



SOUTH CAROLINA SEA GRANT CONSORTIUM RESEARCH SYMPOSIUM



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Oral Presentations

May 11, 2022



Integrated Socio-Environmental Vulnerability Assessment of Coastal Hazards Using a Multi-dimensional Coastal Vulnerability Index

Presenter: Erfan Goharian, University of South Carolina

Coastal hazard vulnerability assessment has been centered around multi-variate analysis of geo-physical and hydroclimate setup of a coast. The representation of coupled socio-environmental factors, in particular adaptive capacity valuation, has been often ignored in vulnerability assessment. These call for development of a novel assessment framework and an integrated Coastal Vulnerability Index (CVI) which combines hydroclimatic, physical, socio-economic, and ecological characteristics and relevant hazard information. Considering South Carolina coast as a test bed, a Multi Criteria Decision Making (MCDM) method and Probabilistic Principal Component Analysis (PPCA) have been tied into geospatial framework to assess the natural hazard vulnerability. The datasets are analyzed using the fuzzy logic-based probabilistic normalization, an entropy-based weighting technique for the vulnerability indicators, which further coupled with sensitivity analysis of spatially homogenous vulnerability groups. A range of vulnerability groups' weight are tested to form spatially heterogenous vulnerability groups' weights. Generated hazard vulnerability maps are validated based on National Weather Service (NWS) storm events damage datasets and Sentinel-1 flood maps. The sensitivity analysis of CVI reveals Charleston County is more sensitive to socio-economic factors, whereas in Horry County the physical factors contribute to its high vulnerability.

Keywords: Coastal Hazards; Vulnerability; Probabilistic Principal Component Analysis

Evaluating Trends in Coastal Flooding in Charleston, SC and the Operational Implementation of a Tide Forecast Tool

Presenter: Blair S. Holloway, NOAA/National Weather Service Charleston, SC

The National Weather Service (NWS) office in Charleston, SC provides warning and forecast services for southeast South Carolina. This region includes low-lying coastal areas that are highly susceptible to tidal flooding. Tidal flooding can result in significant impacts to property

and infrastructure, disrupting the lives of those affected. To analyze historical trends in coastal flooding, a database was constructed including all coastal flood events at the Charleston Harbor tide gauge dating back to 1922. The frequency of coastal flood events has increased dramatically over the last century, with a notable acceleration in the number of events since 2015. Using this historical data, NWS Charleston developed and implemented a tide forecast tool to aid in the creation of deterministic Total Water Level (TWL) forecasts. This forecast tool has improved the accuracy of TWL forecasts and the resulting Coastal Flood Watch, Warning, and Advisory products.

Keywords: Coastal flooding, tides, forecasting, sea-level rise



Oceans and Human Health, A One Health Concept Whose Time Has Come: Applying Lessons Learned to Coastal South Carolina

Presenter: Geoffrey I. Scott, Arnold School of Public Health, University of South Carolina and the NIEHS Center on Oceans and Human Health and Climate Change Interactions

“One Health” is a concept developed by the Centers for Disease Control (CDC) that recognizes that human health is connected to the health of nature and the environment. Traditionally scientists have focused on man’s impact of man on the health of the oceans, but more recently have realized that an unhealthy ocean environments may adversely affect human health. Thus, the One Health Concept of Oceans and Human Health evolved. Harmful Algal Blooms (HABs) and antibiotic resistant microbes are 2 major stressors humans may be exposed to in coastal and aquatic environments, through contact recreation and seafood consumption. Climate change and eutrophication have been proposed as 2 major factors causing the recent increase in HABs events world-wide. CDC’s HABISS Surveillance System reports that most HAB events producing toxins occur in freshwater habitats (>96%) with the remaining reports occurring in brackish (1.45%) or marine waters (1.46%), often causing toxin related illnesses. Mammalian toxicology studies with HAB toxins measured in SC waters have been shown to increase inflammatory responses in the liver and kidney leading to increased severity of Non Alcoholic Liver Disease (NAFL), and altered function in the ovary, including endocrine disruption of important reproductive hormones. Similarly, more than 80,000 cases of Vibrio illness occur in the US each year associated with seafood consumption and wound infections associated with highly virulent and antibiotic resistant strains. These interactions of the two public issues will be discussed along with their potential interactions with microplastics in affecting SC coasts and drinking water reservoirs.

Keywords: Oceans and Human Health; One Health; Harmful Algal Blooms; Antibiotic Resistant Microbes

The Citadel’s James B. Near Center for Climate Studies: A Summary of Coastal Research and Engagement

Presenter: Scott Curtis, The Citadel

The James B. Near Center for Climate Studies (NCCS) was founded in 2020, but the inspiration for the Center began with the personal vision of Lt. Col. James B. Near, Jr. (USAF, Ret.), Citadel class of ‘77. Near served twenty years in the USAF as a meteorologist and in fall 2014 returned to The Citadel as an adjunct professor of Physics. Near demonstrated extraordinary generosity by providing The Citadel Foundation (TCF) with a \$3.27 million gift to initiate the NCCS. Ever humble and not wanting to receive any recognition for his donation, he specified to TCF that his

gift remain completely anonymous until his passing in March 2020. The vision of the NCCS is to be nationally recognized as an academic leader in climate science and facilitate the transition of this science from research into operational use to assist in principled decision making. To accomplish this the NCCS will advance climate science through education, research, transition to operations, and community engagement and the development of public-private partnerships. The scope of the Center's activities will consist of the relation of Earth's climate to (a) national security, (b) coastal environment and infrastructure, and (c) human health and welfare. Recent and upcoming undertakings of the NCCS will be described.

Keywords: Center; Academics; Outreach; Research

The Role of the Oyster in the Geomorphology of South Carolina Salt Marsh and Tidal Creeks

Presenter: Joshua Robinson and Nolan Williams, Robinson Design Engineers

It is estimated that more than eighty-five percent of oyster reefs along the South Carolina coast have been lost. Although many of the environmental benefits and functions that oysters provide are widely understood (e.g. water quality improvement, wave energy dissipation) relatively little is known about the holistic contributions of the oyster to the physical structure and geomorphic processes that characterize and sustain salt marsh and their tidal channels. Furthermore, as oyster populations have sharply declined over the last century or so, the widespread deleterious effects of dredging, boat wake, stormwater runoff, and other environmental stressors have increased. The growing number of small-scale oyster restoration and oyster-based living shoreline projects offer some insight, as they trigger the rapid healing of an eroded bank by promoting the accretion of sediment and the expanded growth of vegetation, thereby changing both the form and the processes of the marsh edge. These observations beg the question: how has the widespread loss of oyster reefs changed the physical structure and geomorphic processes of salt marsh and tidal creek systems on a larger scale? In the last several years—working with graduate interns and academic collaborators—the authors have surveyed tidal creeks and marshes, collected tidal hydrology data, performed hydrodynamic modeling, and designed salt marsh restoration and living shoreline projects. This presentation will share the data and hypothesis resulting from these projects, with hopes of creating new opportunities for collaboration with researchers and workers in attendance.

Keywords: Oysters; Living Shorelines; Salt Marsh



Suspended Sediments Contribute to leak Coatings that Reduce *Spartina* Light Use Efficiency

Presenter: Tom O'Halloran, Clemson University

Accurate and integrative measures of marsh productivity as well as the sensitivity of marsh production to environmental drivers (e.g., water level and salinity) over multiple timescales are essential to understanding how salt marshes will respond to future environmental and anthropogenic stressors. To that end, this project supported operation of a state-of-the-art integrated eddy covariance flux tower inside long-term research plots in the *Spartina alterniflora* marsh of the North Inlet Winyah Bay National Estuarine Research Reserve during 2018 to 2020. The major findings of this project are: 1) from the perspective of the atmosphere, for the two complete calendar years of record, the marsh was a small carbon source in 2018 and a modest

sink in 2020 2) daytime NEE is very sensitive to water level, presumably from inundation preventing leaf-gas exchange. 3) marsh productivity (light use efficiency or carbon sequestration per unit light) increases when rain freshens marsh waters, although the effect is modest, not statistically significant and dominated by: 4) marsh *Spartina* leaves become periodically coated in sediments and we have discovered for the first time that this reduces leaf and canopy scale light use efficiency, and the effect is modulated by the time between rain events and progressive buildup of coatings over tidal cycles (from suspended sediment). This is a significant result because it represents a new connection between sediments and plants in the coupled feedbacks that maintains marsh elevation.

Keywords: Salt Marsh Productivity; Sea Level Rise



Assessing Tidal Creek Health in Relation to Coastal Development

Presenter: Catharine Parker, South Carolina Department of Natural Resources

Salt marshes are a dominant feature in southeastern estuarine landscapes and are among the most productive ecosystems in the world, yet estuaries are at risk of habitat quality decline due to steadily increasing development in coastal watersheds. Within this ecosystem, headwater tidal creeks act as sentinel habitats by providing an early warning of potential risks to adjacent marsh and downstream habitats. To assess such risk, 43 unique creeks were sampled between 1994 and 2015 for water quality, sediment contamination, and the benthic community, with the most recent sampling of 18 creeks having occurred in 2014/2015. Watersheds surrounding the creeks were classified as Forested, Forested to Suburban, Suburban, or Urban land use based on impervious cover (IC) levels. Forested to suburban watersheds were those which experienced a significant increase in IC and best management practices (BMPs) over the 20-year period. Analyses of both historical and recent data resulted in significant differences between land use classes or relationships with percent IC for multiple water, sediment, and benthic environmental indicators. These indicators included fecal coliform bacteria, nitrate/nitrite, contaminant levels, and the relative abundance of pollution indicative benthic species. Furthermore, the relationships and patterns identified currently were consistent with historical observation. Trends among the forested to suburban class, with new BMPs implemented, indicated that BMPs were working for some parameters (e.g., sequestering polycyclic aromatic hydrocarbons) but not all (e.g., reducing fecal coliform bacteria entering the waterways).

Keywords: Coastal Development; Sediment Contaminants; Benthic Macroinvertebrates; Water Quality



Linking Land Use, Climate, and Coastal Ecosystems: A Watershed

Perspective for a Changing South Carolina Coast

Presenter: Andrew Tweel, South Carolina Department of Natural Resources

South Carolina's growing population has resulted in widespread changes in land use, particularly in the coastal landscape. Urbanization of watersheds leads to increases in stormwater runoff and the transport of contaminants to downstream aquatic ecosystems. This data synthesis project explored long-term and large-scale environmental datasets, particularly the South Carolina Estuarine and Coastal Assessment Program (SCECAP), to construct a history of habitat quality in South Carolina's estuaries over the last twenty years. Previous studies in coastal South Carolina have demonstrated connections between watershed development intensity and downstream estuarine habitat quality. Data on water quality, sediment contamination, and biological communities were analyzed in relation to watershed characteristics such as

impervious cover along a gradient of development intensities. These relationships were further explored within the context of a changing climate by linking spatially explicit temperature and precipitation metrics to South Carolina estuarine habitat quality data for the period 1999-2018. Associations between these environmental, land use, and habitat quality metrics were used to model how future changes in temperature and precipitation patterns may affect estuarine habitat quality. This study underscores the need for sustainable development strategies as coastal communities brace for climate change in South Carolina and beyond.

Keywords: Climate; Development; Stormwater; Estuary

May 12, 2022

Supporting Community Needs for Data to Drive Decision-making

Presenter: Debora Hernandez, Southeast Coastal Ocean Observing Regional Association

The Southeast Coastal Ocean Observing Regional Association (SECOORA) is one of 11 Regional Associations that partner with the NOAA led Integrated Ocean Observing System, U.S. IOOS®, to provide data and information about marine life, weather, and oceanographic conditions in U.S. coastal waters. SECOORA works with its partners to operate a coastal ocean observing system for North Carolina, South Carolina, Georgia, and Florida. Employing a variety of novel and traditional ocean observing technologies, SECOORA gathers data into a federally approved cyberinfrastructure that both enables speedy and reliable data access as well as supports user driven products. Specifically in South Carolina, SECOORA is supporting ocean observing infrastructure including: 4 coastal buoys operated by the University of North Carolina Wilmington; estuarine soundscape monitoring by the University of South Carolina (USC) Beaufort; 3 surface current monitoring stations in the Grand Strand area operated by USC, a water quality and meteorological station in Charleston Harbor maintained by SC Department of Natural Resources (SCDNR) and a new, low cost water level network which is being deployed by a team of scientists including Coastal Carolina University and the American Shore and Beach Preservation Association (ASBPA). SECOORA is also working with partners from the USC on water quality monitoring and modeling efforts for beaches and shellfish harvest areas, and with SCDNR to improve availability and analysis of fisheries survey data. This seminar will highlight the technologies and techniques used by the SECOORA team to support the blue economy, conserve marine life, and protect mariners and coastal communities.

Keywords: Observations; Communities; Flooding; Weather



Deliberative Processes as a Tool for Stakeholder Engagement

Presenter: Matthew C. Nowlin, College of Charleston

Coastal communities are facing a serious of complex challenges including increased population growth, aging infrastructure, and public health concerns, among others. In addition, these communities face several risks as a result of climate change including increased heat, flooding, and storm surge. Addressing these challenges will require a combination of expert knowledge, collaboration across a wide-range of stakeholders, and support from the public. However, some of these issues (e.g., climate change, COVID-19) are politically polarized, which contributes to distrust among stakeholders and a broader distrust of expertise among the public. In this presentation, I will discuss how deliberative processes, specifically deliberative mini-publics, can work to enhance stakeholder collaboration and provide a venue for input from the public. While

there is some variation, a deliberative mini-public typically involves facilitated discussions among experts, decision-makers, members of the public, and other key stakeholders. Deliberative forums are designed and facilitated to ensure informed discussions occur that can lead to a deeper understanding of the problem(s), an understanding of the communities decision-making processes, and/or a knowledge of the trade-offs associated with the various approaches that could be used to address the problem(s). My presentation will provide a brief overview of deliberative mini-publics and provide some specific examples of a few deliberative mini-public forums.

Keywords: Deliberation; Stakeholder Engagement; Governance



Kids Teaching Flood Resilience: Centering Youth as Ambassadors of Community Hurricane Resilience

Presenter: Merrie Koester, University of South Carolina

Kids Teaching Flood Resilience (KTFR) is a collective impact, capacity-building place-based education initiative. The research model foregrounds an awareness of the disproportionate impacts of climate change and unsustainable development on low-income, racially segregated communities. Our case studies have been developed in mostly Title 1 schools, situated in highly flood prone neighborhoods. We begin each new project by identifying pre-existing conditions of "Educational Vulnerability" – that is, the lack of awareness of or access to knowledge that can mitigate one's risk of harm from an extreme weather hazard. Through a combination of field study, model-based inquiry, and media arts innovations, students learn how to become Weather and Storm Surge Smart, Place-Wise, Prep-Ready, and Water Safe. The KTFR Innovations, all available on the Kids Teaching Flood Resilience website, meet the criteria for effective public hazard risk communication, and are free and open source. With the goal of embedding hurricane resilience into the local middle and high school science curriculum, we will develop (this fall) a high school science teacher PD in partnership with the Citadel's STEM Center for Excellence and Near Center for Climate Studies. KTFR has been recognized by NOAA NWS as Weather Ready Nation Ambassador program of Excellence, with its materials all vetted by both the NWS and local emergency management directors.

Keywords: Education, Resilience, Flooding

EJ Strong: Strengthening Disaster Risk Reduction, Response & Recovery Capacities in SC Environmental Justice Communities: Example of a Community-Based Project


Presenter: Paul Sandifer, College of Charleston

EJ Strong is an EPA-funded Community Disaster Risk Reduction initiative developed by the SC Department of Health and Environmental Control in collaboration with the NIEHS-funded Center for Oceans and Human Health and Climate Change Interactions at the UofSC, CofC, Clemson, and the Lowcountry Alliance for Model Communities. We conducted 2 multi-day immersive workshops and 5 interactive webinars to engage leaders in SC EJ communities in improving resilience, reducing disaster risk, and enhancing wellbeing in their communities. Participants have learned to use tools to help communities cope with hazards such as hurricanes, flooding, chemical releases, pandemics, and climate change and how to prevent them from becoming disasters. By the end of the project, participants will have assessed hazards, capacities, and

vulnerabilities in their communities and will be equipped to teach others how to conduct such appraisals. EJ Strong Core Team members have contributed to workshop and webinar curricula, provided hazard and human health expertise, facilitated events as organizers and speakers, and worked with community members to identify environmental and health hazards; develop community preparedness, response, recovery, and mitigation capacities; and mobilize people and resources. All webinars and learning materials have been recorded and archived and will be available to other communities across the country. Although not SG-funded, this community-participatory project is an example of activities that could be responsive to the SCSGC's strategic plan weather and climate resilience priority, objective 1.2, "Provide science-based information to improve community capacity to prepare for, adapt to, mitigate, and recover from weather and climate hazards."

Keywords: Environmental Justice; Disasters; Risk Reduction; Climate

Poster Presentations

-  1. Something Very Fishy: A marine science STEAM program for teaching ocean literacy to elementary children and the development of undergraduate marine science educators
Presenter: Michael Childress, Clemson University

The ocean is in trouble and needs our help. That is the message we share with children and teachers through our marine science STEAM (science, technology, engineering, arts, mathematics) program, Something Very Fishy. This collaborative research project combining marine science, musical theatre, elementary education, and communication theory is unique in its approach to empower children to see their role in helping to save our oceans while training undergraduate students as marine science educators. Our approach has been to pair a musical theatre performance about a female marine biologist, an overzealous fisherman, and a trio of mischievous marine animals seeking to understand why their beloved coral reef is dying. This moving theatrical presentation of the issues facing our ocean is followed up by an imaginary eco-tour through the Florida Keys, manned by undergraduate students portraying different careers in the arts and sciences, where children and their teachers learn how their actions here and now can help our oceans. Our program assessments show significant gains in understanding of ocean literacy and STEM career interests for children grades 2-5 and an increased efficacy for teaching marine science in our undergraduate student docents. In the two years of our grant, we shared our program with 39 schools, 162 teachers, 2640 children, 67 undergraduate student docents, and 3 graduate students teaching assistants. To date, we have published two peer reviewed papers, attended an invited symposium, and completed 8 presentations at 5 national conferences.

Keywords: STEAM; Ocean Literacy; Science Education; Coral Reefs

2. Terebellid polychaetes are central players in life cycles of fish and sea turtle parasites in South Carolina

Presenter: Isaure de Buron, College of Charleston

Teleosts and sea turtles can be infected with aporocotylid trematodes (blood flukes) and myxozoans, many of which are pathogenic. These two types of parasites are estimated to be very speciose and are commonly found in fish in South Carolina (SC) estuaries. Prior to our work, however, only 4 blood fluke life cycles were known worldwide (3 from the Pacific Ocean and 1 from the North Sea), and only 7 life cycles of marine myxozoans were known, all from the western Atlantic, North Sea, and Mediterranean. None were known from the Americas. Over the past 4 years, we have added to this list, 4 blood fluke life cycles and 1 new infective myxozoan stage (actinospore) from SC estuaries, with each using polychaete annelids as alternate hosts. In each case, larval stages (sporocysts, rediae, and cercariae) of the blood flukes and actinospores of the myxozoan infected those annelids. Herein, we report yet another blood fluke cycle and another novel actinospore, as well as several cases of blood flukes wherein fish definitive hosts are still unknown, all infecting terebellid polychaetes. This work demonstrates that terebellid annelid hosts play a central role in making SC estuaries a diversity hot spot for these significant parasites and emphasizes the importance of considering factors that may modify annelid populations when making ecosystem management decisions.

Keywords: Parasites; Fish; Sea Turtles; Polychaetes

3. Pathogenic parasites of aquaculture candidate Atlantic tripletail, *Lobotes surinamensis*: local and regional case studies

Presenter: Isaure de Buron, College of Charleston

Wild specimens of Atlantic tripletail, *Lobotes surinamensis*, from South Carolina (SC) and Florida (FL) maintained in clean water for ~3 months displayed a profoundly altered swimming behavior. Fish were found to be infected by trematode larvae (metacercariae) and microsporidians, which were identified molecularly via ITS2 region and 18S rRNA gene sequencing, respectively. Infected tissues were processed histologically. Fish from FL were infected in their eyes with numerous metacercariae of the bucephalid, *Proisorhynchus* sp. and along their optic nerve by an unidentified microsporidian. Tripletail from SC were infected in their brain by metacercariae of the strigeid, *Cardiocephaloides medioconiger* and in their liver by the microsporidian *Microgemma carolinus*. Infection by these little-known trematodes with complex, but not yet fully realized life cycles, explains the altered behavior of the fish. Issues associated with infection by congeneric metacercariae *Cardiocephaloides* include their low host specificity and the fish behavior alteration that leads to higher predation. Infection by *Proisorhynchus* spp. may depreciate fillet value (not examined herein). Microsporidians have a simple life cycle: fish typically become directly infected after they swallow spores released in the water from infected fish. Consequently, transmission of all parasites found herein is enhanced in areas of high fisheries activities, including aquaculture settings. Tripletail is a promising candidate for extensive aquaculture in the USA; thus, if left unmonitored, infection by these parasites may jeopardize production as well as propagate to other fish in neighboring natural ecosystems and aquacultural impoundments. Unraveling life cycles will allow for effective mitigation.

Keywords: Tripletail; Parasites; Life Cycle; Aquaculture

4. Stability of cellulases immobilized to silica coated iron nanoparticles: Impact of function group density and protein density

Presenter: Danny Swofford, The Citadel

There is a growing demand to produce bioethanol from inedible biomass – lignocellulose – to curtail emissions, maximize usage of agricultural and urban waste materials. Hydrolyzing cellulose to glucose is a critical step in the production of bioethanol from lignocellulose and can be accomplished through the use of enzymes, cellulases. This work shares the results obtained the stability of cellulases. The most common method of increasing the stability of enzymes is by immobilizing them to a support. This increased stability from immobilization stems from reduced biomolecule dynamics that may lead to conformational changes. The immobilized dynamics can be further reduced by increasing the number of attachment sites between the support and biomolecule and by increasing the density of biomolecule on the support. This work presents the findings of how functional group and biomolecule density on silica-coated iron oxide nanoparticles relate to the stability of immobilized cellulases.

Keyword: Cellulase; Nanoparticles; Biofuels; Enzymes

5. Where the Seawall Ends: A participator and spatial analysis of Neck community opinions towards flooding and the proposed Charleston seawall

Presenter: Judith Taylor, College of Charleston

In response to threats of sea level rise and storm surge posed by climate change, the City of Charleston and the US Army Corps of Engineers (USACE) have proposed a 9-mile-long (14.5km), 12-foot-tall (3.7m) seawall to be constructed around parts of the downtown Charleston peninsula. The seawall will terminate in the Neck of the Charleston peninsula, close to lower wealth communities that contain high populations of minorities. Potential impacts to these communities were not initially considered by USACE or the City of Charleston, despite documented instances elsewhere of detrimental effects of seawalls on biodiversity, erosion, and adjacent property values. This study is guided by the knowledge co-production approach and seeks to fill this knowledge gap using community engagement in the form of interviews, as well as geographic information systems (GIS) to visualize key potential impacts identified by participants. Results indicate that participants overall do not think the seawall will be beneficial to their communities, and have additional concerns related to flooding, drainage, displacement, and inclusion. Results have been compiled into a written report, an ArcGIS Story Map, and conveyed in community meetings, and will provide an accessible, community-owned environmental justice perspective on this major project.

Keywords: Seawall; Environmental Justice; Neck of the Charleston Peninsula

6. Compound flood modeling of Charleston using fully coupled hydrodynamic and distributed hydrologic models

Presenter: Ahad H. Tanim, University of South Carolina

Compound flood (CF) severely impacts coastal urban areas due to its simultaneous high tide and runoff peaks. Compound flood modeling has been practiced by developing loosely coupled one-way or two-way hydrologic and hydraulic models. This study develops a fully coupled model of CF for Charleston peninsula using a high resolution (0.5m) Digital Elevation model (DEM) and

Digital Surface Model (DSM) derived from LiDAR cloud points. The model is developed using fine meshes of node-link-basin network and simultaneous modeling time steps for integrating hydrodynamic and distributed hydrologic models. The representation of urban area is improved by including building footprints using DSM, and imposing energy damping threshold and high roughness coefficients. The fully coupled model simulates the interactions between Charleston's complex drainage network, tidal creeks, tidal channels, underground sewer network, and detention ponds. The CF model performance is calibrated and validated during 2015 major South Carolina flood event and a nuisance flood event using USGS high water marks and SCDOT road closure data.

Keywords: Interconnected Channel and Pond Routing Model; Compound Flood; Charleston

7. Refining assessments of reproductive development in female white shrimp (*Panaeus seiferus*)

Presenter: Lexi Mitchell, College of Charleston

The accurate assessment of female reproductive development is an important component of the sustainable management of the white shrimp fishery in South Carolina (SC) and surrounding states. The most widely used method to categorize ovarian development is based on 5 developmental stages related to ovary color viewed macroscopically in the field. Distinguishing female white shrimp that have not spawned (nulliparous) from those that have previously spawned (primi-/multiparous) can be difficult. Recent research at the SCDNR MRRI has shown that histological markers can be used to effectively track ovarian development. This project will use macroscopic and microscopic observations of ovarian development in white shrimp to 1) characterize the phenology of reproductive development and 2) refine techniques used to assess reproductive status. We will collect a representative sample of white shrimp on a weekly basis from mid-March to mid-May from the Charleston Harbor, SC. For each shrimp, we will macroscopically document ovarian developmental stage and take photographs of ovaries through the carapace, after carapace removal, and after excision of ovarian tissue. Excised ovarian tissues will be preserved for microscopic examination using standard histological techniques and used to determine the phenology of ovarian development. Macroscopic images will be compared with microscopic findings to help refine field-based determination of ovarian developmental stage. This investigation will lead to a better understanding of ovarian development, generate improved linkages between macroscopic and microscopic indicators of development, and will contribute to more effective management of this commercially, recreationally, and ecologically important species.

Keywords: Reproduction; Management; Commercial Fishery; Phenology

8. Cooling Effects of Trees in Charleston, SC

Presenters: Denise Burns and Zachery Campbell, The Citadel

The effects of the UHI in Charleston come from the increasing amount of heat absorbing infrastructure, such as the streets and buildings. The rapid growth of the city exacerbates the changes in local climate. To quantify how best to mitigate these effects, sensors are mounted on live oak trees, crape myrtle trees, and light poles to measure changes in air temperature and relative humidity. They are equipped with radiation shields to negate the impact of possible direct sunlight to the sensors. Analysis was performed to distinguish statistically significant differences ($\alpha=0.05$) in temperature between the tree species and light poles. The cooling

effects of the trees compared to the light pole were strongest during the daytime. The light poles averaged 20.86 °C, the crape myrtles averaged 20.31 °C, and the live oaks averaged 19.92 °C. Overall, the light poles had statistically greater temperature ($p < 0.0001$) than the live oaks, which had statistically greater temperature ($p < 0.0001$) than the crape myrtles. In contrast, during the nighttime, there was no statistical difference between the crape myrtles and light poles ($p = 0.069$). Street tree findings could prove useful for city planning in cities experiencing growth and integrated into planned infrastructure maintenance.

Keywords: Climate; Charleston; Trees; Planning/Infrastructure

9. Charleston street flooding is more than just a nuisance: A pathway for microplastic particles into our coastal waterways

Presenter: Bonnie Ertel, The Citadel

The low-lying streets of downtown Charleston, SC experience flooding more than 50 days annually, with most flooding occurring on sunny days due to high tides. Frequent sunny-day flooding is exacerbated by rising sea levels and may transport pollutants such as microplastics (MP) and tire wear particles (TWP) from the road surface to adjacent waterways. Tidal creeks aid in the drainage of floodwater from the street surface into the Charleston Harbor, which contains an average of 6.6 MP/L. The objective of this research was to establish baseline data on the abundance of MP and TWP in sunny-day floodwater and to investigate if street floodwater may serve as a direct pathway for these pollutants' entry into our coastal waterways. Three locations around the Charleston peninsula were sampled during 13 flood events and their adjacent tidal creeks were opportunistically sampled before and after 4 predicted flood events. Floodwater contained 336.84 ± 59.77 (average \pm SE) MP/L, which is significantly higher than that found in the harbor, however concentrations did vary greatly by site and sampling date. Most particles in floodwater were suspected TWP (87%). Tidal creeks contained an average of 11 ± 1.7 MP/L (average \pm SE), although there were no increases in MP abundance after flooding. This suggests that the street-adjacent marsh may act as a sink for these particles. Understanding how climate-related flooding contributes to coastal pollution is necessary to inform policy decisions.

Keywords: Flooding; Microplastics; Pollution; Climate Change

10. Investigating the potential transmission of white spot disease to native crustaceans in South Carolina

Presenter: Greg Rothman, South Carolina Department of Natural Resources

Viruses are the most abundant biological entity in the water column of the world's oceans, with many remaining in a homeostatic relationship with their hosts and environment until a change in one of those factors initiates a disease outbreak. One widespread virus is white spot syndrome virus (WSSV), the causative agent of the highly virulent white spot disease. This disease is known to infect over 100 arthropod species and has caused significant economic losses in both shrimp and crayfish aquaculture worldwide. While WSSV is known to have rapid transmission and lethal impacts in single-species aquaculture settings, the impact of environmental factors on interspecific transmission remains unclear. The objectives of this study are 1) screen for the presence of WSSV in commercial seafood and the natural environment in South Carolina (SC) and 2) investigate environmental effects on transmission of WSSV from crayfish to shrimp. Screening results documented WSSV in shrimp and crayfish imported into SC, but no records of WSSV were found in wild caught organisms. Next, this study plans to test how

salinity and temperature affect transmission using individual aquaria each housing one infected crayfish and one uninfected shrimp. The occurrence of WSSV in crayfish and other seafood that can potentially be introduced into the environment may pose a significant threat to native crustacean populations such as shrimp and blue crab, SC's largest commercial fisheries. Understanding transmission metrics among these crustaceans, and the impacts of environmental conditions, can inform management decisions related to minimizing disease outbreaks that impact population status.

Keywords: Invasive Species; Marine Disease; Environmental Stressors; Crustacean Viruses

11. Microplastics in sediment along stormwater transects: roads, particle treatment devices and tidal creeks in Mount Pleasant, SC

Presenter: Caroline R. Moore, College of Charleston

Microplastics (MPs, plastics <5 mm in diameter) are pervasive in the environment and enter the estuarine and marine environment through a variety of pathways. Overall input and potential mitigation of MPs from various sources is still not well understood, particularly regarding stormwater runoff. Many stormwater systems have little to no functional pollutant removal. However, some are equipped with best management practices like manufactured treatment devices (MTDs), which are advanced catchbasins designed to capture sediments. Microplastics have a similar size fraction but different density compared to many inorganic sediments, which infers different transport behavior. The objective of this study is to characterize MP composition and abundance on roadways, in a set of installed MTDs, and in receiving tidal creeks in Mount Pleasant, SC. In fall 2021, we collected sediment grab samples inside each compartment of two storm sewer MTDs, at the outfall of the storm sewers, and from surrounding roadways. Analysis of the 63-500 μm size fraction shows fibers to be the most common microplastic at one site and fragments at the other site, accounting for 64% and 41% of all microplastics, respectively. Additionally, both sites showed a higher microplastic concentration per dry weight in the outfall (118.4 MP/g and 612.4 MP/g) compared to the surrounding roadway (21.5 MP/g and 258.4 MP/g, respectively), likely because the outfall contains microplastics deposited from other sources in the tidal reach and accumulation over time. Future work will characterize the microplastic composition in sediments across additional stormwater transects with MTDs.

Keywords: Microplastic; Stormwater; Runoff

12. Rising Water Levels in Northern Coastal South Carolina – How to Get a Grip on Local Lowering Land Levels (Subsidence)

Presenter: Madison S. Fink, Coastal Carolina University

Residents of Horry and Georgetown Counties have observed rising coastal water levels through a series of recently worsening flood events. Rising water tables and flooding intensities in the coastal lowlands are related to regional rising sea and river levels but also local land sinking. Initial data suggests that sea level around Winyah Bay has reached a critical threshold level leading to progressive nuisance flooding. Modeling indicates that Downtown Georgetown was tidally flooded up to 42 days p.a. in 2017-2019 with a projection of 300+ events p.a. by 2040. Modern sea level rises significantly faster in this geographic region (5.2 mm/yr) compared to Charleston (3.3 mm/yr) and Wilmington (2.5 mm/yr) due to an undifferentiated subsidence rate of 2.9 mm/yr in the Winyah region. This mechanism also has an effect on the coastal river systems. River gauge data from the Waccamaw River shows river stage increases 5 times faster

than global sea level. In March 2022 a new project began (funded by SCDNR Archeology and in collaboration with SCGS and College of Charleston), which will reconstruct recent and historic sea-level changes and quantify locally differentiated subsidence rates. Monitoring activities need to be applied at various locations to differentiate local variability in subsidence rates. The project will inform regional managers about the vulnerability of historic and archaeological coastal sites. It will also provide the local communities with valuable data about how rapid urbanization can affect land surface changes as well as flooding frequency and aid in decision making around development and flooding adaptations.

Keywords: Sea-Level Rise; Subsidence; Flooding; Vulnerability

13.



Barriers to park and beach visitation, as perceived by parents of children with autism

Presenter: Nick Laurito and Daniel Guttentag, College of Charleston

Outdoor recreation provides a variety of benefits for children. However, research has shown that children with autism, which is increasingly prevalent in the U.S., may miss out on some outdoor recreational experiences due to perceived barriers felt by their parents. Such barriers include concerns about children's physical safety, concerns about sensory over-stimulation, and concerns about being judged by other parents due to their child's behavior. The present research is ongoing and is being conducted with support from a Sea Grant Study Group Award. The research is examining the barriers that parents of children with autism aged three to twelve perceive with regards to visiting parks and beaches in South Carolina's coastal counties. To date, ten interviews have been conducted with parents of children with autism and with experts on juvenile autism. These interviews have confirmed many of the barriers that had been predicted, and the interviews have highlighted certain concerns – such as fears about children running off – as being particularly acute. The researchers have used these findings to develop a survey on the subject that is being distributed to parents of children with autism and parents of children without autism, so that the results between the two groups can be compared. Preliminary results from the surveys should be available to be shared at the Conference.

Keywords: Autism; Parks; Beaches: Barriers

14.



Evaluating Shellfish Pond Potential to Produce a Compatible Crop of marine fish, Tripletail *Lobotes surinamensis*

Presenter: Jason Broach, South Carolina Department of Natural Resources

Tripletail are a marine finfish found around the globe in tropical and subtropical waters. They possess several traits that make them suitable candidates for commercial aquaculture, but critical knowledge gaps still exist for important production stages including controlled spawning and larval culture. This project focused on controlled spawning efforts utilizing appropriate photo-thermal regimes and feeding protocols for natural spawning, utilizing different hormones and dosages for spawning induction, examining the potential for pheromone induced spawning, and will apply extensive larval culture strategies during co-culture with oysters in ponds. After a full year of housing tripletail in multiple tank systems suitable for natural spawning, no spawning events have been recorded despite having females that possessed vitellogenic oocytes. Addition of the putative pheromone, prostaglandin F-2 Alpha, at three different dosages into tanks with mature broodfish failed to elicit any response or spawning activity. The pandemic slowed mass broodfish collection by SCDNR personnel and local and out-of-state fisherman until early

summer 2021 which hindered testing hormones and dosages for spawning induction until summer 2022. No Larvae have been obtained yet for extensive larval culture in ponds. Other important aquaculture information that has been learned with tripleteil include their susceptibility to a unique parasite that infects the fish through the eye and stages in the brain indefinitely which leads to lethargy, blindness, and lack of appetite. Additionally, methods which utilize skin mucus to determine the sex and developmental stage of tripleteil are being developed.

Keyword: Tripleteil; Mariculture; Spawning; Aquaculture

15. A Comparison of Dimensionality Reduction Techniques for Hyperspectral Imagery

Presenter: Todd Wittman, The Citadel

Hyperspectral images are geospatial images with a large number of spectral bands and are used to detect changes in coastlines and environment. Due to the high-dimensional nature of the data, dimensionality reduction techniques can improve image analysis by reducing memory requirements, making image processing techniques more efficient, and sometimes increasing the accuracy of the results. A wide variety of dimensionality reduction (DR) algorithms have been proposed, ranging from linear transformations like Principal Component Analysis (PCA) to more computationally intensive manifold learning algorithms such as Locally Linear Embedding (LLE). The best dimensionality reduction technique and the ideal dimensionality depend on the dataset and the image processing task under consideration. This project compares various dimensionality reduction methods by evaluating the performance of image analysis tasks on available hyperspectral datasets with ground truth reference.

Keywords: Hyperspectral Images

16. Viewing river flooding in a virtual reality setting

Presenter: Brian Williams, Clemson University

Advancements in computer technology have allowed creation of higher fidelity simulations of the real world phenomena. However, visualization of those simulations has been limited by two-dimensional screens used to view simulated three-dimensional environments. Different viewpoints are often pre-rendered, limiting the user from moving freely through the visualization. First developed in 1968, virtual reality (VR) headsets have traditionally relied on sophisticated, very expensive computer systems to create a three-dimensional environment. In the mid-2000s Google developed Street View in Google Earth, allowing anyone with a computer, and eventually a cellphone, to view 3D scenes across the globe. Oculus released the Quest in 2019 which uses a mobile chipset and was the first standalone VR headset. The Quest can display VR without the aid of a computer. Due to demands on processing power, VR environments have been on a smaller scale and limited scope, such as scenes of house interior or X-ray tomography. In this paper we will discuss constructing a landscape level VR environment for the Oculus Quest. We will show how GIS data, hydraulic modeling, and high resolution photography were used to recreate flooding in a five mile section of the Pee Dee River valley. We will discuss how hardware limitations impacted the realism of the scene, the manner in which the flood model was displayed, and use of complex three-dimensional models.

Keywords: Flooding; Pee Dee River; Virtual Reality; Oculus Quest

17. Using Science-based Training Events to understand Stakeholder Research and Knowledge Needs

Presenter: Abi Locatis Prochaska

The ACE Basin Coastal Training Program hosts over 10 professional training events every year, focusing on water quality, community resilience, habitat conservation and public access. In person events have always been good sources of stakeholder information, however switching to all virtual events in the past two years has greatly increased this opportunity. During a virtual training, attendees provide valuable insight into research and knowledge needs through registration information, questions asked via chat, and written comments in the chat or during other engagement activities. Wetlands, both freshwater and saltwater, have been a high priority training topic during COVID-19, and the CTP analyzed qualitative data from related training using an open coding methodology to reveal opportunities for collaborative research, peer to peer learning and further training about living shorelines, marsh and marshfront management, and wetland regulations.

Keywords: Stakeholder Engagement; Qualitative Methods; Wetlands

18. Identification of Antibiotic-Resistant Fecal Coliform Bacteria in Urban Floodwaters of Peninsular Charleston, SC

Presenter: Kayla Squiggins, College of Charleston

Flooding is a common occurrence in the Charleston peninsula given its geographic location along the Atlantic coastline and its environmental history of filling marshes for development. Much of this flooding occurs either from rainfall (typically, >2.5 cm/day) and/or high/king tides (typically, mean lower low water (MLLW) >7 ft) flooding related to low-lying areas. These floodwaters funnel different types of urban pollutants into the coastal waters, such as fecal bacteria and trace metals, which are known to be present in stormwater runoff, but the prevalence of antibiotic-resistant fecal coliform bacteria (ARFC) in the floodwater is unknown. Floodwater samples were collected from two locations on the peninsula to represent runoff in the urban environment. A tidal-influenced pond at Magnolia Cemetery was a control for comparing results. Multiple days were sampled during rainfall and a king tide for ARFC and trace metals. ARFC samples were processed and plated without antibiotics or with ampicillin/amoxicillin. Total coliform colony counts including *E. coli* were counted, and trace metal concentrations were analyzed. Floodwater from all sites had ARFC present for both antibiotics with the two floodwater sites having higher colony counts than the control site. Metals of concern (e.g., Mo & Mn) were found in floodwater, but the concentrations were dependent on the floodwater being dominated by either rainfall or tides. Local communities are at risk when exposed to these floodwaters because of the presence of ARFC that can cause untreatable bacterial infections, and the flooding is exacerbated by climate change, which makes this a serious problem.

Keywords: Flooding; Antibiotic-Resistance; Metals; Bacteria

19. Developing Map of Depth of Groundwater in Charleston, SC

Presenter: Mary Coastal Watkins, The Citadel

Groundwater plays a key role in many shallow geological processes and an estimate of the level of the water table is an important component of site investigations, assessments of water resources, and environmental studies. Literature cites that data on groundwater level is frequently used as a component within geological models, for example in studies of slope stability, liquefaction, groundwater flood susceptibility, or the suitability of an area for sustainable urban drainage systems. The object of this study is to use observations of groundwater level in wells and boreholes to develop depth to groundwater maps for Charleston, SC. The local civil engineering firms were contacted to get access to their databases. Groundwater table depths for all investigated sites were given in the project reports. These groundwater table depths are used to develop GIS maps. Preliminary results show that the groundwater table depths range from 0 feet to 25 feet. About 50% of the 350 investigated sites have groundwater table depths less than 5 feet. These GIS maps will aid the local practitioners with readily accessible groundwater depths.

Keywords: Groundwater; Groundwater Table Depth; Liquefaction

20. Prevalence of Personal Protective Equipment (PPE) in Macroplastic Litter in Charleston Harbor, South Carolina

Presenter: Jessica Wenclawiak, College of Charleston

Plastic litter is found throughout the aquatic environment. Due to the COVID-19 pandemic, the use of personal protective equipment (PPE) has risen significantly over the last two years. These items are often made of plastic polymers and can degrade over time to produce microplastics. This study aimed to quantify spatiotemporal changes in plastic litter abundance, including PPE, in Charleston Harbor, South Carolina since 2013. Plastic litter and PPE items were collected by volunteers during SC Sea Grant Consortium's Beach Sweep at ten sites along Charleston Harbor on 18 September 2021. Items were weighed and categorized by type and plastic polymer. Differences in PPE abundance and weight between sites were analyzed using Chi Square tests. No PPE was collected in 2013, whereas 286 items of PPE were found in 2021. PPE comprised 2.91% of plastic litter, and 95.8% of PPE was single-use. The total abundance ($\chi^2 = 283.33$, $df = 9$, $p < 0.0001$) and weight ($\chi^2 = 1357.4$, $df = 9$, $p < 0.0001$) of PPE items were significantly different across the ten sites. Gloves were the most abundant type of PPE ($n = 142$), and PPE was found at average densities of 0.028 items m^{-1} and 0.19 g m^{-1} . Compared to other coastal surveys, PPE was present at higher proportions in Charleston Harbor. These results suggest that PPE is now a component of plastic litter that could become more abundant as the pandemic continues.

Keywords: Plastics; COVID-19; PPE; Litter

21. Are ephemeral wetlands hotspots for avian biodiversity in Pine Savanna ecosystems?

Presenter: Jackson Barratt Heitmann, College of Charleston

Wetlands provide humans with critical ecosystem services and serve as important repositories of biodiversity; however, little is known about the importance of small isolated ephemeral

wetlands which are largely ignored by managers and policy makers. Ephemeral wetlands located within Longleaf Pine Savana ecosystems in the south eastern coastal plain support a host of specialist plant and herpetological species, but it is unknown if they support unique bird communities. The purpose of our study is to examine if avian diversity in ephemeral wetlands is distinctly different from surrounding upland habitat and how the unique vegetation attributes of ephemeral wetlands drive avian biodiversity. We collected avian point count, vegetation, and wetland attribute data at two field sites managed for Longleaf pine restoration with prescribed fire. Bird diversity is higher in wetland sites compared to upland sites ($F = 5.787$, $p = 0.025$), and diversity was not different between the two sampling locations ($F = 1.627$, $p = 0.215$). Wetland vegetation attributes including canopy cover ($p = 0.507$), midstory cover ($p = 0.478$), and herbaceous cover ($p = 0.476$) did not change bird diversity amongst wetland sites. In addition to our research, we will be providing job-skills training for field technicians this summer, and have begun presenting our research in academic settings at the College of Charleston and at an outreach event at the Overture senior living community in West Ashley. We will be developing and delivering bird education curriculum this Fall, and will hold a land management symposium in Fall 2023.

Keywords: Avian Biodiversity; Ephemeral Wetlands; Community Composition

22. Marsh and tideland microplastic contamination and the role of river flooding and storm surge impact – the great unknown

Presenter: Till J. J. Hanebuth, Coastal Carolina University

Microplastics are widely and increasingly abundant within coastal wetland systems. In qualitative and quantitative research, the coastal tideland systems are widely neglected due to their cohesive and organic-rich composition. It is important to determine their abundance and polymer type as they are expected have deleterious effects on coastal organisms, and potentially humans, resultant of their easy transport and intake. Important to state, microplastic contamination is also widespread and largely uncontrolled in South Carolina. Primary microplastics, often as beads or pellets, and secondary microplastics are altered by mechanical and (bio)chemical processes and UV exposure within the various freshwater and brackish marshlands and fluvial swamps. This research projects aims to assess microplastics qualitatively and quantitatively in several marshlands and fluvial tidelands in coastal SC. This goal is contingent on the design and construction of a novel, three-step separation line to extract the microplastics, which involves physical elutriation, chemical digestion, and density separation. The study will be the first utilizing elutriation as a preceding step in the extraction of microplastics from cohesive wetland sediment. Once extracted, quantitative and qualitative microplastic data will be gathered through binocular microscopy and FTIR and SEM spectroscopy, respectively. As a particular and probably highly significant process in coastal SC, the mobilization, transportation and concentration effects related to river flooding and storm surge events is in our region as well as in general not investigated and understood yet. These effects should be in the focus of future research, stakeholder engagement, and public information activities.

Keywords: Microplastics; Wetlands; Flooding Events; Hurricane Surges

23.



Stormwater Detention Ponds as a Pathway for Downstream Microplastic and Tire Wear Particle Transport

Presenter: Shannon Bley, College of Charleston

Microplastics (<5mm) are ubiquitous in coastal waterways. Recent attention has turned to tire wear particles (TWP), microscopic fragments produced through tire abrasion that accumulate on road surfaces. These particles can be picked up and transported via stormwater runoff, eventually being deposited in stormwater detention ponds. In coastal South Carolina, stormwater ponds are a common landscape feature designed to mitigate stormwater flooding and secondarily serve to collect contaminants. Therefore, these ponds are expected to play a role in microplastic and TWP transport to coastal waters. The goal of this research is to elucidate the role of stormwater detention ponds in downstream microplastic and TWP transport. Water samples were collected from locations within 5 stormwater ponds and their receiving tidal creeks in Mount Pleasant, SC. Samples were sieved into two size fractions, digested, and analyzed for microplastic abundance and composition under a dissecting microscope. Particles were confirmed as being plastic in origin using a hot needle test. Preliminary results indicate decreasing TWP composition from 38.1% at the pond inlets to less than 10% in the tidal creeks. Microplastic concentrations were found to vary between ponds ($p=0.01$), while TWP concentrations were found to decrease from the pond inlets to the tidal creeks ($p=0.017$). These results suggest that TWP are settling out within the ponds before reaching the creeks, and that microplastic concentrations are site dependent. The results of this research can inform stakeholders and coastal decision makers so that more effective pond infrastructure and management can be implemented to mitigate downstream particle transport.

Keywords: Microplastics; Tire Wear Particles; Stormwater Detention Ponds