SOUTH CAROLINA SEA GRANT CONSORTIUM
~ 2016-2017 IMPACTS AND ACCOMPLISHMENTS ~

COASTAL AND OCEAN LANDSCAPE

IMPACTS

S.C. Sea Grant Consortium and Partners Train 165 on Stormwater Management during Pond Conference

April Turner, S.C. Sea Grant Consortium

Relevance: Stormwater ponds are among the most widely used engineering practices for controlling stormwater quantity and improving water quality in South Carolina, with approximately 9,000 dedicated ponds across the state's eight coastal counties. Stormwater pond systems can play a significant role in watershed function, providing for flood management, pollution mitigation and other amenities to communities. They also can create a unique set of management issues, especially as they age. Poorly managed ponds may impact the health of the pond and services provided, adjacent land values and profitability, and downstream water quality due to connectivity of surface and subsurface waters.

Response: The S.C. Sea Grant Consortium (Consortium) responded to the need to extend the latest scientific information on stormwater ponds to pond managers and owners in the public and private sectors by co-organizing and co-leading a regional pond conference in Charleston, building on previous events held in 2012 and 2014. The purpose of the conference was to increase awareness of the function and maintenance needs of stormwater ponds; provide participants the information needed to overcome common pond management challenges; and integrate communities with service providers to assist in inspection and management actions and capital reserves planning.

Results: One hundred sixty-five participants including community association representatives, property and pond management professionals, stormwater management professionals, homeowner associations, and county and municipal employees attended the conference. The event was an opportunity for participants to hear from local and regional experts, interact with organizations and businesses in the pond management industry, and receive valuable resource information and continuing education credits. Water and sediment quality, pond inspection and maintenance, integrated weed management, shoreline management, capital reserves planning, and low impact development techniques were among the topics addressed. Conference evaluations indicated 96% of participants increased their knowledge of ponds/pond management as a result of the trainings offered, and 86% said they learned something new to apply in their future work. Overall, participant feedback revealed attending this event was a good use of their time (97%).

Recap: The S.C. Sea Grant Consortium hosted a pond management conference that provided training and technical assistance to build capacity and inform 165 stormwater professionals, homeowners, and local government officials and staff. Similar conference events are in the planning stages for 2017 and 2018 for the south (Beaufort) and north (Myrtle Beach) coasts of South Carolina, respectively.

ACCOMPLISHMENTS

Consortium Coordinates Workshop on the Impacts of Coastal Development on South Carolina Tidal Creeks

April Turner, S.C. Sea Grant Consortium

As part of a S.C. Sea Grant Consortium-funded research project, the Coastal Communities Specialist organized and facilitated the Tidal Creek Groundwater Workshop for 20 researchers, stormwater professionals, and local government staff on April 6, 2016. The purpose of the workshop was to identify a representative suite of tidal creeks to sample to best determine the impact of coastal development on groundwater discharge to tidal creeks. During the workshop, participants reviewed results of Consortium-funded research into the impact of development on the composition of surface water in tidal creeks. They also examined conceptual models for groundwater flow to tidal creeks and the implications of this flow for nutrient and contaminant discharges. That was followed by discussions to determine the most appropriate sampling sites. Fifteen representative tidal creeks were identified to sample, including five urban creeks, five suburban creeks, and five undeveloped (forested) creeks. Sampling is underway in the representative creeks to detect possible influence of development on groundwater inputs to estuarine tidal creeks.

Workshop Convened to Share Strategies and Tools to Protect and Restore Coastal Water Quality along South Carolina's Grand Strand

April Turner, S.C. Sea Grant Consortium

A workshop focused on stormwater volume reduction strategies and available tools for local governments to meet stormwater regulations and reduce pollutant load into receiving waters was held in North Myrtle Beach on December 8, 2016. The goal of the U.S. Environmental Protection Agency-funded workshop was to increase local decision-makers' knowledge of coastal water quality issues and the regulatory framework around stormwater management in South Carolina. Several different tools and strategies to protect and improve water quality were introduced to the 58 participants. Those in attendance included: elected and appointed government officials; emergency management, planning and zoning, stormwater, and public works staff; and engineers, developers, landscape architects, and other private sector professionals. Several successful case studies from in and around coastal South Carolina were presented. Workshop evaluations indicated 93% of participants increased their knowledge of coastal water quality protection strategies as a result of the trainings offered, and 89% said they learned something new to apply in their future work. Participants increased understanding of the regulatory framework, water volume reduction strategies, low impact development tools, LID strategies, and successful projects and plans in coastal South Carolina. They also obtained new tools for calculating volume reduction goals. Overall, participant feedback revealed attending this event was a good use of their time (93%). (For workshop presentations see http://southatlanticalliance.org/south-carolina-training-presentations/)

S.C. Sea Grant Consortium Research Begins to Reveal Trends in Nutrient Inputs to Tidal Creeks

Alicia Wilson and Erik Smith, University of South Carolina

Water quality in tidal creeks differs between developed and undeveloped watersheds, particularly in headwater areas. Prior studies on the impact of development on coastal ecosystems have focused on surface waters; however, hydrologic changes associated with development potentially affect groundwater as well. In particular, the delivery of nutrients to creeks by groundwater could impact both

nutrient concentration and form. S.C. Sea Grant Consortium researchers from the University of South Carolina began assessing the impact of coastal development on groundwater inputs of nutrients to 14 South Carolina tidal creeks. A stakeholder workshop was convened to select representative tidal creeks to sample during the summer of 2016. The samples were analyzed for a variety of nutrients, including nitrogen, ammonium, phosphorus, orthophosphate, and dissolved organic carbon. Initial analysis of individual creeks began to reveal trends. For example, at James Island (a developed site), increasing marsh width correlated with increasing salinity, carbon, and nitrogen. This supports underlying hypotheses that recirculation of saline creek water through salt marshes may present a far larger source of nitrogen to tidal creeks than fresh groundwater discharge from uplands, whether the uplands are developed or not. Ongoing sampling plans have been adjusted so that, rather than working to identify seasonal variations in groundwater composition, efforts will focus on defining trends related to marsh and upland width in creeks where other sources of variability can be minimized. Researchers will also focus on sites where it is known that the groundwater discharging to the creek is relatively fresh. These are places where the effects of development on groundwater are likely to be most apparent.

S.C. Sea Grant Consortium Researchers Examine Genetic Contribution to Sudden Marsh Dieback

James Morris, University of South Carolina

The sudden dieback of salt marsh grasses, or "brown marsh," has generated a great deal of interest from the public and among state and local agencies because of the potential threat to salt marsh ecosystems. Diebacks occur throughout the range of *Spartina alterniflora*, and an event in 1985 drew numerous inquiries and complaints from residents around Charleston Harbor concerned that marshes in their viewsheds were dying. Identifying the direct causes of brown marsh is complex and controversial. Despite the widespread interest among scientists, public officials, and private citizens, and numerous meetings between and among them, little progress has been made. Combining field and greenhouse studies, S.C. Sea Grant Consortium researchers at the University of South Carolina examined the hypothesis that genetically-based processes intrinsic to *Spartina* populations of a marsh stand are important determinants of mortality. Researchers reasoned the response of the plant to stress, be it from drought or other factors, is compromised as the plant ages and its DNA becomes methylated, or turned off, leading to DNA that was inactivated by attached methyl groups. This would essentially freeze the physiology of the plant, leaving it unable to respond defensively to a stress. Results indicate that increases in global methylation might not be the answer to the brown marsh ecosystem condition. Instead, the strategic placement of methyl marks on prominent defensive genes results in a decreased or diminished response to both biotic and abiotic stressors, in essence acting as a defense mechanism. These results suggest methylation lost due to aging, not increased methylation over time, causes brown marsh. However, individual studies focusing on genes for stress and defensive purposes should be performed for validation.

S.C. Sea Grant Consortium Researchers Examine Alternative Oyster Reef Restoration Structures for Use by Private Citizens

Peter Kingsley-Smith, S.C. Department of Natural Resources

In South Carolina, research has shown that the oyster (*Crassostrea virginica*) population is limited by the availability of hard substrate suitable for settlement. In recent years, the South Carolina Department of Natural Resources (SCDNR) has experimented with alternative substrates, such as Oyster Castles© and cement-coated crab traps, that have proven to be very successful at recruiting larval oysters and becoming fully functional oyster reefs. Alternative substrates have enabled SCDNR to increase the diversity of habitat types, from low to high wave energy environments, in which habitat enhancement

and restoration efforts can be implemented. Current South Carolina Department of Health and Environmental Control regulations are such that private property owners are only permitted to create living shorelines adjacent to their property once high ground is being lost, even if intertidal marsh habitat is actively eroding. In the current project, a larger-scale, intentionally fabricated, and more cost-effective structure, using cement-coated crab trap mesh materials was evaluated as a viable option for future oyster reef restoration by private citizens. Thirty modified crab traps were deployed in the spring of 2016 at two sites in the ACE Basin National Estuarine Research Reserve and Port Royal Sound. This created new reef surface area and increased oyster reef habitat in these watersheds using the newly designed oyster reef substrate. Oyster larvae settled onto and attached to the modified traps at both sites, demonstrating that they work at attracting larval oysters.

S.C. Sea Grant Consortium Researcher Validates Multi-scale Satellite Remote Sensing for Salt Marsh Mapping

Cuizhen (Susan) Wang, University of South Carolina

Salt marshes in South Carolina are dominated by two species: smooth cordgrass (*Spartina alterniflora*) in regularly flooded low marsh and brackish marsh grasses (mostly *Juncus roemerianus*) growing inland of the intertidal zone. Their relative compositions have not been studied well for a statewide comparison. Using the North Inlet-Winyah Bay (NI-WB) watershed as the focus site, S.C. Sea Grant Consortium researchers tested the feasibility of using satellite imagery in mapping salt marshes at different spatial and spectral scales. Spectra in visible bands were proven not to be useful in delineating marsh for mapping purposes, and differences in the two species were most visible at longer wavelengths. Adding non-spectral features like elevation will improve delineation between the *Spartina* and *Juncus* moving forward. Ultimately, researchers determined that Landsat imagery can be used confidently for state-level marsh mapping and developed a multi-scale remote sensing approach to mapping two marsh species in NI-WB. They are hopeful satellite-extracted spatial maps could assist long-term marsh monitoring, city planning, zoning, and marsh-habitat protection. This approach lays the foundation for future modeling research to predict salt marsh migration under land development and sea level rise scenarios.

S.C. Sea Grant Consortium Researchers Develop Water Runoff Characteristics for Coastal Watersheds

Tim Callahan, College of Charleston

There has been an increase in population of about 1.2 million people in the state of South Carolina between the years 1990 and 2013, and there has been a 40.5% increase in population in this time in the coastal counties of Berkeley, Charleston and Dorchester. Often associated with this rapid population growth is impairment of terrestrial and aquatic landscapes from land-use and land-cover changes related to development. Many areas being developed in the tri-county area are within freshwater watersheds that are headwaters of the coastal water system. This development can impact the natural flow of water on the landscape by increasing runoff and decreasing recharge to groundwater. S.C. Sea Grant Consortium researchers at the College of Charleston examined specific storm events and the resulting runoff patterns in the Turkey Creek watershed in the coastal plain to understand stream response to the events. Smaller watersheds were found to have larger direct runoff contribution, and larger watersheds were found to have larger baseflow contribution. This can be helpful in stormwater and water quality management. Additionally, comparing overall stream flow rates and depths to existing data on the watersheds can be useful for land-use managers and researchers examining the effects of climate variability, land-use change, and disturbance effects like Hurricane Hugo (1989) on stream flow behavior. These results are also useful for scientists who need direct measurements of watershed

conditions for forecasting future conditions, either in natural systems subject to changes in weather patterns or extreme events, or for landscapes that have or may soon change due to land development in support of increasing populations. Broadly, scientists and land use managers can use resulting data to predict runoff changes in areas affected by land development, and can extend techniques to other locations in the coastal plain that are experiencing land-use change due to population growth and development.

S.C. Sea Grant Consortium Research Illuminates Spartina alterniflora *Gene Flow Barriers*

Erik Sotka, College of Charleston

Spartina alterniflora is a dominant plant species of salt marsh habitats along the South Carolina coast that provides numerous valuable ecosystem services. Because of historical and recent destruction and die-off of *Spartina* marshes, restoration of *Spartina* marshes remains a top priority. Restoration efforts have greatest success when *Spartina* genotypes are selected that thrive in restored areas, but understanding of this genetic variation is poor. *Spartina alterniflora* occurs across a wide range of salinities and exhibits substantial genetic variation in ecologically important traits such as growth rate, morphology, and competitive ability. There is also a possibility plants are genetically adapted to those specific microenvironments that occur in the low marsh but not the high marsh. S.C. Sea Grant Consortium research at the College of Charleston tested for evidence of barriers to gene flow between these closely aligned locations, which might suggest local adaptation plays an important role in succeeding within each habitat. Results indicated that there are strong barriers to gene flow across all levels of spatial spread, suggesting that local differentiating selection of genotypes drives the genetic structure. These results have important consequences for restoration managers because *Spartina alterniflora* is likely very locally dispersed, and there is a strong likelihood that adaptation to local salinity, temperature, and soil conditions are extremely common. When plants are moved away from their source, it is likely that the survivorship, growth, or reproductive fitness of these plants is lowered, making restoration efforts less productive than they could be.