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NORTH  
CAROLINA

a report on the  
university of north carolina  
sea grant program for 1974



## From the director

*Dr. B. J. Copeland*

This report highlights activities during the fourth year of Sea Grant institutional support for the University of North Carolina. In spite of reduced funding for 1974, significant progress was made in several areas.

Although structured projects yielded most of this year's progress, Sea Grant's presence, through its management and outreach, made response to current and timely needs possible without large expenditures of funds. Sea Grant was able to initiate important preliminary work to assess the problems of offshore sewage disposal, a high priority state policy problem.

Sea Grant advisory agents responded to an urgent request from the state's Coastal Resources Commission to inform local government officials of guidelines for drawing up county land-use plans. Three workshops, held within six weeks of the request, provided valuable information to the counties and feedback to the Commission.

Combining with the Coastal Plains Regional Commission's Center for Marine Development, the Program conducted needed workshops in coastal zone management, eel fishing techniques and shrimp fishing improvements. Through this cooperative, we produced information bulletins and initiated a seafood processing and handling pilot study.

Pathways of communications were improved with relevant state agencies this year, laying important groundwork for more realistic responses and better coordination. Regular conferences with high level agency personnel have resulted in both better responses on the Program's part to relevant problem areas and the agencies' immediate utilization of research results. This relationship is even more vital in the maintenance of a future, more viable Program.

Most of the research projects initiated during the early days of our institutional program have reached completion during 1974. This means that results and final reports are now reaching user groups and that new, important problems needing solutions can be addressed. Sea Grant has reached higher levels of recognition and is now able to expand into other, more pertinent areas of research and advisory services.

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North Carolina's coast is still teeming with rich natural resources. We depend on them for life's necessities and its pleasures. Future generations will need them too for life, health and happiness.

Too often in the past, we've squandered our resources, destroyed them needlessly, used them foolishly.

But there's a new awareness. It's a brand of thinking that makes a man consider what today's actions could mean tomorrow. It's an attitude that says, "use, but do it wisely."

Sea Grant is a University of North Carolina program concerned with coastal resources and how they're used. Its goals are aimed at developing ways that we can prosper from the earth's natural treasures without taking them away from tomorrow.

To reach its goals, Sea Grant provides funds for research to find new and better ways to use coastal resources, for advisory services to put research findings into the hands of those who need them and for education to instill an understanding of resources and their limitations.

The University of North Carolina Sea Grant Program supports experts at North Carolina State University, East Carolina University and the University of North Carolina at Chapel Hill and Wilmington.

Initiated in North Carolina in 1970, UNC Sea Grant is funded by grants from the U. S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and with state matching funds through the N. C. Department of Administration. The national Sea Grant Program was created by a congressional act in 1966.



## Sea Grant touches people . . .

—Frank Swanson's fish don't spoil as fast as they used to. That makes for more satisfied customers.

—Edwin Clemons and fellow Brunswick Countians may have the advantage over this year's mosquitoes. They've geared up with new weapons to stave off the brunt of insect attacks.

—Guy Hamilton is padding his bank account with money he earns in his part-time eel fishing business.

Swanson, Clemons and Hamilton probably don't know each other. But they have at least two things in common. All three live on North Carolina's coast. And all three are using things they learned



*Clemons*

*Hamilton*

*Swanson*

from the University of North Carolina Sea Grant Program to improve business and living conditions.

There's a good chance the three had never heard of Sea Grant before 1974. But you couldn't really blame them.

After all, for its first three years as part of the University of North Carolina, Sea Grant pretty much hid within an ivory tower. And maybe that's where it should have been at first.

Researchers perhaps needed time to develop basic knowledge about the intricate workings of the coastal environs. Getting to the root of insect, erosion and pollution problems—and then coming up with ways to remedy them—takes years of devoted study. It is such research that forms the backbone of the Program.

But in Sea Grant's way of thinking, that backbone needs exercise. Research results are most worthwhile when put to use by people seeking to upgrade their standard of living.

For the University of North Carolina Sea Grant Program, 1974 was the year to apply the fruits of research. It was time to build a strong ladder leading from and to the ivory tower. Each rung on the ladder made it easier for the Program to reach out. And each made it

## ... a year for reaching out

easier for the public and government agencies to approach Sea Grant with their needs and problems.

By year's end, UNC Sea Grant had been recognized by citizens and state and local government officials as an organization that could accomplish things.

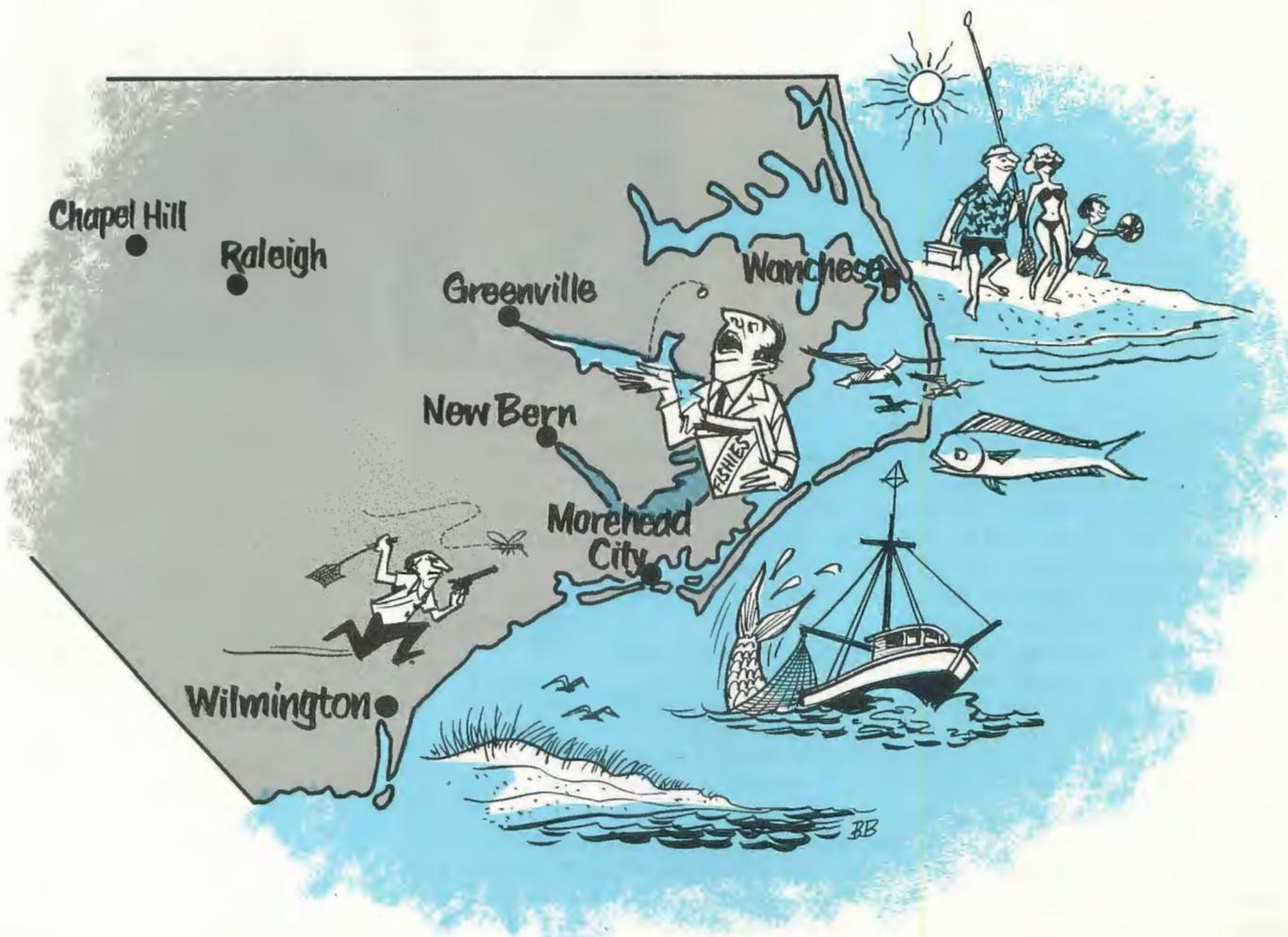
One rung on the ladder was a product of research. Of 18 projects funded in 1974, 10 were completed. Many of those had been supported since the early days of UNC Sea Grant—and results had begun to shine clear through the mounds of data collected over past years.

By the end of 1974, scientists whose efforts to stabilize eroding beaches with grasses had proved successful saw their planting techniques put to use by communities and industry in North Carolina and elsewhere along the eastern seaboard.

Another scientist who sought controls for an insect pest of beach-grass could cite instances where his findings had helped save beach vegetation from destruction.

Data collected by researchers studying nutrients and pollution in the state's estuaries and water circulation patterns in sounds and around inlets had provided bases for state and federal environmental quality criteria and policy.

*The University of North Carolina Sea Grant Program supports projects at North Carolina State University, Raleigh; East Carolina University, Greenville; and University of North Carolina campuses at Wilmington and Chapel Hill.*





Sociologists studying the human resource of coastal North Carolina helped instill a new awareness of people problems for consideration in coastal management.

Continuing research also made significant gains this year. Seafood scientists developed a new seafood product—pizza topped with deboned fish meat—that may soon be school lunchroom fare. A scientist studying disease in aquaculture identified disease organisms infesting experimental mariculture conducted by Sea Grant Programs, government and private industry on the Atlantic, Pacific and Gulf coasts. The Sound and Sea Fishermen's Association, a cooperative of North Carolina fishermen organized with UNC Sea Grant assistance in 1973, grew steadily throughout 1974.

A second rung on Sea Grant's ladder to the outside world was built with the launching of an organized information and communications program. A monthly newsletter featuring Program activities and timely developments in the coastal area told the Sea Grant story to some 2,500 individuals. Information bulletins, news releases and annual reports furnished yet other outlets for Sea Grant's research results—and served to create an increasing awareness of the Program.

Expansion of the advisory services program into the coastal management arena established new inroads to state agencies involved in implementing the state's one-year-old Coastal Area Management Act. Coastal management is a critical issue in North Carolina, one which Sea Grant can further by increasing understanding through education and information.

Another rung on Sea Grant's ladder grew out of efforts to join other agencies concerned with the economic and environmental welfare of the coastal region. This year Sea Grant joined forces with such agencies as the Coastal Plains Center for Marine Development in Wilmington to

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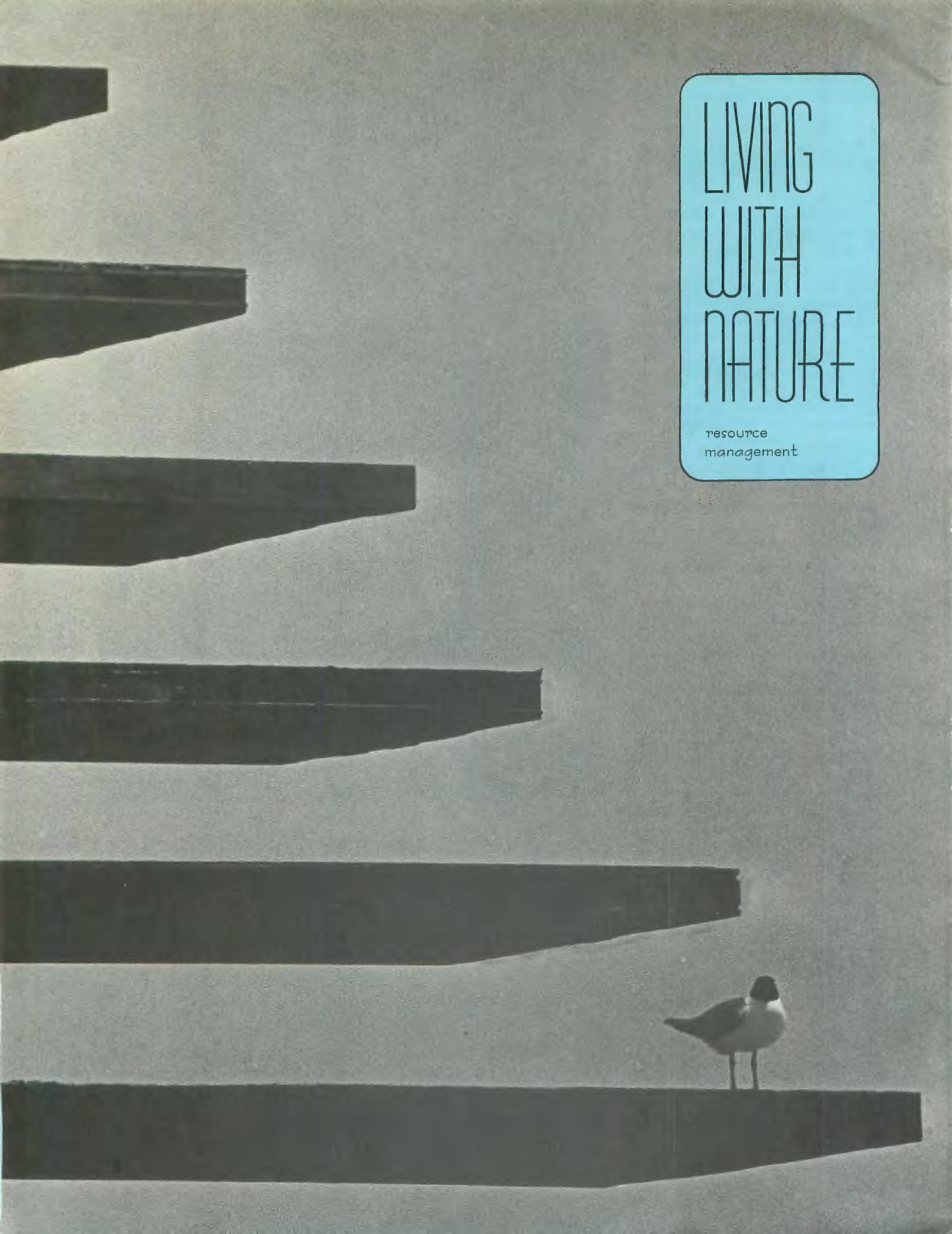
***By year's end, UNC Sea Grant had been recognized as an organization that could accomplish things.***

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reach more people and to conduct broader research.

Seeking to tailor Program efforts and goals to the real needs of coastal citizens, Sea Grant this year organized a citizens advisory panel. The panel, composed of representatives of the commercial fishing, recreation and seafood processing industries, as well as developers, bankers and lawyers in the coastal area, provides program administrators with feedback and guidance aimed at keeping Sea Grant on the track to answering immediate and long-term needs. □





# LIVING WITH NATURE

resource  
management

## **Dredge islands:**

# **A retreat for waterbirds**

Herons and egrets had probably nested on the old dredge island near Beaufort, N. C. for years. It had become the perfect place for a summer home.

Shrubs and woody thickets had grown dense, just the way larger waterbirds prefer it. And the island's isolation from the mainland's hustle and bustle made life there almost carefree.

The seabirds that reared their young there last summer didn't know that dramatic changes were on tap for their island. It had been some years since those monster-like dredging machines had dumped new spoil there, destroying vegetation and leaving it unfit for the needs of such birds as herons and egrets. But this year, plans were in the works to dump a new load of sand and mud that would destroy the heronry.

Luckily, when the birds return in late May and early June, they will never know such plans were on the books. Their island will be intact, thanks to cooperation between UNC Sea Grant researchers and the U. S. Army Corps of Engineers, Wilmington district office. An understanding of the birds' dredge island nesting habits, furnished by the Sea Grant researchers, and a willingness on the part of the Corps of Engineers to alter dredging schedules is saving the heronry. This cooperation appears to be only a beginning to something called dredge island management. Already the researchers have worked informally with the Wilmington District Corps of Engineers office in planning 1975 dredging schedules to minimize

damage to bird colonies and improve habitats.

Sea Grant biologists began studying the hundreds of dredge islands in North Carolina's coastal waters three years ago. Their study first focused on plant succession and spoil stabilization. But when they observed that the level of plant growth seemed to have a direct relationship with the kinds of birds found nesting on the islands, emphasis shifted to the birds. They found, for instance, that terns prefer almost bare sand, gulls like thick grasses and herons nest in shrubs and thickets.

Dumping new spoil on the islands—action which returns vegetation levels to year one—has been beneficial for those birds that prefer little or no plant growth, scientists say. But since it isn't economically feasible to



*An almost bare dredge island is summer home for this colony of royal terns. Sea Grant researchers studying the birds and the nesting grounds they prefer this year sought ways to manage dredge islands for the birds.*



dredge just to suit the birds, Sea Grant biologists began looking for other ways to control plant growth. In 1974, they tested and found that selected herbicides are useful in keeping vegetation levels low. In one area where herbicides were tested, a colony of royal terns made their nests last summer.

A two-day conference detailing research findings and addressing administrative and legal aspects of managing dredge islands was held by the Sea Grant researchers in May. Some 70 participants from more than 20 state, federal and private organizations attended and widespread interest continues.

With information collected in the three-year study, scientists believe they can now predict bird usage of the islands. But they aren't content with that. They know that an important step toward managing a natural resource in the future is knowing its current abundance. New research efforts, therefore, are directed toward determining the size of the state's waterbird population. □

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*Investigators:*  
**J. F. Parnell, UNC-W**  
**R. F. Soots, Campbell College**



# Building and rebuilding with grasses

*Ray Scoggins, Pine Knoll Shores  
erosion control committee member  
and building inspector.*



Teeing off on the first hole of the Pine Knoll Shores golf course without losing your ball in a water hazard has gotten a lot tougher over the past two years. That's because the water hazard, which happens to be Bogue Sound, has gobbled up parts of the first fairway by the mouthful.

But since last spring, the sound's winds and waters, responsible for eating away up to 20 feet of the course in some spots, have all but stopped their destructive act. Why? Marsh grass sprigged in the eroding area last April and May by UNC Sea Grant-supported scientists thrived and is catching and beginning to re-build some of the lost soils.

Ray Scoggins, Pine Knoll Shores building inspector who serves on a local erosion control committee, walked to the sound side of the fairway where the water had cut a series of coves. "We're real proud of this," Scoggins said, pointing to a cove where marsh grass, planted in rows, stood tall and dense. Sand had begun to catch around the roots of the grasses—and the slow process of rebuilding was underway. For the Pine Knoll Shores golf club, that grass means savings of valuable property and high maintenance costs.

Work to stabilize eroding shorelines is just one aspect of research to slow coastal erosion with vegetation. During 1974, the Sea Grant researchers found that a 1973 experiment using marsh grass to hold dredge spoil in place—while creating new



*Bogue Sound's winds and waves had eaten large chunks off the Pine Knoll Shores golf course (above). Sea Grant-supported scientists applying research results planted marsh grasses in the eroding coves. Erosion has now virtually stopped and depleted soils are beginning to rebuild (below).*



salt marsh—is proving successful.

They found that animals normally found in natural marsh also colonize artificially-established marsh. This further indicates that man-made plantings of *Spartina alterniflora*, or smooth cordgrass, do lead to the creation of real marsh over time.

Scientists also continued experiments with mixed beach grasses as a dune stabilizer. Their research is jointly funded by UNC Sea Grant, the N. C. Agricultural Experiment Station and the U. S. Army Corps of Engineers.

Results from their work with marsh grass—which includes testing the success of seeding and transplanting as well as the effects of fertilizing, plant spacing and pruning—are being put to use. In hopes of slowing erosion at its nuclear power plant near Southport, Carolina Power and Light Company planted *Spartina alterniflora*, North Carolina's dominant marsh grass, along 50,000 feet of drainage and discharge canals last June.

In other experiments that could lead to information needed for dune management along the Atlantic and Gulf coasts, the Sea

Grant-supported scientists sought to determine the rate and amount of sand accumulation for various beachgrass planting methods.

Research this year yielded significant progress toward improving techniques for building and stabilizing sand dunes with a combination of beachgrasses. In previous years, studies have focused on American beachgrass. Seeking extra insurance against erosion when a single species of grass dies out, researchers turned their attention to mixed plantings. Significant gains in the propagation of sea oats and running beachgrass were made.

Individual property owners, coastal government agencies from Nova Scotia to Florida and private developers have requested information on using vegetation to stabilize beach property. Many are already putting research findings to work. One beachgrass producer reports selling enough plants to cover two miles of average beach front.

In a related study, researchers identified major insects attacking *Spartina alterniflora*. Insect attacks may result in reduced seed, stand and vigor of marsh grasses. Continued efforts to control the scale insect, a pest of American beachgrass, showed that an application of dimethoate made in 1971 controlled the scale population.

Information gained in this research could be useful in managing pests in areas where stabilization with grasses is critical. □

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*Investigators:*  
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**E. D. Seneca, NCSU**  
**W. V. Campbell, NCSU**



# Unraveling the geologic past and future

Some of the old timers living on Roanoke Island tell a story about folks walking from Manteo to Manns Harbor. That's tough to imagine today since the two communities are separated by a body of water more than two miles wide called Croatan Sound.

Most of the Roanoke Islanders have heard the tale from parents and grandparents. And hard as it is to believe, the story illustrates dramatic geologic changes that have occurred in North Carolina's coastal area.

Geologists, supported by UNC Sea Grant in a four-year study which concluded this year, have peered into geologic history to learn more about why these changes occurred—and to predict how the coast is likely to look in the future. The evidence they've collected on where lands are likely to wash away or build up in the future is vital if you're planning to build a house or hotel anywhere near the water.

During earlier stages of their study, the geologists combined modern technology with a collection of old maps to gather information. In field studies they collected data on where and in what amounts potentially valuable minerals are located in the Dare County area. As their study broadened, they unearthed secrets held in soils beneath the water and land that reveal the story of geologic processes—such as erosion, accretion, inlet openings and closings—that over time have helped shape North Carolina's jagged shoreline.

This year's efforts aimed at putting geologic research findings into the hands of people who might use them—and at making the public aware of the processes acting on their beaches. A film developed by the UNC Sea Grant geologists enabled them to take their work to some 100,000 North Carolinians who viewed it on television and in civic and school presentations.

The film, "Waterbound—Our Changing Outer Banks," describes how geologic processes, particularly erosion, shape the coastline and discusses ways man has tried to control eroding beaches.

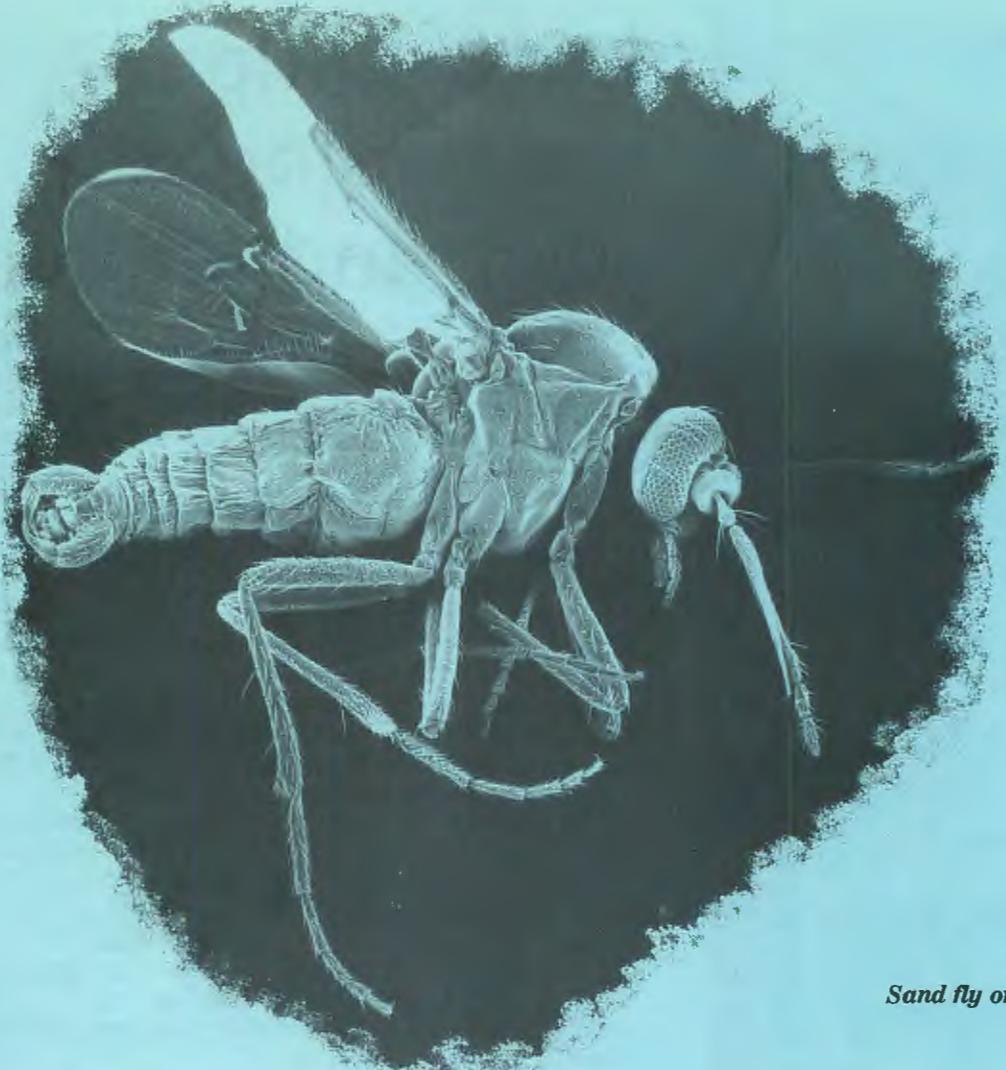
Cape Hatteras National Seashore officials have used the film to provide background in hearings reviewing five alternative means of dealing with eroding Outer Banks beaches proposed by the National Parks Service.

Researchers also began compiling a comprehensive report on their work. The report, a geologic land-use atlas for North Carolina's northeastern coastal area, could become a major tool for land-use planners. Maps included in the atlas will pinpoint mineral resource locations in Dare County. They will also identify present land uses and areas which are environmentally or geologically sensitive. A third set of maps will classify shoreline types in northeastern North Carolina.

*Old timers say they used to walk on good solid ground where this bridge now spans water that is almost three miles wide.*

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**Investigators:**  
**S. R. Riggs, ECU**  
**M. P. O'Connor, ECU**



*Sand fly or biting gnat*

# Arming against the mighty insect

There's no shortage of mosquitoes in Brunswick County. In fact, Edwin Clemons, the county's man in charge of insect control, says he's willing to give them away.

Sometimes Clemons and fellow Brunswick Countians wonder who's really in command—they or the insects. So this year, they decided to try to settle the question. With a beefed-up arsenal of insect-fighting weapons supplied by UNC Sea Grant scientists studying coastal insect management, Brunswick officials feel they may be gaining control.

Local residents and Brunswick County natives have learned to "bite back" at the insects, Clemons said. But the summer people, most of whom are looking for outdoor fun, aren't quite as tough. "We want them to come down and have a good time spending their money," Clemons said. His county, like all counties on the coast, feels an economic pinch when insects bite into their tourist and recreation trade.

If there's one thing people aren't afraid to complain about, it must be mosquitoes. Local governments in charge of insect control have pleaded with university scientists for help with the biting bugs. Sea Grant researchers jointly supported by the N. C. Agricultural Experiment Station are responding to their pleas.

Brunswick officials heard about new insect control meth-

ods last spring at a Sea Grant-sponsored training workshop for coastal mosquito and biting fly control workers. Since then, they've put services and information furnished by Sea Grant scientists into their insect battle plans. And according to Clemmons, director of the county health department's solid waste and vector control division, more of the insect control information will be used in the next couple of years.

Following researchers' recommendations, the county mothballed its fogging truck and replaced it with ULV (ultra low volume) equipment. Lightweight ULV equipment, proven just as effective as fogging, sprays a fine, almost invisible mist, eliminating traffic hazards created by fogging. In addition, it uses less insecticide and fuel, scientists say.

Research to determine the most effective kinds and amounts of chemicals for controlling various pest species was a major emphasis during 1974. County governments, in addition to Brunswick's, and the Division of Health Services of the N. C. Department of Human Resources are using ULV to control insects.

As outlined by Sea Grant researchers, Brunswick pest control operators are plotting areas where mosquitoes and biting flies strike hardest, Clemmons said. "We're putting our control efforts into these target areas," he explained, adding that treatment applied to reduce large outbreaks of insects to tolerable levels saves money on chemicals and fuel.

Many localities treat insect problems by spraying insecticide on a regular time schedule. Sea Grant researchers believe that by monitoring insects to find out when and where they strike hardest, localities can tailor controls to deal with serious outbreaks. Background on breeding sites and growth patterns of common insect pests, compiled in their research, will further assist local govern-



*Edwin Clemmons, director of the Brunswick County Health Department's division of solid waste and vector control.*

ments with pest management.

During 1974, the Sea Grant entomologists also tested and showed the effectiveness of treating window screens with insecticide to keep out tiny biting sand flies. They also completed an economic analysis of the costs of and demand for salt marsh mosquito abatement.



*Coastal North Carolina insect pest control operators learn how to monitor pest populations and gear controls to reduce large insect outbreaks for minimum costs in a training session conducted by Sea Grant scientists.*

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**Investigators:**  
**R. C. Axtell, NCSU**  
**K. L. Knight, NCSU**



## Getting coastal management on sound footing

*It's not an uncommon sight anymore, seeing bulldozers move sand from one place to another making way for new homes, motels or businesses and changing the character of coastal areas. This year North Carolinians took steps that enable them to plan how their beaches will look in the future.*

You might say that North Carolina's coastal area has come to a crossroads. Down one route is the drive to rampant development. Down the other is a roadblock to halt growth and keep things as they are.

This year North Carolina's General Assembly handed the people of the state a tool that promises to help them build a third route, one that runs somewhere between uncontrolled and stunted growth. That tool is the Coastal Area Management Act, legislation that if put into action could be the pact to more peaceful co-existence between developer and environmentalist.

The responsibility of putting the coastal act into effect belongs to state and local governments. But the job of putting it on sound footing is easier if citizenry and decision-makers understand what coastal management is all about and how North Carolina's law works. That's where UNC Sea Grant is able to help.

At the request of the state's secretary of natural and economic resources, UNC Sea Grant's land-use advisory services agent, a newcomer to the Program this year, cooperated with the UNC Institute of Government in conducting three educational workshops. Held in Wrightsville Beach, New Bern

and Elizabeth City, the workshops reviewed guidelines authored by the state which are to be followed by localities in drawing up county-wide growth plans. The 120 professional planners and local government officials attending the workshops furnished feedback to the state Coastal Resources Commission on changes they felt were needed in the guidelines.

The land-use advisory agent, keeping closely attuned with steps to implement coastal management, maintained close liaison with the Coastal Resources Commission throughout the year.

UNC legal researchers working under Sea Grant support also contributed to a better understanding of coastal management and North Carolina's coastal act. One associate professor of law who has been supported by Sea Grant since 1970 was a principal author of the first draft of the Coastal Area Management Bill. During the bill's two-year legislative debate, he assisted legislators and state agency officials in making necessary revisions in the law. An article which he authored for the *N. C. Law Review* in 1974 analyzes the act and its potential weaknesses and suggests solutions to legal problems contained in the law.

More than 30 UNC Law School students gained insight into legal aspects of coastal zone and international sea law in classes taught by a Sea Grant-supported law professor. The students' research, compiled in six 1974 Sea Grant publications, contributed substantially to the legal library holdings on coastal and oceanic issues and provided in-depth analyses of legal problems faced by the state and nation.

Already many law graduates are putting knowledge gained in sea and coastal law courses to work in their careers. During 1974, one student participant of the Sea Grant-supported ocean law project

served as ocean law deputy in the North Carolina attorney general's office. Two graduates served as clerks to North Carolina's federal district court of appeals judges.

In addition to his classroom activities, the Sea Grant legal researcher maintained an information exchange with other members of the legal profession in foreign nations as well as in U.S. federal and state government agencies.

### Tourism's Impact

Data collected in a one year Sea Grant study could yield important information about the human resource of coastal North Carolina. The study aimed at gauging the response of coastal citizens to changes caused by increased tourism and development. Information on the wants and needs of coastal citizens could be important to land-use decision-makers who are seeking to make the best use of all of the state's coastal resources.

Research focused on the human ecology of three coastal communities, where tourist trades can be characterized as slow, rapid and transient or weekend. The computer was employed to project the effects of water-based recreation that could be developed in the communities. An ability to "see into the future" with the computer could help coastal citizens determine whether development of recreation resources would help or harm the social and economic fabric of their communities.

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### Investigators:

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# MEASURING MAN'S IMPACT

environmental quality

*Marsh such as this on Portsmouth Island may not look too important. But scientists know that marsh grasses are a vital link in the food chain leading to our dinner plates. Sea Grant scientists are trying to learn just how valuable marsh really is.*

## Toward a more productive coastal zone

There's more to those acres of swampy marsh you pass on your way to the beach than meets the eye. In fact, that tall straight grass that thrives in marshlands is an early link in a complex food chain leading to your dinner plate.

It may be hard to believe, but many of the fish and shellfish you catch in the sound and ocean depend on marsh plants and animals for food. As marsh plants decay they break into tiny, energy-filled matter on which many organisms feed. Juvenile fish in turn feed on the tiny organisms and decaying plant matter in the marsh and surrounding waters. Marsh grass, therefore, is a vital link in the growth of many fish and shellfish.

So what happens when marshland is filled for building a motel or highway? Does destruction of rich marsh grasses reduce the number of fish in our sounds and ocean? State and local agencies need

answers to these questions in order to make wise decisions about alternate uses for marshlands.

UNC Sea Grant scientists this year began research aimed at answering questions about the value of marshlands. In their study they are relating vegetative growth to the number of animals found in sample marsh areas. They are seeking to learn how productivity of marsh grass affects the number of animals, or consumers, found in the marsh. Their data will aid in determining whether a marsh with more grass than another is capable of supporting more consumers. Findings could help determine if marsh fertilized with city sewage, for example, might support thicker grasses and, therefore, more fish.

Collection of this information in North Carolina will provide a better understanding of differences in salt marsh productivity—and its impact on fisheries—along the East coast.

This work, combined and co-ordinated with UNC Sea Grant work begun in 1975 and with National Marine Fisheries Service research, will provide bases for valid judgments concerning the value of marsh.

### **Estuarine management**

The millions of acres of sounds and estuaries lying between North Carolina's mainland and its strand of barrier islands also provide home and food for the state's fishery resources.

But since Sir Walter Raleigh planted his ill-fated English colony on Roanoke Island in 1587, the state's coastal waters have become dumping grounds for man's and nature's wastes. Agriculture, industry and cities have churned new nutrients and chemicals into the estuaries. Seeking to control the problem before it becomes irreversible, government has taken steps to preserve the quality of the state's coastal water resources.

Basic to wise decision-making

on the part of government agencies are facts on just how much nitrogen, phosphorus and other pollutants are in the estuaries, how much of these substances fish can tolerate and where pollutants travel once in the sounds and estuaries. Two Sea Grant-supported research projects, completed this year, are providing those facts.

In one study, physical oceanographers sought to learn more about water circulation and flow patterns in sounds and inlet areas. During 1974, they completed field measurements of water level, flow and salinity in the Pamlico and Pungo River estuaries and around Ocracoke and Hatteras inlets. Their four-year Sea Grant project completed the collection of circulation data for Pamlico Sound and its tributaries. An analysis of the effects of wind directions on water move-

Project researchers have responded to requests for information from the N. C. Department of Natural and Economic Resources on the potential impact of new trailer parks on nutrient levels in the Neuse River. Information gained in this research provided the basis for a major technical paper requested by the Environmental Protection Agency on nutrient effect and control in the nation's estuarine ecosystems.

Sampling frequencies and locations, established in Albemarle Sound in the four-year nutrient study, have aided data gathering in the Chowan River Project. A joint effort by federal, state and university scientists, the Project, focusing on the Chowan River in northeastern North Carolina and southeastern Virginia, is designed to develop data for coastal river basin management in the Southeast.

An environmental management model, developed under Sea Grant support to predict where waters would go, how fast they would move, what nutrients they are likely to carry and which lands would be flooded in storm conditions, has also been applied in the Chowan River Project.

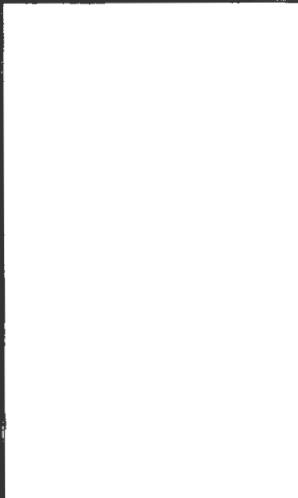
Sea Grant-supported ocean engineers continued studying the interactions and potential impact of waves and currents on marine structures. Research findings promise to lead to the design and construction of safer offshore ports, oil rigs and other marine structures. The National Aeronautic and Space Administration (NASA) is already putting research findings to work and Shell Oil Co. and Exxon have expressed continuing interest in this research.

### **Investigators:**

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**N. E. Huang, NCSU**

# PEOPLE... SEA GRANT IS FOR PEOPLE





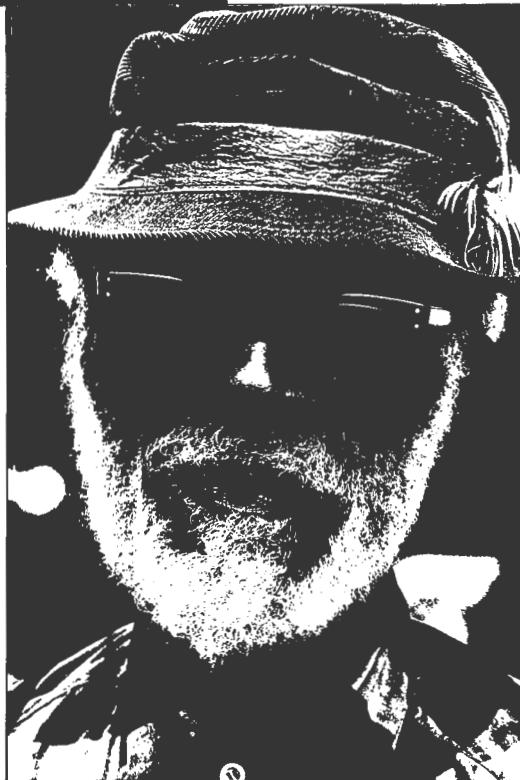
*The people along the sand  
All turn and look one way.  
They turn their back on the land.  
They look at the sea all day.*

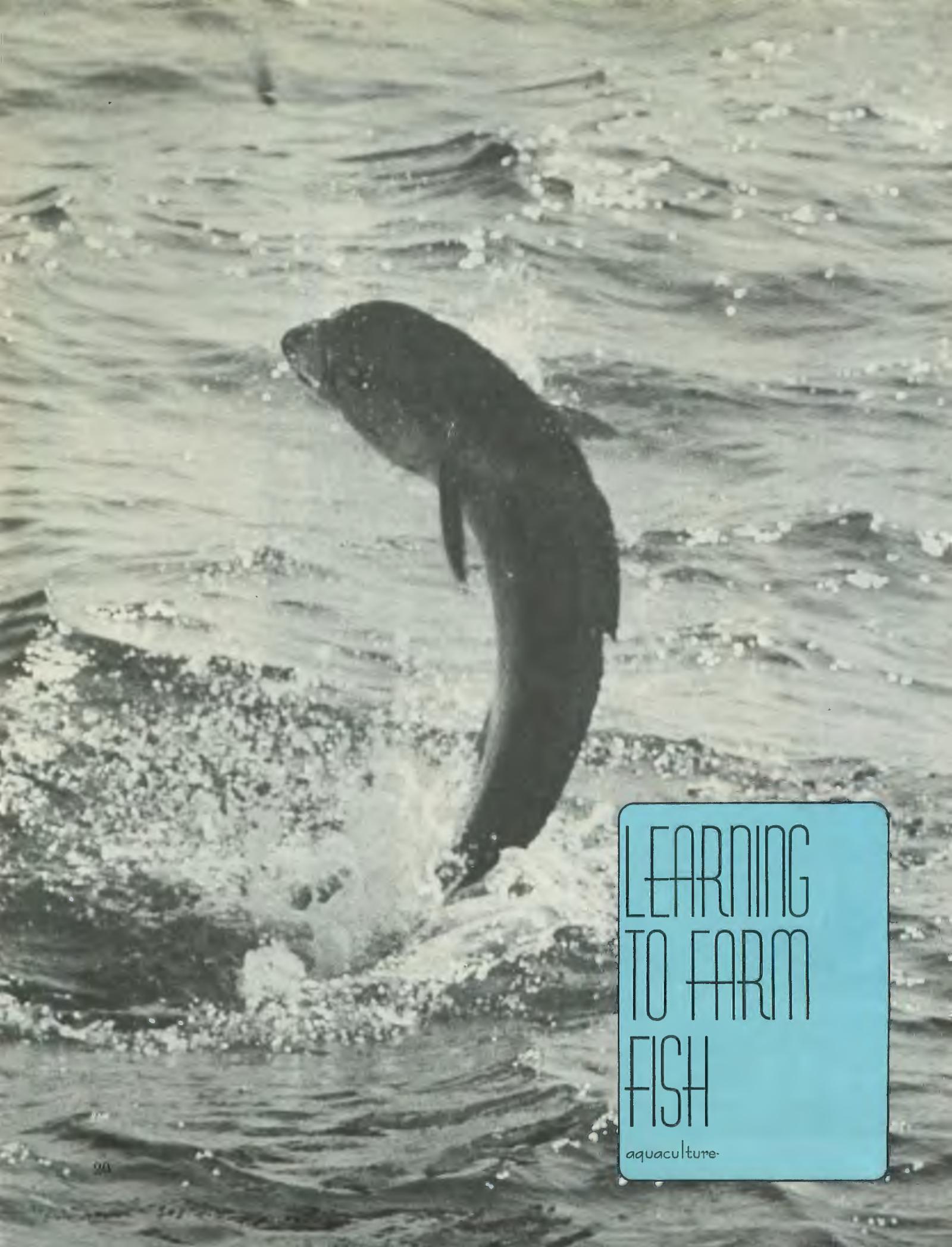
*As long as it takes to pass  
A ship keeps raising its hull;  
The wetter ground like glass  
Reflects a standing gull.*

*The land may vary more:  
But wherever the truth may be—  
The water comes ashore,  
And people look at the sea.*

*They cannot look out far.  
They cannot look in deep.  
But when was that ever a bar  
To any watch they keep?*

—Robert Frost





LEARNING  
TO FARM  
FISH

aquaculture.

## Overcoming obstacles to fish farming

Most of that juicy steak and roast you eat comes from animals grown plump in confined feed lots. Crowded belly-to-belly, cattle nurse a generous supply of grain, turning it into flavorful, tender beef.

But did you ever think of eating shrimp or lobster grown in a feed lot? That, in effect, is what aquaculture, or fish farming, is about.

So far, few commercial fish farms market shrimp, crab, lobster or other marine goodies. But in laboratories supported by universities, government and private industry, scientists are developing techniques and ironing out problems that they hope will clear the way for productive aquaculture businesses.

A major problem plaguing

aquaculture is disease. Once a tank of shrimp, for instance, is infected, a disease organism can spread with lightning speed, often killing every shrimp in the tank. Fungi pose a threat to many shellfish.

A UNC Sea Grant scientist who has spent much of the past four years gazing into microscopes to learn more about fungi affecting blue crab and other marine crustaceans made progress this year toward ultimately controlling disease in shellfish culture.

Studies to identify fungal disease organisms infecting blue crab and shrimp provided the UNC Sea Grant researcher with facts he needed to assist disease-ridden experimental aquaculture operations on the East, West and Gulf coasts. Diseased penaeid shrimp at National Marine Fisheries Service laboratories in Galveston, Texas were found infected by a fungus, common also in North Carolina's blue crabs, known as *Lagenidium*

*callinectes*. The researcher identified the same fungus infesting Dungeness crab larvae at Oregon State University's Marine Science Center and lobster larvae at Bodega Marine Lab in California. He also assisted South Carolina Sea Grant researchers in identifying infection in *Macrobrachium* shrimp.

Perhaps the most exciting development in the scientist's 1974 research was control of *Lagenidium* with chemicals. The fungus can be "cured", the researcher found, with controlled dosages of the chemicals malachite green and DS 9073 without harming the diseased organism. Results are not yet complete.

Disease identification research was expanded to include two kinds of fungi capable of severely affecting shrimp in confined situations. The fungi, *Haliphthoras* and *Fusarium*, are under intense study.

**Investigator:**  
**C. E. Bland, ECU**

## Cobia and dolphin: From egg to adult in captivity

It's just not that easy to grow a fish in captivity, especially if it's one that's likely to weigh almost 75 pounds at only four years of age. And it's doubly difficult if you happen to be the first to try it in your area.

But zoologists, seeking the secrets of growing eggs of cobia and dolphin fish to adulthood in contained tanks, learned more than patience in their four years of Sea Grant-funded research. What they wound up with are some techniques for pampering the fish so they thrive in enclosed areas. Their findings could be just the information someone needs to set up an underwater cobia or dolphin farm.

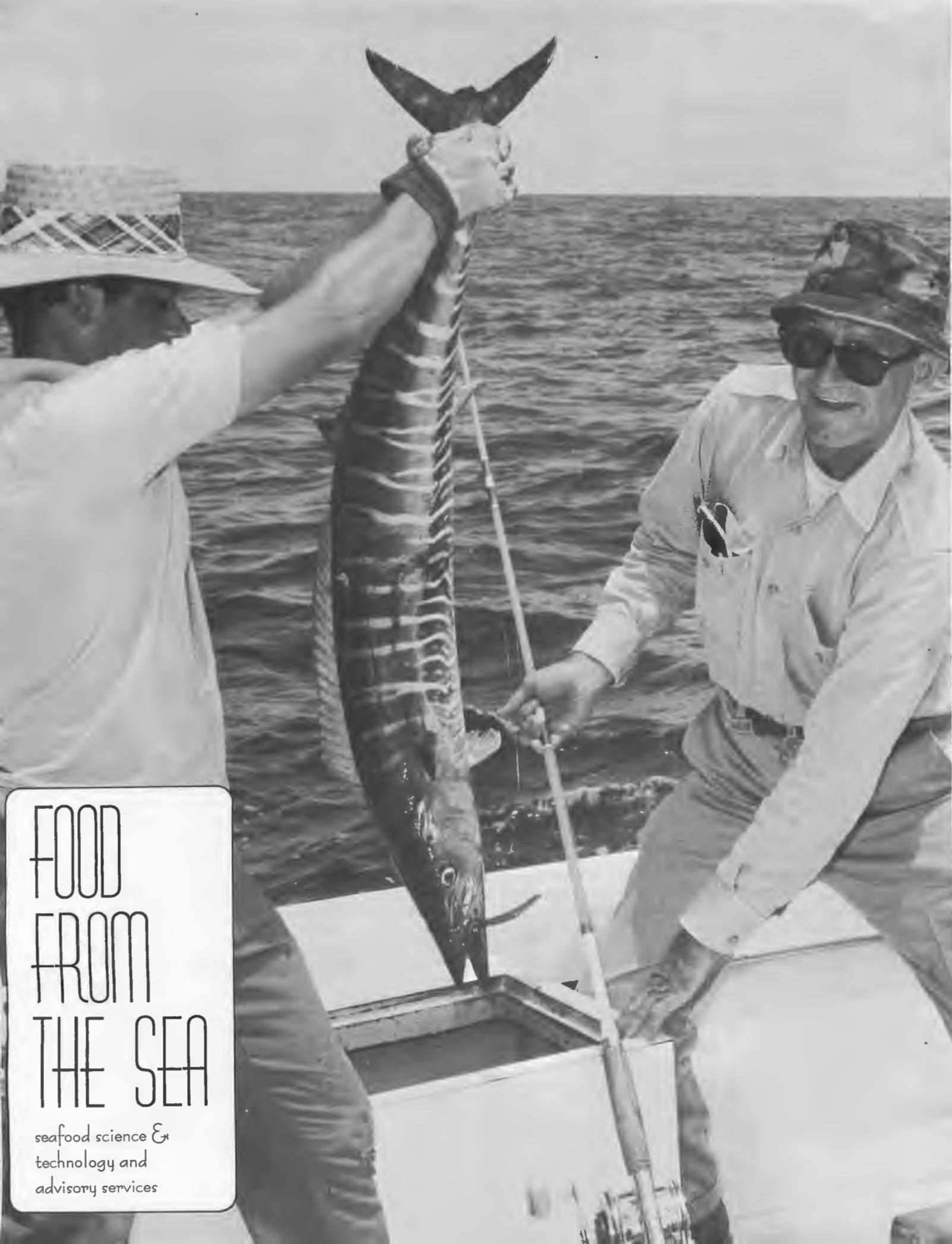
During the study's final year under Sea Grant support, their attention centered on the delicate stages of dolphin development from egg incubation through the precarious larval stage and into adulthood. Working with assistance from the National Marine Fisheries Service Laboratory in Miami, Florida, the researchers successfully collected, incubated and reared dolphin to the landmark age of 23 days. Previous attempts to maintain dolphin larvae past the three-day old yolk-sac stage—the time when the fish must begin to feed—had been

unsuccessful. Later in the year with eggs collected off Hatteras, the scientists scored another "first" when they grew one fish into a real "old timer" of 83 days.

Commercial aquaculture companies have expressed interest in the dolphin-culture study. Because of work to develop capture and live-transport techniques, the UNC Sea Grant supported researchers were able to assist scientists working under a National Institute of Health project in obtaining 40 wild dolphin for visual experiments.

Attempts to develop culture methods for cobia was a natural extension of the scientists' dolphin work. Cobia, like dolphin, are flavorful, rapidly growing fish caught in large numbers off North Carolina's coast in the summer. And in experiments, the researchers found cobia more shock resistant and tolerant to handling and to a wider range of salinities than dolphin. They successfully reared cobia to 131 days, with the largest reaching nine inches in length and weighing three ounces. Although research time was brief, the scientists believe cobia have excellent potential for aquaculture.

**Investigator:**  
**W. W. Hassler, NCSU**



# FOOD FROM THE SEA

seafood science &  
technology and  
advisory services



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## Good grief! fish pizza

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### New uses for seafood

When it comes to school lunches, most kids would rather eat pizza than any other food. Serve them fish and you're likely to get a chorus of groans and a line of wrinkled noses. At least that's what kids surveyed by UNC Sea Grant advisory agents in coastal North Carolina said.

But fish are plentiful and full of protein that's good for growing youngsters. And compared to some meats, fish is cheap.

It took some thinking. But seafood researchers at laboratories in Morehead City and at North Carolina State University in Raleigh, where work is jointly supported by UNC Sea Grant and the N. C. Agricultural Experiment Station, came up with an idea they hope will get kids to eat more fish. Their brainstorm: top pizza with ground up fish meat and make it part of school lunch menus. N. C. School Lunch Program officials liked the idea and encouraged the scientists to pursue it.

Even by the high standards of Morehead City pizza restaurateur Frank Marino, the pizza developed by the Sea Grant team has potential. Marino, who cooperated with the researchers by loaning them his ovens, sees the new pizza going over well, especially in school lunch programs.

Fish pizza offered researchers a chance to expand efforts to develop new food products using fish meat separated from its bones by a

magical deboning machine. This year they continued developing recipes for sausage, hamburger, ravioli, won ton soup and egg rolls, using deboned fish alone and to stretch pork and beef. Even leftover fish skin and bones were used to make flavor-enhancing broths. It's all part of the researchers' goal to help cut down on waste and boost seafood demand.

Before a new product can be put on the grocery counter, seafood scientists test more than taste and appearance. In glistening glass and stainless steel laboratories they study texture, nutritional value, changes in the product after freezing and processing and the length of time the product will stay fresh and nutritious.

Mechanically-deboned fish got a thorough check-up in all those areas this year by Sea Grant seafood researchers. But if products made of the deboned fish—many of which have become popular in Japan—are to be further developed, even more information is needed, scientists say.

Blue crab processors plagued with problems of product quality and deterioration should benefit from research aimed at improving processing and handling techniques. Scientists focused studies

this year on enzyme activity in fresh and frozen crab meat and on protein losses due to cooking and rinsing crab meat in salt brine.

Research was also directed toward microorganisms contaminating fresh and frozen crab and to points during processing where heavy contamination could occur. Their study indicated that more emphasis should be placed on the control of cooking operations to reduce microbe levels.

Examination of a new method to measure crab meat quality continued. Experiments with resazurin reduction tests showed that the resazurin technique has potential for both processors and regulatory officials charged with determining potential crab meat spoilage.

Sea Grant seafood scientists, aware that findings are useful only if placed in the hands of the seafood processing industry, this year began a series of information bulletins detailing their findings. □

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**Investigators:**  
**N. B. Webb, NCSU**  
**G. G. Giddings, NCSU**

*Frank Marino, owner of the Rex Restaurant, Morehead City, N.C.*







*Blue Channel Company officials, seeking new technology and seafood products to improve business, feed crab legs into mechanical deboner at Sea Grant's Seafood Laboratory in Morehead City.*

***For the blue crab industry:***

## **New tools, techniques and products**

The shiny stainless steel monster was gulping down crab legs by the bagful. A crowd gathered as the machine, which looked like an overgrown kitchen meat grinder, spat crushed shells out one side and ground crab meat out the other.

The crowd that day at Sea Grant's coastal seafood laboratory was from Blue Channel Co. of Belhaven, N. C. and Port Royal, S. C. Officials of the company, already one of the nation's biggest blue crab processors, had been scouting for new crab products and technology that could benefit business. Sea Grant's seafood advisory team, jointly supported by the N. C. Agricultural Extension Service, was there to help.

Stan Waskiewicz, manager of the Port Royal plant, and his business partners were eyeing the silver monster, a mechanical fish and crab deboner, to judge its ability to recover more meat from crabs than human "pickers" can. Back home in their own research labs, they planned to evaluate meat processed by the deboner and try using it in products such as crab soup, cakes and deviled crab.

Before they left Morehead City that day, Blue Channel officials sampled a new crab product developed by Sea Grant seafood

scientists and advisory agents. The product: Fish pizza sprinkled with mechanically-separated crab. Judging from reactions, it looked like crab pizza stood a fighting chance of becoming a Blue Channel product.

New products and new tools to make blue crab more marketable—two ways Sea Grant's seafood advisory agents assist North Carolina's multi-million dollar blue crab industry. Striving for quality meats through improved processing and sanitation is another area in which advisory agents have lent a hand.

More stringent quality requirements issued by N. C.'s Department of Human Resources Shellfish Sanitation Division last year gave impetus to efforts to help plants produce higher quality crab meats. Specifically, advisory agents developed improved processing guidelines, furnished information on keeping crabs alive and researched methods to check sanitation during processing. They also developed plans for a crab processing plant with special features designed to improve quality.

***Investigator:  
F. B. Thomas, NCSU***

# Frank Swanson: A pioneer in fish processing

Frank Swanson isn't the type to shy away from something new.

At least that's the impression he's given UNC Sea Grant seafood advisory agents. Frank is the man in charge at Capt. Ottis' Lucky 7 Fishing Fleet and Seafood Market in Morehead City.

It seems that just about as soon as the seafood agents come up with a new idea on handling, packaging and preserving fish, Frank is trying it out in the processing plant he manages. But it's not just a one-way street. Frank lends valuable advice and assistance, as well as some fish that come through his market, to the seafood advisors' work.

"They've given us good ideas," Frank said, referring to agents at Sea Grant's seafood lab in Morehead City. "They've helped us with storing fish in the boat and at the plant with ice and salt-ice packing," he said, bracing himself on a shelf in his office. One of the latest suggestions that he's tried is glazing fish in a lemon juice-gelatin solution. "It killed the odor and made them last longer," he said.

"Everything they're doing with deboned fish meat is going to help," he continued, explaining that new uses for seafoods that don't now demand good prices will increase their market value. "The work they're doing will cut down on waste and help everybody associated with the fishing industry, even the people who service and install freezers," Frank added.

Finding new uses for fish that people don't often buy—either because they're not the most flavorful or the easiest to prepare—is a big part of advisory activities. A dozen women representing Carteret County extension clubs bring their seafood likes and dislikes, as well as polished cooking skills, to the lab once each month to help come up with new seafood dishes. Advisory agents feel that the women's seafood preferences provide information on local tastes that is invaluable in new product development.

The Carteret women, called the Nutrition Leaders Advisory Committee, are a vital cog in research aimed at finding new uses for deboned fish meat. This year they've made sausage, hamburgers, won ton soup and a variety of other recipes with the ground-up fish tissue.

Keeping fish from tasting and smelling "fishy" both while they are fresh and during and after frozen storage is another problem the Nutrition Leaders and seafood agents are tackling. They've found that superchilling, or packing fish in a salt-ice mixture soon after they are caught, slows decay-causing bacteria, thus reducing rank odors. The women also assisted in developing the gelatin-lemon juice glaze to apply to fish before freezing. Frank Swanson recently tried it in his plant, finding that fish glazed with the solution lasted longer and smelled better. Researchers say the glaze helps lock out oxygen that interacts with fish fats to cause rank odors and flavors.

Sea Grant advisory agents continued working with finfish and other seafood processors and provided services for research groups and state and federal agencies this year.

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**'Everything they're doing with deboned fish meat is going to help.'**

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*Frank Swanson, manager of Capt. Ottis's Lucky 7 Fishing Fleet and Seafood Market, Morehead City.*



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*Investigator:  
F. B. Thomas, NCSU*



# FISHING

engineering  
advisory  
services  
and  
fisherman  
education

It's not that North Carolina's commercial fishermen haven't been friends in the past. But in most cases, each was a man in business for himself. Each ran his own boat and each faced the market alone when he had fish to sell.

Not until mid-1973 did fishermen in the northeast corner of North Carolina band together in hopes that as a group they could wield more power in the marketplace. Some 250 members from Dare, Hyde, Currituck and surrounding counties signed the roll of a new fisherman's cooperative, the Sound and Sea Fisherman's Association. The Wanchese-headquartered-Association opened for business in mid-1974.

UNC Sea Grant advisory agents, whose job is to get useful information into the hands of commercial fishermen, lent assistance in almost every aspect of getting the cooperative on its feet. By the end of the year, the Association had grown at a healthy rate and marketing predictions were proving true.

Working hand-in-hand with Association members, Sea Grant advisory agents assisted with

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## Reaching out to fishermen

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organization and in setting up seafood receiving and handling plants from Ocracoke to the Virginia border. They also lent a hand in obtaining funding from such agencies as the Coastal Plains Regional Commission, the N. C. Rural Fund for Development, the National Marine Fisheries Service and the Farmer Cooperative Service. Support from these agencies helped tide the organization through its costly first year of operation.

An in-depth feasibility study, conducted by the Farmer Cooperative Service with Sea Grant assistance prior to the Association's opening indicated that cooperative marketing in northeastern North Carolina could be a promising venture.

Throughout the year, agents continued updating the state's commercial fishing community on new equipment, improved business management and new fishing options. Workshops covered Production Credit Association financing and demonstrations of equipment including hydraulics, twin trawl shrimping gear, black bass fishing with pots and vinyl coated traps. Clam and oyster culture techniques were further developed and introduced to fishermen as potential new business options. A series of 30 "town hall" meetings in four northeastern counties served as a sounding board for fishermen needs.

A mobile library and pamphlet display racks distributed where fishermen congregate were an es-

sential part of activities to get information into the hands of those who can use it. A fisherman's telephone, installed in each of the sea agents homes, made it easy for fishermen to report problems or seek information. □

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*Investigator:  
J. A. McGee, ECU*

Guy Hamilton has a steady job fixing cars at his father's body and fender shop in New Bern. But like a lot of others today, Guy wanted to earn some extra cash.

He probably never dreamed that the lowly eel could be anything more than a bother to a serious sport fisherman like himself. But since last May, Guy has changed his mind about the slimy, snake-like fish. Since then, eels have come to mean money in the bank.

It was through UNC Sea Grant advisory services agents that Hamilton got the idea to eel fish part-time. And with their help, Hamilton built his first traps and holding tanks and learned the best baits and locations for eels. By the end of the year, the eight traps he started with had grown to 30. During one week in the height of the eel season last

## Eels for extra income

fall, 12 of Hamilton's traps caught 600 pounds of eels. With dealers who export eels to Europe paying nearly 50 cents per pound, Hamilton's part-time work began paying off. And the time he spent eel fishing rarely amounted to more than three hours each day.

Hamilton is just one of hundreds of coastal residents in North and South Carolina and Georgia who have taken up eel fishing under the direction of UNC Sea Grant advisory agents.

Five workshops, sponsored jointly by UNC Sea Grant and the Coastal Plains Center for Marine Development introduced more than 100 people from the three states to all aspects of eel fishing. Television appearances by the agents and informal contacts with dozens of interested citizens provided the facts needed to launch many individual eel fishing operations.

The exporting end of the eel business also got a shot in the arm this year when East Carolina Industries, a rural cooperative for migrant laborers in Fairfield, N. C., opened a freezing plant necessary in processing eels for export. Sea Grant agents, who also serve as part of the North Carolina State University Industrial Extension Service, have provided technical assistance to the cooperative on all aspects of the eel-centered enterprise. Based on information supplied by Sea Grant agents, the cooperative now manufactures eel traps, runs a live-haul truck to pick up eels from fishermen throughout the coastal area, and freezes and exports eels to Europe.

Sea Grant engineering advisory agents this year also completed evaluation of twin-trawl shrimping gear in North Carolina. In the past, most Tarheel shrimpers have used a single large net off each side of their boats. The twin-trawl method replaces the single large net with two smaller nets.

In tests conducted in cooperation with the University of Georgia Sea Grant Program, the UNC advisory agents found that the double net method landed more shrimp and less trash fish. Because the twin-trawl apparatus is lighter than single nets, less fuel was needed, they found. Fuel savings in a time of rising prices and shortages could be of extreme importance to the state's shrimpers.



*Eels are sorted by size for marketing.*



*Guy Hamilton, New Bern auto repairman who has found eel fishing a profitable part-time business.*

*Investigator:  
N. B. Angel, NCSU*

## **Students:**

# **Served by — and serving — Sea Grant**

UNC Sea Grant is not a typical university program featuring an organized set of courses for students seeking degrees.

But Sea Grant does offer unique educational opportunities for students on a variety of levels. Young men and women whose interest lies in marine areas have chosen to study and write master and doctoral theses under the direction of researchers supported by Sea Grant. Others are gaining valuable training through work as technicians assisting research and advisory projects. Nearly 50 graduate level students pursuing degrees in law and landscape architecture participated in courses taught by a Sea Grant legal investigator and the Program's land-use advisory agent.

Ten students involved in UNC Sea Grant-sponsored work earned master and doctoral degrees this year. In his graduate program, Donald G. Ruch, working with ECU scientists on fungi control in aquaculture, studied how fungicides affect the development of the fungus *Lagenidium callinectes*. D. L. Kline and W. E. Dale assisted Sea Grant entomologists at NCSU by completing Ph.D. theses on the abundance and distribution of sandflies and biting flies, respectively.

Robert Soots of Campbell College, working toward a degree at NCSU, used part of Sea Grant-supported research on dredge island vegetation

and wildlife to complete his Ph.D. dissertation on breeding bird succession on dredge islands.

Two masters theses from NCSU grew out of Sea Grant research into water circulation and flow in the state's sound and inlet areas. Paul Blankinship's study analyzed the stability and flow of Drum Inlet. J. J. Singer documented circulation patterns and hydrology around Roanoke Island and Oregon Inlet to earn his degree.

Nolan H. Newton, assisting NCSU scientists in finding controls for scale insect damage to transplanted American beachgrass, based his masters thesis on the insect's natural predators. Alice Lepie completed masters requirements in NCSU's landscape architecture department by assisting Sea Grant investigators studying the human ecology of coastal communities.

Joseph Hester's masters work at NCSU traced the migration of organisms in the Neuse River and Albemarle Sound estuaries. Leon Cammen, also of NCSU, concluded in his graduate research that animals typically found in natural marsh also colonize marsh artificially established by man.

In addition, 19 students were involved in graduate programs they plan to complete in the future.

Some 25 undergraduates also came into contact with UNC Sea Grant during 1974 as they assisted researchers both in the field and laboratory.



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Eel harvesting and handling workshops. Beaufort, S. C., Feb. 22; Alliance, N. C., March 26; Jacksonville, N. C., April 16; Savannah, Ga., May 7; and Brunswick, Ga., May 9. UNC Sea Grant, Coastal Plains Center for Marine Development.

Mosquito and biting fly control in coastal areas. Morehead City, N. C. May 8-9. UNC Sea Grant, NCSU Dept. of Entomology, Solid Waste and Vector Control Branch, Div. of Health Services, N. C. Dept. of Human Resources.

Coastal management. Beaufort, N. C. May 16-17. UNC Sea Grant, N. C. State Univ. Center for Marine and Coastal Studies and Coastal Plains Center for Marine Development.

Dredge island management. Atlantic Beach, N. C. May 30-31. UNC Sea Grant and N. C. Agric. Ext. Serv.

Mulligan stew camp seafood taste test. Swansboro, N. C. July 12. UNC Sea Grant and N. C. Agric. Ext. Serv.

N. C. marine fishery resources conference. New Bern, N. C. Sept. 18. N. C. Agric. Ext. Serv., N. C. Dept. of Natural and Economic Resources, National Marine Fisheries Service.

**Proposed coastal planning guidelines.** Wrightsville Beach, N. C. Nov. 1; New Bern, N. C., Nov. 8; Elizabeth City, Nov. 25. UNC Sea Grant and UNC Institute of Government.

**Commercial fishing, financing and equipment.** Manteo, N. C. July 20. UNC Sea Grant.

### UNC SEA GRANT-SUPPORTED GRADUATE STUDENTS

Blankinship, Paul. The stability and flow dynamics of Drum Inlet, N. C.

Dale, W. E. Abundance, distribution and flight activity of Tabanidae (Diptera) in salt marshes of North Carolina.

Kline, D. L. Coastal *Culicoides* of North Carolina: species composition, seasonal incidence and distribution within salt marsh habitats.

Lepie, Alice. Completed masters requirements in landscape architecture.

Newton, Nolan. Predators, parasites and ants associated with *Eriococcus caroliniae* Williams.

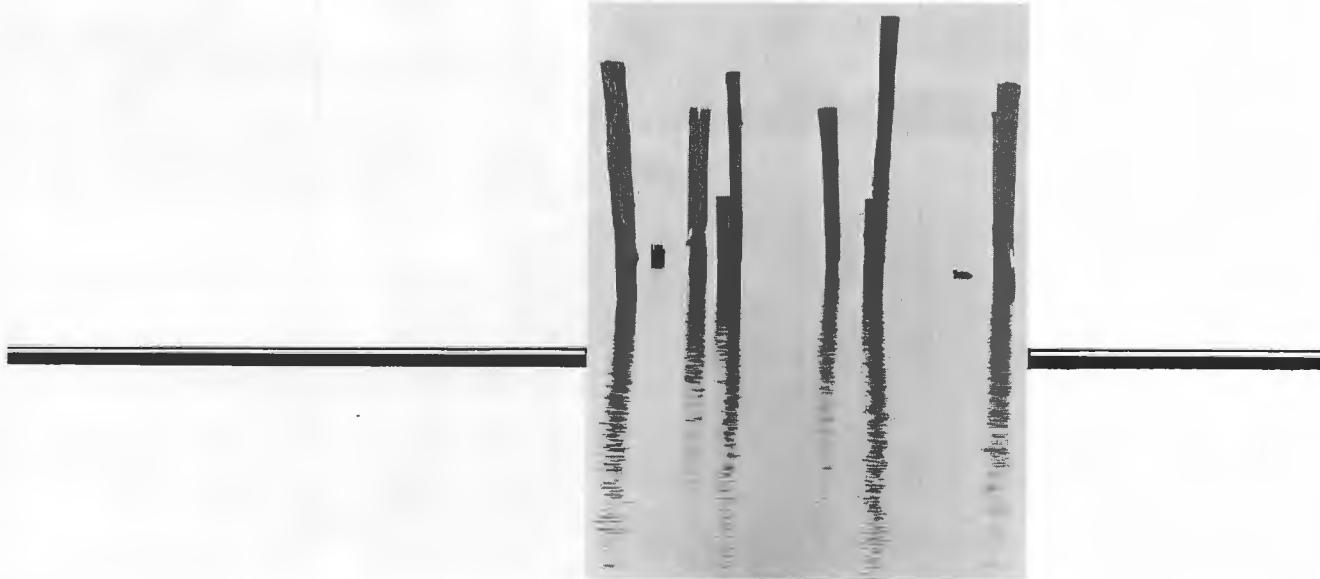
Ruch, D. G. The effects of selected fungicides on growth and development of *Lagenidium callinectes* zoospores.

Singer, J. J. Circulation patterns and hydrology in the vicinity of Roanoke Island and Oregon Inlet, N. C.

Soots, Robert. Succession of breeding birds on dredge islands in estuaries of North Carolina.

**To order publications, write:**

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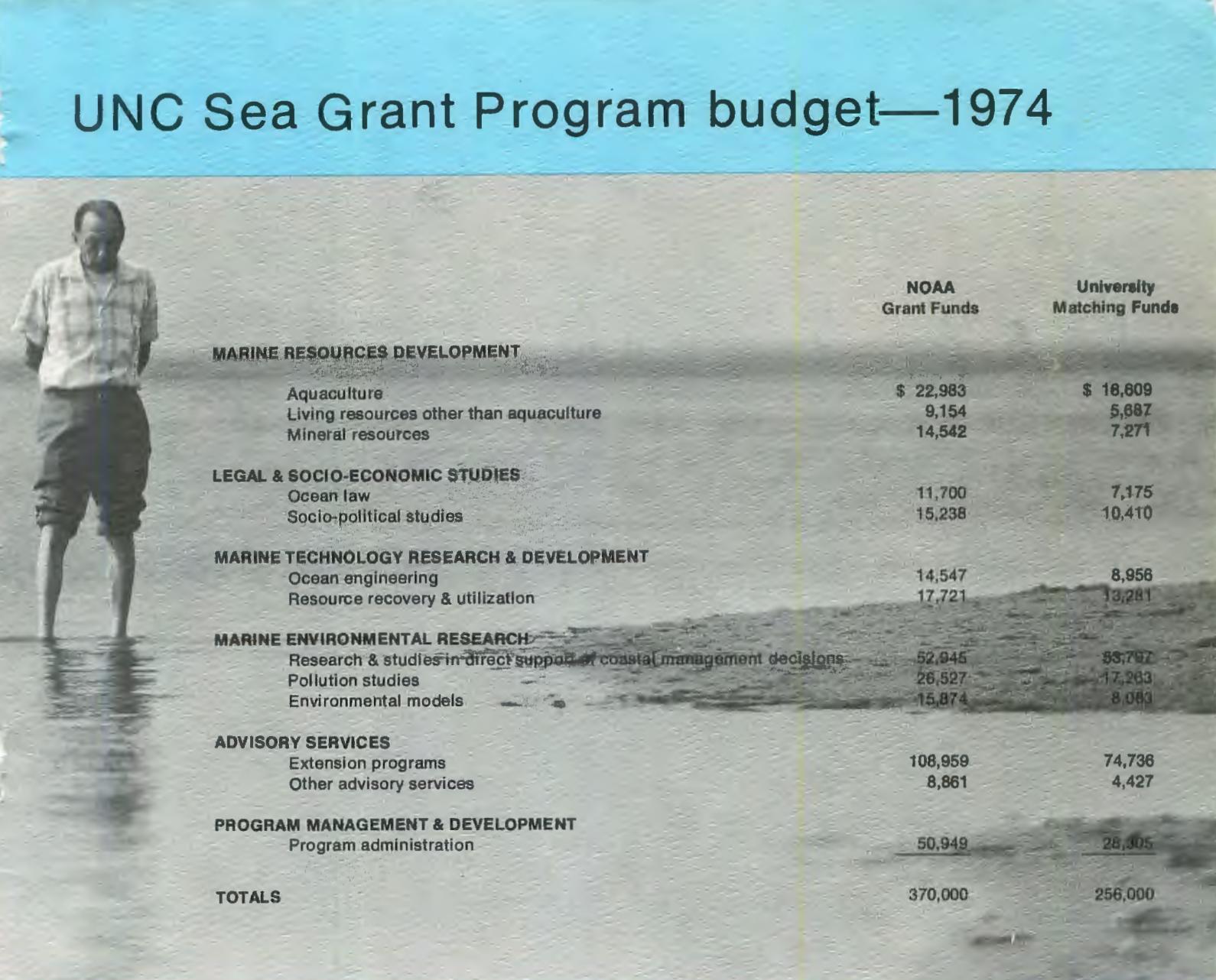
# A review of project status

Project group	Status 1 Jan. 1974	Status 1 Jan. 1975	Project group	Status 1 Jan. 1974	Status 1 Jan. 1975
<b>PROGRAM OPERATIONS</b>					
MD/A-1, Administration & development, Copeland & Rickards	C	C	ESTUARINE STUDIES		
<b>AQUACULTURE &amp; FISHERIES</b>					
R/AF-1, Propagation of dolphin, Hassler	C-R	F	R/ES-5, Nutrients in estuaries, Hobbie	C	F
R/AF-2, Crustacean fungal parasites, Bland	R	C	R/ES-7, Sediments & mineral deposits, Riggs & O'Connor	C	F
<b>COASTAL ZONE STUDIES</b>					
R/ES-1, Dredge island succession, Parnell & Soots	C	F	R/ES-18, Flow in estuaries, Amein & Knowles	C	F
R/ES-2, Dune & dredge spoil stabilization, Seneca & Broome	C	C-R	R/ES-18, Salt marsh detritus, Stiven & Kuenzler	N	C
R/ES-3, Insects affecting vegetation Campbell	C	F			
R/ES-4, Insect pest management Axtell	C	C-R			
<b>LEGAL &amp; SOCIO-ECONOMIC STUDIES</b>					
R/L-1a, <i>Marine resources legal research</i> —international, Wurfel	C	C-R	SEAFOOD SCIENCE & TECHNOLOGY		
R/L-1b, <i>Marine resources legal research</i> —regional, Schoenbaum	C	F	R/SST-1a, Fish muscle properties, Webb	C-R	C
R/L-2, Social aspects of tourism, Peck & Steele	N	T	R/SST-12, Crab meat quality, Webb	C-R	C
<b>OCEAN ENGINEERING</b>					
R/OE-1, Safety analysis of marine structures, Tung & Huang	C	F	R/SST-1c, Publication series, Webb	C-R	C
			EDUCATION & ADVISORY SERVICES		
			A/EA-1, Land-use advisory services, Baker	N	C
			A/EA-2, Engineering advisory services Angel	C	C
			A/EA-3, Continuing education for fishermen, McGee	C	C
			AEA-4, Seafood advisory services, Thomas	C	C
			N-Project initiation		R-Project redirection
			C-Project continuing		F-Project completed

*Scene on a Carolina beach, 1938*



# UNC Sea Grant Program budget—1974



	NOAA Grant Funds	University Matching Funds
<b>MARINE RESOURCES DEVELOPMENT</b>		
Aquaculture	\$ 22,983	\$ 18,609
Living resources other than aquaculture	9,154	5,687
Mineral resources	14,542	7,271
<b>LEGAL &amp; SOCIO-ECONOMIC STUDIES</b>		
Ocean law	11,700	7,175
Socio-political studies	15,238	10,410
<b>MARINE TECHNOLOGY RESEARCH &amp; DEVELOPMENT</b>		
Ocean engineering	14,547	8,956
Resource recovery & utilization	17,721	13,281
<b>MARINE ENVIRONMENTAL RESEARCH</b>		
Research & studies in direct support of coastal management decisions	52,945	53,797
Pollution studies	26,527	17,263
Environmental models	15,874	8,063
<b>ADVISORY SERVICES</b>		
Extension programs	108,959	74,736
Other advisory services	8,861	4,427
<b>PROGRAM MANAGEMENT &amp; DEVELOPMENT</b>		
Program administration	50,949	28,405
<b>TOTALS</b>	370,000	256,000

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