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A look at Sea Grant in North Carolina 1978

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They lost everything: home, business, belongings.

So did their neighbors and friends.

Nineteen people died and property damage amounted to \$125 million when Hurricane Hazel swept the eastern United States in 1954.

On Long Beach, North Carolina, two people who did not leave the island died.

Dan Shannon and his wife, Inez, speak with a quiet respect about that time more than 20 years ago when all but a handful of the 350 buildings on Long Beach were wiped out by the hurricane's waters and winds.

Despite the fact that the hurricanes will come again, the lure of the coast brought the Shannons and their neighbors—in ever-increasing numbers—back to Long Beach. And every year growing numbers of tourists flock to coastal businesses like the Shannons' for gas, food and lodging.

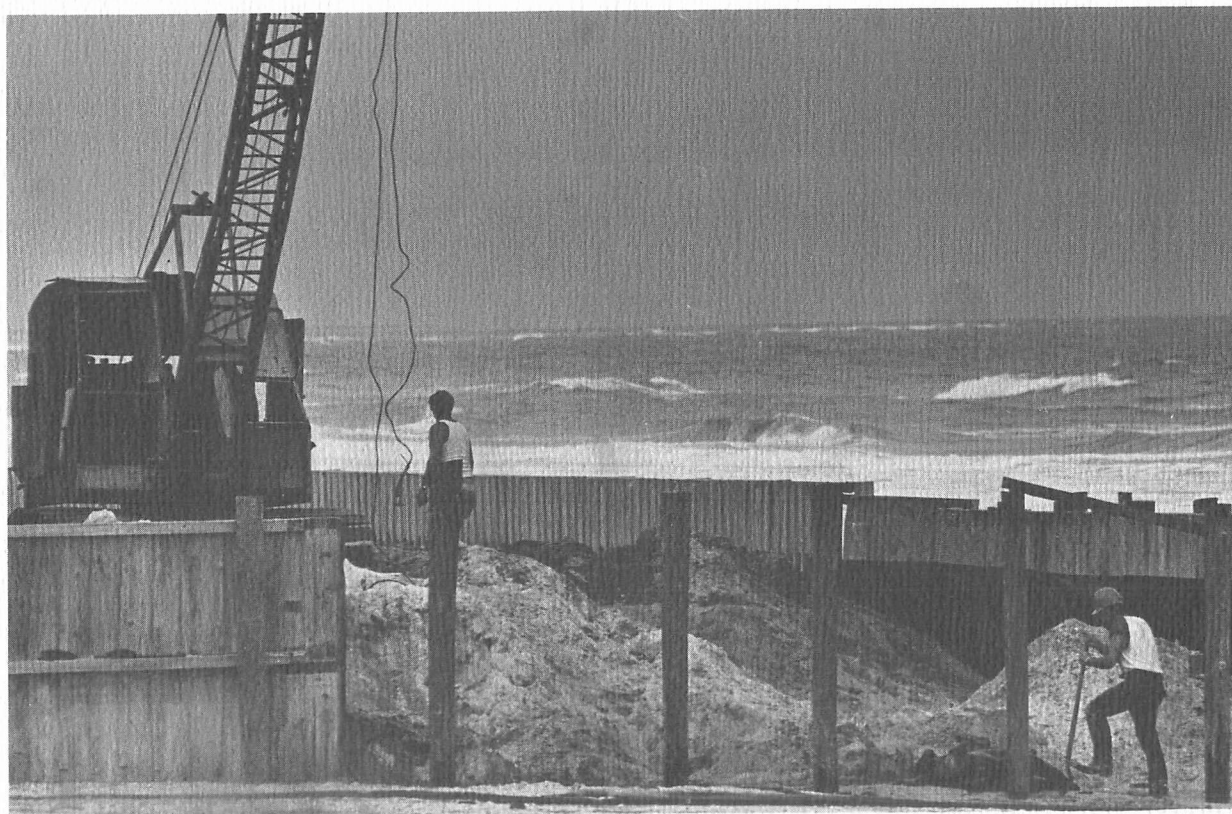
The years have given the Shannons an appreciation of the vagaries of the coast: the annual

fluctuations of the sea, sand, dunes and inlets; changes in protective vegetation. They rely on that coastal environment for their livelihood, just as fishermen rely on the coastal waters for

a living and pleasure-seekers use the coast for sun and fun.

The sensitive coastal environment is, of course, affected not only by natural phenomena but

also by man. Septic tanks—which are widely used on the coast where as much as 80 or 90 percent of the soils are unsuited for them—are blamed for some of the pollution that closes shell-



fishing waters every year. Land clearing for homes and farms affects not only the creatures who inhabit the land, but also the nearby waters. A bulkhead to protect continually-eroding shores may simply be robbing Peter to pay Paul.

Developing the state's fragile yet rich coastal environment is always a balancing act: The coast is a popular place, yet natural phenomena such as hurricanes and erosion take their toll as does man's exploitation of the rich resources.

By supporting research at four campuses of the University of North Carolina, as well as advisory agents and specialists along the coast and in Raleigh, Sea Grant attempts to aid in the balancing act. UNC Sea Grant is one of 28 similar federal/state programs nationwide.

In 1978, UNC Sea Grant used its \$1.3 million in state and federal funds to support 21 extensive research projects and another dozen or so short-term projects. The advisory staff grew to 12 full-time agents with the

addition of a coastal engineer and a marine education specialist.

### ... Highlights

Among the findings and results that grew out of the 1978 work are:

- 22,000 people learned about hurricanes and safety at the coast during Hurricane Awareness Week co-sponsored by Sea Grant at the state's three Marine Resources Centers;
- New North Carolina seafood marketing channels to the Midwest were opened and 1200 people learned about underutilized catches—such as squid—at an 11-week series on unusual seafood;
- The Coastal Area Management Act seemed to be working well in its first year of implementation, though there were start-up problems and inconsistencies in interpretation;
- Most of the islands south of Cape Lookout have experienced

major washover in the past 40 years, and certain islands are likely to be more susceptible to the destructive overwash in future storms;

- Fluoride, a by-product of coastal North Carolina's expanding phosphate industry, appears to be hazardous to blue crabs, which are among the state's most important catches;

- Increasing freshwater runoff, partly due to expanding coastal farming, appears to have an adverse impact on the state's shrimp catch;

- There's reason to hope that North Carolina's rangia clam fishery could be redeveloped.

- Over 250 requests were met for assistance in installing alternative septic systems and construction was allowed to proceed in many coastal locations thanks to the systems;

- Asbestos cement sheet material, used extensively in coastal bulkheads, often isn't suited for use in North Carolina.

- Anthropologists on Harkers

Island observed some of the changes taking place in this traditional fishing community and hope to use what they learn to help other communities undergoing similar changes.

- Fifty officials and private citizens attended a two-day, round-table discussion of the problems of ORV traffic on North Carolina's beaches.

- Researchers who tested 706 samples of North Carolina seafood determined that it was basically of good quality and recommended methods to improve sanitation in seafood processing plants.

- A researcher at the University of North Carolina at Wilmington discovered a new source of protein in the freshwater streams of southeastern North Carolina. One company is now interested in commercially harvesting the seaweed nori for the domestic and export markets. ■





4 Dallas Rose, Harkers Island

## Food from the sea: fishing...

You follow the main hard-surfaced road as it weaves through forested land, down the middle of Harkers Island.

Toward the east end of the island, somewhere between Calico Jack's Marina and the O&D Grocery, you'll spot the sandy lane that curves past Dallas Rose's rambling wooden house, pulls up beside his son's home and runs smack into the edge of Core Sound.

Dallas Rose is around back, his stately figure bent over a skiff with its cracked bottom turned up in the sunny air. He's caulking, working against the only clock that really matters on the island: the tide timetable.

Rose has been racing against the tides all day. At dawn he was digging for clams in the shallows of low tide. By noon he was setting his gill nets in the middle of the sound, hoping for a run of croaker.

Like the soft, mellow tones of his "downeast" accent, versatility in fishing is an inheritance Rose got from a long line of seafaring ancestors. In an

average year, he's likely to fish for at least six different species of finfish, in addition to doing his share of clamming. In an era of specializing, that kind of versatility is the mark of a Harkers Islander.

"Fishing? I guess I was born into it. All my forefathers were fishermen, so I guess it comes natural," he says.

"It's a gamble," adds his son James, unloading a plank of rough-cut wood earmarked for the fishing boat he's building in his back yard. "It's a maybe, maybe not, a kind of disease. I don't know what they call it. It's like a fever."

James Rose's 17-year-old son Jeff grins and nods. Last year he dropped out of high school to join his father and brother Rodney in full-time fishing.

The Rose fishing crew is one of many family operations on this island, where, for nearly 250 years, life has centered around the sea. As recently as the early 1900s, whaling was a mainstay of the island economy. Today its

major industries are boat building and shrimping.

And tourists. Since a bridge first connected the isolated barrier island with the mainland in 1941, a steady influx of newcomers has brought trailer parks, sport fishing marinas and a menagerie of fast food shops. Roads and houses now crisscross the land where swamps lay just a few years ago.

Harkers Island, it seems, has become a nice place to retire or build a summer home. And, with the impending development of the nearby Cape Lookout National Seashore, the islanders are bracing for more changes.

To families like the Roses, these changes mean new wrinkles in the old way of life. You can't, for instance, walk out of your house "of a dewy morning" to shoot your breakfast anymore.

"The growth is good for business," says James Rose. "Grocery prices will go up. But that doesn't help us at all."

Each year the island draws more sport fishermen who use it

as a jumping off place to get to prime fishing grounds on nearby Shackleford and Core Banks. For the commercial fisherman, that spells conflict. Sometimes it means that nets become tangled with hooks or severed by outboard engines. Worse yet, it can mean the loss of a prime fishing spot.

"You come up to the number one place that's been known to commercial fishermen 100 years and there'll be 20 to 50 surf casters on the beach. The commercial fisherman has to pull out," laments James Rose.

Anthropologist Marcus Hepburn has been living on Harkers Island and fishing with Dallas Rose for the past year. Hepburn figures he landed in this unique fishing village at just about the right time to learn something about how changes like these affect the traditional lifestyles of the islanders. He is working with anthropologist James Sabella and sociologists Richard Dixon and Roger Lowery of the University of North Carolina at Wilmington.

The researchers hope that what they learn about Harkers Island can be applied to other coastal communities caught in similar flux. During the two-year project, they plan to survey most of the island's adult residents to find out about their attitudes towards their lives in general and a host of specifics, including extended jurisdiction and fisheries management.

### ...Clams

The Rangia clam isn't exactly a new seafood product. A regular resident of the shallow, brackish waters of the state's estuaries, it was once marketed in North Carolina and elsewhere. But persistent problems with high bacterial levels eventually forced seafood dealers to give up on the Rangia, and the clam was nearly forgotten.

Today the Rangia is on the verge of making a comeback. Rising prices and growing demand for seafood have revived hopes

for the Rangia, perhaps for use in chowder.

Research just completed at East Carolina University indicates that the high bacterial levels may not be a problem after all. Barney Kane and Don Jeffreys have confirmed that Rangia taken from waters open to shellfishing were no more hazardous than any other shellfish. The researchers found that while the Rangia's high bacterial level or "standard plate count" had no sanitary significance, it did shorten the clam's storage life.

They found that dry, refrigerated shell-stock was a better short-term storage method because it did not show as rapid an increase in standard plate count as the shucked clams.

In addition to their bacteriological work, the researchers began recruitment studies to learn more about the clam's population dynamics. This information is basic in determining whether Rangia populations in North Carolina can sustain commercial harvest and at what levels.

In 1979 the researchers will continue their recruitment and bacteriological studies and try to establish which seasonal and environmental conditions are most favorable for harvesting *Rangia* clams.

### ...Seafood lab

Taking the results of research and getting it into the hands of seafood processors and consumers is the job of North Carolina State University's Seafood Lab in Morehead City. Jointly operated by Sea Grant and the North Carolina Agricultural Extension Service, the lab is involved with myriad activities designed to improve the quality, safety and use of North Carolina seafood products.

In 1978, lab specialists Dave Hill, Joyce Taylor, Sam Thomas and project director Frank Thomas placed added emphasis on product yield. Tests were run on a special crab deboner for extracting meat from blue crab

legs—meat which traditionally has been thrown away. As a result of the lab's work, one processor in Belhaven, Blue Channel, already is using the deboner with a reported one percent increase in total yield.

The lab worked extensively with local extension homemakers on developing recipes using fish flake extenders and less expensive, underutilized fish species, including rock shrimp, squid, skate and ray. Specialists at the lab assisted ten seafood processors in designing new plant facilities and modernizing existing ones to improve the efficiency and safety of their operations.

### ...Seaweed

Don Kapraun first noticed nori in 1972. Patches of this flat red alga were growing in some of the tidal creeks near his home in Wilmington. But it wasn't until he discovered that nori is the single most valuable marine resource in Japan, worth an estimated \$100

million a year, that he began to take the plant seriously.

It seems that in Japan and Korea the mild seafood flavor of dried nori is a seasoning as popular as garlic is in the United States. It offers the added bonus of high protein and vitamin content.

Kapraun found nori growing on oyster shells in the shallow waters of tidal creeks. Because it actually attaches itself to the shells, Kapraun speculated that it could be collected along with the oysters to provide added income for fishermen.

With Sea Grant funding, Kapraun set out to test his theory. First of all, he needed to understand the biology of *Porphyra rosengurtii*, the largest and most abundant nori species in southeastern North Carolina. As with any other marine resource, over-harvesting is a danger. But Kapraun found that this nori reproduces asexually, which means that the plant can quickly colonize and probably reseed itself even if extensively harvested.

Kapraun's nutrition tests also turned up promising results. He found that local nori stacks up against the best of the Oriental alga as far as protein content is concerned.

Finally, Kapraun's study indicated that significant amounts of nori occur seasonally in the southeastern section of the state.

At the present time, one Japanese firm is considering the feasibility of commercially harvesting nori in southeastern North Carolina. The nori would be used both for domestic markets and for export.

### ...Sanitation

It happens even in the best of seafood processing plants. A single incidence of carelessness can easily lead to serious contamination of highly perishable seafoods.

That's what North Carolina State University food scientists Marvin Speck and Bibek Ray

discovered when they undertook a two-year study of the quality of North Carolina seafoods. They wanted to assess products going to consumers, and, if necessary, to develop methods to improve their quality. In the process, they tested a total of 706 seafood samples, including oysters, clams, scallops, shrimp, crab and several species of finfish, from processing plants and a variety of markets.

Early in the study, researchers looked at one of the state's largest crab processing plants. There they found that, in an otherwise immaculate operation, cooked crabs were being contaminated by brief contact with live crabs. The problem was easily corrected.

In other crab plants, Speck and Ray found that contamination came mostly from improperly cleaned waste containers. Equipment used for deveining in shrimp plants was a major source of bacteria. And in scallop plants, the researchers found that improperly cleaned flumes were the single predominant source of contamination.

The studies showed that seafood from retail seafood markets tended to have fewer contaminants than that from supermarkets. The difference, the researchers suspect, is due to a faster turnover, better storage conditions and better under-

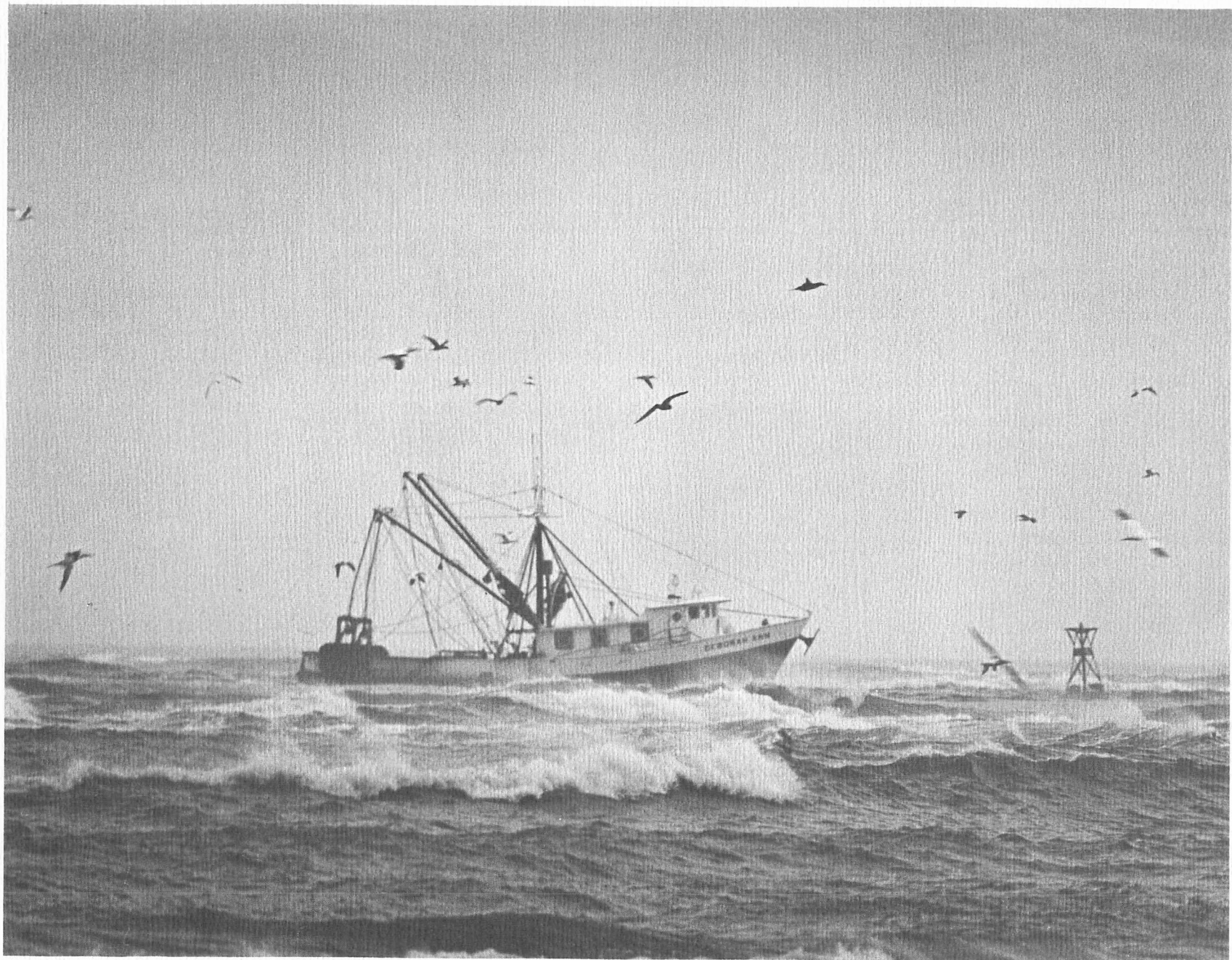
standing of how to deal with seafoods in the seafood markets.

In general, though, Speck and Ray determined that the quality of North Carolina seafoods was good. They found low to moderate levels of indicator bac-

teria and surprisingly low numbers of pathogens.

The researchers did find, however, large numbers of one bacteria, *Vibrio parahaemolyticus*. This led to another project begun in 1979.





# Fisheries: nets to supermarkets...

Captain Milton Gillette spent 20 years fishing and then decided it was time to pass on his knowledge. For the past three years he has taught the state's only commercial fishing course at Cape Fear Technical Institute in Wilmington.

He handles the nets, talks of sophisticated foreign fishing fleets and tries to turn out good fishermen. In the process, he introduces students and local fishermen to improved fishing gear.

So in 1978 when Sea Grant marine advisory agent Jim Bahen suggested he try out a wing trawl net, Gillette was more than happy to oblige. The net was developed on the state's fisheries research vessel, the Dan Moore, following observations of foreign fleets using the large-meshed, light net. Bahen, who works out of the Marine Resources Center at Ft. Fisher, hired a netmaker to construct a similar net one-third the size of the Dan Moore's.

Bahen's aim was to provide fishermen on smaller commercial vessels a versatile, light and inex-

pensive piece of equipment. Since most fishermen in the southern coastal area are shrimpers, he reasoned that the new net would give them a simple way to diversify their catch.

The net can be adapted for fishing bluefish, sea bass, croaker, spot and trout. And, since a larger mesh size and lighter-weight twine are used, the net is half the cost and half the weight of most nets.

Self-sufficiency is the name of the game for commercial fishermen in North Carolina. Few can afford to run to a professional shop every time a net gets torn or an engine stalls.

That's why Sea Grant's commercial fisheries agent Hughes Tillett offered six classes in net mending during 1978. From his headquarters in the N.C. Marine Resources Center on Roanoke Island, Tillett taught about 125 students. Many were commercial fishermen's wives, who wanted to be able to help out in the family business.

Also during 1978, Tillett con-

tinued to spread the word on the labor-saving advantages of hydraulic gear and began testing a promising electric crab-pot puller.

When they're not running workshops on everything from bait rigging to fish filleting, Tillett and Bahen are out in the field trouble-shooting for individual fishermen. In 1978, for instance, both agents worked with the N.C. Division of Marine Fisheries to help get emergency loans for local fishermen and dealers who were hardest hit by a disastrous shrimping season.

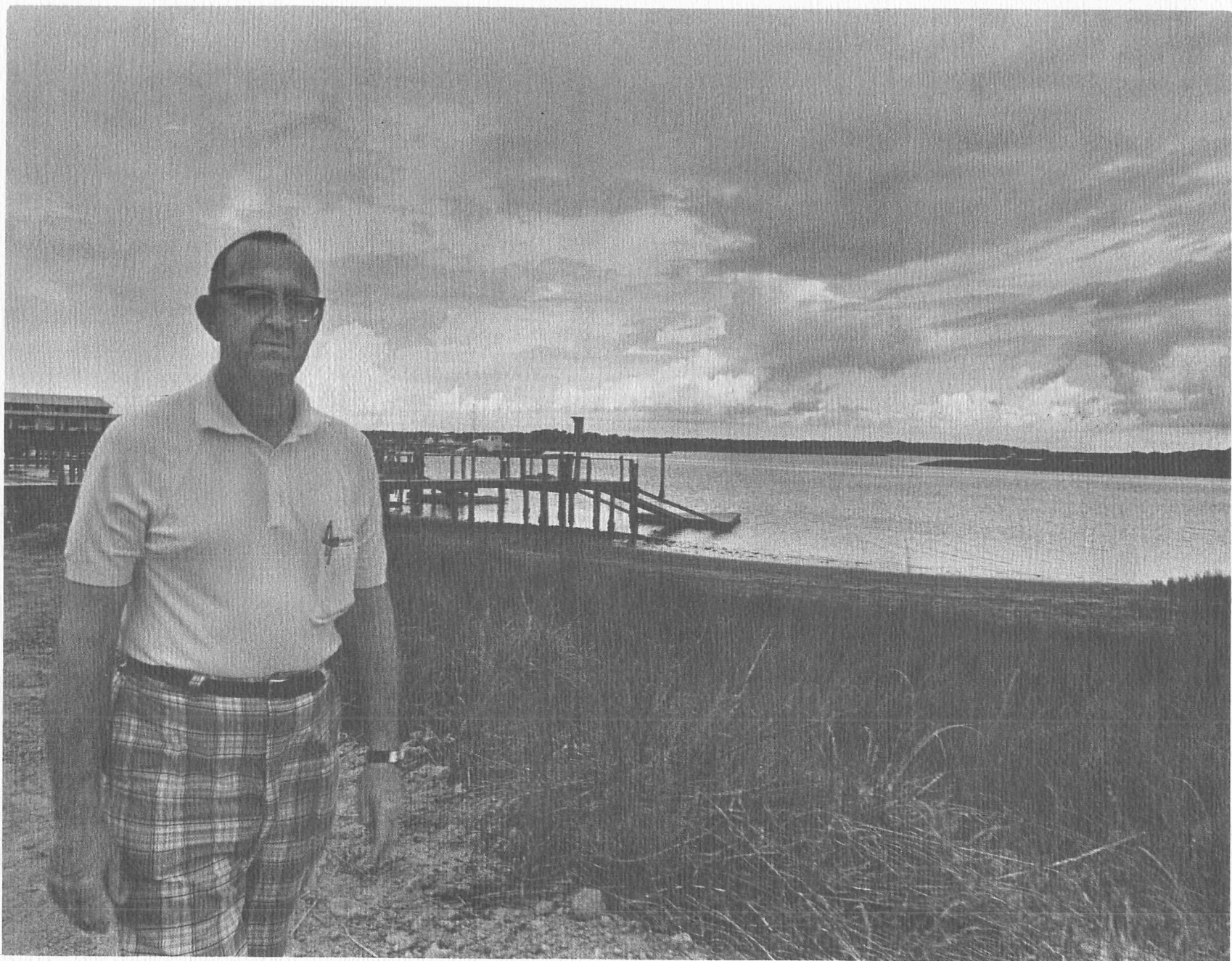
Traditionally seafood caught in North Carolina has been iced and shipped in the round to markets in the North, where it is then resold to retail markets throughout the East.

Sea Grant marine advisory agent Skipper Crow, who covers the central region of the coast from the Marine Resources Center on Bogue Banks, thinks that North Carolina seafood dealers can tap into new markets in the Midwest.

In 1978, Crow worked with state and federal agencies to promote sales of south Atlantic seafood in midwestern states. The emphasis was on establishing year-round markets there for such underutilized species as croaker, grey trout, mullet, rock shrimp, king and Spanish mackerel.

The effort paid off. In January, a major grocery chain, Kroger, Inc., began marketing 100,000 pounds of fresh seafood per week in about 200 of its midwestern stores. Crow estimates that 10 percent of the fish comes from North Carolina boats. Since the Kroger venture, several other major retail chains have expressed interest in marketing fresh seafood in their stores.

In an attempt to tackle the remaining obstacles to seafood marketing, a Sea Grant research project begun in 1979 is taking a look at improved packaging, shipping and quality. The goal of the research, which is being done in cooperation with the packaging industry, is to come up with a way to guarantee shelf-life. ■



10 Dan Shannon stands on site of former Long Beach inlet

## Coastal studies: the storms . . .

Thursday afternoon was sultry and eerie. "We walked out to the beach at low tide. The water was way out, beautiful," recalled Dan Shannon. There was a full moon that night.

By 7 a.m. Friday when the last people got off the island, water from the high tides was already on the highway.

At 9 a.m. on October 15, 1954, the clocks stopped.

By 3 p.m. when Shannon returned to the island, almost everything was gone. Of 350 buildings on Long Beach, five were left in their original locations. Two people who did not leave the island died.

The island had acquired a new feature: New Inlet. Hurricane Hazel brought with her a wallowing wall of water that surged out of the ocean, over the island, into the sound and up nearby creeks. As it passed over the island, the washover carried with it houses, sand dunes and parts of the road.

When the water rushed back out to the ocean—as if a plug had been pulled in a giant bathtub—

it left an inlet several hundred feet wide in the western end of Long Beach. Before it was successfully filled in with dredge material a few years later, the inlet had grown to several thousand feet in width. Now there are houses on the site of the former inlet.

Storms seem to run in cycles. Since the turn of the century, there have been three major storm episodes in coastal North Carolina which caused extensive washovers. A major storm appears to have struck around 1899. Then there were the three major hurricanes that struck between 1954 and 1956. In 1962, the Ash Wednesday storm hit the coast.

Since the 1960s there has been a relative lull in storm activity on North Carolina's coast, but the storms are sure to come again. And researchers Paul Hosier and Bill Cleary at the University of North Carolina at Wilmington have found that once an island has been overwashed, as Long Beach was, it is likely to be washed over again by the surging ocean waves and tides that accompany major tropical storms.

The researchers have found that most of the barrier islands from Cape Lookout to the North Carolina/South Carolina border have been subjected to major overwash in the last 40 years. In addition, smaller washovers occur annually along the coast.

Long Beach, according to the researchers, is neither the safest nor the most vulnerable of North Carolina's southern beaches. Analysis of historical data, dunes and vegetation shows that the islands most susceptible to washover are Bird Island, Ocean Isle Beach, Lea Island, Masonboro Island, Foy's Beach, Fort Fisher, and Carolina Beach extension. Foy's Beach and Lea Island have been affected by all major storms since 1900.

Bogue, Bear, Brown's, Bald Head and Sunset Beaches are the most resistant to washover.

Some locations are more susceptible to overwash penetration than others, due to the condition of the dune line facing the ocean. Dunes take the brunt of coastal storms. Where there are several dune ridges or an extensive dune

field, islands are more resistant to washover penetration. Islands with a single dune line are highly vulnerable to overwash. Wide islands with high relief are generally safer than narrow islands with low relief.

Recovery following the washover is a key to future vulnerability. Though Hazel obliterated Long Beach in 1954, the beach is considered relatively safe today because the sand dunes have been re-established.

The researchers have found that part of the key to dune recovery lies in a grain of sand. Coarse-grained sand beaches are slow to recover, while fine sand overwash areas recover rapidly, remobilizing fine sands into dunes within a few years. Dunes are slower to recover near inlets since the openings are continually forming and reforming.

Like erosion, washover is a natural part of the dynamics of barrier islands. But washovers and steadily increasing coastal development have not mixed well. So once Hosier and Cleary have completed an assessment of

overwash for the entire state coastline, their data will be of use to the N. C. Coastal Resources Commission in deciding how best to manage coastal growth.

### ...Construction

Dr. Samuel Sue of Greensboro found out about the wiley ways of the beach the hard way. In less than six months his beachfront lot lost 80 feet to the sea. Fifteen-foot sand dunes and a wooden bulkhead were wiped out.

As the water began lapping at the pilings of his house, Sue moved the house to a sound-side lot on Long Beach. Since then the ocean-front lot has stabilized. The wild fluctuation was apparently due to naturally shifting channels in a nearby inlet.

While Sue's situation is an uncommonly dramatic one, it exemplifies the hazards of coastal development. Spencer Rogers, Sea Grant's coastal engineering advisory specialist, knows that shifting sands and rising ocean level can make coastal construc-

tion risky. So Rogers works with property owners to anticipate and deal with their special needs.

Fifty property owners consulted with Rogers during 1978, his first year with UNC Sea Grant. Rogers advised them on erosion and coastal construction problems ranging from bulkhead failures to insect-damaged pilings.

Because state policy also affects coastal construction, Rogers worked with the North Carolina Coastal Resources Commission (CRC) in its effort to evaluate the implementation of the Coastal Area Management Act (CAMA). Rogers suggested modifications in the guidelines for ocean-front hazard areas and estuarine areas of environmental concern. CAMA limits development in both areas.

Initial ocean-hazard guidelines limited construction of houses and businesses seaward of a line considered to be the 25-year storm level. That is, a storm intense enough to cause erosion above that line might occur about every 25 years. What

Rogers recommended, and is now drawing up under a grant from the CRC, is a regulatory line based on 100-year storms and an average erosion rate over 30 years.

Finally, Rogers, who works out of the Marine Resources Center at Ft. Fisher, along with Sea Grant's advisory agents near Manteo and Morehead City, helped organize Hurricane Awareness Week. The week-long program of films, lectures and exhibits sponsored by Sea Grant and the three North Carolina Marine Resources Centers, drew an estimated audience of 22,000.

### ...Growth

The Coastal Area Management Act of 1974 brought cheers as well as legal challenges. But how has the implementation of the act gone? Not too badly, according to David Brower of the University of North Carolina at Chapel Hill.

Though he did find, in a 1978 study, start-up problems and in-

consistencies in implementation, Brower says that overall the act seems to be working well. And, he adds, proposed revisions of CRC guidelines appear to contain provisions that will remedy the major problems he found.

Those problems were that:

- Similar developments were not being treated equally. In fact, Brower says, in several instances similar permit requests were being handled quite differently;

- There was little correlation between expected environmental impact of development and the severity of development restrictions imposed.

Brower based his study on the permits that were issued for major construction between March 1, 1978, and March 1, 1979—the first year of the act's implementation. Development of 20 acres or more is considered major. The permit system is the CRC's primary means of controlling development in designated areas of environmental concern.

Still under consideration is whether or not the CRC permit-

ting processing really has made a difference in the type of coastal development taking place and if simplified, effective planning techniques can be developed for rural coastal communities.

### ... Bulkheads

One of the ways sound-side property owners battle the constant rise of sea level is with bulkheads. The sturdy wood, steel or concrete structures are designed to provide a bulwark against the rising waters. Of course, bulkheads can't permanently stave off the loss of land. But some bulkheads have a longer life expectancy and effectiveness than others.

According to Jerry Machemehl of North Carolina State University, asbestos cement sheeting is one material that has frequently failed in coastal North Carolina. Asbestos has been used extensively since 1973 because it is considerably less expensive than other bulkhead materials.

Laboratory tests in 1978 re-

vealed, however, that the material is not suited for use in bulkheads if:

- The bulkhead is higher than about five feet;
- The bulkhead is located in acidic waters (less than pH 7.0);
- The bulkhead is located in

water with high carbon dioxide content, such as stagnant canals where considerable organic matter is decaying;

- The bulkhead is frequently bumped by boats;
- The bulkhead is located in cold waters.

While cold water isn't much of a problem in coastal North Carolina, Machemehl says all the other factors should be considered by landowners thinking of building bulkheads. He strongly recommends water tests for acidity and carbon dioxide. ■





14 Dennis Regan (left) and Jim Stuart practice safe diving techniques

## Recreation: diving and off-road vehicles

They don't call it the Graveyard of the Atlantic for nothing. Strewn across the ocean bottom off North Carolina's shores are at least 2000 shipwrecks, ranging from Civil War blockade runners to World War II German U-boats.

Obviously, a rough place for mariners, but skin divers are finding it to be a paradise virtually unequalled on the East coast. This profusion of shipwrecks largely accounts for a dramatic increase in popularity of diving off the state's coast.

Jim Stuart, for one, is delighted that the state's diving waters are finally being discovered. "It used to be that people either went for the shipwrecks off New Jersey or the clarity off Florida. Now they're finding out that we have some of both here," he says.

Another reason for the increase in diving is a growing number of dive shops, like Thirty-five Fathom, the one Stuart operates in Nags Head, and Outer Banks Unlimited, Art LePage's shop in nearby Wanchese.

Both shops opened their doors in 1977. It wasn't long before they realized most of the divers coming into their shops were poorly informed about North Carolina's shipwrecks. There was no simple guide available which provided wreck locations and background information the divers needed.

Enter Sea Grant's recreation agent Dennis Regan, also an avid diver. Working with several dive shop owners and Leslie Bright of the state's underwater archaeology lab, he collected basic information on the most popular wreck diving sites along the coast.

The end product was a 16-page booklet, complete with maps, brief descriptions of 42 wrecks, lists of North Carolina dive shops and nearby decompression facilities and safety tips. So far *Wreck Diving in North Carolina* has been a hit. "We can't keep it in stock," says Stuart. "I gave out ten a day in the summertime."

Skindivers aren't the only people Regan works with from his headquarters at the Marine

Resources Center on Roanoke Island. In 1978 he completed a study for marina operators on a new method of boat storage.

It probably goes without saying that summer is Regan's busiest season. In 1978 he organized a lecture series for summer visitors to the Marine Resources Center, bringing in experts to talk about everything from weather to Indian culture on the coastal plains.

Off-road vehicles. Over the past several years, they've been at the center of one of coastal North Carolina's hottest controversies. Some people, including large numbers of surf fishermen, like to drive them on the state's beaches. Others, including beachcombers and owners of beach property, consider them destructive and a nuisance.

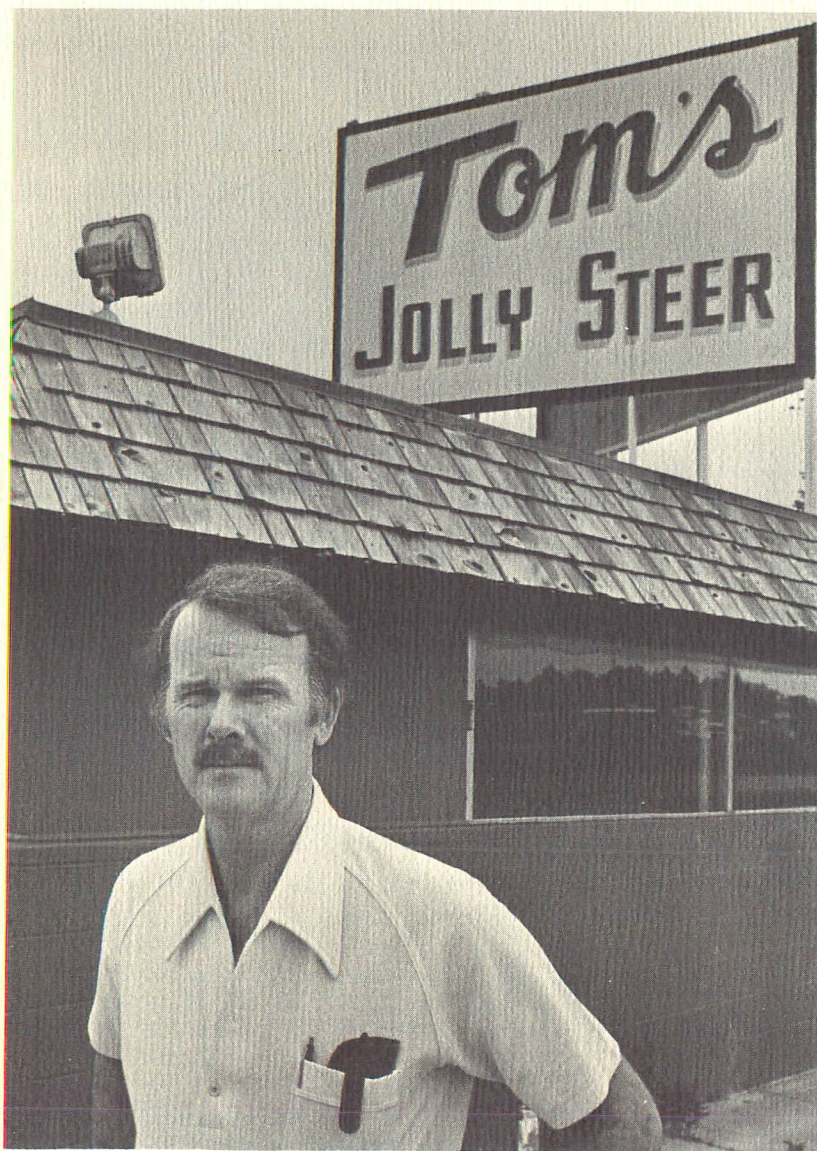
It's a classic quarrel over the use of a limited natural resource, involving a variety of interests, from the National Park Service to sport fishing clubs and environmentalists. And it's right up Leon Abbas' alley.

Abbas is Sea Grant's economist

and recreation specialist. He specializes in helping people understand all the options in cases like these. During 1978 Abbas served on the North Carolina Off-Road Vehicle Task Force, organized to make recommendations to coastal policymakers. Abbas also worked with Sea Grant researchers doing biological studies of the effects of off-road vehicle traffic on ocean beaches.

During 1978 Abbas and graduate student Malcolm Wright conducted a study of the state's natural bait industry. Abbas hopes the study will provide valuable information to those thinking of entering this business.

In addition, Abbas sponsored a series of popular lectures on coastal recreation which were held in Raleigh. And his bait rigging workshops, led by well-known sport fisherman Doug Scott of Jacksonville, Florida, were also a big hit. The workshops were held in Raleigh, Greenville, Manteo, Pine Knoll Shores, Wilmington and Southport. ■



16 Tom Taylor, New Bern

## Estuarine studies: septic tanks...

Tom Taylor had never given much thought to septic waste disposal. When he decided to remodel a gas station and create the Jolly Steer nightclub in New Bern, Taylor assumed that he could use the same type of disposal system that the owner before him had used—a conventional septic tank and an absorption field.

What Taylor didn't realize was that, like much of the land in coastal North Carolina, his was unsuitable for conventional septic waste treatment. Covered by a thick layer of muck soil with the water table only three inches below the surface, the land simply could not handle the waste load that the 175-seat nightclub would generate using a conventional system.

Taylor had just about given up on his nightclub plans when Craven County health authorities Al Harris and C.H. Hamm suggested that he try a new alternative system on the lot. They'd successfully used modified disposal systems before on smaller, single-family sites and were reasonably optimistic that a much larger system could be

made to work at Taylor's nightclub.

So with the approval of the state Division of Environmental Management, they turned to Sea Grant researcher Bobby Carlile of North Carolina State University for help. Carlile has been adapting alternative systems to coastal use since 1976.

A disposal system that combined water conservation devices with a modified mound system for treating the effluent was devised. Several months and \$20,000 later, the Jolly Steer opened for business.

Taylor's trouble with septic waste disposal is not unusual. In some parts of the coast, sandy or tight clay soils and high water tables make as much as 90 percent of the land unsuitable for conventional on-site septic systems. That makes safe disposal of septic waste a major issue in coastal North Carolina.

"It's definitely limited the growth in this county," says Harris, "particularly the uniformity of growth." He estimates that five years ago nearly 30 per-

cent of the applications for septic tank permits received by the county health department were rejected due to site problems.

In nearby Hyde County, 70 percent of the building permits were rejected during 1977 because of waste disposal problems, holding up an estimated half-million dollars in building.

State shellfish sanitation authorities speculate that pollution from improperly treated septic wastes may have played "a significant role" in the closure of more than 400,000 acres of shell-fishing waters in 1978.

Today systems developed by Carlile have been installed in nine of the 20 coastal counties. In Craven County, for example, more than 50 alternative on-site waste disposal systems have been constructed. In Hyde County delayed construction has been allowed to proceed with the use of alternative systems.

"He's given us a new set of systems to work with," says Harris who adds that the septic permit rejection rate is down by

10 to 15 percent in Craven County as a result of Carlile's work.

In 1978, Carlile and associate Dennis Osborne continued work with their two most successful disposal system designs—the low-pressure distribution system and the mound system. As part of the Sea Grant study, microbiologist Mark Sobsey of the University of North Carolina at Chapel Hill looked at the effectiveness of the two systems in removing bacteria and viruses in wastewater. He found that no excessive degradation of water quality occurred as a result of using the alternative systems.

The researchers also expanded their study in 1978 to include two test sites in the southern section of the state where the density of development and high water tables pose the most serious problems. A network of 168 monitoring wells was installed in 11 coastal counties to determine the influence of ground water fluctuations and soil type on waste treatment.

Regional workshops were held

in five coastal counties for more than 150 county sanitarians, contractors, developers, homeowners and Soil Conservation Service personnel on the design, operation and installation of alternative waste disposal systems.

### ...Outfall

North Carolina's estuarine area—it's coastal sounds and rivers—is the third largest in the nation. Only Alaska's and Louisiana's are larger. It's in the estuaries that much of the seafood that's so economically important to the state is nurtured. So man's impact on the state's 2.3 million acres of estuaries is critical.

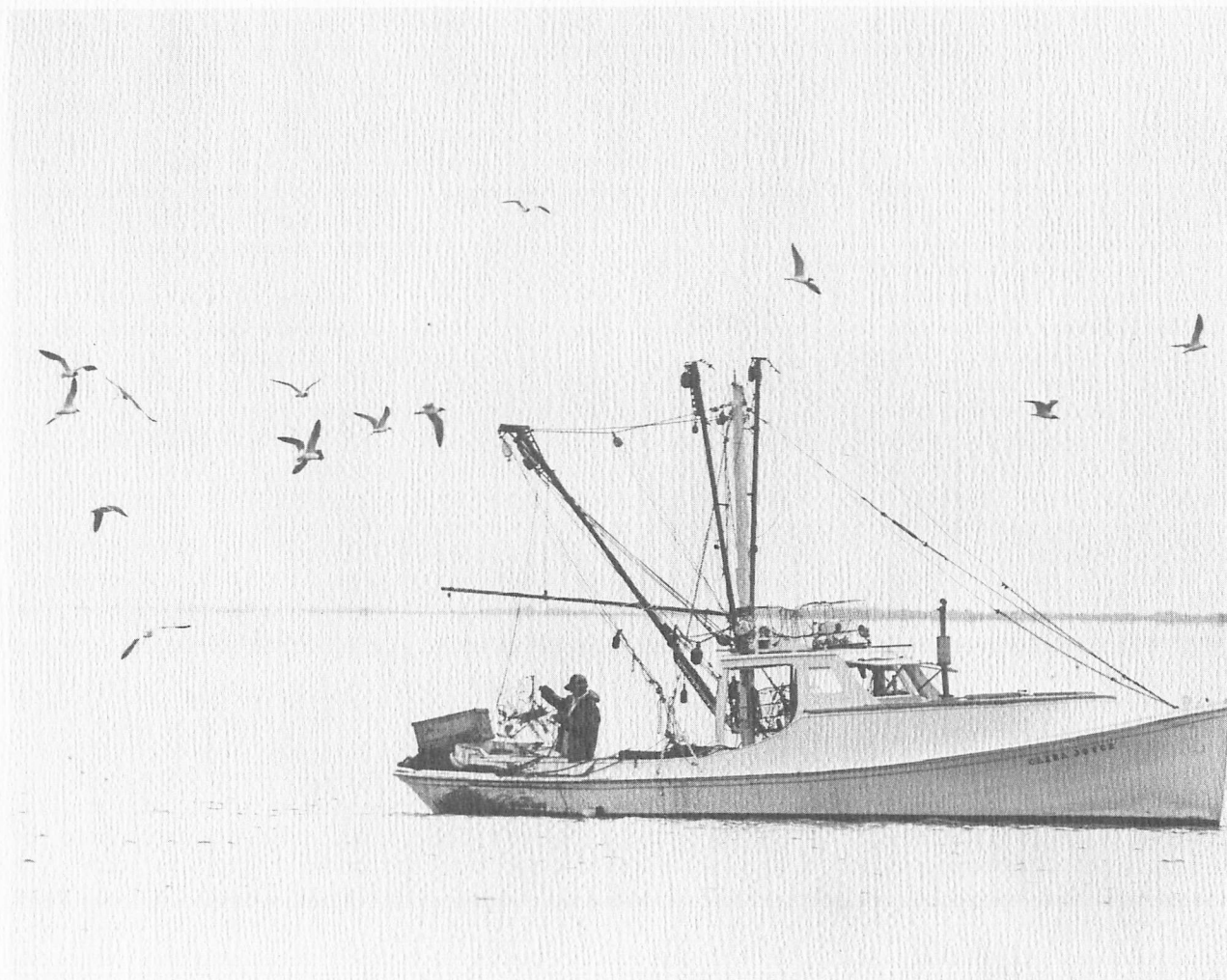
That impact can come not only from septic tanks, but from dumping of human and chemical waste, and increased freshwater runoff—problems which Sea Grant has studied in recent years.

In a study he just completed, Yates Sorrell of North Carolina State University took a look at

the possibility of using ocean outfall for dumping municipal sewage. Several North Carolina coastal communities are considering it. If Sorrell's outfall design works and is adopted, it could mean that fewer sewage pollutants would end up in the sensitive estuaries.

Mixing of sewage and ocean water is the key to outfall safety. Sorrell developed a way to predict the amount of mixing that would take place in the ocean both as a result of pipe design and natural ocean action. What he found was that, contrary to popular opinion and design, the most important factor in outfall design—at least for North Carolina—is water depth over the pipe, not distance from shore.

Information on Sorrell's work available to coastal engineers includes site data required to estimate mixing and flow; estimates of the dilution possible and minimum design criteria; features that North Carolina outfalls are likely to have and how they might differ from outfalls elsewhere; and data necessary for preliminary feasibility studies.



### ...Freshwater

As harmless as it may seem, freshwater—too much of it—can be a bad thing, particularly where shrimp are concerned. Juvenile brown shrimp have a critical tolerance for salinity. If salt levels are too low they will not migrate into shallower, more inland waters where they develop into adults.

Preston Pate of the North Carolina Division of Marine Fisheries has just completed a two-year study sponsored by Sea Grant on the effects of rapid freshwater inflows on juvenile brown shrimp productivity and survival.

He found that lowered salinities—resulting from significant freshwater runoff in 1978—drastically reduced the productivity of primary nursery areas for both shellfish and finfish. Total catches of the state's most valuable seafood crop were down by more than 50 percent in 1978.

Information obtained in the study already is being used by the Office of Coastal Manage-

ment for developing and evaluating land-use standards in areas adjacent to estuarine waters under the Coastal Area Management Act. That's because often the culprit in increased freshwater runoff is development which clears land of vegetation.

### ...Fluoride

Expanding phosphate mining operations along Pamlico Sound have raised questions about the impact of fluoride on the state's \$4.3-million blue crab catch. Fluoride is released as a by-product of phosphate mining, and levels of the substance are higher than normal in the Pamlico River Estuary.

Edgar Heckel of East Carolina University has found that crabs exposed to low levels of fluoride (about 30 parts per million) experience a 50 percent increase in mortality. The presence of magnesium in the water, however, seems to eliminate much of the problem of fluoride-induced mortality. His studies also revealed that fluoride in-

hibits the hardening of the exoskeleton after molting, subjecting the crab to increased mortality through predation.

Heckel's findings are being used by state and federal resource agencies to evaluate existing fluoride effluent standards. In some areas more stringent pollution controls may be necessary to protect blue crab populations.

### ...Milfoil

Sudden and dramatic changes in the environment can occur naturally as well. In Currituck Sound, for example, the explosive growth of an exotic aquatic plant, which first appeared there only ten years earlier, nearly choked the sound. At one point the plant, known as Eurasian watermilfoil, blanketed nearly three-fourths of the 98,000-acre sound.

No one is really sure how the milfoil got started in Currituck Sound. But since its appearance it's been called both an environmental nuisance and a boon to fishing.

In studies involving the control and use of milfoil, Graham Davis of East Carolina University found that mowing was only practical as a limited control technique to maintain localized weed-free "canals" and that high water content of the plant (nearly 90 percent) makes it impractical for commercial use as compost or animal feed.

To learn more about the plant, its effect on the sound's ecology and how to control it, Sea Grant funded a comprehensive study. In 1978 the final two portions of the study were completed.

Fisheries biologists Melvin Huish and Howard Kerby of North Carolina State University concluded that the milfoil did not have an adverse effect on fish populations in the sound and that the overall number of fish actually had increased, while the average weight per fish had decreased.

Ironically, as the studies end, it appears that milfoil may be disappearing from Currituck Sound. By May, 1978, the biomass of milfoil in the sound proper was

down by about 60 percent from 1973 levels. Davis believes that severe northeasters and heavy rains in 1977 and early 1978 may have made the sound too murky for the plant to grow.

### ...Birds

Scientists often use various plant or animal species as a gauge for measuring the impact of development on a particular environment. Along the coast, birds are the most visible indicator.

Sea Grant researchers James Parnell of the University of North Carolina at Wilmington and Bob Soots of Campbell College have completed an extensive atlas of the colonial waterbirds nesting in North Carolina estuaries. The publication includes the first comprehensive estimate of breeding populations of waterbirds ever attempted in North Carolina as well as information on the habitat requirements of each species and the actual location of colony sites. ■



## Education: squid and schools . . .

It looked like chaos.

But there was a method to the madness.

Ann Charles-Craft's first and second grade classroom at Snipes Elementary School in Wilmington was abuzz with groups of youngsters who were buttering fish, opening cans of tuna, cleaning squid and steaming shrimp.

On the blackboard, the recipes were spelled out: SQUID CREOLE, BAKED TROUT, BAKED FLOUNDER, TUNA ON CRACKERS . . .

At one table, the tuna salad crew was counting the number of cans already opened and the number yet to be opened. The squid creole group was reading the recipe to see what went in after the sausage and onions. The scallop team was having a minor altercation over whose job it was to carry the pan to the oven. Mediation saved the day and the two fellows carried it together, gingerly.

When it was all over and the last smidgeon of creole sauce had

been scarfed up, a tired teacher explained what she hoped had happened at the seafood-tasting party which was attended by classes of first, second and third graders:

- All the children had tasted a variety of seafoods;
- The children had realized that the foods are available to them in Wilmington and that the seafood industry is an important one to Wilmington and the coast;
- In order to complete their assigned tasks, the children had read the recipes and used a few math skills;
- They had had an experience with time . . . the idea of how long it takes to cook something;
- They had learned something about cooking;
- And, finally, they had learned about social interaction and working together (even the scallop team).

The seafood party was part of a month-long unit Charles-Craft, Beth Warren and Vicki Rivenbark were using. During the

month, the classes also visited a salt marsh; had "hands on" activities with assorted sea creatures; tended one-gallon aquariums; wrote stories about their experiences ("I went to the salt marsh, but I did not see this tiger. Thank you." Jamie Harrell), and made fish prints.

It was the first time Charles-Craft had used marine education as a tool to teach an interdisciplinary course. She thinks it works: "I've seen kids excited with this who have not been excited all year. That's worth it." And, of course, everyone knows today's children are tomorrow's decision-makers who will need to understand valuable coastal resources.

What led up to that spring day in the Wilmington classroom was a major effort by Sea Grant to promote marine education in North Carolina. It started with Man and the Seacoast workshops held in the summers of 1977 and 1978 under the direction of Dirk Frankenberg of the University of North Carolina at Chapel Hill.

At those workshops 46 secon-

dary school teachers worked for a month with university instructors to devise marine education materials. The result is a series of *Marine Education Manuals*. One thousand copies of *Coastal Geology*, *Seawater*, *Coastal*

*Ecology* and a set of appendices were distributed to teachers throughout the state in 1978. *Coastal Beginnings* went to press in the spring of 1979.

The workshops had a multi-

plier effect. New courses were drawn up. The teachers who attended resoundingly approved of the approach and shared it with their colleagues in both elementary and secondary schools. That's how Ann Charles-Craft



first got involved in marine education.

That's also where Charles-Craft met Sea Grant education specialist Lundie Mauldin. Charles-Craft asked Mauldin to put on a short marine education workshop for other teachers at Snipes School. Many of the activities presented (including the one-gallon aquariums and the squid creole experiments) were included in the month-long unit Charles-Craft and the other teachers used. The teachers also used the *Marine Education Manuals* and another course outline Mauldin compiled called *Coastal Capers*.

Mauldin—who joined Sea Grant in August, 1978, after working on the Man and the Sea-coast project—personally worked with 200 teachers (who each had about 30 students) on marine education techniques in 1978. She participated in National Science Foundation Elementary Awareness conferences held across the state for more than 300 educators. Mauldin also discussed marine education with undergraduate students in education

on four university campuses. She introduced the students to sources for training and materials in North Carolina.

### ...The law

Children are not the only people who need to know about the coast. As the demands on the coastal zone grow, so do the legal constraints regarding its use. To help inform lawyers and government personnel of the issues surrounding ocean and coastal law, Sea Grant has supported a summer course at the University of North Carolina at Chapel Hill law school.

The ocean and coastal law course has now been incorporated in the school's curriculum and the course's originator, Tom Schoenbaum, is taking the course to the Tulane University law school in New Orleans in the fall of 1979.

A bonus of the course is that students work on research issues relevant to coastal law at the moment. Some students took a look at federal involvement in coastal policy issues and concluded that

states do possess the legal tools under federal and state law to exercise a paramount influence on how coastal resources are allocated. Other research projects included an examination of the legal constraints on mariculture development and the effectiveness of the coastal permitting system under the Coastal Area Management Act.

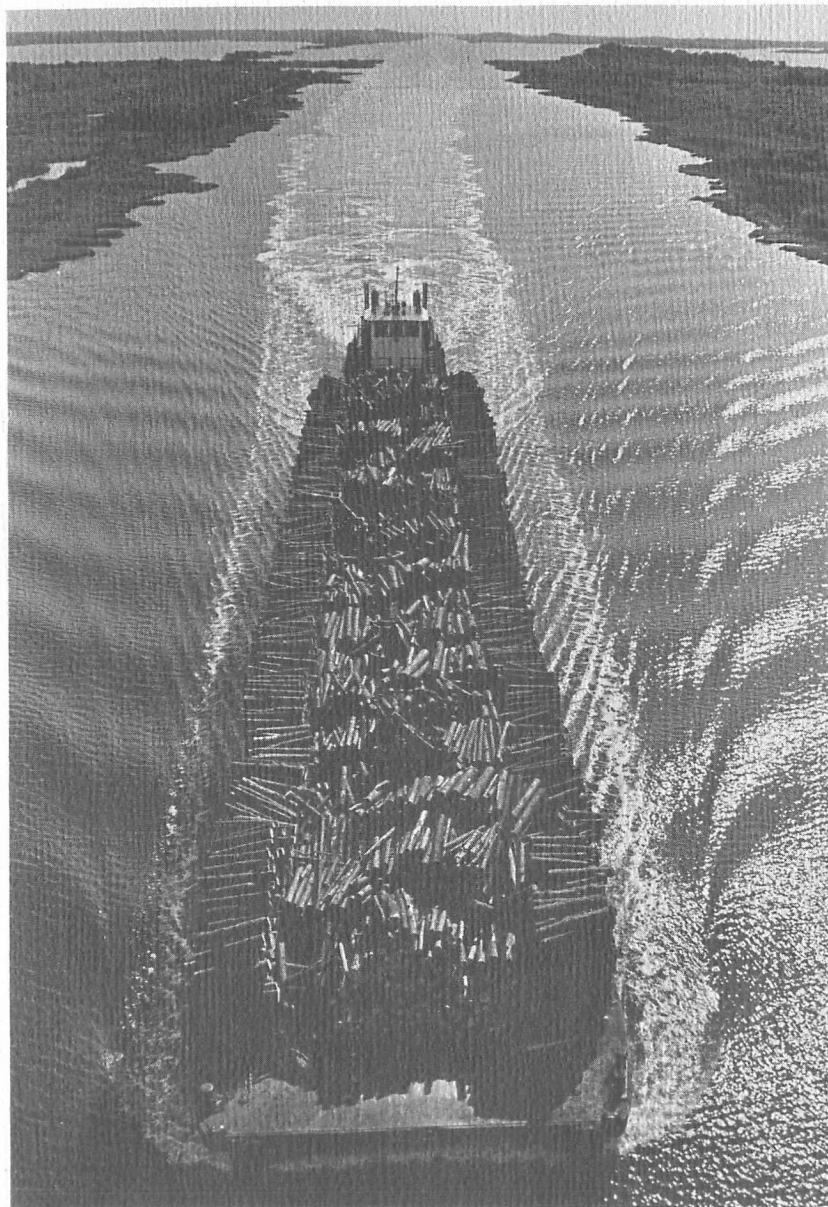
### ...Students

Most research projects require a lot of work, more than can be done by one or two investigators. That's why Sea Grant has always depended upon students, both graduate and undergraduate, to complete the picture.

In 1978, 80 students from four campuses of the university were involved in Sea Grant research. They included students in a variety of fields: from chemistry to engineering to ornithology and computer science. Some worked in laboratories, while others labored in the field, collecting subsurface core samples or mowing milfoil.

The Sea Grant/student partnership benefits both groups. Sea Grant researchers get necessary assistance with their projects. And for students, the work provides valuable experience, which many are able to apply to future studies or jobs. Paul Comar, who worked with East Carolina University researcher Barney Kane evaluating the rangia clam as a food product, now has a job with the National Marine Fisheries Service in Pascagoula, Mississippi.

As an undergraduate at the University of North Carolina at Wilmington, Doug Luster assisted Don Kapraun in studying the potential for commercial harvesting of the seaweed nori. Now a graduate student in plant physiology at North Carolina State University, he is pursuing research on the photoperiod control of the nori life history. ■



## Publications

### GENERAL INTEREST

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

**Baker, S. and K. Jurgensen**, Storms, people and property in coastal North Carolina. UNC-SG-78-15. No charge.

**Baker, S., K. Jurgensen and R. Gourley**, Hurricanes on the coast of North Carolina. Poster. No charge.

**Mordecai, M. D. and K. Jurgensen**, A look at Sea Grant 1977. Annual report. No charge.

**Mordecai, M. D., J. Worthington and K. Jurgensen**, The University of North Carolina Sea Grant College Program Newsletter. Monthly publication. No charge.

**Regan, D. and J. Worthington**, Wreck Diving in North Carolina, a directory of shipwrecks along the North Carolina Coast, UNC-SG-78-13.

**Riggs, S., M. O'Connor, V. Bellis and T. A. Duque**, Estuarine shoreline erosion in North Carolina, a series of five posters featuring Core/Bogue Sounds, Albemarle Sound, Pamlico River Estuary, and Neuse River Estuary. Fifth poster describes cause and effect of erosion. No charge.

**Bringing the catch home.** Brochure. No charge.

### EDUCATION

**Mauldin, L. and D. Frankenberg**, North Carolina marine education manual:

UNC-SG-78-14 A	Unit One, Coastal geology	\$1.50
UNC-SG-78-14 B	Unit Two, Seawater	\$1.50
UNC-SG-78-14 C	Unit Three, Coastal Ecology	\$1.50
UNC-SG-78-14 D	Unit Four, Appendices	\$1.00

## COASTAL STUDIES

**Forman, J. W., Jr., and J. L. Machemehl**, Sediment dynamics and shore response at Drum Inlet, N.C. Working Paper 78-2. \$4.60.

**Gopalakrishnan, T. C. and J. L. Machemehl**, Numerical flow model for an Atlantic coast barrier island tidal inlet. UNC-SG-78-02, \$3.00

**Machemehl, J. L., L. Watson and B. Barnes**, Deterioration of asbestos cement sheet material in the marine environment. UNC-SG Working Paper 78-1. \$4.00 Out of print.

**Owens, D. W., D. C. Herr, N. Noneman and D. J. Brower**, Access to the nation's beaches: an annotated bibliography. UNC-SG Working Paper 78-3. Out of print.

**Pietrafesa, L. J., R. D'Amato, C. Gabriel, and R. J. Sawyer, Jr.**, Continental margin atmospheric climatology and sea level (historical setting 1974-75). UNC-SG-78-09. \$7.00 all requests.

**Pietrafesa, J. L., R. D'Amato, C. Gabriel, R. J. Sawyer, Jr., D. A. Brooks, P. Blankinship and R. H. Weisberg**, Onslow Bay physical/dynamical experiments, summer 1976, UNC-SG-78-16, \$26 (all).

**Sorrell, F. Y.**, Outfall diffuser hydraulics as related to North Carolina coastal wastewater disposal. UNC-SG-78-01. \$1.75.

**Sorrell, F. Y.**, Submarine wastewater outfall near field flow dynamics and mixing. UNC-SG Working Paper 78-4. \$1.00

## ESTUARINE STUDIES

**Cammen, L. M., P. A. Rublee and J. E. Hobby**, The significance of microbial carbon in the nutrition of the polychaete *Neresis Succinea* and other aquatic deposit feeders. UNC-SG-78-12. \$3.00

**Jernigan, L., R. F. Soots, Jr., J. F. Parnell and T. Quay**, Nesting habitats and breeding populations of the least tern (*Sterna Albifrons* Antillarum) in North Carolina. UNC-SG-78-07. \$1.75

**Rublee, P. A., L. M. Cammen and J. E. Hobby**, Bacteria in a North Carolina salt marsh: standing crop and importance in the decomposition of *Spartina alterniflora*. UNC-SG-78-11. \$3.00

## FOOD FROM THE SEA

**Jurgensen, K. and A. P. Covington** (editors), Extended Fishery Jurisdiction: Problems and Progress, 1977 (conference proceedings). UNC-SG-77-19.

**Janier, T. and F. B. Thomas**, Minced Fish: its production and use. UNC-SG-78-08. \$1.50

**Rickards, W. L., J. E. Foster and W. R. Jones**, A feeding tray for use in eel farming. UNC-SG-78-04. No charge.

**Rickards, W. L.** (editor), A diagnostic manual of eel diseases occurring under culture conditions in Japan. UNC-SG-78-06. \$9.00 (all).

## REPRINTS

**Gopalakrishnan, T. C. and J. L. Machemehl**, 1978. Verification of a numerical flow model for Carolina Beach Inlet, North Carolina. Proc. Specialty Confr. on Verification of Mathematical and Physical Models in Hydraulic Engineering, Amer. Soc. Civil Engin., College Park, Md., 9-11 Aug., pp. 509-517. UNC-SG Reprint No. 124.

**Kempler, G. and B. Ray**, 1978. Nature of freezing damage on the lipopolysaccharide molecule of *Escherichia coli* B. Cryobiology, 15:578-584, UNC-SG Reprint No. 125.

**Kneib, R. T.** 1978. Habitat, diet, reproduction and growth of the spotfin killifish, *Fundulus luciae*, from a North Carolina salt marsh. Copeia, 1978(1):164-168. UNC-SG Reprint No. 118.

- Kneib, R. T. and A. E. Stiven.** 1978. Growth, reproduction and feeding of *Fundulus heterclitus* (L.) on a North Carolina salt marsh. J. Exp. Mar. Biol. Ecol., 31:121-140. UNC-SG Reprint No. 119.
- Koch, H. G. and R. C. Axtell.** 1978. Autogeny and rearing of *Culicoides furens*, *C. hollensis* and *C. melleus* (Diptera: Ceratopogonidae) from coastal North Carolina. Mosquito News, 38(2):240-244. UNC-SG Reprint No. 121.
- Parnell, J. F. and R. F. Soots, Jr.** 1978. The use of dredge islands by wading birds. Wading Birds, Research Report No. 7, pp. 105-111. UNC-SG Reprint No. 120.
- Ray, B., S. M. Hawkins and C. R. Hackney.** 1978. Method for the detection of injured *Vibrio parahaemolyticus* in seafoods. Applied and Environmental Microbiology, 35(6):1121-1127. UNC-SG Reprint No. 123.
- Rickards, W. L., W. R. Jones and J. E. Foster.** 1978. Techniques for culturing the American eel. Proc. Ninth Ann. Meeting, World Mariculture Society, pp. 641-646. UNC-SG Reprint No. 127.
- Rublee, P. and B. E. Dornseif.** 1978. Direct counts of bacteria in the sediments of a North Carolina salt marsh. Estuaries, 1(3):188-191. UNC-SG Reprint No. 126.
- Schoenbaum, T. J. and F. Parker, Jr.** 1979. Federalism in the coastal zone; three models of state jurisdiction and control. N.C. Law Review, 57(2):231-260. UNC-SG Reprint No. 129.
- Schoenbaum, T. J. and P. E. McDonald.** 1977. State management of marine fisheries after the Fishery Conservation and Management Act of 1976 and *Douglas vs. Seacoast Products, Inc.* William & Mary Law Review, 19(1):17-42. UNC-SG Reprint No. 128.
- Sobsey, M. D., R. J. Carrick and H. R. Jensen.** 1978. Improved methods for detecting enteric viruses in oysters. Applied & Environmental Microbiology, 36(1):121-128. UNC-SG Reprint No. 122.

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## To order

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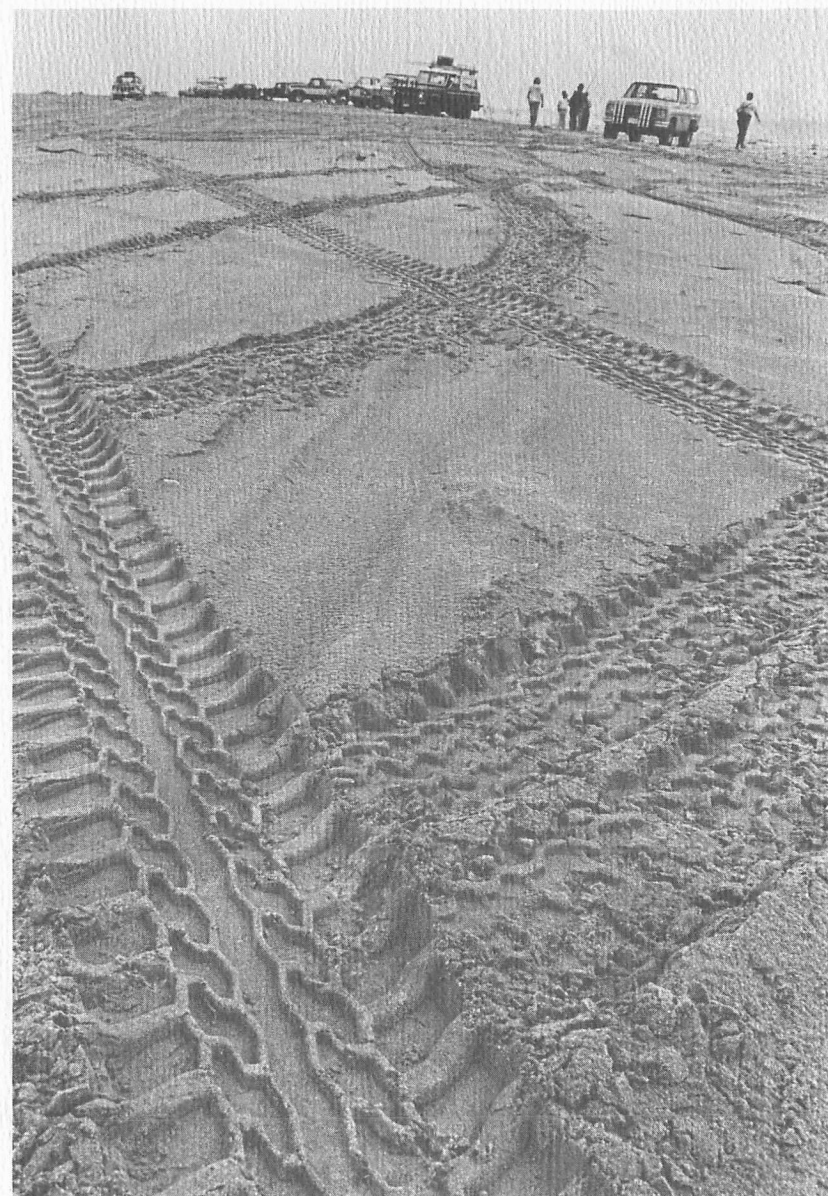
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## UNC Sea Grant budget, 1978

	NOAA	STATE
<b>Marine Resources Development</b>		
Aquaculture	30,576	17,397
Living resources other than aquaculture	17,004	9,542
Marine law and socio-economics	50,808	27,518
<b>Marine Technology Research and Development</b>		
Ocean engineering	18,120	10,645
Resources recovery and utilization	66,947	36,393
<b>Marine Environmental Research</b>		
Research supporting coastal management decisions	123,875	64,583
Pollution studies	61,959	23,917
Applied oceanography	40,019	12,796
<b>Marine Education and Training</b>		
College level	9,180	5,813
Other education	31,231	16,352
<b>Advisory Services</b>		
Extension programs	234,380	131,068
<b>Program Management and Development</b>		
Program administration	119,996	40,069
Program development	45,905	28,907
<b>Total</b>	<b>\$850,000</b>	<b>\$425,000</b>



# Project standing

N—Project initiation  
 C—Project continuing  
 F—Project completed  
 R—Project redirected  
 T—Project terminated

		Status 1 Jan. 1978	Status 1 Jan. 1979			Status 1 Jan. 1978	Status 1 Jan. 1979
<b>PROGRAM MANAGEMENT</b>				<b>COASTAL STUDIES</b>			
MD/A-1	Program Management and Development; Copeland, Rickards	C	C	R/CZS-11	Flow Dynamic and Sediment Models for Barrier Island Tidal Inlets; Machemehl	N	T
MD/A-2	Project Initiation and Rapid Response Capability; Copeland, Rickards	C	C	R/CZS-12	Development of a Methodology to Predict Mixing and Dispersion of Effluents from Ocean Outfall on the North Carolina Coast; Sorrell	C	F
MD/A-3	Program Communications; Copeland, Mordecai, Jurgensen, Worthington	C	C	R/CZS-13	The Physical and Biological Parameters Affecting Establishment of Marsh Vegetation for Shoreline Erosion Control; Seneca, Knowles, Broome	C	C
<b>MARINE EDUCATION</b>				R/CZS-14	Vegetation Patterns and Succession in Overwash Environments; Cape Lookout to Cape Fear, NC; Hosier, Cleary	C	F
E/LS-1	The development of an Ocean and Coastal Law Program; Schoenbaum	C	F	R/CZS-15	Building Science Technology for Residential and Commercial Structures in Coastal Hazard Zones; Machemehl	N	C
E/GS-1	Man and the Seacoast-Past and Future Perspectives: A Program of Instruction and Teaching Materials for Use in Middle Schools; Frankenberg, Still	C	F	R/CZS-17	Development Planning and Control in Rural Coastal Communities; Brower, Heeter	N	F
<b>ADVISORY SERVICES</b>							
A/EA-10	Marine Advisory Services, Copeland	C	C				

		Status 1 Jan. 1978	Status 1 Jan. 1979			Status 1 Jan. 1978	Status 1 Jan. 1979
<b>FOOD FROM THE SEA</b>				<b>ESTUARINE STUDIES</b>			
<b>R/AF-5</b>	Aquaculture of the American Eel, <i>Anguilla rostrata</i> ; Rickards	<b>C</b>	<b>F</b>	<b>R/ES-20</b>	Coastal Bird Population Study; Parnell, Soots	<b>C</b>	<b>F</b>
<b>R/AF-6</b>	Biology and Control of Fungal Diseases Affecting Aquaculture; Bland	<b>C</b>	<b>F</b>	<b>R/ES-21</b>	Eurasian Watermilfoil: Its Control and Potential Use; Davis, Abbas, Huish	<b>C</b>	<b>F</b>
<b>R/AF-7</b>	Nori Processing and Harvesting: A New Seafood Industry for North Carolina; Kapraun	<b>N</b>	<b>F</b>	<b>R/ES-23</b>	Development of Alternative On-Site Septic Waste Disposal Systems for the Coastal Zone of North Carolina; Carlile, King, Sobsey	<b>C</b>	<b>C</b>
<b>R/SST-5</b>	Identification and Incidence of Hazardous Microorganisms in Seafood; Speck, Ray	<b>C</b>	<b>F</b>	<b>R/ES-24</b>	Evaluation of <i>Rangia Cuneata</i> As a Food Product for Compliance with Public Health Standards; Kane, Jeffreys	<b>N</b>	<b>F</b>
<b>R/SST-6</b>	Investigation of the Functional Properties of Fish Protein and Application to New Products Having Improved Texture; Hamann, Lanier, Thomas	<b>C</b>	<b>C</b>	<b>R/ES-25</b>	Assessment and control of Virus Contamination of Shellfish; Sobsey	<b>N</b>	<b>C</b>
<b>R/AF-8</b>	A Study of the Markets and Marketing Channels for Eels Produced in North Carolina; Leonard, Easley, Abbas	<b>N</b>	<b>F</b>	<b>R/ES-26</b>	Effects of Fluoride on Resorption and Redeposition of Calcium in the Blue Crab ( <i>Callinectes Sapidus</i> ); Heckel	<b>N</b>	<b>T</b>
<b>R/LS-11</b>	The Sociocultural Organization of Fishing in a North Carolina Coastal Community—Perspectives for Economic Development; Sabella, Dixon, Lowery	<b>N</b>	<b>C</b>	<b>R/ES-27</b>	Physical Studies of Pamlico Sound, N.C.; Weisberg, Janowitz, Pietrafesa	<b>C</b>	<b>C</b>
				<b>R/MP-1</b>	Development of Policy Alternatives for Shrimp Fishery Management; Fishman		<b>C</b>



## 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 vice-president for research and public service programs, coordinates university marine science programs, including Sea Grant.



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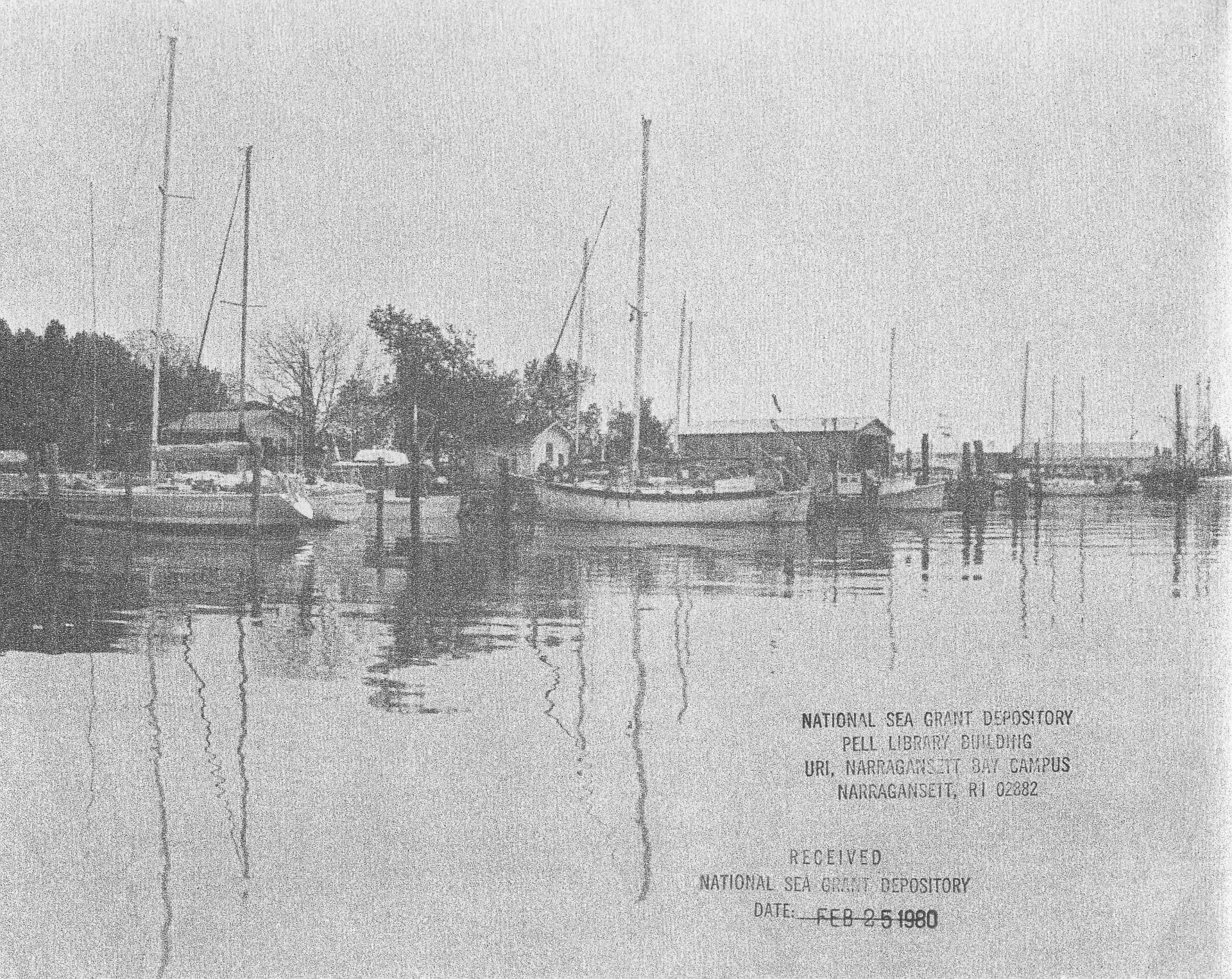
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*A look at Sea Grant in North Carolina, 1978* was written and edited by Karen Jurgensen, Mary Day Mordecai and Virginia Worthington; designed by Karen Jurgensen and John Kirtz.

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