VIRTUAL JOINT MEETING

ABSTRACT BOOK

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Contents by Title

Attenuation of boat-wake energy and habitat creation using novel living shoreline approaches

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Poster, Student

Structured, estuarine habitats (e.g. intertidal oyster reefs, salt marshes) provide critical ecosystem services, including nursery habitat and erosion mitigation. However, increased wave energy associated with commercial and recreational boating can erode estuarine habitats and displace faunal communities. Previous data suggests that vegetated shorelines may be less effective at attenuating vessel-driven waves when compared to wind-driven waves and therefore may require structural features, such as breakwaters, to protect shoreline habitats in heavily trafficked areas. This project will assess the effectiveness of OysterCatcherTM breakwaters, a novel design for living shorelines in NC, for attenuating boat-wake energy in a heavily trafficked waterway. We will evaluate the impact of breakwater presence and height on boat-wake wave attenuation, shoreline conditions, and faunal community assemblages. We hypothesize that oyster breakwaters will reduce wave energy incurred by the adjacent shoreline and the magnitude of wave attenuation will be positively correlated with vertical relief. Furthermore, we hypothesize that faunal diversity and abundance will be higher at reef sites compared to control sites. This study will assess the effectiveness of OysterCatcherTM reefs at reducing erosion and providing habitat for oyster-reef communities, thus contributing to the understanding of how living shorelines can be used for coastal protection and habitat provisioning.

What factors affect the distribution of the ribbed mussel (Geukensia demissa) in Georgia Salt Marshes?

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Geukensia demissa (ribbed mussel) is an ecologically important bivalve species found in salt marshes along the Atlantic coast. *G. demissa* has been found to increase *Spartina alterniflora* (cordgrass) growth in marsh restoration projects. Byssal threads from *G. demissa* stabilize marsh sediments and nitrogenous waste fertilizes *S. alterniflora*. Despite *G. demissa's* potential application in marsh restoration, the factors driving their spatial distribution in Georgia are poorly resolved. This study seeks (1) to examine both landscape and marsh scale factors that may contribute to the distribution of *G. demissa* in Georgia and (2) to determine how growth rate, survival, and recruitment of *G. demissa* vary at different locations in the marsh. These objectives were addressed through a GIS analysis and field experiments. Preliminary data from two sites shows that on the marsh scale, *G. demissa* densities are affected by elevation, slope, and distance to creek heads. Highest *G. demissa* densities were found on the lower marsh platform, close to creek heads. Lowest *G. demissa* densities were found on levees along subtidal creeks. In these low elevation areas close to creek heads, *G. demissa* growth rates and recruitment were the highest. Therefore, this study provides data on the mechanisms driving local mussel distribution.

The utility of ribbed mussels to aid in living shorelines success in Georgia

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Poster

Ribbed mussels are ecologically important bivalves found in salt marshes along the Atlantic coast. They help stabilize sediments and adding nitrogenous wastes to sediments which act as fertilizer for the marsh grasses. However, ribbed mussels are often overlooked in marsh management practices in Georgia. Several living shorelines projects have been built throughout the state, with varied success. We sought to determine whether the presence of ribbed mussels placed in marsh grasses immediately adjacent to a living shoreline project would increase plant productivity. Working at Cannon's Point Preserve, we established control, low- and high-density mussel plots and monitored the change in plant productivity over the course of 15 months. Our results demonstrate mussel-driven enhanced plant productivity - high mussel treatments exhibited >300% increase in biomass relative to the start of the experimental period, driven by a combination of slightly higher plant density and much taller plant heights. However, mussel mortality remained relatively high throughout the study period, which can be problematic if using mussels as a restoration tool. We conclude that if effective strategies for mussel transplantation are developed (i.e., higher numbers, protective devices), using ribbed mussels on living shorelines projects can help marsh grass to grow back faster and healthier.

Influence of Urea and Temperature on Cyanobacteria in a Stormwater Detention Pond

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Student

Increased urban and suburban population growth along the South Carolina (SC) coast has led to a rise in impervious surfaces, altering the course of stormwater runoff events. The construction of stormwater detention ponds (SDPs) is one of the many ways to best mitigate the flow of this water. In their function as natural pollutant traps, SDPs often contain increased levels of nutrients (nitrogen, N and phosphorus, P), which can lead to eutrophication. Under these high eutrophic conditions, primary production is overstimulated, and the formation of phytoplankton blooms, including harmful algal blooms (HABs) can occur. In recent decades, the forms of nitrogen (N) exported to coastal waters have changed, with more than half of all N fertilizers being urea-based. Research has also shown that species-specific differences to various concentrations and forms of fixed N exist. More specifically, cyanobacteria seem to thrive under higher concentrations of ammonium and urea. Research has also shown that cyanobacteria thrive under warmer conditions. This proposed work aims to examine the seasonal variability in phytoplankton communities in a single SDP over a small-time scale in response to urea and temperature. These effects will be tested using nutrient addition bioassays under a 72 h incubation conducted every 14-days.

Water quality dynamics in tidally influenced blackwater creeks along a rural-urban gradient in Northeast Florida

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Reduced water quality, characterized by nutrient and contaminant loading, is a major potential consequence of urbanization. Eutrophication, toxin exposure and shellfish degradation are problems that can arise as a result. Water quality response to urban development is often specific to a locality or region; therefore, it is important to understand how development will affect the water quality of a region's receiving waters. The goal of this research is to determine the effects of urbanization on water quality of three blackwater creeks in Northeast Florida. Land use and cover were estimated for the three stream watersheds along a rural-urban gradient in St. Augustine, FL; Pellicer Creek is most rural, Moultrie Creek intermediately urban and San Sebastian River is highly urbanized. Turbidity, dissolved oxygen, fDOM, chlorophyll a, salinity, total coliform and *E. coli* levels were measured routinely. We hypothesized urbanization will negatively influence water quality dynamics, leading to more variable water quality, characterized by higher fecal bacteria concentrations, temperatures, turbidity, chlorophyll a, and lower dissolved oxygen, fDOM and specific conductivity. Results of ongoing analyses will be presented.

Implementing and Monitoring a Living Shoreline at NWS Earle, Raritan Bay, NJ

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The Raritan Bay coastline is at risk due to sea level rise, increased storm surge threats and changes in precipitation patterns. Nature-based tools can address these risks by increasing sedimentation on the shoreward side of projects, dampening wave energy, and reducing erosion. The presence of living shorelines supports increased biodiversity of associated marine species by adding much-needed habitat to urban areas. Due to the unique challenge of working in an urban estuary (pollution, contaminants, loss of hard substrate), as well as natural challenges (predators, poor visibility, access issues), incorporating artificial shorelines into restoration projects is necessary. In 2016, NY/NJ Baykeeper implemented the first living shoreline in the NJ portion of the Raritan Bay. To date, 600 oyster castles set with oyster spat have been placed at the project site. Monitoring for structural integrity, scouring, and oyster growth and survivorship is conducted via SCUBA and visual assessments. Shoreline monitoring and sediment traps assess accretion/erosion patterns, while fish traps and sediment plates determine biodiversity. Preliminary data shows fast growth of oysters at the site, an increase in species diversity in and around the castles (especially encrusting organisms and juvenile fish species), and sedimentation buildup in and around the castles.

Using sedimentary characteristics to assess living shoreline effectiveness against erosion

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Poster, Student

We investigated percent organic matter and sediment particle size associated with living shorelines along the Tolomato River, N.E. Florida. This was part of a larger living shoreline project conducted by Angelini et al. at UF. The purpose of this study was two-fold: to use two sedimentary parameters as indicators of wave energy dissipation by living shorelines, and to investigate the changes to the benthic environment that result from three types of living shoreline structures in the intertidal zone at the treatment sites: breakwalls, gabions, and BESE. Surface sediments at treatment sites were collected 40 cm behind break walls, gabions, and in front of the marsh edge. Control samples were collected at equivalent elevations at sites 30-40m downstream. Percent organic matter was measured using the loss-on-ignition method (corrected for salt content), and grain size was measured by wet sieving samples (pre-treated with peroxide and dispersant). We found significantly higher percentages of organic matter at treatment sites compared to control sites and there was no significant difference in silt and clay between the treatments and control sites. However, one site had much higher silt and clay behind the gabions and breakwalls, indicating that they were effectively dissipating wave energy.

Denitrification Occurs on Engineered Structures With Oysters and Other Filtering Organisms

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Concrete structures in coastal waters have been deployed for shoreline protection and for habitat enhancement. Reef balls and oyster castles add vertical structure and surface area to benthic environments. The intentional seeding of oysters, and the opportunistic growth of other filtering organisms, results in the focusing of energy and materials onto the structure surface. We incubated reef balls and oyster castles in a large tank to assess rates of nutrient cycling and metabolism. The rates of oxygen uptake and the rates of denitrification were exceptionally high and on an areal basis were several orders of magnitude higher than sediments. While rates were highest in the oyster-seeded structures, metabolic rates on structures with barnacle and bryozooan communities were nevertheless very high. Nitrogen removal via denitrification adds a valuable additional ecosystem service to these structures.

Using a multisensory approach to teaching marine and estuarine ecology

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Scientists and educators have the opportunity to reach a wide range of audiences in both formal and informal settings. Here, I will share a few examples of outreach activities that were based on university-level research that have been published for use by K-12 teachers. Topics include ocean currents, harmful algal blooms (HABs), fish abundance data, and marine mammal sounds. Many of these activities have simple modifications that enable participation by the visually impaired, who are often underserved by the science community. There is broad evidence that multi-sensory learning helps most of us retain material better, and in addition, sighted persons enjoy the creative ways that sense of feel or sense of sound can be used to express scientific findings.

The response of the seagrass associated echinoid Lytechinus variegatus to physical disturbances: effects of habitat fragmentation and hurricane Michael

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The progression of climate change has led to the increased frequency and intensity of physical disturbances, such as habitat destruction and hurricanes. Documenting the outcome of disturbances is important for monitoring biological change, particularly in coastal communities where extensive human-environment interaction exists. The purpose of these studies was to investigate spatial and temporal variation in the abundance of the seagrass-associated echinoid *Lytechinus variegatus* in response to seagrass bed edge effects (i.e. habitat fragmentation disturbances), and the passage of the category 5 storm hurricane Michael across St. Joseph Bay in the northern Gulf of Mexico. Field surveys revealed negative responses along seagrass bed edges, as *L. variegatus* maintained higher abundances in interior portions of seagrass beds, relative to seagrass bed edges (i.e. the seagrass-sandflat interface). Field surveys also revealed that the resident *L. variegatus* population did not respond negatively to the destructive power of the hurricane, as urchin abundances were not different after the storm. These results have implications for ecosystem functioning of seagrass communities in the Gulf of Mexico, where *L. variegatus* plays a pivotal trophic role via high density populations with high seagrass grazing rates.

Changing Seagrass Patterns in Barnegat Bay

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Poster, Student

Barnegat-Bay Little Egg Harbor Estuary is an extremely productive, economically and ecologically important ecosystem in southern New Jersey. Seagrass there can be used as a bioindicator to judge ecosystem health as the region experiences impacts from poor water quality, increasing temperatures, and anthropogenic involvement. To track changes in health, data on seagrass percent cover, biomass, epiphytic coverage, and macroalgae biomass were collected at nine sites in spring and fall of 2015 and 2017. Previous studies have found that over the past 20 years, *Zostera marina* has been declining while being replaced by opportunistic *Ruppia maritima*. In this study, northern and southern regions of the estuary experienced significant decline in *Zostera* while central regions significantly increased cover. At northern sites which previously showed presence of *Zostera*, there was no longer a presence and *Ruppia* did not increase at these sites. Water conditions such as temperature and turbidity have changed, which may be preventing *Ruppia* from replacing *Zostera*. Additionally, macroalgae increased at all sites, which may also indicate decreases in water quality. These data show that this estuary is experiencing environmental change, which is leading to degradation of the ecosystem and could cause a cascade of negative responses both environmentally and socioeconomically.

Zostera marina seed bank resiliency following Hurricane Florence (2018) and Hurricane Dorian (2019)

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Poster, Student

Zostera marina is the dominant seagrass species at its western-Atlantic southern range limit in North Carolina. High summer water temperatures there cause *Z. marina* populations to be thermally stressed and die off completely in the summer. Consequently, NC *Z. marina* populations show evidence of a mixed-annual life history strategy and rely fully on seeds in the sediment seed bank to come back each year. However, hurricanes, which have increased in frequency and intensity in recent years, have potential to affect the *Z. marina* seed bank through physical disturbance and reduced water quality conditions which could affect the amount, germination, and viability of *Z. marina* seeds. Hurricanes Florence (2018) and Dorian (2019) impacted the NC coast and were characterized by differences in wind speed and rainfall. To determine the effects of these storms on the *Z. marina* seed bank, sediment cores and biomass cores were collected from Middle Marsh, NC shortly before and after each hurricane, as well as the following growing season. Seed density, viable seed density, percent viability, and shoot and flowering shoot biomass and density were compared between storms. Understanding how resilient *Z. marina* populations are to storm-associated disturbances will be important for management of this important resource.

Assessing the resilience of coastal protection to multiple storm events in North Carolina

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As coastal populations continue to increase, the socioeconomic impacts of hurricanes and other major storm events are also expected to increase, with hurricane damages already costing the United States nearly a trillion dollars since 1980. To protect people, infrastructure, and property from storms, coastal residents frequently elect to harden their shorelines with seawalls and bulkheads, which has been shown to cause coastal habitat loss and degradation. Alternatively, living shorelines can restore coastal habitat functions, while also preventing shoreline damage and erosion during storm events. Further, recent work has suggested that living shorelines can be less costly to maintain and require fewer repairs after storms than bulkheads. However, the ability of living shorelines to prevent shoreline damage and erosion over multiple storm events has not been evaluated. In many regions, including coastal North Carolina, multiple hurricanes have made landfall and have caused significant damage in the last decade. To understand the impacts of multiple hurricanes on waterfront properties and shoreline habitats, we conducted shoreline surveys and online surveys of waterfront residents before and after five hurricanes over ten years. Results suggest that living shorelines are resilient to multiple storm events, while bulkheads require repeated, costly interventions to provide continued protection.

Climate change impacts on spawning aggregations of reef fishes in the Greater Caribbean

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Poster, Student

Climate change has altered environmental conditions on a global scale and prompted changes in latitudinal distribution, depth range, and phenology of fish species in marine environments. This study focuses on modeling the effects of climate change on the distribution and phenology of spawning aggregations of eight snapper and grouper species in the Greater Caribbean. The Non-Parametric Probabilistic Ecological Niche Model coupled with the NOAA GFDL earth system model were applied to project changes in the distribution and seasonality of spawning sites under the RCP 8.5 climate scenario. Sea surface temperature, seasonal temperature gradients, vertical velocity, and geostrophic currents were selected as variables influencing spawning distribution. Groupers shifted spawning phenology later at a mean rate of 2.77 days/decade, while snappers were projected to spawn earlier at a rate of 4.65 days/decade. Groupers showed a mean northward latitude shift of spawning sites by 16.14 km/decade and snappers shifted by 5.88 km/decade. Differences between these speciesâ€™ reactions to climate change were predicated on the fact that groupers spawn during colder months. This research has implications for how marine protected areas and seasonal sales bans should be adjusted under changing environmental conditions.

Investigation of polyethylene terephthalate (PET) bottles as a reservoir for Enterococcus pollution

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Polyethylene terephthalate (PET) plastic is frequently used in the food industry, particularly in the manufacture of beverage bottles. As such, PET accounts for a considerable amount of plastic marine debris. Upon entering the environment, plastic debris is quickly colonized by microbially-mediated biofilms. Genomics studies of such biofilms have found pathogenic microbes present at abnormally high concentrations. The fecal indicator bacterium Enterococcus is used for beach water contamination assessments. Enterococcus has been found to colonize plastic in medical settings, but its colonization of marine plastic debris is unknown. In order to examine if PET bottles act as habitats for Enterococcus, a study was conducted within euhaline tidal waters of Wrightsville Beach, NC, via the deployment of pre-sterilized PET bottles. Uncapped bottles were attached to a float and positioned nearby two stormwater outfall pipes, known to drain an area contributing high loads of Enterococcus to the receiving waters. Plastic bottles were retrieved weekly to assess the effect of time and location in the accumulation of bacteria. Each bottle was analyzed for the presence of Enterococcus in water inside the bottle and on the plastic surface. Abundance of Enterococcus was found to be significantly greater associated with PET bottles versus the surrounding waters.

The effects of Salinity, Depth and Turbidity on Submerged Aquatic Vegetation (SAV) abundance in Eastern North Carolina.

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Student

The state of North Carolina is concerned about the loss of submerged aquatic vegetation (SAV), which is critical fish and wildlife habitat in low-salinity estuaries. Sentinel sites have been established by the East Carolina University/Albemarle Pamlico National Estuarine Partnership (APNEP) team at locations where SAV has been observed in historical surveys. Using monitoring data collected from low-salinity sentinel site locations in the Neuse River Estuary (NRE) Pamlico River Estuary (PRE), and Albemarle Sound (AS) from 2015 to 2019 I evaluated the effects of turbidity, salinity and water depth on SAV abundance. My goal was to understand what physical parameters have an impact on low-salinity SAV survival and growth. Data came from inshore quadrat diver surveys that measure percent cover using 1m2 quadrats at depths of 0.25, 0.5, 0.75 and 1 meter. Dry biomass abundance was found by taking core samples along sampling transects. Some sentinel sites were omitted from the study that never contained SAV. I found that low turbidity as well as low salinity was associated with higher SAV percent cover. The abundance of SAV increased with increased Secchi depth supporting my hypothesis that light is a main contributing factor for SAV growth in North Carolina Estuaries.

The Effects of Climate and Coastal flooding on low-lying American holly (Ilex opaca Aiton)

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Poster, Student

Low-lying forests adjacent to tidal marshes are at risk of loss through rapidly rising sea level. Future salt marsh extent, also at risk of loss through sea level rise, is linked to the demise of low-lying forests. Patterns of forest losses and marsh gains are spatially and temporally variable, which limits our ability to predict coastal change as sea levels rise. We used tree rings to analyze the effects of temperature, precipitation, and maximum tidal water levels on the growth of over 100 American hollies (*Ilex opaca* Aiton) in two Mid Atlantic estuaries. Results from partial correlation tests suggest differences in the significance of environmental conditions seasonally and between sites. For instance, tidal water levels were not significantly related to growth at one site, but this relationship was positive and significant for winter water levels at the other site ($p<0.05$). Additional differences were found for temperature and precipitation. Results support the hypothesis that local conditions are important in the susceptibility of forests to decline as surficial flooding and salt exposure increases. Future studies may also consider the role of groundwater-sea level rise interactions, as there is evidence of positive responses to higher maximum tidal water levels in American holly.

Assessing the utility of eDNA techniques to monitor white shrimp abundance on the Georgia coast

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Poster, Student

The white shrimp (*Litopenaeus setiferus*) commercial fishery is the largest fishery in Georgia, generating around $9 million annually in landings over the past decade. These shrimp are also a key indicator species to changes in estuarine water quality and habitat alteration, particularly deterioration and loss of salt marshes, allowing them to be a useful model organism for examining ecosystem changes. Effective management relies on sound predictive models relating environmental factors and their alterations to biodiversity and fisheries production. Due to the importance of white shrimp to Georgia's coastal communities, methods for cost-effective monitoring must be developed. Currently, the Georgia Department of Natural Resources monitors shrimp populations using both monthly trawling and drop-ring surveys, however, with declining state budgets, it becomes important to explore more cost-efficient emerging technologies to monitor critical species. My research seeks to use environmental DNA (eDNA) sampling within an experimental design explicitly aimed at moving beyond presence/absence and toward estimates of abundance. Having successfully developed probes for white shrimp, I plan to conduct fully factorial experiments to establish relationships between eDNA concentrations and environmental parameters to white shrimp abundance and biomass. This poster will present my research plan, and I welcome input.

Oyster Spat Monitoring in the GTM Research Reserve

Al Knoell*, Pa Marcum, Ni Dix
GTM National Estuarine Research Reserve

The eastern oyster, Crassostrea virginica, is a keystone species abundant in southeastern U.S. estuaries, providing a myriad of services, including water filtration, buffering against storm surges and wave action, and serving as a habitat for many estuarine organisms. Recent oyster population assessments and oyster restoration efforts in the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) revealed the need for information on local oyster settlement dynamics. By observing settlement patterns of spat, or newly settled oysters, knowledge on the site-specific larval availability and settlement is provided and can further aid in understanding oyster population dynamics. In 2015, the GTMNERR initiated a monitoring program to determine spatial and temporal patterns in oyster spat using the hanging shell method. Cleaned shells were deployed monthly in five major waterbodies of the GTMNERR estuary. Shells were evaluated under microscope and all spat settled on the inner shell surface were counted. Over the course of the study, peak settlement shifted later in the summer and overall abundance increased annually. Small-scale variation in minor peak timing and abundance was observed both between and among waterbodies. Monitoring data have been shared regularly with local oyster harvesters, citizens, regional resource management stakeholders, and scientists.

Zooplankton community structure within a stormwater detention pond in coastal South Carolina

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Student

Stormwater detention ponds (SPDs) on the coast of South Carolina have become increasingly prevalent as the area experiences rapid urbanization. SDPs are man-made reservoirs of standing water that were first implemented to provide stormwater storage to control runoff and enhance stormwater quality to minimize pollution inputs into receiving waters. SDPs may host a variety of aquatic organisms, such as invertebrates, reptiles and fish. All SDPs vary in terms of size, depth, geometry, surrounding vegetation and pollution levels and type. These factors can affect water quality parameters and thus have affect zooplankton communities. Zooplankton are ecologically important because they act as a good water quality indicator due to their quick response times. Biological and chemical features of an aquatic system, such as food availability and salinity, have a large effect on zooplankton community composition in certain environments. This proposal aims to determine the seasonal variability in zooplankton community composition in one SDP located in Murrell's Inlet, SC.

Biogeographic Distribution of Free-Living Macroinvertebrates in Invasive Agarophyton vermiculophyllum

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Student

The red seaweed Agarophyton vermiculophyllum, native to northwestern Pacific, has invaded much of temperate estuarine habitats around the globe. In the U.S. East Coast, this seaweed has physically transformed soft-sediment estuarine habitats by providing novel habitat complexity. The structure of A. vermiculophyllum provides interstitial space to accommodate large abundances and diversities of native macroinvertebrates. From May-August 2019, we surveyed A. vermiculophyllum and their associated macroinvertebrates along the U.S. East Coast, ranging from Durham, NH to Charleston SC, spanning across three biogeographic provinces. Across all sampled sites (n = 17), we found that Gammaridean Amphipods were most prevalent (>72%), followed by Caprella spp. (>9%), Common Periwinkle (>7%), and Isopods (>6%), while other taxonomic groups comprised <2% of total prevalence. The prevalence of Gammaridean Amphipods decreased across the biogeographic boundaries from north to south: >84% north of Cape Cod, >66% in Virginian Province, and >52% south of Cape Hatteras. Overall densities of macroinvertebrates increased with A. vermiculophyllum biomass (R^2 = 0.151), but the trend was not significant (p = 0.211). Understanding macroinvertebrate abundances associated with A. vermiculophyllum on a biogeographic scale is critical at monitoring how the faunal diversity will respond as this invasive seaweed physically transforms these estuarine habitats.

Comparing Side-Scan imagery and Single-Beam SONAR for Benthic Habitat and Vegetation Surveys

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Poster

Surveys of submerged aquatic vegetation and benthic habitat are a challenge in estuarine systems with high turbidity. Sonar methods provide a rapid way to characterize the bottom habitat. Two relatively inexpensive sonar methods with GPS positioning are available for biologists using off-the-shelf technology: side-scan sonar and single-beam sonar. Side-scan sonar has the advantage of covering a wide swath of the bottom, producing an image that can be classified with supervised methods. Single-beam sonar does not provide a wide swath but instead provides bathymetry and allows computer-based classification of the bottom habitats that can be interpolated over wider areas. We compared these methods at sentinel sites and along-shore transects in Albemarle Sound, Pamlico River, and Neuse River in North Carolina for SAV change detection. Side-scan and single-beam SONAR agree when SAV is present on transects. When used on the same transects, side-scan SONAR produced lower area estimates of SAV coverage and required greater effort to process the data; single-beam SONAR provided higher estimates of SAV coverage. Together, these two methods can be used simultaneously to create an acoustic remote sensing approach to SAV and benthic habitat surveys that is rapid, inexpensive, and sensitive to changes over time

Population Dynamics of Common Forage Fish Species in the Delaware Inland Bays

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Forage fish species play an important role in trophic transfer in estuarine food webs, affecting the health of economically valuable, managed fish species. The value of forage fish also extends to seabirds and marine mammals, where they serve as an important dietary component for many coastal species. Forage fish populations are highly sensitive to environmental conditions like water temperature and turbidity due to the interaction between variable aquatic habitats and life history dynamics including reproduction and early life history traits. When forage fish populations decline or collapse, the effects on piscivorous predators and estuarine food webs can be significant. Given the importance of forage fish to numerous estuarine vertebrate species, it is critical to understand population dynamics of these species, along with spatially and temporally variable factors that impact these dynamics. Here we present long-term population trends for three resident (Mummichog (*Fundulus heteroclitus*), Sheepshead Minnow (*Cyprinodon variegatus*), and Striped Killifish (*Fundulis majalis*)), and one migratory (Atlantic Silverside (*Menidia menidia*)) forage species common to mid-Atlantic estuaries, along with information on the scale and timing of these changes. These species account for the majority of saltmarsh and nearshore fish abundance and are therefore of major ecological importance to mid-Atlantic estuarine food webs.

Nutrient breakpoints for estuarine phytoplankton communities

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Nutrient breakpoints are the concentration at which there is a fundamental change in phytoplankton responses to further increases in nutrient loading. The ecological implication is that nutrient breakpoints signal a community transition from a relatively stable state to an alternate or transition state with marked changes in structure and, by extension, function. Nutrient breakpoints for the total phytoplankton community and individual phytoplankton groups in response to increases in dissolved inorganic nitrogen (DIN) concentrations were determined for two contrasting estuarine systems. Phytoplankton were exposed to increasing N addition scenarios (0 – 100 µmol DIN l-1) under high and low irradiance conditions. Our results suggest that ambient DIN concentrations should not exceed breakpoint concentrations to prevent possible shifts from a stable to a transitional or alternate state. DIN thresholds should be 25 and 50 µmol l-1 for the high and low salinity estuaries, respectively. These levels should mitigate the risk of major alterations in phytoplankton community structure and function in these two estuarine systems.

Community science exploration of biodiversity of an urban estuary using visual and molecular methodologies

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In the past half century, urban harbors in the United states have de-industrialized and these estuaries are now backdrops for waterfront retail, entertainment, and residential uses. As societal perception of these waters has evolved, there is renewed interest in them as ecosystems, as they struggle to rebound from their industrial legacy. In Baltimore, shoreline developments and restoration projects have been proposed, yet there is little baseline data on the harbor's living resources, and targets for restoration are sometimes ill-defined. The National Aquarium (NA) recently committed to constructing a Waterfront Campus that restores ecosystem services by introducing modified habitats, and simultaneously educates the public about estuarine ecosystems. NA has partnered with academic researchers, community scientists, and science educators to collect baseline biodiversity data using reproducible methods. The methods, of video-documentation and DNA meta-barcoding, have proven to be engaging for a wide variety of groups including K-12 students and teachers, artists, and the general public. Community science analysis of meta-barcode data has deepened our knowledge of the sessile communities in the harbor. The data analyzed thus far reinforce the importance of physical structures and oxygen for the health of urban estuaries, and provide narratives for how water quality affects living resources

The effects of oyster aquaculture on submerged aquatic vegetation (SAV) water quality and light habitat requirements

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Oyster aquaculture and submerged aquatic vegetation (SAV) in the Chesapeake Bay have generally been increasing over the past decade, leading to increased competition for the shallow bottom. Studies in other regions of the United States have shown that, in some cases, aquaculture can have negative effects on submersed plant growth and distribution. However, the extent to which aquaculture affects SAV in Chesapeake Bay and the ecological processes driving these interactions are unclear at present. The aim of this project is to collect baseline, or "Before," data for a multi-year Before-After-Control-Impact (BACI) study that will assess the effects of floating aquaculture cages on SAV distribution and habitat at a mesohaline site in Chesapeake Bay near Tilghman Island, MD. Although we measured a suite of variables, this presentation will report baseline water quality and light measurements in relation to SAV habitat thresholds and discuss plans for future work after an array of oyster floats is installed at the study site. Ultimately our goal is that the results of this study, when combined with similar work being conducted around the estuary, will provide scientifically defensible information to inform policy and management decisions that maximize both SAV restoration and continued growth of the oyster aquaculture industry.

Effects of oyster aquaculture on biogeochemical habitat requirements for submersed aquatic vegetation (SAV) in Chesapeake Bay, Maryland

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Submersed aquatic vegetation (SAV)and oyster aquaculture in the Chesapeake Bay have both been increasing over the past decade. Because they both tend to occupy shallow water, these two important living resources are also beginning to more frequently spatially overlap. Current regulations restrict aquaculture activity within SAV protection zones based on the assumption that aquaculture has negative effects on SAV. However, the extent to which oyster aquaculture modifies SAV growth and the mechanisms driving these effects are unclear at present. The aim of this project is to collect baseline, or "Before," data for a multi-year Before-After-Control-Impact (BACI) study that will assess the effects of floating aquaculture cages on SAV distribution and habitat at a mesohaline site in Chesapeake Bay near Tilghman Island, MD. Although we measured a suite of variables, this presentation will report baseline physical and biogeochemical properties in relation to SAV habitat requirements and discuss anticipated outcomes as we continue to continue the project. Ultimately our goal is that the results of this study, when combined with similar work being conducted around the estuary, will provide scientifically defensible information to inform policy and management decisions that maximize both SAV restoration and continued growth of the oyster aquaculture industry.

Co-occurrence of Atmospheric Heatwaves, Estuarine Heatwaves & Extremes in Water Quality Variables

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Heatwaves in the atmosphere and the open ocean have been formally defined within the past decade as discrete periods when air or water temperature exceeds a seasonally adjusted 90th percentile threshold for 3+ days in the atmosphere or 5+ days in aquatic systems. These extreme events have received considerable attention in marine ecosystems due to their increase in frequency and intensity, and negative impact on marine communities. However, heatwaves in inland waterways have received little attention. Similarly, little attention has been given to the co-occurrence of extreme events such as estuarine heatwaves and low dissolved oxygen and low pH events. This study provides evidence that ~40% of estuarine heatwaves within the USA co-occur with an atmospheric heatwave, and that ~20% of low DO events and ~6% of low pH events co-occur with an estuarine heatwave. Lastly, we provide evidence that the number of moderate strength heatwaves and the number of estuarine heatwave days has increased between 1996-2019, while the frequency and number of low pH days have decreased over the same period within estuaries around the USA.

Wind effects on estuary exchange flow at a barrier island inlet

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Estuary exchange flow is the primary driver of sediment and larval transport, making it an essential coastal process to study. A moored Acoustic Doppler Current Profiler was deployed at Little Egg Inlet, New Jersey, in Fall 2019. Two significant meteorological events occurred during this period, one with an elevated sea level from October 9 to October 13 and a depressed sea level from October 17 to October 18. The goal of this study was to describe and determine the cause of these two events. During the study, tidal current speeds were approximately 1.2 m/s, and there was a mean outflow of 0.09 m/s. The elevated sea level was associated with moderate wind (2 m/s) from the north, and subtidal velocity increased by a factor of 3.5 in an outgoing direction. The depressed sea level was associated with strong wind (6 m/s) from the west, and subtidal velocity reversed to a slight net inflow (0.11 m/s). There was a positive cross-covariance (R=0.43) between wind and sea level, which had a lag of 3.5 hours. These results are consistent with wind-driven change in sea level and exchange flow due to coastal pumping.

Charleston Planet Stewards: Building a Generation of Informed and Resilient Coastal Citizens

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Charleston Planet Stewards is a project created by the National Centers for Coastal Ocean Science, originating from NOAA Planet Stewards Education Project (PSEP). PSEP provides formal and informal educators working with K12 educators the knowledge and resources to build scientifically literate individuals and communities who are prepared to respond to environmental challenges monitored by NOAA. Students will create a stewardship project that will mitigate the impacts of climate change. Studentsâ€™ understanding of science and their perception of their role in their environment will be assessed to identify how environmental project-based learning experiences may influence student scientific literacy and personal motivation.

The unprecedented complete loss of SAV in the tidal freshwater St. Johns River, Florida

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Submersed aquatic vegetation in the tidal freshwater portion of the St. Johns River, primarily Vallisneria americana, disappeared following Hurricane Irma in September 2017. This loss occurred in the tidal, primarily freshwater portion of the River, from just south of Jacksonville through Palatka and Lake George, covering at least 165 km of the River. More than 3 years later, grass has not (yet) recovered.

Documentation of this loss comes primarily from 'backyard' observations of seven residents spread along 150 km the River. Observations indicate that dense grass beds had continually persisted since at least the early 1960s. However, following Irma and the heavy rains that followed, combined with the usual fall high water levels, led to very low light levelsâ€"the presumed cause of the crash.

Prior to the crash, blades of Vallisneria near the deep edge of beds were often 1-1.5 m long. In Spring 2019, seedlings rapidly appeared along the shallow edge of the Riverâ€"but only in ankle-deep water at low tide. These young plants spread by rhizomes, but have so far been only 3-6 cm tall. Both density and extent of grass declined from Spring to Summer in 2020, again presumably due to dark and turbid water.

New Jersey Tidal Marshes and Sea Level Rise

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Current SLR in NJ is 5-6 mm/year. Elevation in the Meadowlands: Spartina marshes increased 3.03-5.0 mm/year; Phragmites marshes increased 8.17 and 11.75 mm/year. Raritan Bay has been measured for only 1 1/2 years, but sites were subsiding. Barnegat Bay had only two sites increasing over 5 mm/yr. Delaware Bay had five sites accreting over 5 mm/year. Horizontal changes in Meadowlands are problematic because development reduces acreage and mitigation increases acreage. Raritan Bay marshes are not losing acreage. Barnegat Bay lost 12% 1972-2012, and Delaware Bay lost 1-2%/decade.

Possible mitigation (1) Migration Pathways: Creating pathways involves local governments working with landowners, using such instruments as rolling easements. (2) changing Phragmites management: this invasive plant enables marshes to elevate more rapidly (3) Sediment: Dredged material can be sprayed on the marsh surface to increase elevation or piled in open water nearby where currents moves it onto the marsh. Narrow channels (runnels) facilitate drainage from ponded areas. (4) Living shorelines: Adding harder materials, such as coir logs or oyster reefs at a marsh edge can reduce erosion and preserve the horizontal extent of the marsh.

Leaf tip morphology does not support species status for Halodule beaudettei in Florida, USA

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There are 9 recognized species in the genus Halodule, most named by den Hartog in the 1970s. The study of Halodule taxonomy has been challenged by the scarcity of reproductive material, preferred for differentiating morphospecies in Angiospermae. Sexual reproduction remains seldom seen and is not easily studied, leaving leaf-tip morphology and geography to define species identity. Leaf-tips vary based on protrusion of lateral vascular bundles and/or the midrib to create 1-3 teeth of varying relative sizes. In Florida, two species are thought to exist: the bicuspidate H. wrightii and the tricuspidate H. beaudettei. Early work by Phillips and McMillan questioned the genetic determinism of leaf-tip morphology, and concluded only a single phenotypically plastic species, H. wrightii, should be accepted. To inform the ongoing debate, we used leaf-tip images from the literature to train a CART model capable of differentiating the two species. We revisited Phillip's study site to collect Halodule runners, and using our model to predict species identity, we confirm that sufficient phenotypic variation exists within genets to argue against species status for both H. wrightii and H. beaudettei using leaf tip morphology alone. This study highlights the need for more definitive molecular methods to understand Halodule taxonomy.

Borrowing ecological principles: Effect of substrate orientation and complexity on reef formation

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Marine ecologists have long been interested in determining the drivers of population success and community structure in marine ecosystems. Understanding the causes and consequences of recruitment and survival of organisms within a community are important goals of population and community ecology. Past oyster reef restoration studies have mostly explored how substrate and environmental factors affect oyster development. This project seeks to determine the role substrate orientation and complexity have on the formation of biogenic reefs, as well as its effect and interaction with structural complexity and habitat availability. I will deploy 14cm x 14cm 3D-print molded ceramic settlement tiles mounted on steel racks across intertidal sites in Taylors Creek, an estuarine tidal creek in North Carolina. Half of the tiles will be constructed using 3D-printed molds to contain structural components (i.e. pits and grooves) to test for structural complexity (simple or complex) alongside orientation. There will be a total of four monitoring treatments (horizontal and simple, vertical and simple, horizontal and complex, vertical and complex). Determining whether conceptual understanding of processes driving community assembly in one ecosystem can be used to predict patterns of community assembly in another ecosystem will help in providing guidance for creating ideal designs for restoration.

Barrier island spit evolution at the terminus of a mainland attached coastal system: DeBordieu Island, SC

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Southward building barrier spits bound the entrances to Winyah Bay in northeastern South Carolina. This study focusses on DeBordieu spit, which is located updrift of the smaller northern inlet. Optically stimulated luminescence (OSL) chronology data is added to ground penetrating radar (GPR) and core stratigraphic and LiDAR geomorphic studies to better understand the evolution of the barrier spit. DeBordieu spit consists of a northern landward ridge formed by southward spit accretion during the mid-18th century (CE 1744-1777). Seaward of the southern end of the ridge, a northward accreting ridge developed during the mid-19th century (CE 1859-1875). Historical charts show that the most recent southern spit advance formed in the CE 1930's. The OSL chronology allows for comparisons with North Island spit to the south where episodic advance may be tied to greater downdrift sediment supply resulting from increased storm activity.