North Carolina Sea Grant Provides Sound Science for Coastal Decisions

North Carolina Sea Grant (NCSG) supports the University of North Carolina (UNC) system's 17 public campuses and private institutions. Since 1970, NCSG has provided funding, technical support and educational services, leveraging $5 for every $1 of state match.

NCSG staff in Raleigh and three coastal UNC system facilities connect with faculty, students, government officials, state agencies and business leaders. NCSG program impacts, investments and activities directly align with the strategic focus areas of NOAA's National Sea Grant Program, addressing local, state, regional, national and international priority issues. In 2010 to 2013, NCSG:

- **Directly impacted coastal economies and communities**, including: more than **$1.98M in federal assistance** to 173 shrimpers to enhance business plans to offset impacts of imports; **$1M in savings** for coastal property owners on wind and flood insurance premiums due to identification of resilient building practices; approximately **$225,000/year with 60 jobs sustained annually** from a value-added seafood product developed with an industry partner.
- **Provided significant resources** across UNC system institutions, the state, two Sea Grant regions and the nation, **resulting in substantial scientific and technology contributions** supporting coastal resource management needs. NCSG has **invested $14.7M, including federal, state and industry support**, resulting in: quantification of oyster ecosystem services; management applications, including fishery and coastal habitat plans; an innovative online shellfish aquaculture siting tool; and improved emergency management through hazard modeling.
- **Helped to leverage over $6.2M** in additional external research through NCSG-funded scientists.
- **Shared results in 129 peer-reviewed publications** such as: *Nature Climate Change*; *PLOS ONE*; *Microb. Ecol.*; *MEPS*; *Integrative and Comparative Biology*; *L&O: Methods*; *Estuarine, Coastal and Shelf Science*; *Biogeosciences*; *Molecular Ecology*; and *Ecological Application*.
- **Invested in developing the next generation** of researchers and coastal decision makers, including over **177 undergraduates** and more than **400 graduate and professional** students trained. NCSG offered 7 competitive fellowships, with **50 state and national fellows**. Also, **more than 99,500 K-12 students** were reached statewide in the reporting period.
- **Received recognition of state leadership roles, including in a 2013 AAAS review of UNC system investments in coastal and marine programs**. That panel, citing NCSG expertise and stakeholder engagement, recommended that UNC system leaders: use NCSG's communication and outreach capabilities; capitalize on NCSG experience in translating science into economic benefit for the state; optimize NCSG expertise with stakeholder engagement; and benefit from efforts to foster community relationships into successful economic development efforts.
- **Supported local community needs** through strategic extension and communication efforts to: develop local capacity for N.C. seafood marketing; support local governments' planning needs; diversify income through value-added seafood and environmental/cultural heritage tourism; establish new aquaculture businesses; and identify emerging issues for estuarine shorelines.
- **Expanded information dissemination** through an award-winning communications program, including *Coastwatch* magazine, with over 10,000 readers at *ncseagrant.org*. Rip current research and beach safety partnerships routinely receive extensive state and national coverage, and strong community support to enhance public health and safety through education.
- **Provided technical expertise, leadership and continuing education** through local, regional, national and international efforts. NCSG events drew **17,800** participants interested in tidal creeks, marine recreational fisheries, local seafood, building construction, hurricanes, etc. Workshops certified to provide **continuing education or licensure credits served over 1,344 individuals**, while NCSG sessions at partners' events drew at least **314,000 participants**. NCSG international efforts include assisting the Sea Partnership Program in Indonesia, sharing strategies for seafood marketing in Ireland, and collaborating on rip current research in Australia.

NCSG provides robust returns on investments and significant programmatic impacts in coastal resource management, science, extension and communications statewide, regionally and nationally.

North Carolina Sea Grant: Safe and Sustainable Seafood Supply

Coastal Collaborations: Partners in Fisheries, Seafood Science and Outreach

North Carolina Sea Grant (NCSG) helps N.C. fishing captains and university researchers forge trusted partnerships. These collaborations generate reliable data and recommendations that are used to develop resource management plans for habitat, and commercial and recreational fisheries. NCSG also works with business owners and community leaders to ensure seafood safety, meet consumer demand via value-added products, improve aquaculture methods, and expand markets through supply chain innovations.

This tradition of success has led state and federal officials to seek NCSG expertise to lead three applied research programs, allocating leveraged funding received outside the Sea Grant omnibus. The N.C. General Assembly has funded the N.C. Fishery Resource Grant Program (FRG). The Blue Crab and Shellfish Research Program is funded via the University of North Carolina (UNC) system. NOAA Fisheries funds the Bycatch Reduction of Marine Mammals in Mid-Atlantic Fisheries Program. For each, NCSG has administered competitive, peer-reviewed, proposal-based programs. They are models for programs in Virginia and Gulf states.

In 2010–13, the two state programs, totaling nearly $2.2 million, complemented NCSG core research and minigrant investments. Long-term impacts are realized in the management of black sea bass, which has Atlantic stocks divided at Cape Hatteras, N.C. A fishing captain and university biologists have studied the stock managed by the South Atlantic Fishery Management Council (SAFMC). They estimated the best mesh size to catch legal-sized fish and survival rate of black sea bass after release. Other projects addressed specific research needs, but the total impacts have greatly benefited the fishery. In 2013, NOAA Fisheries approved an SAFMC recommendation for annual commercial and recreational catch limits for black sea bass to increase from 847,000 pounds to more than 1.8 million pounds. NCSG discard mortality research results had been used in a federal stock assessment that determined the population is rebuilt. A NOAA fisheries fellow also has studied black sea bass population dynamics.

Other impacts include more sustainable gear, such as bycatch-reduction devices for shrimp trawls and crab pot improvements. Projects have: helped launch a company developing a new crab bait; tracked juvenile sea turtle migrations to limit interactions with fishing operations; developed value-added products such as smoked soft-shell crabs; reused derelict crab pots to enhance oyster growth; identified habitats for juvenile spiny dogfish and other coastal sharks; and developed protocols to allow aquaculturists to raise two species at once. The panel updating the N.C. blue crab management plan incorporated many NCSG research results into their deliberation. Not only have state management panels considered shellfish research results but so too has a statewide steering committee developing recommendations for N.C. General Assembly funding for oyster reef restoration and shellfish aquaculture enhancement.

NCSG is a Sea Grant Network leader in NOAA collaborative research, reflected in our success in an open competition to administer the federal marine mammal bycatch program. From 2010 to 2013, $225,000 was competitively awarded to regional researchers to evaluate gear options to reduce interactions with the protected species, and update stock assessments of bottlenose dolphins in the Mid-Atlantic.

A focus on industry collaboration in research and outreach is reflected in aquaculture, such as advancements in hybrid striped bass broodstock genetics. Also a 2010 National Sea Grant initiative project funded development of a shellfish aquaculture-siting tool. That project has resulted in several new aquaculture businesses.

Sea Grant
North Carolina

STRATEGIC PLANNING TO MEET FISHERIES AND SEAFOOD CHALLENGES

Fishing and seafood are woven into the culture, tradition and economies of North Carolina's coastal region that includes more than 300 miles of oceanfront, thousands of miles of estuarine shoreline, and an extensive system of sounds, bays, coastal rivers and tidal creeks. With the offshore confluence of the Gulf Stream and the Labrador Current, the range of fish and shellfish species includes those found in the Mid- and South Atlantic regions. NCSG identifies fisheries and seafood topics as areas for investment. Our strategic plan also shows the importance of vibrant fisheries for other focus areas, including healthy ecosystems, sustainable coastal development and marine literacy. NCSG set, met and exceeded high objectives for the Safe and Sustainable Seafood Supply Focus Area. These include providing research results and expertise to dozens of public coastal-resource management bodies at federal, state, county and community levels. Research findings and NCSG specialists' expertise feed into state and federal fisheries management decisions and the N.C. Coastal Habitat Protection Plan (CHPP) developed by four statewide commissions.

Partnerships enhance our scientific and societal impacts identified within our strategic plan. NCSG extension staff collaborated with Sea Grant network partners on a U.S. Department of Agriculture Trade Adjustment Assistance program linking sustainable shrimping and good handling practices to economic success. The joint NCSG/N.C. Division of Marine Fisheries (DMF) fellowship is so successful that the agency now covers two-thirds of the cost. NCSG also provides leadership in outreach efforts of the federal South Atlantic fisheries region, NOAA in the Carolinas and The Governor's South Atlantic Alliance. Climate change research partnerships with various federal agencies consider ecosystems that are important fishery nurseries. Joint calls for proposals with the U.S. Geological Survey-funded Water Resources Research Institute of the UNC system enhance connections among freshwater habitats and saltwater ecosystems that support fisheries. With South Carolina and Georgia Sea Grant, NCSG co-founded the Center for Ocean Sciences Education Excellence South-East (COSEE-SE), funded by the National Science Foundation (NSF). COSEE-SE has provided current fisheries/ecosystem data for classroom use — building marine literacy and inspiring a new generation of scientists. Public and school audiences have benefited from partnerships with UNC-TV for "North Carolina Science Now" series and the *North Carolina's Local Catch* documentary.

SIGNIFICANT ADVANCES IN SCIENCE AND TECHNOLOGY

The results of NCSG-funded research and outreach are regularly published in peer-reviewed journals, advancing state, national and international understanding of fields related to seafood, fisheries and aquaculture. Publications and topics include: *Nature Climate Change* on oyster reef response to rising sea levels; *Ecosphere* on the value of oyster reefs' ecosystem services; *Journal of Shellfish Research* on choices of oyster reef restoration substrates; *PLOS One* on genomes for hybrid striped bass broodstock; *Fish & Shellfish Immunology* on *Perkinsus marinus* in oysters; *Marine Ecology Progress Series* on diamondback terrapin bycatch in crabpots; *Developmental and Comparative Immunology* on antibiotic peptides in blue crabs; *Limnology & Oceanography* on impacts of severe drought on estuarine trophic levels; *North American Journal of Fisheries Management* on release of hatchery-reared striped bass; *Marine Policy* on a review of fisheries management under the Magnuson-Stevens Act; *Human Organization* on local seafood awareness efforts; and *Endangered Species Research* on mortality rates of sea turtles released after interactions with gill nets.

Leveraged Funding: NCSG's scientific influence is broad, not only through projects funded by Sea Grant but also through NCSG-managed projects. In addition to managing various state and federal cooperative fisheries research programs, NCSG staff have been successful in receiving additional external funding. For example, NCSG collaborates with Mid-Atlantic Sea Grant programs to reduce introduction of nuisance species through the live-bait trade, and with South Atlantic and Caribbean partners to integrate research and extension to support management of lionfish.

NCSG scientific influence also is seen in proof-of-concept results that our researchers employ to successfully compete for grants from other agencies that provide broader impacts — in topic and geographic scope. A minigrant looking at potential impacts of environmental hypercapnia and ocean acidification in estuaries on oysters strongly suggested that rising CO_2 can pose profound ecological

and economic impacts in estuarine ecosystem. Those results sparked a $300,000 NSF study. NCSG researchers received: $555,000 to study oyster metapopulation dynamics; $228,000 to evaluate migration dynamics and estuarine habitat use of southern flounder; $400,000 to expand telemetry approaches to estimate mortality of weakfish; $316,000 to consider a molecular approach to assess black sea bass fertility; and $100,000 to evaluate potential improvements to the N.C. seafood supply chain from state and federal sources.

Tools, Technologies and Products: In addition to the shellfish aquaculture siting tool and other research and outreach activities, NCSG has provided a wide range of tools, technologies and products to advance science related to sustainable fisheries, seafood and aquaculture businesses, and to better allow resource managers, educators and consumers to understand and use data. For example:

- NCSG researchers quantified the role of beaches and surf zones as highly productive habitats for primary producers, including zooplankton, and a primary nursery area for migratory fishes. The U.S. Army Corps of Engineers uses these results to review beach nourishment projects.
- Through a photographic database and sample analysis, researchers have expanded understanding of the bottlenose dolphin population, a protected species that may interact with fishing activities.
- Using NCSG research, a stock assessment of striped bass in the Albemarle Sound-Roanoke River system for the first time included striped bass fishing mortality outside that system. Accurate stock assessment will ensure sustainable striped bass recreational and commercial fisheries.
- Advances in hybrid striped bass broodstock genetics are being applied by the national industry.
- State fisheries managers now consider culverts' roles in hampering migration of alewifes.
- A low-cost prototype for an underwater video data-logger for fish stock assessments exceeded expectations for reliability, deployment time and fish observation totals.
- NCSG demonstrated successful use and the potential of text messaging to compile online recreational fisheries data, resulting in further testing by DMF and interest from federal fishery managers. The resulting discussions sparked a fisheries data collection program in Maryland. RecText also drew interest from citizen-science programs.

SIGNIFICANT SOCIETAL BENEFITS

Our PIER PRP Safe and Sustainable Seafood Supply Focus Area Report highlights a range of applied societal impacts beyond the science generated by NCSG research. Here are just a few examples of how NCSG meets varied goals of the National Sea Grant College Program:

- **Stakeholders' changes in behavior**: NCSG has provided critical leadership in working with coastal communities to develop "local catch" programs, shifting the focus to connecting consumers to fishermen and local seafood. In 2010 to 2013, Brunswick Catch, Carteret Catch, Ocracoke Fresh and Outer Banks Catch thrived, drawing diverse membership, including fishing families, processors, wholesale and retail sales managers, restaurant chefs and their staff, and community partners. The new statewide North Carolina Catch nonprofit helps the four local groups collaborate, serves other coastal counties and offers a website at *nccatch.org*. Other partners include the N.C. Department of Agriculture and Consumer Services, Saltwater Connections, and the Resourceful Communities program. Consumers also continue to respond to NCSG outreach, including seafood availability poster updates, the *Mariners Menu* blog, demonstrations and exhibits at local and state seafood festivals, and *Coastwatch* feature stories and recipes.
- **Public health and safety**: NCSG researchers and local fishermen collaborated on an FRG project to determine mercury and PCB levels in six inshore species. More than 97 percent of the samples were below Environmental Protection Agency-recommended levels for both chemicals. The results suggest that seafood consumption recommendations based on mercury and PCB content should utilize local data rather than regional or national lists. NCSG assists seafood processors to meet federal seafood safety requirements. Our seafood specialist also is a co-leader of a highly regarded annual "seafood school" for county health inspectors who rate retail markets and restaurants. In light of the Deepwater Horizon oil spill, NCSG supplemented a core project with a minigrant to expand collection of baseline physical oceanographic, biological, geological, human dimensional, and biochemical data from the N.C. coast. The results will allow govern-

ment officials to gauge effects of potential future crises such as oil spills.

- **Economic impact and industry implementation**: NCSG is a national leader in marine finfish and shellfish aquaculture, from broodstock development to efficient grow-out systems and effluent discharge that improved business success without impacting the environment. In 2010–13, NCSG assisted 2 N.C. seafood processors to launch 9 new value-added products in wholesale and retail trades. While many crab houses have closed along the N.C. coast, one business attributes its continued success to a crab cake that was developed with NCSG. Other seafood industry assistance includes a workshop to help processors prevent recalls of their products and educational marketing products. In a NOAA Cooperative Research Program Grant project, an NCSG fisheries specialist found that expensive electronic monitoring equipment was no more accurate than traditional log books in identifying bycatch rates in selected offshore fisheries.
- **Natural resource management implications**: NCSG teams of scientists and commercial fishermen characterized the spiny dogfish population south of Cape Hatteras, N.C., which had not previously been monitored by NOAA. The resulting integration of survey and monitoring data, tagging research and other research, combined with that of colleagues in the United States and Canada, spurred a new research paradigm. The results have influenced fishery council and commission management decisions for the Mid-Atlantic, New England and the Atlantic states regions. Overall, at least 15 state and regional fisheries management plans have been influenced by NCSG research. NCSG and DMF co-sponsor an annual marine fisheries fellowship that has provided important data analysis for state fisheries plans and to identify potential Strategic Habitat Areas. The joint NCSG/N.C. Coastal Reserve fellow studies critical fishery habitats.
- **Community impacts**: The Saltwater Connections program, which grew out of a past NCSG research project looking at changing land uses, also was a key partner in the formation of N.C. Catch. In a multicounty region, Saltwater Connections promotes fishing heritage and culture within today's economy. The program has used NCSG fish house surveys to leverage new research on the seafood supply and value chains, complementing NCSG's ongoing efforts, including participation in a major U.S. Department of Agriculture study of N.C. local foods. An NCSG fisheries specialist has been a leader on an expert panel helping 21 communities map assets and identify business options that celebrate the past and cultivate the present, such as the Outer Banks National Scenic Byway and related regional heritage and ecotourism trails.
- **Crosscutting educational benefits**: Within the Safe and Sustainable Seafood Supply Focus Area, NCSG initiates and executes a robust portfolio of educational investments including: graduate, undergraduate, and K-12 student investments and teacher training; professional trainings; and targeted public education efforts. In addition to the marine fisheries fellowship cited above, programs address local, state, regional, national and international needs resulting in increased awareness across a breadth of audiences (e.g., citizens, students, industry leaders). Through COSEE-SE, NCSG graduate students have developed educational programs for teachers and informal educators, including a traveling trunk and curriculum on ocean predators developed by a NOAA Fisheries fellow. An Advanced Placement science lab at the N.C. Estuarium showed students how fish ear bones reflected water quality.

RECOGNITION BY OUR PEERS

NCSG program excellence in Safe and Sustainable Seafood Supply is widely recognized as advancing science and providing significant societal benefit. In the 2010 and 2012 selections for NOAA Walter B. Jones Awards, two NCSG science communications fellows, along with four other NCSG-funded students, received honors for outstanding graduate studies. Our partners in the Town of Plymouth, N.C., earned Jones local government honors for efforts including NCSG-led planning scenarios for the town that sees recreational fisheries as a key economic driver. In 2010 to 2013, other awards included multiple honors from national and regional Sea Grant networks, and yet another NCSG extension specialist was selected for an N.C. Governor's Conservation Achievement Award. The communications and extension teams also were recognized at the state and national levels for outstanding outreach products, including *Coastwatch* and *The Sustainability Series*.

PIER PRP Program Focus Area Report

North Carolina Sea Grant

Safe and Sustainable Seafood Supply

Program Focus Area: SAFE AND SUSTAINABLE SEAFOOD SUPPLY

Program Goals

1. A sustainable supply of safe seafood that meets public demand at affordable prices.
2. A healthy domestic seafood industry that harvests, produces, processes, and markets seafood responsibly and efficiently.
3. Informed consumers who understand the importance of ecosystem health and sustainable harvesting practices to the future of our domestic fisheries, who appreciate the health benefits of seafood consumption, and who understand how to evaluate the safety of the seafood products they buy.

JUMP TO REPORT SECTION

Impacts and Accomplishments toward Program Goals

1. **Program Goal: A sustainable supply of safe seafood that meets public demand at affordable prices.**
   Impact(s)
   - 21100 - NC Sea Grant/NC DMF Partnership Notes Culverts Block Alewife Passage
   - 19700 - Crabcake Success Keeps NC Processor in Business
   - 18619 - Research Guides Identification of Strategic Habitat Areas for NC Saltmarsh Fish
   - 17718 - Determining Low Levels of Mercury And Polychlorinated Biphenyl Levels In N. C. Seafood
   - 17345 - New Techniques Estimate Natural Mortality of Small Fish in Dynamic Habitats

   Accomplishment(s)
   - 20892 - Assessing Harvest Efficiencies and Consumer Demand for North Carolina Lionfish
   - 20828 - Quantifying Trophic Dynamics of Large Pelagic Fishes off North Carolina

2. **Program Goal: A healthy domestic seafood industry that harvests, produces, processes, and markets seafood responsibly and efficiently.**
   Impact(s)
   - 21330 - NC Researchers Lower Salinity of Water for Cultured Flounder, Enable Discharge to Be Used on Land Plants
   - 21315 - Online NC Aquaculture Siting Tool Launched after Successful Pilot Testing
   - 21138 - NC/SC Team Develops Tool That Helps National Hybrid Striped Bass Breeding Program Select Desirable Broodstock
   - 21094 - NC Sea Grant Identifies Growth and Mortality of Hatchery-Reared Striped Bass Stocked into Non-Natal Systems
   - 21084 - NC Sea Grant Blue Crab and Shellfish Research Results Inform Fishery Management, Industry Efforts
   - 21076 - NC Fishery Resource Grant Research Results Inform Marine Fishery Management and Industry
   - 21071 - NC Sea Grant Researchers Identify Sustainable Oyster Settlement Substrate; Now Used In State, Federal Restoration Work
   - 20941 - Electronic Monitoring Study Supports NOAA Fisheries Implementation Plan
   - 20883 - Pilot Study of Novel Crab Bait Leads to New Business and Leveraged Funding
   - 19282 - Fish Houses in NC Continue to Decline but at a Slower Pace
   - 18882 - Population Dynamics Model Informs NC Oyster Restoration Habitat Suitability
   - 18738 - NC Sea Grant Facilitates Decade of Marine Mammal Bycatch Reduction Research
   - 18600 - Diamondback Terrapin Research Informs NC Blue Crab Fishery Management
   - 18595 - NC Striped Bass Migration Now Factors into Stock Assessment
   - 18589 - Improved Flounder Hatchery Technologies Assist Stock Enhancement
   - 17449 - Increasing Seafood Safety
   - 17444 - Assisting Shrimpers Coping with Competition from Imports
   - 15795 - New Paradigm for Spiny Dogfish Population Dynamics
   - 14457 - Effects of High CO-2 Concentrations on Eastern Oysters

   Accomplishment(s)
   - 21054 - NC Sea Grant Scientists Developing Cost-Effective Vaccine Against E. tarda Leading to Healthier Cultured Marine Finfish
   - 21032 - NC Sea Grant Invests in Continuing and Emerging Regional Research and Outreach

Priorities
- 18888 - Oyster reef vertical growth found to match SLR

3. **Program Goal: Informed consumers who understand the importance of ecosystem health and sustainable harvesting practices to the future of our domestic fisheries, who appreciate the health benefits of seafood consumption, and who understand how to evaluate the safety of the seafood products they buy.**
Impact(s)
   - 21284 - NC Sea Grant and NC Catch Leadership Host Successful Local Catch Summits
   - 21156 - UNC-TV Science Now Team Partners with NC Sea Grant Research and Outreach Experts to Deliver Information Statewide
   - 19212 - Seafood Quality and Safety: A Practical Workshop for Environmental Health Specialists
   - 17640 - Developing Coastal Community Capacity to Sustain and Develop Economic Opportunities
   - 17449 - Increasing Seafood Safety

   Accomplishment(s)
   - 20892 - Assessing Harvest Efficiencies and Consumer Demand for North Carolina Lionfish

Back to Top

Full Text of Impacts and Accomplishments

21330 - NC Researchers Lower Salinity of Water for Cultured Flounder, Enable Discharge to Be Used on Land Plants
Relevance: In the U.S., the culture of southern flounder mainly occurs in recirculating aquaculture systems (RAS). RAS allow producers to manage water quality by using low salinity groundwater and adding select minerals and salts. Although RAS are inherently designed to conserve water, some discharge is inevitable and is highly regulated. While freshwater effluent may be applied onto terrestrial plants, this option is not available to marine aquaculture producers because the sodium (Na+) content of the water is destructive to soil and chloride (Cl-) is toxic to plants. The ability to lower the Na+ and/or Cl- content of effluent water to allow land application would increase the number of effluent treatment options available to producers, thereby improving the environmental sustainability of marine RAS.

Response: North Carolina Sea Grant researchers worked to manipulate the ionic composition of RAS culture water for southern flounder to optimize survival and growth. They wanted to improve the environmental sustainability of RAS by making effluents suitable for disposal on terrestrial plants.

Results: Flounder have the ability to adapt to low sodium water as early as two months after hatching, and this ability continues to improve up to the age of five months. These results provide the first evidence that flounder, and perhaps other marine fish, can be cultured in water with low sodium content, which opens up a variety of options for effluent treatment.
RECAP: Flounder culture in recirculating aquaculture systems is hampered by the inability to discharge water to receiving streams because discharge is too high in sodium. This North Carolina Sea Grant project investigated the ability of flounder to adapt to water with low sodium. Researchers determined that flounder as young as two can adapt to low sodium water, which would allow producers to use lower sodium water that can be discharged and improve the economic viability of their business.

Back to Goals

21315 - Online NC Aquaculture Siting Tool Launched after Successful Pilot Testing
Relevance: Shellfish aquaculture in North Carolina is a small, yet traditionally important industry to coastal communities, providing locally grown clams and oysters and supplemental income. Despite increasing seafood demand and growers' efforts, acreage under lease and total number of leases in NC have remained relatively constant in recent years. Traditionally, NC shellfish growers placed loose shell or cultch on bottom leases to capture natural larval set. With the development of new techniques, hatchery sources of larvae and gear, shellfish growers may be able to expand into areas that were previously productive.

Response: North Carolina Sea Grant researchers from the University of North Carolina Wilmington developed an interactive decision-support tool that helps these entrepreneurs assess growing conditions on the North Carolina coastline based on existing datasets. This GIS tool is designed to assist potential shellfish growers determine site feasibility and identify potential risks and long-term suitability for particular areas. Clear identification of risks associated with specific locations may help the industry, researchers and managers identify and promote methods, techniques and/or gear to reduce obstacles to shellfish production.

Results: Based on successful pilot testing, the N.C. Shellfish Lease Siting Tool, www.uncw.edu/benthic/sitingtool, was launched in October 2014. Since then, the website has received almost 1,200 unique visits. This tool has been demonstrated at several conferences, including the N.C. Oyster Summit, North Carolina's Coastal Conference and the N.C. Aquaculture Development Conference. Although not a substitute for on-site evaluation, the tool helps save time and effort in

reviewing the 1,200 miles of N.C. estuarine coastline.
RECAP: To increase shellfish aquaculture in the state, a team led by North Carolina Sea Grant developed an interactive decision-support tool for the N.C. coastline. This tool is intended to ease the process of getting new shellfish leases. Pilot testers report it helps shellfish growers determine where to locate new leases. The N.C. Shellfish Lease Siting Tool, www.uncw.edu/benthic/sitingtool, was launched in October 2014. Since then, the website has received almost 1,200 unique visits.

Back to Goals

21284 - NC Sea Grant and NC Catch Leadership Host Successful Local Catch Summits
Relevance: North Carolina Catch supports the work of the four local seafood promotion initiatives that stretch from Currituck County to Brunswick County. Carteret Catch, Ocracoke Fresh, Brunswick Catch, and Outer Banks Catch have emerged as the buoys and markers that guide consumers to local fish and shellfish sources. However, the members are generally unfamiliar with conference and event planning, particularly with regard to agenda development and identification of speakers and content to address current and emerging issues related to seafood.

Response: North Carolina Sea Grant extension specialists were requested and provided support to North Carolina Catch to assist in the development, coordination and delivery of three annual Catch summits from 2012-2014. The location of the summit would be rotated to co-inside with the location of the local Catch group. Each agenda was different and designed to address local Catch group issues at the time as well as those of the North Carolina Catch group as a whole.

Results: Feedback from attendees at all three North Carolina Catch Summits was overwhelmingly positive. With three summits complete, North Carolina Catch leadership is now capable of developing and hosting annual summits with minimal support from Sea Grant. North Carolina Catch plans to organize and host the fourth annual summit in 2015.

RECAP: North Carolina Catch supports the work of the four local seafood promotion initiatives that stretch from Currituck County to Brunswick County. North Carolina Sea Grant extension specialists provided support to North Carolina Catch to assist in the development, coordination and delivery of three annual Catch Summits from 2012-2014. With three summits completed, North Carolina Catch leadership is now capable of developing and hosting annual summits with minimal support from Sea Grant.

Back to Goals

21156 - UNC-TV Science Now Team Partners with NC Sea Grant Research and Outreach Experts to Deliver Information Statewide
Relevance: UNC-TV and North Carolina Sea Grant have a strong history of collaborations. Thus, UNC-TV, a component of the University of North Carolina system, sought Sea Grant as a partner in developing its Science Now series within North Carolina Now, a weeknight public affairs program.

Response: The Science Now partnership includes NC Sea Grant researchers and extension specialists as experts providing key research findings and other useful information in terms that can be understood by not only by the general audience, but also by students in classrooms where teachers use the Science Now lesson plans that meet state and national science standards. The communications team works with UNC-TV team to identify potential coastal stories reflecting a variety in topics, locations, etc. and also to share Science Now's mission through stories in Coastwatch, on social media, in blog posts, etc. Susan White, NC Sea Grant executive director, services on the Science Now advisory panel.

Results: In 2014-15, Sea Grant topics included estrogen impacts on blue crabs, oyster reef designs to enhance ecosystem services, shellfish sanitation/safety tips, and the role of tidal creeks in estuarine water quality. They are available online also at: science.unctv.org. The average Wednesday night audience for Science Now is nearly 14,000 viewers, about 2,000 more than the nightly average audience for all days. A rip current story also was developed for broadcast to open the 2015 beach season, and other stories were planned for 2015 field production and broadcast.
RECAP: For its Science Now series, UNC-TV engages North Carolina Sea Grant as a trusted partner for coastal science and policy information. A weekly segment in the North Carolina Now public affairs program, Science Now reaches nearly 14,000 viewers. In 2014-15, Sea Grant topics included blue crabs, oysters reefs, tidal creeks and shellfish sanitation. The videos and blog posts are key components of classroom-ready materials that meet national and state science standards. Back to Goals

21138 - NC/SC Team Develops Tool That Helps National Hybrid Striped Bass Breeding Program Select Desirable Broodstock
Relevance: Close to half of the 4-year-old female striped bass in the National Program for Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, which are held at the North Carolina State University Pamlico Aquaculture Field Laboratory in Aurora, NC, produce poor quality eggs. There is no apparent difference between the growth rates of these females as the size at reproduction was uniform between fish that spawned good and poor quality eggs.

Response: In this joint North and South Carolina Sea Grant project, researchers from NC State University developed and are using a new transcriptomic fingerprinting method to assess the reproductive potential of female hybrid striped bass.

Results: The offspring of striped bass with low-fertility eggs (less than 5 percent) are no longer being

considered for rearing and are being culled such that this trait is no longer propagated. Although there is no overt genetic effect on egg quality, epigenetic effects are implicated and further research will be required to identify husbandry practices that may mitigate these egg quality problems.
RECAP: Colleagues are using North Carolina Sea Grant researchers' new transcriptomic fingerprinting method to assess the reproductive potential of female hybrid striped bass. In an effort to only include fish that produce high-quality eggs in a national program to improve the culture of hybrid striped bass, this tool is being used to cull striped bass with low fertility eggs from being included in that program's brood stock. Back to Goals

21100 - NC Sea Grant/NC DMF Partnership Notes Culverts Block Alewife Passage
Relevance: Alewife populations in North Carolina are at historic lows. Ongoing efforts seek to restore this once thriving fishery. These efforts are hindered by lack of data regarding the migration ability of fish to pass through road culverts.

Response: Researchers with North Carolina State University's Center for Marine Sciences and Technology conducted a study with N.C. Division of Marine Fisheries using North Carolina Sea Grant/N.C. Division of Marine Fisheries student fellowship to model the passability of eight culverts in the Albemarle Sound area for alewives.

Results: Of the eight culverts examined, only one was passable all the time. Most were not passable during most of the modeled period due to three main issues: water in the culvert was too shallow, water flowed too fast through the culvert, or there was too much elevation difference between the culvert and the pool below it. Thus, culverts are predicted to be a major obstacle to migrating fish. Modeled results are being corroborated with field measurements. This new data will provide N.C. Division of Marine Fisheries with solid science-based results to seek culvert removal when opportunities present themselves.
RECAP: Alewife populations are at historic lows in North Carolina. Ongoing efforts seek to restore this once thriving fishery. Lack of access to spawning grounds has been suggested as one possible contributing factor. Culverts were found in this study to be a significant blockage to fish. Due to a North Carolina Sea Grant-funded study, N.C. Division of Marine Fisheries now has science-based data to seek culvert removal when opportunities present themselves. Back to Goals

21094 - NC Sea Grant Identifies Growth and Mortality of Hatchery-Reared Striped Bass Stocked into Non-Natal Systems
Relevance: The state of North Carolina stocks striped bass juveniles into the Pamlico and Neuse Rivers in an attempt to increase the population sizes in those areas. It is unknown why this stocking effort has not led to increased abundance.

Response: The jointly funded North Carolina Sea Grant-N.C. Division of Marine Fisheries marine fisheries fellow used tag return data (1990-2010) from an ongoing stock enhancement program to estimate growth and mortality of hatchery-reared striped bass of Roanoke River (RR) origin in the Pamlico and Neuse rivers.

Results: Despite their RR origin, stocked juveniles exhibited high fidelity (>90%) to Pamlico and Neuse Rivers and similarly high growth as in their natal habitat. However, time-at-liberty estimators of total mortality (Z) indicated stocked striped bass experienced significantly higher mortality in the Pamlico and Neuse Rivers (Z's 0.48-0.51) vs. Roanoke River (Z = 0.33). The state of North Carolina is looking into new release locations in an attempt to reduce mortality of stocked fish.
RECAP: North Carolina is trying to rebuild stocks of striped bass in the Pamlico and Neuse Rivers. A study by N.C. Division of Marine Fisheries and Sea Grant found stocked juvenile striped bass had high site-fidelity and growth rates in these rivers. Stocking appeared effective in supporting some local fisheries, but potentially limited from a stock-rebuilding perspective due to high mortality of fish. State officials are looking into new release locations in an attempt to reduce mortality of stocked fish.
Back to Goals

21084 - NC Sea Grant Blue Crab and Shellfish Research Results Inform Fishery Management, Industry Efforts
Relevance: N.C. Blue Crab and Shellfish Research Program, funded by the N.C. General Assembly and administered by North Carolina Sea Grant, pairs members of the fishing community with researchers and resource managers to investigate and enhance critical fisheries. Founded in 2001 with an initial focus on crabs, the program expanded in 2008 to include shellfish. Focus areas for grants include five priority areas for blue crab research (stock enhancement, population assessment, blue crab biology, shedding technology, and social/economic aspects) and five for shellfish (mariculture, shellfish restoration, shellfish economics, harvest technology and shellfish safety, and health/disease of shellfish populations). Grants are typically one-year awards with numerous impacts recorded that support N.C. Division of Marine Fisheries management issues and/or address local fishermen needs.

Response: In 2014-15, seven projects were active. One project wrapped up during the reporting period, with the other six ongoing. Stakeholders often seek and use results of ongoing, recently completed and past projects.

Results: The project completed in 2014-15 looked into the use of citizen volunteers to help remove derelict crab pots from state waters during the designated "no pot" clean up period. Overall, participants claimed the pilot project a success and felt that greater trust was garnered among

commercial fishermen and N.C. Marine Patrol as a result of this new collaboration. Due to assistance from fishermen with the cleanup effort, only half the normal number of N.C. Marine Patrol officers had to be on the water each day, saving the state in human and financial resources.
RECAP: North Carolina Sea Grant continues to administer the N.C. Blue Crab and Shellfish Research Program addressing priority management concerns identified by state fisheries managers, as well as issues related to industry, ecosystems, communities and other state agencies. Stakeholders seek research results. A recent project reflects effectiveness of volunteers assisting the N.C. Division of Marine Fisheries' Marine Patrol in removing derelict crab pots from state waters. A pilot effort increased collaboration/trust and cut state costs. Back to Goals

21076 - NC Fishery Resource Grant Research Results Inform Marine Fishery Management and Industry
Relevance: The N.C. Fishery Resource Grant research program is a legacy program that is not funding new projects. Since the mid-1990s, FRG has integrated university researchers with fishermen to address varied fishery concerns along the N.C. coast. Focus areas included new or refined equipment/gear to more effectively and efficiently fish; aquaculture development efforts, advances in seafood safety and technology, and pilot environmental study projects. The typically yearlong projects generated results used by the N.C. Division of Marine Fisheries and regional federal fishery management councils, as well as local fishermen.

Response: Through wise use of awarded funds, 17 projects continued in 2014-15. Eleven of these wrapped up during this reporting period, providing important results to fishery managers and industry stakeholders. The remaining six projects continue using earlier funding.

Results: Projects completed during this reporting cycle provided varied impacts, including: a new bycatch-reduction design for shrimp trawls; tracking of juvenile sea turtle migrations to help limit interactions fishing operations; reuse of derelict crab pots to enhance oyster growth; identification of juvenile spiny dogfish habitats; identification of the impact of discard mortality for dolphinfish caught by hook and line; improved aquaculture techniques designed to allow aquaculturists to raise two species at the same time; and efforts to develop a market for farm-raised sturgeon meat. Many of these projects are of high interest to our N.C. Division of Marine Fisheries, as well as to our fishing and seafood industries. Sea Grant extension and communications teams help share the research results.
RECAP: N.C. and regional fishery managers continue to directly apply N.C. Fishery Resource Grant Program results to update and revise numerous stock assessments and fishery management regulations. North Carolina Sea Grant administered the program for many years. Ongoing projects using previously allocated money will continue to deliver results for this legacy research program that the N.C. General Assembly discontinued in 2013. Back to Goals

21071 - NC Sea Grant Researchers Identify Sustainable Oyster Settlement Substrate; Now Used In State, Federal Restoration Work
Relevance: Oysters provide important ecosystem services and economic value. However, reduced natural stocks need to be restored. Oyster restoration is growing rapidly worldwide because there are fewer wild oysters to be found, their increased importance as a food item, and the species' provision of ecosystem services. Identifying sustainable substrates for restoring the oyster population is key to the success of this endeavor.

Response: North Carolina Sea Grant researchers quantified the effects of different substrate types and presence/absence of boring sponge on oyster larval settlement. Boring sponge can damage oysters by boring into the bivalves' shells, which can weaken the shell. In some cases, the damage can kill the oysters. The scientists also studied subsequent growth and survival with and without the presence of boring sponge.

Results: Concrete substrates provided the best combination of those tested in terms of balancing high larval settlement, post-settlement growth and survival and inhibition of boring sponge. Because of this research, the North Carolina Division of Marine Fisheries and U.S. Army Corps of Engineers have switched to using concrete for oyster restoration in North Carolina.
RECAP: Oysters provide important ecosystem services and economic value. However, reduced natural stocks need to be restored. North Carolina Sea Grant researchers found that concrete substrates provided the best combination of balancing high oyster larval settlement, post-settlement growth and survival and inhibition of boring sponge. The N.C. Division of Marine Fisheries and U.S. Army Corps of Engineers have switched to using concrete for oyster restoration in North Carolina. Back to Goals

21054 - NC Sea Grant Scientists Developing Cost-Effective Vaccine Against E. tarda Leading to Healthier Cultured Marine Finfish
Relevance: Identification of pathogens causing mortality of southern flounder raised in low salinity recirculating aquaculture systems is needed to develop strategies to prevent or to manage disease outbreaks. Disease outbreaks remain a technical barrier to consistent production of this species.

Response: North Carolina Sea Grant researchers sent symptomatic southern flounder reared in a recirculating system under low-salinity conditions to an aquatic animal health company. The company identified Mycobacterium marinum and Edwardsiella tarda in these fish.

Results: The identification of the specific pathogens in southern flounder raised in low-salinity

recirculating aquaculture systems enabled North Carolina Sea Grant researchers to start developing a cost-effective autogenous vaccine against E. tarda, a primary pathogen of cultured marine finfish, including flatfish. The efficacy of this new vaccine must be evaluated through practical production trials of southern flounder grown in low-salinity recirculating systems from fingerling through full marketable stages. This tool has potential for overcoming a major technical barrier to commercial production in NC and in the southeastern US.

RECAP: Mycobacterium marinum and Edwardsiella tarda were identified as pathogens that caused mortality in southern flounder raised in low-salinity recirculating aquaculture systems in North Carolina. Sea Grant researchers developed a cost-effective vaccine against E. tarda, which causes significant mortality in marine finfish, including cultured flatfish species. This tool has potential for overcoming a major technical barrier to commercial production in North Carolina and in the southeastern U.S. Back to Goals

21032 - NC Sea Grant Invests in Continuing and Emerging Regional Research and Outreach Priorities

Relevance: NC Sea Grant recognizes that the coastal resource issues of North Carolina often are intimately connected with those in nearby states, to the north and south. Therefore Sea Grant programs plan for, and engage in, regional projects and investments benefiting respective states. For example, NC Sea Grant continues to support the 2013 Mid-Atlantic joint research efforts investigating climate change impacts on summer flounder in this region.

Response: In a new South Atlantic regional initiative, Sea Grant programs of Florida, Georgia, North Carolina and South Carolina and the NOAA Office for Coastal Management jointly solicited proposals for a regional research project focused on coastal community resilience. To be competitive, proposals needed to include a team of researchers, one from each state, to partner with a coastal community in each state, and engage with Sea Grant extension specialists and OCM.

Results: The desired outcome is a quantitative assessment of the efficacy of a new or existing tool that can be used by coastal communities in South Atlantic states to increase their resilience to hazards; contemporary such as storm surge, and future such as sea level rise. Four pre-proposals were received, with full proposals requested from three of those. Full proposals will be reviewed in Summer 2015 with an expectation that one project will be funded for two years for up to $225,000 per year, or $450,000 total, with resources provided from all South Atlantic Sea Grant programs and OCM.
RECAP: Coastal resource management needs and issues are not constrained by state boundaries. North Carolina Sea Grant continues to partner closely with Sea Grant programs in the Mid-Atlantic and South Atlantic to address cross-boundary research needs in fisheries and coastal community resilience through jointly funded research approaches. Back to Goals

20941 - Electronic Monitoring Study Supports NOAA Fisheries Implementation Plan

Relevance: There is growing desire for electronic monitoring (EM) and electronic reporting (ER) in fisheries as managers collect and analyze increasing amounts of data needed for management. Many EM pilot studies have been conducted in the U.S., but none have been fully implemented due to lack of pilot testing, uncertain programs costs, and unknown issues that may arise if and when the National Oceanic and Atmospheric Administration (NOAA) transitions to these new data collection platforms.

Response: North and South Carolina Sea Grant extension specialists, with project funding from NOAA, led a cooperative research study in 2010 that evaluated the use of EM systems on offshore reef fish vessels from North Carolina to Georgia. This is the second of three EM pilot studies in the Southeast region and the only EM pilot study conducted to-date from the South Atlantic. The study was designed to compare and contrast observer data with EM data, as well as develop a better understanding of the technical challenges associated with EM use in fisheries.

Results: The EM approach as tested has great potential technologically, but operational costs and infrastructure limitations posed insurmountable challenges to implementation. The EM pilot study results fed directly into the development of the NOAA Fisheries Southeast Region EM/ER Implementation Plan. Results from a North Carolina Sea Grant-led EM pilot study, funded by NOAA, served as a basis for much of the discussion in the regional plan and identified many of the challenges inherent in EM implementation.
RECAP: There is a growing desire for more electronic monitoring (EM) and electronic reporting (ER) approaches in fisheries. As such, NOAA Fisheries recently developed EM/ER action plans for each U.S. region. Results from a North Carolina Sea Grant-led EM pilot study in the South Atlantic, funded by NOAA, served as a basis for much of the discussion in the NOAA Fisheries Southeast regional plan, and exposed many of the challenges inherent in EM implementation. Back to Goals

20892 - Assessing Harvest Efficiencies and Consumer Demand for North Carolina Lionfish

The invasive lionfish is now one of the most dominant predators on offshore artificial and hard bottom reefs in North Carolina. A significant number of juvenile grouper and snapper are among the species consumed by lionfish and both are important to commerce. Lionfish have been difficult to target and capture using traditional hook and line gear used for other reef fish. Spearfishing by SCUBA divers has been the most effective removal method, but the deep-water habitat of lionfish has limited the wide scale applicability of this technique. With funding from North Carolina Sea Grant, researchers experimented with using Florida lobster traps to capture lionfish in Onslow Bay, NC through repeated

deployments of the gear. While the study is still ongoing, initial results indicate that the lobster traps were only mildly successful at capturing lionfish in NC waters.

RECAP: The invasive lionfish is now one of the most dominant predators on offshore artificial and hard-bottom reefs in North Carolina. Spearfishing and hook-and-line are currently used to harvest lionfish, but both methods have drawbacks. North Carolina Sea Grant-funded researchers have tested Florida lobster traps to capture lionfish in N.C. waters. Initial results indicate that lobster traps were only mildly successful at capturing lionfish. Back to Goals

20883 - Pilot Study of Novel Crab Bait Leads to New Business and Leveraged Funding
Relevance: The blue crab supports North Carolina's most important commercial fishery in terms of pounds landed and economic value. The commercial fishery relies on crab pots baited with natural fish species and/or other animal products. The pots are placed in riverine and estuarine waters to attract crabs for harvest. Fishermen and entrepreneurs have long sought a manmade substitute for natural baits, provided the product could be cost effective and could perform as well as or better than traditional baits.

Response: Researchers based in North Carolina had previously developed a new, patent-pending bait, "Organobait," designed to attract crustaceans. The researchers applied for and received North Carolina Sea Grant funding to pilot test the effectiveness of the new bait formulation for use in the state's crab fishery.

Results: The initial results indicate that the bait formulation has potential for the N.C. blue crab fishery. The proof-of-concept results were leveraged to obtain an additional $150,000 in funding from National Science Foundation for Kepley Biosystems Inc., to expand testing with other species.
RECAP: Blue crab rank as North Carolina's leading commercial fishery. Having previously developed Organobait to attract crustaceans, researchers received North Carolina Sea Grant funding to refine the formulation and pilot test effectiveness in the N.C. blue crab fishery. Initial results are promising. Researchers leveraged Sea Grant minigrant results to secure $150,000 in additional funding for Kepley Biosystems Inc, which expects more external funding in 2015. Back to Goals

20828 - Quantifying Trophic Dynamics of Large Pelagic Fishes off North Carolina
Relevance: The offshore sportfish industry is of considerable economic value to North Carolina and other coastal states. The ecology and feeding patterns of large pelagic fishes that contribute to this industry are poorly understood. These species may compete with one another and also impact their prey communities in uncertain ways.

Response: Researchers from the University of North Carolina Wilmington, with funding from North Carolina Sea Grant, carried out a study to examine the food habits of several species of pelagic fish commonly found off the North Carolina coast. The research team partnered with recreational and charter fishermen, fishing tournament organizers, and state fisheries agencies to sample fish off the coasts of North and South Carolina during multiple months for two consecutive years. The researchers used established gut-content identification methods and chemical ecology analyses to examine the feeding habits of large pelagic fishes.

Results: The researchers observed a considerable amount of overlap in the diets of dolphinfish, wahoo, yellowfin tuna and blackfin tuna, but with clear seasonal patterns and some diet specificity. The chemical ecology analyses validated the gut content findings and revealed that large pelagic fish predators were feeding at high trophic levels. The diet analysis for blackfin tuna was unique, as no comprehensive food habits data exist for this species in this part of their range.
RECAP: Very little is known about the feeding ecology of economically important tunas, wahoo and dolphinfish found off the North Carolina coast. University of North Carolina Wilmington researchers used traditional diet analysis and chemical ecology to reveal that considerable diet overlap exists among pelagic fish predators and that some diet specificity exists. Findings will be useful for the management of the pelagic ecosystem off the North Carolina coast. Back to Goals

19700 - Crabcake Success Keeps NC Processor in Business
Relevance: North Carolina seafood processors need to develop value-added products in order to meet consumer demand while also competing with imported seafood that is cheaper but often of lower quality.
Response: A North Carolina crab processor came to North Carolina Sea Grant's seafood technologist about 2006 for help in developing a retail line of crabcakes based on the flavor profile of a classic recipe. NC Sea Grant assisted with testing for commercial-scale production, as well as sensory panels. This included identifying ingredients and the respective sources. This effort resulted in the new product, that continues to be widely available via seafood vendors and at least one grocery store.
Results: The processor reports that the crabcake has kept the company going, including about 60 seasonal jobs. The price point is approximately $2 per cake wholesale. The company is producing about 1,000 crabcakes per day in season. To conservatively estimate 75 production days, that would be $150,000 per year. Additional profits are reaped by the next-level distributors, as the cakes are known to go for $5 each in some metro markets. Thus the total economic value of the product would be about $225,000 annually. Based on the crabcake success, the company has requested to again work with NC Sea Grant to develop new products in 2014-15.
RECAP: A crab processor in North Carolina, has established a crabcake line that is marketed as fresh

from NC waters. The product is based on a formulation developed with key assistance by North Carolina Sea Grant seafood technologist. The economic impact is estimated at $225,000 per year and the processor notes that it is key to the business that has about 60 seasonal jobs. Back to Goals

19282 - Fish Houses in NC Continue to Decline but at a Slower Pace

Relevance: The demand for local seafood grows stronger even as the North Carolina commercial fishing industry continues to contract.

Response: North Carolina Sea Grant funded a socioeconomic analysis - as a follow-up to an earlier survey of fish houses - to learn what seafood-packing capacity has been on a decline since 2007. The study also considered how seafood dealers still in business are adapting to market opportunities and challenges.

Results: The NC Sea Grant survey revealed that the state lost 9.78% of its fish houses from 2006 to 2011 as compared to almost 30% from 2001 to 2006. From 2001 to 2011, North Carolina lost 47 operations, a 36% decline in one decade. Factors contributing to fish-house closures included: 1) stricter fisheries regulations limiting the volume and variety of seafood the industry can harvest; 2) imported products taking market share from domestic producers; and 3) a declining labor pool for harvesters and processors to conduct their activities. The industry seems to be transitioning from a high-volume business model to a number of consumer-oriented commerce models focused on satisfying the increasing local and regional demand for coastal seafood. The research team outlined recommendations to help fishermen and processors sustain their industry for the long term. Results have fed into other studies on seafood supply chain including a major grant that North Carolina State University received from United States Department of Agriculture

RECAP: North Carolina seafood-packing capacity declined 36% from 2001 to 2011, even as demand for local seafood increased. To remain viable, current fish-house owners focus on satisfying local and regional demand for NC seafood products, according to North Carolina Sea Grant researchers, who provide recommendations to help fishermen and processors continue moving in a consumer-focused direction. In 2013, Sea Grant seafood supply chain data was used as a key factor in the US Department of Agriculture's major study of NC local foods. Back to Goals

19212 - Seafood Quality and Safety: A Practical Workshop for Environmental Health Specialists

Relevance: Health concerns and changing consumer tastes have increased the demand for seafood; however, seafood has unique quality and handling issues compared to other foods. Each county in North Carolina has environmental health specialists who are responsible for conducting sanitation and safety inspections at restaurants and retail outlets, and most have very little knowledge of seafood.

Response: To provide sound guidance in evaluating the safety and quality of marine products, North Carolina Sea Grant organizes and assists in teaching the "Seafood Safety & Quality Inspection for Environmental Health Specialists."

Results: Over 600 specialists have received their certification in seafood inspection from the University of North Carolina-Chapel Hill School of Public Health and the North Carolina State of Practice Committee since 1993. NC Sea Grant organizes and facilitates the certification workshop.

RECAP: Seafood has unique quality and handling issues compared to other foods. County environmental health specialists who conduct safety inspections at restaurants and retailers have very little knowledge of seafood. North Carolina Sea Grant holds an annual workshop to provide certification and training in evaluating the safety and quality of marine products to specialists with those responsibilities. Back to Goals

18888 - Oyster reef vertical growth found to match SLR

Relevance: Oyster reefs in central to southern North Carolina are intertidal in nature. They are limited on one side by over-exposure and on the other by water borne predators. This relationship is also impacted by sea level rise which can cause reefs that can not keep up to disappear. NC Sea Grant - funded researchers examined this relationship using intertidal reefs in central N.C.

Response: Oyster reef accretion rates were determined and compared to oyster reef environmental setting. Accretion rates were compared to area sea level rise rates.

Results: The results from the research of the research team at University of North Carolina Chapel Hill show that accretion rates of intertidal oyster reefs have the potential to surpass all other coastal ecosystem engineers, which are primarily macrophytes like saltmarsh (about 1 cm/yr in river-dominated areas), seagrass (0.3 to 0.9 cm/yr) and mangrove (1.35 to 0.1 cm /yr).

RECAP: North Carolina Sea Grant-funded researchers examined the vertical accretion rates of intertidal oyster reefs in central NC waters. Results show that accretion rates of intertidal oyster reefs have the potential to surpass all other coastal ecosystem engineers, which are primarily macrophytes like saltmarsh (about 1 cm/yr in river-dominated areas), seagrass (0.3 to 0.9 cm/yr) and mangrove (1.35 to 0.1 cm /yr). With global warming resulting in higher rates of sea-level rise, existing intertidal oyster reefs that have reached their growth ceiling could respond to sea-level rise and the associated reduction in aerial exposure time by demonstrating enhanced vertical accretion. The high rates of reef growth suggest that the intertidal high-salinity portions of estuaries can be hot spots for oyster-reef productivity. Back to Goals

18882 - Population Dynamics Model Informs NC Oyster Restoration Habitat Suitability

Relevance: Understanding metapopulation dynamics - how a group of spatially separated populations of the same organism interact - is key to effectively guiding conservation and restoration strategies of focal species like oysters. Recent modeling efforts suggest that a network of no-take oyster reserves in

Pamlico Sound, NC, is not self-sustaining. Yet, oyster densities in 8 of 10 reserves are increasing or are stable, suggesting that these reserves are being supplemented by larvae from neighboring fished oyster reefs.
Response: North Carolina Sea Grant researchers quantified population density, recruitment, growth, survivorship and maximum potential larval output at two types of subtidal, fished oyster reefs (one cultch-planted and one natural) in Pamlico Sound. These data were compared to demographic data collected previously collected in marine reserves by the NC State team (Puckett and Eggleston 2012).
Results: The oyster demographic and mapping data are being integrated into a biophysical model to estimate larval connectivity among reserves and fished sites. The connectivity matrices, in turn, will be integrated into a metapopulatuion model to estimate population sources versus sinks. This could point to fished areas that might better serve the overall metapopulation by being reclassified as a no-take reserve, and to identify reserve areas that might serve as fished sites due to fast growth and mortality. The biophysical and metapopulation approach in this project also has been integrated with a geographic information system (GIS) habitat suitability model now providing guidance to the North Carolina Division of Marine Fisheries and U.S. Army Corps of Engineers on future oyster restoration sites.

RECAP: Understanding metapopulation dynamics - how a group of spatially separated populations of the same organism interact - is essential to oyster reef restoration. North Carolina Sea Grant research results suggest the network of no-take reserves in Pamlico Sound is not self-sustaining. The biophysical model developed by NC State University researchers is providing guidance to the NC Division of Marine Fisheries and US Army Corps of Engineers on where to site future oyster reefs. Back to Goals

18738 - NC Sea Grant Facilitates Decade of Marine Mammal Bycatch Reduction Research
Relevance: Based on on-going federal mandates, federal officials have a continuing need to engage fishing and academic communities to identify ways to reduce marine mammal interactions with commercial fishing gear.
Response: Based upon the success of the North Carolina Fishery Resource Grant Program, the National Sea Grant office was requested to administer NOAA Marine Fisheries Service (NMFS) Bycatch Reduction of Marine Mammals in Mid-Atlantic Fisheries Program. A regional competition to selected North Carolina Sea Grant as aptly suited to administer this program based on its record of excellence in grant management of programs of this type of design. The NMFS Bycatch Reduction grant program is a competitive, peer-reviewed proposal-based program that encourages integrated research including university researchers and stakeholders.
Results: Since 2005, 11 projects have been funded to work on reducing bycatch of protected species. Grants totaling $530,516 have been awarded covering by-catch reduction research needs in the Atlantic from Virginia through Florida. Research focus areas include gill net and longline interactions, fishermen data observations and analysis of interactions, technology development (e.g. hooks, leaders, and pingers) to reduce impacts, and improving understanding of stock discrimination for risk assessments of current and future negative interactions. In 2013, research continued on projects investigating the stock identity of stranded dolphins with indications of fishery interactions, and field testing of dissuasive technology devices in the longline fishery in North Carolina. In addition to working directly with fishery managers, impacts of the research and findings are shared through Coastwatch, peer-reviewed publications, professional conferences and other venues.
RECAP: North Carolina Sea Grant is a Sea Grant Network leader in collaborative research with NOAA line offices. NCSG was successful in an open competition to administer the NMFS Bycatch Reduction of Marine Mammals in Mid-Atlantic Fisheries Program. The highly successful partnership builds fisher/scientist research collaborations. Since 2005, 11 projects totaling $530,516 have included recent studies on bottlenose dolphins' fishery interactions and testing of dissuasive devices in longline fisheries. Back to Goals

18619 - Research Guides Identification of Strategic Habitat Areas for NC Saltmarsh Fish
Relevance: Coastal development will continue to place increasing anthropogenic pressures on cordgrass-dominated saltmarsh creeks that are vital to fish production. Roughly 12% of saltmarsh habitats in the U.S. South Atlantic have been lost to development (Gedan and Silliman 2009). Maintenance of the biological integrity of developing watersheds requires an understanding of the relationship between urbanization and metrics of habitat impairment (Wang et al. 1997). Accurate understanding of the status and trends in biological production become increasingly difficult the further altered coastal habitats are from their baseline conditions (Peterson and Lowe 2009).
Response: North Carolina Sea Grant researchers at NC State University used traditional and portable field sampling techniques (throw trapping and minnow trapping), as well as Passive Integrated Transponder (PIT) tags - a novel technique to the saltwater environment - to collect fine-scale information on density, distribution and abundance of the aggregate of actively swimming aquatic organisms. Sampling was done in six, variably altered tidal creeks in coastal North Carolina.
Results: Statistical modeling revealed that anthropogenic impacts on habitat had a negative influence on the densities of smaller fishes and invertebrates. Fishery managers in the N.C. Division of Marine Fisheries are using the data with identification of Strategic Habitat Area (SHAs). Results also are informing decisions made by the NC Division of Coastal Management related to permitting for commercial and residential coastal development projects.
RECAP: Coastal development can threaten North Carolina's saltmarsh habitats. Responses to development are most discernible among the assemblage of smaller fishes and invertebrates that use the marsh platform for foraging and refuge. These species are key in the food web. North Carolina Sea Grant researchers at NC State University used novel tagging techniques to provide data being used by

state resource managers charged with protecting habitats that are strategic to fish production.

Back to Goals

18600 - Diamondback Terrapin Research Informs NC Blue Crab Fishery Management

Relevance: Diamondback terrapins are a species of special concern in North Carolina. Fisheries interactions with this important species must be minimized as much as possible. To better understand the potential impacts of the Blue Crab Fishery, a post card survey was utilized to document terrapin habitat range and areas where interaction was likely to occur.

Response: North Carolina Sea Grant-funded researchers sent out 696 post card surveys to commercial fisherman in North Carolina. The NC Division of Marine Fisheries has used data from surveys to modify the Blue Crab Fisheries Management Plan. Survey results have been used to help design ongoing research projects.

Results: The University of North Carolina Wilmington team found that 18 crabbers in 7 of the 10 counties have observed terrapins in their fishing areas. Of these 18 crabbers, 56% were from Beaufort, Dare or Hyde counties. These northern fishermen averaged 300 hard crab pots per operation in the spring, 422 in the summer, 416 in the fall, and 200 in the winter months. Additionally, they set out an average of 212 peeler pots in the spring and summer months. The crabbers that responded indicated the county and body of water they fished in, which was used to create a map for DMF of fishing operations, and thus potential overlap of crab pots and terrapins.

RECAP: Results from North Carolina Sea Grant-funded research at University of North Carolina Wilmington factored into the 2013 Blue Crab Fishery Management Plan update. Through a survey of fishermen, the researchers documented the interaction of diamondback terrapins with the blue crab fishery in NC waters. The findings also continue to guide sampling locations of ongoing research projects funded by NCSG and others.

Back to Goals

18595 - NC Striped Bass Migration Now Factors into Stock Assessment

Relevance: Striped bass are an important recreational and commercial fish. The NC Division of Marine Fisheries assesses the Albemarle Sound-Roanoke River (AR) stock. Larger striped bass migrate out of the AR system and experience fishing mortality that has not been accounted for in past North Carolina assessments. Accurate information on probability of migration by size of striped bass is needed to improve the North Carolina assessment.

Response: A fellow jointly funded NC Division of Marine Fisheries/North Carolina Sea analyzed 18 years of tagging data. These data were from striped bass known to be AR origin because they were tagged on the Roanoke River spawning grounds. The return rates from different regions, estuary and ocean, were used to estimate the probability of migration into the ocean as a function of striped bass size.

Results: Striped bass from the AR stock exhibit a strong size-dependent emigration pattern. Larger (older) adults >600 mm in total length (TL) were much more likely to migrate to ocean habitats (after spawning) than were smaller adults (350-600 mm TL), which mostly remained in inshore estuarine habitats. In the 2014 North Carolina stock assessment of AR striped bass, these estimates of probability of migrating into the ocean were used to, for the first time, estimate fishing mortality by age experienced by AR striped bass outside of the AR system.

RECAP: Fishery managers used North Carolina Sea Grant research results in the 2014 stock assessment of the Albemarle Sound-Roanoke River (AR) striped bass stock. This stock supports an important recreational and commercial fishery. For the first time, fishing mortality on striped bass outside of the AR system was accounted for in the striped bass stock assessment. A more accurate stock assessment will ensure a sustainable AR striped bass fishery.

Back to Goals

18589 - Improved Flounder Hatchery Technologies Assist Stock Enhancement

Relevance: Development of flounder hatchery technologies is important, not only for commercial aquaculture in North Carolina, but also for stock enhancement in other areas of the US where natural populations have declined due to overfishing and environmental degradation.

Response: Improved spawning and larval culture technologies for southern flounder was developed through a project funded by the North Carolina Sea Grant. The results drew interest in the application of these technologies in the Gulf of Mexico region, where recent oil spills have degraded estuarine habitats, and where southern flounder is an important commercial and recreational fishery species.

Results: The Gulf Coast Marine Life Center in Florida has provided funding to University of North Carolina Wilmington to assist with the design of a commercial hatchery in Destin, Florida, and to supply southern flounder fingerlings for stock enhancement and aquaculture efforts in the Gulf region.

RECAP: Hatchery technologies for southern flounder developed during a North Carolina Sea Grant-sponsored project has spawned additional funding from a private organization, the Gulf Coast Marine Life Center in Florida, to provide hatchery expertise and to supply fingerlings for stock enhancement and aquaculture initiatives in the Gulf Region.

Back to Goals

17718 - Determining Low Levels of Mercury And Polychlorinated Biphenyl Levels In N. C. Seafood

Relevance: Mercury and PCBs levels are cited by national non-governmental organizations and federal agencies as factors when they inform consumers regarding seafood safety recommendations. The variability in pollution dynamics suggest recommendations on the national scale may be too large to accurately reflect local conditions.

Response: Researchers from Duke University joined a local fisherman to evaluate soft-shell and hard-shell blue crabs, white and pink shrimp, oysters, clams, spot, and mullet from fishers in estuaries in

each of the three North Carolina fishery districts. The N.C. Fishery Resource Grant Program, administered by North Carolina Sea Grant, funded the project.

Results: More than 97 percent of the samples were below the EPA levels of concern for both mercury and PCBs. Mercury and PCBs have different spatial dynamics, but both differ significantly by water body, suggesting that seafood safety recommendations should occur by water body instead of at the national scale. These findings support previous research suggesting that differences in water chemistry, terrestrial influence, and flushing time in a particular water body control the contaminant load in locally resident species. The fisherman is able to use the results in marketing his seafood from Core Sound. One of the Duke researchers also used her experience team as background for her dissertation looking at collaborative research involving similar teams that include citizen scientists.

RECAP: Recommendations for seafood consumption -- known as watch cards -- based on regional or national scales often do not reflect local conditions. North Carolina Sea Grant researchers and local fishers worked together on an state-funded project to determine mercury and PCB levels in six inshore species commonly harvested from N.C. waters. Greater than 97 percent of the samples were below EPA recommended levels for both measurements. Differences between levels were found by water body. The results of the project further suggest that seafood consumption recommendations based on mercury and PCB content should utilize local data rather than regional or national. Back to Goals

17640 - Developing Coastal Community Capacity to Sustain and Develop Economic Opportunities

Relevance: N.C. coastal communities are rich in history, heritage and natural resources. For them to prosper economically and socially, working together is important.

Response: NCSG staff assisted local and state leaders, along with NCSG researchers, to form Saltwater Connections, a regional initiative aimed at sustaining livelihoods, cultural heritage, and natural resources along North Carolina's central coast, including Hatteras and Ocracoke islands and Down East Carteret County. The program's goal is to increase the region's economic prosperity by building upon, rather than sacrificing, the cherished cultural and natural heritage, while encouraging an asset-based economic development strategy. Saltwater Connections is a direct result of a previous NCSG core research project focused on Down East Carteret County. Those results provided leverage to a multicounty grant from the N.C. Rural Center, which has also partnered on ongoing efforts such as Outer Banks Catch and a study of seafood supply chains.

Results: The Saltwater Connections resource team, including NCSG staff , researchers and longtime partners, has developed two local community organizations (Hatteras Island Community Task Force and The Down East Council), sponsored two leadership development workshops (N.C. Rural Center Partners Forum and a Regional Winter Assembly), developed a community planning / region-building program that was featured at an Institute of Emerging Issues Discovery Forum, collaborated on local foods/seafood marketing projects (NC Catch coast-wide organization, Day at the Docks in Hatteras Village) and heritage development projects. The group is also working on the Outer Banks Scenic Byway project.

RECAP: Saltwater Connections' projects bring small N.C. coastal communities together to work on economic development, such as wild-caught seafood marketing and heritage tourism, while also offering leadership development. North Carolina Sea Grant staff and researchers are key partners providing critical expertise to the organization that has received funding from the N.C. Rural Center. Saltwater Connections cites its roots as the collaborative Voices of Down East project funded by NCSG core research. Back to Goals

17449 - Increasing Seafood Safety

Relevance: Emergencies stemming from the accidental or intentional contamination of food that may result in illness or injury to consumers need to be resolved through prevention or preparedness, detection, response and recovery. In addition, health concerns and changing consumer tastes have increased the demand for seafood.

Response: Two extension seafood safety courses were designed and implemented by the North Carolina Sea Grant seafood specialist.

Results: Preventing a Recall - Protecting Your Food Business trained businesses in procedures for removing hazardous food from commercial markets. Forty-five individuals attended two workshops in 2012. The second program, Seafood Quality & Safety for Environmental Health Specialists trained environmental health specialists who are responsible for conducting sanitation and safety inspections at restaurants and retail outlets. Known as the Seafood School, the program educates health inspectors about the impact of harvesting and processing on seafood quality and safety; HACCP safety plans; and retail measures to ensure the safety and quality of seafood. Twenty-nine inspectors were certified in seafood inspection in 2012 by the North Carolina State of Practice Committee. Over 600 specialists have received their certification since 1993.

RECAP: Seafood safety is a necessary part of any seafood program. Emergencies stemming from the accidental or intentional contamination of food that may result in illness or injury to consumers need to be resolved through prevention or preparedness, detection, response and recovery. trough Two safety

programs designed and conducted by the North Carolina Sea Grant seafood specialist, 45 restaurant staff being trained, and another 29 North Carolina food inspectors were certified in seafood safety.

Back to Goals

17444 - Assisting Shrimpers Coping with Competition from Imports

Relevance: The U. S. Department of Agriculture announced in 2010 that U.S. shrimp producers in the Gulf and South Atlantic States were certified as eligible for Trade Adjustment Assistance (TAA) for Farmers and Fishermen Program benefits. TAA focuses on providing training to producers of eligible commodities. It also provides assistance in developing a business plan and up to $12,000 in payments to help implement business plans and lessons learned from the technical training workshops.

Response: North Carolina Sea Grant developed one of several industry-specific intensive training courses for the program (Shrimp Marketing Opportunities). In addition, NCSG conducted in-person training workshops throughout the state so that producers could partially complete the program.

Results: At least 173 shrimp businesses in North Carolina have collectively participated in 2,076 credit hours of TAA courses (12 hours per business) and received. $1.98 million in financial assistance to implement new business plans. The training course developed here was useful at the state and regional levels. For example, 2,041 shrimp producers (38 percent of all TAA shrimp producers nationwide North Carolina to Texas) elected to take this particular course for partial fulfillment of program completion. In addition, the course template served as a model for use in the TAA lobster program. To date, "Lobster Marketing Opportunities" has been taken for course credit by 1,269 fishermen or 31 percent of lobster producers in the TAA program. This is listed in the economic impacts section as well.

RECAP: N.C. shrimpers benefited from a North Carolina Sea Grant collaboration with partners to develop and deliver technical training to allow shrimp businesses to meet requirements for a federal program. At least N.C. 173 shrimp businesses have collectively participated in 2,076 credit hours of courses and received $1.98 million in financial assistance to implement new business plans to respond to markets that include significant shrimp imports.

Back to Goals

17345 - New Techniques Estimate Natural Mortality of Small Fish in Dynamic Habitats

Relevance: Advances in electronic tag technologies and mark-recapture models could offer new opportunities to estimate natural mortality and emigration separately in multiple open estuarine creeks. Managers also seek to examine the effects of anthropogenic alteration, predator abundance and fish density on growth, mortality and emigration rate.

Response: North Carolina Sea Grant researchers from NC State University used multiple recaptures (resightings) of juvenile fish that had passive integrated transponder tags, known as PIT. The researchers used manual and stationary receivers to estimate natural mortality and emigration rates of small saltmarsh fish (e.g., spot and mummichog). The proportion of spot that lived and retained tags increased as a function of fish size, but for mummichog, these were not a function of size. For field application, the researchers recommend that spot be at least 68-mm total length in order to obtain a PIT tagging success rate of 90 percent. Autonomous detection equipment recorded a large number of re-sightings on a nearly continual basis throughout the study period. The high-temporal resolution of resightings allowed for precise estimates of model parameters and fine-scale movement patterns of spot and mummichog. The quantity and resolution of autonomous data would have been logistically impossible to collect using traditional fishing gears.

Survival estimates following surgical implant of a PIT tag for spot were 29, 72, and 93 percent for the small (45 to 50 mm), medium (51 to 55 mm) and large (56 to 69 mm) size groups, respectively. In tagged mummichog, survival was not size dependent, with 95 percent survival of small mummichog, 100 percent survival of medium, and 85 percent survival in the large category using a 12.5mm PIT tag. Tag retention estimates in spot were 28, 65, and 86 percent for the small, medium and large size groups, respectively. Small and large mummichog had a retention rate of 95 percent, while medium mummichog had a 90 percent rate of retention when tagged with a 12.5mm PIT tag.

Results: This project was the first to estimate survival of a marine fish using relatively small (12.5mm and 2.04mm) PIT tags. The study demonstrates the utility of PIT tags and autonomous detection systems to track fish at fine temporal scales. The new tools and techniques will improve estimates of demographic parameters in saltmarsh creeks difficult or impractical to sample with active fishing gears.

RECAP: North Carolina Sea Grant researchers from NC State University were the first team to use relatively small (12.5mm and 2.04mm) passive integrated transponder tags, known as PIT, to estimate survival marine fish. Results revealed the utility of PIT tags and autonomous detection systems to track fish at fine temporal scales. The findings also improve estimates of demographic parameters in saltmarsh creeks that are difficult or impractical to sample with active fishing gears.

Back to Goals

15795 - New Paradigm for Spiny Dogfish Population Dynamics

Relevance: Current quotas for Atlantic coast populations are established from data collected on NMFS spring bottom trawl surveys. It is uncertain whether the bottom trawl survey catch per unit effort (CPUE) accurately represents the standing stock biomass. Therefore, to develop best management practices for this fishery, it is imperative that the short- and long-term movement patterns are

identified throughout its range.

Response: The N.C. Fishery Resource Grant program, which is administered by North Carolina Sea Grant, funded ECU researchers and local fishermen to use trawling surveys and acoustic tags to monitor the movement of spiny dogfish. The data will show how dogfish move and congregate. Understanding these patterns will help fishery managers improve sampling surveys and population estimates.

Results: The researcher was instrumental in establishing a new paradigm for spiny dogfish stocks and migratory movement. Research results affected council and commission management decisions for the mid-Atlantic, New England and the ASMFC. The graduate student on this project received a Knauss Marine Policy fellowship and has been nominated for a Walter B. Jones Award.
RECAP: An important fishery for North Carolina, spiny dogfish are reported in many different coastal habitats, from the N.C. sounds, to off the continental slope. NMFS does not sample below Cape Hatteras, despite the fact that significant numbers of the fish have been reported by recreational and commercial fishermen in this area. An East Carolina University team and collaborating commercial fishermen have characterized the population south of Cape Hatteras. With state funding administered by North Carolina Sea Grant, researchers improved population models by identifying mortality from trawl and gillnet capture and from tagging studies. The integration of survey and monitoring data, tagging research, and other fishery dependent and independent research in both the U.S. and Canada has allowed for the development of a new research paradigm that challenges the traditional management of spiny dogfish as a single-unit stock. The research results have affected council and commission management decisions for the mid-Atlantic, New England and the Atlantic States regions. The project website is : www.spinydogfish.org. Back to Goals

14457 - Effects of High CO-2 Concentrations on Eastern Oysters
Relevance: Oysters are critical species of North Carolina's coastal ecosystems, habitat and economies. Changes in CO-2 may affect the metabolism of Crassostrea virginica (Eastern Oysters).

Response: NCSG funded a minigrant to a researcher at UNC-Charlotte to develop a proof of concept.

Results: The study results provided the data to set the stage for a new National Science Foundation project: LiT: Effects of Temperature and Elevated CO2 Levels on Biomineralization and Metabolic Physiology of Marine Bivalves, funded at more than $300,000. The NCSG study data strongly suggest that the rise in carbon dioxide can impact the physiology and biomineralization in marine calcifiers such as oysters threatening their survival and potentially leading to profound ecological and economic impacts in estuarine ecosystems. These findings contribute to a better understanding of the potential impacts of environmental hypercapnia and ocean acidification in estuaries on this key group of marine calcifiers.
RECAP: Recap: NCSG identified the emerging need for a better understanding of the potential impacts of environmental hypercapnia and ocean acidification in estuaries on Crassostrea virginica. Known as Eastern oysters they are a key group of marine calcifiers. The NCSG minigrant's results strongly suggest that the rise in carbon dioxide can impact the physiology and biomineralization in marine calcifiers such as oysters threatening their survival and potentially leading to profound ecological and economic impacts in estuarine ecosystems. The results have led to a $300,000 study funded by the National Science Foundation, thus showing the return on investment for the NCSG minigrant program. Back to Goals

Back to Top

Program Performance Measures (2010 - 2013)

Program Performance Measure	Program Plan Target (2010-2013)	Reported	Program Comments
Number of fishermen, resource managers and seafood businesses (i.e.: aquaculturists, processors, and commercial or recreational interests) who consider and/or implement responsible harvest or processing techniques and practices.	1,000	1,913	2013 - The local catch programs and a new overall NC Catch organization, all developed with NCSG expertise and mentors, have combined memberships of hundreds of fishermen, seafood dealers, processors, retailers and restaurants, community leaders and consumers, as well as partners in state and local government agencies. NCSG also has had extensive research on fishery stocks, habitat and gear, the results of which are incorporated into fishery management plans that guide the actions of fishers and resource managers. Additional research results in areas such as finfish and shellfish aquaculture, blue crab shedding, and

			seafood safety are widely shared in the respective industries.
Number of producers, distributors and consumers of seafood who reconsider and/or modify their practices/behavior using knowledge gained from NCSG on fishery sustainability, seafood safety and the health benefits of seafood.	2,000	2,900	2012 - NC Seafood Festival= 200 OBX Seafood Festival= 100 Day at the Docks= 60 Carteret County Local-Foods Workshop=29 Local Catch Summit=44 Social Coast Forum=25. 2013 - NCSG has a strong consumer education program, including extremely popular materials explaining seafood availability, sustainability and quality, as well as programs at community events at the coast and inland. Research has shown that consumers respond well to the branding of local seafood. An annual local seafood summit provides information to industry members, while the seafood specialist works directly with processors to develop or update safety plans and identify potential for healthy, value-added seafood products. Also, environmental health instructors trained by NCSG and the UNC School of Public Health inspect seafood markets and restaurants.

Back to Top

Program Objectives (2010 - 2013)

Program Objective	Achieved (yes/no)	Program Comments
By 2014, 2 government resource management agencies (NMFS and NC DMF) will have used NCSG research results on 15 occasions in the management of fisheries stock.	Yes	2013 - NC Sea Grant has worked closely with the NC Division of Marine Fisheries and the National Marine Fisheries Service and regional fisheries management councils to fund and conduct applied species-specific research, the results of which have been considered in development of a variety of Fishery Management Plans, including: oyster, red drum, blue crab, spiny dogfish, spotted sea trout, kingfish, summer flounder, southern flounder, black sea bass, striped mullet, spot, scallops, hickory shad, river herring, shrimp, striped bass (estuarine and ocean) and the extensive snapper/grouper complex. NCSG also administers a National Marine Fisheries Service cooperative research program to reduce marine mammal bycatch in longline fisheries. The work has reviewed potential new or adaptations to gear, as well as bottlenose dolphin stock identiification surveys/documentation. The South Atlantic Fisheries Management Council has used the results of research led by NCSG to identify the costs and level of benefit achieved in electronic monitoring to gather bycatch data. On an ecosystem basis, NCSG has contributed to the identification of Strategic Habitat Areas as part of the Coastal Habitat Protection Plan.
By 2014, 40 current or prospective aquaculture venture investors or operators will have considered and/or adopted research-based guidance developed and received from NCSG.	Yes	2013 - NCSG is a key player in the aquaculture/mariculture community, including funding research and outreach and cosponsoring the annual NC Aquaculture Development Conference. Each year from 2010 to 2013, the meeting drew more than 60 business operators and potential business owners and investors . Local, state and federal officials attend each year, as well as about a dozen dozen researchers who present results of projects funded by NCSG, including studies of genetics, feed and growout, tank technology and effluents. At least 3 new shellfish aquaculture operations started in 2010 to 2013 in light of direct involvement of NCSG research and extension. A new sturgeon aquaculture operation in Carteret County also moved forward with an NCSG project that examined potential consumer demand and markets.

		Also, at least 20 members of the industry were directly involved in research projects of the NC Fishery Resource Grant Program and the NC Blue Crab and Shellfish Research Program or Sea Grant core research. Advancements in hybrid striped bass culture were shared with the 15 growers and 4 fingerling producers in the state, which combine for a value of about $11.8 million. Hybrid striped bass impacts are felt nationwide as our core research results have fed directly into a national broodstock genetics program in partnership with the U.S. Department of Agriculture and other partners. An NC shellfish aquaculture siting tool developed thorugh a national Sea Grant project has been shared widely, especially among 12 active members of the NC Shellfish Growers Association and others interested as potential investors. Shellfish aquaculture research has included identifying genetic strengths of local oyster broodstock comparing growout systems for oysters and identifying size of mesh bags for clam growout.
By 2014, 6 coastal fishery community-based marketing and/or community-supported seafood programs developed with NCSG research and outreach support will have provided accurate information on local seafood supply, quality and/or value not only to residents and visitors to their localities but also to consumers in 3 major inland North Carolina metropolitan areas.	Yes	2013 - NCSG research and exenstion has been critical to the formation of the local catch groups in the state: Carteret Catch, Brunswick Catch, Ocracoke Fresh, Outer Banks Catch. In this reporting period, North Carolina Catch was formed and a part-time director hired to increase collaboration and serve areas outside the original groups.NCSG is particularly interested in the seafood supply chain and efforts to provide more NC seafood to inland markets and restaurants. NCSG-administered research coined the term community supported fishery, of CSF, and NCSG continues to work with CSFs in the state, including Walking Fish & Core Sound Seafood, as well as other direct marketing of seafood via Locals Seafood, Dock to Door, Shore to Door. Metropolian areas served include the Research Triangle - Raleigh, Durham and Chapel Hill - as well as Charlotte region and the Triad area that includes Greensboro, Winston-Salem and High Point. Visitors from around the state and beyond filled the Chefs Tent at the NC Seafood Festival for demonstrations organized by NCSG seafood specialist and to receive NCSG seafood availability and quality information products. Other local food outreach has included funding a documentary on UNC-TV providing story contacts for Flavor NC TV program sharing consumer materials at a Whole Foods seafood dinner, the NC State Fair, and a Southern Foods dinner and food show in the Triangle and participating in local foods network meetings across the state including the Triad, and the state local foods council. NCSG also has provided information and contacts for stories in Edible Piedmont and Edible Charlotte magazines and particpates in a statewide campaign to encourage consumers to spend at least 10 percent of their weekly food budget on local foods. The blog at marinersmenu.org showcases recipes developed by NCSG as well as a weekly roundup of news coverage of NC seafood and recipes, including newspaper and television features.
By 2014, at least 90 seafood processors/wholesalers/retailers will have adopted or improved safety or processing practices, leading to either fuller compliance with current food	Yes	2013 - During the reporting period, 147 seafood processors/wholesalers/retailers/inspectors have completed education and training workshops for Hazard Analysis and Critical Control Point food safety plans or the Seafood Quality and Safety Workshops for Environmental Health Specialists. The health

handling/safety regulations or new value-added products.		specialist training is in partnership with the UNC-Chapel Hill School of Public Health to train inspectors of seafood markets and restaurants for local health departments. NCSG also works closely with seafood industry to develop value-added foods. For example, a Hyde County seafood processor developed a crabcake with assistance from the NCSG seafood specialist, and the product has been a success in markets in the Triangle. An NCSG partnership with Virginia Sea Grant and Viriginia Tech helped Sunburst Trout in the NC mountains to develop a trout burger, with the lessons then provided as a demonstration in an industry workshop and publication. The NCSG seafood specialist developed a project with NC Cooperative Extension and Locals Seafood to identify the market for peeled-and-deveined shrimp compared to shell-on shrimp. Another project looked at the potential palatibility of sturgeon meat from an operation that will have a main focus on caviar. And NCSG also worked with another processor to provide sensory evaluations of six proposed retail products. A research project looked at a Tyrrell County fisherman's plan for smoked softshell crabs as an opportunity to save excess supply for sale during the off-season. NCSG led efforts in the state for the Trade Adjustment Assistance Act to help 173 shrimp businesses, which received a total of $1.98 million in financial assistance to implement new business plans, some including direct marketing techniques or improved quality control, to respond to markets that include significant shrimp imports.
By 2014, because of two state-supported fisheries research and demonstration (R&D) programs and other research managed by Sea Grant, at least 10 new gear or harvest technology innovations will have been introduced to North Carolina recreational anglers and commercial harvesters that will reduce bycatch mortality and/or improve rates of catch rate efficiency.	Yes	2013 - One of the most unusual harvest demonstrations has been the If You Can't Beat 'Em, Eat 'Em tournament to catch invasive lionfish. The partnership has included working with restaurants to serve the catch and with partners in the region and nationally to develop additional gear research proposals in 2015. Other gear projects have included a regional effort to reduce barotrauma in fish caught in deep waters, and ongoing work to improve turtle-excluder devises in shrimp trawls and other bycatch reduction improvements. Projects in the N.C. Fishery Resource Grant Program have included studies of gear and techniques to reduce mortality for released mahi-mahi and black sea bass testing of new gillnets recycling of old crab pots as substrate for oyster reef restoration tank production of mudminnows as baitfish and techniques to hold black sea bass for growout to optimal size. The N.C. Blue Crab and Shellfish Research Program has funded projects looking at strategies of one pot or two per buoy, andvarious designs of crab pots including modifications for bait placement and to reduce crab pot bycatch of flounder. Others include filter and tank modifications for blue crab shedding operations to hold crabs until they molt for the lucrative softshell market. The two state-funded program focused on teams that included individuals from the fishing communities and academic partners. NCSG also hosted Marine Recreational Fisheries Forums that provided technique updates for anglers. NCSG also administers a National Marine Fisheries Service regional cooperative research program that includes testing of gear and techniques to reduce bycatch of marine mammals.
Objective "By 2014, four year-	Yes	2013 - Partners at NC Division of Marine Fisheries

long Sea Grant/DMF marine fellowships will have provided to more than 12 public management or advisory entities critical findings that lead to enhanced habitat and ecosystem-based management practices and policies, including the Coastal Habitat Protection Plan." also contributes to this outcome.		have declared this joint fellowship a great success. The 4 graduate students during the reporting period each had a mentor at NC State University and DMF. The fellows focused on statistical analysis, with results presented to DMF staff, the NC Marine Fisheries Commission and its 4 regional panels and multiple topical panels that consider fishery management plans for species such as striped bass and river herring. The fellowship also provided signficant advances to analysis of data to determine Strategic Habitat Areas under the NC Coastal Habitat Protection Plan. A fellow developed several GIS fisheries and habitat data layers as well as multiple outputs from MARXAN software that allowed for extensive maps to be used by committees making Strategic Habitat Areas recommendations for specific coastal regions. The recommendations went to the 18-member Coastal Habitat Protection Plan Steering Committee, which has members from not only DMF and the NC Marine Fisheries Commission, but also from the NC Wildlife Resources Commission staff and appointed board NC Coastal Resources Commission and NC Division of Coastal Management, which includes the NC Coastal Reserve and the NC Environmental Management Commission and NC Divison of Water Resources.