



PROJECT Updates

Fiscal Year 2024–2025

TABLE OF CONTENTS

Healthy Coastal Ecosystems.....3

Sustainable Coastal Development and Economy15

Weather and Climate Resilience17

Sustainable Fisheries and Aquaculture.....21

Scientific Literacy and Workforce Development.....26

HEALTHY COASTAL ECOSYSTEMS

S.C. Sea Grant Extension Program: Healthy Coastal Ecosystems

Pls: Brooke Saari, Shu-Mei Huang, Landon Knapp, Lola Renauer, S.C. Sea Grant Consortium

Stormwater Management

The stormwater programming efforts included the Ecological Landscape Design for South Carolina partner-led training series that addressed the need for native plants in landscape design. This hybrid program included online videos and field experiences, teaching participants best practices for incorporating native plants and green infrastructure to enhance local water resources and biodiversity. Additionally, the Grand Strand Healthy Pond Series connected Grand Strand residents and HOA members with stormwater professionals through quarterly workshops, fostering knowledge sharing and collaboration to solve stormwater pond issues.

Water Quality

Water is a major resource in South Carolina, and understanding and maintaining water quality is vitally important. The second season of the Water Chats program connected over 350 natural resource professionals with the latest water quality research to inform management decisions, supporting these efforts through the publication of a special issue journal and seven webinars, covering topics such as water quality issues, emerging contaminants, water resilience, and stormwater controls. Additionally, the South Carolina Water Monitoring Portal is continually updated to optimize its use, with data formatted and marketing strategies considered as capabilities improve.

Impact to Ecosystem Health

Decision-makers need scientific information to make choices. The Southeastern Contaminants of Emerging Concern project supported innovative research addressing priorities identified through various needs assessments. Four study teams were awarded \$300,000 to focus on a variety of contaminant issues. Other efforts included creating a collaborative networking tool and supporting the new network PFAS community of practice. Additionally, the South Carolina Sea Grant Consortium partnered with the National Sea Grant Law Center on a grant to integrate scientific research into state policy through research-to-application partnerships.

Marine Debris

Marine debris is an increasing issue worldwide. The Lowcountry NETwork project engaged communities in marine debris prevention by distributing around 700 shrimper-made up-cycled stow bags created from derelict nets, reaching 480 adults and children in Georgia and South Carolina. The Microplastics in the Coastal Region Conference brought together nearly 80 participants to discuss microplastics, featuring 35 presentations and facilitating meaningful collaborations. The From Blue-Gray to Blue-Green project evaluated alternatives to plastic use in coastal sectors, incorporating stakeholder feedback and end-user needs.

Program Development and Planning

PIs: Susan Lovelace, Ph.D., Susannah Sheldon, and Badriah Diab, S.C. Sea Grant Consortium

The South Carolina Sea Grant Consortium's FY2024-2027 strategic plan aims to maintain and implement programs that address the evolving needs of coastal communities, emphasizing responsiveness, innovation, partnerships, and flexibility. This plan was shaped through a broad and inclusive strategic planning process involving academic, governmental, nonprofit, and community stakeholders.

The plan outlines five key programmatic areas: Healthy Coastal Ecosystems, Sustainable Coastal Development and Economy, Weather and Climate Resilience, Sustainable Fisheries and Aquaculture, and Scientific Literacy and Workforce Development. Each area includes a vision focused on integrating research, outreach, and education to support informed coastal decision-making and resource stewardship. Implementation includes a biennial proposal solicitation and review process.

The Consortium also supports ongoing innovation through program development grants, enabling rapid responses to emerging needs and fostering novel research ideas. Notable projects include studies on microplastics, dune hazard literacy, parasite diversity, and hurricane resilience.

In addition, the Consortium fosters collaboration through events such as the biennial Research Symposium, aimed at connecting researchers, stakeholders, and extension teams while building capacity for community-engaged research. Special initiatives include the Blue Carbon Law Symposium and the Upper Estuarine Forested Wetlands Conference, which seek to advance legal, ecological, and community-based understanding of coastal systems.

Through these efforts, the Consortium enhances scientific literacy, promotes sustainable development, and builds resilience among South Carolina's coastal communities, ensuring that research translates into meaningful, real-world benefits.

Program Management and Administration

PIs: Susan Lovelace, Ph.D., Ryan Bradley, and Susannah Sheldon, S.C. Sea Grant Consortium

The South Carolina Sea Grant Consortium operates based on three core directives set by the South Carolina General Assembly: managing the state's Sea Grant Program in collaboration with adjacent regions, enhancing research and educational services related to ocean and coastal resources, and promoting regional cooperation in addressing marine and coastal challenges. These guiding principles emphasize sustainable economic development and responsible resource management.

To fulfill its mission, the Consortium leverages the expertise of nine member institutions, including major universities and state agencies. It facilitates collaboration through the exchange of scientific knowledge and technical assistance. Oversight is provided by a Board of Directors composed of the chief executives of the member institutions. The Board meets annually to set strategic goals, approve policies, and review budgets, maintaining direct communication with the Consortium's executive director, who also consults regularly with the Board chair and relies on mentorship from its members.

The Consortium's overarching goal is to provide robust management and support for its research, education,

extension, and communications initiatives. Key objectives include developing strategic, constituent-informed program direction; integrating research and outreach; increasing external financial support; expanding participation among academics and students; promoting marine education at the K-12 level; and responding to public requests regarding coastal and marine resource issues.

The Consortium functions through a team-based structure. Staff include faculty, specialists, and communication professionals who act as intermediaries between research and community needs. These staff members work collaboratively with researchers and local stakeholders to address critical coastal challenges and foster partnerships. An executive team, consisting of senior leadership and program managers, meets weekly to coordinate agency activities. Monthly staff and departmental meetings, along with daily informal communication, ensure alignment and responsiveness across the organization.

How Does Disturbance Shape Avian Community Composition and Diversity in Ephemeral Wetlands?

PI: Daniel McGlinn, College of Charleston

Small, isolated wetlands are ubiquitous in the southeastern coastal plain. They provide critical ecosystem services and are important habitats for wildlife. However, they are largely unprotected and are vulnerable to habitat loss and often lack clear management prescriptions. The purpose of this project was to better examine how to manage these sensitive habitats. Specifically, Consortium researchers examined how the biodiversity of songbird communities responded to restoration of wetlands that removed canopy tree cover in the wetlands. Additionally, the team reintroduced a population of Canby's dropwort - a federally endangered plant - into two wetlands with a goal to test how to best manage this sensitive species. They found that the songbirds were more diverse and abundant in the wetlands compared to the surrounding pine savannah uplands. Additionally, the songbird community had similar abundance and diversity in controlled and restored wetlands. This indicates that restoration efforts targeting highlight wetlands specialists will not negatively impact the songbird communities in those wetlands. After one year, the survival of Canby's dropwort plugs was approximately 60% in both burned and mowed wetlands which indicates that mowing is a suitable alternative to prescribed fire. Researchers also found that the deepest parts of the wetland could be inundated for too long which resulted in mortality of some of the plants. The plants that were the largest at the time of the planting had higher survival and flowering rates. This effort examining songbirds and Canby's dropwort represents important steps towards better management of isolated wetlands.

Interaction of Biofilms and Microplastics in Floating Vegetation Root Systems

PI: Peter van den Hurk, Clemson University

The overall goal is to take first steps towards developing new, innovative ways to reduce the amount of microplastics that enter coastal waters. One way to achieve that goal is to improve the effectiveness of stormwater ponds in retaining and biodegradation of microplastics through the employment of floating treatment wetlands (FTWs). The potential for this technique has been recognized, but no real information is available on the actual capacity of FTWs for capturing and degrading microplastics.

Objectives 1 and 2: The FTWs contain three potential target species of plants, *Carex aquatilis*, *Pontederia cordata*, and *Andropogon virginicus*. These three native plants are good targets for strong biofilm formation based on previous microbiome data and are native to South Carolina. The mesocosms were dosed with fluorescent microplastics, and the root system biofilms were analyzed for uptake of these particles by counting the number of fluorescent beads under blacklight. Examples of these samples are presented in the photos below. Based on these results we can conclude that microplastics are indeed trapped in root systems of FTWs and that the mesocosms are a suitable system for further research into the function of these FTWs for the bioremediation of microplastics.

Objective 3: Samples have been collected to determine differences in plant species for the trapping of microplastics, but those samples have not yet been analyzed.

Objective 4: Biofilm samples are being analyzed for the composition of the microorganism communities. These samples will also be analyzed and comparisons made between saltwater and freshwater environments. More samples will be taken to determine how these communities change over time and which microbes form the stable biofilm communities that can capture microplastics.

Objective 5: The microbial genera found on the root systems are being analyzed for enzymes, which have the potential to break down plastic polymers.

Advancing Management of Tidal Freshwater Forested Wetlands: Integrating Science and Community Needs for Decision-Making

PI: Brita Jessen, S.C. Sea Grant Consortium

Freshwater and low-salinity forested wetlands occur in tidal reaches of rivers around the world. Though often overlooked, these systems provide important ecological services and human benefits with opportunities for management interventions in a dynamic and changing environment. The Forested Wetlands of the Upper Estuary conference was held March 5-7, 2024, in Charleston, S.C. This conference highlighted tidal freshwater forested wetlands as distinct and critical transition ecosystems, particularly in the southeastern U.S. Nearly 120 participants discussed the state of knowledge regarding tidally-influenced forested wetlands (TFW) in the Southeast, Gulf of Mexico, Pacific Northwest, and Australia in order to build an understanding of information needs. Attendees shared their research on ecosystem and ecological services provided by TFWs, cultural identities related to this resource, cross-system management comparisons, and decision-management frameworks. A special issue of *Estuarine, Coastal, and Shelf Science* in association with this conference is in progress. The conference was sponsored by the National Sea Grant Office and co-hosted by the Consortium, Clemson University, College of Charleston, U.S. Geological Survey, and U.S. Forest Service.

From Blue-Gray to Blue-Green: Facilitating the Transition to Non-Plastic Natural Material Use within the Coastal Zone Economy

PI: William Strosnider, Ph.D., University of South Carolina; Brooke Saari, Amanda Guthrie, Ph.D., Matt Gorstein, and Susan Lovelace, Ph.D., S.C. Sea Grant Consortium

The S.C. Sea Grant Consortium, in partnership with University of South Carolina, Clemson University, the University of Dayton, Johnson C. Smith University, and Robinson Design Engineers, is working to evaluate

alternatives to plastic use in three coastal sectors: water quality, restoration, and aquaculture. Stakeholder feedback and end-user needs have been utilized to inform the materials selected for field and lab testing. Natural materials have a long history of traditional use in aquaculture, water quality protection, and shoreline restoration industries, but have been displaced by non-biodegradable proprietary alternatives (plastics) that accumulate and persist in marine and estuarine environments. Although the specific amount of plastic waste produced by these sectors is unknown, evidence suggests that the use of plastics in these sectors can contribute to the deterioration of the ecosystems they aim to protect. The project team, which includes students, has worked together to evaluate these materials through a combination of field, lab, and mechanical testing that look at their durability, feasibility, and longevity. Additionally, wood stakes are being tested in the field as a substrate for oyster recruitment and growth, which has the potential to replace the use of plastic oyster bags. To ensure the project is addressing youth education needs, a three-day summer 2024 workshop was convened with 13 educators to discuss the development of a marine debris/microplastics game for K-12 students that will be piloted in summer 2025 to be available for use during the 2025 - 2026 school year. Students (nine graduate students, seven undergraduate students, one post-undergraduate) have been incorporated into all activities. Specific focuses include 1) initial surveys and preparation for the material cost analysis, 2) documentation of oral history interviews with Gullah Geechee community members to record historical processes and practices used for marsh and oyster restoration, oyster cultivation and aquaculture, and water quality improvements, and 3) testing of glass aggregate for alternative floats on floating treatment wetlands.

Climate Factor Influences, Spatiotemporal Variability, and Bottlenose Dolphin Health Related to Phthalate Exposure Measured Over 30 Years in Sarasota Bay, Florida

PI: Leslie Hart, Ph.D., College of Charleston

Over the past year, significant progress has been made towards the objectives of evaluating climate drivers of phthalate exposure and associated health impacts in bottlenose dolphins. A total of 110 archived urine samples from dolphins examined during health assessments in Sarasota Bay, FL (1993-2010) were screened for 14 phthalate metabolites. These results, received in October 2024, were integrated into a comprehensive database containing urinary metabolites from dolphins sampled between 2011-2024, resulting in 202 samples from 138 individuals. Environmental data, including major storm events, rainfall, and *Karenia brevis* cell counts from 1992-2024, were retrieved and merged with dolphin demographics and phthalate concentrations for statistical analyses. Descriptive statistics were calculated to determine the prevalence of phthalate exposure, measures of central tendency and dispersion, and the occurrence of health assessment events relative to storm and algal bloom events. To understand sources and pathways of phthalate exposure, photo-identification sighting histories for dolphins screened for phthalate exposure were obtained, and dolphins were categorized into subgroups. This data is being prepared for spatial analyses using statistical software and density methodologies. Outreach efforts included working with partners to prepare materials for distribution in early spring 2025, such as surveys, social media content, a webpage, and a press release to inform the public and stakeholders about phthalate contamination and the objectives of our study. This project also supports the thesis work of a graduate student being advised by the PI. Overall, the project is on track, with favorable developments in data collection and analysis. No significant problems or delays have been encountered, and the team is actively working to resolve any minor challenges that arise.

Impact of Drinking Water Treatment on the Fate of Per- and Polyfluorinated Alkyl Substances (PFAS) and Precursors in Wastewater Reuse Application

PI: Ching-Hua Huang, Ph.D., Georgia Institute of Technology

Objective 1: Significant progress has been made in investigating the kinetics and mechanisms of oxidation of PFAA precursors with ozone, free chlorine, and ozone/H₂O₂. A range of PFAS precursors was selected, authentic standards purchased, and liquid chromatography methods developed for analysis. A lab-scale experimental setup for ozonation, chlorination, and UV/H₂O₂ treatments was established for studying target PFAS transformations and oxidant measurement concentrations. Extensive experiments to investigate the transformation of PFAS precursors during oxidative treatment were conducted and revealed varying reactivity among precursors. Ongoing work includes testing additional precursors and examining the effects of water quality parameters.

Objective 2: Preparations for simulating the oxidation of PFAA precursors in a pilot-scale drinking water treatment are underway. We submitted a study plan to the hosting water utility, held meetings to discuss details, and obtained their support. Preliminary tests on real water samples from a wastewater treatment plant were conducted to determine ozone oxidant demands, aiding in designing operational conditions for the pilot study scheduled for April 2025. Overall, the project is progressing well, with favorable developments in experimental setups and preliminary tests. Collaboration with partners is ongoing, and preliminary results have been presented internationally. The project is also supporting one Ph.D. graduate student, one master's graduate student, and one postdoc. No significant problems or delays have been encountered, and the team is actively addressing minor challenges to ensure successful completion of the objectives.

Develop a Community-Based Participatory Approach to Evaluate the Dietary Exposure of Per- and Polyfluoroalkyl Substances (PFAS) in an Underrepresented Community

PI: Xiaoyu Xu, Ph.D., University of Georgia

Objective 1: Collaborative partnerships have been successfully established with the downtown Augusta community through the University of Georgia Extension Office in Richmond County. A technician position was created and a local resident hired at the University of Georgia using matching funds to conduct surveys and serve as a bridge between academia and the local community. This role is a key component of our community-based participatory research approach, helping to successfully gather information and collect samples. Over a three-month survey period in summer 2024, 63 participants from 18 families were recruited.

Objective 2: The family-based survey tool was developed to gather consumption data in Downtown Augusta. A total of 18 family-based questionnaires were completed, along with 18 residential tap water samples, key food items, and 33 hair samples.

Objective 3: The probabilistic exposure model using Monte Carlo simulation has been developed. Using survey data, the demographics of the participant community were characterized, information was collected on their general food consumption habits, consumption rates were calculated for major food items, and PFAS concentrations were measured in residential tap water samples using EPA Method 1633. Daily intake rates

of total PFAS compounds were calculated using Monte Carlo simulation modeling, though the data requires validation before release.

Objective 4: Risk communication efforts are underway. We identified at least two families whose tap water PFAS concentrations exceed the US EPA's Maximum Contaminant Level. Once data analysis is finalized, we will provide these families with materials detailing their water PFAS levels, community PFAS intake rates, tips for mitigating exposure, and advice on water consumption. Overall, the project has progressed well and will be completed on time. Two graduate students were involved in survey collection and sampling. A poster was presented at the 2024 SETAC North America Meeting, and a manuscript is being prepared for publication in peer-reviewed journals.

Rising Waters and Increasing River Flooding Changing the Transport Pattern and Fate of PFAS in the Lower Winyah Watershed

PI: Till J.J. Hanebuth, Ph.D., Coastal Carolina University

The original goals of this project were to produce a comprehensive PFAS dataset for surface water and soil/sediment samples across the South Carolina Pee Dee watershed, compile a GIS project with PFAS data and eco-socioeconomic layers, conduct sampling before and after major flooding events, combine PFAS data with regional climate change predictions, and organize outreach events to inform local communities. Despite initial delays, significant progress has been made. Stringent guidelines were established to prevent cross-contamination during sampling and preparation. The research strategy evolved to focus first on water samples to understand PFAS contamination variability, then on soil/sediment samples. This strategic adjustment saved funding for targeted sampling campaigns in summer and fall 2025, pending approval of a non-cost extension request. Analysis was conducted on 45 water and 3 soil samples from all five river systems, avoiding areas of known contamination and focusing on understudied regions. Most samples indicated widespread PFAS contamination, with only 15% appearing uncontaminated at the time of sampling. Data showed systematic contamination increases from upstream to downstream, pointing to possible local contributors like wastewater treatment plants. Elevated PFAS levels were found in specific areas, such as Bucksport and Galivants Ferry, requiring further investigation. Ongoing tasks include extending the water sample dataset to cover full seasonal cycles, identifying local PFAS sources, and conducting detailed soil/sediment analysis. A no-cost extension would enable the achievement of these objectives and provide comprehensive insights into PFAS contamination in the Pee Dee watershed. Overall, the project is progressing well, with adjustments made for timeline issues. A current no-cost extension has allowed for additional time for data collection. Partnerships are on board and collaborating with the project team. Various presentations have been given throughout the community on contaminant issues and project developments. Three graduate students have been supported through the project. While challenges have arisen, they have been addressed to ensure the successful completion of the objectives.

Building a Regional Network to Study the Influence of Changing Conditions on Contaminants of Emerging Concern

PIs and Partners: Brooke Saari and Lola Renauer, S.C. Sea Grant Consortium; Katy Austin Smimth, Georgia Sea Grant; Catherine Marie Janasie, National Sea Grant Law Center

The geographical scope of this project encompasses South Carolina, Georgia, and Florida, including both the Atlantic and Gulf coasts of Florida. This initiative supports innovative, extension-led research that addresses the priorities identified through our literature gap analysis, legal scan, and advisory committee discussions. Four study teams were awarded cumulatively \$300,000 as part of a research competition. Outreach and networking activities were initiated within and beyond the project focus area. Interactions of increased pollution and extreme weather have put pressure on water quality in the southeast U.S., lending a need for future research to address contaminant impacts on human and ecosystem health. Contaminants of Emerging Concern (CECs) pose potential threats that are understudied, especially their reactions to various extreme weather drivers. The project team and partners collaborated to review and fund \$300,000 in research on identified research priorities related to CECs. In addition, work began on the creation of a collaborative networking tool, communication of project efforts, and PFAS activities around policy and education. In February 2024, a nationwide panel of 13 experts reviewed and selected four study teams, awarding \$300,000 cumulatively for the southeastern research grant competition. The overall project was presented through several poster and oral presentations, a pilot dataset for the Network Tool was created, and a project website was completed. Leveraged partner efforts focused on PFAS included the creation of a PFAS community of practice, PFAS policy and litigation briefs, and new grant funding acquisition.

Rain and Tide: Assessing Coastal Stream Flow and Compound Flooding Risk

PI: Tim Callahan, Ph.D., College of Charleston

Consortium-funded researchers studied the causes and impacts of compound flooding from multiple sources (rainfall, stormwater, and tidal inundation) in local areas of Charleston County to allow municipal decision-makers to plan for novel flood conditions. This study addressed the growing problem of extreme flooding occurring more frequently within coastal cities, where tidal forces and stormwater runoff combine to exacerbate flood risks. The study examined two watersheds within Charleston, S.C.: the rural Church Flats Creek and the urbanized Shem Creek. Findings indicate that Shem Creek, with its impervious surfaces and overwhelmed drainage systems, is highly vulnerable to compound flooding, even during moderate storm events. The key findings of this study underscore the heightened vulnerability of urban areas like Shem Creek to compound flooding, where stormwater runoff from impervious surfaces often exceeds the tidal prism, leading to a greater potential for flooding risks. The research also revealed that existing stormwater infrastructure may not be sufficient to manage the increasing risk of compound flooding. The traditional design of these systems, primarily focused on managing either stormwater or tidal inundation separately, does not adequately account for the simultaneous occurrence of these events. As a result, urbanized watersheds, which already face pressure from land development and population growth, are at a higher risk of experiencing compound flooding, leading to potentially severe consequences for both property and public safety. Recommendations include integrating tidal and stormwater management, updating modeling and predictive methods, increasing stormwater storage capacity, using site-specific data for infrastructure planning, and fostering stakeholder

collaboration. The study emphasizes the urgent need for tailored strategies to mitigate flood risks in coastal urban areas, providing a blueprint for enhancing flood resilience.

Parasite BioBlitz at Stono Preserve: a Moonshot-Like Approach to Boost our Knowledge of Local and Global Parasite Diversity

PI: Isaure de Buron, Ph.D., College of Charleston

A BioBlitz is an intense local effort to bring together experts and often lay participants to categorize biodiversity. The BioBlitz concept has become popular across taxonomic fields, attracting interest globally to increase knowledge of local biodiversity. However, BioBlitzes are typically performed in a single environment targeting macrobiota, which are observed easily and identified immediately on-site. Large-scale application of BioBlitz events for parasites has not occurred due to the need for wide taxonomic expertise and in-field sample processing and microscopy. Inspired by the success of this approach, Consortium-funded researchers undertook a parasite BioBlitz of fish and invertebrates at an unexplored locality (College of Charleston's Stono Preserve, S.C.) to determine the feasibility and effectiveness of such an approach for parasites. A team of parasitologists with individual, complementary expertise was assembled and adopted the concept of a BioBlitz as a proof-of-concept in the research field. Over a period of two weeks, they screened fishes and various invertebrate taxa (annelids, crustaceans, snails, bivalves) for parasites, and sampled sediment and water for environmental DNA (eDNA) from four aquatic habitats: wetland, freshwater pond, brackish impoundment, and tidal creek at Stono Preserve to capture ecosystem-level parasite diversity. The field station provided an essential controlled environment to facilitate parasite collections and record keeping. The team also successfully incorporated participatory science assistance from non-parasitologists and students for host collection and identification. Researchers identified eight major parasite taxa, several of which were new host and/or locality records with numerous host-parasite combinations. Finding species new to science and numerous host-parasite combinations supports the idea that short-term and intensive surveys improve knowledge of parasite diversity, which is understudied yet essential for a deeper understanding of ecosystems at local and global scales. The team demonstrated that a parasite BioBlitz can be effective for rapid discovery of the dimensions of parasite assemblages in a novel environment.

Envisioning the Future of South Carolinas Antebellum Rice Fields: Development of a Decision Support Tool

PI: James Anderson, Ph.D., Clemson University

South Carolina's 600,000 acres of coastal marshes and wetlands are vital ecosystems that provide critical wildlife habitats, mitigate flooding, and support local economies. Rapid population growth (20.4% increase from 2010 to 2020), rising sea levels, and frequent hurricanes have intensified ecosystem service loss, impacting both vulnerable communities and economic hubs. Historically, over 236,000 acres of wetlands were converted to rice fields between the 1670s and 1870s using enslaved African labor. The resulting network of canals, dikes, and water-control systems laid the foundation for waterfowl management in the early 1900s, with intact impoundments supporting more waterfowl than unmanaged areas.

Today, historic rice fields are increasingly valued for their potential to mitigate sea level rise and storm impacts. However, reduced sediment input and soil subsidence have lowered impoundment elevations,

hindering drainage and reducing ecosystem functionality. Despite maintenance challenges, these wetlands remain essential habitats for waterfowl, other waterbirds, fish, and federally listed species like the black rail and wood stork. Researchers compiled and analyzed published data from multiple databases to assess the ecological, environmental, and socioeconomic aspects of South Carolina's historic rice fields. Forty historical rice field impoundments were surveyed to estimate waterfowl abundance. The team designed a rapid field-based assessment tool to determine the existing management operations and their impact on restored rice field projects. They are in the process of identifying restored rice fields for field site visits to assess the methodologies used and the successes, failures, and challenges of restoration efforts. Two targeted surveys were developed to assess experiences, perceptions, and beliefs about historic rice fields, rice field infrastructure, wildlife conservation, climate variability, and fiscal responsibility related to these issues. The first survey focused on the public communities along coastal South Carolina. The second survey targeted historic rice fields and waterfowl managers, and ecological data relevant to rice field management were gathered. For the community survey, a total of 100 Gullah Geechee respondents participated, fifteen responses were collected from historic rice field managers for the second survey, and an additional 469 responses were obtained from the online survey. Results are being analyzed. Finally, researchers developed the framework for a decision-support tool and risk-benefit matrix profile to evaluate the ecological and societal trade-offs of maintaining versus abandoning historic rice field impoundments. This progress lays the foundation for tool development, validation, calibration, and stakeholder engagement.

Determining Bacteria and Turbidity Sources to Inform Management and Outreach Across the Edisto Island Watershed

PI: Amy Scaroni, Ph.D., Clemson University

Many of South Carolina's coastal communities are served by on-site wastewater treatment systems (septic systems), which can both contribute to water pollution and be rendered ineffective by rising groundwater levels and surface flooding. Not surprisingly, bacteria are the most common water quality impairment across South Carolina. According to SCDHEC's 2018 303(d) list, out of roughly 1,000 impaired waterbodies, 362 are impaired because bacteria levels exceed the state water quality standards. As a result of these impairments, both recreational and commercial shellfish harvesting is restricted or prohibited across a large percentage of the watershed's shellfish beds. These closures create economic hardship for those who generate income from shellfish harvest and those who depend on shellfish as a source of protein. Culturally, oysters bring people together, and the restoration of water quality to protect shellfish beds was a key factor driving stakeholder participation in the development of the recently completed Edisto Island Watershed Plan. Two of the key recommendations of the plan were to definitively identify bacteria sources and turbidity sources to better prioritize restoration projects to protect and restore oyster and salt marsh habitats and to provide outreach and education focused on the connections between water quality, shellfish consumption, and human health. Consortium-funded researchers address these gaps with this study. Sampling sites were tested monthly for fecal contamination, levels of which were below maximum acceptable levels. To better understand the source of fecal contamination, microbial source tracking (MST) analyses are being conducted on the same set of samples as above. None of the samples collected during the winter were positive for either humans, dogs, deer, or birds using the MST markers. Additional and more specific markers for cow and goose are being optimized and will be added to the list of analyses. Analyses of solids that contribute to turbidity and nutrient concentrations will be completed in the next phase of the study.

Profiling Contamination in Floodwaters and the Coordination of a Community Science Floodwater Quality Program in Vulnerable Communities of Charleston, S.C.

PI: Vijay Vulava, Ph.D., College of Charleston

In this study, Consortium-funded researchers collected tidal and rainfall floodwater samples from four locations in Charleston, S.C. Three sites were impacted by tidal and rainfall flooding, and the fourth site was affected by tidal flooding only. All sites are highly urbanized, but a green buffer surrounds the tidal flooding site. All water samples were analyzed for nutrient and trace metal contaminants, coliforms, and *E. coli*. Coliforms and *E. coli* were also tested for antibiotic resistance: amoxicillin, ampicillin, augmentin, and erythromycin. All these antibiotics are commonly prescribed for bacterial illnesses in humans and animals; this study aims to analyze antibiotic resistance patterns in coliforms as correlated to flood sources, land-use patterns, and chemical contaminants. Floodwater from all areas contained high chemical contaminants, coliforms, and *E. coli*. Antibiotic-resistant coliforms and *E. coli* were also found in all water samples. The most densely urbanized sites had the highest contamination levels, while the lone site with a green buffer had lower contamination. Coliform and *E. coli* concentrations correlated with rainfall, suggesting rain runoff is a primary vector for pathogen transport. Of all antibiotics, coliforms and *E. coli* were least resistant to augmentin. A positive correlation was observed between the percent coverage of impervious surfaces and coliforms at all the sites. Overall, the results suggest that land-use patterns increase the prevalence of antibiotic-resistant coliforms and increase the likelihood of human exposure to these potential pathogens. Environmental change is expected to exacerbate the presence of antibiotic-resistant bacteria in floodwater generated from rainfall and tidal flooding in coastal cities.

Quantifying Key Constraints on Marsh Resilience in South Carolina

PI: Andrew Tweel, Ph.D., S.C. Department of Natural Resources

Salt marshes provide a broad suite of economic and ecological benefits, including hurricane and flood protection, wildlife habitat, fisheries production, tourism, and many other valuable services. South Carolina contains the greatest expanse of estuarine marshes on the U.S. Atlantic coast. Population growth, increased development, and sea level rise present significant management challenges for coastal communities. While the management community is ready to move forward with planning and/or implementation, there is a significant lack of local data and knowledge of which areas are most vulnerable to submergence, how the marsh landscape may change with increasing sea levels, and how this marsh loss may be offset or compounded by available lateral migration opportunities. Consortium-funded researchers made considerable progress in gathering preliminary observations. They analyzed secondary data sources to ensure variability in both demographic and ecological factors across the study sites in South Carolina. This approach allowed them to identify key regions that represent a range of marsh types and ecological conditions and select three primary study areas: Fort Johnson, ACE Basin, and Cape Romain. A stakeholder survey for site selection included outreach to the Gullah Geechee Chamber of Commerce and Queen Quet, as well as scientific stakeholders ACE NERR and S.C. Geological Survey. Data collection is underway at the two Fort Johnson sites, which include both high marsh (short-form) and low marsh (high-form) systems. At these sites, water level wells were constructed and

installed, and are actively measuring water levels using Leveloggers, which allows researchers to monitor tidal fluctuations over time. The team is also in the process of developing the coding script for the Marsh Equilibrium Model (MEM), which will integrate various ecological factors such as sediment deposition, plant biomass, water levels, and elevation. This model will simulate marsh conditions under different environmental stressors, such as sea level rise, altered sediment supply, and changes in hydrology. As data collection progresses, researchers will continue to monitor and analyze the variability in these ecological factors, which will provide deeper insights into the key drivers of marsh resilience and help inform future strategies for South Carolina's coastal regions.

SUSTAINABLE COASTAL DEVELOPMENT AND ECONOMY

S.C. Sea Grant Extension Program: Sustainable Coastal Development and Economy

PI: April Turner, S.C. Sea Grant Consortium

The Consortium leads the South Carolina Coastal Information Network (SCCIN), coordinating outreach and information-sharing among more than 25 federal, state, regional, and local partners. Activities include organizing regular network meetings, maintaining the SCCIN event calendar and resource portal, and partnering on educational programs such as pond conferences and water quality trainings.

The Consortium continues to manage Calling the Coast Home, an accredited continuing education program for real estate professionals. This year, in partnership with SCCIN members, a new freshwater wetlands course was developed, and the Consortium and partners taught this five-module course series to 174 coastal real estate professionals in South Carolina.

The Consortium also improved the functionality of the S.C. Low Impact Development (LID) Atlas, a statewide interactive tool showcasing public and private LID projects. In collaboration with Clemson Extension and other partners, the Consortium promoted the atlas and began gathering new project data to provide a resource for communities interested in implementing green infrastructure.

The Consortium continues to manage and enhance the S.C. Clean Marina Program. Major revisions were made to the clean marina checklist and guidebook. Two training workshops were held for marina owners and staff, resulting in a new clean marina certification designation and six marinas committed to pursuing certification.

The Consortium also maintains its commitment to sustainable working waterfronts through active participation in the National Working Waterfront Network (NWWN), including key planning contributions to the upcoming 2025 NWWN Conference in San Diego.

To promote nature-based tourism and outdoor recreation, the Consortium collaborated with the S.C. Nature-Based Tourism Association (SCNBTA). The Coastal communities extension specialist offered leadership in areas such as website management, annual membership outreach, new member orientation, and event planning—including a webinar, a workshop, and the annual conference. The specialist also supported marketing efforts, including newsletter production and promotion of local businesses at events such as the Southeast Wildlife Expo, Palmetto Sportsman's Classic, and the Bulls Bay Nature Festival.

At the national level, the Consortium worked alongside other Sea Grant programs through the National Extension Tourism Network (NET) to strengthen collaboration between Sea Grant and Land Grant professionals in the tourism sector.

Guiding Successful Applications of Floating Treatment Wetlands in Brackish Coastal Ponds

PI: William Strosnider, Ph.D., University of South Carolina

Brackish ponds are the last line of defense before stormwater impacts downstream estuaries and coastal waters. Yet, brackish treatment applications are challenging, as treatment technologies are typically designed for freshwater applications but rarely those with intermediate or fluctuating salinity. Floating treatment wetlands (FTWs) can be installed directly within existing stormwater infrastructure and are a relatively economic best management practice. Since FTWs are a nascent technology that only saw application beginning in the early 2000s, significant questions remain regarding contaminant processing capacity and habitat creation potential. Of specific concern in coastal regions is the adaptability of FTW designs for the innumerable brackish coastal ponds in the USA and abroad. Previous FTW studies focused on contaminant processing in freshwater settings, with one addressing ecosystem services, and none systematically quantifying habitat provision. FTW-aided contaminant removal and habitat provision capacity is largely unknown in brackish systems, with just a few studies encountered in the literature. In addition, the few studies available have been performed in Europe using plants not native to North America, including invasive species (e.g., *Phragmites australis*). Consortium researchers approached developing guidance to enable successful FTW installations using three scales of experimental complexity: greenhouse, mesocosm, and field. It was determined that several plant species, including *Spartina alterniflora* and *Spartina patens*, may be successfully deployed in floating treatment wetlands in ponds of varying salinities and additionally revealed that coastal stormwater ponds serve as biological hotspots for several fish and arthropod species, which has substantial implications for pond design and management. While not designed with habitat value or ecology in mind, these stormwater ponds are acting as refugia in the midst of disrupted landscapes (e.g., housing developments) for a multitude of species, indicating that habitat value should be included in future design criteria for these ubiquitous systems.

WEATHER AND CLIMATE RESILIENCE

S.C. Sea Grant Extension Program: Weather and Climate Resilience

PIs: Landon Knapp, S.C. Sea Grant Consortium and College of Charleston; Katie Finegan, S.C. Sea Grant Consortium and Coastal Carolina University; Amanda Guthrie, S.C. Sea Grant Consortium; Ke'Ziyah Williamson, S.C. Sea Grant Consortium; Shu-Mei Huang, S.C. Sea Grant Consortium and College of Charleston; and Sophia Truempi, S.C. Sea Grant Consortium

The Coastal Resilience Program had full staffing of five specialists, one program manager, and two interns. The Program Manager continues to provide leadership for the extension team through monthly meetings as well as creating platforms to share materials, coordinate engagement, and problem solve as a group. All staff and interns attended at least three regional or national conferences, meetings, or trainings. Consortium activities were shared through 39 presentations to a diversity of audiences. 51 resiliency trainings or technical assistance were provided to 30 different communities, with hazard resiliency improving for nine of those communities as a result of those activities. A living shoreline was installed in one community as a result of Consortium activities and two communities worked on local resilience plans with assistance from staff. 11 new tools and technology initiatives were developed including resources on options for local wetlands protections, a resilience policy toolkit, and a salt march mapping tool for the state.

Staff either led or substantially contributed to over 15 separate projects focusing on resilience topics and spanning coastal communities from the North Carolina to Georgia borders of the state. For the groundwater modeling project, Beaufort County Adapts, a stakeholder roundtable meeting and a webinar were hosted to disseminate results which led to a local water and sewer authority requesting this data to aid in securing funds to address sewage pollution. There was continued engagement with three counties around water level sensors, in addition to the Consortium leading the regional coordination of Southeast Sea Grant programs on the topic. A new water level sensor was installed in Williamsburg, S.C. in May 2024. The Consortium provided regional resilience coordination for South Atlantic Sea Grant programs, creating a report of in-person meeting findings, facilitating a steering committee and quarterly calls, and establishing a structure to share information amongst the group. Ten communities were chosen with community action teams formed for the S.C. Resilient Coastal Communities Collaborative. The feasibility of thin layer placement in the state continued to be analyzed through an interdisciplinary framework that included a workshop, collection of economic data, and laboratory analyses of sediment composition.

Developing a Framework for Assessing the Benefits and the Feasibility of Thin Layer Placement in South Carolina

PIs: Katie Finegan, S.C. Sea Grant Consortium and Coastal Carolina University; Lexi Watson, Matt Gorstein, Amanda Guthrie, Ph.D., S.C. Sea Grant Consortium

In 2023, the Consortium was awarded nearly \$500,000 over four years from a joint grant competition of the NOAA National Sea Grant College Program and the U.S. Coastal Research Program to develop an assessment

framework on the benefits and feasibility of thin layer placement (TLP) in South Carolina. TLP can be a beneficial restoration technique used by engineers and coastal managers to increase marsh resilience to sea level rise and storms. Chronic (e.g., sea level rise) and episodic (e.g., storm impact) changes to the south Atlantic coast are increasing the vulnerability of coastal wetlands beyond the marshes' ability to recover naturally. TLP is a process where sediment removed during dredging is transported to a marsh and applied to the surface of the marsh. This sediment addition to marshes can be beneficial as a dredge material disposal site and in supporting marsh resilience. The Consortium and partners will develop a multi-sectoral framework to assist in decision-making for potential TLP sites in South Carolina. Potential TLP locations will be assessed from an economic, regulatory, ecological, and socio-cultural lens, and then representative sites will be implemented in a geomorphological model (MarshMorpho2D) to evaluate the potential for success. Three summer workshops with mapping exercises were held to gather feedback from local communities on social values and uses of marshes. Two students at the University of South Carolina supported economic cost data collection. An intern conducted a regulatory analysis to support defining a permitting pathway in South Carolina. Mud and silt contents from South Carolina marshes were used to calibrate the model. Presentations were given at the S.C. Beach Advocates meeting, the American Shore and Beach Preservation Association, and the American Geophysical Union.

Kids Teaching Flood Resilience: Step Up! Get Ready! Respond!

PIs: Merrie Koester, Ph.D., University of South Carolina; Scott Curtis, The Citadel; Susan Lovelace, Ph.D. and Amanda Guthrie, Ph.D., S.C. Sea Grant Consortium

The S.C. Sea Grant Consortium was awarded nearly \$160,000 for a two-year grant through the NOAA National Sea Grant College Program and the NOAA Disaster Preparedness Program to expand and document culturally responsive activities for students to learn about the science behind hurricane formation and steps to be more resilient during a storm. Studies on hazard risk communication reveal that unless messaging is consistent with the beliefs, needs, and goals of a given social group, it is not likely to be acted upon. With few exceptions, minority communities are at greater risk in disaster situations, while community-based organizations that serve and represent these minority communities are not well-linked with disaster loss reduction and preparedness efforts. A Consortium researcher is expanding upon the Kids Teaching Flood Resilience program (www.kidsteachingfloodresilience.com) developed in response to a key challenge in the City of Charleston's 2015 Sea Level Rise Strategy Plan. A two-year grant was secured in 2023 to expand and create an educational program for youth educators to teach about hurricanes and improve science literacy and hurricane resilience. The project team has created resources, such as classroom activities and education videos, for youth educators to use in their programs. Leaders have been engaged to ensure the project addresses local needs. A team of teachers has been involved in the testing of the materials and has provided feedback on the implementation and use of the materials.

Southeast Heat and Equity Pilot: Heat as a Stressor in Urban Low-resource Neighborhoods

PIs: Scott Curtis, The Citadel; Susan Lovelace, Ph.D. and Amanda Guthrie, Ph.D., S.C. Sea Grant Consortium

Due in part to heat-health assessment activities by the S.C. Sea Grant Consortium and partners, the City of Charleston is working to increase its awareness of extreme heat as a health and community hazard. In the

U.S., heat kills more people than any weather-related hazard. Due to climate change, hotter days and nights will create an additional stressor that will harm outdoor workers, low-wealth communities, people with chronic health conditions, and many others. As heat is seen as a normal part of life in the Southeast, there is a growing need to increase awareness of and reduce heat health impacts in the short and long term.

The Consortium partnered with state and federal agencies to better assess heat within the City of Charleston. After the Charleston peninsula was mapped to identify heat islands, additional funding was secured through the NOAA Climate and Equity Roundtables to more equitably reduce heat island effects and heat-health stress in the city. The Consortium, The Citadel, and Charleston County collaborated to evaluate how road treatment affected heat islands. Additionally, the Consortium led the development of flyers and paper hand-fans to help disseminate heat health safety resources and information about heat illness symptoms. The team tabled at multiple outdoor events to increase heat knowledge and awareness among residents. Lastly, the team partners developed an online toolkit about what is being done and what can be done to reduce extreme heat impacts for local communities in South Carolina.

SOS (Solutions on Septic): Identifying Resilient Solutions for Septic Management in Coastal South Carolina

PI: Tim Callahan, Ph.D., College of Charleston

On-site wastewater treatment systems (OWTS), commonly referred to as septic systems, reliably manage wastewater given appropriate site conditions, sound design standards, and proper operation. Coastal South Carolina and similar low-lying areas are prone to failing septic systems because of shallow water table conditions. The best design standards and current regulations cannot overcome such site conditions, leading to wastewater discharge from the septic leach fields and pollution of groundwater and nearby receiving water bodies. Typically, OWTS are used in rural or exurban areas lacking municipal sanitary sewer service, but can also exist in clusters in older suburban communities. Septic failure due to age, improper maintenance, or poor design can jeopardize public and ecosystem health. These coastal water quality risks are magnified by environmental change, specifically sea level rise-driven influences on shallow groundwater and increased storm intensity. Consortium-funded researchers recruited four septic owners, installed six groundwater monitoring wells, and collected one round of samples. They began to gather necessary GIS data and are continuing to build the base layer needed for the geospatial risk assessment model to characterize potential septic vulnerability to environmental change impacts. Researchers want to identify septic owners' motivations for septic maintenance and their willingness to accept solutions that provide for long-term performance and water quality protection. To achieve this, they have created recruitment materials, a survey, focus group questions, interview questions, and identified communities in Mount Pleasant in which to hold focus groups.

Climate Action Engagement Academy for Small Businesses: Fostering Economic Empowerment in the Midst of the Evolving Environment

PI: Scott Curtis, Ph.D., The Citadel

Climate stressors impact not only employees, business facilities, and supply chains, but also customers and clients. Resource constrained coastal small businesses are particularly vulnerable, as they are faced

with additional barriers to resilience. They often do not have the financial buffer or capacity to sift through information to prepare for, respond to, and recover from episodic events (e.g., hurricanes) and chronic stressors (e.g., more frequent sunny-day flooding and rainstorms of ever-increasing intensity). Not only do small business owners need to be responsive to climate stressors, they are increasingly expected to contribute to a climate-compatible and future-oriented economy. Sustainable business practices are varied, however, and unlike large corporations, small businesses often lack technical expertise, skills, and resources needed to address climate-driven challenges.

Two working group meetings were held to discuss project objectives, participant recruitment, and logistics. Lessons learned were that: a) small business owners won't give up their time unless they have tangible takeaways, b) participants want to share their experiences through stories and visuals, rather than responding to science and related jargon. PIs are viewing this as an emergent model of teaching where they can add context to participants lived experiences, and c) the agreed-upon thread for academy participants are that business owners who are motivated, environmentally aware, and growth minded are willing and able to step out of their business operations for new opportunities. This exercise will help with recruitment infographics. Secondly, four students were recruited and are currently collating websites and studies relevant to small businesses in coastal South Carolina, providing input as small business owners themselves, and developing thesis projects. The team designed a project logo for better communication and visibility, and created a survey for the academy. Because of the working group, the increasing application of force majeure was added as a potential consequence of climate stress. Finally, the team is exploring having businesses "brand" their climate stressors by collecting photos.

SUSTAINABLE FISHERIES AND AQUACULTURE

Sea Grant Extension Program: Sustainable Fisheries and Aquaculture

PIs: Jocelyn Juliano, Sarah Pedigo, Angela Treptow, Matt Gorstein, Kate Chatman, S.C. Sea Grant Consortium

The S.C. Sea Grant Consortium is leading several fully funded projects aimed at advancing reef fish research and sustainability. This includes leading outreach and dissemination efforts for a five-year South Atlantic red snapper abundance study. In partnership with the North Carolina, Georgia, and Florida Sea Grant programs, the Consortium also supports a regional reef fish extension initiative focused on fisher engagement and barotrauma reduction to minimize discard mortality.

To strengthen South Carolina's local seafood economy, the Consortium provided critical grant application support for shrimp industry infrastructure improvements through the 2018 shrimp freeze disaster relief program.

Guided by recent industry assessments, the Consortium is actively addressing workforce needs by administering the Commercial Seafood Apprenticeship Program in McClellanville, S.C. This hands-on training initiative is preparing the next generation of seafood professionals, ensuring the long-term resilience and sustainability of the state's commercial seafood sector.

The Consortium develops and supports collaborative research projects with the seafood industry, including a project evaluating the impact of oyster cage resubmergence on *Vibrio* levels in mariculture oysters.

Extension specialists continue to add to the Consortium's Aquaculture Toolkit, with new additions over the past year including a GIS mariculture siting tool and an improvement to the business planning tool for the user to enter 5 years' worth of data. The siting tool, in particular, is a significant accomplishment and a tool now consistently used for technical assistance.

This past year was the third successful installment of the Consortium's summer aquaculture intern program, where interns are placed with host farms during the summer to assist with operations and gain valuable hands-on experience.

Finally, the Consortium organized three collaborative scoping workshops related to the feasibility of offshore marine aquaculture off the coast of South Carolina.

The Lowcountry NETwork: Building a Coalition of Community Members, Shrimpers, Educators, and Conservationists to Remove and Recycle Marine Debris

PIs and Partners: Jocelyn Juliano, Brooke Saari, Sarah Pedigo, Taylor Campbell, S.C. Sea Grant Consortium; Bryan Fluech, Katie Higgins, Marine Extension and Georgia Sea Grant; Angel Parson and Erica Xavier-Beauvoir, Gullah Geechee National Cultural Heritage Corridor

Trawl to Trash engages the public in outreach and stewardship activities that educate communities about the impacts of marine debris and encourage the use of up-cycled stow bags made by commercial shrimpers from derelict nets to prevent littering, and to collect and remove debris from waterways. This project has been expanding the program to additional communities that have commercial shrimping activity, enhancing education and outreach capacity, and working toward a sustainable, successful program with existing community partners while fostering new collaborations. Heavily worn trawl nets that are no longer fishable become burdens to fishermen. If disposed of improperly, they can become “ghost fishing gear” or take up property space. Additionally, many shrimpers go months in the offseason without earning income. In creating a product from these used nets, shrimpers can earn extra income while the nets are repurposed. Resulting stow bags are distributed through community outreach and stewardship efforts to prevent and collect litter from coastal waterways. Project partners coordinated with 15 shrimpers across the South Carolina and Georgia coasts to create approximately 700 stow bags and paid out over \$14,000. These stow bags were then distributed to volunteers cleaning up litter in waterways, partners, and the public so they could collect and dispose of marine debris. Marine debris prevention and education events included public workshops and tabling efforts in GA, reaching 480 adults and children. In South Carolina, the team coordinated a water-based cleanup in partnership with a nature-based tourism operation where 40 volunteers cleaned up a local barrier island. All the project partners worked together, with one graduate and two undergraduate interns, to coordinate the Maritime Days community event, resulting in 21 vendors from different environmental advocacy organizations, with nearly 200 members of the community in attendance.

Developing a Commercial Seafood Workforce Training Program in South Carolina

Pls: Jocelyn Juliano, Angela Treptow, Matt Gorstein, S.C. Sea Grant Consortium

In response to a declining commercial fisheries workforce, the S.C. Sea Grant Consortium developed a commercial seafood apprenticeship program to be hosted in the major southeast fisheries hub of McClellanville. An aging workforce is one of several challenges facing the commercial fishing industry in the Southeast. Variability in operations and structure, lack of training pathways, fragmented industry organizations, and increased costs of entry with little access to resources/capital make this issue particularly challenging. The S.C. Commercial Seafood Apprenticeship Program was developed through long-standing collaboration with local organizations and is funded by NOAA and USDA, with additional support from private sponsors. The program offers a comprehensive package—room and board, gear, materials, and a stipend—alongside mentorship from experienced watermen to remove barriers to entry and equip participants for success in commercial fishing and mariculture. The Consortium and partners graduated 5 apprentices for the inaugural 2024 class of the S.C. Commercial Seafood Apprenticeship Program. Apprentices received a U.S. Coast Guard accepted marine safety training certification, CPR and Mariner’s First Aid certification, and a program certificate. A second cohort will be hosted in the spring of 2025.

2020-2023 South Atlantic Red Snapper Research Program (SARSRP)

PIs: Susan Lovelace, Ph.D. and Jocelyn Juliano, S.C. Sea Grant Consortium; William Patterson, Ph.D., University of Florida

The research team is progressing with population size estimates of age 2+ Atlantic red snapper from North Carolina to Florida. Red snapper, *Lutjanus campechanus*, is an ecologically and economically significant reef fish in U.S. Atlantic waters from North Carolina through south Florida, where it has been estimated to be overfished since the early 1980s. Regulations aimed at rebuilding the Atlantic red snapper stock have not met the requirements to declare the stock no longer overfished, which causes challenges for natural resources managers and commercial and recreational fishers. Researchers are estimating the population size of Atlantic red snapper independent of the stock assessment. With the additional allocation of funds, the research team will enhance the population size estimate portion of the study, conduct 3D telemetry experiments to estimate discarding within telemetry arrays to produce more robust estimates of the effective sampling areas for camera-traps, as well as estimate and analyze the sample sizes needed to estimate the number of discards in the U.S. Atlantic red snapper fishery, as this has a known substantial effect on the population. The research team has produced three publications to date. A 3D telemetry effective sampling area experiment was conducted and analyzed. Genotype sequencing of fin clip samples was completed and analyzed. Results from simulation analyses for estimating the magnitude of discards in the U.S. Atlantic red snapper recreational fishery were finalized.

Refining Assessments of Reproductive Activity in White Shrimp (*Penaeus setiferus*) to Improve Management dDcisions

PI: Michael Kendrick, Ph.D., S.C. Department of Natural Resources

The commercial penaeid shrimp fishery in South Carolina consistently ranks among the top three state fisheries in terms of both landings and value and is an integral part of the cultural heritage and economics of the South Carolina coast. The nature of the fishery has changed in recent years, however, with increases in the landings of large, higher value roe shrimp in the spring as a proportion of the total annual harvest. One of the tools that the South Carolina Department of Natural Resources' (SCDNR) Office of Fisheries Management uses for the sustainable management of the white shrimp fishery is the opening and closing of state waters to commercial trawling. The decision to open the spring white shrimp season is primarily based on two data sources: 1) abundance trends for overwintering white shrimp collected through fishery-independent (FI) methods; and 2) the reproductive status of adult female white shrimp. This project has developed and published on the use of tools that effectively track ovarian development and distinguish shrimp without evidence for prior spawns from those that show evidence of prior spawns. When comparing microscopic and macroscopic assessments of white shrimp ovarian tissues in Charleston Harbor, S.C., the agreement between the two approaches declined as the spawning season progressed from April to June. When compared across the coasts of both South Carolina and Georgia, there was 57% agreement on reproductive stage between microscopic and macroscopic approaches. This project shows trends to earlier reproductive development in female white shrimp over the past 40+ years and a tendency for more northern areas of South Carolina to show delayed development compared with the rest of South Carolina and Georgia. Fisheries managers of regional state agencies now have contemporary information about the timing of reproductive development in white shrimp, as well as an improved field

guide with which to make assessments in the field. This is particularly pertinent in South Carolina, where the reproductive status of female white shrimp is critical in decisions regarding when to open the commercial shrimp season in the spring.

Long-Term Trends and Drivers in South Carolinas Commercial Shrimp Fisheries

PI: Ryan Rezek, Ph.D., Coastal Carolina University

Considerable progress has been made in this project, with confidential trip-level commercial fisheries data successfully obtained and cleaned to remove errors, irrelevant entries, and financial data has been adjusted for inflation to permit meaningful comparisons across years. Analyses indicate distinct shifts in shrimp fisheries trends from 1980 to 2023, raising key questions about the underlying causes of these changes. Annual landings increased steadily between 1980 and 1995, followed by a sharp decline until 2007, after which landings remained stable. Similarly, effort has declined significantly since 2004 and exhibited a steep drop-off through 2006. Although effort stabilized in the following years, another breakpoint in 2012 marked a continued decline of 174 trips per year through 2023. A notable trend is observed in white shrimp CPUE (catch per unit effort), which remained stable between 2004 and 2013, with an increase of 25 kg per trip per year after 2013, suggesting a potential shift in population dynamics or fishing efficiency. The inflation-adjusted (2023) ex-vessel value of the shrimp fishery has also experienced a long-term decline, decreasing at a rate of \$526,470 per year since 1980. In contrast, the price per kilogram of shrimp followed a different pattern, declining at a rate of \$0.42 per year from 1980 to 2004, before reversing to an increase of \$0.16 per year through 2023. Among the most dramatic structural changes in the industry has been the decline in the number of vessels, which decreased at a rate of 79.7 vessels per year from 2004 to 2005. After 2005, this decline slowed to 4.3 vessels per year, indicating a period of relative stabilization following an initial period of rapid contraction. These patterns suggest that market dynamics have played a substantial role in shaping the trajectory of South Carolina's shrimp fisheries. The sharp declines in landings, effort, and CPUE align with shifts in market demand, competition from imports, and changes in fleet composition. The substantial decrease in shrimp price per kilogram, which bottomed out in 2004, coincided with a marked decline in effort and vessel numbers, likely due to reduced return on trip value. While price and CPUE have increased since this period, vessel numbers and effort have continued a downward trend, suggesting that economic pressures and market forces are key drivers of participation in the fishery.

A Collaborative Effort to Understand the Movements of Atlantic Blue Crab (*Callinectes sapidus*) in Support of Improved Sustainable Fisheries Management

PI: Daniel Sasson, Ph.D., S.C. Department of Natural Resources

The Atlantic blue crab (*Callinectes sapidus*) is a vital species in coastal South Carolina, both ecologically and economically. They form a critical link in the coastal food web, eating plants and small animals while serving as prey for larger animals such as fish, dolphins, and sea turtles. Blue crabs also support one of the state's oldest and largest fisheries, with landings valued at over \$6 million annually. While the annual value of blue crab landings in South Carolina is at near-record highs, the catch of blue crabs has declined in recent years, reaching a 50-year low in 2021. The blue crab life cycle is complex and known to be sensitive to environmental

conditions. Changing environmental factors in the coastal estuaries of South Carolina are associated with shifts in the timing, movement, and abundance of blue crabs in the state. Mark-recapture studies are an effective means to quantify the movement and habitat use of blue crabs. However, tagging studies of blue crabs in South Carolina are relatively rare and have focused exclusively on females. Males and females differ in their habitat use and movement patterns as adults. An understanding of how fall movement patterns and habitat use differ between sexes is essential for informed management and sustainable fisheries practices. In the case of mark-recapture studies, commercial and recreational crabbers represent important stakeholders that encounter the resource in a variety of habitats, thus allowing them to participate in the acquisition of data in the form of reporting recaptured crabs. Engaging stakeholders in the project could be critical. In the first year, Consortium-funded researchers sexed and measured almost 3,000 blue crabs, tagging approximately half that were non-molting adults. Sex, size, and maturity status all affected where blue crabs were found. Females were significantly more likely to be found in higher salinity areas than males, and, consequently, larger crabs were found at lower salinities. Immature crabs of both sexes were also found at lower salinities than mature crabs of the same sex. Researchers are currently using the reports from recreational and commercial crabbers to analyze the movement of these crabs.

Utilization of Coupled Human and Natural Systems Modeling to Assess Marine Debris Removal Impacts on Cryptic Coral Reef Biodiversity

PI: Michael Childress, Ph.D., Clemson University

Human-made debris in the ocean often becomes habitat for small marine organisms known as cryptofauna. Cryptofauna are among the most essential reef organisms; however, little is known about them, let alone their fate, considering degrading coral reefs and increasing anthropogenic disturbance. This study explored differences in naturally occurring cryptofauna biodiversity compared to synthetic sources of marine debris. To explore this difference, researchers measured invertebrate diversity from autonomous reef monitoring systems (ARMS) located on patch reefs along the Middle Florida Keys Reef Tract. These systems were used as a substitute for natural structure to compare with marine debris removed from five reef locations. Plastic debris was the most abundant of all the debris material collected. Wood and concrete were treated as equal variables since they originate from wooden lobster traps. Taxa diversity varied significantly between ARMS and debris, indicating that each structural unit contained significantly different and diverse communities. The most influential taxa identified included commensal shrimps, hermit crabs, brittle stars, segmented worms, and several families of crabs. Additionally, while functional richness increased with taxa richness for ARMS communities, debris communities showed decreasing functional richness and high functional similarity, suggesting a specialization of debris-specific taxa. There is compelling evidence that high natural structure from reef-building corals contributes to reef biodiversity. Therefore, the concern is that the loss of reef-building corals will lead to flattening of the reef and a corresponding loss of biodiversity. This may also elevate the importance of structure from marine debris, which may serve as unintentional artificial reefs, attracting the settlement of reef species. This raises an important question when considering the net benefits of the removal of debris heavily covered in sessile species, with a shrinking natural area for settlement. Future studies will work to better understand debris patterns on Florida reefs and the potential costs and benefits of debris on cryptic marine biota. Such research will aid in natural resource management and assist in safe marine debris removal for cleaner, healthier reefs.

SCIENTIFIC LITERACY AND WORKFORCE DEVELOPMENT

Marine Education Program

PI: E.V. Bell, S.C. Sea Grant Consortium

The S.C. Sea Grant Consortium's marine education program is on target with the scope-of-work outlined for this reporting period. During this time, the education program became a separate department with two full-time educators (Education and Outreach Manager and Marine Education Specialist). The program continues to coordinate and/or partner on high-quality professional development programs, including S2S, Teachers on the Estuary, Educator Science Cafes, All Booked Up Coastal Reading Club, and Marine Debris (supported through a National Oceanic and Atmospheric Administration (NOAA) Marine Debris Challenge Grant). Climate workshops and a REconnect (Researcher-Educator) Symposium are in development. The BioDiscovery Project pivoted from formal trainings to an on-demand opportunity. The program continues to engage inland and coastal K - 12 students with the S2S salt marsh restoration program. Loaner kits (e.g., Enviroscape©) continue to be offered free-of-charge for educators to use in their classrooms. A new fish printing kit ("gyotaku") is available, and a marine debris kit (funded through the NOAA Marine Debris Challenge Grant) is currently in development. Publications aligned to S.C. State Science Standards continue to be produced, including a revised lesson plan based on the 2012 Elementary Basic Observation Buoy curriculum. Agency opportunities are promoted through the education newsletter, The Lettered Olive (published monthly), and during professional conferences (e.g., Environmental Education Association of South Carolina). Workforce development and career paths are fostered through the Consortium's leadership in the Palmetto Environmental Education Certification program. Community outreach continues to grow, including public involvement in salt marsh restoration efforts, the annual Beach Sweep/River Sweep volunteer clean up, and festivals (e.g., Lady Cougar STEM Day). In progress is the formalizing of a public coastal engagement series and Marine Debris Derby Days (part of a NOAA Marine Debris Challenge Grant). An evaluation of the education program is currently in development.

Increasing Coastal Resiliency through Marine Education

PI: E.V. Bell and Morgan Treon, S.C. Sea Grant Consortium

The Consortium hired Morgan Treon in September 2022 to assist with the From Seeds to Shoreline® (S2S) program, professional development, and general outreach. The program continues to coordinate and/or partner on high-quality professional development programs, including S2S, Teachers on the Estuary, Educator Science Cafes, BioDiscovery, and the All Booked Up Coastal Reading Club. In addition, the program continues to engage inland and coastal K - 12 students with the S2S salt marsh restoration program. Loaner kits (e.g., Enviroscape©) are offered free-of-charge for educators to use in their classrooms. Lesson plans and curricula aligned to the S.C. State Science Standards continue to be produced, including Curriculum Connection, which is the education supplement of the Consortium's quarterly magazine, Coastal Heritage. In addition, agency opportunities and resources are promoted through the education newsletter, The Lettered Olive (published monthly), and during professional conferences, such as the Environmental Education Association of South Carolina. Workforce development and career paths are fostered through the Consortium's leadership in the Palmetto Environmental Education Certification program and the "Navigating Coastal Conservation Careers"

Consortium-supported project coordinated by the S.C. Department of Natural Resources (SCDNR). Community outreach grew during this time, where as a partner on a SCDNR grant (awarded by the National Oceanic and Atmospheric Administration), the Consortium modified the S2S program to involve community volunteers in salt marsh restoration. The education program supports the Consortium's annual Beach Sweep/River Sweep, specifically coordinating volunteers/serving as site captain for the Folly Beach location. The education program continues to work closely with the researchers and the Consortium's Extension Team to offer innovative and relevant education programming reflective of agency goals.

Communications and Education Services

PI: Crystal Narayana, S.C. Sea Grant Consortium

The goal of Communications is to put the work of the S.C. Sea Grant Consortium in context for strategically identified audiences and to support the Extension and Education departments with products that enhance their programs.

In 2024, Communications was restructured to include two generalists with skills in science writing, design, photography, and social media. This allowed for a broadening of scope, which led to a 100% increase in social media reach, as well as the development of 24 articles, including 2 feature articles, communicating the research, education, and extension work of the Consortium to a general audience.

Over 100 new communication products were designed and created in support of internal programs, including rack cards, infographics, flyers, signage, and collateral.

Staff produced monthly issues of the Coastal Science at Work newsletter, which highlights accomplishments and the results of projects and research to government and partner organizations for the purpose of communicating the Consortium's value to the state.

Communications continued to maintain and develop the Consortium's main website and 5 focused program websites, providing Consortium-funded and -developed coastal science and marine education resources to approximately 128,000 visitors.

Additionally, Communications supported outreach events with materials and staff presence, including organizing the annual Beach Sweep/River Sweep waterway cleanup event, which drew over 2,600 volunteers throughout the coastal counties.

Program Management: Fellowships, Internships, and Scholarships

PIs: Susan Lovelace, Ph.D., Susannah Sheldon, and Matthew Gorstein, S.C. Sea Grant Consortium

Supporting undergraduate and graduate students and early career professionals in earth and marine sciences leads to an informed, engaged, and well-trained workforce. The S.C. Sea Grant Consortium is involved in initiatives that support educational and professional development for these individuals.

Sixty-seven Knauss South Carolina fellows have been selected since 1984, and 20 South Carolina coastal management fellows have been placed since 1997. The Consortium and S.C. Space Grant Consortium support the Kathryn D. Sullivan Earth and Marine Science Fellowship to increase trained scientists and to enable

graduate students to conduct NASA- and NOAA-related research. Additionally, Community Engaged Internships, Margaret A. Davidson Resilience Scholars Program, and the Minorities in Aquaculture Internship Program support undergraduate students.

In 2024, the Consortium supported 20 undergraduates, 16 master's-level students, and 11 Ph.D. students in conjunction with Consortium-funded research, internships, and fellowships. 47 were new to Sea Grant support, and 13 received continued support. Six of the students were Consortium interns. Three Sea Grant-nominated students were selected for the Knauss fellowship, and another was selected for the Sullivan award. Student support has improved student and early professional ocean and coastal literacy while helping secure employment.

Gullah/Geechee CREATE: Coastal Debris Removal Engaging Artists through Environmental Cleanups

PIs and Partners: Matt Gorstein, S.C. Sea Grant Consortium; Queen Quet, Gullah/Geechee Nation; Marilyn Hemingway, Gullah Geechee Chamber of Commerce; Zenobia Harper, Gullah Preservation Society

The S.C. Sea Grant Consortium and partners received \$300,000 for Gullah/Geechee CREATE: Coastal Removal Engaging Artists through the Environment as a part of the National Sea Grant Office's marine debris community action coalition competition. This project is focused on collecting and removing marine debris from the coastal environment and upcycling the collected material into artwork. In South Carolina, marine debris is found throughout coastal watersheds, posing risks to food systems, economies, and culture. This is particularly challenging for people and communities that live adjacent to these waterways. By creating a community action coalition with partnerships across Gullah/Geechee communities in South Carolina, the project team is directly reaching coastal community residents and empowering them to be a part of the solution. Coastal communities in South Carolina have a rich history of fishing, harvesting, and preparing marine resources, highlighting a longstanding direct connection to marine resources, as well as a vulnerability to marine debris in waterways and marine food chains. By engaging with artists throughout the project and given that the project is led by community-based organizations, the team is building local coalitions and partnerships to identify and actively address marine debris prevention and removal at the community level. 216 people were engaged across ten events focusing on cleanups, environmental stewardship, and community art infused with education. A 5th-grade lesson plan focused on sea turtle biology with an associated art project was developed. Three showcases were held in St. Helena Island, Conway, and Charleston for February 1, February 22, and March 29, 2025, respectively. Eight artists completed pieces made of marine debris.