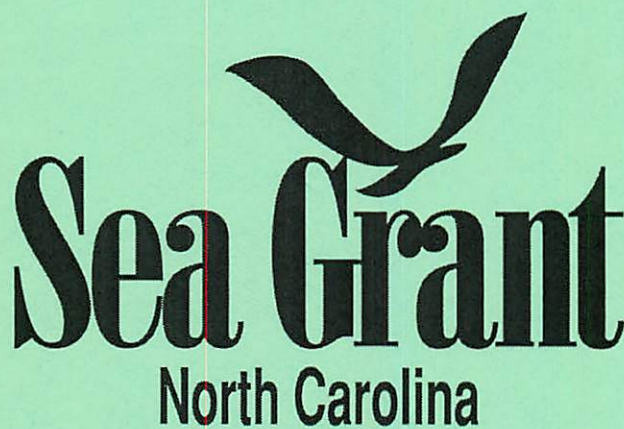


Science Serving
Our Coast and Beyond

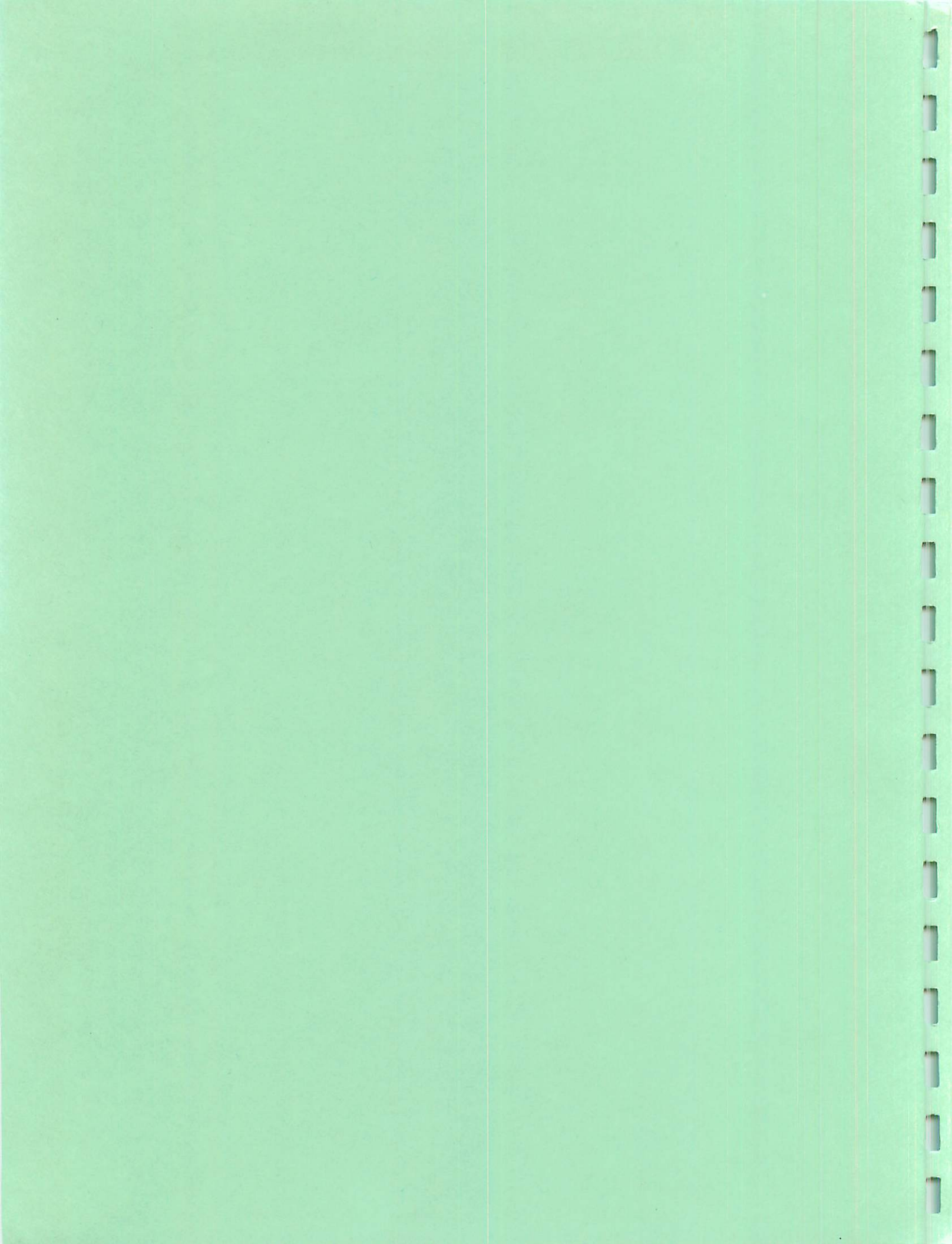
2004 Annual Report



North Carolina Sea Grant * NC State Box 8605 * Raleigh, NC 27695-8605
Ronald G. Hodson, Director * 919/515-2454 * www.ncseagrant.org

UNC-SG-04-10





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NORTH CAROLINA SEA GRANT HIGHLIGHTS 2004

North Carolina Sea Grant has had yet another successful year. In particular, Ron Baird, The National Sea Grant College Program Director praised North Carolina Sea Grant: "The program is very successful at integrating research, education, extension and communications elements across projects." His comments complemented a Fall 2003 review by a team of national experts known as a Program Assessment Team.

While Sea Grant's research efforts are focused in our coastal region — on topics ranging from water quality to fisheries, changing population dynamics to the impact of beach nourishment — Sea Grant extension efforts are seen around the state. For example, seafood safety education programs allow processors, dealers and grocery chains to meet federal Hazard Analysis and Critical Control Point requirements. In addition, seafood technology assistance has helped companies from Vandemere to Canton, and from Morehead City to Charlotte, to develop, package and market new value-added seafood products.

Other highlights include:

- North Carolina Sea Grant and Wrightsville Beach hosted the national news conference to launch the *Break the Grip of the Rip[™]* campaign developed by NOAA and the U.S. Lifesaving Association. The May 2004 event, offered as a satellite broadcast by UNC-TV, generated news coverage around the country to alert beach goers to rip current safety tips.
- Planning continued for the 2005 creation of the new **N.C. Coastal Law, Policy and Planning Center**, a collaboration of North Carolina Sea Grant, UNC School of Law and the UNC Coastal Studies Institute. The center will look at emerging policy issues, and will provide technical assistance on policy topics for coastal communities
- Shrimpers who were affected by the influx of imports received technical training from Sea Grant extension specialists as part of the **Trade Adjustment Assistance** program. The program will continue in 2005.
- Sea Grant research revealed that peptides previously isolated from hybrid striped bass may have implications for **controlling certain viral diseases** in fish as well as in humans. The peptides were highly inhibitory to channel catfish virus, as well as certain amphibian viruses, according to Ed Noga of the NC State University College of Veterinary Medicine. The peptide antibiotics or "piscidins" originally were isolated from mast cells — a highly common, tissue immune cell found in fish and other vertebrates, including humans.
- Sea Grant joined the National Marine Fisheries Service in providing information to the recreational fishing community regarding **highly migratory species** — including tunas and billfish. Sea Grant also is developing a video on use of circle hooks for these species.
- Dozens of teachers have participated in marine science workshops organized by North Carolina Sea Grant and the Center for Ocean Science Education Excellence: Southeast. **Ocean Awareness Days** locations have included Greenville, Statesville and Charlotte.
- Local officials along the coast who are facing new land-use planning requirements were invited to attend **water quality planning roundtables** hosted by Sea Grant. The meetings provided information on resources for the towns and counties that are coping with increased demands for development within an environmentally sensitive region.
- Spencer Rogers, coastal erosion and construction specialist, spent several weeks in Florida helping state and federal officials evaluate the damages caused by the sequence of **2004 hurricanes**, in particular the damage along the Gulf Coast from Hurricane Ivan.
- The SouthEast Atlantic Coastal Ocean Observing System — better known as **SEACOOS** — is developing a "codar" system along the Outer Banks. The program will deploy a prototype buoy off Cape Lookout to provide weather and wave conditions, as well as water temperature, salinity, water speed and direction near the surface and underwater. The new programs will benefit commercial and recreational fishers, charter boat operators, scuba divers and other boaters, as well as educators looking for real time data.
- North Carolina Sea Grant's program is serving as a model for **international efforts**. In particular, Walter Clark, coastal communities and policy specialist, is developing a program for countries in North Africa, including Tunisia, Algeria and Morocco. Katie Mosher, communications director, expects to travel to Indonesia in Spring 2005 to share Sea Grant strategies with the developing Sea Partnership Program.
- Sea Grant was a lead agency in planning the **2005 Oyster Protection and Restoration Summit**. Partners include the N.C. Department of Environment and Natural Resources and the N.C. Coastal Federation. Sea Grant's **The Amazing Oyster DVD** and an oyster culture manual developed with funding from the N.C. Fishery Resource Grant Program, will be featured along with research findings.

- Sea Grant shared the story of coastal North Carolina to millions of visitors to the **Smithsonian Folklife Festival**, held in Washington, DC, last summer. In particular, the state's shrimping and crabbing efforts were highlighted, along with boatbuilding and other aspects of coastal culture.
- **NOAA in NC** is the new banner for North Carolina programs within the National Oceanic and Atmospheric Administration. Sea Grant initiated the initial NOAA in NC meeting in May 2004 to encourage increased outreach partnerships.
- Sea Grant continues to provide leadership on **sustainable tourism** efforts, such as the **N.C. Birding Trail Initiative**, which is seeking a \$1 million grant from the U.S. Department of Transportation. Also, the **N.C. Paddle Trails Association**, which grew out of coastal paddling trails efforts.
- A new book, ***Drowning the North Carolina Coast: Sea-Level Rise and Estuarine Dynamics***, by North Carolina Sea Grant Researcher Stanley R. Riggs and East Carolina University Research Associate Dorothea V. Ames, provides in-depth information about erosion processes and rates along North Carolina's northeastern estuarine shoreline.
- Fisheries specialists and communicators participated in state advisory panels reviewing various **Fishery Management Plans** and the new **Coastal Habitat Protection Plan**.

News and Honors

- **Kim Fogg** joined North Carolina Sea Grant as our new finance director. A certified research administrator, she has been in various positions at NC State since 1992. She serves on the North Carolina Sea Grant management team.
- New extension staff members include: **Katherine Ardizone**, water quality planning specialist, and **Brian Efland**, coastal business specialist, whose position replaces a former shellfish extension slot.
- **Sandra Harris**, public information assistant, and **Walter Clark**, coastal communities and policy specialist, stepped into the winners' circle at the NC State Awards for Excellence ceremonies for the Division of Research and Graduate Studies.
- North Carolina Sea Grant had four **Knauss Fellows** in Washington in February 2004. They are: **James "Bo" Dame** of East Carolina University, **Shauna Slingsby** of University of North Carolina at Wilmington, **Jessica Maher** and **Adrienne Harris**, both of Duke University.
- In addition, four more North Carolina graduate students were selected to begin Knauss Fellowships in February 2005. They are: **Sara Carr** from UNC-Chapel Hill Institute of Marine Sciences; **Elizabeth English** from Duke, **Katherine Eschelbach** from UNC-CH, and **Stephen Workman** from ECU.
- *The Dune Book* — written by **Spencer Rogers**, Sea Grant coastal erosion specialist, and **David Nash** of N.C. Cooperative Extension, and edited by **Ann Green**, won a Grand Award in the national Apex Communications Competition.
- *Coastwatch* took first place in the N.C. Association of Government Information Officers competition for continuing publications. The magazine also won an Award of Excellence in the Apex competition.
- **Melanie Harrison**, a student at Johnson C. Smith University working with Sea Grant researcher **Inna Sokolova** of University of North Carolina at Charlotte, presented results at the 4th Annual Louis Stokes Alliance for Minority Participation Conference, which is a national forum for students in biology and biomedicine, in October 2004 in Houston, TX. The MBRS-TARE program sponsors Harrison and **Paige Waymer**, whose project is to identify genetic markers of high resistance to *Perkinsus*, for minority students at JCSU.
- Graduate fellow **Charlene R. Couch**, a Sea Grant Industrial Fellow working with **Craig Sullivan** of NC State and Kent SeaTech, was awarded a 2004 Gov. and Mrs. Dan K. Moore Fellowship to Keep NC Clean and Beautiful for her work on striped bass breeding genetics. The award is for \$10,000 in travel and research funds, effective 5/1/04-5/1/05.
- **Kathleen Angione** was selected the first North Carolina Sea Grant Science Communications Fellow.

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INTRODUCTION

North Carolina Sea Grant continues to advance research, education and outreach programs focused on the needs of people, businesses and agencies responsible for coastal and marine resources. A university-based science program, Sea Grant is a link between academic discoveries and the people of North Carolina. Together we build understanding and appreciation of the coastal ocean, sustainable use of its resources and better conservation. Thus, it is our challenge and privilege to join other coastal and Great Lakes states in a network of Sea Grant programs meeting the needs of our society.

In particular, 2004 marked the receipt of the outstanding rating from our second Program Assessment Team review, conducted in September 2003, as well as other state and national awards. Our core-funded researchers initiated projects in a two-year funding cycle, while the Sea Grant management team worked with our Outreach Advisory Board to identify current and emerging priorities. Sea Grant research projects sparked additional funding from the National Science Foundation and other prestigious agencies. Results from the studies have been shared with state and federal agencies. Our staff and researchers have collaborated with dozens of agencies and involved many graduate students. In all, it has been a successful year.

LEADERSHIP AND STRATEGIC PLANNING

Ronald G. Hodson has been North Carolina Sea Grant director since July 1998, having previously served as associate director for research and as interim director. Hodson is an internationally respected aquaculture researcher, who has been a leader in technology transfer to the industry.

The management team — which meets regularly to address program issues, review master calendar items and provide overall coordination for the program — includes:

- Steve Rebach as associate director, with an emphasis on research. Formerly a biology professor at the University of Maryland, Eastern Shore, his research focus has been on crabs and their ecology.
- Jack Thigpen as extension director, leading the staff of 11 specialists and four administrative staff in three coastal offices and the Raleigh headquarters. He also participates in the program's "coastal communities" efforts.
- Katie Mosher as communications director, leading the four members of the communications team at the Raleigh headquarters. A former print and broadcast journalist, she chaired the National Sea Grant Communications Network in 2001.
- Tammy Sumner served as finance and information systems director through October 2004. Her duties included budgetary oversight and management of internal databases, as well as technical aspects of the Web site. In late 2004, Kim Fogg joined us in the role of finance director. A certified research administrator, she has held various finance positions at North Carolina State University.

An integral part of the Sea Grant program is a planning process that seeks input from outreach staff members, researchers and scientists at universities across the state, government agencies dealing with fisheries, water quality, coastal management, etc., and community groups with a deep and abiding interest in coastal resources. The result is our strategic plan, which is available on our Web site, www.ncseagrant.org. While the program's formal strategic plan is updated every two years, the planning process is constant, as Sea Grant staff is in regular communication with coastal communities, government agencies and some of the nation's top universities.

North Carolina Sea Grant also seeks ongoing input from an Outreach Advisory Board. Members representing various program areas have staggered terms. They provide comment on overall program direction, suggest research priorities and provide input for specific projects for the extension and communications teams. This list identifies advisory board members, with respective program areas.

**North Carolina Sea Grant Outreach Advisory Board
(Fall 2004)**

Inland (2)

Jean Spooner

Water Quality Group Director
Bio & Ag Engineering
North Carolina State University
Program Component — water quality

Thomas Blue

President
BLUE: Land, Water & Infrastructure
Program Component — sustainable
development

Central Coast (4)

Donald Cross

Co-owner
Pamlico Packing Company, Inc.
Program Component — seafood
safety/technology

Todd Miller

Executive Director
N.C. Coastal Federation
Program Component — habitat protection/
estuarine ecology

Preston Pate

Director
N.C. Division of Marine Fisheries
Program Component — fisheries

John Merriner

Assistant to Director for Fisheries
NMFS Service Center for Coastal Fisheries
and Habitat Research
Program Component — NOAA partner,
fisheries

Gregory Rudolph

Carteret County
Program Component — coastal processes

Northeast Coast (2)

Bill Crowell

Director
Albemarle-Pamlico National Estuarine Program
Program Component — habitat
protection/restoration

Heather Maxwell

Tournament Director
Pirates Cove
Program Component — fisheries

Southeast Coast (4)

Bob Black

Member
Long Bay Artificial Reef Association
Program Component — recreational fisheries

David Weaver

Assistant County Manager
New Hanover County
Program Component — coastal hazards

Jim Swartzenberg

Owner
J&B AquaFood Inc.
Program Component — aquaculture

Marty Feurer

Public Affairs Director Eastern NC
Time Warner Cable
Program Component — informed citizenry

Advisory board members serve three-year terms that are staggered. The board participated in two priority identification sessions in 2004. The results will be reflected in updates to work plans for Sea Grant staff members as well as to the strategic plan, which will be the foundation of the 2005 Request for Research Proposals for projects to be funded for February 2006 to January 2008.

With offices in Manteo, Morehead City, Wilmington and Raleigh, the North Carolina Sea Grant staff has regular interaction with coastal residents, policy makers, university researchers and state officials. This interaction enables staff members to see issues developing on the horizon. Regular conference calls and quarterly staff meetings provide cohesion.

The strategic plan — with input from the coastal communities, top scientists and Sea Grant staff — is a critical component of our biennial call for major research proposals. A panel of North Carolina officials and community leaders review all “preproposals” to ensure that questions posed and the anticipated findings are relevant to North Carolina and the region. Full proposals go through a formal peer-review process to ensure the strongest scientific research projects are selected. The final list of funded projects is chosen to reflect Sea Grant's spectrum of coastal topics.

PROGRAM ACCOMPLISHMENTS AND IMPACTS

In line with priorities set by the National Sea Grant Program, North Carolina Sea Grant has implemented successful efforts in targeted coastal and marine topics. While much of the Sea Grant funding is focused on major academic research, the program approaches each topic as an opportunity to combine research, extension, communications and education efforts. In addition, minigrants of up to \$10,000 allow Sea Grant to provide a rapid response to a critical situation arising during the project period. The minigrants also allow researchers an opportunity to lay groundwork or test out a theory before implementing a major project funded by Sea Grant or another agency. A number of minigrants have resulted in larger projects funded by the National Science Foundation, etc. For a listing of 2003-2004 minigrants, see Appendix A.

While Sea Grant research crosses a spectrum of science, engineering and social sciences, there is a common thread: the results of Sea Grant research should have direct application to the needs of the people. While new academic discoveries are exciting, they must be spread beyond the scientific community. Our extension and communications teams are conduits for transferring this new understanding and technologies to our coastal communities and beyond. Through workshops, publications, the World Wide Web and personal contact, the scientific results are translated into terms the public can understand, then shared with residents, regulators, elected officials and other business and community leaders. In turn, the Sea Grant outreach staff hears specific concerns from the public, which can then be shared with the academic community.

Sea Grant's research and outreach projects are organized into three broad categories:

- Economic Leadership,
- Coastal Ecosystem Health and Public Safety, and
- Education and Human Resources.

The following summaries highlight North Carolina Sea Grant projects during 2004. In addition, several appendices are included at the end of this document. Additional details for specific research and outreach projects are included in the program's omnibus proposal, and each researcher was asked to complete a more detailed progress report of accomplishments in 2004. Details on extension and communications efforts are outlined in annual plans of work for the outreach staff.

ECONOMIC LEADERSHIP

During the infancy of the National Sea Grant program in the 1960s, coastal North Carolina was a region dotted by coastal fishing villages and clusters of vacation cottages, with its “cities” focused on the ports in Wilmington and Morehead City. As the North Carolina program received full Sea Grant College Program status in 1976, the coastal region already was undergoing a metamorphosis. Tourists and retirees arrived in greater numbers, and many decided to live at our coast year-round. By the turn of the new century, highways granted easier coastal access for the growing Research Triangle region and other areas of the state and the nation. Now, concerns regarding sprawl development and pollution at the coast are becoming more frequent. Traditional portions of the economy, such as commercial fishing and shellfishing, face new regulations. Conflicts are rising among various users of the coastal waters that have long been considered part of the state's “public trust.”

Amid this sea change, North Carolina Sea Grant continues to provide stabilization in terms of science-based solutions to a variety of coastal concerns. We have worked with the fishing industries that were once the cornerstone of the coastal economy. In addition to studies of various wild stocks, we also work with the longstanding seafood industry and the growing aquaculture community. And we work with recreational anglers — another important economic segment — to consider conservation practices such as catch-and-release techniques. We assist state and local leaders as they look for “sustainable” solutions for coastal management. We help lower-wealth coastal plain communities to see the value of nature-based and heritage-based tourism efforts that value their unique resources.

Fisheries

For centuries, North Carolina’s vast fishery stocks served as the foundation of the coastal economy. While commercial fishing was a mainstay for generations of coastal residents, the economic role of recreational fishing has become increasingly apparent. In recent decades, numerous fishery stocks have declined, and state and federal agencies have considered a variety of restoration efforts — efforts that often draw drastically different responses from the commercial and recreational fishing perspectives and from community groups. Sea Grant looks at various perspectives on fisheries topics, including:

- Improving the return on investment in the fishing industry, including the application of new technology to improve yields or to protect declining stocks.
- Helping to resolve conflicts over the use of fishery resources.
- Providing a technical basis for developing more effective fishery management programs.
- Demonstrating the linkages between nutrients and related factors and the estuarine fish stocks.

Sea Grant has had a longstanding role in fishery efforts, including projects involving blue crabs, shrimp, flounder, red drum and other important commercial and recreational fisheries.

Finfish Focus

“**Estimating Direct and Indirect Effects of Hypoxia on Estuary-Dependent Fish**” by James Rice and Kevin Craig of North Carolina State University expands upon earlier Sea Grant work on the effects of low-dissolved oxygen on estuarine habitat quality for juvenile fishes. Because little is known about the movements of juvenile fish, particularly under varying water quality conditions, these researchers are tracking juvenile spot in the upper Neuse River estuary in relation to oxygen concentration, temperature and salinity. The work will help fishery managers evaluate the obvious effects of low oxygen (i.e., fish kills) relative to less visible effects (habitat loss, reduced growth, etc.) that may have equal or greater impacts on estuarine fish production. The work also will provide a basis for managers to evaluate the effects of degraded water on juvenile estuary-dependent fish in relationship to other sources of anthropogenic change and potential management measures, including fishery harvest or stock enhancement.

The work grew out of an earlier project, “**Hypoxia and Estuarine Nursery Habitat Quality: An Experimental and Modeling Approach Linking Low Dissolved Oxygen with Fish Survival and Growth**,” in which Rice worked with Tim Targett of the University of Delaware, to develop a model that uses impacts of hypoxia on feeding, growth, survival, and behavior of juvenile estuarine fishes to predict the impacts of changes in water quality (e.g., decreased dissolved oxygen) on fish growth, survival, and distribution.

“**Functional Evaluation of Fish Habitat Quality: Juvenile Southern Flounder**,” by John Miller of NC State looks at habitat conditions for the state’s most commercially valuable finfish. Habitat evaluation will be a critical factor in any potential stock enhancement as well as habitat enhancement efforts. This project will test a portable tool to enable the easy evaluation of various habitats in the Pamlico and Albemarle sounds considered for release, protection or restoration and as well as evaluate the success of restoration efforts. The researchers will build and test a portable automated respirometer to measure routine metabolic rate (rMR) and limiting oxygen concentrations (LOC) of southern flounder within 12 selected sites. The researchers will compare the growth rate, marginal metabolic scope (MMS) and lethal dissolved oxygen (LDO) of southern flounder in colonized and under colonized habitats to determine if stocked juvenile southern flounder would grow and survive in the under colonized habitats.

This project builds upon an earlier regional project by Miller, W.H. Neill of Texas and K.M. Leber of Florida that identified where juvenile flounder, red drum and snook would thrive. The resulting models take into account factors such as food, dissolved oxygen, temperature, salinity and pH levels. The models evaluate the potential for a species to thrive in a given area, even if those fish are not currently there. Most current habitat assessments are based on the existing abundance of fish in an identified area. In particular, the flounder research

revealed lethal rates of dissolved oxygen, which were considered in concert with the marginal metabolic scope. The flounder work has led to collaborations with leading flounder researchers in Japan and use of the model there.

“Estimating Fishing And Natural Mortality Rates For Red Drum In North Carolina Estuaries Using a Combined Telemetry-Conventional Tag Approach,” by Jeffrey Buckel, Joseph Hightower and Kenneth Pollock of NC State, looks at the state’s saltwater fish, the red drum. Important in recreational and commercial fisheries, the red drum is currently considered “overfished.” Recent spawning potential ratios (SPR) were estimated at 18 percent, below the 40 percent SPR recommended for optimal yield. The state’s Red Drum Fishery Management Plan identified the priority need for precise natural and fishing mortality rates for juvenile and sub-adult red drum (ages 1-3). The plan also cites the need for improved tagging techniques to obtain mortality data from different user groups. This project combines telemetry and conventional tagging and an updated model to determine mortality estimates in an effort to provide solid information — including breakdowns for recreational and commercial fisheries — for managers making decisions about this species. Early work shows that submersible receivers can detect nearly 100 percent of pulses from tags at 400 m in South River. To ensure fish do not leave study systems unnoticed, submersible receivers will be placed no more than 600m apart so that 400m detection distances will overlap. Also, beach seines, otter trawls, gill nets, trammel nets, and hook-and-line sampling have been used to collect juvenile red drum. The efficacy of collection methods is dependent upon the habitat in which sampling occurs, the researchers note.

In an earlier project, Buckel and Hightower studied **“Impact of Striped Bass Predation on Young-Of-The-Year River Herring in The Albemarle Sound Estuary”** to look at limits to population growth of river herring (blueback herring and alewife) in the Chowan River. The N.C. Division of Marine Fisheries is often faced with public concern that striped bass are having a negative impact on a variety of economically important species (e.g., blue crab, American eel, and river herring). This project determined that striped bass predation on *Alosa* spp. is buffered by other juvenile fishes such as Atlantic menhaden, yellow perch, bay anchovy, and silversides; these prey make up a large part of age-1 striped bass diets during summer months. However, given the densities and feeding rates of age-1 striped bass, the researchers found that at times, age-1 striped bass predation could account for all juvenile American shad losses observed during summer months in western Albemarle Sound. If the proportion of American shad juveniles in age-1 striped bass diets remains stable from year to year, the impact of striped bass predation on juvenile American shad should decrease if efforts to rebuild the American shad population are successful. The results of the study are being used by fisheries managers to provide diet data for striped bass in North Carolina estuarine systems.

Blue Crab Movements

Although the blue crab has been fished for centuries, scientists are still unlocking secrets about adult crab movement and feeding responses to changes in water quality.

In **“Linking Water Quality and Trophic Interactions In Eutrophic Coastal River: Movement Patterns, Foraging, and Mortality of Blue Crabs,”** David Eggleston, Thomas Wolcott and Geoff Bell of NC State are finding out about blue crabs’ behavior by strapping biotelemetry tracking transmitters across their backs.

Contrary to what the researchers expected, the adult blue crabs were largely unsuccessful at fleeing low-dissolved oxygen water or hypoxia that upwells along the shall flanks of the Neuse River during certain wind conditions. They also found that crabs could even spend several hours in hypoxic and near-anoxic water.

While tracking the movement and feeding behavior of free-ranging adult blue crabs, the researchers also collected samples of prey that live in sediments. Preliminary data suggests that blue crabs do not choose to feed in areas where such prey is most abundant. Instead, they may rely on alternative sources of prey like dead fish from trawler bycatch or fish kills.

This information will help provide new tools, techniques and information to water quality and fishery managers that must make decisions about hypoxia in coastal waters.

Eggleston and colleagues have studied blue crabs with funding from various programs administered by North Carolina Sea Grant, including core research funding, National Sea Grant initiatives, and state-funded Fishery Resource Grant and Blue Crab Research programs.

The work has been a true partnership, including colleagues at the N.C. Division of Marine Fisheries (DMF), NC State, University of North Carolina at Wilmington and independent crabbers — along with teachers and high school students trained to gather and report larval crab data.

Blue crabs are commercially and ecologically important — and mobile. Thus studies such as crab response to hypoxia will be important factors in population models that could eventually assign economic value to varying levels of water quality and the resulting change in growth or survival of blue crabs.

Marine Fisheries Fellowships

North Carolina Sea Grant and the N.C. Division of Marine Fisheries (DMF) established the **North Carolina Marine Fisheries Fellowship** to provide research and statistical review of data needed for fishery management plans.

The current project is developing and validating juvenile abundance indices for selected North Carolina finfish. The ongoing data and analysis by fellow Stacy Luthy and DMF researchers will be used by DMF as input in stock assessment for target species. Corey Oakley, who is currently a biologist with the N.C. Wildlife Resources Commission, started the project. The assessments will be used to help develop fishery management plans. DMF biologists will use juvenile abundance indices as input into stock assessment analyses for each of the target species. These stock assessments will be used when developing fishery management plans. The fishery independent monitoring of juvenile fishes by DMF may also be adjusted, depending on findings of the study.

Previously, movements and mortality rates of striped mullet in North Carolina were the focus of studies by fellow Nathan Bachelor, working with DMF marine biologist Rich Wong. The research confirmed that independent mortality estimates derived from landing data are realistic. Also, the research showed striped mullet to be localized in their movement. This means the state is correct in the assumption that striped mullet appear to be a single unit stock in North Carolina.

Estuarine Habitats

In **“Broken Rungs At The Bottom Of The Ladder: Effects Of Stratification-Induced Hypoxia On Trophic Transfer Between Plankton And Grazers In A Shallow Eutrophying Estuary,”** by Pete Rand, formerly of NC State and now of the Wild Salmon Center, and Chris Taylor of NC State, expanded upon earlier North Carolina Sea Grant research utilizing mobile sonar surveys as well as traditional trawl sampling methods. This project sought to increase understanding of trophic transfer to second consumers, specifically zooplankton and planktivorous fishes, and how that energy transfer might be modified by adverse water quality. The researchers found that intermittent hypoxia in the early summer may not have a detrimental effect on the pelagic community in the Neuse River estuary. However, later in the summer season — when copepod production decreases because of reduced primary production — hypoxia may effectively limit prey availability for juvenile anchovies and cause a reduction in growth and production of this trophic level. N. C. Department of Environment and Natural Resources officials used the study results in developing the N.C. Coastal Habitat Protection Plan (CHPP), including water-column habitats. The project builds upon **“Linking Water Quality in Pelagic Fish Distribution and Behavior: A Multi-Scale Approach,”** by Rand and Taylor.

Outreach

Extension Considers Commercial, Recreational Fisheries

The largest component of the North Carolina Sea Grant extension staff focuses on fisheries, with specialists located in each of three coastal offices. Sea Grant staff members traditionally have had strong contacts within the coastal communities — often drawing upon the “highliners” to demonstrate new gear or participate in sampling studies. Extension specialists initiate efforts to highlight new, environmentally sound fishing technology, such as the skimmer trawl for shrimp. Two new fisheries specialists joined the staff in autumn 2003. Sara Mirabilio, a former Knauss marine policy fellow, is based in Manteo. M. Scott Baker, Jr., moved from Louisiana to join our Wilmington office.

Upon the departure of Philip “Skip” Kemp to become director of the Aquaculture Program at Carteret Community College, his former Sea Grant shellfish extension slot was redesignated as a coastal business extension position. Brian Efland joined the staff in the new position in Summer 2004. His early efforts included general outreach to coastal businesses regarding business topics, as well as developing a “Blueprint” to help consumers select an appropriate recreational fishing boat to suit their needs. He is also providing business perspective on several fisheries projects including encouraging charter fleers to use circle hooks.

Building Community, Consensus

When controversial fisheries management issues have come up through the years, Sea Grant has been instrumental in helping to bring diverse voices to the table to ensure that policy decisions are based on science.

Fisheries extension specialists cement relationships with constituencies through personal contacts and participation on various advisory committees and commissions. Every call is important — graduate students seeking research resources, teachers or students needing materials, or commercial and recreational fishers with questions about new regulations. Specialists serve on a variety of regional and topical advisory committees for state and regional fisheries management and habitat protection.

In addition to the formal advisory committee format, Mirabilio established a “collaborative learning” project to consider the blue crab fishery, the state’s most economically significant fishery. In this setting, the crabbers had equal footing as the scientists and regulators to offer their perspective on the past, present and potential future of the fishery and the habitat. While the group had a geographic focus on the Albemarle Sound region, many of the topics and suggestions reflected the overall fishery.

Ethical Angling: Catch-and-Release

North Carolina's coastal waters draw thousands of recreational anglers each year. Sea Grant promotes ethical angling practices — especially use of circle hooks and catch-and-release methods — to optimize the survivability of sportfish.

In 2004, the focus included highly migratory species (HMS), including tuna, sailfish and billfish. Sea Grant received a grant from the National Marine Fisheries Service, also known as NOAA Fisheries, to convene a focus group of tournament officials, charter boat captains and state marine fisheries officials to discuss ways to improve NOAA Fisheries’ outreach efforts regarding new HMS permits for recreational anglers. The project also funded reprinting 10,000 copies of a *Coastwatch* magazine cover story on the new HMS permits.

Sea Grant fisheries specialists are also working with a Raleigh video producer to develop a DVD to show the correct rigging of circle hooks for “big game” species. A preview of the video was shared at the Big Game Fish Expo in Morehead City.

Ongoing research funded by the FRG program has shown lip hooking associated with circle hooks and terminal gear can significantly reduce post-release mortality for red drum and grouper, compared to traditional J hooks. The grouper study resulted in a “Blueprint” to be shared with recreational anglers.

Sea Grant continues to distribute educational products for anglers, including catch-and-release “how to” waterproof bookmarks; ethical angling brochures; and red drum catch-and-release waterproof tackle box stickers. Extension specialists also make presentations to numerous fishing clubs and arranged for the distribution of the materials at major events, such as the N.C. Seafood Festival, regional boat shows, etc.

A 2003 recent survey of recreational anglers revealed that more than half of the 450 respondents say they use circle hooks — an indication that educational efforts are paying off.

Fisheries Extension Enhancement

A national effort launched in 2002 is invigorating fisheries-related outreach by Sea Grant. With connections to the Mid-Atlantic and South Atlantic regions, North Carolina Sea Grant is involved with five regional projects. These programs are designed to strengthen Sea Grant's ability to promote a sustainable future for fishing families and fish resources.

The current projects also include regional FEE projects with South Atlantic States (NC, SC, GA, FL):

- **Marine Protected Areas (MPAs):** To promote reasoned dialogue and decisions about MPAs by increasing awareness and knowledge of their purpose, identification, design, declaration, management, and costs/benefits among key stakeholder, including marine industries, resource managers, extension educators and the general public.
- **Essential Fish Habitat (EFH):** To promote dialogue about EFH by increasing awareness and knowledge of its definition, purpose, identification, declaration, management, potential costs, and potential benefits among key stakeholders, including marine industries, resource managers, extension educators and the general public through cooperative efforts of South Atlantic Sea Grant programs.
- **Fisheries Extension Facilitation and Planning:** To establish a facilitation/planning process that will assist in the development and evaluation of fisheries extension education programs and projects by Sea Grant programs in the South Atlantic region.

The regional FEE projects with mid-Atlantic states (NC, VA, MD, NJ, DE and NY) include:

- **Enhance Education and Outreach to the Mid-Atlantic Charter Boat Fisheries:** To improve the understanding of the fishery management complex by the “for hire” fishing industry and provide better understanding of this sector by federal, regional and state managers. Additionally, enhanced cooperation among the industry and the government will be fostered with the educational outreach.

Such an educational focus on the for-hire fishing industry may improve industry's willing cooperation with various management agencies; providing feedback and involvement that is increasingly vital both in the formulation of fishery management options and the ultimate implementation of management measures.

- **Exploring the Collaborative Learning Process for Management of Mid-Atlantic Fisheries:** To enhance fisheries extension activities in the Mid-Atlantic region by introducing a "collaborative learning" approach in efforts with Sea Grant staff and key fisheries management personnel in the region. Maryland Sea Grant has used this approach in the ongoing blue crab debates, and can evaluate the applicability of the process to other state and regional fisheries management issues.

FRG Combines Intuition and Science

Those who make their living from North Carolina waters often raise the most pertinent questions and suggest the best answers to fisheries-related issues. Thus, the N.C. General Assembly created the **N.C. Fishery Resource Grant Program** in 1994. Known as FRG, it is administered by North Carolina Sea Grant and supports cooperative research among fishing communities and scientists.

The \$1 million per year program has funded more than 280 innovative research that to help improve, protect and restore North Carolina's marine fishery resources. In 2004, 15 new projects were added in the four target categories: aquaculture/mariculture, fishery equipment and gear, environmental pilot projects and seafood technology.

"The guiding principles of this program are very similar to those of extension: encouragement and development of stakeholder participation in problem solving," explains Bob Hines, fisheries specialist and FRG coordinator.

Hines encourages development of research proposals, monitors funded projects, and helps to share the results with the respective fishing communities, state and federal resource managers and the general public. Projects provide data relevant for state and federal management plans, such as new methods to minimize bycatch; information on species-specific habitat use; and ways aquaculture operations may be able to contribute to wild populations.

- One project found that larger hook size had a significant effect on bycatch rates in the red grouper, gag and scamp fisheries (03-FEG10)
- Another project documented juvenile sea turtles spending most of their time in the National Marine Fisheries (NMFS) deepwater closed area during the summer and fall months, suggesting that seasonal closing of this area to the large-mesh gill net fishery is a well-placed management measure (02-FEG-05). The project also made an unexpected, but fascinating discovery regarding sea turtle life history. Data from a satellite-tracking system showed some large juveniles — once believed to undergo an ontogenetic habitat shift into coastal waters — as moving long distances into the North Atlantic by way of the Gulf Stream.
- And a recent aquaculture study examined whether cultured oysters actually contribute to local recruitment through reproduction (01-AM-07). Using oysters from the Gulf of Mexico and the Atlantic Ocean (which are the same species but exhibit distinct differences in their mitochondrial genome), researchers determined a modest enhancement of the wild oyster population attributable to the Gulf oysters.

Participation in Sea Grant programs fosters cooperation and credibility among the fishing and academic communities, even for controversial issues. For example, one Outer Banks fisher allowed scientists to use his boat to measure effects of trawling on soft bottoms, notes Hines. The study reported minimal impact on benthic organisms, lending another piece to the larger puzzle of trawling impact.

Top Fishery Nets Research Program

Building upon the success of the FRG program, in 2000 the General Assembly created a \$500,000 per year research program targeted at the blue crab fishery, the state's top commercial fishery. Sea Grant administers the **Blue Crab Research Program (BCRP)**, which encourages those in the crabbing community and industry to submit proposals for research that will enhance the fishery.

Fisheries specialist Marc Turano oversees projects all along the coast, including suggesting potential teams of crabbers and university researchers, as well as working with state officials to determine research needs and sharing project results.

- One current project is working to develop a prototype male pheromone as bait for female peeler crabs (04-BIOL-01). A previous BCRP study found that male pheromones are transferred to the

female seminal receptacle during mating and slowly dissipates over time. Therefore, researchers are harvesting this receptacle from females during the crabmeat picking process.

- Another current project (04-POP-02) is assessing the population structure of offshore blue crabs. Such information could help determine the feasibility of an offshore fishing effort, which could be a viable fishery for crabbers during the slow season.

- And still another BCRP researcher is designing and testing a device for crab pots that would cull smaller crabs and allow valuable finfish to escape (04-ECON-02).

Since its creation in 2000, the North Carolina crabbing community as well as fishery managers have welcomed this research program.

Aquaculture

As the population increases, so too does seafood consumption. Even if wild harvests were at maximum sustainability, demands for foodfish would be higher. Thus the role of aquaculture, which includes fish farming, is gaining attention. Aquaculture producers and community leaders want to know how to develop profitable and economically sound aquaculture businesses. Thus the goals of the Sea Grant aquaculture program include:

- Increasing return on investment in rapidly growing aquaculture industries, especially hybrid striped bass.
- Assisting in production of high quality seafood products by developing new culture species, such as flounder, and new systems.
- Improving the efficiencies of a variety of shellfish aquaculture and shellfish mariculture operations.

Aquaculture efforts have followed the Sea Grant model of cutting-edge research that is quickly transferred to the industry.

Hybrid Striped Bass: Genetic Advances

Sea Grant researchers at NC State continue to develop genetically enhanced broodstock for the hybrid striped bass farm industry through selective breeding based on molecular genetics and growth biomarker analyses. In “**Accelerated Genetic Improvement of Striped Bass: Molecular Markers of Growth Performance**,” Russell Borski and Craig V. Sullivan, both of NC State, offer the following findings:

- Phase I, striped bass: Experimental striped bass families were created by spawning pairs of males from each of two geographic and one domesticated lineage with females originating from one domestic and one wild stock. Offspring were evaluated from fingerling to market size for growth hormones (IGF) and IGF-binding proteins and myostatin.
- Phase II, hybrid striped bass. The researchers produced hybrid striped bass larvae from both wild parents and domesticated broodstock. Experimental families were raised from fingerling through growout stages. The scientists currently are genotyping HSB progeny and have completed evaluating the use of plasma IGF-I — an insulin-based growth hormone — as a biomarker of growth performance in HSB.

These studies are the first to show that plasma measures of IGF, the most critical fish growth factor, reflects the current growth status of HSB under various culture conditions. This sets the framework for evaluating whether higher expression levels of plasma IGF-I is inheritable in HSB and SB selectively bred for high growth performance.

If so, this biomarker, along with genotyping, could be used to rapidly screen progeny with elevated growth performance and select the appropriate parental lines for selective breeding of HSB and SB.

The research team expects improvements in growth rate of at least 10 percent for HSB and SB. This will lower the costs of production, allowing HSB markets to expand into the domestic retail and export sectors — an important economic outcome.

The Sea Grant studies by the NC State team have generated additional support from USDA, the UNC Office of the President Genomic Sciences, NSF and a North Carolina Fishery Resource Grant.

In addition, Charlene R. Couch, has been funded as a Kent Sea Tech/National Sea Grant Industry Fellow for her study, “**DNA Marker-assisted Selective Breeding of Striped Bass - Phase I**”

The goal of the Sea Grant Industry Fellow's research is to provide a foundation of knowledge to support full domestication and improvement of cultured *Morone* species through selective breeding. More specifically, the results contributed to an understanding of the genetic influences on performance of striped bass during the first and most critical phase of culture, Phase I fingerling production. Production efficiency through selective breeding is necessary for the U.S. hybrid striped bass industry to survive in competitive global aquaculture markets.

Coldbanking: Advances in Aquaculture Science and Economics

Craig Sullivan, of NC State, is leading efforts to enable hybrid striped bass growers to increase productivity and profit through multiple cropping of hybrid striped bass fingerlings produced from coldbanking striped bass broodstock. Coldbanking blocks final stages of ovarian maturation while delaying onset of ovarian degradation, atresia. Sullivan reports that results from **“Reproduction of Domesticated Striped Bass: Coldbanking to Arrest Maturation and Atresia”** have scientific and economic significance:

- The rigorous research protocols showed that the maximum period for which female striped bass could be coldbanked, and still produce high percentages of normal fry, appears to be about four months.
- This project delivered the means to extend the spawning season of striped bass from a few weeks to a few months. This will allow multiple cropping of fingerling production ponds and targeting of fry production to specific times when weather conditions promote survival.
- Findings make it possible to conduct large numbers of crosses required for selective breeding of genetically superior hybrid striped bass for farming.
- Findings to date on striped bass set the stage for similar progress with other farmed fish species around the world.

The work has generated a capability of the newly established National Program of Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry — a consortium of growers, researchers and government scientists. Sullivan was elected co-coordinator of the new program, while North Carolina Sea Grant Director Ronald G. Hodson was elected a senior research advisor to the group. The creation of this program culminates 15 years of Sea Grant-supported research at NC State on the reproduction of striped bass that led to the growth of hybrid striped bass farming across the country. In earlier groundbreaking research, Hodson and Sullivan domesticated the parent species of the hybrid striped bass (white bass, *M. chrysops* and striped bass, *M. saxatilis*) over several generations.

Flounder: Temperature and Timing

The diverse research team of Russell Borski, Harry Daniels and John Godwin, all of NC State, along with Wade Watanabe of the University of North Carolina at Wilmington, is turning up the heat on Southern flounder to produce all-female cultured stocks. Earlier research showed how water temperature manipulation to control sex during the flounder’s early development — not on genetic engineering.

Their current study, **“Improving Production Efficiency of Southern Flounder Growout: Evaluation of Monosex Populations,”** moves the monosex population from the nursery through the growout phases required for commercial operations.

From an economic standpoint, the work is significant because production of all-female stocks pushes Southern flounder up a notch as a candidate for aquaculture in North Carolina. Studies show that female flounder grow two to three times larger than male flounder within two years. Given the high consumer demand and world-market value, the ability to produce larger flounder in a short time frame could increase profitability.

Monosex female culture should reduce the size difference between individuals during the grow-out period, lessen mortality from cannibalism, decrease labor costs for size grading, and give a higher return on investment for feed and infrastructure. Large-scale commercial flounder farming operations would provide year-round “crops” with consistent size, quality and flavor.

Early Sea Grant efforts in flounder culture generated more than \$1 million of additional funding from the National Science Foundation, the National Institutes of Health and the National Marine Fisheries Services’ Saltonstall-Kennedy Program.

A \$150,000 grant from North Carolina’s Golden LEAF Foundation is underwriting a flounder-breeding facility — part of the state’s first hatchery/breeding complex for Southern flounder. A feature story in *The (Raleigh) News and Observer* was picked up by news wire agencies.

The flounder research builds upon earlier studies, such as **“Aquaculture of Southern Flounder: Improved Fingerling Production,”** which offered the first reported use of methods for producing all-female southern flounder fingerlings through gynogenetic techniques, and the first report of the use of nonrelated sperm from a mullet to fertilize flounder eggs. The colleagues from NC State, ECU and UNCW developed methods for producing all-female fingerlings through gynogenetic techniques.

The development of all-female production will have a positive effect on the production economics by yielding more uniform growth rates, faster growth and improved yields of larger fish with better feed conversion efficiencies. The production of large numbers of fingerlings opens the door for aquaculture production and potential stock enhancement of this species.

Daniels and Watanabe of UNC-W wrote a flounder hatchery manual, edited by Sea Grant communicator Pam Smith, that still is gaining attention on state, national and international levels.

“Characterization of Novel Polypeptide Antibiotics for the American Oyster,” by Ed Noga of NC State’s College of Veterinary Medicine, looks for ways to characterize antibiotic activities in oysters in order to help avoid infectious disease, one of the greatest economic and biological threats to oyster productivity and population integrity. Noga and his lab associates have discovered at least three polypeptide antibiotics that have potent antibacterial activity. This project will include the purification and identification of these antibiotics and then determination of the antibiotic activity against important bacterial and parasitic pathogens. They will also develop antibody probes to determine where the antibiotics are produced and stored within oyster tissue, as well as to see if similar antibiotics occur in other important bivalves. Results of the study are expected to be useful not only for aquaculture operations, where the oysters have economic value, but also will be used for managers working with wild stocks.

In earlier breakthrough research, Noga discovered a new family of antibiotics in hybrid striped bass, which are raised on fish farms. The discovery may have implications for treating diseases in both humans and fish.

Named piscidins after the Latin term “pisces” for fishes, the antibiotics were isolated from mast cells — the most common tissue immune cell found in fish and other vertebrates, including humans. Mast cells are found in many tissues, including the skin, gills and gastrointestinal tract.

Getting the Word Out

Shellfish aquaculture has its special set of biological, environmental, social and marketing challenges. Thus, Sea Grant gets reliable information into the hands of commercial shellfish growers, prospective gardeners, researchers and the general public — including how to produce shellfish for consumption or to improve water quality.

An FRG project by Jim Swartzenberg, a commercial shellfish grower in Onslow County, is resulting in a comprehensive, technical oyster hatchery manual. Sea Grant communicator Pam Smith edited the CD manual, which offers links to video clips of experts and to online resources.

“The Amazing Oyster: A Keystone Species for the Health of Our Coast” includes interviews on oyster aquaculture, as well as biology, reef structure, policy/regulations and community restoration projects. The DVD was highlighted at a poster session during the 7th International Conference on Shellfish Restoration, held in Charleston, S.C., in November 2004. It is also widely used as an educational tool by state fisheries officials and community organizations such as the N.C. Coastal Federation.

Also, Sea Grant staff and researchers present findings at the annual N.C. Aquaculture Development Conference. Sea Grant is a cosponsor of the N.C. Department of Agriculture event, which promotes commercial aquaculture ventures.

Seafood Technology

One of the earliest Sea Grant projects in North Carolina was the funding of seafood laboratory projects at NC State. That tradition of leadership continues today through research, extension and communications efforts, as well as extensive education programs for the seafood processing industry. Overall goals for this category include:

- Expanding the seafood industry by improving product quality and handling, and increasing the development of value-added products.
- Improving the safety of seafood for consumers.
- Developing new technology to increase the use of byproducts, thus reducing waste and improving use and value of traditional products.

In the 2004-2006 funding cycle, North Carolina Sea Grant not only is expanding upon past success, but also will move into new arenas of this cutting-edge industry. In addition, North Carolina Sea Grant’s leadership in seafood technology is evidenced in the role of Director Ronald G. Hodson as co-chair of the Seafood Science and Technology Theme Team for the national Sea Grant network. Hodson has coordinated development of a “white paper” to evaluate existing Sea Grant efforts in seafood technology, as well as research and outreach needs on regional, national and international levels.

Seafood Processing

“An Alternative Approach To Improving Gel-Forming Ability Of Seafood Muscle,” by Tyre Lanier of NC State is the most recent step in North Carolina Sea Grant’s applied research in seafood processing. In this project, Lanier is looking for a simpler process to achieve a good gelling process for seafood meat — attaining an even, homogenous distribution of proteins prior to heating. He is looking at common denominators of gelling success in acid and alkaline processing. If successful, the simpler process would increase yield, improve quality and reduce waste, sodium and costs. And it could equal the performance of — and effectively replace — the current use of surimi in most product applications, Lanier explains. The primary hypothesis to be tested is that disintegration of muscle microstructure, to facilitate better protein distribution prior to heating and gelation, is the key to the enhancement of meat protein gelation, rather than microfibrillar protein purification/refining, conformational changes, and/or ease of solubiliziation as has been supposed.

Meanwhile, commercial fish processing plants in Chile and Iceland are testing an alkaline surimi process that could greatly enhance the use of low-value fish, including menhaden. Lanier, working with Sea Grant colleagues Jae Park of Oregon State University and Herbert Hultin of the University of Massachusetts, developed the new process through an earlier regional project.

Surimi — used to make imitation crab, scallop and lobster products — now is made by mincing fish fillets, followed by extensive water washing to remove unwanted components. The yield of surimi from whole fish is only 25 percent. Only larger, white-fleshed fish species, including pollock, had previously proved economical.

The new process promises a similar quality product with 20 to 30 percent higher recovery rates from the whole fish. It also reduces waste treatment costs by 20 to 30 percent, because high quality proteins normally lost to the wastewater are retained in the surimi.

Another benefit of the new alkaline surimi process is that it easily accommodates smaller fish that require only deheading and evisceration — removing the fish’s insides — but not filleting before processing.

Vibrio Vulnificus Studies

NC State food scientists have developed a new strain of *Vibrio vulnificus* that can be used to evaluate the safety of raw oysters. When the bacterium *V. vulnificus* is present in raw oysters, it can be a serious health threat to people with compromised immune systems and gastrointestinal disorders.

The new strain — which expresses a green fluorescent protein — can be used in inoculation studies. Sea Grant researchers MaryAnne Drake, David P. Green and Lee-Ann Jaykus conducted “**Characterizing the stress response of *Vibrato vulnificus* to sublethal stresses during oyster handling and processing.**” to compliment an earlier Sea Grant study on the thermal and freeze-thaw tolerance of *V. vulnificus* on pasteurized oysters, the scientists also characterized the stress response of the bacterium on sublethal stresses during oyster handling and processing.

They found that cold or starvation stress of *V. vulnificus* does not impact heat or freeze/thaw tolerance of the pathogen from a food processing perspective. However, cold adaptation did enhance cold storage survival. Thus, the effect of refrigeration temperatures to reduce *V. vulnificus* may be compromised without prompt and thorough chilling of the food product.

With regulatory agencies seeking to reduce *V. vulnificus* infections by 60 percent by 2007, effective control of this bacterium in raw shellfish is vital. The study results can be used to set up processing or handling guidelines that minimize the risk of *V. vulnificus*, including heat shock of shell oysters, freezing of oysters on the half shell and the addition of acidified sauces (cocktail) to raw oysters for retail sale.

By minimizing risk, the N.C. seafood industry will be able to better market oysters and other seafood. The study also will allow North Carolina companies to enter the value-added marketplace with minimal risk to consumers.

Since 1996, there have been more than 30 confirmed cases of disease caused by *V. vulnificus*, *V. parahaemolyticus* and *V. cholerae* in North Carolina. All the cases occurred in eastern North Carolina as a result of wounds or ingestion. To understand the epidemiology of these pathogens, North Carolina Sea Grant researcher James D. Oliver of UNC-Charlotte conducted samplings at five study sites on the Pamlico and Neuse rivers. “**The Viable but Nonculturable State in Human Bacterial Pathogens in Eastern North Carolina Waters**” focused on the changes in the DNA of these bacteria and correlated it with exposure to stress and water temperature, nutrient starvation and other factors. The results may be significant because the pathogens exist for part of the year in a dormant state that cannot be detected by routine bacteriological methods.

Outreach: Adding Value to Seafood

Barry Nash doesn't make seafood products, but he does help make seafood better — and hopefully profitable and palatable for producers and consumers alike.

Global competition is taking larger commodity market shares. So, to economically stay afloat, the state's seafood sector must be informed about the latest technology and processes — and develop new or value-added products. That is where Nash, Sea Grant seafood technology specialist, steps in.

The strongest demand for novel seafood products comes from restaurants and regional specialty markets. Unlike multinational companies that must appeal to a broad consumer base to meet operating expenses, North Carolina seafood processors are positioned to exploit these niche markets. Also, surveys show consumers prefer locally grown or harvested and processed seafood — and are willing to pay a premium price for flavorful, healthy, and easy-to-prepare, value-added seafood.

For example, Nash has worked with Southern Farms to develop value-added seafood products that reflect the strong potential for partnerships among small businesses in Eastern North Carolina. The products are popular in the growing restaurant, catering and other food service arenas.

Nash's "Seafood Enterpriser" column in *Marine Extension News* offers seafood processors — and all 2,500 subscribers — information about technology, ingredient sources, and market trends in the seafood processing industry. The topic is gaining attention as more people realize that value-added seafood products may more than quadruple the dollar value of commercial landings of finfish and shellfish — a significant economic impact for the industry and the state.

Ensuring Seafood Safety

Nash continues to ensure the quality and safety of seafood through education programs for processors and seafood handlers. Over the years, he has organized and conducted workshops to certify more than 300 individuals through the federally required Hazard Analysis and Critical Control Point (HACCP) and Sanitation Control programs.

Nash also has provided on-site consultations with dozens of coastal processors who needed technical assistance in revising their HACCP and sanitation plans to ensure their companies' compliance.

To educate state environmental health specialists about seafood safety, Nash has organized and taught "Seafood Quality and Safety Workshop for Environmental Health Specialists" in partnership with the University of North Carolina at Chapel Hill School of Public Health. Since 1998, workshops have enabled more than 150 individuals to receive their certification in restaurant and retail quality and safety inspection.

As a sign of the times, Nash participates in the Bioterrorism Response Curriculum Project for the N.C. Department of Health and Human Services and the Community College System. He helped develop a teaching module to assist seafood processors comply with the Public Health Security Bioterrorism Preparedness Act of 2002. The concepts are incorporated into a variety of training and workshops.

Coastal Policy and Sustainable Development

The dramatic increase in the population of many coastal communities places new demands on traditional coastal businesses and creates the need for new ones. Many rural coastal communities are generally unprepared for such changes and, as a result, must adjust to a variety of economic and social changes. Many coastal economies are based on natural resources that can be jeopardized during rapid change. Thus, our priorities in this area include:

- Modeling the coastal economy and its links to the geological and ecological sustainability of coastal communities.
- Defining existing land- and water-use patterns and exploring techniques — such as zoning, land- and water-use planning — to meet challenges posed by an increasing population.
- Defining parameters needed to support nature- and heritage-based tourism and quantifying the economic impact of such activities.
- Understanding the policy and economic implications of public-trust resource allocation and use — with particular attention to the range of issues associated with beach nourishment, beach access and surface-water activity conflicts.

Once again, Sea Grant's reputation as an "honest broker" is crucial as researchers and staff members tackle the often-controversial topics that fall under this category.

Fisheries Economics

“Measuring Interrelated Demands for Commercially Caught Fish.” by Matthew Holt of NC State, working with colleagues in other states. This project has started in the Great Lakes, where researchers estimated a six-equation system of normalized quadratic inverse demands — price is a function of quantities — for fish landed in the Great Lakes with monthly landings and valuation data updated through 2001. The model then generates dollar measures of consumer welfare loss estimates associated with imposing catch restrictions on various species landed. A novel feature, and an improvement over all previous efforts in this area, is that the researchers are able to use sub-sample bootstrap techniques to obtain estimates of standard errors (i.e., estimates of precision) associated with the dollar values of consumer welfare loss even while imposing curvature restrictions (i.e., inequality constraints on the parameters).

The researchers are finding that for a 10 percent reduction in catch, whitefish is associated with the largest overall loss in consumer welfare on an annualized basis: a point estimate of \$776,122 with a 90-percent confidence interval of \$729,655 to \$1,056,655 based on the sub-sample bootstrap procedure. Whitefish is followed by yellow perch, indicating that a 10-percent reduction in catch is associated with a \$294,816 loss with a 90 percent confidence interval of \$267,138 to \$536,437 based on the sub-sample bootstrap procedure. Similar results, but smaller in overall magnitude, were obtained for other species commercially landed in the U.S. Great Lakes region.

Changing Coastal Communities

In **“Developing “Best Practices” for Coastal Communities Experiencing High Levels of Immigration,”** David Griffith and Jeffrey Johnson of East Carolina University cite the need to identify both the needs and impacts of new arrivals in our coastal communities. The researchers will compare three groups: new foreign-born immigrants, new U.S. citizens moving into coastal regions, and native North Carolinians to determine their perceptions of land- and water-use activities. The researchers also will investigate the new arrivals’ roles in surface-water activity conflicts and their demands for coastal recreational facilities. Griffith and Johnson also will look at community response to the new arrivals and the role of social entrepreneurs in disseminating information about the coast. With that information in hand, the researchers will determine the “best practices” communities have found to address these needs and potential conflicts. Products will include two sets of educational materials, one to assist communities to implement the “best practices” identified in the study and the other to educate the new arrivals about our coast.

“Demographic Change in North Carolina's Coastal Counties and Related Policy Implications,” by Lauriston King of East Carolina University and Jack Thigpen of North Carolina Sea Grant, looks to quantify the broad national changes in coastal populations that continue to be reflected in similar changes in North Carolina. This study will compile, synthesize, and analyze demographic and socioeconomic data to document the nature, extent, and variability of change in North Carolina’s coastal counties over the past 30 to 40 years.

Documenting a Fishing Community

Matthew Barr of the University of North Carolina at Greensboro has turned his cameras on Sneads Ferry — one of the few coastal communities where a fishing tradition is still forefront after 300 years.

Barr literally is in a race with time. Since he began the project, Sneads Ferry has grown at “an astonishing rate” and has changed significantly. A Sea Grant minigrant allows Barr to complete the editing process, taking 95 hours of digital videotape down to a feature-length documentary that he hopes will air on UNC-TV.

In addition, he collected more than 800 still images to capture the heart of the veteran commercial fishers and their families. Those will go into a book project, funded with a second minigrant. A shorter version of the documentary and other material will be archived at the Southern Folklife Library at the UNC-Chapel Hill, and will be distributed in the education market.

The finished product will provide an invaluable historical record. In interviews, the fishers are candid about the future of commercial fishing and aspects of their disappearing lives.

Traditional Knowledge Complements Standard Science

Combining traditional ecological knowledge (TEK) and scientific ecological knowledge (SEK) can provide the basis for sound coastal resource management, ECU social scientists David Griffith and Jeffrey Johnson conclude in **“Local Knowledge and Scientific Resource Management in Changing Coastal Communities.”**

Relying on their TEK, for example, crabbers and shrimpers have developed elaborate, holistic models for predicting the behaviors of fish and shellfish. They factor in such variables as salinity, water temperature, time of

year, wind direction, human influences, gear condition, behaviors of birds or other fish, the moon and tide, and bottom conditions.

The project has helped to legitimize TEK in the eyes of scientists and to further “professionalize” commercial fishing. TEK can benefit SEK by aiding in research design in terms of sampling for particular species. TEK also can inform fishery managers of potential boundaries for marine protected zones, or times to close various fisheries.

Their Sea Grant findings were the basis for a presentation to a National Science Foundation review panel, which helped the researchers secure an NSF grant to broaden the study to understand the ecological change in the nearshore Kotzebue Sound ecosystem in Alaska.

North Carolina’s policy makers will be especially interested in another Sea Grant-funded project — understanding stakeholder perceptions of water quality. In a first round of open-ended interviews, Griffith and Johnson found disparate perceptions among survey groups. Among environmentalists, there is a high degree of shared belief about the impacts of nutrient loading from agriculture. On the other hand, farmers who operate confinement livestock operations, point to municipal waste as the primary problem.

Outreach: On the Soundfront

State and federal agencies and community groups continue to turn to North Carolina Sea Grant to learn how coastal development may be compatible with protecting coastal resources. With funding from the N.C. Division of Coastal Management (DCM), Sea Grant published a text on estuarine shoreline. *Drowning the North Carolina Coast: Sea Level Rise and Estuarine Dynamics*, is written by Stanley R. Riggs and Dorothea V. Ames of East Carolina University, and edited by Sea Grant communicator Ann Green.

The detailed text was an outgrowth of *The Soundfront Series*, which was also supported by DCM. Walter Clark, Sea Grant coastal communities and policy specialist, and former Sea Grant educator Lundie Spence initiated the series with DCM colleagues, who funded the project with a grant from the National Oceanic and Atmospheric Administration. Authors include experts from Sea Grant, East Carolina University, NC State and the N.C. Coastal Federation. Sea Grant communicators edited the series. Each guidebook focuses on specific aspects of the estuarine science and policy. The series continues to be used in N.C. Estuarine Research Reserve and N.C. Coastal Federation workshops, and by community groups such as Carteret Crossroads.

Coastal Communities Initiative

Sea Grant provides science-based information and innovative tools to encourage sustainable development and mitigate potential user conflicts. Building upon Sea Grant's national focus on coastal communities, North Carolina Sea Grant is more closely coordinating its long-standing programs in coastal law/policy and recreation/tourism.

Clark, past president of The Coastal Society, is leading North Carolina's new initiative to foster an understanding of legal, planning and policy tenets that can guide growth while protecting coastal ocean and estuarine ecosystems. He addresses a range of topics as co-editor of *Marine Extension News*. He has discussed legal aspects of sound-bottom shellfish leases, and land use/water quality links in the quarterly newsletter. Through “Legal Tides,” a regular feature in *Coastwatch* magazine, Clark reaches a broader audience to explain issues such as the legal and policy implications of sea-level rise, rebuilding after hurricanes and beach nourishment.

Clark, a lawyer, also works with Thigpen, a sociologist, and Sea Grant researchers to address emerging demographic patterns, such as increasing populations and wealth along shoreline areas, and declining populations and income levels for many inland coastal plain communities.

Sea Grant worked with the N.C. Cooperative Extension Service and the state Division of Water Quality to develop a “water quality planning specialist” position, held by Kate Ardizone. Clark designed this partnership effort that will provide a specialist in a coastal location to identify and assess existing outreach and education opportunities for local governments in land use plan development and implementation. In addition, Ardizone will assess options for coordinating existing opportunities and identify gaps that need attention. This position was funded through an initial two-year federal EPA grant to the state DWQ.

Thigpen is working with NOAA’s Coastal Services Center to study demographic changes in coastal counties. That work will be coordinated with King’s research project. Thigpen will also continue sustainable development projects, such as the successful coastal paddling trails initiative.

SEACOOS: Exploring the Coastal Ocean

How much do we know about the coastal ocean? Who needs reliable coastal ocean data?

The Southeast Atlantic Coastal Ocean Observing System (SEACOOS) collects, manages and disseminates observations and information from the coastal ocean off North Carolina, South Carolina, Georgia and Florida. This regional effort is a part of a national plan to coordinate observing systems.

North Carolina Sea Grant's leadership in identifying potential user groups will be a national model for other ocean observing systems. Extension Director Jack Thigpen was the initial leader of the SEACOOS Outreach and Education Workgroup, coordinating efforts with other Sea Grant programs in the region and partner agencies.

The SEACOOS consortium also includes the University of North Carolina at Chapel Hill, North Carolina State University, North Carolina Supercomputing Center, University of South Carolina, South Carolina Sea Grant Consortium, South Carolina Department of Natural Resources, Skidaway Institute of Oceanography, University of Georgia/Sea Grant, University of Florida/ Sea Grant, University of Miami and University of South Florida. Federal agency partners include more than a dozen offices within the U.S. Navy, National Oceanic and Atmospheric Administration, and U.S. Army Corps of Engineers.

Ongoing interaction between researchers and outreach staff will ensure two-way communications between public group needs and the agency/university experts designing the systems. In addition to providing support to the overall outreach and education efforts, North Carolina Sea Grant is involved with several pilot ocean observing outreach projects specific to our coast. These include:

- Explaining SEACOOS capabilities to potential North Carolina users, including coastal resource management groups, emergency management agencies, recreational boating associations, ports and harbors, recreational and commercial fishing associations, and commercial shipping. Efforts include products introducing SEACOOS;
- Determining local needs for high frequency radar data from a new system on the northern Outer Banks. Audiences may include commercial fishing and recreational boating groups;
- Evaluating an information delivery scheme for a new Cape Lookout buoy measurement system that could include real-time wind and wave information to improve safety for recreational boaters, anglers, commercial fishers, underwater divers and wind-powered sailors in the Morehead City region; and
- Partnering with "Ocean.US" on a 2004 national workshop on outreach and education methods for regional ocean observing systems.
- Developing an informational kiosk to explain various observing projects along the Outer Banks. The kiosk is expected to be available at Jennette's Pier, a new educational center in Nags Head, in summer 2005.

EPA Smart Growth Extension Partnership

"Making it Happen: A Coastal Community Development Resource Guide" is scheduled for printing and distribution in early 2005. The resource guide provides a comprehensive listing of grant opportunities for local governments engaged in sustainable development. The guidebook, which targets local decision-makers, will be published in 2005. Lindsay Fullenkamp, Sea Grant's Coastal Management Fellow, as part of the Sea Grant Coastal Communities Initiative, compiled the guide, which includes an introduction by Walter Clark, North Carolina Sea Grant coastal communities and policy specialist.

COASTAL ECOSYSTEM HEALTH AND PUBLIC SAFETY

In the category of Coastal Ecosystem Health and Public Safety, our strategic plan includes a number of topics, including coastal processes and natural hazards, water quality and habitat protection and restoration. In fact, some of the first Sea Grant projects in North Carolina involved evaluations of estuarine ecosystems and habitats. We continue to build upon the strong base we have built in this area. We look to new challenges in addressing the ongoing needs of the coast, while also responding to immediate needs resulting from storms and other events.

Coastal Processes and Natural Hazards

The coast is a dynamic place, where the land meets the sea. This sets the stage for beautiful vistas, constant change and the potential for danger. North Carolina Sea Grant has several goals in this category, such as:

- Reducing the loss of property and other capital investments in the coastal zone.
- Improving the ability of man to live and recreate in the coastal hazard zone.
- Enhancing the socioeconomic status and environmental quality for coastal residents.

Thus, our strategic plan to implement these goals includes both research and outreach activities.

Nourishment: Environmental Impact

While beach nourishment projects protect structures, few scientific studies have been conducted to evaluate the biological/ecological impacts of beach nourishment. **“Constraints to Rapid Recovery of Habitat Function Following Beach Nourishment,”** by Charles Peterson of UNC-Chapel Hill’s Institute for Marine Science, builds upon an earlier project, **“Enhancing the Scientific Basis for Predicting Fish Habitat Impacts of Beach Nourishment,”** by Peterson and John Wells, then also of IMS.

They found that a Bogue Banks project “dramatically transformed” beach habitats for shorebirds and surf fishes.

In a report 17 months after the 2000-01 phase of the Pine Knoll Shores nourishment project, biological recovery of the abundance and biomass of intertidal vertebrates was only about 50 percent. A year after the Emerald Isle project, a similar pattern emerged although recovery rates in the first warm season were faster on these beaches. Ghost crabs, a signature beach predator that digs burrows on the beach for daytime refuge, also declined by 20 to 50 percent and showed little recovery as of November 2003 in both areas.

The researchers report that this nourishment effort failed to match the grain size distribution or mineralogy of the natural beach sand. Heavy surface shells block access of shorebirds and surf fish to the invertebrates. The beach nourishment also added fine sediments, silts and clays on the beach, resulting in increased turbidity even during calm weather. Turbidity reduces the ability of visually feeding birds, such as pelicans and fish, such as bluefish.

The results were considered in the development of the state’s Coastal Habitat Protection Plan (CHPP), as well as the federal Essential Fish Habitat discussions. Also, the N.C. Coastal Resources Commission is using the results to review sediment standards for state permits for beach nourishment. In addition, the U.S. Army Corps of Engineers can use the data in developing plans for beach fill.

Peterson is vice chair of the N.C. Environmental Management Commission.

Impacts of Erosion Control Structures

Through **“Effects of Erosion-Control Structures on Adjacent Benthic and Nektonic Communities,”** Martin Posey and Troy Alphin of the University of North Carolina at Wilmington are looking at how faunal patterns have been impacted by established bulkheads, sills and revetments. The scientists also will look at the short-term impacts of erosion-control devices on benthic and nektonic communities. Sampling began in 2004. The researchers are working closely with Spencer Rogers, North Carolina Sea Grant coastal erosion specialist. The project builds upon an earlier minigrant that looked at the impacts of bulkheads — one of the dominant structures used in coastal sounds, and one that has received stricter regulatory attention — with enough statistical rigor to draw conclusions about potential community effects.

In 2003, the N.C. General Assembly authorized the immediate adoption of a general permit for stone marsh/sills. The legislation was based in large part on results from studies conducted by Rogers and partner agencies, including the N.C. Coastal Federation, NC State soil scientists, the National Albemarle-Pamlico Estuarine Research Program, N.C. Cooperative Extension and the N.C. Sediment Control Commission and NOAA.

Sea Grant helped write the general permit regulation to allow a one-day permit, making marsh/sills permits equal to bulkheads, revetments and groins. Wider use of environmentally desirable erosion-control alternatives is expected. Sea Grant described the stone marsh/sill design along with other erosion control techniques in *Managing Erosion on Estuarine Shorelines*, part of *The Soundfront Series*.

Dune Plant Survival

Along barrier island dune systems, large events, such as hurricanes, as well as day-to-day stress activities, including temperature, affect dune species. Through **“Global Change and Natural Stabilization of Barrier Island Sand Dune Ecosystems,”** William K. Smith of Wake Forest University will compare the impact of day-to-day factors to episodic events on the growth, reproduction, and survival of the embryo and primary dune species. Smith also will evaluate the impacts of global change on these species, including sea-level rise and increasing intensity and frequency of storms. The first phase of data collection will be completed by January 2005. The results can be used by conservation agencies, land-use managers and economic planners to identify early global change impacts, as well as predicting future impacts on primary dune vegetation and barrier island stabilization.

Minigrants offer substantial findings

“Coastal Hazards Building Inventory Scope of Work” by Marjorie Overton of NC State and Rogers is a pilot study to assemble and analyze a detailed community building inventory — including damage assessment data — to evaluate the causes and severity of structural damage from Hurricanes Bertha, Fran, Bonnie and Floyd in North Topsail Beach. Data will be assembled in a GIS (ArcView) from existing data sets, including a complete building inventory of the community that was conducted by the Federal Emergency Management Agency.

In **“Establishing Long-Term Monitoring Plots to Study Sea-Level Rise and Marsh Invasion of Estuarine Forests on the Albemarle Peninsula, North Carolina,”** N.L. Christensen and Ben Poulter of Duke University are tracking vegetation structure and composition, as well as environmental parameters for soil and topography in marsh, transition-forest and upland forest communities around the Albemarle peninsula. The data can be used by land management agencies to monitor trends in vegetation change over time and the effect of other interactions, including prescribed fire.

Outreach

Break the Grip of the Rip™

As the 2004 summer beach season opened, a national “Break the Grip of the Rip” safety campaign was launched in Wrightsville Beach. The campaign highlights a partnership between NOAA — including the national Sea Grant network, the National Weather Service and the National Ocean Service — and the U.S. Lifesaving Association.

The news conference, which was broadcast via satellite by the University of North Carolina Television, highlighted new designs for rip current safety signs and brochures. Speakers included NOAA Administrator Conrad Lautenbacher (VADM Ret.) and Sandee LaMotte of Atlanta, whose husband, CNN broadcaster Larry LaMotte, died while trying to save his son from a rip current in Florida in 2003.

Local state and national officials attended the event, as did CNN, Raleigh’s *News & Observer*, the *Wilmington Star-News*, and North Carolina-based media affiliates for ABC, CBS, NBC and NPR. Local logistics for the conference, held at the Holiday Inn SunSpree, were coordinated by Katie Mosher, North Carolina Sea Grant communications director, who also served on the national task force.

North Carolina’s rip current safety program was among the models for the national campaign. Over the years, North Carolina Sea Grant has partnered with beach communities and the National Weather Service on a variety of rip current safety efforts, including posters, a 1998 video, brochures, and more than 600 signs. The North Carolina rip current education effort received a national APEX communications award.

Also, Rogers is leading efforts by Sea Grant coastal processes specialists to provide the national Coastal Hazards Theme Team with technical information on rip currents and safety efforts. He was among the organizers of a 2004 technical workshop on rip currents attended by Sea Grant researchers and specialists and weather service experts.

Rogers and Mosher also are working with a New Hanover County rip current safety program spearheaded by the Wilmington office of the weather service and a wide range of New Hanover County agencies, as well as the Swart family, whose daughter Crystal died off Wrightsville Beach. Another pilot project is being developed in Dare County.

Dune Views

An outreach campaign centered upon *The Dune Book*, written by Rogers and David Nash of N.C. Cooperative Extension, received national honors in 2004. The efforts, which also included workshops and distribution of printed and online copies to educators and community organizations, received a Grand Award from the APEX competition, sponsored by Communications Concepts in Virginia.

The dune management guide — edited by Ann Green, designed by Kathy McKee and with illustrations by David Williams — explains dune processes and recommends plants and planting strategies to encourage natural dunes on our barrier islands. Dunes are important to the North Carolina coast, which was hit by five hurricanes between 1996 and 1999. The back-to-back hurricanes caused severe dune erosion along a third of our coast. Then in 2003, Hurricane Isabel arrived, washing out much of the Outer Banks’ dune system.

Rogers, a member of the N.C. Coastal Resources Advisory Committee, has partnered with the N.C. Cooperative Extension Service, N.C. Shore & Beach Preservation Association and local governments to conduct annual dune management workshops. Sea Grant emphasizes where and how to build the dunes. Cooperative Extension provides expertise in dune plant selection, propagation and planting techniques. Numerous site visits resulted in diagnosis and recommended treatments for dune problems of various towns, homeowners

associations and individual property owners.

Water Quality

The water quality topic includes a broad range of issues, from restoration of urban streams in the piedmont to studies of the chemical mix found in estuarine and coastal waters. In particular, we look to:

- Apply the latest technology to improve environmental quality and reduce the impacts of pollution.
- Reduce the eutrophication of coastal waters by recognizing the variety inputs from throughout the river basins.
- Enhance the environmental quality and resulting socioeconomic status of coastal communities.

Water Quality in the Cape Fear River Estuary

Led by Stephen Skrabal, Sea Grant researchers at the University of North Carolina at Wilmington are collecting data on dissolved mercury concentrations in the Cape Fear River Estuary and at freshwater stations in the Lower Cape Fear basin including the Black, Northeast Cape Fear and mainstream Cape Fear rivers. The Cape Fear River Estuary is an important fishery nursery habitat for many economically important species including spot, flounder and mullet. Preliminary results show that dissolved mercury concentrations here are comparable to several East Coast systems, including the Chesapeake Bay.

This project, “**Mercury Speciation in the Organic-Rich Cape Fear Estuary,**” will provide the first water column concentrations of various mercury species in the estuary, which includes an area near the site of a former chemical plant. Scientists who are assessing atmospheric mercury contamination and mercury in various fish species in the Lower Cape Far basin will use data in concert with ongoing studies. Funding from NCSG project enabled the researchers to obtain matching funds from UNCW to purchase a state-of-the-art mercury analysis system.

Meanwhile, concentrations of ammonium in the Fear River Estuary have nearly doubled between 1996 and 2004. Results from “**Increasing Ammonium Concentrations in the Cape Fear River Estuary: Where is it Coming From?**” show that major contributors of ammonium are riverine sources, with seasonal contributions from sediments and atmospheric deposition. Robert Kieber, Joan Willey and Skrabal, all of UNCW, now are quantifying the input rates of critical nitrogen nutrient fluxes in the Cape Fear in addition to ammonium to understand nutrient cycling within the estuary. The scientists suggest that rivers, sediments and the atmosphere also will be seasonal sources of these nutrients.

Results on both the estuarine behavior and atmospheric sources of the important nitrogen species, ammonium, amino acids and dissolved organic nitrogen provide critical information for state and local agencies responsible for managing or assessing water quality of the Cape Fear River. The researchers are contributing members of the Lower Cape Fear River Program.

The ammonium study followed an earlier Sea Grant project led by Skrabal, “**Sediment-Water Exchange in the Lower Cape Fear Estuary: Effects of Metal Speciation on Water Quality and Benthic Biota.**” The study set out to examine speciation of Copper and Zinc in influencing water quality at two sites in the Cape Fear River Estuary, and the role of the biota in influencing sediment-water exchange (fluxes) of Cu and Zn and complexing ligands, which control their speciation. The scientists found that concentrations of total dissolved copper and zinc are significantly less than state water quality standards in saltwater (3 ppb for Cu and 86 ppb for Zn) — surprisingly low, considering the proximity of two major shipping terminals, the Port of Wilmington and the Military Ocean Terminal Sunny Point. Such terminals often are sources of these metals from anti-fouling paints applied to ship bottoms.

This study of fluxes of Cu and Zn complexing ligands is among the first to be performed in estuarine sediments. The results will be useful for estimating the role of benthic fluxes in other estuarine systems containing similar sediment types and water chemistry.

The UNCW researchers also are collaborating with colleagues from the Space and Naval Warfare Systems Center, Environmental Sciences Division of San Diego and from the University of Wisconsin-Madison Water Science and Engineering Laboratory. The U.S. Department of Defense and NOAA Ocean Services fund related research. The results of this project will be of considerable interest to several agencies investigating water quality issues, including the U.S. Army Corps of Engineers and the N.C. Division of Water Quality.

Neuse Estuary Studies

In “**Eutrophication and Trophic Transfer in the Neuse River Estuary: Dynamics of Nutrients and Phytoplankton at the Chlorophyll a Maximum,**” Hans Paerl and Michael Piehler of UNC-Chapel Hill

Institute of Marine Sciences are looking at “problems” that may result from solutions. For example, chlorophyll a maximum —the phytoplankton photopigment commonly used as an indicator of total phytoplankton biomass — may have shifted downstream in the Neuse River Estuary over the past few decades due to significant reductions in phosphorus (P) discharge, accompanied by continued high rates of nitrogen (N) loading. These findings have ramifications for estuarine eutrophication dynamics and long-term water quality and food web structure trends. Results from this research support a rationale for pursuing a dual nutrient reduction strategy aimed at reducing the unwanted symptoms of eutrophication. The project complements Sea Grant-supported work on Neuse River Estuary-Pamlico Sound fisheries health and habitat conditions by NC State, Duke and UNC-Chapel Hill researchers.

For example, in **“Phytoplankton and Zooplankton Community Responses to External Nitrogen Loading in the Pamlico Sound: Mechanisms and Links to Management of Coastal Eutrophication,”** Paerl and colleagues evaluated phytoplankton and zooplankton grazer responses to various supply rates of nitrogen (N) in the Pamlico Sound. They examined how different forms of N, originating from anthropogenic and natural sources, affected the structure and function of phytoplankton communities supporting the sound's food web. The project offered an opportunity to assess the hydraulic and nutrient enrichment effects of catastrophic floods that accompanied Hurricanes Dennis and Floyd in 1999. The researchers suggest that nutrient management efforts aimed at stemming eutrophication of the Pamlico Sound and its subestuaries must incorporate large episodic loading events associated with hurricanes. This is timely advice considering the predicted 10- to 40-year period of elevated tropical storm and hurricane activity in the Atlantic Basin.

Data and conclusions are being utilized by the state of North Carolina and federal agencies in formulating assessments of the ecological and economic importance of hurricanes on water quality, fisheries resources and habitat in a major nursery. The data are also of use in formulating allowable Total Mean Daily Loads (TMDL) of N and other nutrients for nutrient-sensitive estuarine and coastal waters in hurricane-prone areas.

The Sea Grant results lead to additional studies on the impacts of nutrient loading has on human health. Paerl is collaborating on a \$1.2 million National Science Foundation Ecology of Infectious Disease Program (EID) study of watershed-based nutrient enrichment to estuarine water quality and microbial pathogen responses. He will address phytoplankton community responses to nutrient enrichment and their interactions with microbial pathogens that may pose threats to human consumers of seafood and recreational users of estuarine waters.

Paerl's Sea Grant studies also provided crucial background on Pamlico Sound water quality and ecology to merit a \$6 million U.S. Environmental Protection Agency grant. This multi-university project is developing a new generation of indicators for large coastal ecosystems under the influence of anthropogenic and climatic changes. The research has also been featured in stories on BBC, ABC, WCTI and WRAL.

Fecal Pathogens

Sediment-associated fecal microbes are widely recognized as a source of contamination of shellfishing and recreational waters. Currently more than 300,000 acres of coastal waters are closed to shellfishing, with nonpoint pollution cited for much of the problem. In **“Effects of Sediment Phosphorus Concentration on Fecal Pathogen Indicators in Estuarine Sediments,”** Larry Cahoon and Mike Mallin of the University of North Carolina at Wilmington are testing a hypothesis that sediment phosphorus concentrations limit fecal microbial concentrations in coastal sediments. Their approach combines observational fieldwork to identify correlations between relevant parameters and experimental fieldwork to test hypotheses re: cause/effect relationships. The various parameters to be reviewed include salinity, water temperature, rainfall history, sediment grain size distribution, sediment organic content, sediment phosphorus content, sediment carbohydrate and protein content, overlying water column nitrogen and phosphorus, chlorophyll a, turbidity, fecal coliform concentrations and solar irradiance intensity.

In a separate study, **“F+ Coliphages as Source Tracking Viral Indicators of Fecal Contamination in Coastal Waters and Shellfish,”** Mark Sobsey of the University of North Carolina at Chapel Hill is working with the N.C. Shellfish Sanitation Program and the N.C. Estuarine Research Reserve to develop an assay kit to perform coliphage analysis and F+ coliphage grouping on samples of estuarine and shellfishing waters. The kits would then be the focus of workshops, at which representatives of state agencies and private labs would learn to use the kits and associated sampling methods. These new tools will improve the tracking of fecal contamination sources and reduce exposure risks to for the public who use the waters for recreational uses and shellfishing.

***Pfiesteria* Population Studies**

“Fine-Scale Spatial and Temporal Variation in Abundance of *Pfiesteria* Species in North Carolina Waters,” Parke A. Rublee, of the University of North Carolina at Greensboro, is seeking to determine the distribution of *Pfiesteria* species in coastal North Carolina waters, and to determine whether distribution is related to adjacent land uses. Sampling continues in sections of the Albemarle, Pamlico and Neuse rivers on an “as needed” basis at the request of state or federal agencies. To date, results indicate that populations of *Pfiesteria* displaced down estuary during the 1999 hurricane season were re-establishing in North Carolina estuaries prior to Hurricane Isabel in 2003, but were depressed again after the storm. The aquatic laboratory provides a resource for federal and state agencies to test estuarine samples. Results from studies provide an understanding of the distribution and risks associated with *Pfiesteria*. Rublee and colleagues JoAnn Burkholder and Howard Glasgow of NC State have presented numerous papers at scientific conferences, including the National Academy of Sciences (USA).

Antibiotic Inputs in Estuaries

In “**Ecosystem Effects of Antibiotics: Proof of Concept,**” Hans W. Paerl, Timothy Steppe and Rachel Noble, all of UNC-CH Institute of Marine Sciences, found that, as with other anthropogenic stressors such as nitrogen inputs, short-term exposure to antibiotics may not lead to substantial alterations in the structure or function of microbial communities. However, the potential for chronic, low-level antibiotic exposure in aquatic systems to alter microbial community dynamics may be of concern. The researchers suggest, that future research and experimental efforts concentrate on developing antibiotic detection methods for highly organic laden waters; determining the sources and mechanisms of the spread of antibiotic resistance; understanding how low levels of antibiotics impact fundamental sediment processes; and establishing long-term monitoring efforts for all the above. Through these efforts, the researchers hope to be able to devise strategies for developing indicators that can be used to monitor the fate and potential impact antibiotics might have aquatic systems. This minigrant project helped to leverage a National Science Foundation project led by Paerl and Noble to examine the impacts of nutrients on human pathogens and harmful algal blooms in the Neuse River Estuary

Habitat Protection and Restoration

This category is tied closely to the water quality efforts listed above. North Carolina has taken steps in recent years to reduce nutrient runoff and thus protect the delicate balance in coastal ecosystems. The goals include:

- Assisting in better management of estuarine ecosystems.
- Reclaiming estuarine habitat that has been destroyed or damaged by development.
- Contributing to state and federal management plans to more effectively manage estuarine waters.

Building Better Oyster Reefs

Sea Grant researchers Martin Posey and Troy Alphin spend a lot of time knee-deep in mud, determining the best design for oyster reef restoration efforts. The reefs, which vary in vertical height and edge complexity, are part of a North Carolina Sea Grant project — “***Oyster Reefs as Fisheries Habitat: The Influence of Edge Characteristics and Vertical Complexity***” — to determine how characteristics of intertidal reef morphology affect fishery habitats.

Oysters may have greater economic consequences than their value as a fishery. Reefs provide critical habitats for commercial and recreational species. The South Atlantic Fishery Management Council and the N.C. Marine Fisheries Commission’s advisory committees have recognized the importance of oyster reefs as a critical fisheries habitat.

After studying the oysters for two years, the University of North Carolina at Wilmington researchers found that high complexity reefs with numerous crevices were used more as a crab habitat than reefs with fewer crevices. These reefs also were used more by species like pinfish — which are food for other fish species — than other reef types. Edge can also make a difference. Reefs that have convoluted edges with lots of indents and curves have greater effects on surrounding tidal flats.

The study may have important implications for the design of artificial reef restoration projects in areas designated as reserves to encourage biofiltration or to serve as seed banks. The study also may help fishery managers better understand the potential impacts of non-native oyster species that thrive on different reef morphologies. In light of the research, the scientists are working with the U.S. Army Corps of Engineers and partners to start an oyster restoration project in the Lower Cape Fear River system.

Oyster reef restoration has become a national priority along both the Atlantic and Gulf coasts of the United States. North Carolina Sea Grant researchers are actively working with researchers from New Hampshire, New Jersey, Delaware, Maryland, Virginia, South Carolina, Florida, Alabama, Louisiana, and Texas to develop criteria for oyster reef restoration based on restoration goals and regional ecological conditions. Meetings related to this process have been conducted at the World Aquaculture meetings, shellfish restoration conferences, habitat restoration workgroup meetings, and the recent Oyster Restoration Success Criteria Workshop.

In a related minigrant study, "Evaluation of the Biological Filtration Capacity of Oyster Reefs in Small Tidal Creek Systems." Alphin and Posey looked at the potential influence of oyster filtration on the overlying water column, including turbidity and fecal coliform counts. Resource managers can use the results in developing plans for shellfish rehabilitation that must include water quality and habitat function as well as harvestable resource concerns. Preliminary analysis of data from nine relatively small tidal creek systems with defined channels and restricted flow shows turbidity, fecal counts and chlorophyll a are highly variable between upstream and downstream areas as well as between high-and low-density oyster reefs.

Identifying Harmful Algal Blooms

UNC-W's Carmelo Tomas introduced his Marine Phytoplankton Identification Series at the Tenth Annual International Conference on Harmful Algal Blooms, receiving positive response. So far, six identification sheets of North Carolina Harmful Algal Blooms have been completed, and two more are expected in 2005.

Funded by a Sea Grant minigrant, the set targets agency professionals, students and environmental researchers who want reliable identification guides for phytoplankton blooms. The coated pages can be used next to a microscope as an aide to identification of harmful organisms. Additional identification sheets are in progress.

Tomas also received a minigrant to develop training/workshop materials on the identification of harmful algal species. The courses are in response to the need for greater training opportunities and information exchange of researchers, students and state personnel dealing with water quality issues and public health.

Linking Water Quality and Fisheries

Along North Carolina's coast, Martin Posey, Troy Alphin and Lawrence Cahoon of the University of North Carolina at Wilmington are providing links between water quality and fishery resources — especially at levels where conditions have not reached hypoxia — through their project, "Interactions Between Nutrient Additions and Trophic Controls: Scaling Effects and System Variability."

In the White Oak River — the least impacted area — the scientists found an interaction between top-down and bottom-up factors. In the absence of predators, fauna show a distinct increase when nutrient levels jump. However, in the eutrophic Cape Fear estuary, predation and nutrient additions have little effect. These results support the fact that food web interactions may dampen initial responses.

The scientists are building upon an earlier North Carolina Sea Grant project that looked at the importance of top-down predation and bottom-up resource or nutrient effects on benthic communities in small tidal creek estuaries.

The results are being used by the U.S. Army Corps of Engineers to help interpret river monitoring information and by the City of Jacksonville and Camp Lejeune Marine Corps officials to develop a monitoring program in the New River.

Outreach: Amazing Oysters

A proactive approach regarding policy and biology of oyster stocks is gaining momentum. Sea Grant participated with other partners to plan the 2005 Oyster Summit to cover a wide variety of information on oyster status in the wild and in aquaculture; the species' role in water quality and improving aquatic habitat; and restoration of this shellfish as an economically viable product. Oyster research and outreach programs are highlighted in North Carolina Sea Grant's first DVD, *The Amazing Oyster*. Jason Talley produced the DVD while a student worker. He has since started his own video production company.

Outreach: Renewing Streams and Habitats

When Barbara Doll, North Carolina Sea Grant's water quality specialist, looks at a degraded coastal stream, visions of restoration form in her head. Her goals: stop erosion, sedimentation and run-off pollution in their tracks; protect water quality in the stream — and in downstream estuarine fish nurseries.

Doll has spearheaded major restoration projects that have required creative engineering — and funding — strategies. Land-use changes in coastal New Hanover County have dramatically altered the course, function and habitat of a stream that traverses what is now the Pine Valley Country Club in Wilmington.

The stream drains about a half-mile watershed comprised of the golf course and residential areas. Its fresh waters ultimately mix with the tidal waters of Hewlett's Creek — an important shellfish and finfish habitat in the Cape Fear River Basin.

Doll worked with the Pine Valley Golf Course Association, N.C. Cooperative Extension Service, City of Wilmington, New Hanover County and Cape Fear Resource Conservation and Development to implement 1,000 feet of stream restoration. The project is a restoration model.

The project also demonstrates the high cost of urban stream restoration — a familiar lesson for Doll, who raised more than \$4.9 million in state and federal grants for the restoration of Rocky Branch, a highly degraded stream on the North Carolina State University campus. The stream flows into a tributary of the nutrient-sensitive Neuse River.

Phase I (3,000 feet) of the three-phase restoration project — which includes 6,000 linear feet of stream restoration, landscaping and greenway construction and the construction of two pedestrian underpasses beneath busy highways — is completed. The project continues, with construction scheduled for summer 2005. Working with faculty from the Marine, Earth and Atmospheric Sciences and Zoology departments, Doll organized student activities to monitor and evaluate the aquatic health and stability of Rocky Branch.

Doll also is a member of the N.C. Stream Restoration Institute (SRI), and participates in planning for various workshops and conferences that can draw hundreds of public and private engineers, landscape architects and planners.

EDUCATION AND HUMAN RESOURCES

North Carolina Sea Grant's education efforts target many audiences. In October 2003, Terri Kirby Hathaway, long-time educator at the N.C. Aquarium on Roanoke Island, joined the Sea Grant staff as our marine educator. In addition to working with teachers, Hathaway works with informal educators who provide "lessons" in parks, museums and aquariums.

Walter Clark, coastal law and policy specialist, also teaches future leaders in courses at North Carolina State University. Also, Kathleen Angione, science communications fellow, will teach an undergraduate science-writing course at NC State in spring semester 2005.

Sea Grant also provides educational materials for coastal residents and others to continue in their lifelong journey of learning about the world around them. These products include safety and consumer information, from identifying rip currents to purchasing safe seafood or understanding the lingo and regulations of coastal development. In addition, professional staff members work directly with university and graduate students, who are critical factors in the Sea Grant mission of transferring new technology and academic findings to "real world" applications.

Developing an Informed Citizenry

North Carolina Sea Grant seeks to increase coastal knowledge across a variety of audiences. This requires a delivery system that provides relevant information — through personal contact, printed or electronic products — to the public in a timely manner. In particular, we present the following goals:

- Increase marine literacy among people of all ages.
- Organize and design a delivery system to get relevant information to the public.
- Deploy an effective extension program to respond to state and regional priorities.

These goals are reflected in a variety of activities across the Sea Grant spectrum.

Sea-View: Lessons from the Outer Banks

It wasn't your average field trip — high school students working alongside teachers and scientists to develop new earth science lessons.

Through "Sea-View," funded by North Carolina Sea Grant, the team incorporated lessons learned on the Outer Banks into earth science materials for North Carolina high school students. In 2004, the team completed drafts of six teaching modules that relate to curriculum goals set in the N.C. Standard Course of Study.

Although North Carolina high school graduation requirements now call for an earth/environmental science course, many teachers have not had appropriate training in earth sciences or access to educational resources.

Karen Dawkins, director of East Carolina University's Center for Science, Mathematics, and Technology Education and ECU geologist Stan Riggs are leading the effort. Lundie Spence, former North Carolina Sea Grant marine educator, and Terri Kirby Hathaway, current North Carolina Sea Grant marine educator have participated in the project, along with Dorothea Ames of ECU.

During an eight-day Outer Banks visit in 2002, 10 teachers and eight students viewed barrier island processes, and related community conflicts. Five critical locations included the eroding section of N.C. Hwy 12 in Avon and Buxton. In 2003 and 2004, the team developed lesson content, researched additional sources for student projects, and selected appropriate graphics for inclusion in the documents. Pilot teachers have tested the inquiry-based lessons before they are distributed throughout the state. During 2005, they will edit final DVD and print materials.

By creating a partnership among students, teachers and university experts, students receive a much richer product. In the long-term, these research-based materials will help students become better-informed citizens about coastal processes and related policies. Students in other states also can use the materials to compare North Carolina's geological processes to their own.

COSEE: Expanding Regional Outreach Efforts

In February 2003, North Carolina Sea Grant lost a veteran educator, but gained a new regional partnership when Lundie Spence became director of the Center for Ocean Science Education Excellence - Southeast, located in Charleston, S.C.

Known as COSEE Southeast, the program is funded by the National Science Foundation, NOAA's Coastal Services Center and NOAA's Office of Ocean Exploration. The regional program is developing partnerships to integrate ocean science researchers with educators from North Carolina, South Carolina and Georgia. Current Sea Grant Marine Educator Terri Kirby Hathaway is a key North Carolina participant in the program that provides educators with access to Sea Grant's broad base of marine and coastal research.

Annual COSEE Southeast's Ocean Sciences Education Leadership Institutes and other workshops strive to increase the involvement of under-represented groups in marine science. Teachers who attend the workshops then develop Ocean Awareness Days in local or regional settings.

COSEE Southeast also is taking a lead role in developing K-12 curricula based upon real-time data that will be available through the new Southeast Atlantic Coastal Ocean Observing System, known as SEACOOS. North Carolina Sea Grant, along with colleagues in South Carolina, Georgia and Florida, is leading outreach efforts for the multimillion-dollar SEACOOS project.

Public Awareness: Increasing Coastal Literacy

In the simplest terms, all our extension and communication efforts are "public education" projects. Throughout this plan, we have cited these efforts in a variety of fields, from fisheries and water quality to erosion control and coastal policy, from marine education to aquaculture and seafood technology. This coordinated effort links university researchers, our extension and communications staffs to the people of North Carolina. Our staff members also work on regional and national efforts.

Over the years, Sea Grant extension specialists have reached countless residents through workshops, personal contact, publications and interviews in the mass media. By providing accurate, relevant information to businesses, interest groups, agencies and consumers, Sea Grant has helped the state and nation to realize gains in both economic and environmental terms. New aquaculture businesses were initiated. Better and more profitable seafood processing operations were set in place. Lives have been saved by our rip current education efforts. Damage from coastal hazards has been reduced by our coastal construction research. Coastal resources were conserved as people learned more about their environment. Community needs and issues were presented to researchers.

Our communications program pulls the public into ongoing extension efforts and translates results of scientific research. The program's hallmark publication is *Coastwatch* magazine, which continues to win national awards for its writing style that brings cutting-edge marine science and complicated coastal policy debates into understandable terms. *Coastwatch*, which draws praise from researchers, legislators and the general public, reaches thousands with each of six issues published annually.

Communicators and extension specialists work together to produce newsletters for targeted audiences. Each has a subscription list of more than 2,200. *Marine Extension News*, published quarterly, provides updates on a variety of Sea Grant extension projects. *Conch Shell*, published three times a year, provides classroom teachers

and other educators with a variety of resources on coastal and marine topics. *WaterWise*, published quarterly, has provided information on coastal water quality issues. The *WaterWise* publication is now on hiatus while Barbara Doll works on other projects.

Other communications projects include a variety of special products, from guidebooks or brochures to videos and media relations. Again, these products are the result of a team effort of communicators, extension specialists and partner agencies. A listing of the communications products in 2004 is in Appendix D.

North Carolina Sea Grant's online presence — www.ncseagrant.org — links a wide potential audience to the program's research and outreach efforts. The site is appealing, useful and meets national accessibility standards. Online databases provide additional information regarding research projects and expert contacts. The site includes online versions of our newsletters, such as *Conch Shell* and *Marine Extension News*, and links news releases issued by Sea Grant. The home page highlights topical areas and offers links to hot topics, such as rip currents, new products, calendar items, etc. Increased focus on the Web is expected in 2005.

Media Relations: Reaching the General Public

North Carolina Sea Grant continues to place a major emphasis on media relations. We issue news releases, media advisories and tip sheets to the North Carolina media — newspapers, radio and television and Web sites — and worked with members of the national media.

With an average of 30 news releases per year, we receive about 300 "hits" in newspapers across the state, on radio and TV, and in online news sites. In addition to the media coverage of the Break the Grip of the Rip™ launch, North Carolina Sea Grant saw varied media coverage in 2004.

- Following Hurricane Ivan and other hurricanes on the Florida coast in 2004, coastal erosion and construction specialist Spencer Rogers was interviewed in several publications, including *The New York Times* and *Mobile Register*. Rogers also was featured in the *News & Record* of Greensboro about coastal construction and numerous other publications.
- After the publication of *Drowning the North Carolina Coast: Sea-Level Rise and Estuarine Dynamics*, Sea Grant researcher Stan Riggs was featured on the front of the Sunday "Opinion" page of *The Charlotte Observer*. A summary of his book also was included in a *CAMAGram* newsletter produced by the N.C. Division of Coastal Management.
- *Mariner's Menu: 30 Years of Fresh Seafood Ideas*, a seafood resource book complete with nutrition and seafood safety information as well as 160 recipes, received coverage in the *News & Observer* and the *Virginian Pilot*. Coverage also is expected in *Southern Living* in 2005.
- Blue crab research by David Eggleston of NC State was highlighted on the NC State Web site.
- Seafood technology & marketing specialist Barry Nash was featured in several publications about value-added products, including NC State Extension and Engagement's *Achieve*.
- Throughout the year, several *Coastwatch* stories were featured on Web sites and in other publications. For example, "North Carolina Seafood Simmers Under Lights at Famed Fulton Fish Market" by Ann Green was reprinted in the N.C. Fisheries Association's *Tradewinds*, "Value-Added Products Boost Sales at Seafood Company" by Green was featured on the NC State Web site.
- Lee-Ann Jaykus of NC State received coverage about food safety and bioterrorism in several national publications, including the *Pittsburgh Post-Gazette*, *Commercial Appeal* in Memphis and *Cincinnati Post*.
- UNC-Wilmington's Center for Marine Science Web site featured Sea Grant Knauss fellow Shauna Slingsby.
- North Carolina Sea Grant's exhibit at the 2004 Smithsonian Folklife Festival in Washington, D.C. received play in the *Outer Banks Sentinel* and other publications.

North Carolina Sea Grant communicators have good rapport with reporters from around the state. Having worked as journalists and in government and university public affairs in North Carolina, they know many reporters and editors personally. They also visit newsrooms during trips to the coast in order to put a friendly face to the Sea Grant news releases generated in Raleigh.

Our communicators participate in national meetings, such as the National Association of Science Writers and the Society of Environmental Journalists, and respond to queries from Sea Grant's national media relations office.

Training of Scientists, Engineers and Resource Managers

North Carolina Sea Grant uses a variety of avenues to reach this goal, including:

- Developing a means of technology transfer via the availability of well-trained graduate students and extension personnel.
- Providing opportunities to train the best graduate students, thus producing future researchers, problem-solvers and teachers.

In each funding cycle, Sea Grant funds research by some of the best and brightest university faculty members in the state. In turn, those faculty members incorporate outstanding graduate students — and in some cases undergraduates — in this high quality, cutting-edge research. These students are then well prepared and trained to take the latest technology and theories into practice in the private and public sectors of the U.S. economy. North Carolina Sea Grant takes several avenues toward this goal.

Each year, we provide stipends for graduate students working on Sea Grant research projects. The list of students funded in 2003-2004 is included in Appendix C. Most of those students also receive tuition and health insurance.

Sea Grant also suggests promising graduate students as partners with members of the fishing communities who propose projects in the Fishery Resource Grant Program and the Blue Crab Research Program. The programs give the students contact with the “real world” fisheries issues, while also ensuring the scientific validity of the research projects.

University Focus: Training Future Leaders

In 2004, the North Carolina Sea Grant Science Communications Fellowship was established with funding from the N.C. Fishery Resource Grant Program and the Blue Crab Research. The first fellow, Kathleen Angione, developed Blueprints, *Coastwatch* stories, news releases, web items and various reports related to the two programs. A second fellow will start in June 2005.

The FRG and Blue Crab programs also provide an opportunity for graduate students, post-doctoral students and in some cases undergraduates to participate in research projects alongside members of the fishing communities.

North Carolina Sea Grant has been a leader in the national Knauss Marine Policy Fellowship, which began in 1979. In 2004, four fellows were from North Carolina. In all, more than 40 fellows have represented North Carolina Sea Grant since 1985. Alumni of the program have gone on to important roles in state and federal agencies and academia. Clark coordinates the Knauss efforts in the state, as well as the NOAA Coastal Services Center Coastal Management Fellowship.

In recent years, North Carolina Sea Grant initiated the N.C. Coastal Management Fellowship, which provides exceptional graduate students hands-on experience in resource management to enhance their career choices. The first fellow looked at estuarine impacts of sea-level rise. Lindsay Fullenkamp, the 2003-04 fellow, focused on smart growth and sustainable development topics for coastal communities, developing a resource guide. Rather than a single fellowship, the program will shift to cover partial stipends for student interns for the planned N.C. Center for Coastal Law, Planning and Policy, a joint effort with the University of North Carolina School of Law and the UNC Coastal Studies Institute.

In 2002, Sea Grant joined with the N.C. Division of Marine Fisheries to establish the N.C. Marine Fisheries Fellowship, which brings a young scientist into the policy arena. Details are presented in the fisheries section.

SEA GRANT NATIONAL STRATEGIC INITIATIVES

North Carolina Sea Grant encourages researchers across the state to develop proposals to be entered in various “national initiatives” announced by the National Sea Grant College Program. The strength of North Carolina's marine science research is evident in the quality of the proposals and the national funding that is offered to these projects. Recent national projects include:

Looking for Blue Crab Biomarkers

In “*Callinectin: A Novel Indicator of Estuarine Ecosystem Condition*,” Ed Noga of North Carolina State University is looking to identify a useful — and more sensitive — biomarker to assess health and disease in dynamic estuarine regions.

Noga is expanding upon tests of callinectin — a peptide antibiotic within blue crabs. Callinectin is mainly responsible for antibiotic activity in crab blood that can fight lethal bacteria, but such activity is depressed among crabs in stressed environments. In earlier research, Noga and his team had purified callinectin and developed a simple “ELISA immunoassay” to measure it. In this project, they will determine the affects of selected toxicants on callinectin levels. And they are testing the ELISA to identify immunosuppressed crabs compared to other recognized indicators, such as shell disease. They also will field test the biomarker as part of an environmental monitoring survey in conjunction with the EPA-EMAP Program in the Albemarle-Pamlico Estuary. The research team will produce enough ELISA kits to provide samples for interested fisher/environmental managers, as well training in the use of the kits and interpretation of the data.

Challenging Assumptions

David Eggleston of North Carolina State University, along with Steven Searcy of NC State and Jon Hare of the NOAA Beaufort Lab, considers “**Is Growth a Reliable Indicator of Essential Fish Habitat?**” A common assumption would be the answer is “yes.” But these researchers note that growth may be a factor of habitat or simply reflect the continuation of “good: larval characteristics. Thus they are providing one of the first tests of the “nursery role hypothesis.” Specifically, they are testing the assumption that fast growth is an appropriate indicator of high habitat quality and increased survivorship to the next stage by quantifying the effects of abiotic and biotic habitat characteristics on individual growth and survival of Atlantic croaker, while simultaneously accounting for individual characteristics of larvae and juveniles. The project will include research opportunities for undergraduate students at Carteret Community College as well as for graduate students at NC State.

Lessons from Oyster Sanctuaries

The dramatic decline in oyster reefs in the United States — coupled with the rising recognition of the biofiltration, habitat and other ecosystem benefits of oyster reefs — has led to increasing efforts to restore and conserve oyster reef habitat.

Sea Grant researchers Charles Peterson and Sean Powers of the University of North Carolina-Chapel Hill Institute for Marine Science, consider seven of 11 Eastern oyster sanctuaries in North Carolina to be successful — with multiple generations of *Crassostrea virginica* and high densities in these areas closed to harvest.

The sanctuaries also had prevalence rates of *Perkinsus marinus* that were no higher than in nearby harvested areas, and in some cases, rates significantly lower. Known as Dermo, the parasite kills many oysters in commercial shellfish areas before the bivalves reach harvest size of three inches.

Oysters that survive past three inches are of particular interest because they may have genetic resistance to the parasite. But sanctuary locations also may dictate exposure to poor water quality and other environmental factors, such as current velocity, dissolved oxygen levels and sedimentation patterns, all of which influence oyster restoration success, explains Peterson, vice chair of the state's Environmental Management Commission.

Funded by Sea Grant's national oyster disease program, Peterson's studies suggest that “local small-scale variation in environmental factors may result in significant among — and within — reef variation in the prevalence and severity of *P. marinus* infection,” Peterson writes.

Thus, studies will help define the combination of factors that predict disease resistance — and could determine the locations for cultch planting for harvest or restoration. A follow-up study is also funded by the National Sea Grant competition.

The current project draws upon a variety of studies funded by Sea Grant and the N.C. Fisheries Resource Grant Program. In Fall 2001, Peterson drew international attention as coauthor of an article in the journal *Science*, which included results of Sea Grant oyster research. Peterson will continue studies on Dermo infection in a new National Sea Grant oyster project funded this year.

Oyster restoration has entered a larger debate in the mid-Atlantic, where fishers, scientists and policymakers are debating the introduction of non-native oysters.

New Brevetoxin Surveys Promising

Every year from the late summer through mid-winter, “red tide” events close shellfish areas along the Gulf Coast — at what some estimate is an annual economic loss of \$49 million.

Before these areas can be reopened for shellfish harvesting, officials must know that the brevetoxins produced by the harmful algae are not at dangerous levels.

With National Sea Grant oyster disease funding, Daniel G. Baden and Jerome Naar of UNC-Wilmington are developing more accurate tests to determine the brevetoxin levels. The new antibody bioassays — known as

ELISA — are being tested in vitro rather than by testing the levels in mice. Current regulatory levels for approved shellfish are based on MUs, or “mouse units.”

Results indicate that shellfish metabolize brevetoxins and that these metabolites can remain in shellfish tissue for months after the red tide dissipates. However these metabolites do not appear to be a direct threat to human health. The studies did not reflect toxicity in mice.

The team is working with Gulf States' officials, as well as with research collaborators in Texas and Florida. The tests measure both the toxins from the algae and the toxins from the oysters themselves.

When the project is complete, the researchers expect to define a new permissible level based on the more accurate — and more rapid — assays. Their new tool also may provide better evaluation of Red Tide effects on finfish. Baden expects finfish testing with the next Red Tide outbreak.

Ballast Water

Increasingly, ballast water is fingered as a major pathway for the arrival of new invasive species that can be detrimental to fisheries, ecosystems, waterways and facilities.

William Cooper of UNC-Wilmington — along with nine colleagues from universities in Washington state, private industry including BP Exploration, the Smithsonian Environmental Research Center and the U.S. Fish and Wildlife Service — has found promising results in ozone treatments of ballast water aboard the 125,000-ton oil tanker *S/T Tonsina*.

Funded by a National Sea Grant Initiative, the research shows the ozone process is effective in killing greater than 99.9 percent of the culturable microorganisms found in ship's ballast water. Phytoplankton levels, excluding diatoms, were reduced by 90 percent. Zooplankton was reduced by 80 to 99 percent. Results with caged bioassay organisms were mixed, but chemical analysis showed the residual oxidants were primarily bromines.

At the present there is no approved or standard method for treating ballast water. The most common approach to treating ballast water is to undertake an open-ocean exchange — a method that is not particularly effective, and in rough seas is not possible.

The ozone treatment process appears to be effective, and not weather dependant. The research team suggests that continued research could result in a cost-effective process — one that saves ship owners money and time, and, protects the environment by minimizing the introduction of nuisance organisms.

The research team has shared results with congressional staff, scientific groups and a coalition of private companies during the discussion of the reauthorization of national invasive species legislation. The testing process drew media attention in 2002.

Based on the Sea Grant research, the team received a grant from USF&WS to do additional research at the port in Long Beach, Calif., as well as the original site in Puget Sound, Wash.

Appendix A: Program Development Funds Projects

North Carolina Sea Grant encourages novel research through “minigrants” provided from program development funds. Often this “seed money” allows researchers to gather initial data or to test a hypothesis before developing larger projects that may be funded by Sea Grant or other agencies. In addition, program development funds allow Sea Grant to sponsor meetings and otherwise “partner” with other state, federal and community-based agencies. The following list reflects the diverse topics covered through minigrants initiated in 2003 and 2004.

Project title	PI last name	First name	University	Dates	Grant #	Amount
Marsh Fragmentation and Extent (Area) Versus Barrier Island Topography: An Investigation using Aerial Photography, Digital Terrain Modeling and GIS	Hall	Joanne	University of North Carolina at Wilmington	01/01/2003-12/31/2003	RMG0301	\$5,000
An Analysis of Economic Impacts and Economic Benefits of Recreational Boating on the Atlantic Intracoastal Waterway in North Carolina	Herstine	James	University of North Carolina at Wilmington	01/01/2003-12/31/2003	RMG0303	\$4,995
Snead's Ferry: Portrait of a Fishing Town	Barr	Matthew	University of North Carolina at Greensboro	04/01/2003-08/31/2003	RMG0304	\$10,000
Oyster Culture and Restoration Project	Kemp	Skip	North Carolina State University; North Carolina Sea Grant	04/01/2003-09/30/2003	RMG0305	\$1,000
Proposal for 'Mini Grant' from Sea Grant	Clavijo	Ileana	University of North Carolina at Wilmington	05/01/2003-12/31/2003	RMG0306	\$2,500
Use of Hydrolyzed Whole Poultry Mortality as Ingredients in Feed for Marine Fish	Gernat	Abel	North Carolina State University	05/01/2003-12/31/2003	RMG0307	\$5,000
Settlement on a New Artificial Reef at AR-330	Thomas	Carrie	North Carolina State University	06/01/2003-12/31/2003	RMG0308	\$4,996
The Foraging Ecology and Reproductive Success of Royal Terns (<i>Sterna maxima</i>) in Relation to Fisheries Data in North Carolina and Virginia	Emslie	Steven	University of North Carolina at Wilmington	06/01/2003-12/31/2004	RMG0309	\$2,880

Phytoplankton Identification Series-Sheets #4-8	Tomas	Carmelo	University of North Carolina at Wilmington	07/01/2003-01/31/2004	RMG0310	\$10,000
Response of Benthic Microalgal Biomass to Renourishment of Ocean Beaches	Cahoon	Lawrence	University of North Carolina at Wilmington	08/01/2003-01/31/2004	RMG0311	\$6,486
Defining the Needs of the Marine/Watercraft Manufacturing Industries in Coastal North Carolina	Lucas	Charles	North Carolina State University	09/01/2003-01/31/2004	RMG0312	\$9,994
Sustainable Tourism as an Economic Development Strategy in the Waterways and Coastlines of the Southeastern North Carolina Region	Edgell	David	East Carolina University	10/01/2003-03/31/2004	RMG0313	\$7,500
Effects of Hurricane Isabel in Eastern Pamlico Sound	Crowder	Larry	Duke University	10/01/2003-09/30/2004	RMG0314	\$10,000
Snead's Ferry: Portrait of a Fishing Town	Barr	Matthew	University of North Carolina at Greensboro	11/01/2003-01/31/2004	RMG0315	\$5,000
Identification of genetic markers of high resistance to <i>Perkinsus marinus</i> and <i>Vibrio vulnificus</i> in the Eastern oysters <i>Crassostrea virginica</i>	Sokolova	Inna	University of North Carolina at Charlotte	03/01/2004-02/28/2005	RMG0401	\$5,000
Establishing long-term monitoring plots to study sea level rise and marsh invasion of estuarine forests on the Albemarle Peninsula, North Carolina	Christensen	N.	Duke University	01/01/2004-12/31/2004	RMG0402	\$5,000
Traditional use of Ocean Beaches in North Carolina	Brower	David	University of North Carolina at Chapel Hill	01/01/2004-12/31/2004	RMG0403	\$10,000
Determination of the natural host for <i>Bonamia</i> in North Carolina, and evaluation of the potential for infection of commercially important shellfish species	Peterson	Charles	University of North Carolina at Chapel Hill	01/01/2004-12/31/2004	RMG0404	\$7,310
Functional Validation of a Recombinant Vitellogenin Receptor-Binding Peptide	Sullivan	Craig	North Carolina State University	05/01/2004-06/30/2005	RMG0405	\$10,000

Global change and natural stabilization of barrier island sand dune ecosystems	Smith	William	Wake Forest University	05/15/2004-12/31/2004	RMG0406	\$4,926
The foraging ecology and reproductive success of Royal Terns (<i>Sterna Maxima</i>) in relation to fisheries data in North Carolina and Virginia	Emslie	Steven	University of North Carolina at Wilmington	05/15/2004-05/15/2005	RMG0407	\$2,362
National Rip Current Awareness Safety Campaign	Patterson	Kathleen	North Carolina State University-Sea Grant	05/01/2004-12/31/2004	RMG0408	\$5,000
Circle Hooks and Billfish Video Footage Mini Grant Proposal	Thigpen	Jack	North Carolina State University-Sea Grant	07/28/2004-02/01/2005	RMG0409	\$4,600
The effect of water quality on nocturnal food web in the Cape Fear River Basin	Ruppell	Matina	University of North Carolina at Greensboro	05/15/2004-01/31/2005	RMG0410	\$5,582
Mercury risk awareness and fish consumption among the fishing community on the Tar-Pamlico River	Griffith	David	East Carolina University	09/01/2004-01/31/2005	RMG0411	\$5,850
Development of a New Process to Manufacture More Healthy and Natural Textured Formed Seafood Products from Low-Valued Seafood Resources	Lanier	Tyre	North Carolina State University- Food Science	10/01/2004-07/01/2005	RMG0412	\$10,000
Sensory analysis of wild and saltwater of freshwater farm-raised flounder	Drake	MaryAnne	North Carolina State University- Food Science	10/01/2004-07/31/2005	RMG0413	\$7,013
Enhancing the quality of North Carolina's fisheries extension and applied research products	Thigpen	Jack	North Carolina State University-Sea Grant	10/01/2004-09/30/2005	RMG0414	\$8,457
Selective breeding of reciprocal hybrid striped bass (White Bass X Striped Bass): microsatellite marker evaluation	Sullivan	Craig	North Carolina State University- Zoology	10/01/2004-09/30/2005	RMG0415	\$10,000
Establishing a trained sensory panel for use in the evaluation of seafood and value-added product development	Green	David	North Carolina State University- Food Science	12/01/2004-12/31/2005	RMG0416	\$3,800

Seafood traceability: A comparative study of the European Union (EU) and United States (US) systems for addressing consumer concerns	Green	David	North Carolina State University-Food Science	12/01/2004-12/31/2005	RMG0417	\$7,500
Identification and Distribution of a Newly Abundant <i>Gracilaria</i> Species in Southeastern North Carolina	Wilson	David	University of North Carolina at Wilmington	01/01/2003-12/31/2003	RMG16810 4	\$2,923

Appendix B: Institutions and Agencies Collaborating With North Carolina Sea Grant

North Carolina Sea Grant is part of the 16-campus University of North Carolina system, with the Sea Grant director reporting to the system's vice president for research. The Sea Grant program also includes Duke University through a consortium agreement. Researchers at the following universities received funding from Sea Grant in 2003-04:

- North Carolina State University
- East Carolina University
- University of North Carolina at Chapel Hill
- University of North Carolina at Wilmington
- University of North Carolina at Greensboro
- University of North Carolina at Charlotte
- N.C. A&T State University
- Duke University

In addition, North Carolina Sea Grant partners with campuses of the North Carolina Community College System for specific projects. For example, Sea Grant's Morehead City Office is located at the NC State Center for Marine Sciences and Technology, which is on the campus of Carteret Community College (CCC). Sea Grant and CCC have a class in shellfish aquaculture that is also broadcast to Brunswick Community College.

Partners Working with North Carolina Sea Grant Staff and Researchers

North Carolina Sea Grant encourages researchers and staff to participate in regional and national projects. The following are some of the agencies, institutions, universities, organizations and private businesses that worked with Sea Grant on research or outreach projects in recent years.

- NOAA
 - Estuarine Research Reserves
 - National Marine Fisheries Service
 - Office of Ocean Exploration
 - National Undersea Research Program
 - National Weather Service
 - Coastal Services Center, National Ocean Service
 - NOAA/NMFS lab in Beaufort; NC
- US Fish and Wildlife Service
- US Environmental Protection Agency
- National Park Service
- US Army Corps of Engineers
- NC Dept. of Environment & Natural Resources
 - Division of Shellfish Sanitation
 - Division of Marine Fisheries
 - Division of Water Quality
 - Division of Coastal Management
 - Office of Environmental Education
 - NC Aquariums
 - NC Museum of Natural Sciences
- NC Division of Parks and Recreation
- NC Coastal Reserves
- NC Wildlife Resources Commission
- National Albemarle-Pamlico Estuary Program
- NC Department of Transportation
- NC Department of Agriculture
 - Aquaculture Division
 - Seafood Marketing Division
- University of North Carolina Press
- UNC Institute of Government
- North Carolina State University
 - Water Quality Group
 - Water Resources Research Institute
 - Zoology Department
 - Crop Science Department
 - College of Design
 - Department of Marine, Earth and Atmospheric Sciences
 - Division of Multidisciplinary Studies
 - Master of Arts in Liberal Studies Program

- First year College, Living/Learning Community Initiative
- Center for Marine Sciences and Technology
- Sociology & Anthropology Dept.
- Parks, Recreation & Tourism Dept.
- UNC-TV
- *The News & Observer*
- Dare County
- Progress Energy
- NC Partnership for the Sounds
- Mid-East Resource Conservation
- NC Coastal Federation
- NC Fisheries Association
- NC Marine Trades Association
- NC Real Estate Commission
- UNC Institute of Management
- NC Division of Emergency Management
- NC Department of Cultural Resources, Underwater Archaeology Branch
- NC Cooperative Extension Service
- Shellfish Gardeners of North Carolina
- The Nature Conservancy
- NC Stream Restoration Institute
- Carteret Community College
- Carteret County Economic Development Council
- Carteret County Nonprofit CORPS
- Carteret County Wildlife Club
- Coastal Carolina Community College
- Brunswick Community College
- NC Aquaculture Development Conference
- City Of Jacksonville
- Sturgeon City
- Pine Valley Golf Course Association
- City of Wilmington
- New Hanover County
- Center for Science, Mathematics, and Technology Education at East Carolina University, part of the NC Mathematics and Science Education Network.
- NC Shore and Beach Preservation
- US Lifesaving Association
- American Zoo and Aquarium Association
- Striped Bass Growers Association
- Coastal Conservation
- Neuse River Foundation
- Tar-Pamlico River Foundation
- Pamlico Packing Seafood
- Brunswick County
- 30 NC Beach Communities
- BLUE: Land, Water and Infrastructure
- Carolina Bird Club
- North Carolina Audubon
- Cape Hatteras Bird Club
- Outer Banks Paddlers Club
- Friends of the Coastal National Wildlife Refuges
- Roanoke Island Historical Association
- University of South Carolina
- Clemson University
- Duke University
- Texas A & M
- Mote Marine Lab
- University of Washington
- Western Washington University
- Smithsonian Environmental Research Center
- Ohio State University
- University of Maryland
- Texas Parks and Wildlife Division
- Kent SeaTech, California
- BP Exploration (Alaska)
- NuTech O-3
- Northeast Technical Services Company
- University of South Florida
- University of Arizona
- Virginia Institute of Marine Science
- University of Maryland Center of Marine Biotechnology
- Israel Oceanographic and Limnological Research Institute
- Louisiana Sea Grant
- University of Delaware/DE Sea Grant
- Star Kist Inc.
- Oregon State Univ.
- University of Massachusetts
- Florida Marine Research Institute
- Delaware Department of Natural Resources & Environmental Control
- Texas Dept of Health.
- Space and Naval Warfare Systems Center, Environmental Sciences Division
- University of Wisconsin-Madison Water Science and Engineering Laboratory.
- U.S. Civilian Research and Development Foundation
- Marine Hydrophysical Institute, Sevastopol, Ukraine
- South Carolina Dept. of Environment
- SEACOOS Partners
- U.S. Lifesaving Association

Appendix C: Outside Funding

North Carolina Sea Grant is a federal state partnership. Our core federal funding is from the National Oceanic and Atmospheric Administration. Our state funding is from the North Carolina General Assembly through an appropriation to the University of North Carolina system. North Carolina Sea Grant's headquarters is on the campus of North Carolina State University in Raleigh.

Researchers and staff members also participate in national grant competitions sponsored by the National Sea Grant Office and other funding agencies. For example, the extension program received funding from the Fisheries Extension Enhancement Program. And various researchers have been successful in Sea Grant National Strategic Initiatives.

In addition to the core funding, North Carolina Sea Grant partners with a variety of agencies for special projects. In 2004, these agencies included, but were not limited to:

Non-Federal Sources

- The North Carolina General Assembly (Fishery Resource Grant Program and the Blue Crab Research Program)
- The N.C. Clean Water Management Trust Fund (Rocky Branch restoration project)
- The N.C. Department of Environment and Natural Resources (various projects)
- The N.C. Department of Transportation (Rocky Branch restoration project)
- N.C. Division of Marine Fisheries (Marine Fisheries Fellowship)

Federal Sources other than Sea Grant

- The U.S. Environmental Protection Agency (Rocky Branch restoration project and Smart Growth initiative)
- Office of Naval Research, through University of North Carolina System (SEACOOS)
- National Oceanic and Atmospheric Administration (various projects)

Appendix D: Sharing Results

Communications Products

Each year, North Carolina Sea Grant develops a number of communications products to help the public better understand coastal and marine resources. In 2003-04 those products included:

- *The Amazing Oyster: A Keystone Species for the Health of our Coast* (DVD)
- Highly Migratory Species, *Coastwatch* Reprint
- *North Carolina Seafood Availability Chart* (poster)
- *Marine Phytoplankton Identification Series*:
 - Gyrodinium instriatum Freudenthal & Lee
 - Heterosigma akashiwo (Hada) Hada Ex. Sournia
 - Prorocentrum minimum (Pavillard) Schiller
- *Onboard Handling to Reduce Histamine* (poster)
- *Making It Happen: A North Carolina Coastal Community Development Resource Guide* (book)
- *Culturing Oysters in North Carolina* (Manual on CD)
- *NOAA in NC: Innovation + Collaboration = Success* (CD)
- *White Belly Crabs* (Blueprint)
- *Catch and Release Mortality in Grouper* (Blueprint)
- *Mariner's Menu: 30 Years of Fresh Seafood Ideas*: (Book)
- *Drowning the North Carolina Coast: Sea Level Rise and Estuarine Shoreline Erosion*: (Book)
- Updated Abstracts for the Fishery Resource Grant Program
- *North Carolina Sea Grant Annual Report 2003*
- Updated *Fishing for Good Ideas: Writing a Fishery Resource Grant*:
- *Coastwatch* Magazine (6 issues)
- *Marine Extension News*
- *Conch Shell*
- *WaterWise*

North Carolina Sea Grant also recognizes the fine work done in other Sea Grant programs around the country. Thus, we will often choose to buy into a print run on specific items that have regional or national appeal.
Break the Grip of the Rip (signs and brochures)

Scientific Publications:

PROJECT TITLE: Workshop for Dust Storms and Their Impacts on Human Health

PROJECT SEA GRANT NUMBER: RMG0214y

PROJECT LEAD PI: Lian Xie, North Carolina State University

ARTICLES: None.

STORIES:

1. News Report: "China plans clean sweep on dust storms", *Nature*, 421, 101 (09 Jan 2003);
2. Report: "Dust busters gather", *Environmental Health Perspectives*, Volume 111, Number 2 February 2003.

PROJECT TITLE: Aquaculture of Southern Flounder: Improved Production Through Environmental and Nutritional Optimization

PROJECT SEA GRANT NUMBER: R/AF-39

PROJECT LEAD PI: H. Daniels NCSU

ARTICLES:

Daniels, H. V. and M. L. Gallagher. 2000. Effect of dietary protein level on growth and blood parameters in summer flounder, *Paralichthys dentatus*. . *Journal of Applied Aquaculture* 10 (1): 45-51.

Gallagher, M. L. Daniels, H. V. and J. E. Harcke. 2001. Influence of enrichment time with algae paste preservations on the fatty acid content of rotifers. World Aquaculture Magazine. (invited paper)

Gallagher, M. L. Daniels, H. V. and J. E. Harcke. 2001. Influence of culture time with algae paste on the fatty acid content of rotifers. Global Aquaculture Alliance (invited paper)

Watanabe, W.O., P.M. Carroll, and H.V. Daniels. 2001. Recent progress in controlled reproduction of southern flounder *Paralichthys lethostigma*. Proceedings of the twenty-eight US-Japan Natural Resources Aquaculture Panel. UJNR Technical Report 28: 1451-148.

Watanabe, W.O., P.M. Carroll, and H.V. Daniels. 2001. Sustained, natural spawning of southern flounder *Paralichthys lethostigma* under an extended photothermal regime. Journal of the World Aquaculture Society 32: 153-166.

ABSTRACTS:

Gallagher, M. L. Daniels, H. V. and J. E. Harcke. 2001. Influence of enrichment on fatty acid composition of rotifer, *Artemia*, and southern flounder larvae *Paralichthys lethostigma*. World Aquaculture Society Meeting. January 20-23, 2001, Orlando, FL USA page 123.

Gallagher, M. L. Daniels, H. V. and J. E. Harcke. 2001. Influence of duration of enrichment with algae paste on the fatty acid content of rotifers. World Aquaculture Society Meeting. January 20-23, 2001, Orlando, FL USA page 124.

STORIES: GENERAL MEDIA

December 1, 2001, Scientists Successfully Spawn Flounder Virginia-Pilot daily newspaper serving the Norfolk, Newport News, Hampton and Northeast North Carolina areas. Additional worldwide dissemination to WorldCatch, an online seafood information service.

PRESENTATIONS:

Daniels, H.V., M.L. Gallagher and W.O. Watanabe. 2001. Aquaculture of Southern Flounder. Annual Meeting of the World Aquaculture Society. January 20-23, 2001, Orlando, FL USA (invited)

Daniels, H.V. 2001. Southern Flounder Culture. Annual Meeting of the American Fisheries Society. August 14-16, 2001, Phoenix, AZ USA (invited).

Daniels, H.V. 2001. Advances in the Culture of Southern Flounder. Presentation to the North Carolina Division of Marine Fisheries Southern Flounder Advisory Committee. April 14, 2001, Washington, NC USA (invited).

Gallagher, M. L. Daniels, H. V. and J. E. Harcke. 2001. Influence of enrichment on fatty acid composition of rotifer, *Artemia*, and southern flounder larvae *Paralichthys lethostigma*. World Aquaculture Society Meeting. January 20-23, 2001, Orlando, FL USA.

Gallagher, M. L. Daniels, H. V. and J. E. Harcke. 2001. Influence of duration of enrichment with algae paste on the fatty acid content of rotifers. World Aquaculture Society Meeting. January 20-23, 2001, Orlando, FL USA.

Watanabe, W.O., P.M. Carroll. Natural spawning of Southern flounder (*Paralichthys lethostigma*) broodstock under an extended photothermal regime. Aqua 2001, Nice, France.

PROJECT TITLE: The Foraging Ecology and Reproductive Success of Royal Terns

PROJECT SEA GRANT NUMBER: RMG0407

PROJECT LEAD PI: Steven D. Emslie, Univ. of North Carolina at Wilmington

ARTICLES: a Master's Thesis at UNCW will be completed in Dec. 2004; a paper for publication will be completed in spring 2005.

PRESENTATIONS:

The data were shared at the Royal Tern Working Group meeting at Fisherman Island, Fall 2004.

PROJECT TITLE: Phytoplankton and Zooplankton Community Responses to External Nitrogen Loading in the Pamlico Sound, NC: Mechanisms and Links to Management of Coastal Eutrophication

PROJECT SEA GRANT NUMBER: R/MER-43

PROJECT LEAD PI: Hans W. Paerl, UNC-CH Institute of Marine Sciences

ARTICLES:

Paerl, H. W., et al. 2000. Hurricanes' hydrological, ecological effects linger in major US estuary. EOS 81(40): 457-462.

Paerl, H.W., et al. 2001. Ecosystem impacts of 3 sequential hurricanes (Dennis, Floyd and Irene) on the US's largest lagoonal estuary, Pamlico Sound, NC. Proc. Natl. Acad.Sci. USA. 98(10): 5655-5660.

Paerl, H. W. (2001). Primary Productivity and Producers. pp. 329-341, In C. J. Hurst (ed.) Manual of Environmental Microbiology (2nd Ed.). ASM Press, Washington, DC.

Richardson, T.L., J.L. Pinckney and Hans W. Paerl. 2001. Responses of estuarine phytoplankton communities to nitrogen form and mixing using microcosm bioassays. Estuaries 24(6A): 828-839.

Paerl, H.W. et al. 2001. Water quality and fisheries habitat changes in the Pamlico Sound after three hurricanes: A short-term and long-term perspective. Pp. 255-263, In, J.R. Maiolo, J.C. Whitehead, M. McGee, L. King, J. Johnson and H. Stone (Eds.), Facing Our Future: Hurricane Floyd and Recovery in the Coastal Plain. Coastal Carolina Press, Wilmington NC.

Pinckney, J. L., T. L. Richardson, D. F. Millie, H. W. Paerl. 2001. Application of photopigment biomarkers for quantifying microalgal community composition and in situ growth rates. Organic Geochemistry 32:585-595.

Pinckney, J. L., H. W. Paerl, P. Tester and T. L. Richardson. 2001. The role of nutrient loading and eutrophication in estuarine ecology. Environ. Health Perspect. 109 (Suppl. 5): 699-706.

Paerl, H.W. and J. Kuparinen. 2002. Microbial aggregates and consortia. In: G. Bitton (Ed). Encyclopedia of Environmental Microbiology, Vol. 1, p. 160-181. John Wiley and Sons, Inc. New York, NY.

STORIES:

TV: ABC evening news with Peter Jennings, BBC & ITN (UK), local TV stations (WCTI, New Bern, NC; WRAL, Raleigh-Durham; WITN, Washington, NC).

Newspapers & Magazines: Charlotte Observer, Raleigh News and Observer, Washington Post, Baltimore Sun, National Geographic, Picayune Times, New Orleans, New Bern Sun, Wilmington Morning Star, Carteret News-Times.

Endeavors (UNC-CH Research Magazine). Article, 2000

PRESENTATIONS:

H. W. Paerl, D. R., Whittall and R. L. Dennis. Integrating Atmospheric N Deposition in Estuarine and Coastal N Cycling and Eutrophication Dynamics. Invited Lecture, N2001 Symposium, Potomac. MD. October 2001.

H. W. Paerl. Neuse River Estuary Water Quality. Invited Lecture, special symposium on the Neuse River Basin, Annual Meeting of the American Society for Agronomy & Soil Science, Charlotte, NC, October 2001.

H. W. Paerl. The Problem with Atmospheric Nitrogen Deposition. Keynote Lecture, Workshop on the Importance of Atmospheric Nitrogen Deposition in Coastal Environments, Univ. of MD Appalachian Laboratory, Frostburg, MD, December 2001.

H. W. Paerl. Harmful Cyanobacterial Blooms Invited lecture, Univ. of MD CEES Horn Point Environmental Laboratory, Cambridge, MD, February 2002.

H. W. Paerl. Coastal Eutrophication Dynamics: New Issues and Paradigms Invited lecture, Univ. of MD CEES Horn Point Environmental Laboratory, Cambridge, MD, February 2002.

H. W. Paerl. The state of estuarine eutrophication research. Keynote Lecture, Symposium on Pearl River Water Quality and Management, Hong Kong Univ. of Science and Technology, Hong Kong, April, 2002.

PROJECT TITLE: Eutrophication and trophic transfer in the Neuse River Estuary: Dynamics of nutrients and phytoplankton at the chlorophyll a maximum

PROJECT SEA GRANT NUMBER: R/MER 47

PROJECT LEAD PI: Hans W. Paerl, UNC-CH Institute of Marine Sciences

PROJECT CO-PI: Michael F. Piehler

ARTICLES:

Paerl, H. W., J. Dyble, J.L. Pinckney, L.M. Valdes, D.F. Millie, P.H. Moisander, J.T. Morris, B. Bendis, B., and M.F. Piehler. 2004. Using microalgal indicators to assess human and climatically induced ecological change in estuaries. In S. Bartone (Ed.) Proceedings of the Estuarine Indicators Workshop. Boca Raton, Florida: CRC Press. (in press).

Paerl, H.W., L.M. Valdes, M.F. Piehler and M.E. Lebo. 2004. Solving problems resulting from solutions: The evolution of a dual nutrient management strategy for the eutrophying Neuse River Estuary, North Carolina, USA. Environmental Science & Technology 38: 3068-3073.

Twomey, L.J., M.F. Piehler and H.W. Paerl. 2004. Phytoplankton uptake of ammonium, nitrate and urea in the Neuse River Estuary, NC, USA. Hydrobiologia. (In press).

Paerl, H.W. 2004. Estuarine eutrophication, hypoxia and anoxia dynamics: Causes, consequences and controls. Pp. 35-56, In, Rupp, G.L. and M. D. White. Proceedings of the 7th International Symposium on Fish Physiology, Toxicology and Water Quality. May 12-15, 2003, Tallinn, Estonia. U.S. Environmental Protection Agency Office of Research and Development, Ecosystems Research Division, Athens, Georgia, USA. EPA/600/R-04/049. (In press).

Piehler, M.F., L.J. Twomey, N.S. Hall and H.W. Paerl. 2004. Impacts of inorganic nutrient enrichment on the phytoplankton community structure and function in Pamlico Sound, NC USA. Estuarine, Coastal and Shelf Science. (In press).

STORIES:

NOAA National Sea Grant College Program, Biennial Report 2002-2003.

Baltimore Sun, Raleigh News and Observer, Miami Herald (all articles pertaining to using microbial indicators to distinguish human from climatic impacts on estuarine and coastal water quality)

PRESENTATIONS:

Paerl, H.W. 2004. Developing indicators to assess human and climatic impacts on estuarine and coastal water quality and ecological condition. Invited lecture, Smithsonian Environmental Research Center, Edgewater, MD, February 2004.

Paerl, H.W. 2004. Anthropogenic and climatic influences on the eutrophication of large estuarine ecosystems. Invited lecture, Dept. of Marine Science, Univ. of Georgia, Athens, GA, March 2003.

Paerl, H.W. 2004. Developing and Applying Indicators of Human- and Climatically-induced Changes in Estuarine and Coastal Water Quality. Invited Lecture, Coastal Water Quality Symposium, Rutgers Univ., New Brunswick, NJ. April 2004

Paerl, H.W. 2004. Human and climatically induced ecological change in estuarine and coastal waters: What's manageable and what's not? Ludwig Lecture, Dept. of Oceanography, Old Dominion Univ., Norfolk, VA, April, 2004.

Paerl, H.W. 2004. Hypoxia dynamics in the Neuse River Estuary. Invited Presentation, MD Sea Grant supported Workshop on Dissolved oxygen dynamics in estuaries. College Park, MD. July 2004.

PROJECT TITLE: Identification and Distribution of a Newly Abundant *Gracilaria* species that is Hampering Commercial Fishing Operations in Southeastern North Carolina

PROJECT SEA GRANT NUMBER: RMG168104 (03-EP-05)

PROJECT LEAD PI: Dr. D. Wilson Freshwater Center for Marine Science, UNCW

PROJECT CO-PI:

Mr. Frank Montgomery, Commercial Fisherman

ARTICLES:

We are preparing three manuscripts for publication based on this research. As a result of this study, we have also discovered that one of the native North Carolina *Gracilaria* species is new to science, and we are describing it in a third manuscript.

PRESENTATIONS:

Greene, J.K., Hamner, R.M., Montgomery, F., Whitfield, P.E. & Freshwater, D.W. (2003) Distribution and seasonality of an invasive Gracilaria species that is hampering commercial fishing in southeastern North Carolina. Southeastern Phycological Colloquy, Duke University Marine Laboratory, October 2003, Poster presentation.

PROJECT TITLE: Ecosystem Effects of Antibiotics: Proof of Concept
PROJECT SEA GRANT NUMBER: RMG0212
PROJECT LEAD PI: Hans W. Paerl, UNC-CH Institute of Marine Sciences
PROJECT CO-PI: Timothy Steppe, UNC-CH IMS; Rachel Noble, UNC-CH IMS

ARTICLES:

Paerl, H.W., J. Dyble, P.H. Moisaner, R.T. Noble, M.F. Piehler, J.T. Pinckney, L. Twomey and L.M. Valdes. 2003. Microbial Indicators of Aquatic Ecosystem Change: Current Applications to Eutrophication Studies. FEMS Microbial Ecology 46 (3): 233-246.

PROJECT TITLE: An Analysis of Economic Impacts and Economic Benefits of Recreational Boating on the Atlantic Intracoastal Waterway in North Carolina
PROJECT SEA GRANT NUMBER: RMG0303
PROJECT LEAD PI: James H. Herstine, Ph.D., UNC-Wilmington
PROJECT CO-PI: John Whitehead (UNCW and Appalachian State University) and William Hall (UNCW)

ARTICLES:

An article entitled "Economic Implications for Recreational Boating of Maintenance Dredging on the Atlantic Intracoastal Waterway in North Carolina" is currently in the draft stage

PRESENTATIONS:

The results were presented at the Southeastern Recreation Research Conference in Charleston, South Carolina in February 2004

PROJECT TITLE: Utilizing Signage to Protect Barrier Island Dunes and Sand Ridges: A Case Study on Bear Island at Hammocks Beach State Park
PROJECT SEA GRANT NUMBER: RMG0210
PROJECT LEAD PI: James H. Herstine, Ph.D., UNC—Wilmington
PROJECT CO-PI: Rebecca Barry, East Carolina University and Arizona State University

ARTICLES:

A journal article is currently in draft form and expected to be submitted for publication in 2005.

PRESENTATIONS:

The results were presented at Coastal Zone '03 in Baltimore, MD in July 2003

PROJECT TITLE: EPA Smart Growth Extension Partnership
PROJECT SEA GRANT NUMBER: EPA-01
PROJECT LEAD PI: Jack Thigpen, North Carolina Sea Grant
PROJECT CO-PI: Walter Clark, North Carolina Sea Grant

ARTICLES: Draft guide in press.

STORIES: Marine Extension News, summer 2003

PRESENTATIONS: Presentation planned for Coastal Zone 05

PROJECT TITLE: The Viable but Nonculturable State in Human Bacterial Pathogens in Eastern North Carolina
PROJECT SEA GRANT NUMBER: R/SST-28
PROJECT LEAD PI: James D. Oliver, University of North Carolina at Charlotte

ARTICLES:

The ecology of *Vibrio vulnificus* in estuarine waters of eastern North Carolina. 2003. Pfeffer, C.S. and J.D. Oliver. Appl. Environ. Microbiol. 69:3526-3531.

A comparison of thiosulphate-citrate-bile salts-sucrose (TCBS) agar and thiosulphate-chloride-iodide (TCI) agar for the isolation of *Vibrio* species from estuarine environments. 2003. Pfeffer, C. and J.D. Oliver. Lett. Appl. Microbiol. 36:150-151.

The role of reactive oxygen species in the viable but nonculturable state in *Vibrio vulnificus*. 2004. Kong, I.-S., A. Huelsmann, T.C. Bates, H. Hassan, and J.D. Oliver. FEMS Microbiol. Ecol. (in press, September 2004)

RAPD-PCR analysis indicates there are two subgroups of *Vibrio vulnificus* that correlate with clinical or environmental isolation. Rosche, T.M., Y. Yano, and J.D. Oliver. Submitted to Appl. Environ. Microbiol.

PRESENTATIONS:

Isolation and incidence of *Vibrio vulnificus* from the Neuse and Pamlico estuaries of North Carolina. 2001. Pfeffer, C.S., M.F. Hite and J.D. Oliver. Q459, p. 677. Ann. Meet. Amer. Soc. Microbiol.

The VBNC state of pathogenic *Vibrio* species. 2004. Dyer, K.D. and J.D. Oliver. Ann. Meet. Amer. Soc. Microbiol.

RAPD-PCR analysis suggests two *Vibrio vulnificus* genotypes correlating with isolation source. 2004. Rosche, T.M., Y. Yano, and J.D. Oliver. 10th Intern. Symp. Microb. Ecol.

In situ and in vitro gene expression in *Vibrio vulnificus*. 2004. Smith, B. and J.D. Oliver. 10th Intern. Symp. Microb. Ecol.

PROJECT TITLE: Identification of genetic markers of high resistance to *Perkinsus*

PROJECT SEA GRANT NUMBER: RMG0401

PROJECT LEAD PI: Inna Sokolova, University of North Carolina at Charlotte

PROJECT CO-PI: James Oliver, Larry Leamy, University of North Carolina at Charlotte

ARTICLES: None

PRESENTATIONS:

The results obtained so far in our project will be presented by a student, M. Harrison, at 4th Annual Louis Stokes Alliance for Minority Participation Conference, which is a national forum for students in biology and biomedicine, in October 2004 in Houston, TX.

PROJECT TITLE: Sediment-water exchange in the lower Cape Fear estuary: Effects of metal speciation on water quality and benthic biota

PROJECT SEA GRANT NUMBER: R/MER-40

PROJECT LEAD PI: Stephen A. Skrabal, UNCW

PROJECT CO-PI: Robert J. Kieber, UNCW

ARTICLES:

Shank, G.C., Skrabal, S.A., Whitehead, R.F., and Kieber, R.J., 2004. Fluxes of strong Cu-complexing ligands from sediments of an organic-rich estuary. Estuarine, Coastal and Shelf Science 60. 349-358.

Shank, G.C., Skrabal, S.A., Whitehead, R.F., and Kieber, R.J., 2004. Strong copper complexation in an organic-rich estuary: The importance of allochthonous dissolved organic matter. Marine Chemistry 88, 21-39.

STORIES:

S.A. Skrabal interviewed in 2001 on Sea Grant-funded work research by Pam Smith for *Coastwatch* magazine

PRESENTATIONS:

Skrabal, S.A., 1999. Trace metal studies in the Cape Fear estuary. 14th Annual Duke/UNC Oceanographic Consortium Annual Meeting, Beaufort, NC.

Shank, G.C. and Skrabal, S.A., 2000. Dissolved copper speciation in the Cape Fear Estuary, North Carolina. American Geophysical Union Ocean Sciences Meeting, San Antonio, TX.

Skrabal, S.A., 2001. Fluxes and cycling of dissolved copper and zinc in estuaries. Partners in Environmental Technology Technical Symposium and Workshop, Washington, DC (Invited).

Skrabal, S.A., Kieber, R.J., Cooper, W.J., Whitehead, R.F., Shank, G.C., Smith, C., Lieseke, K., MacGillivray,

K., and Movasseghi, J., 2001. Dissolved copper and zinc in the Cape Fear estuary: Speciation, fluxes and photochemical reactions. Center for Marine Science, University of North Carolina at Wilmington.

Whitehead, R.F., Shank, G.C., Skrabal, S.A., Kieber, R.J., and Cooper, W.J., 2001. Photochemical interactions with copper-complexing DOM in the Cape Fear Estuary, NC. American Society of Limnology and Oceanography Aquatic Sciences 2001 meeting, Albuquerque, NM.

Shank, G.C., Skrabal, S.A., Whitehead, R.F., and Kieber, R.J., 2002. Mechanisms controlling strong copper-complexing ligands in the Cape Fear estuary, North Carolina. American Geophysical Union Ocean Sciences Meeting, Honolulu, HI.

Shank, G.C., Skrabal, S.A., Whitehead, R.F., and Kieber, R.J., 2002. Mechanisms controlling dissolved copper speciation in the Cape Fear estuary, North Carolina, USA. Seventh International Estuarine Biogeochemistry Symposium, Grimstad, Norway.

Skrabal, S.A., Whitehead, R.F., Kieber, R.J., Cooper, W.J., Shank, G.C., Lieseke, K., MacGillivray, K., and Smith, M., 2002. Speciation, fluxes and cycling of dissolved copper and zinc in estuaries: The roles of sediment-water exchange and photochemical effects. Partners in Environmental Technology Technical Symposium and Workshop, Washington, DC.

Skrabal, S.A., Shank, G.C., Whitehead, R.F., Kieber, R.J., MacGillivray, K.A., and Lieseke, K.L., 2003. Copper and zinc complexing ligands in estuarine waters: The role of sediment-water exchange. 225th American Chemical Society National Meeting, New Orleans, LA.

Skrabal, S.A., Kieber, R.J., Whitehead, R.F., Shank, G.C., Smith, M.L., and Lieseke, K.L., 2003. Speciation, fluxes and cycling of dissolved copper and zinc in estuaries: The roles of sediment-water exchange and photochemical effects. Partners in Environmental Technology Technical Symposium and Workshop, Washington, DC.

Skrabal, S.A., Smith, M.L., Kieber, R.J., Shank, G.C., and Whitehead, R.F., 2004. Dissolved copper in organic-rich estuarine waters: Interactions of light and suspended sediments in altering speciation. American Society of Limnology and Oceanography/Oceanography Society Ocean Research Conference, Honolulu, HI.

PROJECT TITLE: Local Knowledge and Scientific Resource Management in Changing Coastal Communities

PROJECT SEA GRANT NUMBER: R/BS-12

PROJECT LEAD PI: David Griffith, East Carolina University

PROJECT CO-PI: Jeffrey C. Johnson, East Carolina University

ARTICLES:

Local Knowledge, Multiple Livelihoods, and the Use of Natural and Social Resources in North Carolina. David Griffith (Chapter in a forthcoming book edited by Charles Menzies for University of Nebraska press).

PRESENTATIONS:

Dirty Ice and Dead Water: perceptions of environmental change among Inupiaq hunters and Carolina Watermen. Canadian Anthropological Assn meetings, Halifax, Nova Scotia, May 2003.

Poster at the Human Dimensions of the Arctic Conference, Seattle, September 2003.

PROJECT TITLE: Mercury speciation in the organic-rich Cape Fear estuary

PROJECT SEA GRANT NUMBER: R/MER-49

PROJECT LEAD PI: Stephen A. Skrabal, UNCW

PROJECT CO-PI: Robert J. Kieber, UNCW and Joan D. Willey, UNCW

ARTICLES: None

PRESENTATIONS:

Zvalaren, S.D., Willey, J.D., Skrabal, S.A., and Kieber, R.J., 2003. Mercury speciation in the organic-rich Cape Fear River, North Carolina, USA. SOLAS (Surface Ocean-Lower Atmosphere Study) Summer School, Corsica.

Zvalaren, S.D., Willey, J.D., Skrabal, S.A., and Kieber, R.J., 2004. Mercury speciation in the organic-rich Cape Fear River. UNCW Symposium on Chemistry and Biochemistry, Wilmington, NC.

Zvalaren, S.D., Willey, J.D., Skrabal, S.A., and Kieber, R.J., 2004. Mercury speciation in the organic-rich Cape Fear River. Sigma Xi meeting, UNCW, Wilmington, NC.

Zvalaren, S.D., Willey, J.D., Skrabal, S.A., and Kieber, R.J., 2004. Mercury speciation in the organic-rich Cape Fear River, North Carolina, USA. American Society of Limnology and Oceanography meeting, Savannah, GA.

PROJECT TITLE: Aquaculture of southern flounder: improved fingerling production

PROJECT SEA GRANT NUMBER: R/AF-42

PROJECT LEAD PI: Harry Daniels, North Carolina State University

PROJECT CO-PI: Russell Borski, NCSU; Margie Gallagher, ECU; Wade Watanabe, UNCW

ARTICLES:

Daniels, H.V. and Gallagher, M.L. (2002) North American Flounder. In: Webster, C. and Lim, C. (eds.) Nutrient Requirements and Feeding of Finfish For Aquaculture. CAB International, Wallingford, UK, pp. 34-45.

Luckenbach, J.A., Godwin, J., Daniels, H.V. and R.J. Borski. 2002. Gonadal differentiation and effects of temperature on sex determination in southern flounder (*Paralichthys lethostigma*). Aquaculture.

Daniels, H.V. and W.O. Watanabe. 2003. A Practical Hatchery Manual: Production of Southern Flounder Fingerlings. NC Sea Grant 40 pp. UNC-SG-08, Raleigh, NC.

STORIES:

Science Nets Better Fish: Changing temperature changes gender of flounder. October 12, 2002. News and Observer, Raleigh, North Carolina

Luckenbach, J.A., Godwin, J., Daniels, H.V. and R.J. Borski. 2002. Optimization of North American flounder culture: A controlled breeding scheme. World Aquaculture 33(1): 40-45 and 69.

PRESENTATIONS:

Borski, R.J., Luckenbach, J.A., Beasley, J.M., Daniels, H.V. and Godwin, J. Strategy for enhancing production of southern flounder through all-female culture. Paper presented at World Aquaculture 2003, Bahia Convention Center, Salvador, Brazil. May 19-23, 2003.

Luckenbach, J.A., Godwin, J., Daniels, H.V. and R.J. Borski. Effect of temperature on sex determination and growth in southern flounder *Paralichthys lethostigma*. Paper presented at World Aquaculture 2003, Bahia Convention Center, Salvador, Brazil. May 19-23, 2003.

PROJECT TITLE: Increasing Ammonium Concentrations in the Cape Fear River Estuary: Where Is It Coming From?

PROJECT SEA GRANT NUMBER: RMER-44

PROJECT LEAD PI: Robert Kieber, University of North Carolina at Wilmington, Department of Chemistry and Biochemistry

PROJECT CO-PI: Joan Willey, University of North Carolina at Wilmington, Department of Chemistry and Biochemistry,

Stephen Skrabal, University of North Carolina at Wilmington, Department of Chemistry and Biochemistry

ARTICLES:

Long, M.S. 2004 Atmospheric Deposition In Southeastern North Carolina And Its Impact On The Cape Fear River Estuary, MS Thesis, University of North Carolina at Wilmington

PRESENTATIONS:

2004 Long, M.S., Willey, J.D., Kieber, R.J. and Gamble, D. Ammonium in the Cape Fear River Estuary: The Role of Atmospheric Water Column Interactions, SOALS Open Science Conference, Halifax, Nova Scotia, Canada

2004 Bradshaw, L.C., Skrabal, S.A., Kieber, R.J., Willey, J.D., and Cahoon, L.B., Ammonium in the Cape Fear River Estuary; The Role of Particle-Water Interactions, American Society of Limnology and Oceanography, Savannah, GA.

2004 Kieber, R.J., Bradshaw, L.C.; Long, M.S., Skrabal, S.A. and Willey, J.D. Increasing Ammonium Concentrations in the Cape Fear Estuary: Where is it coming from? American Society of Limnology and

Oceanography Ocean research Conference, Honolulu, Hawaii

2004 Bradshaw, L., Skrabal, S.A., Kieber, R.J., and Willey, J.D. Ammonium in the Cape Fear River Estuary: The Role of Particle water Interactions, 6th UNCW Symposium on Chemistry and Biochemistry, Wilmington North Carolina.

2003 Bradshaw, L.C., Skrabal, S.A., and Kieber, R.J. Ammonium in the Cape Fear River Estuary: The Role of Sediment Water Column Interactions, North Carolina Academy of Science 100th Annual Meeting, Wilmington, NC.

2003 Long, M.S., Willey, J.D. and Kieber, R.J. Ammonium in the Cape Fear River Estuary: The Role of Atmospheric Water Column Interactions, North Carolina Academy of Science 100th Annual Meeting, Wilmington, NC.

PROJECT TITLE: Marine Ornamental Fish Culture

PROJECT SEA GRANT NUMBER: RMG0306

PROJECT LEAD PI: Ileana E. Clavijo, Biological Sciences, University of North Carolina at Wilmington

ARTICLES: None

STORIES:

Clavijo gave a presentation at the Fort Fisher Aquarium on September 10, 2004. This was advertised for the general public in the Wilmington Star News.

PROJECT TITLE: Measuring Interrelated Demands for Commercially Caught Fish

PROJECT SEA GRANT NUMBER: R/BS-16

PROJECT LEAD PI: Matthew T. Holt, North Carolina State University

ARTICLES: None

PRESENTATIONS:

A paper entitled "Bootstrapping Your Fish or Fishing for Bootstraps?: Precision of Welfare Loss Estimates from a Globally Concave Inverse Demand Model of Commercial Fish Landings in the U.S. Great Lakes," (C.E. Hilmer, M.T. Holt, and R.C. Bishop) was presented at the annual American Agricultural Economics Meetings in Denver in August, 2004.

PROJECT TITLE: Marine Fisheries Fellowship

PROJECT SEA GRANT NUMBER: E/IGS-6

PROJECT LEAD PI: Jeffrey A. Buckel

PROJECT CO-PI: Ronald G. Hodson

ARTICLES:

Bacheler, N.M., R.A. Wong, and J.A. Buckel. in press. Movements and mortality rates of striped mullet in North Carolina. North American Journal of Fisheries Management.

STORIES:

Striped mullet: valuable fishery with rich tradition, Coastwatch, Autumn 2003.

The Carteret News Times published a special tabloid section (September 2004) describing all of the marine facilities in Carteret County. The description of NCSU-CMAST contains a description of the Marine Fisheries Management Fellowship and the collaboration between North Carolina Sea Grant and NC Division of Marine Fisheries.

Perspectives Magazine. 2003 (Fall). "When the blues don't get you down". Article describing Buckel's research projects contained a description of this fellowship.

PRESENTATIONS:

Bacheler, N.M., J.A. Buckel, and R.A. Wong. 2003. Movements and mortality rates of striped mullet (*Mugil cephalus*) in North Carolina. Paper presented at the American Fisheries Society, Quebec City, Canada.

PROJECT TITLE: Impact Of Striped Bass Predation On Young-Of-The-Year River Herring In The Albemarle Sound Estuary

PROJECT SEA GRANT NUMBER: R/MRD-46

PROJECT LEAD PI: Jeffrey A. Buckel, Department of Zoology, North Carolina State University

PROJECT CO-PI: Joseph E. Hightower, North Carolina Cooperative Fish and Wildlife Research Unit and Department of Zoology, North Carolina State University

ARTICLES:

Rudershausen, P.J., J.E. Tuomikoski, J.A. Buckel, and J.E. Hightower. in review. Prey selectivity and diet of striped bass in Albemarle Sound, North Carolina. Transactions of the American Fisheries Society (submitted June 2004)

J.E. Tuomikoski. in preparation. Impact of age-1 striped bass predation on Alosa spp. in Albemarle Sound. M.S. Thesis, Fisheries and Wildlife Sciences. Anticipated December 2004.

STORIES:

Striped bass predation of River Herring Explored, Coastwatch, High Season 2003.

Striped bass predation of River Herring Explored, The Coastland Times, August 21, 2003

Storm Stories, From the Editor, Coastwatch, Holiday 2003.

When the blues don't get you down. Perspectives Magazine (NCSU College of Agricultural and Life Sciences). 2003 (Fall). Article describing Buckel's lab research projects, including striped bass project.

PRESENTATIONS:

Rudershausen, P., J.E. Tuomikoski, J.A. Buckel, and J.E. Hightower. 2004. Diet and selectivity of age-1 striped bass in western Albemarle Sound. Paper presented at Tidewater Chapter of the American Fisheries Society, Salisbury, MD.

Tuomikoski, J.E., P.J. Rudershausen, J.A. Buckel, and J.E. Hightower. 2004. Effects of age-1 striped bass predation on Alosa spp. in Albemarle Sound. Paper presented at North Carolina Chapter of the American Fisheries Society, Asheville, NC.

Tuomikoski, J.E., P.J. Rudershausen, J.A. Buckel, and J.E. Hightower. 2004. Impact of age-1 striped bass predation on Alosa spp. in Albemarle Sound. Invited paper presented in New Perspectives in Fish Energetics: A Return to Academic Nursery Grounds. Symposium, American Fisheries Society, Madison, WI.

Buckel, J.A. 2004. Interactions between age-1 striped bass and their prey in western Albemarle Sound, North Carolina. Invited seminar, Marine Sciences Research Center, SUNY Stony Brook, Stony Brook, NY.

PROJECT TITLE: The effect of water quality on a nocturnal food web in the Cape Fear River Basin

PROJECT SEA GRANT NUMBER: RMG0410

PROJECT LEAD PI: Matina C. Kalcounis-Ruppell, UNC-Greensboro

ARTICLES: None

STORIES:

There has been coverage of this project in both North Carolina statewide papers (front page of the City and State Section of the Raleigh News and Observer on 8/12/04 and the front page of the Local and State Section of the Charlotte Observer on 8/5/04). Additionally this project was part of a CNN Science and Technology four-minute television segment that aired on the Next@CNN program on 8/14/04 and 8/15/04. A corresponding online news article was featured as a main headline on www.CNN.com under the Science & Space link from 8/13/04 to 8/17/04.

PRESENTATIONS:

Two oral papers are being presented at the North American Symposium for Bat Research from 27-30 October 2004 in Salt Lake City:

Graduate student Alison Boyko will present a paper entitled: The effects of water quality on bat foraging behavior in stream ecosystems of the Cape Fear River Basin.

Undergraduate Student Stacy Huff will present a paper entitled: The effects of water quality on the riparian insect community in the headwaters of the Cape Fear River Basin in North Carolina.

PROJECT TITLE: Estimating fishing and natural mortality rates for red drum in North Carolina estuaries using a combined telemetry-conventional tag approach

PROJECT SEA GRANT NUMBER: R/MRD-48

PROJECT LEAD PI: Jeffrey A. Buckel, Department of Zoology, North Carolina State University

PROJECT CO-PI: Joseph E. Hightower, North Carolina Cooperative Fish and Wildlife Research Unit and Department of Zoology, North Carolina State University;

Kenneth H. Pollock, Professor, Department of Statistics, Biomathematics & Zoology, NCSU.

ARTICLES: None.

STORIES: Perspectives Magazine. 2003 (Fall). When the blues don't get you down. Article describing Dr. Jeff Buckel's lab research projects, including red drum project.

Perspectives Magazine. 2004 (Fall, in press). Article describing Nathan Bacheler's NC Beautiful award.

"May chosen for Hutton Program," Carteret News Times, June 16, 2004. Story describing the American Fisheries Society's Hutton Junior Fisheries Biology Fellowship award that Melyssa May, a West Carteret High School student, received. Melyssa May is working in our lab and assists Nate Bacheler on his red drum research.

PRESENTATIONS:

Bacheler, N.M. 2004. A combined approach to estimate mortality of red drum. Zoology Graduate Student Symposium, NCSU.

PROJECT TITLE: Oyster Reefs as Fisheries Habitat: The influence of Edge Characteristics and Vertical Complexity

PROJECT SEA GRANT NUMBER: R/MER-46

PROJECT LEAD PI: Dr. Martin Posey; Department of Biological Sciences; University of North Carolina at Wilmington.

PROJECT CO-PI: Troy Alphin; University of North Carolina at Wilmington

ARTICLES:

Nelson, K.A., L.A. Leonard, M.H. Posey, T.D. Alphin and M.A. Mallin. 2004. Transplanted oyster (*Crassostrea virginica*) beds as a self-sustaining mechanism for water quality improvement in small tidal creeks. *Journal of Experimental Marine Biology and Ecology*. 298: 347-368

Cressman, K.A., M.H. Posey, M.A. Mallin, L.A. Leonard and T.D. Alphin. 2003. Effects of oyster reefs on water quality in a tidal creek estuary. *Journal of Shellfish Research*. 22: 753-762

Molesky, T.J., M.H. Posey, T.A. Alphin. Interactions between oyster reefs and adjacent sandflats: effects on microphytobenthos and sediment characteristics. In prep. (target journal: *Journal experimental Marine Biology and Ecology*).

Harwell, H.A., M.H. Posey and T.A. Alphin. Landscape aspects of oyster reefs: fragmentation and habitat utilization. In prep. (target journal: *Journal experimental Marine Biology and Ecology*).

STORIES:

2 articles in the local newspaper (Wilmington Morningstar)

1 feature news article in local T.V. news

1 feature article in Coastwatch with a follow-up article planned for an upcoming issue

Aspects of research included in a Raleigh News and Observer article on Encore for Oysters forum

PRESENTATIONS:

Posey, M.H., T.D. Alphin, H.D. Harwell and T. Molesky. 2004. Effects of reef complexity on habitat function for intertidal oysters. Invited Presentation, 2004 World Aquaculture Meetings.

Posey, M.H., T.D. Alphin, H.D. Harwell and T. Molesky. 2004. Habitat function of intertidal oyster reefs: importance of reef complexity. Marine Benthic Ecology Meetings.

Harwell, H.D., M.H. Posey and T.D. Alphin. 2004. Landscape approaches to created oyster reefs: fragmentation and habitat utilization. Marine Benthic Ecology Meetings.

Vinson, J., M. Posey and T. Alphin. 2004. Movement patterns of the mud crab, *Panopeus herbstii*. Marine Benthic Ecology Meetings.

Posey, M., T. Alphin, D. Meyer, C. Wilson. 2004. North Carolina Intertidal Reefs. Invited Presentation at Oyster Restoration Success Criteria Workshop.

Posey, M.H., T.D. Alphin, H.D. Harwell, T. Molesky. 2003. Form and function in oyster reefs: influence of reef morphology on habitat function and oyster survival. Invited Talk at the National Shellfish Association Meetings.

Cressman, K.A., M.H. Posey, M.A. Mallin, L.A. Leonard and T.D. Alphin. 2003. Effects of intertidal oyster reefs on water quality in a tidal creek. Marine Benthic Ecology Meetings

Sonnier, J.M., M.H. Posey and T.D. Alphin. 2003. Relative use of seagrass, woody debris and oyster shell habitats in estuarine systems. Marine Benthic Ecology Meetings

Molesky, T.J., M.H. Posey, L.B. Cahoon, L.A. Leonard and T.D. Alphin. 2003. The influence of created oyster reefs on a southeastern North Carolina intertidal sandflat: benthic microalgae biomass and biogeochemical fluxes. Marine Benthic Ecology Meetings

Harwell, H.D., M.H. Posey and T.D. Alphin. 2003. Fragmentation and habitat function in created oyster reefs. Marine Benthic Ecology Meetings

Posey, M.H., T.D. Alphin, H. Harwell and T. Molesky. 2003. Effects of reef complexity on habitat use and oyster recruitment. Marine Benthic Ecology Meetings

Posey, M.H., T. Alphin, H. Harwell, and T. Molesky. 2002. Landscape aspects of oyster reefs: effects of vertical complexity, edge convolution and fragmentation on faunal use. International Conference on Shellfish Restoration. Invited Talk.

Alphin, T.D., M.H. Posey, A. Wilbur and J. Swartzenberg. 2002. Restoration and enhancement: growers, researchers and community collaborative efforts. International Conference on Shellfish Restoration, Invited talk.

Molesky, T., M. Posey, L. Cahoon, L. Leonard and T. Alphin. 2002. The effects of artificial oyster reefs on benthic microalgae. Southeastern Estuarine Research Society Meetings

Cressman, K.A., M.H. Posey, M.A. Mallin, L.A. Leonard and T.D. Alphin. 2002. Effects of the eastern oyster, *Crassostrea virginica*, on water quality in a tidal creek. Southeastern Estuarine Research Society Meetings

Noller, B., J. Horner, M. Posey and T. Alphin. 2002. Oyster reef health in selected southeastern North Carolina tidal creek estuaries. Marine Benthic Ecology Meetings.

PROJECT TITLE: Effects of Erosion Control Structures on Adjacent Benthic and Nektonic Communities

PROJECT SEA GRANT NUMBER: R/MER-48

PROJECT LEAD PI: Dr. Martin H. Posey; Department of Biological Sciences; University of North Carolina at Wilmington

PROJECT CO-PI: Troy Alphin, University of North Carolina at Wilmington; Spencer Rogers, North Carolina Sea Grant

ARTICLES: None

PRESENTATIONS:

Sonnier, J.M., M.H. Posey, T.D. Alphin and S.M. Rogers, Jr. 2004. Erosion control structures and their effects on adjacent benthic and nektonic communities. Marine Benthic Ecology Meetings.

PROJECT TITLE: Interactions Between Nutrient Additions and Trophic Controls: Scaling Effects and System Variability

PROJECT SEA GRANT NUMBER: R/MER-42

PROJECT LEAD PI: Dr. Martin Posey; Department of Biological Sciences; University of North Carolina at Wilmington

PROJECT CO-PI: Troy Alphin, University of North Carolina at Wilmington; Dr. Lawrence Cahoon, University of North Carolina at Wilmington

ARTICLES:

Posey, M.H., T.D. Alphin, H. Harwell and B. Allen. 2004. Importance of low salinity areas for juvenile blue crabs, *Callinectes sapidus* Rathbun, in river-dominated estuaries of southeastern United States. *Journal of Experimental Marine Biology and Ecology*. In Press.

Posey, M.H., T.D. Alphin, L.B. Cahoon, D.G. Lindquist, M.A. Mallin and M.B. Nevers. 2002. Top-down versus bottom-up limitation in benthic communities: direct and indirect effects. *Estuaries*. 25: 999-1014.

Mallin, M., M.H. Posey, M.R. McIver, D.C. Parsons, S.H. Ensign and T.D. Alphin. 2002. Impacts and recovery from multiple hurricanes in a piedmont-coastal plain river system. *BioScience*. 52: 999-1010.

Mallin, M.A., J.M. Burkholder, L.B. Cahoon and M.H. Posey. 2000. North and South Carolina coasts. *Marine Pollution Bulletin*. 41: 56-75.

Mallin, M.A., J.M. Burkholder, L.B. Cahoon and M.H. Posey. 2000. North and South Carolina coasts. Pp. 341-361, In: C. Sheppard (ed.) *Seas of the Millennium*. Elsevier Science, Ltd.

Mallin, M., M. Posey, M. McIver, S. Ensign, T. Alphin, M. Williams, M. Moser and J. Merritt. 2000. Environmental assessment of the lower Cape Fear River system, 1999-2000. CMS Report 00-01.

Mallin, M., M. Posey, T. Lankford, M. McIver, S. Ensign, T. Alphin, M. Williams, M. Moser and J. Merritt. 2001. Environmental assessment of the lower Cape Fear River system, 2000-2001. CMS Report 01-01.

STORIES:

Research featured in Coastwatch magazine

Interviewed for articles in Wilmington Star newspaper on river health and juvenile blue crabs

PRESENTATIONS:

Alphin, T.D., M.H. Posey, L.A. Leonard and C.T. Hackney. 2003. Fluctuations in infaunal and epifaunal utilization of tidal wetlands across an estuarine gradient in response to changing salinity, tidal amplitudes, and flow. *Estuarine Research Federation Biennial Meetings*.

Owens, M., M. Posey, and T. Alphin. 2003. Growth, reproduction and survivorship responses to food enhancement for two species of estuarine polychaetes: *Streblospio benedicti* and *Laeonereis culveri*. *Marine Benthic Ecology Meetings*

Barbour, R.W., M.H. Posey and T.D. Alphin. 2003. Patterns of larval distribution and settlement in a river dominated estuary. *Marine Benthic Ecology Meetings*

Markovsky, W., T. Lankford, A. Wilbur, M. Posey, T. Alphin and S. Kinsey. 2003. River discharge plumes and fisheries production: the trophic advantage hypothesis. Spring Meeting, Southern Division of the American Fisheries Society.

Mallin, M.A., M.R. McIver, M.H. Posey, T.D. Alphin and M.J. Durako. 2003. The Cape Fear River plume: Water quality and ecology. Southeast Coastal Ocean Science Conference, Charleston, SC.

Owens, M., M. Posey and T. Alphin. 2002. Estuarine infaunal responses to food enhancement: do patterns indicate specialists or generalist strategies? *Marine Benthic Ecology Meetings*.

Posey, M.H. 2002. Top-down versus bottom-up limitation in benthic communities: direct and indirect effects. North Carolina State University Department of Zoology Seminar Series. AND East Carolina University Department of Biological Sciences Seminar Series. Both Invited seminars.

Posey, M.H., T. Alphin, L. Cahoon, M. Mallin and M. Nevers. 2001. Food web dynamics in tidal creek estuaries. Invited presentation at the Biennial Estuarine Research Federation Meetings.

Posey, M. 2001. Top-down versus bottom-up limitation in benthic infaunal communities: direct and indirect effects. Invited seminar at the South Carolina Marine Research Institute.

Hartsell, J., M. Posey and T. Alphin. 2001. Mesoscale disturbance and consequences for benthic community structure. Paper presented at the 2001 Marine Benthic Ecology Meetings.

Posey, M. 2000. Top-down versus bottom-up controls in tideflat communities: questions of scale for benthic infauna. Invited seminar at the Dauphin Island Sea Lab, Alabama Marine Consortium

PROJECT TITLE: Wind Load Identification on Coastal Structures Using the Intelligent Parameter Varying Approach

PROJECT SEA GRANT NUMBER: RMG0215

PROJECT LEAD PI: Mohammad N. Noori, Department of Mechanical & Aerospace Engineering, North Carolina State University

ARTICLES:

S. Saadat, M. N. Noori, G. D. Buckner, and T. Furukawa Health Monitoring and Damage Detection in Base-Excited Structures using the Intelligent Parameter Varying (IPV) Technique, In Proceedings of the 9th International Conference on Applications of Statistics and Probability in Civil Engineering ICASP9, University of California at Berkeley, San Francisco, California, July 6-9 2003, Vol. 1, 467-472, Editors: A. D. Kiureghian, S. Madanat, and J. Pestana

S. Saadat, G. D. Buckner, T. Furukawa, and M. N. Noori. An Intelligent Parameter Varying (IPV) Approach for Non-linear System Identification of Base Excited Structures, International Journal of Nonlinear Mechanics, Vol. 39, Issue 6, August 2004, 993-1004.

S. Saadat, M. N. Noori, G. D. Buckner, T. Furukawa, and Y. Suzuki Structural Health Monitoring and Damage Detection using an Intelligent Parameter Varying (IPV) Technique, International Journal of Nonlinear Mechanics, Vol. 39, Issue 10, December 2004, 1687-1697.

R. J. Alonso, M. N. Noori, S. Saadat, A. Masuda, and Z. Hou. Detection Accuracy of Orthogonal Wavelet Decomposition for Structural Health Monitoring and Damage Detection Applications, Journal of Earthquake Engineering and Engineering Vibration, Vol. 3, No. 1, June 2004, 101-106

S. Saadat Structural health monitoring and detection of progressive and existing damage using artificial neural networks-based system identification, Ph.D. Dissertation, North Carolina State University, Department of Mechanical & Aerospace Engineering, 2003

PRESENTATIONS:

S. Saadat, F-G. Yuan, M. N. Noori, and G. D. Buckner Estimation of Wind Load on Structures, In Proceedings of the 15th ASCE Engineering Mechanics Conference, Columbia University, New York City, New York, June 2-5 2002, CD-ROM, pp 6, Editor: A. W. Smyth

S. Saadat, G. D. Buckner, M. N. Noori, and T. Furukawa Structural Health Monitoring and Damage Detection using the Intelligent Parameter Varying (IPV) Technique, In Proceedings of the International Symposium for Young Researchers on Modeling and their Applications, Convention Center, Osaka University, Japan, October 21-22 2002, 327-334, Editors: E. Tachibana, T. Furukawa, Y. Mukai, and H. Ma.

S. Saadat, G. D. Buckner, T. Furukawa, and M. N. Noori. Non-linear System Identification of Base Excited Structures using An Intelligent Parameter Varying (IPV) Modeling Approach, In Proceedings of SPIE 10th International Symposium on Smart Structures and Materials: Modeling, Signal Processing and Control, San Diego, California, March 2-6 2003, Vol. 5049, 555-564, Editor: R. C. Smith

S. Saadat, M. N. Noori, and G. D. Buckner. An Overview of Structural Health Monitoring and Damage Detection Strategies, Impact of Prognostics on Organizational Success: Proceedings of the 57th meeting of the Society for Machinery Failure Prevention Technology (MFPT), Ramada Plaza Resort Oceanfront Hotel, Virginia Beach, Virginia, April 14-18 2003, Vol. 57, 423-436, Editors: H. C. Pusey, S. C. Pusey, and W. R. Hobbs

Y. Cao, M. N. Noori, S. Saadat, Z. Hou, G. D. Buckner, A. Masuda, and W. Prosser. Preliminary Study of A Bayesian Probabilistic System Identification Approach For Structural Health Management, ASCE Joint Specialty Conference on Probabilistic Mechanics and Structural Reliability, Albuquerque, NM, July 26-28, 2004, Hosted by Sandia National Laboratory.

T. Furukawa, M. Ito, K. Izawa, R. Inoue, S. Saadat, G. D. Buckner, and M. N. Noori. System Identification of Base-Isolated Buildings using Nonlinear State-Space Models, In the Proceedings of the International Symposium on network and Center-Based Research for Smart Structures Technology and Earthquake Engineering, Convention Center, Osaka University, Suita, Osaka, Japan, Edited by E. Tachibana, B. F. Spencer, Jr. and Y. Mukai, July 6-9 2004, 175-180

PROJECT TITLE: Snead's Ferry: A Portrait Of A Fishing Town: Oral History

PROJECT SEA GRANT NUMBER: RMG 0315
PROJECT LEAD PI: Matthew Barr

ARTICLES: None

PRESENTATIONS:

American Anthropological Association- Visual Anthropology Section. Presentation On Snead's Ferry With 22-Minute Documentary At AAA Annual Convention, New Orleans, LA. November 2003

PROJECT TITLE: Characterizing the stress response of *Vibrio vulnificus* to sublethal stresses during oyster handling and processing

PROJECT SEA GRANT NUMBER: R/SST-27

PROJECT LEAD PI: MaryAnne Drake, North Carolina State University

PROJECT CO-PI: Lee-Ann Jaykus and David Green, North Carolina State University

ARTICLES:

Bang, W. and Drake, M.A. 2004. Acid adaptation of *Vibrio vulnificus* and subsequent impact on stress tolerance. Food Microbiol. In Press.

PRESENTATIONS:

Drake, S.A., L. Jaykus, M.A. Drake, and D.P. Green. 2004. Comparison in the recovery of *Vibrio vulnificus* under different microbial stresses with the use of sodium pyruvate. Annual Meeting of the International Association for Food Protection, Phoenix, AZ. August 8-11, 2004. T21.

Drake, S.L., L. Jaykus, M.A., and M.A. Drake. 2004. Using a green fluorescent protein strain of *Vibrio vulnificus* to evaluate microbial stress in the oyster matrix. IFT Annual meeting, July 12-16, Las Vegas, NV. Abstract 30-11.

Bang, W.S., M.A. Drake, and L. Jaykus. 2004. Recovery of viable cells of *Vibrio vulnificus* and detection with PR and RT-PCR during cold storage. IFT Annual meeting, July 12-16, Las Vegas, NV. Abstract 114D-5.

Bang, W. and Drake, M.A. 2003. Resistance of *Vibrio vulnificus* to physical stresses following different acid adaptation times. Annual IFT Meeting, July 12-16, Chicago, IL Abstract 29G-20.

Drake, S.L., Bang, W., Jaykus, L., Drake, M.A., Green, D. and Elhanafi, D. 2003. Evaluation of growth and survival characteristics of *Vibrio vulnificus* expressing green fluorescent protein. Annual IFT Meeting, July 12-16, Chicago, IL Abstract 59-3.

PROJECT TITLE: Effect of Hurricane Isabel on Pamlico Sound

PROJECT SEA GRANT NUMBER: RMG0314

PROJECT LEAD PI: Larry B. Crowder, Duke University

ARTICLES: None

STORIES:

Carteret News Times

News and Observer

PROJECT TITLE: Sustainable Tourism As An Economic Development Strategy In The Waterways And Coastlines Of North Carolina

PROJECT SEA GRANT NUMBER: R/MG-0313

PROJECT LEAD PI: David L. Edgell, Sr. / ECU

ARTICLES:

Dr. Edgell's work under this grant will be included in the book of sustainable tourism, and will likely be included in another book as well.

PROJECT TITLE: Estimating Direct and Indirect Effects of Hypoxia on Estuary-Dependent Fish

PROJECT SEA GRANT NUMBER: R/MRD-49

PROJECT LEAD PI: James A. Rice, North Carolina State University, Department of Zoology

PROJECT CO-PI: J. Kevin Craig, North Carolina State University, Department of Zoology

ARTICLES: None

PRESENTATIONS:

Craig, J.K., K.A. Rose, J.A. Rice. 2004. Low dissolved oxygen and juvenile estuarine fishes: evaluating alternative approaches to incorporating movement into a spatially explicit, individual-based model. American Fisheries Society Annual Meeting, August 20-26, Madison, WI.

PROJECT TITLE: Enhancing the scientific basis for predicting fish habitat impacts of beach nourishment

PROJECT SEA GRANT NUMBER: R/CZS-31

PROJECT LEAD PI: Charles H. Peterson, University of North Carolina at Chapel Hill, Institute of Marine Sciences (IMS)

PROJECT CO-PI: John T. Wells, University of North Carolina at Chapel Hill, IMS

ARTICLES:

Manning, L.M., and N. Lindquist. 2003. Helpful habitat or pernicious passenger: interactions between an infaunal bivalve, and epifaunal hydroid and three potential predators. *Oecologia* 134:415-422.

Peterson, C.H., and M.J. Bishop. 2005. When monitoring represents abrogation of agency responsibility: environmental impacts of beach "nourishment". *Bioscience*: in review.

Manning, L.M., and C.H. Peterson. 2005. Disturbance of an exposed sandy beach: impacts of enhancing fine sediments on benthic infauna by beach nourishment. *Ecological Applications*: in review.

Bishop, M.J., S.B. King, J.T. Wells, and C.H. Peterson. 2005. Enhancing recognition of important differences in sediment size distributions by non-parametric multivariate ordination: a sandy beach application. *Journal of Sedimentology*; in review.

Peterson, C.H., G. Johnson, L. D'Anna, M.J. Bishop, and L.M. Manning. 2005. Large impacts of beach fill by coarse shell on benthic invertebrates do not vary with fill date over winter. *Marine Ecology Progress Series*: in preparation.

STORIES:

Newspaper articles in Carteret County News Press (4), Raleigh News and Observer, Jacksonville Daily News, Winston Salem Journal, Charlotte Observer.

Radio presentations on WTKF, the Talk Station" (2).

Live media Presentation on the NOAA NERRS Estuary Live program - April 11, 2003.

PRESENTATIONS:

March 2002 Presentation by L. Manning to the Benthic Ecology Meeting in Orlando, FL

Aug 2003 - Presentation by L. Manning to the Ecological Society of America Meeting in Savannah, GA

April 2002. Presentation on biological impacts of beach nourishment to NC Coastal Resources Commission

Sept 2002. U.S. Congressional Science Briefing on biological impacts of beach nourishment

Nov 2002 Presentation on conservation of sand beach habitat function to NC Marine Fisheries Commission Habitat and Water Quality Committee

Nov 2002. Panel participation on beach nourishment impacts at NC Shore and Beach Association meeting

April 2003. Presentation on biological implications of changing sedimentology on ocean beaches and sediment compatibility criteria to CRC Coastal Hazards Science Panel

Oct 2003 - Presentation on biological implications of changing sedimentology on ocean beaches and sediment compatibility criteria to CRC Coastal Hazards Science Panel

Nov 2003 - Presentation on biological implications of changing sedimentology on ocean beaches and sediment compatibility criteria to CRC Coastal Hazards Science Panel

PROJECT TITLE: Establishing long-term monitoring plots to study sea level rise and marsh invasion of estuarine forests on the Albemarle Peninsula, North Carolina

PROJECT SEA GRANT NUMBER: RMG0402

PROJECT LEAD PI: Dr. N.L. Christensen, Duke University

PROJECT CO-PI: Ben Poulter, Duke University (PhD candidate)

ARTICLES: None

STORIES:

We have had our map of potential lands inundated due to sea level rise projected for the year 2100 published in "Horizon 2100" (Environmental Defense), "Wildlife" (NC Wildlife Commission), and "State of the Coast" (NC Coastal Federation). The field research funded by NC Sea Grant complements this prior research.

PROJECT TITLE: Evaluation of the Biological Filtration Capacity of Oyster Reefs in Small Tidal Creek Systems

PROJECT SEA GRANT NUMBER: RMG0213

PROJECT LEAD PI: Troy Alphin; University of North Carolina at Wilmington

PROJECT CO-PI: Dr. Martin Posey, University of North Carolina at Wilmington

ARTICLES:

Nelson, K.A., L.A. Leonard, M.H. Posey, T.D. Alphin, and M.A. Mallin. 2004. Transplanted Oyster (*Crassostrea virginica*) beds as self-sustaining mechanisms for water quality improvement in small tidal creeks. *J. of Exp. Mar. Bio. and Ecology*. 298 (2004) 347-368.

Cressman, K., M.H. Posey, M.A. Mallin, T.D. Alphin, and L.P. Leonard. 2003. Effects of oyster reefs on water quality in a tidal creek estuary. *Journal Shellfish Research*. Vol. 22(3) 753-762.

STORIES:

Several interviews for the articles with the local newspaper (Wilmington Morning Star)

PROJECT TITLE: Fine-Scale Spatial and Temporal Variation in Abundance of *Pfiesteria* Species in North Carolina Waters

PROJECT SEA GRANT NUMBER: R/MER-41

PROJECT LEAD PI: Parke A. Rublee, UNCG

PROJECT CO-PI: JoAnn M Burkholder, NCSU

ARTICLES:

Burkholder, J.M., H.B. Glasgow. 2002. The life cycle and toxicity of *Pfiesteria piscicida* revisited. *Journal of Phycology* 38:1261-1267.

Burkholder, J.M. 2002. *Pfiesteria*: the toxic *Pfiesteria* complex. Invited, peer-reviewed contribution for the Encyclopedia of Environmental Microbiology, by G. Bitton (ed.). Wiley Publishers, New York, pp. 2431-2447.

Jakobsen, K.S., T. Tengs, A. Vatne, H.A. Bowers, D.W. Oldach, J.M. Burkholder, H.B. Glasgow, P.A. Rublee, and D. Klaveness. 2002. Discovery of the toxic dinoflagellate *Pfiesteria* in northern European waters. *Proceedings of the Royal Society of London (B)* 269:211-214.

Lewitus, A.J., K.C. Hayes, B.M. Willis, J.M. Burkholder, H.B. Glasgow, A.F. Holland, P. Maier, P.A. Rublee and R. Magnien. 2002. Low abundance of the dinoflagellates, *Pfiesteria piscicida*, *P. shumwayae*, and *Cryptoperidiniopsis* spp. in South Carolina tidal creeks and open estuaries. *Estuaries* 25(4A):586-597

Rhodes, L.L., J.M. Burkholder, H. Glasgow, P.A. Rublee, C. Allen, and J.E. Adamson.

2002. *Pfiesteria shumwayae* (Pfiesteriaceae) in New Zealand. *New Zealand Journal of Freshwater and Marine Science* 36:621-630.

Scholin, C., E. Vrieling, L. Peperzak, L. Rhodes, and P. Rublee. 2003. Detection of HAB species using lectin, antibody and DNA probes. Chapter 5, In (D. Anderson, ed.) *IOC Manual on Harmful Microalgae*, 2nd ed. UNESCO Monographs on Oceanographic Methodology.

Burkholder, J., D. Eggleston, H. Glasgow, C. Brownie, R. Reed, G. Melia, C. Kinder, G. Janowitz, R. Corbett, M. Posey, T. Alphin, D. Toms and N. Deamer. 2004. Comparative impacts of two major hurricane seasons on the Neuse River and western Pamlico Sound. *Proceedings of the National Academy of Sciences (USA)* 101:9291-9296.

Doblin, M.A., L.A. Drake, K.J. Coyne, P.A. Rublee, and F.C. Dobbs. In press. *Pfiesteria* species identified in ships' ballast water and residuals: A possible vector for introductions to coastal areas. In: *Proceedings of the*

Xth International Conference on Harmful Algae, by K.A. Steidinger, J.A. Landsberg, C.R. Tomas and G.A. Vargo (eds.).

Drake, L.A. A.E. Meyer, R.L. Forsberg, R.E. Baier, M.A. Doblin, S. Heinemann, W.P. Johnson, M. Koch, P.A. Rublee, and F.C. Dobbs. In press. Potential invasion of microorganisms and pathogens via interior hull fouling: Biofilms inside ballast-water tanks. *Biological Invasions*.

Mallin, M.A., S.H. Ensign, D.C. Parsons, V.L. Johnson, J.M. Burkholder, and P.A. Rublee. In press. Relationship of *Pfiesteria* spp. and *Pfiesteria*-like Organisms to Environmental Factors in Urbanizing Tidal Creeks. In: *Proceedings of the Xth International Conference on Harmful Algae*, by K.A. Steidinger, J.A. Landsberg, C.R. Tomas and G.A. Vargo (eds.).

Rublee, P.A., C. Allen, E. Schaefer, L. Rhodes, J. Adamson, C. Lapworth, J. Burkholder, and H. Glasgow. In press. Global distribution of toxic *Pfiesteria* complex species. In: *Proceedings of the Xth International Conference on Harmful Algae*, by K.A. Steidinger, J.A. Landsberg, C.R. Tomas and G.A. Vargo (eds.).

Villareal, T., J.D. Simons, and P.A. Rublee. In press. *Pfiesteria* distribution along the Texas (USA) coast. In: *Proceedings of the Xth International Conference on Harmful Algae*, by K.A. Steidinger, J.A. Landsberg, C.R. Tomas and G.A. Vargo (eds.).

STORIES:

Rawlins, W. 2004. Floyd, Fran Did Some Good. *The News & Observer*, Raleigh, North Carolina (6 July).

PRESENTATIONS:

Deamer, N.J., K. Brejwo, M. Parrow, P.A. Rublee, H.B. Glasgow, and J.M. Burkholder. Comparison of PCR and standardized fish bioassays for detection of toxic *Pfiesteria* complex species in estuarine sediments. Xth International Conference on Harmful Algal Blooms, St. Petersburg, FL, October 2002.

Doblin, M.A., L.A. Drake, K.J. Coyne, P.A. Rublee, and F.C. Dobbs. *Pfiesteria* species identified in ballast water and residuals: a possible vector for introductions to coastal areas. Xth International Conference on Harmful Algal Blooms, St. Petersburg, FL, October 2002.

Mallin, M.A. M.R. McIver, S.H. Ensign, J.M. Burkholder and P.A. Rublee. Eutrophication and the distribution of *Pfiesteria* in urbanized tidal creeks. Xth International Conference on Harmful Algal Blooms, St. Petersburg, FL, October 2002.

Rublee, P.A., C. Allen, E.F. Schaefer, L. Rhodes, J. Adamson, J.M. Burkholder, and H. Glasgow. Global distribution of *Pfiesteria*-complex species. Xth International Conference on Harmful Algal Blooms, St. Petersburg, FL, October 2002.

Shumway, S.E., J. Springer, P.A. Rublee, H.B. Glasgow, and J.M. Burkholder. Toxic *Pfiesteria* strains found in shellfish from estuaries know for toxic activity: Implications for seafood safety. Xth International Conference on Harmful Algal Blooms, St. Petersburg, FL, October 2002.

Villareal, T., J.D. Simons, and P.A. Rublee. *Pfiesteria* distribution along the Texas coast. Xth International Conference on Harmful Algal Blooms, St. Petersburg, FL, October 2002.

Dobbs, F.C., M.A. Doblin, Kampschmidt, Diallo, Graczyk, Jiang, P.A. Rublee. Microorganisms in NOBOB ships arriving in the Great Lakes. International Association of Great Lakes Research Conference, 2003

Drake, L.A., R.E. Baier, M.A. Doblin, F.C. Dobbs, R.L. Forsberg, S. Heinemann, W.P. Johnson, M. Koch, A.E. Meyer, P.A. Rublee, and L.K. Scott. Potential invasion of microorganisms and pathogens via interior hull fouling: biofilms inside ballast-water tanks. Third International Conference On Marine Bioinvasions, La Jolla, CA, March 2003.

Rublee, P.A. Searching for dinoflagellates: Approaches Used and Lessons Learned. Society of Protozoologists Annual Meeting, Smithfield, RI, June 2004.

PROJECT TITLE: Kent SeaTech/Sea Grant Industry Fellow Charlene R. Couch: DNA Marker-assisted Selective Breeding of Striped Bass - Phase I

PROJECT SEA GRANT NUMBER: EST 2

PROJECT LEAD PI: Craig V. Sullivan, Dept. Zoology, N.C. State University

ARTICLES: None

STORIES:

Kane, D. (Ed.). Building Better Bass. Raleigh News and Observer. August 28, 2002. Pages 1-3B.

PRESENTATIONS:

Craig V. Sullivan, Charlene R. Couch and Amber F. Garber. 2004. Toward the goal of increased production efficiency: domestication and selective breeding of striped bass *Morone saxatilis* and its hybrids. The Annual International Conference and Exposition of the World Aquaculture Society, March 1-5, Honolulu, Hawaii.

Russell J. Borski, Harry V. Daniels, Thomas M. Losordo and Craig V. Sullivan. 2004. Improving production technology for finfish aquaculture in North Carolina. North Carolina Aquaculture Development Conference, January 23-25, Atlantic Beach, North Carolina.

C.R. Couch, A.F. Garber and C.V. Sullivan. 2004. Marker-assisted selective breeding of striped bass (*Morone saxatilis*): Phase I common garden performance trials. International Plant and Animal Genome Conference XII, January 10-14, San Diego, CA.

A.F. Garber, C.R. Couch and C.V. Sullivan. 2003. *Morone* broodstock improvement and selective breeding: what's underway at NC State University. Striped Bass Growers Industry Forum at the Annual National Conference and Exposition of the U.S. Chapter of the World Aquaculture Society, February 20, Louisville, KY.

C.V. Sullivan, C.R. Couch, A. F. Garber and C. L. Morton. 2003. Genetic improvement of finfish broodstock: DNA marker-assisted selective breeding of hybrid striped bass. North Carolina Aquaculture Development Conference, January 23-25, Atlantic Beach, NC.

Hodson, R.G., C.R. Couch, and C.V. Sullivan. 2002. *Morone* broodstock: reproduction, domestication and selective breeding. Aquaculture America 2002, January 27-30, San Diego, CA.

C.R. Couch, A.F. Garber, and C.V. Sullivan. 2003. NCSU research summary: common garden progeny performance trials. Second Annual Workshop on Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, October 22-23, Stuttgart, AR.

C.V. Sullivan, A. S. McGinty, C.R. Couch and A. F. Garber. 2002. Selective breeding of striped bass: reproductive capabilities and limitations. Workshop on Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, October 22-23, Stuttgart, AR.

PROJECT TITLE: Reproduction of Domesticated Striped Bass: Coldbanking to Arrest Maturation and Atresia

PROJECT SEA GRANT NUMBER:R/AF-38

PROJECT LEAD PI: Craig V. Sullivan, Dept. Zoology, N.C. State University

ARTICLES:

Hiramatsu, N., Hara, A., Matsubara, T., and C.V. Sullivan. Vitellogenin as a biomarker for endocrine disruption: molecular and biochemical considerations. In: Biochemical and Molecular Biology of Fishes, Vol. 6 Environmental Toxicology (T.W. Moon and T.J. Mommsen, editors). Elsevier Science BV, Amsterdam (in press).

Hiramatsu, N., Chapman, R.W., Lindzey, J.K., Haynes, M.R., and C.V. Sullivan. 2004. Molecular characterization and expression of vitellogenin receptor from white perch (*Morone americana*). *Biology of Reproduction* 70:1720-1730.

Donato, D.M., Hiramatsu, N., Arey, K.M., Hiramatsu, K., Kennedy, A.M., Morton, C.L., Hara, A., and C.V. Sullivan. 2003. Aresia in temperate basses: cloning of hatching enzyme (choriolyisin) homologues from atretic ovaries. *Fish Physiol. Biochem.* 28:329-330.

Hiramatsu, N., Hara, A., Matsubara, T., Hiramatsu, K., and C.V. Sullivan. 2003. Oocyte growth in temperate basses: multiple forms of vitellogenin and their receptor. *Fish Physiol. Biochem.* 28:301-303.

Hiramatsu, K., Hiramatsu, N., Hara, A., Matsubara, T., and C.V. Sullivan. 2003. Multiple vitellogenins in white perch (*Morone Americana*). *Fish Physiol. Biochem.* 28:347-348.

Sullivan, C.V., Hiramatsu, N., Kennedy, A.M., Clark, R.W., Weber, G.M., Matsubara, T., and A. Hara. 2003. Induced maturation and spawning: opportunities and applications for research on oogenesis. *Fish Physiol. Biochem.* 28:481-486.

Patiño, R., and C.V. Sullivan. 2002. Ovarian follicle growth, maturation, and ovulation in teleosts. *Fish Physiol. Biochem.* 26:57-70.

PRESENTATIONS:

Sullivan, C.V., Kennedy, A.M., Hiramatsu, N., Morton, C.L., Weber, G.M., Klenke, U., and Y. Zohar. 2004. Reproduction of striped bass: Endocrinology of ovarian atresia. 5th International Symposium on Fish Endocrinology, September 5-9, 2004, Castellón, Spain.

Sullivan, C.V. 2003. Ovary: different types of ovaries, oocyte growth, and cytoplasmic maturation. *Curso: Reproduccion en Peces.* 17-21 November, 2003. Centro de Investigaciones Biologicas, Universidad Autonoma del Estado de Morelos, Cuernavaca, Morelos, Mexico.

Sullivan, C.V. 2003. Hormonal control of reproduction: steroids, receptors, and gametogenesis. *Curso: Reproduccion en Peces.* 17-21 November, 2003. Centro de Investigaciones Biologicas, Universidad Autonoma del Estado de Morelos, Cuernavaca, Morelos, Mexico.

Donato, D.M., Hiramatsu, N., Arey, K.M., Hiramatsu, K., Kennedy, A.M., Morton, C.L., Hara, A., and C.V. Sullivan. 2003. Atresia in temperate basses: cloning of hatching enzyme (choriolyisin) homologues from atretic ovaries. 7th International Symposium on the Reproductive Physiology of Fish, 18-23 May, 2003, Ise-Shima, Mie Japan.

Hiramatsu, N., Hara, A., Matsubara, T., Hiramatsu, K., and C.V. Sullivan. 2003. Oocyte growth in temperate basses: multiple forms of vitellogenin and their receptor. 7th International Symposium on the Reproductive Physiology of Fish, 18-23 May, 2003, Ise-Shima, Mie Japan.

Hiramatsu, K., Hiramatsu, N., Hara, A., Matsubara, T., and C.V. Sullivan. 2003. Multiple vitellogenins in white perch (*Morone americana*). 7th International Symposium on the Reproductive Physiology of Fish, 18-23 May, 2003, Ise-Shima, Mie Japan.

Sullivan, C.V., Hiramatsu, N., Kennedy, A.M., Clark, R.W., Weber, G.M., Matsubara, T., and A. Hara. 2003. Induced maturation and spawning: opportunities and applications for research on oogenesis. 7th International Symposium on the Reproductive Physiology of Fish, May 18-23, 2003, Ise-Shima, Mie Japan.

PROJECT_HONORS: PI (C.V. Sullivan) elected Coordinator of the National Program of Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry in 2002 and re-elected to this position in 2003.

Best Student Poster Award: Dominique Maria Donato. 7th International Symposium on the Reproductive Physiology of Fish, 18-23 May, 2003, Ise-Shima, Mie Japan.

Invited Seminar: Sullivan, C.V. 2003. Oogenesis in teleost fish: myths and miracles. Department of Zoology, University of New Hampshire, 28 February, 2003, Durham, New Hampshire.

Invited Lecture: Sullivan, C.V. 2003. Graduate aquaculture research and education at NCSU. N.C. Aquaculture Development Conference, 23-25 January, 2003, Atlantic Beach, NC.

PROJECT TITLE: Linking water quality to pelagic fish distribution and behavior: a multiscale approach

PROJECT SEA GRANT NUMBER: R/MRD-44

PROJECT LEAD PI: Peter Rand, NCSU & Wild Salmon Center

PROJECT CO-PI: Chris Taylor, NCSU - Zoology and CMAST

ARTICLES:

Taylor, J.C. and P.S. Rand. In prep. Linking water quality to habitat selection and trophic interactions between estuary-dependent pelagic fishes. *Ecological Modeling.*

J.C. Taylor. In prep. Activity rates and behavior of anchovies (*Anchoa spp.*) in an intermittently mixed estuary: implication for individual energetics and trophic dynamics. *Journal of Fish Biology.*

J. C. Taylor and P.S. Rand. 2003. Spatial overlap and distribution of anchovies (*Anchoa spp.*) and copepods in a

shallow, stratified estuary. *Aquatic Living Resources* 16: 191-196.

STORIES: Article in Winter 2001 Coastwatch. PRESENTATIONS:

J. C. Taylor. 2003. Spatial structuring of anchovy biomass during episodic hypoxic disturbances. Invited paper in the Mesoscale Features in Estuaries Symposium. Biennial Meeting of the Estuarine Research Federation, 14-18 September, Seattle, WA.

J.C. Taylor and P.S. Rand. 2002. Coupling spatially explicit models and sonar surveys to assess distribution of fishery resources. Invited paper in the Spatial Movement of Fishes Symposium, 132nd Annual Meeting of the American Fisheries Society, 18-23 August, Baltimore, MD.

J.C. Taylor and P.S. Rand. 2002. Spatial overlap and interactions between plankton and grazing fishes in an oxygen-stratified estuary. Invited paper in the Bays, Sounds, Gulfs and Lagoons: Estuarine Fisheries for the 21st Century Symposium, 132nd Annual Meeting of the American Fisheries Society, 18-23 August, Baltimore, MD.

J.C. Taylor. 2001. Science at the speed of sound: Applications of fisheries sonar to study pelagic fish in the Neuse River, Duke University Marine Laboratory.

J.C. Taylor and P. Rand. 2002. Acoustic assessment of spatial overlap and trophic interactions of fish grazers and planktonic prey in a shallow stratified estuary. 6th International Council for the Exploration of the Sea Symposium on Acoustics in Fisheries and Aquatic Ecology, 10-14 June, Montpellier, FRANCE.

J. C. Taylor and P.S. Rand. 2001. Linking water quality and pelagic fish distribution in a eutrophying estuary. Invited paper in the Use of Acoustics to Monitor Fish Populations in Large Rivers Symposium, 131st Annual Meeting of the American Fisheries Society, 19-23 August, Phoenix, AZ.

J.C. Taylor. 2001. Science at the speed of sound: Applications of fisheries sonar to study pelagic fish in the Neuse River, Duke University Marine Laboratory.

PROJECT TITLE: Broken rungs at the bottom of the ladder: effects of estuarine stratification on trophic transfer between plankton and grazers

PROJECT SEA GRANT NUMBER: R/MRD-47

PROJECT LEAD PI: Peter Rand, NCSU & Wild Salmon Center

PROJECT CO-PI: Chris Taylor, NCSU - Zoology and CMAST

ARTICLES:

Taylor, J. C. Distribution, Behavior And Trophic Interactions Of Pelagic Planktivores And Copepods In An Intermittently Stratified Estuary. Doctoral Dissertation, NC State University, Department of Zoology, 165p.

Taylor, J.C. and P.S. Rand. In prep. Linking water quality to habitat selection and trophic interactions between estuary-dependent pelagic fishes. *Ecological Modeling*.

J.C. Taylor. In prep. Activity rates and behavior of anchovies (*Anchoa* spp.) in an intermittently mixed estuary: implication for individual energetics and trophic dynamics. *Journal of Fish Biology*.

J. C. Taylor and P.S. Rand. 2003. Spatial overlap and distribution of anchovies (*Anchoa* spp.) and copepods in a shallow, stratified estuary. *Aquatic Living Resources* 16: 191-196.

STORIES:

Article in Winter 2001 Coastwatch.

PRESENTATIONS:

J. C. Taylor. 2003. Spatial structuring of anchovy biomass during episodic hypoxic disturbances. Invited paper in the Mesoscale Features in Estuaries Symposium. Biennial Meeting of the Estuarine Research Federation, 14-18 September, Seattle, WA.

J.C. Taylor and P.S. Rand. 2002. Coupling spatially explicit models and sonar surveys to assess distribution of fishery resources. Invited paper in the Spatial Movement of Fishes Symposium, 132nd Annual Meeting of the American Fisheries Society, 18-23 August, Baltimore, MD.

J.C. Taylor and P.S. Rand. 2002. Spatial overlap and interactions between plankton and grazing fishes in an oxygen-stratified estuary. Invited paper in the Bays, Sounds, Gulfs and Lagoons: Estuarine Fisheries for the 21st Century Symposium, 132nd Annual Meeting of the American Fisheries Society, 18-23 August, Baltimore, MD.

J.C. Taylor. 2001. Science at the speed of sound: Applications of fisheries sonar to study pelagic fish in the Neuse River, Duke University Marine Laboratory.

J.C. Taylor and P. Rand. 2002. Acoustic assessment of spatial overlap and trophic interactions of fish grazers and planktonic prey in a shallow stratified estuary. 6th International Council for the Exploration of the Sea Symposium on Acoustics in Fisheries and Aquatic Ecology, 10-14 June, Montpellier, FRANCE.

J. C. Taylor and P.S. Rand. 2001. Linking water quality and pelagic fish distribution in a eutrophying estuary. Invited paper in the Use of Acoustics to Monitor Fish Populations in Large Rivers Symposium, 131st Annual Meeting of the American Fisheries Society, 19-23 August, Phoenix, AZ.

J.C. Taylor. 2001. Science at the speed of sound: Applications of fisheries sonar to study pelagic fish in the Neuse River, Duke University Marine Laboratory.

PROJECT TITLE: Accelerated Genetic Improvement of Striped Bass: Molecular Markers of Growth Performance

PROJECT SEA GRANT NUMBER:R/AF-41

PROJECT LEAD PI: Russell J. Borski, Dept. Zoology, N.C. State University

PROJECT CO-PI: Craig V. Sullivan, Dept. Zoology, N.C. State University

ARTICLES: None

STORIES:

Kane, D. (Ed.). "Building Better Bass." Raleigh News and Observer. August 28, 2002. Pages 1-3B.

PRESENTATIONS

Russell J. Borski, Harry V. Daniels, Thomas M. Losordo and Craig V. Sullivan. 2004. Improving production technology for finfish aquaculture in North Carolina. North Carolina Aquaculture Development Conference, January 23-25, Atlantic Beach, North Carolina.

Picha, M.E., Fruchtman, S., Noga, E.J., and Borski, R.J. 2004 Increases in insulin-like growth factor-I during compensatory growth in a teleost fish. Annual Meeting of the Society for Integrative and Comparative Biology, New Orleans, LA. January 5-9. Pg. 312.

Picha, M.E. and Borski, R.J. 2004. Compensatory growth in hybrid striped bass. International Triennial Meeting of the World Aquaculture Society, Honolulu, HI. March 1-5. Pg. 63.

Picha, M.E., Caldwell, J.M. and Borski R.J. Insulin-like growth factor I and the compensatory growth response in hybrid striped bass. 5th International Symposium on Fish Endocrinology, Castellon, Spain. Sept 5-9. P 137.

Craig V. Sullivan, Charlene R. Couch and Amber F. Garber. 2004. Toward the goal of increased production efficiency: domestication and selective breeding of striped bass *Morone saxatilis* and its hybrids. The Annual International Conference and Exposition of the World Aquaculture Society, March 1-5, Honolulu, Hawaii.

Charlene R. Couch, Amber F. Garber and Craig V. Sullivan. 2004. Marker-assisted selective breeding of striped bass, *Morone saxatilis*: phase I common garden performance trials. The International Conference on the Status of Plant & Animal Genome Research, January 10-14, San Diego, California.

Amber F. Garber, Charlene R. Couch and Craig V. Sullivan. 2004. Domesticated versus wild broodstock: pond-reared hybrid striped bass performance evaluation utilizing microsatellite markers. The International Conference on the Status of Plant & Animal Genome Research, January 10-14, San Diego, California.

Charlene R. Couch, Amber F. Garber, and Craig V. Sullivan. 2003. NCSU research summary: common garden progeny performance trials. Second Annual Workshop on Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, October 22-23, Stuttgart, Arkansas

Amber F. Garber, Charlene R. Couch, and Craig V. Sullivan. 2003. *Morone* broodstock improvement and selective breeding: what's underway at NC State University. Striped Bass Growers Industry Forum at the Annual National Conference and Exposition of the U.S. Chapter of the World Aquaculture Society, February 18-21, Louisville, Kentucky.

Craig V. Sullivan, Charlene R. Couch, Amber F. Garber, and Cynthia L. Morton. 2003. Genetic improvement of finfish broodstock: DNA marker-assisted selective breeding of hybrid striped bass. North Carolina Aquaculture

Development Conference, January 23-25, Atlantic Beach, North Carolina.

Craig V. Sullivan, Andy S. McGinty, Charlene R. Couch, and Amber F. Garber. 2002. Selective breeding of striped bass: reproductive capabilities and limitations. Workshop on Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, October 22-23, Stuttgart, Arkansas.

Hodson, R.G., C.R. Couch, and C.V. Sullivan. 2002. Morone broodstock: reproduction, domestication and selective breeding. Aquaculture America 2002, January 27-30, San Diego, CA.

PROJECT TITLE: Linking water quality and trophic interactions in a eutrophic coastal river: movement patterns, foraging, and mortality of blue crabs

PROJECT SEA GRANT NUMBER: R/MRD-43

PROJECT LEAD PI: David B. Eggleston, Dept. of Marine, Earth, & Atmospheric Sciences, North Carolina State University, Box 8208. Raleigh, NC 27606. Tel: 919-515-7840

PROJECT CO-PI: Thomas G. Wolcott, Dept. of Marine, Earth, & Atmospheric Sciences, North Carolina State University, Box 8208. Raleigh, NC 27606. Tel: 919-515-7866

ARTICLES:

Bell G.W. (2002). Behavioral response of free-ranging blue crabs to episodic hypoxia. M.S. thesis, North Carolina State University, Raleigh. 58 pp.

Bell GW, Eggleston DB, Wolcott T.G. (2003). Behavioral responses of free-ranging blue crabs to episodic hypoxia. I. Movement. Mar Ecol Prog Ser 259: 215-225

Bell G.W., Eggleston D.B., Wolcott T.G. (2003). Behavioral responses of free-ranging blue crabs to episodic hypoxia. II. Feeding. Mar Ecol Prog Ser 259: 227-235

Bell G.W. and D.B. Eggleston (in press). Species-specific avoidance responses of blue crabs and fish to chronic and episodic hypoxia. Mar Biol

Eggleston D.B. and G.W. Bell (in review). Interactive effects of episodic hypoxia and cannibalism on juvenile blue crab mortality. J Exp Mar Biol Ecol

PRESENTATIONS:

Bell, G.W., D.B. Eggleston, and A.D. Amavisca. Interactive effects of episodic hypoxia and cannibalism on juvenile blue crab mortality. 2004 Benthic Ecology Meeting.

Bell G.W., D.B. Eggleston, and T.G. Wolcott. Feeding response of free-ranging blue crabs to episodic hypoxia in a highly eutrophic river. 2003 Crustacean Society Meeting.

Bell G.W., D.B. Eggleston, and T.G. Wolcott. The effect of periodic and dynamic hypoxia on blue crab movement, distribution, and abundance patterns. 2002 Benthic Ecology Meeting.

Bell, G.W., D.B. Eggleston, and T.G. Wolcott. Periodic hypoxia, blue crab movement patterns and feeding behavior in a highly eutrophic river. 2001 Benthic Ecology Meeting.

Bell, G.W. The impact of water quality on the movement patterns, foraging behavior, and agonism of adult blue crabs, *Callinectes sapidus*, in a highly eutrophic river. 2000 MEAS Dept. Student Seminar Series

PROJECT TITLE: Demographic Change in North Carolina's Coastal Counties and Related Policy Implications

PROJECT SEA GRANT NUMBER: R/BS-14

PROJECT LEAD PI: Lauriston R. King, East Carolina University

PROJECT CO-PI: Jack Thigpen III, NC Sea Grant

ARTICLES:

Shared EXCEL spreadsheet developed by Emily Boyd with Drs. Jack Thigpen, Thomas Fish, and Rhonda Crawley, to contribute to development of GIS maps produced in their NOAA Coastal Services Center atlas, Mapping Social Change in U.S. Coastal Counties: North Carolina (2003)

Project provided information required to develop Op-Ed piece, Lauriston R. King, A new focus on North Carolina's coast, The News & Observer, September 21, 2004

PRESENTATIONS:

Poster presentation (Emily Boyd) at the National Sea Grant Performance Assessment Team review of the North Carolina Sea Grant Program.

Appendix E: Graduate Students

Other undergraduate and graduate students participate in North Carolina Sea Grant research projects without direct compensation from Sea Grant.

North Carolina Sea Grant Stipend-Supported Students in 2003 and 2004

Student	PI	University
Nathan M. Bachelor	Jeffrey Buckel	NCSU
Matt Picha Amber F. Garber	Russell Borski Craig Sullivan	NCSU
Rebecca Gerhart Michelle Ortwine Bryon Toothman Renee Harrington	Larry Cahoon	UNCW
Felix Del Toro Silva	John Miller	NCSU
Thomas E. Gallo	Hans Paerl	UNC-CH
L.M. D'Anna	Charles Peterson	UNC-CH
Stephen Artabane Sara Colosimo Joe Sonnier	Martin Posey	UNCW
Lori A. Davias	Jim Rice	NCSU
David Love	Mark Sobsey	UNC-CH
Larry McSwain	David Griffith	ECU
Henry Allen Klaiber	Matthew Holt	NCSU
Brad Wright	Tyre Lanier	NCSU
Anirudh Ullal Jone Corrales	Ed Noga	NCSU
Leslie Bradshaw Erin Lail	Steve Skrabal	UNCW
Marc Turano	Harry Daniels	NCSU
Daniel Lee Dickerson	Karen Dawkins	NCSU

Special Fellowships

Student	School	Advisor	Fellowship
Shauna Slingsby James "Bo" Dame Jessica Maher Adrienne Harris	UNC-Wilmington East Carolina Duke Duke	Walter Clark	Knauss Fellowship in Marine Policy — position in Washington, D.C.
Lindsay Fullenkamp	Master's from Duke, fellowship position at NC State	Walter Clark	NC Coastal Management Fellowship
Charlene Couch	NC State	Craig Sullivan	Industrial Fellowship with Kent SeaTech
Marie Ruilova	NC State	Tyre Lanier	Industrial Fellowship with Star-Kist
Beth Shimps	NC State	Jim Rice	National Science Foundation Graduate Fellowship
Stacey Luthy	PhD from University of Miami, Coral Gables. Position at NC State	Jeffrey Buckel	NC Fisheries Management Fellowship
Kathleen Angione	Master's from NC State, position at NC State	Katie Mosher	NC Sea Grant Science Communications Fellowship

Appendix F: Honors and Awards

North Carolina Sea Grant continues its tradition of state and national recognition. Honors and awards received by Sea Grant staff, researchers and students in 2003-2004 included:

- Sandra Harris and Walter Clark received the Award for Excellence, North Carolina State University, Office of Research and Graduate Studies, 2004.
- An outreach campaign focusing on *The Dune Book* received a Grand Award from the national APEX communications competition. Authors Spencer Rogers and David Nash also led workshops based on the book. Ann Green edited the publication and coordinated media relations for the campaign.
- *Coastwatch* received an Award of Excellence from the national APEX Communications competition.
- *Coastwatch* magazine took first place in the N.C. Association of Government Information Officers competition for continuing publications.
- North Carolina Sea Grant continues to be among the top programs in sending Knauss Fellows to Washington, D.C. Four North Carolina fellows were selected in 2003 for the term beginning in February 2004, while four more were selected in 2004 for the term beginning in 2005.
- Researcher Lian Xi of North Carolina State University was asked to organize the "International Forum on Environment" in Beijing, China Sept. 13 to 14, 2004. It is a follow-up to a 2002 workshop on dust storms and their impact on the environment. The first conference was partially funded by North Carolina Sea Grant and earned national media coverage. The China conference was sponsored by the 2008 Beijing Olympic Committee and Beijing Environmental Protection Agency.
- Researcher Matt Barr presented a 22-minute documentary at the American Anthropological Association meeting in New Orleans in November 2003.
- Deniz Aygen, a graduate student working on a minigrant with Steven D. Emslie of the University of North Carolina at Wilmington, received a \$400 award from the Carolina Bird Club.
- Hybrid striped bass research by Sullivan and Russell Borski of NC State has netted several additional awards.
 - Graduate fellow Charlene R. Couch was awarded a 2004 Gov. and Mrs. Dan K. Moore Fellowship to Keep NC Clean and Beautiful for her work on striped bass breeding genetics. The award is for \$10,000 in travel and research funds, effective 5/1/04-5/1/05.
 - Matt Picha earned "Best Abstract" and student travel awards for the 2003 Annual World Aquaculture Society Conference in Salvador, Brazil.
 - Amber F. Garber was awarded an Agricultural Foundation Fellowship for 2004-2007.
 - Jennifer McDonald and Jonathon Scheffe, students working with Russell Borski and Craig Sullivan at NC State, received Best Presentation Awards at the NC State Undergraduate Symposium.
 - Sullivan, longtime Sea Grant researcher at North Carolina State University, was re-elected Coordinator of the National Program of Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry.
- Researchers Stephen Skrabal and Robert Kieber received the Strategic Environmental Research and Development Program (SERDP) compliance project of the year award in 2003 for a project that was leveraged from their Sea Grant project on effects of metal speciation on water quality and benthic biota.
- Graduate student Russell Barbour received best student paper award at the Crustacean Society Meeting. His paper was based on work with Martin Posey of the University of North Carolina at Wilmington.
- Melanie Harrison, a student at Johnson C. Smith University working with Sea Grant researcher Inna Sokolova of University of North Carolina at Charlotte, presented results at the 4th Annual Louis Stokes Alliance for Minority Participation Conference, which is a national forum for students in biology and biomedicine, in October 2004 in Houston, TX. The MBRS-TARE program sponsors Harrison and Paige Waymer, who are working a project to identify genetic markers of high resistance to Perkinsus, for minority students at JCSU.
- Wrightsville Beach, NC, was selected as the location for a news conference to launch the national "Break the Grip of the Rip" safety campaign developed by NOAA and the U.S. Lifesaving Association. Katie Mosher and Spencer Rogers served on the task force that developed the campaign.
- Kim Fogg, assistant director for finance, received a Certified Research Administrator designation.