when to harvest or produce.

The Seafood Industry

Time was when Reginald Caroon kept a group of 60 pickers busy at his Lowland plant during crab season. That was about 15 years ago. These days he uses only 15 to 18 pickers during the peak of the season.

True, there aren't as many crabs as there used to be and there are more crab plants vying for the supply. But Caroon points to a dwindling supply of labor, rather than of crabs, as the real reason for the business slowdown.

"All the crab plants would keep 30 to 40 pickers if they could get them," he says. "It's hard to believe. Most people think that everyone is looking for jobs. But the old people that used to pick are dropping out. It looks like our industry is going to have to go to machinery to survive."

Machinery. It's not a new approach to the United States crab industry. For several years now machines have been used to pick larger crabs like snow, queen and red on the West and North Atlantic Coasts. But until the staff of the Seafood Lab in Morehead City got involved in 1977, only one crab processor had ever used any mechanical means of picking the smaller North Carolina blue crab.

It was a question from an Englehard crab processor that got North Carolina

State University Seafood Lab director Ted Miller interested in testing out a crabmeat roller extractor. The results were surprisingly good: the mechanically picked meat had excellent color, well-defined flakes and fewer shell fragments than most hand picked meats. Miller then worked with the state Shellfish Sanitation Program to have the roller extractor approved for use in North Carolina crab plants.

When Caroon heard that the lab was testing the extractor, he made a trip to Morehead City to see it. Before long he was convinced that the machine could help solve some of his problems. He bought one for his small crab plant "Grandad" in Hobucken.

So far Caroon is tickled pink with the machine. It can pick 1,000 pounds of meat a day and only takes 13 people to operate. It would take 25 pickers to pick that much meat by hand in a day. "We're thinking it's going to cut the cost of actually picking the crab in half. At least you don't have to pay employment and social security on a machine," he says.

And Caroon is pleased with the quality of the product. "The meat's pretty. Real pretty. And it's got good texture. The only disadvantage is that you have to hand pick if you want lump meat which brings a higher price." So Caroon still uses hand pickers at his larger Lowland plant.

Miller notes that because of large amounts of water used in the mechanical picking process, the flavor of the meat suffers slightly. That makes it best suited for processed foods; Caroon sells most of his crabmeat to larger operations for use in deviled crab or crabcakes.

Keeping seafood processors informed about the latest in equipment is just one of the roles of the seafood lab staff. The staff's overall goal is to improve the seafood industry in North Carolina. Sometimes that means helping processors stay in line with increasingly complex and demanding government regulations. At other times it means making simple good housekeeping suggestions that will improve sanitation in a plant.

Some facts and figures

The North Carolina State University Seafood Laboratory, operated jointly by University of North Carolina Sea Grant and the Agricultural Extension Service, is located in Morehead City. In 1977 project coordinator Frank Thomas and staff members Ted Miller, Joyce Taylor, Dave Hill, Keith Gates and Clark Calloway:

— Assisted seafood processors in redesigning or making additions to facilities of ten companies in coastal North Carolina.

— Experimented with the Torrymeter, an electronic instrument developed in Scotland which can be used to assess freshness of fish. A Torrymeter was later purchased for agents to use in monitoring seafood samples in the field.

— Distributed 6,075 pieces of literature in response to requests.

— Had 436 extension and advisory service contacts and made 175 visits to clients in the field.

— Deboned North Carolina and Gulf Coast croaker on a quarterly basis for use in seafood research programs. Staff member Joyce Taylor used deboned fish meat in her work with Nutrition Leaders to prepare new seafood products, expand use of traditional seafoods and substitute fish for other protein sources.

— Began a study of the sources of bacterial contamination on commercial fishing vessels. Results should produce economical, easy ways for fishermen to improve boat sanitation.

— With mini-grant funding student assistant Freda Ramey compiled an annotated bibliography on deboned fishery products. The booklet, printed early in 1978, should prove valuable to researchers and processors all over the world.

As world populations continue to grow so does the need for an inexpensive supply of protein. More and more, researchers are beginning to look to the sea to meet that need. They recognize that many types of nutritious seafoods are never harvested from United States coastal waters. Other large quantities of finfish are harvested and then discarded because of their size or the low price they bring on the market.

One study, for instance, shows that between four and seven pounds of finfish are thrown away for every pound of shrimp caught in North Carolina's Pamlico Sound. That's the kind of waste no one can afford today. UNC Sea Grant is constantly searching for new ways to put to use these wasted seafoods.

Bringing in a cownosed ray

From waste to profit

Dan Yeomans has watched the cownosed rays roll into North Carolina's sounds year after year. Chances are his father and grandfather, also Harkers Island fishermen, watched them too.

But somehow the sight of thousands of rays beating the water white with their wing-like fins has brought special chagrin to Yeomans in recent years. It's as if there weren't already enough trials and tribulations for the full-time fisherman.

"Fishing has been worse, absolutely, than it used to be," contends Yeomans. "I ain't got any income but fishing and it's been hard on me."

What bothers Yeomans about the rays is that they live up to their reputation for destroying shellfish beds and tearing up the eel grass that's a prime habitat for other fish species. And that cuts into his fishing income.

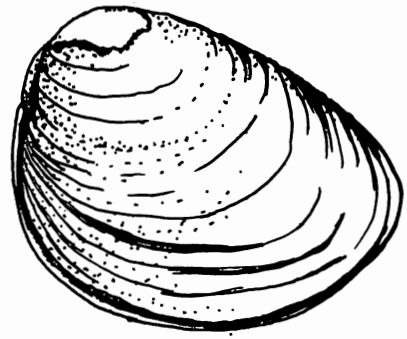
So Yeomans was more than interested when Sea Grant agent Skipper Crow and North Carolina State University food scientist Steve Otwell decided to turn the ray problem into an advantage for fishermen. Until then Yeomans hadn't known that the ray's cousin, the skate, is considered a delicacy in many European countries. Crow and Otwell wondered whether a market could be found for the North Carolina ray.

As they saw it, finding a profitable market for the rays would solve two problems. It would cut down on the populations of rays moving up the sounds twice each year and possibly minimize damage to shellfish beds. And it would give fishermen a crack at a new fishery during what are usually lulls in the fishing season. Crow and Otwell believe that the ray can be successfully harvested by long haul nets.

The researchers sent test shipments of North Carolina rays to some European buyers and investigated freezing, packaging and shipping techniques in 1977. Early studies indicated that North Carolina rays might be acceptable on European markets in spite of the fact that their flesh is considerably darker than that of the ray's popular cousin the skate.

But starting a new fishery is serious business. Preliminary evidence suggests that the cownosed ray may be vulnerable to overfishing. So Crow and Otwell are cautiously continuing their studies in 1978.

Meanwhile, Dan Yeomans is waiting. The new fishery would give him a big boost. "It would help me a whole lot. It would give me one or two months in the spring and the same in the fall ... if I could sell 'em."



Rangia clams

The Rangia clam is a familiar resident of the shallow brackish waters of North Carolina's estuaries. It looks more like a mussel than a clam and those who have ventured to taste it say its flavor is "musty."

While it is not a prime item in seafood restaurants, the Rangia has been marketed. In the 1890s it was sold in Texas as the "Texas little neck." And for a brief spell in the 1960s one North Carolina seafood dealer sold the Rangia to markets in New York.

That business came to an abrupt halt when a shipment of freshly shucked Rangia failed to pass inspection by New York health authorities. The shipment was seized because the clams had an extraordinarily high level of bacteria. Ten thousand dollars worth of Rangia clams was destroyed.

In spite of that financial setback, today some seafood dealers have hopes of reviving the Rangia market. But

before they do, Bob Benton of the Shellfish Sanitation Program in Morehead City wants the answers to a few questions. What is the cause of the high bacterial count in the Rangia? Does it pose health hazards?

With project initiation funds, researchers Barnie Kane and Donald Jeffreys of East Carolina University periodically sampled Rangia at four sites in the Albemarle Sound. The clams were taken from waters representing extremes in environmental and sanitary conditions.

The researchers determined that the Rangia has a naturally high level of bacteria. More importantly, they found that the samples taken from waters that were open to shellfishing did not contain disease causing bacteria.

At this point Kane and Jeffreys believe that the Rangia is no more harmful to the consumer than any other shellfish. But they aren't yet ready to give the Rangia a completely clean bill of health. At the request of Benton and the U.S. Food and Drug Administration, they are trying to identify specifically the bacteria found in the clam.

The researchers are continuing their work in 1978 to study a few more marketing questions associated with the clam. They want to know, for instance, whether the clam's populations in North Carolina can support large scale harvesting. Kane has also observed that, because of its high bacterial count, shucked Rangia meat goes bad quickly. He is experimenting with pasteurization to see if the shelf life of the clam can be extended.

Fish pups?

Picture this: you're checking out of your favorite supermarket. In the cart, along with the usual supply of red meats and poultry, you've got a few fish products. You've selected fish pups for the kids, fish spread to use in sandwiches and fish bits to use in salads. And, oh yes, a little fish jerky for snacking.

Sound bizarre? It may not be far from reality in a few years. Food scientists Don Hamann and his associate Tyre Lanier of North Carolina State University have dreamed up those products to make better use of croaker, one of the state's underutilized finfish.

An excellent source of protein, croaker meat is also very low in fat and carbohydrates. And although about 15 million pounds of croaker were landed in North Carolina during 1977, most of it was ground into pet food and fertilizer. The reason? Because croaker is a bony fish, the recovery from filleting averages only about 30 percent. Mechanical deboning and flaking of the fish for seafood products solves that waste problem.

In 1976, Hamann discovered that the texture and flavor of croaker products varied with the origin of the catch. That was one problem that had to be solved because product consistency is one of the keys to marketing. This year Hamann found that the undesirable mushy texture found in some croaker meat was due partly to poor handling techniques and could be dramatically improved by rapid heating of the fish flesh.

In 1977 the researchers also perfected their key product, luncheon loaf. Using it as a base, they developed a number of other products, including a fish hot dog (called a "sea pup"), dry fish jerky, party dip, sandwich spread and fish bits.

Seafood Safety

It was a nightmare come true. In September, 1973, 15 cases of infectious hepatitis were reported in Calhoun, Georgia. The following month another 270 cases broke out in Houston, Texas. Illness in both cities was traced to unsafe oysters from a shipper in Louisiana.

Bob Benton knows that case history almost by heart. It's the kind of story that makes him squirm. "If we have something like that from this state, my seat's too hot to sit in," he says.

As supervisor of the North Carolina Shellfish Sanitation Program in Morehead City, Benton is responsible for protecting the consumer from health hazards associated with these highly perishable seafoods. He and his counterparts all over the country know that theirs is no easy task. It involves keeping tabs on everything from pollution in the estuaries to sanitation in seafood processing plants and, finally, proper testing to pick up contaminated products.

Benton can use all the help he can get. In 1977 Sea Grant sponsored four projects aimed at keeping the nightmare from recurring.

Bacteria . . .

It was just one of those fluke accidents. But it could have cost Southern Seafoods as much as $25,000.

Sea Grant researcher Cameron Hackney was making a routine check of the scallop plant near Swansboro when he discovered the problem. Samples of scallops taken from all stages of processing showed alarmingly high fecal coliform counts. That meant that the scallops could pose health hazards to the consumer. Because Southern Seafoods is a clean, well managed operation, Hackney was surprised. So was plant manager David McAlister. He asked Hackney to continue testing to find the source of contamination.

The bacteria turned out to be coming from the well which supplied water for the plant's fluming operation. The top of the well had accidently been broken off and contamination had seeped in. Hackney recommended that the well be chlorinated and resealed and the problem was cleared up immediately.

The tragedy of it is that if it hadn't been for Hackney, McAlister might not have found out about the contamination. Most North Carolina seafood processors don't have the equipment or know-how to conduct sanitation checks on their products. Only when a shipment is tested, rejected and returned by the Food and Drug Administration does the processor know he's got a problem. And that costs him a lot of money.

Hackney is assisting food scientists Marvin Speck and Bibek Ray at North Carolina State University, who are studying this and other problems of microbiological contamination of North Carolina seafood. Based on their research, Speck and Ray have recommended that seafood plants be periodically monitored to ensure safety to the consumer.

And the researchers have come up with another test that could save processors money. They have developed a direct plating method for determining fecal coliforms in seafood that's simple and effective. It also cuts down on the time required for the test—from 96 to 24 hours. That could make a big difference to a processor whose seafood shipment is being held up because of suspected contamination. Speck and Ray are continuing their work in 1978.

During 1977 the researchers tested 220 samples of fresh seafoods from North Carolina processing plants, supermarkets and seafood markets. Results indicated the need for more uniform sanitation in the handling of seafoods. Many of the samples exceeded permissible limits for a variety of bacteria.

The researchers found that seafoods from North Carolina's seafood retail markets had consistently fewer contaminants than those from supermarkets. They attributed the difference to fast turnover, better storage conditions and better sanitation in the seafood markets.

Dumping scallop shells at Southern Seafoods

. . . Viruses

When it comes to shellfish sanitation in the United States, the buck stops at Dan Hunt. As assistant chief of the shellfish sanitation branch of the Food and Drug Administration (FDA), he has an awesome job.

One of the things that worries Hunt is increasing evidence suggesting that current standard shellfish sanitation tests aren't all they're cracked up to be. The bacterial test for fecal coliforms in shellfish, it turns out, may not be an adequate indicator of enteric viruses which cause such diseases as hepatitis and polio. More and more Hunt is looking toward new developments in the field of virology for better tests.

Mark Sobsey of the University of North Carolina at Chapel Hill is one of the people Hunt is relying on. With Sea Grant funding in 1976 Sobsey developed a method for detecting enteric viruses in oysters and clams. Sobsey believes that his test may be a better indicator of harmful contaminants in seafoods than the current standard tests. Hunt would like to see Sobsey's method or a similar one perfected so that it can be used all over the country. Several scientists in Hunt's agency are also experimenting with Sobsey's method.

In 1977 Sobsey did further evaluations and field tested the new method. He plans to use it in a 1978 Sea Grant project designed to establish the relationship between sewage contamination and enteric virus levels in shellfish and in the waters and sediments of their environment.

The question of metals

Zinc, copper, cadmium and mercury. They're probably the last things on your mind when you sit down to a succulent seafood dinner. But traces of these heavy metals do occur in seafoods. And, if the levels are high enough, they can be extremely harmful to man.

Because of the danger these heavy metals pose to the consumer, it's important that scientists be able to test adequately for them. With Sea Grant support in 1976 George Giddings of North Carolina State University perfected a simple, inexpensive method that will do just that.

In 1977 Giddings and his associate Lila Hill applied the method to see how manual and mechanical processing affect the levels of trace metals in blue crab meat. Their results show that manual processing appears to have little effect on trace element levels except when the viscera are richer in a particular metal than the meat. In those cases evisceration and washing prior to steaming result in reduced levels. The results with mechanical processing varied. Copper and arsenic levels, they found, were reduced while zinc levels increased and mercury levels remained the same.

In general the researchers found that while processing decreases water soluble and blood-related metals, it has little effect on insoluble and muscle-bound elements.

Giddings is also interested in how processing affects the nutrition of seafoods. He picked one of North Carolina's plentiful but undertuilized finfish, spot, for testing. The results indicate that spot is a good candidate for processing, as it loses little nutritional value or texture. In comparing three frozen storage forms—in the round, headed and gutted, and mechanically deboned—Giddings and Hill found that spot frozen in the round was least subject to spoilage.

A lot of factors influence the fishing industry. Too much rain. Too little rain. A long, cold winter. The weather, unfortunately, is something nobody can do much about. But these days there are other forces which help determine the supply of fish. Man's development of coastal land and the resultant pollution can have adverse effects on the industry. Often it's difficult to tell exactly how these pollutants work. In 1977 Sea Grant sponsored two mini-grant research projects designed to look at pollutants believed to be influencing the North Carolina fishing industry.

Too much Fresh water

When Harold Harris decided to go into commercial fishing 11 years ago, he left Pitt County and settled near Swanquarter. The way he saw it, that was the logical place for a full-time fisherman to be. The nearby Pamlico Sound offered some of the best oystering, crabbing, shrimping and finfishing in North Carolina.

But today Harris thinks that area is "a totally different place." Dozens of oyster shucking shacks lining the shore of the once famous Rose Bay stand unused. The number of boats crabbing in the area has dramatically declined.

Harris thinks he can pinpoint the reason for the decline of fishing in these waters. It's called fresh water intrusion and it refers to the runoff of fresh water into normally brackish or salty waters.

Fisherman Harold Harris

Too much fresh water lowers the salinity levels in estuarine areas that are the nursery grounds for shrimp, oysters and some commercially important finfish. Most species can tolerate a certain amount of fresh water; beyond that, their populations can be affected dramatically.

Runoff is a natural phenomenon. Every time it rains, water from upland areas runs eventually to the shore. But what concerns Harold Harris and other fishermen is that a sudden burst of superfarms and housing developments has meant that large tracts of nearby land have been cleared and drained by canals. In the process swamp forests that naturally trap and slowly filter the rain water were cut down. In the canals, fresh water runs faster and more directly into the estuaries.

"I know a farmer has got to be able to drain his land," Harris says. But he thinks that there ought to be more stringent regulations on just how it's done. In June, 1976, Harris and another fisherman from Rose Bay decided to take their gripes to the state Marine Fisheries Commission in Raleigh. They did, along with a petition signed by 3,000 commercial and sport fishermen urging an investigation of the fresh water intrusion problem in the Rose Bay area.

In response to that petition, Sea Grant funded a study of the effects of drainage on Rose Bay fisheries. Preston Pate of the North Carolina Division of Marine Fisheries decided to look closely at populations of juvenile brown shrimp in the bay. Shrimp are very sensitive to salinity levels and less affected by other complicating factors. But Pate also is studying oysters and several commercially important finfish.

Early in the winter, Pate set up monitoring stations in Rose Bay. But as luck would have it, the spring and summer of 1977 were so dry that there was virtually no upland runoff. He was able to determine that the selected sampling sites were located in productive nursery areas for the brown shrimp. Pate is continuing the study in 1978.

Fluoride And crabs

Fluoride is one of the known pollutants of estuarine waters that has caused increased concern in recent years. The number of industries—especially phosphate mining operations—which produce or use fluoride is on the rise. In North Carolina, for instance, the Pamlico River has a higher than normal fluoride level which may be attributable to a large phosphate mining operation located on the river's banks. Mining operations there are expected to double within the next two years.

That prospect interests East Carolina University chemist Edgar Heckel. Heckel suspects that high fluoride concentrations impair the ability of the blue crab to molt properly. He knows that the Pamlico River is one of the state's important blue crab fishing areas.

In 1977 North Carolina fishermen harvested more than 12 million pounds of blue crabs in North Carolina and sold them for a dockside value of about $2.1 million. Most of the crabs were bought and processed by the state's 20 crab houses. So, any change in the blue crab industry is bound to affect a lot of lives and pocketbooks.

After several months of testing, Heckel determined that high fluoride concentration in water adversely affects blue crab survival rates. Heckel is continuing in 1978 to look at the connection between impaired molting and high mortality of the crabs.

If fluoride is found to significantly decrease the crab's chances for survival, federal and state policies pertaining to effluents with high fluoride counts will need to be reexamined.

Left: empty shell following successful molting. Right: crab, unable to escape from shell, died.

Aquaculture, the business of raising food normally harvested from the sea, is a young science. But already it provides 10 percent of the world's seafood. Through its demonstration eel farm and a project on disease in aquaculture, Sea Grant is helping to solve some of the problems that plague the fledgling industry.

Farming Eels

Nobuyoshi Kuraoka knows eels. He's been eating them all his life. What's more, he owns two of the finest Japanese restaurants in New York and handles a food export business for top Tokyo restaurants.

So when he responded with rave reviews to a test shipment of eels from the North Carolina State University Eel Aquaculture Project, it meant something. In fact, Kuraoka was so sold on the eels that he hopped a plane to New Bern the next day just to take a look at the culture operation that produced them. His response was good news for Sea Grant staff Bill Rickards, Walt Jones and John Foster who run the eel farm. It meant that the culture techniques they had perfected over the last three years were finally paying off where it counts—in taste tests.

The eel farm got underway in 1974 when Sea Grant agents wanted to expand the market for North Carolina eels, which were then being shipped exclusively to Europe. They discovered that only the smaller, tastier eels produced by culture commanded top prices on the Japanese and Taiwanese markets. Preliminary investigation showed that eel culture could be a profitable business venture in coastal North Carolina. Culture operations could rely on large supplies of wild elvers (baby eels) in coastal waters for stocking ponds.

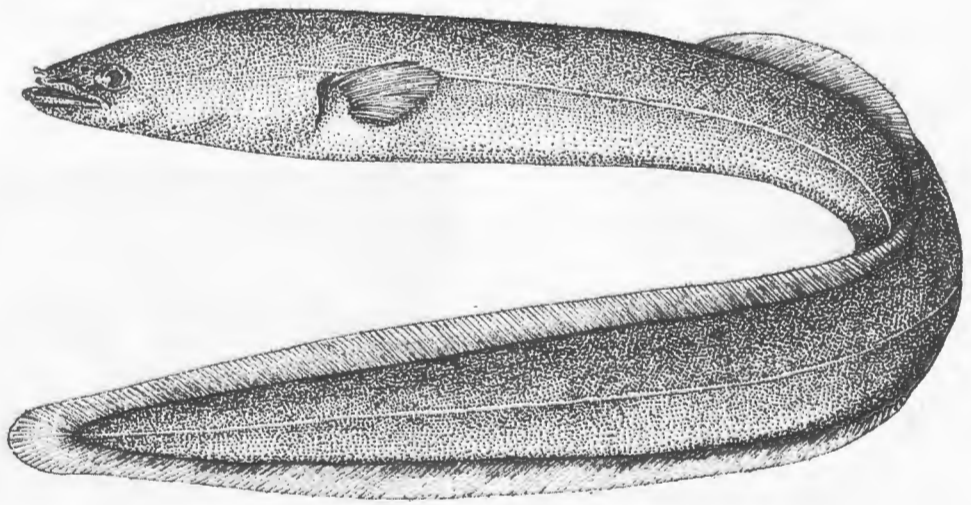
So the eel farm was set up as an experimental model. Since then the farm has provided information to at least seven culture operations and five eel research projects which have been started in the United States.

The eel aquaculture project has now gained recognition on a national and international scale. In 1977 Rickards organized a two-day workshop in New Bern for informal exchange of information on eels and eel farming. More than 70 people attended, including fishermen, culturists, researchers, marketing specialists and fisheries management personnel. In addition about 230 visitors, including several from foreign countries, toured the farm during the year.

Also in 1977 researchers designed an elver trap which drastically cut the amount of time required to collect elvers for stocking the farm's ponds.

More Questions

In response to many requests for information, North Carolina State University economist Jim Easley took a serious look at the economic feasibility of eel farming on a commercial basis.



American eel, Anguilla rostrata

The prospects look good for a commercial operation similar to the demonstration farm in New Bern. Easley found that the initial investment for an eel farm capable of producing about 20 metric tons of eels per year was about $61,000. The break-even sale price for those eels would be about $1.08 per pound. Cultured eels now being sold to Japan can bring as much as four times that.

Another mini-grant project got underway in 1977 which could result in a major breakthrough for culture operations that depend on wild elvers for stocking ponds. East Carolina University biologist Charles O'Rear began experiments to find an easy method for determining the sex of elvers. The technique would allow eel farmers to stock their ponds largely with females, which have a much faster growth rate. The study is continuing in 1978.

Fungus Infections

Every business has its difficulties. But sometimes it seems that the infant industry of aquaculture has more than its share. Troubles often take the form of microscopic disease-causing fungi.

In the confined spaces used for aquaculture, a fungal infection can spread in a hurry—sometimes wiping out entire crops of shrimp, crab or lobster in a matter of hours. Since ten percent of the world's seafood supply comes from aquaculture, these fungi can be at the root of financial disaster on a very large scale.

Unfortunately, not many of the disease-causing fungi have been identified and there are few known treatments for them. That's why East Carolina University biologist Chuck Bland started investigating the problem seven years ago. Now he's an authority on fungal diseases which affect cultured crustacea.

Fighting back

According to Bland pathogenic fungi enter culture operations in two ways: via the water system or through captured wild stock. Once in the system, they multiply and infect the cultured animals—breaking down muscle tissue and eventually killing the stock. Bland believes that filtration and chlorination of the water system are essential steps in reducing fungal attack. But water treatment alone usually won't control a fungus. Chemical treatment of the animal itself is necessary.

So far Bland's Sea Grant supported work has concentrated on one particularly prevalent and deadly fungi, *Lagenidium*. In 1977 Bland identified and cultured seven different strains of the fungus and found three chemicals that inhibit its growth. He also did further work on another fungus, *Halipthoros milfordensis* and he found five chemical compounds to combat it.

So far the most promising chemical Bland has found for the treatment of fungal diseases is malachite green. In 1977 he discovered that the chemical inhibits growth by poisoning the fungus cell's respiratory system. Unfortunately, malachite green has not been approved by the Food and Drug Administration (FDA) for commercial use because it has been implicated as a carcinogen.

The key question that must be answered before FDA will consider approval is: does the chemical remain in the cultured animals' tissues after treatment? This year Bland and a group of scientists at the University of Arizona's shrimp culture facility at Puerto Penaseo, Mexico, tackled that question. After a series of experiments they determined that a negligible amount of malachite green remained in treated shrimp eggs and larvae. Bland will continue work with malachite green in 1978.

Of course, there's immediate practical application for many of Bland's findings. In 1976, for instance, he identified and recommended treatment for a fungus that was on the verge of wiping out one aquaculture firm in Honduras.

In 1977 Bland completed most of the writing for a manual on identification and control of fungal diseases in aquaculture. The book will help aquaculturists recognize common diseases and tell them how to prepare and ship specimens to labs for diagnosis and treatment information.

Recreation

All good sport fishermen have their favorite techniques for just about everything—from choosing lures to rigging bait and outfitting boats. And a lot of them guard their secrets jealously.

That makes it rough on hundreds of sportsmen who try their hands at fishing for the first time each year. Too often they find that they can't get enough information to make the sport really enjoyable. In 1977 Sea Grant's recreation specialist Leon Abbas decided to give some of the novices a break. So he brought in professional fisherman Doug Scott of Jacksonville, Florida, to share his knowledge of terminal rigging for offshore trolling. A day-long workshop was held for 150 local fishermen at the North Carolina Marine Resources Center at Fort Fisher.

"It busted the secrets wide open," recalls Wilmington resident J. W. Johnson. And it wasn't just for the novices, Johnson contends. "I've bait rigged all my life and I still learned something," he says.

An avid fisherman, Johnson is a past president of the New Hanover Fishing Club, which boasts between 1,500 and 2,000 members. He and others responded to the workshop so well that Abbas scheduled a series of similar workshops for 1978.

Coastal recreation. It's play for some, business for others. As an economist and Sea Grant's recreation specialist, Abbas is concerned about both ends of the spectrum.

Lending a hand to sport fishermen is just one aspect of the job. Abbas also is interested in the folks for whom recreation means business—people such as Charles Overbeck who operates the Wrightsville Beach Marina. J. W. Johnson and 129 others dock their boats at Overbeck's marina, the oldest one in the southern section of the state.

Marina business

Overbeck is interested in making a good living in the marina business. What with the high costs of labor and repair materials, bulkheading and pilings, that's not so easy. "Our main concern is keeping our heads above water," he says.

Overbeck is one of the people Abbas and his student assistant interviewed for a study of the saltwater marina industry in North Carolina. Abbas planned the study when he discovered that nobody in the state had a good overall picture of the marina industry. The results of the survey of all 54 marinas will be published in 1978.

Overbeck, for one, is looking forward to reading the report. "What we're doing wrong might help somebody else do it right. And we might find different ways to save a little money," he says.

Abbas also knows that you don't have to live near the ocean to be interested in coastal recreation. To reach some of the inland residents, he sponsored a series of lectures in Raleigh during the spring of 1977. Experts on salt water and freshwater fishing, birding, sailing, coastal folklore and power boating addressed large crowds.

Recreation in coastal North Carolina means everything from hang gliding on Jockey's Ridge to surf fishing at Cape Hatteras. That's a lot of territory for one person to cover. So in 1977 Sea Grant hired recreation agent Dennis Regan to help round out the picture.

Regan's home base is the Marine Resources Center on Roanoke Island. He had hardly moved in before he was out helping community residents plan a bike trail along the Outer Banks. Regan began work on a directory for SCUBA divers of wreck sites off the North Carolina coast which will be published in 1978. He also completed a study of dry stack boat storage, which may prove valuable to marina operators on the coast.

Fishing facts

Sometimes there's no substitute for hard, cold facts—even in a fun loving field like recreation. Abbas and Regan find that it pays to know something about the people they're working with. So Sea Grant funded sociologist Richard Dixon of the University of North Carolina at Wilmington to do a study of sport fishermen at Wrightsville Beach. Among other things, Dixon wanted to know where they came from, how often they visited the area and how much money they spent there.

Dixon's study, conducted in early summer and fall, showed that two-thirds of those interviewed had visited the area before and a little over half owned their own fishing boats. All this information will be useful to the recreation industry and planners for the Wilmington-Wrightsville Beach area.

In many cases education is the key to some of the common dilemmas of contemporary coastal life. UNC Sea Grant moved full steam into the area of education in 1977—reaching out to public school teachers, law students, urban and land planners, and the general public.

Education

Everybody knows that the children of today are the decision-makers of tomorrow. So it makes sense that one good way to protect valuable coastal resources is to teach school children about the coastal area.

In 1977 UNC Sea Grant took a new step in that direction. In cooperation with the North Carolina Department of Public Instruction and the North Carolina Marine Resources Centers, the program funded two summer courses for public school teachers.

Twenty-one middle school teachers were selected for a month-long course in marine studies taught at the Marine Resources Center on Bogue Banks. The course was designed by Dirk Frankenberg of the University of North Carolina at Chapel Hill to introduce teachers to a multi-disciplinary approach to marine education. Eight faculty members from four campuses of the university lectured and led field trips on a variety of subjects ranging from coastal geology to sociology.

The educators earned three hours of credit toward renewal of their teaching

certificates. In return they worked to convert the lectures into materials that can be used to introduce other North Carolina teachers to marine studies. The first sections of the resulting marine education manual were prepared and evaluated in the public schools late in 1977. The manual includes background information and a variety of lesson plans which can be adapted to grades four through nine.

Course participant Susan Warren introduced her fourth, fifth and sixth graders at Morehead Elementary School in Durham to marine science this year. And she's sold on the idea. "I think it's extremely important. There are few children who don't make it to the beach sometime. They need to know something about the coast just for an appreciation of their environment," she says.

Part of the material being used in the manuals came from another Sea Grant educational program held at the Bogue Banks center earlier in the summer. Six science teachers who enrolled in the Marine Awareness Program spent a week immersed in intensive study of a variety of marine environments. Then they went home to spend the rest of the summer developing lesson plans for teaching marine sciences in grades six through nine. The lesson plans were designed to complement physical, natural and earth science curricula already used in those grades.

UNC Sea Grant is now committed to moving steadily ahead with marine education in the public schools. Plans for 1978 call for the addition of a marine education specialist to the advisory services staff. The specialist will conduct a series of workshops designed to instruct teachers in using the new marine education manuals.

Coastal law

As life in coastal areas becomes more complex, so do the legal issues surrounding it. In the United States, a ponderous body of law has grown up around the ocean and the coast—law that becomes increasingly important as the struggle for control of limited resources intensifies.

Unfortunately, the laws are so new and rapidly changing that few attorneys or policymakers are able to keep up with them. That can mean trouble for those who have to enforce or explain legislation governing coastal and marine development.

With Sea Grant funding Tom Schoenbaum took one step toward solving this problem in North Carolina. He taught the state's first ocean and coastal law policy course at the University of North Carolina School of Law in Chapel Hill during the summer of 1977. The five-week course drew a full class, including graduate students in law and urban planning and a few practicing professionals. Course work was based on a two-volume text prepared by Schoenbaum and seven of his students and published by UNC Sea Grant. Already the texts have proved helpful to scientists, policymakers and lawyers in North Carolina and other states.

Schoenbaum believes that the course will be crucial to lawyers going into private practice in the coastal area as well as to the growing numbers of law school graduates who enter government work. "Just about everybody who works with the coastal area will have some contact with marine policy or law," he says.

Ocean law topics considered in the course included international law of the sea, fisheries management, marine mammal protection, laws concerning marine pollution control and laws governing non-living resources. Students also studied the public and private rights to coastal resources, construction and regulatory activities of the U.S. Army Corps of Engineers and land use planning.

As an important spin-off of Schoenbaum's project, graduate students conducted legal research designed to benefit the state of North Carolina. Schoenbaum and student Patricia McDonald wrote a Sea Grant publication based on their research into the state's role under the federal extended fishery jurisdiction law. Other students developed a more efficient maintenance, control and scheduling system for the state's 11 major research vessels. A study of the state's management of Outer Continental Shelf resources is still in progress.

Land use

Sea Grant's land use management specialist believes that land use planning is everybody's business. That's why he turned his attentions to public education in 1977.

For starters Simon Baker and graduate student Les Thornbury produced a 30-minute color documentary film. "An Act to Protect" examines the North Carolina Coastal Area Management Act and the problems which led to its passage in 1974. The film has been aired several times over the UNC-TV network, which reaches audiences all over the state.

Baker also helped design a poster on the state's commercial fisheries for North Carolina's public school children and wrote "A Citizen's Guide to North Carolina's Shifting Inlets." This popular booklet of aerial photographs tells the story of the migration of the state's 22 active inlets.

An expert in aerial photography, Baker put his skills to work on a project that could prove crucial in the aftermath of a major coastal storm. Working with the Raleigh squadron of the Civil Air Patrol, he took a series of oblique angle slides of all 320 miles of North Carolina's coastline. By comparing these slides with those taken right after a coastal storm, the staff of the Division of Civil Preparedness in Raleigh will be able to make speedy assessment of damage. That could mean that aid will get to the stricken area sooner.

Destruction following Hurricane Hazel in 1954

Hurricanes

Educating the public about important issues in the coastal area is one of Sea Grant's major roles. Sometimes that means talking about matters of life and death.

That's what agent Skipper Crow had in mind when he organized Hurricane Awareness Week during the summer of 1977. Crow figured that it had been 17 years since a severe hurricane hit North Carolina. In the interim, millions of dollars worth of construction had gone up along the coast. He was beginning to fear that residents had lost a healthy respect for these deadly storms.

Hurricane Awareness Week featured lectures, films and exhibits on emergency preparedness and the history of North Carolina hurricanes. The activities drew a total of 6,500 visitors to the Marine Resources Center on Bogue Banks. In fact, the program was such a success that advisory agents at all three centers are planning similar activities for 1978.

A long summer season and idyllic beaches make North Carolina's coast an ideal vacation spot. Consequently, each year more houses, businesses and roads dot the coastline. Development has resulted in the inevitable conflicts—between man and the forces of nature and between public and private interests. In 1977 Sea Grant sponsored research aimed at encouraging wiser development in the future.

Beach access

Just a few short years ago the 11-mile stretch of beach at Emerald Isle was sparsely populated. But like most North Carolina beaches it has changed. Private cottages, trailer parks and motels have sprung up along the beach strand.

Beach development has been good for local business. But it has also produced a host of difficulties which sometimes has mayor Ronnie Watson bewildered. Not the least of these is the problem created by large numbers of visitors who drive to Emerald Isle for a day on the beach.

"They drive all the way out here. Then they can't find parking places and can't figure out how to get on and off the beach," says Watson.

Too often for the peace of mind of local residents, the "day visitors" end up parking off the side of the extremely narrow beach road and tromping over private property to get to the beach. Watson admits that the tourists don't have much choice. There are few marked public access ramps and only one commercial parking lot along the 11 miles of beach.

Watson and other residents of Emerald Isle aren't content to sit by and watch the problem get worse. In 1977 they began planning for the construction of access ramps and additional parking areas.

Beach access. The problem isn't unique to Emerald Isle. According to David Brower, associate director of the Center for Urban and Regional Studies in Chapel Hill, there are vast stretches of beach in North Carolina which the public can reach only by trespassing.

The same problem is being raised all over the nation: how do you guarantee people the right to use what is legally theirs—the beach proper—without infringing on the private property rights of others?

Brower took a look at some of the possible answers to that question. He found that there is a multitude of legal techniques that can be used by federal, state, regional or local governments to provide accessways to the beach. And there are federal programs which provide technical and financial assistance to governments working on the problems. All this information will be published in 1978 in two resource books.

There's one more thing Brower is convinced of: beach access problems will only become more acute and difficult to solve as development continues. Now, he says, is the time to act.

Tidal inlets

North Carolina's tidal inlets are a fickle part of a changing coastline. They open, close, widen, narrow and migrate—sometimes with no warning at all. Their fluctuations can mean drastic loss of land and construction.

But whether or not they encroach on man's development, inlets play crucial

roles in the natural system. Because they connect rivers and estuaries with the ocean, they control the circulation of water and sediment in the whole estuarine system. Consequently, inlets affect pollution control, navigation, recreation, flood discharge and fish migration.

Hurricanes or other similar storms are usually responsible for inlet fluctuations. But in recent years man has played an increasing role in inlet formation and change.

As is often the case when man tinkers with natural forces, unexpected things happen. Take the case of Drum Inlet on Core Banks, for example. In 1971 the U.S. Army Corps of Engineers, under pressure to increase the salinity of Core Sound and give fishermen passageway to the ocean, blasted the inlet open. Old Drum Inlet, located two miles north, had previously filled with sand.

The new inlet didn't behave exactly as expected. Steady erosion caused it to widen so much that residents of the area complained of being exposed to increased danger from storm waves. The Corps of Engineers is still wrestling with ways to solve that problem.

North Carolina State University civil engineer Jerry Machemehl is one who believes that it's possible to predict more accurately the effects of man-made changes on flow dynamics and sediment movement in tidal inlets. He developed a finite element flow model for a typical Atlantic Coast barrier island tidal inlet. The model can be used by coastal engineers to assess the effects of inlet alterations on the shoreline and estuaries. Machemehl calibrated the model for Carolina Beach Inlet. It is now available for state and federal agencies to use in making decisions concerning navigation improvements being considered for that inlet.

Overwash

Building a home close to the beach can be a risky business. But Paul Hosier and Bill Cleary are trying to take some of the guesswork out of selecting relatively stable ocean front lots.

They're interested in oceanic overwash, a natural process that is not very well understood by most coastal residents. The two researchers at the University of North Carolina at Wilmington are using aerial photography and on-site surveys to study patterns of overwash between Cape Lookout and the North Carolina/South Carolina border.

Washovers occur when high waters breach the sand dunes and invade coastal land. The wall of water may destroy buildings in its path. It often uproots vegetation and flattens dunes, carrying sand to the inland side of barrier islands or dragging it out to sea again. The displaced sand is usually deposited in a fan shape behind the original dune line. A severe storm or a series of storms may result in deposits that form terraces.

These fans and terraces are the first signs of overwash that Hosier and Cleary look for in their surveys. They are usually visible for several years after a major washover. But Hosier and Cleary believe that they can accurately date washovers as far back as 1900. They have found that regrowth of vegetation on an overwashed beach occurs in predictable stages. Once they've identified the condition of the dunes and the type of vegetation, they have a pretty good idea of when the last washover occurred there.

Hosier and Cleary now believe that some beaches are much more stable than others. They've found that in the last 75 years about 44 percent of the southeastern section of coastal North Carolina has been subjected to washover. The barrier islands north of

Photos: Before and after a winter storm at Cape Hatteras

Cape Fear between Bald Head Island and Topsail Beach seem to be the most vulnerable to overwash.

The researchers also have found that washovers are likely to occur repeatedly in the same places.

Hosier and Cleary believe that information on washover locations will be very valuable to state and local agencies concerned with land planning and permit letting. They plan to make recommendations on land use once their study is completed in 1978. The two are working now on a series of maps which details the history of washover in the study area. Copies of the maps will be made available to developers, land planners and individuals.

During 1977 Hosier and Cleary made a surprising discovery. They found that regrowth of vegetation on washover sites depends partly on the grain size of overwashed sand. Sand dunes re-form more rapidly and plants grow back more quickly if the sand is fine-grained, they say. No extensive dune recovery occurs when the sand is coarse-grained. Cleary believes that the lack of fine sand on North Carolina's southern beaches may be the reason these beaches are smaller and less stable than those in the nothern section of the state.

Erosion. The word itself has an ominous ring that many coastal landowners consider only fitting. As more of them sink small fortunes into premium river front and soundside property, erosion is fast becoming enemy number one.

Unfortunately for many, estuarine erosion is one of those facts of life that isn't considered until the property deed is in hand or the cottage is built. That's when the desperate struggle begins. Many landowners fight back with bulkheads, most of them expensive and only a few effective. Even then the victory is usually temporary. Others pitch anything from old cars to concrete slabs onto their shorelines in a feeble attempt to slow the erosion process.

There's no mystery in the cause for erosion. As the ice caps continue to melt, a rising sea level simply gobbles up land. But there are some questions about erosion that need to be answered. What makes some shorelines erode so much faster than others? Is there anything that can slow or stop erosion without upsetting nature's delicate balance? In 1977 UNC Sea Grant sponsored several projects designed to find the answers.

This lone cypress now marks the site of Bat's Grave, in 1749 a 40-acre island, complete with houses and orchards

Erosion

It's a known fact that some of North Carolina's estuarine shorelines erode faster than others. Erosion may claim a paltry six inches a year at one site and a whalloping 20 feet just a few miles away.

To the person who's thinking of buying river front property, that's a crucial difference. But too often the prospective buyer has no idea how to estimate the rate of erosion of a particular piece of property.

Three Sea Grant researchers at East Carolina University think it doesn't have to be that way. They have spent the last several years gathering information on the state's estuarine shoreline that can be used by the typical landowner and planner.

Geologists Stan Riggs and Mike O'Connor and biologist Vince Bellis knew that erosion rates were dependent upon a variety of factors which ran the gamut from the type of shore vegetation to height of bank. But until they began work, no one had yet applied that knowledge in a specific way to North Carolina's estuarine shoreline.

In 1977, along with a team of students, the researchers completed mapping more than 2,000 miles of shoreline in their little boat the Sweet Agona.

From these maps, they drew up a classification system based on five major types of shoreline: low bank, high bank, bluff, swamp forest and marsh. Final tabulations showed that high banks and bluffs make up only about eight percent of the coastal shoreline, with an average erosion rate of two feet per year. At the other extreme is marsh, which comprises about 55 percent of the shoreline and erodes at an average rate of 3.1 feet per year. Low banks make up 30 percent of the shoreline and swamp forests, seven percent. The researchers also identified three special features which appear in front of some shorelines and generally inhibit erosion: cypress fringe, marsh fringe, and sand aprons or beaches (in front of marsh or swamp forest only).

Bulkheading

For several years, the researchers have paid special attention to one unique type of shoreline—man-modified. These are areas which have bulkheads. By monitoring dredge and fill permits issued by the U.S. Army Corps of Engineers, Bellis found that in 1977 permits were let for bulkheading on about seven miles of estuarine shoreline.

The erosion facts and figures have been broken down on a county-by-county basis so that local planners can use the information more readily.

The county-by-county data already is being put to use by North Carolina's Coastal Resources Commission (CRC). Under the Coastal Area Management Act, local permit officers began to control construction in sections of the coast which were designated as areas of environmental concern by the CRC. In late 1977 Riggs and O'Connor helped to train these officers in the problems of shoreline erosion. Each officer was given a copy of the estuarine shoreline map for his county.

Charles Prevette, permit officer for Beaufort County, put his maps and training to immediate use. "Sometimes people have a hard time understanding our regulations, but if they can see the erosion rates on a map, it makes a difference," he says.

The researchers also drew up simplified maps for the general public of four major estuarine systems—Pamlico Sound, Core-Bogue Sounds, Albemarle Sound and the Neuse River. These maps will be included in a series of five educational posters on North Carolina's shoreline erosion. The posters will be made available to the general public and to schools in 1978.

Another practical result of the research is a formula for predicting shoreline erosion on a particular piece of property. The researchers devised a chart which assigns erosion values to each of 12 shoreline variables—including such factors as depth of the water 20 and 100 feet from shore, bank composition, shoreline orientation and the effect of boat wakes on the shore. An individual landowner can plug in details of his own shoreline and compute the average yearly erosion rate of his land. Storms, however, play a major role in erosion and Riggs cautions that they can't be predicted.

Also in 1977 the researchers established ten shoreline monitoring stations along the Pamlico River. The stations represent each type of all of the major variables which contribute to ero-

Photo: Bulkheading to slow the inevitable erosion of North Carolina's estuarine shoreline

sion. Early data from these stations show that rates of erosion may be considerably higher than the researchers' previous studies had indicated. Riggs and O'Connor are continuing to work with the monitoring stations in 1978.

During 1977 the researchers made a total of 18 presentations on erosion problems for a variety of lay audiences and presented six papers at professional or scientific meetings. They also provided information to several private engineering firms conducting studies for projects on the North Carolina coast and assisted archaeologists with the North Carolina Department of Archives and History in determining erosion rates at a number of archaeological sites.

Ocean side

One of the coast's highest rates of erosion occurs at Fort Fisher, a state historic site near Wilmington. There the ocean laps about 15 feet a year from the beach and maritime forest that used to surround a Civil War earthenwork fort. Most of the fort has already fallen into the sea and the state is contemplating a multi-million dollar jetty and revetment project to save the rest.

The rapid erosion of Fort Fisher has long been puzzling. In 1977 Tom Moorefield, one of Riggs's geology graduate students, spent the summer and fall studying the modern and relict sediment and rock units in the nearshore area of Fort Fisher for a clue to the cause of its erosion. He found that the man-induced closure of the nearby New Inlet in 1881 had a tremendous effect on erosion there. He recommends that construction of inlet dams be more carefully considered in the future. With mini-grant funds, Moorefield is preparing an educational map which will be a guide to the coastal systems of the Fort Fisher area.

Trees help

Scientists have long known that vegetation is one of the best ways to stabilize the shifting sands along the ocean. Trees have the added benefit of offering protection from wind and erosion. But few trees can tolerate the severe salt spray and sand blast of the coastal area.

Researcher Ewald Maki of North Carolina State University has confirmed that the Japanese black pine is better suited to these rugged conditions than the native loblolly pine. The black pine, it seems, can remain vigorous and green very close to the ocean.

Maki is interested in finding out which soil types and treatments are best for the Japanese black pine. He began experimental plantings in 1976 at four sites from Fort Macon to Kitty Hawk. In 1977 an additional five plots were planted in Kitty Hawk and Hatteras. The second year two-year-old Japanese black pines were used.

Average survival rate of the two-year-old black pine seedlings proved to be considerably higher than the one-year-old plants used the previous year. In spite of the fact that growing conditions during both years were unfavorable, the black pines flourished in most areas.

Based on Maki's work agricultural extension agents on the Outer Banks are now encouraging residents to use black pines to form windbreaks around their beach homes.

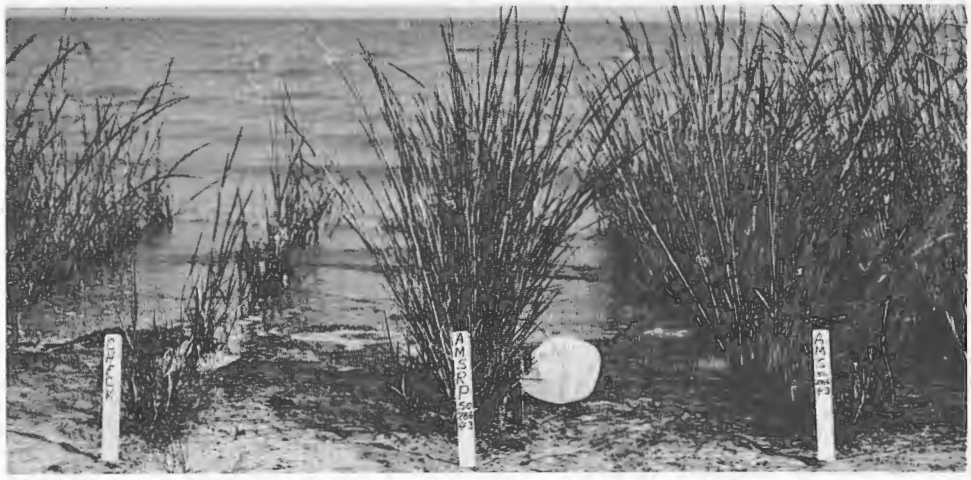
So do grasses

Paul Foster had reason to be upset when the bank of the canal behind one of his houses began to slip slowly away. He had put a lot of time, energy and money into his property and two homes in the posh Figure Eight Island development outside of Wilmington. And he didn't want to lose any of it to erosion.

So when Foster read in the Sea Grant newsletter about the erosion control work of two North Carolina State University scientists, he was relieved. Botanist Ernie Seneca and soil scientist Steve Broome had been experimenting with combating erosion in a natural, but effective, way. In lieu of expensive bulkheading, the two were planting marsh grasses along eroding shores and banks. The idea appealed to Foster, an avid environmentalist and consultant in urban and regional planning.

So Broome paid a visit to Figure Eight Island and explained his techniques to a group of residents. Before long several residents had planted grasses along the canal banks. And after only two months' growth, Foster could point proudly to a slightly accreting shoreline.

Seneca and Broome have been working with grasses as an alternative erosion control method for several years. They have used the grasses to stabilize dunes, rebuild marshes and slow erosion on estuarine shorelines. For the estuarine work they use mainly three grasses—*Spartina alterniflora*, *Spartina patens* (salt-meadow cordgrass) and a hybrid bermuda grass.



Fertilized plantings (right) may be the key to successful growth

In 1977 the researchers planted 30,000 plants along 3,000 feet of estuarine shoreline. That brought the total number of acres they've planted in marsh grasses to 11.5.

Early experiments indicated that the grasses don't work everywhere. In 1977 the researchers began to take a serious look at the conditions under which the grass plantings will slow or reverse erosion. So far it seems that areas with steep embankments or a great deal of wave activity are unlikely prospects for successful plantings. Oceanographer Ernie Knowles, also of North Carolina State University, joined the research team to work on determining just how much wave action the young plants can withstand. He selected locations for five gauges to measure wave height at different sites along the coast. The gauges will be installed and monitored in 1978.

The researchers also found in 1977 that fertilizer is the key to the success of some grass plantings. They experimented with a variety of fertilizers and application techniques.

The news of the grass planting studies is being well received in coastal North Carolina and in other states. During 1977 about 100 agencies and individuals requested information on planting techniques. The researchers introduced their work at a number of conferences and workshops.

In addition, they continued to monitor grass plantings on a section of Croatan Sound shoreline belonging to the Cape Hatteras National Seashore, at Maria Creek in Carteret County and on property owned by the U.S. Army Corps of Engineers in New Hanover County. Other grass planting sites include property along the Albemarle Sound in Bertie County, the Neuse River in Pamlico County and Bogue Sound in Carteret County.

It happens every year. Relatively sparsely populated coastal areas in North Carolina begin to teem with tourists and summertime residents. On the little island of Ocracoke, for instance, the winter population of 600 shoots up to 300,000 visitors during the summer season. The influx is a boost for the coastal economy. But it also fosters difficulties, not the least of which is disposal of human wastes. And because the vast majority of coastal soils is unsuitable for conventional septic tanks, the difficulties are compounded. Sea Grant researchers are working on new ways to deal with the present and anticipated waste disposal problems in the coastal area.

Waste disposal

Last winter David Esham had a familiar problem on his hands. One of two septic tanks at his Pony Island Motel and Restaurant in Ocracoke had failed again.

Esham knew he needed to install a new system before the summer tourist season got underway. But it would make the third new septic tank in five years. The prospect of sinking a lot of money into another system that was bound to fail wasn't a pleasant one.

So Esham didn't hesitate when Dare County sanitarian Ernest Perry suggested that he call North Carolina State University soil scientist Bobby Carlile. Perry knew that Carlile had developed several alternative septic systems designed especially for the problem soils of North Carolina's coastal area.

After surveying the situation at the Pony Island Motel, Carlile decided that what Esham needed was a mound system. The natural soil there was so poor that dirt and sand had to be trucked in to form a mound through which septic tank effluent could be distributed and purified. Within a week the new system was installed and working.

A mound system usually costs about $2,500, twice as much as the average conventional system. But Esham figures that's a small price to pay for the use of his restaurant. He expects the new system to handle easily the 1,500 gallons of water his restaurant uses daily during the peak of tourist season. And he doesn't expect to do any major repairs for another five years.

"If this system works, that's what I'm going to use from here on out," he says.

Mound systems are designed to be used in areas with extremely poor soils or high water tables, where no conventional system will work. Other available alternatives, Carlile points out, can run the price tag for a home sewage treatment unit as high as $25,000.

Esham isn't the only one in coastal North Carolina suffering from the septic tank blues. More than 80 percent of coastal soils are unsuitable for conventional septic systems. And yet municipal sewage treatment plants remain impractical for many coastal communities. It all adds up to a lot of failed septic systems and stalled development.

Consequently, about a dozen mound systems have been installed in the coastal area since Carlile began his work in 1976. The less expensive low

pressure pipe system is more popular, however. Almost 100 of those systems have been installed at a cost of about $1,200 each. That has meant increased revenues for four businesses that install the new systems.

To make matters worse for coastal landowners, new state regulations governing septic systems went into effect in July, 1977. The regulations require that sanitarians administer a more reliable soils test before issuing septic tank permits. The inevitable result is that even more building permits are being denied on a regular basis all over the coast. Thousands of dollars worth of construction is held up.

That's how Carlile and his associates Dennis Osbourne of North Carolina State University and Mark Sobsey of the University of North Carolina at Chapel Hill became heroes overnight. The demand for information on their Sea Grant work grew by leaps and bounds. They received inquiries from 50 individuals in 13 counties who wanted assistance. To help spread the word on the new systems, Carlile conducted six workshops for more than 300 sanitarians, developers and others.

So far the systems have been quite successful. But the researchers are still experimenting with a variety of soil types. In 1978 they plan to install more systems in the southern section of the coast, where a high water table is the basic impediment to conventional septic systems.

In 1977 the researchers began work on another important aspect of their study. Current regulations require that trenches for laying septic tank pipes be dug at least a foot above the high water table. The trouble is that the simple test sanitarians use for determining the location of the water table may not be very accurate. Inaccurate testing could be partially to blame for the pollution of large areas of coastal shellfishing waters.

In 1977 Carlile and his associates dug hundreds of tiny wells all over the coastal area. Regular monitoring of the wells will help them determine the seasonal and regional fluctuations in the level of the water table. Work along this line continues in 1978.

David Esham and his son David Scott at the Pony Island Motel

Ocean outfalls?

Many people are convinced that even the best septic systems aren't the long-term answer to waste disposal problems in densely populated areas of the North Carolina coast. Municipal treatment plants are already used in some communities and seem to be in the cards for others.

Right now treated effluent from these plants is discharged into coastal rivers, canals or estuaries. In a few cases, it is pumped into the ground. Scientists are already beginning to ask how much effluent the land and water can take before environmental or health hazards develop.

Ocean disposal of waste is one solution that's being considered for the North Carolina coast. It's no new idea. There are about 150 working outfalls in the United States now. But state authorities are reluctant to approve any outfall plans until some basic questions are answered.

For one thing the officials are determined to avoid the dismal situation created in some states when effluent from ocean outfalls has washed back on shore. They need to be able to predict where the effluent will go once it leaves the outfall pipe. In 1977 a North Carolina State University geoscientist completed a study that will enable officials to do just that.

For three years Len Pietrafesa studied the ocean's currents off the coast of North Carolina. In 1977 he stationed eight complex moorings at various locations between 13 and 70 miles off shore. The moorings collected information on water temperature, salinity, currents, winds and surface elevation.

Using these data Pietrafesa took a close look at the three bays formed by the jutting capes on North Carolina's coast. He wanted to find out how long it would take effluent to be washed out beyond Raleigh, Onslow and Long Bays. Because each bay is partially enclosed by the scalloped shape of the shore,

each has its own circulation patterns.

The prospects look promising for ocean disposal in Raleigh Bay, which lies between Cape Hatteras and Cape Lookout. Pietrafesa found that a Gulf Stream spin-off event hits Raleigh Bay every seven to 10 days, displacing 25 to 30 percent of the bay's volume. That means that about every month and a half the water in the bay is completely replaced. The nearshore waters there are also being constantly renewed by fresh water from the Chesapeake Bay.

On the other hand, Pietrafesa found that there is a strong onshore flow in Onslow Bay which could bring effluent back to the beaches of the area during certain seasons. He is still studying data from Long Bay, but it now appears that water replacement there is much more gradual than in Raleigh Bay.

Pietrafesa's work is continuing in 1978 with partial funding from the Coastal Plains Regional Commission (CPRC). Because the outfall question is of great regional concern, CPRC is funding a comprehensive outfall research project in North Carolina. And because an understanding of water movements and currents is the groundwork for any type of offshore development, Pietrafesa's work is also being supported by the United States Department of Energy and the National Aeronautics and Space Administration.

In 1977 Pietrafesa shared data with scientists doing similar circulation studies at other universities, including Skidaway Institute, Johns Hopkins University and the University of Miami.

Technical questions

There are other technical questions that need to be answered about ocean outfalls so that officials can draw up criteria for evaluating individual outfall proposals. Yates Sorrell, a North Carolina State University mechanical and aerospace engineer is taking a look at outfall designs and waste treatment plans. When his work is completed in 1978 he will make recommendations for guidelines to the state's Division of Environmental Management.

In 1977 Sorrell predicted outfall costs, probable diffuser and pipe sizes, and wastewater flows for four North Carolina communities: Morehead-Bogue Banks, Wilmington-Wrightsville Beach, Dare County beaches and Surf City. These areas, because of population density or chronic septic system failures, are considered prime candidates for outfalls.

Sorrell has found that there are a number of complex factors which would affect outfall designs, such as the depth of nearshore waters and whether secondary treated sewage must be chlorinated before being dumped into the ocean. North Carolina's shallow nearshore waters may pose a problem. The diffuser pipes must stretch far enough offshore to allow adequate initial mixing of the effluent with the ocean's waters.

Milfoil

J. C. Barrow first noticed it growing in tiny patches in Currituck Sound 13 years ago. He didn't like Eurasian water-milfoil then and he likes it even less now.

Since about 1965 the exotic, rooted water plant has propagated by seeds, winter buds and fragments so that it covers large portions of the sound from spring through fall.

"For 10 to 12 years it got progressively worse. Year before last it completely choked the sound. There just weren't any clear areas. I was afraid the sound would be ruined," says Barrow.

Barrow wasn't alone in his fear. Commercial fishermen complained vociferously that the long weeds clogged their nets and made fishing in the sound impossible. And they suspected that the milfoil depleted the water's supply of oxygen because eels and crabs died before they could be removed from traps. Boaters cursed as the weeds tangled motors and overturned sailboats.

Residents with sound-side property complained that the putrid stench of rotting masses of milfoil on the sound's shores during the fall was almost unbearable. And they suspected that mosquitoes, biting flies and spiders bred in the stuff.

But not everybody raised cain over the milfoil. Some sport fishermen and fishing guides contended that the fishing was better than ever. They said that black bass, for which the sound is famous, like to eat it.

In short milfoil was at the center of a full blown controversy. And as president of the Coinjock Ruritan Club, Barrow was one of the community's spokesmen. Feeling helpless to handle the problem locally, he and others tried desperately to get some state or federal agency to take action. In 1968, 1971 and 1974 the North Carolina Department of Natural and Economic Resources tried small scale chemical control of the milfoil, but it was costly and not wholly successful.

Milfoil was obviously a problem with no easy solution. Similar difficulties have been encountered in other areas of the East Coast where milfoil established itself. Scientists believe that milfoil, which is native to Europe and Asia, came to the United States in the 1880s on a foreign ship. It quickly crept from New Jersey to the Chesapeake Bay where it was a problem in the 1950s and 1960s until it mysteriously died away.

North Carolina scientists speculated that the milfoil in Currituck Sound might disappear in the same mysterious way. But no one could predict how long that would take.

Researchers sampling fish populations

In July, 1976, Sea Grant stepped in and organized a conference on the milfoil issue at the North Carolina Marine Resources Center on Roanoke Island. It was a rap session for scientists, state officials and residents, and it helped to shape the research Sea Grant initiated the following year.

Milfoil research undertaken in 1977 tackled the problem from several angles. Graham Davis, an East Carolina University biologist, set out to test one suggested method of control—mechanical mowing. He and a team of students mowed selected plots of the milfoil periodically during the peak growing season. The mechanical mower can cover only about an acre per hour and is therefore impractical for controlling milfoil over the entire sound.

Davis' results suggest that four mowings during the season are needed to adequately control milfoil in areas where boat traffic is light. But where there is moderate to heavy boat traffic, one or two mowings each season would probably provide sufficient control. In water quality testing Davis did not observe accelerated growth of algae or lowered oxygen content of the sound's water.

Another major question to be answered concerned the effect of milfoil on black bass and other fish such as spot, bluegills and carp. North Carolina State University fisheries scientists Mel Huish and Howard Kerby tackled that issue. After one year of sampling they determined that bass populations have not declined significantly over the past 20 years. Sampling also indicated that populations of several other species of fish may have actually increased in recent years. Kerby and Huish are continuing their studies in 1978.

Fish biologists in Currituck Sound

Sea Grant's recreation specialist and economist Leon Abbas set out to discover exactly what effect milfoil has had on the attitudes of Currituck Sound residents and the economy of the area. Through an extensive survey he found that activities related to the sound contribute a whopping $5 million to the economy of the area.

More than 70 percent of those interviewed in Abbas' survey felt that something should be done about the milfoil.

In response to complaints from local residents that milfoil is a breeding ground for a variety of insects, Sea Grant asked North Carolina State University entomologist Richard Axtell to take a look at the problem. Axtell set traps in and around the milfoil during the summer and fall of 1977. His conclusion: biting flies, mosquitoes and other nuisance insects did not breed in the milfoil. But Axtell concedes that in years with just the right tidal and weather conditions coupled with long-lasting accumulations of milfoil along the shoreline, the biting fly production in the milfoil could become a problem.

Throughout the study Sea Grant researchers and staff kept in close contact with residents of the Currituck Sound area. Two town meetings were held in 1977 at which researchers discussed plans and findings with the residents.

It's hard to picture a North Carolina beach without gulls screeching overhead and spindly-legged sandpipers dashing in and out of the surf. Birds are an integral part of the coastal magic.

But to the naturalist birds are more than a pleasant addition to the scenery. Because they react to the subtlest changes in habitat and air and water quality, they are among the best environmental barometers. A drop in their populations can sometimes be an early clue to dangerous pollutants in the coastal environment.

But unless ornithologists have an accurate baseline count of coastal birds, they can't tell whether populations are declining. In recent years Sea Grant has sponsored several projects aimed at firming up basic information on North Carolina's coastal birds.

Coastal birds

Sometimes the demands of ornithology are enough to try a man's patience. Just ask James Parnell and Bob Soots. Ever since they tackled the job of counting North Carolina's coastal birds, they've been crawling through thick underbrush and climbing trees.

For the past two summers the scientists and a troop of students have scoured dozens of barrier and estuarine islands in search of colonies of breeding birds. With Sea Grant funding beginning in 1975, Parnell of the University of North Carolina at Wilmington and Soots of Campbell College developed techniques for accurate censusing of the colonies. They found that some species, such as the Royal Tern, can be counted by aerial photography. But in other colonies, nothing short of a hot, sweaty ground survey of nests will do.

In 1977 Parnell and Soots identified all major breeding sites of 21 species of colonial birds. They found about 200 colonies of ground nesting gulls, terns, skimmers and pelicans and about 20 colonies of herons, egrets and ibises. The total number of nests exceeded 51,000.

Now in the final stages of their study, Parnell and Soots are drawing up a series of maps which will pinpoint the location of each of the colonies. The maps will become part of a coastal bird atlas to be published in 1978. Basic biological information on each bird species and details on the colonies will be included in the atlas. Parnell expects the books to be used by private organizations and government agencies responsible for land management in the coastal area as well as scientists and bird overs.

Chuck Roe, coordinator of the North Carolina Natural Heritage Program, has big plans to make practical use of the Parnell and Soots data on coastal birds. Once the atlas is published he will feed information on bird populations and locations into a special computer bank. The bank serves as a clearinghouse for individuals and agencies doing environmental impact studies or land planning. That means that the researchers' study could have far-reaching effects on development in the coastal area.

Already the Parnell and Soots research has made a difference to some colonial nesting birds. Early in their Sea Grant work, the researchers discovered that many water birds are fond of nesting on numerous islands built by the U.S. Army Corps of Engineers. The islands are formed of sand and other spoil from the dredging of harbors and waterways. Because natural nesting sites are rapidly being destroyed by development, the spoil islands have become crucial to the birds' survival.

The trouble was that the Corps frequently dumped additional dredge spoil on already stable islands, sometimes destroying nesting colonies. In North Carolina that doesn't happen any more. According to James Wells of the Corps' Wilmington district office, the dumping schedule now is planned around the birds' nesting seasons.

Before long birds all over the country may be given the same treatment. As a direct result of his Sea Grant research, Soots spent several months working with the staff of the Corps' Waterways Experiment Station in Vicksburg, Mississippi. He helped to draw up a management plan for dredge spoil islands which takes the birds into consideration.

As an outgrowth of his Sea Grant work, Parnell was appointed to the North Carolina Wildlife Resources Commission's advisory committee on endangered species. He has been funded by the commission to study thoroughly the state's colony of threatened brown pelicans. The researchers also provided information on colonial nesting birds to the National Park Service, the U.S. Fish and Wildlife Service, and the Maryland Department of Natural Resources.

Offshore birds

There's another segment of the bird population that scientists know even less about: pelagic or oceanic birds. Until recently almost nothing was known about the seasonal and geographic distribution of offshore and pelagic seabirds along the Atlantic seaboard.

Information gathered on North Carolina's seabirds has been based mainly on storm casualties, a less than reliable source. Since 1975 David Lee and other naturalists with the North Carolina Museum of Natural History have been trying to fill in some of the gaps.

This year Lee was awarded a minigrant to help continue his studies. Thus far he and others have made 46 offshore trips on charter boats out of Oregon Inlet, Hatteras Inlet, Beaufort and Virginia Beach, Virginia. Most of the trips were made between late spring and early fall. They've identified 26 species of offshore and pelagic birds, some of them not previously sighted off North Carolina.

Johnny Booth of Manteo is one of the charter boat captains who took the researchers out to sea on several occasions. Fishing, he says, will never be quite the same again. Like most good fishermen Booth had always kept a look out for clusters of birds when he was leading sport fishing groups. The birds often hover over and feed on large schools of fish. But now Booth has caught the birdwatching bug and he keeps both eyes peeled for seabirds. What's more, he can call most of them by species name.

Booth and other charter boat captains are interested in the birds for another reason, too. They think they might be able to increase their business by scheduling birding trips for serious birdwatchers who would be interested in the large populations of seabirds off North Carolina's coast.

Students and Sea Grant

It takes a lot of people to make up the Sea Grant team—researchers, advisory agents and administrators. But there's another link in the chain that sometimes gets overlooked: students, 172 of them to be exact. Acting on the theory that experience is the best teacher, each year Sea Grant gives them a chance to assist in a variety of research projects.

In 1977 students from four campuses of the University of North Carolina participated in Sea Grant work while they worked toward bachelor's, master's and doctoral degrees. Two doctoral candidates and 27 master's degree candidates are producing theses or dissertations on their Sea Grant-related work. The rest, graduates and undergraduates, worked as technicians for Sea Grant-supported projects. And dozens of other students were exposed to Sea Grant research through course work with some of Sea Grant's principal investigators.

Tony Duque is one of several candidates for master's degrees in geology who worked with Stan Riggs and Mike O'Connor at East Carolina University. For the past two summers Duque assisted the researchers in mapping North Carolina's estuarine shoreline. In 1977 he put the finishing touches on his thesis. Then he put his drafting skills to work in designing a series of five posters on estuarine shoreline erosion to be published by Sea Grant. Duque is now a field geologist with The Anaconda Co. in Denver, Colorado.

William Dreyfoos, a student who worked on Sea Grant's beach access research project, received a joint degree in law and urban planning at the University of North Carolina at Chapel Hill in 1977. He is now a member of the faculty at Florida Atlantic University, where he is helping to solve Florida's beach access problems.

J. A. Daniels is currently employed by New York Sea Grant at Cornell University. He completed a master's degree at North Carolina State University, where he worked with Sea Grant researcher George Giddings on the seasonal variation in composition of spot. John Burke, who worked on Sea Grant's minced fish research project, is now employed by the food division of Lever Brothers Company in Edgewater, New Jersey.

Johanna Bazzolo assisted with Sea Grant's marine education program for public school teachers during the summer of 1977. After completing her master's degree in education, she began teaching junior high school sciences in Chapel Hill.

Ornithology student Leon Jernigan completed his master's degree at North Carolina State University in 1977 and immediately took a position teaching biology at Campbell College in Buies Creek, North Carolina. For three summers Jernigan worked with researchers James Parnell and Bob Soots, helping to conduct a census of colonial shore and wading birds. His project-related thesis on the least tern will be published by Sea Grant.

During 1977 doctoral candidate Steve Otwell worked with food scientist Don Hamann on a Sea Grant project to improve the texture of minced seafood products. After completing his thesis on the texture of squid, he began work on another Sea Grant mini-grant, an analysis of marketing channels for North Carolina skates and rays. Otwell is now employed as a seafood processing specialist with the Sea Grant program at the University of Florida.

Some of the other students worked in fisheries research, erosion control, education and economics.

1977 publications

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Baker, S. The citizen's guide to North Carolina's shifting inlets. UNC-SG-77-08. $1.00 all requests.

Bliven, L., N. E. Huang and **G. S. Janowitz.** An experimental investigation of some combined flow sediment transport phenomena. UNC-SG-77-04. $3.00

Cleary, W. J. and **P. E. Hosier.** New Hanover Banks: then and now. UNC-SG-77-14. $2.00 all requests.

Levi, M. and **J. Machemehl.** Proceedings of a seminar on wood in marine structures. UNC-SG-77-12. $2.50

Machemehl, J. L., M. Chambers and **N. Bird.** Flow dynamics and sediment movement in Lockwoods Folly Inlet, North Carolina. UNC-SG-77-11. $3.00

McClain, C. R., N. E. Huang and **L. J. Pietrafesa.** Application of "radiation type" boundary condition to the wave-porous bed problem. UNC-SG-77-10. $2.50

Pietrafesa, L. J., D. A. Brooks, R. D'Amato, L. P. Atkinson. Onslow Bay—Physical dynamical experiments summer-fall, 1975 data report. UNC-SG-77-07. $16.00 all requests.

Seneca, E. D., W. W. Woodhouse, Jr. and **S. W. Broome.** Dune stabilization with *Panicum amarum* along the North Carolina Coast. UNC-SG-77-03. $1.00

Woodhouse, Jr., W. W., E. D. Seneca and **S. W. Broome.** Ten years of development of man-initiated coastal barrier dunes in North Carolina. UNC-SG-77-01. No Charge.

ESTUARINE STUDIES

Carrick, R. J. The development of an improved method for the detection of enteric viruses in oysters. UNC-SG-77-13. $3.00

FOOD FROM THE SEA

Abbas, L. To eel or not to eel: economic analysis of a part-time eel fishing enterprise. UNC-SG-77-02. No charge.

Easley, J. E. and **J. N. Freund.** An economic analysis of eel farming in North Carolina. UNC-SG-77-16. $1.00

Ramey, F. An annotated bibliography on mechanically separated finfish and crustacea meats. UNC-SG-77-17. $.75

OCEAN AND COASTAL LAW

Brower, D. Access to the nation's beaches: legal and planning perspectives. UNC-SG-77-18. $3.00

Schoenbaum, T. Ocean and coastal law teaching materials. Volume I, ocean law. UNC-SG-77-09. $7.00 all requests.

Schoenbaum, T. Ocean and coastal law teaching materials. Volume II, coastal law. UNC-SG-77-09. $5.50 all requests.

Schoenbaum, T. J., P. E. McDonald. State management of fisheries: the twin impacts of extended federal jurisdiction and Douglas vs. Seacoast Products, Inc. (William and Mary Law Review—journal on the law of the sea). UNC-SG-77-15. $1.50

GENERAL INTEREST

Baker, S. 25 coastal problems in search of answers, suggested research topics for masters and Ph.D. candidates in North Carolina. UNC-SG-77-06. Out-of-print.

Jurgensen, K. Sea Grant? Sea Grant 1977, where we've come from, where we're headed. UNC-SG-77-05. Out-of-print.

Sea Grant in North Carolina a report on the University of North Carolina Sea Grant College Program for 1976. No charge.

University of North Carolina Sea Grant College Newsletter. A monthly newsletter on Sea Grant and coastal issues. May be obtained free of charge upon request.

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108. **Carlile, B. L., L. W. Stewart,** and **M. D. Sobsey.** 1977. Status of alternative systems for septic waste disposal in North Carolina. Proc. Second Annual Illinois Private Sewage Disposal Symposium, Jan. 17-19, 1977. 16 pp.

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114. **Hassler, W. W.** and **W. T. Hogarth.** 1977. The growth and culture of dolphin *Coryphaena hippurus*, in North Carolina. Aquaculture, *12*:115-122.
115. **Jurgensen, K. M.** and **G. Crow.** 1977. The $6-million eel, or from bait to delicacy in four years. Trans. N. Amer. Wildlife & Nat. Res. Confr., *42*:329-335.
116. **Tharp, T. P.** and **C. E. Bland.** 1977. Biology and host range of *Haliphthoros milfordensis*. Canadian J. Botany, *55*(23):2936-2944.
117. **Woodhouse, W. W., E. D. Seneca** and **S. W. Broome.** 1976. Propagation and use of *Spartina alterniflora* for shoreline erosion abatement. U.S. Army Corps of Engineers, Coastal Engin. Res. Center, Tech. Rept. No. 76-2 72 pp.

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Project standing—1977 and 1978

N—Project initiation
C—Project continuing
F—Project completed

		Status 1 Jan. 1977	Status 1 Jan. 1978
PROGRAM MANAGEMENT			
MD/A-1	Administration & development, Copeland, Rickards	C	C
COASTAL ZONE STUDIES			
R/CZS-8	Shoreline Erosion and Accretion, O'Connor, Riggs Bellis	C	F
R/CZS-9	Physical Studies of Raleigh and Onslow Bays, Bane, Janowitz Pietrafesa, Knowles	C	F
R/CZS-11	Flow Dynamic and Sediment Models for Barrier Island Tidal Inlets, Machemehl	N	F
R/CZS-12	Methodology to Evaluate Ocean Outfalls, Sorrell	N	C
R/CZS-13	Marsh Vegetation for Shoreline Erosion Control Seneca, Knowles, Broome	N	C
R/CZS-14	Vegetation Patterns and Succession in Overwash Environments, Hosier, Cleary	N	C
ESTUARINE STUDIES			
R/ES-20	Coastal Bird Populations Study, Parnell, Soots	C	F
R/ES-21	Eurasian Watermilfoil: Its Control and Potential Use, Davis, Abbas, Huish	N	C
R/ES-22	Detection Methods for Enteric Viruses in Shellfish, Sobsey	C	F

		Status 1 Jan. 1977	Status 1 Jan. 1978
ESTAURINE STUDIES (cont.)			
R/ES-23	Development of Alternative On-Site Septic Waste Disposal Systems, Carlile, King, Sobsey	C	C
FOOD FROM THE SEA			
R/AF-5	Aquaculture of the American Eel, Rickards	C	C
R/AF-6	Fungal Diseases Affecting Aquaculture, Bland	C	C
R/SST-4	Effects of Processing on Contaminant Content of Seafoods, Giddings	N	F
R/SST-5	Identification and Incidence of Hazardous Microorganisms in Seafood, Speck, Ray	N	C
R/SST-6	Developing Texture in Minced Seafood Products, Hamann, Thomas	N	C
LEGAL AND SOCIO-ECONOMIC STUDIES			
R/LS-10	Public Access to N.C. Ocean Beaches, Brower	N	F
EDUCATION AND ADVISORY SERVICES			
E/LS-1	Ocean and Coastal Law Program, Schoenbaum	N	C
A/EA-10	Marine Advisory Services, Hammond	C	C

Sea Grant budget

	NOAA	STATE
Marine Resources Development		
Aquaculture	34,387	18,613
Living Resources Other Than Aquaculture	11,230	6,768
Marine Law and Socio-Economic	8,575	4,680
Marine Technology Research and Development		
Ocean Engineering	8,969	5,600
Resources Recovery and Utilization	63,936	35,639
Marine Environmental Research		
Research and Studies in Direct Support of Coastal Management Decisions	155,761	78,800
Pollution Studies	29,575	12,425
Environmental Models	61,984	15,432
Marine Education and Training		
College Level	38,445	20,847
Advisory Services		
Extension Programs	188,866	110,748
Program Management and Development		
Program Administration	93,500	28,948
New Applications Development	35,772	27,000
Total	731,000	365,500

Credits

A look at Sea Grant in North Carolina was written and designed by Mary Day Mordecai and edited by Karen Jurgensen.

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Drawings by: Lundie Mauldin, p. 11; Anneka Bane, p. 16.

A partnership

Sea Grant is a state-federal partnership designed to promote the wise use and development of the nation's coasts and oceans through research, extension and education. The U.S. Department of Commerce's National Oceanic and Atmospheric Administration provides two-thirds of program support while the N.C. Department of Administration through its Office of Marine Affairs provides matching dollars on a one-to-two basis. Sea Grant is an inter-institutional program within the University of North Carolina, a 16-member institution under the direction of a Board of Governors, William A. Johnson, chairman. William Friday is president. The University's Council for Marine Science, chaired by E. Walton Jones, UNC associate vice-president for research and public service programs, coordinates university marine science programs, including Sea Grant.