

SUSTAINABLE COASTAL DEVELOPMENT AND ECONOMY

IMPACTS

Collaborative Effort Leads to Connected Land Conservation Plan for the East Cooper Region

April Turner, SC Sea Grant Consortium

Relevance: Natural asset planning is a strategic landscape approach to open space conservation in which local communities, landowners, and organizations work together to identify, design, and conserve their local land network in order to maintain healthy wildlife and human communities. Natural asset planning can be used to prioritize land that should be conserved or restored while also pointing out areas that are more appropriate for development.

Response: The S.C. Sea Grant Consortium in conjunction with the East Cooper Land Trust and the College of Charleston received a Green Infrastructure technical assistance grant (\$50,000) from the S.C. Forestry Commission to develop a connected land conservation plan for the East Cooper region of Charleston County, S.C. The purpose of the plan is to provide a regional perspective of local development patterns and natural resources in the area between the Cooper and Santee Rivers. To create this plan the project team partnered with the communities of Mount Pleasant, Daniel Island, Cainhoy, Sullivan's Island, Isle of Palms, Awendaw, McClellanville, and Charleston County. This partnership was formalized by the six mayors through signing a memorandum of agreement for the East Cooper communities. The project team synthesized technical knowledge regarding urban and regional planning, landscape architecture, and ecology. The team also organized workshops to garner feedback from the mayors and planning staff to develop a land conservation plan.

Results: The project partners completed this cross-jurisdictional land conservation plan (http://www.scseagrant.org/pdf_files/2017-East-Cooper-Connected-Land-Conservation-Plan.pdf) with the seven communities in December 2016. This plan serves as a resource for these communities providing them with the capability to identify and review their highest quality natural assets on a regional scale and to develop strategies to conserve them, while identifying the best locations for promoting development.

Recap: The S.C. Sea Grant Consortium collaborated with partners to create a connected land conservation plan for seven communities in the East Cooper region of Charleston County, S.C. The six mayors of this region signed a memorandum of agreement in support of this natural asset planning project. The development of an accompanying online mapping application is underway and will be completed in May 2017.

Grant from S.C. Sea Grant Consortium Fosters Expansion of S.C. National Heritage Area for Communities in the Bulls Bay Region

April Turner, S.C. Sea Grant Consortium

Relevance: The Bulls Bay area of South Carolina between Mount Pleasant and Georgetown has a wealth of natural and cultural resources and attractions, but it is under development pressure from communities to the north and south. To build greater awareness of the pristine landscape in the area, Bulls Bay Chamber of Commerce, leaders, and community partners sought assistance with branding the region as Bulls Bay Historic Passage to help protect and promote the unique and diverse resources of this stretch of the S.C. coastline.

Response: The S.C. Sea Grant Consortium (Consortium) awarded a Sustainable Coastal Communities Initiative grant to the Bulls Bay Chamber of Commerce representing the Town of Mount Pleasant, McClellanville, Awendaw, Charleston County, Francis Marion National Forest, the Cape Romain National Wildlife Refuge, and Santee Coastal Reserve to support efforts to have the region added to the South Carolina National Heritage Corridor.

Results: The project partners leveraged Consortium support to acquire additional funding to implement a plan to protect and promote the Bulls Bay region, culminating in the area being incorporated into the South Carolina National Heritage Corridor in January 2017. The partners identified community goals and the means to sustain local resources. They also created a database of outdoor recreation sites and amenities, an interpretive and wayfinding signage plan, a destination development plan in keeping with the S.C. Great Outdoors Initiative, and print material for promotion of local resources.

Recap: The S.C. Sea Grant Consortium supported the Bulls Bay Chamber's efforts to designate the coastal communities of the Bulls Bay region as part of the South Carolina National Heritage Corridor to protect and promote a natural and cultural resource-based economy for this rural area.

S.C. Sea Grant Consortium Support Leads to Patent on Anti-biofouling Process Awarded to Okeanos Research Laboratory

Andrew Mount, Clemson University

Relevance: Biofouling from oysters can result in higher fuel costs to overcome the increased drag on ship hulls, and can back-up pipes in an aquaculture facility, which can lead to higher maintenance and repair costs.

Response: The S.C. Sea Grant has supported work of the Okeanos Research Laboratory, and individual studies by its director, Andrew Mount, for two decades. Mount's early research led to the discovery of the cellular process oysters use to build and repair their shells. Those findings were published in *Science* in 2004. The unlocking of the oyster building process, which involves cellular adhesion, led to work sponsored by the Office of Naval Research on using the process to deter biofouling, or the buildup of marine larvae on underwater surfaces.

Results: In 2016, Mount earned a patent for an anti-biofouling coating. Mount, working with Engineered Marine Coatings of Charleston, S.C., also is awaiting word on a National Science Foundation grant to fund research on the efficacy of an anti-biofouling paint product using the newly patented process. The paint would be more environment-friendly and last longer than common copper-based anti-biofouling products.

Recap: The S.C. Sea Grant Consortium has supported research at the Okeanos Research Laboratory several times in the past two decades. The lab's breakthrough discovery in 2004 of the cellular process led to a patent in 2016 for an anti-biofouling coating. A proposed study of a paint product using the process is the next step in this long-term impact of S.C. Sea Grant Consortium support.

S.C. Sea Grant Consortium Research Evaluating Wetland Function to Support Low Impact Development Decision-making

Dan Hitchcock, Clemson University

Relevance: While ponds have been the standard practice for stormwater management in the region, stormwater control measures (SCMs) that include vegetation-based practices are becoming more common. Low impact development (LID) practices are increasing in use for site design in coastal South Carolina. Properly sited, selected, and designed SCMs that incorporate vegetation into system design for water quality improvement can complement or replace ponds in the stormwater treatment train while also enhancing the managed landscape. In coastal areas with shallow water tables and low gradient topography, surface and groundwater coupling complicates decision-making with respect to LID and stormwater management. Groundwater-surface water interactions are not appropriately considered in the stormwater management practice siting, selection, and design process.

Response: S.C. Sea Grant Consortium researchers at Clemson University continued investigating the ecohydrological function of natural and engineered wetland systems for stormwater quantity and quality management in lower coastal plain landscapes typified by shallow water tables and seasonally high evapotranspiration rates.

Results: Researchers expanded a geospatial LID suitability index with information layers that indicate appropriate sites for wetland (retention-based) versus bioretention (infiltration-based) systems from Georgetown County to three additional coastal counties (Beaufort, Charleston, and Horry). Based on the Coastal S.C. LID Manual and S.C. Department of Health and Environmental Control Best Management Plan Manual siting criteria, this exercise demonstrated that for Georgetown and Horry counties – given their soils, low-gradient topography, and shallow water table conditions – a larger percentage of land area favors bioretention systems over wetland-based systems. The opposite is true to the south in Charleston and Beaufort counties.

Recap: S.C. Sea Grant Consortium-supported research at Clemson University led to expansion of their previously-developed geospatial LID suitability index tool that differentiates sites best-suited for wetland versus bioretention systems in coastal South Carolina.

S.C. Sea Grant Consortium Research Develops and Expands Tool to Detect Harmful Algal Blooms

Dianne Greenfield, University of South Carolina; and William Jones, MUSC

Relevance: Incidences of harmful algal blooms (HABs) are increasing globally. In coastal South Carolina, HABs are associated with one out of every four fish kills, and phycotoxins are routinely detected, making HABs an environmental and public health threat. Traditional methods for identifying and quantifying HABs use time-consuming microscopy. Moreover, many species are morphologically similar, which is problematic for early warnings and timely management.

Response: S.C. Sea Grant Consortium researchers at the University of South Carolina and the Medical University of South Carolina examined methods to rapidly detect and quantify HAB species associated with coastal fish kills and toxin production, focusing on tools that would be cost- and time-efficient and could be used in either a field or a laboratory setting.

Results: S.C. Sea Grant Consortium researchers and their partners developed a novel and economical molecular tool (sandwich hybridization assay; SHA) that aids rapid and accurate HAB assessments in the

field. One of the fascinating findings was the identification of a neurotoxin-producing species of *Pseudo-nitzschia*, *P. fukuyoi*, which is entirely new to this continent. In fact, this species was only recently described (2013), and to date, only in Asian waters. Detection of this HAB species in the Southeast has far-reaching implications for *Pseudo-nitzschia*'s biogeography and *P. fukuyoi*'s likely impact on the region's public and environmental health. As a result, this species was included in the SHA tool development efforts for water quality research and management activities. Additionally, the research was used to revise the South Carolina fish kill and bloom response protocol manual in conjunction with the S.C. Department of Health and Environmental Control, including a flow chart allowing field staff to rapidly characterize a water body according to certain traits (color, turbidity, odor) then determine whether further environmental sampling for HABs was necessary.

Recap: S.C. Sea Grant Consortium-supported research resulted in development of a novel molecular tool for field assessments of harmful algal blooms, and revisions to the S.C. Department of Health and Environmental Control Field Manual for the Investigation of Fish Kills.

ACCOMPLISHMENTS

The Consortium Provides Leadership to Nature-Based Travel and Tourism in South Carolina **April Turner, S.C. Sea Grant Consortium**

A 2009 study by the Darla Moore School of Business at the University of South Carolina documented that the state's diverse natural resource sectors contributed \$29.1 billion and 236,110 jobs to the state's economy in 2008. Overlapping this sector is tourism, which is a \$15 billion industry in South Carolina. The eight coastal counties account for approximately 50 percent of that total and support almost 81,000 jobs. The interest of the S.C. Sea Grant Consortium (Consortium) in coastal tourism has focused on two issues: 1) balancing between the vitality and abundance of South Carolina's coastal and marine resources and the economic health of the tourism industry that depends on them, and 2) assisting rural coastal communities, away from the booming tourist destinations (such as Myrtle Beach), with developing/encouraging/promoting tourism practices that are economically, environmentally, and culturally sustainable. The Consortium supports sustainable statewide, nature-based tourism by providing technical assistance, leadership service, committee participation, and annual conference programming and workshops. The Consortium's Coastal Communities Specialist serves the S.C. Nature-Based Tourism Association (SCNBTA) as its current President, providing guidance and support through her role as technical advisor to the association's board. Through the activities of the specialist there is increased support and exploration of nature-based tourism and recreation businesses in South Carolina by coastal communities. This support helps to ensure the continued sustainability and viability of the SCNBTA.

South Carolina Coastal Information Network and Its Resource Portal Expand to Better Serve Constituents

April Turner, S.C. Sea Grant Consortium

Recognizing a need for improved communication and coordination among coastal information providers, the S.C. Sea Grant Consortium (the Consortium) organized the South Carolina Coastal Information Network (SCCIN) in 2006. The Consortium has been facilitating and organizing quarterly network meetings in addition to providing oversight and maintaining the SCCIN event calendar and resource portal. Over the past 11 years, the network has developed and expanded to serve its common

audiences in a more organized, coordinated, and efficient manner. For example, the SCCIN has fostered a series of shoreline change workshops and a NERR-funded collaboration to produce a low impact design manual to enhance stormwater management practices in South Carolina. In 2016, network members determined that the website needed to be updated, and the Consortium, as network administrator, took on the task of coordinating the redesign. A complete website overhaul was performed. In the fall, the new SCCIN website (www.sccoastalinfo.org) was launched and a training session for members was offered. The redeveloped site provides a streamlined and easy-to-navigate site with expanded partner profiles and approximately 400 resources (such as community resilience, stormwater management, shoreline change, habitat restoration, watershed management, coastal tourism, and natural asset planning) available for download from the portal.

Sea Grant Fosters Regional Approach to Developing a Clean and Resilient Marine Initiative **April Turner, S.C. Sea Grant Consortium**

To further efforts begun by the Governors' South Atlantic Alliance, partners from North Carolina, South Carolina, Georgia, and Florida are working collaboratively to implement resilience elements adapted from the Clean and Resilient Marina Initiative originally developed under the Gulf of Mexico Alliance. A Clean and Resilient Marina Program (CRMP) Taskforce was organized to explore the possibility of developing a standardized resiliency program across all four states. Building upon existing Clean Marina efforts in the region, two workshops were convened over the course of the year (Feb. 8-9 & Sep. 21-22) to develop an action plan, including a resilience component checklist and an education strategy. The goal is to increase the resiliency of coastal and inland marinas to adapt to the impacts of and recover from hazards. While each state program is in different stages of developing and adopting the resilience component, the next step is to pilot the CRMP in South Carolina and begin an outreach campaign to marina owners and operators. As a result of this initiative, the Coastal Communities Specialist serves on the S.C. Clean Marina Program Committee and will be assisting with outreach through workshops for marina owners/operators and with the implementation of the resilience component of the certification program.

S.C. Sea Grant Consortium Analyzes County-Level Laws, Policies, and Regulations for Stormwater Ponds in Coastal South Carolina **Bridget Cotti-Rausch, S.C. Sea Grant Consortium**

The S.C. Sea Grant Consortium (Consortium) developed the S.C. Stormwater Pond Research and Management Collaborative (Collaborative) to investigate and address the challenges and identify information needs associated with coastal stormwater ponds in the state. Consortium researchers from Clemson University documented the policy and regulatory framework for stormwater pond management in South Carolina. An overview of the regulatory framework for stormwater management from the federal and state levels was examined by describing existing laws and policies at these levels. Online surveys and focus groups were used, and initial findings were completed in 2015. The Consortium requested the authors revise their work to include a focus on local-level policy analyses. This addition (completed December 2016) includes a comparison of the local laws, code of ordinances, and local programs that regulate stormwater management within the jurisdictions of three coastal counties: Horry, Charleston, and Beaufort. These three counties are regulated Small Municipal Separate Storm Sewer Systems (SMS4s) and represent areas of high population growth and development. This work is a first step in the efforts of the Collaborative to provide information on the effectiveness of stormwater pond management locally and how policies and management are integrated through state and federal levels. The report will be used to complete a state-of-the-knowledge report for stormwater ponds in the

state to be produced in 2017. The revised chapter, titled “A Policy Lens of South Carolina Coastal Stormwater Management,” was published in the peer-reviewed *Journal of South Carolina Water Resources* (Volume 3, Issue 1).

S.C. Sea Grant Consortium Develops an Integrative Visualization Tool to Share and Coordinate Coast-Wide Water Research and Monitoring Programs

Bridget Cotti-Rausch, S.C. Sea Grant Consortium

In response to the flood of October 2015, the S.C. Sea Grant Consortium (Consortium), with emergency funding provided by the National Oceanic and Atmospheric Administration (NOAA) National Sea Grant College Program, facilitated the documentation, coordination, and sharing of information collected in response to the flood. Through collaboration with researchers at our partner institutions, the Consortium created the South Carolina Coastal Water Monitoring Network (SCCWMN; <https://scseagrant.maps.arcgis.com/apps/webappviewer/index.html?id=34eafc714c8e4007ad7b9d891386888f>). This web-based application, which is accessible on the Consortium website, displays a historical record (from 1907 to present) of the location, types, and frequencies of water resource monitoring efforts in the state’s eight coastal counties. Post-October 2015 flood sampling efforts included biological, chemical, toxicological, and microbiological indicators. The SCCWMN application provides stakeholders access to spatial information on sampling locations and data sources. The framework for collecting the sampling metadata was developed based on guidelines from the National Water Quality Monitoring Council. Information for each sampling site includes the name of the sampling agency, contact information, links to data availability, brief site descriptions, and parameters measured. Users can search, query, and download metadata from long-term and short-term monitoring sites. SCCWMN will be included as part of the Consortium-hosted South Carolina Coastal Information Network (SCCIN; <http://www.sccoastalinfo.org/>). The effort was publicized in the National Water Quality Monitoring Council Fall 2016 newsletter and on the National Sea Grant Office website, and through presentations at the Carolinas Climate Resilience Conference, the S.C. Water Resources Conference, and the Waccamaw Watershed Data Conference.

S.C. Sea Grant Consortium Develops a User-Friendly Flood Resources Guide for Flood Disaster Preparation, Response, and Recovery Materials

Bridget Cotti-Rausch, S.C. Sea Grant Consortium

The South Carolina Coastal Information Network (SCCIN; www.sccoastalinfo.org) was created in 2006 by the S.C. Sea Grant Consortium (Consortium) to enhance coordination of outreach efforts and the strategic dissemination of information to coastal communities. In response to the October 2015 flood, the Consortium, with emergency funding provided by the NOAA National Sea Grant College Program, reached out to SCCIN members, other Sea Grant College Programs, and the Extension Disaster Education Network (EDEN) to compile useful materials to be housed in and accessed through SCCIN. This resulted in nearly 400 products, mostly websites and hosted PDFs, which addressed issues related to flood disaster preparation, response, and recovery. To better serve the South Carolina coastal community, the Consortium led a team of 11 SCCIN members and Consortium staff to review and assess these materials. Reviewers completed a Resource Evaluation Rubric, identifying the state or regional focus of each product, and evaluating its clarity (e.g., visual appeal, quality of writing) and overall quality (e.g., sources listed, contained unique information). If the resource scored at least 20 out of 30 on the rubric, it was included in the Flood Resources Guide, a PDF with clickable links to nearly 200 SCCIN resources. Users can browse the guide by function (e.g., preparation, adaptation), focus (e.g., property, food safety), and audience (e.g., farmers, business owners).

Consortium Receives Grant to Explore Use of Deliberative Discussion in Prioritizing Natural Resources Management in the Future

Susan Lovelace, S.C. Sea Grant Consortium

The National Academies of Sciences Gulf Research Program awarded the S.C. Sea Grant Consortium an exploratory grant of \$259,414 for the two-year project, *Can Deliberative Discussions Lay a Foundation for Integrated Decision-Making, Networks Under Pressure from Changes in Population, Climate and Energy Needs?* The goal is to hold a large event in October 2017, Our Coastal Future Forum, where people from different backgrounds will come together to learn about some of the most important challenges faced by coastal residents and to discuss priority activities to solve them. Working with researchers from the College of Charleston and the University of Oklahoma to conduct, understand, and evaluate the process and outcomes, the team also includes scientists from the University of South Carolina, Coastal Carolina University, and the S.C. Department of Natural Resources. A cultural cognition survey will be used to ensure many different attitudes and beliefs are represented in the discussion groups. Municipal officials and natural resource managers will also take part in the discussions and carry the outcomes forward to their workplaces. More information can be found on the project webpage at <http://www.scseagrant.org/Content/?cid=937>.

Sea Grant Consortium Research Evaluates “Cause and Effect” Link of Coastal Development on Tidal Creek Headwaters

Denise Sanger, South Carolina Department of Natural Resources

Correlations have been established between coastal development and tidal creek environmental quality. However, decision-makers have consistently asked whether the relationships can be directly attributed to coastal development. Historical data available since 1994 provided a unique opportunity to re-examine a number of these upland-tidal systems, some of which have experienced further development since originally studied. A number of these systems have changed land uses, and many of the undeveloped watersheds have been developed since requirements for best management practices (BMPs), mainly stormwater pond installations. S.C. Sea Grant researchers at S.C. Department of Natural Resources-Marine Resources Research Institute identified 48 previously sampled tidal creeks in South Carolina, North Carolina, and Georgia as the population for this study. Spatial analyses indicated population density, impervious cover, development-related ponds, and stormwater runoff increased significantly from the 1990s to the 2010s. A crucial aspect of this study was the assessment of tidal creeks found in watersheds with varying degrees of development to determine whether the use of BMPs in the watershed has a direct impact on tidal creek environmental quality. Environmental quality was found to be similar among the creeks, and incorporation of BMPs was determined not to have altered the delivery of materials to receiving water bodies, at least at the development levels tested in this study. Whether changes in environmental quality observed in tidal creek ecosystems are a direct result of coastal development remains unclear. Simultaneously, the outreach component of the project was expanded with the continued development of a headwater tidal creek website, which can be found at <http://www.dnr.sc.gov/marine/mrri/tidal/index.html>. In addition, a StoryMap was developed to provide an interactive visualization of the land cover changes and is undergoing testing.

S.C. Sea Grant Consortium Develops Preliminary Tool to Rapidly Detect and Quantify CyanoHABs

Dianne Greenfield, University of South Carolina; and William Jones, MUSC

Knowledge of harmful algal bloom (HAB) abundances has important implications for assessing bloom severity, and rapid detection enables forecasting. Technologies that facilitate expedient and accurate monitoring of a bloom's progress will facilitate early warning of potentially toxic events and enable water quality managers and public health officials to take appropriate actions related to drinking water or swimming warnings that protect public safety. S.C. Sea Grant Consortium (Consortium) researchers at the University of South Carolina and the Medical University of South Carolina examined methods to rapidly detect and quantify cyanobacterial HABs (CyanoHABs) associated with severe public health risks, coastal fish kill, and declining water quality, focusing on tools that would be cost- and time-efficient and could be used in field or laboratory settings. Focusing on the cyanobacteria *Microcystis* because it is the most common and is almost always toxic, researchers developed four capture probes using sequenced DNA from several species strains within this genus. Validation of the probes through testing allowed researchers to develop the blueprint for a tool (sandwich hybridization assay; SHA) that will facilitate rapid and accurate HAB assessments in the field. Researchers followed the progression of a dense and toxic CyanoHAB bloom in four stormwater ponds on James Island, South Carolina for most of the spring and summer of 2016. This enabled them to track changes in water quality, sample for SHA validation, and evaluate population trends. Researchers anticipate finalizing validation of the tool and extending it to public health and water quality managers in the coming year.

S.C. Sea Grant Consortium Researchers Test Hydrology and Pollutant Removal Performance in Coastal Plain Detention Ponds

Erik Smith, University of South Carolina; and Richard Peterson, Coastal Carolina University

Stormwater ponds, especially detention ponds, are by far the most common best management practice for controlling stormwater runoff from developed landscapes in coastal South Carolina. S.C. Sea Grant researchers at the University of South Carolina and Coastal Carolina University are conducting an assessment of the hydrologic and water quality control services provided by ponds of the lower coastal plain. Understanding surface and groundwater inputs is essential to assist coastal communities in managing stormwater and to preserve vital coastal water quality and aquatic resources. In consultation with Horry County stormwater management personnel, two ponds were selected for sampling during the first phase. Initial project results were vetted with local end-user representatives, and a collaborative decision was made to continue sampling in one of the original ponds and to sample a new pond that had a contrasting shape (increased length/width ratio). Nearly continuous records of all parameters required to quantify the complete water budgets for each pond were collected throughout the two-year period. The bathymetry of the second pond was mapped and, when combined with continuous records of water levels, allowed researchers to assess changes in pond volume over time. A total of 31 rain events were sampled in each pond to assess total nutrient load and suspended sediments. Pond performance in pollutant-removal efficiency exceeded expectations for all pollutant types, and by wide margins for some. Ponds were efficient at removing sediment and associated pollutants but demonstrated lower removal efficiencies for total nitrogen. This is of concern because of nitrogen's role in the eutrophication and associated degraded water quality of coastal marine receiving waters. Results are being incorporated into the Integrated Design and Assessment for Environmental Loadings model, which provides S.C. Department of Health and Environmental Control with stormwater design methods based on effluent control best management practices.

S.C. Sea Grant Consortium Examines Stormwater Pond Sedimentation Sources and Rates to Better Plan for Maintenance Dredging

Erik Smith, University of South Carolina

Stormwater ponds are the most common best management practice for controlling runoff in coastal South Carolina and are frequently associated with residential developments. Dredging is the largest cost associated with the life-cycle maintenance of stormwater ponds and is often the responsibility of residential neighborhood homeowners associations. Direct estimates of sedimentation rates occurring in residential stormwater ponds typical of coastal South Carolina and a comprehensive understanding of what factors influence the variability of sedimentation rates among ponds are critical to aid in pond management. Providing locally relevant estimates of pond sediment sources and accumulation rates will allow pond owners to better anticipate and plan for maintenance dredging. To accomplish this goal, S.C. Sea Grant Consortium researchers surveyed 14 ponds in Georgetown and Horry counties. Surprisingly, sediment accumulation rates were found to be far less than what was anticipated based on S.C. Department of Health and Environmental Control guidance. Researchers are also examining stormwater permits, real estate records, and historic aerial imagery in an effort to provide detailed and more accurate pond sedimentation sources and rates. Results thus far indicate sedimentation is primarily terrestrial in nature, with little input from internal algal sources. Preliminary analysis of nutrient concentrations to date suggests phosphorus content increases with residential development density but nitrogen content does not. Nutrient analysis is ongoing and will aid researchers in developing technical recommendations to homeowners associations for stormwater pond sediment management.

S.C. Sea Grant Consortium Researchers Examine Sources and Toxicity of Black Microplastic Fragments in Local Estuaries

John Weinstein, The Citadel

Marine plastic debris is considered to be a top environmental problem and has been identified as an emerging global issue that may affect our ability to conserve biological diversity and maintain ecological interrelationships. Despite resistance to degradation, plastics are vulnerable to eventual decomposition into microplastic particles (<5 mm) as a consequence of prolonged exposure to ultraviolet radiation (UV), physical abrasion from sediments, and biological degradation. This is particularly relevant along beaches and in estuaries where UV penetration into shallow waters and wave action make plastic brittle, increasing the potential for fragmentation. These particles may be ingested by a variety of organisms, from invertebrates to fish, with various consequences, including gut blockage, translocation from the gut into tissues, and the transfer of persistent organic pollutants from the microplastic into the tissues of the organisms. S.C. Sea Grant Consortium researchers at The Citadel and Clemson University examined sediment and water samples from local rivers, including locations in close proximity to outfalls from industrial manufacturers of plastic products. They also conducted degradation studies using a variety of items, including: silt fencing, bags used in the South Carolina Oyster Restoration and Enhancement program, and monofilament fishing line. Preliminary results suggest shorelines of the Ashley River had the highest abundances of microplastics. Since there are few plastics manufacturing facilities in this study site, this suggests non-point sources contribute significantly to microplastic pollution in Charleston Harbor, rather than point-source industrial effluent. Headwaters of coastal watersheds were also found to be a significant contributor of microplastics in coastal waters. Degradation studies suggest that fishing line and nets produced the greatest number of microplastic particles, and grocery bags and silt fencing the fewest. Consortium research will be incorporated into an elementary afterschool science program, What's in our Water Jr., and in art projects to be displayed in the local library.

S.C. Sea Grant Consortium Research Demonstrates Microplastic Particle and Contaminant Impacts on Estuarine Organisms

Peter van den Hurk, Clemson University; and John Weinstein, The Citadel

Particle pollution is becoming more widespread and may have direct adverse effects on organisms and indirect effects through delivery of adsorbed contaminants. Previously, investigators at the College of Charleston reported the discovery of synthetic microfibers, likely remnants of clothes removed in the wash, in the tissues of local oysters. S.C. Sea Grant Consortium researchers at Clemson University and The Citadel conducted a study of microplastic particles in the Charleston Harbor and Winyah Bay estuaries, and categorized them by source, type, shape, erosion, color, and size class. Particle toxicity was assessed using salt marsh-tidal creek organisms such as grass shrimp and amphipods. Microplastic particles were found on the sea surface of both Charleston Harbor and Winyah Bay and in the sediments of both estuaries. There were significantly higher levels of microplastic particles at the Winyah Bay sea surface than Charleston Harbor, and vice versa for particles in the sediments. At both sites, the dominant microplastic was a nylon fragment. There was no difference in the size of microplastic particles collected between sites; however, there was a difference in the type collected. In both Charleston Harbor and Winyah Bay, fragments were significantly more abundant than spheres. Additionally, there were significantly higher levels of microplastic particles in the sediments of Charleston Harbor than in Winyah Bay. Particle ingestion impacted organismal development even at statistically insignificant levels, slowing growth dramatically in copepods. Toxicity testing resulted in a 100% mortality rate when contaminants were introduced with the microplastics, as opposed to a 50% mortality rate with the particles alone. Freshwater amphipods also demonstrated significant contaminant uptake when in the presence of microplastics. Collectively, these results suggest that microplastic particles are present in estuarine systems of South Carolina. Additionally, at high enough levels, these particles are toxic, and persistent organic pollutants on their surface may increase the toxicity to organisms that ingest them.

S.C. Sea Grant Consortium's Coastal Heritage magazine increases awareness about the future of five working waterfronts

Susan Ferris-Hill and Joey Holleman, S.C. Sea Grant Consortium

The Summer 2016 issue of *Coastal Heritage*, "S.C.'s Working Waterfronts: Fishing Villages Evolve," was Communications' contribution to a working waterfronts project led by the S.C. Sea Grant Extension Program. It focused on five communities struggling to maintain traditional working waterfronts as they evolve under economic and social pressures. In 2015, the project team held stakeholder meetings in each community. With information gathered during those sessions and from additional interviews and research, *Coastal Heritage* provided target audiences with perspectives on each community's past and present, and prospects for the future. The magazine article also was posted online along with a story map that provided a condensed version. Four months later, most of the content was reprinted in *The Georgetown Times* (circulation 8,446). Another month later, Consortium science writer Joey Holleman participated in five community forums organized by the project team. The Communications staff also created and distributed press releases about the events. Each of the 150 people who attended the events was given a copy of the Summer 2016 issue of *Coastal Heritage*. The forums led to stories in 17 newspapers (combined circulation 497,099) and two television stations (combined coverage 939,120 households), as well as editorials in *The (Charleston) Post and Courier* (circulation 92,062) and the (Pawleys Island) *Coastal Observer* (circulation 5,136).