

## SC Sea Grant Consortium – FY14-15 Impacts and Accomplishments

### Sustainable Coastal Development and Economy

#### IMPACTS

##### *Evaluating Wetland Function in Coastal South Carolina to Support Low Impact Development (LID) Decision-making*

**PI:** Daniel Hancock, 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 may 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 low-impact development (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 researchers at Clemson University began 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 deployed sampling and monitoring equipment at six locations, two along the flow gradient of a “natural” wetland system and four along the flow gradient of a stream-wetland-pond system at DeBordieu Colony (“engineered” system). Sampling began in summer 2014, and since then, grab samples have been collected at each of these locations every 3-4 weeks for nutrient and bacterial laboratory analyses. Monitoring of water quality data at each location via deployed data sondes is ongoing. Preliminary data were used to design a wetland system in Murrells Inlet, SC in cooperation with the Georgetown County Stormwater Engineer and the Waccamaw Regional COG. This stormwater wetland system is to be installed in Murrells Inlet, SC.

**Recap:** S.C. Sea Grant-supported research at Clemson University collected stormwater quantity and quality monitoring data from both natural and engineered wetland systems, which led to development of design and siting criteria for an engineered stormwater wetland system that will be installed in Murrells Inlet, SC. This is being done in partnership with the Georgetown County Stormwater engineer and Waccamaw Regional Council of Governments, and will serve as a future demonstration site.

## ACCOMPLISHMENTS

*Particle contamination: Direct Effects on Salt Marsh-Tidal Creek Organisms and Indirect Effects on the Bioavailability and Toxicity of Polynuclear Aromatic Hydrocarbons*

*PI: Stephen Klaine, Clemson University and John Weinstein, The Citadel*

**Relevance:** Particle pollution is becoming more widespread, and includes nanomaterials and plastic debris. Previously, investigators at the College of Charleston reported the discovery of synthetic microfibers, likely remnants of clothes removed in the wash, in local oysters. Particle pollution may have direct adverse effects on organisms and indirect effects through delivery of adsorbed contaminants. While some collection and characterization of plastic debris has occurred throughout the world, no study has been reported for estuaries. Further, little work has been performed to identify the direct and indirect adverse effects of plastic particles on the health of estuarine organisms.

**Response:** S.C. Sea Grant researchers at Clemson University and The Citadel are conducting a characterization study of microplastic particles in the surface microlayer and sediments of the Charleston Harbor and Winyah Bay estuaries, and categorized them by source, type, shape, erosion, color, and size class. Particle toxicity is being assessed using standard bioassays with the copepod, *Amphiascus tenuiremis*, the grass shrimp, *Palaemonetes pugio*, and an amphipod, *Hyalella azteca*.

**Results:** Microplastic particles were found in the sea surface microlayer of both Charleston Harbor and Winyah Bay. There were significantly higher levels of microplastic particles in Winyah Bay than Charleston Harbor. There was no difference in the size fraction of microplastic particles collected between sites; however, there was a difference in the type of microplastics collected. In Charleston Harbor, fragments and foam were significantly more abundant than spheres. In Winyah Bay, fibers and foam were significantly more abundant than spheres. There were significantly higher levels of microplastic particles in the sediments of Charleston Harbor than in Winyah Bay. In Charleston Harbor, there were significantly more fragments than other particle types. In Winyah Bay, there were significantly more fragments and fibers than spheres.

In both locations, the dominant microplastic fragment was a black fragment identified as nylon. Adsorption of fluoranthene to polypropylene (PP) and high density polyethylene (HDPE) was quantified, and PP micoroplastics adsorb almost double the amount of fluoranthene than HDPE. Researchers also tested toxicity of microplastics to a freshwater amphipod, *Hyaella azteca*. Results indicate chronic effects on growth and reproduction.

**Recap:** Winyah Bay demonstrated significantly higher levels of microplastic particles than Charleston Harbor and, while there was no difference between sites in the size fractions collected, there was a difference between sites in microplastic types. Nylon was the dominant microplastic fragment type at both sites. Microplastics also impacted growth and reproduction of the amphipod, *Hyaella azteca*.

***Development and validation of a novel molecular tool to rapidly detect and quantify harmful algal bloom (HAB) species linked with fish kills and public health concerns***

**PI:** Dianne Greenfield, University of South Carolina

**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 decision-making.

**Response:** S.C. Sea Grant researchers at the University of South Carolina and partners are developing a novel and economical molecular tool (sandwich hybridization assay; SHA) that facilitates rapid and accurate HAB assessments in the field. Assays are being developed for three locally-abundant HAB species: *F. japonica*, *C. subsalsa*, and *P. pseudodelicatissima*.

**Results:** The summer of 2014 was characterized by high numbers of dense and pervasive HABs and fish kills. Sampling for water quality, phytoplankton, SHA, and nutrients was conducted to monitor the blooms. Whole water samples were collected to generate local isolates of each of the three proposed HAB species, and these isolates are now growing in the laboratory.

**Recap:** S.C. Sea Grant researchers at the University of South Carolina have successfully generated isolates of each of the three target HAB species, to be used with signal probes to be developed in year two as a tool for rapid HAB identification and quantification.

***Hydrology and Pollutant Removal Performance in Detention Ponds Typical of the Lower Coastal Plain of South Carolina***

***PI: Erik Smith, University of South Carolina***

**Relevance:** Stormwater ponds, especially detention ponds, are by far the most common best management practice (BMP) for controlling stormwater runoff from developed landscapes in coastal South Carolina. While previous studies of pollutant removal efficiencies of detention ponds have yielded highly variable, but generally significant removal rates for nutrients, suspended sediments and bacterial pathogens, the ability of ponds to mitigate the impacts of development cannot be broadly generalized and must therefore be assessed on a local to regional basis.

**Response:** S.C. Sea Grant researchers at the University of South Carolina are conducting a quantitative assessment of what hydrologic and water quality control services ponds of the lower coastal plain do provide. This study will include an analysis of the relative roles of both surface and groundwater inputs, which is essential to assist coastal communities in understanding and better managing stormwater to preserve vital coastal water quality and aquatic resources.

**Results:** Two ponds were selected for sampling for this project in consultation with Horry County stormwater management personnel. Nearly continuous records of all parameters required to quantify the complete water budgets for each pond were collected. The bathymetry of each pond has been mapped, and when combined with continuous records of water levels, have allowed researchers to assess changes in pond volume over time. A total of 17 rain events were sampled in each pond to assess total nutrient load and suspended sediments. Of these, for approximately 11 events the researchers were successful in obtaining samples of all parameters in all locations (piped runoff, sheetflow, groundwater, and piped outflow) sufficiently to apply the data to pollutant removal calculations.

**Recap:** Preliminary results from S.C. Sea Grant-supported research at the University of South Carolina to quantitatively assess hydrologic and water quality control services of stormwater ponds in the lower coastal plain in South Carolina was generated. Water budgets and pollutant removal performance are being assessed for each pond, and bathymetry was mapped to assess changes in pond volume over time.

***Evaluating the Cause and Effect after 20 Years of Assessing the Impacts of Coastal Development on Tidal Creek Headwaters***

***PI: Denise Sanger, SC Department of Natural Resources***

**Relevance:** Relationships have been established between coastal development and tidal creek environmental quality; however, decision-makers have consistently asked whether the relationships represent a direct effect caused by coastal development. Historical data are available starting in 1994, which can provide a unique opportunity to restudy a number of systems that have been further developed since then. A number of the systems have changed land-use categories and many of the undeveloped watersheds have been developed since Best Management Practices (BMP), mainly stormwater pond installations, were required.

**Response:** S.C. Sea Grant researchers at S.C. DNR-Marine Resources Research Institute identified 48 previously sampled tidal creeks in South Carolina, North Carolina, and Georgia as the population for this study. A series of spatial data layers (land cover, impervious cover, block level population data, soil data, and stormwater ponds) were intersected with the watershed boundaries at four time periods, and stormwater runoff for each watershed was modeled. The watershed size, impervious cover, population density, modeled runoff, salinity, and geographic region were assessed to identify 18 creeks for field sampling in the summers of 2014 and 2015. Eighteen (18) creeks were selected for field sampling to ensure that a diversity of land use classes was represented.

**Results:** Preliminary analyses of the population of tidal creeks indicate that population density and impervious cover increased significantly from the 1990s to the 2010s. Sample processing of the macrobenthic, nekton, sediment type, and sediment chemical composition is underway. The sample analyses of the water quality parameters have been completed. A headwater tidal creek website is now being developed.

**Recap:** S.C. Sea Grant researchers at S.C. DNR-MRRI have generated preliminary results which indicate that population density and impervious cover in selected coastal watersheds has increased significantly over the last 25 years, which may have significant implications for tidal creek environmental quality. The study will explore this during FY15-16.

### *Aerating Stormwater Ponds Shown Not to be Effective in Eliminating Hypoxic and Anoxic Conditions*

**PI:** Erik Smith, University of South Carolina

**Relevance:** Increasing urbanization of the SC coastal zone has led to the proliferation of stormwater detention ponds. While these ponds are effective at minimizing localized flooding, they are generally ineffective at removing the high nutrient loads associated with residential area runoff. As a result, stormwater ponds accumulate nutrients that stimulate excessive phytoplankton growth, which results in high concentrations of organic matter, especially

dissolved organic carbon. Quantifying the magnitude and fate of organic matter is critical to determining the influence of stormwater ponds on coastal water quality impairment.

**Response:** S.C. Sea Grant-supported research at the University of South Carolina assessed the effects of aeration on water quality dynamics in stormwater detention ponds. Diffuser-type aerators were installed in one randomly selected pond from each of two pairs, leaving an unaerated control pond in each pair. Data on the following components were collected 15 times over the year: phytoplankton growth and community composition, concentrations and bioavailability of dissolved oxygen content, and nitrogen and phosphorous concentrations and forms.

**Results:** Prior to installation, all ponds showed distinct stratification and hypoxic to anoxic conditions in bottom waters; post installation, the two aerated ponds had similar surface and bottom water oxygen conditions, consistent with complete mixing of pond waters. Despite these physical effects, aeration had little to no significant effect on overall pond water quality. Neither phytoplankton primary production rates or algal biomass were significantly different pre- and post-aeration or between aerated and control ponds. Similarly, concentrations of biological oxygen demand (BOD) were unaffected by aeration treatment. Aeration did produce some significant differences in phytoplankton species composition among ponds, although aeration failed to achieve reduction in the contribution of cyanobacteria or promote the growth of potentially more beneficial diatoms in aerated ponds.

**Recap:** While aeration was capable of preventing hypoxic or anoxic conditions in stormwater ponds, research results demonstrate that aeration is not an effective means of improving water quality in stormwater ponds. Efforts must focus on reducing nutrient input from residential landscapes before they enter ponds; there are simply no easy technological fixes for water quality degradation once ponds become over-enriched in nutrients.

***The SC Sea Grant Consortium co-leading the Governors' South Atlantic Alliance Working Waterfronts Technical Team***

***PI: April Turner, SC Sea Grant Consortium***

**Relevance:** Although the southeastern United States has a small coastal population relative to other regions, it is growing rapidly. In South Carolina, more than 25 percent of the state's greater than 4 million residents live in the state's eight coastal counties where population is expected to increase to 1.4 million people by the year 2030. Traditional waterfront users in many areas of the S.C. coast are in danger of being squeezed out as development pressures cause property values to

increase along the waterfront. Increasing development and land-use changes will impact access to coastal resources typically available to the public.

**Response:** The Consortium's Coastal Communities Extension Specialist has served as South Carolina state representative and team lead for the Governors' South Atlantic Alliance Working Waterfronts Issue Area Technical Team (WWIATT). In two years of leadership with the WWIATT, she has coordinated activities and planned meetings for the group.

**Results:** The Consortium's Coastal Communities Extension Specialist, in conjunction with the WWIATT, worked to develop a clearinghouse for planning and policy tools and resources for communities in the region, and to promote the efforts of the Alliance by delivering presentations and exhibiting posters at national and regional conferences. As a result of the team's efforts, several projects are underway that will serve as the basis for future resource funding requests, including a report identifying areas along the Intracoastal Waterway for dredging to improve recreational and commercial navigation opportunities. Preliminary steps have also been taken to explore the relevance and feasibility of developing a Clean and Resilient Marinas Initiative for the South Atlantic states.

**Recap:** The S.C. Sea Grant Consortium is taking a leadership role in the implementation of working waterfront priority actions in the Governors' South Atlantic Alliance Implementation Plan by addressing waterfront access issues along the South Carolina coast and the South Atlantic region.

*The SC Sea Grant Consortium assists coastal community with feasibility studies to determine viability of alternative energy*

**PI:** April Turner, SC Sea Grant Consortium

**Relevance:** With the effectiveness of prior wind energy outreach in the North Myrtle Beach, SC, several beachfront condo/rental communities have started to request more information regarding rooftop wind and possible wind resource viability to offset power usage. Specifically working with the North Strand Coastal Wind Team and the City of North Myrtle Beach, ongoing research on wind viability in the area lead to a request from the Springs Towers condo community for assistance from the Consortium's Coastal Processes Specialist to examine the potential for rooftop wind turbine installations.

**Response:** The Consortium's Coastal Processes Extension Specialist completed a 1-year wind resource study in partnership with Horry County and the Springs Towers condo community to assess viability of rooftop wind power. This required installation of an anemometer on their roof and analysis of wind resource compared with commercially available rooftop wind turbines to

assess viability of the installation. A final report regarding the outcome was provided to the Sand Resort Homeowner's Association for consideration.

**Results:** The Springs Towers rooftop wind resource was just barely sufficient to generate energy for the available commercial turbines. Despite the fairly consistent production from one of the turbine models, the amount of power generated would have only been enough to offset the equivalent of two months energy usage for 1 unit which is not economically feasible at this time. However, based on these initial findings, as wind turbine technology continues to evolve, the HoA is planning on keeping abreast of future possibilities.

**Recap:** The SC Sea Grant Consortium provided wind resource analysis to help a community determine viability of rooftop wind. The resort community opted to not invest in rooftop wind at this time due to lack of economic benefit from currently available commercial rooftop systems.

***The S.C. Sea Grant Consortium and partners write and publish a comprehensive Low Impact Development Manual for coastal South Carolina***

***PI: April Turner, SC Sea Grant Consortium***

**Relevance:** Many coastal decision-makers lack the expertise, guidance, and resources to implement low impact development (LID) techniques for mitigating stormwater impacts. Development of an LID document that is specific to coastal South Carolina will provide guidance for overcoming barriers to implementing best practices.

**Response:** The South Carolina Sea Grant Consortium, in partnership with the ACE Basin National Estuarine Research Reserve (NERR), the North Inlet-Winyah Bay NERR and the Center for Watershed Protection, secured a grant of \$329,943 from the NERR Science Collaborative to advance the practice of LID in South Carolina. As part of the effort, an interdisciplinary group of stakeholders were engaged in a process to design a coastal LID manual which is responsive to the needs of the intended users, will act as a resource for effective planning and decision-making, and is appropriate for current and future landscape and climate conditions.

**Results:** The project team, including the Consortium's Coastal Communities Extension Specialist, organized stakeholder workshops, research roundtables, and provided technical assistance as part of manual development. The 425-page manual, *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (<http://www.scseagrant.org/Content/?cid=156>), was published in October 2014 with more than 300 copies distributed to South Carolina coastal municipal staff and consulting professionals. The manual includes an overview of LID terms, offers regulatory and planning strategies; covers

conservation and site design considerations, specifications and case studies as well as addresses climate change predictions. Three training workshops on the manual were held with participation from more than 140 stakeholders representing private and public sector engineering, stormwater, and planning staff.

**Recap:** The Consortium collaborated with partners to develop an interdisciplinary, user-defined, Low Impact Development Manual for Coastal South Carolina. The document provides local decision-makers with stormwater engineering specifications, land-use planning resources, and site design practices that are tailored to the conditions of the South Carolina coast and thereby removes barriers to implementation of LID practices on the community level, neighborhood scale, and site scale.

### *South Carolina Sea Grant Consortium Provides Leadership to Nature-Based Travel and Tourism in SC*

**PI:** April Turner, SC Sea Grant Consortium

**Relevance:** 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. Tourism is now a \$15 billion industry in South Carolina, with its eight coastal counties accounting for approximately 50 percent of that total and supporting almost 81,000 jobs. The interests of the Consortium in coastal tourism has focused on two issues: 1) balancing the vitality and abundance of South Carolina's coastal and marine resources with the economic health of the tourism industry that depends on them, and 2) assisting rural coastal communities, located away from the booming tourist destinations, with developing tourism practices that are economically, environmentally, and culturally sustainable.

**Response:** The Consortium's Coastal Communities Extension Specialist serves the SC Nature-Based Tourism Association (SCNBTA) as the current Vice President providing guidance and support through her role as technical advisor to the Association's Board, assistance in program planning for the annual educational/membership conference, as well as participating on its "Green," Web, and Marketing and Membership Committees.

**Results:** Through the activities of the Consortium's Coastal Communities Extension Specialist there is increased support and exploration of coastal natural resource-based tourism and recreation businesses in South Carolina by coastal communities. Her leadership has enhanced the sustainability and viability of the SCNBTA.

**Recap:** The SC Sea Grant Consortium supports sustainable statewide, nature-based tourism by providing technical assistance, leadership service, committee participation, and support for annual conference programming and workshops through the S.C. Nature-Based Tourism Association.

*The S.C. Sea Grant Consortium Provides Leadership to the Sustainable Coastal Community Development Network*

**PI:** April Turner, SC Sea Grant Consortium

**Relevance:** Sea Grant has established informal and formal networks and communities of practice in order to collaborate and share information with each other and a variety of stakeholders. The National Sea Grant Sustainable Coastal Community Development (SCCD) Network works to develop vibrant, productive coastal communities in healthy coastal and marine ecosystems. Participation in an annual meeting and training are required of members by the Network bylaws.

**Response:** The SC Sea Grant Consortium's Coastal Communities Extension specialist partnering with other state Sea Grant College programs, organized and facilitated the annual meeting of the SCCD Network on November 2, 2014 in National Harbor, MD, in conjunction with an interactive training session focused on environmental economics and valuation. The SC Assistant Director for Development and Extension also participated in the workshop.

**Results:** Twenty-eight individuals from across the SCCD Network participated in the event. In addition to the business meeting, participants engaged in a facilitated discussion on enhancing the visibility of the SCCD Network and increasing cross-coordination and collaboration among all of the Sea Grant collaborative networks. Annual meeting and training workshop presentations are available from the SCCD Network's Facebook Group at [www.facebook.com/groups/159645337535428/](http://www.facebook.com/groups/159645337535428/). As part of a coordinated effort with the Climate Network, a subcommittee was formed and planning for a joint Network training event to take place during the National Adaptation Forum in May 2015 has been initiated.

**Recap:** The SC Sea Grant Consortium was instrumental in convening a Sustainable Coastal Community Development Network meeting and training opportunity for 28 Network members, representing 14 state Sea Grant programs from around the country.

***S.C. Sea Grant Consortium Serving as Program Manager for Multi-Institutional Effort to Map and Analyze Potential Coastal Ocean Areas off the Northern shoreline of South Carolina for Wind Energy Development***

***PI: M. Richard (Rick) DeVoe, SC Sea Grant Consortium***

**Relevance:** Offshore wind resources in the U.S. Atlantic are abundant, stronger, and more consistent than land-based wind resources, and the wind resource found off the coasts of southern North Carolina and northern South Carolina show high potential. Several coastal areas have been identified as potential locations to be outlined in a BOEM Call for Information and Nominations (Call) off the northern portion of the South Carolina coast where areas of quality wind resources and limited conflict for utilization and development exist.

**Response:** Officials from BOEM's Office of Renewable Energy program contacted the S.C. Energy Office to begin discussions about providing funding to initiate a mapping and analysis program in the northern portion of the state's coastal ocean, and the S.C. Energy Office asked that the Consortium work with its member institutions and others to coordinate the preparation, submission, and management of a formal BOEM-funded program to begin this work.

**Results:** The Consortium was able to solicit and assemble a formal proposal to BOEM within a 30-day period, which was funded in November 2014 for \$750,000. More than \$780,000 was provided as match. Proposal objectives are to: (1) Initiate a systematic geophysical survey areas offshore of South Carolina that have high probability of being initially developed for wind power generation; (2) Conduct detailed surveys to assess geoarchaeological potential of pre-historic habitation at select sites and to provide baseline information concerning the potential to identify prehistoric and relict landforms, historic shipwrecks and objects, and hazardous MEC/UXO lying in the SC-OCS; and (3) Conduct a detailed geophysical survey connecting the proposed survey area and a similarly extensive geophysical survey completed through a Consortium partnership with the USGS from 0-5 miles offshore.

**Recap:** S.C. Sea Grant Consortium is serving as program manager for a \$750,000 BOEM-funded program to conduct detailed bottom mapping and data analysis of potential coastal ocean areas off the northern shoreline of South Carolina in anticipation of the possibility of offshore wind energy development in this region.