

North Carolina **Coastal Conference**

November 19-20, 2019

Wilmington, N.C.
#NCCoastalConf
ncseagrant.org



Welcome from North Carolina Sea Grant

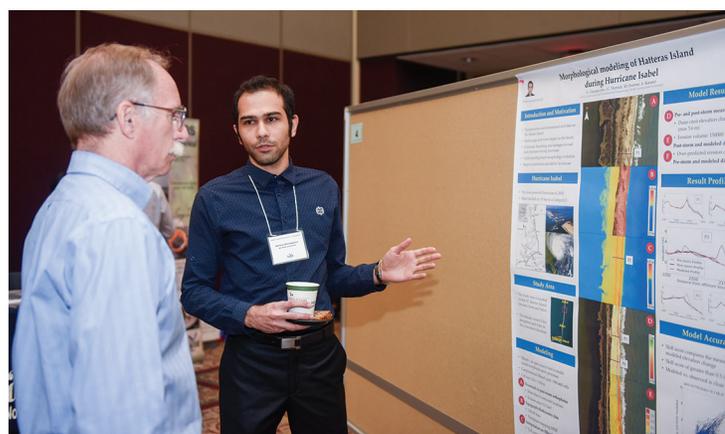
On behalf of the North Carolina Sea Grant team, welcome to the 2019 North Carolina Coastal Conference! I am confident that you will be enlightened and challenged by a great mix of presentations and perspectives over these two days. You likely will find a common theme of resilience in many sessions. While the word often is highlighted in response to and preparation for storms, we also see a broader sense of resilience, including in our coastal ecosystems, economies and communities overall.

Our keynote speakers bring perspectives from outside North Carolina. Michelle Covi comes from just over the border in Virginia to share the challenges and lessons learned in the Hampton Roads region. Timothy Gallaudet brings the National Oceanic and Atmospheric Administration's perspective on resilience of the Blue Economy. This year's conference has a few changes, based on comments from attendees at past events. For one, we are at the coast. In 2015 and 2017, we brought coastal and watershed topics to Raleigh to encourage statewide discussions. This year we are here in Wilmington, one of many areas hit by flooding from Hurricane Florence last year. You also will hear from scientists and community leaders along our northern and central coastal regions.

This whole week has a focus on future leaders, as our program is a co-sponsor of a regional Coastal Careers Workshop. The Coastal Society is leading the series to honor the late Margaret A. Davidson, who was a mentor to me and to countless members of the coastal workforce. She also was the keynote for our first North Carolina Coastal Conference.

We also opened up our planning process, by requesting proposals for oral presentations and posters — and our new category: lightning talks. The variety is clear in the concurrent sessions. Also take note of special sessions throughout the conference. We offer thanks to partners who have identified and invited speakers and who offer alternate formats for discussions.

We also give special thanks to our sponsors. Four provided the highest level of support: the University of North Carolina System; NC State University's Office of Research and Innovation; the University of North Carolina Wilmington; and the University of North Carolina at Chapel Hill's Office of Research. You will see them highlighted in this program guide.



Students present posters at the 2017 North Carolina Coastal Conference.



Other sponsors include: the N.C. Biotechnology Center; NOAA's Southeast and Caribbean team; East Carolina University's Integrated Coastal Programs; the Kenan Institute for Engineering, Technology & Science; the Albemarle-Pamlico National Estuary Partnership; and the North Carolina Water Resources Research Institute. We also are especially pleased to have a sponsor that notes the role of music, humanities and arts in the lifeblood of our coast: King Mackerel and the Blues are Running.

The closing of this letter is actually the opening of a great conference. We invite all of you to engage, including but not limited to posing questions to speakers during sessions, discussing research that students present in their posters, and, especially, meeting someone new and finding common experiences and goals.

Sincerely,

Susan N. White
North Carolina Sea Grant Executive Director

Table of Contents

Sponsors	2
Keynote Speakers	5
Agenda	6
Guest Speaker Bios	11
Concurrent Session Abstracts	15
Lightning Talk Abstracts	27
Poster List	30
Poster Presentation Abstracts	31
Venue Map	37

Follow us on Facebook and Twitter • Share your conference experience with #NCCoastConf



@NCSeaGrant



@SeaGrantNC

**Community Collaborative Research Grant
applications due Jan. 20, 2020.**

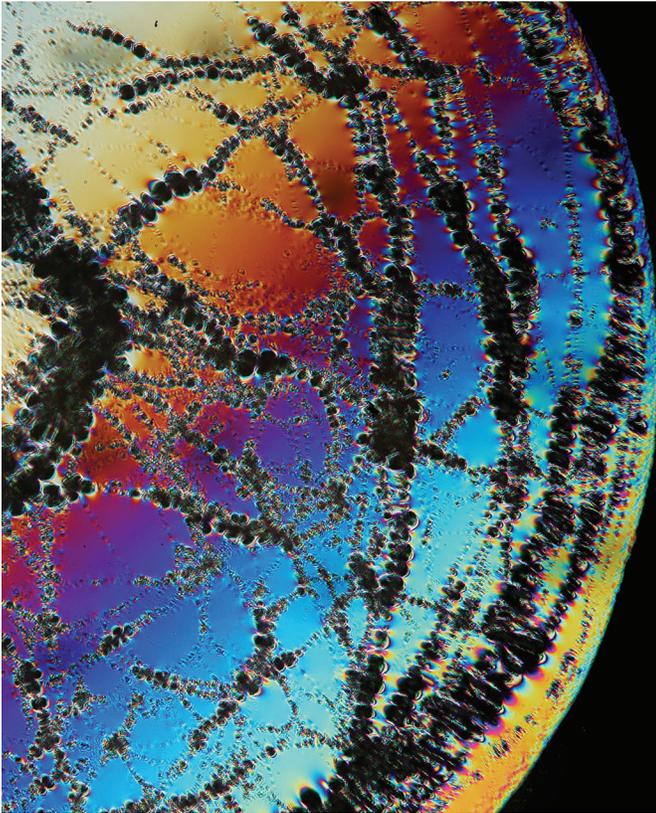
Details: ncseagrants.org



*Your link to research and
resources for a healthier coast*

Thank You to Our Sponsors!

Emerald Level



Results

the research and innovation magazine of NC State.

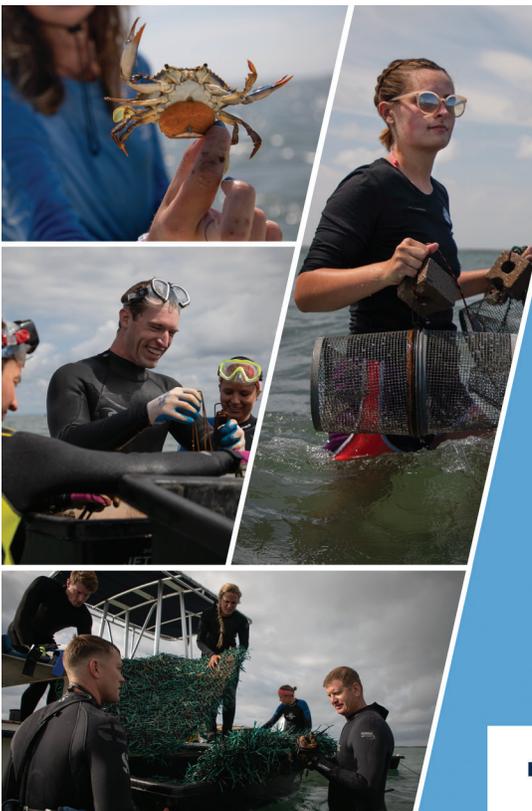
Wherever it starts—in a lab on campus, in a field in rural North Carolina, on an island in the Pacific—NC State research finds the same destination: **the real world.** Our researchers engage with real global problems, and they find real solutions. Find out about our research by visiting *Results* magazine.

NC State. Think and Do.

results.ncsu.edu

NC STATE
UNIVERSITY

Photo Credit: Taylor Neumann, NC State Envisioning Research



 | RESEARCH

Serving North Carolina, Changing the World

5th

Federal Research Expenditures Nationally

\$1.1
BILLION

Total Annual Research Spending

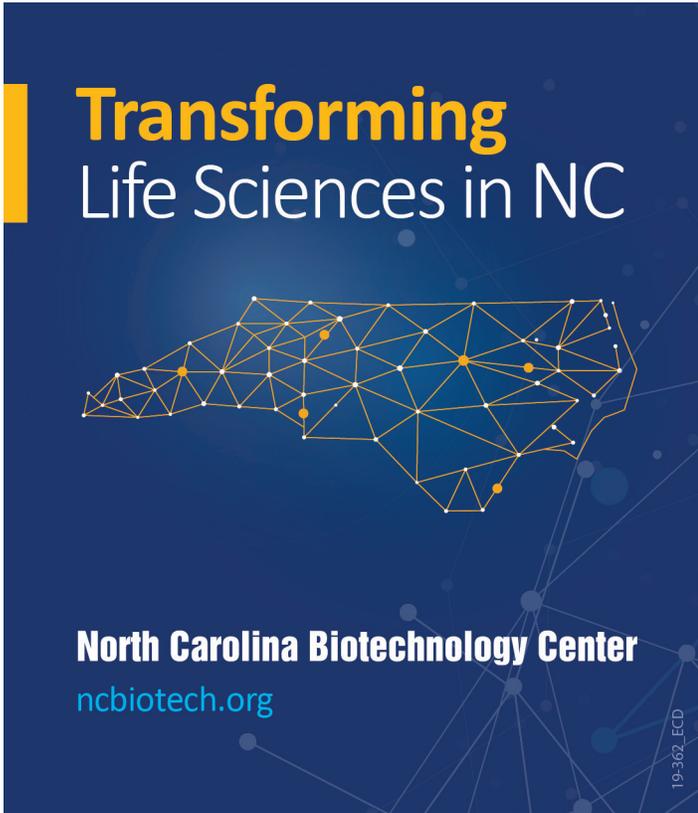
11K+

UNC Employees Funded by UNC Research

research.unc.edu | Follow us on social media @UNCRResearch

Thank You to Our Sponsors!

Sapphire Level



Ruby Level



Crystal Level



Tuesday Keynote Speaker



Michelle Covi, Old Dominion University and Virginia Sea Grant

Michelle Covi is a Virginia Sea Grant extension partner and a member of Old Dominion University's faculty in ocean, earth and atmospheric sciences. She conducts research and outreach activities for climate adaptation and coastal resilience efforts for Virginia's coastal communities. Her research areas include sea-level rise risk perception and communication, public participation in adaptation planning processes, and other engagement/outreach practices. She co-organizes the Hampton Roads Sea Level Rise/ Flooding Adaptation Forum, a quarterly meeting of adaptation stakeholders, and has served on the Governor's Advisory Council for Environmental Justice. She has a doctorate in coastal resources management from East Carolina

University, where she focused on sea level rise risk communication and policy, including working on several North Carolina Sea Grant projects. She has a master's degree in marine science from University of Georgia, where she studied salt marsh ecology.

Wednesday Keynote Speaker



Rear Admiral **Timothy Gallaudet**, U.S. Navy Retired, U.S. Department of Commerce, and National Oceanic and Atmospheric Administration

Since October 2017, Timothy Gallaudet has served the U.S. Department of Commerce as the assistant secretary of commerce for oceans and atmosphere, and as deputy NOAA administrator. His current duties include leadership in NOAA's efforts to power the nation's Blue Economy. Previously, Gallaudet had risen to the rank of rear admiral in the U.S. Navy, where his service included roles as oceanographer of the Navy and commander of the Navy Meteorology and Oceanography Command. During his 32 years of military service, he gained experience in weather and ocean forecasting, hydrographic surveying, developing policy and plans to counter illegal, unregulated and

unreported fishing, and assessing the national security impacts of climate change. He has led teams of Navy sailors and civilians performing diverse functions, such as overseeing aircraft carrier combat operations, planning and conducting humanitarian assistance and disaster response efforts, assisting Navy SEAL Teams during high visibility counter-terrorism operations, and developing the Navy's annual \$52 billion information technology, cyber security and intelligence budget. Gallaudet holds a bachelor's degree from the U.S. Naval Academy, and oceanography master's and doctoral degrees from Scripps Institution of Oceanography.

Agenda

Tuesday – November 19

<p>8:30 a.m.</p>	<p>Registration Load presentations, set up posters and exhibits, enjoy coffee and morning refreshments</p>
<p>9:00 – 9:45 a.m.</p> <p>Lower Level Grand Ballroom</p>	<p>Welcome and Opening Session</p> <p>Susan White, North Carolina Sea Grant Jonathan Pennock, National Oceanic and Atmospheric Administration National Sea Grant College Program Christopher Finelli, University of North Carolina Wilmington Mladen Vouk, North Carolina State University</p>
<p>9:45 a.m.</p> <p>Lower Level Grand Ballroom</p>	<p>Keynote</p> <p>Perspectives on Coastal Resilience Michelle Covi, Old Dominion University and Virginia Sea Grant</p>
<p>10:15 – 10:30 a.m.</p>	<p>Networking Break</p>
<p>10:30 – 12:00 p.m.</p> <p>Lower Level Grand Ballroom</p>	<p>Resilient Communities: Urban and Rural Perspectives</p> <p>Veronica Carter, Brunswick County Voluntary Organizations Active in Disasters Mark Willis, NOAA National Weather Service, Wilmington Lawrence Cahoon, University of North Carolina Wilmington</p>
<p>12:00 – 1:30 p.m.</p>	<p>Lunch and Networking</p>
<p>1:30 – 3:00 p.m.</p> <p>Bellamy Room</p> <p>1:30 – 1:45</p> <p>1:45 – 2:00</p> <p>2:00 – 2:15</p> <p>2:15 – 2:30</p> <p>2:30 – 3:00</p>	<p>Concurrent Session 1</p> <p>Water Resources Moderator: Frank Lopez, North Carolina Sea Grant</p> <p>Adverse Ecological Impacts of Novel and Legacy Per- and Polyfluoroalkyl Substances (PFAS) in Coastal North Carolina, Scott Belcher, NC State</p> <p>Wastewater Treatment in the Coastal Plain: Planning for Resilience and Water Quality Protection, Victor D’Amato, Tetra Tech</p> <p>Watershed Education with the NC Watershed Stewardship Network, Christy Perrin, NC Water Resources Research Institute (WRRRI)</p> <p>Maintenance Costs of Stormwater Control Measures in North Carolina, Sarah Waickowski, NC State</p> <p>Q&A with Panel</p>
<p>DeRosset Room</p> <p>1:30 – 1:45</p> <p>1:45 – 2:00</p> <p>2:00 – 2:15</p>	<p>Education and Learning Perspectives Moderator: Terri Kirby Hathaway, North Carolina Sea Grant</p> <p>RAIN: A School-to-Community Citizen Science Program, Colleen Karl, State Climate Office of North Carolina</p> <p>Using Pocket Lab Sensors to Uncover the Science Behind the Storm, Harris Muhlstein, UNC Wilmington MarineQuest</p> <p>Engaging Lifelong Learners Through Citizen Science, Miriam Sutton, Science by the Sea</p>

Agenda continued

2:15 – 2:30	Empowering Youth to Contribute to Climate Resilience Efforts in Their Communities, Dana Haine , UNC Institute for the Environment
2:30 – 3:00	Q&A with Panel
Dudley Room	<p>Coastal Economic Development Moderator: Chris Ellis, NOAA Office for Coastal Management</p>
1:30 – 1:45	Transient Boaters’ Potential for Economic Development on N.C. Communities Proximate to the Atlantic Intracoastal Waterway, Hans Vogelsong , ECU
1:45 – 2:00	What’s the Hook for Fisheries Education Efforts? Lessons Learned While Communicating Science to N.C. Saltwater Anglers, M. Scott Baker Jr. , North Carolina Sea Grant
2:00 – 2:15	From Rivers to Sounds: A Natural Resource-Based Model for Sustainable Coastal Ecotourism in the Bertie Peninsula and Waterscape, Stanley Riggs , ECU, NC Land of Water
2:15 – 2:30	Mariculture Workforce Development, Jane Harrison , North Carolina Sea Grant
2:30 – 3:00	Q&A with Panel
Latimer Room	<p>NC Sentinel Site Cooperative: Research Updates (Double Session) Session 1 Moderator: Sarah Spiegler, North Carolina Sea Grant, NC Sentinel Site Cooperative</p>
1:30 – 1:40	Welcome and Introduction to NC Sentinel Site Cooperative, Sarah Spiegler , North Carolina Sea Grant
1:40 – 2:00	Marshes: North Carolina’s Coastal Wetlands in an Era of Sea Level Rise, Jenny Davis , NOAA
2:00 – 2:20	Marshes: Resilient Coastal Sites for Conservation in North Carolina and the South Atlantic United States, Brian Boutin , TNC
2:20 – 2:40	Dunes and Beaches: The Influence of Dune Aspect Ratio, Management and Beach Morphology on the Protective Services of Coastal Dunes, Michael Itzkin , UNC-Chapel Hill
2:40 – 3:00	Dunes and Beaches: Remote Sensing and Machine Learning Aid in Examinations of Land Change, Justin Ridge , Duke Marine Lab
3:00 – 3:15 p.m.	Networking Break
3:15 – 4:45 p.m.	Concurrent Session 2
Bellamy Room	<p>Community Preparedness and Resilience Moderator: Christy Perrin, North Carolina Sea Grant</p>
3:15 – 3:30	Hurricane Preparedness and Recovery: Down East Perspectives, Karen Ampacher , Core Sound Waterfowl Museum & Heritage Center
3:30 – 3:45	Strengthening Rural Resilience in N.C. Coastal Communities: Challenges and Opportunities, Frank Lopez , North Carolina Sea Grant
3:45 – 4:00	The Place We Call Home: A Critical Analysis of the Risk Perceptions and Place Attachments of Coastal Communities at Risk for Sea Level Rise in North Carolina, Michelle Divil , Florida A&M University
4:00 – 4:15	Deaf Community Partnerships and a Different, Different World: An Exercise in Hazard Communication Challenges, Steven Pfaff , NOAA National Weather Service
4:15 – 4:45	Q&A with Panel
DeRosset Room	<p>Species Science and Aquaculture Moderator: M. Scott Baker Jr., North Carolina Sea Grant</p>
3:15 – 3:30	Survival and Density of a Dominant Fish Species Across a Gradient of Urbanization in N.C. Tidal Creeks, Paul Rudershausen , NC State
3:30 – 3:45	UNCW Pilot Hatchery Studies Improve Availability and Cost of Black Sea Bass Fingerlings to Support Education, Outreach and Commercial Growout Trials in the Eastern U.S., Wade Watanabe , UNC Wilmington

Agenda continued

3:45 – 4:00	Sweating the Speckles: Darker Least Tern Eggs Become Hotter Under Direct Solar Radiation, Rebekkah LaBlue , UNC Wilmington
4:00 – 4:15	Partners in Slime: Headstarting Gopher Frogs at the N.C. Aquarium, Carol Price , N.C. Aquarium at Fort Fisher
4:15 – 4:45	Q&A with Panel
Dudley Room	Gullah/Geechee Resiliency: Traditional Knowledge Education from a Carolina Living Cultural Community Moderator: Queen Quet, Gullah/Geechee Nation
3:15 – 3:30	Queen Quet , Gullah/Geechee Nation
3:30 – 3:45	Dan Rizza , Climate Central
3:45 – 4:00	Katie Derickson , Gullah/Geechee Sustainability Think Tank
4:00 – 4:45	Discussion
Latimer Room	NC Sentinel Site Cooperative: Research Updates (Double Session) Session 2 Moderator: Sarah Spiegler, North Carolina Sea Grant, NC Sentinel Site Cooperative
3:15 – 3:35	People: Assessing the Damage from Hurricane Matthew and How People Surveyed Indicated an Increased Concern for Coastal Hazards, Including Sea Level Rise, Carter Smith , Duke Marine Lab
3:35 – 3:55	People: NWS Advancements and Building Partnerships Over the Past 10 Years: Improving Readiness for Hazardous Weather Events, David Glenn , NOAA National Weather Service
3:55 – 4:15	Water Quality: Impacts of the New Normal in Tropical Cyclone Rainfall and Flooding on Assessing and Managing Estuarine/Coastal Water Quality, Hans Paerl , UNC Institute for Marine Sciences
4:15 – 4:30	Water Quality: Nitrogen Inputs Along our Changing Coasts: Evaluating the Role of Onsite Wastewater in an Era of Climate Change, Michael O'Driscoll , ECU
4:30 – 4:45	Discussion
4:45 – 5:30 p.m.	Networking Break
5:30 – 7:30 p.m.	Poster Session and Networking Reception at Hotel Ballast

Wednesday – November 20

8:30 a.m.	Registration Load presentations, enjoy coffee and morning refreshments
9:00 a.m.	Welcome and Opening Session
Lower Level Grand Ballroom	Susan White , North Carolina Sea Grant John Nicholson , North Carolina Department of Environmental Quality
9:20 – 10:00 a.m.	Keynote
Lower Level Grand Ballroom	NOAA's Blue Economy Initiative: North Carolina Connections Rear Admiral Timothy Gallaudet , U.S. Navy Retired, U.S. Department of Commerce, and National Oceanic and Atmospheric Administration

Agenda continued

10:00 – 10:15 a.m.	Networking Break
10:15 – 11:45 a.m.	Concurrent Session 3
Bellamy Room	<p>Adaptations to Changing Conditions Moderator: Chris Ellis, NOAA Office for Coastal Management</p> <p>10:15 – 10:30 Science Advice to Policymakers: Lessons from North Carolina’s Sea Level Rise Controversy, Jessica Weinkle, UNC Wilmington</p> <p>10:30 – 10:45 Hurricane Florence’s Unique Aspects, Impacts and Decision-Support Services in Southeastern North Carolina and Northeastern South Carolina, Reid Hawkins, NOAA National Weather Service</p> <p>10:45 – 11:00 Understanding Climate Change Adaptation in Rural Eastern North Carolina: Perceptions of Risk and Barriers to Action, Cynthia Grace-McCaskey, ECU</p> <p>11:00 – 11:15 Coastal Resiliency and Shoreline Restoration: Design and Post-Construction Review of Living Shoreline Projects, Ben Nash, Brown & Caldwell</p> <p>11:15 – 11:45 Q&A with Panel</p>
DeRosset Room	<p>Estuarine Ecosystems Moderator: Sara Mirabilio, North Carolina Sea Grant</p> <p>10:15 – 10:30 Teaming Up on the Mean Green: Multi-institutional Collaborations to Address the Chowan River Bloom Problem, Nathan Hall, UNC-Chapel Hill; Colleen Karl, Chowan Edenton-Environmental Group</p> <p>10:30 – 10:45 Mapping Coastal Protection and Carbon Storage by North Carolina’s Coastal Habitats, Katie Warnell, Duke</p> <p>10:45 – 11:00 Two Years of Neuse Estuary Hypoxia Forecasts: Lessons Learned and Future Directions, Daniel Obenour, NC State</p> <p>11:00 – 11:15 Impacts of Invasive <i>Phragmites australis</i> on Nitrogen Processing, Mollie Yacano, UNC-Chapel Hill</p> <p>11:15 – 11:45 Q&A with Panel</p>
Dudley Room	<p>Lightning Talks Moderator: Sarah Spiegler, North Carolina Sea Grant, NC Sentinel Site Cooperative <i>Each speaker is allotted five minutes.</i></p> <ol style="list-style-type: none"> 1. Cape Hatteras Lionfish Mitigation Case Study, Jordan Bridges, N.C. Aquarium on Roanoke Island 2. Thriving in Sun, Salt and Sand: Seacoast Plants of the Carolinas, Paul Hosier, UNC Wilmington 3. Science Communications Strategies, Frank Graff, UNC-TV 4. Seaside/Saltmarsh Sparrow Ecology, Evangelyn Buckland, UNC Wilmington 5. The State Climate Office of North Carolina, Kathie Dello, State Climate Office 6. Using Citizen Science for Wetland Monitoring, Kim Matthews, Carolina Wetlands Association 7. Student Perspectives on Coastal Change, Evan Ferguson, Dare County Public Schools 8. Saltwater Intrusion in Shallow Coastal Aquifers, Alex Manda, ECU 9. Green Infrastructure for Coastal Climate Resilience, Nicole Barclay, UNC-Charlotte 10. NWS and Rip Currents in the Carolinas, Victoria Oliva, NOAA National Weather Service
Latimer Room	<p>Albemarle-Pamlico National Estuary Partnership: Ecological Flows, Water Resources and Water Availability in the Coastal Plain Moderator: Stacey Feken, Albemarle-Pamlico National Estuary Partnership</p> <p>10:15 – 10:35 Progress on Ecological Flows Within the Coastal Plain, Robert Christian, ECU, and Stanley Riggs, ECU, NC Land of Water</p> <p>10:35 – 10:55 Water Resources Data to Support Coastal Plain Ecological Flow Assessment in the Albemarle-Pamlico Basin, Mike O’Driscoll, ECU</p> <p>10:55 – 11:15 Managing Competing Water Demands in the Coastal Carolinas, Laura Gurley and Ana Maria Garcia, USGS South Atlantic Water Science Center</p> <p>11:15 – 11:45 Q&A with Panel</p>

Agenda continued

11:45 – 1:15 p.m.	Lunch and Poster Presentation Awards
1:15 – 2:45 p.m.	Concurrent Session 4
Bellamy Room	Marsh Interface: Edges of Land and Water Moderator: Gloria Putnam, North Carolina Sea Grant
1:15 – 1:30	Blue Carbon Stocks and Salt Water Intrusion: What Do We Really Know? Matthew Ricker , NC State
1:30 – 1:45	Monitoring the Influence of Disturbance and Bivalve Facilitation on Seagrass Bed Resilience, Sarah Donaher , UNC-Chapel Hill
1:45 – 2:00	Impacts of Incident Waves and Vegetation Properties on Wave Attenuation by Salt Marshes, Jana Haddad , UNC-Chapel Hill
2:00 – 2:15	Using Parasite Diversity to Quantify the Success of Coastal Habitat Restoration, Christopher Moore , ECU
2:15 – 2:45	Q&A with Panel
Lower Level Grand Ballroom	Investing in the Blue Economy via Sustainable Tourism: Roundtable Discussions Moderator: Emily Yeager, East Carolina University
1:15 – 1:35	Roundtable 1: Sustaining Ocracoke’s Tourism Workforce, Whitney Knollenberg , NC State
1:35 – 1:55	Roundtable 2: Mariculture Tourism: Building the N.C. Oyster Trail, Jane Harrison , North Carolina Sea Grant
1:55 – 2:15	Roundtable 3: An Inventory of the Eastern Tar River’s Blue Economy, Emily Yeager , ECU
2:15 – 2:45	Q&A with Panel
Latimer Room	Post-Storm Assessments Moderator: Jennifer Dorton, Southeast Coastal Ocean Observing Regional Association
1:15 – 1:30	A Tale of Two Storms: Geomorphic Response of Masonboro Island to Hurricanes Florence and Dorian and the Impact of Recovery in Between, Joseph Long , UNC Wilmington
1:30 – 1:45	Forecasting and Communicating Life -Threatening Storm Surge on Ocracoke and Hatteras Islands Associated with Hurricane Dorian, Carl Barnes , NOAA National Weather Service
1:45 – 2:00	Modeling and Validating Residential Flood Vulnerability at High Spatial Resolution in North Carolina’s Coastal Region, Narcisa Pricope , UNC Wilmington
2:00 – 2:15	Direct Impacts of Hurricane Florence at Landfall and Subsequent Post-Storm Recovery: Wrightsville Beach, North Carolina, Joni Thomas Backstrom , UNC Wilmington
2:15 – 2:45	Q&A with Panel
Dudley Room	Carolina Wetlands Workshop Moderators: Rick Savage, Kim Matthews, Amanda Johnson, David Shouse, Carolina Wetlands Association
1:15 – 2:45 p.m.	The Value of Wetlands to the Communities
2:45 – 3:00 p.m.	Networking Break
3:00 – 4:00 p.m.	Closing Session Resilient Communities: Traditional and Emerging Sectors
Lower Level Grand Ballroom	Janice Lee Allen , North Carolina Coastal Land Trust Stanley R. Riggs , NC Land of Water Chuck Weirich , NOAA National Sea Grant College Program

Guest Speaker Bios

Alphabetical by Speaker Last Name



Janice Lee Allen, North Carolina Coastal Land Trust

Janice Lee Allen is director of land protection for the North Carolina Coastal Land Trust, an organization she joined in 1997. Allen is responsible for advancing the land trust's efforts to protect priority natural, scenic or historic areas in the coastal plain of North Carolina.

Her interest in the work of the Coastal Land Trust stems from her vast background in wildlife biology and natural resources conservation. Before joining the Coastal Land Trust, she spent over 10 years working for the U.S. Fish and Wildlife Service, including time at the Roanoke River National Wildlife Refuge and the Asheville Field Office, both in North Carolina, and at the Southeast Regional Office in Atlanta, Georgia. She received a bachelor's degree from the University of Michigan, and a master's degree in wildlife biology from Auburn University.



Lawrence Cahoon, University of North Carolina Wilmington

Lawrence Cahoon is currently a professor of biology and marine biology at University of North Carolina Wilmington, where he joined the faculty in 1982. He received a bachelor's degree at Washington & Lee University, and a doctorate in zoology at Duke University. He had

a postdoctoral fellowship at Mountain Lake Biological Station with the University of Virginia, was a temporary instructor at Duke, and has taught biological oceanography at Duke Marine Lab. He currently teaches an undergraduate course in limnology (the study of freshwater ecosystems), graduate courses in biological oceanography and coastal science and policy, and a doctoral seminar in oceanography and environmental science at UNC Wilmington. Cahoon has won UNC Wilmington's Faculty Scholarship and Graduate Mentor Awards, and the UNC Wilmington Distinguished Teaching Professor Award in 2017. He has served as a gubernatorial appointee to the North Carolina Marine Science Council and the N.C. Ocean Affairs Council, as chair of the N.C. Ocean Resources Task Force, and as vice-president and president of the N.C. Academy of Science. He also has been a member of the Ocean Policy Advisory Committee for the N.C. Division of Coastal Management and a state legislative study subcommittee on Offshore Energy Development. His research interests include coastal biological oceanography — particularly the ecology of the

sediment-water interface and of 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.



Veronica Carter, Brunswick County Voluntary Organizations Active in Disaster

Veronica Carter is a former civil servant on national and international scales, and a retired Army officer with over 38 years of service. Recently, Carter has been instrumental in starting the Brunswick County Voluntary Organizations Active in Disaster (VOAD), the county's Long-Term Recovery Group. Nonprofits and faith-based organizations now work with the county and municipalities to help residents trying to recover from storms. She also won her recent race for Leland Town Council. Previously, she led diverse supply chain and logistics operations in military, government and international organizations on four continents. She has held leadership roles at Military Ocean Terminal, Sunny Point and also served the United Nations Peacekeeping Operations in five countries. Carter is a past member of the N.C. Coastal Resources Commission and board member for Cape Fear and Brunswick County's Habitat for Humanity affiliates. She has served on Leland's Parks and Recreation Board. Carter has devoted much of her time to ensuring environmental justice. She currently serves on the N.C. Coastal Federation Board of Directors, the Duke Superfund Advisory Board and the N.C. Department of Environmental Quality Secretary's Environmental Justice and Equity Board. A native of Brooklyn and a product of New York City Public Schools. Carter has a bachelor's degree from Fordham University and a master's in public administration from Troy State University. She is a graduate of the U.S. Army's Command and General Staff College.



Christopher Finelli, University of North Carolina Wilmington

Christopher Finelli currently serves in the dual role of dean of the graduate school and interim executive director of marine science at the University of North Carolina Wilmington, putting him in the unique position of overseeing the administration and development of all graduate programs and the interdisciplinary research programs

Bios continued

in coastal and marine science. Coastal and marine sciences figure prominently in the history and future of UNCW, with a well-funded research portfolio and academic programs that span across all academic disciplines. In addition to programmatic oversight, he is responsible for stewardship of prominent marine facilities, including the Center for Marine Science, Shellfish Research Hatchery, Finfish Mariculture Center and Marine Biotechnology Center (MarbioNC). He joined the UNCW faculty in biology and marine biology in 2007, where he served as department chair from 2011 to 2017. Throughout his career, he has published over 40 peer-reviewed papers on ecology of benthic marine organisms living on coral reefs, in salt marshes, and on oyster reefs. In addition to his disciplinary research, Finelli has been involved with several national programs to advance best practices in biology education, and he has served as a national leadership fellow for the Partnership for Undergraduate Life Sciences Education since 2015. Finelli holds a bachelor's degree in biology from St. Francis College and a doctorate in marine science from the University of South Carolina.



John Nicholson, North Carolina Department of Environmental Quality

John Nicholson serves as the chief deputy secretary for the N.C. Department of Environmental Quality. He provides direct support to the Secretary and coordinates the efforts of the department and the senior staff in executing the department's mission and associated goals and objectives. Nicholson joined DEQ in his current role in February 2017. He is a retired colonel in the U.S. Marine Corps, where he served on active duty for 28 years. He is a skilled executive with international leadership experience in solving critical and complex challenges. He also was the military affairs advisor to two North Carolina governors. Nicholson has experience in advanced strategic planning, policy development and workforce analysis while leading high performance teams. He has also advanced programs in energy efficiency and environmental conservation while serving his country. Nicholson earned a master's degree in national security and strategic studies from the U.S. Naval War College, a master's degree in military studies from the U.S. Marine Corps Command and Staff College and a bachelor's degree from San Diego State University.



Jonathan Pennock, NOAA National Sea Grant College Program

Jonathan Pennock is the director of the National Sea Grant College Program. Prior to joining NOAA, he was the director of the New Hampshire Sea Grant Program and the deputy director of the School of Marine Science and Ocean Engineering at the University of New Hampshire.

Pennock is a nationally known coastal scientist with expertise in oceanography and estuarine sciences. His research has focused on understanding human impacts on coastal marine food webs. He has a doctorate in oceanography and master's in marine studies from the University of Delaware, and a bachelor's in biology from Earlham College.



Stanley R. Riggs, East Carolina University and NC Land of Water

Stanley R. Riggs is an internationally recognized geologist who has been on faculty at East Carolina University since 1967. He is presently the Distinguished Professor of the College of Arts and Sciences and Distinguished Research Professor of East Carolina University. Riggs has degrees from Beloit College, Dartmouth University and University of Montana. As a coastal-marine geologist, Riggs has been doing research on ancient and modern coastal systems since 1964. His work has included funding from North Carolina Sea Grant and many national agencies. His recent research focuses on the interrelationships between the natural resources, environmental dynamics and cultural history. In addition, Riggs is the founder and director of a public outreach nonprofit: North Carolina Land of Water, known as NCLW, where his projects have included Nightscape Resources of the Outer Albemarle Peninsula.



Mladen Vouk, NC State University

Mladen Vouk is NC State University's vice chancellor for research, and as chief research officer oversees all research activities at NC State. Under his leadership, units reporting to the Office of Research and Innovation centrally manage research administration, the university's intellectual properties, and industry

Bios continued

and government agency alliances on the university's award-winning research campus. Vouk is a highly respected computer scientist and an IEEE Fellow who has received the IEEE Distinguished Service Award, the IEEE Golden Core Award and the IFIP Silver Core award. A faculty member at NC State for more than 30 years, Vouk served as department head for computer science from 2004 to 2016. He is co-inventor of NC State's Virtual Computing Laboratory, one of the world's first cloud computing systems, and co-founder of NC State's Computer Science Software Systems and Engineering Laboratory. He formerly served as technical director of the Center for Advanced Computing and Communication and was the associate vice provost for information technology from 2002 to 2012. He has been the director of NC State Data Science initiative since 2014 and was the associate vice chancellor for research administration from 2016 to 2018. Vouk is the author or co-author of more than 300 publications. He has conducted groundbreaking research in software engineering, scientific computing and analytics, information technology and education, and high-performance computing. Vouk earned a doctorate in solid-state physics at King's College London and a master's degree in computer science at NC State.



Chuck Weirich, NOAA National Sea Grant College Program

Chuck Weirich serves as aquaculture manager at the National Sea Grant Office. Before joining that office in 2019, Chuck was North Carolina Sea Grant's marine aquaculture specialist. In 2018, he was a founding partner of the North Carolina Shellfish Initiative and also played a

key role in helping the state's shellfish aquaculture industry identify losses and receive assistance after hurricanes Florence and Michael. His North Carolina Sea Grant roles also included applied research regarding production of oysters, sunray venus clams, scallops and blue crabs. Weirich is skilled in the culture of over 20 aquatic species, including freshwater and marine finfish and crustaceans, and marine bivalves. He has held positions in the public and private sectors, with experience in research, extension, academia and the commercial aquaculture industry. A native of the Texas Hill Country, Weirich holds a bachelor's degree from Texas A&M, a master's degree from Texas State University and a doctorate in animal physiology from Clemson University.



Susan White, North Carolina Sea Grant

Susan White is the executive director for North Carolina Sea Grant, the Water Resources Research Institute for the University of North Carolina, and North Carolina Space Grant. All three programs provide targeted research, outreach and education projects to address critical issues

in the state and within the region. Sea Grant, with funding from the National Oceanic and Atmospheric Administration, and WRRI, with funding from the U.S. Geological Survey, focus on coastal, ocean and water resource topics for ecosystems and communities. Space Grant projects, with funding from the National Aeronautics and Space Administration, include partnerships with the aerospace industry. In fall 2017, White was named chair of the N.C. Sediment Control Commission by Gov. Roy Cooper. She previously was director of NOAA's Hollings Marine Laboratory in Charleston, S.C. Formerly the national research coordinator for NOAA's Estuarine Reserves Division and National Estuarine Research Reserve System, she has served on national and regional steering committees on topics including technology transfer, integrated drought monitoring and early warning, and climate connections to health. White earned a doctorate from the University of Georgia and a bachelor's degree from Duke University.



Mark Willis, NOAA National Weather Service

Mark Willis serves as meteorologist in charge for the NOAA National Weather Service (NWS) office in Wilmington, North Carolina. That office is responsible for weather forecast, warning and observation operations for Southeast North Carolina and Northeast South

Carolina. This includes official information as it relates to forecasts and preparedness for hurricanes, marine weather, extreme heat, fire weather, winter weather, severe weather and beyond. Willis moved to Wilmington from the Outer Banks, where he served as director of forecasting for the popular marine weather company Surfline, which is known for a global network of coastal web cams and wave forecasting services. Prior to that, his career included roles as a forecaster at the National Hurricane Center and NWS office in Morehead City. He also served as the marine program manager for the NWS Eastern Region Headquarters in Long Island. Willis received his bachelor's degree in meteorology from Florida State University and completed his graduate work in meteorology at the University of Hawaii at Manoa.

Concurrent Session Abstracts

Alphabetical by Presenter Last Name

Hurricane Preparedness and Recovery: Down East Perspectives

Presenter: **Karen Amspacher**, Core Sound Waterfowl Museum & Heritage Center, kwamspacher@gmail.com
Co-authors: Lisa Campbell, Liz Demattia, Baxter Miller, Ryan Stancil

In 2018, Hurricane Florence illustrated the importance of community preparation and social networks to long-term recovery. Small rural communities like those found in Down East Carteret County relied on critical information and services via their local connections, as well as those from afar. This presentation will describe how such communities mobilized in the face of disaster and provide insights to planning for future storm events. Results will be shared from a representative survey of Down East residents, which was conducted to learn exactly how individuals prepared for and are recovering from Florence. In addition, the survey included questions about Hurricane Dorian.

Direct Impacts of Hurricane Florence at Landfall and Subsequent Post-Storm Recovery: Wrightsville Beach, North Carolina

Presenter: **Joni Thomas Backstrom**, University of North Carolina Wilmington, backstromj@uncw.edu

Hurricane Florence made landfall near Wrightsville Beach, a developed barrier island located in Southeastern North Carolina, as a strong Category 1 storm on September 14, 2018. Sustained winds were near 90 mph and nearby wave buoys measured significant wave heights of close to 5.0 m, exceeding previous maximum values since measurements began in May 2008. In order to assess coastal change attributed to Florence, a series of shore-perpendicular beach transects using high-resolution GPS-RTK were undertaken approximately one week before and one week after landfall at three separate locations along Wrightsville Beach. Although coastal infrastructure damage was minimal, beach morphological change was significant at all locations, especially closest to Mason Inlet to the north. Direct impacts included massive scarping, dune removal, dune erosion and overtopping, and up to 1.0 m of vertical erosion in many places, especially where wide berms were present before the hurricane. Significant sediment deposition was also observed in many higher elevation areas landward of the high-tide line. Post-storm 'recovery' surveys were undertaken 3, 6 and 12 months after Florence's landfall to assess recovery rates, which appear to be very slow and gradual. The recent impacts from Hurricane Dorian (September 2019) are likely to stall any short-term beach recovery that may have taken place one year after Florence. This study will detail storm-induced coastal change and post-storm recovery using high-resolution survey techniques, visual observations and conceptual models. Note: This study is complementary to one being presented by Joseph Long of UNC Wilmington regarding impacts to Masonboro Island.

What's the Hook for Fisheries Education Efforts? Lessons Learned While Communicating Science to North Carolina Saltwater Anglers

Presenter: **M. Scott Baker Jr.**, North Carolina Sea Grant, bakers@uncw.edu
Co-author: Sara E. Mirabilio

North Carolina has a long tradition of saltwater angling – and it is a popular sport. In 2016, almost 2 million anglers fished in North Carolina. Of those, about 800,000 were North Carolina residents. In 2017, North Carolina Sea Grant conducted a statewide, stratified-random mail survey of the North Carolina resident coastal recreational fishing license holders to better understand their education needs and information delivery preferences. Among other topics, anglers expressed interest in keeping abreast of fisheries research and attending trainings to better understand the basic fisheries science principles and how they relate to management. To better serve the marine recreational fishing

industry, in 2018 we started *Hook, Line & Science*, a blogsite offering a weekly post designed to provide anglers with short updates about scientific studies that might impact their angling. In early 2019, we held a 4-night, 8-total contact hour class for fishermen highlighting introductory fishery science principles using a mix of in-person and online instruction and local fisheries experts. Readership trends and exit evaluations, respectively, will be discussed as plans are underway to expand each initiative. We anticipate that our efforts will be of interest to a range of educators, resource managers and interest groups.

Forecasting and Communicating Life-Threatening Storm Surge on Ocracoke and Hatteras Islands Associated with Hurricane Dorian

Presenter: **Carl Barnes**, NOAA National Weather Service, Newport/Morehead City, N.C., carl.barnes@noaa.gov

The Outer Banks is a unique intersection of nature, weather, society and the economy. Hurricane preparedness is a year-round activity there, with decision makers and NOAA National Weather Service (NWS) personnel continually building relationships, conducting outreach and improving scientific understanding. Hurricane Dorian presented a unique set of forecasting challenges, passing just off the Southeast coast before making landfall at Cape Hatteras. While the National Hurricane Center forecast track of the storm was notably consistent and accurate, the storm's trajectory roughly parallel to the coastline meant that small shifts in the track could result in a significant variation in impacts for coastal locations. Based on a historical perspective of storms that have taken a similar path in the past several decades, and in close collaboration with the National Hurricane Center's Storm Surge Unit, the threat for a complex and dangerous storm surge event became apparent. This presentation will lay out the science behind the forecast, and how that forecast was then communicated through multiple channels, including official NWS text products, social media, media partners, and state and county officials via NWS forecasters embedded in Emergency Operations Centers. Based on NWS forecasts and decision support services, targeted evacuations and preparations were made. Post-storm surveys have revealed that Dorian produced the greatest storm surge inundation observed for many locations along the Southern Outer Banks. Despite this, no injuries or fatalities have been directly attributed to Dorian's impacts, a testament to the improvements made across the entire weather enterprise in recent years.

Adverse Ecological Impacts of Novel and Legacy Per- and Polyfluoroalkyl substances (PFAS) in Coastal North Carolina

Presenter: **Scott Belcher**, North Carolina State University, smbelch2@ncsu.edu

Per- and polyfluoroalkyl substances (PFAS) are anthropogenic chemicals that contain long and short carbon chains with attached fluorine atoms. PFAS are found in a variety of industrial and consumer products such as aqueous film forming foams (AFFFs), heat resistant lubricants, non-stick coatings, water and oil repellents, and fluoropolymers and plastics. In 2017, residents of Wilmington, North Carolina learned of elevated levels of PFAS in the Cape Fear River and drinking water. Now, communities along the Cape Fear River and in Wilmington have grown concerned about consuming PFAS-contaminated fish from the Cape Fear River might impact their health and the health of the river's ecosystem. The objective of the current study was to determine levels of a wide suite of PFAS, and evaluate health impacts of PFAS exposure in American alligators (*Alligator mississippiensis*) and striped bass (*Morone saxatilis*). Compared to American alligators sampled from Lake Waccamaw, alligators from the Cape Fear River have been found to have high serum levels of PFAS, with very high concentrations of perfluorooctane sulfonate (PFOS) detected in their serum. High levels of numerous PFAS were also detected in the serum of Cape Fear River striped bass; as in alligators, the predominant PFAS found was PFOS. These elevated PFAS levels were associated with biomarkers of adverse liver and

Abstracts continued

immune health. Continuing studies are examining PFAS in the muscle tissue (filets) of recreationally harvested species from the Cape Fear River, including flathead catfish, largemouth bass and American shad.

Resilient Coastal Sites for Conservation in North Carolina and the South Atlantic United States

Presenter: **Brian Boutin**, The Nature Conservancy, bboutin@tnc.org
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 1

Coastal areas in the South Atlantic provide critical habitat for wildlife and are home to a human population that continues to grow faster than that of inland areas. Yet coastal wetland sites vary widely in their ability to accommodate rising seas, based on inherent natural features and the degree of human influence on key ecological processes. Scientists from The Nature Conservancy evaluated over 1,200 coastal sites in the South Atlantic for their capacity to sustain biodiversity and natural services under increasing inundation from sea level rise. Each site received a resilience “score” based on the likelihood that its coastal habitats can and will migrate to adjacent lowlands. With no action, the region could experience an estimated 77% loss of existing tidal habitats to severe inundation. However, there are many sites where tidal habitats could increase and expand through landward migration, reversing this trend. With conservation and management, these resilient sites have the potential to offset over 60% of the estimated tidal habitat loss, providing critical habitat for birds and other wildlife and buffering communities from the effects of storms and floods. We will provide an overview of our approach to identify resilient coastal sites in the South Atlantic and North Carolina, examine the results, and show different ways the results can be used to prioritize conservation action.

Progress on Ecological Flows Within the Coastal Plain

Presenters: **Robert R. Christian**, East Carolina University, christianr@ecu.edu;
Stanley R. Riggs, East Carolina University, NC Land of Water, riggss@ecu.edu
Topic 1 of the Albemarle-Pamlico National Estuary Partnership Technical Session: Ecological Flows, Water Resource and Water Availability in the Coastal Plain

Ecological flows (EF) are those that minimize ecological impacts on surface waters from human activities. Establishing EF for waterways within the coastal plain is challenging. Flows may be bi-directional, and often proxies for flow are used (e.g., water level or salinity position). Initial efforts in North Carolina occurred through the EF Science Advisory Board in 2013. APNEP is continuing these efforts. Separate studies of patterns in flows and water levels in and around Bertie County and the Town of Windsor may provide insights into issues germane to EF assessment. We examined patterns along the Cashie River and found the transition between uni-directional and bi-directional flows occurs within a few miles and far from ocean inlets. Bi-directional flow and therefore water levels near Windsor had both semi-diurnal and diurnal cycling. Flows and levels along the Roanoke River in 2018 were at historic highs from upstream rains and dam management decisions. Impacts on riparian zones suggest that EF assessments should consider high flows as well as low flows. Albemarle Sound is a major control over the flows and levels of the Roanoke, Cashie and Chowan Rivers with substantial portions of each reflecting the Sound's dynamics. Thus, we have identified issues that contribute to the difficulties of establishing EF of coastal rivers and provide examples of how these issues express themselves empirically.

Wastewater Treatment in the Coastal Plain: Planning for Resilience and Water Quality Protection

Presenter: **Victor D'Amato**, Tetra Tech, victor.damato@tetratech.com

Facing rising seas, nutrient-sensitive surface waters, vulnerable water supply aquifers and limited opportunities for economic development, communities in the

coastal plain of the mid-Atlantic and Southeastern U.S. have particularly complex challenges related to wastewater management. On one hand, conventional centralized sewerage tends to increase secondary impacts related to growth that may exceed the carrying capacity of ecologically-sensitive coastal areas. On the other, decentralized soil-based wastewater systems are limited by rising water tables and coarse-textured soils that provide only limited treatment. Supported by work supporting the U.S. Environmental Protection Agency's Chesapeake Bay Program (CBP) Wastewater Treatment Workgroup, this presentation will describe efforts to develop scientifically robust methods for managing nutrient loads from wastewater systems within a practical planning framework intended to optimize wastewater management efforts within the local socioeconomic and environmental context. Specifically, the CBP developed a framework and scientific basis for better factoring nutrient attenuation into Chesapeake Bay TMDL onsite wastewater treatment system (OWTS) load estimates. The CBP established a series of total nitrogen (TN) attenuation factors for four different soil textural classifications within 15 distinct hydrogeomorphic regions (HGMRs) that span the entire watershed. Wastewater management planning efforts for coastal areas ranging from small communities to states and territories (Delaware, Maryland and Puerto Rico) and case studies providing examples of sustainable wastewater management that leverage the water-food-energy nexus will also be provided to show that wastewater systems in the coastal plain can meet multiple socioeconomic needs while protecting water quality.

North Carolina's Coastal Wetlands in an Era of Sea Level Rise

Presenter: **Jenny Davis**, NOAA National Centers for Coastal Ocean Science, jenny.davis@noaa.gov
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 1

The initial goal of the NOAA Sentinel Site Program was to shed light on the impacts of climate change with an emphasis on sea level rise and coastal inundation. Here, we present data from a series of Surface Elevation Tables (SETs) installed in marshes across central North Carolina. All of the SETs included in this analysis have been installed and collecting data for ≥ 10 yrs. We compare trends in marsh surface elevation to local trends in relative sea level rise (RSLR) using both the long term rate of RSLR change (1953 to present; 3.1 mm yr⁻¹) and rates of RSLR that correspond to the same time period as the SET data (~2004 to present; 7.5 mm yr⁻¹). These data show that with few exceptions, marsh surface elevations are not keeping pace with local RSLR and that relative starting elevation in the tidal frame is an important predictor of how the various marshes performed over time. Our results suggest that if rates of RSLR remain elevated, coastal marshes in North Carolina will need to migrate to higher elevations in order to survive.

Monitoring the Influence of Disturbance and Bivalve Facilitation on Seagrass Bed Resilience

Presenter: **Sarah Donaher**, University of North Carolina at Chapel Hill, sdonaher@live.unc.edu
Co-authors: Chris Baillie, Rachel Gittman, Stacy Zhang

Globally, human-induced degradation of seagrasses has accelerated. These productive nearshore habitats provide crucial ecosystem services to the North Carolina coastline, including habitat provision for fish and invertebrates, wave energy mitigation and sediment sequestration. Restoring these productive habitats has proven to be both challenging and costly, and it is critical to test restoration strategies which promote innate bed resilience to disturbance. We hypothesize that facilitation from a mutualist bivalve (the hard-shell clam) could aid in seagrass bed restoration in North Carolina by mitigating stress on seagrasses. We tested the ability of bivalve facilitation to enhance mixed community seagrass bed resilience with two separate simulated disturbance regimes: a pulse (physical perturbation from propeller scars) disturbance and a

Abstracts continued

press (nutrient-loading) disturbance. We monitored the effect of clam additions and disturbance (either nutrient-loading or physical perturbation) on seagrass growth rate, percent cover, shoot density, bed extent and elevation, and blade epiphyte load. Preliminary results suggest that the *Zostera marina*, but not *Halodule wrightii*, growth rates may be reduced by nutrient-loading and that both nutrients and clam presence increase epiphytic blade loadings in early summer. For the next year, we will continue monitoring seagrass expansion into disturbed patches and sampling seed viability among treatments to determine if harnessing ecological facilitation can be an effective restoration technique for seagrass beds degraded via propeller scars or nutrient loading. Understanding how mutualistic plant-animal interactions may reduce seagrass recovery time will allow for the modification of restoration designs to take advantage of natural ecological relationships.

The Place We Call Home: A Critical Analysis of the Risk Perceptions and Place Attachments of Coastal Communities at Risk for Sea Level Rise in North Carolina

Presenter: **Michelle Dovil**, Florida A&M University, michelle.dovil@fam.u.edu
Co-authors: Tia Maxwell, Tenesha Washington

For centuries, the world has undergone dramatic environmental changes attributed to both natural and anthropogenic causes. These changes include, but are not limited to continental shifts, global temperature warming, wetland erosion, land submergence and sea level rise. As the changes progress, pressure on particularly vulnerable populations also increases. The Union of Concerned Scientists (2013) notes sea level rise is dynamically changing our coasts, and with these changes, coastal communities, economies, and ecosystems impacting some ninety coastal communities at risk for sea level rise in the United States. Despite these unfavorable and risky living conditions, millions of people still choose to reside along the coastlines of the United States. Furthermore, there remains a gap in both climate science and disaster literature regarding the influence of risk perceptions and place attachment on vulnerable populations, specifically those at risk for sea level rise due to climatic changes. Therefore, understanding how coastal residents internalize risk along with their attachments to particular places plays a critical role in risk communication, coastal management, and climate policy. This project examines coastal communities currently at risk for sea level rise in North Carolina. The goal of this research is to employ a mixed-methods approach using both survey questionnaires and in-depth interviews to help explain the connections and dynamic relationship between vulnerable populations and land. Specifically, this research is useful to both the public and governmental officials charged with enactment of policies that consider the attachments of these populations to land subject to climate-induced hazards and resilience efforts, while effectively determining an appropriate response to this social phenomenon.

Albemarle-Pamlico National Estuary Partnership Technical Session: Ecological Flows, Water Resources, & Water Availability in the Coastal Plain

Moderator: **Stacey Feken**, Albemarle-Pamlico National Estuary Partnership, stacey.feken@ncdenr.gov

Presenters: Topic 1 – **Robert R. Christian** and **Stanley R. Riggs**; Topic 2 – **Michael O'Driscoll**; Topic 3 – **Laura N. Gurley** and **Ana Maria Garcia**
Individual topic abstracts listed under name of first presenter

This multi-topic technical session covers the current status of data collection and analysis in support of the Ecological Flows Action Team of the Albemarle-Pamlico National Estuary Partnership (APNEP) in efforts to develop coastal ecological flows and water policy in the coastal Carolinas. Session goals include: share information about the current status of water resources analyses and tools that support development of ecological flows in the Carolinas coastal plain; highlight the importance of understanding impacts on surface and groundwater

from human activities and climate stressors, and explore linkages to minimizing those impacts by establishing ecological or environmental flows; raise awareness of the importance of ecological flows in protecting the ecological integrity of streams, rivers and estuarine systems downstream; highlight efforts of the North Carolina Ecological Flows Science Advisory Board, recent USGS and ECU studies, and proposed future work of the APNEP Coastal Ecological Flows Team; and ensure a technical basis for future efforts to develop ecological flow and related water resources policy in North Carolina and the Southeast.

NWS Advancements and Building Partnerships Over the Past 10 Years: Improving Readiness for Hazardous Weather Events

Presenter: **David Glenn**, NOAA National Weather Service, Newport/Morehead City, N.C., david.glenn@noaa.gov
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 2

Water (storm surge, heavy rain, or flooding) remains the number one cause of death related to hurricanes. Over the past decade, NOAA National Weather Service (NWS) has made several technological advancements and messaging improvements for life-saving predictions of hazardous weather events, especially related to storm surge and flash flooding. This presentation will focus on recent enhancements related to storm surge and flash flooding prediction and messaging; namely, the Potential Storm Surge Inundation Graphic, the Storm Surge Watch/Warning product, and the recent paradigm change for Flash Flood products across the coastal Carolinas. The presentation will cover the reasons for developing the storm surge specific watch/warning program, along with removing storm surge from the Saffir-Simpson Hurricane scale. Additionally, the Weather Ready Nation (WRN) Ambassador initiative will be discussed, highlighting the importance of public-private partner relationships and promoting weather safety, awareness, and preparedness activities throughout the year. The WRN effort seeks to empower local communities and people to make pre-event decisions that can be life-saving and prevent or limit devastating losses. The NWS cannot fulfill its mission of creating a weather-resilient community without the collective participation of federal, state, and local government agencies, along with non-profit, non-governmental organizations, and academia.

Understanding Climate Change Adaptation in Rural Eastern North Carolina: Perceptions of Risk and Barriers to Action

Presenter: **Cynthia A. Grace-McCaskey**, East Carolina University, gracemccaskeyc15@ecu.edu
Co-author: Cassandra L. Workman

In the past four years, Eastern North Carolina has been severely impacted by three major hurricanes, resulting in widespread flooding, extreme storm surge and wind damage, contamination of water sources, and the displacement of residents. Simultaneously, incremental environmental changes such as sea-level rise and saltwater intrusion threaten the livelihoods and well-being of residents and visitors, who are dependent on coastal areas for economic, social, and cultural reasons. This presentation describes preliminary results from interviews conducted with Eastern North Carolina town and county employees and officials regarding the challenges faced before, during, and after storms and related flooding events. We also examine whether incremental environmental changes and extreme weather events are perceived as threats related to climate change, and what affects the willingness and ability of individuals and communities to actively pursue adaptive strategies.

Abstracts continued

Managing Competing Water Demands in the Coastal Carolinas

Presenters: **Laura N. Gurley**, USGS South Atlantic Water Science Center, lgurley@usgs.gov; **Ana Maria Garcia**, USGS South Atlantic Water Science Center, agarcia@usgs.gov

Topic 3 of the Albemarle-Pamlico National Estuary Partnership Technical Session: Ecological Flows, Water Resources, and Water Availability in the Coastal Plain

Projected changes in population, land-use and climate will place significant stress on water resources of the coastal Carolinas as competition from societal and ecological needs increase. The Coastal Carolinas Focus Area Study of the U.S. Geological Survey National Water Census Program was initiated to investigate these water stressors and potential impacts from increasing demand. Reliable predictions of water availability that take into consideration a suite of future scenarios in land-use, climate and population with associated changes in drinking water supplies have been developed. This session will showcase the tools, results and projections that have resulted from this study.

Impacts of Incident Waves and Vegetation Properties on Wave Attenuation by Salt Marshes

Presenter: **Jana Haddad**, University of North Carolina at Chapel Hill, jhaddad2@live.unc.edu

Co-authors: J. Rosman, R. Luettich, C. Voss

Use of natural and nature-based solutions for coastal and estuarine shorelines requires the ability to predict how a vegetation canopy reduces wave energy reaching the shore. We implemented a process-based model of wave transformation through a marsh that is based on the conservation of wave energy flux and accounts for dissipation of wave energy by vegetation, depth-limited wave breaking and bottom friction. The model was tested and calibrated using an extensive dataset that includes continuous wave measurements, elevation profiles and vegetation data from transects across five North Carolina salt marshes. The measurements and model were used to understand how wave energy dissipation varies as a function of water depth, wave conditions and vegetation properties. Both the measurements and model show that wave attenuation increases with incident wave height, smaller water depth, submerged vegetation height and stem density. However, small waves were attenuated more dramatically than predicted by the model, suggesting a need for a vegetation drag coefficient that varies with wave properties (e.g. the Keulegan-Carpenter number). Commonly used spectral wave models that include vegetation effects (e.g. SWAN) assume that vegetation-induced dissipation occurs equally across all wave frequencies. Analysis of field data shows that high-frequency waves are dissipated more rapidly than lower frequency waves in the vegetation canopy, suggesting the need for a frequency-dependent representation of vegetation-induced dissipation. We explore the relationship between these findings and assess the extent to which frequency-dependent dissipation can be represented using a drag coefficient that varies with the Keulegan-Carpenter number.

Empowering Youth to Contribute to Climate Resilience Efforts in Their Communities

Presenter: **Dana Haine**, University of North Carolina Institute for the Environment, dhaine@unc.edu

Co-authors: Sarah Yelton, Kathleen Gray

Cultivating climate literacy among youth positions them to develop solutions and advocate for actions that promote community resilience and protect the health and well-being of all people. This presentation will describe the growing efforts of the UNC Institute for the Environment to engage youth in learning about and taking action on climate resilience by providing relevant and authentic learning opportunities in a non-formal educational setting. In this session we'll describe program models for two extracurricular, long-duration programs designed to

empower grades 9-to-12 youth to contribute to climate resilience efforts in their communities. UNC-CH's Climate Leadership and Energy Awareness Program is conducted in partnership with three university environmental health programs at the University of North Carolina at Chapel Hill, Columbia University and Harvard University, and their community collaborators: the Alliance for Climate Education, Boston Children's Hospital Pediatric Environmental Health Center and WE ACT for Environmental Justice, and Youth Engaging in the Science of Resilience in Urban and Rural NC in partnership with the North Carolina Museum of Natural Sciences. In this session we will feature the strategies, STEM-based activities and resources we use to engage youth as they examine their communities, identify and evaluate climate adaptation and mitigation strategies, and promote climate resilience through community-action projects. This session will include program evaluation data and lessons learned as youth explore climate resilience in their own communities.

Teaming Up on the Mean Green: Multi-Institutional Collaborations to Address the Chowan River Bloom Problem

Presenters: **Nathan Hall**, University of North Carolina at Chapel Hill, nshall@email.unc.edu; **Colleen Karl**, Chowan-Edenton Environmental Group, cmkarl@ncsu.edu

Over the past four summers, cyanobacteria blooms have reappeared in the Chowan River-Edenton Bay where they have not been common since the 1970s and 1980s. The unsightly blooms are also often toxic and cause hypoxia, which collectively degrade the value of the Albemarle Sound waters for wildlife, fisheries, recreation and tourism. The most basic question regarding how to control the proliferation of these harmful algal blooms is what nutrients, nitrogen (N) and/or phosphorus (P), limits their growth. Through a partnership between the Chowan-Edenton Environmental Group (CEEG) and UNC Institute of Marine Sciences (IMS), a series of five nutrient limitation bioassay experiments were conducted at Edenton Bay during the Fall 2018, spring, summer (two experiments) and Fall 2019. The Fall 2018 and Spring 2019 experiments revealed that biologically available N was the primary nutrient-limiting growth of total phytoplankton biomass and cyanobacteria. These experimental findings of N limitation are consistent with parallel long-term increases in total N and phytoplankton biomass measured as chlorophyll a over the past 20 years. Collaborative monitoring efforts between N.C. Department of Environmental Quality, IMS, CEEG and the Albemarle Commission are seeking to identify the cause/ sources of increasing N levels, and collaborative efforts with NC State University, North Carolina Sea Grant and the Albemarle Pamlico National Estuary Program are educating the public about the bloom problem and its causes. Such collaborations, public involvement and stakeholder engagement will be critical for developing the science and political will for nutrient reduction strategies to reduce the magnitudes and frequencies of harmful blooms.

Mariculture Workforce Development

Presenter: **Jane Harrison**, North Carolina Sea Grant, jane_harrison@ncsu.edu

Marine aquaculture (mariculture) education and career resources for young people are critical to developing a skilled workforce for this growing industry. North Carolina Sea Grant, in partnership with North Carolina coastal high school teachers and Carteret Community College (CCC), developed a suite of mariculture lesson plans, a careers video and a mobile aquaculture laboratory to make coastal high school students aware of this career path. Educators can now access 10 free lesson plans, which are easy to use in science, technical and career classes. Each lesson is aligned with N.C. education standards and includes videos, worksheets, presentations, discussion questions and more. The lesson-planning team included N.C. Sea Grant coastal economics specialist Jane Harrison, N.C. Sea Grant marine education specialist Terri Kirby Hathaway, N.C. Sea Grant science writer Julie Leibach, Sea Grant marine aquaculture specialist Chuck Weirich, high school science teacher Amy Sauls, science

Abstracts continued

illustrator Melissa Smith, and graphic designer Kathy McKee, as well as high school science and agricultural teachers who helped to develop and field-test the lessons. The careers video team included Harrison, Leibach and video producers/directors Baxter Miller and Ryan Stancil. The mobile aquaculture laboratory team included CCC Aquaculture Department Chair Dave Cerino and CCC student and mariculture grower Tommy McArthur.

Building the N.C. Oyster Trail

Leader: **Jane Harrison**, North Carolina Sea Grant, jane_harrison@ncsu.edu
Roundtable 2 of the Investing in the Blue Economy via Sustainable Tourism Roundtable Discussions

Shellfish mariculture tourism has the opportunity to diversify existing coastal tourism offerings, expand the market for N.C. shellfish and encourage entrepreneurial growth. A project is underway to support development of mariculture tourism products in the state, including the N.C. Oyster Trail. Research will be undertaken to develop a profile of potential shellfish aquaculture tourists so N.C. coastal communities can capitalize on growing interest in food tourism. A survey of national and N.C. food tourists and potential shellfish aquaculture tourists will reveal preferences and barriers to participation in shellfish mariculture tourism, in addition to other demand indicators (e.g., demographics). Community-based asset mapping will be used to compare current shellfish aquaculture tourism product supply in N.C. coastal communities with potential shellfish aquaculture tourists' demand. This comparison will identify where demand for shellfish aquaculture tourism can be met and opportunities for business and resource development related to aquaculture tourism. Ultimately, these data will be used to develop recommendations to support sustainable development of shellfish aquaculture tourism in North Carolina, including recent efforts to establish the N.C. Oyster Trail. These findings will also generate resources for aquaculture tourism entrepreneurs to use in the establishment of sustainable business practices. This applied research and extension effort is being conducted by NC State University and East Carolina University faculty and a North Carolina Sea Grant researcher in partnership with shellfish stakeholders, including oyster growers, restaurateurs, tourism agencies, and environmental education and advocacy groups.

Hurricane Florence's Unique Aspects, Impacts and Decision-Support Services in Southeastern North Carolina and Northeastern South Carolina

Presenter: **Reid Hawkins**, NOAA National Weather Service, Wilmington, N.C., donald.hawkins@noaa.gov

Hurricane Florence was a large, slow-moving storm producing devastating and long-lasting flooding, destructive storm surge, damaging tornadoes and hurricane-force wind gusts in September 2018. This presentation will provide a review of Hurricane Florence's historic passage through the Carolinas and will focus on Florence's unique aspects, including the track, the impacts and NOAA National Weather Service (NWS) Wilmington's (ILM) Decision Support Services. Other impacts and aspects of Florence's passage across Southeastern North Carolina and Northeast South Carolina will be presented. These include the record number of tropical storm-induced tornadoes, an overview of the Atlantic Multi-decadal Oscillation influence on the frequency of hurricanes, and a review of the loss of life in the NWS Wilmington, North Carolina warning area.

The Influence of Dune Aspect Ratio, Management and Beach Morphology on the Protective Services of Coastal Dunes

Presenter: **Michael Itzkin**, University of North Carolina at Chapel Hill, mitzkin@unc.edu
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 1

The barrier islands within the NCSSC sustain rich ecosystems, host valuable infrastructure, and protect the mainland coast from sea level rise (SLR) and storms. A transdisciplinary team of coastal geomorphologists, ecologists, and managers is working to transform the way vulnerability, resiliency and the ecological effects of SLR are assessed in the NCSSC through the development of a new instrument, designed to provide guidance to management, called the Coastal Recovery from Storms Tool (CReST). This innovative modeling system couples an emerging understanding of the feedbacks between dune vegetation and sand transport with a recently developed coastal dune model to assess beach and dune evolution in both natural and managed systems in response to SLR and extreme storms. This presentation will explore one aspect of this effort focused on dune response during storms. Foredunes serve as the first line of defense against storm wave run-up and inundation. Taller dunes are generally considered more protective because they are less likely to be overtopped. However, foredunes may be shorter and wider given local dune management choices (e.g., sand fencing) and natural processes (e.g., changes in dune vegetation), which have the potential to shorten and widen dunes. We suggest that management efforts aimed at restoring dunes should consider the aspect ratio of the foredune in conjunction with beach morphology and management strategies such as fencing. The characteristics of dune morphology that offer the best protection during storms will vary with storm characteristics and merely restoring dune elevation may not be sufficient to prevent erosion.

RAIN: A School-to-Community Citizen Science Program

Presenter: **Colleen Karl**, State Climate Office of North Carolina, cmkarl@ncsu.edu

The RAIN (Raising Achievement through Inquiry and Networking) Across the River program is an outreach science program of the State Climate Office of North Carolina for middle school students in two northeastern North Carolina counties that engages students in the process of science, empowering them to investigate, communicate and develop solutions to student-directed research questions focused around meteorological concepts. As part of the program, RAIN Across the River students and their families are trained as citizen scientists for their communities to observe local weather and collect precipitation data for submission to the national CoCoRaHS (Community Collaborative Rain, Hail and Snow) Network. The students participate in meteorological focused activities during a week-long Summer Academy and an after-school component during the academic year. These students develop environmentally focused research questions, design an experiment to test their hypotheses, and conduct their investigations throughout the school year with guidance from teachers, the RAIN program coordinator, scientists from the State Climate Office of North Carolina Cooperative Extension professionals and other community members. The RAIN Across the River program develops individual environmental responsibility through local rainfall collection, and models collecting and comparing data as components of solid environmental management decision-making. This 20-minute presentation will share lessons learned about implementing a community-based science program in rural North Carolina. The RAIN Across the River program presentation will include successes, challenges and opportunities, and will provide resources easily transferred to other locations and groups seeking to implement or refine similar educational outreach programs.

Ocracoke Tourism Workforce

Leader: **Whitney Knollenberg**, NC State University, wgknolle@ncsu.edu
Roundtable 1 of the Investing in the Blue Economy via Sustainable Tourism Roundtable Discussions

In many coastal communities, tourism is a significant economic driver. High-amenity coastal towns like Ocracoke Island attract large influxes of visitors each summer, requiring a sustained tourism workforce. A study was undertaken to identify existing community resources that support the tourism workforce

Abstracts continued

and those community resources that require greater investment to support the tourism workforce. Interviews and focus groups were used to gather insight from tourism stakeholders, including tourism employers, residents, members of Ocracoke's Latino community, high school students and policymakers. The analysis of this qualitative data was guided by the Community Capitals Framework, which revealed how different community resources' impact Ocracoke's tourism workforce. Analysis indicated the resources that should be sustained to support Ocracoke's tourism workforce include social capital, cultural capital, human capital and natural capital. Community resources that need greater investment to support Ocracoke's tourism workforce include political capital, built capital and financial capital. Ultimately, the findings of this study can be used to help set a course for increasing support for Ocracoke's tourism workforce, which is vital to ensure the sustainability of the tourism industry in a community which relies greatly upon the industry's success. This research was facilitated through partnerships between NC State University, Ocracoke Alive!, the Ocracoke Civic and Business Association and North Carolina Sea Grant.

Sweating the Speckles: Darker Least Tern Eggs Become Hotter Under Direct Solar Radiation

Presenter: **Rebekkah L. LaBlue**, University of North Carolina Wilmington, rll2400@uncw.edu
Co-author: Raymond M. Danner

Eggs are markedly vulnerable to thermal challenges. Despite the wide interspecific variation in eggshell appearance, current knowledge surrounding pigment thermoregulatory function does not adequately address how coloration in the visible spectrum affects heating. The color-mediated heating hypothesis posits that darkly pigmented eggs heat more quickly than lighter pigmented ones; previous studies have explored this hypothesis using artificial eggs to compare data among different species with mixed results, but there is no support from intraspecific studies. The eggs of shorebirds deserve special attention because solar radiation poses a significant overheating risk on embryos. Eggshells were collected from a Least Tern (*Sterna antillarum*) breeding colony on Lea-Hutaff Island, North Carolina, and monitored in timed, variously lighted trials, with thermal imagery to track heating. Overall coloration was assigned using median luminance values from standardized photographs. Results show that darker eggs heat more significantly than lighter ones, which could influence individual development and survival.

A Tale of Two Storms: Geomorphic Response of Masonboro Island to Hurricanes Florence and Dorian and the Impact of Recovery in Between

Presenter: **Joseph Long**, University of North Carolina Wilmington, longjw@uncw.edu
Co-authors: Andrea Hawkes, Eman Ghoneim, Lynn Leonard, Devon Eulie, David Wells

Beaches and barrier islands play a well-studied role in protecting inland communities from elevated waves and water levels during storm events. After a storm, these coastal areas are typically expected to have narrower and lower sloping beaches, scarped dune faces and/or dune sediments overwashed into back barrier regions. Previous studies show that these abrupt changes, occurring in a matter of hours, are then followed by a period of recovery that occurs over longer timescales (years to decades). Here we present a contrasting picture of storm response at Masonboro Island, N.C. during Hurricanes Florence (an erosive event) and Dorian (an accretive event) despite similarities in the forecasts of wave height (NOAA), surge elevation (NHC), storm intensity (NHC) and probabilities of dune erosion (USGS). This study includes a unique dataset with two cross-shore transects of pressure sensors measuring storm-induced shoreline water levels, two vertical arrays of sediment traps measuring wind and wave driven sediment transport, and pre/post-storm UAV and ground-based topographic surveys. In addition, topographic surveys and aeolian sediment transport were measured

every 2 to 3 months in the intervening period between storms and an offshore array of wave buoys documented wave conditions for both storm and recovery periods. We use these data to investigate causes for the different erosion vs. accretion responses, which could include variations in pre-storm island topography (slope, elevation, width), measured wave or water level forcing, or wind versus water level sediment transport in an effort to better understand the island resiliency and improve pre-storm forecasts of coastal change hazards.

Strengthening Rural Resilience in N.C. Coastal Communities: Challenges and Opportunities

Presenter: **Frank Lopez**, North Carolina Sea Grant, fmlopez@ncsu.edu

Rural coastal communities have unique vulnerabilities compared to coastal urban areas that have growing populations, increasing property values and extensive infrastructure. Higher rates of poverty, aging demographics and out-migration create a condition of diminished capacity, which challenges the resilience of rural coastal communities (Jurjonas and Seekamp, 2018). The 2018 Atlantic hurricane season brought Hurricanes Florence and Michael to North Carolina. In less than a month, North Carolina experienced two significant storm events resulting in widespread damage across communities within the coastal plain, including oceanfront, soundside and upriver, as well as in multiple inland locations. North Carolina Sea Grant and the University of North Carolina at Chapel Hill Institute for the Environment received funding from NOAA to assist communities with recovery in the aftermath of these storms. The team has elected to identify and work in pilot communities using resilience planning tools and methods to facilitate a framework for rural community resilience. The project has three phases: building relationships, planning analysis and developing tools and techniques for managing resilience. To select pilot communities, the team reviewed objective criteria like median household income and demographics. Next, several exploratory meetings were held with community officials to understand needs and values. Common themes from these discussions included developing strategies for floodplain management, providing affordable housing, and maintaining community and neighborhood cohesion. Scopes of work have been developed for New Bern, and two rural communities near Burgaw in Pender County. This presentation will introduce the ongoing effort and how its lessons can assist other similarly impacted rural communities.

Using Parasite Diversity to Quantify the Success of Coastal Habitat Restoration

Presenter: **Christopher Moore**, East Carolina University, moorech16@students.ecu.edu

Tropically transmitted parasites require multiple hosts to complete lifecycles, and parasite and host abundance are often tightly correlated. Previous studies have shown that parasite prevalence in more easily sampled intermediate hosts (e.g. mollusks, crustaceans and small fish) has good predictive power for the community diversity of other taxa required for the parasite to complete its lifecycle (e.g. birds, fish, terrapins). In collaboration with North Carolina Sea Grant and the National Estuarine Research Reserve, we are using parasite diversity as a proxy for overall community diversity to evaluate the success of different coastal habitat restoration techniques within North Carolina's Rachel Carson Estuarine Reserve. Portions of the Reserve were restored using a block design incorporating three replicates of three different treatments: control (no restoration), shell bags and oyster catcher material. Pre-restoration sampling of parasite diversity (January to May 2018) showed no significant differences among treatment sites. Post-restoration monitoring is ongoing and planned for an additional 1 to 2 years. Many host organisms are elusive (e.g. diamondback terrapins) or time-intensive and costly to sample using traditional survey methods (e.g. shorebirds, large demersal fishes). However, because of the tight co-evolutionary relationship between hosts and their parasites, parasite diversity in easily collected upstream hosts can provide clear evidence that the necessary

Abstracts continued

downstream hosts are recruiting to the restored habitat. Parasites thus offer a promising assessment tool for quantifying biodiversity and environmental health, particularly in sensitive ecosystems subject to frequent monitoring.

Using Pocket Lab Sensors to Uncover the Science behind the Storm

Presenter: **Harris Muhlstein**, University of North Carolina Wilmington
MarineQuest, muhlsteinh@uncw.edu

Join University of North Carolina Wilmington MarineQuest to learn about our recent adventures taking a new hurricane outreach initiative on the road to enrich student understanding of the science behind and impacts of Hurricane Florence. Discover how these STEM lessons helped make connections to climate literacy in 4th grade to high school classrooms in six N.C. counties. Participants will explore real-world storm data collected by researchers from UNCW's Center for Marine Science and get hands-on as they utilize Pocket Lab sensors to uncover meteorological phenomena and hurricane science.

Coastal Resiliency and Shoreline Restoration: Design and Post-Construction Review of Living Shoreline Projects

Presenter: **Ben Nash**, Brown and Caldwell, bnash@brwnncald.com

The City of Norfolk is projected to experience a sea level rise of approximately 1.5 feet in the next 50 years. Due to concerns related to public safety, loss of property, protection of infrastructure and water quality, the city has launched a coastal resiliency initiative aimed at improving fish and wildlife habitat, improving water quality, providing flood protection and minimizing erosion along the shoreline. A Hurricane Sandy Coastal Resiliency Grant awarded to the City of Norfolk will allow the city to restore miles of shoreline, use living shoreline techniques, and create acres of oyster reef and tidal wetlands on the Lafayette River. The City of Norfolk selected six project sites for living shoreline restoration design with Brown and Caldwell providing design and permitting services for each site. To date, five of those sites have been designed. Two of the sites have been constructed and two sites are under construction and expected to be completed in early 2019. The two completed project sites were bid separately and the two sites currently under construction were bid together, due to site proximity, and are being constructed by one contractor. The city is providing inspection services for all of the projects with construction administration support being provided by Brown and Caldwell. The presentation will review the project sites; review the design methodology for the sites; and share photographs of before, during and after construction, as well as discuss lessons learned that can be applied to future living shoreline designs.

Two Years of Neuse Estuary Hypoxia Forecasts: Lessons Learned and Future Directions

Presenter: **Daniel Obenour**, North Carolina State University,
drobenour@ncsu.edu
Co-authors: Alexey Katin and Dario Del Guidice

The Neuse Estuary of North Carolina suffers from severe eutrophication that is exacerbated by anthropogenic watershed nutrient loading. As a result, hypoxia and fish kills are common occurrences in most summers. Mechanistic water quality modeling plays a key role in quantitatively linking hypoxia to nutrient loading and other environmental drivers, and in assessing the effectiveness of watershed management strategies under various climate scenarios. Such models can also be used to forecast the severity of hypoxia, raising awareness of potential water quality problems for both natural resources managers and the public. Seasonal hypoxia forecasting is successfully performed in many large coastal systems (e.g., Chesapeake Bay, Louisiana-Texas Shelf), though the Neuse Estuary presents unique challenges related to its shallow morphology and short water residence time. Here, we present an approach to forecasting summer hypoxia using a

probabilistic (Bayesian) mechanistic model. We discuss the medium and long-term mechanistic drivers on which the forecast is based (river flow and nutrient load), as well as short-term hydro-meteorological variability, which adds uncertainty to any seasonal water quality forecast. In particular, we present the Neuse hypoxia forecasts that were developed for the summers of 2018 and 2019, as well as their retrospective assessments based on monitoring data and hindcast model simulations. Forecast performance is compared to that of other coastal hypoxic systems. Potential enhancements of the current forecasting system, in terms of both model inputs and forecasting period, are discussed considering the benefits of the modeling approach to address coastal ecosystem challenges.

Water Resources Data to Support Coastal Plain Ecological Flow Assessment in the Albemarle-Pamlico Basin

Presenter: **Michael O'Driscoll**, East Carolina University, odriscollm@ecu.edu
Topic 2 of the Albemarle-Pamlico National Estuary Partnership Technical Session: Ecological Flows, Water Resources, and Water Availability in the Coastal Plain

This research focused on the status of available flow and ecological flow-related data for the Albemarle Pamlico (A-P) Drainage Basin. Water withdrawals and meteorological conditions can influence streamflow, particularly low flows. These flows are important components of ecological flows (the magnitude and timing of streamflow needed to maintain ecological integrity) because of their influence on contaminant dilution, saltwater intrusion, aquatic habitat and public water supplies. Ecological flow assessment for coastal streams can be challenging due to the lack of streamflow data in tidal areas, flow reversals from wind and tides, spatiotemporal variability of salinity in coastal waters, and complex river-groundwater interactions. An analysis of low-flow data at sites with greater than 30-year records suggests that low-flow indicators at the majority of the Coastal Plain river discharge sites showed declines over the last several decades. Groundwater inputs to streams were minimal in smaller watersheds (< 250 square miles). Baseflow along low-order streams in these catchments was more likely to cease (relative to higher-order streams) during summer months with elevated evapotranspiration. Gaps in water use data and wastewater/irrigation return flows may influence the accuracy of water budgets and assessment of anthropogenic influences on baseflow for watersheds in the region. Future work is needed to evaluate the relative influences of meteorological forcing vs. water withdrawals on low flows and to quantify the range of low flows that are protective of ecological integrity.

Nitrogen Inputs Along our Changing Coasts: Evaluating the Role of Onsite Wastewater in an Era of Climate Change

Presenter: **Michael O'Driscoll**, East Carolina University, odriscollm@ecu.edu
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 2

Nutrient inputs have been characterized as the most extensive water quality problem in U.S. coastal areas due to their influence on harmful algal blooms and eutrophic conditions. In coastal settings, nitrogen (N) is of concern because eutrophication in temperate zone estuaries is often N-limited. Typically, major sources of N are fertilizer, animal manure, atmospheric deposition, urban runoff and municipal wastewater. Additionally, there is growing evidence that N inputs from onsite wastewater treatment systems (OWTS) can contribute to coastal waters. Coastal onsite wastewater treatment is often facilitated by sandy soils, however shallow groundwater and proximity to surface waters can lead to water quality impairment. Water quality changes in the surficial aquifer can affect surface water quality because surface waters and wetlands in the Coastal Plain are often nourished by groundwater discharge from the surficial aquifer. In situations with poor N treatment, exports from OWTS can affect human and ecological health, locally by affecting drinking water supplies and regionally by contributing to nutrient enrichment of surface waters. This talk will emphasize recent studies in nutrient-sensitive watersheds of North Carolina

Abstracts continued

and South Carolina that highlight the controls on N exports from coastal OWTS. Climate change can potentially threaten the effectiveness of OWTS in coastal communities by reducing the thickness of unsaturated soils during storms and as a result of sea level rise. Examples of recent and current research will be presented that address the potential effects of land use and climate change on the effectiveness of OWTS N treatment in coastal watersheds.

Impacts of the New Normal in Tropical Cyclone Rainfall and Flooding on Assessing and Managing Estuarine/Coastal Water Quality

Presenter: **Hans Paerl**, University of North Carolina Institute of Marine Sciences, hpaerl@email.unc.edu
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 2

Coastal North Carolina has experienced three extreme tropical cyclone-driven flood events since 1999, causing catastrophic human impacts from flooding and leading to major alterations of water quality, biogeochemistry and ecological conditions. The apparent increased frequency and magnitudes of such events led us to question whether this is just coincidence or whether we are witnessing a “new normal” in rainfall associated with these storms. Rainfall records since 1898 reveal a period of unprecedentedly high precipitation since the late-1990’s, and a trend toward increasingly high precipitation associated with tropical cyclones over the last 120 years. This represents a recent climatic regime change with major ramifications for hydrology, carbon and nutrient cycling in the U.S. Mid-Atlantic and other coastal regions.

Watershed Education with the North Carolina Watershed Stewardship Network

Presenter: **Christy Perrin**, North Carolina Water Resources Research Institute (WRRI), caperrin@ncsu.edu

Coordinated by WRRI, N.C. Sea Grant and the N.C. Department of Water Resources, the N.C. Watershed Stewardship Network (NCWSN) leverages the passion and talent of volunteers to encourage and support local stewards’ watershed improvement efforts. Since 2015 the NCWSN has provided state-wide training workshops on watershed management and funding, online resources and networking opportunities. In 2019, work teams are focusing on education and outreach, particularly with the goal of supporting stewards in increasing recognition about the value of water. At this session we’ll share a new free, online watershed lesson we’re developing in partnership with UNC-TV Science, N.C. Project Wet, Albemarle-Pamlico National Estuary Partnership, municipalities and others for 4th to 5th grade students. We’ll also share results from a statewide survey of watershed organizations’ educational resources and goals, including educational methods that have been most effective for respondents.

Deaf Community Partnerships and a Different, Different World: An Exercise in Hazard Communication Challenges

Presenter: **Steven Pfaff**, NOAA National Weather Service, steven.pfaff@noaa.gov

The NOAA National Weather Service (NWS) is tasked with disseminating watches and warnings about life-threatening events; however, challenges remain as to how messages are received by the public. Personal communication issues result from a variety of reasons, and populations with unique circumstances may not effectively receive warnings. Emergency managers and the NWS share a common mission for the reduction in loss of life and property. It is imperative that partnerships promote inclusiveness. The NWS mission of building resiliency is sustained by developing partnerships through the Weather-Ready Nation Ambassador program. This program enabled

NWS Wilmington N.C. to cultivate a partnership with the N.C. Division of Services for the Deaf and Hard of Hearing (N.C. DSDHH). The NWS and N.C. DSDHH partnership has helped create solutions to challenges faced by the deaf community with weather preparedness. The Different, Different World Hazard Communication Exercise also was developed to help hearing able people understand communication issues often experienced by deaf people. The exercise consists of a fictional community administered by people who are deaf. Participants make decisions with life-or-death consequences. Ultimately, people without a hearing disability often take for granted the ability to access audible communication. This presentation demonstrates the need for exploring multiple forms of communication to build an inclusive system of messaging. Considering challenges faced by all demographics and looking for opportunities to strengthen emergency action planning, exercises and public preparedness are also important. Future efforts must seek new partners to strengthen community preparedness.

Partners in Slime: Headstarting Gopher Frogs at the N.C. Aquarium

Presenter: **Carol Price**, North Carolina Aquarium at Fort Fisher, carol.price@ncaquariums.com
Co-author: Ryan McAlarney

Since 2011, the North Carolina Aquarium at Fort Fisher (NCA) has partnered with the North Carolina Wildlife Resources Commission (WRC) to head start gopher frogs (*Rana capito*). A Coastal Plain specialist, the gopher frog is state listed as endangered in North Carolina and is under consideration for federal listing under the Endangered Species Act. Habitat alterations to upland areas of longleaf pine ecosystem or ephemeral wetlands used for breeding present significant risks to this species. Only seven of 23 historical populations of this species are currently extant. To bolster declining populations, the NCA and WRC have developed successful protocols for collecting eggs from ponds at several locations, rearing the frogs through metamorphosis and releasing them back into their natal ponds. We describe egg collection procedures, egg and tadpole husbandry, methods and tank systems for metamorphosis to froglet stages, and release strategies. Visual implant elastomer is injected into froglets prior to release, enabling long-term assessments of the program’s successful contribution to wild gopher frog populations. Over 1,300 froglets have been head started at the NCA and released. Similar head starting is done at the North Carolina Zoo for an inland population of gopher frogs. Additionally, the NCA supports analysis of the gopher frog populations’ genetic structure, which is being conducted at the University of North Carolina Wilmington. Together, these projects support the WRC comprehensive strategy to conserve and enhance gopher frogs in the state.

Modeling and Validating Residential Flood Vulnerability at High Spatial Resolution in North Carolina’s Coastal Region

Presenter: **Narcisca Pricope**, University of North Carolina Wilmington, pricopen@uncw.edu
Co-authors: Christopher Hidalgo, Joanne Halls, Pat O’Mahony, Alice Wilson

Densely populated low-lying coastal locations are vulnerable to threats associated with land use changes and climate variability, especially pluvial and coastal inundation. Through a combination of poorly coordinated regional land-use planning, weak implementation of mitigation or adaptation practices and high socio-ecological vulnerability, in the United States alone, millions of coastal households are at risk and will be affected by inundation related to storms and sea-level rise in coming decades, as most recently evidenced by Hurricane Florence. With such large at-risk populations, identifying the intersection of social vulnerability and physical risk to inundation is essential for both planning and adaptation purposes in complex socio-ecological systems. We present an integrated socio-ecological model of vulnerability at the block-group level of geography using census data to measure social variability and highly-resolved physical exposure based on finished floor elevation of individual buildings. We

Abstracts continued

identify in a spatially-explicit manner and at multiple levels of governance areas of high social vulnerability and their intersection with areas of high physical exposure to inundation. We then work with local and regional governance bodies to create actionable, needs-based resources to help build community resilience at multiple scales in vulnerable coastal communities. Testing our socio-ecological vulnerability model against actual pluvial and coastal inundation extents resulting from Hurricane Florence, we show how we can merge socio-ecological modeling efforts with needs-based digital tools aimed at enhancing resilience in low-elevated coastal zones by co-designing planning and adaptation strategies with stakeholders, communities, and transboundary governance bodies in areas that suffer from repeated catastrophic inundation events.

Gullah/Geechee Resiliency: Traditional Knowledge Education from a Carolina Living Cultural Community

Lead Presenter: **Queen Quet**, Gullah/Geechee Nation (or Gullah/Geechee Sea Island Coalition), GullGeeCo@aol.com
Co-presenters: **Dan Rizza**, Climate Central; **Kate Derickson**, Gullah/Geechee Sustainability Think Tank

The Gullah/Geechee Nation exists from Jacksonville, North Carolina to Jacksonville, Florida. This unique cultural community is the living embodiment of the term “resilient.” They have thrived and survived numerous hurricanes from the 1600s to the present age, and their leadership has established a “Gullah/Geechee Sustainability Think Tank” in order to insure the continuation of their cultural heritage on the coast for decades to come. Members of the Gullah/Geechee Sustainability Think Tank will host an interactive session focused on community outreach and engagement in the process of enhancing resiliency and sustainability in coastal communities. Including those that are native to the coast in the adaptation and resiliency planning is a necessary element to successful plans and community continuation. As the Gullah/Geechee state: “Yeddi we bout stayin pun de sea!”

Blue Carbon Stocks and Salt Water Intrusion: What Do We Really Know?

Presenters: **Matthew Ricker**, North Carolina State University, mcricker@ncsu.edu
Co-author: Greg Taylor

Many scientists are currently trying to determine the amount of carbon our environment can withstand. What are the long-term effects of saltwater intrusion? How do we plan for all possibilities, and how do we restore areas affected? However, when one begins to explore existing data, no one seems to have a good understanding of where we currently are. How much carbon is currently sequestered in coastal environments/soils? What levels of saltwater intrusion are these ecosystems currently withstanding? We need base data to determine the direction we’re headed and at what rate. The USDA/NRCS recently awarded North Carolina State University a grant to find these answers by sampling along selected areas of Albemarle and Pamlico Sounds while collecting all existing and relative data. The outcome will include data and maps showing extent of salt water intrusion, quantification of soil organic carbon (SOC) stocks, and correlations between SOC, soil accretion and saltwater intrusion. It is the hope that this project will be expanded to other bays and estuaries along the Atlantic and Gulf coasts.

Remote Sensing and Machine Learning Aid in Examinations of Land Change

Presenter: **Justin Ridge**, Duke University Marine Lab, justin.ridge@duke.edu
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 1

The Marine Robotics and Remote Sensing (MaRRS) Lab at Duke University Marine Lab has been monitoring changes to the islands that make up the Rachel Carson Reserve (part of the North Carolina National Estuarine Research Reserve/ North Carolina Coastal Reserves). These islands shelter the town of Beaufort from oceanic energy entering through nearby Beaufort Inlet and are of particular interest as they are influenced by both estuarine and oceanic processes. Using imagery from satellites and unoccupied aircraft systems (drones), we assess changes to Bird Shoal that have occurred over the last several decades related to hurricanes and long term processes that also coincide with a widening of Beaufort Inlet as Shackleford Banks, an island in Cape Lookout National Seashore, erodes. This talk will also provide a broad overview of how the MaRRS Lab is helping examine land change throughout the North Carolina Sentinel Site Cooperative using remote sensing and machine learning.

From Rivers to Sounds: A Natural Resource-Based Model for Sustainable Coastal Ecotourism in the Bertie Peninsula and Waterscape

Presenter: **Stanley Riggs**, North Carolina Land of Water, riggss@ecu.edu
Co-authors: David Hodges, Robert Christian, David Mallinson, Dorothea Ames, Karen Clough

Bertie Peninsula (BP) extends southeast from the Virginia-North Carolina border to Albemarle Sound. The BP is bounded by the Bertie Water Crescent (BWC) with the Roanoke River system along the southwest and south boundaries and Chowan River system along the east boundary. The lower portions of both river systems transition into the Albemarle Sound and Chowan River estuaries by ongoing sea-level rise. The BP contains a series of smaller, black-water tributary drainages that include the Cashie River and Salmon Creek, mid-scale Black Walnut and Cashoke swamps, and ephemeral streams that form steep ravines rimming the highland Wicomoco and Talbot terraces. North Carolina Land of Water (NCLOW) focused on the natural resources for developing ecotourism and environmental education as a means of diversifying the rural economy while minimizing the stifling impact of flooding and drought. NCLOW defined five water hubs utilizing the world-class system of land- and waterscape resources within BP and BWC, along with over 125,000 acres (195 mi²) of public lands to form the basis of a sustainable ecotourism network. The NCLOW 2018 report provides a framework for the water hubs and forms the basis for requesting a U.S. National Park Service designation as a “Rivers to Sound National Water Trail” for the BWC. The water hubs include: 1) Windsor urban waterfront park: upper Cashie River; 2) Sans Souci: lower Cashie River; 3) Salmon Creek Natural Area and Bertie Recreational Area: Western Albemarle Sound; 4) Weeping Mary: lower Roanoke River; and 5) Colerain’s Wicomoco Bluff and Cow Island Swamp: Chowan River estuary.

Survival and Density of a Dominant Fish Species Across a Gradient of Urbanization in North Carolina Tidal Creeks

Presenter: **Paul Rudershausen**, North Carolina State University, pjruders@ncsu.edu

Development in the Southeastern U.S. coastal plain generates the need for a better understanding of how survival and abundance of estuarine nekton respond to urbanization. Apparent survival and density of the dominant Atlantic coast salt marsh fish, the mummichog *Fundulus heteroclitus*, were estimated in four North Carolina tidal creeks using a model simultaneously fitted to mark-resight and mark-recapture data. Rates of weekly loss (mortality plus emigration) were high (~10%). Sampling for tagged fish within and outside of study creeks showed high site fidelity to each creek, indicating that loss largely resulted from mortality rather than emigration. Estimated rates of apparent survival were lowest in the creek with the least instream- and watershed-level impacts. This creek has direct (non-culvert) access downstream to a larger waterbody, suggesting that enhanced access by predators and/or greater rates of permanent emigration may have contributed to lower apparent survival in this creek. There was a positive relation between minnow trap catch-per-unit-effort (CPUE) and density, and CPUE

Abstracts continued

was used to index density. The largest CPUE estimates occurred early in each growing season and were associated with creeks possessing characteristics most representative of undisturbed salt marsh mosaics: high percentage of marsh coverage instream and downstream and high percentage of marsh edge. Given generally limited movement outside of creeks, differences in abundance among creeks likely result from different levels of recruitment that are related to salt marsh availability. Priority preservation of salt marsh habitats may be warranted by natural resource planners to maintain abundance levels of this trophically important species.

Educating Local Decision Makers about Wetland Values and How They Can Help Their Community

Lead Presenters: **Rick Savage**, rick.savage@carolinawetlands.org, Carolina Wetlands Association; **Kim Matthews**, kim.matthews@carolinawetlands.org, Carolina Wetlands Association

Co-Presenters: **Amanda Johnson**, **David Shouse**

This workshop is aimed at educating and communicating the value of wetlands to local officials and others, and how wetlands' use in nature-based solutions can build resilience in their communities and help protect their communities from future extreme events that deal with flooding. The need for this workshop came about from work done by Carolina Wetlands Association with the Natural and Working Land effort in realizing that much of the restoration work that needs to be done will involve communities and other private landowners. Other nonprofit organizations who have worked with coastal landowners have found a mindset that is basically business as usual. We are living in a time where the intensity of storms and flooding are occurring as 500-year storms every few years (for example, hurricanes Matthew, Florence and Michael) and calls for solutions that are not business as usual.

This workshop will foster an understanding of the occurrence and function of natural wetland ecosystems in the landscape. This will provide a basic understanding of the natural occurrence of wetlands and the multiple economic, environmental and social benefits (ecosystem services) they provide communities. We will then explain how wetlands can benefit communities and how communities can include wetlands as a part of their resiliency strategies. Instead of the business as usual mindset, we will show how wetlands can be used as a vital part of their community by providing critical services, such as reducing flood risk and impacts. This more holistic perspective is aimed toward building resilience for their community.

Next we will explain how to develop and implementation strategies of nature-based solutions that are available for communities, which may involve better wetland management practices, wetland restoration or enhancement, or wetland creation. We will introduce nature-based solutions and how communities should embrace their natural ecosystem to turn them into an asset for the community and not a risk. Although communities can't stop the natural forces, they can integrate wetlands and other nature-based solutions as part of a green infrastructure toolkit for more proactive preparation and response to increased flooding, prolonged drought, and rising seas. We will provide evidence-based case studies highlighting the benefits to the community and show how the investment in nature-based solutions can result in generated revenue and avoidance of costly damages. Finally, we will discuss with the participants about potential issues and roadblocks that they perceive and how they may be overcome.

The workshop will be interactive, so that the participants express their concerns and have plenty of opportunity for hands-on interactive learning. We also want to ensure we have the interaction and feedback we need. This is, in fact, a test run of a workshop we hope to run in various communities in early to mid-2020.

Assessing the Damage from Hurricane Matthew and How People Surveyed Indicated an Increased Concern for Coastal Hazards, Including Sea Level Rise

Presenter: **Carter Smith**, Duke University Marine Lab, carter.smith@duke.edu
Part of NC Sentinel Site Cooperative: Research Updates (Double Session) Session 2

The future of coastal habitats and the adaptive capacity of communities rely in part on understanding and modifying the decision-making process of coastal stakeholders. The goal of this project was to gain a better understanding of how hazards like hurricanes and sea level rise (SLR) are affecting coastal communities, and in turn how homeowner experiences impact decision-making and risk appreciation. We surveyed 300 waterfront property owners in Dare, Carteret, and Brunswick counties to understand: 1) which factors were the best predictors of shoreline and home damage during Hurricane Matthew; and, 2) whether hurricane damage correlated with an increased concern for hurricanes and SLR. Our results show that past hurricane damage to shorelines and homes was a strong predictor of damage during Hurricane Matthew, suggesting that there are patterns of repeated damage to certain properties. Furthermore, homeowners that reported damage from Hurricane Matthew indicated an increased concern about the impacts of SLR. These data may suggest that hurricanes act as signaling events that make homeowners feel more vulnerable to all coastal hazards.

NC Sentinel Site Cooperative: Research Updates Double Session

Moderators: **Sarah Spiegler**, North Carolina Sea Grant and NC Sentinel Site Cooperative, sespiegl@ncsu.edu; **Carolyn Currin**, NOAA National Centers for Coastal Ocean Science, carolyn.currin@noaa.gov; **Nathan Hall**, University of North Carolina Institute of Marine Sciences, nshall@email.unc.edu; **Justin Ridge**, Duke University Marine Lab, justin.ridge@duke.edu

Presenters: **Brian Boutin**, The Nature Conservancy; **Jenny Davis**, NOAA National Centers for Coastal Ocean Science; **David Glenn**, NOAA National Weather Service; **Michael Itzkin**, University of North Carolina at Chapel Hill; **Michael O'Driscoll**, East Carolina University; **Hans Paerl**, University of North Carolina Institute of Marine Sciences; **Justin T. Ridge**, Duke University Marine Lab; **Carter Smith**, Duke University Marine Lab

Abstracts for each presentation listed under individual presenters' names.

The North Carolina Sentinel Site Cooperative (NCSSC) is one of five cooperatives in the NOAA Sentinel Site Program, which leverages existing research and monitoring resources to ensure resilient coastal communities and ecosystems in the face of changing conditions. The program's place-based approach focuses on issues of local, regional and national significance that impact habitats, species and people, managed by NOAA and surrounding coastal communities. The NCSSC was established in 2012 to provide coastal communities and resources managers in Eastern North Carolina with information on the potential impacts of sea level rise on coastal habitats and communities. In 2018, the NCSSC expanded to include the 20 coastal CAMA counties in North Carolina and also Jones and Martin counties.

The mission of the NCSSC is to work collaboratively and leverage resources to provide research, monitoring and information to address flooding, inundation and sea level rise. The NCSSC facilitates research and monitoring, integrates science into decision making, and informs coastal residents about the impacts of sea level rise. The Cooperative hosts trainings, workshops and partner meetings, conducts outreach and facilitates communication among stakeholders and builds a collaborative network of partners in coastal North Carolina.

At the most recent NCSSC Partners Meeting, participants identified the need for an update of research and monitoring efforts related to sea level rise and coastal resiliency in North Carolina. During this NCSSC session, speakers will showcase recent research by NCSSC partners that encompasses interdisciplinary, collaborative efforts to monitor change in N.C. habitats and

Abstracts continued

communities. Participants will learn how research and monitoring can be used by resource managers and end users to better address impacts of sea level rise and flooding in North Carolina, and the importance of partnerships in collaborative research efforts.

Speakers will provide research updates addressing topics such as the response of marshes to sea level rise in North Carolina; the impact of storms and sea level rise on dune formation on N.C. barrier islands; people's perceptions of sea level rise in coastal North Carolina; the impact of storms, sea level rise and flooding on water quality; involving end users in the collaborative research process; and using NCSSC research results to reach a broader audience and increase communication of science to new user groups.

The NCSSC invites their partners to attend this session to learn about research updates and invites new participants to learn more about the Cooperative and opportunities for engagement.

Engaging Lifelong Learners through Citizen Science

Presenter: **Miriam Sutton**, Science by the Sea, mirsutton@gmail.com

Citizen science provides an excellent way to engage lifelong learners to learn more about the world around them and to share their experiences with researchers and the general public. Two coastal-based citizen science initiatives will be demonstrated to encourage participants to engage in one or more of these programs: AMOY (American Oystercatcher Banding) and Jelly Watch®. Tips for successful fieldwork and for species identification and counts will assist participants with accurate data collection. Participants will receive guidance with the AMOY and Jelly Watch® websites to enhance their understanding and navigation of each portal for accurate data entry. QR codes will be provided to session participants, allowing them to gain easy access to each initiative for future reference and participation.

Transient Boaters' Potential for Economic Development on North Carolina Communities Proximate to the Atlantic Intracoastal Waterway

Presenter: **Hans Vogelsong**, East Carolina University, vogelsongh@ecu.edu

The Intracoastal Waterway (ICW) is a protected transportation route that runs from New England to the southern tip of Florida and continues north along the coast of the Gulf of Mexico and is maintained by the Army Corps of Engineers (USACE). This water trail provides passage for commercial, recreational and transient watercraft. While a great deal is known about commercial freight use of this waterway, little if any data is available concerning recreational and transient use patterns of the ICW. Transient users known as "snowbirds" may be of particular interest to N.C. coastal communities. It is believed that these users make annual trips up and down the ICW based on seasonal climate conditions. Much like migratory birds, in the fall they travel south to escape the cold of the northern winter, and then return north in the spring. Coastal communities who wish to attract transients may provide amenity-rich waterfront areas in the hopes that they will stop for a few days and provide positive economic impacts in the communities. The primary purpose of this project was to develop, test and refine a methodology to collect travel behavior data from transient boaters on the ICW. A secondary purpose of the project was to collect data on travel behaviors and to develop a preliminary social-economic profile of ICW transient boaters. Data was collected through a combination of short intercept surveys and more extensive mail-back surveys that were given to transient boaters at several locations on the ICW in N.C. during fall 2015.

Maintenance Costs of Stormwater Control Measures in North Carolina

Presenter: **Sarah Waickowski**, North Carolina State University, sewaicko@ncsu.edu

With urbanization the need for stormwater control measures (SCMs) to meet stormwater regulations grows. Maintenance is necessary and typically required by state and local entities to ensure SCMs remain functional and continue to mitigate the impacts of urbanization. Previous research has quantified maintenance costs for some SCMs in North Carolina but (1) this study is dated; (2) there remains a lack of data regarding costs for routine, preventative/proactive and restorative maintenance; and (3) the relationship between aesthetic need and maintenance frequency was not evaluated. North Carolina State University sought these answers with the help of the Water Resources Research Institute (WRRI) of the UNC System and the N.C. Coastal Federation. While maintaining the interviewees' anonymity, NC State interviewed representatives from N.C. communities with active stormwater programs, at least 10 individuals from private maintenance firms who have been certified under the NC State Stormwater BMP Inspection & Maintenance workshop series, staff from the NC State and University of North Carolina-Chapel Hill stormwater maintenance groups, and employees of the North Carolina Department of Transportation. To optimize maintenance and budgeting across the state, data from private firms were compiled into a publicly available Microsoft Excel based tool and user's manual.

Mapping Coastal Protection and Carbon Storage by North Carolina's Coastal Habitats

Presenter: **Katie Warnell**, Duke University, katie.warnell@duke.edu

Coastal habitats provide a variety of benefits, including opportunities for recreation, nursery habitat for commercially-harvested fish and aesthetic beauty. Two of these benefits are particularly relevant in the face of climate change: coastal protection and carbon storage. Habitats such as salt marsh, coastal forest and seagrass protect coastlines by slowing storm surge and reducing the energy of incoming waves. This can reduce the exposure of vulnerable residents, community assets and critical habitats to hazardous storm conditions, which are likely to increase in the future with sea level rise and ocean temperatures. These same habitats also store and sequester carbon, helping to prevent even more extreme climate change. We mapped coastal protection and blue carbon storage by coastal habitats in North Carolina using two InVEST models to identify areas where coastal habitats are currently providing these services (and therefore are good targets for protection) and areas where coastal habitat restoration would be most valuable for enhancing these benefits. We also consider how future habitat migration due to sea level rise influences where benefits will be provided and what interventions are best suited to certain areas. The resulting map products can help communities, conservation organizations and others understand the role that coastal habitats are playing in their local areas and how management decisions can target areas that can provide the greatest benefits for coastal protection and carbon storage.

Pilot Hatchery Studies at UNCW Improve Availability and Cost of Black Sea Bass Fingerlings to Support Education, Outreach and Commercial Growout Trials in the Eastern U.S.

Presenter: **Wade Watanabe**, University of North Carolina Wilmington Center for Marine Science, watanabew@uncw.edu
Co-authors: Patrick M. Carroll, Md Shah Alam, Christopher F. Dumas, Jennifer E. Gabel

The black sea bass (*Centropristis striata*) is a heavily exploited, high-value marine finfish and an important candidate for commercial aquaculture in the Eastern U.S. Critical variable cost in the development of a commercial finfish

Abstracts continued

mariculture industry is the price of a reliable source of fingerlings to support growout operations. Based on our preliminary economic analyses, a hypothetical commercial scale hatchery producing advanced fingerlings (5-g wt., 105 days post-hatching) at a final nursery tank (NT) stocking density of 1.5 fish/L had an output of 92,340 fingerlings per year at a breakeven price of \$1.67 each. Sensitivity analyses revealed that maximizing safe stocking densities and minimizing the rearing cycle optimized use of hatchery resources to improve fingerling output, quality and affordability. With support from N.C. Sea Grant, we investigated under pilot hatchery conditions the effects of NT stocking density of post-metamorphic (p-m) stage black sea bass (47 dph, mean wt. = 0.54 g) on survival, growth and stress resistance to a transport-ready juvenile stage. The results demonstrate that stocking early p-m stage black sea bass in NTs at moderate to high densities of 4.5 to 6.5 fish/L does not affect survival, growth variation or feed conversion ratio to a transport-ready stage on 60 dph. Fingerlings from this project are enabling startup farmers to grow and market black sea bass as a foundational resource for outreach and industry development in the Eastern United States.

Science Advice to Policymakers: Lessons from North Carolina's Sea Level Rise Controversy

Presenter: **Jessica Weinkle**, University of North Carolina Wilmington, weinklej@uncw.edu
Co-authors: Shelby White, Jennifer Biddle

In recent years, North Carolina policymakers made national headlines for the way they interact with science advice. Scientists and policymakers need each other for legitimacy, but the relationship and its outcomes often frustrate both groups and the public. Using a case study approach, we appraise the success and failures of science advice to policymakers in coastal North Carolina towards higher order goals of preserving public trust in the policymaking process. Three case studies are used: drinking water quality, shrimp trawl and sea level rise. The cases illustrate the interrelationship between scientist and policymaker interactions with the broader social context and, in turn, the acceptability of information and public trust in the policymaking process. To improve trust in the policy process, scientists in advisory roles need guidance on how to effectively interact with the democratic policymaking process without undermining policymaker authority. Policymakers need to understand and acknowledge the limitations of science. The analysis provided here contributes to current discussion in the policy sciences about the strategic production and use of knowledge and ignorance in policymaking.

Impacts of Invasive *Phragmites australis* on Nitrogen Processing

Presenter: **Mollie Yacano**, University of North Carolina at Chapel Hill, moyacano@live.unc.edu
Co-authors: Michael Piehler, Suzanne Thompson

Marshes function as a buffer zone at the land-sea interface and play a key role in global nitrogen (N) cycling. Invasive species pose a threat to these systems globally. One of the most aggressive invasive plant species in marshes across the United States is the aggressive European haplotype of *Phragmites australis*, which has spread throughout the U.S. over the past several centuries and has all but completely pushed out its native counterpart, due to its ability to thrive in high-nutrient conditions. *P. australis* is often considered an undesirable species and can play a role in decreasing biodiversity; recent studies show it also performs very closely to native counterparts in terms of ecosystems services such as carbon

storage, shore stabilization and greenhouse gas emissions. We hypothesized that *P. australis* may play a currently unacknowledged role in marsh N cycling. In this study, we completed seasonal N fluxes at three sites within the Albemarle-Pamlico Region (Currituck Banks Reserve, Kitty Hawk Woods Reserve and the Rachel Carson Reserve), focusing on invasive *P. australis*, native *Spartina alterniflora* or *Juncus roemerianus*, and unvegetated mudflat. We found that *P. australis* at all sites was performing net denitrification over the course of our flux experiments. When spiked with 20 mmol NaNO₃, *P. australis* performed denitrification at a significantly higher rate (<0.05) than *S. alterniflora*. These results indicate *P. australis* has the potential to alter how marshes process the N that is delivered into them, which may have larger implications for the adjacent estuarine waters.

Investing in the Blue Economy via Sustainable Tourism: Roundtable Discussions

Presenters: **Emily Yeager**, East Carolina University, yeagere18@ecu.edu; **Jane Harrison**, North Carolina Sea Grant, jane_harrison@ncsu.edu; **Whitney Knollenberg**, North Carolina State University, wgknolle@ncsu.edu.
Abstracts for each Roundtable Discussion listed under individual presenters' names.

The session consists of three facilitated roundtable discussions designed to engage participants in conversation related to new and continuing research projects. We intend for the conversations generated in this session to provide participants with the opportunity to learn about multiple research projects related to tourism's contribution to N.C.'s Blue Economy. The discussion leaders will facilitate the conversation in order for participants to provide their insight on the future directions of this research, appropriate applications of the research findings, and ideas for related topics in need of investigation.

An Inventory of the Eastern Tar River's Blue Economy

Roundtable 3 of the Investing in the Blue Economy via Sustainable Tourism Roundtable Discussions

Leader: **Emily Yeager**, East Carolina University, yeagere18@ecu.edu

Located within the Tar-Pamlico River Basin, the lower 1/5 of the Tar River flows through North Carolina's Coastal Plain physiographic region. This eastern portion of the Tar River offers a range of ecotourism, hospitality and socio-cultural heritage attractions and activities, including but not limited to camping platforms, paddling, angling, wildlife viewing, microbreweries and outdoor recreation outfitters emerging in these newly renovated spaces. While maps of this eastern portion of the Tar River exist, they are outdated and are not comprehensive records of the range of assets that exist on this segment of the river's banks and within its waters. Therefore, this project seeks to inventory the ecotourism, hospitality and socio-cultural assets available to all users of this eastern portion of the Tar River to promote a Blue Economy within Tier 1 and Tier 2 North Carolina communities east of Interstate 95. Upon completion of this inventory, the assets database will be used to create a digital interactive map through which users can turn filters on and off to curate their experience in communities along the rivers (e.g., Rocky Mount, Greenville, Tarboro, Princeville, Washington) and all the places in between. This research is being conducted by faculty at East Carolina University in partnership with Sound Rivers (the Pamlico-Tar Riverkeepers), N.C. Growth, the City of Greenville CVB, Knee Deep Adventures (a private paddling outfitter), Beaufort County Department of Economic Development, Washington Tourism Development Authority, N.C. Folklife Institute, and the Economic Development Partnership of North Carolina.

Lightning Talk Abstracts

Alphabetical by Presenter Last Name

Green Infrastructure for Coastal Climate Resilience

Presenter: **Nicole Barclay**, University of North Carolina Charlotte, nbarclay@unc.edu

Climate change exacerbates flooding events in low lying coastal communities, thereby creating an increasing need for the implementation of green infrastructure strategies. The State of North Carolina already recognizes this need for large-scale green infrastructure practices, such as the preservation of wetlands and forested areas. Thus, it can be of added benefit if the short-term and long-term impacts are quantified, so these practices are promoted. The purpose of this work is to present the development of an analytical and planning tool that quantitatively shows the impact of policies that support or hinder green infrastructure measures. This work adopts a system dynamics approach to investigate scenarios, evaluate watershed management decisions and provide recommendations for planning adaptation strategies. The system dynamics tool created as a result of this work can also be used to engage and educate stakeholders about the impact of green infrastructure. The system dynamics model will incorporate hydrological scenarios and community responses. Further work will use a case study to validate and refine the tool. The use of the developed tool can advance informed implementation and development of policies in the field of watershed and stormwater management for climate resilience.

Cape Hatteras Lionfish Mitigation Case Study

Presenter: **Jordan Bridges**, North Carolina Aquarium on Roanoke Island, jordan.bridges@ncaquariums.com
Co-author: Shawn Harper

North Carolina's coastal waters are nicknamed "The Graveyard of the Atlantic," as they are host to thousands of shipwrecks offshore, and many now function as artificial reefs. Unfortunately, they have also been inhabited by a problematic invasive fish – the red lionfish (*Pterois volitans*). In the Atlantic, lionfish have no known natural predators, allowing their populations to thrive. The overpopulation of lionfish on some of North Carolina's shipwrecks can result in negative impacts to native fish, either from direct predation or depletion of competing food resources. To offer some relief for these ecosystems, the North Carolina Aquarium on Roanoke Island's (NCARI) Dive Department established a Lionfish Mitigation Project. With funding provided by the North Carolina Aquarium Society, NCARI brought together a collaborative team of scientific divers from its staff, the Coastal Studies Institute and East Carolina University to survey and remove lionfish on four wrecks offshore of Cape Hatteras. Since the project began in 2017, 363 lionfish have been removed from the study sites. Collectively, this effort reduces lionfish consumption of local prey species by an estimated 1.4 million individuals annually. Onshore activities supported additional objectives, including submitting data to REEF's collaborative online lionfish database and hosting "Seafood Series" cooking programs, in which local seafood processors prepare the fish, then local chefs teach patrons how to cook and enjoy lionfish. Mitigation of the invasive lionfish can improve North Carolina's marine environment, serve as a conservation success story to engage the public and stimulate its economy through tourism and the food industry.

Overwinter Survival and Population Size Estimates of Seaside and Saltmarsh Sparrows in Southeastern North Carolina

Presenter: **Evangelyn Buckland**, University of North Carolina Wilmington, elb9021@uncw.edu
Co-authors: Marae Lindquist, John Carpenter, Raymond Danner

Little is known about the overwintering populations of seaside sparrows (*Ammospiza maritima*) and saltmarsh sparrows (*Ammospiza caudacuta*) along

the southern Atlantic Coast, yet populations of both species are experiencing declines across their ranges. Winter seasonal survival probabilities and population estimates remain two important unknowns for these species in North Carolina. My objectives are to estimate overwinter survival and population size for both species using a novel approach, combining mark-recapture and radio-telemetry during their winter stationary period. We have conducted one season of field research on Masonboro Island, North Carolina, in 2019 and will complete the second season in 2020. To estimate survival, I am analyzing mark-recapture data with CJS and Robust models and radio-telemetry data with known-fate models using the R package RMark. To estimate population size, I am using closed population capture-recapture models. I will present survival and population size estimates for both species. This investigation into the winter population biology of seaside sparrows and saltmarsh sparrows contributes to a deeper understanding of these species throughout their ranges and across the seasons of their life cycles, which will provide vital assistance toward their conservation.

The State Climate Office of North Carolina

Presenter: **Kathie Dello**, State Climate Office, kddello@ncsu.edu

The State Climate Office of North Carolina (SCONC), located at North Carolina State University, serves as the primary scientific extension resource for weather and climate science focused on North Carolina. The SCONC's mission is to define, predict and disseminate information about the climatic and environmental factors that impact the people of North Carolina. Founded in 1976 and chartered as a Public Service Center by the UNC Board of Governors in 1998, SCONC focuses on service to the public and private sectors of North Carolina through climate science extension, research and education. The North Carolina State Climate Office is one of the largest in the country, and has been serving the people of North Carolina for over 43 years. SCONC can serve as a resource for coastal managers, scientists and residents. We will briefly explore existing tools, resources and services available for coastal communities. SCONC is always eager to partner and serve in a variety of roles with North Carolinians, from co-producing relevant coastal research and products to acting as an informal climate advisor and resource.

Student Perspectives on Coastal Change

Presenter: **Evan Ferguson**, Dare County Public Schools, fergusonnev@daretolearn.org

In the past three years, two devastating hurricanes have flooded the island of Cape Hatteras, N.C. Hatteras village has been particularly hard hit both times with sound-side flooding from Hurricanes Mathew and Dorian. In addition to the village of Hatteras, Hurricane Dorian also flooded the villages of Frisco, Buxton and Avon. One-third of Cape Hatteras Secondary School, located in Buxton, was damaged due to wind and water. Families have been displaced and island youth have incurred trauma from these events that seem to be happening more frequently and with more intensity. This lightning talk will focus on student perspectives, grades 6 to 12, on coastal change. It will consist of interviews, student photos and testimony regarding Hatteras Island youth's experiences and opinions from these weather events. What happened to students whose homes and families incurred damage? What are their feelings on these events? How does the community come together to help those in need? What are their views on climate and coastal change? What are other communities doing to address similar issues? What ideas do students have to combat these pressing issues? Evan Ferguson, Career and Technical Education teacher at Cape Hatteras Secondary School of Coastal Studies, will lead students from her CTE Advanced Studies class in creating a presentation that will encompass the student perspectives mentioned above.

Lightning talks continued

Science Communication Strategies

Presenter: **Frank Graff**, UNC-TV, fgraff@uncvtv.org

We've all sat in a talk or listened to an interview and thought, "I know this person is speaking my language, but I have no idea what they are talking about." Yes, they might as well have been speaking in some language from a planet in the Star Wars universe. Also, we live in a time when "alternate facts" are a thing. Experts aren't always valued. Sadly, both of these issues often center on a topic involving science. So, communicating science is more important than ever. Whether you are a scientist, science communicator or government leader, this lightning talk will provide you concrete tips to help deliver science ideas in a clear and understandable way, as well as make those ideas relatable to the average viewer/reader. The tips will apply to interview situations as well as digital content delivery. One of those tips: Every science communication must answer the WIIFM question – What's In It For Me? Frank Graff is the producer/host of UNC-TV's *Sci NC* program, which is focused on science happenings in North Carolina. He is a multiple Emmy-award-winning reporter with more than 30 years of experience in news reporting. He joined UNC-TV six years ago and helped launch its UNC-TV Science project.

Thriving in Sun, Salt and Sand: Seacoast Plants of the Carolinas

Presenter: **Paul Hosier**, University of North Carolina Wilmington *emeritus*, hosier@uncw.edu

The Carolina coastlines offer salty ocean waters and muddy estuaries, nutrient-poor and highly mobile sandy substrates, saltshaded forests and expansive coastal grasslands, occasional nor'easters and punishing hurricanes. These elements, combined with dynamic wave and tide actions, merge in time and space to create a unique complex of conditions to which only a limited number of plants and animals have adapted. More than 200 of these plants are highlighted in *Seacoast Plants of the Carolinas: A New Guide for Plant Identification and Use in the Coastal Landscape*. Since the book launched in 2018, it has gained attention for its photos and detailed plant profiles. It also generated public discussion – and even a ruckus when folks discovered that *Spartina alterniflora*, a smooth cordgrass, is now *Sporobolus alterniflorus*, thanks to new taxonomic research. Readers learn to avoid invasive plants. Instead, they can identify native plants to enhance landscaping, survive droughts and add resiliency in tropical storms. The book was published by UNC Press in partnership with North Carolina Sea Grant. Author Paul Hosier, former provost at the University of North Carolina Wilmington, is an active member of the Coastal Landscapes Initiative.

Saltwater Intrusion in Shallow Coastal Aquifers

Presenter: **Alex Manda**, East Carolina University, mandaa@ecu.edu

Saltwater intrusion along North Carolina's coast is causing aquifer and soil salinization problems that have the potential to significantly impact coastal economies that are dependent on agriculture. The phenomenon is of great concern to farmers because crops (e.g., soybeans) that are planted in impacted areas eventually die, leaving a patchwork of bare ground and unhealthy/healthy crops in the agricultural fields. This talk will highlight the drivers that threaten the viability of agriculture and freshwater resources in the coastal region. The mechanisms that are likely influencing saltwater intrusion and increasing

salinity in freshwater reservoirs and the shallow subsurface are natural and man-made. These include sea level rise due to climate change, lowering of the ground surface due to groundwater withdrawals and/or isostatic rebound, lowering of the water table through the development of drainage ditches and canals, evaporation of saline groundwater and capillary action, and inundation of saline water in low lying areas due to wind tide events and/or storm overwash. The first step in addressing the challenge of saltwater intrusion and aquifer/soil salinization is the identification of the causes that lead to the phenomenon. Using field data, archival data and other resources, this talk will add insight to this coastal problem affecting eastern North Carolina.

Wetland Monitoring: Can Volunteers Be the Solution?

Presenter: **Kim Matthews**, Carolina Wetlands Association, kim.matthews@carolinawetlands.org
Co-author: Rick Savage

Wetlands account for about 14% of the land area in North Carolina and almost 20% of South Carolina. Most of these wetlands are found in the coastal plain. Wetlands provide great benefits to communities and save them billions of dollars every year in flood protection, water filtration and recreational opportunities like fishing and birding. However, wetlands are more misunderstood than lakes and rivers, and neither North Carolina nor South Carolina has a regular program to monitor their condition and function. Come learn about a new effort to develop a monitoring program using volunteers in North Carolina to collect vital information about wetlands and the benefits they provide.

Rip Currents in the Carolinas

Presenter: **Victoria Oliva**, NOAA National Weather Service, victoria.oliva@noaa.gov

Rip currents are the number one hazard people face at the beaches in the Carolinas. According to the United States Lifesaving Association, 80% of all ocean rescues are rip related. Between 2000 and 2018, there were 137 rip current fatalities in the Carolinas, approximately seven per year. Since 2011, approximately 27% of rip current drownings have been Good Samaritans who drowned making an attempted rescue. These statistics highlight the need to increase public awareness and readiness. At the NOAA National Weather Service, we are working towards mitigating this hazard through improving our rip current forecasting and increasing awareness through various outreach efforts. Forecasting for rip currents is difficult due to the many factors involved: coastline characteristics, incoming wave and swell height and period, wind forecasts, and tide levels. Recent advancements in wave modeling and experimental rip current models have led to refining our surf forecasting methods. The newest addition to our surf forecast product is an outlook section, mainly used to highlight the rip current risk across the area for the next few days. We partner with many local lifeguards and beach communities to help provide consistent messaging to the public and assist with beach safety training. Our partnership with the lifeguards also gives us an opportunity to receive ground truth of surf conditions, which further helps us fine-tune our rip current forecasting techniques. In addition, the local YMCAs in Myrtle Beach and Georgetown, S.C., are doing a great job promoting rip current safety with the use of rip current simulators at their facilities.

Poster List

Alphabetical by Presenter Last Name

* denotes student presenter

1. Evaluation of UNCW-Formulated and Premium Commercial Weaning Diets on Growth Performance, Survival and Whole-Body Proximate and Fatty Acid Composition of Post-Metamorphic Stage Black Sea Bass

Presenter: **Md Shah Alam**, UNC Wilmington, alamm@uncw.edu
Co-authors: Wade O. Wantanabe, Patrick M. Carroll, Jennifer E. Gabel

2. Alteration of Coastal Watershed Drainage Characteristics and Vulnerability to Tidal Inundation

* Presenter: **Chris Brown**, College of Charleston, brownce1@g.cofc.edu

3. Using Passive and Active Acoustics to Assess Oyster Reef Restoration Success

* Presenter: **Olivia Caretti**, NC State, oncaredt@ncsu.edu
Co-authors: David Eggleston, DelWayne Bohnenstiehl

4. America's Forgotten World War II Battlefield

Presenter: **Tane Casserley**, NOAA's Monitor National Marine Sanctuary, tane.casserley@noaa.gov
Co-author: David Alberg

5. Uncloaking the Cloacal Microbiome of Wild Sea Turtles in North Carolina: A Comparative Analysis of Healthy versus Debilitated Turtles

* Presenter: **Tara Clancy**, UNC Wilmington, NOAA, tlc9009@uncw.edu

6. An Investigation of Rapid Water-Level Rise Events Along the Soundside Outer Banks

* Presenter: **Justin Condry**, UNC Asheville, jcondry@unca.edu
Co-author: Carl Barnes

7. Preparing for, Responding to and Mitigating Compound Coastal Water Hazards for Resilient Rural Communities

Presenter: **Scott Curtis**, ECU, Curtisw@ecu.edu

8. Development of an Automated Algorithm to Capture Timing and Duration of Dune Erosion Events from Publicly Available Webcams

* Presenter: **Deanna Edwing**, UNC Wilmington, dbe2385@uncw.edu
Co-authors: Kelsea Edwing, Joseph Long

9. Mechanisms Generating Growth Variation in Southern Flounder (*Paralichthys lethostigma*)

* Presenter: **Spencer Gardner**, UNC Wilmington, gardner.spencer.t@gmail.com

10. Determining River Herring Edna Shedding and Decay Rates to Develop a Methodology for Quantification

* Presenter: **Seth Gibbons**, ECU, gibbons18@students.ecu.edu

11. To Randomize or Not to Randomize: An Evaluation of Survey Design for a Long-Term Monitoring Program

* Presenter: **Danielle Goldberg**, UNC Wilmington, dag6690@uncw.edu
Co-authors: Frederick Scharf, Lee Paramore, Laura Lee

12. Communicating Hurricane Dorian's Uncertainty Using Social Media

Presenters: **Shane Kearns**, NOAA NWS Newport/Morehead City, N.C., shane.kearns@noaa.gov

13. Predicting the Effects of Sea Level Rise on Marsh Birds of Conservation Concern in Coastal North Carolina

* Presenter: **Marae Lindquist**, UNC Wilmington, mcl6280@uncw.edu
Co-author: Raymond Danner

14. Movement and Habitat Use of Female Sand Tiger Sharks (*Carcharias taurus*) in North Carolina Coastal Waters

* Presenter: **Madeline M. Marens**, UNC Wilmington and N.C. Aquarium
Co-authors: Dewayne A. Fox, Bradley M. Wetherbee, Amanda S. Williard, Frederick S. Scharf

15. In the Wake of the Storms: Working Waterfronts and Access in Coastal North Carolina

Presenter: **Sara Mirabilio**, North Carolina Sea Grant, semirabi@ncsu.edu
Co-authors: Barbara Garrity-Blake, Susan West, M. Scott Baker Jr.

16. Ecological Impacts of Per- and Polyfluoroalkyl Substances (PFAS) on Striped Bass (*Morone saxatilis*) in Coastal North Carolina

* Presenter: **Madison Polera**, NC State, mpolera2@ncsu.edu
Co-authors: Theresa Guillette, James McCord, Mark Stryner, Ben Reading, Scott Belcher

17. One Year – Storm Surge Protectors

Presenter: **Katelyn Sullivan**, UNC Wilmington, MarineQuest and AmeriCorps, katelynsullivan21@gmail.com

18. Identifying Populations Vulnerable to Hurricane Impacts in Coastal North Carolina Using Mappable Indicators

Presenter: **Robert Truesdale**, RTI International, rst@rti.org
Co-authors: James Cajka, Paramita Sinha, Donna Womack

19. Effects of Invasive Marsh Grass and Wave Energy on Shoreline Change and Essential Fish Habitat

* Presenter: **Erin Voigt**, NC State, epvoigt@ncsu.edu
Co-author: David Eggleston

20. The Place We Call Home: A Critical Analysis of the Risk Perceptions and Place Attachments of Coastal Communities at Risk for Sea Level Rise in North Carolina

* Presenter: **Tenesha Washington**, Florida A&M University, tenesha1.washington@fam.u.edu
Co-authors: Michelle Dovel, Tia Maxwell

21. Using Virtual Reality to Educate about Human Impacts on Sea Turtles

* Presenter: **Nicholas Weaver**, ECU, weavern17@students.ecu.edu

Poster Presentation Abstracts

Alphabetical by Presenter Last Name

* denotes student presenter

1. Evaluation of UNCW-Formulated and Premium Commercial Weaning Diets on Growth Performance, Survival and Whole-Body Proximate and Fatty Acid Composition of Post-Metamorphic Stage Black Sea Bass

Presenter: **Md Shah Alam**, University of North Carolina Wilmington, alamm@uncw.edu

Co-authors: Wade O. Wantanabe, Patrick M. Carroll, Jennifer E. Gabel

To determine the optimum weaning diets for post-metamorphic stage black sea bass, a feeding trial was conducted under controlled laboratory conditions comparing two UNCW-formulated diets (D1 and D2) and two premium commercial marine finfish fry diets: Gemma Diamond, Canada (D3) and Otohime, Japan (D4). The UNCW diets incorporated a combination of high-quality protein sources, including menhaden fish meal and other practical sources. D1 contained high fish meal (40% of diet), whereas D2 replaced 50% fish meal protein by poultry meal protein. To begin the experiment, 75 metamorphic stage black sea bass (~ 0.60 g, d40ph) were each stocked in twelve 75-L tanks (N = 4 per diet) at a density of 1 fish per L (75 per tank). Fish were fed four times per day for 28 days under 32 g/L salinity and 22°C. At the end of the feeding trial, fish fed the UNCW-formulated D1 and D2 diets showed significantly higher body weight, specific growth rate and percent weight gain than fish fed the commercial diets D3 and D4. Feed intake was significantly lower for fish fed the commercial diets than in fish fed the UNCW-formulated diets. Survival was 99-100% in all treatments. Proximate and fatty acid analyses of the diets and of fish tissues at terminal sampling will be presented. Based on maximum growth performance and lower fish meal content, the UNCW-formulated D2 was selected and successfully applied in high-density nursery rearing trials with black sea bass under pilot-scale conditions.

2. Alteration of Coastal Watershed Drainage Characteristics and Vulnerability to Tidal Inundation

* Presenter: **Chris Brown**, College of Charleston, brownce1@g.cofc.edu

One of the many challenges facing coastal communities is managing stormwater infrastructure in the face of increasing population and changes in land use. A common practice in topographically low areas is to design ditches that empty stormwater from urbanized areas into headwaters of tidal creeks. This can have unintended consequences on runoff characteristics, tidal dynamics, and the water balance and ecology of coastal systems. These ditches lower the water table, thereby creating baseflow in the ditches and avenues for flood tides to reach areas that were previously nontidal, altering ecosystems as they introduce saltwater to previously freshwater areas. These gateways for flood tides also result in a smaller hydraulic gradient between the outlet and the upstream portion of the ditch, exacerbating compound flooding events if precipitation events coincide with tidal inundation. In this study, we analyzed characteristics for a site near Hollywood, South Carolina, including drainage area, runoff volume and peak flow rates for the watershed of a 10-km-long ditch system. Tidal influence in the ditch was measured in terms of flood volume and duration in an area predicted to be previously nontidal. A model created to predict flood duration based on tidal factors was developed for different scenarios of sea level rise to predict how tidal behavior within the ditch may change in the future. Preliminary results indicate the drainage infrastructure has increased total watershed drainage area as well as the average runoff-to-rainfall ratio, and model simulation suggests that tidal inundation will increase in duration as sea level rises.

3. Using Passive and Active Acoustics to Assess Oyster Reef Restoration Success

* Presenter: **Olivia Caretti**, North Carolina State University, oncarett@ncsu.edu
Co-authors: David Eggleston, DelWayne Bohnenstiehl

Coastal habitat restoration efforts often manipulate the complexity of the seabed in order to improve ecosystem function. A set of six subtidal restored oyster reefs in Pamlico Sound, North Carolina, were studied by repeated mapping of these areas using high-resolution bathymetric and side scanning sonar data and by collecting a two-year time series of passive acoustic data that monitored changes in the local soundscape. The data were used to examine (1) how the construction and location of a restored habitat affects its persistence over time, and (2) how the structural complexity of a restored habitat affects the oyster and fish community response to restoration. All reefs persisted for two years post-restoration, although sedimentation did occur and was highly variable. After two years, 40-50% of the restored habitat area was lost to sedimentation at reefs made from marl (limestone gravel), whereas at reefs made from recycled oyster shell only 20% of the habitat area was lost to sedimentation. These patterns may reflect different rates of sediment accumulation, as well as variable rates of subsidence for these different material types. Declines in habitat availability altered oyster recruitment and survival. The high frequency sounds generated by invertebrate and fish feeding activities decreased on reefs with >40% habitat loss, indicating a decrease in habitat quality, change in community composition and overall loss in restored ecosystem function. These results underscore the importance of habitat site selection and design in determining oyster restoration success and provisioning of ecosystem services.

4. America's Forgotten World War II Battlefield

Presenter: **Tane Casserley**, NOAA's Monitor National Marine Sanctuary, tane.casserley@noaa.gov
Co-author: David Alberg

Beyond the Monitor National Marine Sanctuary's (MNMS) current boundaries off North Carolina lie waters associated with nearly 500 years of Western maritime history, including shipwrecks representing coastal heritage, the American Civil War, U.S. naval aviation, World War I and, most prominently, World War II (WWII). MNMS is proposing a boundary expansion to protect and honor these additional resources. MNMS's expansion represents an ideal opportunity to celebrate, study and preserve a nationally significant collection of shipwrecks and would serve as a uniquely accessible underwater museum and memorial to WWII's Battle of the Atlantic. MNMS's expansion boundaries will contain the most publicly accessible collection of WWII shipwrecks near America's shore and would constitute the largest area designated as a WWII battlefield anywhere in the United States. With the 75th anniversary of the close of WWII, this is the time to honor the history and sacrifice of Allied servicemen and the U.S. Merchant Marine.

5. Uncloaking the Cloacal Microbiome of Wild Sea Turtles in North Carolina: A Comparative Analysis of Healthy versus Debilitated Turtles

* Presenter: **Tara Clancy**, University of North Carolina Wilmington and National Oceanic and Atmospheric Administration, tlc9009@uncw.edu

Microbiome research has become instrumental in assessing the health and homeostasis of numerous species, including threatened sea turtles. The development of disease treatments can begin with analysis of the microbiota

Poster abstracts continued

present within the digestive tract. Conservation efforts can be directed through the metagenomic study of microbiomes and their role in overall health. To investigate the microbiome of threatened and endangered sea turtles, cloacal sampling was performed on wild individuals from three species of sea turtle: green (*Chelonia mydas*, n=12), loggerhead (*Caretta caretta*, n=16), and Kemp's ridley (*Lepidochelys kempii*, n=11), found within Core Sound, North Carolina. As current research in this field to date has not examined *L. kempii*, this study will provide a first look into their microbiome. Pound net sampling was employed to capture and sample healthy turtles, followed by a release back into the wild, typically occurring on the same day. Cloacal swabs were also collected from turtles that washed ashore exhibiting compromised health. Debilitation was characterized using blood packed cell volume (PCV) and total solids, as well as stranding status. DNA extraction will be performed on the swabs to characterize the microbiome using 16S rRNA gene sequencing of the V4 region. Pending the return of sequencing data, based on previous studies, anticipated genera include *Aeromonas*, *Citrobacter*, *Enterobacter*, *Escherichia*, *Pseudomonas* and *Salmonella*. A comparative analysis across turtle species and between healthy and debilitated individuals will determine the healthy microbial signature of each species and how these communities might change with declines in host health.

6. An Investigation of Rapid Water-Level Rise Events Along the Soundside Outer Banks

* Presenter: **Justin Condry**, University of North Carolina Asheville, jcondry@unca.edu
Co-author: Carl Barnes

The Outer Banks is a notoriously vulnerable stretch of coastline, facing threats from oceanside, soundside and rainfall flooding on a yearly basis. While tropical and extratropical storm surge inundation forecasts have improved markedly in the past 10 years, feedback from residents and decision makers have conveyed that more information about the rate at which the water rose would be beneficial for public safety when presented in addition to the maximum forecast water level. The first step to accomplishing this forecasting capability was to create a climatology of water level rise events and empirically relate these to the causative weather pattern. We utilized water level observations from the two most reliable and accessible tidal observing stations on the soundside of the Outer Banks: the Hatteras Village and Oregon Inlet National Ocean Service tide gauges. The events that displayed the highest rates of water level rise over the near decade-long history of the gauges were extracted, and considered individually. Likely causation was then determined and categorized by weather type. We found that rapid water level increases are possible with both microscale and mesoscale phenomena. However, the rapid water level rise associated with microscale phenomena were typically followed shortly after by rapid water level decreases back to the more typical water level. Conversely, the mesoscale phenomena were more likely to produce a rapid water level rise followed by a sustained period of increased water levels. We also examined the potential applicability of the findings to operational forecasting during high-impact weather events.

7. Preparing for, Responding to and Mitigating Compound Coastal Water Hazards for Resilient Rural Communities

Presenter: **Scott Curtis**, East Carolina University, Curtisw@ecu.edu

Coastal estuarine environments are susceptible to a combination of multiple water hazards that are concurrent or sequential, often storm-related, and that contribute to societal, economic and health risks. These have recently been defined as compound events. River flow, extreme precipitation, coastal water level, surge and water-related morbidity/mortality intersect at varying spatial and temporal scales at the coast. The combined risk is often much more complex and impactful than when considering one hazard in isolation. Studies of compound events have gained traction in the climate community,

but traditional risk assessment and communication usually focus on one hazard at a time. Furthermore, there are gaps in our understanding of the geographic context of compound events, especially in understudied rural estuarine areas. This poster gives an overview of a new project, funded by NOAA's Coastal and Ocean Climate Applications Program and Sectoral Applications Research Program, which seeks to co-produce non-structural tools with emergency managers and planners in North Carolina's 28 coastal counties, making up four regional government councils and coinciding with the northeast and southeast economic zones. Our three objectives are: 1) use focus groups to understand the perceived risks and needs of emergency managers and planners, 2) quantify the economic and health impacts from recent compound events in the region, with an emphasis on Hurricanes Matthew and Florence and, 3) return to the same focus groups to report on the research and relate it to their initial perceptions and experiences with the goal of developing best practices.

8. Development of an Automated Algorithm to Capture Timing and Duration of Dune Erosion Events from Publicly Available Webcams

* Presenter: **Deanna Edwing**, University of North Carolina Wilmington, dbe2385@uncw.edu
Co-authors: Kelsea Edwing, Joseph Long

As U.S. coastal regions become increasingly populated, accurate models for coastal flooding and erosion hazards are required to enable community preparedness. While operational model guidance is available for offshore wave height and water levels (tides and surge), the contribution of waves at the shoreline (e.g., wave setup and swash) and potential dune erosion impacts are not included, in part, due to a lack of observations to validate models. This project addresses the need for additional data to build and further validate wave runup and dune erosion models across diverse coastal areas using several webcam sites established by the Southeast Coastal Ocean Observing Regional Association Web Cameras Application Testbed project to monitor hourly maximum water levels using an automated algorithm. These webcam videos provide a way to continuously monitor water levels throughout an ensuing hazard, providing continuous data about the time-varying maximum water level and reducing the need to rely on before-and-after topographic surveys to infer water level extent. The algorithm developed can record the timing, frequency and duration of dune impacts caused by elevated shoreline water levels using these publicly available webcams without the need for labor intensive camera surveying and image rectification. Hence, the algorithm may be applicable to the large number of existing webcams along the coast that were originally intended for surf or weather monitoring.

9. Mechanisms Generating Growth Variation in Southern Flounder (*Paralichthys lethostigma*)

* Presenter: **Spencer Gardner**, University of North Carolina Wilmington, gardner.spencer.t@gmail.com

Ontogenetic shifts in diet and habitat during the early life history of fishes can have a large influence on growth and subsequent survival. Considerable variation in body size at the end of the first year of growth is evident for southern flounder in North Carolina estuaries. Previous research suggests that age and settlement timing only contribute marginally to ≈ 2 -fold differences in length at age 1. We hypothesize that the timing of ontogenetic shifts in diet and habitat may be largely responsible for the observed growth variation in southern flounder. Biweekly sampling followed the 2018 southern flounder cohort each month. Stomach contents were used to quantify the occurrence of piscine prey. Muscle and liver tissues provided an analysis of $\delta^{13}C$ and $\delta^{15}N$ to document habitat and trophic shifts over weeks to months. Otolith examination provided growth estimates for the most recent 30-45 days. Stomach contents and $\delta^{15}N$ revealed an ontogenetic shift to piscivorous feeding that occurred at smaller body sizes within mesohaline habitats relative to fish found in oligohaline habitats. Muscle

Poster abstracts continued

and liver tissues produced $\delta^{13}\text{C}$ signatures that largely differed between low and high salinity habitats, with only moderate overlap. Differences in $\delta^{13}\text{C}$ were indicative of recent transitions from oligohaline to mesohaline habitats.

10. Determining River Herring Edna Shedding and Decay Rates to Develop a Methodology for Quantification

* Presenter: **Seth Gibbons**, East Carolina University, gibbons18@students.ecu.edu

River herring – blueback herring (*Alosa aestivalis*) and alewife (*A. pseudoharengus*) – were once abundant in North Carolina waters and were an economically important fishery, but their populations across their ranges are smaller due in part to anthropogenic causes. A method of quantifying the spawning population sizes is needed because North Carolina's turbid and large river systems make traditional sampling difficult. By detecting trace DNA shed by river herring, the relative abundances and locations of spawning could be more easily determined. In order to obtain accurate eDNA shedding and decay rates, we performed three experiments. Two time series experiments used different quantities of herring in tanks of various size to determine how much eDNA is shed from known biomasses of fish. The third experiment was abundance sampling to discover if there could be a linear relationship between biomass of fish and amounts of eDNA in ambient water. While there was a general trend of increasing eDNA over time while the fish were in the tank, the relationship between herring abundance and eDNA amounts did not appear to be linear in the samples that have been processed to this point. The results from these experiments should yield information about how DNA is shed by different biomasses of herring over time, as well as how quickly the DNA is degraded after removal. With this information, a model can be developed to quantify eDNA sampling data for river herring in N.C., which has not been done previously and can be used for future monitoring projects.

11. To Randomize or Not to Randomize: An Evaluation of Survey Design for a Long-Term Monitoring Program

* Presenter: **Danielle Goldberg**, University of North Carolina Wilmington, dag6690@uncw.edu
Co-authors: Frederick Scharf, Lee Paramore, Laura Lee

The primary objective when designing a population survey is to ensure that the segment of the population that is sampled will be representative of the entire population of interest. In 1991, the North Carolina Division of Marine Fisheries initiated a yearly survey to estimate the relative abundance of age-0 juvenile red drum (*Sciaenops ocellatus*) as an index of recruitment. The sampling design includes a set of fixed stations and, therefore, lacks a random component, creating the potential for bias due to spatial and temporal variation in station performance. From 2016 to 2018, a number of randomly selected stations was added to the survey to evaluate the potential for a partial-replacement design to improve upon the existing fixed station design. Preliminary analysis revealed differences in catch rates, variation and peak CPUE between fixed and random stations. Additional analyses will focus on the relative contributions of individual fixed stations to year-class variability. We further plan to examine spatial and temporal persistence within the long-term data set (1991 to 2018). This historical data analysis and supplemental random sampling will enable the NCDMF to make informed decisions about the design and possible expansion of the survey to other regions of the state.

12. Communicating Hurricane Dorian's Uncertainty Using Social Media

Presenters: **Shane Kearns**, National Weather Service, Newport/Morehead City, N.C., shane.kearns@noaa.gov

Dorian became a named storm on August 24 and over the course of two weeks presented itself as a volatile system with a challenging forecast. Initially slated to pass to the west of Puerto Rico, Dorian shifted north, passing east of the island on August 28 and becoming a hurricane in the process. As Dorian rapidly intensified into a destructive Category 5 hurricane and stalled over the Bahamas, the question of where Dorian would go next proved challenging to answer, threatening coastal communities from Florida to North Carolina. The hurricane ultimately spared Florida a direct landfall, instead grazing the East Coast from The Space Coast to the Outer Banks, eventually making landfall in Cape Hatteras, N.C., on the morning of Sept. 6, 2019. Because of Dorian's unprecedented strength in the Bahamas and high uncertainty in the forecast track, it posed a unique communications challenge within the eastern North Carolina region. With the area still on edge after Hurricane Florence in 2018, the Newport/Morehead City Weather Forecast Office was aware that "what we said" and "when we said it" would have large implications. Expressing forecast uncertainty and utilizing clear-cut messaging was critical in our communication strategy with our partners and to the public. We review how the Newport/Morehead City office tackled long-term forecast uncertainty and how we evolved our communications on social media to generate a proportional public response as forecast confidence increased throughout the event.

13. Predicting the Effects of Sea Level Rise on Marsh Birds of Conservation Concern in Coastal North Carolina

* Presenter: **Marae Lindquist**, University of North Carolina Wilmington, mcl6280@uncw.edu
Co-author: Raymond Danner

Many species in coastal North Carolina depend on habitats that are at high risk of degradation and loss from sea level rise (SLR). In order to better understand how SLR will affect critical wildlife habitats, we need to fill our gaps in knowledge of species' use of marsh habitats and predicted habitat change in the future. We are helping close this knowledge gap by modeling how SLR will affect the extent of tidal marsh habitats used by saltmarsh sparrow (*Ammospiza caudacuta*) and seaside sparrow (*Ammospiza maritima*) on Masonboro Island and Lea-Hutaff Islands in southeastern N.C. and by modeling how changes in habitat area would affect sparrow population sizes. Our hypotheses are: 1) SLR will contribute to habitat loss on the wintering grounds of saltmarsh and seaside sparrows, and 2) Habitat loss from SLR will be severe enough to reduce population sizes of saltmarsh and seaside sparrows in winter. We are using SLAMM (Sea Level Affecting Marshes Model) version 6.7 to generate scenarios for marsh sparrow habitat loss at low, intermediate and high rates of SLR until 2060 and calculating how changes in habitat extent as a result of SLR would change the number of sparrows that could be supported. For the conclusion of this project we aim to provide pertinent information to aid with the conservation of both saltmarsh and seaside sparrows.

14. Movement and Habitat Use of Female Sand Tiger Sharks (*Carcharias taurus*) in North Carolina Coastal Waters

* Presenter: **Madeline M. Marens**, University of North Carolina Wilmington and North Carolina Aquarium at Fort Fisher, mmm8071@uncw.edu
Co-authors: Dewayne A. Fox, Bradley M. Wetherbee, Amanda S. Williard, Frederick S. Scharf

In the western North Atlantic, sand tiger sharks (*Carcharias taurus*) range from the Gulf of Maine to the Gulf of Mexico. The reproductive cycle of *C. taurus* includes seasonal migrations extending hundreds of kilometers. Coastal waters off North Carolina serve as a migratory corridor, but the degree of residency in these waters is unknown. Aggregations of *C. taurus* have been observed near previously hypothesized birthing areas along southern U.S. Atlantic waters and are presumed to be associated with seasonal reproduction. However, patterns of seasonal residency, habitat use and migration at finer spatial scales are

Poster abstracts continued

lacking. It is hypothesized that pregnant females may utilize habitats differently than resting females and that residency of mature female sand tigers exist in North Carolina coastal waters. From 2016 to 2019, mature female sand tiger sharks were equipped with internal acoustic transmitters to identify movement patterns. On-board ultrasound imaging confirmed shark pregnancies at the time of tagging in various stages, and residence time was quantified to identify essential reproductive habitats using passive tracking techniques. Preliminary findings indicate seasonal residency in North Carolina surrounding Cape Fear and Cape Lookout. Individual sharks showed patterns of residency in North Carolina over seven days (CRT= 9-124 days) from November 2017 to May 2018. More extensive movements were also observed in individuals along the western North Atlantic during spring and fall months. Tracking will continue in 2019 to refine our understanding of habitat-use patterns off the North Carolina coast, as well as compare habitat use between active and resting mature female sharks.

15. In the Wake of the Storms: Working Waterfronts and Access in Coastal North Carolina

Presenter: **Sara Mirabilio**, North Carolina Sea Grant, semirabi@ncsu.edu
Co-authors: Barbara Garrity-Blake, Susan West, M. Scott Baker Jr.

Hurricanes Florence and Michael devastated coastal North Carolina. Officials estimated damage to the seafood industry alone at \$17 billion dollars. While fisheries recovered relatively quickly, the commercial, charter and recreational fishing industries did not. Damage to working waterfronts and public access infrastructure was striking. Since late spring 2019, we have surveyed the commercial industry to better understand how recent hurricanes affected processing capacity, distribution, markets and overall food security. We also have documented the industry's role in recovery within the seafood industry and in the wider community. Inventories conducted in 2006 and 2011 indicated a 36% cumulative decline since 2001 in the number of local seafood wholesale facilities (referred to as "fish houses"). Our surveying continues this data set and initial analysis reveals episodic catastrophes occur in the context of ongoing instability and contraction of the seafood industry. Survey data also show that, as devastating as storms are, few in the fishing industry list hurricanes as a top issue they face. To provide accurate recovery assistance, and to improve planning for future storm events and ensure a mixed coastal economy, resource managers must develop a better understanding of the broader impacts of storms on North Carolina's fishing operations.

16. Ecological Impacts of Per- and Polyfluoroalkyl Substances (PFAS) on Striped Bass (*Morone saxatilis*) in Coastal North Carolina

* Presenter: **Madison Polera**, North Carolina State University, mpolera2@ncsu.edu
Co-authors: Theresa Guillette, James McCord, Mark Stryner, Ben Reading, Scott Belcher

Per- and polyfluoroalkyl substances (PFAS) are persistent, water-soluble chemicals of emerging concern. As a class, PFAS exhibit unique surfactant properties and are robustly stable. These qualities make them attractive for use in a variety of common industrial applications and consumer products, leading to ubiquitous presence in the environment. Environmental monitoring studies reveal a prevalence of hexafluoropropylene oxide dimer acid (HFPO-DA, or, GenX) and other novel PFAS within the Cape Fear River system, however, there is limited PFAS exposure data available for the North Carolina aquatic ecosystem. High-resolution mass spectrometry was used to assess striped bass (*Morone saxatilis*) exposure to PFAS, and exposure associated impacts on health-related endpoints were determined. Perfluorooctane sulfonate (PFOS) was the predominant PFAS found within the Cape Fear River Striped Bass serum at the time of spawning in April 2018. By contrast, striped bass sampled from Pamlico Aquaculture Field Laboratory had 40-fold lower concentration of PFOS in serum. Correlation analysis indicated that PFOS concentration in Cape Fear's striped

bass serum was positively associated with biomarkers of immune (lysozyme) and liver dysfunction (aspartate aminotransferase). No association between markers of health and PFAS concentration in serum were found for the fish collected from the aquaculture facility. Ongoing analyses are focused on expanding PFAS exposure analysis to areas with higher reproduction and survival (like Roanoke River) and experimentally determining whether individual and combined exposure to PFAS mixtures adversely impact striped bass egg quality, embryo development or survival.

17. One Year – Storm Surge Protectors

Presenter: **Katelyn Sullivan**, University of North Carolina Wilmington, MarineQuest and AmeriCorps, katelynsullivan21@gmail.com

Storm Surge Protectors is a University of North Carolina Wilmington MarineQuest citizen science project, which aims to collect long-term data that will help determine the ecological condition of coastal wetlands in New Hanover and Brunswick Counties. The project promotes an understanding of coastal wetlands through community engagement and direct assessment of wetland health throughout the year. By providing an opportunity for members to preform fieldwork, the project highlights the connections between a healthy ecosystem, storm resiliency and community. In the past year, Storm Surge Protectors has held five workshops, connecting with over 100 community members. These workshops provide citizen scientists background information about wetlands and how they protect coastal communities from hazardous storm damage. Additionally, the workshops offer a unique occasion for community members to socialize and engage with each other on a different level, sharing comraderies and welcoming new individuals. Once background information has been provided, participants relocate to a pre-selected monitoring site to conduct a wetland assessment and record the data on the projects database. At the N.C. Coastal Conference, Storm Surge Protectors will engage with colleagues and students in the field to identify opportunities for growth, as well as expose individuals to the successes and learnt lessons of this project. Information, data and photos will be assembled on a poster to offer a glimpse inside this dynamic program. We know that an educated and involved community ensures steps towards resiliency to extreme weather events along the coast and towards reducing their community's risk, and we are eager to share this understanding.

18. Identifying Populations Vulnerable to Hurricane Impacts in Coastal North Carolina Using Mappable Indicators

Presenter: **Robert Truesdale**, RTI International, rst@rti.org
Co-authors: James Cajka, Paramita Sinha, Donna Womack

Local, high resolution information on vulnerable populations is critical to providing timely and adequate resources and prioritizing strategies before, during and after storm events. RTI International, in collaboration with the U.S. Environmental Protection Agency, has developed an indicator-based approach to estimate the impacts of extreme events on vulnerable subpopulations using spatial mapping techniques. We are extending this methodology to incorporate RTI's synthetic population, a realistic, spatially refined representation of persons and households derived from public data sources. The method also can be used to address event-driven impacts from contaminated sites, including pathways of contaminant release, environmental fate, transport, potential exposures and health risks. State and local decision makers can use mappable indicators to develop, prioritize and target response strategies to prepare for, prevent and mitigate negative health and environmental outcomes. Examples of potential pre-event uses include prioritizing areas and routes for evacuation, identification of shelter locations, allocation of supplies to medical facilities, and deployment of emergency personnel. During the event, the approach can provide responders the flexibility needed to react to the latest storm-tracker information (e.g., spawning of tornadoes) to support last-minute communications concerning sheltering and subsequent quick response to threatened communities. Post-

Poster abstracts continued

event applications include the identification of potentially contaminated environmental resources, including water supplies, and allocation of resources to support communities most impacted, least able to recover and most in need of ongoing support.

19. Effects of Invasive Marsh Grass and Wave Energy on Shoreline Change and Essential Fish Habitat

* Presenter: **Erin Voigt**, North Carolina State University, epvoigt@ncsu.edu
Co-author: David Eggleston

North Carolina has over 16,945 km of estuarine shoreline, 87% of which is part of the Croatan-Albemarle-Pamlico estuarine system (CAPES). Much of the estuarine shoreline in N.C. is eroding due primarily to a combination of storms, sea level rise and low elevation. Wave energy is a major factor affecting shoreline change, especially over relatively short time scales, and can be highly variable in space and time. Invasive species may further exacerbate marsh habitat loss by displacing dominant native species and decreasing biodiversity. In particular, invasive marsh-grass, *Phragmites australis*, can outcompete native marsh-grass, *Spartina alterniflora*. Studies examining the effects of *Phragmites sp.* presence on shoreline change rate (SCR) and habitat formation have been mixed. Additionally, marsh shoreline provides essential fish habitat in the form of shallow detrital habitat, especially for economically important juvenile blue crabs. Significant decreases in recruitment of juvenile blue crabs to the population may be linked to changes in nursery habitat abundance and value. Models that predict SCR or fisheries nursery production require accurate information on how invasive versus natural marsh grass influence these processes, especially in shallow, wind-driven estuaries such as the CAPES. In this study we assess the interacting effects of invasive marsh grass distribution and wave energy on SCR and essential fish habitat availability. Specifically, we use, 1) unoccupied aerial systems to quantify short-term SCR, and 2) marsh surveys to quantify shallow detrital habitat availability as a function of percent cover of native versus invasive marsh grass and predicted wave energy.

20. The Place We Call Home: A Critical Analysis of the Risk Perceptions and Place Attachments of Coastal Communities at Risk for Sea Level Rise in North Carolina

* Presenter: **Tenesha Washington**, Florida A&M University, tenesha1.washington@famu.edu
Co-authors: Michelle Divil, Tia Maxwell

For centuries, the world has undergone dramatic environmental changes attributed to both natural and anthropogenic causes. These changes include, but are not limited to: continental shifts, global temperature warming, wetland erosion, land submergence and sea level rise. As the changes progress, pressure on particularly vulnerable populations also increases. The Union

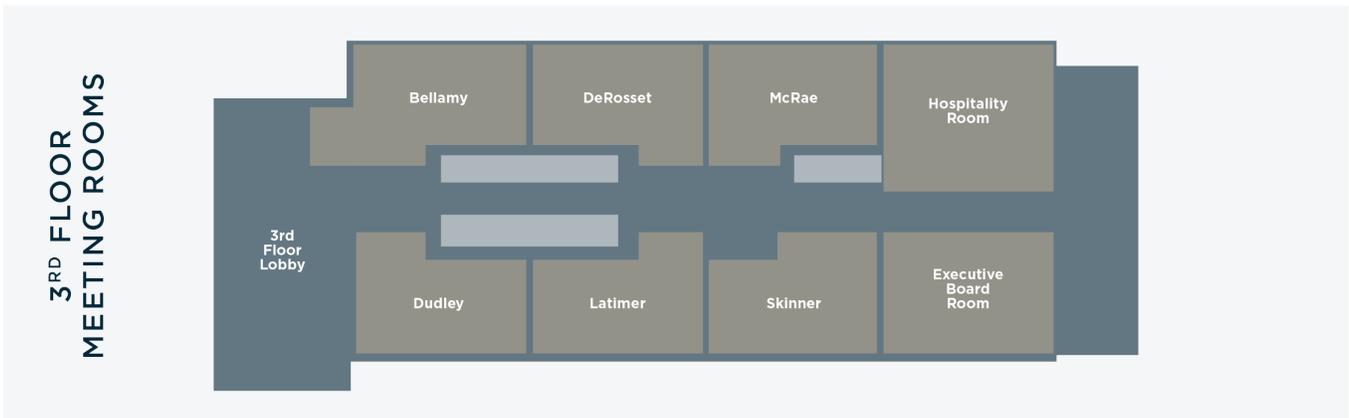
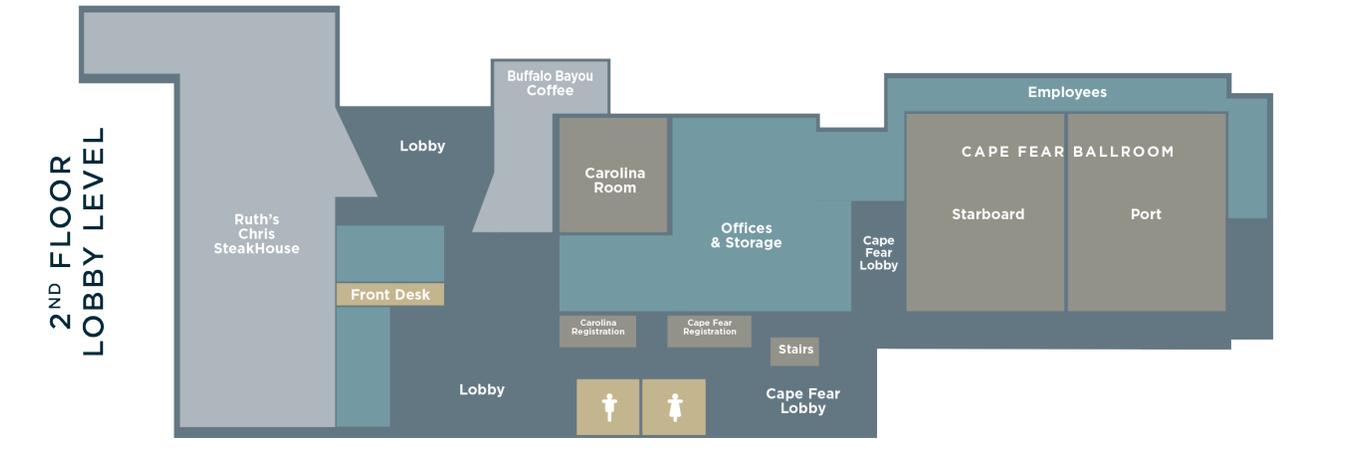
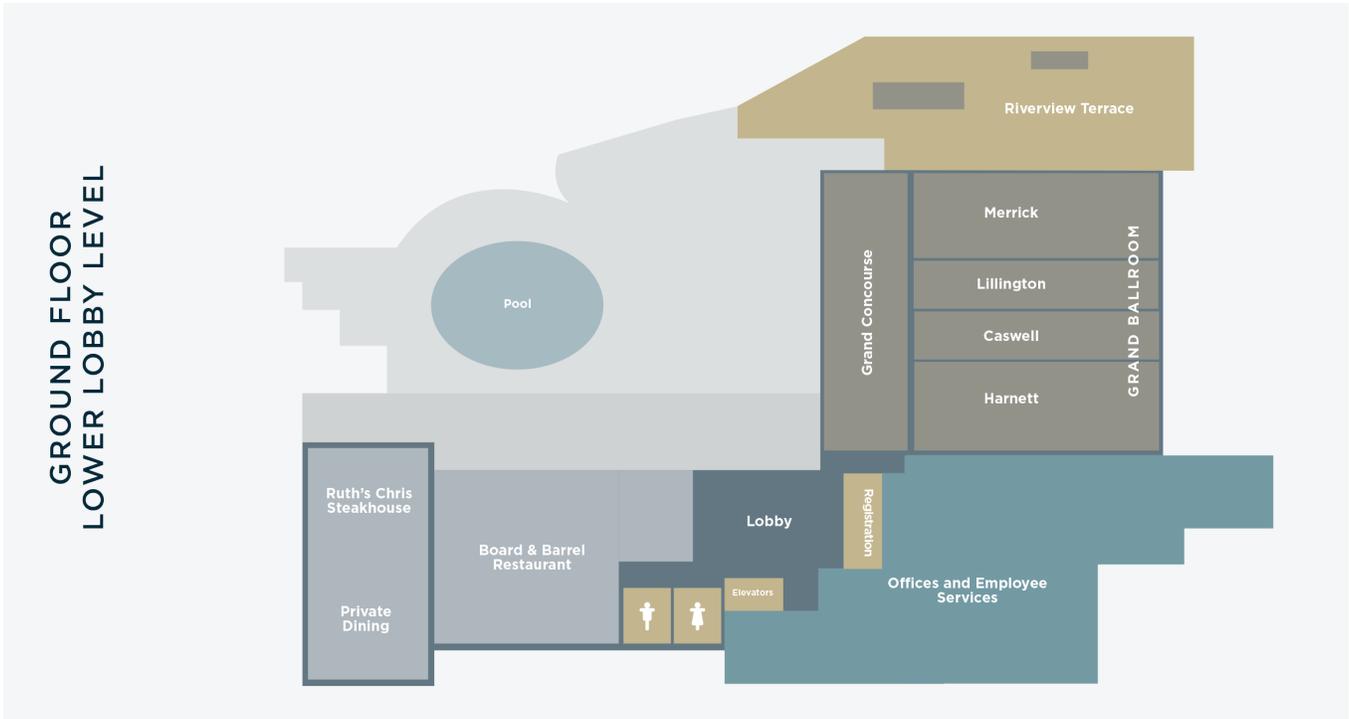
of Concerned Scientists (2013) notes sea-level rise is dynamically changing our coasts, and with these changes, coastal communities, economies, and ecosystems impacting some ninety coastal communities at risk for sea level rise in the United States. Despite these unfavorable and risky living conditions, millions of people still choose to reside along the coastlines of the United States. Furthermore, there remains a gap in both climate science and disaster literature regarding the influence of risk perceptions and place attachment on vulnerable populations, specifically those at risk for sea level rise due to climatic changes. Therefore, understanding how coastal residents internalize risk along with their attachments to particular places plays a critical role in risk communication, coastal management, and climate policy. This project examines coastal communities currently at risk for sea level rise in North Carolina. The goal of this research is to employ a mixed-methods approach using both survey questionnaires and in-depth interviews to help explain the connections and dynamic relationship between vulnerable populations and land. Specifically, this research is useful to both the public and governmental officials charged with enactment of policies that consider the attachments of these populations to land subject to climate-induced hazards and resilience efforts, while effectively determining an appropriate response to this social phenomenon.

21. Using Virtual Reality to Educate about Human Impacts on Sea Turtles

* Presenter: **Nicholas Weaver**, East Carolina University, weavern17@students.ecu.edu

Coastal habitats around the world are being impacted by humans. Educating people on these issues can help them to understand how simple choices about our everyday actions can benefit the environment. Virtual reality (VR) is a way people can immerse themselves in a learning environment instead of sitting in the traditional classroom. Being able to interact with tools used out in the field allows a more intimate connection with the information being communicated. Going through the different scenes of the virtual reality experience, users will learn of the hardships turtles go through due to human impacts on the environment. Using the HTC Vive VR headset and Unity game engine, we have created an interactive experience that allows users to gain first-hand experience about pollution problems and why they are detrimental to turtles. The virtual reality experience asks users to take on the role of a scientist as they go through scenes related to light pollution, plastic pollution, water quality, beach modification and nest threats. The experience integrates informative videos, interactive tools for data collection from the environment, and analyses to be performed in the lab. Ultimately, the user will apply what they have learned to make choices about potential solutions to reduce the impacts on turtle habitats. Through this process of being immersed in a virtual environment with sounds and interactions, the virtual reality experience puts users in an engaging and effective learning environment with the goal of effecting behavioral changes in the real world.

Venue Map





This conference has earned the designation of
Wolfpack Certified Sustainable Steward

from our home institution, NC State University.

We're grateful for your help preserving resources and protecting the environment!

Here's how to contribute to the conference sustainability goals:

- Hand back or recycle your conference booklet, unless you will be saving it for future reference.
- Return your nametag after the conference, so we can reuse it.
- Use appropriate facilities offered throughout the **Hotel Ballast** for other conference waste (recycling, trash) and ensure waste goes into the proper receptacles.
- Reuse water and coffee cups – or better yet, bring your own reusable mug or thermos and water bottle.
- Monitor your personal water usage.
- Take advantage of alternative transportation, like the bus or carpools, during the conference to avoid single-car trips.
- Turn off unnecessary electronics.
- Move around frequently to increase circulation and burn calories – your health and well-being are worth sustaining, too!

