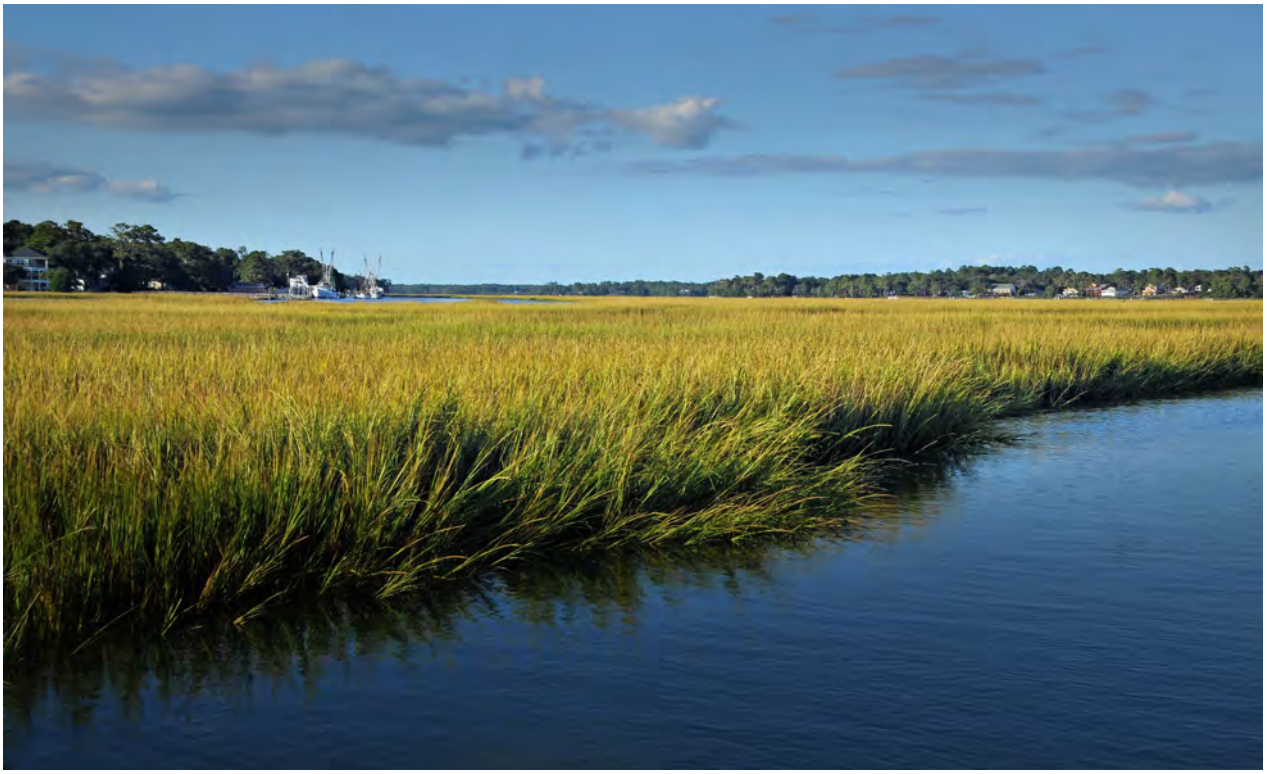
North Carolina Sea Grant Research Symposium:

Investments and Opportunities



Summary Report

April 16, 2014 Symposium

Issued July 2014

Executive Summary:

Report for 2014 North Carolina Sea Grant Research Symposium: Investments and Opportunities

Now in its fifth decade of service to the state, North Carolina Sea Grant provides research, education, and outreach opportunities relevant to North Carolina and its communities. With such a rich history of investments in the state, the *North Carolina Sea Grant Research Symposium: Investments and Opportunities*, hosted on April 16, 2014, highlighted examples of excellent research sponsored by N.C. Sea Grant over the last decade. The goals included:

- Assisting N.C. Sea Grant with identification of current and future strategic investment areas.
- Identifying partnership opportunities among researchers and resource managers.
- Highlighting strong integration across research disciplines and identifying new opportunities.

This one-day event focused on the four Sea Grant thematic areas of hazard resilience in coastal communities, sustainable coastal development, a safe and sustainable seafood supply, and healthy coastal ecosystems. To accomplish the goals and to create a symposium with broad appeal across the state, a Symposium Steering Committee was convened to work with N.C. Sea Grant staff to fine-tune the direction and execution of this one-day event. With members representing university marine science research programs and resource managers, the Steering Committee assisted with agenda development and helped to identify plenary and panel presenters. Based on the Steering Committee recommendations, the symposium included four panel sessions that followed the four Sea Grant thematic areas. Each panel session included three to four speakers who have made significant impacts or accomplishments at applying their research findings to management community concerns. The plenary speakers — University of North Carolina Vice President Chris Brown and Margaret Davidson, then acting director of the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management — set the stage by addressing respective state and national priority research needs for the coast, along with existing and potential roles for Sea Grant research and outreach.

Each thematic panel highlighted diverse research endeavors within the focus area and addressed multiple management concerns. After each suite of panel presentations, attendees and panelists participated in facilitated breakout groups to identify future research, extension, and applied science investment opportunities in that arena, along with collaborative partnerships to effectively address North Carolina's coastal needs now and into the future.

N.C. Sea Grant will remain engaged with symposium attendees and the broader Sea Grant community within North Carolina. The following next steps, based on attendee feedback and facilitated breakout group discussions, reflect those efforts:

- N.C. Sea Grant has committed to a one-time funding opportunity to move forward research projects based on topics or issues identified during the April 2014 symposium. A request for proposals (RFP) will allocate $40,000 for projects that cover one or more of the symposium theme areas: hazard resilience in coastal communities, sustainable coastal development, safe and sustainable seafood supply, and healthy coastal ecosystems. The RFP opportunity will encourage inter-institutional collaborations among university researchers, the management community, and other stakeholders. N.C. Sea Grant anticipates this RFP will be published by mid-Summer 2014.
- North Carolina Sea Grant anticipates convening future meetings throughout coastal North Carolina. These meetings could possibly highlight tools and technologies developed with Sea Grant funding, partnerships that have been created, and student research.

To learn more about the N.C. Sea Grant Research Symposium, please visit http://ncesagrant.ncsu.edu/ncsgday2014, where you can access the event's agenda, program, presentations, and posters. If you have additional feedback on the event or questions, please contact N.C. Sea Grant Deputy Director john Fear at jmfear@ncsu.edu, or 919-515-9104.

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List of Abbreviations

APNEP: Albemarle Pamlico National Estuary Partnership

AAAS: American Association for the Advancement of Science

BOEM: Bureau of Ocean Energy Management

EPA: U.S. Environmental Protection Agency

FEMA: Federal Emergency Management Agency

GSAA: Governors' South Atlantic Alliance

N.C.: North Carolina

NCDA: North Carolina Department of Agriculture & Consumer Services

NCCF: North Carolina Coastal Federation

NCDCM: North Carolina Division of Coastal Management

NCDENR: North Carolina Department of Environment and Natural Resources

NCDHHS: North Carolina Department of Health and Human Services

NCDMF: North Carolina Division of Marine Fisheries

NCDWR: North Carolina Division of Water Resources

NERRS: National Estuarine Research Reserve System

NIH: National Institutes of Health

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Administration

NOS: National Ocean Service

RFP: Request for Proposals

SALCC: South Atlantic Landscape Conservation Cooperative

UNC: University of North Carolina

Report for 2014 North Carolina Sea Grant Research Symposium: Investments and Opportunities

1.0 North Carolina Sea Grant Overview

North Carolina Sea Grant provides research, education and outreach opportunities relating to current issues affecting the North Carolina coast and its communities. Since 1970, N.C. Sea Grant has prided itself on being a valuable resource for scientists, educators, local officials, government agencies, coastal businesses and the public to access unbiased information — that is scientifically sound, useful, practical and relevant— about the state's coastal ecosystems.

Headquartered at North Carolina State University in Raleigh and with coastal offices in Manteo, Morehead City and Wilmington, North Carolina Sea Grant is an interinstitutional program within the University of North Carolina system. As part of the National Sea Grant College Program, N.C. Sea Grant receives funding from the National Oceanic and Atmospheric Administration (NOAA), within the U.S. Department of Commerce, as well from the State of North Carolina. Through this combination of federal and state dollars, N.C. Sea Grant facilitates university-based research to answer complex questions about the state's diverse coastal ecosystems and meet the needs of coastal communities. Initiatives and projects touch a broad range of topics, including fisheries, seafood science and technology, water quality, aquaculture, community development, law and policy, marine education and coastal hazards. This research fuels outreach and education programs that promote discovery, learning, new research, and awareness across the state and the nation.

2.0 N.C. Sea Grant Research Symposium: Investments and Opportunities

The North Carolina Sea Grant Research Symposium: Investments and Opportunities took place on April 16, 2014 at the McKimmon Center on the NC State campus in Raleigh. The event included 15 presentations by N.C. Sea Grant researchers from across the state, 20 student poster presentations and 137 attendees.

The purpose of the event was to highlight excellence across N.C. Sea Grant-sponsored research and extension efforts, while also facilitating stakeholder discussions. Additionally, the event provided the opportunity for N.C. Sea Grant researchers, staff, and stakeholders to identify research, extension, and applied science investment opportunities, and collaborative partnerships to effectively address North Carolina's coastal needs now and into the future. The goals of the symposium were to:

- Assist N.C. Sea Grant with identification of current and future strategic investment areas.
- Identify partnership opportunities among researchers and the management community.
- Highlight strong integration across research disciplines and identify new opportunities.

To accomplish these goals and to create a symposium with broad appeal across the state, N.C. Sea Grant convened a Symposium Steering Committee to fine-tune the direction and execution of this

one-day event. The committee was comprised of the marine and coastal sciences leads for a recent American Association for the Advancement of Science (AAAS) review from several UNC system campuses, as well as a representative from UNC General Administration and the North Carolina Division of Coastal Management (NCDCM). The Steering Committee formed in August 2013 and met monthly through March 2014 to plan the symposium. Jennifer Dorton served as the symposium coordinator and was responsible for overall coordination of the event. Steering Committee members and their affiliations are provided in Appendix A.

The Steering Committee determined that the highlighted research should follow the National Sea Grant Strategic Plan (2009-2013) and focus on the four thematic areas of hazard resilience in coastal communities, sustainable coastal development, a safe and sustainable seafood supply and healthy coastal ecosystems. The committee agreed that the interrelated focus areas are of critical importance to the health and vitality of the state's coastal resources and communities. The Steering Committee worked together to review N.C. Sea Grant-supported research conducted between 2002 and 2012, as this time period corresponds with recent National Sea Grant Omnibus time periods and the projects address relevant management concerns in the state and southeast region. The Steering Committee identified three to four speakers within each thematic area, choosing researchers who have made significant impacts or accomplishments at applying their research findings to management community concerns. Additionally, the Steering Committee provided guidance on the agenda design, meeting format, and inclusion of a student poster session. The symposium program, including the agenda, presentation abstracts and presenter biographies, and the poster abstracts, is in Appendix B. These items are also available on the event website: http://ncseagrant.ncsu.edu/ncsgday2014.

2.1 Summary of Plenary Speakers

N.C. Sea Grant Executive Director Susan White opened the symposium by welcoming attendees. University of North Carolina Vice President Chris Brown provided opening remarks, citing Sea Grant's role in fostering collaborative research among campuses, providing graduate and undergraduate student learning opportunities, and contributing to the economic growth of the state. Brown, who leads research and graduate education for the UNC system, highlighted the need to focus on coastal economies and the jobs that coastal counties provide in the fields of recreation, tourism, commercial and recreational fishing, aquaculture, and community development. Coupled with the economic opportunities are challenges that research institutions and management agencies must address. These challenges include environmental degradation (e.g. water quality, coastal erosion, fish stock declines), displacement of traditional communities and industries, and increased vulnerability to natural hazards. Thus, the UNC system and N.C. Sea Grant must support integrated research to generate results that the management community can consider when establishing policies regarding the coastal ecosystems and economies. He also cited N.C. Sea Grant as a leader in providing education and outreach opportunities that enable students and residents to be good stewards of the environment.

Margaret Davidson, then acting director of NOAA's Office of Ocean and Coastal Resource Management, provided an overview of the issues and opportunities that coastal states are facing. Approximately 52% of the nation's population lives in coastal watershed counties and coastal

communities support more than 51 million jobs. The increasing hazard risks to coastal communities require mitigation efforts at the property owner, local, and state levels to maintain the necessary infrastructure to support our coastal economies. State and local governments will need to be proactive in their approach to risk mitigation in order to plan for the future and homeowners need to be more aware of "who pays" for risky behaviors (e.g. building a house in the coastal environment). Davidson also noted the need for federal agencies to increase collaborations to address coastal hazards, noting a particular need to increase training and outreach for, and awareness of, the risks of living in the coastal environment. One product now available through NOAA is the Digital Coast website, at: http://csc.noaa.gov/digitalcoast. This portal provides access to coastal lidar, coastal economic data, navigation charts, tides and water levels. It also includes a sea-level rise and coastal-flooding impacts viewer. Davidson noted that state and federal agency roles are changing to include incentives for coastal homeowners, cities/towns, and counties to incorporate hazard adaptation strategies. There are opportunities for research to address four regional priorities: 1) hazards and coastal change; 2) ecosystem services/valuation; 3) green infrastructure; and 4) energy issues. This research should lead to applications that can be used by the management community to help make our economies and infrastructure more resilient.

3.0 Summary of Facilitated Discussions

The symposium format included panel presentations based on four thematic areas: hazard resilience in coastal communities, sustainable coastal development, a safe and sustainable seafood supply, and healthy coastal ecosystems. There were three to four speakers per panel and a facilitated breakout session followed each panel. There were five breakout groups with 25 to 30 people per group. Each breakout group was asked to identify management concerns and emerging research opportunities within each of the four thematic areas. Additionally, the breakout groups were asked to identify partnership opportunities for future research opportunities. These partners could participate on future research projects, or may help further define management concerns and research needs.

Each breakout group included representatives from academia, state and federal management communities, and other Sea Grant partners. The identified needs and possible partnership opportunities highlighted throughout the day, while not exhaustive, provided N.C. Sea Grant with baseline information that can inform future investment opportunities and highlight outreach needs within the UNC system and federal and state management communities. Sections 3.1 to 3.4 provide a summary of ideas and information captured during each breakout session. Appendix C provides notes from each breakout group, organized by session topic.

3.1 Hazard Resilience Breakout Session

Several common themes emerged from the five Hazard Resilience breakout groups. The following areas of management concern and research opportunities were identified:

- Increased public education/environmental literacy on resiliency and coastal hazards is needed. Participants also cited the need to define the term "resiliency" so that messaging is

consistent. The breakout groups identified a need for better communications strategies and the development of targeted communications materials for specific population groups, such as rural, urban, elderly and non-English speakers.

- Public infrastructure is at risk from coastal hazards (e.g. hurricanes, sea-level rise, saltwater intrusion). The groups identified needs to: 1) create a comprehensive database of our coastal infrastructure; 2) quantify the risk to infrastructure from each of these hazards; and 3) develop hazard-mitigation plans that include cost/benefit analyses to enable communities/counties to prioritize infrastructure upgrades and replacement in order to achieve resiliency within the system. Partners may include the Governors' South Atlantic Alliance (GSAA), academia, state agencies, and county government.
- Identify vulnerable populations (e.g. elderly, immigrants) within coastal communities. Several social vulnerability research opportunities were identified, including: 1) Incorporation of a social vulnerability index within hazard resilience projects. Partners may include the Federal Emergency Management Agency (FEMA), National Institutes of Health (NIH), state agencies, and county governments. 2) Environmental health disparity research for coastal populations. Partners may include the NIH and the North Carolina Department of Health and Human Services (NCDHHS).
- Increases in coastal populations have led to increased development pressure in the coastal counties. The expansion of the built environment has negatively impacted ecosystems and ecosystem resilience. There is an opportunity to work with state regulatory agencies, such as NCDCM, to identify mechanisms to support continued population growth while still maintaining environmental health and ecosystem services.

3.2 Sustainable Coastal Development Breakout Session

There were overlaps between the Sustainable Coastal Development and Hazard Resilience breakout sessions, with some participants even using the words resiliency and sustainability interchangeably. This highlights the need to better define resiliency and sustainability. Several common management concerns emerged among the breakout groups. However, in some cases, research opportunities and partnerships need to be further defined.

The following areas of management concern and research opportunities were identified during the breakout sessions:

- Living shorelines should be encouraged over shoreline armoring as a means to control erosion. Research opportunities associated with living shorelines includes cost/benefit analysis of living shorelines and armoring (e.g. bulkheads) for state agencies such as NCDCM and homeowners.
- Currently coastal development is based on plentiful funding for dredging, beach nourishment, etc. Coastal communities will need to reconsider their planning efforts as funding for these activities decreases. State and local leaders need to identify sustainable planning options, such as conservation development, including a better understanding of the number of people that can live in a certain area while still being able to maintain natural barriers/buffers (e.g. dunes, marsh). One example is RTI International's land-use

optimization for the Chesapeake watershed. This plan included economic and environmental benefits of green infrastructure. Research opportunities include cost/benefit analyses of development practices as well as cost/benefit analyses of established Best Management Practices. Partners may include academia, state agencies, county and/or city government, GSAA, and the U.S. Environmental Protection Agency (EPA).

- Offshore energy is emerging in North Carolina as a coastal concern. For wind energy and oil/gas energy production, there is a need to better understand the types of infrastructure and support systems required to bring the energy onshore. Additionally, potential impacts to the coastal environments should be noted. Partners include GSAA, Bureau of Ocean Energy Management (BOEM), U.S. Department of Energy, academia, and state agencies.

3.3 Safe and Sustainable Seafood Supply Breakout Session

The Safe and Sustainable Seafood Supply breakout sessions focused on many concerns expressed in recent years by the research and management communities. Water quality was a primary concern in each breakout group. Potential causes of degraded water quality include pathogen/contaminant loading, nutrient input from runoff, harmful algal blooms, and changes in water parameters based on climate change (e.g. increasing water temperatures, shifting salinity levels). Many North Carolina academic institutions, including Sea Grant, and state agencies, already are involved in water quality research, from watersheds, tidal creeks and estuaries, out to the coastal waters. Problems associated with degraded water quality include habitat loss, shellfish-harvest area closures, and bioaccumulation of contaminants in fish species (e.g. mercury). Increasing baseline water quality testing was identified as needed for the state, with potential research partnerships including academia, NCDENR, Albemarle-Pamlico National Estuary Partnership (APNEP), EPA and NOAA.

Additional areas of management concern and research opportunities listed below were identified during the breakout sessions:

- Many coastal areas have been closed to fishing and shellfishing due to water-quality concerns and/or habitat loss, with current management efforts not successful in restoring access to closed fishery areas. University researchers could work with local county governments; state agencies such as the North Carolina Division of Marine Fisheries (NCDMF) and the water quality programs in the North Carolina Division of Water Resources (NCDWR); and federal agencies such as EPA to review rules and enforcement and to determine if there is a way to restore closed areas.
- Fisheries stock assessments need to be improved over current methodologies. Novel stock assessment techniques are needed so that state officials do not rely solely on landing data and fish-monitoring programs. More accurate fish stock data is needed for ecosystem-based modeling and to improve current fishery models.
- Within North Carolina, tensions exist between commercial and recreational fishing communities. For example, tensions have increased in light of requests by recreational fishing leaders to enact legislative changes in commercial fishing regulations. The workgroups suggested that investments need to be made in fisheries research to better understand broad and specific impacts of commercial and recreational fish takes, and fish

kill rates. Partners in this research may include the South Atlantic Fishery Management Council, community-based Catch groups, NCDMF, organizations representing recreational fishing interests, and academia.

- Aquaculture policy, management, and research needs were identified across the breakout groups. Within the policy realm, participants expressed needs to: stimulate aquaculture production for finfish and shellfish; increase understanding of aquaculture at legislative and public levels; and open more lease areas for aquaculture production (known as public-bottom leasing and controlled by the state). On the management level, some participants suggested state officials determine whether the North Carolina Department of Agriculture and Consumer Services (NCDA) or NCDMF should lead aquaculture development in finfish and shellfish. Participants cited difficulties establishing shellfish aquaculture sites, as the existing permitting process through NCDMF is not streamlined. Overall, the groups cited a need for stakeholders and managers to work together to revise bottom leasing and aquaculture permitting processes. Finally, research is needed to quantify environmental impacts of finfish and shellfish aquaculture. Various partner organizations were listed for aquaculture including academia, NCDA, NCDMF, North Carolina Department of Commerce, and private partners from aquaculture industries.

3.4 Healthy Coastal Ecosystems Breakout Session

Concerns over water quality, similar to those expressed in the Safe and Sustainable Seafood Supply breakout, were reiterated during the Healthy Coastal Ecosystems breakout sessions. Research that includes quantification of the effects of excess nutrient loading on aquatic flora and fauna should be encouraged. Additionally, the participants noted a need for more outreach and education on how inland communities influence coastal environments. There may be opportunities to work more closely with the South Atlantic Landscape Conservation Cooperative (SALCC) to address some issues regarding habitat connectivity.

Other areas of management concern and research opportunities, cited below, were identified during the Healthy Coastal Ecosystem breakout sessions. Note that research opportunities and partners were not always identified for each of the management concerns.

- North Carolina needs to establish healthy coastal ecosystems baselines. Once a baseline is established, the state can then set goals for restoration efforts and determine if restoration efforts were successful.
- Oyster ecosystem services, or the economic and environmental value that oysters and their habitat provide to communities, should be evaluated for native and restored oyster reefs and oyster aquaculture systems. There is an opportunity to expand research to better explain the oyster's role in nutrient management. Projects could be done at specific scales so that information can be incorporated into spatial models that can then inform restoration efforts. Partners may include NOAA's National Marine Fisheries Service (NMFS), NOAA's National Ocean Service (NOS) for habitat mapping, academia, state agencies, and coastal nonprofits such as the North Carolina Coastal Federation (NCCF).

- Participants identified a need for more water-quality data. This need takes many forms. 1) More monitoring is needed in areas where there are few historic datasets, such as the Albemarle Sound. 2) Data sets need to be more publicly accessible in order to facilitate data discovery and sharing. Many datasets are housed within an academic institution or a state or federal agency that has not made them easily accessible to colleagues and the public. Symposium participants noted that many parties must commit to increasing the transfer of data in order for the research and management communities to understand the breadth and depth of data available. 3) Once additional water-quality monitoring data is available, such data must be incorporated into maps that include habitat types, characterizations, monitoring and water-quality. 4) Breakout group participants realized that limitations within the datasets currently available would require "Big Data" analytics to identify and understand connections and correlations among the existing data sets.
- Habitat conservation considerations were discussed in the Sustainable Coastal Development session, as well as the Healthy Coastal Ecosystems session. Two specific areas were highlighted. 1) Coastal communities need a certain amount of natural habitat to maintain ecosystem services and buffers. City/county managers and elected officials need additional support from a variety of partners to determine appropriate proportions of critical habitats to set aside. This would require quantification and prioritization of habitat types. 2) Growth and development across the state is occurring at a rate that surpasses the information that we have on land-based impacts to aquatic systems. There is a need to better understand the effects of land-based activities on aquatic habitats. Such research findings would then translate into better development and watershed-based planning. Partners that could support needs related to habitat conservation include organizations such as the NCCF, local governments, NCDENR, National Estuarine Research Reserve System (NERRS) Science Collaborative, SALCC, and academia.

N.C. Sea Grant and the Symposium Steering Committee anticipated common research themes would emerge within the breakout sessions. However, each session highlighted different research opportunities that N.C. Sea Grant could consider. Each focused discussion provided good perspectives and highlighted various research opportunities for consideration.

4.0 Sea Grant's Ongoing Leadership

N.C. Sea Grant administered a symposium evaluation and requested that attendees score the usefulness of the event and provide feedback for how such a program could be improved. The survey had a 52% response rate on the evaluation. The responses can be found in Appendix D. Within the survey, meeting participants listed opportunities for N.C. Sea Grant to share research and outreach materials. Among the opportunities listed by multiple respondents were:

- Conduct outreach within the community college system, UNC System, and minority-serving colleges and universities.

- Lead forums focused on priority issues to bring stakeholders together. These forums could focus on Sea Grant and non-Sea Grant priority issues. Additionally, these meetings should be hosted not only in Raleigh, but also in other areas of the state.
- Increase information-sharing methods or make current methods better known (e.g. create a listserv for the broader community, create a project library, highlight the online calendar of events, social media, host booths at public events such as the North Carolina State Fair, Farmers Markets, etc.).

Meeting participants also shared how the symposium could be improved. Many suggestions focused on agenda timing (e.g. more or less time in breakout discussions, more time for Question and Answer sessions, more time for posters). The overall suggestions will be considered when planning future events. Multiple respondents noted the following potential improvements:

- Create a symposium format that is tailored to increase dialogue among the research community and the management community/stakeholders.
- Include more topical experts in each breakout group to draw out more detailed information.
- Host more frequent events that target a specific issue or topic, and have resource managers as panelists to increase diversity of panel.

5.0 Next Steps

N.C. Sea Grant plans to remain engaged with symposium attendees and the broader Sea Grant community within North Carolina. The following next steps, based on attendee feedback and the facilitated breakout group discussions, are ways that N.C. Sea Grant plans to continue engagement.

5.1 Research Funding Opportunity

N.C. Sea Grant has committed to a one-time competitive funding opportunity for N.C. researchers to move forward research projects based on topics or issues identified during the symposium. This request for proposals (RFP) will allocate $40,000 for projects centered on the theme areas hazard resilience in coastal communities, sustainable coastal development, safe and sustainable seafood supply, and healthy coastal ecosystems. This RFP opportunity will encourage interinstitutional collaborations and inclusion of partnerships among university researchers, the management community and other interested parties, along with outreach and education efforts with identified partners. N.C. Sea Grant anticipates this RFP will be published by mid-Summer 2014.

5.2 Future Meetings

N.C. Sea Grant anticipates convening future meetings throughout coastal North Carolina. These meetings could highlight tools and technologies developed with Sea Grant funding, partnerships that have been created, and student research. Participants would include researchers, resource managers, state and local officials, community organizations, and stakeholders.

6.0 Closing

North Carolina Sea Grant thanks the Symposium Steering Committee for its combined efforts to make 2014 Research Symposium a reality. The committee members' diligence and feedback during the planning process was invaluable. N.C. Sea Grant also thanks all of the symposium presenters, students and attendees for sharing their thoughts and ideas on management concerns and future research opportunities that are important to coastal North Carolina. See Appendix E for a full list of symposium attendees.

To learn more about the N.C. Sea Grant Research Symposium, please visit http://ncseagrant.ncsu.edu/ncsgday2014, where you can access the event's agenda, program, presentations and posters. If you have additional feedback on the event or questions, please contact N.C. Sea Grant Deputy Director John Fear (jmfear@ncsu.edu).

Appendix A: Steering Committee for 2014 North Carolina Sea Grant Symposium

Daniel Baden, UNCW Center for Marine Science

Liz Baird, NC Museum of Natural Sciences and North Carolina Sea Grant Advisory Board

Courtney Thornton, UNC General Administration

Braxton Davis, NC Department of Environment and Natural Resources, Division of Coastal Management

Jennifer Dorton, UNCW Center for Marine Science

David Eggleston, NC State Center for Marine Sciences and Technology

David Griffith, ECU Institute for Coastal Science and Policy

Rick Luettich, UNC-CH Institute of Marine Sciences

Antonio Rodriguez, UNC-CH Institute of Marine Sciences

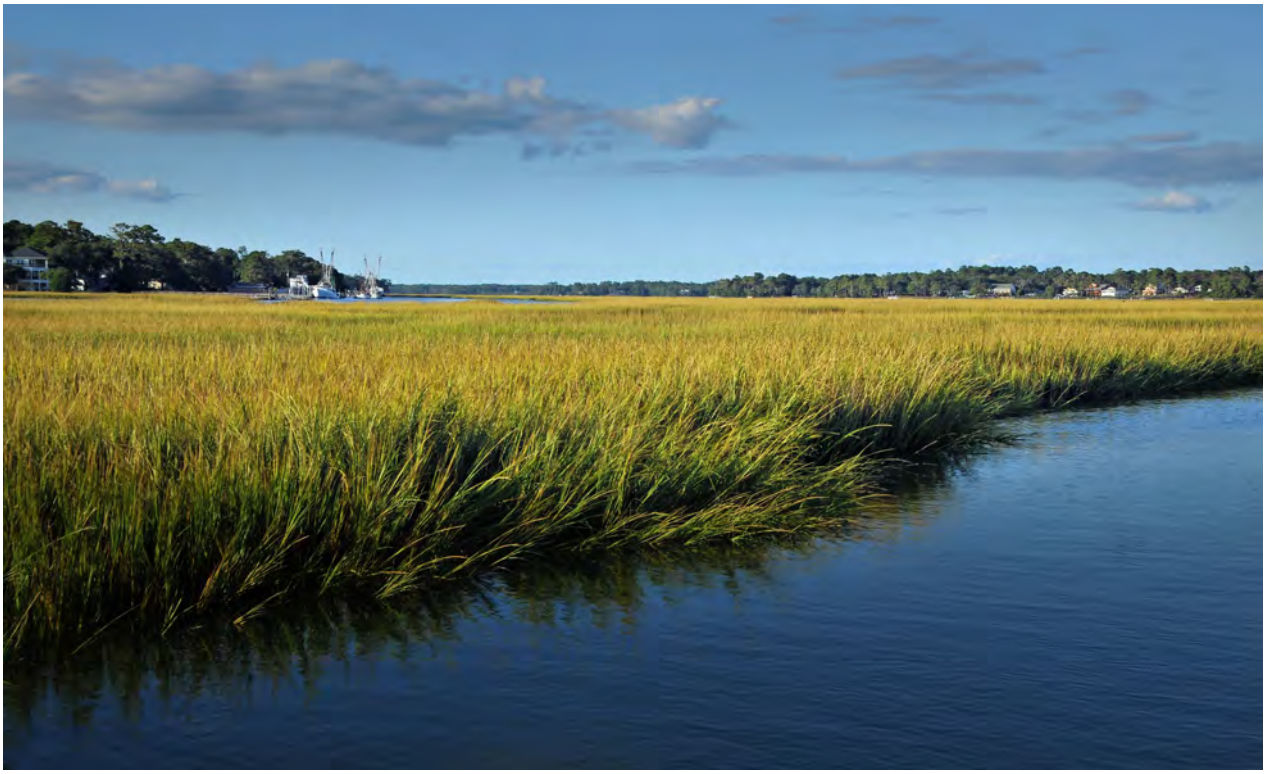
Nancy White, UNC Coastal Studies Institute

Susan White, North Carolina Sea Grant

Appendix B: 2014 North Carolina Sea Grant Research Symposium Program Booklet

North Carolina Sea Grant Research Symposium:

Investments and Opportunities



April 16, 2014

McKimmon Center

North Carolina State University

Raleigh, NC

North Carolina Sea Grant Investments and Opportunities

North Carolina Sea Grant's leaders and partners are immersed in impacts as they review the program's history and look ahead to its future.

"I have been here more than a year, and each week I am learning more about the strength of the investments the Sea Grant program has made in coastal science over the past four decades," notes Susan White, executive director.

"In business terms, we have a strong brand that is respected across the state. We have an amazing portfolio of research and outreach across a broad range of topics. Our challenge is to build on that success while also providing incentives for innovators to take bold steps."

White cites a multitude of partnerships, including with community leaders, internationally recognized experts, new faculty and resource managers making policy decisions. "They all will be key in helping us identify our path forward," she adds.

Sea Grant's value in North Carolina was cited in the 2013 review of all coastal and marine science programs in the state. Requested by the University of North Carolina system, the study was conducted by a team from the American Association for the Advancement of Science. White has continued to lead a committee looking to increase collaborations in marine sciences across the state.

Sharing Success Stories

As White and a committee of coastal experts from various universities developed plans for a North Carolina Sea Grant Research Symposium, the theme quickly emerged: *Investments and Opportunities*.

"I am excited to see this new collaborative initiative by North Carolina Sea Grant," notes Chris Brown, UNC system vice president for research and graduate education.

"It's increasingly important to engage an array of stakeholders — including researchers, government officials on all levels, business owners and residents — to identify and leverage expertise and resources to address these strategically. Such discussions will move North Carolina coastal and marine research and outreach programming forward to address emerging issues."

The event highlights outcomes from core projects over the past 10 years. Each agenda segment will provide snapshots of results that are being used by resource managers, community leaders and/or property owners.

"The audience is there to participate. Each focus-area discussion could start with how the particular results can be shared with additional partners," notes Jennifer Dorton, symposium coordinator.

"From there, we can move to additional current and emerging problems and potential solutions. These sessions will provide inspiration and focus for future research," she adds.

Moving Forward

John Fear, Sea Grant's deputy director, says the day will show how research projects link seamlessly to the organization's outreach to varied groups.

Fear is especially interested in the graduate students working with expert mentors. "I look for these students to seek out — and at times create — new tools for data gathering and analysis, as well as to find new ways to communicate results. These future leaders reflect generations that grew up with online resources and connections," he explains.

"Also, these days, nearly all research projects are interdisciplinary, because so many tackle problems from many perspectives at the same time."

Presentations from the symposium will be posted online for follow-up discussions.

"We had a difficult time selecting topics just from the core projects, but we will be offering a wonderful spectrum of biological, physical and social sciences, as well as communications studies that traditionally may have been placed in the humanities," White adds.

Future gatherings could focus on minigrants, North Carolina Sea Grant's nationally recognized seed-funding opportunities that often provide proofs of concepts that can be expanded through major grants from other agencies. Other success stories include state and federally funded programs supporting cooperative fisheries research.

Adapted from Coastwatch*, Spring 2014*

Agenda
Wednesday, April 16, 2014

8:00	**Check-in**
8:20 – 8:30	**Welcome** Susan White, Executive Director, North Carolina Sea Grant
8:30 – 8:40	**Opening Remarks** Chris Brown, Vice President for Research and Graduate Education, University of North Carolina System
8:40 – 9:15	**Opening Plenary** Margaret Davidson, Acting Director, National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management
9:20 – 10:30	**Session 1 — Hazard Resilience in Coastal Communities** • Catherine Smith and Donna Kain, East Carolina University • Scott Hippensteel, University of North Carolina Charlotte • Jessica Whitehead, North Carolina Sea Grant
10:30	**Break**
10:40 – 12:00	**Session 2 — Sustainable Coastal Development** • Lisa Campbell, Duke University • Antonio Rodriguez, University of North Carolina - Chapel Hill • Craig Landry, East Carolina University • Huili Hao, East Carolina University
12:00 – 1:30	**Lunch *(provided by NC Sea Grant)* and Poster Session**
1:30 – 2:50	**Session 3 — Safe and Sustainable Seafood Supply** • Jeffrey Buckel, North Carolina State University • David Eggleston, North Carolina State University • Craig Sullivan, North Carolina State University • Scott Baker, North Carolina Sea Grant
2:50	**Break**
3:00 – 4:25	**Session 4 — Healthy Coastal Ecosystems** • Hans Paerl, University of North Carolina - Chapel Hill • Michael Piehler, UNC Chapel Hill/UNC Coastal Studies Institute • Troy Alphin, University of North Carolina Wilmington • Larry Cahoon, University of North Carolina Wilmington
4:25 – 4:40	**Group Discussions**
4:40 – 5:00	**Future Planning**
5:00	**Adjourn**

Opening Session Speakers

Susan N. White
Executive Director, North Carolina Sea Grant and
the Water Resources Research Institute of the University of North Carolina System
Susan White leads two inter-institutional UNC System programs based at NC State University that provide targeted research, outreach, and education projects to address critical water and coastal resource issues in the state and region. Previously, she was the director of the National Oceanic and Atmospheric Administration's Hollings Marine Laboratory in Charleston, S.C. There she provided research vision and organizational management, including strategic planning with the partner agencies and universities. She also served as national research coordinator for NOAA's Estuarine Reserves Division and National Estuarine Research Reserve System.

Chris Brown
Vice President for Research and Graduate Education, University of North Carolina System
Chris Brown promotes research, sponsored programs, and graduate education across the full spectrum of academic disciplines and interdisciplinary activities carried out by UNC's 16 university campuses. He helps advocate for increased levels of external support from federal, state, and private sources and works closely with UNC General Administration staff and campus administration to support a culture of innovation and entrepreneurship, and to develop research and sponsored-program agendas that are supportive of the mission of each. He previously served as associate vice chancellor for research development at NC State, where he was a professor of plant biology.

Margaret Davidson
Acting Director, National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management
Longtime director of the NOAA Coastal Services Center, Margaret A. Davidson joined NOAA in 1996 after 12 years as executive director of the South Carolina Sea Grant Consortium. She served as the acting assistant administrator for NOAA's National Ocean Service from 2000 to 2002 and previously served as special counsel and assistant attorney general for the Louisiana Department of Justice. An attorney active in coastal resource management issues since 1978, she holds a faculty appointment at the University of Charleston and serves on the adjunct faculties of Clemson University and the University of South Carolina. She has served on numerous local, state, and federal committees and has provided leadership for national professional societies. She has focused her professional work on environmentally sustainable aquaculture, mitigation of coastal hazards, and impacts of climate variability on coastal resources.

Presentation Abstracts
Session 1 – Hazard Resilience in Coastal Communities

Reception and Use of Hurricane Risk and Hazard Information

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To assess or to improve hazard resilience in coastal communities, we need to understand risk perceptions and the efficacy of warning communications. Results of the 2008-2011 NOAA-North Carolina Sea Grant supported study "Risk Perceptions and Communication Effectiveness in Coastal Zones" in 20 coastal counties show that residents (sample 1079) as well as businesses/organizations (sample 603) differ in how they 'pull' warning messages to decide on their own response, as well as how they 'push' warning information in social and cultural networks to assist others.

Findings, reports, and selected presentations from this study are accessible at our Risk Communication website (www.ecu.edu/riskcomm). Publications are available from the authors Catherine Smith, Donna Kain and Kenneth Wilson.

About the Speakers:
Catherine F. Smith is Emerita Professor of English/Technical and Professional Communication, East Carolina University. She is the author of Writing Public Policy: A Practical Guide to Communicating in the Policymaking Process, 4th edition forthcoming 2015 (Oxford University Press). She was principal investigator (with co-PIs Donna J. Kain and Kenneth Wilson) of the 2008-2011 NOAA-Sea Grant North Carolina study of hurricane risk and hazard communications. Results of that study are presented at this symposium. Additionally, she was co-investigator (with principal investigators Kenneth Galluppi, Jessica Losego, and Burrell Montz) of the 2009-2011 NOAA-NWS-RENCI (UNC) studies of the use of National Weather Service products and services for decision-making by North Carolina emergency managers, hospital and school administrators, utility companies, and other support functions during winter and tropical storm emergencies. Since retiring from ECU in 2012, she focuses on public affairs and environmental interests. She contributes public comments in federal rule-making, participates in local government as a concerned citizen, and writes funding applications for community groups in Orange County, North Carolina, and Centre County, Pennsylvania. She lives primarily on an old farm (http://chicorylane.com) where she is active in wildlife habitat preservation, conservation ecology, native plant inventory, historical land-use research, and public environmental education.

Donna Kain is an Associate Professor of Rhetoric, Writing, and Professional Communication in the English Department of East Carolina University. She teaches courses including technical communication, writing for business and industry, and risk communication. Her research includes risk communication and natural hazards including severe weather and sea level rise and related public policies, visual information, and new media. Related positions have included Director of Outreach and Communication for the ECU Renaissance Computing Institute (RENCI) Engagement Center and affiliate faculty in the Center for Natural Hazard Research and the Center for Sustainable Tourism at ECU. Kain is currently the Editor of Technical Communication Quarterly, the journal of the Association of Teachers of Technical Writing.

Paleotempestology of Onslow Bay, North Carolina

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As coastal populations continue to grow, and as recent Gulf Coast and New England hurricanes dramatically demonstrated, there is a need for better understanding of storm frequency. The paucity of historical records for hurricane landfalls along the southern Atlantic coast limits their use as a predictive tool. Whereas historical records of hurricanes along the Atlantic coast are limited to the past 300 years, and reliable instrumental records extend back only half that length of time, proxy records taken from coastal sedimentary archives offer the potential to extend this record several thousand years, offering better statistical constraints on hurricane prediction. Paleotempestology is the study of ancient hurricanes. Two primary proxies have been the most studied during the last decade: sedimentary criteria and microfossils. During hurricanes, sand and microfossils are eroded from shallow marine environments and deposited by storm surge across backbarrier marshes. Eventually these sand layers are reburied by the marsh and may be preserved for millennia in the backbarrier strata.

In this North Carolina Sea Grant-funded study, Hippensteel used a microfossil-based proxy — displaced marine foraminifers — to investigate a 1,500-year paleostorm record of Onslow Bay, North Carolina. He also compared marsh sediments and foraminifers pre- and post-Hurricane *Irene*, which made landfall in Onslow Bay on August 27, 2011. He found fewer hurricanes archived in the 1,500 years of backbarrier marsh deposits than have made landfall in Onslow Bay since 1950. This absence of preserved hurricane deposits, as well as the lack of a definitive signature from Hurricane Irene, suggests caution in respect to the sensitivity of sedimentological or micropaleontological proxies in paleotempestology studies. He concludes that, at best, only direct strikes from intense storms are being preserved. It is likely Hurricane Irene's landfall will not be detectable in the future in the marginal-marine sediments from this region.

To share findings with other geologists, climatologists, and the general public, the research team submitted manuscripts to high-impact journals with different audiences. One was published in December 2013 as the cover article for *GSA Today*[1], the highest circulation journal in all of the earth sciences. The findings were presented at the Geological Society of America's annual meeting in Charlotte, North Carolina. A second manuscript is in press with the *Journal of Coastal Research*[2],

[1]Hippensteel, S., Eastin, M., and Garcia, W. 2013. The geologic legacy of Hurricane Irene: Implications for the fidelity of the paleo-storm record. *GSA Today*, v. 23, n. 10, p. 4-10.
[2]Hippensteel, S.P., and Garcia, W.J., (in press), Micropaleontological evidence of prehistoric hurricane strikes from southeastern North Carolina, *Journal of Coastal Research*

About the Speaker: Scott P. Hippensteel is an Associate Professor of Earth Sciences at the University of North Carolina Charlotte where he teaches environmental geology, paleontology, and coastal geology. He graduated from the University of Delaware in 2000 with a Ph.D. in Geology. His research interests include using microfossils to solve environmental problems, such as quantifying Late-Holocene sea-level rise and documenting ancient hurricane strikes along the Atlantic coast. The research he most enjoys involves Civil War geoarchaeology and the Confederate submarine *H.L. Hunley*, where his micropaleontological analysis provided new insights into both the sinking and sediment infilling history of the boat and the eventual fate of the crew.

Preparing Plymouth, North Carolina for Future Flood Risks

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Co-Authors: Gloria Putnam, North Carolina Sea Grant and Michele Covi, Old Dominion University/Virginia Sea Grant

North Carolina's coastal communities are already exposed to weather and climate hazards like flooding and hurricanes. This exposure may increase as rainfall becomes more variable and sea levels rise. Simultaneously, many communities are becoming more sensitive to damage from these hazards as critical infrastructure ages and economies change. In 2010, the Town of Plymouth, North Carolina, asked for North Carolina Sea Grant's assistance to begin exploring how changing environmental conditions may impact their community, with a particular focus on the town's already aging infrastructure. With funding from NOAA Sea Grant and the NOAA Sectoral Applications Research Program, North Carolina Sea Grant coordinated the plan of work with the town manager and mayor, as well as East Carolina University's Renaissance Computing Institute (RENCI) and the Social and Environmental Research Institute (SERI), to conduct interviews and a participatory adaptation assessment using the Vulnerability, Consequences, and Adaptation Scenarios (VCAPS) process (Putnam et al 2012). Interviews with 18 local leaders were conducted in 2010 to identify their concerns about how a changing environment may impact Plymouth and to identify areas that are currently prone to flooding from stormwater runoff or rising water levels on the Roanoke. In 2011, town leaders worked with the research team to implement the VCAPS process, allowing them to further explore their concerns and identify strategies with regards to how localized flooding could impact the town's stormwater and wastewater collection and treatment systems.

During the interview, local leaders reported noticing changes in shoreline erosion, localized flooding, stormwater management, drainage systems, saltwater intrusion to the river, drought, sea level rise, weather patterns, groundwater quantity and quality, river flow, wetlands and marshes, and other infrastructure (roads, buildings, and water and sewer facilities). Primary issues of concern centered on addressing current and future challenges associated with the wastewater treatment plant collection system, reducing localized flooding, improving the local economy, protecting and utilizing local natural resources, and providing amenities for and retaining youth within the community.

The team used the VCAPS process to further examine stormwater management and impacts to wastewater infrastructure further. Using a process rooted in the causal structure of hazards, during a VCAPS exercise a group of local decision-makers convenes for a facilitated discussion about a management issue. In real time, the facilitation team captures this discussion in a diagram that reflects the group's collective expertise on the stressors, consequences, and possible solutions. Through the VCAPS process, Plymouth leaders were able to identify many of the outcomes of the town's increased flooding risks and some general strategies to address them. Consequences of concern included fish kills, worsening inflow and infiltration, and flooded sewer pump stations and treatment facilities. However, many of the adaptation options identified depend on Plymouth's ability to get future grant funding to repair and move vulnerable infrastructure. The conditions of such grant funding often limit its use for preventive measures that build resilience. This lack of funding continues to provide Plymouth with barriers to implementing adaptive measures that reduce flood vulnerability.

Putnam, G., J. Whitehead, J. Thigpen, M. Covi, and S. Tuler, 2012. Facing the Future in Plymouth, NC: Preparing for Increased Flooding Risks. North Carolina Sea Grant Publication # UNC-SG-12-05. http://www.ncseagrant.org/images/stories/ncsg_pdf/documents/products/reports/facing_the_future_in_plymouth_nc_12-05.pdf

About the Speaker: Jessica Whitehead is the Coastal Communities Hazards Adaptation Specialist for North Carolina Sea Grant. Previously, she worked in North Carolina and South Carolina as the regional climate extension specialist for the South Carolina Sea Grant Consortium, North Carolina Sea Grant, and Carolina's Integrated Sciences and Assessments program at the University of South Carolina. She assists coastal users with integrating information about coastal hazards into their decision-making processes. Her work ranges from giving talks on coastal weather and climate hazards to community groups to working with scientists to develop decision-support tools for weather and climate hazards risk and adaptation. Whitehead holds a Ph.D. in Geography from Pennsylvania State University, where her dissertation focused on building scenarios of small drinking water utilities' capacities to adapt to climate change. She also holds a master's in Meteorology from Pennsylvania State University and a bachelor's in Physics from the College of Charleston.

Presentation Abstracts
Session 2 – Sustainable Coastal Development

Change in Coastal Communities: Perspectives from Down East

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From 2008-2010, a group of researchers at Duke University conducted research to better understand the perspectives of residents and landowners in Down East, Carteret County, North Carolina, on changing economies, cultures, and environments. Data were collected through door-to-door and mail surveys, in-depth interviews that were also used in a documentary film, and county tax records. Results were discussed at a series of community meetings, with a focus on identifying possible responses by communities to both perceived problems and possibilities. Although results are interesting for what they illustrate about areas of common and different concern among respondents (see Boucquey et al. 2012; Campbell et al. 2009; Voices of Down East at http://communityvoicemethod.org/change-in-coastal-communities/), in this presentation, we highlight how the project and its results have been translated into a number of other projects and initiatives designed to improve the economic, environmental, and social well-being of communities Down East, as well as on Ocracoke and Hatteras islands.

Boucquey, N., L.M. Campbell, G. Cumming, Z.A. Meletis, C. Norwood, and J. Stoll, 2012. Interpreting Amenities, Envisioning the Future: Common Ground and Conflict in North Carolina's Rural Coastal Communities. *Geojournal* 77: 83-101.

Campbell, L.M., N. Boucquey, G. Cumming, C. Norwood, Z. Meletis, and J. Stoll. (2009) Summary of Survey Results: Change in Coastal Communities: Perspectives from Down East. Retrieved from http://www.ml.duke.edu/coastalcommunities/Survey%20Results,%20Coastal%20Communities.pdf

About the Speaker: Lisa Campbell's research focuses on policies and projects designed to reconcile resource conservation with socio-economic development. She studies the process of policy-making, the transition from policy to practice, and the impacts of (and responses to) implementation at the local level. At the policy-making stage, she examines how the interaction of science and other values, and how negotiations between stakeholders (local people, bilateral agencies, NGOs, and 'experts') inform the process. Specific policies include participatory development, community-based conservation, sustainable use, and ecotourism. A major research focus of her work has been on marine turtle conservation policy, and its implementation in Latin America and the Caribbean. More recently, she has studied rural change in communities in eastern North Carolina and works with community partners to envision and implement responses to such change.

Examining the Geospatial Linkage between Modern Erosional Hotspots and Holocene Progradation and the Implications for Predicting Future Shoreline Positions along the Outer Banks, North Carolina

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Co-Authors: Greg Rudolph, Carteret County Shore Protection Office, and Christopher Freeman, Geodynamics, LLC

This research project was aimed at examining possible linkages between along-shore variability in barrier-island evolution over millennial time scales, the locations of underlying paleochannels that intersect barriers and variability in shoreline retreat rates over decadal time scales. The study area was Bogue Banks, the southernmost barrier of the Outer Banks island chain. The island contains areas of high-elevation beach ridges, large island widths, and stratigraphy consistent with regressive barrier islands. These regressive-island segments are separated by a broad and narrow section of the island devoid of any transgressive or regressive morphologic elements. The analyses of seismic data from the inner continental shelf reveal paleo-channels intersect the wider sections of the island, while the narrow central part of the island occupies an inter-fluvial area. Reworking of fluvial sediment from paleo-channels was an important sediment source for the barrier during regression. Transects of cores, seismic data, ground-penetrating radar data, and radiocarbon and OSL dates show that prior to ~1500 cal yr. BP the central narrow section of the island was wide and regressive similar to adjacent areas. Back-barrier erosion of the central part of the barrier primarily caused island narrowing as a result of increased storminess, which occurred around the Medieval Warm Period (~1100 cal yr. BP). The presence of historical inlets along the narrow central section of the island indicates Bogue Banks may be nearing a critical width threshold and will subsequently transition to a transgressive barrier. Maps from the study were used by managers and coastal engineering firms to locate nearshore sand resources.

Proxies, such as changes in beach profiles and shoreline positions, are commonly used in management and research for estimating changes in subaerial beach volume; however, the accuracy of these proxies across increasing time scales and complex morphologies is unclear. Management decisions and research results may be adversely influenced by inaccurate depictions of beach volume change that were based on a proxy that is not well suited to that particular beach morphology or time frame of interest. This study assessed the impacts of morphologic variations, associated with beach cusps and nourishment material, on volume change estimates from profiles and shoreline change at 0.5 to 3.5 year time periods. Results indicate that profiles spaced $\geq$ 150 m apart and the shoreline-change proxy will likely estimate volume change inaccurately over periods $\leq$ 1 year at beaches that are consistently eroding or accreting and contain cusps. However, over longer time periods (1–3.5 years), estimates of volume change from both proxies improved at those types of beaches. Results from these studies were communicated to decision makers by publishing in peer-reviewed journals, giving public stakeholder presentations, and most importantly, having a beach manager and coastal-engineering business owner directly involved with the project.

About the Speaker: Antonio Rodriguez grew up in Connecticut playing and working on Long Island Sound, and those experiences inspired his interest in coastal geology. He graduated from Hamilton College (Clinton, NY) in 1994 with a bachelor's degree in geology and Rice University in May 1999 with a Ph.D. in geology and geophysics. He stayed at Rice for the next year as a Postdoctoral Research Associate (from May 1999 to January 2000) and as a Lecturer (from January to July 2000). In August

2000, he accepted a job at the University of Alabama, Department of Geological Sciences as an Assistant Professor. There, he pursued research mainly looking at the evolution of estuaries in response to changes in sea level and climate over the last 9,000 years across the northern Gulf of Mexico. He left the University of Alabama in August, 2005 as a College of Arts and Sciences Leadership Board Faculty Fellow, and the George Lindahl Fellow. He is currently an Associate Professor at the University of North Carolina at Chapel Hill's Institute of Marine Sciences and Department of Marine Sciences. While his research emphasis is still on estuarine evolution, most of his work now takes place in the middle Atlantic coast. He also collaborates with many of his colleagues at UNC-CH examining anthropogenic and climate impacts on the ecogeomorphology of marsh, oyster-reef, and beach environments.

Economic Values of Coastal Erosion Management

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Co-Author: John C. Whitehead, Appalachian State University

North Carolina currently faces many problems related to the management of its beaches. Problems stemming from coastal erosion, storms, and sea-level rise are exacerbated by development along the coast and, especially, by development at the water's edge. Potential solutions include shoreline hardening, beach replenishment and coastal retreat. The project employs a survey of North Carolina households to estimate the benefits and costs of beach erosion management alternatives. The survey gathers data on use (and non-use) of North Carolina's coastal beaches, perceptions of coastal resource quality, and knowledge of coastal processes. We collect information on recreational visitation under current and hypothetical future conditions in order to assess the effects of coastal erosion and erosion management policies on tourism in the coastal zone. We use contingent valuation to assess households' willingness to pay for different approaches to shoreline erosion management. Our survey design also permits assessment of the economic costs of negative environmental impacts.

We contracted with Online Sampling Solutions, Inc. to access an eRewards online panel of 1,005 North Carolina households, receiving a 61% response rate. Comparing our descriptive statistics to data from the U.S. Census, we find our sample is comparable in terms of gender and household size, but our respondents tend to be slightly more educated and wealthier than the average North Carolina household. Our results indicate that shoreline retreat receives a larger proportion of support (71.3% indicating 'support' or 'highly support' on a 5-point Likert scale) relative to beach nourishemtn (67.2% support) and shoreline armoring (58.1%). We estimate recreation demand regression models in order to assess the effects of travel costs, management regimes, beach width, and environmental impacts on the intensity of visitation. Projected visitation is roughly the same (about 3 trips per year) under beach replenishment, but increases (by approximately 0.5 trips on average) under shoreline retreat management approach. The shoreline-armoring scenario reduced average trips to 2.25 per year. Negative environmental impacts reduce the number of trips for each scenario: to about 2 trips per year under beach nourishment, 1.75 trips per year under shoreline armoring, and 2.5 trips per year under shoreline retreat. Annual consumer surplus (the net value that visitors accrue over-and-above the expenditures they incur with visiting) is around $450 per household per year. Consumer surplus is roughly the same under beach nourishment, somewhat

larger under shoreline retreat ($560 per household per year), and smallest under shoreline armoring ($344 per household per year).

Turning to the contingent valuation data, we assessed North Carolina household willingness to pay for coastal erosion control using a simulated referendum, where the payment vehicle was an increase in state income taxes (coupled with an additional property tax assessment on beach houses). The average household was willing to pay an additional $18.84 for beach replenishment (only $8.77 if it entials negative environmental effects), $9.20 for shoreline armoring ($6.40 with negative environmental effects), and $23.41 for shoreline retreat ($17.88 with negative environmental effects).

About the Speaker: Craig Landry received bachelor's and master's degrees in Environmental Economics and Natural Resource Management from the University of Georgia in 1996 and 1998, respectively. He earned a Ph.D. in Natural Resource Economics from The University of Maryland, College Park in 2004. His research has been funded by the National Science Foundation, Bureau of Ocean Energy Management, National Oceanic & Atmospheric Administration, the North Carolina Energy Center, and North Carolina Sea Grant. External grant projects have focused on determinants of disaster migration and preference for rebuilding New Orleans in the wake of Hurricane Katrina, the impacts of coastal wind farms on recreation and tourism, economic impacts and value of the North Carolina for-hire recreational fishing fleet, individual risk perceptions and behavior in the context of tropical storms, and economic values for coastal erosion management. Landry has served as an Ad Hoc scientific peer reviewer on over 130 scholarly papers and research proposals and is current Associate Editor for Marine Resource Economics, The Natural Hazards Review, Ag & Applied Economics, and Journal of Ocean & Coastal Economics. Landry has over 30 peer-reviewed publications on various topics including individual decision-making in the context of natural hazards risk, recreation demand, econometrics of non-market valuation, hedonic property price models, community hazard mitigation, and experimental analysis of individual charitable giving. His current research projects include an analysis of amenity and structural capitalization in coastal property rental and sales markets, assessing individual preferences for multi-hazard insurance coverage, understanding the relationship between beach quality and coastal property values, and assessing economic costs of beach erosion management.

Tourism Impacts and Second Home Development in Coastal Counties (Brunswick, Currituck and Pender): A Sustainable Approach

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Co-Author: Patrick Long, East Carolina University

The coastal tourism economy and coastal tourism products are based upon a fragile environment, a declining water-based culture, and a history of suffering from neglect. As more and more people come to the coastal area for economic and recreational opportunities, stakeholders have come to realize the importance of managing growth while protecting social, environmental and economic resources and values. A clear understanding of the level of support for sustainable tourism development is a critical step for effective planning and management. Population growth and second home development in the past two

decades have accelerated demand for natural resources, land-use change management, coastal housing and service provision. Issues associated with economic trends and population migration, such as second home development, investment in community infrastructure, and services for second-home owners and tourists, have created additional pressure for coastal resource management.

The goal of our research was to improve the ability of coastal communities to plan more effectively for long-term sustainable development in tourism and create information on which they can ultimately balance "profit with preservation". This research provided information to stakeholders regarding the attitudes of homeowners, both full time residents and second-home owners, of the impacts of tourism and second home development, identified the importance of sustainable actions to the county's long-term economic health, as well as determined the manner and extent that climate impacts resident and second home properties and recreational decisions. It was also undertaken to explore research questions that contribute to the broader understanding of how communities, rich in natural amenities, might adjust to the many changes and pressures brought about by tourism and second home development.

Written reports were prepared for all stakeholder groups who advised the study, and followed up with face-to-face presentations to each county planner, Tourism Development Authority director, and Convention and Visitor Bureau director. The reports and PowerPoint presentation on the findings of this research have also been made available on the Center for Sustainability website (http: www.sustainabletourism.org). In order to understand how local decision-makers use information provided by this study in their planning decisions, we conducted a follow-up study that assessed municipal and county planning staff opinions about how their respective planning board might use the study findings. Eight out of the 13 interview participants responded that their board would like to use the study. This study has since advised us in three current master's theses, one on climate and weather effects on tourism business decision-making in coastal counties, one on the effects of maritime history on coastal county tourism development, and one investigating the investment value of the second homes in coastal North Carolina. To date, we have affected scholarship in the topic area of sustainable tourism in coastal destinations through 12 conference presentations and three journal articles and others in progress.

Hao, Huili, Patrick Long and Scott Curtis (2012). "Attitudes of Property Owners to Climate Change Considerations and Their Effects on Future Property Values in Coastal Communities". Journal of Risk Analysis and Crisis Response, Vol. 2 (4), pp 285-291.

Patrick Long and Huili Hao (2012) "Property Owners Attitudes of the Effects of Tourism and Second Home Development on the Future Economic Stability in Coastal Counties". Research Papers of the Transit Chair in Tourism, Special Edition, Montreal, Canada.

Hao, Huili and Patrick Long (2012). "Assessing Place Attachment Among Permanent and Second Home Property Owners In a Tourism Dependent Coastal County." Travel and Tourism Research Association 43rd International Annual Conference Proceedings.

About the Speaker: Huili Hao is on faculty at the Center for Sustainability: Tourism, Natural Resources and the Built Environment, East Carolina University. Her research interests include the impacts of second home and tourism development, sustainability, community sense of place, and sustainable brownfield redevelopment. Hao is also interested in applying Geographic Information Science and spatial techniques to her research projects.

Presentation Abstracts
Session 3 – Safe and Sustainable Seafood Supply

Estimation of Mortality and Selectivity of Red Drum with High Rates of Catch and Release

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Co-Authors: Nathan M. Bacheler, NOAA National Marine Fisheries Service; Lee M. Paramore, N. C. Division of Marine Fisheries; Joseph E. Hightower and Kenneth H. Pollock, North Carolina State University

Red drum *Sciaenops ocellatus* support commercial and recreational fisheries in North Carolina, but the stock was overfished in the 1980s. Stock status is difficult to assess in red drum because of migration to ocean waters, prohibited harvest of older fish, and relative importance of catch and release. Prior assessments relied on landings data and lacked information on selectivity of caught-and-released fish. Furthermore, natural mortality rates were indirectly estimated with no empirical information. We conducted a conventional and telemetry tag study and analyzed historical tagging data from the N.C. Division of Marine Fisheries to estimate fishing mortality, natural mortality, selectivity, and movement patterns. We found that regulation changes were successful in having a dramatic reduction in fishing mortality. Selectivity of harvested fish was generally dome-shaped and shifted toward larger, older fish in response to regulation changes. Selectivity of caught-and-released red drum was highest on the youngest and smallest fish in the 1980s and 1990s, but increased on larger, legal-sized fish in the 2000s. Within a year, there was a strong seasonal pattern to monthly fishing mortality rate estimates from both conventional and telemetry tags. Highest fishing mortality occurred in fall months and lowest levels occurred during winter. Although monthly fishing mortality values were similar in pattern and magnitude between conventional tagging and telemetry, information on fishing mortality in the combined conventional and telemetry tag model came primarily from conventional tags. The estimated natural mortality rate in the combined model was low and based primarily upon the telemetry approach. Tag return locations confirmed the assumption of a separate northern stock of red drum. Findings from our work were relied upon heavily in the 2009 coastwide stock assessment of red drum and patterns in fishing mortality and spatial patterns in movement can be used for spatial and temporal management.

Bacheler, N.M., L.M. Paramore, J.A. Buckel, and F.S. Scharf. 2008. Recruitment of juvenile red drum in North Carolina: spatiotemporal patterns of year-class strength and validation of a seine survey. N. Am. J. Fish. Mgmt. 28:1086-1098.

Bacheler, N.M., J.E. Hightower, L.M. Paramore, J.A. Buckel, and K.H. Pollock. 2008. Changes in fishing mortality and selectivity of North Carolina red drum due to fishery regulations: estimates from an age-dependent tag return model. Trans. Am. Fish. Soc 137:1422-1432.

Bacheler, N.M., L.M. Paramore, J.A. Buckel, and J.E. Hightower. 2009. Abiotic and biotic factors influence the habitat use of an estuarine fish. Mar. Ecol. Prog. Ser. 377:263-277.

Bacheler, N.M., L.M. Paramore, S.M. Burdick, J.A. Buckel, and J.E. Hightower. 2009. Variation in movement patterns of red drum inferred from conventional tagging and ultrasonic telemetry. Fish. Bull. 107:405-419.

Bacheler, N.M., J.A. Buckel, J.E. Hightower, L.M. Paramore, and K.H. Pollock. 2009. A combined telemetry – tag return approach to estimate fishing and natural mortality rates of an estuarine fish. Can. J. Fish. Aquat. Sci. 66: 1230-1244.

Bacheler, N.M., J.E. Hightower, S.M. Burdick, L.M. Paramore, J.A. Buckel, and K.H. Pollock. 2010. Using generalized linear models to estimate selectivity from short-term recoveries of tagged red drum *Sciaenops ocellatus*: effects of gear, fate, and regulation period. Fish. Res. 102: 266-275.

About the Speaker: Jeff Buckel is currently a Professor in the Department of Applied Ecology at NC State University. His laboratory uses a combination of traditional and novel field and analytical approaches to address research questions related to the assessment of finfish populations and their habitat. Current projects include: estimating fishing and natural mortality in spotted seatrout, weakfish, and southern flounder; assessing habitat impacts on fish movement and demographic rates in tidal and non-tidal creeks; identifying important predator-prey linkages in North Carolina estuaries; and estimating discard mortality and gear selectivity in reef fishes. Buckel serves on the N.C. Marine Fisheries Commission's finfish advisory committee and the South Atlantic Fisheries Management Council's science and statistical committee.

Metapopulation Dynamics Guides Oyster Restoration in Pamlico Sound

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Concepts such as (i) metapopulation and source/sink dynamics, (ii) marine protected areas (MPAs) and (iii) functional equivalency are powerful tools for guiding habitat restoration and conservation in marine systems. Metapopulations consist of spatially separated sub-populations that are often connected by larval dispersal or animal movement. Some "source" sub-populations may contribute disproportionately to the overall metapopulation and some "sink" sub-populations may only persist due to immigration from sources. No-take, marine protected areas often preserve the size-at-age structure of populations, which can enhance reproductive output and subsequent spillover of larvae to downstream fished populations. Restored habitats are often assessed in terms of whether or not their demographic rates, as well as ecosystem functions and services, are equivalent to natural habitats or populations. We applied these concepts to a large-scale oyster restoration program in Pamlico Sound being conducted by the N.C. Division of Marine Fisheries (NC DMF).

NC DMF constructed 10 no-take broodstock reserves in Pamlico Sound with the main goal being to establish a self-sustaining network that would also provide spillover of larvae to fished oyster populations. We applied a complementary suite of field measurements and experiments, as well as modeling tools, to determine that: (i) demographic rates (e.g., density, growth, survival, fecundity) of oysters in restored reefs was equal to or greater than natural reefs that have been protected in other estuaries such as Chesapeake Bay, (ii) certain reserves serve as population sources, (iii) the network of

reserves, however, was not self-sustaining, yet oyster densities increased nearly 400% at 8 of 10 reserves over 4 years, (iv) the network of reserves is likely supplemented by larval supply from fished oyster reefs, (v) the optimal locations for future oyster restoration are in the NE and SW portions of Pamlico Sound, and (vi) restored oyster reefs harbored more unique species of finfish than unstructured bottom, thereby enhancing the overall diversity of estuarine fish assemblages.

This study provides (i) information on how best to manage, restore and conserve an ecologically and economically important species, and (ii) a blueprint for creating a network of sustainable reserves that subsequently support oyster harvest through larval subsidies to harvested areas. This information has been applied by NC DMF and the U.S Army Corps of Engineers in (i) siting additional oyster reserves, (ii) planning the location of future reserves, and (iii) considering substrate materials for restoration. Future work will provide an estimate of the role of fished sub-tidal and inter-tidal reefs to the overall larval pool that is sustaining oyster populations in reserves, as well as examine how to combine oyster restoration practices (reserves and cultch-planting) to increase oyster metapopulation growth rate in Pamlico Sound. The research framework in this study can be applied to restoration and conservation of a broad range of marine species and habitats.

Haase, A., D. Eggleston, R. Luettich, R. Weaver, B. Puckett. (2012). Estuarine circulation and predicted oyster larval dispersal among a network of reserves. Estuarine, Coastal & Shelf Science 101:33-43.

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Dunn, R., D. Eggleston, N. Lindquist. (in review). Cliona boring sponge preferentially infests oyster shells over alternate reef substrates, but does not affect early-life demographic rates of eastern oyster (Crassostrea virginica). Estuaries and Coasts.

Puckett, B. and D. Eggleston. (in review). Metapopulation dynamics and the design of a marine reserve network. Ecological Applications.

About the Speaker: David Eggleston is a marine ecologist with an interest in testing ecological theory in marine systems in a manner that can be applied to the management and conservation of species, habitats, and ecosystems. He has applied (i) predator prey theory to better understand the impact of predatory crabs on their bivalve prey, (ii) optimization models to predict ontogenetic habitat shifts in coral reef fish, (iii) metapopulation and source/sink theory to guide oyster restoration and understand population connectivity of deep-sea benthic communities, and (iv) soundscape ecology to understand the role of sound on larval biology, as well as sound diversity as an indicator of habitat quality. He also pioneered work on the grow-out of blue crabs in freshwater systems for aquaculture. Eggleston earned his bachelor's degree in biology from Old Dominion University, master's and Ph.D. degrees in marine science from The College of William and Mary, and was a post-doctoral research scholar at the College of Ocean and Fishery

Sciences, University of Washington. His has published more than 100 peer-reviewed research articles, logged over 3,000 hours as a scientific research scuba diver, and has trained over 35 graduate students and post-doctoral scholars. Eggleston is a National Science Foundation Early Career Awardee, a member of the North Carolina Academy of Outstanding Teachers, Outstanding Extension Service Awardee at NC State University, and serves on the advisory boards for local, regional, national and international organizations and research teams. He is currently a Professor of Marine Science in the Department of Marine, Earth & Atmospheric Sciences at NC State University. He also serves as Director of NC State University's marine laboratory in Morehead City, known as the Center for Marine Sciences and Technology, or CMAST.

Hybrid Striped Bass Farming: Sea Grant Fosters a New Aquaculture Industry for North Carolina and the Nation

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In the late 1980s, North Carolina Sea Grant supported evaluations of hybrid striped bass (HSB), a cross between striped bass (SB) and white bass (WB), as a potentially profitable cultivar on farms in eastern North Carolina. The fish were initially produced by Lee Brothers, a young farmer from Aurora, in a couple of 3-acre ponds dug on row-crop land. For the project, Brothers partnered with Ron Hodson, a highly experienced aquaculturist working at Sea Grant, and the next year Craig Sullivan joined the team after being hired by the NC State University Zoology Department as a fish reproduction expert. Over the next 25 years, this team and other Sea Grant researchers addressed most challenges faced by the nascent industry, as HSB production grew into a major form of fish farming in North Carolina, eventually rivaling rainbow trout production in North Carolina and spreading nationwide. Advances were made in engineering, water quality management, veterinary medicine, fish nutrition, and reproductive physiology. This presentation focuses on mastery of the reproductive biology of HSB and its parents.

In the early days, most HSB were produced from female SB, but farmers had limited access to females mature enough to reproduce because capturing fish from the spawning grounds was prohibited. Sullivan and Hodson developed a special hormone implant that made it possible to reproduce the less mature females available from commercial pound nets downstream. They went on to pioneer reproduction of fish adapted to or reared in captivity for several years. Detailed characterizations of the reproductive cycles of the species were undertaken, including discovery of major hormones and proteins controlling maturation. The new knowledge yielded clinical measures of maturity that empowered the researchers to identify environmental conditions under which the fish could be reproduced most successfully. All the while, the NCSU scientists obtained wild fish from most known natural stocks and interbred them, founding genetically diverse broodstocks that have been domesticated and subjected to intense selection over many generations. Domesticated NCSU SB are more than twice the size of wild fish of the same age. These animals are foundation stock for the National Program for Genetic Improvement and Selective Breeding

for the Hybrid Striped Bass Industry, a unique consortium of government and university scientists and fish farmers that the NCSU researchers were instrumental in founding.

Recent efforts in HSB breeding have been directed at accelerating gains from selective breeding of its parent species through application of state-of-the-art methods in molecular genetics, such as DNA marker-assisted selection. The striped bass is now one of a handful of species belonging to the National Aquaculture Genome Project. Its genome has been mapped using a certain type of DNA (microsatellite) marker, and a preliminary assembly of the complete sequence of the SB genome is under construction.

North Carolina Sea Grant provided key support for all of these developments in HSB farming and the HSB story epitomizes the Sea Grant focus on basic research that transits into societally important applications, which are extended to stakeholders and the general public.

About the Author: Craig Sullivan is widely regarded as the premier scientific expert on reproduction and selective breeding of the striped bass and its relatives (genus *Moronidae*), having developed most of the procedures employed to domesticate and breed these species in captivity. He established at North Carolina State University the foundation stocks of the U.S. National Program of Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry (National Breeding Program), and he selectively bred these stocks for over 30 years at NC State's Pamlico Aquaculture Field Laboratory. Sullivan is founder and coordinator of the Striped Bass National Breeding Program, and he has served since its inception as the Striped Bass Species Representative to the U.S. National Aquaculture Genome Project. He is recognized internationally as a leading researcher in the scientific fields of fish reproductive physiology and breeding in aquaculture, having authored over 170 scientific publications in leading peer-reviewed journals of these disciplines. For these achievements, he was named William Neal Reynolds Distinguished Professor of Biology at North Carolina State University in 2005 and was elected as a Fellow of the American Association of the Advancement of Science (AAAS) in 2010. These honors recognized him for excellence in research, scientific outreach to the aquaculture industry, and education. Sullivan retired from the NC State faculty in 2013 and is presently President and CEO of Carolina AquaGyn, a contract research and consulting company operating in the general field of fish reproductive biology with emphases on physiology, genomics, genetics and selective breeding, including assisted reproduction technologies. He is presently continuing his 30 years of Sea Grant research in a project on black sea bass in South Carolina.

Adding Value to the North Carolina Seafood Industry through Use of Collaborative Partnerships

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Commercial fishing is an integral part of North Carolina's heritage and coastal economy, contributing $122M in total economic impacts and more than 3,500 jobs in 2012. Historically, the state's fishermen satisfied a strong demand along the East Coast for fresh, seasonal seafood. Since 1995, less expensive imports have taken a significant market share from domestic processors. Operational costs, regulation, and particularly the rise in seafood imports have further stressed the fishing industry. As such, many

businesses have struggled to remain profitable. Product safety and local food movements, however, are impelling people to buy more domestic seafood — and directly from fishermen when possible. To adapt to this change, local seafood businesses must become consumer-focused. Companies must discern consumer needs and product trends to compete in the new global economy. Over the last decade, North Carolina Sea Grant has initiated positive change within the seafood industry by working collaboratively with a diverse array of partners to source and deliver objective information. This presentation will focus on the impacts and outcomes of three projects that were positively enhanced by Sea Grant involvement: (1) development of the first Community Support Fishery program, (2) development and delivery of direct marketing technical training to shrimp fishermen in North Carolina and beyond, and (3) development of individual county and state umbrella "Local Catch" community organizations.

About the Speaker: Scott Baker has been a fisheries specialist with North Carolina Sea Grant since 2003. In his position, Baker helps the commercial and recreational fishing communities understand and apply the latest in fisheries management, research and technology. Some of his latest activities have included pilot testing electronic monitoring and reporting approaches for recreational and commercial fisheries, providing technical training to shrimp fishermen in the Gulf and South Atlantic as part of federal trade adjustment assistance program and organizing the Third Annual North Carolina Catch Summit in February 2014 in Southport. Current activities include developing a webinar series to replace the N.C. Marine Recreational Fisheries Forum, partnering with N.C. Division of Marine Fisheries to educate commercial fishermen about fisheries observing, and reviewing what seems to be an endless number of research proposals from state and federal fisheries research programs. Originally from Washington, N.C., Baker holds a master's in oceanography and coastal sciences from Louisiana State University and a bachelor's in biology from the University of North Carolina at Chapel Hill. Prior to joining Sea Grant, Baker worked as a research associate at Louisiana State University and as a biological science technician for NOAA Fisheries in Panama City, Fla.

Presentation Abstracts
Session 4 – Healthy Coastal Ecosystems

Assessing Human and Climatically Driven Changes of North Carolina Estuarine Water and Habitat Quality: Management and Decision-Support Applications

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Nutrient over-enrichment and resultant eutrophication is a pervasive problem in the estuaries comprising the United States' second largest estuarine system, the Albemarle-Pamlico Estuarine System (APES). These microtidal, poorly flushed estuaries are highly efficient in transforming nutrients into primary (phytoplankton) and secondary (i.e., shellfish and finfish) production, sustaining highly valued fisheries resources. There is a fine line, however, between adequate fertility and nutrient over-fertilization that leads to harmful algal blooms, hypoxia, and fish kills. Compounding this problem is climatic variability and change, including an increase in tropical Atlantic cyclones and record droughts, which modulates eutrophication by influencing the delivery, retention, and cycling of nutrients. Our North Carolina Sea Grant-supported projects focused on improving our understanding of the interactive roles of human nutrient enrichment and freshwater discharge in the eutrophication dynamics of the APES with a focus on the Neuse River, a primary tributary estuary. A long-term UNC-CH and North Carolina Department of Environment and Natural Resources (NC DENR) collaborative monitoring program, ModMon (www.unc.edu/ims/neuse/modmon/), and a novel, ferry-based autonomous monitoring program, FerryMon (www.ferrymon.org), served as platforms for investigating the causes, consequences, and controls of eutrophication.

Nutrient addition bioassays identified nitrogen (N) as the key nutrient mediating eutrophication in the Neuse River Estuary. This information was used to develop a U.S. Environmental Protection Agency (EPA) and NC DENR mandated Total Maximum Daily Load (TMDL) for N, the nutrient management tool aimed at reducing algal biomass and improving water-quality conditions in the NRE. Using pigments as measures of algal biomass (i.e. chlorophyll a for total algal biomass), our intensive, collaborative monitoring programs allow the State (NC DENR) to better assess when and where "acceptable" levels of algal biomass are exceeded. Pigment-based indicators developed for identifying and quantifying algal groups forming harmful blooms are now used for early detection and quantification of blooms throughout the NRE and Pamlico Sound, providing a means for the State, EPA, and NOAA to link nutrient inputs and climatic events to bloom formation and establish links between such blooms and fish kills. This provides managers with tools to more effectively develop long-term, nutrient-management strategies aimed at mitigating eutrophication. Pigment-based indicators have also been used for calibrating aircraft and satellite-based remotely sensed imagery of the Albemarle-Pamlico Sound System and nearby coastal waters, enabling State (NC DENR) and federal agencies (NASA, EPA, NOAA) to "scale up" quantification of algal biomass and detection of blooms at larger ecosystem and regional levels.

These projects have: 1) clarified the linkage between human and climatic drivers and eutrophication in this ecologically/economically important system, and 2) provided indicators and supported platforms to better assess conditions and trends in water and habitat quality for developing adaptive nutrient management strategies in a more climatically extreme world.

About the Author: Hans W. Paerl is Kenan Professor of Marine and Environmental Sciences at the University of North Carolina – Chapel Hill's Institute of Marine Sciences. His research addresses microbially mediated nutrient cycling and primary production dynamics, environmental controls and management of harmful algal blooms, and assessing effects of human and climatic alterations of water quality and sustainability of inland and coastal waters. He has published over 250 peer-reviewed articles and book chapters on these subjects. He received the 2003 G. Evelyn Hutchinson Award from the Association of the Sciences of Limnology and Oceanography, and the 2001 Odum Award from the Coastal and Estuarine Research Federation for addressing the causes, consequences and controls of eutrophication in aquatic ecosystems.

Ecosystem Engineers Contribute to Maintaining Water Quality in Coastal Ecosystems

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Controlling eutrophication and improving estuarine water quality are priorities for many government and non-government organizations. An agreed upon solution is to control loading of nutrients (particularly nitrogen), thus reducing excesses in phytoplankton production. Restoration of estuarine ecosystem engineers, such as marsh grass, oysters and sea grass, could potentially ameliorate eutrophication by removing or retaining nutrients. The goal of this project was to determine if ecosystem engineers increase nitrogen removal and contribute to enhancing levels of water quality. We were especially interested in understanding how ecosystem engineers alter estuarine nitrogen cycling.

This research involved a combination of field measurements, laboratory experiments, and mesocosm manipulations to determine whether and how ecosystem engineers enhance water quality in eastern North Carolina estuaries. Initial field observations assessed the mechanisms by which oysters, sea grass and marsh grass modify biogeochemical exchanges between the sediment and water column through regeneration and removal of nutrients. In mesocosm experiments, nutrient concentrations were manipulated to determine how variation in nutrient availability alters ecosystem engineer-mediated nitrogen cycling. Additional field experiments were conducted on one ecosystem engineer, the eastern oyster, to determine the contribution of oyster structure and biotic activity to modification of nitrogen cycling, and to assess the role that landscape position plays in determining oyster impacts on nitrogen cycling.

We found that salt marshes, oyster reefs and seagrass beds all had elevated levels of denitrification relative to unstructured subtidal and intertidal flat habitats. Oyster reefs had among the highest rates of

denitrification. Manipulative experiments found oyster reef structure alone enhanced denitrification, but that maximum enhancement of denitrification occurred when both the structure and biotic process of filtration were present. Landscape was found to affect the degree to which oyster reefs modified denitrification. Reefs on flats away from other structured habitats resulted in the largest increase in denitrification.

Our improved understanding of the interactions between biogeochemistry and ecosystem engineers has informed efforts to model the interactions between estuarine habitats and water quality. Additionally, this information has been conveyed to government and non-government organizations conducting estuarine restoration with water-quality improvement goals.

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About the Speaker: Michael Piehler was born and raised in Pittsburgh, Pennsylvania,where through the collapse of the steel industry in the 1980s, he experienced first-hand the complex relationship between human activities and aquatic ecosystems. After completing his undergraduate degree in biology, he worked as an environmental consultant in Washington, D.C. Following that, he received a master's of science degree in public health and a Ph.D. in environmental sciences and engineering from UNC Chapel Hill. He holds a dual appointment as an Associate Professor at the UNC-Chapel Hill Institute of Marine Sciences in Morehead City, N.C. and as Head of the Program in Estuarine Ecology and Human Health at the UNC Coastal Studies Institute in Wanchese, N. C. Additionally, he is Director of Graduate Studies for the Curriculum for the Environment and Ecology at UNC-Chapel Hill. His research focuses on material transport and processing at the coastal land-water interface. He has conducted work on a broad range of microbial systems, including benthic microalgae, epiphytic microalgae, phytoplankton, benthic bacteria and bacterioplankton. His research is funded by the National Science Foundation, the U.S. Environmental Protection Agency, the National Oceanographic and Atmospheric Administration, the Strategic Environmental Research and Development Program and North Carolina Sea Grant. Piehler serves on scientific advisory panels for governments, nongovernment organizations and industry.

Success in Oyster Reef Restoration: Population and Ecosystem Measures

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Declining oyster populations — and the interrelated impact of poor water quality, habitat loss and reduction in ecosystem services — has raised oyster restoration along the Atlantic coastal states to a national issue. Oysters once supported a major fishery in the Mid-Atlantic and Southeast, and oyster reefs were critical ecosystem components providing habitat for juvenile finfish, crabs and shrimp as well as influencing local water quality and biogeochemical cycling. However, oysters have undergone significant declines over the past 5 decades, with oysters in the Chesapeake Bay region less than 1% of their former abundance and parts of Pamlico Sound having only 5 to 10% of former levels. Although the extent of decline varies along the North Carolina coast, oysters are clearly a fishery and habitat of concern along the entire coast. There are multiple causes for this decline that have been highlighted in a number of studies, workshops and congressional hearings, including impacted water quality, siltation and increased suspended solids, disease, and overfishing.

Over the past 2+ decade there have been numerous efforts to restore oyster reefs for habitat, fishery, support of other fisheries and filtration functions. In particular, private conservations groups and state agencies have been engaged in shell planting and introduction of seed oysters in both subtidal and intertidal habitats. Unfortunately, the short-term nature of restoration-monitoring efforts is in direct contradiction to the goal of establishing stable long term functioning oyster habitats. Therefore management and restoration groups (both industry and citizen based) need a set of reliable metrics that can be used to assess both the oyster habitat in general, and oysters themselves, that will give a more accurate indication of restoration success. This need has been underscored by state and regional workshops on oyster restoration success that emphasize the need to follow restoration efforts over a longer period, applying standardized sampling protocols to restored oyster reefs and control areas in order to examine aspects of oyster population and ecosystem success.

Here, we have applied a series of metrics to restoration sites of varying ages to identify those metrics that lend themselves to identification of long-term success. Some methods provide clear indication of reef development and oyster health with minimal effort while other metrics are conditional or may only provide a portion of the information needed. The development of a unified set of "success" criteria is key to the future of restoration efforts in North Carolina and other states with goals directed at enhancing the ecosystem function of oyster populations.

About the Speaker: Troy Alphin currently serves as Senior Research Associate with the University of North Carolina Wilmington in the Department of Biology and Marine Biology and the Center for Marine Science. He is a benthic ecologist and shellfish biologist, who has worked on issues related to trophic dynamics and ecosystem function of oysters. His research has focused on issues related to estuarine, beach, nearshore and offshore systems on the Atlantic coast of the United States and the Gulf of Mexico since 1991. Specific investigations include issues related to ecosystem health, beach renourishment and borrow-site impacts, dredging impacts in estuarine systems and beach functionality, as well as evaluation of erosion control structures and living shorelines. He served as a member of the Shellfish Advisory Committee to the N.C. Division of Marine Fisheries from 1999 to 2012, as well as serving on Fisheries

Management Plan committees for oysters, clams and bay scallops. He has served on the Board of Directors for the East Coast Shellfish Research Institute since 2009 and as the Vice-President from 2010 to 2011. He has published over 50 peer-reviewed scientific articles and presented or co-authored more than 95 presentations at national and international scientific meetings.

Key Parameters for Assessing Beach Functionality

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Beach nourishment is the preferred option for mitigating ocean shoreline retreat in North Carolina. As demand for nourishment rises, assessment of biological impacts in coastal ecosystems becomes more important. This project examined the beach and surf zone as an ecosystem, sampling the near shore food chain across seasons at nourished and unnourished sites and at sites immediately before and after nourishment in New Hanover County, the most heavily urbanized coastal county in North Carolina.

Nourishment impacts varied with time and trophic level. Microflora (surf zone phytoplankton and beach microalgae) and small fauna (surf zone zooplankton and beach meiofauna) responded to nourishment, but only briefly. Benthic macrofauna were much more variable and taxon-specific in their responses to seasonality and nourishment, which is conducted in winter and early spring. Surf zone fishes responded to the disturbance of nourishment activity in terms of species composition (with more transient species associated with disturbed locations) and lower body fat densities, implying lower feeding success, although overall numbers of fishes were not affected.

The overall view emerging from this study and others is that the nearshore ecosystem is a productive and biologically important link between coastal ocean and estuarine ecosystems. The surf zone supports high primary and secondary productivity, which in turn provides important food resources for higher trophic levels, including commercially and recreationally important fishes. In particular, juvenile fishes recruiting from offshore spawning to the near shore environment find a food-rich refuge from predation that allows them easy longshore access to inlets and estuarine nursery habitats. Evaluation of human impacts on beaches and inlets should therefore consider the connectivity of coastal, nearshore and estuarine ecosystems.

Publications

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M.S. Thesis

Kelly Jo Stull, "Zooplankton abundance in the surf zone of renourished beaches in southeastern North Carolina," M.S., 2011.

About the Speaker: Lawrence Cahoon is currently Professor of Biology and Marine Biology at UNC Wilmington, where he joined the faculty in 1982. He received his Bachelor of Science in biology (summa cum laude) at Washington & Lee University in 1975, and his Ph.D. in zoology at Duke University in 1981. He had a postdoctoral fellowship at Mountain Lake Biological Station with the University of Virginia, was a Temporary Instructor at Duke University, and has taught biological oceanography at Duke University Marine Laboratory. Cahoon currently teaches an undergraduate course in limnology (the study of freshwater ecosystems), a graduate course in biological oceanography, and a doctoral seminar in oceanography and environmental science at UNCW. He has served as a member of the North Carolina Marine Science Council and the North Carolina Ocean Affairs Council, as Chair of the North Carolina Ocean Resources Task Force, as Vice-President and President of the North Carolina Academy of Science, and as member of the Ocean Policy Advisory Committee for the North Carolina Division of Coastal Management and a legislative study subcommittee on Offshore Energy Exploration. His research interests include coastal biological oceanography, particularly the ecology of the sediment-water interface and ocean beaches; the effects of nutrient loading and grazing in estuarine and freshwater environments; environmental aspects of concentrated animal production; and a wide variety of water-quality issues.

Poster Viewing List

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2. **North Carolina Coastal Atlas: Transforming Information to Empower Decisions**
   Tom Allen, Robert Howard, and Michael Flynn, East Carolina University

3. **Improving Outreach of Information on Contamination in Self-Caught Fish**
   Liz Brown-Pickren, East Carolina University

4. **Monitoring Water Quality in Falls Lake Using High Spatial Resolution Satellite Imagery**
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5. **Comparison of Fish and Invertebrate Assemblages among Variably Altered Tidal Creeks in a Coastal Landscape**
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6. **Experimental Analysis of Cold Tolerance in Spotted Seatrout**
   Timothy A. Ellis, Jeffrey A. Buckel, and Stephen J. Poland, North Carolina State University

7. **First Step in Understanding Striped Bass Maternal Contribution: Larval Otolith Formation and Growth**
   Brie A. Elking and Roger Rulifson, East Carolina University

8. **Impact of Endocrine Disrupting Compounds on Sex Determination and Development in the Blue Crab, *Callinectes sapidus***
   Andrew Goff, Lauren Ryan, Joseph Covi, and Susanne Brander, University of North Carolina Wilmington

9. **Effects of Mixed Alternative Protein Sources and Meat and Bone Meal Protein Substitution for Menhaden Fish Meal Protein on Growth Performance, Body Composition, and Digestibility of Juvenile Red Porgy, *Pagrus pagrus***
   James C. Hill, Md Shah Alam, and Wade O. Watanabe, University of North Carolina Wilmington

10. **Utilizing Water Chemistry in the Albemarle Sound/Roanoke River Management Areas to Establish Natal Origin and Movement of Juvenile Striped Bass *(Morone saxatilis)***
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11. **Plankton Assemblages as Sentinels for Ecosystem Change within Estuarine Food Webs**
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12. **Modeling Overwash on a Barrier Island: Land Cover Implementation**
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13. **Economic Value and Impact of Visitation to Cape Hatteras National Seashore: Addressing Onsite Sampling**
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14. **Effects of Sea-Level Rise on Coastal Freshwater Wetland Animals**
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15. **Seasonal and Size-Specific Variation of Total Mercury Content in Large Pelagic Fishes Off North Carolina**
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16. **The Influence of Landscape Setting and Duration of Inundation on Oyster Reef Growth**
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    Charlton H. Godwin, North Carolina Division of Marine Fisheries; Roger A. Rulifson, East Carolina University

18. **Climate Change Risk Perception Among Adolescents**
    Kathryn T. Stevenson, M. Nils Peterson, Howard D. Bondell, Susan E. Moore, and Sarah J. Carrier, North Carolina State University

19. **Integrating Eukaryotic and Prokaryotic Plankton Community Transcriptomics into an Ecological Network Analysis of the Neuse River Estuary**
    Christian Stackhouse, Jamie Browne, Nathan Hall, Dave Schruth, Hans Paerl, ModMon Team, and Adrian Marchetti, University of North Carolina-Chapel Hill

20. **Evaluating Proxy Methods for Estimating Subaerial Beach Volume Change**
    Ethan J. Theuerkauf and Antonio B. Rodriguez, University of North Carolina-Chapel Hill

21. **Visitor Use and impact Monitoring at North Carolina National Estuarine Research Reserve Sites**
    Katharine Conlon, Chelsey Walden-Schreiner, and Yu-Fai Leung, North Carolina State University

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The Use of Norm Curves to Investigate Acceptability of Resource Condition and Recreational Use Levels

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Coastal ecosystems offer a variety of important ecosystem services including tourism, recreation, and aesthetic and cultural value. Ecosystem services are the benefits people derive from the environment, reflecting social values, goals, and desires. However, production of these services also involves trade-offs between environmental and social objectives. One way of understanding the attributes people value in ecosystems and the associated trade-offs is from a normative perspective. Research was conducted on recreational visitors to Buck Island Reef National Monument between March and August 2013. As concern for coral reef conditions persist, perspectives from the park visitors were needed in order for managers to have a complete understanding of current coral reef conditions. Normative theory was used to investigate visitors' views on acceptable levels of resource conditions and use. Norm curves were constructed to reveal critical information on coral reef conditions and resource use by illustrating when 'acceptable' becomes 'unacceptable'. Results indicate that park visitors accept seeing no more than 25% coral bleaching, 25% algal cover, or underwater visibility no less than 20 ft. They also have standards for appropriate numbers of snorkelers, divers, and boats in one area at one time. This information can help identify the ecosystem attributes that people value, as well as the potential trade-offs between services. If used in conjunction with ecological data, decision-makers can have a more complete picture of what specifically needs to be addressed.

North Carolina Coastal Atlas: Transforming Information to Empower Decisions

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East Carolina University is collaborating with the North Carolina Division of Coastal Management, North Carolina Sea Grant and other partners to develop the North Carolina Coastal Atlas (www.nccoastalatlas.org), an online mapping and investigation system that provides both static and interactive maps and related data for exploration and analysis. The Atlas combines physical, ecological and human-use data to support education, management and decision-making. We are developing the atlas to incorporate user objectives and review user experience iteratively. A needs assessment of coastal planners, managers and other potential users revealed a desire for thematic maps in the areas of ecosystem health, biological resources, shoreline change and hazards such as flooding and storm surge. Multiple datasets are now available including estuarine shorelines and associated structures, submerged aquatic vegetation, wetlands extent, and FEMA designated flood risk areas. A unique partnership with East Carolina University's Joyner Library makes scholarly research discoverable using geo-referencing. This

presentation will highlight thematic maps, demonstrating use cases for planners in high flood risk coastal communities and the identification of protected-resource areas, such as wetlands, for waterfront property owners interested in obtaining development permits. Future capabilities of the atlas include decision-support tools and public-engagement programs that have the potential to help make coastal and estuarine research more accessible and relevant to managers and the public.

Improving Outreach of Information on Contamination in Self-Caught Fish

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Recreational fishing is popular and fish is a good source of health benefits, yet self-caught fish may be a source of contaminants. Each state issues consumption advisories, some statewide and some specific to water bodies, and each state manages marine fish and shellfish through catch limits, size limits and closed areas. An open-ended intercept survey of coastal anglers in North Carolina revealed extensive knowledge of catch restrictions, but minimal knowledge of the effects of contaminants on health, little concern for contaminants in their catch, and a misguided faith that the government would post warnings at every water body at risk for contaminants. This project is intended to encourage collaboration between fishery management agencies and public health agencies, and to outline an effective outreach framework.

Monitoring Water Quality in Falls Lake Using High Spatial Resolution Satellite Imagery

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An important resource for any city is a reliable source of clean drinking water. Falls Lake provides a drinking water reservoir for Raleigh and flood control and recreational opportunities for communities surrounding the lake. Despite these vital functions, the water quality of Falls Lake has been problematic for some time with the upper reaches of the lake listed as 303(d) impaired waters. Phytoplankton blooms, high suspended sediment loads and other impairments are potential hazards to both the drinking-water supply and human health. Rapid population growth in the communities surrounding the lake make the monitoring of water quality in Falls Lake increasingly difficult and important. A water body the size of Falls Lake is difficult to adequately monitor using traditional boat- or mooring-based sampling strategies. One solution is to use high spatial resolution satellite imagery. In collaboration with the Center for Applied Aquatic Ecology at NC State University, Global Earth Observation and Data Analysis Center at National Cheng Kung University and the National Space Program Office of Taiwan a program was instituted to integrate remotely sensed images and a suite of water-quality measurements taken from small boats. The goal of this joint effort is to produce maps of important water-quality parameters for the

entirety of Falls Lake at a given time. These synoptic snapshots of the health of Falls Lake can provide a valuable tool for managers at both the state and local levels. The preliminary results of this work are presented here.

Comparison of Fish and Invertebrate Assemblages Among Variably Altered Tidal Creeks in a Coastal Landscape

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Anthropogenic alterations to saltmarsh watersheds along the U.S. South Atlantic coast can impact the production of common resident taxa. We deployed a 1 m^2 throw trap monthly in summers 2012 and 2013 in the vegetated portions of five variably altered saltmarsh creeks in coastal North Carolina to compare the density of resident macrofauna: the mummichog Fundulus heteroclitus, mosquitofish Gambusia holbrooki, sheepshead minnow Cyprinodon variegatus, and grass shrimp Palaemonetes spp. For each species, the relationship between density and a combination of biotic and abiotic variables was examined using poission-distributed generalized linear models (GLMs). Model parsimony was evaluated using Akaike Information Criteria (AIC). The GLM that best fit the data (lowest AIC score) for each species included creek as an explanatory variable. Salinity, depth, and percent coverage of Spartina alterniflora were additional factors that explained patterns of faunal density. Percent imperviousness also explained patterns of density, but the direction of the effect was dependent on species. Results of this study emphasize the importance of imperviousness and vegetative cover in affecting the density of resident species inhabiting saltmarsh creeks along the U.S. South Atlantic coastline.

Experimental Analysis of Cold Tolerance in Spotted Seatrout

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In the U.S., cold fronts can expose fish in relatively shallow temperate estuarine ecosystems to rapid drops in temperature. Without thermal refugia, acute cold stress can lead to episodic mass mortality. Populations existing near the northern extent of a species' latitudinal range, such as spotted seatrout (Cynoscion nebulosus) in North Carolina, are particularly vulnerable to lethal winter conditions. Only anecdotal information on cold tolerance exists for spotted seatrout, limiting our understanding of a likely important source of natural mortality for this species. In this study, we applied two different methods for controlled exposure of spotted seatrout to dynamic decreases in water temperature, in order to determine cold tolerance as affected by temperature severity and salinity. Critical thermal minimum (CTMin) methodology was used to determine stressful but sublethal low temperatures, defined as the temperature at which fish lost equilibrium, across two representative overwinter salinity treatments. The CTMin of 2.3 °C at high salinity was significantly lower than that of 3.4 °C at low salinity ($p < 0.001$). Chronic lethal methodology was adapted to examine the effects of prolonged exposure to three temperatures representing a range of winter severity on spotted seatrout survival. Temperature had a significant effect on 10-day survival; no survival at 3 °C, moderate survival at 5 °C, and high survival at 7 °C. Patterns in survival were similar across high- and low-salinity treatments. Given the propensity of spotted seatrout to

overwinter in shallow lower salinity environments, some benefit must outweigh the higher risk of acute cold stress found in these habitats.

First Step in Understanding Striped Bass Maternal Contribution: Larval Otolith Formation and Growth

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Otolith studies have become more prevalent in recent years as use has expanded from only aging to examination of migration patterns and fidelity to natal habitats. The otolith of Striped Bass, Morone saxatilis (Walbaum; 1792), is used for all of these purposes, yet its formation and early development have not been documented. We were able to identify the timing and formation of the three otolith pairs during late egg stage, yolk-sac larvae, and post yolk-sac larvae. The sagittal otoliths were first to appear, forming shortly before hatch and were observed growing larger throughout the larval stage. The lapilli otoliths formed within the first 24 hours post hatch. The asterisci otoliths were difficult to locate, but seemed to form between 4 and 15 days post hatch. At hatch the sagittal otoliths appear circular, and by 5 days post hatch seem to gain some dimensionality. At 15 days post hatch the sagittal otolith began to elongate along the anterior/ posterior axis. This knowledge of the when the otoliths form will affect any microchemical analysis done in in the first year of life, especially as the asterisci otoliths form around first feeding, and should be taken into account when choosing an otolith for analysis.

Impact of Endocrine Disrupting Compounds on Sex Determination and Development in the Blue crab, *Callinectes sapidus*

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Over the past two decades a large body of work has established a clear link between endocrine disrupting compounds (EDCs) and deleterious physiological impacts on aquatic organisms. EDCs act at low concentrations, and originate from a variety of sources, including urban or agricultural runoff (e.g., pesticides) and components of treated wastewater effluent. Endocrine disruption in crustaceans is of particular concern to North Carolina considering the importance of the blue crab fishery. The Division of Marine Fisheries issued a draft report in November 2011 that emphasizes the need for research on endocrine disruption in blue crabs. Although the USGS has conducted preliminary analyses of EDCs in North Carolina watersheds that detected a wide array of pharmaceuticals and pesticides, to date the biological impacts of EDCs in North Carolina blue crab populations have yet to be assessed. Initial sampling surveys were conducted from spring through fall in 2013 to assess potential impacts on populations of blue crabs. A preliminary analysis of morphological endpoints from 4 different sampling regions shows a size disparity of high significance (ANOVA) between the control site (Santee River, SC)

and the putatively most polluted site (Cape Fear River, NC). Furthermore, ecdysteroid (molting hormone) concentrations in hemolymph differ among collection sites. Sites will be sampled again in 2014, and molecular analysis of vitellogenin (egg yolk protein) and insulin-like androgenic gland hormone (masculinizing hormone), is currently being conducted. Additionally, chemical analysis on suite of common EDCs is being performed on eggs and embryos from each site.

Effects of Mixed Alternative Protein Sources and Meat and Bone Meal Protein Substitution for Menhaden Fish Meal Protein on Growth Performance, Body Composition, and Digestibility of Juvenile Red Porgy, *Pagrus pagrus*

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In order for finfish mariculture to become a sustainable and profitable industry, effective protein sources other than fishmeal (FM) need to be identified for each species. This study tested meat and bone meal (MBM) as well as a mixture of three different alternative protein sources (MPS), including poultry by-product meal, corn gluten meal, and soybean meal, as a substitute for FM in the diet of hatchery raised juvenile red porgy (RP). Eight iso-nitrogenous (50% CP) and isolipidic (11%) diets were formulated where the control diet 1 contained 60% FM. Diets 2, 3, 4 and 5 had increasing levels of the MPS (25, 50, 75, and 100%), and diets 6, 7, and 8 had increasing levels of MBM (20, 40, and 60%) in replacement of FM as the protein source. Crystalline L-methionine, L-lysine, arginine, taurine and leucine were added to all diets, and iso-leucine and threonine were also added to diets 6, 7, and 8 to simulate the calculated values of these amino acids found in the control diet 1. Diets were fed twice daily to triplicate groups of juvenile RP (mean initial weight = 12.5 g) to apparent satiation for 8 wks. Fish were held in 75-L rectangular tanks (12 fish per tank) using a recirculating seawater (34 g/L) system maintained at 22 °C. To measure apparent protein digestibility, chromic oxide (0.5%) was added to the diets once the feeding trials ended, and fecal samples were collected for 7 d for analysis.

Utilizing Water Chemistry in the Albemarle Sound/Roanoke River Management Areas to Establish Natal Origin and Movement of Juvenile Striped Bass (*Morone saxatilis*)

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Striped bass (Morone saxatilis) is an important anadromous species that provides valuable ecological and economic benefits to North Carolina. This fishery accounts for over 45 million dollars in revenue from commercial and recreational activities within the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA) (NCDMF 2011). The strategic habitat areas of striped bass

continue to be a topic of interest to researchers, fisheries managers, and recreational and commercial fishermen. The fundamental basis of otolith microchemistry (a technique used to characterize movement and natal origin in fish) is reliant on knowing the spatial and temporal variation of water chemistry. Surface water chemistry can be used to discriminate between different water bodies because typically each system has different types and abundance of elements (Elsdon and Gillanders 2003c; Dorval et al. 2007). This research examines dissolved elemental concentrations in water samples. Water samples will identify whether watersheds have elemental signatures, and if so determine the trace elements that make each of these river systems unique. Previous research has shown that the ASMA/RRMA has stable patterns of water chemistry over time and temporal variations have been relatively short (Mohan 2009; Zapf 2012). However, collecting water samples over several seasons and years is essential to verify stable conditions. Assessing trace elements in water chemistry will determine spatial and temporal variability in the ASMA/RRMA.

Plankton Assemblages as Sentinels for Ecosystem Change within Estuarine Food Webs

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Bogue Sound can be considered an ideal case study for North Carolina's estuarine environments that experience multiple stressors both long- and short-term, from eutrophication to change in global climate parameters (e.g., temperature and carbon chemistry). These stressors impact abundance and species composition in phytoplankton and zooplankton and thereby energy flux to higher trophic levels such as shellfish, crab or fish. For instance, excess nutrients can drive shifts from diverse algal assemblages to dominance by few or even single species as seen during Harmful Algal Blooms (HAB). Latter may disrupt food webs or lead to lowoxygen conditions when excess biomass accumulates. A better predictive understanding of how environmental perturbation can lead to plankton regime shifts and effect ecosystem resources requires knowledge of plankton dynamics over spatial and temporal scales. Presented here is a one-year time-series of phyto- and zooplankton dynamics at two study locations within Bogue Sound. Preliminary analyses of weekly data show that Bogue Sound is characterized by high-biomass events dominated by diatoms that include Pseudo-nitzschia spp, a microalgae capable of producing domoic acid (cause of Amnesic Shellfish Poisoning). Here, we discuss observed trends in plankton abundance and species composition, examined together with pertinent physiochemical parameters (temperature, salinity, dissolved oxygen, inorganic nutrients).

Modeling Overwash on a Barrier Island: Land Cover Implementation

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Communities and businesses on barrier islands are extremely vulnerable to landform changes brought on by extreme events such as hurricanes. State-of-the-art morphological models with high predictive capabilities are essential to predict landform response to storms; understand the risks; and make informed decisions. One effort to improve the predictive capabilities of morphologic models is to consider the influence of land cover such as vegetation and pavement. Land cover becomes especially important in modeling cases with overwash since the water flow directly interacts with the features landward of the dune crest. To study this phenomenon a location at US Fish and Wildlife Pea Island National Wildlife Refuge (PINWR) on the Outer Banks of North Carolina was selected where overwash has occurred multiple times. Hurricane Isabel (2003) and Hurricane Sandy (2012) both created overwash fans at the selected location spreading sand approximately 150m and 130m landward of NC 12. Thirty-six cross-shore profiles were extracted from pre-storm lidars and modeled using eXtreme Beach behaviour (XBeach). The simulations were carried out in 1D mode given its widespread use due to the significantly lower computational requirements. XBeach was implemented in two frameworks, first; all the profiles were represented as sand, and in second; land cover was incorporated to profiles as concrete/pavement, vegetation and sand. The results of the simulations were compared to post-storm field measurements focusing on the landward extent of the washover fan and the average depth of deposition. Results indicate that the incorporation of land cover has improved the prediction capability of the model.

Economic Value and Impact of Visitation to Cape Hatteras National Seashore: Addressing Onsite Sampling

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We examine recreation demand, travel costs, and visitor expenditure patterns for Cape Hatteras National Seashore (CHNS) on the Outer Banks, North Carolina. CHNS is one of the largest protected barrier islands on the East Coast, comprised of nearly 30,000 acres along 140 miles of shoreline. The island system is unique, consisting of primarily thin barrier islands, dunes, and mud flats, backed by a large and shallow back-barrier estuary; CHNS is remote, accessible only by ferry or a single stretch of road running along the chain of islands. Data were collected at various beaches along CHNS in 2001-2002. We estimate count data demand models, controlling for endogenous stratification stemming from the on-site sampling. We present corrected estimates of economic value and extend the analysis of avidity bias to

examine the impact of on-site sampling on economic expenditure analysis. Our hypothesis is that expenditure estimates will be downward biased (reflecting lower spending patterns of more avid users that live closer to CNHS), which would give rise to underestimates of economic impact. The estimated net benefit of a day at CHNS is estimated at $75.89/household and $17.21/individual (2002 USD).

Effects of Sea-Level Rise on Coastal Freshwater Wetland Animals

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In light of rising salinity levels in coastal freshwater ecosystems, we have designed a series of experiments that will investigate how the physiological mechanisms that maintain osmotic balance during each stage of the anuran life cycle interact with, associate with, and influence tolerance to brackish conditions, biological interactions (e.g., parasitic, mutualistic, predator/prey, competition), phenotypic plasticity (e.g., larval morphology, behavioral traits, life history traits), and community organization. We plan to utilize these data to create predictive risk maps to forecast species distributions according to present and future environmental conditions and recommend management and intervention strategies to prevent amphibian losses along the coast of North Carolina.

Seasonal and Size-Specific Variation of Total Mercury Content in Large Pelagic Fishes Off North Carolina

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The large pelagic fish community in the U.S. South Atlantic supports valuable commercial and recreational fishing industries in several states. Some members of this community, including blue marlin and wahoo, have previously been found to contain mercury levels sufficient to impact reproduction and survival as well as pose a potential health risk to consumers. However, most regional consumption advisories are based on studies with small sample sizes of fish collected outside of state waters which may not be representative of fish landed by North Carolina anglers. The objectives of our study were to estimate the mercury concentrations in tissues of several large pelagic fish species in state waters and assess seasonal and size-specific variation in mercury concentration. Fish were collected through fishing tournaments and cooperation with charter captains from North and South Carolina. A sample of muscle tissue was dried and homogenized using mortar and pestle then the mercury concentration was estimated using a Tri-Cell Direct Mercury Analyzer (model DMA-80) and values converted to wet weight mercury concentration. Mercury concentrations exceeding the FDA action level of 1.0 ppm were observed in wahoo, blackfin tuna, and blue marlin, with all mercury concentrations for dolphinfish and yellowfin tuna falling below. Mercury concentration increased with increasing fork length and trophic level for all species. Seasonal differences were observed for blackfin tuna, with highest mean mercury concentration during the spring. Trends in mercury concentration from this study support those reported previously for the southeastern U.S. and will help to inform regional advisories from the FDA.

The Influence of Landscape Setting and Duration of Inundation on Oyster Reef Growth

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Physicochemical boundaries and optimal conditions characterizing the response of coastal foundation species to sea-level rise must be defined to accurately predict sustainability. Using 15-year-old experimental oyster reefs in Middle Marsh, Back Sound, we examine the effects of varying inundation levels and landscape settings on vertical reef growth and oyster density, two proxies of productivity that determine the ability of reefs to maintain their position relative to sea level. These reefs were constructed adjacent to sandflat and saltmarsh habitats over a subtidal-to-intertidal depth gradient. Reefs surrounded by sandflats are defined by a strong parabolic growth pattern in relation to duration of aerial exposure. We find an abrupt switch from reef accretion to reef deterioration occurring at a critical exposure duration of 10%, an optimal reef growth zone (30-40% exposure) defined by the highest vertical accretion rates (~ 2 cm/yr), and a growth ceiling near mean sea level (~55% exposure) where exposure stress becomes too high to support additional vertical growth. We also discover a landscape-specific response in reef growth as reefs adjacent to salt marshes exhibit a negative relationship between vertical accretion and aerial exposure. Considering impacts from rising sea level and associated changes to tidal regimes, we present a model that predicts sandflat reef productivity for any inundation condition. Based on our model and future predictions of accelerating sea-level rise, shallow, sandflat reefs will subsist in the euhaline waters of North Carolina, while oyster reefs below the critical exposure depth will perish.

Alewife *Alosa pseudoharengus* Population Changes in Lake Mattamuskeet are Related to Water Control Structures

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The alewife population at Lake Mattamuskeet has been in decline since the early 1990s. This research documented changes in the population level after a redesign of the water control structures, which provide access to spawning grounds at Lake Mattamuskeet. Tyus in 1970 and 1971 estimated 150,000 to 200,000 alewife were entering the lake each spring. Wall (1997, 1998) determined that the population was nearly wiped out after a new steel flapgate design installed in 1989 caused high water velocities preventing good lake access by fish. After new flapgates of the original design were installed in 2001, the 2001 alewife spawning run was estimated at 8,424 alewife (Godwin and Rulifson 2002). Sampling from the 2003 spawning season yielded a population estimate of 38,689 alewife. It is clear that the new flapgates installed in 2001 had immediate success in passing alewives to Lake spawning grounds. This study may help other fishery managers in the proper design and implementation of water-control structures in habitats similar to Lake Mattamuskeet.

Climate Change Risk Perception among Adolescents

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Though many climate literacy efforts attempt to communicate climate change as a risk, these strategies may be ineffective because, among adults, worldview rather than scientific understanding largely drives climate-change risk perceptions. Further, increased science literacy may polarize worldview-driven perceptions, making some climate literacy efforts counterproductive among skeptics. Because worldviews are still forming in the teenage years, adolescents may represent a more receptive audience. This study examined how worldview and climate-change knowledge related to acceptance of anthropogenic global warming (AGW) and in turn, climate-change risk perception among middle school students in North Carolina, USA (n = 387). We found respondents with individualistic worldviews were 16.1 percentage points less likely to accept AGW than communitarian respondents at median knowledge levels, mirroring findings in similar studies among adults. The interaction between knowledge and worldview, however, was opposite from previous studies among adults, because increased climate-change knowledge was positively related to acceptance of AGW among both groups, and had a stronger positive relationship among individualists. Though individualists were 24.1 percentage points less likely to accept AGW than communitarians at low levels (bottom decile) of climate-change knowledge, there was no statistical difference in acceptance levels between individualists and communitarians at high levels of knowledge (top decile). Non-whites and females also demonstrated higher levels of AGW acceptance and climate-change risk perception, respectively. Thus, education efforts specific to climate change may counteract divisions based on worldviews among adolescents, versus polarize them as among adults.

Integrating Eukaryotic and Prokaryotic Plankton Community Transcriptomics into an Ecological Network Analysis of the Neuse River Estuary

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Eutrophication of estuarine and coastal systems can often result in harmful algal blooms (HABs), hypoxia and fish kills. Non-point sources of pollution in the Neuse River Estuary (NRE) watershed have been increasing as the area has experienced steady growth in agriculture, industry and urbanization. Efforts to reduce nutrient inputs of phosphorus have had positive results; however, similar efforts for nitrogen input reduction have not been as successful. Necessary to the effective management of this ecosystem are the identification of the abiotic and biotic components of the system and subsequent understanding of the relationships of those components. The aim of this project is to provide insight into bloom dynamics, causes, and effects, and to provide new molecular tools that may aid in forecasting HABs. We seek to build ecological relationships between the plankton communities incorporating transcriptomic (analysis of RNA sequences) data from eukaryotic phytoplankton, cyanobacteria, and heterotrophic bacteria. The

utilization of next-generation sequencing technologies will provide high resolution of biotic components of this ecosystem. These data will be contextualized with environmental data routinely collected by the ModMon monitoring program in the NRE, such as chlorophyll a, particulate organic matter, primary productivity and dissolved organic and inorganic nutrients. The coupling of these data, with an emphasis on nitrogen cycling, will elucidate important ecological networks that can then be used to guide best management practices to promote healthy ecosystems. The models, approaches, and tools produced by this study could be expandable to other coastal and estuarine systems.

Evaluating Proxy Methods for Estimating Subaerial Beach Volume Change

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Proxies, such as changes in beach profiles and shoreline positions, are commonly used for measuring changes in subaerial beach volume; however, the accuracy of these proxies at representing the true volume change is unclear. Volume change associated with along-beach variations in morphology may not be captured well by changes in profiles, while volume change associated with across-beach variations in morphology may not be captured well by shoreline changes. This study assesses the impacts of variations in morphology associated with beach cusps and nourishment material on volume change measurements from profiles and shoreline change at varying time periods. Results indicate that it is unlikely cross-beach transects spaced ≥150 m apart will accurately measure volume change over both short- and longer-time frames at beaches with cusps, on the border of a nourishment area, and where high temporal variability in shoreline position exists. Changes in beach profiles accurately measure volume change over longer (~3.5 year) time scales at beaches with consistent magnitudes and directions of change. The shoreline change proxy works best at beaches with low temporal variability in shoreline position, at beaches where there are no significant morphologic changes to the backshore, and at beaches with ramp-like morphologies, which often exists after nourishment material is graded. Topographic data collection using LIDAR methods is essential at beaches where volume change oscillates between erosion and accretion on both short and long time scales because the magnitude of small-scale changes in beach volume will always be similar to the long-term net volume change.

Visitor Use and Impact Monitoring at North Carolina National Estuarine Research Reserve Sites

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Coastal protected areas offer myriad ecosystem services, including biodiversity conservation, natural disaster alleviation, and recreation and tourism opportunities. The N.C. Coastal Reserve and National Estuarine Research Reserve (NCCR-NCNERR) program protects unique coastal environments along the North Carolina seaboard for education, long-term research and compatible recreation. However, ecological processes and anthropogenic pressures threaten the sites and play an important role in their management. Many sites receive high levels of visitation, with increases closely related to the rapidly growing population along the coast. High levels of visitation can further degrade resource conditions and health of these coastal ecosystems. Despite the managerial relevance of visitor use and related impact

information, data are often scarce and a common limitation to proactive management. Meetings with managers of NCCR-NCNERR sites during a workshop hosted by the NCCR-NCNERR program and NOAA in 2012 identified salient visitor use issues for study and began an ongoing partnership to collect managerial relevant data. Specifically, this partnership strives to facilitate proactive management by collecting timely visitor use and impact-monitoring data and engaging the public and local communities in monitoring. Three main issues (i.e., compliance with dog-leash regulations, visitor interactions with feral horses, proliferation of visitor-created trails and campsites) were selected for study at two NCNERR sites. Volunteers were recruited from the local community, provided with a training workshop, and began collecting data in 2013. This poster will highlight data collection methods for all indicators, lessons learned from 2013 and a discussion of future plans.

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Group 2: Chrissa Waite, NOAA Coastal Services Center

Group 3: Jack Thigpen, North Carolina Sea Grant

Group 4: Paula Gillikin, NC Coastal Reserve Program

Group 5: Christy Perrin, NC Watershed Education for Communities & Officials

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Appendix C: Breakout Group Notes

Session 1 - Hazard Resilience
Group 1
Facilitator: Chris Ellis

Concerns or interests related to Hazard Resilience

Social Vulnerability

- Trying to incorporate more of a social vulnerability index. How can that be done? What might be the policy/legal issues associated with that?
- Social vulnerability as part of the analysis, how can that be incorporated/applied?
- Research is needed to validate the social vulnerability index.
- Partners? FEMA, local partners, local communities
- The underlying data and how it is available is somewhat limiting. We need to evaluate what data we need. How can it be applied? There are real limitations to the dataset.

Public Infrastructure

- We have a general problem with public infrastructure to be vulnerable to various hazards but it is really expensive to repair.
- We need to take a look at some other approach to managing wastewater. Maybe some onsite system solution? The problem is NC doesn't permit alternative systems. We need to work with tech and permitting.
- Central wastewater is not always the answer.
- Permitting generally is a big issue (concern/opportunity).
- What are the unique challenges to rural communities to fund upgrades or updates to their system? There are unique challenges to these (rural) communities. How can we assist them? The Rural Center is cut. Who will step in?
- Who is going to work with rural communities to help them?
- What are the main resilience issues that these communities face? How do they get training?
- What kind of educational opportunities can we offer, online and in-person, to provide training?

Other issues to discuss

- We talk about coupling the built and the natural environment, but we are not even close to doing that. Continue to assess various degrees to which these can increase or decrease resilience. There needs to be a realistic assessment of what to expect. Oyster reefs cannot protect Manhattan.
- Beach nourishment. The funding model for that has broken down. Beach communities' #1 priority is to fund that program. Feds are out of the business.
- New funding models, eventually we are going to get into a triage situation. Topsail Island is a great example.
- Sand sources are getting to be difficult. That's a big problem. "That's our sand and you can't have it." Sand is getting scarce and more expensive.

- Nourishment may not be an option for much longer.

Environmental literacy

- How to approach that challenge in terms of resilience is something we all need to work on. Think of those opportunities whenever you do a research program of how to get the word out. Do people listen and internalize the message?
- We should never let a disaster go without using it as a teaching tool.
- How do we prepare? And also, how do we respond when we get the next big storm? Rather than immediately rebuild, we should have the conversation now about what we will do when the next big storm occurs.
- We should look at the ways information is provided and work within those. Don't create new avenues. There is already an inundation.
- "Not being compensated for outreach that's not my job" when I hear that, I think maybe they are not good at it. Maybe not all researchers are good at that. Is it fair to ask that they be good at research, teaching and outreach? Maybe someone that is good at outreach can come and assist that researcher or groups of researchers?

Session 1 - Hazard Resilience
Group 2
Facilitator: Chrissa Waite

Emerging management issues and concerns:

- Vulnerable populations re: hazards…elderly, immigrants.
- Where responsibility lies re: response…local, national, complication about who is actually responsible to the hazard response.
- How do you define "response"…mitigation, preparedness, recovery?
- Education of public on emergency management.
- "Victim blame" isn't valuable…won't be our partners in moving forward if we treat them as the problem…FEMA calls them survivors instead of victims.
- The counties at the coast perceive "government is doing to us" … not the same educational level as the cities.
- Different opinions on whether the government should replenish the beach sand…public perception re: wealthy vs. poorer citizens' beach replenishment.
- Resilience: financial support in Northeast varied the ability to restore or replenish.
- Infrastructure: Is it good, quality?
- Public fatigue about bringing things back online after a disaster…lots of tax dollars to shore up things that broke.

Opportunities

- Show coastal economic values and prosperity as it impacts the whole state.
- Local hazard mitigation plans…could these be broadened at the local level…residents and stakeholders and specialists. Partner with local Emergency Management groups and local planning offices and elected officials.

- Partner with local festivals on the coast to increase public awareness
- How many communities develop plans but don't implement them…is this a funding issue?
- Partner with the school districts re: emergency management. They have funding and interest.
- County commissioners could be good partners.
- Environmental health disparity research re: coastal populations have more exposure and are more vulnerable…NIH concerned
- Research on personal attachment to their places, why people feel connected to their homes and location…a social science research project…NIH concerned about health issues
- Cost-benefit analysis of efforts to put disaster areas back to the pre-disaster level.
- Infrastructure … how many pump stations are below the 1% flood zone…how long to get back online…what do community planners know about relief money available after an emergency.

Session 1 - Hazard Resilience
Group 3
Facilitator: Jack Thigpen

- Do we have a database of all NC coastal infrastructure? This information could help us decide what priorities to place on replacement and funding requirements.
  Partners: Planning agencies, and resource managers.
- What do we know about ocean acidification and what the impacts might be in our areas? How is this impacting our shellfish, etc. Need a geochemist to tell you how there are impacts.
  Partners: N.C. Sea Grant, fishing community. (They would be recipients of information.)
- Issues of population increase and pressure on shoreline development and other development, and in turn these impacts on ecosystems and the resiliency of those systems. Be sure to address current conditions of environmental systems and they are impacted. The ability of the community to support increased populations and maintain its community and environmental health.
  Partners: Regulatory community.
- What is the insurability of our coastal built environment for the long term? This should include some sort of consideration of profitability for private business and affordability to property owners.
  Partners: insurance companies, academics, construction community (e.g. local and national home builders associations).
- Economic impacts of hazards to business: which ones are most vulnerable and how do we make them more resilient. We've focused on residents-need to focus on businesses too. Could focus first on episodic storms then turn to droughts. Need to quantify the hazards for different regions of the coast, including sea level rise, saltwater intrusion, hurricanes, etc.
  Partners: economists, chambers of commerce, climate scientists/meteorologists. To quantify risks involve academia, insurance companies, chambers of commerce. We really need to make that information connected to infrastructure and other things in the community.

Session 1 - Hazard Resilience
Group 4
Facilitator: Paula Gillikin

Hazard Resilience in Coastal Communities, Breakout group #4
C=Concerns; O=Opportunities; P=Partners

- C=Lack of outreach from research projects; O=conduct a needs assessment to determine how to structure research; P=NC Coastal Reserve
- O=New opportunities include initiating new partnerships; more effective and new collaborations
- C=Tailoring communications to target audiences – aka – picking the right message (attributable to 2 points above).
- O=Develop a standardized list of hazards/concerns that all communities would pick their concerns/issues from –so that we are not reinventing the wheel.
- O=Reward university researchers for communicating sciences with general public.
- C=Access to information; difficult for general public to assess specific information targeted to their community (e.g., NC Coastal Atlas). ECU and state agencies are a lead in this field within NC.
- C=Look at positive and negative outcomes of management scenarios (Historical analyses of copying strategies); O=Look at BMPs. P=universities, state agencies.
- C=People do not understand the risk/reward aspect, more education needed.

*Lack of Education and outreach emerged as the principle concern from this group.
Top Concerns: Lack of education/outreach
Opportunities: Needs assessments; new partnerships; reward/don't penalize/encourage university researchers to communicate science; predefine process and potential outcomes for prioritization of issues in local communities

Session 1 - Hazard Resilience
Group 5
Facilitator: Christy Perrin

Management Concerns

- Cost is a concern. Cost of research, cost of options, cost of implementation.
- Location is a concern. For example, remote areas, underserved areas need to be identified. These areas also have less financial resources.
- Time lines and spatial scale of a management concern could be quite different. Also agency vs. local scale can be a concern (carry across jurisdictions – who is in charge).
- Communication – how do you reach diverse people, young vs old, English and non-English speakers
- The GSAA is talking about resilience right now. Infrastructure is a concern (roads, storm water systems, waste water systems, etc.). Impact from storms – these systems need to be resilient too. Infrastructure improvements.

- Towns have to update beach front management plans. Need to include resilience needs in these plans.
- Partnerships need to be fostered – need public/private partnership.

Research
- Difficult to define resilience. Need to define and operationalize the term.
- Need a "network" to get stakeholders together with researchers. Communication lines.
- Develop text and mobile messaging in multiple languages to address weather concerns. It was noted that this is available but not certain if it is available for other languages. Need to make it better known as well. Readync.org
- Crowd sourcing with the public (citizen science). Use camera phones to take photos of events.
- Develop a tool that looks at vulnerability based on shoreline change. Tool (AMBUR – HVA tool) developed for 1 coastal county. Possibly expand beyond the pilot area.

Priority: Infrastructure topic – intersects with adaptation and contains cost and timescales. Need to better identify resilience and could be easier to do under the infrastructure theme.

Session 2 - Sustainable Coastal Development
Group 1
Facilitator: Chris Ellis

- Water supply management and capital improvements. There is a lack of planning on these to pay for and set water supply. Coastal communities share an aquifer. What/where/who can they look to for water supply management in the future?
    - Assessment of local governments would be useful. Which have active capital improvement plans? How many communities are actively doing this?
    - Assessment around water supply management would be useful.
- Living shorelines and shoreline armoring solutions. Research into getting people to understand the benefits of living shorelines. Social science research into this issue.
- Shoreline movements. How about shoreline *landward* movements? Coastal flooding? When NOAA says we are not having many storms, we should all be really scared. Mapping shoreline movements in estuaries and making that information obtainable/accessible. Understanding why it is eroding. Moving away from NOAA passive inundation models.
- Towns are required to do hazard mitigation plans, but they are all over the map. They are inconsistent plans in scope and quality. I don't know if this is a research or outreach endeavor to improve this.
- Offshore energy. Everyone knows that in 2017 offshore oil and gas exploration could begin. There needs to be an assessment of what kind of infrastructure will be needed to be built to get the energy on shore. What it will look like? What impacts will there be to coastal communities (e.g., to tourism or commercial fishing)?
    - Should we include 'risk'? Those that are involved with offshore energy development such as coastal degradation risk e.g., Deep Water Horizon spill.

- Interaction between coastal development and natural systems.
- Impacts of tourism development on natural systems. What are the costs of tourism?

Partners the group came up with for the research opportunities mentioned above: BOHM, Duke, NC State UNC Institute for the Environment, Environmental Finance Center, NOAA, US Department of Energy, Governors' South Atlantic Alliance, Division of Coastal Management, EPA, NC State.

- Keeping the beaches and shorelines public and accessible. We need to set aside access areas.
    - The research there would involve beach visitation.
- Inlets and ports. Dredging is one item that is becoming increasingly difficult. There are a lot of research angles there. Social ramifications, fisheries impacts
    - Related to that is that the Coast Guard wants to add a lot more shipping lanes.
    - Where are we with coastal and marine special planning issues?

Additional partners: DMF coastal habitat protection plan CHPP, NOAA CZM

- Literacy. "Resilience" and "sustainability" as terms need to be defined.
- Management strategies for shorelines. There is a lot of research that is needed. Geological, economic, social every angle possible.
- As communities plan they have the choice of elevating or buying people out also infrastructure costs, seems like a cost benefit analysis for hazard mitigation is needed.
- Hazard mitigation plans should have this.
- What about tourism itself? What is its impact on culture, environment?
    - Tourism investment. Money is made from room tax but what about cost? For fire, emergency rooms? Tourism is not free.
- Maintain rather than retreat has a huge impact on the tax base for the community. What is the effect on the tax base for each of these different strategies? Economics of retreat vs. hold your ground. There is a lot of research potential. It is huge for the community.

Session 2 - Sustainable Coastal Development
Group 2
Facilitator Chrissa Waite

Emerging management issues and concerns:

- Engaging second-home owners politically, economically, socially
- Timeframe issue…what is "sustainable"?
- Cost…is a person's willingness to change based on how much it is going to cost them.
- Is "sustainable" re: energy efficient development or environmental quality development…avoid high risk areas?
- Is economic growth still possible with sustainable growth? Public perception that development always equals economic growth.
- What are impacts on wetland development? If wetlands are available, will they be filled by governmental agencies?
- Avoidance on improving energy efficiency may be due to length of time to see a return on investment. Are there other ways to get returns faster?

- How do decisions based on homeowners, etc. impact natural preserves adjacent to the home?
- Are the sustainable issues the same at the rural level as the city level?
- What happens when the sea absorbs a house and the land? If the property owner doesn't move the house, they still have to pay the mortgage…some go into bankruptcy and the county loses the tax income.
- What about the impacts on water, sewage, as it relates to development?
- What timeframe is relevant to define "sustainable" and to implement it? Something that lasts 50 years? Change our culture to be more long-sighted instead of throw-away?

Opportunities:

- EPA and HUD could possibly get some money similar to how they fund energy efficient windows and low income housing…get a dollar or two from sporting event tickets.
- To help understand impacts on natural and historical areas, get involvement and partner with local and state parks and historical agencies, local historic district commissions.
- To identify impacts on natural areas, do assessments (surveys) based on different levels of development. Probably have the historic data available (photos, census) to compare to assessment data.
- Composition of the homes, placement, mobile homes. Partners include building companies.
- Contact government, elected officials to discuss how the community defines "sustainable" and see if there are ways to help implement new policies. If there aren't many regulations, developers feel they are "meeting the requirements".
- Use community groups and videotape them to gather data on definitions of sustainable and development. Use the community input (unless it's really bad input).
- If you encounter opposition, it's important to have the support and buy-in from the community.
- Foundations are required/volunteer to fund issues at the lower community levels. For partners, the bigger the business (Sheetz, John Deere, etc.) will fund such projects.
- Target multiple audiences for maximum impact: households, businesses.
- Disclosure statement for real estate sales. State of North Carolina so far does not require seller to disclose hazard issues (i.e., sand bags under beach property) except flood plain and asbestos.
- Hold classes or education sessions for the public to understand more about the issues you may need to address if you are buying a second home at the beach.

Session 2 - Sustainable Coastal Development
Group 3
Facilitator: Jack Thigpen

- Outreach to developers on structural resiliency and placement of structures. Work with local governments and large groups to relay information, teach techniques – professional development. If you look at energy efficiency teach homeowners. Partners: NCNERR, NC Sea Grant.

- Alternative energy production = both positive and negative impacts to communities including equity. Getting the local voices involve with these issue. Partners: Military, academics, energy companies.
- How do we deal with loss of structures because of rising sea level – on coastal land? What sorts of policies do we implement? Determine what homes and businesses are at risks, what economic and legal analysis needs to be conducted, and what the options to deal with this? Partners: Local government because they are on the line to make these decisions, DCM, insurance companies.
- Receptiveness of local governments to consider sustainable development which includes how they understand this topic. Build awareness of options and offering facilitation for local conversations. Support participatory research. Include case studies in outreach. NGOs.

Session 2 - Sustainable Coastal Development
Group 4
Facilitator: Paula Gillikin

C=Concerns; O=Opportunities; P=Partners

- 3C=Interdisciplinary communications are needed between SG investigators; O=The SG Research Day is a good start; NSGO Library is another good one
- C= Human relationships to coastal resources, such as "attachment to place"; P= Duke Marine Lab; other social science experts; O=building upon what other groups have started (e.g., Saltwater Connections).
- 1C=Lack of understanding of community values and attitudes; O="Community Voice"; Economic studies; Promoting "Local"; P=Duke, Local government
- 8C=Disconnect between facts and perception (ex. NC State MEAS encourages science communication); O=Incorporate education and outreach into research projects; make it a part of university rewards program; Have scientific messages vetted through government agencies.
- 1C=Need to focus more on inner banks rather than barrier islands; O=Engage wider range of partners (agriculture, riverine, and general upstream users).
- C=Lack of information about type and rate of development; P=DCM for land-use plans, county planners
- 1C=A lot of cultural heritage, life, money on the coast; need to prioritize ; O=VCAPS implementation; if conducted, there is an opportunity to get information back to decision makers such that laws and policies can be created.

Top Concerns: Disconnect between facts and perception
Opportunities: Education/outreach; vetting information from sources;

Session 2 - Sustainable Coastal Development
Group 5
Facilitator: Christy Perrin

Management concerns

- Looking at the public opinion on re-nourishment vs. retreat. ECU project is conducting Internet sample of NC households. 5% live on the coast.
- Targeting people based on their concerns and based on where they live. What properties they live on. What are the values of primary and second home owners?
- Early warning for environmental concerns (e.g. HABS, storms). Develop infrastructure monitoring tools and then getting the tools/equipment into people's hands in order to conduct real-time monitoring.
- Development is based on plentiful funding for dredging, nourishment, etc. How do we plan for this as funding sources are decreasing? Can we sustain what has been done into the future? If the answer is "no," how do we plan for this?
- Putting a value on sustainable shorelines, or ecosystem valuation, on living shorelines instead of man-made structures. Economic analysis for the management community.
- After dredging, consider re-suspension of legacy contaminants such as DDT. Are we thinking about contamination associated with dredging?
- Too many people – over development. Need to identify sustainable planning options. Understand the number of people that can live in a certain area and still be able to maintain natural barriers (e.g. dunes, marsh). Conservation development in order to encourage population diversity in the natural world.
- Land-use plans – how are they created and implemented. Is there a real plan and are they used? Coastal counties – DCM mandates a county land-use plan.
- There is a challenge in communicating with local communities on development issues. Need to consider traditional communities, local access, etc. when considering sustainable coastal development.
- Good to look at lesson's learned from other states and other countries.

Research opportunities

- Cost/benefit analysis on alternatives for projects.
- Need attention paid to barriers to establishing sustainable development initiatives. What are the social and financial barriers?
- Research opportunities to document cost/benefit analysis of development practices. Is there adequate performance data on BMPs? Are there new BMPs that will be introduced as we move towards sustainable development practices?
- Right now we have more BMPs than we have economic analysis.
- RTI is conducting a land use optimization study in Chesapeake watershed; economic and environmental benefits of green infrastructure. Challenge now is to scale down to the township level.
- Economics – Need to measure tradeoffs (could be monetary) and use this info to inform management. Include communication strategies in order to better inform the target audience. This includes ecosystem services provided by the environment.

- Need to consider rural areas. They are funding limited so they may not be able to transform.

Session 3 - Safe and Sustainable Seafood Supply
Group 1
Facilitator: Chris Ellis

Information on economics, providing safe and sustainable seafood vs economics of not having safe and sustainable seafood

What specific info needed?
- Economic info- habitat in order to have seafood
- Emerging field
- Ecosystem services/evaluation of those services

Outreach component- make community members aware of seasonality, what is available- do community members know when is best time to buy specific species?
Water quality problem
- Shellfish closed
- Managers have not corrected problem
- Cannot take shellfish
- Regulatory regime- it is not clear if they have fixed problem- water is not being reopened
    - Point is to reopen these places
- Linkages
- Blame on storm water runoff
- Central waste water problem
- Other pollution problems: fish not supposed to eat due to mercury

Management regime has not restored access to closed fisheries: what do we have to do differently to make that happen?
- Partners: EPA (write rules, enforcement), DENR, coastal government (cities and counties), user community (folks who want to fish)

Protected from us, but off limits to us, water quality not getting good enough
Change Label: Safe Seafood and Sustainable Fisheries
Genetic diversity: aquaculture and fisheries
- How do we maintain diversity?
- There is a problem with farm fish getting into wild
- Disease vulnerability

Wild fisheries: high harvest reduces genetic diversity
Costs associated with construction of artificial reef, and long-term production of these reefs (what services do they provide)
- Initial investment vs long term benefit (potential fish production)

Stock assessments finfish and shellfish rely on landing data streams and fish monitoring programs (from state agencies etc.)

- These are not done in the best way; improve monitoring programs
- Are some measurements worth continuing? Are there others that need to be taken?

Gray areas in policy (state, federal, what waters are you in?)
- How do you get fish back to shore without breaking policy
- Maintaining a universal policy; what is and what isn't ok
- Measuring and maintaining fish stocks- what is a safe size to fish?
    - Threshold levels for fish to successfully maintain population

Improvements in stock assessment approaches
- How do you model fish populations (a lot of different ways to do that)?
- Need research into novel stock assessment techniques
- Research to fill some of data gaps
- Provide data for ecosystem based modeling- more data required for that
    - ID what those data requirements are

Model reliability- how do we know our model is reliable?
- Quality of the data
- ID what data we need, what we are lacking

Aquaculture and the environment
- Rely on aquaculture as a seafood supply; need to know about implications to environment: there is more to be done here
- Do not have to be negative, could be positive outcomes but need to verify that positives are positives
- Oyster culture; presumes that they have same effects on environment as a natural reef but they do not.

Validating stock assessment approaches
ID seafood portion size
ID one focus area for Safe Seafood, one for Sustainable Fisheries
Safe Seafood: water quality issue
Sustainable Fisheries: fish monitoring programs. Partners: state fisheries agencies (DMF), NOAA, NMFS, private fisheries groups, commercial fishermen (cooperative research).

Session 3 - Safe and Sustainable Seafood Supply
Group 2
Facilitator: Chrissa Waite

Emerging management issues and concerns:
- Fish kill rates
- Stimulate aquaculture production in the US (will we?)
- Marketing of farm raised fish and wild caught, public perception
- Polyculture – maximize effort and energy usage
- Water quality – source water of aquaculture
- Fiscal inaccessibility of property to implement successful aqua/polyculture

Opportunities:

- Commercial vs. Recreation (fish kill rates) research
- We need the support ($) for aquaculture at the legislative level, public level, extension programs – demonstration projects (Extension network through Sea Grant and NC State, probably not DMF?, USDA, NOAA fisheries)
- Aquaculture techniques (more research!) and better marketing
- Potential outreach/education (Extension, Industry [e.g. Whole Foods, Harris Teeter])
- Examples of successful polyculture – The Plant (Chicago) – NOAA fisheries, local municipalities
- Public land or leasing (legislature, DMF, Fisheries and aquaculture committee? Start some sort of initiative)
- "Aquapark" concept – somewhere for people to test their ideas (such as Marshallburg Farm)
- Use algal fatty acids in hatchery feeding

Session 3 - Safe and Sustainable Seafood
Group 3
Facilitator: Jack Thigpen

Is NC positioned to enhance aquaculture? Can do that but what about distribution?

- Need to get product to market. some of these aquaculture businesses are far from distribution areas

Concern: Seafood value chain
Opportunities:

- Create the products that chefs and consumers want.
- Some business models available that are being promoted to individual counties.
- Provide this to the industry to adopt using agriculture examples.
- New ways to produce and market seafood,
- Partners: NC Commerce Dept., NCDA, ECU, NC State, county/regional economic development councils
- Keep value in-state.

Concern: Do we have regulatory environment that will allow us to move aquaculture products? Compete with wild-caught product. Might also be different regulations for those?

- Distribution might be a problem because we are not in money fish.
- Part of fisheries reform act to promote aquaculture. Share with NCDA (planting/growing)
    - Rules to prevent against non-native species (where DMF comes in), there's already regulations for that.
- Bottleneck in getting a site established.
- Other agencies are involved in process, not just DMF.
    - Could be better coordination, DMF could address this.
    - Planning ahead is the best way to do it.
- Nothing in place to promote more shellfish culture in state within DMF.
- Some policies can restrain this:
    - Reporting requirements "onerous"
    - Process is established, it can be navigated but it doesn't promote ease

    - Streamline the process might be needed
    - What policies in place to determine leasing rights? Etc.?
- Coordination between agencies and permitting process at DMF could be improved.
- Potential to streamline.
- Hold workshop to combine the work on how to get a permit.

Concern: User conflict for a wild resource (recreational vs commercial)
Opportunities:

- Better knowledge about who is impacting it.
- Find source of current impacts.
- Get stakeholders groups to work together more frequently. Conflicts often based in misinformation, misperceptions. Collaborations bridge those gaps, appreciation for how each uses resources. Build trust.
- Strong special interest groups from rec community. Need for single voice for commercial fishermen that will represent them at the state level.

Partners:

- MFC (advisory groups)
- Catch Groups
- Academic researchers
- DMF
- NC restaurant association, tourism, hotels, hospitality industry
- Organizations representing recreational fishermen (such as CCA)
- Other constituent organizations

Concern: Habitat destruction
Connection between ecosystem health and safe and sustainable seafood needs to be understood

Opportunities

- Tidal creeks research
- Freshwater inflow all the way up before it gets to tidal creeks, needs to be quantified
- Already good ideas (e.g. CHPP) but need support for implementation
- Expand CHPP
- APNEP

Partners

- APNEP
- DENR
- USGS
- Academics
- NGOs: NCCF, TNC etc.

Session 3 - Safe and Sustainable Seafood Supply
Group 4
Facilitator: Paula Gillikin

Concerns:
Habitat – need to understand the best habitats for fisheries
Conflicts between various users

Example: oysters have parameters for success. Need to understand where to focus efforts – reefs and shellfish farming
Opportunities – measure habitat suitability through models, tagging.
Partners: NC State, UNC-CH IMS, UNCW, DMF
Oysters already are a good example of looking at fishery, habitat, etc.

- Must look at water quality issues that affect fisheries – examples: salinity, pathogens, and temperature.
- Oysters – can be conflict with other uses – riparian rights; leases regulations.

Concern: Pharmaceuticals and other pollution in waters

- Baseline testing and monitoring needed? Better water treatment to remove chemicals before it moves into surface waters and eventually to fishery nursery areas.
- ID concentration levels; what happens with long-term exposure? Does it hold in our system? What impacts are chemicals causing?

Aquaculture – opportunity because there is more control over the conditions.

- Change perception that commercial fisheries and aquaculture do not have to be at odds. Bring all to the table.

Concern: Climate change and its potential impacts on fisheries; NC critical location as biogeographic break that lends itself well to research. Topics include:

- Water temperature and salinity changes
- Pathogens
- HABs
- Changing ranges/distribution of species – including invasive species.
- Habitat range
- Increased acidification
- Plankton --- grazing patterns – lower levels of food web.

Concern: Lack of technology transfer – results and scientific data.
Work with business community to improve tests, etc.
Water Quality – top concern for fisheries

- Toxic algal blooms.
- Ocean acidification.
- Habitat health in general – healthy habitats for fisheries.
    - And linking those habitats to the various species, then taking back to different management strategies being implemented to see how we can impact management, like looking at co-benefits of oyster restoration (comment added after prioritization)
- Specific habitat – submerged aquatic vegetation.
- Fishery-independent assessments – seems like those are harder to do. A lot of assessments based on fishery data on catch returns. Ones that are independent of that also are useful to assess stocks.
- Contaminants – affect fish health or that bioaccumulate and affect human health.

- Aquaculture in general – cost benefit analysis, how sustainable aquaculture is and what impact it has.
- Nutrient enrichment and eutrophication – ties in with algal blooms and anoxia.
- Disease competition.
- Temperature increase and climate change.
- Overfishing.

Session 3 - Safe and Sustainable Seafood Supply
Group 5
Facilitator: Christy Perrin
Future research opportunities (e.g. perceptions of local vs. non-local seafood supply, fishery stock assessments and enhancement).

- Identify differences in impact/how to identify impacts of commercial vs. recreational fishing in different species.
- How climate variability/change impact fish stocks and/or fishermen. (Note "fish" and "fishermen" include finfish, crabs, oysters, shrimp, etc.)
    - Climate change impacts on food web, disease outbreaks, competitor species.
- Economic impacts of any of these things/valuation of services.
- Food web regime shifts in regard to how resilient the plankton are:
    - Additional comment: both top down and bottom up. What if there's overfishing on a species, what are impacts downwards.
- Invasive species.
- Designing experiments that look at multiple stressors – climate change, disease occurrence, increased competition, and algal blooms may be happening simultaneously.
- PARTNERS: interdisciplinary.
- Systems approach to community structures and composition.
- Policy research.

REPHRASED TOP CONCERN FOR REPORT OUT:

- How climate variability and change affects the system – food web regime, disease outbreaks, competitive species, stocks, and linking it all to fishermen and management decisions.

Session 4 - Healthy Coastal Ecosystems
Group 1
Facilitator: Chris Ellis

Water quality

- Once you get past the criteria to drive closures→nutrient loading.
- Nutrient loading.
    - So many more of us in coastal ecosystems, we are importing our food, and then excreting it and it goes into coastal waters

- Issue: nutrient loading imbalance, importing nutrients into coastal watersheds, nutrients stimulate bacteria too
    - Whole system is out of kilter due to nutrient loading
    - Effects: SAV, bacterial regrowth (function of phosphorus and dissolved organic carbon)

Closed areas serving as de facto reserves
- Depends on the location
- Other impacts on the oysters
- Need to tease apart
    - Not closing for turbidity, PCBs; only based on fecal coliforms

Ecosystem service component of oysters
- What will it take to protect that?
    - Nutrient standards, denitrification associated with oysters
    - Role of oyster reefs, oysters as nutrient managers (getting it OUT of the system)
- Research opportunity: oysters as nutrient managers: need to scale this to larger level
    - Integrate nutrient information into a spatial model to inform restoration (restoration is an ecosystem-scale effort)
        - Neuse River is a nutrient loading problem: currency in model is nitrogen

Studies that look at more than one habitat together
- Interdisciplinary project: look at habitats together not just oyster reef
- We view marine habitats as discrete
- Questions: how do we keep these habitats healthy and thriving- look at whole, not individual components, productivity of the habitat (habitat connectivity)

Top down vs bottom up control for water quality
- Important question in north Carolina, especially as you are changing both
    - Alter striped bass, alewives
    - Rectify how the system is function, management intervention
    - Managing a lot of different things- sometimes synergy, sometimes conflict

Priority issue: habitat connectivity
- Land-water interface, different parts of the “aquascape”
- Connectivity among those systems
- Management: how do different portions of “aquascape” interact with each other?
- Partners: university, states, coastal nonprofits, marine fisheries, NMFS, some federal fishes spawn in estuaries, NOS (habitat mapping)

Session 4 - Healthy Coastal Ecosystems
Group 2
Facilitator: Chrissa Waite

Emerging management issues and concerns:
- What do we consider healthy?
- Lack of understanding of how the system operates, its complexities.
- Ecosystem valuation.

- What policies are actually benefitting the system, or how are they impacting practices?
- How are the 46% of people that do not live at the coast being impacted by coastal water quality issues? They are impacting the coastal systems! They are dumping on them.
- Inter-institutional cooperation should be much better - people need to work together more!
- Exploitation of ecosystems once they are given value? Is it a bad thing? If not managed or regulated carefully, it could make things worse.

Opportunities:

- Monitoring! Lots of it, and long term (cooperation/collaboration among institutions).
- Education/outreach on coastal economy and how inland people are influencing coastal systems (general education that will capitalize on tourists – kiosks on ferries, ACOE, FEMA).
- Funding crunch makes us work together – cooperation is being incentivized – requirement for funding in grants – ask people in their proposals to do Use Cases / applications – where will the results go? Start thinking beforehand.
- Create a standard for how ecosystems are valued – "standard currency", literature reviews (Regulatory agencies, industry, local and regional governments, nonprofits [PEW Trust, Rockefeller])
- Policies need to be examined through a comprehensive review – Sea Grant could host a meeting to determine successful policy.
- Sea Grant data archive/library.

Session 4 - Healthy Coastal Ecosystems
Group 3
Facilitator: Jack Thigpen

Concern 1: Nutrient thresholds and criteria for water-quality standards that are protective of key species, ecologically appropriate

- Protective of biota that are out there
- Make sure the species can get a foothold
- That support biotic health

Opportunities:

- landscape conservation cooperatives (SALCC)
- GIS, water quality, statistical analysis to ID thresholds
- Decision support tool, visualization tool?
- Mapping + data + analysis

Partners: Water quality monitoring groups, DWQ, academics, regulators, USGS, EPA,

Concern 2: Habitat preservation

- Especially in light of predicted population growth.

Opportunities:

- Need a certain amount of habitat to maintain the conservation.
- CHPP and SHA
- Wetlands/marsh preservation that have been identified.
- Intentionally setting aside a set area in a space.
- Determining appropriate, relative proportions of critical habitat types to set aside, quantify and prioritize.

- ID habitat parameters that are needed for healthy ecosystems.
- Protect the watershed upstream.

Partners
- Academia
- DENR
- Land trust
- NGOs

Concern 3: Transferable data, de-siloing data
- Focus studies so we can make tools with data that come from different systems that are required for healthy ecosystem
- Wider application for the data (e.g., data from Wilmington can be transferred to other parts of coast)
- Also to the public
- Among organizations and general public
- Standardizing how data are collected/data layers

Opportunities:
- Coalesce databases
- Synthesis around habitat/issue to show what information/research is out there and future plans

Partners
- Specific-issue NGOs
- State and fed agencies, such as GSAA (cross-communication across states)
- EPA's interagency wetlands workgroup

Concern 4: Establishing better understanding of effects of land-based activities to aquatic habitats.
- Translating that into development planning.
- Growing and developing at a rate that surpasses the info we have on those issues.

Opportunities:
- Good example is Lockwood Folly project: Projected growth and looking at different scenarios and how that might continue (or not) to support resource there. Multiple scenarios.
    - Watershed planning, analysis that is focused on maintaining the resource.
- NERRS Science Collaborative is a good framework: academics are required to seek out managers, get feedback from stakeholders before they can proceed.
- Meld GIS data on land with that in the water.

Partners
- NCCF
- Local governments
- DENR
- NGOs

Concern 5: Responding to increasing rate of ocean-front erosion: How are we going to do it?
- Not even having the right debate about possible solutions

Opportunities:
- Economic analysis of costs of solutions (management strategy evaluation)

- Analysis of effectiveness of proposed solutions
- Ecosystem analysis
- Efficacy analysis: what works
- What is it going to do to the communities

Partners

- DCM
- CRC
- Academics,
- coastal geologists
- Local reps
- County government
- USACE: dredging and nourishment and their resources

De-siloing data will help with habitat preservation.

Session 4 - Healthy Coastal Ecosystems

Group 4
Facilitator: Paula Gillikin

TOP CONCERN:
Quantifying value of ecosystem services – concern and opportunity
Opportunity to encourage/build upon financial value/monetization – i.e.: tax benefits
Partners: UNC-CH, ECU, UNCW, NOAA, NCDENR
Identify conflicts with other options such as shoreline hardening.
Concern: Need holistic view of ecosystems: oyster reefs and surf zone/beach shown today but Sea Grant could expand this research and look at other ecosystems and habitats. Larger scales.
Partners: Sentinel Sites, Coastal Reserves and APNEP – already have a group that has interest in these topics and data. Onslow Bight Cons Forum; Cape Fear ARCH, etc.
Water Quality – similar to the seafood discussion

- Eutrophication
- Climate
- Others in seafood list

User conflicts – Opportunity to bring to table varied groups: developers who prefer hardscapes, Army Corps, navigation interests and others.
What is the baseline for Healthy Coastal Ecosystems?

- What is goal of restoration?
- Need to identify and then analyze long-term data sets.
- Use Big Data analytics to understand connections in existing data sets – i.e.: Coastal Atlas. Data integration.

How to link healthy ecosystems to community needs – identify the value to healthy humans?

- People not getting sick from eating oysters or other seafood.
- How to sell restoration work to broader community who may not understand the value of a healthy marsh.

Public health – not represented here today

- Many agencies and university programs dealing with these topics.

Need education/outreach to audiences to answer: How does it affect me?
- New partners: medical field.

Opportunities: Living shorelines may show ecosystem services & smart coastal planning.

Session 4 - Healthy Coastal Ecosystems
Group 5
Facilitator: Christy Perrin

Emerging management concerns which NCSG research could help address (e.g. septic system failure (N inputs), oyster restoration); include information about partnerships and integration.
- Invasive species
- (Comment: Group took "ecosystem" route with the seafood topic already – overlap.)
- Need for better data and monitoring. Don't have maps; don't have good understanding of where habitats are. Data needed to make good decisions not at our fingertips. Includes habitat types, characterization, monitoring, water quality data
    - Comment – a lot of info is out there but you can't find it. Communications, dissemination issue.
- Biodiversity loss.
- RTI leading ecosystem study on Camp Lejeune habitats, have a portal with 20 million data points that is available (DCERP project)
- Modeling capabilities at freshwater/estuarine interface.
- Having a decision support system for managers that talks about ecosystem services, including tradeoffs for various service values to help evaluate those tradeoffs
- Getting ecosystem services into the policy dialogue! Not usually in the statutes.
- Much of this could be coupled with sustainable development discussions
    - water quality and stormwater issues

Future research opportunities (e.g. marsh burning and food web interactions, ocean acidification in estuarine habitats). These opportunities can be physical science or social science based.
- Capitalize on partnerships.
    - Questions: USGS and APNEP: where do you see gaps?
    - UNC-CH IMS doing a good job of real time on the Neuse with his group, but monitoring data continuous and real time for Pamlico and Albemarle in general. Amazing how little, even just stage, is available. Rapid deployment for hurricane storm surge but don't have on a daily basis. General hydrodynamic models don't have enough information to create them.
    - Identified complexity and scale, but just can't get to it. Satellites available but can't measure nutrients with them. Data gaps are still a challenge.
    - Technology is coming along, so you can measure parameters of importance in strategic places, and have managers access it. Road flooding, HABs.
- Predictive tools would be holy grail. This much rainfall from a storm leads to telling agriculture how much fertilizer to put down in a field.

- Invasive species – don't have idea of what they are or how they will spread with climate change. At docks of Center for Marine Science see this.
    - Economic cost of these – can only find one study in UK of this.
- Communicating – to stakeholders. Being done but always a challenge. Importance of the work (ex. Invasive species, water quality) – make them understand why it's important to them (what's the direct impact).
- Business and economic valuations are really important for this – put a dollar value on it. Get biologists working with economists?
- Valuation of living shorelines.
- Shifting baselines – trying to get back to what it one was isn't always possible, so what is?
    - Notion of historical ecology – knowledge of how the system used to be.

NOTES ON PRIORITIZING:

- Data gaps come up in both.
- A lot of data IS being collected, but how to analyze and compare between systems? DCERP needs ModMon data, etc. How do we advance data sharing capabilities?
- EPA has data nodes and idea is people put their data there and make it more shareable. USGS and ECU submitted proposal to try to improve some of their own data sharing. But a lot of other data is living in a professor's hard drive, some UNIX box from the 1990s, etc. If you're an APNEP or some other funder, can you make archiving/data management part of funding to prevent this in future?

TOP CONCERNS:

- Facilitate data discovery and sharing, communication.
- Ecosystem assessment and valuation, including creating economic valuation data and weighing benefits of it.
    - Valuation done with decision-makers to determine where you want to be, what's acceptable, tradeoffs that must be made
    - Assessment tells you where you are now and what you need to get there
- Long-term monitoring (to see trends, variability, cycles)

Appendix D: Evaluation Form Responses

1. How successful was the symposium in the following areas:

Ranking options for 1A - 1D Numerical Ranking	Unsuccessful 1	Limited 2	Moderately 3	Very 4	Exceedingly 5	Average Score	Total Responses
A. Increased understanding of NC Sea Grant research & outreach *Number of responses per ranking*			7	42	22	4.21	71
B. Networking and partnership building *Number of responses per ranking*	1	6	19	31	14	3.72	71
C. Learning about emerging issues *Number of responses per ranking*		5	16	39	11	3.79	71
D. Increased understanding of NC Sea Grant impacts *Number of responses per ranking*			10	43	18	4.11	71

2. Research and Outreach

A. How satisfied were you with the combination format of panels and break-out sessions? See following pages for detailed responses
B. List opportunities for NC Sa Grant to share research and outreach information? See following pages for detailed responses
C. How could we improve the Symposium? See following pages for detailed responses

3. Social Media

Possible Answers	Yes	No	Total Responses
A. Do you use Facebook for coastal science and policy news?	23 (32.4%)	48 (67.6%)	71
B. Do you use Twitter to learn about coastal science and policy?	14 (19.7%)	57 (80.3%)	71

Possible Answers	< Weekly	1-2 times/week	Several times/week	Daily	Total Responses
C. If you use Facebook for coastal science and policy news, how often do you follow NC Sea Grant?	17	2	3	1	23
D. If you use Twitter to learn about coastal science and policy, how often do you follow @SeaGrantNC and/or @NCSG_katiem?	5	2	5	2	14

2A. How satisfied were you with the combination format of panels and break-out sessions?

64 responses out of 71 evaluations. Individual responses are listed below.

Seemed to work well with this group-will need to adjust for future NCSG efforts in communication, linking outreach and research, discussions with partners on needs, etc.
Very
Very satisfied.
I liked the combination approach. The breakouts were just a little short in terms of time.
Panel sessions were great. Break out sessions were okay. We were worn down by the 4th breakout. Maybe only 2 breakout sessions is enough.
I found the breakout session odd, but can understand their importance for sea grant.
Good but might have profited from more focused target groups - the range of people made the topic jump back and forth from a policy to a biology to an economic view point. It certainly was eye opening in regard to the view points I do not consider on a daily basis.
I did not like the assigned break out sessions. My group was dominated by two rather myopic, small-picture specialists. The facilitator was unmotivated to help facilitate conversation except from these two.
Worked better than I thought they would. Felt very compressed, would have liked at least 5 more minutes per breakout group.
This was the first time I have attended a symposium with this alternating design. It worked beautifully.
I appreciated the opportunity to both hear about past SG activities in plenary and discuss issues in more detail in break-out. While there was some fruitful discussion during break-out, I think the sessions were not particularly successful in drawing out deep discussion, both because of the short time period and the mix of participants.
The break-out sessions were a good idea, but the pace was a bit chaotic. We didn't really have much time to fully discuss any of the issues we were bringing up.
It was informational. By the end of the day, not as many people so, it was not as helpful.
Good variety of topics. Breakout sessions were a bit repetitive, though I understand the purpose.
I liked it and took part in good discussions but it seemed like people got a little tired of the break out sessions.
I was not satisfied with the format as it was but believe the general idea could work. As it was, the breakouts were too rushed to allow critical thinking, the group members were too diverse and many topics were completely out of their area of knowledge often, and the set-up with presentations was not very beneficial for the following discussions. Next time consider having fewer "sessions" during the day with each one having more or longer presentations and perhaps have someone do an opener for each session about what the topic area covers and questions that might be covered in the breakout, and have longer breakouts with people grouped in areas they have some background in. There could be multiple groups meeting simultaneously or you could have separate events for different topics so people don't have to choose. OR you could do several regional events (or one per year) that focuses on research being done in the area (e.g. one or a few river basins) - and this could include multiple topics but encourage discussion among many stakeholders.
I'm very satisfied.

Breaking up the presentations was great. I would suggest possibly holding concurrent sessions and break-outs in smaller spaces if possible. The short presentation times and large audience left little time for questions. Concurrent sessions mean you don't get to see everything, but the upside is that you can get a more in-depth presentation for the topics you're interested in. Personally, I prefer the latter. The break-out sessions were great, but having them in such a large room made it difficult to hear.
I really enjoyed the break out sessions to make stronger connections with participants and share ideas.
Worked well - impressed with the time management aspects and focus on-point.
I thought the breakout sessions were very useful. I was glad for the opportunity to provide input and to hear what issues my colleagues believe are important.
Great! Maybe have circles instead.
I liked the format. Allowed us to focus on certain objectives then move on.
Fairly. Would have liked group swaps after the sessions. New people.
Moderate.
Breakout sessions not very helpful. Same old issues. Plus hard to hear with multiple groups in room.
Very interesting format.
Good. It provided an opportunity for discussion.
Very.
It was great. Very interesting work is being done.
It felt a little rushed, though I can't really think of a better way to do it!
Very - liked the pace.
Very effective in increasing understanding and beginning discussions on how to advance needs in thematic areas.Further investigation/discussion is needed to further flesh out concerns and opps (next step).
Worked well, but perhaps one session too many for a day trip.
Reasonably satisfied, although the mix of "science meeting" talks versus more issue-based talks was sometimes confusing.
Good.
Good format but would have liked a little more time for networking. Glad we got to talk to each other.
Satisfied. It was great to have the opportunity to pitch in.
Good.
Good. Early breakouts seemed short.
I liked the combo of panels and breakout sessions. The small groups were big enough to have enough discussion, but small enough to give those who wanted to speak to have the opportunity to speak.
Breakout sessions fairly useless, everybody talking about the obvious ... improved communication, more research, inter-agency cooperation, etc. ... broken record but no action.
Very satisfied.
Very.

Could benefit by inclusion of local stakeholders and decision makers.
The time allocated to each format was good.
A little confusing on the end goal of breakout groups.
Satisfied, although it became rather repetitive after four sessions - maybe some plenary speeches later in the day would have been helpful.
Very Satisfied
Fairly satisfied. I think the panel topics could have been introduced more clearly. To get the panel started, the moderator could have had a starting question that all panel members could answer. The break-out sessions were well facilitated but perhaps we should only have had two group sessions...the afternoon sessions were not well attended.
I liked the shorter, 10 minute talks with the panel questions at the end. I do think we could have done with fewer break-out sessions. Maybe just one at the end next time.
I liked this format; however, there was not enough time in the breakout sessions.
Satisfied - got a bit rushed on some sessions though, and losing people by final breakout changed dynamics of discussion.
While the breakouts were short because of the one-day format, I thought it was important to capture discussions from the audience as well as presenters. I liked that everyone heard all the panels -- to see connections across the topics. Also, the short format and focus on impacts had them answer the obvious question about any results: So what?
This was an interesting format that I had not seen before and it things easier to understand.
Moderately satisfied. The venue did not lend itself well to these breakout session, and the time allotted was insufficient.for discussion. Moderators did not stick to the session topics, generally.
Good, although a little long and quiet at the end
Very satisfied. Broke up the time nicely.
Fairly content
Satisfied
Like the short presentations coupled with extended discussion and QnA period. This format allowed for non-traditional thematic partners to hear about what others were doing with SG funding. The breakouts were too many and too short to be really effective, IMO.
I found the break out sessions not very satisfying. The facilitator moved quickly from ideas about problems to 'opportunities' and 'partners'. It just isn't the way I think about research, and it seemed the final lists were random, based on who was willing to speak up in the constrained circumstances.
Good, although a little long and quiet at the end.
An interesting format, but determining priorities via input from the break-out sessions was not practical in my view. The session on seafood was heavily dominated by water-quality specialists, so developing new markets for local seafood was predictably low priority for this group.
It seemed effective.

2B. List opportunities for NC Sea Grant to share research and outreach information.

33 responses out of 71 evaluations. Individual responses are listed below.

Great need to reach out within and across the UNC System, including but not limited to minority colleges and universities, community college system.
I would love a booklet or something for potential grant applicants that talks about effective outreach programs and how to go about putting something together. I feel very weak in that aspect of the grant process and have not found a great deal of resources either.
Conferences in specialty fields. One example is to partner with FEMA in delivering the VCAPS methods for identifying risks, actions, and mitigation strategies. This could be presented as the annual Association of the Society of FloodPlain Managers (ASFPM). Other examples too - you get the idea. See next comment.
I think maybe having some focused forums (separate forums for each of the focus areas) might bring more stakeholders together that have specific experiences.
NC Sea Grant could organize events in the state to share research in topical areas not just SG funded projects (e.g., oyster restoration). This could include more controversial issues that might be priority topics for us where facilitated discussions or simply opportunity for discussions could allow or encourage movement on a topic (e.g., sea level rise or climate change planning).
Social media
Liaison with relevant citizens' and management-oriented groups - BIWA, CRAC, etc.
Integrated with NC Coastal Atlas.
Provide more funding for academic outreach programs.
Create a library of projects. Calendar (digital) of events. Advertise.
How about an online newsletter? Although this might already exist and I am not aware of it.
This symposium should be annual!
I'm not aware of how this information is currently shared.
Perhaps if there was a general means to communicate research outcomes and applicability to local governments (via COG meetings, etc.) that would help incorporate results into practice.
Could Sea Grant conduct a workshop on how to improve outreach?
More extensive website.
Improve your website and add data obtained (papers published, databases, GIS maps). Make the information available.
Would like to see a list of projects and funding source as well as NOAA, State, etc needs.
Collaborate with NCEE. Storify to summarize conference.
Require proposers pf projects to create use cases to project how the research will be useful (and to software developers who write ? in order to know how the design ? that meets user requirements). Possibly, attach the annual reporting from the call for proposals, to get proper thinking harder about SG expectations as they design projects. Convene meetings of NC legislators and researchers for mutual exchange to lead to policy reform. Identify potential for collaboration or cooperation.
Association of State Floodplain Managers (NC & National).Governor's South Atlantic Alliance. National Emergency Management Association. NC Emergency Management Association.
Encourage Sea Grant staff to continue participating in partnerships.
State Fair Booth - Show impacts and wide reach of most impressive projects and efforts.
Public events (Beaufort Farmer's Market, Earth Day events, NC Seafood Festival).
More articles in the newspapers (print and on-line) about the program and its research - this might help the general public understand the program and its issues.
Host meetings in coastal locations to entice other researchers.

Increased collaboration between NCSG researchers and extension specialists
Co-sponsoring coastal science conferences with other programs. Maybe rotate leadership each year among Sea Grant, APNEP and NC Coastal Reserve? Or see below re: grad students?
Investigators should be required to incorporate a robust plan for outreach in their proposals. The audience may vary from other researchers to industry partners to the public at large, but this activity should be a valued component of each proposal.
Symposiums like this, Coastwatch, social media (Facebook, Twitter), advertise the symposium to undergrads in nearby universities that are not necessarily involved in the research but may be interested. (Undergrads in NCSU's College of Natural Resources, College and Biology, CALS).
Cape Fear River Watch
We need to share the great work we're doing with legislators and their staff.
No ideas come to mind.

2C. How could we improve the Symposium?

54 responses out of 71 evaluations. Individual responses are listed below.

I think it went great--perhaps longer for poster session, perhaps more targeted questions depending on the audience/need (e.g. technical advances needed, tool development needs, next generation technologies to apply, emerging/future issues to consider).
More give and take discussion with presenters and less break out time.
I would love to know more about other groups' dicussion results from the breakout sessions.
More time devoted to breakouts. I would suggest another 15 minutes per breakout session would be good.
Great job. Have dessert in the poster session after lunch. Move the posters to a larger area so there is more space between them and people can eat their cookies and brownies, etc. while browsing through the posters. The area between posters was not adequate for the amount of people trying to view them.
It was somewhat mismatched between its theme and the audience. The talks seemed to be geared towards informing funders or government partners, but I didn't see very many in attendance. It seemed mostly academics, who don't really need that information. While the possibilities for outreach were interesting, there was very little "here is how you can accomplish this as well" which would have been very welcome. If the audience will primarily be academics, something more along the lines of a traditional report results conference would be more appropriate.
Panel members may have come up with theme questions that may have raised more vivid discussions.
The mix of topics brought together some radically different foci. I think it would be great to develop each of the topics among a more far-reaching audience. It seems like inside of this academic/research bubble, the needs of the users and stakeholders on the ground are not adequately addressed. Involvement of end users may help to ground some of the efforts and steer the research paths towards more useful and less esoteric investigations. Sea Grant has the key to bringing the two together unlike the academic institutions themselves, yet they do not seem to be using that key to open the door and bridge that gap.
start earlier...see above.
At the start of each breakout, state the goal set by NC Sea Grant for that discussion. The reasoning (relative impact) for that goal was implied, but still unclear for some who are new to the coast.
Move the lunch session to allow more time for the poster session!
Expand on the break-out sessions; focus on topical experts in small groups with more time to draw out more detailed answers.
Consider more forums that appeal to subsets of constituents.
I would have only had 3 breakout sessions. Attendence drops off, which is not kind to the presenters, but understandable as the day was very long.
Maybe highlight a little more on the front end that is will be a discussion or information exchange rather than a standard conference so people come more prepared to interact.
Please see about comments.
Include presentations of ongoing Sea Grant funded projects.
As above, I would have preferred opportunity for more in-depth discussion of the projects.
More guidance to speakers on desired format of their talks - some presented little or no results.
I think the symposium could be improved by extending the program by half a day. I think there was too much packed into a one-day event and believe even more valuable discussion could have taken place if there was more time to devote to breakout discussions.
More frequent.

More frequent.
See above. Group swaps after the sessions. New people. Create a library of projects. Calendar (digital) of events. Advertise.
Get rid of lightening rounds. More time for questions.
More questions.
Only one breakout session.
It was an excellent symposium. Thank you.
I liked the format. But might be more effective to have separate poster session from lunch.
The breakout groups got repetitive. Maybe group some of the themes/panel discussions to allow for fewer but longer breakout groups on several topics.
Intro more policy-related issues.
Do on a regular basis to showcase/synthesize work in topical areas.
See # 1. Worked well, but perhaps one session too many for a day trip.
More time for posters (i.e. not during lunch).
Mix groups from session to session.
I guess I wasn't sure of the goal of the symposium/breakout sessions. IDing future funding areas? Thank you!
Symposium has been great.
Would like to see presentation information ahead of meeting.
Time for more structured networking - "speed-meeting" or other mechanism.
More time for questions in panel discussion (for times when there were more questions).
No changes needed. Excellent as is.
No seafood for lunch? How does that happen?
Explain role and intended purpose of information gathered during breakout groups.
Encourage people to stay until end! Closing plenary?
Fewer small-group breakout sessions.
Have managers as the panelist. This way the audience can learn directly from the management community about research impacts.
Would have liked more time for networking between transitions to panels and break-outs.
I did not have enough time to appreciate the great student posters. The day was already packed, so we could not provide more time at lunch. If you tried to put them the night before, you would likely only get a small portion of the audience. Maybe alternate years among partners to have one similar to this year and the next one that focuses on grad students?
The time frame was too short for coverage of the broad suite of program activities. Separate the symposium into focus areas, allow more time for discussion, arrange a venue with appropriate settings to facilitate the discussions.
Advertise the symposium to undergrads in nearby universities that are not necessarily involved in the research but may be interested. (Undergrads in NCSU's College of Natural Resources, College and Biology, CALS)

Adhere to the time frame establish by the schedule
Maybe more space for posters (spread them out some)
Its difficult to do everything in one day between 8 and 5 pm. It is a lot for people to process and contribute to but there are tradeoffs to breaking up the meeting into multiple days as well. People become tired and unfocused for 8 hr events. May be good to have formal evening function beforehand and then shortened meeting the following day.
Again, break-out sessions should not be used to set #1 priorities for our topic areas. That information should be assembled, reviewed and set by management in consultation with field personnel.

Appendix E: Participants

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