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FEAR PLAN • LAST MENHADEN PLANT • ECHOES OF A FISHERY

# Coastwatch

NORTH CAROLINA SEA GRANT 25TH ANNIVERSARY • 1976-2001  
Winter 2001 • \$3.75



Giving Clams  
A Helping Hand



## A Silver Year

Turning 25? I guess your reaction depends on your perspective.

When I was in my late teens, I recall decorating a coworker's desk in dreary colors and emphasizing the quarter-century mark as being a milestone of aging. And in today's dot.com world of teenage entrepreneurs, that feeling may be heightened.

Today, though, I look at 25 as a time of adventure, when the sky is the limit. Yet it is also a time to build a plan and see it through.

So, what does it mean that the North Carolina Sea Grant College Program is turning 25? Once again the interpretation may vary.

On the one hand, the program has the perspective of seeing the state — and our coast in particular — move through a period of tremendous growth.

Yet ahead of us, we have the opportunities of not just the new century, but also this new millennium.

And so this year is one of both celebration and challenge.

Later this year, we will offer an entire issue that traces the North Carolina Sea Grant College Program from its official start — the plaque on our wall has a memorable date: July 1976 — to the present.

Now, some of you with especially sharp memories are undoubtedly ready to pick up the phone or sign onto e-mail to offer me, a relative newcomer to Sea Grant, a slight correction. Of course, you remember Sea Grant projects back in the early 1970s.

And yes, you are right. The first Sea Grant projects in North Carolina were funded in 1970 through an institutional grant, with a primary focus on commercial fisheries and seafood processing.

Because of the success of those early projects, North Carolina's program was elevated to a Sea Grant College Program in 1976. In the years since, the program has expanded to consider additional areas, including water quality, erosion, coastal law and policy, recreation and tourism, marine education, and aquaculture.

Our "Sea Grant College" title has confused some outsiders, who think that we are a degree-granting institution. Rather, the title is recognition that the program fulfills all of the multiple aspects of the



Herman Lankford

National Sea Grant College Program's mission: research, education, extension and communications.

While our administrative office is at North Carolina State University, the program is not limited to this campus. Sea Grant is part of the University of North Carolina system, and thus can support projects in any of the 16 institutions. Through a consortium agreement, we also work with Duke University, which has had its Marine Laboratory in Beaufort for decades. Our Morehead City office is in NC State's new Center for Marine Sciences and Technology. Our Wilmington office is in the University of North Carolina at Wilmington's Center for Marine Science, and our Manteo office operates through East Carolina University's Institute for Coastal and Marine Research.

We are planning our special issue, but we already have one exciting product: a new brochure that describes the North Carolina Sea Grant program. If you are a new reader — perhaps you received a *Coastwatch* subscription as a holiday gift — the brochure will acquaint you with the program. If you are an old friend, you'll appreciate the photos of staff members in the field — or, more likely, in or near the water — and a discussion of recent projects.

The challenge of this year will be the update of our North Carolina Sea Grant strategic plan. Director Ron Hodson and Associate Director Steve Rebach have been meeting with researchers around the state, seeking their input. We're also seeking guidance from our Outreach Advisory Board and Ad-Hoc Research Advisory Board, both of which have representatives from state and local government and coastal business and community interests.

The current plan is posted on the Web at [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant). Take a few moments on a cold winter day to read it over. Then send me a note or an e-mail with your thoughts on the issues Sea Grant should be addressing as we move into our next quarter-century.

And, if you are planning some major house or office cleaning this winter or spring, keep an eye out for old photos of Sea Grant staffers and researchers at work. I am sure we can find some way to put those images to good use — especially if they have mod haircuts from the 1970s or a touch of disco fever from the 1980s.

*Katie Mosher, Managing Editor*

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Rebecca Dunning □ Mark Hooper □ Herman Lankford □ Katie Mosher □ Pam Smith □ Scott D. Taylor □ Sheri Thomas





# Coastwatch

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, North Carolina Sea Grant supports several research projects, a 12-member extension program and a communications staff. Ron Hodson is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

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and table of contents photo  
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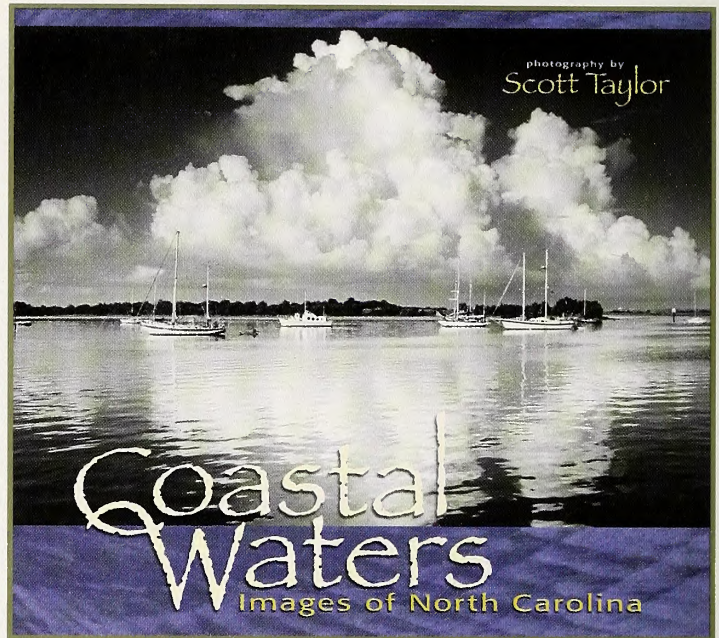
### New Book Captures Seashore Beauty

If winter months have you longing for a walk along the shore, Coastal Carolina Press has just released what could be considered the next best thing to being there — *Coastal Waters: Images of North Carolina* by Scott Taylor.

Taylor, whose photographs have lived

*Coastwatch* pages through the years, has chosen images he captured over the past two decades in and around Core Sound, Cape Lookout, Swansboro, Beaufort, Shackleford Banks, Ocracoke, Cedar Island and Portsmouth.

Dolphins and wild ponies frolic in the surf, gulls circle a trawler returning with the day's catch, and oysters peek from a tidal creek bottom as reminders of the coast's diversity. In all, 90 photographs reveal both the tranquil and stormy beauty of the edge of the sea.



The book has caught the eye of North Carolina outdoors author Bland Simpson, who calls Taylor "one of the premier visual interpreters of our coast's natural and human world."

For those tempted to cut pages from the book for framing, the publisher has an option. Two groups of prints — "Along the Shore" and "At the Edge of the Sea" — offer four, ready-for-framing 11"x14" images.

The book is \$25.95; the prints are \$18 per set. For more information, call Coastal Carolina Press at 877/817-9900. — P.S.

### In the Next Issue of *Coastwatch*

Pam Smith tags along with East Carolina University students as they translate their classroom studies of fisheries techniques to hands-on experience at the ECU Field Station for Coastal Studies at Lake Mattamuskeet National Wildlife Refuge in Hyde County. Ann Green takes readers on a tour of some of the state's remaining drawbridges and the pontoon bridge at Sunset Beach.



## Writing Honored

*Coastwatch* again has taken national honors in the annual Awards for Publication Excellence. The competition, known as APEX, is sponsored by Communications Concepts, Inc., based in Virginia.

The Award of Excellence in the magazine or journal writing category was presented for the Winter 2000 issue. It included feature stories on the oysters in North Carolina, renovations at the Chicamacomico Life Saving Station and the Sailors' Snug Harbor home for retired merchant marines.

"Through *Coastwatch* we share the wonder of the North Carolina coast," says Katie Mosher, managing editor.

The *Coastwatch* writing staff also includes Ann Green and Pam Smith, senior editors, and Cynthia Henderson Vega, contributing editor.

And Raleigh writer T. Edward Nickens' story on Old Currituck, which appeared in the Spring 1999 issue, was honored by the Outdoor Writers Association of America. It received second place among stories on small game. — K.M.

## Two Scholars Named Knauss Fellows

Two North Carolina scholars named Dean John A. Knauss Marine Policy Fellows will spend the coming year experiencing policy-making processes affecting the ocean, coastal and Great Lakes resources.

Kristen Jayne Long and David S. Canny, both graduate students in the Nicholas School of the Environment at Duke University, were selected for the prestigious fellowship that is sponsored by the National Sea Grant College Program. They will be assigned to host offices in the executive or legislative branches of the federal government.

Long, who comes from Hawthorne, N.J., is completing a master's degree in environmental management, with a concentration in coastal management. She earned a bachelor of science degree in marine and freshwater biology from the University of New Hampshire. Her career interests include marine policy, fisheries management and sea turtle conservation.

During the summer of 2000, operating



David S. Canny

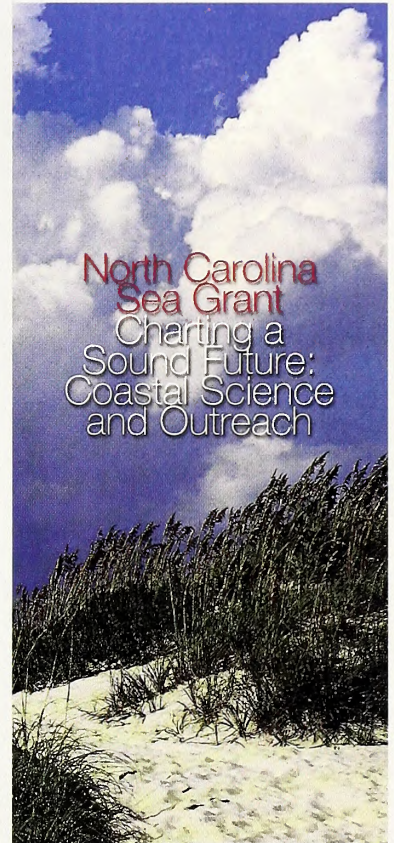


Kristen J. Long

from the Duke Marine Lab in Beaufort, she organized a volunteer sea turtle nesting monitoring program for Salter Path. She served as a liaison to the N.C. Sea Turtle Program coordinator.

Canny, who comes from Hamden, Conn., is completing his master's degree in environmental management with a concentration in resource ecology, landscape and conservation ecology. He earned a bachelor of arts degree from Dartmouth College in environmental and evolutionary biology. His career interests include coral reef ecology, island biogeography, and integrating socially and environmentally sustainable practices into small communities.

Recently, he has concentrated on marine reserve issues. Working as a marine reserve selection specialist, he helped devise habitat selection criteria. Canny also is helping to streamline an oceanographic model to predict suitable sites for artificial reefs or marine protected areas off the coast of North Carolina. — P.S.



## Brochure Highlights Sea Grant Program

North Carolina Sea Grant's diversity is highlighted in a new brochure: *Charting a Sound Future: Coastal Science and Outreach*.

Colorful photos document field work performed by Sea Grant staff, while the text outlines the program's multiple missions — research, extension and communications.

"Sea Grant plays a leadership role in the development of science-based solutions that guide local, state and federal policy-makers and stimulate North Carolina's economy," says North Carolina Sea Grant director Ron Hodson.

The free publication can be ordered. Call 919/515-2454. For more information about Sea Grant, visit the Web: [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant). — A.G.



## Tip Sheet Helps Red Drum Anglers

A new take-along product from North Carolina Sea Grant is tailor-made for recreational anglers interested in catch-and-release techniques to help boost red drum fishery stocks.

The waterproof tip sheet — the size of a bookmark — can be tossed into a tackle box or folded and tucked in a shirt pocket for quick reference.

One side gives an illustrated, step-by-step, catch-and-release guide. The other side describes the red drum and offers some of the “whys” behind state regulations. Named North Carolina’s saltwater fish in 1971, red drum stocks have been depleted by overfishing.

The tip sheet is the brainchild of Jim Bahen, Sea Grant recreational fishing specialist. Bahen served on the N.C. Division of Marine Fisheries (DMF) advisory committee that helped draft the proposed red drum fishery management plan.

“Sea Grant is promoting strategies to help restore this popular recreational fishery,” Bahen says.

He says it’s important to know that size and catch limits are meant to protect sexually mature red drum stocks — allowing fish to spawn over many seasons.

DMF permits only one 18- to 27 inch red drum per day to be kept. Using

catch-and-release techniques can enhance anglers’ enjoyment — and red drum stocks. Using circle hooks can further reduce fish injury and mortality for red drum as well as other recreational fisheries.

The red drum tip sheet is being distributed by Sea Grant personnel, DMF agents and tackle shop owners. It is the first of a series of educational products to help protect and restore recreational fisheries.

To request tip sheets, call 919/515-9101. Ask for UNC-SG-00-05, *Red Drum: North Carolina’s Saltwater Fish*. — P.S.

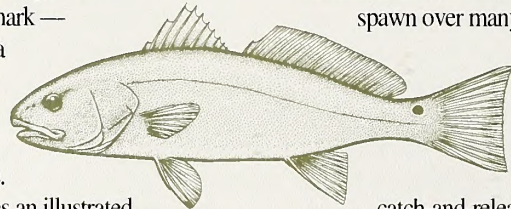


Illustration by Peter Norton

## Turtle Workshop Scheduled for New Bern

A Jan. 25 workshop will consider the current status of turtle populations along the East Coast and efforts to protect the endangered and threatened species within traditional fishing areas. Some areas have been closed to commercial fishing nets because of turtle strandings.

The workshop — co-sponsored by North Carolina Sea Grant, the National Marine Fisheries Service and the N.C. Division of Marine Fisheries — will be held at the Sheraton Grand Hotel in New Bern. The goal will be to assemble a work group to recommend research on turtle populations and fishing gear development.

Commercial and recreational fishers, and others interested in coastal issues are invited to join the discussions with members of the Atlantic States Marine Fisheries Commission, Mid and South Atlantic Fisheries Management Councils, U.S. Navy, U.S. Coast Guard, U.S. Army Corps of Engineers, university researchers and state officials.

For more information, contact Nancy Fish at the Division of Marine Fisheries at 800/682-2632. — K.M.

## Video Highlights FRG Success Stories

It’s a catch not to be missed.

Anyone interested in seafood-related activities will want to catch an hour-long broadcast highlighting projects funded through the North Carolina Fishery Resource Grant Program (FRG). The video began airing on local cable access channels in November. Check local television listings or call your local cable system for air times.

Produced by Hitchcock Broadcasting, the video features successful projects from various coastal areas, including:

- A whale disentanglement network developed by Bill Foster of Hatteras.
- Quaker Neck Dam removal and its impact on shad and striped bass migration on the Neuse River.
- A study of water quality on the Chowan River and its impact on river herring.

- Gill-net selectivity for the spiny dogfish, a study by Dave Beresoff and Teresa Thorpe in Brunswick County.
- A new technology for cold-binding small scallops into scallop medallions by Joey Daniels of the Wanchese Fish Company.
- An aquaculture pond project for South Brunswick High School.
- Changes in the Cape Fear Dam locking schedule to enhance shad migration.
- New devices to collect catch-per-unit-effort data, by Mark Hooper of Smyrna.

FRG — a state-funded program administered by North Carolina Sea Grant — allows individuals in the fishing community to test their ideas for improving fisheries and related businesses. For more information, call 919/515-2454. On the Web, go to [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant) and follow the research link to FRG pages. — C.H.V.



## Gyotaku: Art From the Sea

Want to add a touch of the sea to your home or office? Consider an ancient Japanese art form: Gyotaku.

Lessons in “fish rubbing” often are offered at coastal festivals, at the state aquariums and in schools across the state. Or you could try it at home.

“This would be great for my kindergartners,” says Donna Martens of Maryland as she made her first prints during the Wings Over Water festival last fall.

Fresh fish tops your supply list. The fish may be frozen, then thawed, to use again and again.

Paint or ink choices vary. Acrylics work well for T-shirts. Watercolors are popular for newsprint. India ink is the traditional choice for rice-paper prints. Don’t forget paintbrushes, water, and newspaper or a tarp to cover your work area.

Large scales on sea bass or carp provide interesting patterns. Flounder

have detailed fins. The lookdown offers an unusual shape.

First, wash the fish to remove the protective mucus, then pat dry.

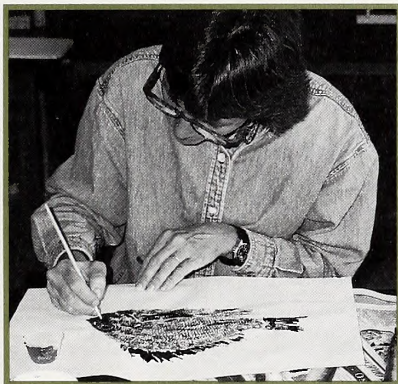
Apply an even coat of the paint or ink on the top side. Avoid painting the eye.

Place the paper or material over the painted fish, and gently rub with your fingertips. Don’t forget the fins. For larger fish, a piece of putty or clay can brace the fins.

Carefully pull the paper or material off to see your print. Add more paint for the next print — or wash the fish and change colors. The prints improve with multiple rubbings.

When the print is dry, add the eye with black ink. “That is what gives it life,” says Hilda Bayliss, who began teaching fish rubbing about 20 years ago.

Sea Grant marine educator Lundie Spence agrees. “Matted and framed fish prints are often found in seaside galleries.” —K.M.



TOP: Hilda Bayliss adds the final touch.

BOTTOM: Gyotaku highlights scale patterns and fin shapes.

## Mosher Takes New Role

Katie Mosher has been named North Carolina Sea Grant’s assistant director for communications.

Communications coordinator since October 1998, Mosher joins the management team for the program, a state-federal partnership that sponsors research, education and outreach projects that promote science-based solutions to coastal issues.

Mosher will continue her duties as

managing editor of *Coastwatch*, the program’s centerpiece publication. She also oversees production of Sea Grant materials and contact with the media.

A former reporter for *The Raleigh Times* and *The News & Observer*, she also served as assignment manager for the WFLA-TV news. An Ohio native, she is a graduate of Kent State University and holds a master’s degree from North Carolina State University.

## Researchers Make New Discovery About Shell Disease in Blue Crabs

North Carolina Sea Grant researcher Ed Noga and his colleagues have unlocked some new mysteries about blue crab disease.

Noga found that you couldn’t tell the extent of shell disease in blue crabs by measuring lesions. Shell disease is one of the most common diseases in crustacean aquaculture — including crabs, shrimp and lobsters — and is often used to assess environmental health in fishery populations.

“There is no correlation between how large the shell lesions are and the severity of the tissue damage,” says Noga, professor at North Carolina State University College of Veterinary Medicine.

“To accurately assess the extent of shell disease, blue crabs need to be examined under a microscope,” he says. “We think that biologists dealing with shell disease epidemics in crustaceans need to be aware of this because in the past, the severity of the outbreaks has been determined by simply recording the size of the shell disease lesions. We know now that this is not an accurate means of assessing the problem.”

The Sea Grant study was conducted over several years on diseased crabs found in the Albemarle-Pamlico estuary. Noga collaborated with Lester Khoo of Mississippi State University and Roxanna Smolowitz of the Marine Biological Laboratory, Woods Hole, Mass.

For more information, call Noga at 919/513-6236 or e-mail: [ed\\_noga@ncsu.edu](mailto:ed_noga@ncsu.edu).

—A.G.





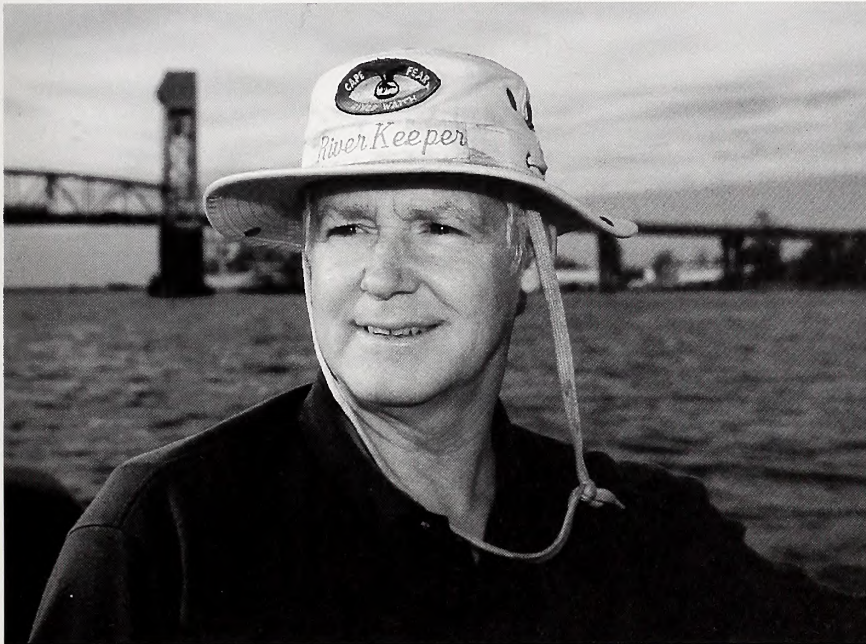
# Planning for Water Quality:

## STRATEGIES TO PROTECT THE CAPE FEAR RIVER

*By Pam Smith*



"It'll get quieter once we get out on the river," Cape Fear Riverkeeper Bouton "Bouty" Baldrige shouts above the cacophony of traffic clattering across the steel grid of Wilmington's Memorial Bridge.



Cape Fear Riverkeeper "Bouty" Baldrige is in his element on the river near Wilmington. The evolving urban waterfront presents environmental challenges.



Photos by Scott D. Taylor

The Cape Fear River flows past the diverse habitats of a host of plants and animals.

He pushes the skiff away from the boat ramp just across Surry Street from Cape Fear River Watch headquarters — a no-nonsense, one-story, cinder block building dwarfed by the towering bridge.

The gray morning sky hints of rain. But Baldrige, who is clad in deck shoes, khakis, an expedition hat and a short-sleeved River Watch shirt, doesn't seem to notice the bite in the damp air. He's in his element on the Cape Fear River.

He maneuvers the skiff into the channel and cruises upriver, passing in review of the *USS North Carolina* and Wilmington's evolving urban waterfront. Once deemed undesirable by local gentry because of the clutter of commerce, the waterfront district has been rediscovered as prime real estate. Derelict buildings are being replaced by pricey condos. Abandoned sites are being prepared for new hotels to accommodate an expanding tourist trade.

The local economy seems poised to cash in on a port-deepening project that is designed to bolster the state's import-export capabilities. It also could entice the cruise ship industry to name Wilmington a port-of-call.

Change has its benefits, Baldrige notes. A major push is under way to clear away decaying boats at the river's edge and rusting debris on nearby dredge spoil islands. Scattered reminders of long-gone industries linger within view of a revamped waterfront that includes marinas, floating homes and a yacht-building operation.

Baldrige slows the skiff as he enters the waters of the North East Cape Fear River to share a dreamscape that could become a unique addition to this burgeoning economy — ecotourism.

He points toward an undeveloped island ringed by marsh, criss-crossed by canals and creeks, and dotted with cypress and pine trees.

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“Eagle Island,” he says. “It’s the remains of the earlier lucrative rice plantation economy of this region.”

Once privately owned, the 140-acre site recently was placed in conservancy. Baldrige dreams of the day it will become a wildlife refuge with Cape Fear River Watch as its overseer.

“There’s not another wildlife refuge within a hundred miles of here,” he explains. “It would be ideal for wetland demonstration and a natural for birding since it’s under the eastern flyway.”

A tall cypress near the opening to Alligator Creek is topped with an osprey’s nest, its former occupant by now wintering in a warmer climate. He steers the skiff into the creek, one of the many outstanding paddling routes offering up-close views of coastal vegetation, waterfowl and other wildlife. Rounding a bend, a lake comes into view. It was created when sand from the middle of the island was “borrowed” for the construction of a nearby bridge. The lake provides a secluded environment for fish and fowl.

In such a tranquil and seemingly secluded setting, it’s difficult to believe that a bustling port city is only minutes away.

## Reality check

Baldrige is a realist. He knows that environmental sustainability of a jewel such as Eagle Island — and the Cape Fear River — requires vigilance by the state and other concerned “caretakers.” In the Lower Cape Fear, environmental advocacy is growing in all sectors — government, industry, university and private.

But the Cape Fear River does not belong exclusively to Wilmington or New Hanover and Brunswick counties. Dependency on it, and responsibility for it, is far greater.

The Cape Fear is a vast and complex river system flowing from its headwaters near Greensboro into the Atlantic Ocean near

Wilmington, covering more than 9,000 square miles. It is fed by the Deep, Haw, Black, South, and North East Cape Fear rivers, each with dozens of intricate watersheds and unique topographical and hydrological characteristics. Its waters flow past 107 cities and towns with cumulative populations approaching 1.75 million.

The river basin is the largest, most highly populated, most industrialized and the most agriculturally diverse of the 17 river systems in the state. Importantly, the Cape Fear is the only North Carolina river that flows *directly* into the Atlantic Ocean.

Division of Water Quality (DWQ) is charged with developing comprehensive plans for each river basin every five years.

“There is no one-size-fits-all plan for water quality,” explains Cam McNutt, an environmental specialist with the DWQ basinwide and estuary planning unit. The Cape Fear River Basinwide Water Quality Plan, adopted in July 2000 by the Environmental Management Commission, identifies causes of pollution of individual streams to facilitate local efforts.

The plans also outline DWQ strategies for addressing point and nonpoint source pollution of impaired waters. While DWQ



*Mike Mallin is among the cadre of researchers at the University of North Carolina at Wilmington providing scientific information about the Cape Fear River.*

## A plan for quality

So, how does the N.C. Department of Environment and Natural Resources (DENR) make environmental sense of a dynamic natural resource of this size and scope?

Charged by the state legislature with protecting all aspects of the environment, the department has adopted a basin-by-basin approach to protecting water quality. Its

prepares basin plans with stakeholder input, it is up to local governments to implement many of the nonpoint source remedies.

Even with detailed guidelines, the challenge is no less great. Since the initial Cape Fear River plan was crafted in 1996, population in the basin grew by 13.2 percent.

Its “hot spots” include the fastest-growing urban centers in the state — the





*The port of Wilmington will see more activity once the expansion project is complete.*

Triad, Triangle, Fayetteville and Wilmington. Typical of streams in urban settings, many that flow into the Cape Fear have been channeled or diverted into culverts.

“We have built on them and over them,” McNutt says. He illustrates his point with an aerial photo of a typical urban stream that disappears beneath one-third of its host city to accommodate development.

Sediment from land disturbance and runoff from newly constructed roads, parking lots and rooftops contribute to the river’s pollution. In addition, more than half of the state’s hog operations are located in the Cape Fear River basin, representing a substantial potential for pollution.

The basin approach to water quality planning makes sense, because it follows natural ecological boundaries, McNutt says. The long-range mission of basinwide management is to address the complex problem of planning for increased development and economic growth while protecting or restoring the quality — and the intended uses — of the Cape Fear River basin’s waters.

Water bodies are classified according to their best-intended uses. For example, some waters are classified primarily for commercial

shellfish harvesting, others for water supplies. A high quality water (HQW) supplemental classification calls for special management strategies to prevent degradation of critical habitat or fishery nursery areas.

The Cape Fear basin includes four coastal Outstanding Resource Waters (ORW) — Stump Sound, Middle and Topsail Sounds, and Masonboro Sound — and one inland ORW — a portion of the Black River. The aquatic ecosystems in the Cape Fear River basin support a variety of commercial and recreational fisheries. Wetlands, estuaries, blackwater rivers and rocky streams support 30 endangered species in the basin.

DWQ, sister agencies and university researchers gather data from about 150 monitoring sites to measure the river’s health. Data help determine how well a water body supports its designated use.

About 20 percent of the monitored waters in the Cape Fear River basin are rated as impaired, that is, partially supporting or not supporting their intended uses. Most of the impaired streams are located near urbanized areas.

To achieve its overall basinwide management mission, DWQ has set short-

term goals to identify and restore impaired waters in the basin; to identify and protect high value resource waters and biological communities of special importance; and to protect unimpaired waters while allowing for reasonable economic growth.

Two-inches thick, the Cape Fear plan gives a wide-angle view of the basin as well as close-up snapshots of individual watersheds. The idea, McNutt says, is to use the plan as supporting data to address local problems with specific solutions.

McNutt believes that achieving good water quality involves more than adopting a menu of best management practices. “Environmentally sound reasons are needed for specific actions,” he says.

## Science provides key

That’s where supporting research comes in. Mike Mallin and a cadre of fellow researchers at the University of North Carolina at Wilmington are working on a number of fronts to collect long-term environmental data that could help shape policy.

While the Cape Fear is generally in good condition, some areas have serious problems with low dissolved oxygen and excessive fecal coliform bacterial contamination. Mallin says sediment and runoff pollution from urban and rural development are pressing problems — and the most difficult to control.

His analysis of several tidal creeks over time found a strong correlation between fecal coliform bacterial counts and watershed population, percent of developed area, and especially with the percent of impervious surface coverage — parking lots, roof tops and driveways.

Impervious surfaces pose a serious threat to shellfish beds since rains wash pollutants that gather on hard surfaces into shellfish beds without treatment.

“We need to get a handle on land-use factors — the relationship of developed land with the percentage of impervious surfaces in a given watershed,” Mallin says. “Under 10 percent impervious surface, and the watershed is in good shape. The quality goes downhill if the percentage is greater.”

He knows that scientific data won’t stop

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coastal development, but he hopes that it can help convince planners and developers to adopt “greener” practices — maximize green space, maintain natural buffers along creeks and streams, and safeguard wetlands. The goal is to filter pollutants flowing into sensitive waters.

Individual citizens also need to take responsibility, Mallin says. His studies suggest that a high percentage of nutrients and fecal coliform pollution is due to pet waste. “Pet manure can continue to release high levels of fecal bacteria up to a month after deposition,” he warns. He suggests burying the manure a few inches below the surface of the ground where it is not subject to storm runoff.

Mallin is the lead scientist on a number of collaborative programs concerned with coastal water quality issues, including the City of Wilmington’s Watersheds Project, the New Hanover County Tidal Creek Project and the Coastal Ocean Monitoring Project.

He frequently teams with Barbara Doll, North Carolina Sea Grant water quality specialist, on stream and wetland restoration efforts in the region that seek to improve the viability of important shellfish habitat.

He also directs the research component of the Lower Cape Fear River Program, an unprecedented collaboration among academia, government, industry and the public. This large-scale water quality and environmental assessment effort covers the Cape Fear River Estuary and a large portion of the lower Cape Fear watershed. “It is an attempt to develop an understanding of the fundamental scientific processes shaping and controlling the ecology of the river system,” Mallin explains. It also provides a forum for information exchange and public education.

Steve Skrabal’s Sea Grant-funded research might provide an interesting round table discussion.

Skrabal, an assistant professor of chemistry at UNC-Wilmington, is examining the cycling of trace metals such as copper, zinc and iron in estuarine and coastal waters and sediments. He is interested in what influences trace metal speciation — the distribution of a metal among its various chemical forms. He wants to know how speciation affects the availability and

potential toxicity of the metals to aquatic plants and animals.

Trace metals have many sources, he explains. Copper, used in protective paints on boat bottoms, and zinc, used in most galvanized products, can leach off into the water. And, because copper and zinc are nutritional ingredients of livestock feeds, they also may be deposited by agricultural runoff.

An important feature of this work, he says, is determining the role of sediment-water exchange in influencing metal speciation. So far, it appears that nearly all dissolved copper in the middle estuary is chemically bound to organic substances, possibly as a result of a flux from bottom sediments.

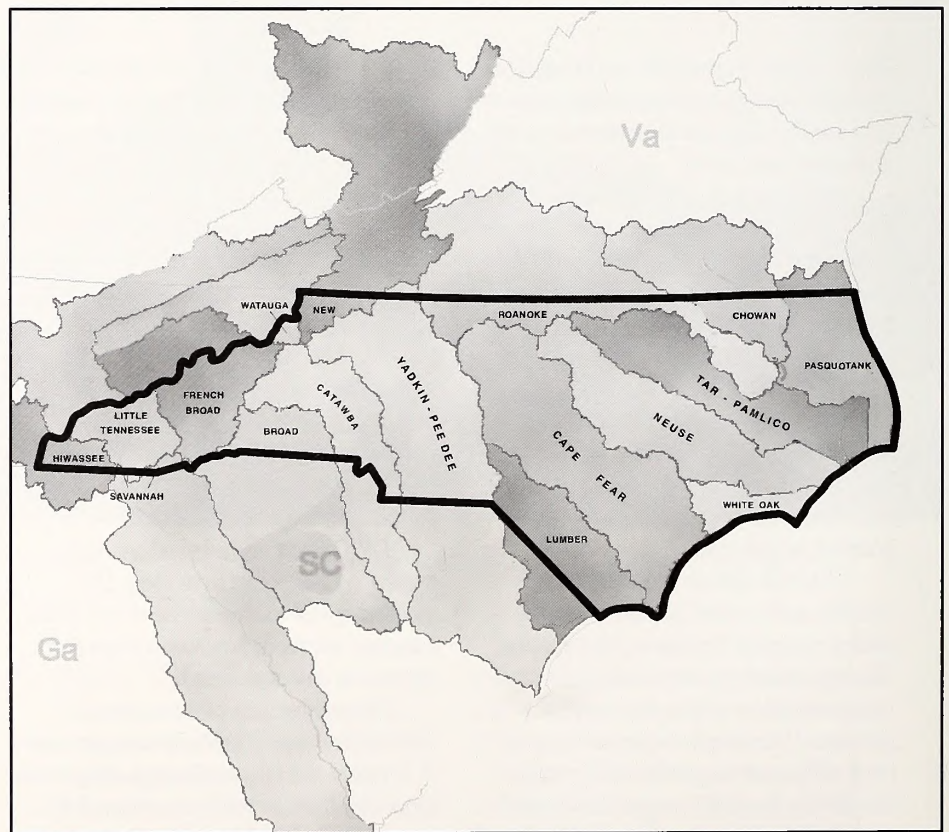
Skrabal and his research associates also are collaborating with Sea Grant researcher Troy Alphin at UNC-Wilmington to examine the role of bottom-dwelling organisms on the sediment-water exchange and speciation of

copper and zinc in the Cape Fear Estuary. Data from this work will enable the scientists to calculate the potential for toxic concentrations of these metals in the benthic, or sea bottom, environment.

## More teeth

Mallin wishes the scientific data documented on many fronts had been used to give *The 2000 Cape Fear River Basinwide Water Quality Plan* more “teeth.” Mallin says, “The information about the river system is useful, but the plan needs to come out in favor of regulations based on the scientific data, not just voluntary measures.”

It’s true that the Cape Fear River is not categorized “nutrient-sensitive” as its sister rivers, the Neuse and the Pamlico, whose nutrient-rich waters linger in the Pamlico Sound and slowly escape through narrow inlets into the Atlantic.



The map of North Carolina water basins is based on the 1997 work of John Fels Cartographics, designed to promote environmental awareness. It was adapted by Lee Ratcliffe for the N.C. Department of Environment and Natural Resources.





Scott D. Taylor

*The Cape Fear River is a critical natural resource that provides aesthetic enjoyment and supports water supplies, industry, transportation and recreation for many North Carolinians.*

However, even with the Cape Fear's dynamic, direct outlet to the ocean, scientific evidence clearly shows that pulses of sediment and nutrient pollution released into the Cape Fear in the upper Piedmont region have a lingering impact far downriver in the sensitive shellfish beds in the lower region.

"I think this makes a strong case for mandatory buffers along the Cape Fear, just as it is dictated for the Neuse," says Mallin.

Riverkeeper Baldrige agrees that the plan should incorporate mandates for protecting critical wetlands in the Cape Fear basin. He believes the public shares this view. Certainly, public awareness of water quality issues has been at an all-time high since the 1999 post-hurricane flooding.

Baldrige and Mallin collaborated on Fishery Resource Grant (FRG) projects to assess the river's water quality after hurricanes. Sea Grant administers the state-supported FRG program.

Their study found that after a hurricane, bacteria from organic wastes — from sources such as sewage and hog waste lagoons — create an increased biochemical oxygen demand. Decreased levels of dissolved oxygen cause fish to die along with river

bottom organisms — critical fish food. Persistent loss of an abundant food source can impact future fish populations.

Their work contributed to scientific evidence that convinced the state to restrict locating hog lagoons in flood plains.

## Growing grassroots

An earlier FRG grant that supported the purchase of water-sampling equipment allowed Baldrige to become part of the quick-response effort. The FRG work enabled River Watch to form a unique liaison with university researchers and community members who live near and use the river. He and the fishing community have a mutually beneficial relationship. He has gained knowledge from their experience, and they are comfortable contacting him about problems on the river because "they know we share their concerns," he says.

Baldrige believes the public and politicians have water quality issues on the radar screen. To help keep it that way, the grassroots group conducts community education programs that target diverse groups — commercial and recreational fishers, youngsters from an after-school program,

teachers seeking continuing education credits, and local candidates for public office.

River Watch staff and volunteers sponsor a water quality demonstration site at Greenfield Lake and are about to launch a wetland restoration project with the City of Wilmington at Burnt Mill Creek. Soon, Baldrige hopes to add Eagle Island to the list of responsibilities.

The organization also looks for ways to involve the community in the discussion of important environmental issues, such as the Cape Fear River plan.

And for his part, McNutt welcomes comments, scientific and anecdotal information from citizens across the state. The river, after all, is an important natural resource that supports industry, transportation, recreation, drinking water supplies and the aesthetic enjoyment of all North Carolinians. □

## Want to know more?

To learn more about the Cape Fear River Basinwide Water Quality Plan, contact the Division of Water Quality at 919/733-5083; or e-mail Cam McNutt at [cam.ncnutt@ncmail.net](mailto:cam.ncnutt@ncmail.net).

To learn more about the ongoing, coastal water studies by Mallin, Skrabal and colleagues, visit the University of North Carolina at Wilmington's Website for the Center for Marine Science at [www.uncwil.edu/cmsr/](http://www.uncwil.edu/cmsr/), and click on the research icon.

To learn about the Cape Fear River Watch outreach programs, call 910/762-5606, or e-mail Bouty Baldrige at [cfw@wilmington.org](mailto:cfw@wilmington.org). Or, go to [capefearriverwatch.wilmington.org](http://capefearriverwatch.wilmington.org/) on the Internet.





## Menhaden

## Research:

## Echoes

## of a Fishery

*By Ann Green*

*Photographs by Scott D. Taylor*

It's almost dusk when North Carolina Sea Grant researcher Chris Taylor anchors an old white research boat in the middle of the Neuse River.

As several seagulls flutter over the boat, Taylor drops a brown metal cylinder, similar to a fish finder, deep into the water.

Within a fraction of a second, he can pinpoint every school of tiny menhaden and anchovies within 90 feet of the boat. Pings from the cylinder pierce through the water and echo back the exact location in the water column, target size and behavioral information to Taylor's computer.

This is the first time researchers have used the cylinder — a scientific echosounder based on technology developed by the U.S. Navy during World War II — in a North Carolina estuary to conduct a biological study.

"The use of hydroacoustics could provide a reliable method for estimating the number of pelagic fish in the estuary," says lead researcher Pete Rand, assistant professor at North Carolina State University. "Stock assessments for menhaden rely almost entirely on commercial landings data. Our approach could provide a less-biased method for estimating population size."

Through monthly sampling of Atlantic



menhaden and other pelagic fish that live near the water surface, the NC State scientists hope to model distribution and abundance of pelagic fish that travel between estuaries and the open sea.

"This would provide a way to estimate the number of fish in the estuary," says Rand. "There is a fisheries management plan for menhaden. Now there is no direct way to measure the density of pelagic fish in the Neuse."

The National Marine Fisheries Service's stock assessment of Atlantic menhaden, categorized by regions, is predominantly for fish one year and older.

Street, DMF chief of habitat protection and chairman of the Atlantic Menhaden Advisory Committee for the Atlantic States Marine Fisheries Commission. "We don't know the environmental reason for the decline, but it is not caused by fishing."

By tracking the menhaden's behavior and distribution in the river, Sea Grant scientists hope to unlock some mysteries about the impact of nutrient loading on pelagic fish in estuaries.

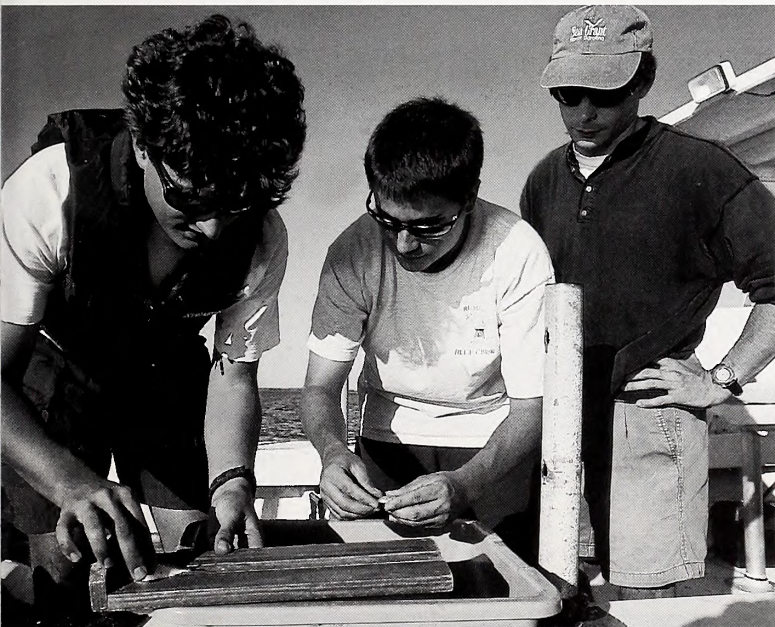
"These fish may be happily feeding on plankton in well-oxygenated surface waters until a wind event like an afternoon blow or even a hurricane stirs the water column and

## Menhaden important to ecological community

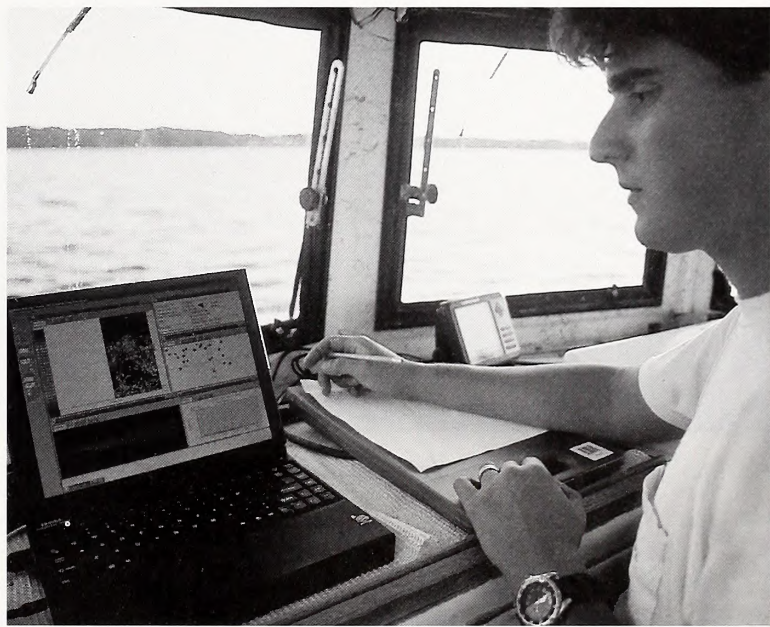
Menhaden, which feed on phytoplankton and other minute organic matter, serve as an important link in estuarine food webs by converting plant life to fish biomass.

"In some well-studied Gulf of Mexico estuaries, it has been estimated that up to 25 percent of primary production in salt marsh communities are exported every year through a mass exodus of fish," says Rand.

In the fall and winter, menhaden migrate in droves through North Carolina's barrier island inlets to spawning sites along the continental shelf.



*Pete Rand, right, watches as research assistants examine samples of menhaden from a trawl catch.*



*A Sea Grant researcher looks at the location of menhaden in the water column.*

From 1985 to 1996, North Carolina had the highest median catch of menhaden on the East Coast, according to a 1999 National Oceanic & Atmospheric Administration Technical Report.

The N.C. Division of Marine Fisheries (DMF) data includes only landings for menhaden in the Neuse. In 1999, 11,625 pounds of menhaden were caught in the Neuse, compared to 29,951 pounds in 1997.

"Reproductive success of menhaden has dropped since the late 1980s," says Mike

upwells anoxic water to the surface," says Rand. "That could lead to trouble."

These events can have lethal or sublethal effects on the fish.

"While the fish kills tend to grab the headlines, the thousands of fish reported dead at the scene of a fish kill is small potatoes in the context of the entire fish population," says Rand. "It is my feeling that the sublethal effects of exposure of fish to hypoxic water may be far more important in the context of the overall fish population."

During migration, Atlantic menhaden are caught by ocean-going purse-seine vessels, then processed for fish meal, oil and bait.

"From early in the 20th century until 1995, menhaden was the highest volume fishery in North Carolina," says Street. "Now it ranks second to blue crabs. We used to have as many as 150 vessels fishing for menhaden in the late 1950s and 1960s along the Atlantic coast. Now we have only about a dozen boats that fish for menhaden, 10 from Virginia and

*Continued*





Chris Taylor and Pete Rand use a variety of technology.

two from Beaufort.”

The number of menhaden reduction plants also has declined along the Atlantic Coast from nine in 1983 to two today — one in Virginia and one in Beaufort, according to Street.

Menhaden and other pelagic fish serve another important role by indirectly supporting several commercial and recreational fisheries. Along the route, the fish are eaten by many predators, including bluefish, striped bass and mackerel, birds and marine mammals.

### Research involves intensive field work

To determine if low-oxygen levels and other factors affect the growth rates and behavior of pelagic fish, the Sea Grant

research team is collecting samples over two years.

The research is tedious and involves long hours on the water at night. Three times a month from May to October, the research team, which includes Taylor, Jacob Rash, Brian Degan and Nathan Hall, motors into the Neuse.

“It’s pretty gruelling work,” says Taylor. “By the time we get off the water at sunrise, we are pretty tired.”

The team leaves in two boats — the 18-foot *Atlantic* and 23-foot *Sea Ox* — from a dock at Cherry Point Marine Base in Havelock. First, they use water quality sensors to measure the salinity, temperature, dissolved oxygen and pH of the water.

“Water quality sensors have revolutionized the way we assess habitat conditions for fish in the field,” says Rand. “We can moor them on buoys, tow them behind a boat near the bottom or surface, or cast them down to a depth to generate a complete water column

profile. We know that other factors such as salinity and temperature also can negatively impact fish.”

The researchers also use plankton traps to measure the abundance of copepods — plankton eaten by anchovies.

“We are trying to draw a link between plankton dynamics and large predators like striped bass, trout and bluefish,” says Taylor. “Menhaden and anchovies — which feed primarily on plankton and also serve as food for large predators — are undoubtedly the important players.”

The scientists also set out the high-tech sonar device at several locations.

To back up the results of the sonar device, they put on white rubber boots and foul-weather gear and set surface trawls in the

water between the two boats.

The surface trawl is pulled between the boats and captures fish in the top three feet of the water column.

On this day, Taylor throws out a surface trawl between two boats. After five minutes, he vigorously pulls the trawls in like a veteran fisher.

As he empties the trawl, about a dozen menhaden flutter in the bucket.

This catch is smaller than usual. “Sometimes we pull in twice as many menhaden,” Taylor says. “The anchovy catch is much larger, sometimes as many as 10,000 in a single tow,” he adds.

“Catches of fish in the trawl give us an idea of the composition of species as well as the size distribution of fish,” says Taylor.

Although the data collected in 2000 has not been completely analyzed, it appears that menhaden and other pelagic fish are responding quickly to the river’s water quality, says Taylor.

Rand says the study will provide a link to other models developed by researchers on the Neuse. For example, Sea Grant researcher Larry Crowder is conducting water quality studies on bottom animals with trawl gear.

In addition, ModMon — a multi-investigation group from the University of North Carolina Institute of Marine Sciences, Duke University, NC State, East Carolina University, the University of North Carolina at Charlotte, Weyerhaeuser Corp. and federal and state agencies — has sampled water quality at 19 estuarine stations on the Neuse. North Carolina has a mandate to reduce nitrogen loading into the Neuse by 30 percent each year.

“The way we conduct research in fisheries is changing rapidly,” says Rand. “We need to be aware of changes occurring throughout the ecosystem — from development patterns in the headwaters and floodplains, to long-term climate patterns, to sources of nutrient loading leading to eutrophication.

“My work on pelagic fishes in the lower Neuse River compliments on-going work by a variety of scientists throughout North Carolina. We just don’t know how the system will respond to the state-mandated reductions in nutrient loading. My hope is that this research will bring us one step closer to the answer.” ■





*Menhaden boats are unloaded at Beaufort Fisheries, where the catch is processed long into the night.*

## BEAUFORT FISHERIES:

### Last Menhaden Plant in State Faces Uncertain Future

*By Ann Green  
Photographs by Scott D. Taylor*

Inside Beaufort Fisheries, the strong smell of menhaden drifts through a dark, empty room. Large cobwebs hang down like a white veil on a light bulb. Huge presses sit empty throughout the room.

“At night, it is like a horror show in here when the plant isn’t operating,” says Jule Wheatly, president of Beaufort Fisheries, Inc.

The plant, which only operates when the day’s catch comes in, is reminiscent of a bygone era when menhaden plants were thriving in North Carolina.

“There used to be seven menhaden plants in Carteret County,” says Wheatly. “Now my plant is the only left in the state.”

Beaufort Fisheries also is one of only two menhaden plants on the Atlantic Coast. The other plant is in Reedville, Va. North

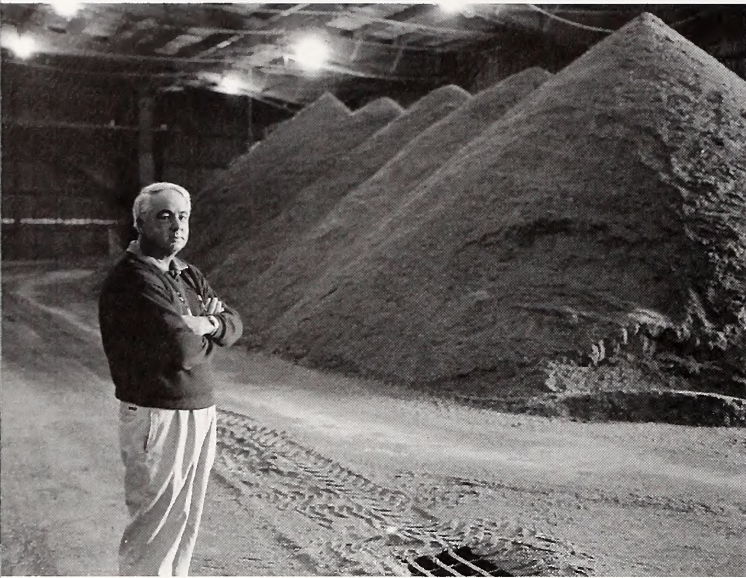
Carolina and Virginia are the only states that have reported menhaden landings along the Atlantic since 1993, according to an Atlantic States Marine Fisheries Commission draft management report. Before that, there were some landings in New England.

With the Atlantic States Marine Fisheries Commission scheduled to vote on an Atlantic menhaden fishery management plan in January, the Beaufort plant may be closing. The draft amendment — which was developed to address declines in the population of Atlantic menhaden — proposes restricting menhaden purse seine fishing one mile from shore.

“We may not be here after this year,” Wheatly says as 2000 draws to a close. “If the Atlantic Fisheries Commission puts a

*Continued*





*Jule Wheatly surveys a warehouse with piles of fish meal produced from menhaden.*

one-mile limit for fishing we'll have to close. Seventy-five percent of our catch is from the shoreline to one mile."

Some citizens in Brunswick County support the restriction of menhaden fishing on beachfronts. In 1999, a large fish kill of menhaden was reported in Brunswick County.

"You can't look at just what is best for menhaden fisheries alone," says Oak Island Mayor Joan Altman. "You also have to look at what is best for beachfront communities. Many people in our community think that menhaden fishing should be kept a mile offshore."

For the past several years, Wheatly has been fighting to keep his business open. On a recent day, he holds up a 1998 aerial photo of schools of menhaden near the shore of Core Banks. White spots show dead menhaden; dark spots show live menhaden. All told, there are about 200 million menhaden.

Wheatly says the photo has saved him at many meetings.

"The fish get close to shore, and when the tide goes out, the fish are trapped and often for lack of oxygen die in the center of the school," says Wheatly.

While sitting in his wood-paneled office, Wheatly also points to other photos, including an old black-and-white photo of a menhaden boat.

"When I was a kid, they had 100 menhaden boats like that one" docked on Front Street in Beaufort, says Wheatly. "Now there are none."

The only two menhaden boats left in Beaufort are owned by Beaufort Fisheries. On a recent day, the *Gregory Poole* — a refurbished World War II mine sweeper — is docked at Taylor's Creek. A small purse-seine boat used to catch

menhaden is parked near the stern.

"This boat was built in 1945," says Wheatly. "It was immediately put in mothballs and never did battle. We bought it in 1972 and converted it to a menhaden boat. We redid it again in 1988."

Visitors can see the boat as they enter the front of the factory at the guard station on Front Street.

Built at the turn of the 20th century, the plant was bought by Wheatly's grandfather, C.R. Wheatly, and William Potter in 1934. Jule Wheatly joined the operations in 1973.

"When I came here, there was only one house here and a pond close to the fish factory," he says.

Now the end of Front Street is lined with rows of new homes and condominiums.

The factory, which has about 75 employees, includes a number of buildings, two wooden piers and a huge net wheel that stretches 300 yards.

"Men used to walk inside and turn the wheel by hand," says Wheatly. "Now, it has a hydraulic motor."

The processing begins right after the menhaden catch is brought to the dock. The fish are left on the boat where they are sucked with a pump that then dumps the catch into a raw box shaped like a boat hull. About 1,000 menhaden can be sucked through at one time.

"The technology has improved a lot," says Ross Goode, who has worked at the plant since 1948. "You used to have to move fish with a fork before they got air hoses."

Now the fish are ready to be cooked in huge boilers, then sent to large presses where the liquid is squeezed out of the fish.

"We pressed about a million fish last night," says Wheatly.

During the next process, the liquid goes to a large centrifuge that spins the liquid to separate the water from the oil. The oil is saved in tanks and later sold for cosmetics and other purposes. The bulk of the material goes to a dryer that prepares it for fish meal.

"We can process about 110,000 pounds of fish meal an hour from start to finish," says Wheatly.

The fish meal, which is high in protein, is then stacked in mounds like small mountains in a warehouse where it is ready to be transported.

Menhaden, which comes from an Indian word meaning "makes things grow," has a tremendous growth factor, says Wheatly. Indians used the fish as a fertilizer to make corn grow.

The plant's busiest season is the fall, when menhaden have gotten large enough to be profitable for processing into oil.

In the summer, you only get about one gallon of oil per thousand pounds of menhaden, in comparison to the fall when you get 10 or 11 gallons per thousand, says Wheatly.

The plant closes in mid-January and reopens in April or May when the N.C. Division of Marine Fisheries opens the spring menhaden season.

In the height of the season, two vessels run near shorelines. When both crews bring in more than 3.5 million pounds of menhaden, the plant operates around the clock.

"It takes 24 hours to cook 3.5 million pounds of fish," says Wheatly. "Sometimes we start at Thanksgiving and never stop until Christmas."

Wheatly hopes to continue to see busy seasons.

"I can't tell you how many meetings I have gone to, fighting for my plant," he says. □





Rebecca Dunning

*The Southern Farm Tilapia operation includes an extensive tank system. Other facilities include a hatchery and processing plant.*

## FISH FARMING: AQUACULTURE OFFERS DIVERSITY

*By Katie Mosher*

AS EASTERN NORTH CAROLINA FARMERS LOOK TO DIVERSIFY THEIR OPERATIONS, AQUACULTURE OPPORTUNITIES CONTINUE TO DRAW ATTENTION.

JUST ASK HUNTER CLARK OF VANGUARD FARMS. ALTHOUGH HIS FAMILY TRADITIONALLY HAD RAISED HOGS, HE STARTED FARMING FISH WITH A HYBRID STRIPED BASS OPERATION A FEW YEARS BACK.

AFTER TWO SUCCESSFUL YEARS, HE DOUBLED THE AQUACULTURE ACREAGE AND EXPANDED INTO YELLOW PERCH. CLARK ALSO ADDED AN ICE MACHINE AND TANKS TO GRADE AND HOLD FISH FOR LIVE SALES THAT DRAW PREMIUM PRICES.

“The face of North Carolina agriculture is changing,” says Tom Ellis, who heads the aquaculture efforts in the N.C. Department of Agriculture and Consumer Services.

“The tobacco program is changing annually, and we’ve seen historically low prices for corn, soybeans and small grains. Some of these farmers — and others involved in livestock and poultry — are looking to diversify to establish a stronger economic base,” Ellis adds.

At the same time, a combined effort — research by Sea Grant scientists, demonstrations by the N.C. Cooperative Extension Service and marketing efforts by state agriculture officials — has expanded the state’s aquaculture operation with new species and new technology.

*Continued*



Overall, North Carolina's foodfish aquaculture operations totaled nearly \$17 million in 1999, including shellfish and hybrid striped bass operation in coastal areas and trout farms in the mountains. In addition, hatchery operations, which produce the young fish that are sold to the fish farmers, were worth nearly \$1.5 million in 1999.

A major aquaculture industry in coastal counties is hybrid striped bass. In 1999, 23 producers had 600 acres of ponds that produced 1.8 million pounds of fish worth \$4.5 million.

Sea Grant research and demonstration projects in the 1980s showed commercial operations could be profitable. After a period of rapid growth through the 1990s, the number of hybrid striped bass producers has stabilized, but their acreage continues to expand, says Ron Hodson, North Carolina Sea Grant director and past president of the Hybrid Striped Bass Growers Association.

"The role of state agriculture officials has been crucial in the maturation of the industry," Hodson adds.

In November, the N.C. Aquaculture Development Conference planning committee honored now-retired Agriculture Commissioner Jim Graham and former Farm Bureau President Bob Jenkins for their support over the years. Hodson also cites Ellis' daily efforts.

"Tom developed a streamlined permitting process that is critical for new and expanded aquaculture operations. Through cooperation from various state agencies, a single request can be routed for approval within the state system," Hodson says.

And the traditional agricultural community considers aquaculture part of the family. Hodson was one of several aquaculture "pioneers" recently designated as "Ambassadors of Agriculture." Others honored include Sea Grant researcher Harry Daniels of North Carolina State University, Tom Losordo of Cooperative Extension, and Rob Mayo of Carolina Classics Catfish of Ayden.

In recent years, the aquaculture market has seen economic fluctuations — and North Carolina has responded.

When initial supplies of farm-raised hybrid striped bass were low, the product commanded premium prices, thus allowing

even small farms to be quite profitable, explains economist Rebecca Dunning of the state agriculture department.

As the supply has increased, the price has dropped. In recent years, established farmers have expanded production, yet it has been harder for potential farmers to cover initial overhead — tanks, fingerlings, etc. — with small operations, she adds.

But the lessons learned in hybrid striped bass — from spawning and hatching to water quality and feeding cycles — now are being applied to other, high-value species.

Sea Grant researchers expect commercial operations in flounder in just a few years. Meanwhile, Lee Brothers, a hybrid striped bass farmer, has a state Fishery Resource Grant (FRG) project to look at farm-raised mullet. And yellow perch farms are running in Brunswick County.

Agribusiness leader R.C. Hunt still has plenty of livestock, but his farm operations now include Southern Farm Tilapia. His facilities — a hatchery, grow-out operation and processing plant that includes 4,000-square-feet of freezer space — are located in Franklin, Nash and Wilson counties.

For tilapia, he is building upon the lessons — both positive and negative — learned in the pork industry. His fish farm runs the gamut, from spawning through delivery to retail stores and restaurants, thus eliminating steps that many commodities take before reaching the consumer.

"With tilapia, we can break that chain to several links," Hunt says.

He expects to process up to 1 million pounds per year by the end of 2001. And he hopes to sell young fish from his hatchery to new tilapia farmers — and to process and market fish from those farms and others. "We made investments to be an anchor in fish farm development," Hunt says.

The state's largest category of shellfish production is soft-shell crabs, with 853 operations that provided nearly 700,000 pounds in 1998, worth \$2.6 million. The combination of oyster and clam operations totaled 279 in 1998. That year, 2,170 acres of shellfish beds netted nearly 18,400 bushels worth nearly \$760,000.

Shellfish operations also have benefited from a combined state effort. Those efforts include FRG research projects by Jim and Bonnie Swartzenberg of J&B Aquafood of Stump Sound. Their business started off as a harvest of wild shellfish, but they soon expanded into mariculture, or growing of cultured oysters in nurseries until they are large enough to be planted in leased shellfish beds.

Sea Grant's mariculture demonstration facility is a cooperative venture with Carteret Community College in Morehead City. The facility serves as a lab for students and will house Sea Grant demonstrations for culture of clams, oysters, mussels and soft-shell crabs.

Some aquaculture operations have a second economic role — nature-based tourism. Visitors to the Blue Ridge Mountains often stop at farm-raised trout farms to fish in the stocked ponds.

And at the coast, Kevin Midgett of Hatteras finds tourists clamor to be clammers. The "u-pick-it" portion of his shellfish operation has become his most profitable. □



Rebecca Dunning

Vanguard Farms hosted a recent aquaculture field day.





Mark Hooper

Young clams are graded after spending their first year in bags.

## A NEW BAG OF TRICKS FOR CLAM FARMERS

By Cynthia Henderson Vega

Want to know how to keep a clam as happy as, well, a clam? Mark Hooper's got it in the bag.

With support from the Fishery Resource Grant program (FRG), Hooper is using bags to dramatically increase the survival of hard clams during the first critical year of grow-out. His findings could make other North Carolina clam mariculturists happy, too.

For their first year, tiny clams are taken from the protective environment of the nursery and planted in the bottom beds of open waters — where the wild things are.

The clam nursery at Hooper Family Seafood is a series of raceways on a dock on the Core Sound in Smyrna. A great blue heron lifts noiselessly from its hiding place near the clear water's edge. It's peaceful, but beneath the water's surface...it's a jungle in there.

Blue crabs, mud crabs, snapping shrimp and whelk are a few of the things that go chomp in the night — or any time, for that matter. Typically, Hooper says, clam farmers try to protect young clams by covering them

with polypropylene mesh. Even this protective covering, however, cannot prevent the 50 percent mortality that is common the first year. The statistics are daunting for anyone considering clam mariculture as an alternative to harvesting from increasingly pressured wild stock.

In Florida, mariculturists found a way to beat the odds, decreasing mortality by raising clams in tented mesh bags. Now, according to Leslie Sturmer, Sea Grant shellfish aquaculture extension agent at the University of Florida, the bag method is the only way clams are raised and harvested there, bringing in around \$12.7 million annually.

Sturmer says other states have tried to follow Florida's example, but most have been unsuccessful. The farther northeast the state, she says, the less effective the bag system is. She speculates that Florida's success may be because the warmer climate means a shorter grow-out period — 12 to 15 months. In North Carolina, grow-out periods are two years or more.

Hooper tested a variation of the Florida system with his FRG project. He, too, had problems. The clams grown in bags were significantly smaller after the first year than those grown in beds. But his success lay in the survival rates of clams raised in bags.

Hooper says "mortality is primarily a first-year problem." That's when clam shells are too thin to defend against the jaws and claws of the deep. Bags protect newly planted clams by forming four-by-four-foot tents around them supported by center stakes of 12-inch long PVC pipes. The bags are secured at the corners, with clams piled in the centers.

Clams don't grow as large in this maricultural tent city — possibly because of a decreased flow of nutrient-carrying water to the bivalves or because of competition for food. In nature, clams feed by burrowing under the substrate. Siphons extend up, taking in plankton and microorganisms carried along by water currents.

It takes valuable growing time for sediment to accumulate in the bottoms of bags and simulate a natural environment. So clams grow more slowly, but, because they are protected from predators, more survive.

Hooper has found 13 mm to be an optimal planting size. That's bigger than the diameter of a number-two pencil, smaller than a dime. Planted in bags at this size, his clams had an impressive 90 percent survival rate.

The Hooper variation combines the bag and bed methods, increasing survival with bags the first year, then planting in beds the second year to catch up in growth. The method has proved so successful, Hooper says he now uses it exclusively.

The bag/bed method has the additional benefit of allowing Hooper to grade the clams before planting them in beds. When clams are harvested with the bed method, those too small to be sold are replanted to keep growing.

Now when Hooper pulls his bags up after the first year, he separates them and plants similar sizes together. He saves final harvesting time by starting with beds where the largest clams were planted.

In a current FRG project, Hooper is investigating this grading system in order to improve shellfish crop management. It's a matter of one good project leading to another.

Hooper wades into his clam beds staked off in the glistening sound. A gull laughs raucously as Hooper gently rakes up 175 clams to fill an order. It doesn't take long. He picks up a perfect, nicely rounded specimen and proudly points out the smooth white edge that, he says, "indicates a good year's growth."

On the dock, a few small terrapins peek up from a watery containment. Hooper is interested in ways to prevent terrapin entrapment in crab pots. Another FRG project? Could be. As Hooper says, "We've got a lot of ideas around here." ■





An expanded Tidewater Research Station provides more aquaculture space for researcher Harry Daniels, pictured with Joanne Harcke.

## FLOUNDER FOR THE FUTURE

By Katie Mosher

They may be flatfish, but the market for flaky flounder filets is anything but flat.

Flounder is popular, both among health-conscious consumers in the United States and in the fresh markets in Asia. But the commercial flounder fishery has been limited in areas considered overfished — and some North Carolina waters have been closed to flounder gill-net fisheries because of sea turtle strandings.

“As demand increases and more restrictions are placed on wild populations, there is a clear opportunity for aquaculture to meet that demand,” says Sea Grant researcher Wade Watanabe of the University of North Carolina at Wilmington. “Flounder is a versatile fish, suited to a variety of cooking styles.”

Aquaculture may be especially lucrative to supply the live fish market, where flounder command a premium price.

Asian flounder aquaculture has been

successful. In 1994, Japan produced about 7,000 tons. Korean production is now easily three times that amount, says Harry Daniels, a Sea Grant researcher at North Carolina State University.

North Carolina is considered a breaking point in the habitat for summer and southern varieties — and Sea Grant research includes both. Researchers

anticipate commercial production operations in the state within three to five years.

“We have the fingerling production problem solved,” Daniels says. “We are consistently and reliably producing fingerlings.”

Watanabe anticipates that commercial operations will utilize both natural and hormone-induced spawning. “Both approaches are going to be needed to produce the numbers necessary for commercial operation,” he says.

Both Watanabe and Daniels are now focusing efforts on “grow-out,” taking the young, finger-size fish to a market weight.

An on-farm demonstration project for summer flounder likely will be expanded for a side-by-side demonstration with southern flounder. Watanabe also has a demonstration project in Wrightsville Beach.

While the state’s successful hybrid striped bass industry uses ponds for the grow-out process, flounder production will more likely be done in covered tanks with 18 to 24 inches of water.

Tom Losordo, an aquaculture specialist with the N.C. Cooperative Extension Service, has worked with Sea Grant researchers on the demonstration tanks, while Christopher

Dumas of UNC-W is reviewing the economics of flounder aquaculture.

Tank systems encourage flounder’s natural instinct to stack on top of one another. “They lay on each other like cats,” Daniels says. But in tanks, the feeding instinct changes.

“In the wild they are lone predators,” Daniels says. “In the tanks they can be trained to come up to the surface to eat dry pellets. They almost school.”

Daniels’ work has been boosted by an expansion at NC State’s Tidewater Research Station in Plymouth. The aquaculture facility has grown to 3,000 square feet. The state legislature funded the initial facility, and Southern States Cooperative funded an expansion for commercial scale fingerling production.

Like some reptiles whose gender can be determined by the temperature of the eggs, the gender of individual flounder is determined by temperature early in life. Males like the extreme hot and cold temperatures — and a graduate student is doing a thesis project to determine the timing of the determination and the turning point temperature.

More important to the fish farmers will be that females — which grow to a larger size — like moderate temperatures.

“We will need good temperature control for year-round production,” Daniels says. “The effort will be to produce all female fingerlings.”

### N.C. AQUACULTURE DEVELOPMENT CONFERENCE

Aquaculture research, technology and marketing will be highlighted during the annual North Carolina Aquaculture Development Conference to be held Feb. 1-3. A self-guided tour of aquaculture operations will be offered Feb. 1. A conference at the Sheraton Grand Hotel in New Bern will be held Feb. 2, while workshops will fill the morning of Feb. 3. For more information, call 919/733-7125. On the Web, go to [www.ncaquaculture.org](http://www.ncaquaculture.org).

For information on Fishery Resource Grant projects in aquaculture go to [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant) and follow the research links to the FRG pages.



# Seafood is Heart Food

By Joyce Taylor

There is big news for health-conscious people. The American Heart Association now recommends that individuals eat “at least two servings of fatty fish, such as tuna or salmon,” weekly.

The dietary guidelines were announced last fall in *Circulation: Journal of the American Heart Association*. Based on results of more than 200 recent studies, the guidelines have been expanded to include specific recommendations tailored to an individual’s risk of heart disease and stroke.

The guidelines are easier to use because they stress overall eating patterns, rather than a percentage of dietary fat or other nutrients.

A diet rich in fruits and vegetables, legumes (beans), whole grains, low-fat dairy products, lean meats and poultry is still recommended. And, for the first time, two weekly servings of fish are included.

Why seafood? Research in the 1970s revealed a direct relationship between the consumption of seafood and the low incidence of heart disease in Greenland Eskimos. This was attributed to the presence of highly polyunsaturated fat called omega-3 fatty acids — found



Scott D. Taylor

primarily in seafood — in their diet. Since then, continuing studies have confirmed the benefits of fish in cardiovascular health.

Other studies indicate seafood may have a part not only in preventing heart disease, but also in the prevention of other diseases.

In May 1985, the prestigious *New England Journal of Medicine* stated: The consumption of as little as one to two fish dishes per week may be preventive in relation to heart disease.

For years physicians have recommended low-fat fish as part of a healthy diet. Now we know that seafood with higher fat content is also good for us because of omega-3s.

How can you know the omega-3 content? The general rule: The higher the fat content, the higher the omega-3s.

While the new AHA guidelines mention fatty fish, remember that other fish and shellfish are also beneficial in many ways.

Most seafood is low in fat, saturated fat and cholesterol. Many species of finfish contain less than 5 percent fat. Shellfish have less than 2 percent. The oil in seafood is rich in polyunsaturated fat, the type that tends to lower blood cholesterol.

A common misconception is that shellfish are high in cholesterol. Early tests measured all sterols in shellfish, not distinguishing cholesterol from the others. Now with sophisticated equipment, we know this is not true.

Most oysters, clams, scallops and mussels contain about 30 to 50 mg per serving. Shrimp and crabs have about 55 to 150 mg, making them acceptable in the diet.

Most finfish have fewer than 100 milligrams of cholesterol per serving — 3.5 ounces raw.

Cooking methods can add fat, cholesterol and calories. Baking, broiling, steaming and poaching usually require less fat.

Frying is out of favor with most nutrition guidelines. But you can often lightly sauté food without adding much fat.

In light of the current controversy about harmful effects of trans fatty acids found in margarine, some people have begun to use a little butter instead. And you can use olive oil, which is monounsaturated.

Remember that the fat in a recipe should be divided by the number of servings

Continued



to determine the individual amount consumed.

Seafood is low in calories and sodium. Most fish have fewer than 100 calories per serving, and shellfish are similar. Fish generally contain less than 100 mg of sodium. Shellfish are also low in sodium, containing from 150 to 300 mg.

People often ask, "Isn't seafood high in sodium because it comes from salty water?" Fresh seafood has very little sodium, but we often change that by adding too much salt in preparation. Canned, smoked and pickled seafoods usually are higher in sodium because salt is added during processing.

Fish and shellfish contain top-quality protein. One serving contains about half the protein needed daily.

Seafood is also rich in some B vitamins as well as some minerals, which vary among species.

Composition varies depending upon size, season, sex, location and feeding habits.

For a healthy heart — and for other nutritional reasons — eat seafood.

### **Baked Salmon with Sour Cream and Dill**

- 1 2-pound skinless, boneless salmon filet
- 2 tablespoons margarine or butter, melted
- 1 tablespoon fresh lemon juice
- 2 tablespoons minced onion
- 1 cup light sour cream
- 2 tablespoons liquid egg substitute
- 1 tablespoon minced, fresh dill or 1 teaspoon dried
- 1/4 teaspoon freshly ground white pepper
- 1 teaspoon grated lemon zest

Place salmon in greased baking dish. Brush with margarine or butter. Mix lemon juice and onion and spread over fish. Bake at 400 F for 20 minutes.

Meanwhile, mix sour cream with egg, dill and pepper. Spread on fish. Continue baking for 5 minutes, or until fish flakes easily when tested with a fork. Sprinkle with lemon zest before serving. Serves 6 to 8.

### **Braised Fresh Tuna**

- 4 tuna steaks
- 1/4 cup margarine or butter
- 1/2 cup chopped onion
- 1 tablespoon flour
- 1 cup dry white wine
- 1/2 cup tomato puree
- salt
- freshly ground black pepper
- 1 cup thinly sliced fresh mushrooms
- 1/4 cup finely chopped fresh parsley
- 2 tablespoons sugar

Melt margarine in large pan. Brown tuna on both sides. Remove from pan and set aside. Add onions to pan and cook until lightly colored. Stir in flour and brown until medium. Add wine, tomato puree and sugar. Sprinkle with salt and pepper.

Lightly salt and pepper the tuna. Place in the sauce. Bake at 350 for 20 minutes or until done.

At this point, depending upon the thickness of the sauce, do one of the following:

1. If sauce is thick enough, add the mushrooms and cook for 5 more minutes.
2. If sauce is not thick enough, remove tuna (when done) and place on serving platter. Reduce sauce until desired thickness. Add mushrooms and cook 5 more minutes. Sprinkle with parsley. Pour sauce over fish. Serves 4.

### **Sautéed Tuna Steaks with Tarragon**

- 4 tuna steaks, about 1-inch thick
- 2/3 cup dry white wine
- 1 tablespoon finely chopped fresh tarragon
- 1/4 cup margarine or butter
- salt
- freshly ground white pepper

Blend wine and tarragon. Lightly salt and pepper fish. Melt margarine in large skillet. Add steaks and brown on both sides. Spoon tarragon and wine over steaks as they cook. Cook 10 to 15 minutes or until done. Place fish on a serving platter and pour remaining wine mixture. Serves 4.

### **Baked Oysters with Fine Herbs**

- 3 dozen select oysters
- 1/4 pound margarine or butter, softened
- 3/4 cup green onions, including tops, finely chopped
- 1/4 cup finely chopped fresh parsley
- 1/4 cup finely chopped fresh tarragon, or 4 teaspoons dried
- 1/4 cup fresh cracker crumbs
- 2 teaspoons fresh lemon juice
- rock salt

Shuck oysters and place the deep half of the shells level on a bed of rock salt on baking pan. Mix together margarine, onions, parsley, tarragon, crumbs and lemon juice. Divide evenly over oysters. Broil about 4 inches from heat until desired doneness, 3 to 8 minutes. Serves 6.

### **Charcoal-Grilled Marinated Shrimp**

- 1 1/2 pounds medium or large shrimp, peeled, with tails left on
- 2 tablespoons fresh lime juice
- 3/4 teaspoon freshly ground black pepper
- 1/2 teaspoon salt
- 1/8 teaspoon dill weed
- 1/4 teaspoon sugar
- 1/2 teaspoon ground cumin
- 1/2 teaspoon basil
- 1 1/2 teaspoons pressed garlic
- 2 teaspoons finely chopped onion tops
- 1 tablespoon vegetable oil

In wide, shallow dish combine lime juice, pepper, salt, dill, sugar, cumin, basil, garlic, onion and oil. Mix thoroughly. Lay shrimp flat in mixture and marinate in refrigerator for 20 to 30 minutes, turning once. Remove shrimp from marinade and thread on skewers or place in hinged wire grill. Cook about 4 inches over medium coals, about 6 to 7 minutes on each side. Serves 6. ☐

*Joyce Taylor is compiling a book of her Sea Grant seafood education materials.*



# *Monitor 2000 Expedition: Divers Face Tough Conditions*

*By Ann Green*

Photo courtesy of NOAA Monitor collection.



As the dive safety officer on the 2000 *USS Monitor* expedition off Cape Hatteras, Doug Kesling never knew when the Atlantic Ocean would “create havoc.”

“I know why this part of the ocean — where the Gulf Stream and Labrador currents converge — is called the ‘Graveyard of the Atlantic,’ ” says Kesling of the National Undersea Research Center at the University of North Carolina at Wilmington.

“You can have visibility anywhere from 100 feet plus to zero from day to day. The surface water currents vary from slack tides to 3 knots. The sea states can range up to 12 feet.”

Each day from May to August, Kesling had to make sure conditions were safe for diving near the historic Civil War ironclad — which sank during a storm in 1862 just 16 miles off the coast in 240 feet of water. He had to follow these strict safety guidelines: current no greater than a knot, sea state five feet or lower and clear visibility on the bottom.

“We also had a safety standby diver onboard UNC-W’s research vessel, *R/V Cape Fear*, ready to go to the bottom in an emergency,” says Kesling. “We were lucky because there were no emergencies last summer.”

No divers had to be treated for the “bends” — caused by the release of gas bubbles in blood and body tissue upon too rapid decrease in pressure while surfacing, he added.

To coordinate the efforts of 30 National Atmospheric and Oceanic Administration (NOAA) divers, several organizations worked with NOAA’s National Marine Sanctuary Program. The U.S. Navy provided rigging and operations for stabilization of the hull. The Cambrian Foundation in Florida provided many divers from its volunteer network and worked with NOAA and UNC-W on the self-contained scuba dives. In addition, East Carolina University’s Program in Maritime Studies provided divers with archaeological training.

“It’s a team effort,” says Kesling. “It requires proper training, top-side support for the divers and rigid procedures. It also requires personal commitment because of time involved and the depth of dives. It is not your typical scuba dive to the bottom.”

To follow safety procedures, all diving tasks had to be rehearsed, says expedition dive supervisor Terrence Tysall of the Cambrian Foundation. “All divers had to be ready to dive at the same time.”

Even with careful monitoring of the weather conditions, divers can face adverse conditions before they reach the bottom where the hull lies upside down, resting on its famous revolving turret with guns.

In 1999, ECU archaeologist Frank Cantelas had good visibility as he left the diving platform, says Tim Runyan, director of the maritime studies program. “By the time, Frank got 240 feet down, he bumped into the *Monitor* and never knew it,” adds Runyan. “The bottom was so stirred up from the currents that there was no visibility.”

The wreck site of the *Monitor* was discovered in 1973.

Two years later, the *Monitor* site was designated the first National Marine Sanctuary.

NOAA began the first expedition in 1977. The first artifact found was a brass ship’s lantern lying partly buried on the ocean bottom near the turret.



*Navvy divers prepare to enter the rough waters.*

Photo courtesy of NOAA Monitor collection



The cooperative diving efforts resulted in a few treasures last summer. On the last day, the divers recovered a white porcelain pitcher near a wooden drawer.

“The pitcher was exposed by an oyster fish,” says Kesling. “The toadfish did the excavation work for us.”

The divers also recovered a porcelain drawer pull and a brass ring that was probably attached to a signal lantern.

The wreck site of the *Monitor* was discovered in 1973. Two years later, the *Monitor* site was designated the first National Marine Sanctuary. NOAA began the first expedition in 1977.

The first artifact found was a brass ship’s lantern lying partly buried on the ocean bottom near the turret.

Over the years, NOAA has recovered a number of artifacts, including condiment bottles, a storage jar filled with pickle relish, and an anchor. All artifacts are taken to The Mariners’ Museum in Newport News, Va., for conservation, study and exhibition.

In 1990, NOAA discovered parts of the *Monitor* were deteriorating because of strong ocean currents. The midship bulkhead had partially collapsed. The propeller was unstable. Iron plates from the lower hull had been displaced.

To save the ship’s major parts, NOAA developed a long-range preservation plan.

“We decided that we couldn’t recover all the artifacts,” says John Broadwater, manager of the Monitor National Marine Sanctuary. “So we proposed to recover the major components — propeller, engine, turret and cannons.”

To help salvage some of the famous shipwreck’s most important parts, the Navy was brought onboard in 1995.

“It takes 16 to 24 Navy divers to put two people in the water,” says Broadwater. “It is labor-intensive and expensive. But because Navy divers have to undergo training each year, the Navy’s work on the *Monitor* is not an added expense to taxpayers.”

Last summer, the Navy divers recovered a section of propeller shaft and

the skeg — the beam that supported the rudder.

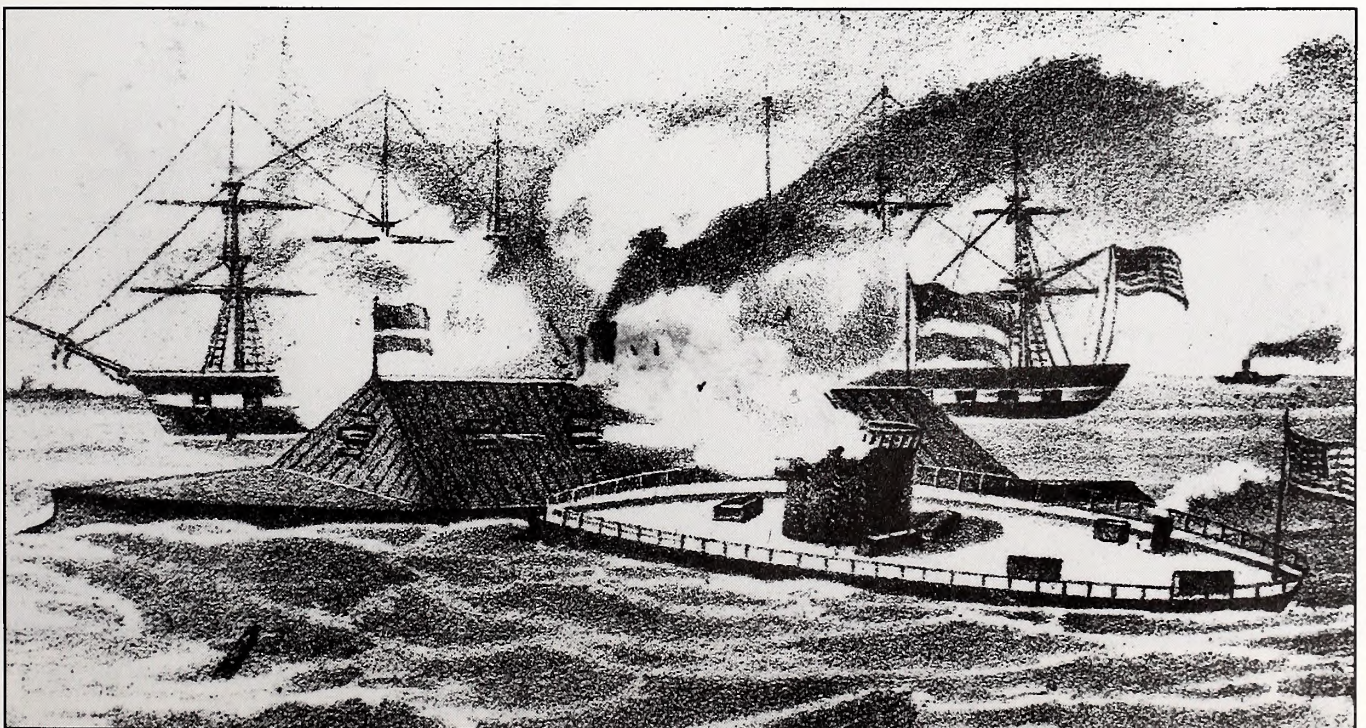
While resurfacing one day, the divers met a new buddy.

“Navy divers officially adopted a project mascot today: a five-foot barracuda who always meets the divers at a depth of 110 feet as they are returning to the surface,” according to *Monitor* logs. “He has been dubbed ‘Barry Cuda.’ ”

As researchers plan for the 2001 expedition this spring, they are targeting the recovery of the engine.

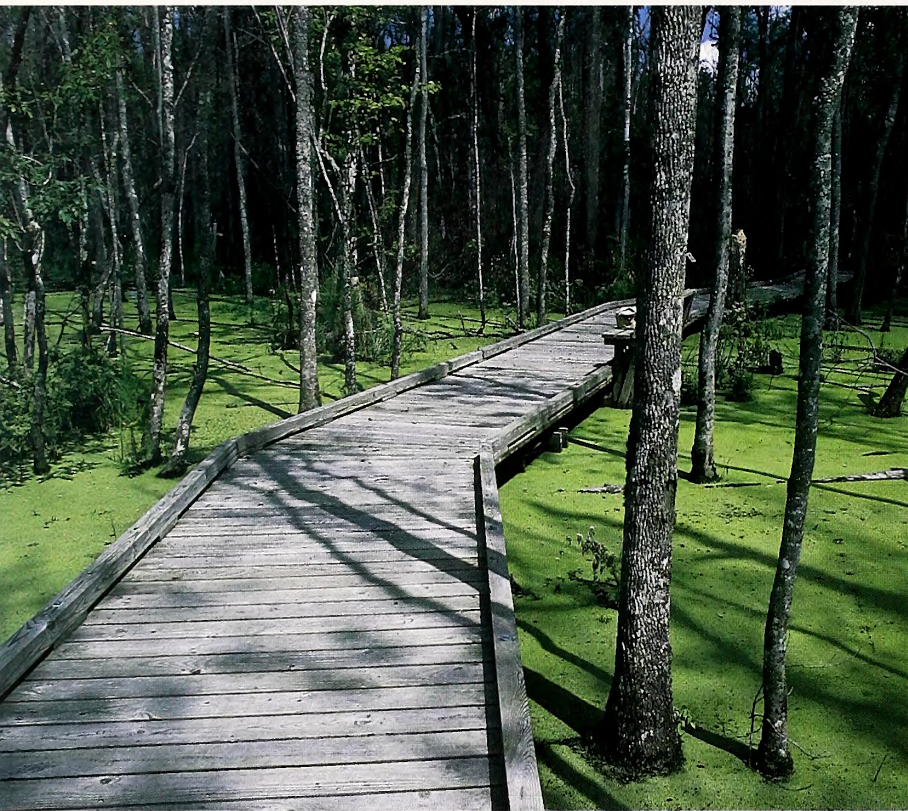
Last summer, divers were able to lower a 90-ton engine recovery structure over the wreck, says Broadwater. “And during diving 2001, we will remove the *Monitor*’s 45-ton steam engine and lift it to the surface using the recovery structure. The *Monitor* 2001 expedition will challenge both the Navy and NOAA teams, but we’ll be ready.” ■

For more information about the *Monitor*, visit the Web: [www.monitorcenter.org](http://www.monitorcenter.org)



The Battle of the Monitor and the Merrimack, with Union gunships in the background.





*TOP LEFT: The boardwalk at Goose Creek gives a picturesque view of the swamp. TOP RIGHT: Water grass flourishes in the marsh.  
BOTTOM LEFT: Goose Creek Park has open space for picnics.  
BOTTOM RIGHT: The park runs an extensive controlled-burn program to clear underbrush.*



# Goose Creek State Park: *Home to Diverse Ecosystems*

By Ann Green

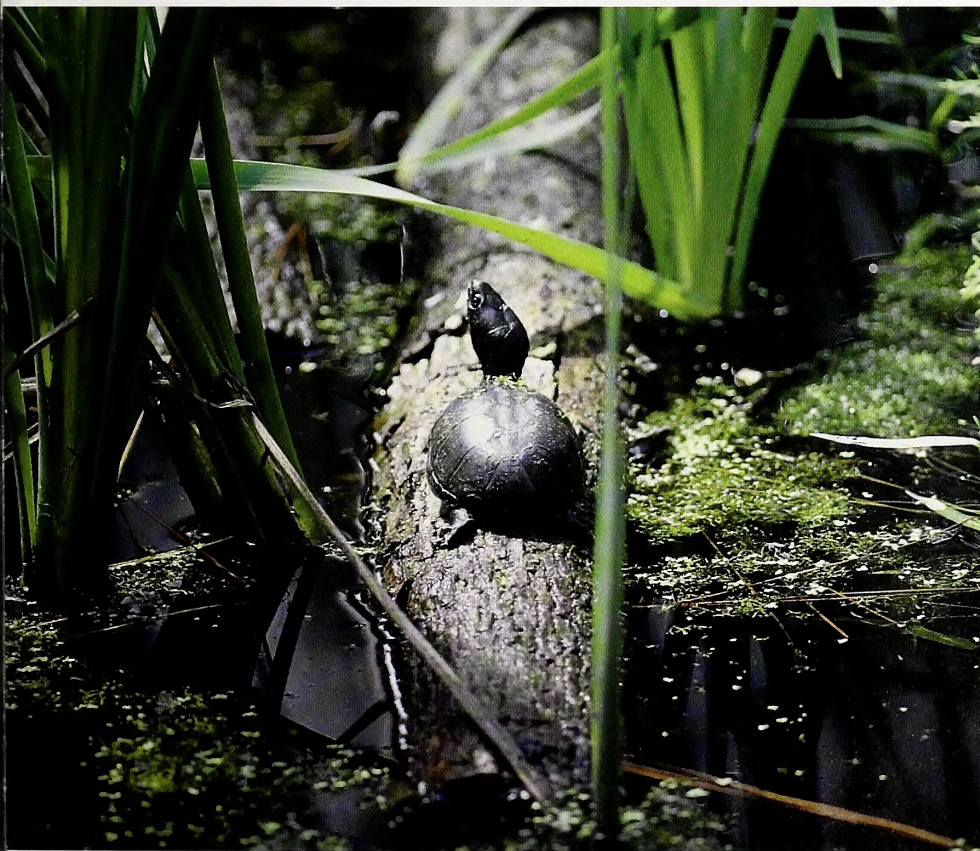
Photographs by Scott D. Taylor

As the drumming of the pileated woodpecker echoes through a tea-colored swamp, Goose Creek State Park ranger Phoebe Wahab surveys the water for signs of wildlife.

Bending down on a wooden boardwalk overlooking a hardwood swamp, she spots a copperhead curled around a red maple.

"The snake is usually in this spot when the sun comes out," says Wahab. "Most of the time snakes also sun on logs over there. Sometimes there are so many snakes on the log that school kids think we put out props."

Wahab, who seems to know every hiding place for snakes, walks a few feet on the other side of the boardwalk. Then she eyes another reptile — a redbelly water snake coiled in front of a thin tree.



TOP: The park's brackish marsh overlooks the Pamlico River.  
BOTTOM: A turtle suns on a log.

*Continued*



"The boardwalk is a good place for people who are scared of snakes to see them and get comfortable with them," she says. "It is a great place to learn about a wetland environment."

The hardwood swamp isn't the only wetland at Goose Creek State Park, which stretches over 1,596 acres. Located near Washington, the park also is home to a cypress swamp and brackish marsh. A 375-acre brackish marsh along the Pamlico River has been designated a national natural landmark. It also is the longest segment of publicly-owned, undeveloped, low-salinity estuarine shoreline in the state.

"It is not a park where you just ride through," says park superintendent Scott Kershner. "You need to get out and explore the seven miles of trails. A lot of animals make their home here in the wetlands because it is isolated."

North Carolina Sea Grant acting extension director Jack Thigpen agrees.

"The diverse ecosystem of Goose Creek makes it a great place to see many different types of plants and animals," Thigpen adds.

Goose Creek also has an environmental education center. Interactive exhibits showcase the cypress and hardwood swamps and marsh. In the cypress swamp, you can hear sounds of wildlife — from a frog croaking to a screech owl hooting.

Nearby, specimens of animals peer from the wall and ceilings of the Discovery Room. A black bear has its mouth open like it is getting ready to take a bite out of a plant. A beaver is poised to slap the water with its tail.

"We look at taxidermy mounts as a teaching tool," says Wahab. "It helps students and adults understand wetlands."

From the center, you can walk down a trail to the hardwood swamp where many species of plants and trees flourish. On the edge of the swamp, towering loblolly pines line the path. Many have charred tree trunks from burning.

The park runs a controlled-burn program to slowly bring back the forest to its natural state, says Kershner. Frequent fires remove undesirable hardwood species that otherwise would crowd out desirable species, such as the long leaf pine. The burn program also restores the open long leaf pine savannas that existed prior to European settlement and subsequent extensive logging, he adds.

The park's forest benefits in other ways — from disease control and improved accessibility to enhanced appearance and release of valuable nutrients back into the environment.

Burning also helps the park's wildlife by reducing the amount of hazardous fuels from hurricane debris and leaf litter in the forest — which could build up and pose a serious wildfire threat, he says. In



*Scott Kershner shares his knowledge of the various habitats in the park.*

addition, Kershner says that wildlife such as deer, turkey, quail and dove benefit from fires, which increase yields of legumes and hardwood spouts, and provide open areas for feeding and travel.

Near the edge of the swamp, transition species — holly, yellow poplar, river cane and sweet bay — dominate the forest.

Throughout the swamp, many dead trees adorn the water. Some are stacked like a wall. Others look like pieces of sculpture.

"Dead trees can be useful for the environment," says Kershner. "Animals such as wood ducks and flying squirrels nest in the cavities of the dead trees."

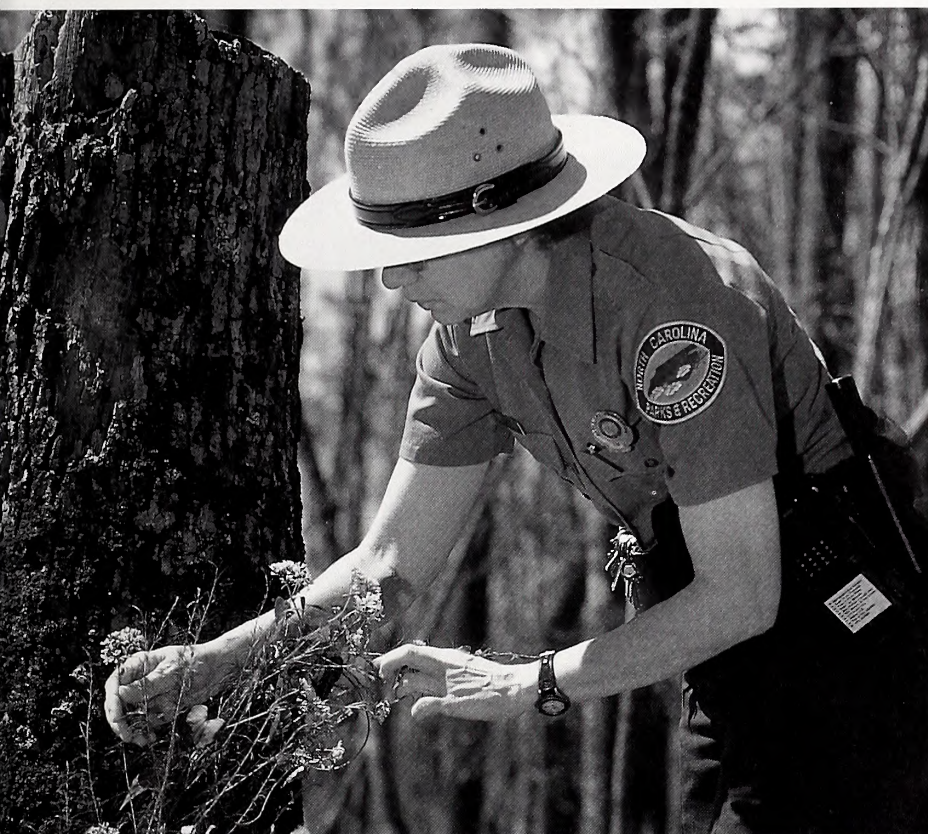
Further down on the boardwalk, more wet-tolerant species, including black gum and green ash, provide a canopy for the swamp. Ferns and the dwarf palmetto palms create a tropical feeling. The swamp water also changes color from tea-colored to a mossy green.

To get a close-up of the brackish marsh, you have to drive or walk to another area of the park. The mile-long Flatty Creek Trail leads to the brackish marsh.

Along the way, you can see a variety of flora, including wax myrtles that beautify the forest. Loblolly pines also line the trail.

As you get to marsh filled with tall grasses and rushes and a seashore mallow, an osprey screeches like a tea kettle. A butterfly flutters across the path, and several dragon flies create a blue reflection on the marsh.





*Phoebe Wahab examines a plant in the swamp.*

“The marsh is important because it is a nursery area for ducks and fish,” says Kershner. “It also filters out pollutants.”

The trail ends at an elevated observation deck that overlooks the Pamlico River and marsh.

“This is my favorite spot in the park,” says Kershner. “It is real peaceful. You can see the marsh and the Pamlico River.”

During the winter months, you can see a variety of birds on their migratory path. In late December, serious bird watchers come out for the Christmas bird count. Last year, bird watchers spotted a bald eagle.

“It is a big deal to see a bald eagle in the Christmas count,” says Kershner. “Usually they just see migratory bird fowl — duck, geese and swan.”

Goose Creek also is a haven for other birds, including barred owls and red-shouldered hawks and summer migrants like prothonotary warblers.

Along Goose Creek Trail, you can experience the mysterious feeling of the cypress swamp where large cypress trees crowd the muddy water. Sometimes, the swamp is not accessible because of large amounts of rain.

“The swamp is doing what it is supposed to,” says Kershner. “It is like the edge of a soup bowl and collects all the water around it.”

Large bald cypress trees dominate the swamp. Sweet and red bay, swamp cyrilla and sweet pepperbush grow below the cypress trees.

“The trees have a unique character because of their large knees and flared base at the buttress,” says Kershner.

Near the swamp entrance, a white-tailed deer leaps through the forest.

Visitors can fish from a beach on the Pamlico River. A trail runs from the road to the beach.

“This is one of the few public water accesses in Beaufort County,” he says.

Not too far from the beach area, a tiny cemetery commemorates 19th-century residents who are believed to have died from yellow fever, according to Kershner.

The gravestones are made of both wood and stone. Because the wooden markers have deteriorated, visitors can no longer read names of the dead.

“The people were brought across the Pamlico River and buried here to keep the disease from spreading to other people,” says Kershner.

As you walk down a trail to the main park road, you can see an open area where artificial nesting boxes have been inserted in trees to encourage nesting by the endangered red-cockaded woodpecker.

“It takes more than a year for a red-cockaded woodpecker to create a cavity,” says Kershner.

“Active nesting colonies are located beyond the park.”

Along the park road, you can spot other wildlife, including snakes, frogs and turtles sunning in their wetland habitat.

“Goose Creek is a great place to discover the wonderful mysteries within wetlands,” says Kershner. And, he adds, exhibits at the Environmental Education Center help visitors interpret wetland areas and understand the importance of wetlands to wildlife — as well as to ourselves. □

You can paddle the waters of Goose Creek State Park April 1 during Coastal Plain Waters 2001. For more information about the research conference, symposium and field trips, visit the Web: [www.coastalwaters2001.ecu.edu/](http://www.coastalwaters2001.ecu.edu/).

Goose Creek State Park is in Beaufort County on the north side of the Pamlico River. From Washington, follow U.S. 264 for 10 miles, then turn onto Hwy. 1334 (Camp Leach Road) for 2.5 miles to the park entrance. Park hours vary by season. For more information, call 252/923-2191 or visit the Web [www.ncsparks.net](http://www.ncsparks.net) and follow the links to coastal parks and Goose Creek.



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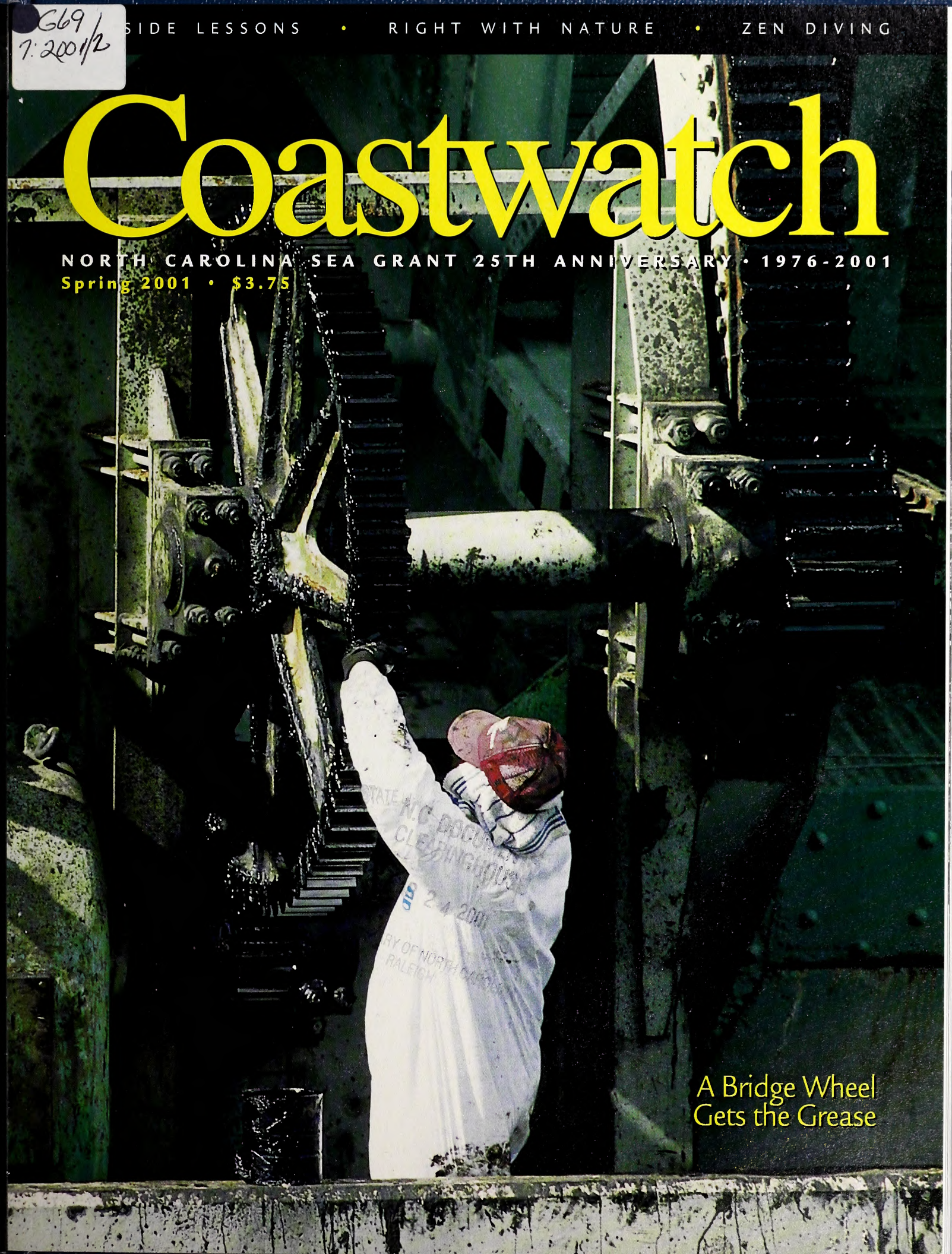
RIGHT WITH NATURE

ZEN DIVING

# Coastwatch

NORTH CAROLINA SEA GRANT 25TH ANNIVERSARY • 1976-2001

Spring 2001 • \$3.75



A Bridge Wheel  
Gets the Grease



## Silver Threads

It's hard to decide where to begin to say "Thanks."

When we kicked off our 25th anniversary with a program in Raleigh Feb. 7, I found it quite humbling to see so many folks take time from busy schedules to join us in recognizing the designation of the complete North Carolina Sea Grant College Program.

At the same time, it was quite exciting to see the mix of people who came together. I wish I could get a full report of all the potential collaborations sparked that night. Some may be immediate projects among longtime colleagues, who, while catching up, realized they had common priorities.

In other cases, a researcher may have met someone from a state or federal agency for the first time. Now, when either has a question or a new project, they know whom to call — or e-mail — for a certain expertise.

We were pleased to see so many veteran legislators stop by to check on progress of Sea Grant's efforts — and many newer legislators who took the opportunity to learn more about our program.

And we offer thanks to friends from the coast — folks involved in commercial fishing, seafood processing, local government or community groups with diverse interests. You brought the realities of the challenges our coast now faces.

Bringing people together has been a hallmark of the Sea Grant program. And, in light of the current state budget constraints, those partnerships will become even more important.

We were especially honored to have Lt. Gov. Beverly Perdue speak. As a longtime New Bern resident, she has seen the changes in coastal counties first hand. And she has recognized the Sea Grant's efforts to preserve ecosystems that are crucial on so many levels — to the environment, to local economies, and to the quality of life along the coast.

Russ Lea shared his perspective from The University of North Carolina System. We will provide excerpts from his comments, as well those from the lieutenant governor and other speakers, in our special anniversary issue later this year. In the meantime, flip to the inside back cover for a peek at the celebration.

Throughout the festive evening, we were able to mix in the Sea



Herman Lankford

Grant story — even with the wonderful donated seafood.

For example, *oyster* harvests have declined in the past century, but Sea Grant is working with shellfish aquaculture researchers and business owners to promote healthy new harvests.

*Blue crabs* are the state's leading commercial fishery. Sea Grant has a long history of crab projects, from the early days of working with processors on pasteurization, to a new state-funded blue crab research program.

*Scallop* medallions, featured in an earlier issue of *Coastwatch*, are considered a value-added seafood. The product was developed with funding from the N.C. Fishery Resource Grant program.

It was obvious that the *shrimp* cocktail was a favorite. Our extension specialists have worked

extensively with North Carolina shrimpers to introduce more efficient and environmentally friendly gear, including the skimmer trawl.

And Sea Grant's *hybrid striped bass* aquaculture technology sparked a multi-million industry. Those lessons are now being transferred to flounder aquaculture.

In closing, I offer special thanks to those who helped to make the Raleigh event such a success.

- Acro Café at the N.C. Museum of Natural Sciences, Raleigh
- Carolina Fisheries, Aurora
- Friends of the N.C. Museum of Natural Sciences, Raleigh
- J&B AquaFood, Jacksonville
- North Carolina Beer and Wine Wholesalers Association, Raleigh
- North Carolina State University Office of Research and Graduate Studies, Raleigh
- Scott Taylor Photography, Inc., Beaufort
- Sea Safari, Ltd., Belhaven
- South End Brewery, Raleigh
- Theo Davis Sons, Inc., Zebulon
- Wanchese Fish Company, Wanchese

Again, we thank all of those who have supported Sea Grant over the years — down to the first-time readers of *Coastwatch*. We could not do it without you.

Katie Mosher, Managing Editor

## C O N T R I B U T O R S

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# Coastwatch

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, North Carolina Sea Grant supports several research projects, a 12-member extension program and a communications staff. Ron Hodson is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

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Front cover photo of bridge tender Troy Shepard at Wrightsville Beach and table of contents photo of sea oats by Scott D. Taylor.  
Printed on recycled paper. ♻️

### Sea Turtle Strandings Cause Concern

A record 839 sea turtle strandings reported along the North Carolina coast in 2000 has sparked concern from diverse groups of citizens.

Some environmentalists are calling for more restrictions on commercial fishing. But commercial fishers say they should not assume all the blame — and consequences. They say more information is needed to pinpoint causes of turtle mortality and to implement preventive measures — short of closing fisheries.

During a January workshop, commercial fishers, state and federal officials, researchers and other interested citizens shared information and explored solutions. The forum — hosted by the National Marine Fisheries Service, the N.C. Division of Marine Fisheries (DMF) and North Carolina Sea Grant — focused on ways to protect these endangered and threatened species while maintaining traditional fishing activities.

Ruth Boettcher, former sea turtle coordinator for N.C. Wildlife Resources Commission, said that the cause of death for 91 percent of the turtles could not be determined. Boating interactions caused the highest number of known mortalities, she added.

In spring 2000, the carcasses of more than 300 turtles washed up on Outer Banks beaches in two mass strandings. Large mesh net fragments attached to



Daryl Lee

several turtles led officials to link the events to out-of-state monk fishers in waters off the North Carolina coast. Late last year, additional turtle strandings in the southern Pamlico Sound prompted DMF to close the area to large gill nets used to catch flounder.

Jerry Schill, executive director of the N.C. Fisheries Association, said the industry has shown a willingness to adopt technology to protect turtles. For example, turtle excluder devices used to release turtles from shrimp nets have been effective in reducing turtle deaths.

DMF director Preston Pate described the workshop as a starting point for continued discussion, including the formation of a working group to recommend research needs.

Individuals or groups interested in joining the effort should contact Nancy Fish, DMF Public Affairs, by e-mail at [nancy.fish@ncmail.net](mailto:nancy.fish@ncmail.net) or by phone at 252/726-7021.

— P.S.

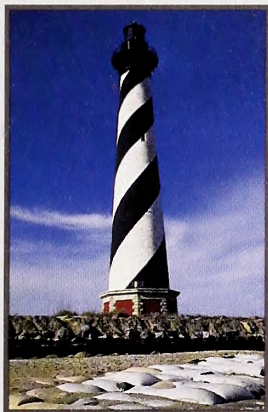
### In the Next Issue of *Coastwatch*

Delicate coral reefs may be considered canaries in the coal mine — they are often the first species to show stress when an ecosystem is degraded. Pam Smith shares the research of Alina Szmant, a scientist at the University of North Carolina at Wilmington. And, ever wonder how museum displays seem so lifelike? Ann Green takes you into the world of taxidermy.



## Hatteras Light History, Engineering Honored

Through the first half of the 20th century, the Cape Hatteras Lighthouse was a beacon of safety in treacherous seas. In recent years, it also became known for an engineering feat. Both aspects of the Dare County landmark will be recognized May 5-6.



Cape Hatteras Light  
prior to move

Scott D. Taylor

The National Park Service will rededicate the light station in its new location, away from an eroding shoreline. An architectural landmark, the lighthouse will have a plaque citing the move as the "most significant engineering event of 1999," according to the American Society of Civil Engineers.

The May 5 ceremony — which is open to the public — is part of the weekend's Lighthouse Keepers' Descendants Homecoming. The park and lighthouse will be open all day. For information on the Web, go to [www.nps.gov/caha](http://www.nps.gov/caha) and follow news and events links. While online, check out the "live cam" views, including one from the top of the lighthouse.

Throughout the weekend, the public will mingle with descendants of light-

house keepers dating back to the early 1900s. The homecoming is expected to draw 1,500 relatives from across the country. Because of facility capacity, those programs will be limited to the descendants.

The Outer Banks Lighthouse Society, with the work of genealogist Sandra Clunies, has developed a database of 85 keepers and assistant keepers, many from seven core families. An executive

planning committee has worked with volunteers to organize the homecoming and gather information for a book, *Hatteras Keepers: Oral and Family Histories*.

Proceeds from the book, published by the society and edited by Cheryl Shelton-Roberts, will help defray reunion costs. Interviews include Jennie Fulcher, now age 94, and Edna Casey Gray, now 93, whose fathers were assistant keepers in the 1910s and 1920s.

To see if you are part of the lighthouse keepers' family, check the web at [www.outer-banks.com/hatteraskeepers](http://www.outer-banks.com/hatteraskeepers).

— K.M.

## Preparing for Natural Disasters

East Carolina University will host a conference, "Of People, Places and Progress: Extended Recovery in the Coastal Plain," May 23-25, on the university campus in Greenville. The conference is co-hosted by the Eastern Area Health Education Center. North Carolina Sea Grant is a co-sponsor.

Citizens, scientists and public officials will focus on environmental change, long-term effects, decision-making and public health issues associated with natural disasters. James Lee Witt, former director

of the Federal Emergency Management Agency, will be among the speakers.

Eastern North Carolina still is recovering from the effects of the catastrophic 1999 hurricane season — massive flooding in the wake of Hurricane Floyd. The conference will highlight recent research advances on coastal plain hazards.

Contact Ronald Mitchelson at [mitchelsonr@mail.ecu.edu](mailto:mitchelsonr@mail.ecu.edu), or call 252/816-8308 for additional information. Or, go online to [www.ecu.edu/hazconf](http://www.ecu.edu/hazconf).

— P.S.



Scott D. Taylor

## NC Boasts True Blue Crabs

A mini-documentary and Web site, "True Blue Crabs," promotes the state's leading commercial fishery in the face of competition from cheaper imported crabmeat.

Television producer Bill Hitchcock of Newport developed the project through the N.C. Fishery Resource Grant Program, funded by the North Carolina General Assembly and administered by North Carolina Sea Grant.

North Carolina produces more blue crab than any other state — annual crab landings here have exceeded 60 million pounds, with a value that surpassed \$30 million.

But consumption trends are changing. Five years ago the ratio in the United States was 70 percent domestic crab to 30 percent import. Now those figures are reversed.

"True Blue Crabs" points out that the "blue swimming crab" imported from Pacific countries is not the same species as North Carolina's blue crab.

The Web site [www.ncrabs.com](http://www.ncrabs.com) allows you to view the video and order a free VHS copy. The video also airs on some coastal Time Warner Cable public access channels. Call local cable offices for air times.

— K.M.



## Conference Focuses on Marine Mammals

Want to find out the latest research on diversity and conservation of marine mammals from Maryland to Texas?

Attend the first Southeast and Mid-Atlantic Marine Mammal Symposium at the Duke University Marine Lab on Pivers Island in Beaufort.

Formerly known as the Atlantic Coastal Dolphin Conference, the meeting — which targets biologists — will be held

March 30 to April 1.

The keynote speaker will be Doug Demaster, director, National Marine Mammal Lab, National Marine Fisheries Service, Seattle. The program will include oral presentations and a poster session.

To register, download the registration form on the Web: [kogia.ml.duke.edu/](http://kogia.ml.duke.edu/). For more information, call Caterina D'Agrosa at 252/504-7530. — A.G.



### Extreme Deep: Mission to the Abyss

In the depths of Earth's oceans, there are many unusual life forms — from giant red-tipped tapeworms to clams larger than dinner plates.

You can delve into this mysterious world at the “Extreme Deep: Mission to the Abyss” exhibit at the N.C. Museum of Natural Sciences.

The traveling exhibit, on display until May 6, includes a life-size replica of the deep-sea submersible, *Alvin*. Visitors can step inside the submersible and simulate a three-mile dive below the surface.

In the shipwreck area, you can explore a model of the *Titanic* and footage of the famous ocean liner. You also can get a peek at a model of the German warship *Bismark* and video footage of the wreckage of an ancient Roman vessel.

For more information about museum hours and admission prices, visit the Web: [www.naturalsciences.org](http://www.naturalsciences.org) or call 919/733-7450. — A.G.

## Deaton Earns Clean Marina Flag



Deaton Yacht Services of Oriental is the first marina in North Carolina to be sanctioned to fly the Clean Marina flag.

To earn the designation, the boatyard, owned and operated by Bob Deaton, voluntarily completed a comprehensive checklist that was developed by the N.C. Marine Trades Services (MTS) and the N.C. Division of Coastal Management. The checklist covers pollution controls, safety issues and hurricane preparedness plans.

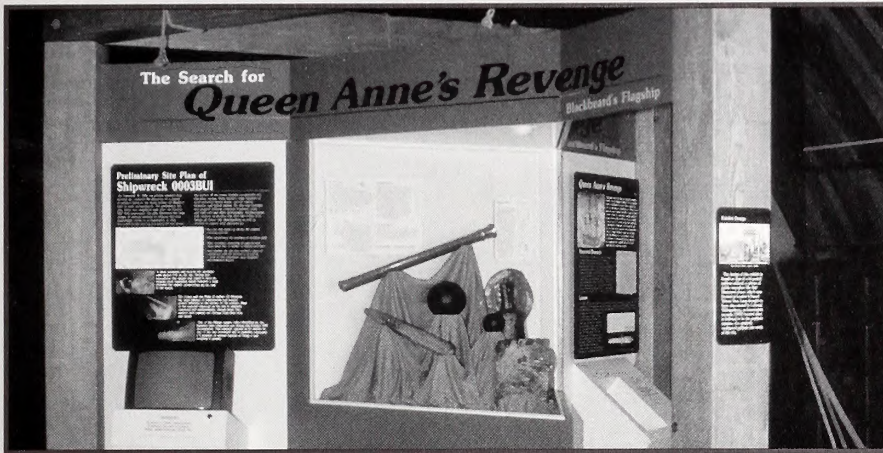
“The flag lets boaters know that they run a clean operation. The successful completion of the checklist indicates that Deaton Yacht Services is using sound management and operational practices to safeguard the environment,” says Wendy Lanimer, an MTS spokesperson.

Clean Marina is a nationwide program developed by the National Marine Environmental Education Foundation, a nonprofit organization that works to clean up waterways for better recreational boating. The foundation encourages states to adapt the program to fit their own needs.

The N.C. Clean Marina program partners also include North Carolina Sea Grant, the North Carolina Trade Association, N.C. Big Sweep and the U.S. Coast Guard Auxiliary.

For information about the program, contact Lanimer at 910/962-3351. — P.S.





Diane Henry

## Blackbeard Artifacts on Display

In 1996, divers brought up the first artifacts from Blackbeard's famous flagship *Queen Anne's Revenge*.

Those artifacts, which included a bell, pewter plate and cannon balls, are on display in a traveling exhibit at the N.C. Maritime Museum in Beaufort until May.

You also can see navigational and medical instruments found on the infamous pirate's flagship at the museum's permanent Blackbeard display that is open year-round.

To make more space for Blackbeard's artifacts and more effectively curate the

collection, the museum is renovating space in another building at the Gallants Channel site in Beaufort.

Some restored artifacts will be on view there on a limited basis.

For more information, call 252/728-7317 or visit the museum's Web site: [www.ah.dcr.state.nc.us/sections/maritime](http://www.ah.dcr.state.nc.us/sections/maritime).

To find out more about Blackbeard, *Queen Anne's Revenge* and related materials, click on: [blackbeard.eastnet.ecu.edu/main.html](http://blackbeard.eastnet.ecu.edu/main.html), or [www.ah.dcr.state.nc.us/qar/](http://www.ah.dcr.state.nc.us/qar/).

— A.G.

## Sign of the Times

Travelers in North Carolina are becoming more aware of their environmental whereabouts — and the importance of water quality — thanks to a partnership between two state agencies.

The N.C. Department of Environment and Natural Resources (DENR) received nearly \$150,000 from the N.C. Department of Transportation (DOT) to install highway signs that designate river basin boundaries along major roads and tributaries from Manteo to Murphy.

The river basin signs are part of DENR's "Know Your Ecological Address" program, designed to increase the public's understanding of their connection to natural systems. The 2000

state highway map highlighted the river basin boundaries and provided a toll-free number for additional ecological information.

According to Anne Taylor, director of the Office of Environmental Education, "No matter where you are in North Carolina, you are in one of the state's 17 river basins."

River basin signs already have been installed in the Neuse, Cape Fear and Tar-Pamlico river basins. Once the statewide program has been implemented, officials hope to pursue agreements with neighboring states to extend the identifying sign program throughout river basins that cross state lines.

— P.S.

## High Point Teens Win Ocean Bowl

Southwestern High School of High Point took top honors in the 2001 North Carolina Ocean Science Bowl. The first-place win means that the team and coach Florence Gullickson will advance to the National Science Bowl Tournament in Miami Beach April 2-3.

In a close second-place finish was the three-time state champion, Walter Williams High School in Burlington. Team members and coach Leslie Haines earned a cruise on the marine research vessel *Cape Hatteras*.

The third place team was from Washington High School in Washington, coached by Clay Campbell.

The top three teams each won a saltwater canoe trip donated by the N.C. Coastal Federation.

Eighteen teams competed in the fourth annual regional event, held Jan. 28 at the University of North Carolina at Chapel Hill's Friday Center.

The Ocean Science Bowl was inaugurated in 1998, The Year of the Ocean, as a way to re-energize precollege educational programs in the marine sciences.

The N.C. Ocean Science Bowl is coordinated by the Consortium for Oceanographic Research and Education (CORE), which includes NC State University, East Carolina University, the University of North Carolina at Wilmington and the University of North Carolina at Chapel Hill. Support also comes from North Carolina Sea Grant, the UNC Math and Science Education Network and Centers, the N.C. Coastal Federation and NC State's Science House.

— P.S.



WAVANSKE





# FISHING FOR CREDIT: ECU Students Explore Lake Mattamuskeet

By Pam Smith • Photographs by Michael Halminski

A dissonant chorus of alarm clocks pierces the predawn silence and bounces across the dark surface of the pond beside the Mattamuskeet Lodge. Minutes later, a flashlight procession rings the water's edge, and muffled voices become more distinguishable.



“We caught an eel,” a voice calls out with decided excitement. “There’s an eel in the trap we set last night.”

That’s good news to Roger Rulifson, East Carolina University professor of biology and director of the Field Station for Coastal Studies at the Lake Mattamuskeet National Wildlife Refuge. He’s hoping to begin research to help pinpoint — and control — a parasite that is taking a heavy toll on the once abundant eel fishery.

But he’s put his own research interests on the back burner this weekend. He and ECU colleague, Steve Norton, have taken 16 fisheries and marine biology students to the famed Hyde County refuge for field training in fisheries techniques.

Here, they’ll put into practice textbook methods they’ve studied. They’ll work in teams to gather data on such things as water quality and fish distribution.

For many of these university seniors and grad students, this is their first hands-on experience with fishing gear. Understanding

how nets and other equipment are used is essential for those planning careers in fisheries resource management, Rulifson explains.

First off, they learn that fisheries-related careers demand long hours of hard work.

Their “workday” begins at 6 a.m. with the first of the six daily water samplings at several sites on the pond, lake and Pamlico Sound. They won’t complete the scheduled tasks until they have set, retrieved and reset gear six times, recorded each catch, shared and compared observations from the day, and organized data. Lights out could be midnight or later.

The Mattamuskeet experience will be the basis for required end-of-term scientific papers — the best of which will be submitted to U.S. Fish & Wildlife Service (USFWS) for annual collection records.

The 50,000-acre Lake Mattamuskeet Wildlife Refuge is managed by the USFWS. A 1994 agreement allows ECU to use the lodge as a field station for studying wetlands, watersheds, estuaries and sounds — and how

they are affected by coastal growth and development.

The lodge and refuge have been the base of operation for long- and short-term research projects by scientists from ECU, North Carolina State University, Notre Dame University and Arizona State University. Their studies reflect the biodiversity of the refuge.

“With five national wildlife refuges and two state parks in the area, the field station at the lake is the perfect place for training students in a variety of academic disciplines. This area is bursting with potential,” Rulifson says.

Various attributes — the largest natural lake in North Carolina; acres of marsh, timber and crop lands; location on the Great Eastern Flyway of migratory waterfowl; proximity to barrier islands; and long history of civilization — add up to a rare combination of educational opportunities for students and faculty.

*[Future use of the historic lodge may be in jeopardy because of structural problems. See page 11 for details.]*

*Continued*





ABOVE: Students work quickly to move fish from nets to waiting tubs. The field study will provide a variety of species for lab work at East Carolina University.

## Immersed in science

For his part, Rulifson focuses on fishery biology and fisheries management, while Norton looks at fish ecology and physiology.

“Researchers must know how to catch fish, and managers must know the biological basics,” Norton explains.

Their differences yield dividends for the students who find themselves on a weekend totally immersed in applied science at the refuge.

Before breakfast, the students already have completed the first round of water quality

data collection near the lodge.

Now, with gear packed into a van and pick-up truck, they head down the unpaved road that follows the canal seven miles from the lodge to the Pamlico Sound.

A petite brunette — nearly swallowed whole by waders — joins classmates walking a seine net into the near-shore waters of the sound at the mouth of the canal. Other students are dipping black water into coolers that will serve as holding tanks for the morning catch. Still another group is recording water quality data — location, time, tidal information, water depth, turbidity, pH, salinity, oxygen,

sediments, conductivity, and water and air temperatures.

Later, they’ll match the data with the list of fish caught and the type of gear used at each site.

The students are having a difficult time pulling the net to shore in the shallow sound water. The tide is out, and the nets are weighted down with organic material — decaying grasses and shrubs that were deposited by hurricane-related flooding in 1999.

In spite of the difficulty, the seine has captured a fair sampling of fish — anchovies, kingfish, gobies, skillet fish, silver perch, croaker, red drum, flounder, a pinfish with a leech on its tail, and a mullet without a tail.

It’s a teach-as-you-go situation for Rulifson and Norton.

Rulifson points out mouth characteristics of two fish. “If the fish has an underbite, it’s a bottom feeder; if its mouth is turned up, it’s a surface feeder,” he explains.

The students continue to toss the fish into the waiting containers, calling out the litany of common names. In response, Norton chants the biological nomenclature. “Common names vary from place to place. In some places a skillet fish is any fish that can fit in a pan,” Norton says.

Back at the lodge workroom, the students work quickly to separate, bag and refrigerate portions of the catch. Rulifson and Norton will have plenty to share for lab work back at ECU — and the weekend is far from over.

“We prefer to use fresh-caught specimens for research,” Norton says. “Prepared and preserved ‘bought’ specimens may be tainted by chemicals.”

## Testing gear and stamina

Over lunch, the students talk excitedly about their work. Purvi Mody, a senior majoring in ecology education, says, “You can’t get this kind of experience in a classroom. I want to learn the tools for fisheries management so I can bring the skills to developing countries after I graduate.”



She won't be disappointed with the afternoon schedule meant to test gear, stamina and some preconceived notions.

At the out-take canal side of the Point on Lake Mattamuskeet, students fight a steady wind and strong current to pull in an experimental gill net they had set earlier. The net has five sections, each with differently sized mesh openings from one-inch to five-inch stretched mesh. They will inventory the catch according to mesh size.

No matter what size the mesh, they discover it's often difficult to extract the fish from gill nets. The gar are fierce fighters and weave themselves into mesh openings with their needle-shaped noses. Some can be removed only by snipping the net.

Gar, which run in both fresh and salt waters, top the inventory list for this collection time and site. One fish measures better than 86 cm. Bowfin are second in abundance.

Both are air breathers and can adapt to low oxygen levels in water because they surface to breathe, Norton explains. Their swim bladders serve as lungs to absorb and release oxygen. "It's a primitive adaptation of fish," he says. The swim bladder is for buoyancy, filling or releasing gas as fish change depth.

Talk about adaptation. The salinity is zero, yet the catch includes ladyfish and blue crabs — both saltwater species. Moreover, the canals that lead from the lake to the sound are fitted with flap gates to keep brackish and saltwater — and salt-loving creatures — from entering the freshwater lake environment.

"Obviously some critters get through at some stage of their lives and thrive in freshwater," Rulifson says. As though to prove the point, a blue crab, measuring about eight inches from point-to-point, stubbornly clings to the net.

"No commercial crabbing is allowed at Lake Mattamuskeet, and recreational crabbers can't use crab pots here," he adds.

Water testing continues as a fyke net is set on the opposite side of the point, where the current is not as swift. Rulifson describes the fyke net as a hoop net with wings.

This method of fishing dates back to biblical times, Norton tells the students. It's been modified according to geographic region and culture. "It's definitely multicultural and multinational in origin. The material will vary according to what's available. In the tropics, they might use reeds, in South East Asia, probably bamboo."

The catch is slim this time.

The students reset the gill net and move on to an inner canal to explore the confined, brackish canal water environment. The wind has died down.

Rulifson and Norton expect some stratification of the water column, with freshwater at the surface.

The pH of the water tells something about the water source and the kinds of fish that can live there. Basically, they are standing in a peat bog.

Though not bountiful, the fyke yields some additions to the day's inventory — a bluegill or bream, war mouth (another type of sunfish), and a three-inch threadfin shad.

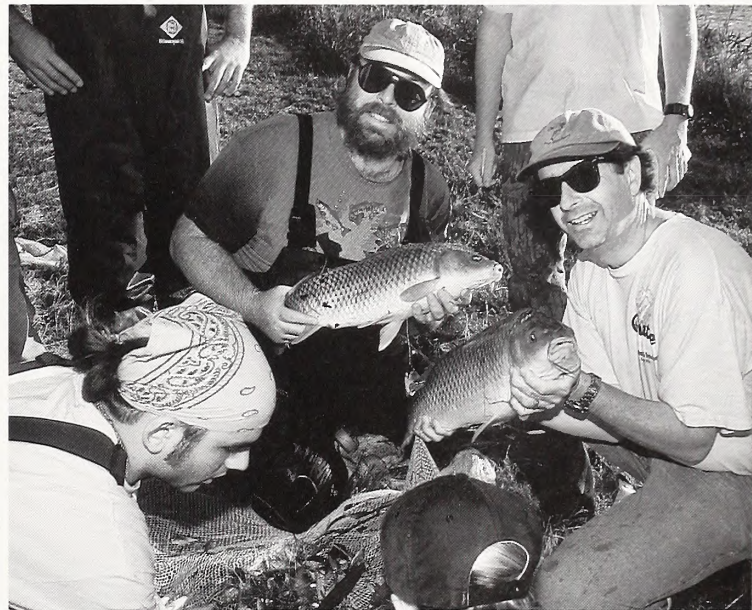
Shadows are growing longer, but there still is work to be done. The group returns to the lodge. While one team sorts and stashes the catch, another moves to sites around the pond to conduct water quality testing.

On a flood control structure near the lodge, Jason Reuter, a graduate student in

*C o n t i n u e d*

BELOW: Steve Norton and students are pleased with the catch.

BOTTOM: Handling a hoop net in shallow canal waters can be tricky.







TOP: Students walk a net through near-shore waters of the Pamlico Sound.

BOTTOM: The task of sorting and recording each catch is time-consuming.

marine biology, is collecting water quality data. He did his undergraduate studies in sociology and ultimately plans to pursue a doctorate in coastal resource management. "I want to make the connection between marine biology and policy," he says.

Reuter says the field study is helping him hone research methods. "Tonight, we'll get together to chart all the data we have gathered today. We'll put it on the board and look for anomalies. We're using different kinds of water-sampling equipment to test the same water quality variables, and the numbers may be different. We'll discuss why this happens, and determine what equipment and method may be the best for these purposes."

The nightly wrap-up sessions ensure that all students will have the same data set for their end-of-term projects.

The weekend also is teaching students that field work often requires a bit

of creative improvisation.

"Duct tape. Always carry duct tape," Reuter advises. "To get a water sample from this point on the flood control structure, we taped a paper cup to the end of a pole to reach the water."

### Call it a wrap

The kitchen crew is swinging into action to prepare a spaghetti supper for the tired and hungry group. But before dinner is served, a skeleton crew will make a run to the Point to pull the gill net.

A small number wait in the workroom,

ready to process their catch. They informally assess the weekend activity and share thoughts about the kind of research they have been scoping out at the refuge.

Charlton Godwin, a senior marine biology student, is interested in doing a fish control/water control study. He intends to study the biological and water quality effects of the recent retrofit of the flap gates used to keep saltwater and fish from passing into the freshwater lake. It won't be the first study for him. He's looked at the aging of Atlantic needlefish from the lake, reading rings in the otoliths, or fish earbones.

The outer door bursts open, and students explode into the room talking all at once about the catch of the day — a 46-cm largemouth bass. They returned the fish to the lake to delight another angler on another day.

A grinning Rulifson affirms. "It was a trophy catch. Only wish I had him at the end of my fishing rod."

By Sunday, students and faculty are calling the weekend a success. The gear has worked, over 40 different species of fish are recorded, and the data sets are complete.

"It has been a great weekend for the students and instructors. Every year we have different 'war stories' to tell. This year it will be the rain and wind, trophy bass, and giant gar," Rulifson says.

"And what a great team-building exercise! These students have gone through four years of college, had each other in the same classes, and never knew their names. Now, they'll have a lifetime of memories about these fellow students and activities from this one, short weekend."

David Gloeckner, a graduate student, agrees. Now a fisheries port agent in Beaufort for the National Oceanic and Atmospheric Administration (NOAA), he has served as a NOAA observer on an ocean-going vessel.

Gloeckner says the Mattamuskeet weekend successfully imitated life in the field. "We've been cold and sleep-deprived. Only thing missing — 20-foot seas." ■



## Historic Lodge Closes for Repairs

Concern over structural deterioration in sections of Mattamuskeet Lodge prompted the U.S. Fish & Wildlife Service officials to close the historic building to the public. Structural repairs could cost \$2 million and take a minimum of two years to complete.

Meanwhile, Roger Rulifson, director of the East Carolina University Field Station for Coastal Studies, is working with the federal government to secure travel trailers or mobile homes as living quarters for students and researchers.

Rulifson is hoping the alternative facilities will be in place this spring, allowing the program to continue to operate, albeit at reduced capacity.

The dorm, kitchen, classroom and lab space in the ECU wing of the lodge could accommodate up to 27 individuals. Since \$1.2 million federal and state funds went into safety and cosmetic repairs to the wing in 1996, the field station has logged about 3,500 "person nights" and has provided logistic support for more than 20 research projects.

Chris Batsavage, a specialist with the N.C. Division of Marine Fisheries at Manteo, attests to the value of the field facility. He experienced Mattamuskeet as an ECU graduate student — once as a student participant and twice as a teaching assistant. "It's the real world, from learning techniques for biological monitoring to using equipment and tagging fish," he says.

The refuge is an ecological laboratory where students gain skills they can take down many career paths, not just fisheries management, Batsavage says. "This experience enables them to bring the newest techniques and science to the job," he adds.

In addition to the lodge being the base of operation for teaching and research, a continuously recording

weather station and weather camera operates from the top of the observation tower — the old pumphouse smokestack.

The south wall of the lodge that supports the smokestack was identified as a possible hazard in a structural engineering survey in November 2000.

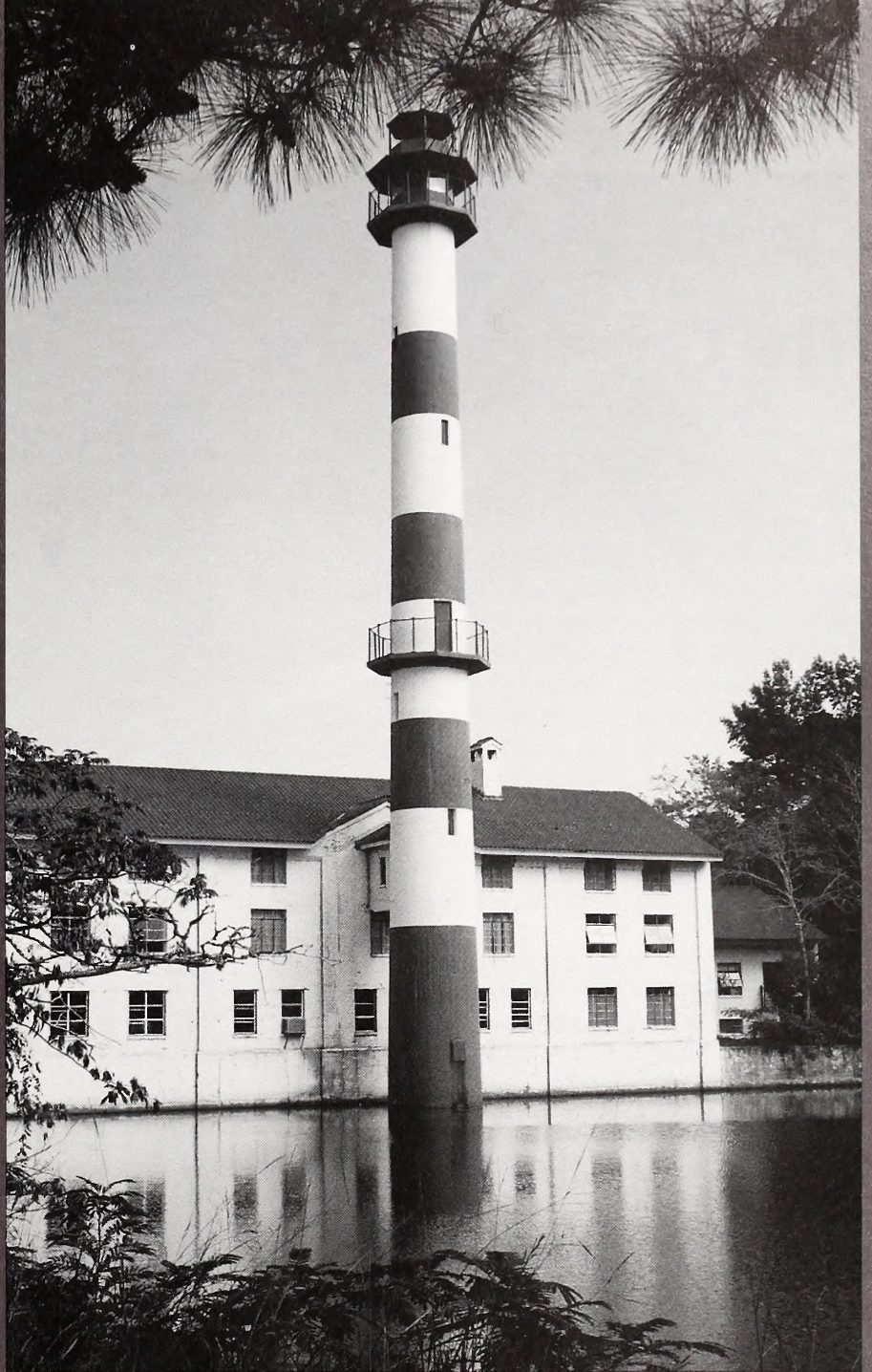
According to Rulifson, this is the side with the largest expense — the dining hall downstairs and the ballroom upstairs. The metal floor support beams in this area are bolted directly to the weakened vertical support beams, which reduces the load bearing capacity of the ballroom floor. The observation tower is attached to the south

side of the building in the center of the ballroom. High winds cause the tower to sway slightly, contributing to the deterioration of the support column.

"The building is not in danger of collapse, but there is concern about the load-bearing capacity being reduced from the original building design," Rulifson says.

The ECU dormitory wing, he adds, is structurally sound because of a different support design and interior load-bearing walls.

University and refuge officials are hopeful that Congress will appropriate the renovation funds in this fiscal year. — P.S.



Doug Smith



# The Great Dividers:

## OLD-FASHIONED DRAWBRIDGES DWINDLING ALONG COAST

By Ann Green

**P**erched in a tiny wood building high on the edge of the Wrightsville Beach bridge, Nancy Cayton focuses her binoculars south toward the Intracoastal Waterway.

As she spots a large sailboat, she's interrupted by a radio call. The captain asks her to delay the opening until he arrives.

"If you can be within the half-mile marker, I can hold," responds Cayton, a bridge tender at the Wrightsville bridge.

After seeing that the sailboat is going to make the marker in time, Cayton lets the other captain know that he will have a four-minute delay.

As the two large sailboats near the bridge, she bends over a console that controls electronic devices, stretching her elbows up like a flying bird.

After pushing several buttons, a siren horn sounds. Gates drop down to stop traffic to and from the beach. Then the bridge splits in two pieces. Within a few seconds, Cayton waves as a 25-foot sailboat from the Isle of Palms, S.C., motors through the bridge opening. The boat continues on the dark green water of the picturesque Intracoastal Waterway past pastel-colored buildings and marinas.

"I talk to people all over the United States," she says. "It is an interesting job."

Every hour, Cayton opens the creaky green bridge for recreational boat traffic.

As the bridge splits, the gears grind. The traffic halts on both sides of the 90-foot horizontal span. "If a malfunction occurs, I have to go to the old way and open the bridge manually," she says.

About four minutes later, Cayton stands at the console and closes the bridge. A siren goes off five times. The bridge sections fit back together. The gates open, and traffic roars by. Access to and from the island is restored.

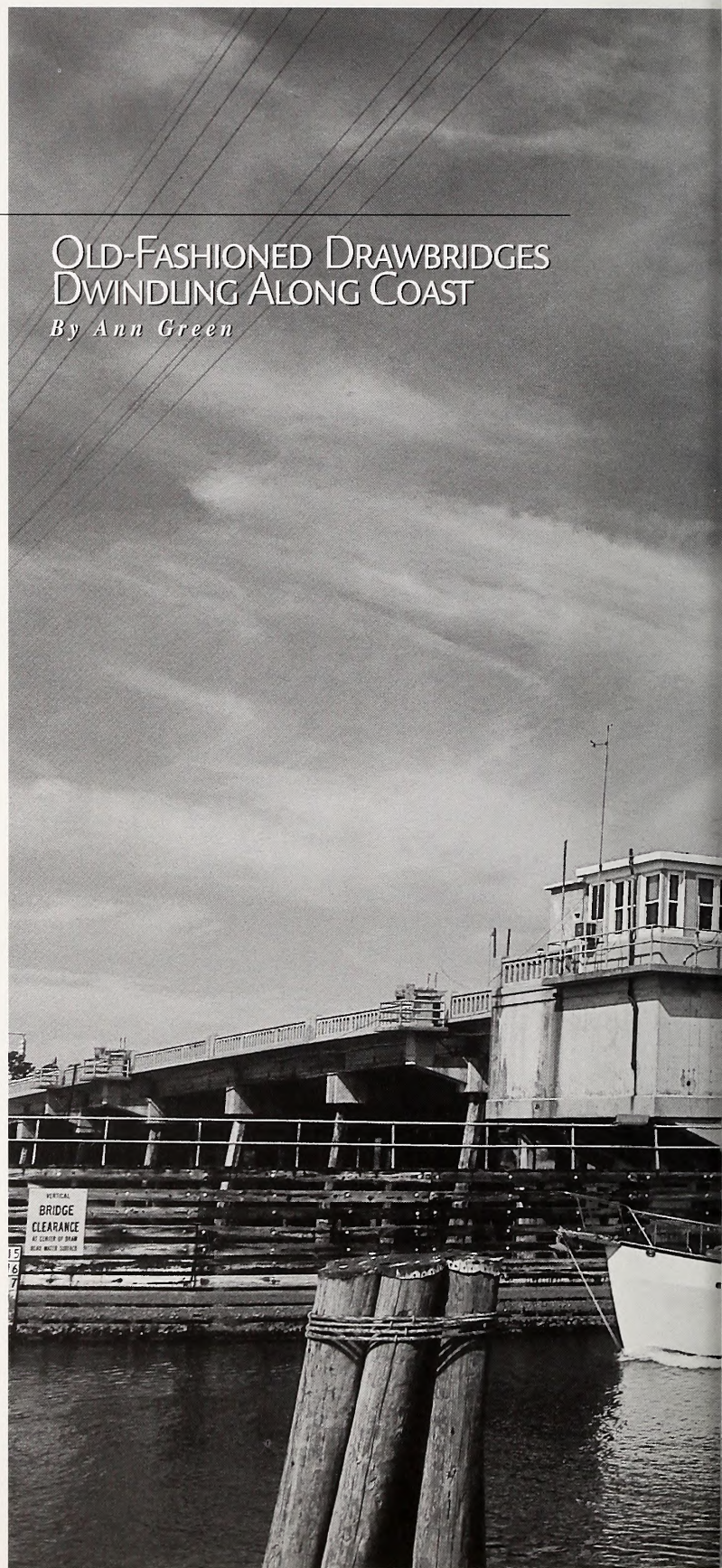
The Wrightsville Bridge, which straddles the Intracoastal Waterway, is one of only 12 coastal drawbridges still maintained on North Carolina's coast by the N.C. Department of Transportation.

Built in 1957, the steel and asphalt drawbridge also opens any time a commercial boat comes through.

"There's not much commercial traffic here," says Cayton, who is dressed in jeans, a jean jacket and tennis shoes. "We get only a few tugs and trawlers this time of year."

As a bridge operator for over 20 years, Cayton has seen her share of recreational and commercial boats.

*Continued*



*The Wrightsville Beach bridge opens wide. Photo by Scott D. Taylor*







## SEASONAL MIGRATION

The busiest seasons are the fall and spring when large yachts and sailboats owned by “snowbirds” crowd the waterways as they migrate to and from Florida, the Bahamas and other southern points.

“We can have anywhere from one to 24 boats,” says Cayton while watching boat traffic from a building on the bridge’s edge during a busy fall day. “Today we had 12 boats come through at one opening.”

As the population in Wilmington has exploded, the number of cars and trucks rattling across the bridge has increased.

“There is a lot more traffic than there was 20 years ago,” she says. “It has doubled or tripled.”

The large amount of vehicular traffic — more than 400 cars waiting during one opening — has created wear and tear on the span. Because of a cracked brass bearing on the western half of the 44-year-old span, the Wrightsville bridge was closed for vehicular traffic, but not pedestrian traffic, on several nights in February.

Before closing the bridge, bridge tenders give aging bridge parts regular boosts of lubricating grease. On a recent day, a bridge operator in a white suit stood beneath the bridge on a ladder and greased the bridge’s gears. Earlier, Cayton had lubricated the gate and the trunion — the balance that keeps the bridge open.

“We each have a section to grease,” says Cayton, whose duties include washing the building’s windows and blinds.

## REPLACEMENTS CONSIDERED

Although no drawbridges are scheduled to be replaced at this time, DOT is conducting preliminary feasibility studies on the Sunset Beach and Beaufort bridges to assess whether the bridges need to be replaced with high-rise structures, says Lin Wiggins, director of DOT’s Bridge Division.

The Beaufort Board of Commissioners supports a DOT bridge improvement plan for a new thoroughfare and bridge for U.S. 70 East, according to a recent resolution.

In addition, the town board wants to keep the Grayden Paul drawbridge or a mid-rise fixed span at the present location so local traffic will have access to downtown Beaufort, according to Corinne Geer, interim town manager. “We are also working with the Coast Guard for amended scheduled openings every 30 minutes,” she adds.

However, DOT doesn’t see any advantage in just building the thoroughfare and not replacing the structure, says Wiggins.

“We routinely get complaints from both sides on the opening schedule for the drawbridge,” he adds. “There is also the continued maintenance and operation cost. Eventually the bridge will have to be replaced. Nothing lasts forever, especially a large structure with moving parts.”

For the past 20 years, the Sunset Beach Association has opposed proposals for a high-rise bridge at Sunset Beach. The bridge is the only link between mainland Brunswick County and Sunset Beach, the state’s westernmost and southernmost barrier island.

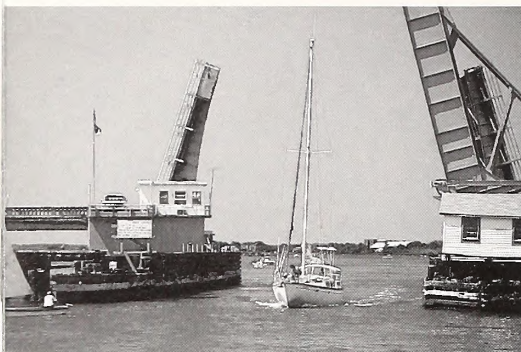
However, DOT supports building a new bridge.

“DOT’s recommendation for a high-rise replacement for Sunset Beach is based on future operating costs of movable span structures and the conveyance of both vehicular and maritime traffic,” says Wiggins. “It is a very difficult operation to balance openings for vehicular traffic needs and maritime needs as well.”

Built in 1959, the Sunset Bridge is the only floating pontoon bridge in North Carolina. A view from the one-lane bridge offers a wonderful visual contrast — a seagull fluttering over a sea of marsh grass on one side and a man fishing on wood pilings near a trailer park on the other.

On a recent day, bridge tender Tom Hewett walks down steep spiral steps to open the bridge, which rests on a barge. As he pulls a cable, the bridge separates from the roadway and makes a 90-degree turn as it meets the pilings in front of the roadway.

As each boat goes through, Hewett jots down the boat’s name, direction and time of entry so he can have a record for the Coast Guard.



### TOP TO BOTTOM:

- *The Beaufort bridge opens for boat traffic.*
- *Nancy Cayton, bridge tender at Wrightsville Beach, is at the controls.*
- *The Cape Fear Memorial Bridge only opens upon a signal.*
- *Surf City’s bridge swings open.*

Photos by Scott D. Taylor



"The Coast Guard needs records for missing and stolen boats," says Hewett.

After the last boat — a sailboat from Canada — clears the opening, Hewett adjusts the cable. The bridge swings back around and fits into the roadway like a puzzle piece.

"It usually takes 10 to 15 minutes for an opening," says Hewett, who saw a busy fall.

"I have seen some of the biggest pleasure boats ever going through," says Hewett. "I have seen boats that cost from \$8 to \$10 million."

## OPEN 24 HOURS

Pontoon and swing bridges on North Carolina's coast operate round-the-clock.

As Diane Edens surveys the boat traffic around the Surf City bridge near Topsail Island, it's pitch dark. Only a few boats twinkle on the churning waters of the Intracoastal Waterway.

"One good thing about the job is that you see the sun come up here," says Edens, who has been at work since midnight. "You also see the full moon shine on the waterway."

On this morning, the sky blazes a bright red. Again, there is also a distinct visual contrast between the two sides of the bridge — a trailer park and a muddy brown marsh on one side and piers and houses on the other side.

Edens, who has been tending the historic Sears Landing Bridge since 1978, was the first female bridge tender in North Carolina.

"It was a challenge the first time," she says. "Nobody worked here but men."

Now many of the bridge tenders are women. It's a job that is quite hectic.

Edens sits in front of a console in a tiny wood-paneled room decorated with a television and photo of her white Pekinese. She watches the boats and then answers a call from the National Weather Service in Wilmington.

"They want to know what the direction of the wind is," says Edens. "We have a wind gauge instrument."

Edens also monitors the radio for information from the rescue squad, Coast Guard and boats.

"You have to be alert and listen to all the radios," she says. "Sometimes, we get a call from the rescue squad. We close as soon as we can."

The swing bridges also shut down during hurricanes.

"If I am working, I am usually the last to leave the island," says Edens. "I have to take down the gates and put chains at each end of the bridge to keep it from moving. I also have to lock up and turn the electricity off."

On rare occasions, the bridge is shut down for a boat accident.

Several years ago, a barge hit the fender system — wood pilings that protect the bridge substructure.

"The dredging outfit came through this building and threw me on the other side of the room," says Edens. "It yanked every connector off and pulled the cable through the concrete. I wasn't hurt, but it was not a good feeling."

Bridge tending is often a solitary job. The only time the operators communicate with other people is when they radio a boat captain or another bridge tender relieves them.

A few minutes before Eden's graveyard shift is over, Faye Phelps comes in.

Phelps has tended the Surf City bridge for 10 years.

"It is a good job," says Phelps. "You are more or less your own boss. Nobody bothers you."

Most of the time, she says the bridge openings and closings run smoothly.

"Ninety-eight percent of the boat captains are good," she says. "But, every once in a while you do get someone that is hard to get along with. Some won't answer the radio. That makes it tough to help them through."

As Phelps scans the waterway with her binoculars, it is clear of boats. But she's enjoying the view.

"You can always enjoy the pretty sights," she says. "One time, we even had a drawbridge from Edenton come through on a barge. The owner of Barefoot Landing near Myrtle Beach couldn't get a bridge built so he bought his own." ☐



## BRIDGING THE DISTANCE

Along North Carolina's coast, there are a variety of drawbridges — from the two-lane bridge that connects Straits to Harker's Island to the towering Memorial Bridge over the Cape Fear River in Wilmington. Here are some other bridge tidbits from the N.C.

Department of Transportation:

- The oldest operating drawbridge, which was built in 1931, is on U.S. 158 over the Pasquotank River in Elizabeth City.
- The newest bridge is a dual structure that was built in 1972 over the Pasquotank River.
- The busiest drawbridge for boat traffic is over the Alligator River in Tyrrell County. In 1999, 5,406 vessels went through the bridge opening.
- The state's tallest drawbridge is Wilmington's Memorial Bridge with a clearance of 65 feet.
- The shortest drawbridge is on U.S. 17B over the Dismal Swamp in Camden County.
- For more information about drawbridges, visit the Web and follow the links to bridge maintenance and drawbridge schedules: [www.doh.dot.state.nc.us/operations/](http://www.doh.dot.state.nc.us/operations/).

TOP: *Sunset Beach Bridge*

Photo by Al Patterson



B y P a m S m i t h

Making it  
right with  
nature



*American Oystercatcher*  
Walker Golder



**N**orth Carolina is among the fastest-growing states in the country. The latest U.S. Census Bureau statistics show the state's population has grown 21 percent since 1990 — much of it clustered within the coastal region.

Land disturbances and loss of habitat that accompany growth have become major threats to the state's natural resources. As coastal development continues, so does the work of grassroots groups looking to protect life-giving ecosystems that are unique to our saltwater marshes, tidal creeks, barrier islands, and sound and ocean waters.

Some efforts yield big environmental dividends; some, incremental gains. But as far as Paul Foster and Walker Golder are concerned, any win is sweet.

The pair of New Hanover County natives guide separate organizations with similar missions — providing decision makers with convincing scientific reasons to balance a healthy environment with a healthy economy. Their paths frequently converge as they go about the business of protecting and conserving parcels of ecologically important coastal real estate.

Foster, a coastal developer, is the founder and president of the Northeast New Hanover Conservancy, which has mapped out a 20-square mile area of responsibility. The conservancy protects more than 1,700 acres of coastal wetlands located within three tidal creek watersheds and flooded salt marsh surrounding Figure Eight Island — a primary nursery area for shellfish and finfish.

"This salt marsh produces more goods than the best wheat field in the midwest," Foster says. Sustaining high water quality is crucial to such a productive environment.

Based in Wilmington, Golder is deputy director for the North Carolina State Office of the National Audubon Society. The society protects the Coastal Island Sanctuary System — 20 islands from Currituck to Brunswick counties that provide habitat for diverse populations of seabirds, wading birds and migratory birds.

"Protecting habitat is essential for birds and other wildlife. Audubon accomplishes this through acquisition, active protection and management, education and advocacy," says Golder, a marine biologist.

Walter Clark, North Carolina Sea Grant coastal law and policy specialist, says, "Acquisition is important because it gives managers the ability to control activities in a specific area. It can be the key to protecting essential habitat."

Acquisition can be in the form of outright ownership or the purchase of development rights in the form of conservation easements, he explains.

## building on history

Audubon's history reaches back nearly a century in North Carolina. Its first sanctuaries — Royal Shoal and Legged Lump, located near Ocracoke Island — were purchased in 1907. The islands were documented as being home to the largest colonies of Least Terns in the eastern U.S.

Today, Audubon's North Carolina sanctuaries offer protected nesting sites for hosts of other species, including pelicans, herons, egrets, ibises, terns, skimmers and gulls. Its Pine Island Sanctuary — about 6,000 acres on the northern Outer Banks and Currituck Sound — includes some of the state's most important habitat for wintering waterfowl and other birds.

Golder says, "Habitat is the key to wildlife survival. It's critical to protect the remaining unspoiled natural areas — they just aren't making any more."

That's why he's excited about the Lea Island Conservation Initiative — a project that aims to protect the 200-acre barrier island and its 3,600 acres of tidal creeks and salt marshes.

Based on stringent scientific criteria, Audubon has identified the island complex as an Important Bird Area, or IBA. These natural areas hold significant numbers — or an exceptional diversity — of birds, and need to be protected to maintain healthy, stable and diverse populations.

Some 300 nesting pairs of Least Tern depend on the area. That's more than 25 percent of all that nest in the state.

The low-profile island complex also is home to black skimmers, American oystercatchers, piping plovers and scores of shorebirds. Dozens of loggerhead sea turtles make their way to the narrow barrier island each season. And, its surrounding waters are

nurseries for fish, shrimp and crabs and support thousands of birds throughout the year.

## setting wheels in motion

Last July, the General Assembly and then-Gov. Jim Hunt authorized the state to purchase the Lea Island complex as a State Natural Area, *not* a State Park. Accessible only by boat, it will provide sanctuary for birds, sea turtles and other wildlife, a living laboratory for scientists — and rare opportunities for nature lovers. While the state will own the island, Audubon will pay for and carry out all of the protection and management activities on the island.

Sea Grant's Clark notes that the arrangement balances public access and the protection of this unique habitat.

Golder must work with the state and the N.C. Coastal Land Trust to raise more than \$1 million to purchase about 40 lots from more than two dozen owners. He's hoping to tap a number of funding sources, including private donations and grants from national and state trust funds.

Most land owners have indicated approval of the natural area concept, one has donated his lots outright, others have agreed to sell their land.

For Scott Burkhead, a businessman from the Triangle, the decision to sell was easy. In the 1980s, he bought several acres on Lea Island, having fallen in love with its natural beauty.

"At one time I toyed with the idea of building a simple cabin with windmills and solar panels. But the more I visited, the more I thought it would be a shame to put anything at all there," he recalls.

When he heard of Audubon's initiative, he thought it would be the best possible use of the land — a natural legacy for all North Carolinians to enjoy and a safe haven for wildlife.

Burkhead plans to continue visiting what he calls "the only bit of sanity left between Figure Eight and Topsail islands."

Unlike Burkhead, who has had a continuing love affair with the island, many owners have not visited the island for a number

*Continued*





*The Lea Island marsh and those surrounding nearby Figure Eight Island are productive nurseries for finfish and shellfish.*

of years, Golder says.

Moreover, the history of the would-be sanctuary speaks to why chances of developing any of the lots are slim to none.

Less than a decade ago, two tiny islands — Lea and Hutaff — existed between Topsail and Figure Eight islands. In 1998, Old Topsail Inlet closed between them, creating one, long barrier island.

Hurricane Fran and subsequent hurricanes leveled the sand dunes. These storms, combined with years of erosion, have claimed the northernmost lots and two of the three houses ever built on the barrier island were washed away.

“We’re talking about serious overwash, even during small northeasters. That means it’s bad for people, but great for sea birds and turtles,” Golder asserts.

“This is a great chance to preserve one of the last undeveloped barrier islands on the North Carolina coast,” he says. “It’s one of the most exciting things I have done professionally, and I’m going to do all I can to make it happen.”

## **making things happen**

By Foster’s assessment, all the pieces seem to be in place for the success of Audubon’s Lea Island project, including strong citizen advocacy and successful collaboration with state and local agencies. And, the most critical element — good science.

Foster would know. “Let the science do the talking” has been conservancy dogma

since he and his late wife, CoCo, launched the citizen-based organization in 1982. Among the earliest settlers on Figure Eight Island in the mid-1960s, the couple understood the uncertain nature of living on a shifting strip of sand in the ocean.

Foster once told a reporter, “When you live on a barrier island, you shouldn’t put too much money into a house, and you shouldn’t fall too much in love with it.”

He followed his own advice and built two modest homes on the island — one overlooking the Intracoastal Waterway, and one with a magnificent view of the ocean. Last year, the ocean view got too close for comfort. After consulting with Spencer Rogers, Sea Grant’s coastal erosion specialist, Foster had the house moved 55 feet out of harm’s way.

He calls the move “the final retreat” from the natural forces constantly at work on any barrier island.

In the mid-1980s, as the pace of homebuilding on Figure Eight Island stepped up, Foster’s group engaged scientists from the University of North Carolina at Wilmington to conduct a baseline study of the shoreline erosion of Figure Eight Island. Measurements were taken monthly for more than two years. At the time, major shifts were occurring in the inlet throat — nearly a meter a day of beach was being eroded at the north end of the island.

Paul Hosier, UNC-W associate vice chancellor of academic affairs, recalls, “The ocean continued to eat into the shoreline until it was within a hundred feet of some homes. Then, suddenly, it slowed down and went the other way.”

Hosier and UNC-W coastal geologist Bill Cleary, a Sea Grant researcher, still study erosion on Figure Eight — assaulted by hurricanes and winter storms — to consider

how best to stabilize the northern tip with more dredging, and to identify compatible sand sources.

According to Foster, the long-term erosion studies help island homeowners understand the coastal processes and the need for shoreline nourishment. This spring, sand from nearby dredge spoil sites will be transported to Figure Eight oceanfront properties at the expense of the Figure Eight Homeowners Association. The association also has submitted permit applications to acquire sand from other sources.

But Foster is most proud of efforts by the Northeast New Hanover Conservancy to improve the water quality of Futch, Howe and Pages creeks, which flow through developing mainland subdivisions into the sensitive tidal marshes and the Intracoastal Waterway.

In 1986, the conservancy funded UNC-W biologists to begin studying an 800-acre tidal marsh the group acquired in 1985. Scientists conducted water quality, invertebrate and bird studies. The data established the near-pristine quality of the marshes between Figure Eight Island and the mainland — and led to an Outstanding Resource Waters designation by the N.C. Environmental Management Commission.

This conservancy water quality project was to become the model for The New Hanover County Tidal Creeks Project, established in 1995. UNC-W scientists now monitor *all* the creeks in *all* the county’s watersheds for pollution, algal blooms, and effects of tides and nutrient loading on water quality. The project is supported jointly by the county and the conservancy.

The water quality data collected over the years will give local officials a huge advantage as they develop plans to comply with new federal storm water management mandates for small municipalities.

## **seeing is believing**

On board his skiff, Foster navigates the clear waters of Marta’s Creek, past million-dollar beach houses, en route to some of his favorite places.

“This is church. This is where I talk to God,” Foster says, as he slows the boat to allow his passengers to fully absorb the



unfolding view. Diamonds of sunlight sparkle on the clear, shallow water, marking likely places for birds to swoop for a successful catch.

He makes a sweeping gesture with his free hand, "Essentially, the conservancy is the caretaker of the marsh. Good clamming. Great oystering. We could get out and fill a basket in no time."

Here and there on the Waterway, fishers are pulling in nets, and researchers are pulling in scientific equipment. Curious dolphins make synchronized leaps along the channel at a safe distance from human activity.

Just past Middle Sound, at Futch Creek, Foster again slows the boat to relate a story that underscores the ability of private citizens to make things right with nature — with the help of good science.

In 1991, the conservancy had added to its monitoring activities the polluted waters of Futch, Howe and Pages creeks. By 1993, UNC-W scientists had gathered enough data to conclude that Futch Creek *could* be cleaned up — just by removing a sand bar at the mouth of the creek to restore tidal flushing.

"Once tidal flushing was restored, bacteria levels went down, and Futch Creek soon was opened to shellfishing. It was the first to be cleaned up in North Carolina," Foster says with pride. "The shellfishing is as good as it gets — an abundance of fat, sweet oysters."

Heading back toward Figure Eight Island, signs of new development dot the mainland shore. Foster winces as he points out some development practices that contribute to the degradation of water quality, including lush lawns planted to the water's edge.

Good planning, he insists, dictates preserving at least 75 feet of the natural trees and shrubs along the shore to filter runoff from yards and paved surfaces.

"Trees are the perfect sink for rainwater. Save trees — and a major part of storm water control is taken care of," says Foster.

## practicing what he preaches

When I-40 opened the way to Wilmington, already scarce oceanfront property was gobbled up, and shore lots on the Intracoastal Waterway and tidal creeks quickly became endangered species.

Meanwhile, Foster was developing — and winning conservation awards for — Porters Neck on Futch Creek and the Intracoastal Waterway. His land-use practices include maintaining shoreline buffers and respecting natural wetlands to protect water quality.

"It's a lesson in how the population can have a positive effect on natural resources," Hosier says.

He paints a different picture of ongoing development nearby. It's not likely that, after three decades of tree clearing and lawns to the water's edge, long-closed shellfish beds there ever will be reopened.

Foster, now in his 80s, was well-schooled in doing things right, having earned his master's in planning and urban design at UNC-Chapel Hill on the GI Bill after World War II. He put the principles into practice in developing countries during his lifelong career in the U.S. foreign service. His wife, a Duke University graduate and nurse, shared each assignment. Soon after the couple retired to his native Wilmington, Foster began a second career as a developer. He quickly earned a reputation as being a stickler for practicing strict conservation methods.

He says he and his wife initiated the Northeast New Hanover Conservancy when they began to feel that the environmentally sensitive area around Figure Eight Island needed better environmental planning and design.

As with projects in developing nations, in the early days of the conservancy, the couple tried lots of things to see what would work, and then concentrated efforts on the successful ventures. Through the years, the grassroots organization membership has ebbed and

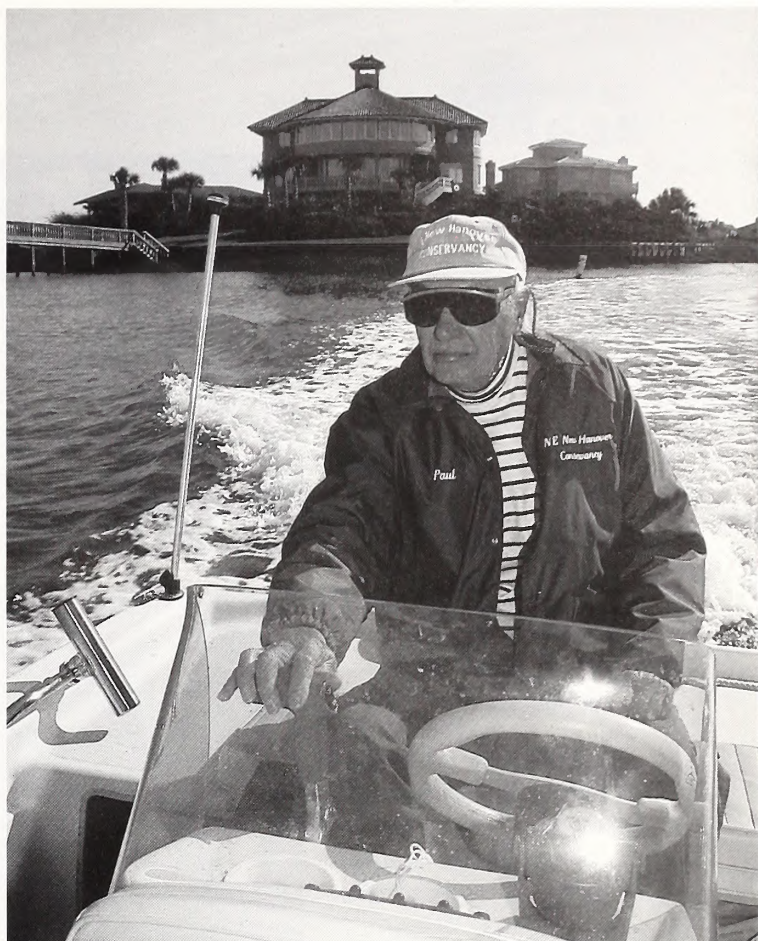
flowed at about 450 members.

Hosier believes the conservancy can claim a string of environmental credits, because, "Foster understands the need for scientific legitimacy, not just a good cause."

But Foster and Golder know that no one person can do it alone. Yes, individuals or grassroots organizations can identify projects and offer scientific data. But, they say, it's important to raise awareness and promote a culture of conservation in the community. They believe the voice of the people is essential.

Clark concurs. "The voice of the people often rings loud and clear from those who have a personal relationship with the land and water in the proposed protected area — and who know and trust the grassroots organization. The voice of the people can have a strong influence on public policy." □

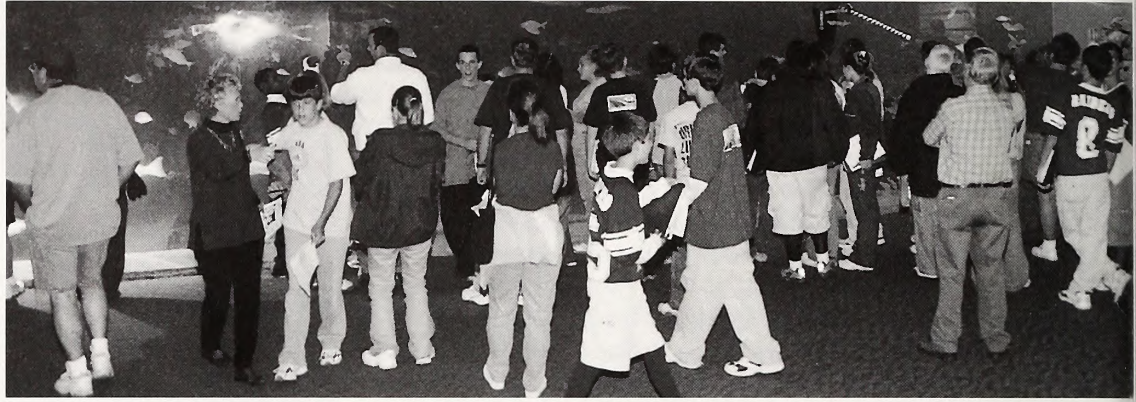
*For additional information about Audubon's Lea Island Initiative, contact Golder at 910/798-8376. For information on the Northeast New Hanover Conservancy, contact Foster at 910/686-0362.*



*Paul Foster is proud of the work the Northeast New Hanover Conservancy is doing to ensure coastal water quality in that region.*



PEOPLE &  
PLACES



*Clockwise from top:*

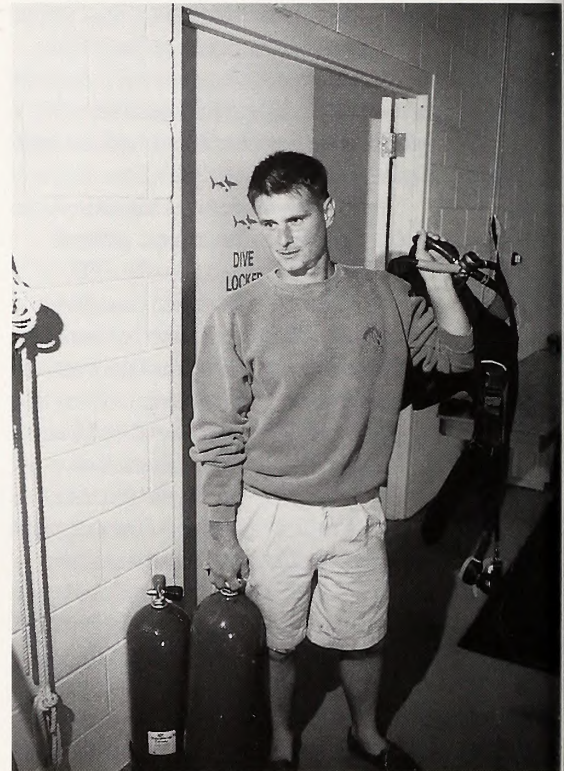
*The Graveyard of the Atlantic tank is a popular attraction at the N.C. Aquarium at Roanoke Island.*

*A diver gathers his tank and suit.*

*A diver at work often delights aquarium visitors.*

*Dive safety officer Pat Murphy writes a note from inside the tank.*

*Murphy joins volunteer Lou Blanchard topside of the tank.*





# Zen Diving: *Aquarium Divers Find Niche*

By *Katie Mosher*

Photographs by *Daryl Law*



It's a volunteer gig with a twist: Diving with saltwater fish, sea turtles — even sharks.

But Pat Murphy, dive safety officer at the North Carolina Aquarium at Roanoke Island, isn't looking for adventurers on an adrenaline rush. He quickly weeds out danger-seekers. Instead, he looks for divers with a Zen-like approach.

"In Zen diving, you feel what the animals feel in the water," Murphy says. "You are not a hunter. You are not a master. You are going in their space to do a job."

The aquarium tank diving experience doesn't compare to open dives, nor to generic pool dives. "These are animals that you could not approach in the wild," says Murphy, who sometimes will strike a Buddha position in the tank. "I could sit in the tank for hours — if I had enough air — and just watch the fish."

"Murph" and his corps of volunteer divers don't even flinch when a green sea turtle tries to nibble at the air bubbles rising just above their heads. "Whenever you exhale, he's there," says Gerald George, who started volunteering last summer.

The largest tank in the Manteo facility, "The Graveyard of the Atlantic," holds 285,000 gallons of saltwater and features a scale replica of the famed *Monitor* shipwreck. The tank also is home to about a half-dozen sharks. That can be unnerving at first, some volunteers admit.

*Continued*

*Preparations for a dive are serious business for aquarium staff and volunteers.*



Others, like Pete Marriner of Hertford figured Murphy had a plan. "I didn't have time to get scared — I was trying to keep up with Murph," Marriner says of his first time in the tank during training.

Overall, the divers quickly learn that nurse sharks and sand tigers are mostly curious. "You have to remember sharks are prehistoric creatures," George says.

Each time divers are in the tank — for the education staff's morning presentation or the volunteers' afternoon maintenance — there is a designated safety leader who keeps an eye on the creatures and offers a visual barrier with a black-and-white striped pole.

By instinct, the animals are not aggressive unless they feel threatened or cornered, Murphy says. "A pole won't protect you if a shark wants you," he adds. The animals are not touched, except for a few gentle nudges.

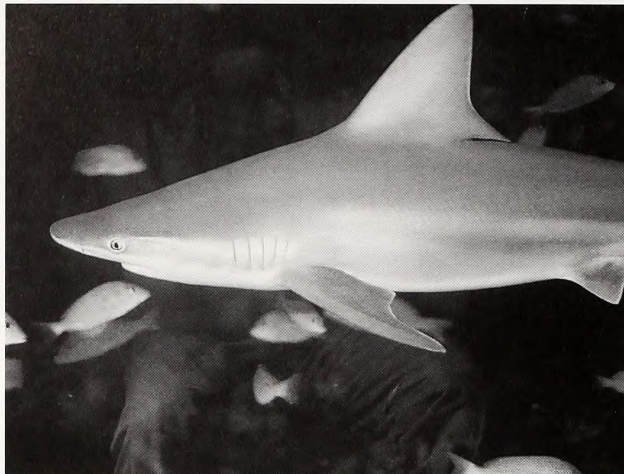
#### • SERVICE-MINDED DIVERS

Well before the new \$16 million-dollar aquarium opened in May 2000, it was clear that staff alone could not keep up with the daily cleaning required in all the tanks. Murphy began working with volunteer coordinator Maura Bourgeois to develop the volunteer diving program, which now handles about two-thirds of the maintenance.

Although applicants must be certified scuba divers, they must attend up to three months of additional training before receiving clearance to begin regular shifts.

Marriner, who was taught to dive as a youth by friends who were U.S. Navy Seals, says his first session at the aquarium made him sure of his offer to volunteer. "I love to dive. This is great," he says. "I am not used to being that close to fish of that size."

That is the case for most of the volunteers. "The first 15 dives are total



*Volunteers find themselves up close to sharks in the tank.*

sensory overload," Murphy says.

The tank's buoyancy factor requires some adjustments. The kidney-shaped tank is about the size of a baseball infield, with a unique current that can be significant.

Working near the *Monitor* replica and the tank's clear acrylic wall can be tricky as well. And divers don't want to spend much time near the surface, where the animals go to feed.

In the general world of diving, about 75 percent are men, Murphy says. But when he was at the Aquarium of the Americas in New Orleans, women filled about half of the volunteer team. "Women tend to do better. They are more intuitive. Many men want to jab and point," he explains.

#### • SAFETY COMES FIRST

Volunteers immediately learn Murphy's priorities: First, diver safety. Second, animal safety. Finally, exhibit safety.

The training concludes with both a written and a practical exam. Then, volunteers are asked to work two three-hour shifts per month.

Many, like George, check in with Murphy to pick up extra shifts. "Any good diver wants to stay current — just like a pilot," says George, who has been a certified diver since 1972.

Ben Presgrave dives for a living — he inspects bridges for the N.C. Department of

Transportation — but spends much of his free time at the aquarium, where the water is considerably clearer.

"This is totally different. It's relaxing," says Presgrave, who proudly claims to be the facility's first volunteer diver.

While many volunteers come from Dare County, Marriner drives 90 minutes each way from Hertford.

"The divers we have are fantastic. They are committed and hardworking — and they enjoy it," Bourgeois says.

Some have learned of the opportunity by word-of-mouth, others through contacts at local dive shops.

Once the program is full, each shift will have four to five divers, including an experienced team leader. In addition to the *Monitor* tank, the volunteers work in other exhibits, including the alligator tank.

To avoid potential contamination, the volunteers use the aquarium's gear, from fins and suits to tanks and buoyancy compensators. "All you bring is your mask," Presgrave says.

The work itself is not glamorous. Much of the time is spent scrubbing algae off walls, or vacuuming waste and other sediment from the tank bottom.

While theirs is not a formal education duty, the volunteer divers find themselves responding to the public, both from inside the tank and outside.

"It's a fantastic experience. We have excellent leadership and feel safe," George says. "It's the most interesting volunteer job on the Outer Banks. ☐"

*To find out more about the volunteer divers and other programs at the North Carolina Aquarium at Roanoke Island, call 252/473-3494, ext. 254. As the expansions of the aquariums at Fort Fisher and Pine Knoll Shores are completed, volunteer diving programs are expected to be implemented.*





Scott D. Taylor

# Oyster Reef Restoration: *A Sound Investment*

*By Cynthia Henderson Vega*

**A** good investment means getting more out of a project than was put in. That's not rocket science. It's not oyster science either, according to Jonathon Grabowski, doctoral candidate in marine ecology at UNC Institute of Marine Sciences, Morehead City.

*Continued*



Jonathan Grabowski



Sean Powers



TOP: Students from the UNC Institute of Marine Sciences had buckets of shells ready for the reef restoration project.

BOTTOM: Oyster reefs provide a grand underwater habitat for a variety of marine species, including juvenile fish.

FAR RIGHT: Oyster shells create a craggy shoreline.

The state invests around \$700,000 each year restoring ever-diminishing oyster reefs. But the total annual oyster harvest is not much more than that — about \$800,000 to \$900,000 — and most does not come from restored reefs,

according to Mike Marshall, fisheries biologist for the N.C. Division of Marine Fisheries (DMF). The math can make oyster reef restoration appear less than profitable.

But Grabowski had a hunch that investments in oyster reef restoration pay back more than is readily apparent on a balance sheet. With funding from the N.C. Fishery Resource Grant Program (FRG), he got a chance to test his oyster market theory.

It starts with the common American or eastern oyster — *Crassostrea virginica* to scientists. A study in craggy gray asymmetry, it's not what could be called pretty. It's not picky, either. Oysters stick to almost any solid surface in the estuary — along shorelines, clinging to pilings or glued to almost any accumulated detritus. Throw in a concrete block; grow a small oyster garden.

Oysters can withstand days of inhospitable conditions just by clamming up. They tolerate a wide range of temperatures, salinity and oxygen levels. En masse, they form fortresses of razor edges standing at attention.

Yet, despite its resilience and penchant for proliferation, the oyster is in trouble. The nearly 2 million bushel harvest in North Carolina at the turn of the 20th century had dropped to about 300,000 bushels by the 1920s and 1930s.

And the state's oyster harvests continue to decrease each year — from 95,000 pounds in 1997 to 54,000 in 1998 and 39,000 in 1999.

"It is reported that (oyster reefs) were so extensive they were obstacles to navigation" in the Neuse River, Grabowski adds. Today,

oyster rocks are hardly grand enough to be thought of as reefs.

Reefs are formed when millions of tiny oyster larvae are released from parent oysters and drift to suitable solid surfaces where they attach and grow. They have a particular affinity for the shells of other oysters. Under the right circumstances, the result is generation upon generation forming huge aggregations that, like the more photogenic coral reefs, can support a busy array of other life forms.

It may not be our appetite for oysters so much as our means for appeasing it that began the downfall of the grand oyster reefs. The use of mechanical dredges for harvesting oysters around the turn of the century probably caused the earliest and most profound losses, Grabowski says. Dredges "hammered oyster reefs," he says, "and removed the foundation upon which oysters had settled previously."

Paradoxically, one reason for the continuing decline, is water quality deterioration — a problem oyster reefs could potentially help to alleviate.

Most scientists believe bivalves such as oysters contribute to good water quality because of their filtering ability, Marshall says. There are no quantitative data on the benefit to the estuary, he adds. But if oysters help purify water, then the larger the reef, the more significant the benefit is likely to be.

In addition to effects on water quality, oyster reefs help stabilize salt marshes, "providing refuge, food and nursery grounds to a diverse assemblage of animals," Grabowski reports.

But restoring oyster reefs is a little like replanting a rain forest. It's difficult to rebuild an ecosystem, especially if the conditions under which the original system developed have changed or no longer exist.

"It can be difficult for extremely impaired systems to recover on their own — restoration may be the only viable option for returning the integrity of these impaired systems," Grabowski says.

"Often ecologists talk about 'stable states' in the applied sciences," Grabowski says. It's difficult to shift the system back



once it's been damaged, he explains. In the case of oyster reef restoration, his FRG-funded study shows it's worth the effort.

#### • OYSTER REEF RESTORATION

The preferred substrate for reef restoration is oyster shell, most of which comes from the shucking industry, Marshall says. Shells from other bivalve mollusks, like clams or scallops, also can be used. Another alternative is marl — fossilized sedimentary rock that contains a substantial amount of calcium carbonate, a main ingredient in oyster shells.

Marshall describes two methods used to rebuild oyster reefs. In shallow, tidal estuaries in the southern coastal region where the moon affects tides, reef material is sprayed off the decks of boats into areas marked off with pilings.

In deeper, subtidal estuaries of the northern areas where tides are wind-driven, the material is dumped into piles with a front-end loader into areas marked off by buoys. Since the water is deeper, the reef materials can be mounded to taller elevations providing a habitat above areas that suffer from low dissolved-oxygen levels.

Grabowski's study — along with those of Charles "Pete" Peterson and Hunter Lenihan of UNC-CH — is providing important data, according to Marshall, and can help determine the best sites for restoring reefs.

#### • BUILDING REEFS

Grabowski restored reefs in Middle Marsh, Carteret County, in three types of areas where oyster reefs tend to form naturally. These areas, or landscapes, are edges of salt marshes isolated from sea grass habitat, areas between salt marshes and sea grass beds, and mudflats away from vegetation.

Shells and the use of shallow-draft barges for Grabowski's study were provided by DMF, with Marshall and Jeff French, also of the division, collaborating. "Though oyster reefs have only recently received recognition as a habitat to protect rather than a single-species resource to exploit, DMF has remained committed to assisting reef research and has been instrumental to the successful design and

completion of several important restoration projects over the last 15 years," Grabowski points out.

Also essential to the study was the fishing expertise of several members of the Saltwater Light Tackle Fishing Club. Grabowski notes that the club "has a real commitment to seeing habitat restored in order to enhance fisheries."

Shortly after constructing the reefs in 1997, sampling began with fish traps, minnow pots, crab pots, gill nets and hook-and-line. Reefs and control areas — similar landscapes without reefs — were sampled to determine the benefits of restored reefs.

Grabowski's study shows that the oyster is hardly "secret, self-contained and solitary," as Charles Dickens described it.

Grabowski puts it scientifically. "A wide diversity of mobile animals utilized restored oyster reefs as juveniles or adults during the day and night throughout the year." It could be said that, for many aquatic animals, their world is an oyster reef. Or, perhaps, build it, and they will come.

#### • THE BIO-DIVIDENDS

What makes an oyster reef a hub of aquatic life is partly protection, but, just as likely, the oyster's place in the food chain. Tiny creatures such as boring sponges and various worms feed on oysters. And where small animals gather, larger ones *will* come.

The study found white urchins, sea stars, right and lightening whelks, banded tulips, moon snails, grass shrimp, mud crabs and spider crabs in higher abundances on reefs than in controls.

Fish found to frequent the reefs include our state saltwater fish, the red drum, along with flounder, speckled trout, gag grouper, snapper, blue fish, spottail pinfish, pigfish, toadfish and sheephead.

Scott D. Taylor



Juvenile fish were found around all the oyster reefs, Grabowski says, "whether in between sea grass and salt marshes, on the fringes of salt marshes away from sea grass habitat, or on mud flats isolated from vegetation."

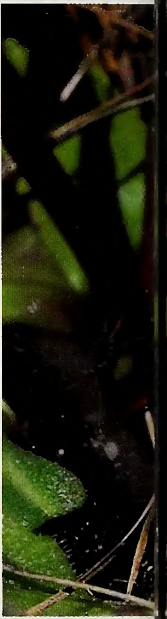
In control areas without reefs, only in sea grass landscapes — areas with aquatic vegetation that is submerged even at low tide — were juveniles found in significant numbers. It seems that reefs function similarly to sea grass beds, Grabowski says, but, "since oyster reefs are the only hard substrate in a predominantly soft-sediment environment, they provide more stable habitats for juvenile fish and enhance fish production within the estuary."

For a state investing in oyster reef restoration, biology merges with economics. Studies of stomach contents of fish suggest "that oyster reefs are important foraging grounds for many economically valuable fish," Grabowski concludes.

But the positive influences on the estuarine environment may be incalculable because so many factors go into the oyster reef equation. "The ecosystem services provided by mud reefs as habitat for juvenile fish, as water purifiers and as habitat stabilizers are not reflected in the economic analysis," Grabowski adds.

If it's not rocket science, it's not Accounting 101, either. Ultimately, Grabowski asks, "How do you put a price tag on biodiversity?" ■







# Insect-Eating Plants Thrive in Green Swamp

By Ann Green  
Photographs by Mike Dunn

When a beetle lands on a yellow pitcher plant in the Green Swamp Preserve, it often falls victim to the deadly plant.

The sweet nectar secreted by the plant's glands draws the beetle inside the tube that is shaped like a pitcher of water.

As the beetle slides down the tube into the plant's yellow stem, it loses its footing on the slippery surface that is covered with downward-pointing stiff hairs. Then it is trapped inside and digested.

Other small insects and animals also can get trapped in the large number of insect-eating plants in the Green Swamp in Brunswick County, where herbaceous plants abound.

Owned by the North Carolina Chapter of The Nature Conservancy, the swamp is home to 14 varieties of carnivorous plants — from aquatic plants with tiny traps to species up to three feet tall.

"The Green Swamp is one of the best places to see insect-eating plants," says Mike Dunn, coordinator of teacher education at the North Carolina Museum of Natural Sciences in Raleigh. "You can find the dead insect remains of meals inside a yellow pitcher plant tube. I have also seen a small lizard trapped in a Venus flytrap, although the plant usually just traps small invertebrates."

A diorama of the swamp's savanna habitat is on permanent display at the Museum of Natural Sciences.

Insect-eating plants thrive in boggy areas like the Green Swamp where the soil is poor in nutrients, especially nitrogen. The southeastern corner of North Carolina has a greater diversity of insectivorous plants than any other state, according to Lundie Spence, North Carolina Sea Grant marine education specialist.

To adapt to a nitrogen-poor environment, the plants absorb nitrogen and other necessary minerals from insect prey trapped through their leaves.

One of the swamp's most prevalent insect-eating plants is the Venus flytrap that flourishes near the edge of the pocosin and savanna.

Insects are attracted to the plant because of its brilliant red color and sweet-tasting nectar.

*C o n t i n u e d*

*BACKGROUND PHOTO: Pines flourish in the Green Swamp's savanna.*

*FAR LEFT: Purple pitcher plants have large, colorful flowers.*

*MIDDLE LEFT: Yellow pitcher plants are shaped like a pitcher of water.*

*LEFT: Venus flytrap is a protected species in North Carolina.*



As an ant or other insect crawls inside one of the flytrap's leaves, its body scrapes against trigger hairs. Suddenly, the leaf snaps shut, trapping the ant inside.

Spectators are also attracted to the plant's snap-trap leaves.

"The late spring flower of the Venus flytrap towers as a white beacon to give away their location to naturalists and poachers alike," says Spence. "The flytrap is a protected species in North Carolina. In addition to southeastern North Carolina, Venus flytraps are found naturally only in a few sites along coastal areas of South Carolina."

To rejuvenate the Green Swamp's population of Venus flytrap and longleaf pine, The Nature Conservancy has a controlled-burn program to keep shrubs from filling the open environment.

"Fire is important to the savanna's ecology," says Dunn. "Historically, the area had periodic wildfires burn every two to seven years on the average. Without fires, other plants dominate and shade the Venus flytrap."

Sundews — beautiful plants with nectar-tipped red tentacles that sparkle like jewels in the sun — also thrive in the Green Swamp. The plants grow in shallow water and moist sand.

Insects are attracted to the sticky, sweet nectar on the tentacle tips. As an insect lands on the leaf, it gets stuck in the sticky juice. The more it struggles, the more it becomes stuck to the sundew's leaf.

When the insect is completely trapped, the tentacles secrete juices that digest it in three to five days. The trap then reopens, and the remains of the insect stay in the trap or drop out.

Some sundew species can catch and digest many insects at one time.

"Once, about 100 insects were counted stuck to a tall, 15-inch-high (38 cm) variety," according to Nancy J. Nielsen's *Carnivorous Plants*.

The bladderwort also thrives in the Green Swamp's shallow water and ditches.

Water fleas and other invertebrates are

attracted to the plant's tiny trigger hairs that resemble algae. Soon the flea is sucked into the plant's tiny balloon-shaped trap, called a bladder, that has trigger hairs.

As the water flea brushes against the trigger hairs, the trap door opens, and water rushes in. Within a fraction of a second, the flea is trapped.

The trap resets in 15 to 30 minutes by readjusting the water pressure, and the trapped flea is digested over several days by enzymes produced by interior glands.

Besides eating water fleas, bladderworts also capture and digest mosquito larvae and tiny, one-celled water organisms. Occasionally, they also trap small tadpoles.

The Green Swamp is also home to another tiny insect-eating plant — the butterwort — that grows close to the ground. Its sticky glands are so small that it can eat only small insects, such as fruit flies.

A fruit fly is attracted to the yellow-green plant because of its musty odor that comes from the gland's sticky juices.

The fly gets stuck in the butterwort's glue. The more the fly struggles, the more glue the plant secretes. Eventually, the fly suffocates in the glue.

"The best time to see the insect-eating plants in bloom is in May," says Dunn. "There are flowers everywhere. The flytraps are tiny. But suddenly, you realize there are lots of flytraps and beautiful wildflowers out there." □

*The North Carolina Museum of Natural Sciences is sponsoring a field trek to Green Swamp for classroom teachers and other educators on May 18-20. During "Southport, Seabird and Swamptramping," you can discover insect-eating plants at the Green Swamp. You also can visit the impressive bird rookery at Audubon's Battery Island Sanctuary where thousands of ibises, egrets and herons nest each year.*

*To register, contact Mike Dunn, 919/733-7450, ext. 620, or mike.dunn@ncmail.net.*

## A SILVER YEAR

For decades, North Carolina Sea Grant has been celebrating the state's coast: Our diverse ecosystems. Crucial nursery waters. Unique communities. Memorable landscapes. Delicious seafood. The list goes on.

In February, the celebration took a new twist with the first in a series of programs to honor the 25th anniversary of North Carolina's designation as a Sea Grant College Program.

Past and present staff members and researchers shared stories with lawmakers and officials from state and federal agencies who have partnered with Sea Grant. Coastal residents who made the trip inland included advisory board members and others who have participated in Sea Grant projects over the years.

Guest speakers included Lt. Gov. Beverly Perdue; Russ Lea, interim associate vice president of The University of North Carolina; former Sea Grant Director B.J. Copeland; and James Murray, former North Carolina Sea Grant extension director who now leads Sea Grant's national extension efforts.

Ronald Hodson, who has led North Carolina Sea Grant since 1997, reminded guests that the program continues to tackle new challenges, including the effects of rapid growth in many coastal counties and river basins.

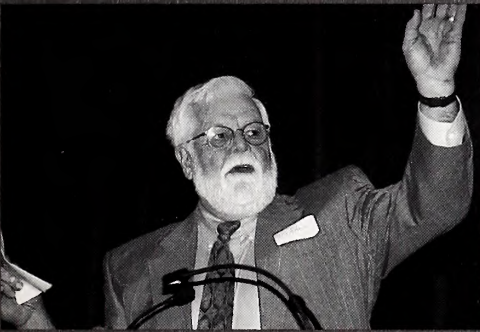
*Excerpts from the Raleigh program will be featured later this summer in a special anniversary issue of Coastwatch. Also watch for recaps of anniversary events in New Bern, Manteo and Wilmington.*

— K.M.





From left: A plateful of delicious oysters. Lt. Gov. Beverly Perdue and Sea Grant Director Ronald Hodson. The Museum of Natural Sciences lobby.



From left: Former Sea Grant Director B.J. Copeland. Lundie Spence and guests. Lt. Gov. Perdue of New Bern.




From left: N.C. Aquariums Director Rhett White and Spence. Lt. Gov. Perdue and legislators. Sen. Charles Albertson with Bonnie and Jim Swartzberg.



From left: Sea Grant guests catching up. James Murray, of the National Sea Grant Office. Researcher Alina Szmant and Russ Lea of the UNC General Administration.

Photo by Bruce Winward





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# Coastwatch

NORTH CAROLINA SEA GRANT 25TH ANNIVERSARY • 1976-2001  
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The Bone Collectors



## Defining Sea Grant

You would think it's a simple task: Define Sea Grant in a sentence or two.

But, as one colleague explained, it is like being pushed forward by your mother, as she says, "Tell the nice people what you do." It can get you tongue-tied even if you love your job.

Putting all of the North Carolina Sea Grant programs into a quick identification is tough enough, considering the variety of missions — research, education and outreach. Then add in the spectrum of topics — commercial and recreational fisheries, aquaculture and mariculture, law and policy, erosion and coastal construction, recreation and tourism, water quality, marine education, seafood technology, etc.

Now consider the entire National Sea Grant College Program that serves Atlantic and Pacific coasts, the Gulf and the Great Lakes' states, as well as programs in Hawaii and Puerto Rico, and projects in Pacific islands. Some focus on fisheries. Others consider ports and urban issues their strength and rarely deal with fish.

During recent national Sea Grant Week meetings, we discussed the Sea Grant identity — and determined that our history of successful projects in coastal communities has "branded" the program, to use a hot phrase from the marketing realm.

While the Sea Grant Association has adopted the phrase "Science Serving America's Coasts," the communicators network will continue fine-tuning descriptions and other efforts to identify the overall Sea Grant program.

A few years back, the national program adopted a "graphic identity" that uses a seabird in flight over the words: Sea Grant. The logo — used by all the state programs and the national office — lets you recognize a report, brochure or video as part of the wider Sea Grant program.

So, if you travel to Galveston, Texas and find rip current information in your hotel room, the Sea Grant logo assures you that you can trust the information. Or, when teachers or students

Herman Lankford



are doing online searches about lobsters or stormwater run-off, they quickly recognize the Sea Grant sites as providing sound science.

Sea Grant Week also offered a chance to review the progress on a national effort known as theme teams. The themes — including urban coasts, coastal ecosystems and habitats, coastal hazards and seafood technology — show that much of our work has impact beyond our state line or geographic region.

For example, a Connecticut Sea Grant project that translates satellite information into programs used by local officials may be quickly adapted for use in West Coast states. Our efforts to restore urban streams as an initial step to improve coastal water quality can be translated to

Great Lakes states. For more information on the national themes for Sea Grant, please send me an e-mail at [katie\\_mosher@ncsu.edu](mailto:katie_mosher@ncsu.edu) or call me at 919/515-9069.

Earlier I spoke of the trust that you can have in products from across the Sea Grant network. Indeed it is a vast array — from bookmarks to interactive online curricula, from videos that entertain while teaching to newsletters that keep folks up-to-date.

Among that strong competition, *Coastwatch* is honored to have received another "People's Choice" award for best magazine, as determined by those attending the meeting. We tied with *Texas Shores*, by, of course, Texas Sea Grant. The judges' blue ribbon winner in the category was *Coast and Sea* by Louisiana Sea Grant.

And probably the greater honor was found in the numerous comments from folks who not only glanced at the magazine during the voting, but in fact are regular readers who recall specific stories of interest. In this busy world, to know that readers make time to read *Coastwatch* is indeed an honor.

In closing, I take a moment to note the passing of David Lawrence of Harkers Island. A wildlife artist, he was co-founder of the Core Sound Decoy Carvers Guild and the Core Sound Waterfowl Museum. Our sympathies go to his family and friends.

*Katie Mosher, Managing Editor*

## C O N T R I B U T O R S

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Alina Szmant □ Ken Taylor □ Scott D. Taylor □ Danielle Waples



# Coastwatch

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# Coastwatch

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, North Carolina Sea Grant supports several research projects, a 12-member extension program and a communications staff. Ron Hodson is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

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Table of contents photo of fox taxidermy by Scott D. Taylor.

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## COASTAL TIDINGS



Andy Fisher

## We All Live Upstream

Did you know that the Neuse River is 207 miles long, runs through 24 counties and is the longest river contained entirely in North Carolina?

Hundreds are expected to turn out for RiverRevival — June 9, from 10 a.m. to 4 p.m. at Lake Benson in Garner — to learn about this precious resource.

RiverRevival is hosted by the Wake Soil and Water Conservation District. Co-sponsors include a number of county, state and federal agencies, as well as community groups. North Carolina Sea Grant will be among the exhibitors.

Organizers say RiverRevival is a community celebration to educate and motivate everyone to respect, protect and conserve water. They have lined up plenty of hands-on activities and

entertainment to give the event a party-in-the-park atmosphere.

The Water Quality Olympics have been designed by local high school environmental clubs to challenge knowledge of water quality issues. Events include Raingutter Revival, a race to follow the path of rainwater runoff through the city storm drains, and Wetland Limbo, a discovery of the importance of wetlands.

Dozens of exhibits will present information on all aspects of water quality and pollution prevention. Participants of all ages will enjoy bands, dancers, storytellers — and lots of food.

RiverRevival is free and open to the public. For more information, call 919/250-1058. Online, go to [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant) and follow the calendar links.

— P.S.

## In the Next Issue of *Coastwatch*

All year we have been reminding you that this is the silver anniversary of the North Carolina Sea Grant College Program. The High Season issue of *Coastwatch* will be a special edition to chronicle not only the growth of our program in the past 25 years, but also some of the changes in our coastal communities and ecosystems. If you have a Sea Grant memory to share, call Katie Mosher at 919/515-9069.



## New Center Highlights Diverse River Life

If you wander through the Roanoke/Cashie watershed, you can glimpse a variety of wildlife — from wild turkeys to gray foxes.

These animals and others are on display in a 25-foot diorama at the Roanoke/Cashie River Center in Windsor, which opened last fall.

“There are more than 25 different species of animals on display,” says Gary Gardner, the center’s administrator. “We have a particularly large population of wild

turkey in the Roanoke/Cashie river bottom.”

Operated by the Partnership for the Sounds, the center also features a quarter-mile boardwalk that stretches from the center to the Cashie River bridge.

In addition, you can view recreated pottery and earthenware from a 17th-century home in northern Bertie County on the Chowan River.

The center is located at 112 West Water St. For more information, call 252/794-2001. —A.G.



Ken Taylor

## New Duties for Thigpen and Sumner

Two North Carolina Sea Grant staff members have new titles and duties on the management team.

Tammy Sumner is now assistant director for finance and information systems. Jack Thigpen is now extension director.

“Both have shown leadership and individual talents that are critical to North Carolina Sea Grant,” says Sea Grant Director Ronald Hodson. “They know the program well. Each will help us build upon our strengths and develop strategies for improvement.”

Thigpen joined Sea Grant in January 1998 as a coastal recreation and tourism specialist based in Manteo. He was named acting extension leader in March 2000. As extension director,

Thigpen supervises specialists based in three coastal offices and the Raleigh office. He will continue to conduct research and outreach programs to serve



Tammy Sumner

Herman Lundford



Jack Thigpen

Michael Hammala

coastal communities, including work with the Natural Resources Leadership Council.

A native of Randolph County, Thigpen holds a doctorate in sociology from the University of Kentucky. He previously served as a faculty member and extension specialist at Texas A&M University.

Sumner, who joined Sea Grant in 1994, has served as the program’s accountant and Webmaster. Last year, she was named computer systems manager. In her new role, she will be responsible for all financial and computer operations. She will continue her role as Webmaster.

A native of Onslow County, Sumner is a graduate of Mount Olive College. She previously served in the NC State University office of contracts and grants.

—K.M.

## Celebrate National Wetlands Month

A freshwater wetland calls attention to itself in many ways.

It might be the low, bass croak of a bullfrog, a thatch of cattails or a red-spotted newt darting over soggy plants.

In North Carolina, there are many types of wetlands besides freshwater marshes — from pocosins with dense thickets of evergreen shrubs to savannas inhabited by the red-cockaded woodpecker.

All types of wetlands contribute to the diversity and beauty of nature and have water quality and habitat functions. Taken as a whole, wetlands are home to one in three of the nation’s endangered plants and animals.

Celebrate National Wetland Month in May with programs by the North Carolina National Estuarine Research Reserve. For more information, contact Gregory Janicke, 252/728-2170, [gregory\\_janicke@ncnerr.org](mailto:gregory_janicke@ncnerr.org); or visit the Web: [www.ncnerr.org](http://www.ncnerr.org).

—A.G.



## Fishery Resource Grants Awarded

From red drum fishing ethics to value-added crabmeat products, this year's Fishery Resource Grant (FRG) projects represent a broad spectrum of coastal interests.

The FRG program awards grants to people involved in commercial and recreational fishing, seafood processing, and others who make a living from the water. The premise is that those with the most at stake in seafood-related industries have unique ideas for improving or protecting coastal resources.

Of 42 proposals received this year, 11 grants have been awarded so far. Others are pending final approval.

George Beckwith of Oriental will study mortality in the catch-and-release red drum recreational fishery.

David Joyce of Beaufort will try out an apprentice program for aquaculturists. Peter Dama seeks to reduce seabird mortality in gill nets in Merritt.

All grant categories are represented: aquaculture and mariculture, fishery equipment and gear, seafood technology and environmental studies.

Look for the next request for proposals this fall.

For more information, call 919/515-2454. Online go to [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant).

—C.H.



Photo courtesy of North Carolina Division of Archives and History

## Destination: Fort Fisher

Renovations at the Fort Fisher Civil War historic site are nearly complete, and officials are predicting a banner tourist season for the popular Pleasure Island attraction — just a ferry stop away from Southport.

With its facelift complete, the visitors' center has reopened its doors. And finishing touches are being put on new exhibits that feature interactive displays and artifacts recovered from sunken blockade runners.

In addition, the \$1 million project to rebuild the protective revetment — a 3,000-foot granite wall facing the Atlantic Ocean — is expected to be completed this summer.

The recreation area features four miles of oceanfront beaches, a snack bar, bathrooms and shower facilities.

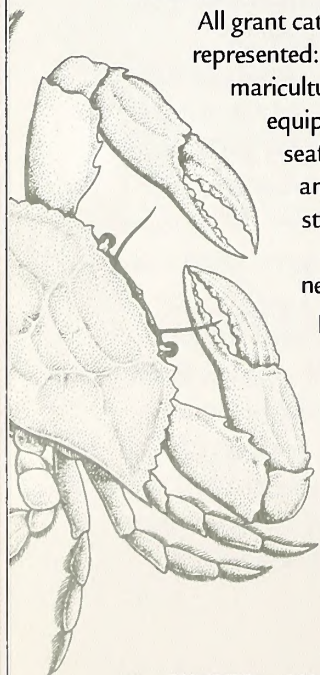
Until the last few months of the Civil War, Fort Fisher kept the port of Wilmington open to the blockade runners that supplied Confederate troops. It fell to Union forces in January 1865.

Mother Nature has dealt an even stronger blow to the earthen fort in recent years. Six hurricanes in four seasons — from Hurricane Fran in 1996 to Hurricane Floyd in 1999 — took their toll on the historic ramparts, visitors' center and surrounding oceanfront beaches. Much of the historic site has been off-limits to the public as renovations took place.

Meanwhile, work continues nearby on the \$16 million expansion of the N.C. Aquarium at Fort Fisher. Closed since 1999, it is expected to reopen in 2002.

For information about the Fort Fisher historic site, call 910/458-8206. For information about the N.C. Aquarium programs, call 910/458-8257.

—P.S.





## Disaster Preparedness Expo Set for June 2

North Carolina Sea Grant will take part in Project Impact: Disaster Preparedness Expo 2001 from 9 a.m. to 7 p.m. June 2 at Trask Coliseum at the University of North Carolina at Wilmington.

Project Impact, a Federal Emergency Management Agency (FEMA) initiative, helps communities protect themselves from the devastating effects of natural disasters. Preparedness involves taking action to reduce disruption and loss.

More than 120 exhibits will include products and demonstrations to make area residents "disaster resistant" and better prepared, says Debbie Reed, project coordinator.

The 2001 expo expands from its hurricane-centered focus of past years to

include all hazards, such as floods, fire and severe weather.

Along with exhibits and demonstrations, the expo will feature activities for youngsters, including a fire safety demonstration, a storytelling corner and face painting.

Spencer Rogers, North Carolina Sea Grant coastal erosion and construction specialist, will present several workshops on building and retrofitting a hurricane-resistant home. Hurricanes are a reality for coastal residents, Rogers says. He'll demonstrate ways to retrofit existing homes for maximum protection against wind and water damage.

For more information, call Reed at 910/341-4595. — P.S.

## 'Protect Wild Dolphins' License Plate

The Wright Brothers might easily have seen dolphins cavorting off the coast at Kill Devil Hills while preparing for that first historic flight. Soon, a pair of leaping dolphins with the words "Protect Wild Dolphins" will adorn special North Carolina "First in Flight" license plates.

The plate will draw attention to the harm that can be done in human-dolphin interactions. Proceeds will support conservation, education and research programs of the North Carolina Maritime Museum in Beaufort.

Dolphins are a special interest of the museum's natural science curator, Keith Rittmaster, who has studied dolphins near Beaufort since 1985. Rittmaster, his wife Victoria Thayer, research assistant Nan Bowles and other volunteers use



photographs of dolphins' dorsal fins to identify and study the animals. (For more on photo-identification studies, see page 26.)

Dolphins often are injured by boat propellers or drown when entangled in fishing gear. Humans also endanger dolphins by feeding them — everything from Twinkies to sunglasses. And dolphins can become aggressive and bite once accustomed to being fed by humans.

Federal laws with stiff penalties prohibit the feeding or harassment of dolphins.

The plates cost \$30 and can be personalized for an additional \$20. For an application, contact the museum at 252/728-7317 or the Cape Lookout Studies Program office at 252/504-2452. For an application online, visit [www.southern-outerbanks.com/clsp-plate.html](http://www.southern-outerbanks.com/clsp-plate.html). — C.H.



## Where the Fish Are

Before you go surf fishing — or head to the pier or boat dock — try surfing the Web for the latest news on what's biting and where.

The N.C. Division of Marine Fisheries (DMF) has launched an online fishing report at [www.ncdmf.net/fishreport](http://www.ncdmf.net/fishreport), where anglers can find details on recent coastal catches, as well as tips on bait and tackle.

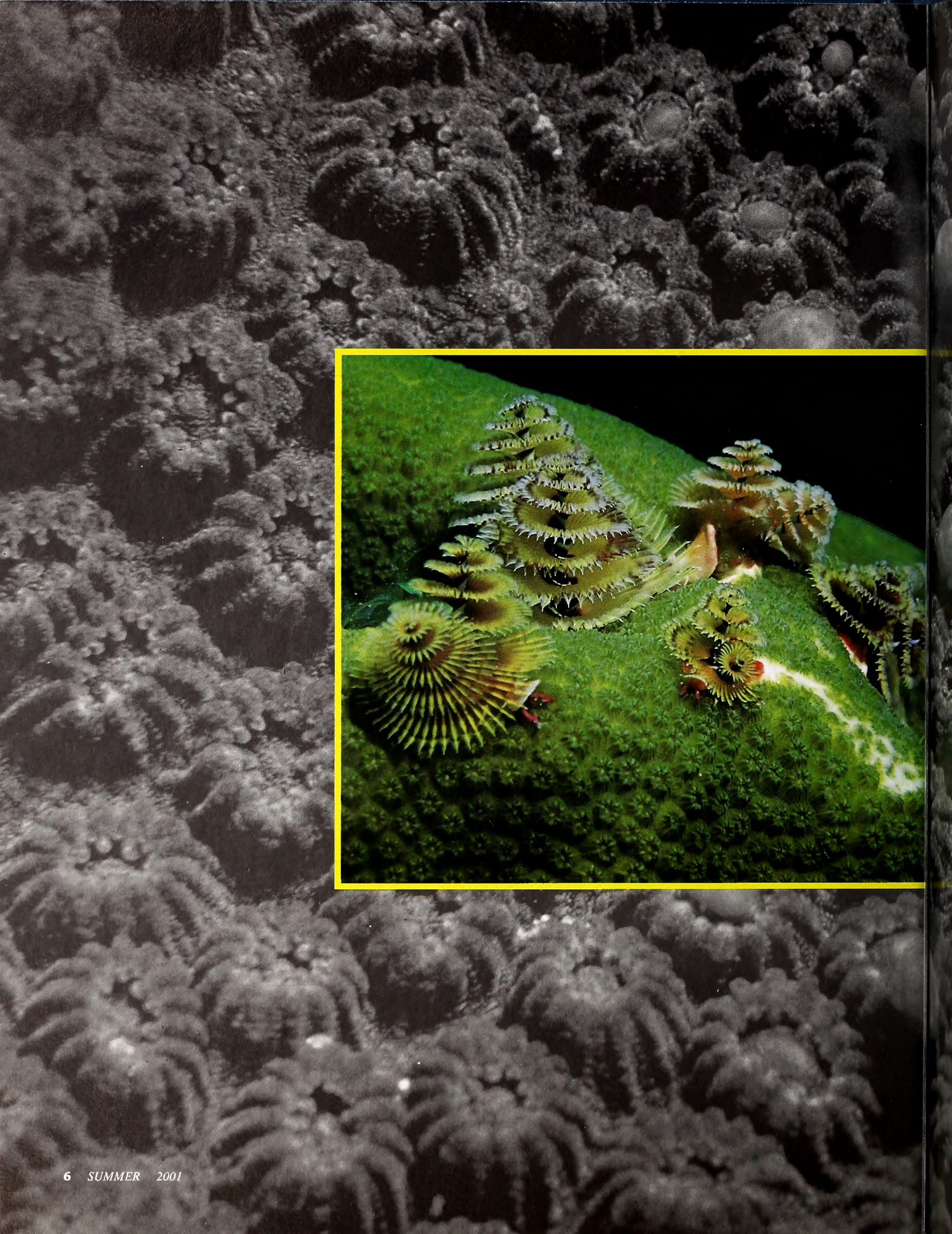
The weekly updates cover charter and head boat activity, pier and surf action, and private boat catches along the northern, central and southern coast. Regional e-mail contacts provide additional details.

DMF recreational port agents canvass 220 locales along the coast to provide data for the Marine Recreational Fishery Statistics Survey. While this information is useful to anglers who want to know what's biting, its real use is to estimate the impact of recreational fishing on our marine resources.

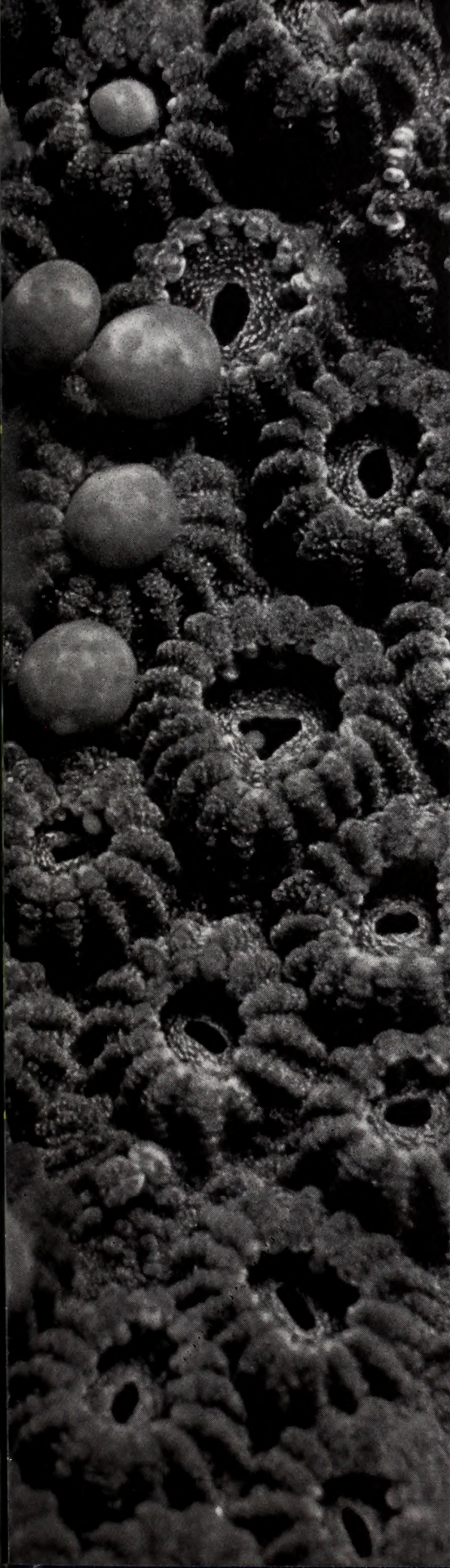
The DMF Web site also offers the latest size and catch limits, fish identification pages, and stock status reports. For more information, contact Doug Mumford at [Doug.Mumford@ncmail.net](mailto:Doug.Mumford@ncmail.net), or call 800/338-7804 or 252/946-6481.

— K.M.









# CORALS AND SEA URCHINS:

## Two Parts of the Same Story

By Pam Smith

**T**he biodiversity of a coral reef often is compared to that of a tropical rain forest. Bountiful. Lavishly beautiful. Teeming with life. Rich enough in resources to feed and heal Earth's six billion souls.

Now, add "threatened" to the list of similarities.

Scientists estimate that in recent decades more than one-third of the world's coral has been destroyed or degraded, and that half of its original rain forest cover has disappeared.

Increased pressure on these natural resources is inevitable — from a world population expected to double by 2060, and from natural phenomena such as global warming.

But Alina Szmant, a marine biologist at the University of North Carolina at Wilmington, refuses to surrender to doom and gloom. She prefers to work toward solutions.

And, she's not alone. She is among a growing number of marine scientists worldwide working to restore and maintain healthy coral reef communities. Likewise, their counterparts elsewhere in the scientific community are emphasizing sustainable land use and forest management methods.

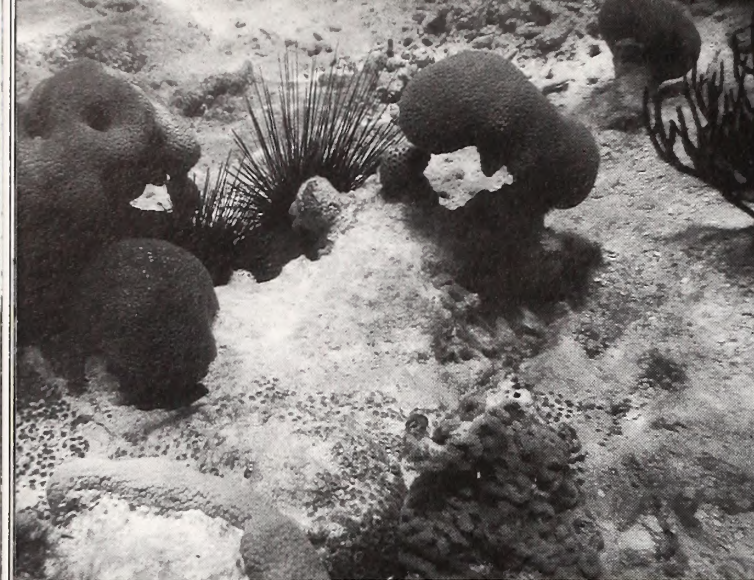
*Continued*

*BACKGROUND: A Sea Grant research project focuses on restoration of coral reefs, including star coral shown releasing gamete bundles.*

*INSET: Montastraea with Spirobranchus giganteus.*

Photos by Julie Robinson





Alina Szmant

TOP: *The Diadema sea urchin is a key player in keeping coral reefs healthy.*

### **A two-front tactic**

For a major research initiative by the National Sea Grant College Program, Szmant has mapped out a novel, ecological approach for restoring coral reef habitat in the Florida Keys National Marine Sanctuary.

Her plan is not simple. But if all goes well, it could become a model for reef recovery.

“Corals and sea urchins are two parts of the same story,” she says, explaining her two-front tactic.

First, the research team is developing methods to culture large numbers of coral larvae for reseeding damaged or degraded reef areas. They are concentrating on star corals, *Montastraea* spp. and branching elkhorn corals, *Acropora palmata* — both reef-building species.

This phase of the project builds on Szmant’s earlier research predicting spawning times, collecting spawn, and culturing the larvae for smaller scale laboratory and field experiments.

Second, they are attempting to restore a population of the sea urchin *Diadema antillarum*. Its dramatic die-off in 1983 may have helped tip the ecological balance of the coral reef communities in the Western Atlantic and Caribbean.

Without the herbivorous *Diadema*, coral reefs in the region gradually became smothered by fleshy algae and thick turfs.

The researchers are developing a mariculture system to rear large numbers of *Diadema* for release in the designated sanctuary restoration site.

They predict that restoring sea urchin populations will help create clean reef surfaces that are capable of supporting the cultured coral larvae. With the fleshy algae and turf held in check, the scientists also hope to see the return of other keystone members of the coral reef ecosystem.

Coral reef habitats are complex, interrelated marine communities. Reefs are built up by layers of calcium carbonate — the accumulated skeletons of billions of soft-bodied sea animals called coral polyps.

Inside the living coral polyps, zooxanthellae — “good algae” — provide oxygen



Alina Szmant

MIDDLE: *Elkhorn coral survival will get help from a Sea Grant research project.*



Scott D. Taylor

BOTTOM: *Alina Szmant hopes her two-pronged project will restore sea urchins and corals.*



and organic compounds. In turn, zooxanthellae receive carbon dioxide from the coral polyps. Additionally, certain species of crustose coralline algae (CCA) are needed on the surface to trigger coral larvae settlement. These good algae were overgrown by fleshy algae and turf with the disappearance of the *Diadema*.

Like most ecological restoration efforts, implementation requires long-term investments of time, talent, ingenuity, patience — and financial support.

Szmant has assembled an experienced research team long on the first four attributes. Co-investigators include Margaret Miller, an ecologist with the National Oceanographic and Atmospheric Administration's Southeast Fisheries Science Center, and Thomas Capo, a senior research associate with the University of Miami's Rosenstiel School of Marine and Atmospheric Science.

National Sea Grant is providing financial support for the project — more than \$400,000 over a two-year period. About \$249,000 in matching funds comes from UNC-W, the University of Miami, The Nature Conservancy's Volunteer Program, and the Institute for Marine Science in Fort Lauderdale.

Additional logistical support comes from the Florida Keys National Marine Sanctuary and UNC-W's NOAA-funded National Undersea Research Center, with field headquarters in the sanctuary.

The ambitious project targets ship-grounding sites on coral reefs in the Florida Keys National Marine Sanctuary. When a ship runs aground on a coral reef, it can damage or destroy an area larger than a football field.

If successful, the techniques will be applicable to the restoration of coral populations in degraded reefs throughout the region, if not the world.

### **A new research frontier**

The timeline for culturing coral is dictated by Mother Nature — in more ways than one. During one week of a defined

lunar cycle in August or September, star corals release billions of gametes in a mass spawn.

"When all the polyps release their gamete bundles, it looks like a snow globe," Szmant says. "It's really quite an incredible sight."

Star corals release egg-sperm packets, which float to the surface. After fertilization, coral larvae drift, then sink to reseed the reef. But mortality exceeds 95 percent, Szmant explains. The researchers are attempting to gather gametes from spawn and nurture them for transplant onto natural reef formations.

Late last August, two teams assembled — one in the Florida Keys directed by Miller and the other in Puerto Rico directed by Szmant. Their goal was to capture the shower of gametes with fine mesh nets and immediately culture the larvae in field chambers resembling floating ponds.

"For the batch from the Florida Keys, the idea was to attempt to seed them directly onto reef substrates, and then try to evaluate their success," Miller recalls.

Unfortunately, when the larvae were about 36 hours old, Hurricane Debbie was bearing down on the region. The Puerto Rico team was first to evacuate.

"It was a major setback when we were forced to shut down and evacuate the Keys," Miller says. She managed to scoop up a small amount of larvae to use in lab studies, but was not successful in getting them to "settle" on an artificial substrate.

For now, lab experiments continue using small numbers of star coral larvae collected from different sites.

The elkhorn coral is a different matter. "We have less history on what it does from year to year, and it did not spawn this year in the Florida Keys or Puerto Rico," Szmant says.

"It could be that it still is recovering from the 1998 bleaching episode. When corals lose their major food source, they may not have the energy for reproduction the following summer."

Coral bleaching she explains, is a major factor in the loss of corals worldwide. Scientists suggest it is caused in part by global warming and associated with elevated water temperatures. It can be exacerbated by ultraviolet radiation or disease.

"The bleaching event in 1998 — with the warmest temperatures in thousands of years — was the worst on record. It killed huge amounts of coral all over the world," Miller points out.

### **The 2001 odyssey**

In August 2001, the researchers will return to the reef for what they hope will be a summer free of hurricanes and bleaching.

"You can't get discouraged," Szmant says. "Some things — especially Mother Nature — are beyond our control."

Meanwhile, *Diadema* urchins — also known as spiny black sea urchins — are thriving in Capo's Key Biscayne laboratory culture system. *Diadema* spawn in winter, so collection picked up when coral culturing ceased.

"We already have three batches — the first major effort to culture them with more to come," Capo reports. "It's a spectacular sight."

By late March, they ranged from extensive larval to benthic juvenile stages, and would require another six months before they would be ready to be introduced into the coral reef environment — just before a new batch of cultured coral larvae would be ready for release.

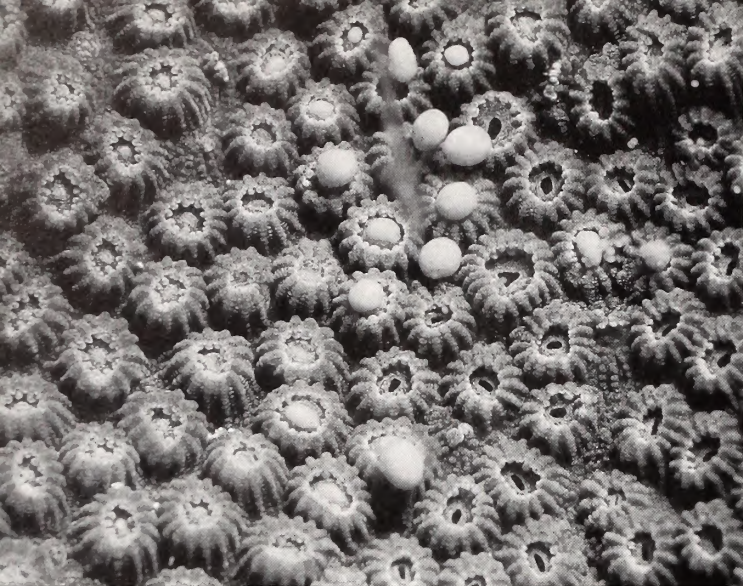
Capo is keeping a detailed account of every stage, noting optimal water temperatures and salinity. During the grow-out stage, he'll be interested in the food of choice for the urchin — brown, red or green algae.

"There is no literature to rely on for any of this, so we're trying a varied menu to see what works best," he says.

"We're heading for a couple of very interesting months. After all, studying the interaction of sea urchin and coral opens up

*C o n t i n u e d*





Julie Robinson



Julie Robinson



Julie Robinson

TOP: *Star coral*

*release thousands of gamete bundles.*

MIDDLE: *This*

*massive spawn of*

*gamete bundles*

*occurred in the*

*Florida Keys National*

*Marine Sanctuary.*

BOTTOM: *Margaret*

*Miller and other*

*divers capture the*

*spawn to nurture for*

*later release.*

brand new avenues of research,” Capo reflects.

The researchers will take a cautious approach to releasing both the urchins and the coral larvae into the reef habitat.

At first, they will evaluate the types of habitats that allow urchins to escape predation. By late spring, Miller and Szmant will have conducted more extensive transplant experiments, stocking urchins in certain experimental sites to see what effect they have on each benthic community.

“Hopefully the weather and the corals will cooperate this August, and we will be able to raise and seed the coral larvae in these urchin-enhanced sites, as well as control sites, to see if the juvenile coral survival improves,” Miller says.

The ultimate measure for success of the project, Szmant, Miller and Capo agree, will come in June 2002 with baby star and elkhorn corals surviving and growing on urchin-enhanced sites in the sanctuary.

“If this two-step approach has the beneficial effects in the sanctuary we think it will, it could change the face of Caribbean reefs in general,” Miller says.

### **A welcome celebration**

No one will be ready to celebrate success more than Billy Causey, superintendent of the Florida Keys National Marine Sanctuary.

Coral colonies grow slowly, building in stages over millennia. Yet, in just a few recent decades, the cumulative effects of natural and human activities have taken their toll on corals around the world.

Natural forces such as global warming, El Nino and La Nina are impacting coral beds globally, Causey says.

In the sanctuary, he has seen tens of thousands of fish die during what he calls “warm water events” marked by doldrum conditions — no movement, no oxygen.

Damaging ocean storms, the loss of sea urchins and serious coral disease outbreaks have been devastating to corals.

On top of that, overfishing of coral



reef fish for food and for the aquarium industry altered the ecological balance of reef systems, adds Brian Keller, sanctuary research coordinator.

In other parts of the world, some fishers are using dynamite to drive rare fish out of the nooks and crannies of coral reefs. Others are using poisonous gas to stun and take rare specimens alive. The corals don't fare as well, Keller says.

The dumping of untreated stormwater, runoff of sediment, and leeching from thousands of septic tanks into near-shore waters of the Florida Keys are exacting their toll on water quality.

"All told, we're talking major pollution, overfishing and habitat destruction," Causey says. "That's why Alina's two-pronged project is so important."

A coral reef, he says, is a one of a kind marine resource with huge environmental, ecological and economic implications. Many world leaders are aware of the importance of coral reef management — it's an issue that crosses political and geographic boundaries.

"My theory — I call it the Billy Causey theory — is that marine life is fairly resilient, given good water quality, good management practices, good habitat. It's a three-legged stool. Without all three, the stool will tip over," he says.

Given the importance of coral reefs habitat, Szmant and her research colleagues are hopeful that their research project will emerge as an effective coral reef management tool.

"We're humble enough to know that this is a small effort. But we are determined to plug away at things that can help even in small ways," Szmant says.

As for Causey, he promises to be there when the researchers release the sea urchins and the cultured coral larvae into the sanctuary reef.

"It's exciting," he says. "Plus, it's my job to see that best methods and the best science are used to help restore the reef. Alina's project is the best of both." □

## National Marine Sanctuaries: Our Deepest Treasures

In 1972, the nation made a commitment to preserve its marine resources by establishing the National Marine Sanctuary Program under the aegis of the National Oceanic and Atmospheric Administration. The mission is "to conserve, protect and enhance the biodiversity, ecological integrity and cultural legacy of our nation's deepest treasures."

The first national sanctuary, the wreck site of the *USS Monitor*, was established in 1975. The historic relic, which rests on the seafloor about 16 miles off Cape Hatteras, is protected from human activities such as vessel anchoring and fishing.

Since that first designation, 12 more sites have been added to the network — encompassing about 20,000 square miles of ocean and Great Lakes waters. Together, these varied marine ecosystems represent a new frontier for increasing an understanding of the importance of healthy oceans — their effects on climate, significance as a food source, importance to commerce and potential for medical cures.

In 1990, Congress created the Florida Keys National Marine Sanctuary, where the University North Carolina at Wilmington oversees the National Undersea Research Program, considered the sanctuary's research arm.

The sanctuary extends from Key Biscayne southwest to the Dry Tortugas Islands, a national park. The sanctuary's 2,800 square miles of coastal and ocean waters and submerged land embrace interdependent marine environments — seagrass meadows, mangrove islands and extensive patch and barrier coral reefs. The Florida Keys' barrier reef is the third largest in the world.

Congress reauthorized the Marine Sanctuaries Act in October 2000, setting new levels of appropriations to protect vital ocean resources.

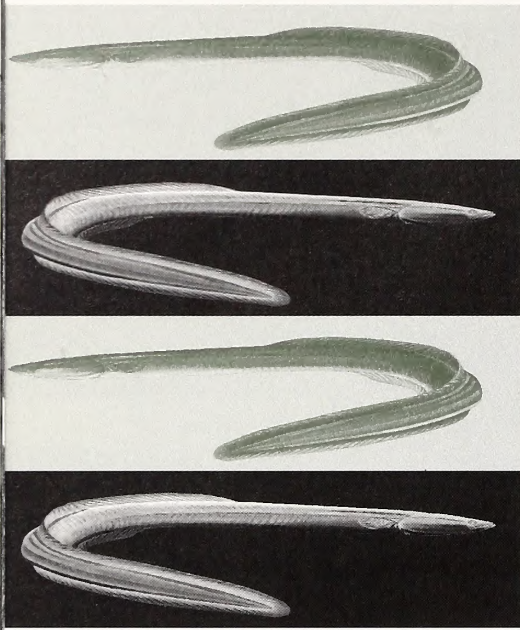
In addition, the U.S. Coral Reef Task Force was established by executive order in 1998 to address threats to the health of the coral reef ecosystem. Joint responsibility was given to NOAA for the U.S. Department of Commerce and federal agencies under the Department of Interior to promote conservation and sustainable use of coral reefs.

In March 2001, the Florida Keys National Marine Sanctuary plan was approved to protect the coral reefs of the Tortugas, west of Key West, by establishing a "no-take" ecological reserve. The plan prohibits the taking of all marine life as well as vessel anchoring and discharge. This area is important spawning waters for snapper and grouper and habitat for golden crab, snowy grouper and tilefish.

There are 23 other no-take areas in the sanctuary network. — P.S.



Illustration by Duane Raver



BORN AT SEA,  
THE CATADRAMOUS EEL  
DRIFTS TOWARD LAND AS  
LARVAE ON OCEAN CURRENTS.  
IT SPENDS MOST OF ITS LIFE  
IN FRESHWATER,  
REACHING MATURITY  
IN SEVEN TO 30 YEARS.  
THE ADULT EEL RETURNS  
TO THE MOTHER WATERS  
OF THE SARGASSO,  
SPAWNS AND DIES.

# THE ENIGMATIC EEL:

A LONG WAY FROM HOME

By Pam Smith • Photographs by Michael Halminski

It's a spectacular day to travel out east — past freshly plowed fields, white country churches, and houses framed with bright daffodils.

Straight ahead lies Belhaven, a quaint village on the Pungo River and the Intracoastal Waterway. The best view of its picturesque waterfront — with piers and boat ramps set against moss-covered live oak trees — is from across the river, south on N.C. 99.

Only a few sailboats skim along the Pungo, shimmering silver in the morning sun. The air is crystal clear. Cool. Not quite spring. It'll be a few weeks before the river community is re-energized by crabbing and fishing activities.

Down the road at Belhaven Crab & Eel Pots & Supplies, Inc., E.T. and Katie Sawyer anticipate the surge of business the changing season brings.

Stacked against the building's red brick facade, cylindrical black eel pots and boxy crimson crab pots are a study of colors and shapes. And inside, in spite of their relaxed manner, the proprietors are bracing for commerce.

The retail portion of the building is lined with row after row of equipment essential to landing, storing, transporting and preparing the catch — no matter the type, size or quantity.

Color explodes from well-stocked bins. Bright orange and hot-pink buoys. Nets, nets, and more nets — you name the mesh size and color. Yellow rain gear and assorted neon-colored gloves. And boots. White, blue, green and black boots — in tall, medium and short — for crabbers, fishers or processors.

E.T. weighs three pounds of pig rings —

also known as cull or escape rings — for a customer planning to repair his crab pots for the coming season.

Their son, Lloyd, is on the phone giving directions to a lost delivery driver, whose rig is filled with rolls of wire mesh for crab and eel pots.

Last season, even when many crabbers reported poor landings, the Sawyers used about 2,000 rolls, each with 100 feet of wire mesh, to build thousands of crab pots.

The blue crab is the traditional “cash crop” for many families on the Pamlico-Pungo peninsula — stretching from Washington on the Tar-Pamlico River to the Hyde County bridge on the Pungo.

“There's less call for eel pots,” E.T. says. “Crabbers may put out an eel pot or two with their crab pots. Mostly, they eel when the crabs are not running.”

## STOCKING UP

These days, with reports of declining American eel stocks, few commercial fishers bother to put out any eel pots at all. Still, the Sawyers maintain an inventory of eel pots and supplies for those who want to give it a try.

From the workroom side of the building, radio music plays counterpoint to a steady swoosh-grind-chomp sound. An employee is using what resembles an oversized paper cutter to snip measured sections of wire mesh to demonstrate eel-pot construction.

To form the cylindrical shape, he rolls the largest rectangle of dark green half-inch mesh around a gallon paint can.

“High tech,” E.T. says with a laugh.





*Katie and E.T. Sawyer, outside their shop, are ready for the crab and eel season in the region.*



*An employee cuts measured sections of wire mesh in preparation for the construction of new eel pots.*

“We used to take the wire sections to a machine shop to shape them. But one of the men came up with the idea of using the paint can. It’s exactly the right circumference and works just fine.”

The height of technology for the process is the high-pressure stapler used to secure the seams with fasteners.

Next, the worker inserts a polyester funnel, 10 inches from the top of the cylinder, and ties it to opposite sides of the cylinder, pulling the unstitched funnel bottom closed. A second funnel, placed higher, is tied at four points, keeping the funnel bottom open to allow the eel to swim inside and take the bait. Bait is packed around the top funnel.

To complete the eel pot, the employee secures the escape panel, bottom, and the top door opening. In all, it takes less than an hour to complete the task — not counting the time it takes Katie Sawyer to cut and sew a supply of polyester funnels with two or four ties.

Why are the eel pots black or dark green, while crab pots are so colorful?

E.T. explains that some say that eels, being bottom swimmers and nocturnal feeders, are scared off by bright colors. Or, he says pragmatically, it could be that size mesh is available only in black or green.

#### LIVING HISTORY

But eel pots are not always cylindrical. What’s more, eels once were plentiful to the point of being a nuisance species in the state’s estuaries, rivers and tributaries, E.T. says.

He leads us outside for a surprising history lesson.

“This is the River Ox. I’m told that a couple of hundred boats just like this one, complete with an outboard motor and a dozen or so eel pots, were given away by some federal program in the mid-1970s. It was part of an effort to develop a commercial eel fishery here,” he says. “This boat really is an ox. It’s indestructible.”

E.T. pulls a square-shaped eel pot from storage. “This is one of the eel pots they gave away. The program was a good idea that never quite caught on, for whatever the reasons.”

Turns out, East Carolina Industries — at that time affiliated with the federally funded Migrant and Seasonal Farmworkers Association — provided the boats on a pay-back basis to 125 eel fishers who had gone through their training program. It was part of a broader initiative by a number of federal agencies, including the Coastal Plains Center for Marine Development Services, attempting to foster economic development opportunities in depressed areas at that time.

Beginning in 1972, Sea Grant agents also were laying the groundwork for a commercial eel fishery. According to an early Sea Grant publication, the idea was to “turn the plentiful nuisance into a big-time, profitable commercial crop.” Developing this underutilized species could assist small fishing operations with limited income potential.

At that time, eel typically was commercially caught for crab bait, bringing no more than 18 cents a pound. If channels could be opened, North Carolina eels could bring at least 50 cents a pound on the world market. While U.S. consumer demand for eels was practically nonexistent, Europe, Japan and China were reportedly consuming a total of 60,000 tons of eels annually.

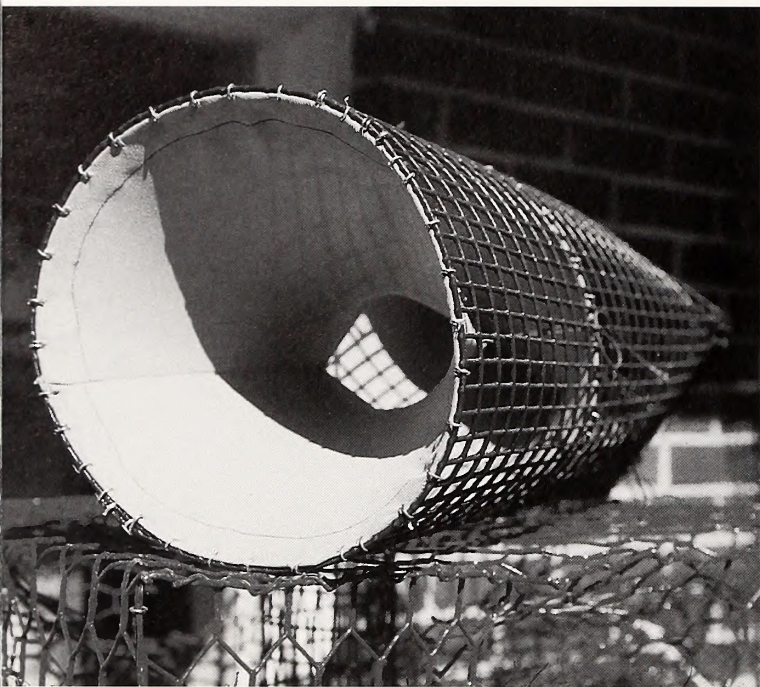
Sea Grant staff conducted workshops on eel harvesting and handling techniques. They demonstrated eel pot construction, made arrangements for facilities to hold live eels for shipment, came up with ways to transport live eels from holding areas, and located exporters.

By 1974, there were 200 licensed eel fishers in the state and four exporters — with exports up to half-million pounds.

Sea Grant agents began to explore a new avenue — eel aquaculture. “It was the next logical step, and federal funding was avail-

*Continued*





The traditional trap is cylindrical and has a double chamber to lure and capture eels.



E.T. Sawyer displays a bit of history — a boat and square trap distributed by a federal program in the 1970s.

able,” says William L. Rickards, former assistant director of North Carolina Sea Grant and principal investigator of the eel culture project.

The Sea Grant demonstration project was a success, by any measure. But by 1980, the surge in eel farming had “died a natural death due to lack of interest,” says Rickards, now director of Virginia Sea Grant. “It could be that once the federal money dried up, so did the interest in pursuing the fishery.”

For at least the past decade, for reasons most scientists have not yet pinpointed, eel stocks have been declining.

Rickards points out, “A number of states are beginning to pay more attention to eel stocks. It seems to be back on a lot of states’ lists for stock surveys.”

He believes that a number of things could account for apparent low stocks, including natural predators, overfishing, habitat loss, pollution of both fresh and brackish water environments — and the natural cycle of abundance. “I think we may be at the low point of a seven-to-ten year abundance cycle,” Rickards says.

#### A LONG WAY FROM HOME

Eel stocks appear to be at historic lows in both America and Europe. But consider the hazards encountered by the American eel (*Anguilla rostrata*) and the European eel (*Anguilla anguilla*) as they journey more than a thousand miles from the Sargasso Sea in the middle of the Atlantic Ocean. There, they begin — and eventually end — their life cycle.

Born at sea, the catadromous eel drifts toward land as larvae on ocean currents. It spends most of its life in freshwater, reaching maturity in seven to 30 years. The adult eel returns to the mother waters of the Sargasso, spawns and dies.

So, between life and death, the eel can fall victim to a number of dangers of natural or human origin, as Rickards suggests. Some North Carolina researchers and commercial eelers would add one more nemesis to Rickards’ list. Nematodes.

The nematode, a parasite that attacks the swim bladder of eels, has been detected in both the American and European eel. It’s believed to have been introduced from ballast water of Asian ships or Asian aquaculture transplants.

Juvenile nematodes are no larger than a speck of lint; the adult, about one-half inch. In

spite of the miniscule size, the nematode may have decimated Asian eel stocks more than a decade ago.

Last year, researchers concluded a two-year study to determine the extent of the nematode infestation in North Carolina waters.

Wesley Patrick, now a graduate student in marine biology at East Carolina University, gathered eels from 15 sites in the state, looking for the presence of the parasite and its effect on the eel.

The study was supported by the North Carolina Fisheries Resource Grant Program, which is funded by the N.C. General Assembly and administered by Sea Grant.

With the help of Robert Hutchinson, a commercial eeler from Chocowinity, the research team collected more than 1,000 eels from rivers and streams from the Cape Fear to the Chowan rivers.

Patrick reports an overall infection rate of 52 percent — higher than the rates in the Chesapeake Bay or the Hudson River. He speculates that higher rates may be related to warmer waters, which support the hatch rate of parasite eggs. Nematode eggs are released into the water, and ingested by an intermediate crustacean host. The eel ingests the crustacean



which contains the infective stages of the parasite.

The researcher notes that the intensity of infection was moderate, with a mean range of from 2 to 12 nematodes per eel. The presence of the nematode in the swim bladder does not affect the edibility of the eel.

"We found little evidence of deleterious effects of nematode infections on the eel," he says.

Few were found to have external symptoms of the nematode's presence, such as lesions around the anus or on the skin. In fact, there was evidence the eel may thicken its bladder as a defense mechanism.

So, the jury still is out on whether the nematode is the smoking gun in the case of the disappearing eel. But, Patrick urges additional eel population studies to get a handle on the status. In addition to having an impact on the commercial eel fishery, a change in eel populations could impact the food chain for several game fish.

Some North Carolina anglers believe the abundance of striped bass, which love eel, also could be a factor in thinning eel supplies.

Whatever the reason or reasons may be, Martie Bouw, owner of the Holland Seafood Company in Arapahoe, knows for sure that export numbers are down. The only eel exporter left on the East Coast, he says last year was the worst year in pounds and in price.

He shipped between 700,000 and 800,000 pounds of American eels — the combined catch from North Carolina, Maryland, Delaware and Virginia. Ten years ago, North Carolina *alone* accounted for nearly 900,000 pounds of eels exports.

But Bouw is inclined to be optimistic. "I think the numbers are down, but not for lack of eels in the waters. I think there needs to be a serious effort by commercial eelers," he says.

To him, a serious effort means working 200 to 300 pots per eeler.

#### BACK AT BELHAVEN

That would certainly mean a lot of extra business for E.T. and Katie. It could seriously cut the time the Sawyers spend hosting East Carolina University marine biology students. During regular class visits, the couple

familiarize students with basic equipment and talk about the local fishing trade.

They also spend a lot of one-on-one time with student researchers needing custom-designed traps or equipment for specific projects. The Sawyers also hook up students with commercial fishers who offer practical knowledge of a particular fishery. In turn, ECU professors are great resources when a local fisher needs to identify a mystery catch.

The Sawyers enjoy keeping close ties to ECU, since E.T. is a 1967 alumnus with a degree in accounting. Except for a few years in Lake Lure, his career in accounting has kept the family close to the Belhaven-Pantego area, where they both grew up. Katie is a professional cosmetician who owned and operated a local shop for a number of years.

Her natural "people skills" easily translated to the supply business they purchased in 1995.

"I kept books for the woman who owned the shop for a number of years. One day she said she thought we ought to buy her out," E.T. recalls.

They did, and have never regretted the decision.

Some days, most of the "business" comes from lost tourists, including journalists. Last year, their hospitality earned Belhaven Eel & Crab Pot & Supply a photo and write-up in *Southern Living* magazine.

"I guess we're really in the people business," Katie observes. "And we do love the people here. You get to hear a lot of fish stories. Sometimes you even can tell which ones to believe."

They have a lot of respect for their customers who make a living on the water.

"It's often an uncertain living. But they never complain — even when we were flooded in 1999. It was a bad time. A lot of them lost boats and equipment. They made do — and blessed what was left," Katie says.

Bad times? Sure. But most of them expect times will get better.

And, Katie and E.T. Sawyer will be ready for a much prayed for, record season of crab and eel landings. As we say good bye, the once-lost 18-wheeler, loaded down with rolls of wire mesh, is pulling in. ■

## The Mysterious Life of an American Eel

From deep below the grassy surface of the Sargasso Sea in the middle of the Atlantic Ocean, eggs from the American eel (*Anguilla rostrata*) hatch into transparent larvae less than a half-inch in size. The currents that whirl about the Sargasso Sea carry the larvae throughout the Atlantic from Greenland to the tropics.

American eels hitch a ride on the Gulf Stream to the East Coast. Their European cousins (*Anguilla anguilla*) drift on the North Atlantic currents to Europe and south to North Africa.

This migration to land can take several years. When they reach the coast, they undergo a metamorphosis — lengthening and flattening, and becoming transparent. At this stage, they are known as "glassers."

As they continue to journey into estuaries and on to freshwater rivers, streams and tributaries, they turn smoky grey, and are known as "elvers."

They grow, turn brownish-yellow and become more determined to complete their upstream journey, even slithering across grass or rocks to reach their destination. The mucus secretion from their skin helps them stay out of water for long periods of time.

They grow to maturity, eating crustaceans, smaller fish and plankton. Many juveniles stay in sound or estuarine areas and don't venture into riverine settings.

Scientists say eels spend from seven to 30 years upstream or in estuaries, growing to nearly a yard in length. Some mysterious signal triggers a color change and the urge to spawn.

Now silver, the mature eel makes the hazard-filled journey back to the Sargasso Sea to spawn — and die.



# Museum 'Morgue' Helps Scientists Assess Habitats

By Ann Green • Photographs by Ken Taylor

When Alvin Braswell spotted a river frog along the edge of North Carolina's Lumber River in 1974, he didn't know that he had found a rare amphibian — the last river frog ever seen in the state.

"There was no indication that there was a population problem with this frog," says Braswell, research laboratory director at the North Carolina Museum of Natural Sciences in Raleigh. "We don't know what happened to the river frog."

But thanks to Braswell's keen eye for identifying amphibians, scientists, teachers and others can view a specimen of the river frog in the museum's laboratory.

Located in a modern building on Reedy Creek Road, the lab houses thousands of specimens and skeletons of fish, amphibians, reptiles and invertebrates — from a water snake found in 1890 to a needle fish recovered in Carteret County in 1999. The lab, which is open only by appointment, also stores a small collection of bird and mammal specimens, including the vertebrae of a whale.

Most of the specimens are stored in jars of ethyl alcohol along gray shelves in dimly lit rooms. The larger ones are kept in tanks on the floor.

"Specimens are important because they tell us a lot about habitats in the state and the past and present status of a species," says Braswell.

For example, he says one species — the Neuse River water dog — is a permanent aquatic salamander that lives only in the Neuse and Tar river basins.

"The water dog has high oxygen requirements and only survives in flowing water," he says. "Surveys indicate that the Neuse River water dog is absent from areas where there are water quality problems. Areas below waste treatment plants in Raleigh and Rocky Mount didn't have any water dogs."

The disappearance of the Carolina gopher frog in New Hanover County also reflects environmental changes in the state.

"We haven't seen a gopher frog in New Hanover County in the last 10 years," says Braswell. "The decline is a result of the loss of wetlands. There has been a lot of development in New Hanover County."

Braswell says that the marble salamander, spotted salamander, chorus frog and gray tree frog that breed in ephemeral wetlands — shallow, temporary ponds that fill with water in the mid- to late-winter and dry up later — have been seriously depleted in urban areas like New Hanover, Wake, Durham, Orange and Mecklenburg counties.

"Many ephemeral ponds in the flood plains have been disrupted by increased hard surfaces and development," he says.

## Donated Specimens by the Thousand

The museum collects its specimens from a variety of sources, including university researchers, federal and state agencies, private citizens and museum staff.

"Even power companies send us specimens," says Braswell.

North Carolina State  
Fishes  
FAM: 248 Belonidae  
*Strongylura timucum*  
Atlantic Ocean, Gulf of Mexico  
United States, Florida, Hills  
Gulf of Mexico, beach and  
St. Petersburg Beach  
Lat/Long: 27.6394° N, 82.7  
Collector(s): WC Stames, I  
Date Coll.: 5 October 1999  
16 SUMMER 2001  
Field/Locality #: WCS-2155  
Label #: 2, alch: 2



In the early 1990s, Duke University gave more than 30,000 specimens of reptiles, fresh water fish and amphibians. Seven years later, Frank Schwartz from the UNC Institute of Marine Sciences in Morehead City gave over 500,000 aquatic specimens to the museum.

Although the museum doesn't put a monetary value on specimens, Braswell says Schwartz's marine collection is quite valuable. "Specimens are irreplaceable if a site has disappeared," he says.

Schwartz's collection includes a jar of shark vertebrae found in 1986 at Shallotte. "These are from 15 female and eight male sharks," says Braswell.

The museum also has a backlog of material collected from stream surveys conducted by the N.C. Wildlife Commission in the 1960s.

"These specimens give us comparative information," says Braswell. "You can go back to the stream now and find out what happened to certain species."

Scientists, policy makers and educators rely on the museum's collection and data for many purposes — from assessing pollutant levels at specific localities to biodiversity research.

"I had tremendous cooperation from the research lab on the identification of some of the fossil bivalves and ostracods that we are finding in an Amazon research project with teachers," says Lundie Spence, North Carolina Sea Grant marine education specialist. "These researchers are a wealth of information on many levels."

The museum's collection dates back to 1890 when two brothers — museum director H.H. Brimley and entomologist C.S. Brimley — wanted a place to showcase some of their skins and specimens.

"H.H. was into alligators and whales and brought the big mammals," says Braswell. "C.S. was into amphibians and reptiles and was responsible for early collections at the museum."

For many years, the specimens were housed in the basement of the old N.C. Museum of Natural Sciences in downtown Raleigh.

In 1998, most of the collection was moved to the new Reedy Creek facility with labs and large storage areas. The skeletons and skins of mammals and birds remain in the downtown facility as well as the rock, mineral and fossil collection.

To protect the specimens from ultraviolet damage, each storage room has ultraviolet shields on the lights. The areas are kept at 68 degrees.

"We couldn't stay downtown because of the large amount of alcohol — a potential hazard," says Braswell. "With many thousands of gallons of alcohol, we have to follow industrial standards. To move into the new museum would have been prohibitively expensive."

The museum's collection is separated into three areas — fish, aquatic invertebrates and amphibians, reptiles and small mammals and birds.

"I call it a morgue because it is full of preserved bodies," says Wayne Starnes, the museum's fish curator.

### **Fish Archives**

The largest collection includes more than a million fish specimens. "We have the fifth-largest regional collection of fish in the United States," says Starnes. We have a lot of freshwater species from the mid-Atlantic region and a lot of marine fishes from the western Atlantic."

The fish specimens are arranged on shelves in phylogenetic order from the most primitive species to the most advanced.

"Our collections are like a library," says Braswell. "We have all the species filed so we can find them. We have data on the specimens on computer files and backup data off-site. The collection and data are permanent. For hundreds of years, the specimens can be used as a research tool."

The primitive fish include a lamprey that migrates up fresh streams to reproduce, as well as a big jar of shark jaws found off Cape Lookout.

On the floor, a large tank houses big shark, swordfish and grouper.

*Continued*







ABOVE: Alvin Braswell shows off an alligator skull in the collection.



BELOW: Researchers and teachers can view salamanders now rare in the wild.

Moving down the shelves to the more advanced species, there is a jar of baby needle fish found by a research vessel in 1957. Near this is a large jar of flying fish found on the North River in 1986.

The collection also includes the robust redhorse — a freshwater fish found in the coastal plain and the piedmont. “The redhorse has been looked for a lot in the last 15 years, and we have found only two specimens,” says Stames.

### Mollusk Collections

In the next room, freshwater and marine invertebrates crowd the shelves.

In the freshwater section, there are about 175 species of bivalves, including freshwater clams found in all 17 river basins in North Carolina, and crayfish.

“Freshwater clams are the most endangered species in North America,” says Arthur Bogan, the museum’s curator of aquatic invertebrates. “We have already lost about 32 species in North America. Since the clams live in rivers and streams, many of their habitats have been destroyed. Dams and pollution have caused most of the problems.”

Bogan says freshwater clams are unique because of their strong ties to fish. Each mussel larvae attaches itself to a specific species of fish, including minnows, darters, bass and some catfish.

To find out more about freshwater clams, Bogan is studying several species from Southeast Asia. “There are some clams in China that appear to be closely related to clams in North America,” he says.

The mollusk collection includes wet and dry specimens. A small scotch bonnet seashell — which is the state seashell — sits on a shelf near a jar of scallops.

### Salamanders to Turtles

Moving into the next area, Braswell is like a walking encyclopaedia on different species of salamanders.

As a herpetologist, Braswell has done extensive research on the Neuse River water dog and other amphibians.

In the primitive section of salamanders, the Neuse River water dog collection includes specimens, eggs, skeletons and even stomach contents. “For each species, we try to document the different life stages,” says Braswell.

As the salamander becomes more genetically advanced, you see a jar with a congo eel that can grow to be three feet in length.

In the shelves filled with frog specimens, there are many varieties of species — from a toad frog to the tree frog.

As we approach the small oak toad that breeds in ephemeral ponds in piney woods, Braswell makes a “peep, peep” sound that echoes across the room. “The small toad’s call is like a baby chicken,” he says.

Because turtles can get quite large, many of these specimens are housed in big tanks filled with alcohol. As Braswell opens one tank, you see a female turtle with a beige shell lying on top of another turtle’s green head.

In the next tank, several Kemp’s ridley sea turtles — which are on the state’s endangered list — are floating in alcohol. On a nearby shelf, a 40-pound, mounted, brown snapping turtle that was on display at the museum for years dominates the area.

“Arsenic was used in the mount for the turtle to keep off the bugs,” says Braswell.



A skull of a large alligator recovered in 1927 from Camp Lejeune also catches your attention. "This is an example of a species that has responded well to being protected," he says. "They were in trouble and put on the endangered list. Now, they have recovered to the point that commercial harvest of alligators is allowed in some states but not in North Carolina."

A few feet away are wet bird and mammal specimens, including a jar of red bats that live in hollow trees in the coastal plain and piedmont.

"Around the country, there are not many wet birds and mammals in museum collections," says Braswell. "You mostly find skins. Our wet collection will be increasing."

### Cold-Blooded Creatures

As we move to snakes, Braswell says that North Carolina has over 37 species, including poisonous and nonpoisonous.

"Most of our snakes aren't primitive," says Braswell while pointing to a rubber boa from Oregon. "Primitive snakes live in tropical climates. Most of North Carolina's snakes are in the modern group, including rattlesnakes that are highly evolved genetically."

Braswell has spent considerable time outdoors studying North Carolina's snakes. His master's thesis at NC State was on the rat snake.

"I have examined over 1,000 rat snakes," he says. "They get in people's attics and shed skins. They can get up to six or seven feet long."

As he picks up a jar of coachwhip, he relates an old wife's tale.

"The name brings wild stories," he says. "The tail has a scaled pattern that looks like a coach whip."

In the poisonous section, there are six species from North Carolina, including the copperhead, cottmouth, timber rattlesnake, eastern diamondback rattlesnake, pigmy rattlesnake and coral snake. All six are found in the coastal plain.

The coral snake and the eastern diamondback rattler are the state's only poisonous species considered by biologists to be endangered.

The most recent sighting of a coral snake was last fall at Carolina Beach State Park. A park official saw a snake that had been run over and sent it to the museum, according to Braswell.

"The coral snake is so rare in North Carolina that we don't go looking for it," he says. "There has never been a recorded bite of a human bitten by coral snake in North Carolina."

Despite Braswell's fascination with slithery creatures, he never picks up a poisonous snake unless he must.

"I have worked with venomous snakes for years and never been bitten by one," he says. "I only handle poisonous snakes when there is no other way."

While showing the snakes, Braswell never misses an opportunity to relate their value to the environment.

"All snakes are part of their community structure," he says. "Some feed on critters we consider pests, while others give us insight on how natural systems work. Snakes give us excitement, beauty, knowledge and even contribute to medical research and cures for human ailments." ■

*The N.C. Museum of Natural Sciences lab is open only by appointment. For more information, call 919/733-7450, ext. 751, or visit the Web: [www.naturalsciences.org](http://www.naturalsciences.org).*



*ABOVE: A 40-pound, brown snapping turtle has been a museum display item.*

*BELOW: The extensive mollusk collection represents bivalves from all 17 river basins in North Carolina.*







# Taxidermy: *Ancient Practice is Now Art Form*

By Ann Green • Photographs by Scott D. Taylor

As you step inside Sandra Owens' Columbia workshop, a red fox is perched on a small wood stump, as if it is going to leap forward.

Nearby, a dark brown otter is stretched out on its belly on a dirt-like surface, as if it is just got back from a swim in the river.

Across the room, a green-headed mallard duck has its white and black wings spread out like it is going to fly away.

Owens created all these lifelike representations of animals and their habitats.

In her eight years as a taxidermist, Owens has mounted a variety of wildlife in realistic poses and settings for Goose Creek State Park, Merchants Millpond State Park, Pettigrew State Park and Hammocks Beach State Park.

For the Goose Creek Environmental Education Center, Owens designed a chunky brown beaver that looks like it is going to slap the water with its tail. The beaver is lying on a dark brown base near a tree stump embedded with teeth marks.

"Sandra is able to put the animals in the context of their habitat and works with us to make sure the poses are realistic," says Goose Creek park ranger Phoebe Wahab. "The quality of taxidermy work is critical when you are working with school children who zero in on anything that is



ABOVE: Sandra Owens has been a taxidermist for eight years.  
LEFT: Completed projects show realistic poses.

wrong. We had a bobcat that became more of a distraction than a learning experience."

Owens also mounts large and small games for hunters. Occasionally, she mounts her own game.

"A lot of people don't have the stomach to handle taxidermy," says Owens. "I have hunted a long time and been around blood."

One of Owens' most prized possessions is a 250-pound black bear that sits on a cypress stump in her living room.

With its mouth open and paw on a knee, the bear looks like it is getting ready to attack its next victim. Owens won third place for the bear in a taxidermy contest at Piedmont Community College in Roxboro.

The room also is decorated with a bear

rug near the fireplace, several mounted deer and a brown, gray and black spotted bobcat on a tree limb.

Owens gathers tree limbs, stumps and other habitat material when trekking in the woods. For a fox habitat, she found a small locust that she placed near a stump.

"I enjoy the habitat scenes as much as doing the taxidermy," says Owens. "I like my animals to look as realistic as possible."

To get her animals to look lifelike, Owens incorporates many

techniques — from tanning deer skins to sewing up bullet holes.

She also uses her artistic skills, including sculpting and painting body parts. On a recent day, she was molding a deer's ear with clay.

"I look on taxidermy as an art form," says Owens. "I used to sew for a living. I also did tole painting for a number of years."

## TAXIDERMY EVOLVED FROM ANCIENT METHODS

The practice of taxidermy evolved thousands of years ago when primitive hunters crudely formed animal skins over mud and rock for use in their hunting rituals.

*Continued*



As the demand for tanned skins increased, the methods became more and more sophisticated. By the 1700s, almost every town had a prosperous tannery business. In the 1800s, hunters began bringing their game to upholstery shops where workers would sew up the animals and stuff them with rags and cotton. "This practice produced some terrible-looking

mounts and gave taxidermy a bad reputation which still haunts the industry to this day," according to the *Taxidermy Net* Web site.

In the 20th century, taxidermy developed into a full-fledged form of wildlife art.

As taxidermy has become more sophisticated, the demand for mounting has increased.

"It is not a dying art," says Ralph Garland, a former taxidermy instructor at Piedmont Community College. "There are more taxidermists than there were 10 years ago."

In North Carolina, there are about 800 licensed taxidermists, according to Tommy Hall, president of the North Carolina Taxidermist Association.

These taxidermists are using improved products and techniques.

"In the last 10 years, taxidermy has changed a lot," says Garland. "There are more products available that counter shrinkage. Now, you can use injectable fluid to stop the shrinkage in squirrels' toes."

Garland says that manufacturers also are designing artificial animal parts that are more anatomically correct, including duck



*Dave Gossett prefers to highlight a bird's most appealing feature.*

bills, feet and legs.

By using an artificial duck's bill, a taxidermist prevents shrinkage and makes the finished product look better, he says.

#### **WATERFOWL TAXIDERMIST**

In Washington, Dave Gossett has become an expert at mounting birds.

On a recent day, a hunter had brought Gossett a white swan with a six-foot wing spread. The swan was lying on a counter, waiting to be placed in a freezer.

"I am working on at least 15 or 20 birds in various stages," says Gossett. "All have names, tags and labels."

Gossett's mounts sell for \$100 to \$800. "Birds in special habitats can run even higher," he says.

While standing near a table, Gossett uses a small needle to preen the feathers of a flying pheasant that has a "wood wool" body, made from wood shavings. After the bird dries, he will use an airbrush to color its bill and feet a bright yellow.

"Taxidermy takes a lot of patience and knowledge of individual species," says Gossett. "If you don't know about a bird's anatomy, there is no way you can do a good job."

Gossett first took a fancy to birds while hunting in North Carolina's backwoods. "When I first started waterfowl hunting, I thought the birds were so pretty that I hated to pull out the feathers and eat the bird," he says.

He takes as much pride in designing realistic habitats as mounting birds. One of his favorite settings is a black duck sitting on a

piece of driftwood in a frozen pond.

"I like to do habitats because it is a break from the routine work," he says. "People like habitats because it brings the outdoors into your home."

Across the room, a blue goose sits in a cornfield. The goose's bill is positioned like it is eating a piece of corn.

"One of the hardest parts of taxidermy is positioning the bird in its natural pose," says Gossett.

Over the years, Gossett also mounted a variety of game birds for state parks, federal agencies and hunters — from wood ducks to ringneck pheasants.

He also has reproduced endangered species, including hawks and owls.

"I only mount endangered species for parks and agencies," says Gossett. "The most unique was a bald eagle that was electrocuted in Nevada." He mounted it for the U.S. Fish & Wildlife Service.

Gossett takes great pride in each bird that he reconstructs.

"All birds are mounted to show the pretty part," he says. "I like to show off my birds as best as I can. The male wood duck is not pretty underneath. So I mount it to show the pretty feathers on the back." ■



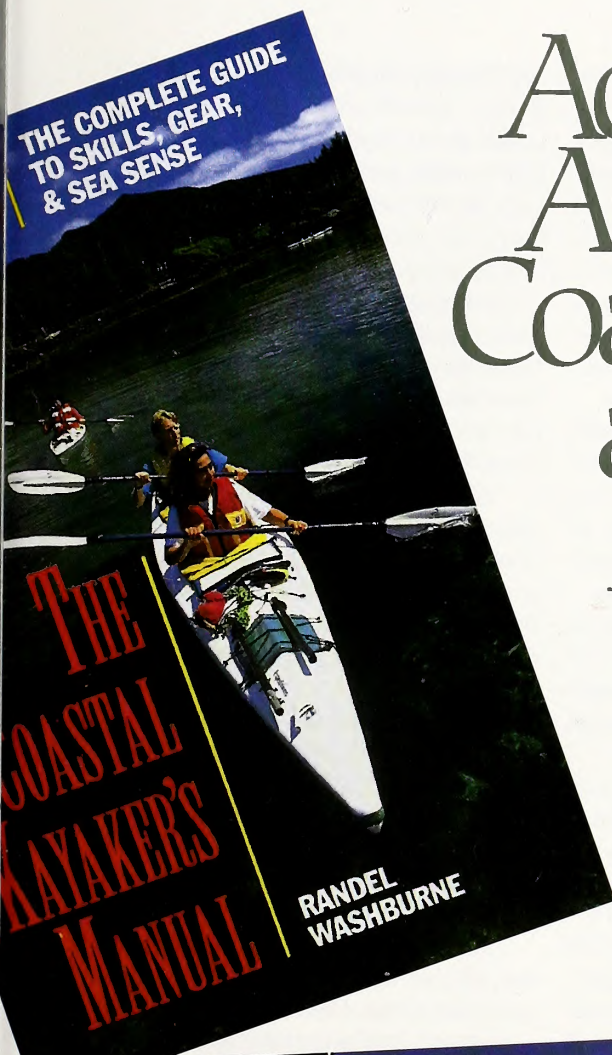
# Adventure Along the Coast is Just a Book Away

By Pam Smith

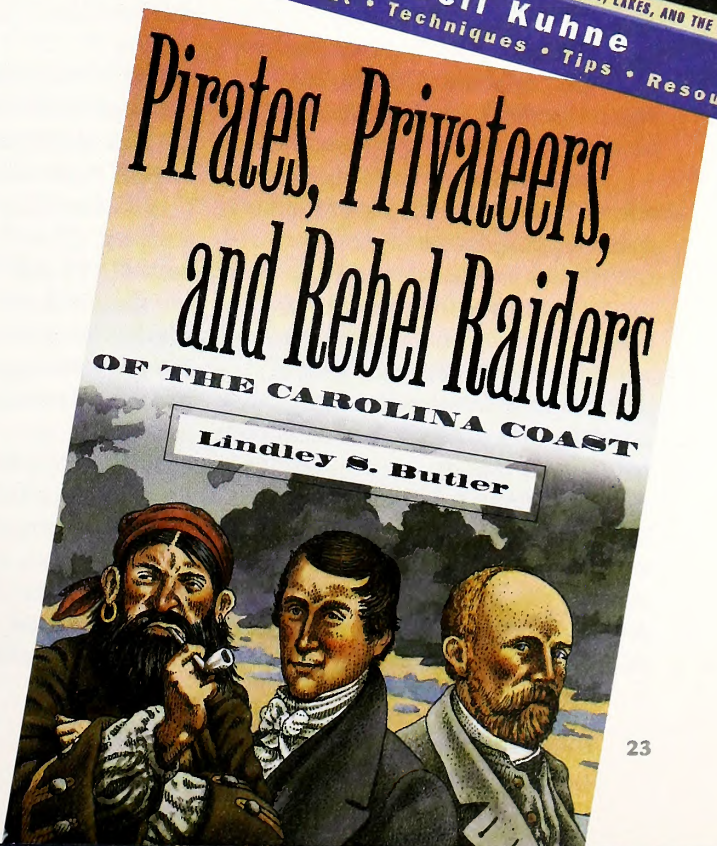
**Y**ou've been waiting all year. You thought it would never get here. But now, vacation time is just around the corner.

It's time to get serious about planning that precious leisure time.

*Continued*



**CRUISING  
GUIDE**  
To Coastal  
North Carolina  
Claiborne S. Young





The great thing about coastal vacations is that there are endless possibilities for adventure — whether it's exploring quiet tidal marshes in a kayak or sailing along the Intracoastal Waterway. Fortunately, there's an array of books to help plot out what to take, where to go and what to do along the way. After all, being prepared means making the most of every hard-earned day off.

Some vacationers prefer the adventure of soaking up local history and culture as an aside to soaking up sunrays on the beach. You guessed it. There are books that can lead you to many treasures.

Okay, so some vacationers may just want to sit it on the cottage porch with an endless supply of sweet tea and a stack of novels. But, when a sudden summer storm has the kids running in from the beach, there's even a book for them — one that combines history and adventure.

Adventure along the coast is just a book away.

• **THE COASTAL KAYAKER'S MANUAL: THE COMPLETE GUIDE TO SKILLS, GEAR AND SEA SENSE**, *Third Edition*, by **Randall Washburne**, *The Globe Pequot Press, Old Saybrook, CT 06475. 240 pages. Paperback, \$14.95, ISBN 0-7627-0168-4.*

In one volume, Randall Washburne offers a broad range of information on coastal kayaking for the novice and veteran alike. The author provides up-to-date information on the types of kayaks available — their features, performance and design. He doesn't leave a thing to chance in the gear department, listing everything from paddles to roof racks — and emergency radios.

The beginner will find a valuable lesson in the sections devoted to skills and safety. Washburne has tips on how to carry and paddle a kayak. He even devotes a section to how to fit yourself to the kayak.

The manual also covers various launching and landing scenarios. For example, "Entry and Exit from High Docks" lets you know that "You will need fairly good arm strength" to make the transition from the dock to the seat. "The key is concentrating your weight on your arms, not your legs ... Relax your arms, and the boat will move off, leaving you hanging in a dire position."

Along with his descriptive passages, the manual contains excellent photographs to help the reader visualize specific maneuvers.

Most helpful is a section devoted to paddling, including how to fine-tune your paddle stroke. He even has advice to help prevent physical problems from paddling. Zinc oxide, he says, is an excellent lubricant and healer for blister-prone areas. Gloves help, too. But, don't forget to pack the Band-Aids.

Kayaking is becoming one of the most popular forms of outdoor recreation. The trick is to do it right and do it safely. Washburne shares his years of experience in understanding personal limitations; putting safety before adventure; and enjoying the unique and exciting marine world up close.

• **THE KAYAKING SOURCEBOOK: A COMPLETE RESOURCE FOR GREAT KAYAKING ON RIVERS, LAKES AND THE OPEN SEA** by **Cecil Kuhne**, *Globe Pequot Press, Old Saybrook, CT 06475. 192 pages. Paperback, \$18.95, ISBN 0-7627-0189-7.*

Cecil Kuhne is a seasoned kayaker who has written five other paddling books. Just as the title suggests, this one is a great resource guide on equipment, techniques and tips.

For starters, how do you choose a kayak? Did you know there are whitewater kayaks, whitewater playboats, surf kayaks, sit-on-top kayaks, folding kayaks and even inflatable kayaks. If not, read this book to find out what kind of *really* need for the kind of kayak travel you want to do.

"Kayaks designed for casual touring," the author says, "are asked to do just about everything — maintain good stability, perform well at tracking, carry big loads when needed, endure heavy wave times, and yet remain relatively easy and fast to paddle."

As kayaking becomes more and more a family activity, children are beginning to paddle at early ages. Many manufacturers now offer boats designed for children. Like a good pair of running shoes, the kayak must be the right size.

Kuhne provides some guidelines for finding the right boat and includes an extensive list of models, features and prices as a starting point for the serious shopper. But he also suggests talking to experienced paddlers about their own boats.

And if you think that choosing a paddle is "no big deal." Think again. There are lots of things to consider, the author says. Like blade orientation, shape and size, as well as paddle material and techniques. The author shares experienced words of wisdom.

In the book's promotional material, the publisher says that the sourcebook gives "the unbiased low-down on equipment." And he does that well. But he also refers readers to other books or places for additional information.

More than simply list and describe equipment and gear, the author fills us in on the history and evolution of the sport. He writes about interesting expeditions and exciting rescues.

Kuhne also provides a glossary of terms for the uninformed kayaker. There's even a listing of kayaking clubs to contact from coast to coast.

*Knowing where to kayak on the North Carolina coast is getting easier, thanks to North Carolina Sea Grant and partners. A Web-based trail map is being developed to help enthusiasts navigate the state's expansive coastal waters. Click on [www.ncsu.edu/paddletrails](http://www.ncsu.edu/paddletrails) for information.*



• **CRUISING GUIDE TO COASTAL NORTH CAROLINA, FIFTH EDITION**, by Claiborne S. Young, John F. Blair, Publisher, Winston-Salem, NC 27103. 380 pages. Paperback, \$24.95. ISBN 0-89587-199-8.

“What a treat it is to anchor for the first time in a cove miles from civilization and to see the incredible array of stars in the clear coastal sky,” the author writes in his introduction. “Such anchorages give mariners an opportunity to feel something akin to what the early settlers must have felt when they first explored this storied coastline.”

In this updated edition of his popular sailing guide, Young attempts to guide cruising captains “to marinas hidden behind a bend in a creek or in the middle of nowhere.”

Along with providing navigational details, Young reviews a number of dockside dining spots. “Unless you happen to dislike all forms of seafood, coastal dining will never be an unpleasant experience,” he writes.

He throws in lessons in history and geography, mixed with a lot of sociology. He reminds the reader that for many years in the state’s early history, coastal communities were isolated — the sea lanes the main communication with the outside world. There grew from this isolation a tradition of storytelling, folk tales and legends. “Through these tales, the unique character of the coastal native can be understood and appreciated.”

He cautions that from mid-March to mid-May, cruising conditions range from good to “simply awful” and that inlets along the coast should be considered hazardous. “Aids to navigation at most North Carolina inlets are seldom charted because they are frequently shifted to mark the ever-changing sands.”

So, be well warned before hoisting the sail and following the course he describes in his book. On the first leg of the cruise, he takes you through the Dismal Swamp, all the way to Elizabeth City — and all the

historical bases between those points. And so it goes until the cruise concludes in Southport on the historic Cape Fear.

In short, in this one book, the boater has a complete guide to the coastal waters of North Carolina. With more than 3,000 miles of coastal, sound and estuarine shorelines and the largest area of inland waters on the East Coast, there is a lot to discover.

The guide includes navigational data, information on anchorages on and off the Intracoastal Waterway, warnings about specific danger areas, detailed information on marinas and facilities, and colorful historical sketches.

Young is an experienced boater who spent months researching this book so that all the recommendations and navigational data could be based on personal and recent experience.

*North Carolina Sea Grant has a number of publications on boating safety. For a complete listing, log on to our Web site at [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant).*

• **PIRATES, PRIVATEERS, AND REBEL RAIDERS OF THE CAROLINA COAST** by Lindley S. Butler, The University of North Carolina Press, Chapel Hill, NC 27515. 296 pages. Paperback, \$15.95, ISBN 0-8078-4863-8; hardcover \$29.95, ISBN 0-8078-2553-0.

North Carolina’s maritime history — at times unsavory — is illuminated in this book by historian Lindley S. Butler. The author covers 150 years from the “golden age of piracy” in the 1700s to naval warfare ushered in by the Civil War. The stories of eight larger-than-life figures — including the infamous Blackbeard, privateer Otway Burns, and Confederate raiders James Cooke and John Maffitt — are presented in the context of their historical times. Butler goes beyond the myths surrounding these legendary figures to tell the true stories of their lives and adventures.

“These North Carolina heroes and rogues shared similar personalities and experiences. They were all skilled seamen

and decisive, imaginative leaders who possessed a deep thirst for adventure, at times pursuing danger with a reckless abandon,” Butler writes of his subjects.

To explain how colonial North Carolina became a haven for the likes of Blackbeard, he suggests, “Carolina’s isolated backwaters provided a perfect haven for the vagabond pirates, and equally appealing were the weak authority of proprietary officials, the sparse settlement and the relative poverty of the colony.”

The author sheds light on the remarkable fact that in spite of the nature of their “business,” a pirate community saw the need for rules to curb antisocial behavior, to address health and safety concerns, or to compensate sailors for injury. Rules devised by Captain John Phillips in 1723 for the *Revenge* warn sailors that stealing from the company would result in being marooned with one bottle of powder, one bottle of water and “one small shot.” Instant death would come to any sailor who dared to “meddle” with a woman without her consent.

He also explains that a privateer was a privately owned, armed ship licensed by the government in time of war to seize enemy ships or prizes. “In effect,” he says, “it was legalized, limited piracy.”

Butler, professor emeritus of history at Rockingham Community College, is a specialist in the colonial era. He has assisted in the excavation of the recently discovered shipwreck thought to be Blackbeard’s flagship, the *Queen Anne’s Revenge*. He says the work on the project has made the history of the Carolina coast more exciting to him than ever.

The book is a must for history buffs with a taste for adventure. It is a fun, well-documented and -illustrated work of nonfiction.

*For a close look at North Carolina’s historical ties to the sea, visit the N.C. Maritime Museum in Beaufort. You’ll see artifacts from Queen Anne’s Revenge and much more. For more about Blackbeard, click on: [blackbeard.eastnet.ecu.edu](http://blackbeard.eastnet.ecu.edu). □*



# Counting Dolphins

By Cynthia Henderson

Like the most diligent detective who pores over countless mug shots, Kim Urian is a pro at getting a make on individuals from minute details in photographs. But hers aren't the usual suspects, and she is a most unusual detective.

Urian identifies bottlenose dolphins from dorsal fin markings and maintains a photographic record of individuals of the species from New Jersey to Florida. Officially, she is curator of the Mid-Atlantic Bottlenose Dolphin Photo-ID Catalog, established by the National Marine Fisheries Service (NMFS) as part of its program for stock structure assessments.

Recently, Urian played a key role in a study proposed by commercial fisher Bill Foster of Hatteras and funded by the North Carolina Fishery Resource Grant Program (FRG). The project was a photographic survey of bottlenose dolphins that inhabit North Carolina sounds and estuaries in northern, central and southern coastal regions.

The idea was to conduct what scientists call a "mark-recapture" study. Instead of tagging dolphins with physical markers, researchers "marked" them photographically and "recaptured" them on film a week or so later.

The technique is not new and drew on the experience of other researchers such as those in Nags Head Dolphin Watch, featured in *Coastwatch* last year. But this was the most comprehensive survey ever done in the North Carolina. The results were surprising: The number of bottlenose dolphins identified in the state's inshore

waters is nearly half of what has been presumed to be the total population along the entire eastern shore of the United States.

In addition to Urian, a unique assemblage of experts came together for the project. Andy Read, assistant professor of marine conservation ecology at Duke University Marine Lab in Beaufort (and Urian's husband), coordinated field surveys and assisted with statistical analysis.

Foster acted as general coordinator and contributed his knowledge of waterways accumulated in 29 years in commercial fishing. He also holds a master's degree in ecology from North Carolina State University. This was not his first project with marine mammals. In a previous FRG grant he established, along with Read, a whale disentanglement network to rescue whales caught in fishing gear.

Ben Wilson of Scotland, internationally recognized for his research with bottlenose dolphins, helped with research design and data interpretation.

Commercial fishers, wildlife officers, fishhouse workers and others who work on the water played an invaluable role as informants, providing "leads" on dolphin sightings to Ann Pierce, in Sea Grant's Manteo office. Pierce relayed the sightings to researchers on the water.

"I've never had a cell phone ring as often out on a boat," Read says.

And Pierce, described by Read as a "dynamo," even took to the air one day for a bird's eye view from a Cessna to help locate schools of dolphins.

*Continued*

*The idea was to conduct*

*what scientists call a*

*"mark-recapture" study.*

*Instead of tagging dolphins*

*with physical markers,*

*researchers "marked"*

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*and "recaptured" them*

*on film a week or so later.*





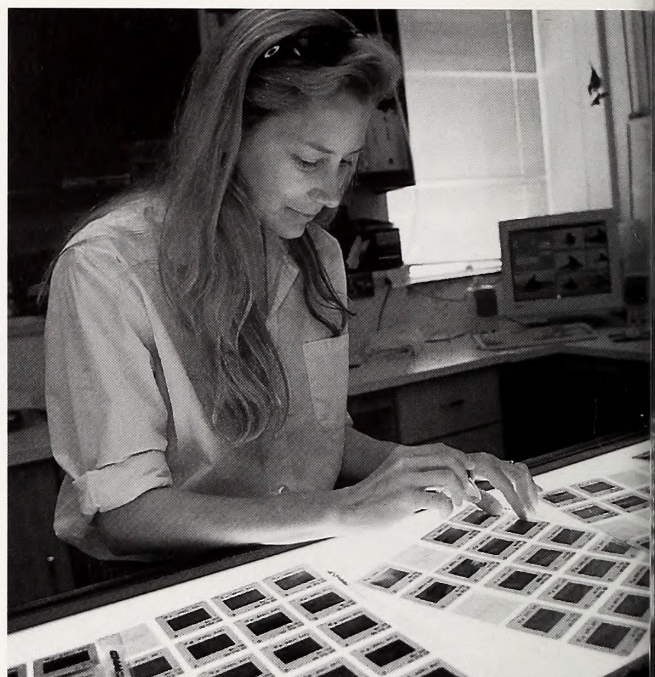
Scott D. Taylor

*Researchers Kim Urian and Andy Read worked on a dolphin survey funded by the Fishery Resource Grant Program.*



Michael Halmnski

Scott D. Taylor



Bill Foster of Hatteras attests that dolphins are attracted to commercial fishing vessels.

Kim Urian reviews slides to identify individual dolphins.

“This project is an example of what FRG does best,” Read says, “having government, fishermen and researchers working together to solve a common problem.”

For Foster, the project was an opportunity to confirm what he had witnessed about bottlenose dolphin abundance and to contribute data to help guide fishery management.

#### WHY STUDY THE BOTTLENOSE?

People find bottlenose dolphins inherently fascinating. With brains nearly as large as human brains, the bottlenose is, by our standards, very intelligent. Easily trainable, they are the species most often seen in oceanariums. With large, wide-set eyes, a mouth seemingly set in a perpetual smile and a propensity for graceful gymnastics, dolphins just enthrall us.

And we fancy they like us, too. Since the Greek god Apollo became a hero at sea by assuming the form of a dolphin, legends have persisted about the animals guiding ships to safety.

Pragmatist Foster calls such romantic notions “the Flipper view,” from the once-popular TV show whose star was a bottlenose.

Subliminally, the show may have given an unintentional nod to the animal’s relationship to horses by having Flipper give the occasional ride to humans.

Read says dolphins descended from land mammals, some of whom returned to the sea 50 to 55 million years ago. Those remaining on land evolved into ungulates, a group that includes hippos, cows and horses.

But our fascination for dolphins is not the most pressing reason for a study on species abundance. Dolphins face dangers that present unique management problems.

Foster personally attests that dolphins are attracted to fishing boats — a fatal attraction when they get tangled in gear and drown, he says. In fact, Foster says he has seen what he believes is a change in dolphin behavior over the last 10 years or so, with more approaching boats looking for food. He attributes this to people feeding dolphins, a practice now illegal under the Marine Mammal Protection Act.

Managing fishing activities in areas of dolphin concentrations is a major reason for studying abundance of the animal. Results from this photo-ID study indicate that some

of our assumptions about dolphin populations may have been wrong.

#### THE QUESTION OF ABUNDANCE

Coastal visitors and residents became alarmed when, in 1987 and 1988, bottlenose dolphins began washing up on shores all along the eastern United States. “We tend to think of these animals as ecological sentinels,” Read says, and people began worrying about water quality and whether there was a danger to humans.

The die-off was determined to be the result of a morbillivirus, which is similar to distemper in dogs and is not a danger to humans. The damage to dolphins was deemed great, however. By some estimates, 50 percent of the bottlenose dolphin population of the eastern shore was lost to the virus, and the species was listed as depleted in the federal Marine Mammals Protection Act.

Yet Foster notes that in years since the die-off, “to people living up and down the coast, it looked like as many (dolphins) as ever.”

The problem according to Read, is that there was a lack of good surveys before the die-off, so there was “a lot of uncertainty about the



Danielle Waples



*Dolphins that frequent sounds often have distinct dorsal fins.*

number of dolphins that died and what effect that had on the population.”

Previous NMFS surveys had relied on aerial counts and did not include inshore waters — despite evidence that many dolphins inhabit bays, sounds and estuaries during summer months, according to Read.

Aerial surveys are not practical over inshore waters because of the complexity of the water systems and the murkiness that cuts down on visibility. And individual dolphins cannot be identified from the air, Urian says.

### STUDY FUNDAMENTALS

Three boats were used simultaneously in northern, central and southern regions. Each vessel was to have a photographer, data recorder and skipper. “Out on the water, everybody did everything,” Urian says. Photographs were taken with 35-mm cameras with 300-mm lenses.

While some people pay good money to go on “dolphin watches,” this was definitely work. The final report acknowledges researchers enduring storms, isolation and greenheads — deer flies, Foster explains — in the north, and “long stretches with no sightings” in the south.

At the Duke Marine Lab, Urian pulls a ring binder full of slides from a shelf of others just like it. About three inches thick at the spine, each represents one day’s work. Duke research assistant Danielle Waples and graduate student Leigh Torres, who also participated in the study, work nearby while Urian points out slides showing distinct notches on dorsal fins.

Waples had the arduous task of sorting through over 7,500 slides, eliminating those of poor quality. The remaining 3,457 slides were independently graded by both Urian and Waples, who compared ratings according to a precise protocol established by Urian for the mid-Atlantic bottlenose dolphin catalog.

Subjectivity in identification

was minimized by the use of a computer program from the University of Texas Medical Branch called Finscan. Each qualifying slide was digitally scanned, and the dorsal fins traced.

The final call on identity, however, is a human one. Identifying dorsal fin markings requires skill in pattern recognition, Urian says. And after identifying more than 1100 individual dolphins, a sense of humor can’t hurt either. “They have names,” she says, laughing.

At naming parties with undergraduates, dolphins got names like “Jay Leno” and “Elvis” because of the profiles their dorsal notches resemble. And then there’s “Bugs,” for unknown reasons.

When all the data was in, 1,154 dolphins were estimated to inhabit North Carolina inshore waters in July 2000. Prior to this study, the minimum population estimate for the East Coast from New Jersey to central Florida was 2,482.

Besides the large number of dolphins, the researchers found evidence that more than one population of dolphins exists rather than just one as was previously thought. Urian says

studies like this one can help point out “hot spots” where dolphin interactions with humans can cause problems.

Single populations have genetic factors in common, Read says, even though individual dolphins may travel outside a group. Urian adds that some dolphin populations seem to have more “site fidelity” than others do. This has important implications for fisheries management.

If a small population exists in an area where fishing pressure is particularly intense, then an entire population could be wiped out, Read explains. Identifying populations can help make fishery regulations more site-specific, protecting the species “without burdening fishermen with unnecessary restrictions” in other areas, he adds.

Read says NMFS is very interested in the findings of the study. In a summary of the project, the researchers write, “We hope that our results will form a benchmark against which future monitoring efforts may be measured.” □

### GUIDE TO MARINE MAMMALS AND TURTLES AVAILABLE

*Rhode Island Sea Grant won a 2000 National Outdoor Book Award for its outstanding Guide to Marine Mammals and Turtles of the U.S. Atlantic and Gulf of Mexico.*

*The 114-page guide is a compact compendium of useful information for ocean-goers or anyone curious about cetaceans (whales, dolphins and porpoises), seals and manatee, and sea turtles.*

*Each entry has color illustrations, maps showing species distribution and a fact list with physical, behavioral and abundance data.*

*And, since many encounters with sea mammals are brief and at some distance, profiles are provided of both the featured species and others with which it can be confused. The sea turtle section has details of head, surface and shell outlines.*

*Single copies cost \$25. Send a check to North Carolina Sea Grant, NCSU Box 8605, Raleigh, NC 27695-8605 or call 919/515-9101.*



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# Coastwatch

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A Sea Grant Journey



## Sea Grant Storytelling

I'm honored when readers tell me they eagerly await a new issue of *Coastwatch* because we can tell coastal stories well.

Of course, we're always telling stories of researchers on the cutting edge of marine science — but that's not all. From little-known histories of coastal communities to controversial debates regarding coastal policy or tips on catching and preparing favorite seafoods, each issue should provide new perspectives on one of your favorite places to live or to visit.

We especially hope that you will enjoy the stories in this issue dedicated to the 25th anniversary of the North Carolina Sea Grant College Program. Yes, it is larger — 50 percent larger — to give us more room to tell you about Sea Grant. (Sorry, but *Coastwatch* will be back to its normal size come autumn.)

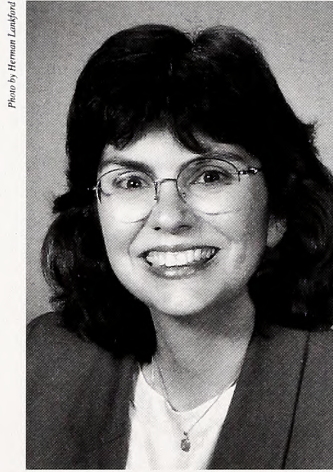
Even with this extra room, there is no way we could tell the complete story of North Carolina Sea Grant in one issue. That's why we opt to take you on a coastal journey, making a few stops to meet folks who show the past, present and future of Sea Grant.

We start out with a quick travel guide — snapshots of the Sea Grant efforts in the past 25 years — to get you thinking about countless opportunities on the trip ahead.

Unlike your summer vacation, our journey includes a trip back in time, to the days when Sea Grant was simply a twinkle in the eyes of the state's leaders in marine science and policy.

On the northern coast, we invite you to meet Joey Daniels, a member of our Outreach Advisory Board, a panel that provides feedback on our extension and communications programs to make sure we are meeting coastal needs. Not only can you visit with the extensive Daniels family, but you also get a tour of Wanchese, which has seen its own changes in the past quarter-century.

It's time to put on your waders — we're going on a marsh hike. The first North Carolina research project funded by the National Sea Grant program was on estuarine research. We are still working on estuarine issues, including the continuing battles with harmful algal blooms.



We pause a bit to reflect on blue crabs — the largest commercial fishery in the state — whose Latin name refers to beautiful swimmers. Sea Grant's newest effort is a state-funded blue crab research program. But, like the state, we have a long history with the blue crab, including early demonstration projects that counted on the help of veteran crabbers like Murray Bridges.

Prepare yourself to move from the present to the future. For years, Sea Grant has included coastal communities in Sea Grant research, but coastal residents themselves now have the opportunity to propose and conduct research projects through the state-funded Fishery Resource Grant Program.

And Sea Grant ensures strong science in the policy arena by placing graduate students in the Knauss Marine Policy Fellowship program. Both these programs identify opportunities to keep science in the communities and before decision makers — critical needs for the future.

Like most tours, the time is up before you know it. We are already on the southern coast, checking in on the multidisciplinary efforts by the Sea Grant researcher Martin Posey, an award-winning faculty member at the University of North Carolina at Wilmington.

Well, it looks like I am running out of time and space, but I can't sign off without saying what fun it has been working on this project. I want to spend more time going through old issues of *Coastwatch* and earlier Sea Grant newsletters.

I am humbled to be in the company of former Sea Grant communications coordinators. For example, Karen Jurgensen is now editor of *USA Today*. Nancy Davis is now associate vice chancellor at the University of North Carolina at Chapel Hill handling public relations. And Kathy Hart is now associate executive director of the North Carolina State University Alumni Association.

And of course, there have been many other talented folks who not only wrote for *Coastwatch*, but provided a wide variety of products. I thank them all for providing such a solid groundwork for us to usher North Carolina Sea Grant into our next quarter-century.

*Katie Mosher, Managing Editor*

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# Coastwatch

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, North Carolina Sea Grant supports several research projects, a 12-member extension program and a communications staff. Ron Hodson is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

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Front cover photo of a Carolina estuary by Scott D. Taylor.  
Table of contents photo of estuary by Scott D. Taylor.  
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## COASTAL TIDINGS



Photo courtesy of NCST Communication Services

### Double Celebration at NC State

Barbara Doll, North Carolina Sea Grant water quality extension specialist, has been named an Environmental Hero for 2001 by the National Oceanic and Atmospheric Administration (NOAA).

The program recognizes individuals for their "tireless efforts to preserve and protect the nation's environment." Doll was cited for her leadership — as a volunteer and as a professional — in focusing attention on critical water quality issues.

Her award was presented by Sea Grant Director Ronald Hodson during groundbreaking ceremonies for the Rocky Branch Stream Restoration and Greenway Project on the North Carolina State University campus.

Doll initiated and designed the multimillion-dollar restoration project to

improve water quality, enhance aquatic and wildlife habitats, and transform the stream into a vital part of campus and community life. The ultimate goal is to improve the quality of the water flowing downstream into the environmentally sensitive Neuse River basin.

For nearly a decade, Doll has collaborated with the university's Facilities Division to raise more than \$4 million in grants from federal and state sources to launch the project. When complete, it is expected to become a national model for urban stream revitalization.

Statewide, Doll collaborates with colleagues from the N.C. Cooperative Extension Water Quality Group to lead field study groups and conduct workshops emphasizing the need for watershed land use/water quality planning.

— P.S.

### In the Next Issue of *Coastwatch*

The Port of Wilmington has played an important role in North Carolina's history and economic growth. Pam Smith looks at what port expansion means for surrounding communities and the state. And join Ann Green as she follows kayakers exploring scenic paddling trails on the Pamlico River.



## September Lecture Set for UNC-W

As part of its ongoing 25th anniversary celebration, North Carolina Sea Grant will co-sponsor a Planet Ocean Lecture at the University of North Carolina at Wilmington.

Former Rhode Island Sea Grant Director Scott Nixon will discuss estuarine research at the event Sept. 4 at the Center for Marine Science (CMS) off Masonboro Loop Road.

"Scott has studied estuarine systems across the globe, including the Nile," says Sea Grant Director Ronald G. Hodson. "We are pleased that he can bring his unique insight to North Carolina."

The Planet Ocean Lecture Series brings outstanding scientists to UNC-W to share their research with the university community and general public, explains Daniel Baden, CMS director.

The free program begins with a reception at 6 p.m., followed by the lecture at 7 p.m. Seating is limited. To make your reservation, call 910/962-2301. — K.M.

## Hurricane Preparedness Saves Lives

Hurricane hazards come in many forms for residents and visitors in low-lying coastal areas — storm surge, high winds and flooding. North Carolina Sea Grant experts say awareness and planning are the best



Photo by Spencer Rogers

ways to maximize personal safety and minimize property damage.

First, develop a family plan based on vulnerability to hurricane hazards. Keep a written copy handy and share it with family and friends.

If a hurricane watch is issued for a coastal area, hurricane conditions are possible within 36 hours. Swing into action. Fill the family car gas tank, store outdoor objects such as furniture and garbage cans, tape or board windows, and pack valuable papers such as deeds, wills and insurance documents to take along should evacuation orders be sounded.

Create a survival box with a first-aid kit, family members' prescription

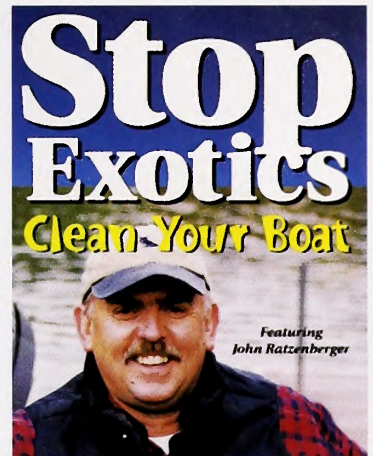
medications, flashlight and transistor radio, extra batteries, bottled water and water purification tablets, nonperishable foods, one change of clothes and sleeping bags.

When a hurricane warning is

issued, the storm is imminent. Prepare to evacuate at once. Monitor emergency radio for evacuation instructions and storm updates. Contact family and friends to let them know your plans. Before leaving, shut off power and the main gas valve.

The National Hurricane Center has a Web site with detailed hurricane preparedness information. Check it out at [www.nhc.noaa.gov/HAW/](http://www.nhc.noaa.gov/HAW/). For information about constructing or retrofitting buildings for hurricane resistance, contact Spencer Rogers, Sea Grant coastal erosion and construction specialist, at 910/962-2491, or [rogerssp@uncwil.edu](mailto:rogerssp@uncwil.edu).

— P.S.



## Cheers' Wise Guy Goes Boating

John Ratzenberger — also known as Cliff Clavin in *Cheers* — has been doing more than occasional commercials since *Cheers* went off the air. Ratzenberger stars in *Stop Exotics: Clean Your Boat*, an informative yet entertaining video about invasive species courtesy of Minnesota Sea Grant.

The video thoroughly describes how boaters can avoid spreading aquatic nuisance species between bodies of water. Ratzenberger eagerly learns the required tasks, remaining in his *Cheers* persona. "The human brain is a sponge," he says, "and this one is super-absorbent."

Though there are many invasive species threatening U.S. waterways, the video concentrates on the most dangerous culprits, including zebra mussels, Eurasian water milfoil and *Hydrilla*. North Carolinians should be on alert for these species as well.

The video concludes with a heartfelt yet comic speech on the importance of protecting waterways so that they can be enjoyed for years to come.

To order *Stop Exotics: Clean Your Boat*, send a check for \$10 to Minnesota Sea Grant, 2305 E 5 St., Duluth, MN 55812. For more information, e-mail [seagr@d.umn.edu](mailto:seagr@d.umn.edu) or call 218/726-8106.

— D.M.D.



## North Carolina Aquariums Celebrate 25th Anniversary

### Grants Cover N.C. Coast

The votes are all in, and the winners are... residents who are active in fishing industries in all of North Carolina's coastal regions. More than \$800,000 has been earmarked for 22 projects in the 2001 Fishery Resource Grant program.

The grants are available for research that involves North Carolina citizens who are active in a commercial or recreational fishing industry, aquaculture, or the handling of fish products.

From Wilmington in the south to Shiloh in the northern region, coastal residents are proving that good ideas for enhancing or protecting fishery resources can come from those who are most intimately involved in those resources.

The grants are funded by the N.C. General Assembly and administered by North Carolina Sea Grant.

"This year there was great diversity in the projects funded. They covered aquaculture of many local species. Other projects examine the effects of trawling on bottom habitat, alternative fishing gear, bycatch and fisheries economics," says Steve Rebach, Sea Grant associate director.

For a complete list of recipients, log onto [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant) and follow the research links.

Applications for the 2002 funding cycle will be due Nov. 30. For more information, call Rebach at 919/515-2454 or FRG coordinator Bob Hines at 252/222-6312. —C.H.

"Up close and personal" best describes the North Carolina Aquariums experience.

In 1976, the aquariums at Roanoke Island, Bogue Banks and Fort Fisher — originally named N.C. Marine Resource Centers — had little more than a few static displays and invertebrate species. Still, they drew visitors, young and old, curious about the world beneath the sea's surface.

Lee Dawkins of Pine Knoll Shores remembers the aquarium's humble beginnings when she and her family first visited in 1983. "We've watched tanks go from small to large, new exhibits go up, reptiles become part of programs and exhibits, another nature trail open for visitors," she says.

The aquariums originally focused on education and research, but that changed when more and more visitors like

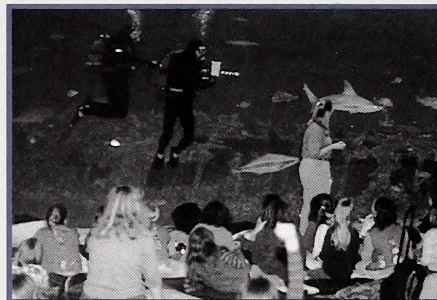


Photo courtesy of N.C. Aquariums

Dawkins showed interest. Aquariums Director Rhett White says, "That encouraged us to expand our general programming in the same direction." In response, the NCMRC was

renamed the N.C. Aquariums in 1986.

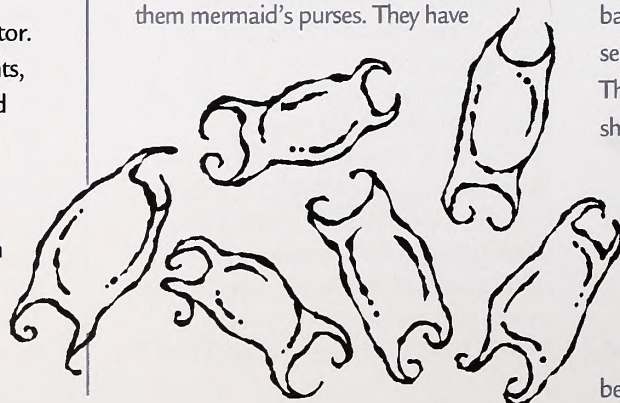
The following year, the Roanoke Island facility opened its most successful exhibit so far, the Grady White Shark Gallery. Since then, watching the divers in the shark tanks has become just as popular as watching the sharks, according to Lisa Schell, the public relations manager.

As part of their Silver Anniversary, the aquariums plan to add 175 species to their exhibits — including river otters, some smaller fish, and several poisonous snakes indigenous to North Carolina.

For more information on upcoming events, visit [www.ncaquariums.com](http://www.ncaquariums.com) on the Web. —D.M.D.

## Beach Bag Bounty

Looking at the small black cases that washed up on the sand, you can understand why some fanciful person first called them mermaid's purses. They have



a glossy, elegant look when wet, and a curled tendril adorns each of the four corners.

But instead of holding a mermaid's baubles, these cases that fit in your hand serve a much more important purpose. They originally held eggs laid by a diamond-shaped fish called a skate.

Skates are flat like a disk, but with a tail. More than 200 species of skates live in waters throughout the world. Although they may not inspire romantic images of mermaids themselves, their nurseries enchant beachcombers of all ages.



## Web Site Identifies Rip Current Threats

Rip currents can be deadly — but this year cautious swimmers may surf the Web before hitting the surf.

The National Weather Service (NWS) now offers online rip current forecasts for most North Carolina beaches. Developed in cooperation with North Carolina Sea Grant, the sites provide twice-daily updates from the Myrtle Beach, S.C., area north to Dare County, N.C. Easy-to-read maps alert the public if conditions along various strands pose a low threat, increased threat or dangerous threat from rip currents.

“The main goal of the NWS rip current program is to warn the public when there is a likelihood of dangerous rip currents,” explains Steven Pfaff of the NWS Wilmington office.

For rip current forecasts for Pender, New Hanover and Brunswick counties in North Carolina, and the

Myrtle Beach, S.C., area, go to <http://nwsilm.wilmington.net> and follow the rip currents link.

For information on Dare, Hyde Carteret and Onslow counties, go to <http://tgsv5.nws.noaa.gov/er/mhx/> and follow the links for local threats.

The NWS office in Wakefield, Va., expects to add rip current forecasts for its region, which includes Currituck County, N.C., and the Virginia Beach area.

Background information on rip currents is available on the sites. In addition, North Carolina Sea Grant offers a brochure that emphasizes the signs that rip currents may be present — and the appropriate response.

“The key message is: Don’t Panic,” says Spencer Rogers, North Carolina Sea Grant coastal construction and erosion specialist. “If you are caught in a rip current, swim parallel to shore.”

— K.M.

## NC State Seafood Lab Honored

North Carolina State University’s Seafood Science and Technology Program in Morehead City received top honors from the North Carolina Cooperative Extension Service.

The program, often referred to as the NC State Seafood Laboratory, was one of three winners of the annual Extension Education Award.

The lab team includes director David Green, who also is director of the Center for Marine Sciences and Technology and a North Carolina Sea Grant researcher; and Barry Nash, North Carolina Sea Grant seafood technology and marketing specialist.

The lab staff includes technician Greg Bolton and public information assistant Lorraine DiBella. Joyce Taylor, a retired Sea Grant seafood education specialist, works part-time at the lab.

The lab’s seafood science and technology program provides educational opportunities for industry, regulatory and consumer groups on issues related to fish and fishery products, public health topics and marketing.

In recent years, the lab has sponsored training for North Carolina seafood dealers, processors and regulatory officials in seafood sanitation and Hazard Analysis and Critical Control Point (HACCP) safety regulatory practices.

The lab staff also helps seafood businesses develop value-added seafood products. By using a cold-binding technology developed by NC State Food Science Department, the staff helped the Wanchese Fish Company create uniformly-sized medallions from scallops.

— A.G.

## September Sweep-Up

September is time to celebrate a Sea Grant legacy: The North Carolina Big Sweep.

This year, volunteers will gather across the state on Sept. 15 to clean up the beaches, sounds and inland waters.

But if you can’t participate that day, don’t fret, says Lundie Spence, North Carolina Sea Grant marine education specialist and Big Sweep founder. Environmental awareness is a year-round activity.

“Every time you visit the coast or a stream, look for litter and debris,” Spence says. “A foam cup or plastic milk jug can be dangerous to sea birds, turtles and other creatures.”

If you would like to volunteer for the official Big Sweep program, now in its 15th year, contact the coordinator in your county. For more information, call 800-27-SWEEP. — A.G.



# SERVING NORTH CAROLINA: Diverse Sea Grant Efforts Making A Difference

*A Coastwatch Staff Report*

Since its earliest days, North Carolina Sea Grant has focused on dozens of coastal topics, funded hundreds of researchers and had direct contact with thousands of residents, teachers and community leaders.

Here are a few snapshots of the efforts over the 25-plus years of Sea Grant projects to enhance and preserve coastal resources.



Charlene Couch, left, and Ronald Hodson, right, spawn fish at the Pamlico Aquaculture Field Laboratory. *Photo by Scott D. Taylor*

## AQUACULTURE

As seafood consumption increases annually, and concerns are raised about potential depletion of wild fish stocks, aquaculture has moved into the national spotlight. North Carolina Sea Grant has been a national leader in cutting-edge research and the quick transfer of those results to on-the-fish-farm demonstrations. Highlights of this work include:

- ◆ Development of breeding strategies and pond technology for hybrid striped bass, which is now a multimillion-dollar industry including 30 or more growers and several hatcheries in North Carolina alone;
- ◆ Continuing research into reproductive physiology and genetic coding to develop a domesticated broodstock for hybrid striped bass;





Sea Grant research led to requirements for deeper pilings to provide resistance for oceanfront homes. Photo by Spencer Rogers



Marine educator Lundie Spence shows teachers the treasures to be found along Cape Hatteras beaches. Photo by Michael Halminski

- ◆ Initiation of a flounder aquaculture program based on lessons learned with hybrid striped bass;
- ◆ A multidisciplinary approach that includes research on fish disease and immunology as well as optimal nutrition in fish feed; and
- ◆ Support of shellfish aquaculture through research and outreach, including an innovative off-bottom system for oyster culture.

## COASTAL PROCESSES

Since 1974, development along the North Carolina coast has been governed by the Coastal Area Management Act. Sea Grant research provided the background not only for much of the original act, but also for the ongoing updates and current discussions regarding the natural hazards along the barrier islands and surrounding estuarine waters. Highlights of this work include:

- ◆ Research and outreach programs on the role of sand dunes — and critical dune plants — in protecting oceanfront property;
- ◆ Similar efforts regarding marsh grasses and low-cost structures for shoreline erosion control;
- ◆ A guide for buying vacation real estate, developed in partnership with the N.C. Real Estate Commission and the N.C. Division of Coastal Management;
- ◆ Research leading to building code requirements for deeper pilings to brace oceanfront homes against hurricane-force wind and storm surge. In Hurricane Fran, 500 older homes with shorter pilings were destroyed, but newer homes with deeper pilings remained; and
- ◆ Studies outlining requirements for sheet-metal connectors that do not corrode quickly in the harsh coastal conditions.

## MARINE EDUCATION

To educate people of all ages about the state's marine environment, Sea Grant has developed a variety of educational programs — from a coastal issues course for graduate students to a seminar on flood effects for teachers. Marine educator Lundie Spence also led coordination of the first environmental education course in the University of North Carolina System at four universities. In addition, Sea Grant has:

- ◆ Through partnerships with UNC-TV and others, brought science to the public by developing documentaries on Hurricane Fran and harmful algal blooms. The videos also provide teachers up-to-date research on hurricanes and water quality issues, including *Pfiesteria*;
- ◆ Developed curricula on coastal topics, including geology, seawater and ecology;

*C o n t i n u e d*



- ◆ Conducted cutting-edge workshops, including:
  - Sea to Mountain program, which allowed educators to follow over 1,000 miles of water in eight days — from Bald Head to Nantahala;
  - Paddle to Sea Program, which encouraged teachers to incorporate interdisciplinary sciences by following a drop of water from Lake Phelps to the Gulf Stream; and
  - Project COAST — a national summer program providing professional development for teachers — from science concepts to field experiences, including an air tour of the northern Outer Banks.
- ◆ Produced *Conchshell* newsletter — a free publication for more than 2,000 North Carolina educators — since 1978; and
- ◆ Encouraged community understanding of coastal resources through projects such as the Big Sweep waterway clean-up.

## WATER QUALITY

Water touches every aspect of life in coastal North Carolina, providing drinking water from subsurface aquifers and habitat for countless species in surface bodies of water. As North Carolina's population grows, the challenge will be to maintain clean water. To enhance water quality, Sea Grant has:

- ◆ Invested in research to study coastal water quality, including groundbreaking work in 1970 to determine the role of nutrients in the Albemarle/Pamlico and Neuse estuaries;
- ◆ Launched a storm drain stenciling project in 1992, the Year of the Coast, to raise water quality/river basin awareness;
- ◆ Compiled *Protecting Coastal Resources from Cumulative Impacts: An Evaluation of North Carolina Coastal Area Management Act* in 1996 — a strategic plan to expand coastal resource protection, including estuarine environments;
- ◆ Organized the first North Carolina Nutrient Summit for researchers, resource managers, fishers and state officials in 1995;
- ◆ Compiled and published *Coastal Water Quality Handbook* to address water quality issues raised by concerned citizens;
- ◆ Produced a risk-assessment map to identify state sites vulnerable to zebra mussel invasions — which can be financially and ecologically costly; and
- ◆ Initiated stream and wetland restoration projects from the Piedmont to the coast to enhance water quality.

## COASTAL LAW AND POLICY

From the start, North Carolina Sea Grant has had a leadership role in interpreting complex coastal issues and policies. To help open information channels among decision-makers, researchers, and citizens who depend on marine resources as a way of life, Sea Grant has:



Sea Grant water quality specialist Barbara Doll and David Pulley discuss stream restoration plans for the Pine Valley Golf Club in Wilmington. Photo by Scott D. Taylor



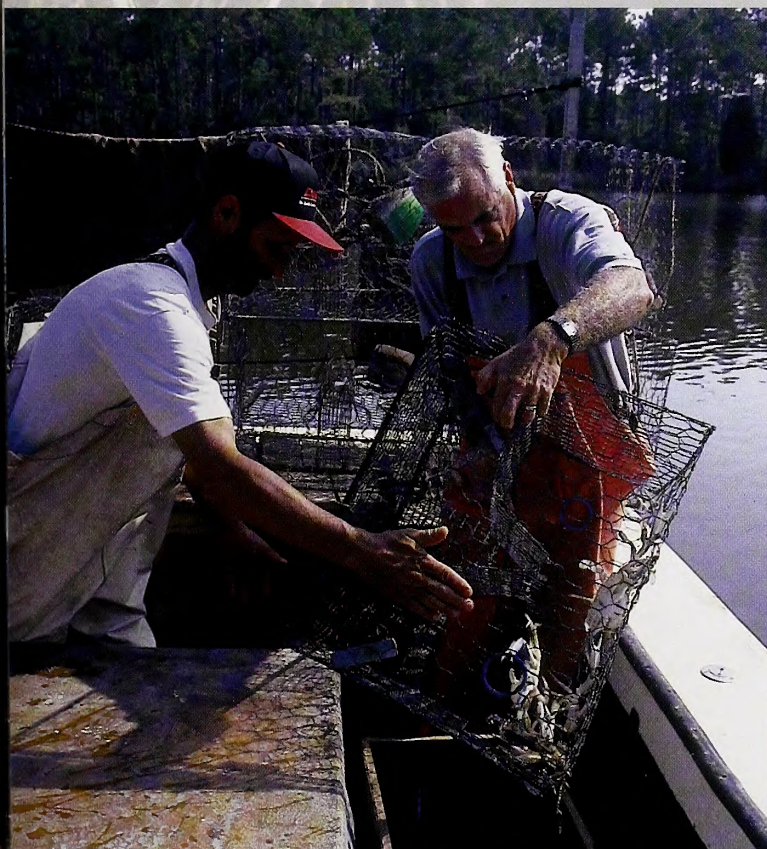
Walter Clark, coastal law and policy specialist, points out shoreline erosion concerns to a field study group from NC State's Encore Center for Lifelong Enrichment. Photo by Scott D. Taylor





Water quality studies supported by Sea Grant help guide fishery management plans as well as coastal land-management policies. *Photo by Jim Bahren*

- ◆ Supported research that led to the first ocean and coastal law course taught at the University of North Carolina at Chapel Hill's School of Law in 1977;
- ◆ Organized North Carolina's first conference on environmental law with the N.C. Bar Association and the UNC Institute of Government in 1984;
- ◆ Organized the first conference on coastal development with the N.C. Bar Association in 1986;
- ◆ Released *Albemarle-Pamlico Estuarine Study — North Carolina's Estuaries: A Pilot Study for Managing Multiple Use in the State's Public Trust Waters* in 1990;
- ◆ Published *North Carolina's Ocean Stewardship Area: A Management Study* — a strategic plan to improve coastal management in 1994; and
- ◆ Compiled recommendations for developing comprehensive public trust policies for the state in 1998.



Sea Grant fisheries specialist Bob Hines, right, provides information and technical assistance to enhance commercial crabbers' efforts. *Photo by Scott D. Taylor*

## HARMFUL ALGAL BLOOMS

Nutrients are essential to river and coastal estuarine ecosystems. They feed the growth of phytoplankton, which form the base of the food chain. But in excess, they can cause unmanageable growth of algae and other aquatic plants that rob the water of oxygen — resulting in fish kills and fish disease. In the 1970s, severe outbreaks of blue-green algal blooms on the Chowan River were catalysts for groundbreaking Sea Grant research — much of which is being replicated by Sea Grant researchers tackling harmful algal blooms concerns in other coastal systems. Researchers:

- ◆ Developed models to correlate algal bloom outbreaks with water flow dynamics;
- ◆ Determined that high rates of phosphorous and nitrogen are key nutrients that support algal blooms in aquatic systems;
- ◆ Developed models to show the impact of nutrients on estuarine and freshwater systems, including the potential changes in food-web dynamics;
- ◆ Developed quantitative estimates for the necessary reduction of these nutrients;
- ◆ Provided scientific findings resulting in regulatory limits on nutrient discharges into the river; and
- ◆ Identified the dinoflagellate *Pfiesteria* for the first time in 1991.

## COMMERCIAL & RECREATIONAL FISHERIES

Fisheries have received significant emphasis from the beginning of the North Carolina Sea Grant program. As beneficiaries of research and targets of outreach, fisheries continue to

*C o n t i n u e d*



have an important place in the overall Sea Grant mission. Highlights include work in the following areas:

◆ **Equipment:** The extension program has demonstrated a variety of equipment, gear and techniques to make fishing less labor intensive and more efficient. Examples include “green-stick” technology in the tuna fishery, the skimmer trawl for the shrimp fishery, electric and hydraulic crab pot pullers and development of gear for the live flounder market;

◆ **Stock assessment and habitat:** Data for improved fisheries management have been obtained on a number of species such as blue crabs, red drum, flounder, striped bass, menhaden and striped mullet. Such research provides critical background for the N.C. Division of Marine Fisheries’ emerging fishery management plans;

◆ **Crab shedding:** Introduction of new crab-shedding technology has helped small shedding operations increase income 10-fold since the 1970s. Closed recirculating shedders, new filtration devices, floating shedders and new methods for peeler grading and soft crab handling are a few of the contributions Sea Grant has made to this important industry;

◆ **Bycatch reduction:** Fish and fowl, sea turtles and marine mammals all benefit from Sea Grant’s efforts to reduce bycatch of nontargeted species in various fisheries. In particular, bycatch in the shrimp fishery was reduced 50 percent. Development of turtle escape devices and biodegradable escape panels for crab pots and certification of bycatch reduction devices are a few of the ways Sea Grant helps protect species while preserving fishing heritage;

◆ **Recreational fishing:** Circle hooks increase survival in catch-and-release fishing, while Sea Grant-sponsored safety workshops and publications increase survival of anglers — helping to make recreational fishing a safe and enjoyable pastime; and

◆ **Tracking fish:** Sea Grant worked with NOAA’s National Weather Service and the National Environmental Satellite Service in the past to provide fishers with information on the location of the Gulf Stream off the North Carolina coast. Sea Grant also has provided charts for sport fishing to help locate prime fishing areas.

## COMMUNICATIONS

Getting the word out has been a key element of the North Carolina Sea Grant success. From simple newsletters to the award-winning books and videos, Sea Grant has considered both the medium and the message, providing solid information in useful formats. Highlights over the years include:



Sea Grant communicators go into the field for first-hand views of coastal research. Here, Ann Green interviews Martin Posey for the story on page 42. Photo by Scott D. Taylor



The streams, lakes and sounds of coastal North Carolina are essential habitat for economically important fish species, and the source of recreational enjoyment for citizens. Photo by Scott D. Taylor



- ◆ The award-winning *Coastwatch* magazine, which provides useful information for a cross-section of readers, from the first-time coastal visitor to the state official;
- ◆ Popular publications, including *Seacoast Plants of the Carolinas*, *Seashells of North Carolina* and *Shifting Shorelines: A Pictorial Atlas of North Carolina Inlets*;
- ◆ Ongoing development of a Web site: [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant);
- ◆ A *Blueprints* series that gives step-by-step instructions for a variety of activities, including how to patch sandbags or how to identify harmful zebra mussels; and
- ◆ A multi-media public safety campaign to warn of the dangers of rip currents. The brochures, posters and videos have been distributed around the country. Now, Sea Grant is teaming with the National Weather Service for online rip current forecasts at beach sites in North and South Carolina.

- ◆ Partnered with public and private organizations to identify more than 1,200 miles of kayak and canoe trails in North Carolina. The trails, a Web site and accompanying map were showcased at Coastal Plain Waters 2001 — a three-day event in Washington. The trails provide recreation and environmental educational experiences for paddlers and economic development opportunities for many rural coastal communities;
- ◆ Conducted surveys on the economic and social impacts of saltwater fishing tournaments, which are growing in numbers and can have significant positive impacts for coastal businesses;
- ◆ Evaluated dolphin watching as an ecotourism industry. Found that the demand for wildlife-related activities such as birding and mammal observation is rapidly increasing;
- ◆ Sponsored and evaluated the economic impact of Wings Over Water — a celebration of wildlife in northeastern North Carolina. Found that the average birders and other wildlife enthusiasts spent hundreds of dollars daily in the Outer Banks area; and
- ◆ Supported a demonstration of a rake-your-own clam operation as a nature-based tourism activity.

## SEAFOOD TECHNOLOGY

Over the years, Sea Grant has excelled in developing ways to deliver research, education and outreach programs in seafood technology. In 1970, the North Carolina State University Seafood Laboratory was established through a subcontract to Frank Thomas in the NC State Food Science Department. Since then, Sea Grant has been on the cutting edge in:

- ◆ Helping to develop the domestic surimi industry and other value-added products to efficiently use resources;
- ◆ Working with two major entrepreneurs to develop the mechanical shucking of scallops;
- ◆ Improving techniques for handling and processing seafood;
- ◆ Pioneering the liquid nitrogen freezing of seafood, especially scallops and fish;
- ◆ Improving safety through education and training programs. Early efforts included sanitation programs and manuals on scallops and blue crabs. Recent efforts include editing and designing *The Hazard Analysis and Critical Control Point Training Curriculum*, a federal guide used to train seafood processors;
- ◆ Using an innovative cold-binding technology developed by NC State researchers to create uniformly-sized medallions from scallops naturally only a quarter- to half-inch wide; and
- ◆ Improving the public's knowledge about seafood quality, safety and nutrition through courses, conferences and publications. ■



Seafood technology specialist Barry Nash works with commercial seafood processors to improve seafood quality and safety. Photo by Scott D. Taylor

## RECREATION AND TOURISM

As tourism has grown into one of North Carolina's largest industry, Sea Grant has been on the forefront of providing support to the industries — from conducting applied research on coastal recreation and tourism events to designing and implementing coastal ecotourism workshops. It also has:



# CELEBRATING A SILVER YEAR

*In February, North Carolina Sea Grant kicked off its 25th anniversary year with a reception in Raleigh. The following are excerpts from comments that evening.*

## **LT. GOV. BEVERLY PERDUE**

Our marshes, swamps, forests, lakes and rivers. Our phenomenal estuarine system and oceanfront. North Carolina's coast is one of the richest natural environments in the world.

Many of you know I am a long-time resident of New Bern in Craven County. My family — my boys — have lived around and in this environment their entire lives. We have seen, firsthand, the changes in our coastal communities.

In fact, my youngest son is in school right now studying environmental science. That is what your work means to my family — and to North Carolina.

It is our future — and the future of our state: water quality, properly managed fishery resources, coastal tourism.

Where else but Sea Grant can you find the best scientists in the country from the best universities in the country working with the best staffs in the country to protect the true value of the coastal resources for the future of the best state in the country?

That is what it means to be a part of Sea Grant, and I am honored to be here with such a group.

I have long supported Sea Grant and the goals that you have set forth. And I know well that Dr. Hodson and the rest of you are the very best resources we have when it comes to questions on coastal issues.

Your work to strengthen the Fishery Resource Grant Program. The *Coastwatch* magazine you publish. The reports I hear almost daily from constituents that have worked with you. These are just a few examples of the very real impact you have on the lives of North Carolinians every day.

So thank you, and keep up the good work.

With every passing moment your work only becomes more important.

Please know that I am always here for you in my role as lieutenant governor — and as someone who lives in North Carolina and loves our coast.

Your work is our future.

## **RUSS LEA, VICE PRESIDENT FOR RESEARCH, THE UNIVERSITY OF NORTH CAROLINA**

North Carolina possesses the fifth longest ocean coastline in the lower 48 states.

This rich heritage and wonderful natural resource supports over 4,000 industries that employ 62,000 workers or 2 percent of the state's workforce. Over the last 10 years, employment has jumped by almost 50 percent and annual compensation of this workforce has more than doubled.

With the recent opening of the NC State University Center

for Marine Sciences and Technology (CMAST), the impressive Myrtle Grove marine science facility recently built at UNC-Wilmington, the new laboratory addition at the UNC-CH Institute of Marine Science, the existing ECU Institute for Coastal and Marine Research, the Duke Marine Lab and the U.S. Dept. of Commerce/NOAA facilities, Army Corps of Engineers facility at Duck AND Sea Grant, we provide the necessary horsepower for our citizens to have access to an academic nucleus for research, development, new technologies and engagement that is unparalleled anywhere else in the world.

Sea Grant has obviously been extremely inventive and successful at leveraging this unique academic nucleus. For example:

- There are hundreds of researchers across the state who have received competitively reviewed Sea Grant research funds;

- Sea Grant extension agents work all along the coast linking with communities and businesses;

- Sea Grant has funded hundreds of graduate students who have contributed through their studies and professional activities to the welfare of North Carolina citizens; and

- Sea Grant leverages its professional network to compete for millions of dollars in competitive funds from agencies such as the EPA, NSF, USDA, NOAA, NASA, etc.

Whether learning about

the ecology of coral reefs, identifying strains of *Pfiesteria*, or helping to bridge marine science with classroom teachers from all over the U.S., our Sea Grant program is on call 24/7 to address the urgencies of a state whose location on the coast makes it vulnerable to pressing issues — such as beach nourishment, drinking water supplies, fisheries protection, aquaculture, water quality, environmental restoration, and many others.

## **SEA GRANT DIRECTOR RONALD G. HODSON**

We are obviously proud of the success of the North Carolina Sea Grant College Program — but I am here to say that we are not content to rest on our laurels. There are many challenges that our coastal communities, and the state as a whole now face.

We hope that all of you will view Sea Grant as a catalyst — opening doors to a better future for unique coastal ecosystems and communities. Sea Grant is dedicated to focusing the state's intellectual resources — and drawing upon the rich history and knowledge in our coastal residents — to tackle a variety of issues. For example:

- Unprecedented growth has stressed some coastal counties — while others seem to have lost out on the state's economic boom;

- Once-abundant fisheries appear to be declining, sparking an overhaul of



management plans to protect species and habitats;

- Declining water quality in tributaries and estuarine waters can negatively affect the very same natural resources that underpin coastal economies; and

- The public demand for information on coastal and marine issues is increasing.

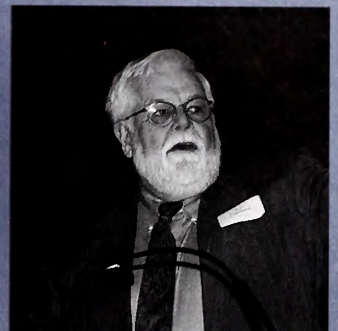
North Carolina Sea Grant is ready and willing to meet those challenges — but we must count on your support.

Ours is a true partnership of federal and state funding. Throughout the program, we have had funding from the National Oceanic and Atmospheric Administration — part of the U.S. Department of Commerce — as well as strong support from the North Carolina General Assembly, which appropriates funding through the University of North Carolina System.

As we move into the new century, I want to point out a pair of common threads running throughout our entire program. One is strong science — our proposals go through a peer-review process.

Second, our projects are relevant to the needs of the North Carolina coast. We are looking for cutting-edge research results that will be useful.

We want new technology or academic recommendations that can be transferred through Sea Grant's long-term partnerships with government, industry, interest groups, business and the general public.



Raleigh: Lt. Gov. Beverly Perdue chats with Sea Grant Director Ronald Hodson. Guests enjoy the N.C. Museum of Natural Sciences exhibits. Former director B.J. Copeland shares Sea Grant history.



Raleigh: Researcher Alina Szmant confers with Russ Lea, UNC system vice president. Jim Murray shares a message from National Sea Grant leaders. Aquariums Director Rhett White catches up with marine educator Lundie Spence.

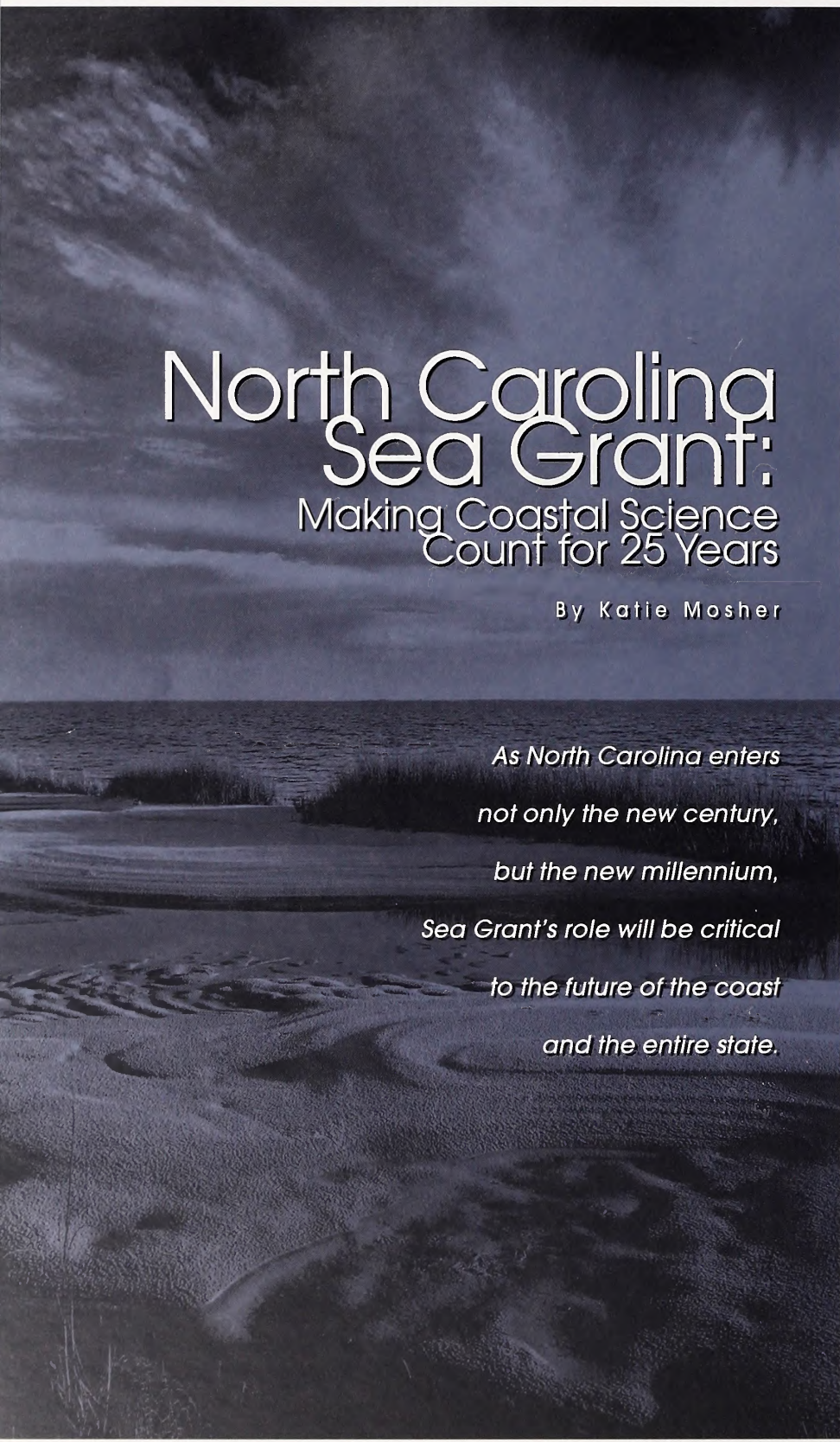


Manteo: Seafood and sea art mix well. Senate President Pro Temp Marc Basnight celebrates with Ronald Hodson. Elizabeth City State Univ. Dean Carolyn Mahoney introduces her husband and graduate student to Sea Grant.



New Bern: Jerry Schill thanks Amy Willis and Karen Pike of the N.C. Fisheries Association. Frank Thomas, Sea Grant Advisory Board chair, and his wife, Rachel, reminisce. Dave Beresoff and Robert Southerland relax at the reception.





# North Carolina Sea Grant: Making Coastal Science Count for 25 Years

By Katie Mosher

*As North Carolina enters  
not only the new century,  
but the new millennium,  
Sea Grant's role will be critical  
to the future of the coast  
and the entire state.*

**F**or 25 years, North Carolina Sea Grant has brought science to coastal communities — and coastal residents have offered healthy doses of common sense to academics.

Take, for example, early efforts to gather input on research and extension needs along the coast, “I sat and talked with one man who was working his eel pots and crab pots. I talked with him for 15 or 20 minutes, making the point of asking him what we could do for him,” former Sea Grant director B.J. Copeland recalls. “He looked at me and said, ‘Sounds like you guys are just looking for something to do.’”

In many ways, that crabber was right. The infant Sea Grant program was looking to do something. Those first staffers were out to make a difference for coastal ecosystems and coastal economies.

“I got his message: They were hardworking people,” Copeland says. “To be accepted, Sea Grant would have to be relevant. We would have to deliver good information and do it when we said we would.”

As the Sea Grant program grew, extension staff and researchers would stay on the lookout for new topics and issues, especially as sleepy fishing villages became tourist meccas, and as development surged in river basins that drain from the piedmont to the estuaries.

“Sea Grant provides a direct — and personal — link between the universities and the coastal communities,” says current Sea Grant director Ronald G. Hodson.

“We have earned a reputation for being available to listen to coastal concerns and being alert to scientific and technological breakthroughs that could be potential solutions,” Hodson says.

As North Carolina enters not only the

Photo by Scott D. Taylor



new century, but the new millennium, Sea Grant's role will be critical to the future of the coast — and the entire state — Lt. Gov. Beverly Perdue of New Bern told Sea Grant's 25th anniversary crowd in Raleigh.

"Our marshes, swamps, forests, lakes and rivers. Our phenomenal estuarine system and oceanfront," she says. "North Carolina's coast is one of the richest natural environments in the world."



Former Sea Grant director B.J. Copeland made frequent coastal trips to keep in touch with citizens' concerns. *File Photo by Daise Berg*

## Getting Started

Mention "marine science" today, and many images come to mind. But that was not always the case. In the late 1950s, only 13 marine-related doctorates were presented across the country.

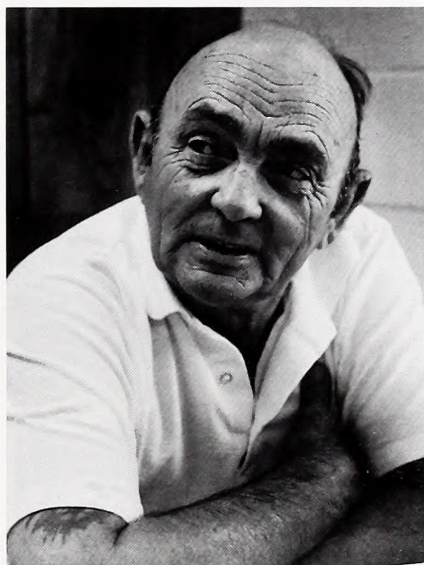
But as space exploration filled imaginations, earthly science — and in particular coastal — gained attention as well. The first proposal for a National Sea Grant program — patterned after the "land grant" universities that had developed the vast Cooperative Extension network — came in 1963.

By 1965, U.S. Sen. Claiborne Pell of Rhode Island and U.S. Rep. Paul Rogers of Florida proposed federal legislation to create a Sea Grant program. With the support of U.S. Rep. Alton Lennon from Wilmington, who chaired the House Merchant Marine and Fisheries Committee, the bill moved quickly. In less than a year, President Lyndon Johnson signed the

National Sea Grant College and Program Act of 1966.

"In truth, if Sea Grant wasn't invented in 1966, someone would invent it today. People depend on Sea Grant for good information and to help them survive," Copeland says. "You can't argue with priorities when they are to improve the quality of life and enhance economic opportunities. That's what Sea Grant is all about."

The national program — which



Hughes Tillett connected the fishing communities to the infant Sea Grant Program. *Sea Grant File Photo*

focused on the coastal states, as well as the Great Lakes — awarded its first research grants in 1968. These included groundbreaking studies in ecology by University of North Carolina at Chapel Hill researcher Howard T. Odum.

At the same time, North Carolina officials had begun to focus on marine sciences as well. One of the last actions of Gov. Dan Moore was to create the N.C. Marine Science Council and a university-level marine science program coordinated by John Lyman at UNC-Chapel Hill.

When the National Sea Grant office requested proposals for comprehensive programs, four North Carolina campuses responded — UNC-CH, NC State, East

Carolina and Duke universities. "Clearly, four programs were not going to be funded here," Copeland says.

To solve the problem, the new governor, Bob Scott, took on dual roles — mediator and breakfast chef — in the winter of 1969. He invited representatives of the four universities, as well as state officials, to an early morning meeting at the governor's mansion. The special guest was Bob Abel, the first National Sea Grant director.



Fisheries specialist Jim Bahen, right, knew first-hand of fishing operations along the southern N.C. coast. *Sea Grant File Photo*

"Part of our strategy was: Let's do something for the state of North Carolina. Let's forget about one institution," recalls Walton Jones, whose marine science work included time as a top advisor to Gov. Moore, vice chancellor at NC State, and as vice president of research and public service for the UNC system. "We put the needs of the state ahead of any institution."

Others attending the meeting included Lyman, Leigh Hammond — who worked in the governor's office and later served in the NC State administration and led Sea Grant advisory services in North Carolina — C.Q. Brown from East Carolina, and Bruce Muga from Duke.

Jones also points to strong support from Wayne Corpening, a former N.C. secretary of administration and mayor of Winston-Salem, and Addison Hewlitt, a former N.C. House speaker who served as first chairman of the Marine Science Council.

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Their efforts were successful. In 1970, North Carolina was granted a Sea Grant institutional program that worked with the various universities and was administered by Lyman's office in Chapel Hill.

The turf battles between campuses were minimal. "The proposals were always open and always competitive," explains Bill Rickards, former North Carolina Sea Grant associate director.

coastal communities and found Hughes Tillet and Sumner Midgett as the first extension agents. A few months later, writer Dixie Berg came onboard to launch a newsletter that would evolve into *Coastwatch* magazine over the years.

Lessie Tillet recalls how her late husband loved sharing new Sea Grant gear suggestions or techniques with his lifelong friends who had worked the waters beside

Midgett, whose family had a long history with Outer Banks lifesaving stations, had a strong interest in land use. "They complimented each other. Between them, they were covering the activities in Dare County and beyond," Copeland says.

The agents collaborated with Jim McGee of ECU, who was known along the coast for his short courses on various coastal topics, including bookkeeping for fishing families.



Early seafood technology researchers included, from left, Frank Thomas, the late Donald Hamann, Tyre Lanier and Allen Chao. *File Photo by Allen Weiss*

## Filling Niches

Copeland, whose first North Carolina Sea Grant research was a project with NC State colleague John Hobbie that looked at nutrients in the Pamlico estuary, was named program director in 1973. This meant the North Carolina's Sea Grant headquarters moved to Raleigh.

His goal? Full Sea Grant College Program designation — based on a record of excellence in research, extension and communication — in the minimum time, just three years.

Copeland recalls July 1, 1973, when his staff included only Rickards, who later became director of the Virginia Sea Grant program, and secretary Louise Bame. "I was told to write a proposal and submit it by August 1. We had no extension advisors and no communicators. So we set about getting the word out that we were in business," Copeland says.

His first hires? He looked to the



North Carolina Sea Grant extension staff posed for this 1980s photo. *File Photo by Allen Weiss*

him. "He loved people. They would come to talk to him," she says.

Copeland agrees. "His focus was one-to-one. He would go find a highliner and get him to try something, then everyone else would follow." And, Copeland adds, Tillet took on the personal mission to make sure the university folks were educated about the realities of life on the coast. "He was educating me."

The marine advisory work involved not only finfish, but shellfish as well. "Hughes Tillet was the first Sea Grant advisor to promote shellfish culture," Copeland recalls. "He was the first to grow clams in bags and trays. The first job he had was to get people to change the way they were doing things."



Fisheries specialist Wayne Wescott has been a link to the northern coastal communities. *File Photo by Allen Weiss*

Early Sea Grant work also included efforts by Frank Thomas and Ted Miller at the NC State Seafood Laboratory in Morehead City, who worked with plant owners on a deboning machine and other seafood processing issues. Through the years, the lab had a crew of local cooks who would work diligently with Joyce Taylor to develop flavorful and healthy seafood recipes.

By 1974, Berg began a four-page newsletter and other communications products. "She wanted to get the information out to the people," Copeland says. The first newsletter discussed market opportunities for amberjack and triggerfish and other species considered bycatch. It also profiled the seafood lab and new technology for eel pots.

And, of course, there was the research. "We were funding the best research by our outstanding faculty, who were turning out relevant results," Copeland says.

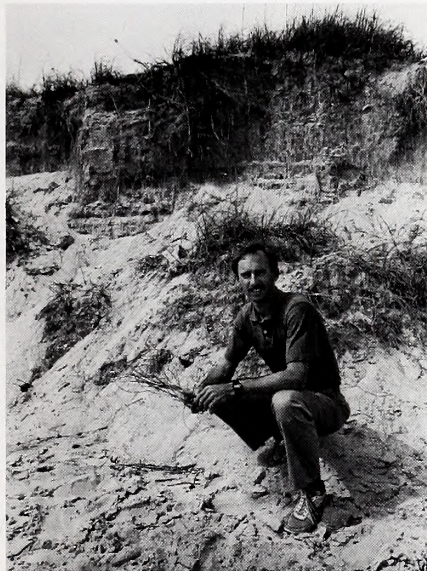
Their efforts paid off. By 1976, North



Carolina had shown three years of Sea Grant excellence. In July 1976, the program received full Sea Grant College Program status — and a new budget of \$1 million.

## Coastal Challenges

It was an exciting time, not only for Sea Grant, but for other coastal programs as well. The marine science centers evolved into the N.C. Aquariums. And the state was



Coastal erosion and construction specialist Spencer Rogers led early efforts to promote dune vegetation. *File Photo by Allen Weiss*

working closely with the federal Coastal Plains Regional Commission, an agency from the War on Poverty.

North Carolina's coast, with its string of barrier islands, was beginning to see tourist opportunities — but Jones and others did not want the result to be the sprawl of Virginia Beach or Myrtle Beach.

"We wanted to be more upscale," he says, pointing to the aquariums as attractions that could focus attention on the coastal ecosystems. "We had a concern about economic development. We wanted development consistent with the environment," Jones explains.

In addition, they saw Sea Grant's applied research and extension programs as offering new opportunities for sustained

economic development. Jones points to aquaculture, or fish farming. "What do you do Down East when you can't rely on tobacco anymore? We looked at marine research as a source of employment, tourism and recreation," Jones says. "We did some good thinking."

And the state benefited through the years. For example, Sea Grant research led to the development of pond-based hybrid



Consumer seafood safety specialist Joyce Taylor developed countless recipes. *File Photo by Cassie Griffin*

striped bass aquaculture that is now a multimillion-dollar industry that has drawn national and international acclaim. "Ron Hodson translated good science into practical husbandry that led to hybrid striped bass as an industry," Copeland says.

Copeland, too, had the strong scientific background and could connect with the public. "He's not only a good scientist, he is a good people person. He could talk to the fishermen. He could talk to the scientists. He could talk to the budget folks at the legislature. We all worked together," Jones said.

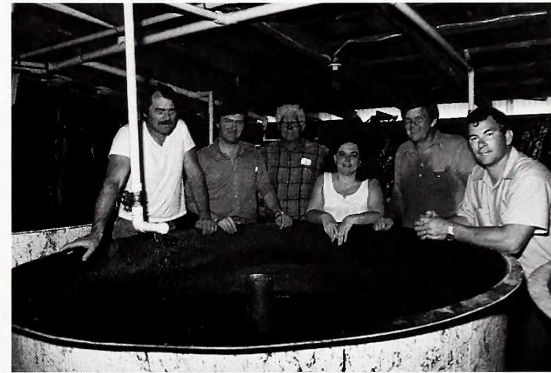
Rickards recalls a reception in Morehead City. After a short social period, Copeland stood up and introduced each of the 80 or 85 people in the room. "The fact that he could do that and remember everyone is amazing," Rickards says.

Copeland was equally adept at growing a staff. "The best thing we did is hire good people," he says.

For example, as extension director,

Jim Murray was always developing new projects. "Jim has tremendous people skills. He could get our staff to do new things and relate to clientele on all levels."

David Duane, who monitored the North Carolina progress as a program officer in the National Sea Grant office and later served as national director, remembers the eclectic nature of the North Carolina program, including work with fisheries, dune and



Aquaculture researchers included, from left, Ronald Hodson, Ed Noga, Mel Huish, Margie Gallagher, Howard Kerby and Randy Roush. *File Photo by Allen Weiss*

marsh grasses, and coastal zone management. And there was seafood technology.

"I used to chuckle about croaker bologna," he recalls. "But they were creating products from underutilized species."

In fact, underutilized species were the topic of a number of studies, not just in food science, but in social sciences as well. Those studies resulted in award-winning publications, a television program and countless presentations.

"The project led to a real and measurable change in people's attitudes and behaviors towards traditionally unwanted trash fish," explains sociologist Jeff Johnson from ECU.

A key to North Carolina's "well-oiled machine," Duane says, was a series of Sea Grant liaisons at various campuses, and outreach to both communities and federal agencies, including the U.S. Army Corps of Engineers and the National Park Service.

And North Carolina research work was

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innovative. Duane points to studies by geologist Stan Riggs of East Carolina University and colleagues who looked at the impact of ground water seeping out into the continental shelf. They also studied factors involved in coastal erosion — a big problem nationwide.

But Sea Grant is not research alone. The results must be shared with the coastal communities and the state as a whole. For example, Spencer Rogers, Sea Grant's coastal erosion and construction specialist,



Sea Grant researcher Charles "Pete" Peterson, center, has studied shellfish.

File Photo by Allen Weiss

worked with Riggs and others to translate research results into engineering terms that could be understood by policy makers and property owners so that they could make science-based decisions.

In fact, the Sea Grant extension program originally was known as the Marine Advisory Service — and that scientific advice, seasoned with doses of reality, resulted in many direct changes in coastal life.

Tillett was known to get calls at home late at night with questions from captains who had just come in from their boats. In a 1979 *Coastwatch* article, he explained why he would spend days poring over publications or calling around the country to get the answers.

"Fishing isn't as simple as it used to be," said Tillett, who helped introduce pot pullers and net winders. "And unless the fishermen get some help, they're going to have a hard time making it."

## Riding the Waves

Sea Grant got off to a strong start in North Carolina — but the picture was not always rosy for the federal/state partnership that provided \$2 in federal funds for each \$1 in state funding.

In 1980, Sea Grant was zero-budgeted in the president's blueprint, and North Carolina responded.

"It wasn't a stretch to show that Sea Grant was doing good things. It was worth something — and worth keeping," recalls Copeland, who spent many days in Washington getting the Sea Grant message out.

"A lot was at stake. You only lose once with Congress," he says. "We passed the test with the help of Rep. Walter B. Jones, Sr."

And it didn't hurt to show a 1981 Sea Grant analysis that showed a 40-to-1 return on the investment. "That's a lot of impact on people we serve," Copeland says.

The direct impact was evident in the growth of the extension program. Initial work in fisheries and marine education, were soon joined by aquaculture and mariculture. Coastal processes work increased, as did coastal law and policy efforts.

Sea Grant's efforts in the 1980s included the initial N.C. Commercial Fishing Show, organized by fisheries specialist Jim Bahen, and the first Beach Sweep clean-up day, organized by marine education specialist Lundie Spence. Those legacies live on today. The fishing show, now sponsored by the N.C. Fisheries Association, features dozens of vendors and workshops, including presentations by Sea Grant researchers and staffers. Beach Sweep evolved into Big Sweep, a separate nonprofit agency that sponsors waterway clean-ups in all 100 counties in the state.

And as coastal development burgeoned, Walter Clark managed to interpret the growing number of state policies meant to balance economic growth and environmental/public trust concerns.

In the 1990s, North Carolina added a new position — water quality specialist. Barbara Doll jumped in with both feet. Her storm drain stenciling and urban stream restoration efforts show the connection

between growth in the Research Triangle area and coastal water quality.

Sea Grant also took on the administration of the N.C. Fishery Resource Grant Program, with fisheries specialist Bob Hines taking on the role of coordinator. By then, fisheries work included shellfish aquaculture, such as oyster grow-out methods demonstrated by Skip Kemp. Meanwhile, Wayne Wescott brought the "green stick" tuna rig to the Outer Banks, to the delight of commercial and recreational fishers alike.

Nature-based tourism was not just a buzzword, but an economic boost for coastal counties, according to surveys by Jack Thigpen, who is now the Sea Grant extension director. Seafood safety had always been a priority for processors, but federal mandates spurred training courses presented by Dave Green and Barry Nash of the seafood lab.

And when the North Carolina coast was hit by major hurricanes, Sea Grant quickly responded. Home construction and retrofitting techniques were highlighted by Rogers after Fran devastated areas such as Topsail Island in 1996. Water quality issues were highlighted in Sea Grant's rapid response to Hurricane Floyd's record flooding. From research to workshops, publications to media interviews, Sea Grant got the word out.

Russ Lea, vice president of research for The University of North Carolina, says Sea Grant's decades of research background is crucial when such disasters strike. "In the wake of catastrophic climatic impacts to our coastal communities, the importance to react in a coordinated way to revitalize our coastal economy takes on considerable importance," he says.

As we enter the new century, Hodson sees new challenges for Sea Grant as the program must be on constant watch for coastal changes wrought by humans and by nature.

"In the next 25 years, we will be challenged to continue our tradition of excellence," Hodson says. "We must meet the needs of the diverse coastal community. These are no longer simply fishing villages."

And, in the end, the work must be relevant. "We must maintain our connection to the people," he says. □





Joey Daniels Jr. loads fish into boxes at the Wanchese Fish Company.

## DANIELS FAMILY THRIVES ON FISHING TRADITIONS

By Ann Green • Photographs by Michael Halminski

With dawn just breaking at Wanchese Harbor, the red and white trawler *Richard Wayne's* green light beams as it motors slowly down the narrow channel.

More than a dozen pelicans line up on the water waiting for a taste of the fresh catch as the trawler pulls into Wanchese Fish Company's dock and anchors.

Immediately, Joey Daniels Jr. jumps aboard to help unpack the flounder catch.

"This is one of the draggers that is not allowed to catch much," he says. "Right now there is a 5,000-pound limit on flounder."

With the strong odor of fish permeating the air, he helps the crew pull fish from

the box and throw them onto a conveyor belt.

A few minutes later, he jumps back on the dock and hurries to the loading area. Dressed in camouflage overalls and a green shirt, he hooks up the scales to weigh the flounder and then shovels ice into boxes.

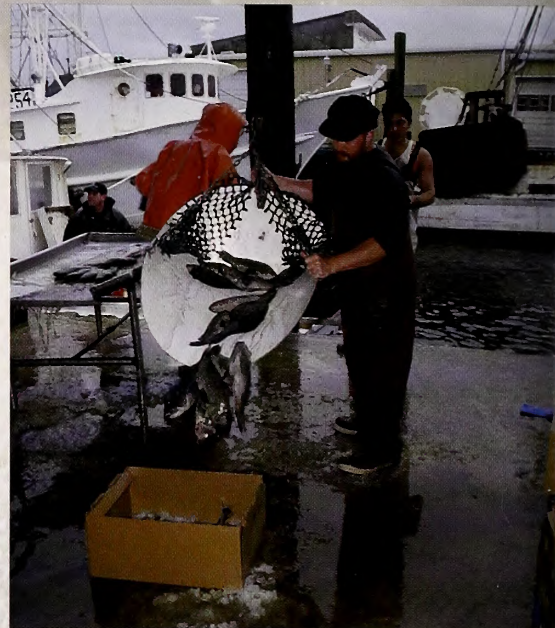
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Background photos by Scott D. Taylor





The Daniels family, including the late Malcolm Daniels, is synonymous with fishing on the Outer Banks.



The early morning is a busy time at Wanchese Fish Co.

“I do whatever they want me to do,” says Joey Jr. “I repair boats on the water, drive the tractor trailer and work on the dock.”

He is the fourth generation of his family to earn a living from the water.

On the Outer Banks, the Daniels family has become synonymous with fishing.

“The Daniels family has been assisting the seafood industry in moving products for 65 years,” says Wayne Wescott, North Carolina Sea Grant fisheries specialist.

Now, eight members of the Daniels family help run the fish company that has evolved into a major seafood processor and packer on the East Coast. Their trawlers work the waters as far away as Argentina.

With such a large and diverse operation — from a trawl supply store to trucking company — there is a different job for everyone.

“All of the important jobs are headed by family members,” says Mikey Daniels, who oversees the boat maintenance. “No one looks after our business as well. Hopefully, when one of us steps down, there will be another Daniels to take his place.”

The company is headed by Joey Daniels. A robust middle-aged man with

an entrepreneurial spirit, he is past chair and current board member of the N.C. Fisheries Association.

While trudging through a puddle of water in the loading area, Daniels points to a box of frozen scallops that will be processed into scallop medallions at the Hampton, Va., plant.

In the 1990s, the fish company launched the scallop medallion on the East Coast as a way to market its surplus of small sea scallops.

The technology for the value-added product was developed by the North Carolina State University Food Science Department. With support from a North Carolina Fishery Resource Grant and North Carolina Sea Grant, the lab offered a cold-binding technology that created uniformly sized medallions from scallops naturally only a quarter- to half-inch wide.

Scallop medallions now are sold throughout the U.S. and Europe.

“The scallop medallions are selling good,” says Joey Daniels, who now serves on the North Carolina Sea Grant Outreach Advisory Board. “We are making 60,000 pounds of scallop medallions a week.”

## Beginnings

Wanchese Fish Co. started in 1936 when Joey’s father, Malcolm Daniels, inherited the fish company from his father-in-law, Capt. Will Etheridge.

“My grandfather took small boats fishing in the sound,” says Joey Daniels, who serves on the Joint Legislative Commission on Seafood & Aquaculture.

All of Malcolm and Maude Daniels’ 11 sons and four daughters got an early start in the fish business.

“When the children came along and reached a certain age, Malcolm put them to work in the fish business,” says family matriarch Maude Daniels while sitting in her living room filled with family photos. “He said it was their heritage, and he wanted them to work to protect it.”

In those days, everything was done by hand, says Mikey, a former Dare County commissioner. “The older you got, the bigger the job. At 16, I drove my first tractor and trailer and was told to go to Hampton.”

When a boat came in, the children would leave school to help pack the fish. “On Sundays, Dad would not let us pack fish until after midnight,” says Mikey. “We





Mikey Daniels has worked at the family business since he was a child.



Joey Daniels heads the large seafood business.

would get up at 4 a.m. on Monday, pack fish, then take a shower and go to school.”

Mikey and his siblings lived in a four-bedroom, frame house on the island. Most of the children slept in a 400-square-foot room in the attic — the boys were on one side, the girls on the other.

“Everybody slept two to a bed,” he says.

To keep up with her large family, Maude would set off a siren at mealtime. “You’d hear it all over the island,” says Maude. “If the children were not home in time, they’d not get anything to eat.”

It was on a bill-collecting mission to Virginia that Malcolm saw his first trawl boat. “He told us kids that Wanchese Fish would have a trawl boat some day,” says Mikey. “Shortly after that, he mortgaged our house and bought his first used trawler.”

He named the boat the *Faith Evelyn* after his oldest daughter.

## Expansion

After that, the Daniels family bought other boats to fish Georges Bank off Nantucket, the Grand Banks off Nova Scotia, New Bedford and Boston. Some of

the boats, including an Army T-boat, were converted by Joey’s father into draggers.

“He bought everything piece by piece,” Joey says. “The freezer was bought in an auction. By using lumber scraps and family labor, my father built Fisherman’s Wharf Restaurant in three months at a cost of \$3,500.”

Even though Malcolm Daniels has been dead a number of years, the woods behind his widow’s brick home are still covered with assorted parts and other items he collected.

“He had vision,” Maude says. “He could see how something worked.”

Over the years, the fish company has faced a number of setbacks — from high interest on loans to small catches. In the fall of 1981, fishing conditions were so bad in North Carolina that they moved some of the smaller trawlers to Florida. “It was a slack year for flounder,” Joey says.

The company also moved its boats and operations out of North Carolina into Virginia when another company lost a trawler in Oregon Inlet in 1981. Later, the Daniels family moved some boats and operations back to North Carolina.

Now, the company has a thriving

scallop and fish business. Their fishing fleet includes 11 boats in North Carolina and Virginia and two boats in South America.

With business expanding, they are building a new \$8 million facility in Suffolk, Va. The 170,000-square foot building will be used for processing seafood and cold storage.

“Half of my fishing fleet is scallops,” Joey says. “They scallop from Virginia to Massachusetts. The federal law for scalloping only allows full-time permits 120 days a year. For each trip, you would lose a day of travel time from North Carolina to Virginia.”

Another benefit of the Virginia plant is its accessibility to air and truck freight. “In Wanchese, we are so far from the interstate and the airports,” he adds.

Like their other operations, this facility will be run by family members.

Mikey admits it is not always easy working with your own kinfolk.

“All of us have different issues,” says Mikey. “Everyone thinks his issue is better than the other person’s. You have to learn to bend. You have 10 to 15 ideas. We are human beings. Through it all, we get back together.”



# CHANGING FACE OF WANCHESE:

## Boatbuilding Booming as Fishing Declines

By Ann Green

Photographs by Michael Halminski

**A**s the wind slices across the waterfront at Wanchese Seafood Industrial Park, Buddy Davis walks briskly toward a sleek white yacht.

Davis, who is CEO of Davis Boatworks, stops and glances at the shiny wooden deck and tuna tower on the new 61-foot boat.

Two of Davis' employees are getting the boat in tip-top shape for the new owner. "This is a \$2.5 million boat," says Davis. "The owner is from Canada. He will fish a little and cruise a lot."

Dressed like a yachtsman in a plaid cap, khaki pants, windbreaker and moccasins without socks, Davis points proudly to another new 50-foot white yacht that has just been completed. "Our client is flying in today from New Hampshire to inspect it," says Davis. "He is a hard-core fisherman."

Directly across Mill Landing Creek from the bobbing new yachts, several weathered trawlers are docked in front of seafood businesses operated by Wanchese families for several generations.

The two sides of the creek show the changing face of Wanchese — a tiny fishing village on Roanoke Island that is still unincorporated.

"The fish industry was booming in the 1970s," says Davis, a former fishing captain. "At times, there were several hundred trawlers in Mill Creek. Now you never see more than a dozen trawlers."

Instead, yachts and sportsfishing boats crowd the dock at the Wanchese Industrial Park where many boatbuilders have their headquarters.

Although the industrial park was first developed in the 1970s, boatbuilders didn't begin leasing space until 1983 when Davis opened the first boatyard.

Now, several boatbuilders and a variety of other businesses — from a seafood distribution company and a trawl supply store to a brewery and radio station — occupy the 30-acre park.

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## Diversification of Park

"In 1993, the client base was expanded from seafood to marine-related businesses," says Bob Peele, the park's director. "Before that, the park focused on the commercial fishing industry."

With the diversification of businesses, the park began to take off.

Now, all but three lots are leased. For the first time, the park also has become profitable.

"In 2000, the annual payroll was around \$5 million for combined businesses," according to Peele. "For 2001, the estimated total gross sales is expected to be at around \$45 million."

The largest employer is Davis Boatworks, which has around 180 employees and a payroll of more than \$6 million. The company manufactures yachts costing from \$750,000 to \$2.7 million. Each boat is designed to order. The boats are sought after because of a unique design — dubbed a "Carolina boat" — that shoulders rough seas.

"Our customer base is all over the world," says Davis. "This year, we will begin production on 30 boats and are targeting \$30 million in sales."

The company also refurbishes and repairs commercial and recreational boats. "Both Davis Boatworks and Harbor Welding and Boat Repair service about 1,000 per year," says Davis.

Many of the park's businesses are mom-and-pop operations that employ only a few people. O'Neal's Sea Harvest — which packs fish and crabs — has five full-time employees, including the owner and manager, Benny O'Neal, his wife and daughter.



TOP: Many boatbuilders have their headquarters at Wanchese Industrial Park.

BOTTOM: Buddy Davis' yachts are sought after across the country.

The O'Neals conduct business out of a one-room office that is above the packing area. When the wind isn't blowing right for fishing, the employees make crab pots.

"I am the new man on the block," says Benny O'Neal. "Other fellows around Wanchese have been real nice. My competitors helped get me started. Everybody knows everybody here."

O'Neal says that running a seafood business is demanding. "It is pretty competitive buying and selling seafood," he adds. "But the crab business has been good."

The outlook for the park hasn't always

been so optimistic. From its inception by the state of North Carolina in 1979, the park has been engulfed in controversy.

A seafood processing facility as well as a restaurant and cannery were proposed for the land but never built. A wastewater treatment plant — which was built to treat wastewater from the seafood plant but never opened — stands empty.

With the original businesses not taking off, the early days of the park were bleak.

"In 1994, there were days that were so slow I didn't think the park was going to make it," says Christine Walker, assistant to the industrial park's director. "Now there is a lot more traffic. All the buildings are leased."

Most of the original tenants are gone, including Wanchese Shiplift Co., started by Davis.

"The business was aimed at servicing the fishing trawler fleet," says Davis. "We could lift boats up to 300 tons," he adds. "To be successful, the

syncrolift had to have a deep-water entry. The park was tied to the opening of jetties at Oregon Inlet. Instead of the jetties and deepwater inlet, we got a shallow inlet and boatyard. So eventually we went out of business."

## Oregon Inlet's Uncertain Future

Oregon Inlet is a vital waterway because it is the closest way for commercial and recreational fishers to get to the Atlantic Ocean from Wanchese. The inlet — long known as one of the roughest



waters on the East Coast — is unpredictable for navigational conditions because of the movement of sand in and around it.

Since 1962, the U.S. Army Corps of Engineers has been dredging the inlet, trying to keep it passable.

More than 30 years ago, a proposal was made to anchor the shifting inlet with two massive stone jetties built by the U.S. government. The jetties would extend into the ocean nearly two-thirds of a mile.

Authorized by Congress in 1970 but never fully funded, supporters say the twin breakwaters would stabilize the inlet and allow for a deeper channel, which would make passage safer for large commercial fishing boats passing between the inlet and Wanchese.

“We are fighting hard for Oregon Inlet,” says Moon Tillett, chairman of the Dare County Oregon Inlet & Waterways Commission and a retired commercial fisher. “It is one of the greatest battles of the century. We could have had the jetties built for \$11 million in 1970. Now it will cost more than \$97 million to build.”

The commission’s latest battle is getting a land transfer from the U.S. Dept. of Interior to the state of North Carolina for 106 acres to connect the jetties to the land. “If the jetties and land aren’t connected, the jetties will wash around on the other side,” says Tillett.

The jetties are opposed by numerous groups — from geologists and biologists to private citizens and environmentalists.

“Oregon Inlet is an extremely high-energy coastal system,” says East Carolina University geologist Stan Riggs. “You



TOP: Davis Boatworks makes Carolina-style boats that shoulder rough seas.

BOTTOM: A new Davis boat is ready for a sea trial.

shouldn’t tame an inlet when you can’t predict the consequences. The inlet is poorly understood, but the dynamics are crucial to beaches and estuaries. Whenever other inlets have been jettied, it has made a mess. It is short-sighted to stabilize Oregon Inlet.”

The inlet’s changing dynamics also has affected family-owned seafood businesses on the west side of Wanchese Harbor.

“Without the jetties, we still have to depend on high water,” says Joey Daniels, president of Wanchese Fish Company, a

major seafood packer on the East Coast. “There is a bad spot close to the bridge. When the tide is coming in, there is a chance of a boat crashing into the bridge.”

In the winter of 1981, a large trawler owned by a Belhaven operator was lost in Oregon Inlet. After this, the Daniels family moved some boats to Hampton, Va., and also set up operations there. Later, some boats were sent back to North Carolina — home of the corporate headquarters.

On a recent day, Wanchese Fish Co.’s dock is bustling with activity. As several seagulls flutter over Wanchese harbor, a white trawler pulls in during a drenching rainstorm with a load of trout. The strong odor of fresh fish permeates the air.

“It was a good catch,” says mate Chuck Seymour. “We were out 24 hours and did not get much rest.”

As Seymour rolls in a gill net, a young woman in a bright orange rain suit throws a handful of blue and gray trout to another worker.

The fish are then weighed and boxed with ice. In another corner of the dock, N.C. Division of Marine Fisheries biologists — who periodically sample fish — are weighing some catch.

A few minutes later, a trawler with sea bass pulls in. The fish are weighed, gutted and packed in 31 cartons.

“The catch was excellent,” says Captain Dave Watkin. “I have been working out of Wanchese for 20 years.”

Like many fishers, Watkin won’t reveal his favorite fishing spots.

*Continued*



"That would affect my bank account," he says. "Be out of business in one day."

### Wanchese Harbor Hub for Fishing

For many years, Wanchese harbor has been the focal point of activities for the tiny village. The harbor leads to some of the richest fishing spots anywhere in the world.

"Commercial fishing was the main way people made a living here when I was a boy," says Capt. Will Etheridge Jr., a retired commercial fisher. "The biggest money fish was shad."

Until the 1930s, the only way to get to the island was by boat, says Etheridge. Around that time, N.C. 345 was built. The highway, which runs off U.S. 64 in Manteo, is still the only land access to the village.

As you turn off onto the highway, you pass a long stretch of marshland. The first sign of civilization is Mann's restaurant, grocery and hardware stores — a meeting place for local fishers and residents.

On a recent day, many local fishers gather to eat a hot plate of spaghetti and swap stories. Even though the village is synonymous with fishing, no seafood is served here. Instead, customers are served home-style meals and desserts in a small room with a counter, tables, booths, blue checkered curtains, a Harley bike sign and bulletin board.

"This is a local hangout," says Ervin Johnson, who has lived in Wanchese for more than 40 years. "I come here every day when I'm not fishing."

After leaving Mann's, you pass a number of cottage-style homes, brick homes and side streets named for local families — from C.B. Daniels Jr. Road to Ronald Tillet Road.



Moon Tillet, who opened a seafood business in the 1970s, continues fighting for jetties at Oregon Inlet.

"I can't see how you could do any better for a rural village," says Etheridge. "Funerals here are still like the old-time. If a neighbor is in need, you help him. Nobody suffers here."

As you near a bend in the road, you can turn left onto Harbor Drive to go to the Seafood Park, or head straight and pass several houses whose yards are cluttered with crab pots. Farther down the road, a cluster of seafood businesses overlook the water.

One of the oldest businesses is Etheridge Seafood, a packing company built upon a family fishing tradition. Capt. Will's son, Will Etheridge III, now heads the operations.

"I have been in the business all my life," says Will Etheridge III, a burly man whose office is packed with big game and fish mounts. "I started out helping my Uncle Malcolm and grandfather pack fish."

When Etheridge's grandfather turned over the business to his aunt's husband — Uncle Malcolm Daniels — Etheridge's family got out of the packing business.

In 1974, Will Etheridge III started his own business when he returned from Navy duty. Around that time, North Carolina Sea Grant helped form a co-op for Outer Banks fishers.

Although the co-op folded, it had a positive impact on fishing communities.

"It brought fishermen together so they all knew what each other was doing and boosted prices, especially at the Outer Banks south," says Sea Grant marine extension specialist Wayne Wescott, who managed the co-op before joining Sea Grant.

In the 1970s, Moon Tillet opened up a

seafood business on the Wanchese harbor across the creek from Wanchese Fish Co. Although Tillet is retired, his son and grandson still operate Moon Tillet Fish Co., which ships seafood all over the country.

"It is a good business," says Tillet. "It helps feed a lot of people. I don't know why people want to stop it."

In recent years, the fishing industry has undergone tremendous changes — from new regulations to a decline in some species.

"We not only have to battle the wind and weather, we have to battle environmentalists trying to put us out of business," says Will Etheridge III. "We have recreational fishermen trying to put us out of business. We can't win the battle because the public is not aware of us."

Tillet agrees. "So far I've not seen anything environmentalists have done to improve fishing," he says.

With these changes, the younger Etheridge doesn't see much future for the next generation in the fishing business.

"My son works here part-time," he says. "The other part of the year, he works as a commercial fisherman. I am not encouraging my children or grandchildren to go into the business. My advice is to find a job with the government." ■





## **ESTUARIES:** *UNIQUELY* *COMPLEX* *ECOSYSTEMS*

*By Pam Smith*  
*Photographs by Scott D. Taylor*

**I**t is the intuitive belief among marine scientists that each estuary and coastal system is unique and different, probably because there are so many possible combinations of important factors of geology, climate, tide and history that identical combinations are improbable. ... It is the whole system phenomena that state departments responsible for estuarine resources must consider. Perhaps it is in the systems study of the overall performance that there is hope for prediction and management.

Coastal Ecological Systems of the United States, Volume I  
Howard T. Odum, B.J. Copeland and E.A. McMahan, editors

The year was 1970. The four-volume document was the product of a two-year review of the state-of-knowledge on estuaries requested by Congress in 1968 as part of a National Estuarine Pollution Survey.

Its editors and contributors were among the prominent pioneers of an emerging field of study. They were led by Odum, ecology professor, and other researchers from the University of North Carolina; and Copeland, then a zoology professor at the University of Texas.

*Continued*





Sea Grant research examines every aspect of economically important estuaries.

The scientists described a systems approach to estuarine studies. They presented the theory of estuarine classification based on dominant energy flows, including biological, geological, chemical and physical classification factors — energy being a common denominator. The human factor in this environmental system approach was not discounted.

“Howard Odum was doing groundbreaking estuarine research. He was very innovative,” says Copeland, a former North Carolina Sea Grant director who considers Odum his mentor. Odum was among the first to take a systems approach to estuarine study. He also was one of the first to investigate the effects of sewage in different estuarine environments.

“He’s still doing innovative things,” Copeland says of the 77-year-old who is director of the Center for Environmental Policy at the University of Florida. Odum teaches environmental engineering and continues to study systems ecology and to evaluate environmental policy.

It was Odum who received the first North Carolina Sea Grant research grant in 1968 for a two-year, multidisciplinary study of North Carolina’s complex estuarine system.

Odum’s early Sea Grant project also provided a model for a multidisciplinary, intercollegiate research approach that has become Sea Grant’s hallmark.

Since then, the scope and impact of North Carolina Sea Grant’s estuarine research has been as broad and diverse as

the environmental treasure itself. North Carolina’s 2.3 million-acre estuarine system is the third-largest in the nation — behind Alaska and Louisiana.

The bays, sounds, tidal salt marshes and wetlands that comprise the Pamlico, Albemarle and Cape Fear estuarine systems play important roles in interdependent coastal processes. And, over the years, Sea Grant researchers have examined nearly every aspect of these economically important and environmentally sensitive fish nurseries.

Scientists know that 90 percent of all commercial and recreational fish species spend some time of their lives in estuaries. Some species spend all their lives in estuarine waters. Others arrive as juveniles to be nurtured to adulthood in these nurseries before returning to the open sea.

Each of these species need the nutrients unique to the brackish waters to grow and survive. The saltwater marsh grasses are home to many types of plants and animals. Nutrients left behind from decomposing grasses, benthic algae and phytoplankton become the basis for the food chain that nourishes almost all marine life.

**A**s the problems with preservation and development of estuaries become acute with expanding populations, there is increasing need for a classification system that has meaning for planning and management.

While the 1969 National Water Quality Act provided the framework for maintaining environmental quality, the U.S. Coastal Zone Management Act of 1972 charged states to adopt coastal protection laws.

Like the federal mandates, North Carolina’s 1974 Coastal Area Management Act (CAMA) is grounded in good science. A cadre of Sea Grant researchers served on a blue-ribbon panel to provide scientific background.

Sea Grant researcher Thomas J. Schoenbaum incorporated foundational research in drafting the coastal management legislation. Schoenbaum, then professor of law at the University of North Carolina at Chapel Hill Law School, placed special emphasis on protecting the “natural values of the estuarine zone.” Calling it one of the

most highly productive areas on earth, he underscored its value as a habitat for fish and wildlife.

In 1977, Schoenbaum developed and taught the first coastal and ocean law policy course at the law school. It was based on a two-volume text he and his students published with Sea Grant support. He now teaches law at the University of Georgia School of Law, where he specializes in environmental law and international trade law.

CAMA remains the guiding tool for managing the state’s coastal and marine resources.

**T**he estuaries of the United States have always been a major resource in development of America’s economy, culture and way of life. .. Now, in the twentieth century, the spread of urban civilization is including the estuaries, alternating cities with wilderness areas in new designs for the planet Earth.

Today, Sea Grant research still is a vital link in coastal management decisions. Researchers from across the University of North Carolina system and Duke University contribute to a growing body of knowledge.

Sea Grant researchers may respond to a particular need — from helping shape developing fishery management plans to guiding the state’s emerging river basin management plans. Sea Grant research also serves as an example of how scientists can help provide businesses with information needed to manage estuarine resources.



Waterbirds are an important part of the coastal food chain.



Researchers even may be called into public service during a natural disaster.

In 1999, state officials and the media turned to Sea Grant researchers in the wake of devastating hurricanes and flooding in the coastal plain. Beyond concern for loss of lives and destruction of property, rising waters could bring environmental and public health risks.

The scientists' quick response enabled them to track and report how advancing flood waters were affecting the estuarine region. UNC-Chapel Hill's Hans Paerl and Duke University's Larry Crowder and Joe Ramus were on the scene on the Pamlico Sound to observe the force of fresh water flushing the dark plume of animal and human waste, sediments and other pollutants out of the system — easing human health fears.

However, depleted salinity levels, especially in the Pamlico Sound, meant stress and delayed growth for many brackish-loving finfish and shellfish populations.

The Sea Grant researchers continue to study the recovery of North Carolina's vast and vital estuaries — where the fresh waters from the state's rivers mix with the ocean's salt water to form productive fisheries nurseries.

**T**he new patterns involve wastes, dredging, and industrial uses of the bays which are changing nature so fast that our comprehension is badly lagging in spite of accelerating efforts at scientific studies of estuarine science.

Copeland and his NC State colleague, John Hobbie, were in the advance guard of estuarine ecology studies. In the early 1970s at the Pamlico Marine Lab in Aurora, they investigated the effects of discharge from the newly opened phosphate mine and studied the effects of raw sewage and heat on estuarine organisms such as plankton, clams, oysters, finfish and grass. They also explored how warm water energy emitted from a nuclear power plant could affect marine organisms in estuaries during winter months.

Copeland also teamed with Ronald Hodson, then a zoology colleague and now director of Sea Grant, to study the impact of

an electric generating plant on the Cape Fear River estuary. They determined that the plant's water intake system was disturbing only a small fraction of the estuary's fish. The study showed that the plant could operate without costly modifications and still meet environmental standards.

More recently, Copeland authored *Salt Marsh Restoration: Coastal Habitat Enhancement*. It is the synthesis of three decades of research by a number of Sea Grant researchers. "Using the report," he writes, "coastal interest groups, management entities and technical practitioners should be better equipped to set goals for valuable salt marsh habitats."

In 1980, NC State zoology professor John Miller was among the early Sea Grant researchers trying to get a better understanding of how estuaries work. Miller was studying juvenile spot and croaker in nursery grounds around Rose Bay — one of the most fertile estuaries in the state. Understanding the length of time juveniles spend in estuaries, their preferred diets and habitat, ideal salinity and water temperature ranges — and their most feared predators — all would have important resource management implications.

The following year, the Governor's Coastal Water Management Task Force tapped Sea Grant's Copeland to coordinate the study of the impact of land drainage on estuaries. The goal was to demonstrate the relationship between an estuarine nursery and water management.

Miller continued his research at Broad Creek, the site of a pumping station, enabling him to manipulate the amount of water entering his estuarine testing site. NC State colleagues Margery Overton and John Fisher attacked the drainage problem from an engineering perspective. And Wayne Skaggs and Wendell Gilliam worked to develop a model to predict the effect of different drainage methods on the flow of water from the fields.

The multidisciplinary project resulted in establishing guidelines under which farming and forestry operations along the coast were managed in harmony with the fishing industry.

**A**ny classification of estuarine systems must include ancient types that preceded man and that remain in wilderness areas as well as new patterns associated with estuaries newly disturbed by man.

For East Carolina University researchers Stan Riggs, Mike O'Connor, and Vince Bellis, doing something about the eroding estuarine coast was long overdue. Their mid-1970s study provided a volume of information describing the course Mother Nature was taking to erode estuarine shorelines and raise the sea level.



Managing shoreline erosion is essential in the face of increasing demands on coastal land.

They found that different types of estuarine shoreline experience different rates of erosion. The researchers devised a formula to help determine an "erosion quotient" for shoreline property. Riggs calls it a do-it-yourself guide for evaluating potential for erosion and planning how best to develop the plot.

They also proposed solutions that called for the use of natural mechanisms to slow down erosion. Cypress trees and grasses, for example, provide natural protection and are CAMA-approved mitigation tools.

Today, remedies for estuarine shoreline erosion are more relevant than ever, with increasing demands being placed on coastal land. Sea Grant Marine Educator Lundie Spence is coordinating a publication series

*C o n t i n u e d*





Estuaries provide a nurturing environment for 90 percent of all commercially important shellfish and finfish.

dealing with estuarine shoreline development.

Riggs will produce the first in the series, incorporating the original data as well as new research findings. Subsequent guidebooks will deal with policy and mitigation methods. Walter Clark, Sea Grant coastal policy specialist, and Spencer Rogers, Sea Grant coastal erosion and construction specialist, will contribute to the series.

**W**hereas studies of single species, single chemical processes, single geological features and single processes of a physical nature have been useful and often rigorous, the behavior of an estuary depends on the total interaction of all the chemical cycles, water circulations and species behaviors.

When the Albemarle-Pamlico sound system was designated an "Estuary of Concern" in 1988, a team of Sea Grant researchers was dispatched to find solutions for the ailing system.

Skaggs and Gilliam would investigate how land uses in the watershed affect estuarine water quality. NC State's Ed Noga would look at a disease suspected of causing a four-year decline in blue crab populations, and Walter Clark would develop a pilot program that would serve as a model for managing multiple uses of public trust waters.

Len Pietrafesa and colleagues from NC State's Department of Marine, Earth and Atmospheric Sciences, would be part of the multidisciplinary effort.

Pietrafesa, would lead landmark studies of the circulation patterns of the Albemarle and Pamlico sounds — their links to each other and to surrounding bodies of water.

He began looking at the sounds and the narrow inlets between barrier islands that funnel water in and out of the estuary. The central coast, he says, is uniquely situated relative to both winter northeasters and summer tropical storms. "It's the center of mass for winter storms, and the point where tropical storms can re-intensify or even spawn."

The estuaries and coastal systems have learned to deal with storms, he says. But often people get in the way of nature. When water and winds build up in the shallow estuary basins, the winds punch the water through the narrow inlets into the coastal waters.

Pietrafesa explains that during a Nor'easter, when the wind blows down the axis of the Pamlico Sound from NE to SW, the system sets up like a teeter-totter with the fulcrum at Bluff Shoals. The strong northeast wind pushes water southward allowing rivers to drain quickly. As winds shift to the southwest, the water is pushed in the opposite direction.

But it's an ill wind that doesn't blow some good. The same ocean surges that may wash over barrier islands — claiming dunes, buildings and roadways — also carry fish larvae from the ocean waters into the sound side of the barrier islands.

On the backside of the storm, Pietrafesa notes, winds from the west push water to the backside of the barrier island. Larvae enter the estuary in heavier sea water, which sinks to the bottom of the water column as wind-driven freshwater enters the system from the west. As the storm subsides and winds shift, the larvae are pushed west safely into the estuary's nursery.

Hurricanes also can mean unusual nurseries of juvenile blue crabs. Recent studies by Sea Grant researcher Dave Eggleston concluded that hurricane winds drive juvenile blue crabs toward the western shore of the Pamlico Sound and into the Croatan, Albemarle and Currituck sounds.

**I**n the ecological approach to environmental systems, man's role is considered as an integral part of nature.

What's a salt marsh without egrets and ibises? Not much says James Parnell, nationally renowned ornithologist at the University of North Carolina at Wilmington. Parnell has devoted much of his research career to studying the habits of colonial water birds.

It was Parnell who first realized the importance of man-made dredge spoil islands that dot the state's estuaries. These islands have provided nesting habitats for large colonies of water birds, most of which used to nest along once undeveloped beachfront.

Sea Grant funded his first water bird census, the atlas resulting from the census, subsequent publication evaluations and numerous publications about avian management.

Scientists and resource managers say the birds are important to the coastal food chain and are indicators of environmental quality. They say that waterbirds are so vital to our coastal ecosystem that management of their nesting and feeding habitat is necessary.

Parnell's later work, *The 1993 Atlas of Colonial Waterbirds of North Carolina Estuaries* and *1990 Management of North Carolina's Colonial Waterbirds* — both published by North Carolina Sea Grant — are considered the ultimate management guides.

**M**an receives from the bay system and its components the yield of aesthetic recreational restoration, foods, services in processing wastes, and other profits. If we draw on these systems without returning some exchange of special value to the estuary, we cause the aspects in which we are expecting continued yield to be diminished.

At the portal of the 21st century, North Carolina Sea Grant remains committed to supporting research and extension activities to underwrite an estuarine policy that balances a mutually sustainable give and take of nature and society. □



# A SCIENTIFIC ASSAULT ON HARMFUL ALGAL BLOOMS

The discovery of *Pfiesteria piscicida* by North Carolina Sea Grant researchers JoAnn Burkholder and Ed Noga of North Carolina State University in 1991 caused a media stir.

Since then, scientists have been trying to unravel the secret of this mysterious organism that has 24 different life stages. It can transform itself from a harmless cyst into a sometimes toxic dinoflagellate capable of killing fish.

But for many environmental scientists, *P. piscicida* is one more harmful algal bloom (HAB) to add to the list of indicators that something is wrong with the water quality of the state's rivers and estuaries.

In previous decades, Sea Grant scientists focused on the effects of red tides, brown tides and blue-green algae. In 1987, red tide closed shellfish beds and beaches along more than 250 miles of North Carolina shoreline — a \$25 million loss to seafood and tourism industries.

Today, Sea Grant researchers continue to search for environmental common denominators that trigger HAB events. Factors include excess nutrient runoff from upstream, depletion of oxygen and salinity levels, temperature and sunlight. Atmospheric deposition and climatic change also could figure in the equation.

Water quality experts know the key to solving the HAB problem is providing the right scientific information to create policy and management plans.

Here's an update on the scientific assault on HABs:

• **DNA Markers:** In a project that started with funding from North Carolina Sea Grant, Parke Rublee of the University

of North Carolina at Greensboro teamed with Burkholder to develop DNA probes that can detect *Pfiesteria* species in water samples. DNA amplification or fluorescent dye markers then make the presence of *Pfiesteria* obvious.

With help from Rublee's work on the *Pfiesteria* probe, Burkholder identified and named *Pfiesteria shumwayae*, a second *Pfiesteria* species that shares many of *P. piscicida*'s qualities — including a strong attraction to fish, the ability to manufacture toxins, a complex life cycle with an amoebic stage, and an animal-like pattern of behavior. *P. shumwayae* appears to thrive best in coastal waters with high nitrogen levels, while *P. piscicida* prefers higher phosphorus levels, although both can stimulate its growth.

The probes have been used to determine the geographic distribution of *Pfiesteria* and its presence or absence at sites of fish kill or lesion events.

Colleagues at University of Maryland's Human Virology Institute developed probes to detect *P. shumwayae* and a cryptoperidiniopsis species that is a "*Pfiesteria*-like organism."

• **FerryMon:** In 2000, Sea Grant researchers Hans Paerl, of UNC-Chapel Hill, and Joe Ramus and Larry Crowder, of Duke University Marine Lab, collaborated with the N.C. Department of Environment and Natural Resources and the N.C. Department of Transportation (DOT) to launch FerryMon, an innovative way to study water quality of the Pamlico Sound and Neuse River. Automated devices are attached to several DOT ferries that make multiple daily crossings on three different routes of the river and the sound. These

devices can detect and relay real-time data on surface water nutrient levels, salinity, turbidity, chlorophyll, oxygen and other dissolved materials that may trigger HABs.

## • **Studying Nutrient Runoff:**

Nitrogen continues to be the nutrient controlling algal production in the Neuse River estuary, and Paerl, Crowder and Ramus track seasonal pulses of nitrogen loading that can support algal blooms. Meanwhile, Sea Grant researchers Martin Posey and Larry Cahoon, both at the University of North Carolina at Wilmington, continue to study the estuarine and coastal waters of the Cape Fear River region on the southern coast of the state. The high rate of development, along with the large number of hog farms in the region, increases the risk for nutrient loading — and HAB outbreaks.

## • **Atmospheric Increases:**

Coastal algal blooms appear to be increasing in regions downwind of growing atmospheric nitrogen deposition associated with agricultural and urban expansion in upwind airsheds, Paerl reports.

Paerl continues to examine the connection between ammonium enrichment and the potential for blue-green algal blooms (cyanobacteria). Given that animal waste is rich in ammonium, and that atmospheric deposition of ammonium in coastal regions has increased in the past few decades, there may be a link between this growing nutrient source and increasing cyanobacterial dominance in the Neuse-Pamlico estuary. — P.S.



# New Project Keeps Blue Crab Industry on Track

By Cynthia Henderson

Photos by Michael Halminski



WILLY PHILLIPS, LEFT, SORTS CRABS WITH HELP FROM MARC TURANO.

*It's the end of a long road in coastal Columbia, North Carolina, where the pocosin meets the Little Alligator River — little only in comparison to its big sister, the enormous Alligator that separates Tyrrell and Dare counties. The gray waters are churlish, spitting white foam as if in disgust at the unseasonably cool, wet day.*

Background photos by Scott D. Taylor

Here Willy Phillips' split-level mobile home looks out toward the river. Artwork is everywhere — from the combat helmeted, gnarled heartwood jutting out of the front yard to an ornamental metal overlay on the board-and-batten shed out back. Phillips' wife, Feather, is the founder of Pocosin Arts in town. Willy is a crabber, has been for 20 of his 25 years in commercial fishing.

He is a hardy man with shoulder-length blond hair, a steady, sometimes mischievous gaze and a quick smile. In town, he seems to know everyone. He definitely knows crabbing, both as a job and as a culture.

That's why Marc Turano of North Carolina Sea Grant has driven all the way from Wilmington to meet Phillips. Turano is heading up a blue crab project initiated by the N.C. General Assembly last year to support this, the state's most lucrative fishing industry. The program is allocated \$500,000 annually to be administered by North Carolina Sea Grant.

Turano has a bachelor's degree in marine biology from the University of North Carolina at Wilmington and a master's in

mariculture from Texas A&M-Corpus Christi. A native Long Islander, he may be the proverbial "new kid on the block," but Turano is acclimating well. Eager to learn about the culture of crabbing, he has driven countless miles along the jagged Carolina coastline getting to know crabbers.

Such knowledge can increase credibility with an independent group whose livelihoods depend on the skills, wit and wisdom accumulated from a lifetime or even generations of working on the water. Crabbers aren't inclined to listen to people who don't seem to know what they're talking about, says Phillips. "A lot of these guys are just on the verge of not listening to anybody, anyway," he adds.

So Turano set out to get crabbers together to talk about problems facing the industry and to identify research needs. The Blue Crab Research Program will provide funds for research projects that include significant participation by people in the crab industry.

More than 3,000 notices were sent out — one for every known crabber in the state





DAVID GALLOP, RIGHT, SHOWS TURANO THE FEISTY JIMMY CRABS.



TURANO CHECKS OUT THE CATCH AT WILLY PHILLIPS' DOCK ON THE ALBEMARLE SOUND.

— and open forums were held in Swan Quarter, Manteo, Morehead and Wilmington.

“I didn’t want to *lead* the meetings,” says Turano, “I waited for the crabbers to state their ideas.”

From the forums, five research priorities emerged: stock enhancement, population assessment, blue crab biology, shedding technology and social and economic impacts of the blue crab fishery.

If the topics sound wide open, consider Phillips’ take on the situation: “We’re operating in a complete unknown” regarding how the crabbing industry affects the blue crab population, he says.

Twenty-seven proposals for research projects have been received and are under review for funding. All research priorities are addressed in the proposals.

North Carolina is the top producer of blue crabmeat in the nation, with harvests as high as 60 million pounds annually, according to David Green, director of the NC State University Center for Marine Science and Technology.

Last year’s hard crab harvest, however, was down to around 38.8 million pounds, according to the N.C. Division of Marine Fisheries (DMF). But Lynn Henry, a marine biologist with DMF, says a one-year drop may not signal a downward trend. Crab harvests historically are unpredictable, he adds.

“We absolutely need to know more about crab biology,” he says, and agrees that having crabbers involved in well-planned research can be beneficial.

Marc Basnight, president pro tempore of the N.C. Senate, was instrumental in initiating the Blue Crab Research Project. “The blue crab fishery is an important part of our fishing economy, but we really know very little about it. This research will help us do a better job of protecting the blue crab fishery and maintaining it for the future,” says Basnight.

A major concern of the crabbing industry is the effect of foreign imports on the state’s blue crab market. Out of more than 40 crab plants that once operated in North Carolina, only about 20 operate

today. And Phillips tells Turano of yet another that will be closing soon after 50 years in business.

Imported meat is cheaper, making it difficult for local processors to compete. Taste tests and forums conducted by North Carolina Sea Grant and the U.S. Department of Agriculture show consumers prefer fresh, local seafood but are often unaware of the origins of the crabmeat they buy.

Imports come from species other than the blue crab, *Callinectes sapidus*, and are chemically preserved and whitened, Phillips says. And while imports are supposed to meet certain safety standards, he maintains that enforcement is inadequate to ensure those standards are met.

Given the many problems confronting the industry, Phillips says he is delighted with the Blue Crab Research Program and with Turano’s eagerness to learn from crabbers.

As part of Turano’s continuing education, Phillips takes him to meet fellow crabber David Gallop described by Phillips as “just the best.”

*Continued*



## A CRAB-SHEDDING OPERATION

David Gallop's crab-shedding operation is in a two-room building beside his neat ranch-style home in a quiet neighborhood in Columbia. Despite the chill outside, the air is heavily humid from eight shallow recirculating tanks.

Inside the tanks are jimmies, male blue crabs. They are lively, and almost comically suspicious as they scuttle on tiptoe with eyes set on stalks, checking out the new arrivals who are checking them out. Sometimes, for no apparent reason, there is a quiet sideways stampede to one or another corner of a tank.

The jimmies will be used as bait in peeler pots to lure sexually mature females about to undergo their last molts. It is during the short 12-hour interval when she has lost her hard shell that the female can successfully mate. Vulnerable during molting, the females seek out males, who offer the protection of their hard shells.

The females' vulnerability during this shell-less time is heightened by the fact that they are now soft shell crabs, much sought by human diners. Female "peelers" will be kept in the tanks until they molt. Since shells begin to harden quickly, the soft shell crabber is on constant watch until all shedding is complete.

In nature, females produce from about 700,000 to 2 million eggs between two and nine months after mating. Out of that incredible number, only a few will grow to become an adult crab.

The microscopic eggs provide food for other species as well as for other crabs. Phillips says this is an "incalculable" contribution of a healthy blue crab population to the ecosystem.

Turano is clearly in his element, talking with Phillips and Gallop about filtering systems, dissolved oxygen and salinity levels and good bacteria that turn ammonia waste products into harmless substances. Besides his background in marine biology, Turano says he hopes his mariculture experience can be a benefit to crabbing operations like Gallop's, which are hybrids

between fishing from the wild and fish "farming."

Turano says Gallop's is a "model" crab shedding operation. Gallop has a very low mortality rate among his shedding crabs in part, he says, by keeping an appropriate ratio of crabs to water in the tanks. That means 1 to 1.5 gallons per crab. It's pure greed, he says, to crowd too many crabs into a system. Ultimately overcrowding works against the crabber because of high mortality.

Turano says it's also a plus that Gallop knows the crabs in his system. He caught them himself and has kept them in optimal condition.

Eventually, the talk turns from the technical aspects of crabbing to the personal. Phillips and Gallop came into crabbing through different routes. Phillips "grew up on an idyllic creek," he says, near the Masonboro Sound. He and his siblings made a little money crabbing as children, he says. After college, the early experiences drew him back.

Ask Gallop how long his family has been in crabbing, and he laughs. He knows it goes back at least to his great-grandfather — probably further. Gallop's older son helps him with crabbing when he's home from college in the summer. Will he, too, be drawn into fishing for a living? Gallop is quick to answer: "He will not be a crabber. You can see it in his eyes."

Phillips also says he doesn't expect his son to follow him into crabbing. Both men are matter-of-fact about this. "You have to have a deep passion" to be a crabber, says Phillips.

But the unspoken question lingers. Might small, independent crabbing operations be approaching the end of a long road?

## ON THE DOCK

The dock Phillips leases for his hard crab operation is at the end of another long road — this one sandy, rutted and puddled. On the other side of a channel are the choppy waves of the Albemarle Sound.

In peak season the area is like a multicultural carnival, Phillips says. Like

agriculture, crabbing attracts recent immigrants looking for a better life. On busy days, voices of different languages fill the air "like you're in an aviary," he says.

But all is quiet on this windy day. Boats line both sides of the channel. Crab pots of many colors and many feet high are stacked on the shore — around 5,000 in all, Phillips says. The folk wisdom is that different colors are effective at different depths and salinities.

Phillips calls the yellow-and-green crab pots "John Deeres," the orange-and-blacks "Halloweens," and the green-and-reds "Christmases." But the unconventional Phillips says, "I'm a traditionalist," and prefers black.

Turano helps Phillips sort a recent crab catch. Any "stills" or unhealthy-looking ones are separated out. Turano jokes about the usefulness of the Neoprene gloves Phillips gives him in defending against the feisty crabs, but he gets into the act wholeheartedly.

One of the recent changes in crabbing is in bait. Some people use chicken parts and believe crabs like them, shall we say, aged. But Phillips says, "Crabs love fresh bait — the fresher the better."


Phillips prefers fish for bait. Yet he has made concessions in order to be competitive. He tugs a basket of shrimp heads out of the freezer, explaining that they catch more crabs.

It is, perhaps, a small concession. How many others might be made in order to sustain the crabbing industry remain to be seen. Turano says he hopes the research that comes out of the blue crab project — research driven by the insights of crabbers themselves — will keep crabbing in North Carolina on the road to a healthy future. ☐

*For more information on the Blue Crab Research Project, call Marc Turano at 910/253-2610. His e-mail address is marc\_turano@ncsu.edu.*

*For information about the blue crab processing industry and the problem of foreign imports, visit [www.nccrabs.com](http://www.nccrabs.com) on the Web.*





# VETERAN CRABBER STILL SETTING THE PACE

*By Ann Green*

*Photos by Michael Halminski*

As water circulates around dozens of crabs in a white tank, Murray Bridges scoops up a small crab.

Then Bridges turns the crab over and points to the red line on the back of the peeler's paddle fin.

"This crab is getting ready to shed," says Bridges, a jovial man with twinkling blue eyes. "I will take this crab out in a couple of hours. Crabs usually shed in three to four days."

As a veteran shedder, Bridges knows every telltale sign of an impending molt — from the color changes on the creature's paddle fin and apron to its docile behavior.

For more than 25 years, Bridges has been tending peelers — crabs that are about to shed their shells — at Endurance Seafood Company in Colington.

His operation includes catching, shedding and shipping crabs as well as fishing for perch, mullet, catfish and eel.

Bridges is the largest crab shedder in Dare County, according to North Carolina Sea Grant extension program specialist Wayne Wescott.

"I sell more than 50,000 dozen soft shell crabs a year," says Bridges.

In North Carolina, blue crabs, including soft and peeler crabs, are an economically valuable fishery. From

*Continued*





Murray Bridges has been tending peelers for more than 25 years.

1999 to 2000, the value of soft shell crabs jumped from about \$2.1 million to \$3.3 million, according to the N.C. Division of Marine Fisheries (DMF). The price per pound increased from \$4.26 to \$4.45.

In the early part of this season, soft crabs were bringing a hefty price — from \$20 a dozen for small “hotel” crabs to \$36 a dozen for jumbo crabs.

### SEA GRANT EXTENSION EFFORTS

When Bridges first started in the crab business, he learned how to operate an electric pot puller from the late Hughes Tillet, a North Carolina Sea Grant extension agent.

“The pot puller has cut my time 75 percent,” he says. “I used to pull 120 pots

by hand in one day. Now I pull 200 to 250 pots a day with the pot puller.”

Through a Sea Grant demonstration, Bridges also learned how to operate a hydraulic net reel that allows fishers to reel in a net with the push of a button.

“The reel was new on the East Coast,” says Bridges. “Sea Grant brought the idea from the West Coast. The hydraulic net reel has improved fishing 1,000 per cent. It has created a lot of income for fishermen and saved a lot of time.”

After Bridges learned to use the reel, he helped North Carolina Sea Grant with demonstrations on-board a boat.

“The net reels caught on good,” says Bridges. “Now, more than 250 fishing boats on the Outer Banks have net reels. Sea Grant has been a godsend to commercial fishers.”

Over the years, Bridges also has provided demonstrations in a number of North Carolina Sea Grant shedding workshops.

“Murray is an innovative man with a lot of knowledge,” says Wescott. “He is willing to take new ideas and equipment and modify them until they work efficiently enough to improve his fishery. Murray also is willing to share with others.”

By sharing his hands-on experience, Bridges gives a different perspective to other fishers.

“Good extension programming is a two-way street,” says North Carolina Sea Grant extension director Jack Thigpen. “We share research-based information from the academic community while providing a forum for our clients to educate researchers about the practical realities of harvesting and producing crabs.”

### FAMILY-RUN SHEDDING OPERATION

Bridges’ seafood business is tucked away in the tiny community of Colington near Kill Devil Hills.

To get to Endurance Seafood, turn off the tourist hubbub on U.S. 158 onto Colington Road — a two-lane road lined with local seafood businesses and restaurants.

After crossing over a small bridge, you see a sign for Endurance Seafood leading down a tree-lined, sandy road.

Bridges’ ranch-style brick home sits on one side. On the other side is his seafood business housed in a white concrete building with two garages piled high with old parts and other items. Near the garage are stacks of crab pots and a net wheel that Bridges uses to make nets.

“I do a little bit of everything,” he says.

In the front of the building, several freight trucks are lined up to the back, waiting to receive boxes of crabs. Inside the building, there are several offices and refrigerated areas to store seafood.

“This is a family-run business,” he says. “My wife, sister-in-law and daughter all work here.”

Toward the back, there is a room with



stacks of soft shell crabs sprinkled with ice and ready to go to market. The crabs are boxed according to size — from jumbo to hotel — and packed in seaweed.

“They will stay alive for three days,” says Bridges. “They are all going to the market in New York.”

Outside the building, more than 150 shedding tanks sit on top of wood frames. The fiberglass white tanks have pipes that draw water from the nearby creek.

“The water is constantly circulating,” says Bridges.

During shedding season from May until November, Bridges and his employees dart from tank to tank, watching the crabs to see when they escape from their shells. Crabs molt to grow, and shed some 20 to 30 times in their two- to three-year lifespan.

“We have to check the tanks every four hours,” says Bridges. “I only get two to three hours sleep during the shedding season.”

The busiest time is May when 75 percent of the crabs shed, says Bridges.

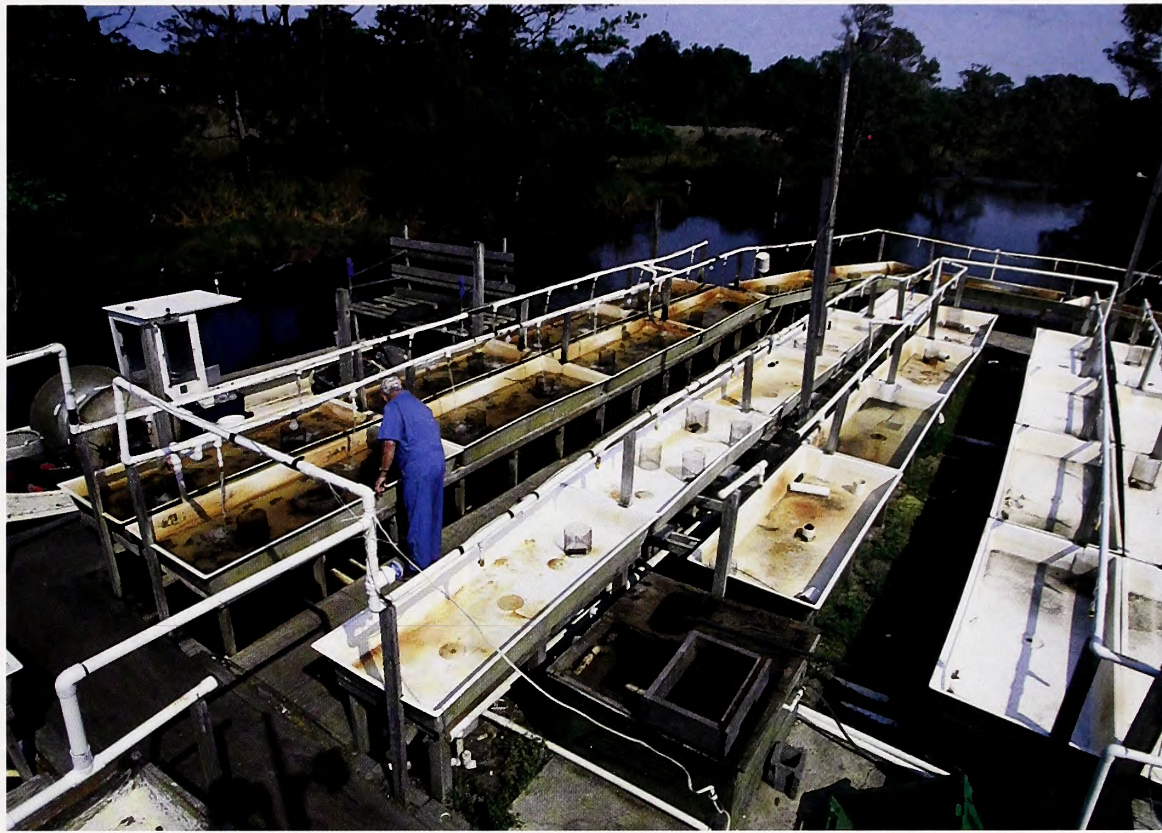
“Last year was an exception. We had a great month in August. It had never happened before. It is just nature.”

Although most crabbers call it quits after the peak shedding season, Bridges sheds until the last crab has crawled into the mud.

“I buy a lot of peelers from hard crabbers,” he says. “This makes it worthwhile for me to shed until the water gets cold in November.”

## NEW SHEDDING TECHNOLOGY

Bridges was one of the first shedders in the state to use a flow-through system. Before installing onshore tanks, he used sunken boats and floating trays offshore while waiting for the critters to bust out.



Bridges checks the tanks at his Colington seafood business, tucked away from tourist traffic.

The efficiency of a flow-through system has attracted more people to the shedding business.

“There weren’t over 10 shedders when I first started over 25 years ago,” says Bridges. “Now, there are over 200 shedders on the Outer Banks. The majority of people have been successful. It just takes a lot of hard work. It is like anything else. You can get out of it what you put in it.”

During crabbing season, Bridges usually leaves before dawn in one of his boats. He usually pulls pots for several hours in Roanoke Sound.

“Yesterday, I got 400 peelers, three bushels of jimmies or hard crabs and 20 pounds of eels,” he says.

During the winter months, Bridges does net fishing for perch, catfish, and other fish in the nearby sounds.

“I enjoy fishing,” he says. “When you set a pot or net, you always wonder what will be in it when you get it back.”

Like many veteran fishers, Bridges is worried about the future of the crab industry. The hard crab harvest in North

Carolina fell 30 percent last year to 38.8 million pounds, according to a DMF report. However, the report says that soft crab landings increased 47 percent — from 510,363 pounds in 1999 to 750,140 in 2000.

During the start of this season, the run for soft crabs in Dare County is the best in five years, according to Bridges.

To maintain a viable crab industry, Bridges suggests that the state inspect all peeler crabs going out of state.

“I think that the state needs to check the type of crabs going out of state,” he says. “A lot of the crabs are classified as peelers when shipped, and they are hard crabs.”

Even though DMF is not proposing to limit crab pots, Bridges also is concerned that the division may set limits like they did with nets.

“The state put a limit on nets in Albemarle Sound,” says Bridges. “It has gotten so bad that no one can make a living out there with nets. I am afraid this is going to happen with hard crabs — and you won’t be able to make a living.” □





Photo by Michael Haimanik



Photo by Michael Haimanik

TOP: Gene Ballance gets a hand from his father, Elisha, while setting up equipment for his FRG mapping project. BOTTOM: Data gathered in the field is then run through a computer analysis.

## Grants Probe Complex Coastal Equations

By Cynthia Henderson

An accountant who likes to fish might think Gene Ballance has it backward. Ballance fishes for a living and studies math “to relax.”

Why, with a degree in math from Campbell University and a strong interest in science, does he choose to fish commercially? After graduation, Ballance says, he realized he “could make more money crabbing than teaching.” As for other white-collar possibilities, “I’m too much of an outdoor type,” he says.

Ballance was able to bring his varied interests together with help from a unique grant program targeted for people in fishing-related industries.

In 1998, Ballance applied for and received funding from the North Carolina Fisheries Resource Grant Program (FRG), to use a global positioning system (GPS) to map geographic features and hazards in blue crab sanctuaries from Ocracoke to Hatteras inlets. The resulting map is more than a delineation of land and underwater structures. Its implications reach from where to fish for red drum to where not to drill for oil. And the mapping project stands as a poster child for FRG and for the unexpected benefits of blending fishing expertise with science.

The North Carolina General Assembly created the FRG program in 1994 to “protect and enhance the state’s coastal fishery resources through individual grants.” The program was custom-designed for people who, like Ballance, make a living from the water and have special insights for improving or protecting coastal resources.

The legislature provides \$1 million each year for FRG projects. North Carolina Sea Grant was chosen to administer the program because of its success with applied research. This year, 22 projects have been approved for funding in each of the four designated research categories: fisheries equipment and gear, aquaculture and mariculture, environmental pilot studies and seafood technology.

To B.J. Copeland, vice-chair of the N.C. Marine Fisheries Commission and former director of North Carolina Sea Grant, it’s a matter of taking advantage of what he calls “native creativity,” which, he says, usually results in good things. “Nobody has a corner on creativity,” he says.

For Ballance, native creative elements include a fascination with celestial navigation and astronomy that led to the skills of mapping and using a sextant. While in college, he tutored calculus, and for the last few years has been working on assembly language programs for a scientific calculator.

“While 99 percent of my income comes from fishing and crabbing, at heart I am more of a scientist and mathematician,” Ballance writes of himself. But having a scientific background is not a requisite for receiving a grant. FRG often pairs grantees with graduate students or academic researchers to help design projects and interpret results.

Research results are not always what was expected. A study on eel migration patterns, for instance, was looking for ways in which dams were having an effect on declines in eel abundance. Instead, a new parasitic infection of eels was discovered. Getting unexpected results is just the nature of research, according to Copeland. “If we knew the answers, we wouldn’t need to do research in the first place,” he says.

Sometimes impacts of projects are difficult to quantify, such as when FRG data are made available for use by different agencies. But any data that add to a body of knowledge can be valuable, Copeland says, even if the value is not immediately apparent.

### One Project: Several Impacts

Ballance’s project mapped navigational hazards such as abandoned sinkboxes — structures used by waterfowl hunters — as well as areas sensitive to navigation, such as those with submerged aquatic vegetation (SAV). Plotting SAVs is vital for both coastal and fishery management plans, such as one for blue crabs.

As Ballance notes in his final report, “SAV is a critical component of shallow marine ecosystems worldwide.” They provide refuge and food for waterfowl, shellfish, blue crabs and a variety of recreational and commercially important fishes.

Ballance mapped more than 19,000 acres of SAV, including 450 acres previously undocumented by state or federal agencies. This totals more than in the Chesapeake Bay and is part of the biggest area of SAV north of Florida,



he says. He adds that his data show that, because of currents, a proposal for oil-drilling off of Cape Hatteras could have been detrimental to SAV between Hatteras and Cedar islands.

Ballance's mapping of SAV has been used to determine clam-kicking areas. Clam kicking is a controversial bottom-disturbing method of harvesting clams that can be harmful to SAV. A letter from Mark Fonseca — research ecologist from the National Oceanic and Atmospheric Administration to the N.C. Division of Marine Fisheries (DMF) — cited data from Ballance's map in recommending areas to prohibit the practice.

Jim Bahen, a Sea Grant fisheries specialist who also sits on the state Red Drum Advisory Committee, says Ballance's map had a direct effect on the fishery management plan for that species. A line proposed by the committee to restrict use of certain gear in order to protect juvenile red drum was altered to allow fishing in an area that would otherwise have been closed unnecessarily.

Bahen says the red drum plan is "a case where a fisherman's knowledge" played a vital role in management. He also says state officials frequently request FRG final reports and ask about projects underway.

Ballance's map is a good example of how FRG projects encourage the protection of fisheries habitats, but the grant program goes much further. In fact, FRG has impacts from habitats to the dinner table.

### **FRG from Habitats to Dinner Tables**

Many other FRG projects have affected habitats. One project studied detrimental effects of the Quaker Neck Dam on anadromous fishes — those that migrate upriver to spawn. Another project studied movement along 139 miles of the Neuse River reopened to striped bass, shad and other anadromous fishes.

Numerous FRG projects have focused on water quality issues, including a study of nitrogen sources in the Neuse River estuary and a pilot program for water monitoring on the Cape Fear River.

One important aspect of fisheries management is protecting species from over-harvesting. Bahen notes a study done by Frank Montgomery on flounder nets to determine the

effects of different mesh sizes on bycatch — nontargeted species caught unintentionally. Bahen says the data from the study have been noted by fisheries agencies. But FRG doesn't stop with reducing fish bycatch. It also funds projects that seek to protect marine mammals, sea birds and sea turtles from entrapment in fishing nets.

Bob Hines, a Sea Grant fisheries specialist, says a project by Tommy Rose of Shiloh has attracted interest from the U.S. Fish and Wildlife Service. Rose and Pete Darna of Merritt have worked on separate grants to reduce seabird bycatch in gill nets. Such projects are "a good example of fishermen trying to find a solution to a problem," Hines, who serves as the FRG coordinator, says.

Shellfish comprise a thriving industry in North Carolina. Skip Kemp, mariculture and marketing specialist with North Carolina Sea Grant, notes projects that have helped improve shellfish "farming." Mark Hooper of Smyrna has developed a successful method of raising clams in tented mesh bags. Kemp says he has extended information from Hooper's projects to other clam growers.

Kemp also points to a successful off-bottom growout system for oyster aquaculture tried by Jim Swartzenberg of Jacksonville with FRG funding. Other projects have studied recirculating systems for crab shedding operations.

But FRG projects go beyond catching or growing seafood. Results of some projects go straight to the table. Sam Daniels of Wanchese Fish Company saw a 20 percent sales increase from a product developed by food science researchers at NC State University. With FRG funding, a natural protein cold-binding process was developed to make small scallops into a larger, more



Photo by Scott D. Taylor



Photo by Keith Rimmer

TOP: Aquaculture is one of four targeted areas for the N.C. Fisheries Research Grant Program. BOTTOM: FRG projects have included a survey of bottlenose dolphins.

uniform and more marketable product.

Moon Park of Coastal USA Fish Company used FRG funding to develop methods for handling flounder for the live fish market, made profitable by an increased demand for sushi. Subsequent funding was used to grow flounder larger and with greater efficiency.

Copeland says he is fond of sushi, noting that the raw fish delicacy is safe as long as it is fresh and handled properly. Again, FRG has projects that help assure seafood safety. Most notable are projects that resulted in a self-guide and workshops to help seafood dealers comply with federal regulations for handling seafood products.

The projects "really improved the quality of our seafood in our small dealers," Copeland says. ☐

*For more information on the Fishery Resource Grant Program, call 919/515-2454, or visit [www.ncsu.edu/seagrant](http://www.ncsu.edu/seagrant) on the Web.*



# KNAUSS FELLOWS APPLY ACADEMICS IN THE REAL WORLD

By Pam Smith

"It was a year to remember," Lise Knelson Fondren says of her year as a Dean John A. Knauss Marine Policy Fellow in Washington, D.C.

Fondren was a trailblazer. In 1985, she was the first of 30 graduate fellows sponsored to date by North Carolina Sea Grant.

"It was, as they say, a learning experience. Politics up close and personal is very different from what most lay people believe," she says. "I got to know Congress."

Now married with children, Fondren lives in Beaufort. Though her career moved away from marine issues, her dedication to rural health issues still touches the lives of many coastal families.

As an East Carolina University sociology graduate student, Fondren was a quick study during her Knauss Fellowship days in then U.S. Rep. Barbara Boxer's congressional office.

Drawing on her undergraduate background in zoology and marine studies, she worked with Boxer on the Royal Seal Commission. She responded to concerns regarding science and the environment.

"It was heavy, full fare," she recalls. "I suppose I was flattered by Rep. Boxer's confidence in my ability to 'just handle it.'"

Knauss Fellows are selected on the basis of their ability to share their scientific or marine policy expertise with policy makers in the nation's capital, says N.C. Sea Grant's coastal law and policy specialist Walter Clark, who monitors the fellowship program.

On the flip side, he says, fellows get a first-hand look at how science is used in the



Photo by Scott D. Taylor

Kristen Long and David Canny, both Duke University graduate students, are the newest Knauss fellows from North Carolina.

policy arena — and how decisions are made.

Clark explains that the National Sea Grant Program has a goal of developing well-prepared professionals who understand the changing nature of science and research in marine and coastal issues.

That's why, in 1979, the unique fellowship program was established. The fellowship gives eligible graduate students one year's work experience on a congressional staff, or with an executive agency dealing with marine programs.

## READY FOR ACTION

The Knauss Fellowship is a vehicle for applying academic lessons to a real world experience.

Kristen Long, one of North Carolina Sea Grant's two current Knauss fellows, says her transition into that "real world" was unexpectedly fast.

Since February, Long has been assigned to the Office of Protected Resources in NOAA's National Marine Fisheries Service.

Long, a master's candidate majoring in environmental management at Duke University, leads a double life as a Knauss. She spends part of her time with the Endangered Species Division working on sea turtle issues. And, she works with International Protected Resources, where she focuses on issues surrounding the Convention on International Trade of Endangered Species of Flora and Fauna.

After a brief round of orientation meetings, Long assisted in convening an



Photo courtesy of the Associated Press, Miami Bureau

Joseph Cione chases hurricanes for a living at NOAA's Hurricane Research Division in Florida.

international workshop on the sustainable trade of stony coral species in Jakarta, Indonesia.

It was a productive meeting. "Three working groups came up with best management principles for stony corals, including an approach ensuring sustainable resource use, best collection practices, and ecosystem assessment and monitoring guidelines," Long says.

So far, it has been an exciting experience — and she has a half year still to go.

But Joe Cione, Knauss Class of 1992, may have topped her for excitement as a fellow and "on the job."

"I was one of the few meteorology students picked at that time," says Cione. He was assigned to NOAA's Office of Global Programs, which oversees the Atlantic Climate Change Program.

Cione, who was completing his doctoral program at North Carolina State University at the time, conducted field work in the Solomon Islands and Australia. He flew in aircraft 60 meters above the ocean to get a better idea of air/sea energy flux.

Now with NOAA's Hurricane Research Division at the Atlantic Oceanographic and Meteorological Laboratory in South Florida, Cione studies the air/sea interaction as it relates to hurricanes. "The ocean is a virtual fuel tank. It's important to know and understand how a hurricane uses that energy."

He flies through two hurricanes a year. "The cowboy in me loves to fly into the storm."





Gearing up for a day's work, from left, are Matt Kendall, John Burke and Jud Kenworthy at the NOAA lab in Beaufort.



Matt Kendall, 1998 Knauss fellow, and John Christensen, 1995 Texas Knauss fellow, map marine resources for NOAA.

## MAPPING OPPORTUNITIES

Matt Kendall's Knauss experience took him in still another direction — underwater. Kendall, Knauss Class of 1998, worked with NOAA's Caribbean Fisheries Management Council to assess data requirements for essential fish habitat amendments to fishery management plans. His work included mapping the benthic resources of Puerto Rico and the U.S. Virgin Islands.

"Tough work, but someone has to do it," Kendall says. After completing his master's from NC State, he returned to work with NOAA's National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Assessment.

He now manages the mapping program he started as a Knauss fellow, spending about one-third of the year in the Caribbean supporting GIS mapping of the 400-square-mile area. "We dive all around Puerto Rico and the Virgin Islands to confirm what we think we see in the waters with GIS technology."

Of his office in Silver Spring, Md., he says, "I'm in good company here. Eleven of my 15 co-workers are Knauss alumni."

Kendall says, "I'm an enthusiastic supporter of the Knauss Fellowship Program. Fellows are presented with a variety of excellent opportunities and possibilities. With so many options for host agencies, fellows can broaden their understanding of the interaction of science and policy."

Opportunity. That's what the Knauss

Fellowship Program is all about, says Terrence R. Schaff, Knauss Class of 1991.

Schaff traded his diving gear for a suit and tie when he took a job as a senior advisor for legislative affairs at the National Science Foundation.

As a Knauss fellow, he was assigned to the U.S. House Merchant Marine and Fisheries Committee on Ocean Science and Policy. Writing legislation, he saw the connection of good science and good policy. He was lucky to have a strong background in the sciences — he had earned a bachelor's degree in marine biology at the University of North Carolina at Wilmington, and was completing his master's in oceanography at NC State.

The experience was very fulfilling, he says. "The learning curve continued to be very high through the year. Ten years later — I'm not sure when it levels out. That year provided an important base of understanding of the processes which drive Washington."

Schaff says, "The Knauss fellowship year was very much a beginning, and certainly the singular enabling event in my career."

## DEDICATED TO PUBLIC SERVICE

Many Knauss alumni remain in public service, Clark points out. "They are committed to using their experiences to help solve some of our country's crucial coastal and marine concerns."

Daniel Lyons, Knauss Class of 2000, is certainly headed in that direction. He will complete two degrees next year — a master's in environmental management from

Duke University and a master's of regional planning from the University of North Carolina at Chapel Hill.

He'll be doubly prepared and is doubly committed to "working to make institutions and policy more responsive to environmental problems and to the social and economic needs of communities."

As a Knauss, Lyons was assigned to the Federal Emergency Management Agency (FEMA). He traveled to disaster sites and field operations, including post-Floyd eastern North Carolina, to research issues for a report to Congress on FEMA's buyout program.

In addition, he provided technical assistance for the report to Congress, a survey of hazard mitigation planning, a coastal construction manual and a technical bulletin on marine-related facilities.

"The FEMA position added variety and depth to my education, allowing me to better understand the connections between open space preservation, economic development and hazard mitigation. I hope to use this knowledge to promote disaster resistance through smart growth and sustainable development," Lyons says.

The fellowship program honors Knauss — a Sea Grant founder and former dean of the Graduate School of Oceanography at the University of Rhode Island. Knauss served as the administrator of NOAA, Sea Grant's parent agency.

"Dean Knauss certainly set the bar high as a model of a dedicated public servant," Clark concludes. ■









## BOTTOM LIFE:

### Posey Digs Deep to Unlock Nature's Secrets

By Ann Green • Photographs by Scott D. Taylor

**A**s a tiny wave ripples onto a sandy marsh off the Cape Fear River, North Carolina Sea Grant researcher Martin Posey stands knee deep in soft mud.

Dressed in knee-high olive boots, a checkered shirt and jeans, Posey places a cage on the muddy sand flat.

The cage will keep out fish and crabs and stay in place for a month, along with six other cages. Some of the cages have nutrients added. Others are nutrient-free.

A short, compact researcher with boundless energy, Posey relishes his hands-on work in the flat, muddy marsh. "I love going out in the field instead of pushing paper," says Posey while digging in the mud. "This is where it is actually happening. It is easy to get lost in the numbers."

Posey also wades in the shallow copper-colored water and helps his assistants pull in a seine net filled with small predators, including flatfish, blue crabs and juvenile croakers.

The marsh's isolation — in the shallow shoulder areas along the Cape Fear River — provides an excellent laboratory for Posey and his colleagues to study the effects of nutrient loading on estuaries.

Although there have been numerous studies on the detrimental effects of nutrients in fresh water, this is one of the first times scientists have experimentally studied the effects of nutrient loading on bottom communities in North Carolina tidal creeks.

Posey, along with colleagues and graduate students, found that low levels of nutrients increased the growth of benthic microalgae — single-celled algae living on the bottom of North Carolina's estuaries.

However, added nutrients did not result in more or larger small bottom animals, including the many small invertebrates that are food sources for fish and crabs.

Algae are a major source of plant production on tidal flats and form the base of many food chains. Posey says the results suggest that the effects of added nutrients may be more complex than often thought.

"Within several weeks, low nutrient loading created a greater biomass of algae," says Posey, a professor at the University of North Carolina at Wilmington. "We know the grazing animals sometimes can keep algae under control and that increased algal production can lead to increased number and/or sizes of the animals that feed on them."

"One of our questions was whether increased nutrients may lead to increased numbers of bottom animals — the food for many fish and crabs. Surprisingly, small increases in nutrients led to more algae but not more fauna, making the issue of nutrient additions in coastal waters much more complex than we had previously thought."

Posey says the study may have important implications for the state's water quality.

"Even though water quality is meeting the Environmental Protection Agency's guidelines, biology and the food web also affect and are affected by water quality," he says. "Our results suggest that the health of the fish population may influence food-web response to moderate nutrient loading. We are seeing small differences in communities with low to moderate nutrient loading. This suggests there may be a threshold for change at higher nutrient loadings."

#### Multiple Studies

Posey's estuarine study isn't the only cutting-edge research that he's spearheading. He is involved in numerous projects — from discovering new nursery areas for blue crabs to the effects of experimental trawling on benthic communities.

*Continued*

LEFT: Martin Posey relishes his research in the flat, muddy marshes.



Because of his groundbreaking research, Posey received the Faculty Scholarship Award from UNC-W last year. He was one of only two professors to receive the award.

"Martin is one of our most engaged faculty members," says Scott Quackenbush, chair of the UNC-W Department of Biological Sciences. "He has more to do on one given day than three people."

Troy Alphin, a research associate and long-time collaborator with Posey, agrees. "He is probably one of the most enthusiastic people in the research field," says Alphin. "He doesn't do anything half way. His interest in water quality issues is tied together in all his projects."

Posey developed an affinity for the water while growing up in rural southern Maryland on the Chesapeake Bay.

"I lived on a creek," he says. "My dad was a small-time fisherman. I helped with the nets — all small stuff."

His interest in estuarine systems led him to study zoology at the University of North Carolina at Chapel Hill where he did an honors thesis on mud shrimp.

"The diversity of organisms got me into benthic ecology from worms to mud shrimp," he says. "The diversity on flats is so amazing. It all intrigues me."

In Posey's doctoral thesis at the University of Oregon, he continued his interest in ghost shrimp — an invertebrate that can kill oysters and is used as bait for fisheries.

"Once, I sunk in the mud," he says. "I had to swim and crawl my way out of a mud slurry."

For several years, Posey worked in the Pacific Northwest on seagrass beds and other projects. In the fall of 1989, Posey began teaching at UNC-W.

At UNC-W, Posey juggles several jobs — from teaching and research to managing, along with Alphin, a staff of 14 assistants and students in the Benthic Ecology Lab where they conduct experiments on bottom fauna.

"The lab is a beehive of activity because Martin has to collaborate with 10 other faculty members," says Quackenbush.

One of the lab's ongoing projects is its

involvement with the Cape Fear River Program, a collaborative program that involves numerous researchers and focuses on the dynamics of the state's largest river system as well as the effects of development on the river's health.

"We have discovered information about the effects of hurricanes on the bottom community," says Posey. "We found dramatic deterioration after hurricanes Fran and Bonnie and to a lesser extent after Floyd. However, we also found that the bottom community recovered the spring after the hurricane, indicating that bottom animals are resilient."

In his work on the Cape Fear, Posey also documented a gradual and steady decline of bottom species at certain locations over the past five years. "That may indicate chronic effects or gradual deterioration in our river system or the cumulative effects of multiple hurricanes," he says.

When Posey isn't teaching or overseeing the lab, he is motoring on a vessel to one of his research sites.

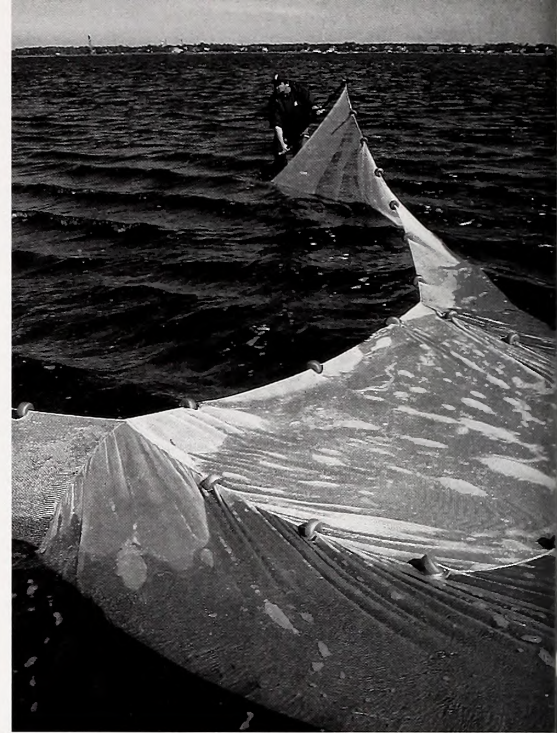
For his ongoing Sea Grant project on blue crab habitats — particularly juvenile crabs — he samples areas near the Cape Fear and New rivers. In North

Carolina, blue crabs are the top commercial fishery, generating more than \$32 million from hard crab harvests in 2000, according to the N.C. Division of Marine Fisheries.

In the past, most researchers had thought that young crabs, which face the greatest danger from the claws of bigger crabs, would rather migrate to seagrass beds.

While studying the thumbnail-sized young crabs, Posey discovered that marsh areas along the state's southeastern coast may be used extensively as nursery areas for blue crabs.

What makes Posey's research so useful is his choice of a region — one that hasn't been studied much for its crab habitats and



TOP: Posey pulls in a seine net at a research site.  
BOTTOM: UNC-W research team members assist Posey with his projects.

has no seagrass beds.

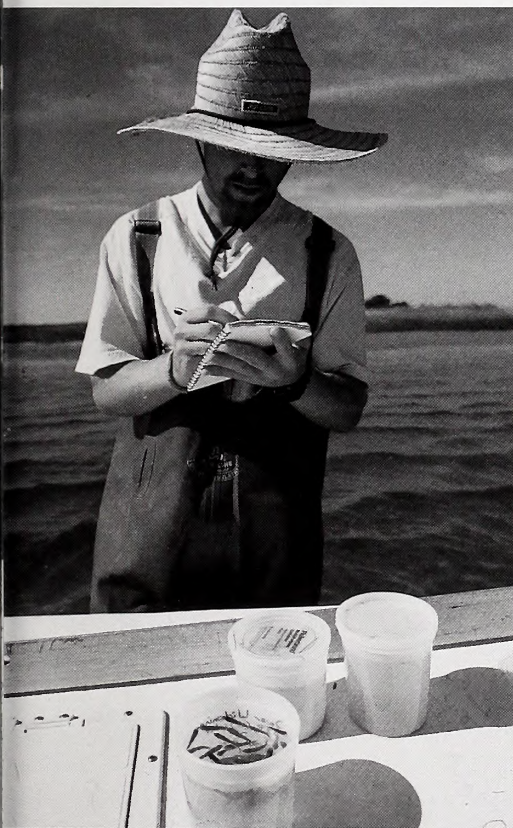
"These crabs may use low-salinity areas — especially in the absence of submerged vegetation," Posey says. The study emphasizes the potential management importance of these riverine systems, he adds.

### **Trawl Research**

Blue crabs aren't Posey's only area of interest.

Through a North Carolina Fisheries Resource Grant administered by North Carolina Sea Grant, Posey and Sea Grant researcher Larry Cahoon studied the effects of experimental shrimp and crab trawling on bottom communities. They worked





TOP: Posey places a cage on the muddy sand flat.  
 BOTTOM: A research team member records data.

alongside veteran fisher Henry Daniels.

In recent years, there has been no shortage of opinions about the environmental impacts of inshore trawling.

Some say trawling is good for productivity of inshore waters, "cultivating" the bottom sediments and stimulating

growth of the tiny creatures that live there. Others say trawling is bad for these waters, unsettling the communities and disrupting their biomass or weight and volume and ability to reproduce.

The study is important because the bottom areas affected by trawling are a prime habitat for soft-bottom organisms that are important food for larger

fish, shrimp and crabs.

The research targeted three types of organisms. Benthic microalgae are important plant producers, especially for small bottom-dwelling animals. Meiofauna live in-between sand grains and are small enough to be prey for shrimp and small bottom-feeding fishes. Macrobenthos include worms, amphipods and clams and are a food source for larger fishes, shrimp and crabs.

"We found no significant effects of experimental trawling on soft bottom organisms," says Posey. "However, there were some differences between trawled and untrawled areas. The differences vary between areas, between years, and among different types of organisms. More work is needed to determine which, if any, of these differences are actually due to the chronic effects of trawling."

### Oyster Filters

Through Sea Grant support, Posey and Alphin also are studying how the genetic selection of the American oyster or *Crassostrea virginica* may influence water quality.

Healthy oysters serve as a natural water-filtration system by cleansing estuaries of suspended material, consuming excess algae and promoting growth of vegetation.

As more people move to coastal areas, water-quality problems are expected to increase.

"The development of oyster populations that are tolerant to low water-quality parameters, especially turbidity and

increased nutrients, is important," says Posey. "The establishment of populations of tolerant oysters would help to create a source of larvae to replenish dwindling stocks, enhancing fishery habitats and possibly affecting the water quality through filtering."

To develop a tolerant strain of native oysters, Alphin, Posey, and Sea Grant researcher Ami Wilbur are examining natural adult populations in two different water-quality environments.

"Results obtained will be a first step in determining possible selection among oyster populations," he says.

Posey also is investigating the value of oyster reefs as a fishery habitat.

"Because currently employed harvesting practices for oysters are destructive to the entire reef, evaluating the use of reefs is important for properly managing, protecting and restoring these habitats and associated fisheries," he says

It has been well documented that reefs are critical habitats for oysters, Posey says. "However, we have not determined if oyster reefs qualify as essential fish habitat for other important species," he adds. "We currently are looking at how reefs are used by fish, crabs and shrimp under a variety of conditions."

Both North Carolina and Virginia have efforts underway to restore oyster reefs for their habitat value. However, these restoration efforts require a firm understanding of factors that influence the quality of oyster reefs as habitat, such as the vertical relief of a reef, the size of oysters, or closeness to other habitat types, says Posey.

As Posey looks into the Cape Fear River, he says that all his projects are interrelated.

"All our projects are centered on the food web," he says. "We need to develop a better understanding of food-web dynamics in estuarine systems. Many nearshore estuaries are important habitats for shrimp, blue crabs and oysters." □

To find out more about Posey's research, log onto: [www.uncwil.edu/cmsr/benthic](http://www.uncwil.edu/cmsr/benthic).



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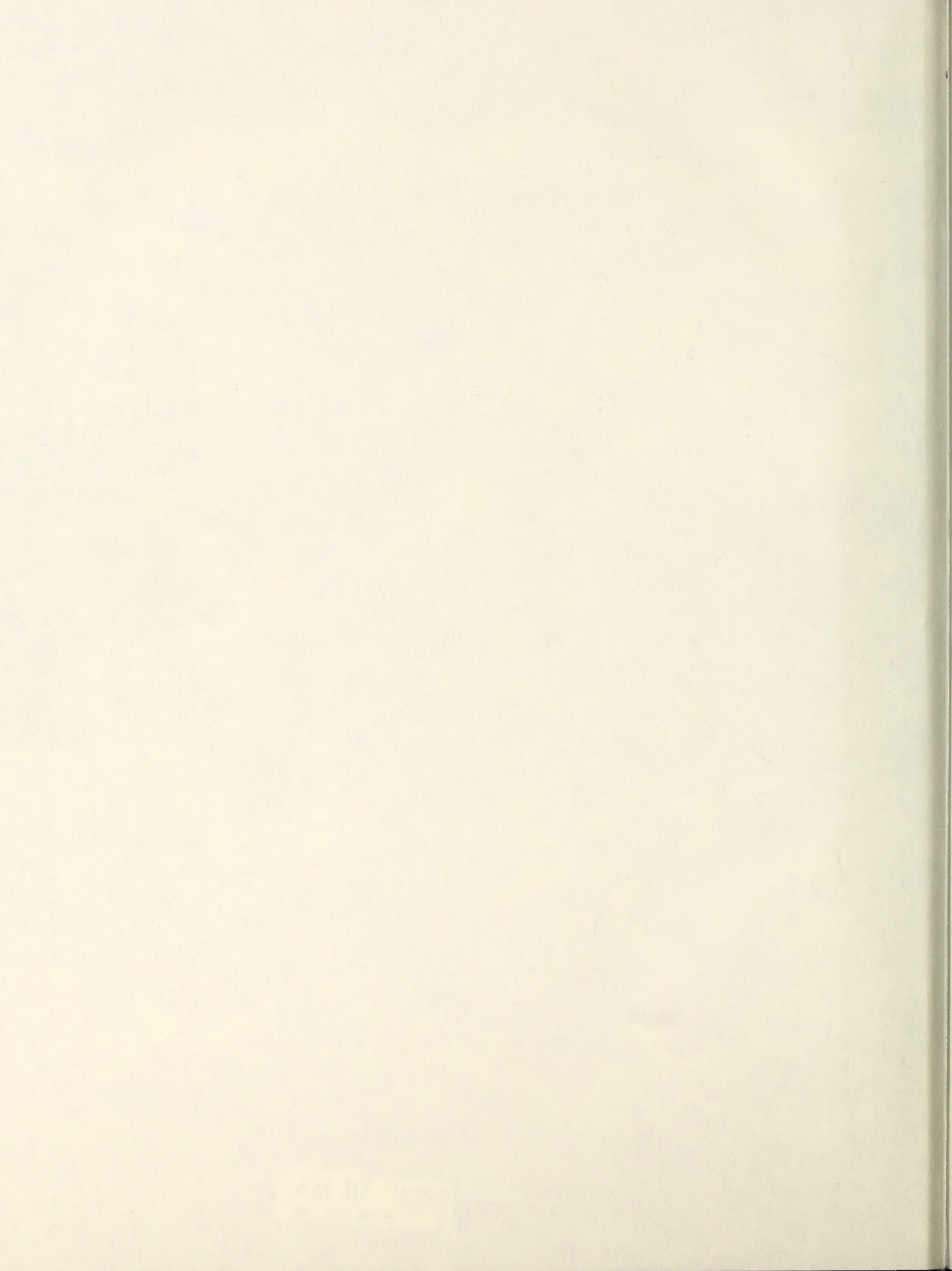
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