



Federal Site Review

October 2-4, 2018



OUR VISION

North Carolina Sea Grant will, in the 21st Century, serve as a leader in addressing the state's urgent and long-term needs in ocean and coastal resource management, and in the successful transition to ecosystem-based approaches through sound science and educational excellence.

OUR MISSION

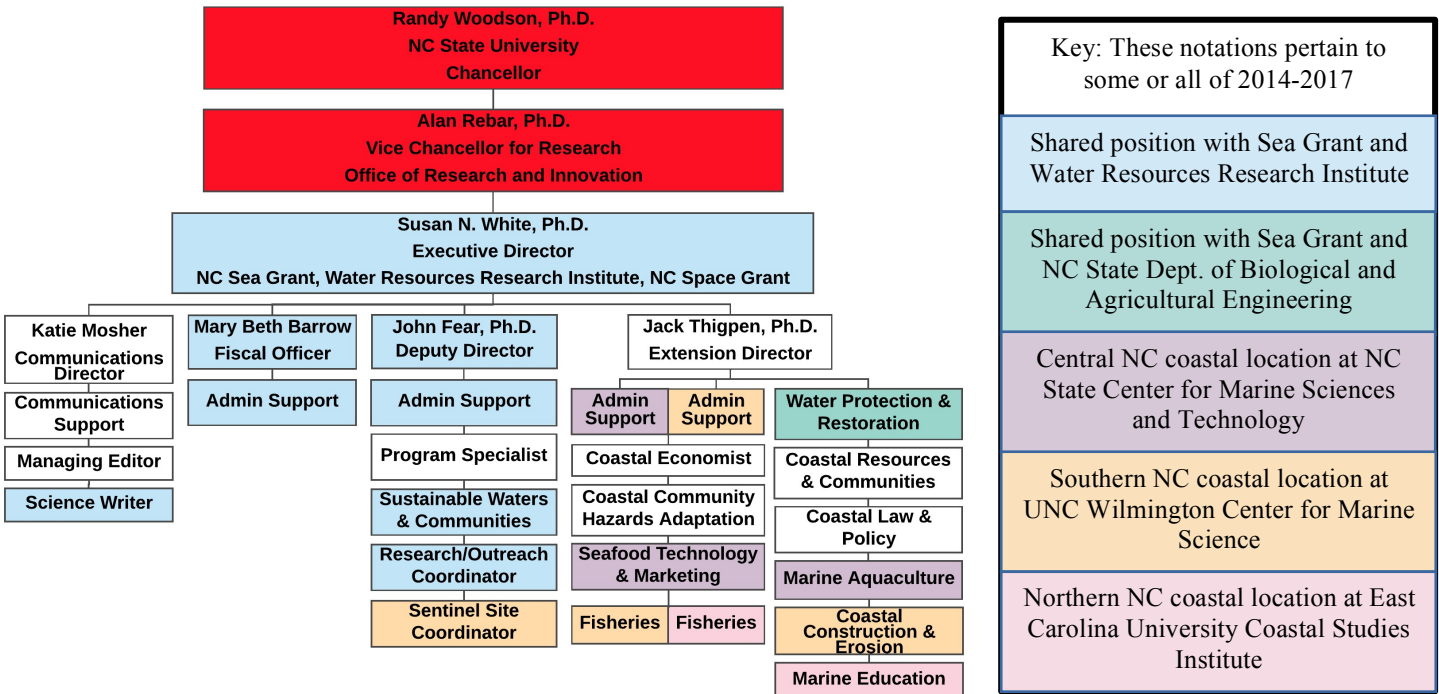
Through integrated research and outreach efforts, North Carolina Sea Grant will enhance sustainable use and conservation of ocean and coastal resources to benefit communities, economies and ecosystems.

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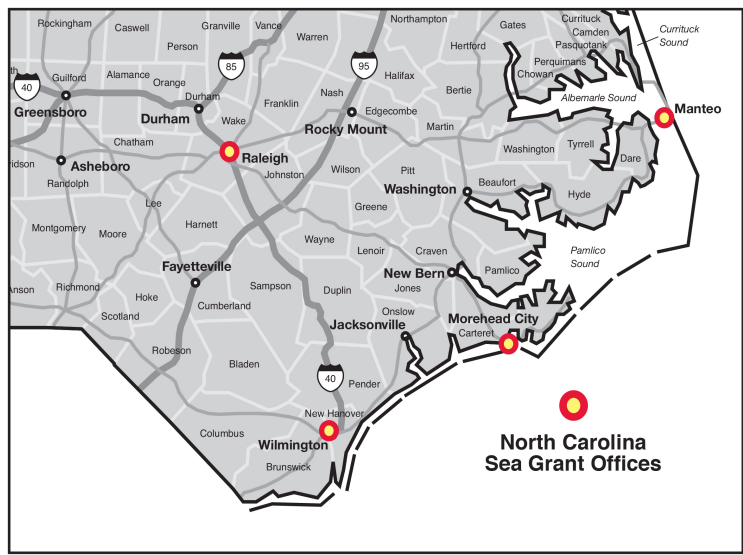
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Our Office Locations



INTRODUCTION

The North Carolina Sea Grant College Program began with an institutional planning and project grant in 1970 and was designated as the nation's 12th Sea Grant College in 1976. Now in its fifth decade, North Carolina Sea Grant (NCSG) provides leadership in original research and outreach programming, as well as in facilitating efforts with numerous partners and stakeholders. The program's investments and expertise support sustainable use and conservation of ocean and coastal resources to benefit communities, economies and ecosystems. These impacts are at the local, state, national and international levels.

This document describes our program's significant and ongoing investments to address the Sea Grant *Standards of Excellence* during the 2014-2017 review cycle. We also highlight a subset of the program's contributions and productivity within four national focus areas. Together, these demonstrate strong successes on many fronts.

SECTION A: PROGRAM MANAGEMENT & ORGANIZATION

The five-member management team interacts daily and meets regularly to plan program activities, special initiatives, staffing opportunities and policies to support an effective Sea Grant program. The members bring varied yet complimentary experience to the team:

Susan White has directed North Carolina's Sea Grant and Water Resources Research Institute (WRI) programs since 2012. In 2017, she also was named director of N.C. Space Grant. White leads the Sea Grant program by: identifying opportunities and resources for team and partnership approaches that address the program's mission; building awareness and opportunities for collaborations that support program priorities and team expertise; and ensuring appropriate accountability and accessibility through improved business practices. Previously, White was director of the National Oceanic and Atmospheric Administration's Hollings Marine Laboratory in Charleston, S.C. She earned a doctorate in marine ecology from the University of Georgia, and a bachelor's degree in biology from Duke University.

John Fear has served as deputy director of NCSG and WRI since 2014. He develops and executes a strong research portfolio, an expanding fellowship program, and increases collaborations among the research, extension and communication programs. Previously, Fear was research coordinator for the N.C. Coastal Reserve and N.C. National Estuarine Research Reserve program within the N.C. Division of Coastal Management. Fear holds degrees from UNC Chapel Hill: a doctorate in environmental sciences and engineering from the School of Public Health, as well as bachelor's degrees in biology and chemistry.

Jack Thigpen served as NCSG extension director from
North Carolina Sea Grant

2000 through his retirement in April 2018. He promoted excellence in statewide extension programming, as well as leading our overall strategic planning. His forte included expanding collaborations among extension specialists and varied stakeholders; and strengthening information dissemination in partnership with the communications team. He holds a doctorate in sociology from the University of Kentucky, a master's degree in rural sociology and a bachelor's degree in agricultural business from the University of Tennessee, Knoxville. During this review period, the program conducted a national search for a new extension director. In March 2018, **Frank Lopez** began serving in that role for NCSG as well as WRI.

Kathleen Mosher has served as communications director since 2000. She ensures that research and outreach products are conceived, developed and distributed in appropriate and meaningful ways to current and future stakeholders, thus ensuring the program's reputation as a trusted adviser and honest broker of information. Mosher holds a bachelor's degree in journalism from Kent State University and a master's degree in liberal studies from NC State University. During part of this review period, she also served as editor of the NC State's *Results* magazine at the request of the campus vice chancellor.

Mary Elizabeth Barrow has served as the NCSG fiscal officer since 2009 and as the WRI business manager since 2010. She ensures accountability and accuracy in fiscal and business practices at the university and federal levels, thus enabling the ultimate success of research and outreach programs. Acknowledging her expertise, NC State granted departmental status to NCSG via Barrow to approve administrative and fiscal matters, thereby increasing our overall program efficiency. Barrow earned a bachelor's degree in political science and business from East Carolina University. She is a certified research administrator.

Advisory Board: The multifaceted mission of the North Carolina Sea Grant Advisory Board includes identifying priority and emerging needs in research and outreach; assessing, evaluating and endorsing program initiatives and general progress; and identifying and developing resources for Sea Grant at the local, state and federal level. The current board includes 15 members representing interests of communities, businesses and organizations that support the state's coastal resources. The board meets in-person twice per year, with conference calls as needed. Temporary working groups focus on specific goals. At least one meeting per year is held jointly with a full NCSG team meeting. The board and team members note that they greatly benefit from formal and informal interactions. The full advisory board listing is on our website, ncseagrant.org.

Board sessions provide updates on NCSG activities, as well as opportunities for members to provide input on improving program focus and efforts. A board charter developed in

2013 defines roles, rotations, responsibilities and procedures. NCSG team members have regular contact with individual board members according to expertise. These relationships strengthen board engagement across a range of program priorities. Team members also participated in the board's public affairs/development and partnerships/programs working groups during this review period. This was a positive programmatic shift to ensure relevant information is shared.

Significant board recommendations and contributions this reporting period have included guidance and support on: adding team expertise to address state/local needs (such as an economist and an aquaculture specialist); additional joint fellowship opportunities; proposal and fellowship reviews and student interviews; hiring panels (e.g., extension director panel in 2017); seafood consumer education and market research efforts; and additional NCSG-focused educational installations (e.g., wave tanks). On a more general scale, the board continues to help enhance our branding, including reaching new audiences.

NCSG also regularly solicits and receives advice through a range of formal and informal advisory mechanisms at local, state, regional, national and international levels to ensure programmatic relevance, effectiveness and efficiency. These multiple channels help gather background information, advise program leaders on complex and/or emerging issues, and guide priority setting. Our team members and funded faculty are continuously involved with a wide variety of state and federal committees, management agencies, commissions, and interest groups, which provide direct and immediate feedback.

Our team members also occupy many leadership positions on boards and commissions responsible for addressing watershed, coastal and marine issues. These connections factored significantly into the program's successful execution of seven statewide, facilitated, strategic-planning focus groups in 2015 and 2016. These focus groups were key to development of our current 2018-2021 Strategic Plan, approved in April 2017. NCSG has built, and continues to expand, a large constituency whose input and involvement are vital to the relevance and effectiveness of Sea Grant programming in North Carolina.

Program Setting: The University of North Carolina's General Administration (UNC GA) formally identifies North Carolina Sea Grant as a multicampus program. That designation indicates the highest levels of program integration across the university system, including shared administrative duties and substantial involvement by multiple campuses in our activities. The organizational chart and map provided on the inside front cover of this briefing book reflects Sea Grant management, organization, and office locations in North Carolina.

UNC GA and the UNC Board of Governors delegated

direct administrative oversight of North Carolina Sea Grant to NC State in 2007. NC State's Vice Chancellor for Research and Innovation provides university oversight and significant programmatic support for the program. We worked closely with UNC GA through an indirect reporting association with the Vice President of Research and Graduate Education through March 2016. At that time a new UNC System President brought reorganization of the general administration offices including the elimination of the research office at the cabinet level.

Our program has a strong tradition of matching funds from the state. Federal funding administered through NOAA is matched by the North Carolina General Assembly through an appropriation to the UNC System. NCSG is committed to applying resources to critical coastal priority needs. Funding allocations for research and outreach is well distributed across the focus areas we identified in our 2014-2017 strategic plan.

Information from PIER, provided by the National Sea Grant Office, details many aspects of NCSG funding. "Core" and "NSI, pass-through, enhancement" research investments are included within the PIER report; however, these represent only a portion of our program's research support. Of note, minigrants, student research fellowships and an aquaculture research project are not included in the tally or percentages. This is because these research opportunities are included in "program development" or "extension" funds and thus are not coded "research" within PIER.

Over the review period, these additional research funds total \$819,354 (\$309,965 in research minigrants, \$211,831 in student research fellowships, and \$297,558 in aquaculture research). Thus, we identify our research investments for the four years as a total \$3,698,193, resulting in an increase in the research functional percentage to 36%, reducing our program development functional percentage to 1%, and reducing our extension functional percentage to 33%. Thus we suggest modifying the table "Distribution of Core Funds (SG + Match) by Functional Area" in Section A.e. of the PIER report.

The incorporation of these additional research funds with the program's additional "pass-through" funding results in a four-year total research investment of \$4,483,526. This increases our research functional percentage to 36%, reduces our program development functional percentage to 1%, and reduces our extension functional percentage to 34%. Thus we suggest modifying the table "Distribution of Funds (SG + Match+ Pass Through) by Functional Area" in Section A.e. of the PIER report.

As noted earlier, our program incorporates student research related to the core research awards within a single award to the grantee. The ability to fund minigrants from program development funds allows NCSG to support small awards,

without match required, ensuring that the funds are most efficiently applied to new, innovative, or rapid-response research needs. Additionally, our large student fellowship portfolio, which includes smaller grant awards, allow for these research funds to stretch further than core funding. We see advantages for our research programming — under long-term, level, federal budgets, and increasingly constrained state funding — to continue to invest in small grants that provide significant return-on-investments.

We also note that research projects are executed by our talented team with NOAA federal funds (other than pass-through funds), state match and significant external research support. Section C.b. in the PIER report, reflects four-year managed funding of \$6,089,394. These funds are also are not reflected in the PIER research output analysis. This is due to the limitations not only in coding in annual reporting, but also in PIER curtailing analysis solely to NOAA federal funding and required match. We are proud of our program’s significant research investments, both internal and external, in support of the Sea Grant mission, as shown in the impressive impacts and accomplishments achieved during this review period.

Additionally, NCSG team members and funded researchers have leveraged considerable additional resources to address priority coastal needs over the course of this reporting period; the PIER report also does not reflect these gains. In total, there is \$6.8 million in leveraged funding that NCSG influenced from 2014 to 2017.

These additional leveraged funds — captured in our annual reports — are a considerable result of our minigrant program. Minigrants are small funding to team members and researchers for projects related to our mission. The result is that often grantees will go on to secure larger awards that meet local, state, regional, national or international coastal needs that they cannot address solely through NOAA federal funding and our state match.

State-appropriated funds provide separate and significant support for NCSG to administer additional marine science-related projects relevant at local, state and regional levels. To address constrained federal and state budget realities, as well as to increase staffing efficiencies and reduce the costs of administering centers and institutes in the UNC System and at NC State, select NCSG positions have joint affiliations with complementary programs and duties with other university programs. These are identified in the organizational chart. Most of these joint affiliations were established prior to this reporting period. However, Sea Grant also now shares one additional extension specialist and two administrative positions. To help offset inflationary erosion and the continuing decline of federal and state funding, the NCSG team has been encouraged to seek external support for their projects in recent years to offset team salary costs and enable programmatic growth.

RECRUITING TALENT

North Carolina Sea Grant draws upon talent from across the state to participate in our research enterprise. The numerous research programs for which we issue Requests for Proposals (RFP) attract significant numbers of individual researchers, and thus their total time on our projects provides significant research full-time equivalents (FTEs). Ultimately our funded projects result in impactful publications and products, many of which are cited in the PIER report. All our efforts maintain exceedingly high levels of scientific rigor. Our RFP formats maximize returns on annual investments by setting expectations that research teams deliver outreach and engagement efforts.

NOAA Sea Grant-Funded RFPs

Omnibus Proposals: Our biennial omnibus proposal to the National Sea Grant Office begins with a review and update of research priorities. The national strategic plan, which identifies general focus areas, provides priority guidance. Next, we consider our current N.C. strategic plan, which reflects the national plan but tailors the focus areas and priorities to meet needs and opportunities in the state. We completed a comprehensive update of our N.C. plan during this review period through a robust, facilitated, stakeholder-driven process. We draw the final guidance for our core research priorities from ongoing contacts with stakeholders and audiences through formal needs assessments, focus group meetings, and input from our Advisory Board described on page 3. The final step prior to RFP release is approval by our federal program officer.

We distribute each RFP statewide through a network of websites, listservs, news releases, social media, in-person campus visits, and targeted emails to universities, including sponsored programs, deans, department heads, and communicators. We also share with agency contacts and others with research partnerships or needs.

Our core research program has two stages: preproposal and full proposal. We typically receive 40 to 60 pre-proposals, which our team members, advisory board, and state-level experts review for relevance to N.C. needs and the RFP’s priorities. Based on these reviews, we typically encourage about half of the preproposal teams to submit full proposals. Teams may submit a full proposal regardless.

Three or four out-of-state, technical peer reviewers — as well as members of our team — review full proposals, guided by seven review criteria from the national program. The final step in the selection process is a review panel with six to eight out-of-state, nationally recognized experts in subject areas represented in the proposals. A National Sea Grant Office program officer observes this discussion. The panel examines proposals and comments from peer reviewers; then makes recommendations of fundable proposals, and provides these to our executive director. In collaboration with the management team, the director selects the final set of proposals for our letter of intent that

is sent to the National Office for approval.

This review period included core cycles of omnibus RFPs: 2014-16 (research in process); 2016-18 (selection and in-process). Core research and other projects funded through these cycles are in A.c. in the PIER report, totaling \$1.79 million. Across these two core cycles, more than \$10.4 million was requested by proposers. Table 1 below details the required metrics associated with the core research cycles identified in PIER. The selection of the 2018-2020 projects was completed in 2017.

TABLE 1 Proposal Metrics for Core Research Cycles

Category	2014-2016	2016-2018
Pre-Proposals	55	59
Pre-Proposal Institutions Represented	10	11
Full Proposals	19	30
Full Proposal Institutions Represented	5	6
Proposals Funded	12	10
Funded Institutions Represented	5	4
New Projects	12	10
Continuing Projects	0	12
New PIs	5	4
Continuing PIs	7	6

Minigrant Program: NCSG continues to successfully execute our minigrant program — an opportunity that occupies a unique niche in our state. We advertise these small grants to fund pilot-scale needs, including but not limited to: rapid response; translating research into educational and outreach opportunities; research seed-funding for exploration and project development in new or novel areas; and graduate student fellowships. With average budgets of \$5,000, many of these projects help developed new partnerships to meet our research and outreach goals. Minigrants often provide a doorway for new faculty and potential partners get to know Sea Grant. More importantly, our minigrants continue to provide significant impacts, accomplishments, and leveraged funding for Sea Grant, the research teams, and the state. Our minigrant program provides extremely high returns on investment, such as attaining a ~14 to 1 ratio in 2016-17.

Minigrant forms and instructions are on our website under Funding Opportunities. Applicants can submit three-page proposals at any time for applied research, extension projects, and other outreach activities. Proposals receive reviews from our team members and outside peers.

Over this reporting period, NCSG funded 82 minigrant projects. Total minigrant funding over the review period equaled \$309,965. Through the minigrant program, NCSG reached 21 new PIs and supported 19 returning ones.

Student Fellowships: We supported 11 separate graduate fellowship opportunities during the reporting period, most

jointly funded with other organizations. From 2014 to 2017, we recruited for and/or administered the following fellowships: John A. Knauss Marine Policy Fellowship; NOAA’s National Marine Fisheries Service (NMFS)-Sea Grant Fellowships in Population Dynamics and Resource Economics; NOAA Coastal Services Center - Coastal Management/Digital Coast Fellowship; NCSG/N.C. National Estuarine Research Reserve - Coastal Research Fellowship; NCSG/N.C. Coastal Resources Law, Planning, and Policy Center Coastal Policy Fellowship; NCSG/N.C. Division of Marine Fisheries - Marine Fisheries Fellowship; the NCSG/Albemarle-Pamlico National Estuary Partnership Graduate Fellowship in Estuarine Research; NCSG/N.C. Space Grant Joint Graduate Research Fellowship; NCSG/N.C. Sentinel Site Cooperative Joint Fellowship; and NCSG/NC Water Resources Research Institute Joint Fellowship focused on Diversity and Inclusion. All occur annually except for the N.C. fisheries fellowship, which has a two-year cycle.

To our knowledge, the number of fellowships we offer is among the highest in the Sea Grant network. For all, NCSG manages applicant recruitment and the review/interview process. Technical review panels evaluate fellowship applications and make selection recommendations. By providing students with unrivaled experience and professional development, they emerge highly qualified, ready for their first post-graduate professional positions or to take their next education steps. Similar to our minigrants, these fellowships provide extremely high returns on investment.

In addition to the student-focused fellowships, we also support graduate students working on core research and minigrants, and interns working directly with our team. These students receive significant training opportunities. Our 2014 site review recognized our fellowships as a best management practice. We firmly believe that our investment in student training remains a critical component of our program and have therefore worked to expand its breadth and reach over the 2014-17 reporting period.

NCSG also jointly funds an RFP with WRRI. Joint RFPs were released in 2014 for faculty, and in 2016 and 2017 for students. This is an important collaboration, because WRRI has a statewide watershed focus, thus allowing NCSG to reach new stakeholders, increase diversity within applicant pools, and broaden our scope to reflect connections to watersheds that affect the coastal region. The review process for the faculty call started with peer reviews (in and out of state), followed by a technical review panel. We funded three research projects from the 2014 call, providing \$213,240 for faculty at three institutions. We also funded five student fellows in 2016 and again in 2017 calls, for a total of \$100,000 for 10 fellows at five institutions.

In 2017, we released an additional call for a joint Diversity and Inclusion Fellowship, even as the Sea Grant network

was still developing a vision plan on this topic. That RFP call established the model for joint NCSG-WRRI fellowships moving forward. Our Diversity and Inclusion Fellowship resulted in five students, representing four institutions, receiving a total of \$50,000. The total requested dollars for the joint student fellowship calls in 2016 and 2017 was \$889,202, showing the strong demand for this opportunity. The review process followed the same one described for fellowships above.

Research Symposium Funding Opportunity: We held *The North Carolina Sea Grant Research Symposium: Investments and Opportunities* in April 2014 to highlight excellence across NCSG-sponsored research and extension efforts. The sessions went a step further by facilitating stakeholder discussions to identify new and ongoing research, extension, and applied science investment opportunities and collaborations to effectively address coastal needs now and into the future. We summarized outcomes and lessons learned from the symposium in a white paper. To capitalize on the momentum, a competitive funding opportunity sought hypothesis-based research proposals reflecting needs that stakeholders identified at the symposium. That RFP had a single-phase proposal/review process similar to the joint NCSG-WRRI faculty call described above. Total request from this competition was 22 proposals totaling \$834,461. We ultimately funded three new research projects that totaled \$119,988. This program resulted in NCSG reaching one new PI and continuing relationships with two others. We have institutionalized the research needs identified through this effort in our other funding opportunities.

National Sea Grant Funding Competitions: Our program also facilitates competitive grants for national opportunities, such as for the 2017 aquaculture competitions. These national competitions were advertised as all our other opportunities. But the National Sea Grant Office coordinated review and selection. During the 2017 competition, we received three N.C. proposals, requesting a total of \$1,098,816. None were funded.

NOAA Pass-Thru Funds RFPs: During this reporting period, NCSG also has administered targeted research programs funded by NOAA outside the Sea Grant core cycle. NCSG has partnered with NMFS since 2004 to administer research programs focused on marine mammal stocks and fishery interactions in the Southeast Atlantic (formally the “Bycatch Reduction of Marine Mammals”). NCSG successfully competed nationally in 2012 and 2014 to continue to partner with NMFS for this program. RFPs in 2014 and 2016 resulted in three new research projects funded, two of those out-of-state. This program provides NCSG a strong regional impact and strengthens our relationships with NMFS and new fisheries-focused stakeholders. This program also resulted in reaching two new PIs, and a continued relationship with another.

Partner-Funded RFPs Not Captured in PIER: In 2015, we initiated a new competitive program, the Community Collaborative Research Grant (CCRG) Program, through a partnership with the William R. Kenan Jr. Institute for Engineering, Technology and Science (KIETS) at NC State. CCRG requires academics to work with local knowledge experts to undertake projects addressing high-priority coastal needs. The CCRG effort specifically addresses the recommendation from our site review panel in 2014 to identify opportunities as a replacement following elimination of the N.C. Fishery Resource Grant and reduced Blue Crab Resource Grant programs.

We issued RFPs in 2015, 2016, and 2017, funding 12 research projects at \$185,265 to recipients representing 11 institutions. The total requested for the CCRG program over the three years was \$722,097. In 2015, there were four new projects. In 2016, there were five new projects and four continuing ones. In 2017, there were three new projects and five continuing ones. The CCRG program has resulted in our program reaching 10 new PIs and continuing relationships with two. The CCRG program has leveraged additional dollars from the NOAA-Climate Program Office-funded Carolinas Integrated Sciences and Assessments program, as well as the NASA/N.C. Space Grant program to support specific projects.

In 2017, NCSG successfully solicited KIETS for continued support for Phase II of the CCRG: an expansion in 2018-2019. The CCRG program also highlights our long-term leadership across the National Sea Grant Network in incorporating local knowledge into our research and educational programs, another topic now considered by national visioning teams. The community partners have ensured the dissemination of results through podcasts, exhibits, and special events, as well as by working with our communication specialists on additional outreach.

The RFP and selection processes for the CCRG program are similarly rigorous to the processes described above. Annual RFPs reflect priorities developed in collaboration with funding partners. RFPs are distributed via websites, listservs, news releases, targeted solicitations, university-sponsored program contacts, blogs, etc. The single-stage selection process is based on proposals of up to five pages. Three or four topical experts review each proposal for scientific rigor, while a team member reviews for relevance. NCSG then convenes a selection committee, including a member of our advisory board, NCSG team members, and the partnering organization. The NCSG executive director considers the selection committee’s recommendations in choosing proposals to fund.

SECTION B: STAKEHOLDER ENGAGEMENT

In North Carolina, the Sea Grant team has a strong tradition of facilitating feedback from partners and stakeholders to shape research and outreach programs. In fact, the PIER

report cites more than 500 partners, at all levels, as actively involved in projects and/or using the results during this review cycle. Our integrated approach encourages collaborations to develop research and outreach programs and products that address the challenges that N.C coastal communities and ecosystems are facing. Sea Grant's "honest broker" reputation, along with our team's subject matter expertise, lead to requests for our participation in a wide variety of local, state and national panels and commissions, including those relating to estuarine science and policy, fisheries management, local seafood, community and economic development, environmental education, and climate change adaptation. In this review cycle, our team played over 90 distinct roles, many of them leadership. Also, five members of our team hold adjunct faculty status at academic institutions across the state, and thus have ready connections across campuses.

Stakeholders often become engaged partners as they interact with our team one-on-one, as well as through our conferences, meetings and online information-sharing. Our team also regularly receives updates regarding priority research and educational needs from stakeholders representing varied interests, including industries, community groups and consumers. As previously noted, our advisory board regularly provides critical and ongoing engagement. During this review period, our regular, intense infusion of stakeholder input has continued to expand our outreach efforts, such as involving new extension specialists in marine aquaculture and coastal economics.

In the development of our new 2018-21 strategic plan, NCSG chose to expand our engagement process to include a wide range of new and existing stakeholders. We hosted seven professionally facilitated focus groups drawing a combined attendance of 150, to gain a better understanding of priorities that expressed. We held three focus groups along our coast: in Morehead City, Wilmington and Manteo. Two focus groups were in Raleigh — the state capital and part of the Research Triangle region — that is within the inland watersheds of two major rivers that flow to the coast. Our advisory board and team comprised the final groups, building upon input from community partners.

In each focus group, participants identified current and future research, education, and outreach that NCSG is uniquely positioned to address. Many participants expressed appreciation for our existing programs, recognizing our ability to serve as a bridge linking academic researchers, coastal communities, policymakers, and people making a living on the coast, as well as others who value these lands and waters. At the same time, they were eager to help us move forward and grow. This process resulted in a forward-looking plan acknowledging current issues, challenges and new opportunities.

NCSG also has a long-standing focus on education. We see students and professionals as future leaders and as our

partners and stakeholders. This includes our K-12 marine education research and outreach efforts that "teach the teachers" and thus extend our ultimate reach. We detail much of our support of university students in Recruiting Talent and Leadership and Productivity sections.

Our team regularly provides varied types of continuing education for attorneys, architects, engineers, emergency managers, geologists, planners, environmental educators, and others. This flow of information allows us to provide research and policy updates, as well as to learn from participants during discussion sessions. On average, about 6,900 people annually have been eligible to receive Professional Development or Continuing Education Units through workshops, conferences and technical trainings that our program presented or cosponsored.

Our team has a strong cadre of outreach professionals who engage stakeholders, build key partnerships and address priority N.C. coastal resource challenges. Brief examples are below. The PIER report provides many additional impacts and accomplishments that include stakeholders. The roles of stakeholders and partners are also key elements in the highlights we provide in "Leadership and Productivity" section of this report. Examples there and below are categorized as to meet at least one National Sea Grant Strategic Plan focus area. In many cases, our work is so interdisciplinary that our connections with stakeholders, and the resulting impacts, tools and products, address multiple focus areas.

Healthy Coastal Ecosystems: The practice of coastal ecosystem restoration lends itself to hands-on involvement. For instance, based on upstream communities' needs to capture and retain more stormwater to help meet water quality standards throughout a watershed, NCSG extension specialists have assisted local partners in installing green infrastructure in partnership with NC State design students, an elementary school and homeowners. Impacts included more captured stormwater, community greenways, and educational opportunities for local schools.

Other work addressed marine debris, which continues to challenge N.C. coastal communities and habitats. In response to feedback from varied stakeholders and a request from the state legislature, NCSG partnered with the non-profit N.C. Coastal Federation and the N.C. Marine Patrol to train commercial fishermen to remove derelict crab pots during a designated offseason window. Building on a NOAA-funded pilot, the project restored 1.2 million acres by early 2017, and provided economic support to crabbers across the state. Based on the success of the initial statewide partnership, legislators chose to extend funding for our stakeholders to continue collections in 2018.

Invasive species also can negatively impact biodiversity, water quality, and recreational and aesthetic values of rivers and estuaries. In response to a request for assistance

from the Town of Edenton, NCSG worked with community volunteers to adapt and use a mobile application to identify invasive *Hydrilla* in the Chowan River. Sea Grant and partners provided mentors and the app for identification and steps to remove the plants, as well citizen-science data opportunities.

Sustainable Fisheries and Aquaculture: NCSG has many contacts with fisheries resource managers, as well as among other stakeholders. These include a long-standing graduate fellowship focusing on N.C. marine fisheries management and a partnership with NMFS to address marine mammal bycatch. Our program also supports seafood processing and finfish/shellfish mariculture through direct technical assistance to businesses and producers. Through these interactions, we have shared new technologies, including resource mapping, recirculating systems for soft crabs, and proper siting tools for shellfish leases and oyster reef restoration projects.

To better serve stakeholders, NCSG works to understand their strengths, needs and salient issues. Our efforts have included conducting assessments of consumer preferences for seafood products and surveying stakeholders to identify the information needs of a growing recreational fishing sector. Armed with information, we respond; for instance, addressing the need to reduce bycatch in commercial shrimping by working with shrimpers and state officials to test gear arrangements and identify optimal combinations in various settings.

Resilient Communities and Economies: Due in part to the significant effects of hurricanes, such as Arthur (2014) and Matthew (2016), NCSG has devoted time and resources to respond to communities' requests for assistance in reducing vulnerability and improving their preparedness for future natural hazards. NCSG and NC State colleagues responded to requests from Bertie County and the Town of Windsor to develop new decision-making tools and models for the Cashie River. Now, other communities and state agencies are adapting these tools to other watersheds.

In response to a Town of Nags Head request, NCSG collaborated with community members and local leaders to incorporate actionable items into their Comprehensive Plan to address current and future sea level rise impacts. This success is not limited to a single town. Others, such as Swansboro, are beginning to examine their own policies using similar community-based discussions. Other hazards are manmade. Dangers associated with abandoned and derelict vessels caused Brunswick County to seek NCSG assistance to convene community organizations to understand the issue, leading to community policy change.

We also tailor projects to communities and their respective workforces. For instance, fewer young people are setting their sights on fishing careers, sometimes referred to as "the graying of the fleet." A Sea Grant core research project

included a series of leadership development sessions called Fish Camps in January 2018 to help younger fishermen succeed not only in their industry but in their coastal communities overall.

Environmental Literacy and Workforce Development: Our educational programs serve all ages. The PIER tally shows that we reached 62,260 students from 2014 to 2017 through direct or indirect programs by NCSG researchers, as well as our extension or communications specialists. Other diverse audiences received trainings, including health professionals, prospective shellfish growers, restaurant owners and chefs, and seafood consumers.

Of particular note, NCSG has a strong and expanding partnership with UNC-TV, which is also known as North Carolina Public Media. Through this relationship during the review period, UNC-TV has produced at least a dozen programs highlighting NCSG research, education and outreach efforts. This partnership has been key to sharing our program's impacts with wide audiences, not only across the state via broadcasts, but also regionally and nationally via online delivery of videos and related lesson plans and educational materials. National partners in a SciTech network also broadcast some stories.

SECTION C: COLLABORATIVE NETWORKS

North Carolina Sea Grant continues to have many impactful collaborative activities with other Sea Grant and NOAA programs, as well as with agency partners at local, state and national levels. A few highlights of our collaborative networks are below, with additional collaborative partners noted throughout the PIER report. Also, the "Leadership and Productivity" section of this briefing book also provides examples detailing our program's relevance and roles in collaborative networks. That section organizes examples by focus areas in the National Sea Grant Strategic Plan, but many of our projects and initiatives produced crosscutting success stories.

State, Regional and National Collaborations: NCSG has a strong tradition and reputation as a convener of stakeholders — including researchers, government officials, business owners, and residents — representing varied perspectives and needs throughout our coastal region and related watersheds.

In 2014, NCSG convened a research symposium under the theme "Investments and Opportunities." With over 150 participants, including 36 graduate students, our goal was to encourage open and constructive networking across a multitude of perspectives. The symposium steering committee included key leaders from across the UNC system and Duke's marine science programs, as well as the N.C. Department of Environmental and Natural Resources' Divisions of Coastal Management, Marine Fisheries, and Water Resources. We engaged industry leaders from RTI

International, Stantec and other consulting firms; N.C. Farm Bureau; N.C. Marine Bio-Technologies Center of Innovation; educational leaders from the N.C. Museum of Natural Sciences; and local leaders from New Hanover County Planning, Onslow County Solid Waste, City of Raleigh, and Cape Fear Council of Governments. Other partners included the State Climate Office, Governors' South Atlantic Alliance (GSAA), U.S. Geological Survey (USGS), EPA, Southeast Regional Partnership for Planning and Sustainability (SERPPAS), U.S. Marine Corps Base Camp Lejeune, and Virginia and South Carolina Sea Grant programs. Foundation partners included The Conservation Fund. NOAA offices included the National Ocean Services' Coastal Services Center, National Weather Service (NWS) and National Sea Grant Advisory Board. The event shared the past decade of our Sea Grant-funded research and impacts, while also engaging the audience in facilitated discussions to identify current and emerging priorities and potential solutions. Sessions provided guidance and direction for funding opportunities, including a special RFP in 2014 focusing on infrastructure in the coastal zone, long-term datasets, tidal creek systems and research to inform restoration. The RFP details were provided in the Recruiting Talent section.

During this review period, NCSG continued to actively respond to an extensive review, requested by the UNC Board of Governors and UNC System President, to study coastal and marine science programs systemwide to ensure efficient and effective operations. The American Association for the Advancement of Science (AAAS) conducted the review, providing its report to the Board of Governors in June 2013. System leaders then convened a workshop to examine the 14 recommendations of the AAAS report and determine next steps. NCSG Executive Director White chaired the statewide workgroup to reimagine a "coastal and marine consortium" for the state. A final report to the UNC System President, "Coastal and Marine Science Review and Recommendations," was released in October 2014. NCSG was specifically identified in the final report as well positioned to provide leadership for a statewide coastal conference to foster collaboration and communication among many interested stakeholders.

Building on the success of the 2014 Sea Grant research symposium, NCSG and UNC leaders partnered to develop and deliver North Carolina's Coastal Conference in 2015, which was followed by a second conference led by NCSG in 2017. With a combined total of nearly 400 participants, these informational-sharing and discussion-driven statewide conferences continue to strengthen collaborations among numerous stakeholders, including elected officials. The sessions, which drew extensive media coverage, addressed interdisciplinary coastal resource management needs of the state and region.

North Carolina's Sea Grant and Cooperative Extension programs are both based at NC State University, but are run
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separately. A strong tradition of partnerships has included shared positions in the past, and many collaborations. During the review period, our water protection specialist worked with Cooperative Extension statewide specialists as well as Bertie County extension officials to respond to 2016 floods from Hurricane Matthew. Those interactions, and resulting impacts, are detailed in the Productivity section. In response to Matthew's flooding, NCSG also strengthened existing collaborations with the U.S. Department of Homeland Security, including its Coastal Resilience Center of Excellence based at UNC-Chapel Hill. These included facilitating community-based discussions to consider local needs regarding immediate housing and planning, as well as efforts to support FEMA informational needs immediately post-Matthew.

The NCSG executive director also leads the state's WRRI. She added duties in February 2017 as interim director for N.C. Space Grant, a NASA program, and then became its director in September 2017. Similar to the administrative and programmatic efficiencies realized between Sea Grant and WRRI, the expanding opportunities to collaborate and support Space Grant are a positive leveraging opportunity for Sea Grant. The Sea Grant/NOAA mission, WRRI/USGS statewide watershed research and education mission, and Space Grant/NASA statewide mission — to promote, develop, and support aeronautics and space-related science, technology, engineering, and math education and training — are additive opportunities for the three program teams, thus supporting impacts at the local, state and regional levels. Sea Grant has supported joint fellowships with WRRI and Space Grant since 2016, strengthening watershed- and technology-related student training, as well as new institutional engagements. WRRI and Space Grant missions are strongly related to Sea Grant in science, technology and education efforts. Each has a separate advisory board. While NCSG does not claim products funded by one program as credits to the other, the value of coordination and leveraging opportunities for these programs are important and beneficial.

Sea Grant Network Collaborations: Our work with other Sea Grant programs includes regional research projects. In 2014, we focused on understanding climate change impacts on summer flounder. In 2016, the project was improving understanding of risk through improved hazard-assessment tools and policy analyses of barriers to adaptation planning. These projects are listed in the PIER report.

Our unique geographic location brings NCSG membership in, and successful collaborations with, two Sea Grant regions: the Mid-Atlantic and Southeast Atlantic. Our team provided leadership to renew a Southeast regional meeting in South Carolina in 2015. The Mid-Atlantic network meets more regularly, often hosted by NCSG in Currituck County, including a session planned during the review period and held in Spring 2018.

NOAA Collaborations at All Levels: NCSG was among founders of the grassroots group “NOAA in the Carolinas” that included NOAA line offices (e.g. NWS, NMFS, NOS, OAR) in the two states as well as NOAA-funded programs (e.g. Sea Grant, Coastal Zone Management, National Estuarine Research Reserves). NCSG was also a leader and partner in the regional GSAA. NOAA in the Carolinas sunsetted in 2014 and GSAA in 2017. Topics covered in these regional groups were folded into the NOAA Southeastern and Caribbean Regional Team (SECART). NCSG continues to engage directly with SECART, most recently through a 2017 Southeast Sea Grant program regional research effort, “Fostering Public-Private Partnerships in the Southeastern U.S. and Caribbean to Advance Resilience and Disaster Recovery.” This effort builds on the Southeast and Caribbean Climate Outreach Community of Practice and Southeast Disaster Recovery Program, a NOAA-funded effort through the Regional Coastal Resilience Grant Program. Funded by Sea Grant and the National Ocean Service, the project is engaging local government officials, emergency managers, and representatives of small business in each southeast state to review recovery strategies and assess the potential efficacy of those strategies in enhancing a public-private partnership (or P3) approach to fostering disaster-recovery planning among members of the business community.

In addition, NCSG has a long-standing collaborative relationship with the NOAA Climate Program Office’s Carolinas Integrated Science and Assessment (CISA) program. With leadership on the CISA advisory board and science technical group, NCSG helps CISA look for win-win opportunities regarding climate services, evaluation and technical training. In fact, CISA separately funded two proposals that NCSG identified as meeting the CISA mission. The projects initially had been submitted to our CCRG program. The two projects were leveraged for state and regional applicability: “Resilience Inclusion on the Coast: Exploring Sea Level Rise in Diverse Communities on the Albemarle Pamlico Peninsula of North Carolina” and “Documenting Water Levels in NC Estuaries through the N.C. King Tide Project.” CISA also has led, with NCSG in an advisory role, a regional component of an interagency partnership housed within NOAA, the National Integrated Drought Information System (NIDIS), in support of a developing pilot southeastern coastal drought salinity index. Also, the U.S. Department of Commerce, NIDIS partners include many federal agencies (e.g. FEMA, U.S. Army Corps of Engineers, and EPA, as well as U.S. Departments of Transportation, Agriculture, Energy, and Interior).

Since the 1970s, NCSG has provided state, regional and national leadership in rip current safety. This is an ever-present challenge for coastal residents and visitors alike, across all surf beaches, including the Great Lakes. NCSG continues to provide extension and communications perspectives on a national task force led by NOAA and the *North Carolina Sea Grant*

U.S. Lifesaving Association. During the review period, our program has printed and distributed — in North Carolina and beyond — hundreds of signs, thousands of magnets with safety messages and tens of thousands of brochures. Our state partners include NWS forecasters, the National Park Service, ocean rescue teams, realty companies and community groups. See our Resilient Communities and Economies section for our rip current research.

Since 2011, a NOAA Sentinel Site Cooperative program has operated in North Carolina. The cooperative is a partnership with NOAA National Ocean Service and multiple state, federal and local community partners to better understand impacts and adaptation opportunities to inform community-level action on sea level rise. During this review period, NCSG has served on the Core Management Team and is currently chairing the team, which includes academic institutions, municipalities (e.g., Town of Jacksonville), NOAA offices (e.g. NOS, NWS, National Centers for Environmental Information, NC) and state agencies (e.g., Division of Coastal Management, NC Coastal Reserves). NCSG also has hosted the coordinator for the N.C. cooperative, as well as an outreach specialist. *Coastwatch* magazine, in print and online, detailed the national Sentinel Site program and its connections to Sea Grant, serving information needs nationally.

Other Agency Collaborations: During this review period, NCSG continued to actively collaborate with the U.S. Department of Defense through the Regional Coordinating Committee for the Defense Coastal/Estuarine Research Program (DCERP) at Marine Corps Base Cape Lejeune. For 10 years, ending in 2016, DCERP had partners including U.S. Department of Energy and the EPA. The Regional Coordinating Committee, representing local and regional stakeholders, was among recipients of DCERP outreach efforts. In addition to NCSG, the committee included non-profits (e.g., The Nature Conservancy, N.C. Coastal Federation), N.C. Cooperative Extension, USDA Forest Service, Croatan and Uwharrie National Forests, Albemarle-Pamlico National Estuary Program, U.S. Fish and Wildlife Service, N.C. Wildlife Resource Commission, and the state Natural Heritage Program.

NCSG continues to provide leadership and technical support to the South Atlantic Fisheries Management Council (SAFMC) through its Citizen Science Initiative, as well as chair the council’s Information and Education Advisory Panel. SAFMC, which includes the Carolinas, Georgia and Florida, initiated the first Citizen Science program for a regional fisheries management council. NCSG extension specialists currently serve in multiple contributory and leadership roles within this developing initiative, beginning with invited “lessons learned” presentations at the 2016 kick-off event.

Sea Grant Network Collaboration and Leadership: NCSG continues to be especially active in Sea Grant networks.

Positions during this review period include as Member-at-Large on the Sea Grant Association board, member of the Program Management Committee, current Chair of the External Relations Committee. Other N.C. leaderships have included current Chair of the Fiscal Network, and as a regional representative to the Sea Grant Extension Assembly. Extension team members also have provided leadership within Sea Grant topical networks, including fisheries, climate, law and policy, and sustainable community development.

In Summer 2017, NCSG committed to key leadership roles in two National Sea Grant Network visioning efforts, as well as formal membership within four additional efforts. Clearly, many visioning efforts were interesting and shared broadly, with NCSG engaging where appropriate. Specifically, NCSG provided co-chairs for Weather and Climate Resilience and also Resilience through the Lens of Diversity, Equity, and Inclusion. Team members also engaged in Traditional and Local Knowledge; Fisheries Extension Network; Water Resources; and Environmental Literacy. All NCSG participants have spent significant time and energy to engage, collaborate and integrate feedback from across the network for the reports completed and submitted in August 2018.

Success in Sea Grant National Competitions: During this evaluation period, NCSG has been highly successful in National and Regional Sea Grant and NOAA Competitions. This list and funding amounts can be found in the PIER report (subsection A.c.). Projects included:

Aquaculture National Competitions

- National Sea Grant Aquaculture Extension and Technology Transfer Project, “University Expansion and Diversification of the North Carolina Shellfish Aquaculture Industry” in 2015.
- National Sea Grant Aquaculture Workshops and Training Events Grant Recipient, Building the Marine Aquaculture Career Pipeline in 2016.

NMFS Bycatch Reduction of Marine Mammals in Mid-Atlantic Fisheries program. NCSG successfully competed to manage this competitive program in 2014.

NOAA Sentinel Site Cooperatives. NCSG successfully competed for this call in 2014 and 2016 to provide a Sea Grant extension specialist to coordinate the N.C. Sentinel Site Cooperative.

NCSG was successful in national fellowship competitions. A total of 10 N.C. students were selected as finalists for the Dean John A. Knauss Marine Policy Fellowship, and seven accepted positions. One student received a NMFS–Sea Grant Fellowship. Three N.C. students were awarded the NOAA Coastal Management/Digital Coast Fellowship.

During this reporting period, one Sea Grant National Strategic Institutions (NSI) project was ongoing:

North Carolina Sea Grant

Enhancing Sea Grant's Ability to Help Coastal Communities Adapt to Climate Change, 2012-2015.

SECTION D: PERFORMANCE VIA LEADERSHIP & PRODUCTIVITY

North Carolina Sea Grant’s tradition of excellence in performance and productivity is rooted in the work of our expert team, researchers and strategic partners. Together, we provide leadership at the local, state, regional and national levels on a wide spectrum of topics.

The PIER report for our efforts in 2014-2017 outlines varied examples of our reach. For instance, our team and funded researchers have published 92 papers in peer-reviewed journals, including *Nature*, *Nature Climate Change*, *Proceedings of the Royal Society*, and *Philosophical Transactions of the Royal Society*.

These journals, and others listed in examples that follow, show recognition from scientific communities for our innovative research and important results. But most impacts arise when findings are put to use in policy decisions and strategy updates for agencies, businesses, landowners and others. Our team members alone have held more than 90 specific leadership and advisory roles. National roles include membership on a federal advisory panel on climate assessment and a subsequent independent committee to continue that work. Another specialist was president of The Coastal Society. Roles in the National Sea Grant network, including leadership on visioning committees, are outlined in the Collaborative Networks section.

Statewide advisory efforts include chair of the N.C. Sediment Control Commission, chair of the N.C. Sentinel Site Cooperative’s core management team, co-vice chair of the N.C. Coastal Resources Advisory Commission. Our team members also are active in professional organizations, and serve on dozens of committees to assist agencies and organizations. Our funded researchers serve similar roles at the state and regional levels.

The PIER report highlights other achievements as well. For example, our economic impacts for the four-year reporting period totaled \$17.6 million, including savings for property owners through lower insurance premiums, as well as new business developments, and jobs created and retained.

The report also includes an extensive list of 165 tools and products, many of which are crosscutting across the goals of the state and national program. In the breakdown, 57 in the total listing benefit ecosystem-based management. Also, 108 fall under the category of environmental literacy and workforce development. These achievements reflect the strength of our applied research in delivering valuable information to stakeholders.

Our program’s 2014-2017 Strategic Plan described five

focus areas. For the purposes of this federal review, we have incorporated our efforts in “sustainable coastal development” and “hazard resilience in coastal communities” into National Sea Grant strategic plan, primarily under “resilient communities and economies.” Our “safe and sustainable seafood” and “environmental literacy and career initiation” focus areas align with the National Sea Grant strategic areas of “sustainable fisheries and aquaculture” and “environmental literacy and workforce development,” respectively. Our fifth focus area, “healthy coastal ecosystems,” reflects the national category.

Below, we highlight examples of success stories within the national categories. In each focus area, we describe our leadership and productivity, while also explaining how our program excels in terms of organizational excellence, stakeholder engagement and collaborative networking activities. Note that in many cases, it was difficult to choose which focus area to consider as “primary” because the efforts are very interdisciplinary.

Environmental Literacy and Workforce Development

North Carolina’s Sea Grant’s 2014-2017 Strategic Plan includes a strong focus on Environmental Literacy and Career Initiation, which parallels the national focus area of Environmental Literacy and Workforce Development. NCSG productivity and performance during this review period includes a range of strategic research initiatives, innovative outreach tools and products, and many resulting impacts and accomplishments, including but not limited to examples below and many within the PIER report. Key performance measures show that NCSG has supported informal education programs that have engaged 362,362 people over the four-years. During the same time, 151 students became employed in a career related to their degree within two years of graduation.

The NCSG team and researchers also provide distinct leadership in various topics within this focus area. For example, in 2017 the National Marine Educators Association honored Terri Kirby Hathaway, our marine education specialist, for her service to the profession. A researcher is prolific in publishing Sea Grant-funded interdisciplinary research findings, such as in the *Journal of Environmental Education*, and brings results to wider audiences through news coverage including in *The New York Times* and *The Washington Post*.

Environmental literacy is a key outreach goal for the NCSG team. During this review period, *Coastwatch* magazine and individual communicators received multiple state and national honors for appealing, engaging and informative stories. A video, highlighted on our website homepage, was developed during the review period and received national honors in 2018. Our team also looks for new methods of communications. A “story map” on N.C. oysters and shellfish mariculture developed by extension specialists

also earned national recognition. Unlike a traditional paper map, the story map combines spatial information with text, pictures and multimedia through an online, interactive platform. Our team also has continued to provide extension and communications expertise in long-term roles on a national task force to improve rip current safety.

Reaching Wide Audiences: Sound science creates a solid foundation for outreach. Thus, our program has priorities to generate and share scientific content for a variety of audiences. The NCSG communications team works with colleagues within our team, our funded researchers and numerous partners to educate the public. *Coastwatch* magazine reached an average of 10,000 readers per issue five times per year. The official NCSG website also continues to evolve. In the reporting period, the *Coastwatch Currents* blog has grown, complementing other efforts. In 2017 alone, *Coastwatch*- and *Coastwatch Currents*-related pages together garnered more than 92,000 unique page views. We also reach wide audiences through Facebook and Twitter.

Other products developed by communication and extension specialists include *Scotch Bonnet*, a well-respected marine education newsletter, and the new *Blue Economy Information Series*. Products for consumers include recipe cards and updates for the *N.C. Seafood Availability* poster. Property owners have learned about flooding definitions, preparations, responses and mitigation options through a variety of products, including a video highlighting Hyde County and news stories explaining the “100-year flood” concept. Many of these are listed in the PIER report’s section on products, tools and information services.

Our team overall also has strong partnerships with other experts within the UNC System and beyond. Susan White serves on the UNC-TV science programming advisory panel. Our communications team has provided story ideas that focus on expertise from extension specialists, funded researchers and graduate students, as well as agency, industry and community collaborators. NCSG also has continued its partnerships with UNC Press. As the review period was coming to a close in early 2018, the new edition of *Seacoast Plants of the Carolinas* was in final edit stages, with publication coming a few months later. The author is a key member of the Coastal Landscape Initiative that NCSG convened in 2017.

New Media and Collaborations: The new CCRG program fits into many areas of this review, including earlier sections on recruiting new talent and stakeholders. CCRG also is a direct response to our last federal review. With the pairing of local knowledge experts with academic researchers, CCRG projects have provided effective tools, technologies and services across a range of disciplines, including natural and social sciences, education and business management. These partnerships have resulted in educational materials for wide audiences. Zombie crab

invasions were highlighted last Halloween at the N.C. Estuarium in Washington, when a new permanent exhibit on invasive species opened with media coverage. New signs explain ecosystem functions and research findings at the Sturgeon City environmental education center on Wilson Bay in Jacksonville, and also at the Currituck Banks site of the N.C. National Estuarine Research Reserve.

Podcasts were key products from a CCRG team who wanted to share perspectives on the 20th anniversary of the N.C. Fisheries Reform Act. In addition to the summaries in the podcasts, detailed oral histories also are readily available online. Focus groups evaluating the products identified the project's depth and breadth. In fact, it spurred the Outer Banks Catch organization to host a Fisheries Reform Act Summit in 2017. The summit attracted policymakers, educators, commercial and recreational fishers, resource managers and community members. The products also generated an hour-long program on WHQR radio in Wilmington. Students, as future leaders, are a key audience, via a discussion guide that has been incorporated into at least one college course.

Rising is a multimedia exhibit developed during the review period through a CCRG award. It has been gaining statewide attention for stunning coastal images and messages that are generating community-based discussions about our changing coast, with a focus on water levels and ecosystems.

North Carolina's rich maritime history is gaining public interest — and provides teachable moments to improve public understanding of local history, as well as the science behind discovering and restoration of cultural artifacts. NCSG minigrants funded teams, led by State Office of Archaeology in the N.C. Department of Natural and Cultural Resources, documented two Civil War-era blockade-runners in coastal waters: the *Condor* and the *Agnes E. Fry*. When state officials designated the *Condor* as North Carolina's first Heritage Dive Site in 2017, they cited NCSG as a key partner in research and public outreach. Related tourism already is increasing in nearby Carolina and Kure Beach. The projects also have generated popular blog posts and stories in *Coastwatch* magazine.

Professional Training: An NC State researcher led a project focusing on Ocracoke, an island accessible only by boat, to better understand its changing demographics, including a growing Latinx population. Community participants attended meetings, and discussions have included particular needs, such as worker housing.

NCSG also leads or participates in conferences and workshops that often count toward professional license renewals. On average, 6,900 individuals were eligible to receive Professional Development Units/Continuing Education Units through NCSG-supported workshops,

conferences and technical trainings.

Nutrition awareness and changing consumer tastes have increased the demand for seafood. While each N.C. county has environmental health specialists who are responsible for conducting sanitation and safety inspections at restaurants and retail stores, most traditionally have little knowledge about seafood handling. As a result, Sea Grant collaborated with state shellfish sanitation experts to organize and teach an annual workshop to environmental health specialists, who then are eligible to be certified by the N.C. State of Practice Committee to conduct seafood quality and safety inspections.

Also hundreds have participated in the popular EcoStream conference and RiverCourse workshops we sponsor in partnership with NC State's Biological & Agricultural Engineering Department (BAE). NCSG also has been a lead organizer for Shape of the Coast sessions offered as part of the UNC Law School's Festival of Learning.

Developing Future Leaders: One of our strategic goals was to increase the number and diversity of student fellowship opportunities in order to support a variety of workforce settings. Our team continues to meet and exceed expectations. As mentioned in Section A under Recruiting Talent, the 2014 site review recognized our fellowships as a best management practice. We continued this focus, through 11 opportunities, most jointly funded with partners. In 2016, we created two new funding opportunities by partnering with N.C. Space Grant, and N.C. Sentinel Site Cooperative (NCSSC).

Our joint fellowship with established partner WRRI offered a new opportunity in 2017 to increase diversity. The new fellowship reaches out to new and diverse audiences — a major goal for both programs — by strongly encouraging applicants to collaborate with Historically Black Colleges and Universities and Minority Serving Institutions, and to provide results that benefit traditionally underrepresented communities. The initial RFP generated five outstanding projects that have gained attention from the local communities to Europe. Several of these fellows will present at the poster session portion of the site review.

White also has worked with partners to develop the next new fellowship opportunity. The N.C. STEM Policy Fellowship grew from a partnership with Duke University, through funding from the California Council on Science and Technology Policy and the Gordon and Betty Moore Foundation. This fellowship not only will benefit the state by supporting informed decisions and retaining technical expertise but also will expose fellows to potential career opportunities, allowing them to gain policy experience. Planning for this fellowship during the review period resulted in commitments from the Burroughs Wellcome Fund to support one fellow per year in 2019 and 2020. NCSG and WRRI also intend to jointly support an

additional fellow per year in 2019 and 2020.

K-12 Environmental and STEM Literacy: NCSG works with K-12 educators to improve their efficiency and effectiveness at teaching marine science topics. This “teach the teacher” strategy is clear in our core research and outreach. In 2015, an NCSG-funded research team from NC State and NC Central universities developed a four-lesson climate literacy module, “The Wildlife, Weather, Climate and Change.” Results showed the curriculum about climate also built hope and resulted in pro-environmental behavior. In a subsequent project, 18 middle school science teachers were trained in a climate literacy curriculum — lessons that have already reached 1,100 students. These examples meet our 2014-2017 Strategic Plan goals to support and enhance K-12 STEM teaching achievements via development of methodologies and materials. Our efforts continue to increase scientific literacy of the public as students become more knowledgeable in marine topics, which also fulfill NOAA’s strategic goals.

As described in our last review, NCSG facilitated development of SciREN, formally the Scientific Research and Education Network. We are thrilled that SciREN continues to thrive, now as a nonprofit. Graduate students plan multiple networking events are held each year in North Carolina. Alumni even took the concept to create a program in Georgia. NCSG continues to be a key sponsor of SciREN events, in particular financial sponsorship of lesson planning workshops to ensure that materials graduate students and educators develop would meet state standards. Our marine education specialist administers the continuing education process for classroom teachers and environmental educators seeking renewal credits. In this reporting period, SciREN has ultimately reached more than 50,000 students, and 215 researchers who have offered real-life research data and findings to nearly 400 educators.

As educators must show student performance in all subjects, often without training in science, NCSG developed DataStreme Ocean, an online graduate-level oceanography course offered to educators that focuses on marine and ocean sciences, including activities to help with reviewing and retaining content. This course increases their content knowledge and increases ocean literacy in their students. In 2017, 23 educators completed the course, used lessons in their classes, and served as local science mentors.

Experiential Education: Of course, learning also happens outside the classroom. NCSG supports varied projects that provide educational experiences that inform public understanding, encourage behavioral change, and help establish and maintain partnerships. Some of these efforts also focus on working with K-12 students, such as an ongoing EPA-funded project that reached its third year in 2017. Teachers collected seeds from *Spartina alterniflora* plants. Students then grew them into seedlings and later

transplanted into local salt marshes. Over the span of the project, 460 students learned about how sea level rise, saltwater intrusion and erosion threaten our salt marshes.

Opportunities for hands-on experience to supplement classroom teachings also are lacking at the college level. NCSG encourages students to assist with field studies. For example, one collaborative team included a former Knauss fellow now on faculty at Chowan University, a minority-serving institution, along with the research coordinator for the N.C. Coastal Reserve, who is a past National Sea Grant/NMFS fellow, and a partner from Audubon North Carolina. With key assistance from Chowan undergraduates, they investigated how marshes in Currituck Sound are responding to sea level rise. Many of the students were first in their families to attend college. Thus, working directly with scientists and resource managers in the marsh and the labs not only helped the students learn scientific content but also increased their interest in related careers.

Many NCSG efforts are crosscutting, including a Raleigh watershed project detailed in the Resilient Communities and Economies section. In that, students shared their new knowledge by conducting a similar workshop for their parents, including a tour of the new rain garden at St. Ambrose Episcopal Church.

Critical Communication Skills: NCSG promotes a holistic approach to supporting the future workforce in marine and coastal professions. This includes direct mentorship to improve communication skills for graduate students — and even for researchers who accept the challenge of writing for our general audiences. This iterative coaching and editing process increases the benefits and impacts of fellowships, minigrants and core research projects alike. The scientists learn to explain their expertise within a discipline and the resulting scientific data and conclusions to various audiences. This key professional development need is only now gaining attention in graduate programs.

While communications efforts are a required part of the jointly funded fellowships, other researchers also often respond to our requests for blog posts. Some fellows even write stories for *Coastwatch* magazine. Our communications team also works with fellows and other NCSG-funded students to share social media highlighting fieldwork. Our graduate students have been invited to present posters at Sea Grant and WRII conferences. NCSG also funds and mentors undergraduate and graduate students working directly with the communications team on projects representing the full spectrum of our efforts.

In 2016, NCSG took its commitment for communications and related work skills to a wider audience via a graduate training symposium, under the theme: *Conveying Your Message*. Our team called upon colleagues from five campuses to share their expertise on topics ranging from

developing elevator messages and using video to reach new audiences, to crafting professional social media and writing successful grant proposals. Graduate students from across the state participated, including several HBCU and MSI. Their majors included several not traditionally in the Sea Grant spectrum, including subfields of engineering. Participants also came from the natural and social sciences, economics and education. The poster session generated synergies as they discussed each other's research. Post-conference participant feedback showed this professional development training highly benefitted students. The impact is still felt two years later. We recently had a visit from a new post-doc who is bringing his textiles expertise to work on biomaterials. He readily explained how the symposium had helped him think more broadly — and to explain to others — about how his work could fit grand challenges in natural resources, such as improving remote sensing via new filters.

Supporting Decision Makers: To continue supporting informed decision-making, NCSG pursues numerous extension and outreach projects that identify issues and topics on which NCSG can guide and support. Examples are provided throughout this briefing book, the PIER report and presentations by members of our panels. In particular, NCSG hosted North Carolina's Coastal Conferences in 2015 and 2017. These events exemplify our commitment to establish and maintain linkages with agencies, researchers and communities alike.

The 2015 conference, in partnership with UNC General Administration, drew diverse participants to discuss energy resources, coastal economies, healthy coasts and communities, hazard resilience and other topics. NCSG reinforced its honest broker role among state and regional partners, stakeholders, researchers and communities. Both conferences also served as one-stop shops for legislative and congressional staff members who wanted updates on critical topics. As described in the Recruiting Talent section earlier, the conference launched a research RFP. In 2017, our second conference continued not only to draw across a wide spectrum of professions and disciplines, but also to generate news coverage that brought discussions to even wider audiences.

Healthy Coastal Ecosystems

North Carolina's coastal region supports a diverse array of species. Indeed, ecosystems like estuaries, sounds, marshes, tidal creeks and maritime forests — to name a few — offer important habitat for sea- and land-faring organisms alike, many of which are typically found at higher or lower latitudes. These rich ecosystems also support human communities, offering protection from storms, respite for tourists, and resources for fishermen, among other services.

The health of our coastal ecosystems is essential to the state's natural, economic and cultural wellbeing. However, rapid coastal development and other human activities have

led to water quality degradation, wetlands loss, proliferation of invasive species and other problems that imperil coastal habitats and those who rely on them.

In the past four years, NCSG has prioritized partnerships and projects designed to help researchers, resource managers and coastal communities to better understand, monitor, and nurture our coastal ecosystems. The ultimate goal is to encourage holistic, adaptable approaches to resource management. Key performance measures include 1,805,486 acres of coastal habitat protected, enhanced or restored as a result of North Carolina Sea Grant activities over the last reporting period. During that time, 285 resource managers used ecosystem-based approaches in the management of land, water, and living resources as a result of projects and activities we supported.

Our team and funded researchers consistently provide leadership on ecosystem topics. Some have national and international reputation, with decades of recognition. Others are emerging leaders at the state and regional levels. As provided in the PIER report, our research has been published in a variety of professional journals, including *Conservation Biology*, *Limnology and Oceanography*, *Biology Letters*, *Estuaries and Coasts*, and *Ecosphere*.

In addition, our team and specialists serve a variety of leadership and advisory roles, including chairing the state's Sediment Control Commission, and co-leading N.C.'s Watershed Stewardship Network. Members of our team have served many other science and/or policy roles. A few examples include with WRRI, the Albemarle-Pamlico National Estuary Program, the Water Resources Research Institute, the N.C. Division of Water Resources (including on a nutrient panel), the N.C. National Estuary Research Reserve, and the Mid-Atlantic Panel on Invasive Species.

Informing Ecosystem-Based Resource Management:

Sound resource management depends on a firm understanding of basic ecosystem processes, along with current and anticipated conditions. Sea Grant has continued to build a scientific foundation that can inform best practices for monitoring coastal ecosystem health, while also ensuring the dissemination of that information to relevant stakeholders.

For example, oyster reefs constitute one area that our program has prioritized, and for good reason: In the inter- and sub-tidal regions where they're found, oyster reefs perform myriad ecosystem services, such as filtering water, stabilizing sediment and providing nurseries for juvenile fishes. Wild and grown oysters also form an important part of North Carolina's shellfish industry.

Assessing reef health is imperative to understanding whether restoration efforts have been successful or are advisable. Traditional oyster reef monitoring methods are field-intensive and time-consuming, while newer remote-

sensing techniques entailing aerial imagery from satellites and occupied aircraft can miss important details. To that end, North Carolina's Sea Grant and Space Grant programs supported a research fellowship that used aerial imagery from drones to assess intertidal fringing oyster reefs in the Rachel Carson Estuarine Research Reserve. The data allowed the team and Reserve partners to rapidly assess reef important metrics including height and area. The results not only set a current baseline for the reefs, but also indicate that drone technology can be an important tool for resource managers and researchers alike.

Like oyster reefs, marshes provide ecosystem services, helping trap nutrients from flowing into coastal waters. While much effort and money have been invested in marsh restoration, resource managers needed to confirm the return on their investments: How well do rehabilitated ecosystems to function as filters?

A collaborative team of university researchers and the City of Jacksonville received funding from the first CCRG round to investigate how well several restored marshes in the Wilson Bay area of the New River removed nitrogen compared to nearby natural marshes. They found that natural and restored marshes along the bay are effective at removing nitrogen. The finding is important evidence to support the strategy of using restored marshes as a measure to alleviate excess nitrogen. This work was also highlighted in a multimedia package produced by UNC-TV, a partner that continues to help NCSG work reach new audiences.

Left unabated, nutrient runoff can contribute to the proliferation of phytoplankton, sometimes resulting in harmful algal blooms, or HABs. These events can deplete water of oxygen, lead to fish kills, and pose health risks.

Phytoplankton blooms that contain *Microcystis* cyanobacteria have become more common in the Cape Fear River, part of a system that provides drinking water to 1.5 million North Carolinians. Drinking-water treatment plant operators require data on their intake water, but very little exists on how toxic those blooms are. To address that need, Sea Grant-funded researchers from two universities collaborated with partners at three water treatment plants along the Cape Fear River to measure the toxin microcystin. Local officials are now using this data to better understand the nature of their source water, including their location along the river flow.

Understanding toxicity of phytoplankton blooms is important. So, too, is identifying the various factors that trigger bloom formation. Through a massive sampling and data-mining effort, the research team also developed a new model of *Microcystis* growth that accurately provides the recent history of bloom dynamics on the river. Results indicate light availability and transit time along the river strongly regulated the blooms. The team shared their work with local and state officials, including the N.C. Nutrient

Criteria Development Plan's Scientific Advisory committee, the Cape Fear River Partners Water Quality Committee, and water utilities' leaders to help them strategize to mitigate and manage future blooms.

But there are many types of phytoplankton blooms. Proper management of blooms also requires an understanding of their composition. Various methods for determining composition exist, but inconsistencies among them remain. Researchers compared several techniques to investigate the genetic and spatial composition of the phytoplankton community in the Neuse River Estuary. They found that phytoplankton have group-specific environmental preferences, a finding that offers a better understanding of how phytoplankton respond to climatic changes.

Ecological effects associated with climate change and sea level rise also continue to be an important focus area. NCSG-funded researchers studied how saltwater intrusion associated with sea level rise along the coast affects freshwater organisms. Preliminary results indicate that coastal frogs, a salt-sensitive indicator species, may be adapting to elevated salinities. This study drew scientific and media attention to research regarding how macro-fauna are adapting to climate-related environmental changes.

Identifying Drivers of Ecological Degradation:

Understanding the causes of ecological changes and how they affect natural resources, local economies and human health is critical to developing strong ecosystem-based management practices. Widespread adoption and support of those practices also requires that relevant information be tailored for different audiences.

Biological invasions are among conservation concerns worldwide, and North Carolina has stories to share. Developing strategies to control invasive species requires a firm understanding of the extent of their presence and their impact. For example, in 2014, the exotic submersed plant *Hydrilla verticillata* became a greater problem in the lower Chowan River and Edenton Bay, but in 2016, the visible presence of *Hydrilla* had significantly declined.

Because *Hydrilla* tubers can remain dormant for years before sprouting again, NCSG collaborated with NC State to produce a video to teach citizen scientists how to identify and sample for *Hydrilla* tubers. The team also secured equipment for participants to use at two locations that historically had been infested. In contrast to previous fieldwork, they found no tubers at one location, and only a small number at the other location. This project not only trained citizen scientists for data collection, but also set best practices and apps that can be adapted for other needs.

Another project also looked at *Phragmites australis*, the invasive grass that poses a significant threat to marsh ecosystems along the Atlantic coast. An NCSG graduate fellow quantified the ecosystem services provided by

marshes with varying densities of *Phragmites* located in the N.C. Coastal Reserve system. The results revealed that increasing densities of *Phragmites* had a neutral impact on ecosystem services, indicating that eradication measures are unnecessary within the study area — a finding that will save time and money. This project also created a lesson plan for 4th- and 5th-grade students on the basic concepts of invasive species and their impacts on ecosystems.

In a similar vein, a team — including university researchers in biology, art and education and representatives of the N.C. Estuarium — also focused on biological invasions. Not only did they gather new data, but they also developed a permanent interactive public exhibit at the Estuarium in the Town of Washington. The research highlights a particularly invasive parasitic barnacle that infects native mud crabs, along with four other coastal invaders of the region. Visitors also learn about ongoing research into how salinity may impact abundance and prevalence of the barnacle. This work was highlighted in multimedia stories produced by UNC-TV and other media.

Marine debris is another problem plaguing North Carolina's coast. NCSG has tackled the problem through several partnerships. Working with the N.C. Coastal Federation, for instance, NCSG helped develop a marine debris reduction plan, initiating a stakeholder meeting and drafting a coastwide marine reduction framework that addresses challenges and opportunities to eliminate debris.

Another effort specifically tackled derelict crab pots, which can trap fish and shellfish, as well as obstruct navigation. With funding from the N.C. General Assembly, our team partnered with the Federation to undertake a statewide pilot crab pot removal project in 2016-17, building upon the success of a smaller pilot program funded earlier by NOAA. The new effort included dozens of commercial fishermen who canvassed more than 1.2 million acres of inland waters, ultimately removing more than 4,300 derelict crab pots. The NCSG final report led legislators to continue annual funding for statewide cleanup.

Restoring Function of Degraded Ecosystems: Monitoring coastal ecosystems and identifying challenges to their health is crucial. Restoration often is essential as well. NCSG continues to support new technologies and methods designed to restore sensitive systems in ways that balance their needs with those of the people who rely on them.

Tremendous resources and efforts have gone into restoring the state's native oyster habitats in estuaries. But many projects have met with limited success, and even failure, often because of a lack of understanding of the physical and biological factors that control oyster populations.

In some cases, research efforts continue to provide findings after the project closes fiscally, such as an earlier project that compared creation of oyster reefs from different

foundation materials at multiple sites in the Newport and North river estuaries in Carteret County. Sampling focused on testing the susceptibilities of oyster communities to boring sponge infestation. Some of these reef communities are viable, while others are virtually bereft of oysters, supporting the hypothesis that carbonate-boring sponges threaten oyster reef sustainability. Data collections at the sites in 2014 and 2015 informed the N.C. Division of Marine Fisheries' decision to change materials and methods used in the construction of expensive oyster sanctuaries and cultch plantings to reduce the risk of boring sponges.

A key part of ecological restoration is identifying optimal sites. Resource managers often rely on habitat suitability index (HIS) models to inform the site-selection process. Such models typically incorporate physical, biological, permitting or logistical factors, but rarely are all four categories represented in one model. An N.C. Sea Grant/Space Grant fellow developed a GIS-based HIS model to identify optimal sites for oyster reef restoration in Pamlico Sound. The goal was to include the restoration project's potential for contributing ecosystem services in the form of nutrient reduction and water quality improvement. The team included scientists from two campuses, the N.C. National Estuarine Research Reserve, and DMF. Using the results, DMF, the N.C. Coastal Federation and the U.S. Army Corps of Engineers Wilmington District are updating oyster-restoration planning processes.

NCSG-supported work also helped inform the design for a restoration project in Hyde County. Government agencies and a nonprofit had developed plans to divert nutrient-rich water from a farm away from the Pamlico Sound through a restored wetland that drains into the Alligator River National Wildlife Refuge. Partners were concerned that the influx of nitrogen would impact high-quality downstream waters in the refuge. In response, research team developed a mesocosm study to show that restored wetlands could achieve significant nitrogen reduction.

Their work provided key information for the restoration design and water management plan. The team also debriefed partners on the work, increasing stakeholder confidence that the restoration project would not adversely impact water quality in the refuge. The project moved forward to restore 1,200 acres, with plans for follow-up studies to document nitrogen removal and the annual diversion of drainage water from Pamlico Sound.

Resilient Communities and Economies

To address objectives from our 2014-2017 Strategic Plan, North Carolina Sea Grant has capitalized on our long-standing relationships with coastal communities and industries to support healthy coastal economies. We also work with communities that value and make efficient use of natural resources, and that seek the awareness and

capacity to develop and demonstrate hazard resilience. This work has included projects that range in scope from macro-analyses to initiatives that explore and support particular sectors of the coastal economy and the needs of individual communities and businesses.

Over the four-year reporting period, 111 communities implemented sustainable economic and environmental development practices and policies (e.g., land-use planning, working waterfronts, energy efficiency, climate change planning, smart growth measures, green infrastructure) as a result of projects and activities we supported. In addition, 145 communities implemented hazard resiliency practices to prepare for, respond to or minimize coastal hazardous events as a result of our work.

Our innovative research and outreach results are found in a variety of peer-reviewed journals, such as *Marine Policy*, *Journal of Waterway, Port, Coastal and Ocean Engineering*; *Climate Risk Management*; *Shore and Beach*; and *Environmental Conservation*. The impacts have also been shared via our *Coastwatch* magazine and blog, the *Legal Tides* newsletter, and technical reports in the *Blue Economy Information Series*. We also produced videos and combined efforts with partners to extend our reach.

As noted earlier, our team members have shown federal and state leadership on topics including climate assessment and adaptation, coastal hazards and planning. We also were a founding and continuing cosponsor for the annual N.C. Hurricane Conference, for which NCSG received a 2016 award from the N.C. Division of Emergency Management. East Carolina researchers host the conference, a legacy of a core research project that had examined communications strategies for tropical storm warnings.

Supporting Healthy Coastal Economies: Because thousands of jobs and billions of dollars in revenue are tied to the ocean and coast, NCSG specialists in economics, law and policy partnered with university researchers to complete the first assessment of existing economic information and the state’s governance framework to better understand North Carolina’s ocean and coastal economy. This two-phase project analyzed the size and extent of North Carolina’s ocean economy and recommended applying the data to create a “blue economy” model. This model seeks to balance the long-term capacity of ocean and coastal ecosystems to support economic activity, and we have widely disseminated it to coastal decision-makers.

As coastal communities and economies have changed in recent years, NCSG has increased its workforce development within the region. NCSG-funded researchers conducted fieldwork on behalf of town managers, business managers, and workers to explore labor relations between mainland communities and the Outer Banks, where businesses rely heavily on workers from inland areas. Sea Grant partnered with researchers and community partners

to study the leadership and labor dynamics of coastal communities, in order to determine labor needs, as well as the labor practices in different economic sectors. This project revealed that bridging social capital has enabled coalitions among various groups invested in a sustainable workforce. To provide effective strategies to attain a sustainable, equitable workforce, the team has disseminated about 50 toolkits to coastal communities.

Tourism is a key economic sector along the coast, with impacts on residents and ecosystems alike. Therefore, assisting and guiding coastal communities, state agencies and businesses to support the industry — a key area of emphasis on the 2014-2017 Strategic Plan — remains a strong focus of our work.

Heritage tourism is critical to many coastal regions. The Outer Banks in particular has embraced this sector as a means for sustainable economic development. Current and future tourism will in part rely on the Outer Banks Scenic Byway. Our team mentored graduate students who developed a geo-spatial analysis and a framework for decision makers about the current and potential economic, environmental and community impacts of the coastal and marine tourism industry in the three counties along the byway. The shared their findings with leaders who can now make more informed resource management decisions.

Our research and outreach has provided key support for several other heritage tourism topics, including collaborating with established community groups, the National Parks Service and others. This included oral history training for community volunteers, who in turn have engaged in a number of oral history projects and leveraged additional funding from the National Park Service and National Maritime Heritage Foundation.

Because our state’s coastal economy also relies heavily on fishing and aquaculture, NCSG has collaborated to increase awareness and foster entrepreneurialism, leadership, and optimal business strategies for seafood and marine aquaculture companies and partners. To help build community leadership among commercial fishers, for instance, we hosted three Fish Camps in January 2018. The sessions grew out of a social science research project provided that considered changes in fishing fleets and communities. Fish Camp mentors included an NCSG fisheries extension specialist, a journalist/community leader, and an anthropologist who is a former member of both the N.C. Marine Fisheries Commission and the NCSG Advisory Board. The camp participants developed action plans that have continued to take shape.

In collaboration with several North Carolina companies, NCSG also has helped to develop value-added seafood products. This industry outreach has become part of a partnership with the Center for Environmental Farming Systems at NC State, which has key funding from the U.S.

Department of Agriculture. In addition, Sea Grant and partners provided assistance and training to Marshallberg Farm in Smyrna, resulting in the aquaculture producer anticipating the farm's output would double.

Sea Grant encourages scientists, coastal communities, commercial stakeholders and others to share ideas. One such project is helping sustain the horseshoe crab species through collaboration with a biomedical company to develop a novel process for combatting the health crisis stemming from antibiotic microbial resistance. Other partnerships first formed through Sea Grant projects have endured beyond the end of the research and result in businesses that bring revenue into the state's coastal communities. For instance, a Sea Grant-funded scientist and a commercial fisherman, who first met while working on a project on fisheries and habitats, later started the Sandbar Oyster Company. Today their operation has national and international attention for green-gill oysters, a specialty food, as well as for using their unique substrate in restoration projects.

Guiding the Efficient Use of Natural Resources: The biggest challenge facing many coastal cities and towns today is managing growth while protecting the health of the ecosystems on which they depend. NCSG has capitalized on our well-established role as a trusted broker across a wide range of interests to provide solutions for using land and water resources, generating energy, and simultaneously preserving environmental health and economic vitality. In alignment with the 2014-2017 Strategic Plan, we continually collaborated with local governments, state agencies, and community stakeholders, engaging and training decision makers to consider sustainability of ecosystems and a broad range of socioeconomic, planning, law and policy approaches. As inland and coastal waterways comprise interconnected ecosystems, this work has stretched across the state.

An integral component of conservation is the removal of marine debris, which mars coastal environments through habitat damage and other adverse effects. These threats include abandoned and derelict vessels, which damage aquatic and shoreline habitat. To address this issue in one of the fastest growing areas of the state, NCSG facilitated a stakeholder meeting on behalf of Brunswick County, which then adopted a new ordinance for managing these vessels.

Another key Sea Grant project identified tidal creek communities — which have had mushrooming development in recent years — as high-priority areas for sustainable landscape improvements. Because such efforts can mitigate adverse impacts from development, Sea Grant researchers surveyed residents along tidal creeks to inform ecologically minded landscape templates that planners and homeowners could use in tidal creek watersheds. Those results are among data highlighted as we established the Coastal Landscapes Initiative with university, agency, and

community stakeholders to convene a broader group invested in sustainable landscaping practices. The initiative has catalyzed partnerships and ignited work groups on projects designed to increase the use of native plants; increase and improve the number of sustainable demonstration gardens; and improve online access to information on sustainable coastal landscaping. As the program moves forward, the partners will be using the new edition of NCSG-funded *Seacoast Plants of the Carolinas*.

Often, our work has married research with real-world environmental demands, such as along the Chowan River and Albemarle Sound. Researchers worked closely with citizen scientists to address cyanobacteria blooms, which occurred with greater frequency and size and with recreational and economic impacts — as well as posing potential risks to human health and wildlife; researchers then presented their results to town officials in Edenton.

Through a wide array of projects, Sea Grant researchers and team members help local, regional, and state groups work together to address public health impacts from contaminants in stormwater runoff. This work has included a core research project that spurred establishment of the Mid-Atlantic Stormwater Stakeholder Group, which consists of local governments and state organizations from North Carolina, as well as representatives from Virginia. The group developed a 10-year vision for a cohesive stormwater management plan and leveraged support from the NOAA National Estuarine Research Reserve System to study the impacts of stormwater contamination in Taylor's Creek on the Rachel Carson Estuarine Research Reserve.

Studying stormwater discharge also requires improved mechanisms to fully understand contamination and its impacts, and NCSG-funded researchers actively engaged shellfish sanitary officials to develop better means of tracking discharge during storm periods; fully identify and recognize sources of contamination; and develop regional predictive models to protect public health.

On the local level, we have worked with coastal communities to address stormwater discharge. Researchers have studied a range of storms in Dare County and the Town of Wrightsville Beach to determine the relative impact of microbial contaminants along beaches and, in turn, to inform the development of new rapid tests for water-quality assessment. When town managers in Bogue Banks wanted to explore strategies to mitigate stormwater flooding, NCSG-funded researchers developed a pilot methodology for training citizen scientists to monitor groundwater levels; and tested the accuracy of their observations. Our researchers also have studied stormwater dynamics in Beaufort, Nags Head, and Pine Knoll Shores to better understand the relationships between microbial concentrations and environmental factors.

The impacts of stormwater require intervention in coastal

and inland ecosystems. Sea Grant has provided expertise to local communities across the state to help address varied water-quality concerns. Education efforts for teachers, staff, administrators, and students have reduced impacts from runoff in Wilmington. In Cary, Sea Grant led a project with teachers, administrators and facilities staff at Kingswood Elementary to plan and implement green infrastructure projects to provide outdoor learning opportunities for students, resulting in successful efforts to intercept and infiltrate runoff or improve infrastructure, reducing adverse effects to waterways.

A related project in Cary focused on improvements to the Black Creek Greenway, a popular greenway slated for widening and renovation. A workgroup of the citizen-based Black Creek Watershed Association, which includes the project engineer, conducted field visits to the greenway to identify potential areas for watershed improvement projects, including green stormwater infrastructure and streamside improvements. The team made recommendations to town officials, who planned to incorporate several suggestions, including planting trees on sparsely vegetated streamside areas, re-grading ditches that drain to the creek, and adding a wetland.

In the vulnerable Walnut Creek neighborhood in a historically African American community in Raleigh, a Sea Grant-led collaboration included focus groups and a pilot survey to identify long-term residents' views of environmental issues and surrounding natural resources. To help alleviate concerns about flooding, the project installed water-level gauges, collected data on hydrological conditions at the nearby Walnut Creek wetlands, and dovetailed their efforts with ongoing work from local citizens for improving environmental literacy, economic development, and environmental protection.

Our work on water quality has also informed the legal sphere. When the U.S. EPA and the N.C. Department of Environmental Quality embarked on a multi-year effort to develop and implement criteria to further reduce pollution in state waterways, Sea Grant and the N.C. Coastal Resources Law, Planning, and Policy Center completed a study to identify potential legal issues and summarized efforts in select states that had completed a similar process.

Additionally, because stream restoration is crucial for watershed management, we have continued a two-decade partnership with NC State's BAE to merge stream restoration science and training, evaluating ecological engineering and natural-resource restoration efforts. In the past year, this project has provided research-backed workshops and other instruction to over 200 professionals, graduate students, and undergraduates. The Sea Grant/BAE partnership also collaborated with a company to develop a new tool that has been instrumental in populating a database of more than 150 streams that the N.C. Division of Mitigation Services manages.

Our 2014-2017 Strategic Plan also included a charge to assess sustainable offshore industries and alternative sources of energy, including wind. Sea Grant's leadership on wind energy includes a review of the legal and policy implications of coastal wind energy development, as well as a governor-appointment for a specialist to serve on the Bureau of Ocean Energy Management – N.C. Offshore Renewable Energy Task Force. Sea Grant provided expertise on the appropriateness of areas for wind energy leases, which later led to the Bureau's release of a proposed wind lease sale and a request for interest for over 120,000 acres offshore. We also had a representative on the N.C. Wind Working Group. When the group needed a multi-state regulatory analysis, our law/policy center partnered with the N.C. Clean Energy Technology Center to conduct the analysis and draft a white paper.

In sum, through all manner of projects, NCSG has helped coastal citizens, community leaders, and industries recognize the complex inter-relationships among social, economic, and environmental values — as well as to work together to balance multiple uses and optimize environmental sustainability.

Hazard Resilience in Coastal Communities: Natural and human hazards place growing numbers of coastal residents and visitors at risk, with major implications for the economic and environmental health of coastal areas. In keeping with the 2014-2017 Strategic Plan, North Carolina Sea Grant's work not only has brought widespread understanding of the risks associated with living, working, and doing business along the nation's coasts, but it also has helped communities build the capacity to develop and demonstrate resilience in the face of all manner of hazards.

Flooding, for instance, remains a pervasive concern. Because small communities do not have the capacity to conduct modeling or analyses necessary to identify factors that exacerbate flooding — or to identify or evaluate potential flood mitigation measures — NCSG collaborates with municipalities in vulnerable areas. When eastern counties suffered tremendous impacts from riverine flooding associated with Hurricane Matthew, we partnered with NC State BAE to develop approaches for addressing flood mitigation in the Town of Windsor. This work now serves as a template for watershed and riverine modeling work, as well as for testing flood-mitigation strategies. Today, state emergency managers and transportation officials are applying this template to Neuse, Tar, and Lumber River basins.

Our community-level work on flooding pre-dates Matthew, including in Hyde County, where repeated flooding due to hurricanes and nor'easters has adversely impacted homes, businesses and crop production. Our partnership with Georgia Sea Grant and Stetson University performed a cost-benefit analysis of elevating structures throughout the county, and worked with stakeholders utilizing the

innovative “Vulnerability, Consequences and Adaptation Planning Scenario” (VCAPS). The project generated a video and widely distributed flood guide, a new partnership with The Nature Conservancy, and dissemination of emergency management messages in county newsletters.

The VCAPS process was also integral to our collaboration with the Town of Nags Head on the Outer Banks. When town leaders wanted to include sea level rise in their planning, several of our extension specialists provided innovative technical and planning assistance to address vulnerabilities. Here, the VCAPS process generated 167 actionable items, and the town became the first municipality in northeastern North Carolina to include sea level rise in its comprehensive plan. To date, 18 U.S. communities have used the VCAPS approach to address various vulnerabilities through resiliency planning projects. A member of our extension team is among the VCAPS co-creators and has provided training nationally, including with the Sea Grant Network.

Because vulnerable populations — such as the poor, elderly or disabled — are at much greater risk when disasters occur, we collaborated with partners in-state, as well as with the Virginia Coastal Policy Clinic and Virginia Sea Grant, to research equal protection law, environmental justice, and good government principles. In cooperation with the N.C. Coastal Resources Law, Planning and Policy Center, this project communicated results widely and across multiple audiences through briefing papers, presentations, an educational program, and a UNC-TV story on social vulnerability and resiliency planning.

To maximize public safety and preserve property, NCSG has developed predictive models and tools. This includes the Kalpana visualization tool, which converts storm-surge model results into formats compatible with GIS and Google Earth software. During the 2017 hurricane season, this helped inform emergency managers at all levels within the state. The new tool enhances usability of the Advanced Circulation Model, known as ADCIRC.

As sea levels rise and storm intensity increases, officials at state and local levels, as well as property owners, continue to look to Sea Grant to increase community resilience and address heightening concerns. Of particular note, our extension work and research on flood and wind insurance have resulted in N.C. property owners saving more than \$2 million annually on their policy premiums. Shoreline damage and erosion also remain pressing environmental management concerns, and to evaluate whether traditional methods of erosion protection meet expectations, a Sea Grant study investigated how different structures perform during major storm events and everyday wave action.

Lastly, but certainly not least, by collaborating to observe and forecast rip currents, NCSG also helps communities address the leading surf hazard for beachgoers. This work,

using drifters with GPS, has helped to improve local forecasting by NWS partners. Also, resulting data visualizations are part of ocean rescue training along our coast. Our in-house expert has been interviewed many times to help media explain the dangers of rip currents.

In these ways, across the entire site review reporting period, we have used research, training, and technical assistance to help local communities build capacity to address and respond to all types of hazards.

Sustainable Fisheries and Aquaculture

North Carolina waters provide seafood to consumers through the commercial fishing industry, a developing marine aquaculture sector, and recreational fishing, each of which must be responsive to social and environmental needs and changing expectations. In keeping with our 2014-2017 Strategic Plan, North Carolina Sea Grant has increased awareness and fostered entrepreneurialism, leadership, and optimal business strategies for seafood and marine aquaculture companies and other stakeholders. This included 635 fishermen, seafood processors and aquaculture industry personnel who modified their practices using knowledge gained in fisheries sustainability and seafood safety as a result of Sea Grant activities.

During the reporting period, our team consistently provided leadership on sustainable fisheries, aquaculture, and related topics. One of our fisheries specialists has served as president of the Tidewater Chapter of the American Fisheries Society and has co-chaired the South Atlantic Fisheries Management Council’s Citizen Science Projects/Management A-Team. He also has chaired the council’s Information and Education Advisory panel. Another fisheries specialist leadership also has taken several forms, including serving as vice chair of the SAFMC Citizen Science Program Volunteers Action Team, vice chair of the Advisory Council for N.C. Aquarium at Roanoke Island, and chair of the Awards and Scholarship Committee for the AFS Tidewater Chapter.

Our seafood safety and technologies specialist has led through roles on the board for Carteret Catch, on the executive committee of N.C. Local Foods Council. Our marine aquaculture specialist, chairs the Member and Industry Governance and Leadership Workgroup of the N.C. Shellfish Mariculture Plan Advisory Committee, and has been the Sea Grant lead for a committee to bring North Carolina into NOAA’s National Shellfish Initiative.

As noted in the PIER report, our research results have been circulated in many peer-reviewed journals, including: *Journal of Shellfish Research*, *Journal of the World Aquaculture Society*, *Fisheries Oceanography*, *Aquaculture*, and *Fisheries*.

Meeting the Demand for Safe Seafood: Ensuring a sustainable supply of safe seafood requires an

understanding of ecosystem-based fisheries management, complex issues related to developing the domestic aquaculture industry, and many other factors — including the clear need to ensure the safety and quality of seafood.

By educating local health inspectors on seafood handling and safety, NCSG provides assurances for consumers who buy from markets and restaurants. Our seafood specialist also works with seafood producers on their product safety planning.

Sea Grant has played key roles in support of shellfish aquaculture. Stakeholders and managers for the state's shellfish aquaculture industry — including the N.C. Shellfish Growers and the N.C. Division of Marine Fisheries — have lacked vital economic information to assess the growth and status of the industry, and training and educational opportunities on production practices have been scarce for potential shellfish farmers. In response, NCSG conducted a survey that will serve as the foundation for an annual *N.C. Shellfish Mariculture Industry Situation and Outlook Report*, a centralized source for industry development and trends.

In addition, when the N.C. General Assembly mandated that the N.C. Policy Collaboratory at UNC-Chapel Hill convene a working group of stakeholders to study and advance the shellfish aquaculture industry in the state, NCSG provided crucial information and expertise for the subsequent Shellfish Mariculture Advisory Committee. Of particular note were our researchers and specialists' contributions to raise awareness about the risks of human pathogenic vibrio — bacteria that can cause foodborne infection, usually associated with undercooked seafood. As a result, the state's *Shellfish Aquaculture Plan* included funding for a human pathogen scientist. This attention to health risks affords industry marketing efforts the luxury of noting the N.C. focus on seafood safety.

Sea Grant also provided an industry-level analysis when the Atlantic States Marine Fisheries Commission needed socioeconomic data to inform a menhaden fishery management plan. A team that included our economic specialist and N.C. researchers gathered economic data across the East Coast menhaden industry supply chain. The team also captured perspectives of representatives of menhaden fishmeal and oil processing industries. Consequently, the commission's menhaden management board increased the total allocation of menhaden, benefitting fishing communities along the Atlantic coast.

Fostering Stewardship and Successful Entrepreneurs: Our 2014-2017 Strategic Plan emphasized supporting a healthy domestic seafood industry that produces, processes, and markets seafood responsibly and efficiently. Accordingly, our work has focused on techniques that address bycatch and damage to marine habitats, development of value-added products, enhanced quality

assurance, education, and much more in order to involve harvesters, recreational fishermen, producers, and managers in responsible stewardship and successful entrepreneurialism. This also has included support and guidance on new technologies and other collaborative efforts to enhance the competitiveness of the state's businesses in global markets.

In particular, our funding has fueled NC State researchers' rearing of nine generations of domesticated striped bass for the National Program for Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry. By simplifying production and capitalizing on added value to the breeding program, the N.C. operation today produces 90% of the nation's hybrid striped bass fingerlings, assessed at \$50 million per year. Approximately \$12 million of the product stays in state, and consumers in the Raleigh-Durham area alone have enjoyed thousands of pounds of farm-raised striped bass. Researchers also have made the striped bass genome sequence available for public access and industry use, providing a blueprint for other important species. North Carolina and South Carolina Sea Grant programs partnered to translate and disseminate results more widely in the industry to improve management of farmed and wild striped bass.

In addition, because the availability and affordability of fingerlings for growout farming have been major constraints to the growth and development of the marine finfish aquaculture industry, NCSG researchers developed a project that live-hauled black sea bass fingerlings from nursery experiments to commercial fish farms in Virginia and North Carolina. The project demonstrated that fingerlings can survive when safely raised in high stocking densities that facilitate hatchery output and reduce overall costs for the industry's growers.

North Carolina also has a growing marine aquaculture industry that includes soft crabs, clams, oysters, and other species. When industry stakeholders and managers — including the N.C. Shellfish Growers Association and the N.C. Division of Marine Fisheries — identified a lack of educational and training opportunities for potential farmers, NCSG held regional shellfish aquaculture workshops on topics of interest to new and established producers. Over 160 attendees participated, and, with follow-up, six new businesses opened, generating two dozen new jobs.

More specifically, NCSG experts have informed and guided aquaculture businesses on new technologies, including two soft-crab businesses on using new recirculating aquaculture systems, both of which in turn produced significant numbers of soft crabs using the new systems. Additionally, because leasing a site to develop a shellfish aquaculture operation in North Carolina can be a long and complicated process, Sea Grant provided funding and expertise to develop a GIS-based online tool that offers siting data to potential shellfish growers. Some growers

already have used the new technology to successfully select sites and submit applications for shellfish growing leases. Also, several Sea Grant projects have analyzed gear in order to optimize harvesting or minimize bycatch. For instance, a collaborative team compared four oyster culture gear types and four regional oyster strains, as well as studying Sunray Venus clams, in order to guide producers in maximizing production efficiencies, profitability, and potential product diversification.

Likewise, when the 2014 amendment to the N.C. Shrimp Fishery Management Plan mandated that an industry work group identify and pilot test broad technological solutions for reducing shrimp trawl sea turtle bycatch, NCSG partnered with state, federal, and industry members to organize and lead development of testing on gear types, which in turn led to broad solutions and recommendations.

In collaboration with scientists and managers — including partners at the Virginia Aquarium and Marine Science Center, N.C. Wildlife Resource Commission, and NOAA Fisheries — Sea Grant assessed the health of sea turtles captured by recreational hook-and-line, determined best practices for handling and releasing these sea turtles, and explored methods to increase awareness about the issue among fishermen.

Our program provided other guidance on recreational fishing as well. Catch-and-release fishing is increasingly popular, but when anglers hook and quickly reel in deep-dwelling fishes, the catch often dies upon discard. Extension specialists from North Carolina, New Jersey, and Virginia Sea Grant programs partnered with Virginia Institute of Marine Science to design and test three descending device prototypes on approximately 200 fish, identifying a promising design capable of safely carrying multiple fish back to depth after capture. Outreach with anglers showed that 93% support charter captains using such a device.

Also, because the state is home to the second highest number of saltwater anglers, NCSG specialists partnered with the N.C. Division of Marine Fisheries to conduct a mail survey of coastal fishing license holders on a range of educational topics and education delivery methods. The survey generated key information about how to build an extension program specifically for saltwater anglers.

In sum, our work on multiple fronts over the last reporting period, in keeping with our 2014-2017 Strategic Plan, has involved spearheading collaborations with harvesters, recreational fishermen, producers, and managers to move the state substantially toward more responsible stewardship and successful entrepreneurialism.

Building a Broader Base of Informed Consumers: Our 2014-2017 Strategic Plan also placed an important emphasis on building the state's base of informed

consumers. Accordingly, our specialists and partners have developed educational projects related to seafood safety, quality, and security for a range of audiences. This work has helped to improve consumer understandings of the benefits and risks of identifying and eating fresh, locally caught, and/or responsibly managed fishery products. Consumers typically prefer convenience and local seafood over imports, but the state's fishers have struggled to capitalize on their competitive advantage over foreign competitors. As a result, Sea Grant helped increase visibility of local seafood through many approaches, such as a partnership with N.C. Cooperative Extension to assess demand for peeled-and-deveined shrimp among Raleigh consumers. Work with seafood processors included shrimp-peeling equipment that produces ready-to-cook product that chefs and consumers prefer. In addition, a collaboration to establish a Community Supported Fisheries program in Morehead City registered 250 people. Also, a partnership with Carteret Catch educated thousands about the seasonal availability and attributes of N.C. seafood.

We also explored consumer perceptions of contaminant risk in seafood. Recreational fishing provides inexpensive protein — yet also can pose a health risk — especially to residents in economically challenged counties. In collaboration with the Albemarle-Pamlico National Estuary Partnership, our program supported a research fellow to identify barriers to accessing local fish, as well as to evaluate knowledge and behavior with regard to fish consumption advisories. The study determined most respondents had inaccurate and incomplete information about various consumption advisories; furthermore, many lower-income residents were not users of the internet, the prime information source for advisories. As a result, the research fellow conducted outreach activities, including a printed flyer, a blog post for the website and a community meeting. A local paper also helped to spread the word by publishing her outreach information on health risks.

In addition, we funded a pilot project for a multifaceted, collaborative sea-to-school program in a coastal fishing community, partnering with Cape Hatteras Secondary School to test the feasibility of sourcing cape shark from local fishers. An instructor and students developed surveys, conducted sensory evaluations, analyzed results, and identified safety concerns. One of the project's hallmarks was its engagement of students and the larger community through taste tests and an associated cape shark interdisciplinary curriculum. The Sea Grant-funded team presented results both to the Dare County Board of Education and public consumers that revealed barriers and opportunities to make cape shark as a viable protein option for coastal schools and institutional food buyers.

Throughout the last reporting period, NCSG has provided key leadership and expertise in advancing public understanding of the nature of problems and opportunities associated with a healthy and sustainable seafood industry.

We anticipate that our signature blend of research, extension, and education will continue to support the kind of informed public and private decision-making that can lead to a sustainable supply of safe seafood long into the future.

SECTION E: RESPONSE TO PREVIOUS REVIEWS

The Site Review Team report from the September 2014 review of North Carolina Sea Grant, covering the period of performance from 2010-2013, resulted in no recommendations that required a formal program response. However, with declining state budget funds, the legislature in 2013 had eliminated the longstanding, successful Fishery Resource Grant program that NCSG had facilitated. Budget reductions also hit a shellfish and blue crab research program. Thus, the 2014 review panel offered a single suggestion, encouraging NCSG to work with university leaders and our advisory board toward restoration of state funds.

Although the funding environment within the state during this 2014-17 reporting period was not conducive to restoring funds for these purposes, NCSG was competitively awarded funding, through the Kenan Institute for Engineering, Technology and Science (KIETS) to develop and execute the new Community Collaborative Research Grant program, or CCRG. This funding opportunity couples the local knowledge of community stakeholders with academic experts to address priority coastal issues that align with Sea Grant goals. The CCRG premise grew from the FRG model that engaged fishing and academic communities in applied research. Although fisheries work has been eligible, the CCRG funding provided a broader set of overall goals from which N.C. communities could benefit.

The initial three-year grant funding for CCRG covered 2015-2018, with a total of \$360,000 from NCSG and KIETS. We recently received a fourth year of support from KIETS to expand CCRG. Although the funds are not included in the PIER report provided to the site review team (as these are not NOAA/Sea Grant funds, nor pass-thru), the CCRG program exemplifies our ability to leverage funding that expands and extends the impact of our mission in local communities and across our state.

The 2015 Performance Review Panel of North Carolina Sea Grant's productivity within the national focus areas provided an overall program rating of 2.01, indicating that NCSG "exceeds expectations by a substantial margin in some areas/aspects." There were no recommendations or findings to address from that performance review. Per a request from the National Sea Grant College Program, NCSG was pleased to provide a letter noting corrections, clarifications and a few constructive recommendations to consider for improvements in future reviewing efforts.

CONCLUSION: RESEARCH + APPLICATION = IMPACT

Building on our five decades of service to our state and beyond, North Carolina Sea Grant's work continued to evolve and expand during the most recent review period. In all four National Sea Grant focus areas, we have met challenges and opportunities, often serving as regional and national models. Our impacts and accomplishments, tools and products, metrics and measures reflect the comprehensive nature of our approach.

This signature blend of research, education, extension and communications has continued to fuel scientific progress: Innovative research and application of results combine to create significant impacts. In particular, our research enterprise is built upon support from varied sources such as NOAA, other federal and state agencies, and nonprofits.

Many of our impacts depend on expertise of our team and researchers, along with a continuing commitment to lead *and* partner with local, state, national, and international public and private groups on a wide array of projects. People across professional spheres and disciplines continue to seek us out for guidance and collaboration. In turn, our work has advanced science and enhanced — directly and indirectly — the lives of North Carolina residents and visitors of all backgrounds and socioeconomic strata.

As we built upon our network of partners and stakeholders, we have benefited from a symbiotic organizational structure with the Water Resources Research Institute, and now with N.C. Space Grant. The efficiency of this structure, along with our collaborative environment and innovative atmosphere, has created an additional and unique level of synergy among all three programs as we leverage funding, expertise, and experience.

Building on our legacy as a state leader, we also completed comprehensive strategic planning, revising our vision, goals, and objectives to provide an updated map for stewarding North Carolina's coastal resources and communities. Just as our work over the last reporting period built on many successes from our first five decades, our next 50 years will reflect our new vision and its implementation. As our new strategic plan notes:

OUR MISSION

Through integrated, unbiased research and outreach efforts, North Carolina Sea Grant enhances sustainable use and conservation of ocean, coastal and watershed resources to benefit communities, economies and ecosystems.

OUR VISION

North Carolina Sea Grant is a key leader in addressing the state's urgent and long-term needs in ocean, coastal and watershed resource management. The program shares sound science, develops educational excellence, and builds extensive and effective partnerships.