

Coastal Science
Serving
North Carolina



2001 Annual Report

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

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INTRODUCTION

North Carolina Sea Grant celebrated a milestone in 2001 — the 25th anniversary of its status as a full Sea Grant College Program with integrated missions of research, education, extension and communications. The anniversary encouraged the staff and extended Sea Grant family to take time to recognize those who built the foundation of the program: The early researchers saw the role of nutrients in the estuaries that serve as critical nursery grounds for many fisheries. The early “marine advisory service” staff took cutting-edge research to the docks and the coastal communities, setting the stage for the expanded Sea Grant extension program. The local and state leaders embraced Sea Grant as a source of science-based unbiased information so critical to important policy and management decisions regarding coastal and marine resources. With three anniversary events along the coast and one in Raleigh, the Sea Grant program joined with state leaders and coastal residents alike to celebrate the anniversary milestone.

But North Carolina Sea Grant is not one to rest on its past laurels. Rather, in 2001, researchers continued to make scientific breakthroughs and staff members continued to ensure that important research results are shared with regulators, elected officials, private industry, community groups and the general public. And the outreach staff continued to address needs — from safety issues to water quality concerns, from continuing development to declining fisheries — that echo from town to town.

With staff located in three coastal communities as well as the state capital, Sea Grant has daily contact with a variety of persons who value our coastal and marine resources. Our research program includes the 16-campus University of North Carolina system as well as Duke University, and thus we can draw upon some of the nation’s finest scientists. We rely upon community leaders to help guide our program and to help us to disseminate important information to the people.

And so, we provide this annual report of the North Carolina Sea Grant Program, as funded by the National Oceanic and Atmospheric Administration Grant NA86RG0036. This report will cover activities in 2001.

PROGRAM ACCOMPLISHMENTS AND IMPACTS

North Carolina Sea Grant provides an extensive program that looks at a wide range of coastal and marine topics. While the focus of the program is on the North Carolina coast, our programs have impact throughout the state, such as the restoration of inland urban streams and the safety of seafood for all consumers. We also see great value in projects that take a regional approach or combine to provide a national perspective on a particular topic.

The successes we outline in this report are possible only with the cooperation of many partnering agencies on the local, state, regional and national levels. These include regulatory commissions, state government divisions, town and county departments and community groups focused on specific topics or locales. We have organized this report into the three overall categories identified in our strategic plan: Economic Leadership; Coastal Ecosystem Health and Public Safety; and Education and Human Resources.

ECONOMIC LEADERSHIP

North Carolina's coast has seen many changes in recent decades. Fishing villages have become vacation and retirement havens. While commercial fishing no longer rules the coastal economy, new fisheries-related businesses, including aquaculture and value-added seafood products, are on the rise. Policy makers must weigh environmental, economic and societal concerns when making decisions. Sea Grant provides research and outreach projects that consider these factors.

Fisheries

North Carolina's vast fishery stocks had long served as the economic cornerstone 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 interests. Thus, our fishery goals include:

- 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.

Research

- **“Field Tests of an Ecophysiological Model of Habitat Value to Predict Performance and Recruitment of Juvenile Marine Fishes,”** by John Miller of N.C. State University, with W.H. Neill of Texas and K.M. Leber of Florida as co-principal investigators. These researchers have developed new models to determine which habitats are best suited for particular species of finfish. The new models take into account factors such as food, dissolved oxygen, temperature, salinity and pH levels, and thus evaluate the potential for a species to thrive in a given area even if the species is not currently present in that location. Most current habitat assessments are based on the existing abundance of fish in an identified area. The new Sea Grant models were successful for three important species in the Southeast and Gulf states. For red drum, which tends to graze for its food, a model accurately predicts the anticipated growth rates under various environmental conditions. For snook, which is known as a “sit and wait” predator, a model accurately predicts the movement of fish through the environment. For flounder, the Sea Grant research revealed lethal levels 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 the use of the model by the Japanese government. Overall, these habitat models can be used in various fisheries management efforts, such as identifying areas as potential sanctuaries or identifying areas where enhancement of particular species would be most successful. Miller and his colleagues anticipate these initial models will be adapted to identify desirable habitats for additional species.

- **“Linking Water Quality and Trophic Interactions in a Eutrophic Coastal River: Movement Patterns, Foraging and Mortality of Blue Crabs,”** by David Eggleston and Thomas G. Wolcott, both of N.C. State University. Using biotelemetry techniques and real-time water quality monitoring, these researchers were able to determine how, when and where adult blue crabs respond to spatiotemporal dynamics of hypoxia within the Neuse River. In the second year

of the project, the researchers also conducted trawl surveys. The results are consistent with findings of previous studies that suggest that blue crabs avoid hypoxic water. However, the researchers collected blue crabs in small numbers at mid-depths during a hypoxic upwelling event (mean DO = 0.23 mg/l), suggesting that some crabs do not avoid hypoxic water. The results obtained from this study are crucial for fisheries managers who are required to make decisions regarding the impact of hypoxia on estuarine food webs and blue crab population dynamics, as well as for ecologists modeling the role of fishery bycatch and fish kills in estuarine food webs. Moreover, the results obtained in this study are important to water quality and habitat managers that are required to assess the ecological consequences of reduced water quality. This project complements other Sea Grant research on nutrients and lower trophic levels, field studies relating water quality to fisheries and marine mammals, and water quality monitoring assays in the Neuse estuary. This water quality information, combined with measures of water quality within the Eggleston/Wolcott sites, has allowed the researchers to characterize the magnitude and frequency of hypoxic upwelling events. The results of this report will be presented in at least two scientific meetings, and journal publications are expected. The work is the focus of one graduate student's thesis. Eight undergraduate and high school students also participated in the project.

- **“Linking Water Quality in Pelagic Fish Distribution and Behavior: A Multi-Scale Approach,”** by Peter Rand of N.C. State University. Rand's project has focused on development of a model to predict temporal and spatial patterns of distribution of pelagic grazing fishes, specifically Atlantic menhaden and bay anchovy in the Neuse River estuary. The model has been tested using hydroacoustics and net capture to measure fish distribution. Rand has found that stratification and bottom hypoxia do not seem to influence the patterns of distribution of prey resources, phytoplankton and zooplankton. Also, vertical distribution of zooplankton corresponds to observed distribution of chlorophyll in the water column. Density stratification of the water column that leads to hypoxic bottom water can play a major role in the distribution of small pelagic fishes. Overall, results indicate that during adverse water quality conditions, such as hypoxic events, plankton and grazers may be spatially separated. This may have important implications for ecosystem function in the system in terms of transfer of nutrients and energy through the food web. Preliminary results already have been shared with the N.C. Division of Marine Fisheries Habitat Section, in particular for the development of the Neuse River Coastal Habitat Protection Plan that is scheduled for revision in 2003. The final results are expected to be useful in a number of coastal river/estuary habitat plans, including the Pamlico River. The results will be submitted to a marine ecology journal and preliminary data regarding the acoustical monitoring was presented at the American Fisheries Society annual meeting and will be presented at a meeting in France in 2002. The research also has been featured in *Coastwatch* magazine. Chris Taylor, who is completing his Ph.D. on research related to this project, has received a STAR Fellowship from the Environmental Protection Agency.

Outreach

The largest component of the North Carolina Sea Grant extension staff focuses on fisheries, with specialists located in each of three coastal offices. These veteran Sea Grant staff members have longstanding ties with the coastal communities and can often draw upon “highliners” to demonstrate new gear or participate in sampling studies. In 2001, those efforts have included expanded demonstrations of a skimmer trawl for shrimp and the “green stick” rigging for tuna.

The staff also has focused efforts on blue crabs, the state's leading commercial fishery, including working on a new poultry-based bait and the refinement of shedding systems for the soft-shell markets. In 2001, aquaculture specialist Marc Turano coordinated the initial cycle of the Blue Crab Research program. Funded by the N.C. General Assembly, it draws together coastal crabbers and university researchers to consider issues facing the blue crab fishery. Fisheries specialist Bob Hines continues to coordinate the Fishery Resource Grant Program (FRG). All fisheries specialists

serve as monitors for FRG projects, The new blue crab effort and numerous FRG projects have been featured in *Coastwatch* and were seminar topics at the 2001 N.C. Commercial Fishing Show.

Fisheries specialists often attend the N.C. Marine Fisheries Commission meetings and are often called upon to provide the commission with background information. Sea Grant fisheries specialist Jim Bahen chairs the commission's Southeast Regional Advisory Committee. Bahen and others also attend other meetings called by state and federal agencies, including sessions on controversial topics, such as efforts to protect endangered sea turtles and marine mammals.

Coastal waters draw thousands of recreational fishers each year — and North Carolina Sea Grant is ready with educational materials on ethical angling and catch-and-release techniques. Earlier efforts have included a pocket-size information card on red drum, the state saltwater fish. In Fall 2001, as state regulators were noticing a high mortality of red drum due to improper tackle, Bahen provided not only the information cards, but also samples of the preferred circle hooks to anglers along the central coast. In 2002, Sea Grant will continue this outreach with a brochure on ethical angling and other efforts with the N.C. Division of Marine Fisheries and the recreational fishing communities.

Aquaculture

Consumers worldwide are increasing the amount of seafood in their diets, yet many wild stocks are on the decline. Thus the role of aquaculture, also known as fish farming, is gaining attention. But aquaculture operators and community leaders have many questions, including costs and environmental impact. 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 and systems.
- Improving the efficiencies of a variety of shellfish aquaculture and shellfish mariculture operations.

North Carolina Sea Grant is recognized as a leader in hybrid striped bass aquaculture, which is now a multimillion-dollar industry. Much of that research is being transferred to other species, including flounder. In addition, Sea Grant researchers are developing new feed formulas to meet the nutritional demands for proper growth.

Research

- **“Reproduction of Domesticated Striped Bass: Coldbanking to Arrest Maturation and Atresia,”** by Craig V. Sullivan, N.C. State University. Continued growth of the hybrid striped bass aquaculture industry will require full domestication of striped bass and white bass as parental lines. In addition, the industry will need the ability to program reproduction at any time during the year. Earlier efforts have provided domesticated white bass and allowed triple cropping of fingerlings. This project is taking the domestication of striped bass to the same level, including attention to both husbandry and diet. Because of Sea Grant efforts, many hybrid striped bass fingerlings produced in North Carolina come from domesticated broodstock. Additional work includes the refinement of methods to allow multiple fingerling crops per year per pond. In addition, techniques are being developed to put broodfish into a temporary maturation arrest so that spawning can be timed to avoid adverse weather. Finally, cold-banking methods will allow fish to be induced to mature out of season, thus offering continuous year-round production. This project continues through 2002. Early results have been presented at national and international meetings, as well as directly to the aquaculture industry. The project provides a post-doctoral student stipend.

- **Improved Methods for Managing Water Mold Infections of Fish,”** by Ed Noga of N.C. State University. This project resulted in the discovery of novel antibiotic factors in fish. The results, as reported in the journal *Nature*, could prove crucial for aquaculture operations, where control of infectious disease is a constant struggle. Traditionally, controlling many of these pathogens has relied heavily on drugs or other chemicals. But drugs can be expensive and must meet strict regulations before they are approved for use in food fish. Also, there are concerns for drug residues and a possible public health threat. Clearly, there is a need for innovative approaches to controlling infectious diseases that have broad application to many fish species and which may be implemented at a relatively low cost. Noga’s team recently isolated potent peptide antibiotics from the gill tissue of hybrid striped bass (*Morone saxatilis* male x *M. chrysops* female). This peptide was determined to constitute a new type of peptide antibiotic. The overall goal of the new project is to characterize what may be a critically important defense in protecting hybrid striped bass, one of the most rapidly growing segments of U.S. aquaculture. Noga’s findings have received extensive media attention, from dozens of newspapers, magazines and Internet sites. Umaphorn Silphaduang, a doctoral graduate of N. C. State University who continues to work with Noga on this topic, received a Walter B. Jones Award for Excellence in Coastal and Marine Graduate Study from NOAA in 2001 for her work on this project.

- **“Aquaculture of Southern Flounder: Improved Production Through Environmental and Nutritional Optimization,”** by Harry V. Daniels of N. C. State University, Wade O. Watanabe of UNC-Wilmington and Margie Gallagher of East Carolina University. This project has resulted in successful out-of-season spawning of southern flounder in the spring, summer and fall. The researchers are able to control spawning during all four seasons, rather than during the normal two-month winter spawning period. This advance will accelerate flounder hatchery research and development of growout technology. The project also demonstrated the requirements of flounder larvae for long-chain omega-3 fatty acids. Researchers have determined the dietary protein requirement for summer flounder appears to be dependent upon water temperature, likely ranging from 45 to 50 percent. Preliminary results of this project has led to four additional grants, including a Saltonstall-Kennedy Grant of more than \$68,000 and a NOAA National Marine Aquaculture Initiative Grant of \$120,000. In addition, the progress on flounder aquaculture studies resulted in an \$80,000 expansion of facilities funded by Southern States Cooperative, Inc. The Sea Grant project results have been the subject of seven journal articles or abstracts and have been presented at meetings, including the World Aquaculture Society, the American Fisheries Society and Aqua 2001 held in France. The work has been featured in *The Virginian Pilot* and on WorldCatch, an online seafood information service. Four master’s students and one undergraduate honors student have worked on the project. The research team, which already represents three N.C. universities, has collaborated with Sea Grant researchers in South Carolina, Florida and Virginia, as well as with GreatBay Aquafarms in New Hampshire.

Outreach

In 2001, North Carolina Sea Grant again presented important research and extension projects at the state’s annual Aquaculture Development Conference. In addition, North Carolina Sea Grant Director Ronald Hodson remains active in the research and outreach efforts, including work with the World Aquaculture Society and the Hybrid Striped Bass Growers Association.

In 2001, the communications team worked with Daniels to distribute a pair of “Blueprints” to help aquaculture operators to determine the optimal feeding schedule and to monitor the ammonium in their tank water. Initial discussions with Daniels on a flounder hatchery manual will be expanded upon in 2002.

Outreach efforts in shellfish mariculture are expanding with new facilities at the Center for Marine Science and Technology in Morehead City. Mariculture specialist Philip “Skip” Kemp has

teamed with Carteret Community College to teach classes in shellfish aquaculture. He also provides workshops, works with the statewide growers association, and monitors aquaculture and mariculture projects for the Fisheries Resource Grant programs. Finfish aquaculture and shellfish mariculture projects were featured in *Coastwatch* magazine and *Marine Extension News* in 2001.

Seafood Technology

One of the earliest Sea Grant projects in North Carolina was the funding of seafood laboratory projects at N.C. State University. 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 2001, North Carolina Sea Grant saw success on both outreach and research fronts.

Research

Two seafood technology projects are slated for completion in 2002. They are:

- **“Acid-Aided Processing to Upgrade Value of Atlantic Pelagic Fish Species”** by Tyre Lanier of N.C. State University. A new surimi process resulting from this research offers greater yields and thus may enhance the opportunity to use currently low-valued Atlantic fish, including menhaden. Surimi, probably best known when used as imitation crabmeat, was the result of earlier Sea Grant research that involved mincing larger, white-flesh fish such as pollock and whiting. The new process involves dissolving most of the fish proteins at low or high pH, then neutralizing to recover the protein. The new process accommodates smaller fish such as menhaden, which is now primarily used for industrial purposes rather than in the seafood markets. The move to smaller fish may help keep the surimi prices low, allowing the larger fish to be targeted for the fillet markets. The project was a collaborative effort with Sea Grant researchers in Oregon and Massachusetts. The project also included a graduate student and has resulted in several papers and presentations. It was also featured in *Coastwatch* magazine.
- **“Infusion of Active Proteins to Improve Quality of Intact Seafood Meats”** by Brian Farkas and Tyre Lanier, both of N.C. State University. Fish products often become soft when stored or cooked slowly, a problem linked to proteases in the fish muscle. These proteases may arise from parasites, gut leaching or normal physiology. Food-grade inhibitors could solve the problem if properly delivered, thus the researchers looked at this option using two techniques: macromolecule spatial distribution and fluorescence recovery after photobleaching (FRAP). The research revealed that low molecular-weight protease inhibitors could be effectively diffused into intact fish muscle to minimize meat softening. Based on the results, a major processor of Pacific whiting and Arrowtooth flounder is testing injection of fillets with beef plasma-derived inhibitors to yield a more robust product for consumer preparation in conventional ovens rather than deep frying. The project is the focus of a doctoral student and master’s student, and several journal articles have been written or are expected. The results will be presented at major fisheries and food technology meetings in 2002.

Minigrants are another opportunity for research in seafood technology. For example in 2001, Sea Grant researchers from several states conducted sensory perception tests that compare local blue crab meat with that of imported “blue swimming crabs.”

Outreach

Seafood technology specialist Barry Nash works closely with state and federal agencies as well as the seafood industry to provide safety training, including classes on the federally mandated Hazard Assessment and Critical Control Point. Nash, who works at the N.C. State University's Seafood Laboratory, helps individual processors to develop and update the required HACCP plans. In 2001, he made special efforts to encourage processors to develop value-added products that make it easier for seafood to be cooked at home and in restaurant or institutional settings. These efforts included a new "Seafood Enterpriser" column in the *Marine Extension News* and his work with participants in the Fishery Resource Grant program. In fact, one of those participants is expecting to announce that a restaurant chain will add a new seafood product that is a result of an FRG project. In addition, Nash has worked with the "True Blue Crab" program and other efforts to identify and market North Carolina seafood.

North Carolina Sea Grant's national leadership in seafood technology is shown in the role of Director Ronald G. Hodson as co-chair of the Seafood Technology Theme Team for the national Sea Grant Network. In 2001, Hodson organized the team's first meeting and began coordinating the development of a "white paper" to evaluate the existing Sea Grant efforts in the seafood technology arena as well as the research and outreach needs on national and regional levels.

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.

Research

Folks who live near and work in the estuarine and ocean waters have an understanding of the coastal environment. In "**Local Knowledge and Scientific Resource Management in Changing Coastal Communities,**" East Carolina University researchers David Griffith and Jeffrey Johnson are comparing knowledge of North Carolina fishers with the scientific knowledge of state regulators. They are finding common threads. Initial interviews show many areas of agreement between fishers and fishery managers, but the two groups may differ on specific factors affecting individual fisheries. Fishers may cite the phases of the moon, wind direction and speed, water depth, salinity, substrates and human pressures in their discussions of changing fish stocks and conditions through the year and from year to year. Crabbers see the abundance of sea turtles and striped bass as affecting their catch, while shrimpers view net mandates as having a greater impact. Many crabbers saw their catch drop

after Hurricane Floyd's flooding, while shrimpers saw fewer effects. While this project focuses on North Carolina fishers and fishery managers, it has served as a springboard for a National Science Foundation-funded study of native groups in Kotzebue Sound, Alaska. The work also led to Griffith's development of a project involving the North Carolina fishing community as part of a larger effort by the North Carolina AgroMedicine Institute and funded by the National Institute for Occupational Health and Safety. That project also includes a public information effort by the Sea Grant communications team. The researchers have given multiple presentations using their preliminary data, and the work was included in several book chapters that Griffith has written. The project has included one doctoral student, who was able to use the work as the basis of a proposal to the National Science Foundation's fellowship program, and one master's student. Also, Johnson and Griffith often work with agencies needing suggestions of ways to package information for public consumption or how to interact with various populations that may be affected by management decisions.

Again, minigrants provide additional opportunities for rapid response to policy and development-related issues during the course of the funding cycle. Past efforts have included studies of community response to, and the economic impact of, coastal storms, as well as efforts to reach consensus on controversial subjects including beach nourishment proposals.

Outreach

Coastal policy and sustainable development outreach efforts are led by Jack Thigpen, extension director, and Walter Clark, coastal law and policy specialist. Thigpen previously served as a coastal recreation and tourism specialist and continues his emphasis on coastal communities. In 2001, he began working with NOAA's Coastal Services Center to study demographic changes in coastal counties. Other efforts included leadership, along with marine educator Lundie Spence, of the successful coastal paddling trails initiative, which resulted in a printed and online coastal water trails map, a three-day symposium complete with proceedings and reports.

As president of The Coastal Society, Clark plays a national leadership role in the discussion of crucial policy and development issues facing communities along all U.S. coastlines. In 2001, duties with the society and his N.C. State University teaching load took much time, but Clark also continued to work on sea-level rise issues in conjunction with the U.S. Environmental Protection Agency. Clark's contribution to "The Soundfront Series" of estuarine guidebooks will focus on policy and management decisions to protect the estuarine shoreline and waters. In addition, he worked on the update of a publication to help potential buyers of beachfront property. And Clark worked with communicators to include regular "Legal Tides" feature stories in *Coastwatch* magazine, including such topics as the state's watershed basin program.

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, and water quality. To implement the plan, we provide research and outreach projects that address 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 investment 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 extension activities.

Research

In “**Relationship of Hazard Zones, Shoreline Erosion and Post-storm Recovery to the Geologic Framework of Selected Southeastern North Carolina Shoreline Segments,**” William J. Cleary of UNC-Wilmington builds upon and provides analysis of data gathered through a project of the National Undersea Research Center at UNC-Wilmington. Cleary, a member of the state’s scientific panel on natural hazards, has looked at whether the variability in oceanfront erosion rates and development of hazard zones is controlled by the underlying geologic framework of the beach and shoreface. Results of this project are expected to be integrated into coastal management plans in efforts to minimize future storm damage. The project has supported four graduate students.

Minigrants provide opportunities to address immediate needs. For example, beach nourishment has become an often-controversial tool to deal with oceanfront erosion in North Carolina, but there are many questions regarding nourishment proposals. In 2001, a Sea Grant minigrant supported a two-day symposium to consider the research needs— geologic, biologic, economic, etc. — surrounding beach nourishment. This meeting led to a proposal from Charles Peterson of UNC-Chapel Hill, which has been accepted for the new funding cycle. Other recent minigrants have looked at the effect of beach bulldozing as an erosion mitigation effort and at various effects of Hurricane Floyd, which caused massive flooding across eastern North Carolina in 1999.

Outreach

Spencer Rogers, our coastal construction and erosion specialist, is considered a national expert on coastal processes. In 2001, he worked extensively with Sea Grant researchers from Clemson University to study the impact of wind damage and to design retrofitting options to reduce damage from hurricanes and other coastal storms. For several years he has invited the Clemson team to join him in presenting retrofitting workshops for homeowners at the annual Hurricane Preparedness Expo in Wilmington. The sessions have drawn attention from the public and media alike.

Rogers, who works closely with the Federal Emergency Management Agency and the U.S. Army Corps of Engineers, has studied storm effects for every major East Coast hurricane since 1978. He is currently working with North Carolina State University researchers to chronicle building damages from recent hurricanes in order to assess the impact of changes in the state's coastal building code. Many of those changes, such as a requirement for deeper pilings, were the result of earlier Sea Grant projects.

A member of the state’s Coastal Resources Advisory Council, Rogers also serves on the state’s scientific panel on natural hazards. In 2001, that panel focused attention on issues surrounding North Carolina’s 22 inlets. In addition, Rogers has worked directly with community leaders and property owners on specific erosion problems associated with various inlets. As attention to inlets continues, the Sea Grant guidebook *Shifting Shorelines: A Pictorial Atlas of North Carolina Inlets*, was reprinted to meet demand. The atlas was the result of an earlier research project by Cleary.

Another Sea Grant product, *Questions and Answers About Buying Real Estate at the Coast* was also updated and reprinted in 2001 to meet the continuing demand for information by property owners and real estate agents. The brochure is a cooperative effort with the North Carolina Real

Estate Commission. Additional outreach efforts in coastal processes, such as a rip current education program, are described in the education section of this report.

Rogers also was part of a national team that developed an outreach proposal as a collaborative effort between the national Sea Grant program, the National Weather Service and NOAA's Severe Storms Laboratory. The project focuses on improving models to predict rainfall in coastal storm and sharing them with local weather service offices and communities. The work comes in the wake of Hurricanes Dennis and Floyd, which combined to devastate major portions of eastern North Carolina with floodwaters in 1999.

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 of inputs from throughout the river basins.

Again, the Sea Grant approach includes a mixture of research and outreach activities.

Research

The role of nutrients and other factors in water quality have been the focus of recent Sea Grant research projects. These include:

- **“Sediment-Water Exchange in the Lower Cape Fear Estuary: Effects of Metal Speciation on Water Quality and Benthic Biota”** by Stephen A. Skrabal of UNC-Wilmington. The project relates the contamination of sediments by trace metals, such as copper or zinc (Cu or Zn), to overall estuarine quality and ecosystem health in the Cape Fear estuary, home to a state port in Wilmington. Toxic effects may result when these metals are assimilated by phytoplankton and eventually by higher levels of the food chain. Preliminary results show that dissolved Cu concentrations in the Lower Cape Fear Estuary are well below federal criteria for the metal. The investigators contend, as do other investigators in the field, that water quality criteria for Cu in estuarine and harbor environments should take into account metal speciation, rather than simply the total dissolved concentrations of potentially toxic chemicals, such as Cu. Research continues on the evaluation of Zn concentrations and speciations in the estuary, and benthic flux data is still being evaluated. The researchers are working closely with the Lower Cape Fear River Program and the Coastal Ocean Research and Monitoring Program, both based at UNC-Wilmington. These preliminary results were the basis of a nearly \$500,000 project funded by the Strategic Environmental Research and Development Program, a joint effort of the federal Departments of Energy and Defense and the Environmental Protection Agency. The expanded project takes a holistic approach to studies of Cu and Zn contamination in estuarine and harbor areas used for military berthing and shipping. The project was included in a *Coastwatch* article on water quality research, and two scientific journal articles are being prepared. The researchers have made seven presentations that included this data and the project is generating one Ph.D. dissertation and two master's theses.
- **“Interactions Between Nutrient Additions and Trophic Controls: Scaling Effects and System Variability”** by Martin Posey, Lawrence Cahoon and Troy Alphin, all of UNC-Wilmington. The project will determine if grazers can mask microalgal responses to nutrient additions. The researchers also will identify how fauna respond to moderate levels of nutrient

enhancement. The findings will provide links between water quality and fishery resources, especially at levels where conditions have not reached hypoxia. Preliminary results indicate that estuary responses show a greater range than responses in tidal creeks. For example, initial data reveal responses to nutrient additions and predator exclusions in the White Oak River. Responses in the Cape Fear River, which has greater background nutrient loading and physical disturbances from the riverine flow, were not as strong. This project has generated additional study in the form of a North Carolina Fishery Resource Grant. It also complements a four-year National Science Foundation study of blue crabs in the same low-salinity areas. The researchers have presented this data at three scientific meetings as well in public meetings, such as monthly sessions of the Lower Cape Fear Technical Committee and to advisory committees to the N.C. Marine Fisheries Commission. One scientific journal article has been submitted and the work was featured in *Coastwatch* magazine and *The Wilmington Star*. Five students have worked on this project, including three master's students. The work complements eutrophication studies in South Carolina, Alabama and Florida and the researchers have exchanged information.

- **“Phytoplankton and Zooplankton Community Response to External Nitrogen Loading in the Pamlico Sound, N.C.: Mechanisms and Links to Management of Coastal Eutrophication”** by Hans W. Paerl and Tammi L. Richardson of the UNC-Chapel Hill Institute of Marine Sciences. Enhanced nitrogen loading due to agricultural, urban and industrial expansion in the watersheds leading to the Pamlico Sound has led to eutrophication, as evidenced in harmful algal blooms, hypoxia/anoxia events and fish kills. The project, which also includes collaborators from the Duke University Marine Laboratory and the University of South Carolina, examines the potential and actual effects of nitrogen inputs from tributary rivers on ecosystem structure and function in the Pamlico Sound. The researchers have teamed with the N.C. Department of Transportation's Ferry Division to place data-gathering equipment on the ferries that make multiple daily crossings on the sound. Three ferries are involved in the innovative effort, which is also supported by the N.C. Department of Environment and Natural Resources. Water samples, identified by the ferry's global positioning satellite system, are taken at 3-minute intervals and tested for various factors such as temperature, turbidity, salinity, dissolved oxygen, etc. The data is downloaded nightly and added to a geo-database that shows bathymetry, land use, etc. Preliminary results show the ranges of salinity and temperature and identify the passage of meteorological fronts that inject salty offshore water through the Ocracoke Inlet. Surface concentrates of photopigment, colored dissolved organic matter and suspended solids from water samples are used to calibrate satellite data to provide information across wide areas not easily studied using traditional means. The results of this study will help establish water quality criteria for Pamlico Sound — and thus will benefit local state and regional estuarine science and management. Long-term results are expected to include tools for predictive numerical modeling of ecosystem results to nutrient enrichment, as well as establishment of threshold values for the phytoplankton community structure and the effects of different concentrations of nitrogen on those communities. The work has involved graduate students as well as undergraduates and is linked to a Marine Ecology course at the Duke Lab. The preliminary results have been included in a number of presentations and papers, and use of the ferries for scientific research was the focus of feature stories in *The (Raleigh) News & Observer* and *Coastwatch* magazine.

In addition, minigrants have provided opportunities for rapid response to water quality issues. For example, when the flooding from Hurricane Floyd brought massive amounts of fresh water into the Neuse/Pamlico and Cape Fear estuaries, Sea Grant provided funding for special research cruises to gather immediate data to show the impact.

Outreach

Barbara Doll, our water quality specialist, has emphasized the links between urban streams in the Research Triangle area and our coastal water quality. Named an Environmental Hero by NOAA

in 2001, Doll is recognized for her innovative projects, including the Rocky Branch stream restoration project on the N.C. State University campus. Doll has drawn numerous agencies together for the multimillion-dollar project. The groundbreaking ceremony in May 2001 drew cheers from state officials, scientists and engineers who have supported the project. Construction will continue through 2002.

Doll also works closely with the communications office on a number of projects, from the well-respected *WaterWise* newsletter to collaboration with state agencies to develop a reference site on the Web for question regarding recreational water quality.

In addition to Doll's varied presentations at state and national conferences, the Sea Grant team works with water quality education for the general public. This includes participation in the RiverRevival festival in Wake County, home to portions of both the Neuse River Basin and the Cape Fear River Basin. Also, the *Coastal Water Quality Handbook*, written by Doll and Lundie Spence, marine education specialist, has proved popular for teachers and coastal residents alike. An updated edition is expected for the handbook.

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 here 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.

Earlier research by Sea Grant scientists provided crucial background for management and policy decisions regarding coastal habitats. Sea Grant was a leader in bringing together scientists, managers and coastal residents to consider management options, and Sea Grant will continue this "honest broker" role.

Research

- *Pfiesteria*, a toxic dinoflagellate discovered by North Carolina Sea Grant researchers, has been linked to a number of fish kills in North Carolina, Maryland and Virginia. Sea Grant has continued supporting this important research, including "**Fine Scale Spatial and Temporal Variation in Abundance of *Pfiesteria Piscicida* and *Pfiesteria*-like Species in North Carolina Waters**" by Parke Rublee of the UNC-Greensboro and JoAnn M. Burkholder of N.C. State University. The work includes continued development of a DNA probe to quickly detect *Pfiesteria* presence in water samples. The lessons learned in the DNA probe will not only advance work on *Pfiesteria*, but also on early detection of other problems in our waterways. The researchers are working closely with state officials to evaluate samples from routine surveys as well as from fish kills. Initial sampling showed relatively low incidence of *Pfiesteria*, but those results may be tied to the flushing of estuaries with hurricane floodwaters in 1999. Circulation patterns may not have provided as great flushing in the northern side of the lower Neuse River. Overall, incidence levels increased in later months of 2001, and the researchers anticipate higher levels in 2002. In addition, the researchers continue efforts to correlate land-use data and *Pfiesteria*, with an expectation that while *Pfiesteria* will be found throughout the coastal region, the local distribution may vary based on land patterns. If the hypothesis is confirmed, managers could include such information in future policy and permit decisions. The researchers continue to collaborate with investigators across the U.S. and in other countries, including Australia and New Zealand. And both investigators have received new funding from the state to assay samples

related to a Center for Disease Control study of North Carolina watermen. Their Sea Grant research has contributed to seven peer-reviewed journal articles or chapters, with four more expected. In addition, the work was included in more than a dozen scientific presentations and was featured in a Maryland Sea Grant video. One master's student has completed a thesis that included this work, while another thesis is in process. This project is part of a larger collaborative effort sponsored by numerous federal and state agencies.

Outreach

Doll's work with the Rocky Branch restoration project, as outlined earlier, not only demonstrates water quality improvements, it also provides examples of habitat protection and restoration. In addition, Doll continues to partner with a variety of agencies on restoration projects — including Jumping Run in Carteret County, which includes shellfish habitat in tidal creeks, and Pine View Golf Course in New Hanover County, and Yates Mill Pond in Wake County. Each provides cutting-edge demonstrations involving multiple agencies and organizations.

In 2001, Doll continued to work with a national committee on a Sea Grant guide to aquatic weeds. Stratford Kay of N.C. State University has been the principal author of the guide, which is being edited by Pam Smith of the North Carolina Sea Grant communications team.

EDUCATION AND HUMAN RESOURCES

North Carolina Sea Grant's education efforts provide a broad spectrum. We teach classroom teachers to utilize coastal and marine topics in many areas, from science and math to reading, social studies and art. We partner with nontraditional educators who provide "lessons" in parks, museums and aquariums. We provide educational materials for coastal residents and others to continue in their lifelong journey of learning about the world around them. We provide important safety and consumer information, from identifying rip tides to purchasing safe seafood or understanding the lingo and regulations of coastal development. In addition, we 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 — from helping elementary classroom teachers to bring coastal lessons alive to providing retirees with science-based information about their new coastal environment. This requires a delivery system that provides relevant information — through personal contact, printed or electronic products and sharing news with the mass media — to the public in a timely manner. In particular, we present the following goals:

- Increasing marine literacy among people of all ages.
- Organizing and designing a delivery system to get relevant information to the public.
- Deploying 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.

Research

North Carolina Sea Grant's marine educator Lundie Spence has participated in a number of research efforts, such as mentoring education graduate students and serving on their committees.

Spence has also teamed with The Science House at N.C. State University to develop pilot classroom lessons using NESDIS satellite system data.

Outreach

In the simplest terms, our extension and communication efforts are “public education” projects. Throughout this report, 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 and the people of North Carolina. In 2001, our staff also worked on a variety of regional and national efforts, including presentations at the Mid-Atlantic Watermen’s Show in Maryland and participation in a collaborative project to identify issues involving the Intracoastal Waterway.

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 extensive communications program pulls the public into ongoing extension efforts and shares and the 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. *WaterWise*, published quarterly, provides the latest information on coastal water quality issues. *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.

In recent years, the Internet has become increasingly important as an avenue to present important information to classroom students and teachers, community leaders and the general public. We already have general information on our program, including our strategic plan, available online. We provide listings and abstracts of the FRG and blue crab research projects and we began adding online editions of our newsletters. We also identified the need to update our Web presence, including elements to provide access for disabled users. That review will begin in 2002.

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. For example, in 2001, we worked on a pair of major projects that will come to fruition in 2002:

- As coastal development interests move increasingly to estuarine areas, Sea Grant is leading an education effort regarding estuarine shorelines. With a grant from the N.C. Division of Coastal Management, Sea Grant has worked with N.C. State University’s College of Design to develop a guidebook series that focuses on shoreline erosion, shoreline stabilization options, landscape design and policy/planning issues. The

guidebooks will be available in printed form and on the Web. Coordinated by Lundie Spence, the guidebook series includes Spencer Rogers and Walter Clark as authors. Other partners on the project include geologist Stanley R. Riggs of East Carolina University, Tracy Skrabal of The North Carolina Coastal Federation and Nancy White of N.C. State University's College of Design.

- North Carolina Sea Grant is considered an East Coast leader in rip current safety information, with its poster, video and brochure series. That effort has expanded through a partnership between Rogers and the National Weather Service, which resulted in daily rip current forecasts for North Carolina that are updated on the Web. Prior to the 2001 summer tourist season, North Carolina Sea Grant teamed with Ben Sherman, the Sea Grant national media relations coordinator, to announce the new forecasting program nationwide. Also in 2001, coastal communities requested a permanent sign similar to the rip current posters and brochure. Katie Mosher, Sea Grant assistant director for communications, coordinated the sign project, with support from Rogers and Steve Pfaff of the National Weather Service. By late 2001, the initial order of 400 signs had already been reserved. Hundreds more are expected to be ordered and posted by the 2002 tourist season. The partnership with NWS is expected to expand, with a NOAA rip current home page and expansion of the sign campaign to other Sea Grant programs.

Communicators, extension staff and management respond to countless requests for information each year — and the demand continues to grow. Communicators also work extensively with the general media to spread news of Sea Grant efforts. For example, in Fall 2001, Sea Grant researcher Ed Noga's groundbreaking research on naturally occurring antibiotics found in fish was published in the highly respected journal *Nature*. Sea Grant communicator Ann Green worked with a variety of general media, including *The (Raleigh) News & Observer*, The North Carolina News Network and other state media. Green worked with Sherman to send the news to national and international publications, including Reuters health news service, *The Scientist* and *DVM* magazines. The news release appeared on, or was linked from, more than 45 Web sites, including *noaa.gov* and *nationalgeographic.com*. (A list of communications products can be found in Appendix D.)

Education

Teaching teachers is a national priority for Sea Grant, and the North Carolina program continues to offer outstanding examples in this arena. Training programs include both those seeking education degrees and those now teaching in both formal classroom settings and more informal locations such as museums and parks.

In late 2001, Lundie Spence was named chair-elect of the national network of Sea Grant educators. She is also active in the National Marine Educators Association and has helped to develop North Carolina's Ocean Science Bowl. Sea Grant continues as a contest sponsor. In recent years, Spence has developed Operation Pathfinder workshops for teachers. She developed and teaches an environmental education course, the first of its kind in the UNC system. The course is taught through an innovative teleconferencing format that includes students at four campuses.

Spence and Walter Clark, coastal law and policy specialist, also teach seminars on ocean policy and ocean frontiers for upperclassmen and graduate students at N.C. State University. The classes offered through the university's Multidisciplinary Studies division, draw a mix of students, including future teachers, engineers, journalists and others who know and love the coast.

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 scientists 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. In the 2001, we supported 14 students. In addition to stipends, most students receive tuition and health insurance. (A list of students is in the Appendix E.)
- Sea Grant encourages researchers to include additional graduate students and undergraduates on projects where appropriate.
- 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.
- Since 1985, North Carolina Sea Grant has sent 32 outstanding graduate students to Washington, D.C., as part of the Knauss Marine Policy Fellowship Program. These students put their scientific background to work in various areas of the legislative and executive branches of the U. S. government. Our Knauss alumni continue to provide critical input as science and policy are brought together at the local, state and federal levels. North Carolina Sea Grant plans to develop a directory of these former fellows. Walter Clark has served as coordinator for the Knauss program for many years. In 2001, the N.C. fellows were Kristen J. Long and David Canny, both of Duke University.
- In 2001, Canny and Umaporn Silphaduang of N.C. State University each received a Walter B. Jones Award for Excellence in Coastal and Marine Graduate Study from NOAA.
- North Carolina Sea Grant encourages applications for various national fellowship opportunities, such as the Coastal Services Center program, an industrial fellows program and a national fisheries fellowship. In 2001, North Carolina fellows included Charlene Couch, who is doing aquaculture research with Craig Sullivan of N.C. State University, and Maria Ruilova-Duval, who is continuing seafood technology research with Brian Farkas and Tyre Lanier of N.C. State University.
- In addition, North Carolina Sea Grant initiated its own fellowship program in coastal community development — a partnership with the N.C. Division of Coastal Management. In Fall 2001, Audra Lescher, a graduate student at UNC-Wilmington, started her fellowship that will include a project to evaluate the impact of rising sea level on estuarine shorelines. In the partnership, Sea Grant will provide the stipend and DCM will provide housing and other resources necessary for the fellow to complete the selected project. A committee consisting of Sea Grant and DCM personnel will select a project each year prior to advertising for and selecting the fellow. This fellowship will be on a trial basis for three years.

Appendices

- **Appendix A: Program Development Funds Projects in 2001**
- **Appendix B: Institutions Collaborating with North Carolina Sea Grant in 2001**
- **Appendix C: Sources of Significant Outside Funding**
- **Appendix D: North Carolina Sea Grant Communications Products in 2001**
- **Appendix E: Sea Grant-Supported Graduate Students, 2001**
- **Appendix F: Program Honors and Awards in 2001**

Appendix A: Program Development Funds Projects in 2001

Researcher	Amount	Project
Hill, Jeff UNCW	\$ 5,000	Improving Managers' Understanding of the Impacts of Hurricanes on Barrier Islands Through the Application of Online Technology
Hopkins, Tom S. NCSU	\$ 5,463	Estuarine Exchange Model of the Pamlico and Albemarle Sounds, Salt Budget Calibration
Kellison, Todd NCSU	\$ 8,843	Use of Emerging Technology to Determine Nursery Origin and Essential Fish Habitat for Summer Flounder, <i>Paralichthys dentatus</i>
Culver, Stephen J. ECU	\$ 5,000	Of People, Place and Progress: Extended Recovery in the Coastal Plain (Conference)
Cantelas, Frank J. ECU	\$ 4,875	Beaufort Inlet Mapping Project, Beaufort, North Carolina
Tomas, Carmelo R. UNCW	\$10,000	Development of a Course on the Ecology of Harmful Algal Blooms
Herring III, William B. ECU	\$ 5,010	Interpretive Dive Slates for North Carolina's Historic Shipwrecks
Overton, Margery NCSU	\$ 9,931	Coastal Hazards Building Inventory Scope of Work
Posey, Martin UNCW	\$ 9,765	Evaluation of the Biological Impact of Estuarine Erosion Control Structures
Clark, Walter NCSU	\$10,000	Converging Currents: Science, Culture and Policy at the Coast (Conference)
Lankford, Thomas E. UNCW	\$10,000	Connecting Coastal Ocean Process and Estuarine-Dependent Fisheries: Impacts of the Cape Fear River Plume on Recruitment
Oliver, James D. UNC Charlotte	\$ 5,000	Ecology of Harmful Algal Blooms
Tomas, Carmelo R. UNCW	\$ 5,000	Identification Leaflet Sheets of North Carolina Harmful Algal Species
Borski, Russell J. NCSU	\$10,000	Biotechnology for Controlled Breeding of Southern Flounder
Barr, Matthew UNCG	\$10,000	"Sneads Ferry: Portrait of a Fishing Town"
Godwin, John NCSU	\$ 9,644	A Functional Biomarker for Assessing Sex Determination in Flounder
Clough, Lisa M. ECU	\$ 9,000	Does Hypoxia Preconditioning Increase Tolerance to Hypoxia in Estuarine Fishes?
Foushee, Doretha B. NCA&T	\$ 6,402	Isolation/Characterization of a Virus Pathogenic for the Toxic <i>Karenia breve</i>

Appendix B: Institutions Collaborating with North Carolina Sea Grant in 2001

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 2001:

- North Carolina State University
- East Carolina University
- University of North Carolina at Chapel Hill, Institute of Marine Sciences
- 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.

North Carolina Sea Grant also encourages researchers to participate in regional and national projects. Co-principal investigators are from around the country, including:

- University of South Carolina
- Texas A & M
- Mote Marine Lab
- University of Massachusetts, Amherst
- Coastal Oregon Experiment Station

Appendix C: Sources of Significant 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 researchers and staff members also participate in national grant competitions sponsored by the National Sea Grant Office.

In addition to the core funding, North Carolina Sea Grant partners with a variety of agencies for special projects. In 2001, 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 (water quality projects)
- The N.C. Department of Transportation (Rocky Branch restoration project)
- The N.C. Division of Coastal Management (estuarine guidebook series)
- Confluence Watersports (coastal paddling trails symposium)

Federal Sources other than Sea Grant

- The U.S. Environmental Protection Agency (Rocky Branch restoration project)
- Office of Naval Research (blue crab research)
- National Marine Fisheries Service (Cooperative Institute of Fisheries Oceanography)

Appendix D: North Carolina Sea Grant Communications Products in 2001

Each year, North Carolina Sea Grant develops a number of communications products to help the public better understand coastal and marine resources. In 2001 those products included:

- Handling Seafood Safety (instructions in English and Spanish.)
- Working Paper on Storm Damage Assessment
- *Rip Currents* metal sign
- State of North Carolina Paddling Report
- Proceedings of the Coastal Paddling Trails Symposium
- Final Report of the N.C. Coastal Paddling Trails Initiative
- A Sea Grant Journey: Special Issue of *Coastwatch*
- *Coastwatch* Magazine (6 issues)
- *Marine Extension News* (4 issues)
- *ConchShell* (3 issues)
- *WaterWise* (3 issues)
- Sea Grant Bookmarks
- *Fishing For Good Ideas* (updated Blueprint for Fishery Resource Grant Program)

A number of projects are in production with completion expected in 2002, including The Soundfront Series of guidebooks on estuarine shoreline issues, an aquatic weed handbook, and working papers on coastal tourism.

A listing of the scientific journal articles based on North Carolina Sea Grant projects is available from the Sea Grant office, 919/515-2454.

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. In 2001, these included:

- A Guide to Sea Turtles and Marine Mammals (RI SG)
- Understanding Fisheries Management (MS/AL SG)
- National Report on Nuisance Species (OH SG)

Appendix E: Sea Grant-Supported Graduate Students, 2001

Student	University	Advisor	Topic
Shelly Austin	NC State	Harry Daniels	Aquaculture
Geoffrey Bell	NC State	David Eggleston	Fisheries
Patricio Caravajal	NC State	Brian Farkas	Seafood Technology
Alexander Reinman	NC State	Tyre Lanier	Seafood Technology
Umaporn Silphaduang	NC State	Ed Noga	Aquaculture (aquatic medicine)
James Taylor	NC State	Peter Rand	Fisheries
Charlene Couch	NC State	Craig Sullivan	Aquaculture
Aaron Bowman	ECU	David Griffith/Jeff Johnson	Coastal Communities
Joni Backstrom, Adam Knierim, Mark Rauscher, Kenneth Wilson	UNC-W	William Cleary	Coastal Processes
Janera Harris	UNC-G	Parke Rublee	Habitat (<i>Pfiesteria</i>)
Jason Hales	UNC-W	Martin Posey	Water Quality (Benthic Response)

Appendix F: Program Honors and Awards in 2001

North Carolina Sea Grant continues its tradition of state and national recognition. Honors and awards in 2001 included:

- Barbara Doll, water quality specialist, was named a NOAA Environmental Hero for her role as advisor to a student group and her service on campus environmental committees. (Marine educator Lundie Spence received the Environmental Hero Award in 2000.)
- Barry Nash, seafood technology specialist, and other staff members of the N.C. State University Seafood Lab received an Extension Education Award from the N.C. Cooperative Extension Service.
- In 2001, David S. Canny of Duke University and Umaporn Silphaduang of N.C. State University each received a Walter B. Jones Award for Excellence in Coastal and Marine Graduate Study from NOAA. Canny has served as a Knauss Marine Policy Fellow in 2001. Silphaduang was a Sea Grant-supported graduate student working with Ed Noga of N.C. State University.
- *Coastwatch* magazine and North Carolina Sea Grant's updated brochure received honors from the national APEX awards program. *Coastwatch* also took home a "people's choice award" from the National Sea Grant Week in Hilton Head, S.C.
- Katie Mosher, assistant director for communications, has served as chair of the National Sea Grant Communications Network.
- Lundie Spence was named chair-elect of the National Sea Grant Educators Network.
- Walter Clark, coastal law and policy specialist, is serving as president of The Coastal Society.
- Director Ronald G. Hodson is serving as the co-chair of the national Seafood Technology Theme Team. Katie Mosher is serving as the communicator for the Urban Coasts Theme Team.