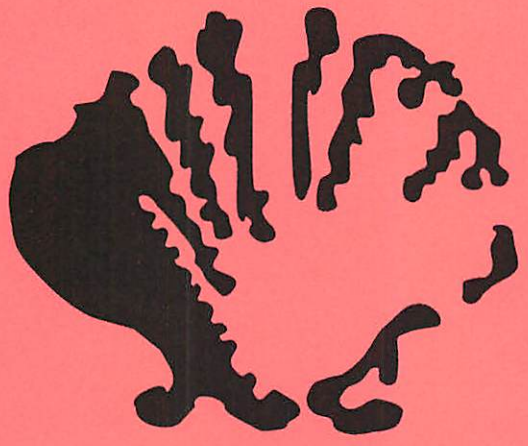
Fishery Resource Grant Program

- Fisheries Equipment & Gear
- Seafood Technology
- Environmental Pilot
- Aquaculture & Mariculture



Selected Impacts

North Carolina Sea Grant
UNC-SG-05-01 March 2005

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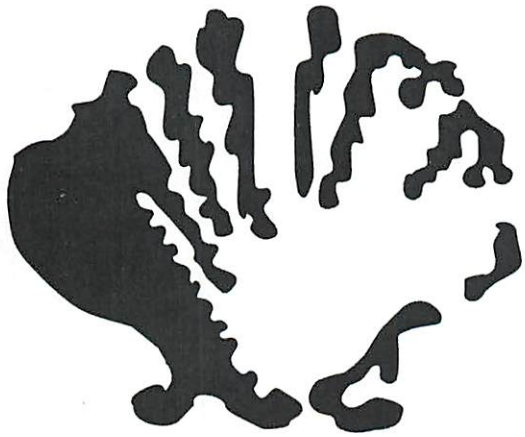

Selected Impacts

North Carolina Sea Grant
UNC-SG-05-01 March 2005

Fishery Resource Grant Program

Selected Impacts 2005

The word is getting out about the Fishery Resource Grant Program, known across the North Carolina coast as FRG.

"The FRG program provides a unique opportunity for all fishers to be involved in research activities that directly affect their livelihoods," says Ronald G. Hodson, director of North Carolina Sea Grant. The FRG program is funded by the N.C. General Assembly and administered by North Carolina Sea Grant.

The value of the program to fisheries resources grows with time as more information is accumulated, according to Hodson.

"Since the program's inception, FRG projects have expanded seafood businesses, created new seafood markets, improved aquaculture practices, provided more accurate data for fishery management plans, improved coastal habitats and provided educational opportunities at high school and college levels," he adds.

Data generated from these projects are increasingly sought after by those in the fishing and research communities, according to fisheries specialists working for North Carolina Sea Grant. Although North Carolina Sea Grant has responded to requests from across the United States for FRG final reports, the reports have the biggest impact here in North Carolina. Many go to agencies such as the N.C. Division of Marine Fisheries (DMF), which develops N.C. Fishery Management Plans.

Each year, North Carolina Sea Grant seeks public input on priorities to be addressed within four FRG funding categories: Aquaculture and Mariculture, Environmental Pilot Studies, Fisheries Equipment and Gear, and Seafood Technology.

North Carolina Sea Grant also spreads the news about the FRG program — from the application process to significant results — through news releases, participation at public events, and through various publications, such as Sea Grant's *Coastwatch* magazine and *Marine Extension News*.

Public interest in FRG is evident from the media coverage it has received over the last year. Many coastal newspapers routinely feature announcements about the FRG program, and research and results from the program were also featured in many news articles during 2004. This year, FRG studies were featured in several mainstream media outlets across the state, including the *State Port Pilot*, the *Outer Banks Sentinel*, the *Pamlico News*, and the *Transylvania Times*.

This booklet describes the impacts to the state and its economy from a selection of FRG projects that have been completed in recent years.

Aquaculture and Mariculture

Aquaculture/Mariculture projects deal with the culture of animals as diverse as oysters, clams, baitfish, food fish and soft-shell crabs. Collectively, these studies contribute to the body of knowledge guiding aquaculture development in North Carolina.

Perhaps of more importance, the FRG program gives aquaculturists a mechanism for trying new techniques and equipment at minimal personal financial risk, and provides the acquired information to others who are interested. In fact, the Aquaculture Development Conference, which is held each winter and cosponsored by North Carolina Sea Grant and the Cooperative Extension Service, routinely features presentations by FRG recipients. This has proven to be an effective means of communicating results to interested persons.

Oysters

- **99-AM-14** *Demonstrated On-Bottom Oyster Grow-Out Method Using Remotely Set Seeded Cultch*

- **98-AM-03** *Remote Setting to Produce Single 30-mm Seed Oysters for Off-Bottom Culture*

These projects developed and implemented techniques for remote setting of oyster larvae. The methods proved so successful that North Carolina extension staff now recommends remote setting as a preferred way to produce seed. Using these techniques, shellfish growers Jim and Bonnie Swartzenberg (98-AM-03) continue to successfully produce oyster seed for their own shellfish lease and to sell to others. In addition, several private operations in North Carolina have started using these methods commercially.

The results from these projects also have helped the N.C. Division of Marine Fisheries (DMF) streamline and improve permitting procedures for importing seed — especially eyed larvae — from other states for planting on North Carolina leases. The DMF is also considering testing remote setting in their oyster reef/shell planting program.

As a result of project 98-AM-03, a video and a print manual were produced. The video and manual describe: how to set a site and nursery area; how to build and set up equipment; and how to order, handle and evaluate larvae. The manual also includes checklists for inventory selection and oyster setting, as well as a list of sources for supplies. Several manuals and videos have been distributed to two area community colleges, Dixon High School, DMF and North Carolina Sea Grant. These products were also featured at the 2005 Aquaculture Conference in Atlantic Beach, N.C., and at the 2005 Oyster Summit in Raleigh, N.C.

Marine Finfish

- **98-AM-25** Codifying Marine Finfish Aquaculture in North Carolina

This project was used in developing the current regulations for aquaculture operations in North Carolina.

Careers in Aquaculture

- **01-AM-09** *Apprentice Program and Training for Career Aquaculturists*

Researchers behind project 01-AM-09 developed a training and apprentice program at Carteret Community College (CCC). Students in the program helped produce some 150,000 seed clams, which are distributed to industry partners. Students also worked as apprentices and gained hands-on experience with industry partners. Although the project is complete, the apprentice program has continued and now has a dedicated building on the CCC campus.

Clams

- **98-AM-02** *More Profits for Clam Farmers by Using an In-Water Nursery System*

- **98-AM-10** *Hard Clam Growth and Survivorship: The Effect of Initial Clam Seed Size in Tented Soft Bags and a Comparison Between Beds and Tented Soft Bags*

- **02-AM-04** *Investigation of the Effect of Sediment Type on the Growth and Survival of Seed Clams Using Soft-Tented Bags and Mesh Covered Bottom Beds*

These projects developed an alternative to land-based shellfish nurseries. Instead of raceways on land, "nursery bags" are used in the marine environment to produce larger, more predator-resistant seeds for planting on leases.

Black Sea Bass

- **98-AM-19** *Growth and Feed Utilization of Wild-Caught Juvenile Black Sea Bass (*Centropristis striata*) Fed Practical Diets in a Recirculating Tank System Under a Semi-Controlled Temperature Regime*

- **00-AM-05** *Growth and Feed Utilization of Captive Wild-Caught Black Sea Bass (*Centropristis striata*) Stocked at Four Different Densities in a Recirculating Tank System*

These projects developed proper diet formulations for growing black sea bass as well as techniques for growing these fish in semi-closed recirculating tank systems. Results from these projects are the first steps toward making commercial culture of this species possible in North Carolina.

Hybrid Striped Bass

- **02-AM-03** *Compensatory Growth: Increasing Production Efficiency of Hybrid Striped Bass Culture*

Results from this study indicate that: 1) hybrid striped bass can undergo compensatory growth (CG) following periods of subsistence feeding; 2) the CG response is accompanied by improved growth rates, hyperphagia and feed efficiency; and 3) IGF-I, a critical regulator of

growth in fish, may serve as a valuable instantaneous biomarker of growth in hybrid striped bass needed to optimize feeding parameters.

This can benefit producers by reducing labor and time with minimum impact in the production efficiency of market-sized fish. Cycled feeding may also improve water quality and mitigate some of the risks farmers face with phytoplankton blooms, oxygen depletion and potential fish losses associated with high nutrient loads. These findings about compensatory growth also raise the possibility that farmers may delay the time when fish are marketed, increasing the flexibility of their marketing strategies and overall capacity for year-round production.

Flounder

- **01-AM-08** *Grow-Out Performance of Hatchery-Reared Summer Flounder (*Paralichthys dentatus*) and Southern Flounder (*P. lethostigma*) Fingerlings in Low- and High-Salinity Recirculating Tank Systems and an Analysis of their Premium Markets*

- **00-AM-04** *Development of a Grow-Out System for Wild-Caught Southern Flounder*

- **97-AM-09** *Development of a Holding and Grow-Out System for Off-Season Sale of Value-Added Flounder*

These projects investigated various aspects of flounder culture, including holding and growing out wild-caught fish, and developing techniques to spawn fish and produce juveniles. Collectively, the projects bring the possibility of commercial flounder culture closer to fruition.

During projects that involved growing out wild fish, control methods for fish louse were developed that help improve the holding of broodstock. This means broodstock fish can be kept in better condition, thus improving spawning. Fishers who provided live fish for the wild fish grow-out project (00-AM-04) received about $1 per pound more than those selling to traditional markets do.

The spawning techniques developed during these projects resulted in the building of a grow-out facility at Lake Wheeler, located near North Carolina State University's main campus in Raleigh, N.C. Approximately 50,000 juveniles are produced annually and experimental grow out of these fish has begun at the Lake Wheeler facility.

Researchers in Wilmington and in South Carolina are also beginning to grow out fish, and many believe commercial culture is probably only a few years away. Southern States Cooperative has augmented these studies with $80,000 and the Golden Leaf Foundation has added $70,000. Sea Grant is beginning to receive inquiries from private individuals interested in the potential for commercial culture of flounder.

Fisheries Equipment and Gear

Projects in this category include: studies of gear selectivity for various species; methods of reducing bycatch in certain fisheries; development of new and improved types of gear; and the compilation of information for use in fishery management decision-making. In studies producing data for fishery management, fishers are given an avenue through which they become actual participants in the decision-making process.

The investigators presented the results of selected projects at different seminars during the 2004 N.C. Commercial Fishing Show. North Carolina Sea Grant has organized the seminars in cooperation with the show sponsors for several years. These seminars often drew crowds of nearly 100 people.

North Carolina Sea Grant routinely provides final reports from projects to the N.C. Division of Marine Fisheries, federal fisheries advisory panels, and individuals who request copies. Many final reports are now posted in .pdf format online at *www.ncseagrant.org*. Follow the research links to the FRG pages.

Reducing Marine Mammal Entanglements and Bycatch

- **98-FEG-54** *Whale Disentanglement Program for the Cape Hatteras Region*

FRG funding for this project provided training for volunteers regarding the proper and safe techniques for disentangling marine mammals that become caught in fishing nets. It also provided an equipment cache (housed at the Oregon Inlet Coast Guard Station) and a portable first response kit (housed at the Duke University Marine Lab in Beaufort) for use in freeing trapped whales.

Soon after the start of the project, a juvenile humpback whale became entangled in a net in the Cape Lookout Area and project personnel were able to free it. In numerous other cases, the North Carolina team has been on alert when fishers or other boaters have spotted entangled marine mammals. If team members are able to locate the animal, they make every attempt to free it after assessing the safety and feasibility of the current situation. In some cases, they are able to attach satellite buoys to the nets so that the animal can be tracked until a more appropriate time for the disentanglement process.

The project not only allows a means to save whales caught in nets, but also has lessened the need for more federal restrictions in North Carolina.

This was the first such response center to be located outside Massachusetts — the first state to develop this capability. Disentanglement is now an integral part of the Large Whale Take Reduction Plan. The disentanglement capability in North Carolina allows fishers to keep fishing while gear modifications and changes in fishing practices are being developed to reduce entanglements.

- **00-FEG 24** *Will Pingers Reduce By-catch of Bottlenose Dolphin in N.C. Gillnet Fisheries?*

Results from this study indicate that pingers are not likely to help reduce bottlenose dolphin bycatch in North Carolina's gill net fisheries. Pingers have been shown effective in reducing bycatch of harbor porpoises in the Gulf of Maine, but the devices do not appear to deter

bottlenose dolphins from approaching gill nets. In fact, pingers may actually have the reverse effect — they may alert the dolphins to the fishers' catch, a potential source of food. With this information, fisheries managers in North Carolina can focus their future efforts on developing new techniques and gear to reduce bottlenose dolphin bycatch.

- **03-FEG-13** *Interactions Between Bottlenose Dolphins and the Spanish mackerel Gillnet Fishery in North Carolina*

This project made several important conclusions regarding the behavior of dolphins around commercial gillnets. From observations aboard commercial vessels, it was determined that dolphins encountered nets frequently and interacted with commercial fishing gear in a variety of ways, including diverting around the net to avoid it, patrolling along the length of the net, engaging in depredation, and occasionally begging for fish from the commercial vessels. Researchers observed a significant reduction in the catch of Spanish mackerel and other commercially valuable species when dolphins interacted with the nets. These interactions may have important economic costs for fishers.

Given these findings, researchers proposed a potentially effective tool for mitigation and management: the use of sound makers, or acoustic alarms, that produce sounds within the hearing range of dolphins but above the upper auditory threshold of Spanish mackerel. If these devices are successful, they offer the possibility of reduced bycatch among dolphins and increased catch rates of Spanish mackerel and other target species.

Spiny Dogfish

- **97-FEG-28** *Biological and Social Characterization of the North Carolina Spiny Dogfish Fishery*

- **98-FEG-28** *Characterization of the Spiny Dogfish Population South of Cape Hatteras for Potential Commercial Harvest and Management Plan Development*

- **98-FEG-29** *Biological Information on the Northern District Spiny Dogfish Fishery Needed for a Fishery Management Plan*

- **99-FEG-47** *Determination of Gill Net Bycatch Potential for the Spiny Dogfish (*Squalus acanthias*) in Southeastern North Carolina*

The Atlantic States Marine Fisheries Commission (ASMFC) is using findings from these projects to develop management plans for the dogfish fishery. North Carolina fishers have traditionally operated in this fishery during the winter, but several years ago ASMFC issued an emergency closure because of concerns the fishery was depleting dogfish stocks from New England to North Carolina. The ASMFC developed a quota landing system for East Coast dogfish stocks that limited annual landings of dogfish.

This presents a significant obstacle for North Carolina: by the time dogfish season begins in our state the quota has already been reached by states to our north. Data from the studies listed above are intended to help managers develop a plan for dogfish and develop equitable regulations by the ASMFC.

Blue Crabs

Since 2001, research on blue crabs has been funded through the N.C. Blue Crab Research Program.

- **97-FEG-33** *North Carolina Blue Crab Harvest Data Collection*
- **98-FEG-08** *Development of Two Simple Devices to Increase the Accuracy of Catch-Per-Unit-Effort Data*
- **98-FEG-10** *Crab Trawl Tailbag Testing*

These projects have provided fishery-dependent data to the N.C. Division of Marine Fisheries (DMF). This data has helped the DMF develop effort-control strategies, socioeconomic information for characterization of the fishery, and verification of fishing trip ticket information. DMF has used information from these projects in the development of the blue crab management plan, which is currently in the public hearing process. More specifically, the projects listed above provided a means of verifying catch-per-unit effort data and helped to establish the suggested size for trawl tail-bags in the crab trawl fishery.

Blue Crab Sanctuaries in North Carolina

- **99-FEG-31** *Mapping of Geographic Features and Their Attributes and Marking of Hazards in and Between the Ocracoke and Hatteras Inlet Blue Crab Sanctuaries*
- **01-EP-06** *Tagging of Adult Female Blue Crabs to Study Migration Toward and Use of Spawning Sanctuaries*

Information derived from these projects could help the N.C. Division of Marine Fisheries (DMF) to change the designated crab spawning sanctuaries from the old static boundary to a more dynamic boundary based on salinity. The boundaries could be contracted in times of high rainfall, and expanded in dry, high-salinity times.

The digital mapping of the Ocracoke/Hatteras sanctuaries (01-EP-06) occurred before Hurricane Floyd. Because this hurricane dramatically affected the physiography of the area, this project provides baseline data for researchers to measure changes due to the hurricane. In fact, the principal investigator in the mapping project has been contracted by the DMF to map those changes.

In addition, data from the mapping study was used in the red drum fishery management plan to determine areas where certain fishing gear would be prohibited in order to protect juvenile red drum. Finally, a research ecologist cited data from the project to make recommendations for areas in which clam kicking should be prohibited.

Blue Crab Dynamics and Stock Assessment

- **99-FEG-10** *Stock Assessment of the Blue Crab in North Carolina*

- **00-FEG-11** *Population Dynamics and Stock Assessment of the Blue Crab in North Carolina*

These studies provided vital information on the status of the state's blue crab stocks. The N.C. Division of Marine Fisheries (DMF) has used data from the projects to develop and refine the Blue Crab Management Plan, particularly as it relates to allowable amounts of crab harvests. Several of the management recommendations in the plan were based on results from this work.

Soft Shell Crab Industry

- **01-FEG-03** *Blue Crab Mortality in North Carolina's Soft-Shell Industry: Biological and Operational Effects*

This project determined the main causes of mortality in soft crab production systems. Based on the results, some producers have changed the way they handle peeler crabs and sources of supply. Ultimately, these producers have lowered mortality in their systems and increased production of soft crabs.

Bycatch in Crab Pots

- **99-FEG-45** *Bycatch in the Crab Pot Fishery*

This project identified and quantified the major species components of bycatch in the crab pot fishery. The information has been used to develop and refine the Blue Crab Management Plan, as well as the Flounder Management Plan. Results from the study indicate that the current regulations governing crab pot bycatch are unnecessary at this time. In particular, the project established a maximum sustainable yield figure for the fishery.

Bycatch Reduction

- **97-FEG-40** *Certification of BRDs for North Carolina Waters*

- **98-FEG-23** *Bycatch Reduction Device Certification Program*

The N.C. Division of Marine Fisheries (DMF) and the National Marine Fisheries Service (NOAA Fisheries) have required the use of bycatch reduction devices (BRDs) in shrimp trawls for many years. When the requirement was initiated, many devices were developed that claimed to effectively reduce bycatch. At the time, the DMF lacked resources to test these products.

In the above projects, students in the Marine Vocations Class at Pamlico High School tested many of these devices using a protocol developed by the DMF. All students were under supervision of their instructor. Besides being a cost-effective solution for the DMF, the projects provided students — many who came from fishing families — with the opportunity to help shape fisheries regulations they will likely face in the future.

- **02-FEG-21** *Use of TEDs in Crab Trawl Fishery*

This project determined the impact of trawl nets equipped with turtle excluder devices (TEDs) on crab catch. There has been some discussion among fishery managers about requiring TEDs in crab trawls, and the project results are relevant to making this decision. Data indicated that such a requirement would devastate the crab trawl fishery. To date, the National Marine Fisheries Service (NOAA Fisheries) has not required use of TEDs in crab trawls.

- **99-FEG-36** *Bycatch Comparison of Flounder Gill Nets Utilizing Different Denier Webbing*

This project compared catch rates of flounder gill nets using different diameters of monofilament webbing. The results showed little difference in catch rate of flounder for the different sizes. This means that fishers can use the larger diameter, heavier webbing (which holds up much better than lighter webbing) with no reduction in catch.

- **01-FEG-15** *Catch Comparison of Three Gill Net Designs in the North Carolina Flounder Gill Net Fishery*

This study compared flounder catch rates to bycatch using three types of gillnet, one of which uses no corkline. In terms of reducing bycatch and maintaining acceptable flounder catch, the nets without corkline worked better than the other two types. The N.C. Division of Marine Fisheries (DMF) is planning to conduct further tests on a variation of this net in an area of Pamlico Sound that has been closed to flounder gillnets because of sea turtle bycatch. This gear could provide a means of reducing or eliminating turtle takes, thus keeping the fishery open.

- **00-FEG-14** *Gill Net Bycatch Potential, Discard Mortality and Condition of Red Drum (*Sciaenops ocellatus*) in Southeastern North Carolina*

- **02-FEG-01** *Evaluation of Large-Mesh Recreational/Commercial Gear License (RCGL) Use in Southeastern North Carolina*

- **02-FEG-13** *Large Mesh Gill Net Bycatch Potential, Discard, and Mortality of Red Drum*

- **02-FEG-18** *What Effect Does Setting a Flounder Net Close to the Marsh Have on the Incidental Bycatch of Red Drum*

These projects examined different aspects of using large-mesh gill nets to catch flounder in North Carolina. One project in particular, 02-FEG-13, addressed the practice on the Newport River where there was a conflict between the flounder gill net fishery and recreational drum fishery. The recreational anglers contended that netters catch an excessive amount of red drum as bycatch in flounder nets. The project showed that these anecdotal observations are not true. Results from this study helped the N.C. Division of Marine Fisheries (DMF) manage this conflict.

- **01-FEG-11** *Alternative Flounder Nets*

Because of several sea turtle strandings that occurred during the flounder gill net fishery season (September through November), the National Marine Fisheries Service (NOAA Fisheries) closed an area adjacent to Hatteras and Ocracoke in Pamlico Sound to large mesh flounder gill nets. This project sought to develop fyke nets as alternative gear that would catch flounder but eliminate turtle mortality.

Results indicated that the fyke nets did not catch flounder successfully, but a concurrent collaborative study with principal investigators and staff from the N.C. Division of Marine Fisheries examined alternative configuration of gill nets. The work resulted in a reconfigured gill net that may allow the flounder gill net fishery to resume operation in the area.

- **03-FEG-10** *Reducing Mortality of Undersize Groupers (Gag and Reds) and Bycatch of Non-Targeted Species by Varying Hook Size and Style*

This project demonstrated that both the commercial and recreational grouper fishery can use "circle" type hooks instead of larger than traditional "J" style hooks to reduce the take of undersized fish without significantly reducing the targeted catch. The finding may have management implications — hook sizes could be regulated in order to reduce bycatch and undersized fish mortality in the state's grouper fishery.

Information from this project was also used in a North Carolina Sea Grant "Blueprint" publication that has been offered at recreational fishing shows.

- **02-FEG-05** *Habitat Use of Sea Turtles in Relation to Fisheries Interactions*

This project attached satellite tags to sea turtles and monitored their movements within an area of Pamlico Sound currently closed to gill netting. The results help shed light on the movements of turtles into, within, and out of Pamlico Sound. This information can help fisheries managers better define areas that should remain closed to gill net fishing and those that might be reopened.

In addition, data presented in this report both corroborate and dispel various hypotheses regarding sea turtle life history and behavior. One particularly interesting finding involves migration routes for juvenile turtles. Researchers expected tagged juvenile turtles to migrate south to warmer waters after leaving North Carolina, but instead they exhibited three different migratory strategies: some migrated south to the Georgia or Florida coast, some headed to North Carolina coastal waters, and still others moved long distances into the North Atlantic by way of the Gulf Stream. Until now, transport in the Gulf Stream and residency in the North Atlantic has been documented for hatchlings and small juveniles, but large juveniles were believed to undergo an ontogenetic habitat shift into coastal waters.

This project received international attention when it was included in a presentation at the annual American Association for the Advancement of Science (AAAS) meeting. The study was cited as an example of research that will be used in a Global Census of Marine Life.

Environmental Pilot Studies

Environmental Pilot Studies examine the effects of natural events and human activities on various habitats, perform assessments of stocks of various species, study incidence of fish diseases, implement water quality monitoring programs and provide various educational opportunities.

Trawling

- **98-EP-21** *Shrimp and Crab Trawling Impacts on Estuarine Soft-Bottom Organisms*

This project addressed questions about the possible impacts of trawling for crabs and shrimp in North Carolina estuaries on populations of organisms living on soft-bottom habitats. Researchers sampled several estuarine locations both before and after experimental trawling. They also sampled areas actively trawled and areas closed to trawling. Finally, researchers sampled during a two-year period to address seasonal and interannual effects.

Researchers concluded that there is little evidence of direct negative impacts of trawling activity on these soft-bottom organisms. However, there are differences between trawled and non-trawled habitats that merit further investigation, especially regarding intensity and frequency of trawling efforts. Researchers noted that seasonal differences were more noticeable than other differences. This type of information, regarding the direct, immediate and long-term effects of trawling on fish habitat, helped in the development of the state's new Coastal Habitat Protection Plan.

- **99-EP-07** *The Role of Trawl Discards in Sustaining Blue Crab Fishery Production*

This project demonstrates that discards from the trawl fisheries, particularly the shrimp fishery, are unintentionally augmenting food supplies for blue crabs. Results from field experiments and onboard monitoring showed that birds and blue crabs were the primary scavengers on the discards. In addition, laboratory experiments revealed a preference by blue crabs for discards over their typical benthic invertebrate prey. These results have implications for the pending fishery management plans dealing with trawl fisheries such as the shrimp management plan under development by the N.C. Division of Marine Fisheries.

Bottlenose Dolphin Populations

- **00-EP-02** *Mark and Recapture Survey of Bottlenose Dolphins in the Bays and Sounds of North Carolina*

This was the first mark and recapture survey of bottlenose dolphins ever conducted for North Carolina's estuarine waters. Results established a population estimate of 1,154 bottlenose dolphins. This estimate is almost half of the minimum population size of 2,482 coastal bottlenose dolphins from central Florida to New Jersey that had been used in stock assessments by the National Marine Fisheries Service (NOAA Fisheries).

Based on their previous estimate, NOAA Fisheries originally set the Potential Biological Removal (PBR) at 0 for bottlenose dolphins, meaning that if any dolphins died from entanglement in fishing gear, fisheries would be closed. As a result of this study, the PBR was adjusted upward. In addition, results from this study are also helping NOAA Fisheries reassess its estimate of the bottlenose dolphin population, which likely will affect the PBR further.

Finally, the abundance estimates produced by this project were incorporated into the Bottlenose Dolphin Take Reduction Plan. These estimates highlighted the inadequacy of previous estimates in other areas, and have become the accepted estimates for all areas along the Eastern Seaboard. Because the allowable take of bottlenose dolphins depends directly on the population estimates, results from this study have helped reduce the burden placed on North Carolina fishers by the take reduction plan.

Striped Bass

- **00-EP-14** *The Seasonal Food Habits of Striped Bass (*Morone saxatillis) *in the Albemarle Sound*

This project provides important life history information for striped bass within North Carolina waters. The study focused on seasonal food habits of the species, once believed to be opportunistic feeders. Prey availability estimates from the study indicated that striped bass are in fact more likely to be selective feeders.

Dolphin Fish

- **02-EP-01** *Age, Growth, and Reproduction of Dolphin (*Coryphaena hippurus*) Caught in North Carolina Waters*

This study provides an updated age-length function for dolphin fish caught off the coast of North Carolina using both scale annual and daily growth increments. It also provides some of the first comprehensive data on their reproduction in North Carolina. Such data will be useful to stock assessment modelers that require age and growth information to determine future sustainable fishing mortality rates for dolphin fish stocks.

Seafood Technology

This category includes projects with commercial applications including the development of new products and processing techniques, evaluation of sanitizing agents and a video perspective of the North Carolina Blue Crab Industry.

Value-Added Seafood

- **97-ST-05** *Development of a Process to Achieve Strong Binding of Seafood Flakes for Restructured Products*

This project demonstrated the use of a simple, enzyme-based process to create value-added products from underutilized seafood. Unmarketable scallops — ranging in size from 150 to 200 pieces per pound — were fused together to produce a more desirable product in the 30 piece-per-pound range. Wanchese Fish Company Inc. employed this technology to create the "Scallop Medallion" line, which has been enormously profitable.

- **01-ST-01** *Value-Added Crabmeat Products for the Retail and Internet Markets*

This project had two objectives: 1) to demonstrate how textured vegetable proteins could bind and extend cooked seafood to create processed seafood that met consumers' expectations for value and convenience; and 2) to show how textured vegetable proteins could enhance a processor's profits by reducing the manufacturing costs of value-added seafood.

Overall, 25 value-added products were developed. Two items — a "deviled crab cake" and a "Cajun crawfish cake"— were successfully marketed to three in-state grocery store chains: Lowes, Piggly Wiggly and Acre Station. In the Fall of 2004, Jerry Smith, proprietor of Enterprises Inc., reviewed the project results and began using textured wheat protein in his line of retail crabmeat spreads. Since then, his profit margins have increased by 50 percent.

- **02-ST-05** *Development of Ready-To-Eat Seafood Meals for the Institutional Market*

This project resulted in four new entrées: deluxe deviled crab casserole; stir-fry shrimp with noodles; seafood jambalaya; and shrimp paella. After completing development at the North Carolina State University Seafood Laboratory, an independent food technology consultant with expertise in frozen foods adapted each entrée to processing parameters suitable for mass manufacturing. Finally, more than 75 consumers were recruited from the North Carolina State University Department of Food Science to evaluate consumer acceptability of the entrée line.

In addition to these entrées, the project also initiated the development of a line of bacon-wrapped seafood appetizers (shrimp, oyster, scallop and tilapia nuggets) manufactured in partnership with Southern Farm Tilapia (SFT) of Bailey, N.C. SFT is a subsidiary of a large North Carolina agriculture business that processes bacon from its hog operation. SFT is only buying its shrimp and oysters from North Carolina fishers, and it has formed a partnership with a North Carolina seafood distributor to sell the bacon-wrapped line to high-end restaurants throughout the state. Distribution began in the Fall of 2004. So far, sales have been a modest $10,000, but interest in the product line is increasing, including a favorable reception at the 2005 N.C. Aquaculture Development Conference.

Since 2001, North Carolina Sea Grant has assisted six companies in commercializing 29 of 53 value-added seafood products.

Safety Processes

- **97-ST-02** *HACCP Program Assistance for Small Seafood Processors and Dealers*

- **00-ST-02** *Methods to Improve the Monitoring of the Crabmeat Picking/Packing Critical Control Point in Accordance with the HACCP (Hazard Analysis and Critical Control Point) Regulation*

The first project, with assistance from the staff of the North Carolina State University Seafood Laboratory, developed *A Self Guide to HACCP Inspection for Small Seafood Dealers, Packers and Processors.* This material is used to train seafood dealers and processors in methods to comply with federal and state HACCP requirements. The Seafood Lab has conducted workshops since January 1997. The workshops use real examples from the seafood industry and teach participants how to develop a HACCP plan for their own businesses. North Carolina Sea Grant later published a follow-up publication containing more specific examples. Both publications were distributed nationally.

The second project examined a potential change in the picking/packing critical control point for crab processors. If accepted by the Food and Drug Administration, it would lessen the burden of HACCP-required paperwork for processors without compromising product safety. The results indicated that as long as standard operating procedures are implemented properly, there is no need to label the picking/packing step as a "critical control point" under the HACCP plan. The benefit to processors would be fewer critical control points to monitor and less paperwork.

- **99-ST-04** *Evaluation of Ozone as a Sanitizing Agent to Improve the Safety, Quality and Shelf Life of Raw, Vacuum-Packed Fish Fillets*

This project evaluated ozone as a sanitizing agent in fish processing. Results demonstrated that ozone could be an effective agent for sanitizing equipment, reducing bacterial levels in fish products and extending shelf life of vacuum-packed fish fillets. This information could lead to the use of ozone in fish processing plants as a sanitizing agent for food and food-contact surfaces, thus reducing the use of toxic chemicals.