Ampuero Reyes*, W, G.L. Chmura
MASS AND VOLUME CONTRIBUTIONS OF BELOWGROUND BIOMASS TO A ST. LAWRENCE ESTUARY SALT MARSH SOIL
Department of Geography, McGill University, Montreal, QC
Many studies assume a constant relationship between mass and volume of plant belowground organic matter. In this study, we examined the relationship of belowground biomass to the belowground volume of four species in a St. Lawrence estuary salt marsh at la Pocatière, Québec. The low marsh zone was dominated by *Spartina alterniflora*. *Spartina patens* dominated the adjacent high marsh. The third zone was also dominated by *S. patens* but included 10% (by cover) of invasive *Phragmites australis*. Tubers and roots of *Carex esculatas*, an invasive in Québec, were found in the *S.patens* and *P. australis/S. patens* zones. Ten soil samples of the top 15 cm of soil were collected from each of three different salt marsh zones. Soil samples were washed over a 1 mm sieve and the organic matter retain was separated as live or dead and by species. The dry mass and volume (measured by displacement of water) of roots and rhizomes were measured individually. Volumes generally, followed a similar pattern in all three zones with the greatest volume contributed by dead biomass and the least by rhizomes. The relationship of volume to the mass of all species' components will be included in the presentation.

Berounsky*, V.M.(1), E. J. Peterson (2)
CLIMATE CHANGE, DECADAL CYCLES, AND WHY WE MIGHT (OR MIGHT NOT) HAVE A VENTILATION IN THE PETTAQUAMSCUTT ESTUARY IN SOUTHERN RHODE ISLAND IN 2020 - PRELIMINARY ANALYSIS
(1)Graduate School of Oceanography, University of Rhode Island, Narragansett, RI; (2)Narrow River Preservation Association, Saunderstown, RI.
The Pettaquamscutt Estuary (Narrow River) in southern Rhode Island is 10 km long and has two deep fjord-type (12 m and 18 m) ice block basins scoured out by glaciers that have almost permanent anoxic waters below 4m. There basins have had documented ventilations (also called overturns) of the deep anoxic water into the surface waters in the fall of 2007, 1990, 1980, 1971, 1957 (so 17,10, 9, and 14 years apart). Ventilations affect phytoplankton, fish and invertebrates of the ecosystem. Ventilations occur when the upper level of oxygenated fresh and salt water and a lower level of deep anoxic water become closer in density due to decreasing air temperature in the fall and there is reduced freshwater inflow caused by drought conditions in the late summer and fall. But there needs to be a rapid decline in water temperature and strong winds. This year, 2020, has been a very dry summer and fall in Rhode Island, which is in a "drought advisory" as declared by the state. Recent dissolved oxygen measurements show the anoxic-oxic interface to be rising from 4 m deep on September 20 to 3 m on September 26, but it has also been a record year for water temperatures, reaching 33°C in August in the Northern Basin. Comparisons are being made with precipitation and water temperatures of other years and other factors indicating climate change, along with comparison of events that are on decadal or fifteen-year cycles, such as the North Atlantic Oscillation, and with long term monitoring in Narragansett Bay. All of these factors will lend insight as to whether or not it is likely a ventilation will happen this fall and will cause disruptions to multiple aspects of this ecosystem.

Casale*, E.T., K. Nyhuis, J.D. Kinsey
BASE-EXTRACTED PARTICULATE ORGANIC MATTER OF THE QUINNIPIAC RIVER ESTUARY
Quinnipiac University
Organic matter (OM) in bodies of water such as the Quinnipiac River estuary play a significant role in biochemical cycling. OM can undergo chemical and physical transformations and be consumed by microbes. Particulate organic matter (POM) consists of the OM too large to pass through a filter. The source of POM can be allochthonous, which refers to material from outside the system, or autochthonous, which refers to primary or secondary production forming within the system. Land use of the surrounding environment can contribute to allochthonous material traveling into the river estuary through anthropogenic (human) activities and weather-related runoff; and therefore can alter the carbon cycling within the system. Water samples and abiotic measurements (temperature, conductivity, and salinity) were collected from nine locations eight times during summer 2019. Each sample was filtered through a GF/F filter. The POM was base extracted (BEPOM) and analyzed for fluorescence and absorbance. The fluorescence excitation emission matrices (EEMs) will be used alongside carbon stable isotope measurements to illuminate sources of POM in the Quinnipiac River, including allochthonous and autochthonous sources. It is expected that BEPOM fluorescence will have noticeably different saturation intensities for protein-like substances, indicating autochthonous production, and terrestrial (humic-like) sources depending on the location along the river estuary, with greater primary production occurring at sites closer to Long Island Sound. This research will be combined with data from the dissolved fraction to gain knowledge on carbon cycling and the effect of land use on the Quinnipiac River.

Castagno*, K.A. (1), J.P. Donnelly (2), K. McKeon (3)
INVESTIGATING WIDESPREAD HISTORIC EROSION IN A CONNECTICUT SALT MARSH
(1) Department of Marine and Environmental Sciences, Northeastern University, Nahant, MA
(2) Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA
(3) Department of Geosciences, University of Massachusetts, Amherst, MA
Salt marshes are important sources of coastal protection that are particularly vulnerable to anthropogenic impacts. Both human and climate dimensions are imperative to better understanding the geomorphic history of salt marshes in the past half millennia. This study investigates a stratigraphic sequence in a salt marsh in Niantic, CT, associated with an erosional unconformity and a 600-year sedimentary hiatus, followed by a period of recovery and a change in vegetation. Building on previous research by van de Plassche et al. [Geology, 34(10), 829–832 (2006)], this expansive, widespread hiatus is correlated with a high-energy event, likely in the mid-seventeenth century. This erosional unconformity was originally thought to be the result of intense hurricane activity, but no modern analog exists for widespread, hurricane-induced erosion in New England, and sediment cores in this location indicate that several historic hurricanes caused deposition instead of erosion. We are exploring multiple hypotheses, including the potential for marsh platform weakening from repeated, well-documented storm events during this 600-year time frame, as well as the hypothesis that the sequence was caused by ice rafting—likely associated with colder temperatures of the Little Ice Age—and potentially augmented by anthropogenic ditching. Understanding both past and present interactions among ice rafting, intense periods of storminess, and anthropogenic ditching—as well as their implications for marsh

resilience—is increasingly important in the face of climate change, which may lead to both increased frequency of extreme cold events and increased storm intensities in middle latitudes.

Chmura, G.L.*, L.B. van Ardenne
REFLOODING DRAINED SALT MARSHES HAS IMMEDIATE CARBON STORAGE BENEFITS
Department of Geography, McGill University, Montreal, QC
Drainage of salt marshes for agriculture has kept them from serving as a blue carbon sinks for centuries. Now below sea level, they are becoming increasingly expensive to maintain as sea level continues to rise, driving an interest in their restoration. When tidal flooding is returned, restoration of the carbon sink can be rapid, particularly on the Bay of Fundy. The limited research published on the rate at which carbon sequestration occurs indicates that on the Bay of Fundy, a surprising amount of organic carbon (OC) is stored within just the first 9 years. To apply for credits for restoration on the carbon market, however, we must be able to estimate the magnitude and value of the renewed OC stock for a much longer period. We examined OC stocks in 13 marshes, previously drained for agriculture, that had been reflooded for periods ranging from 9-92 yr. The marshes, located mostly on the Bay of Fundy, but also on the Gulf of St Lawrence, had tidal amplitudes ranging from 2 to >10 m. In all but the marsh with the 9 yr recovery period, we collected multiple cores within *Spartina patens*, which we used as an indicator of full vegetation recovery. Overall, we collected >56 cores. Using the depth at which an “agricultural horizon” was visible, we found that average thickness of the sediment accumulation within a marsh ranged from 28-96 cm. Although the thickness of sediment accumulation increased with recovery period, the rate of OC accumulation significantly decreased with recovery period. OC accumulation was weakly related to tidal amplitude, but a multiple regression did not produce more significant results than when using recovery period alone.

Cole Ekberg, M.
SCIENTIST SPOTLIGHT INITIATIVE: ENOURAGING EQUITY AND INCLUSION IN THE MARINE SCIENCE CURRICULUM
Diablo Valley College, Pleasant Hill, CA
Diversity is lacking in the environmental science, marine biology and oceanography fields, and STEM professions in general. In math, engineering and science classrooms, students of color do not often see themselves reflected in the curriculum, and thus tend not to feel welcome in those spaces. The students that do pursue majors in these fields are often the only students of color in their classroom or program, and may have difficulty finding peers, mentors or role models that they identify with. “Scientist Spotlight” assignments were developed by Professor Jeff Schinske of Foothill College in the San Francisco Bay area in an effort to make biology classrooms a more welcoming space. The assignments are designed to introduce students to relevant course material and scientists that are currently working in a related field. The assignments include a brief biography, and links to online content including interviews, videos, and scientific publications. Students review the relevant material then write a response to a series of prompts. The scientists highlighted are people of color, first generation college graduates, women, LGBTQ+ or scientists with disabilities. I have been using these assignments in all my courses for a few years now, and the response has exceeded my expectations. While all students get something valuable out of each spotlight, for some, the spotlights have been truly eye opening. The Scientist Spotlight

Initiative is a publicly accessible database, and anyone (student or instructor) can retrieve or create content. More information is available at https://scientistspotlights.org/.

Feldsine*, N.A.(1), G.E. Moore (2), D.M. Burdick (3), S.C. Adamowicz (4) RESTORATION OF NATIVE PLANT COMMUNITIES IN SAND DUNE SYSTEMS: A STUDY OF THE DUNES OF PLUM ISLAND, NEWBURY, MASSACHUSETTS AND EDUCATIONAL OUTREACH

(1) Department of Biological Sciences, University of New Hampshire, Durham, NH;
(2) Department of Biological Sciences, Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH;
(3) Department of Natural Resources & the Environment, Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH;
(4) Rachel Carson National Wildlife Refuge, U.S. Fish and Wildlife Service, Wells, ME

The impacts of Superstorm Sandy on the eastern coast of the United States have emphasized the need for resilient sand dunes. These dunes are primarily dominated by *Ammophila breviligulata* but a host of other native species commonly occur in these systems and provide diversity. Multi-species plantings are not often included in dune restoration efforts and may benefit sites where dune die out is a concern. The goal of this study was to explore the importance of biodiversity on dune resiliency by planting other native species (*Solidago sempervirens*, *Lathyrus japonicus*, and *Cakile edentula*), along with *A. breviligulata*, to stabilize and revegetate dunes on the north shore of Massachusetts. Field experiments were used to determine which of the selected species may be well suited for restoration by recording plant survivorship and changes in percent cover. Comparisons were also made among the sand accretion of three experimental treatments: 1) single species, 2) two species), and 3) four species. Diversity and percent cover were compared between control sites, restoration areas, and dunes exhibiting signs of dune dieout. Results of the three planting efforts indicate that *S. sempervirens* and *L. japonicus* are suitable for restoration plantings in terms of survivorship, however, relative sand accretion was affected by proximity to the ocean rather than diversity level. Percent cover was greatest in the reference sites compared to the restoration and dieout areas, while diversity was greatest in dieout areas. In addition to field study, educational outreach was conducted through the Science, Technology, Engineering, Art, and Math (STEAM) Academy at Dover Middle School.

Forbrich, I.(1), N. Weston (2), K. Alizad (3), Anne E. Giblin* (1)
WILL THE TRANSITION FROM HIGH MARSH TO LOW MARSH ALTER CARBON SEQUESTRATION, NUTRIENT REMOVAL, OR OTHER ECOSYSTEMS SERVICES?
(1)The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA;
(2) Villanova University, Villanova, PA;
(3) Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina, Columbia, SC
Accelerated sea-level rise is leading to an increase of flooding and expansion of *S. alterniflora* in New England salt marshes. To assess the impact of this transition on ecosystem services (e.g. C sequestration and nutrient removal), we are conducting a space-for-time experiment within the Plum Island Ecosystems LTER. Here, high marsh sites correspond to the 'current' conditions and low marsh sites represent the 'future' conditions. In paired creeksheds, we measure marsh-atmosphere CO_2 exchange together with the lateral exchange of C, sediment and nutrients. SETs and core dating were used to assess accretion rates. After 5 years of measurements, a subtle difference in net CO_2 uptake between high marsh and low marsh became apparent, indicating a stronger carbon sink in the low marsh. Our lateral exchange measurements do not detect differences in the tidal carbon exchange between sites. Higher productivity and sediment retention in the low marsh contribute to stronger accretion rates in this environment and constitutes a positive feedback. Furthermore, nitrogen retention in the low marsh is significantly greater than in high marsh. However, this may lead to less nutrients accessible for estuarine primary production in low marsh creeks than in the high marsh creeks. Our findings are consistent with the Hydro-MEM modeling results, which show an increase in low and productive marsh area (3 to 22 percent) with cost of losing high marsh (2 to 18 percent) under intermediate-low, intermediate, and intermediate-high sea-level rise NOAA 2017 projections for the year 2100. These findings highlight that 1) transition to low marsh will prolong marsh persistence and 2) it may come with changes in ecosystem services.

Hagy, J. D. III
THE EVOLVING SCIENTIFIC FOUNDATION FOR REGULATION OF DISSOLVED OXYGEN IN COASTAL MARINE ECOSYSTEMS
Atlantic Coastal Environmental Science Division, Center for Environmental Measurement and Modeling, US Environmental Protection Agency, Narragansett, RI
Dissolved oxygen (DO) is an important water quality characteristic in aquatic ecosystems that can profoundly influence the distribution, abundance, and ecological relationships among aquatic organisms. Early recognition of DO effects placed DO limits among first water quality criteria adopted in the US. Remarkably, these criteria have been retained for decades despite an avalanche of research and policy attention to hypoxia. The US EPA updated its marine DO criteria guidance in 2000, supporting adoption of revised DO criteria in at least 6 US states (RI, CT, NY, MD, VA, FL). Two decades later, the scientific foundations for regulation of dissolved oxygen has evolved, potentially influencing further revisions to DO criteria and related management actions. I will outline the scientific foundation for existing DO criteria, outline new science that is relevant to development of new or revised DO criteria , and briefly mention possible solutions for DO management that could better reflect the new science. Among my important findings is that early DO criteria were based on far more extensive science than expected, with important work dating back 100 or more years. Secondly, I found that the early

work was grounded principally in field-based empirical science, supported by laboratory experiments. This contrasts with EPA's current DO criteria guidance, which is based principally on results of laboratory experiments. This raises the question of whether a similar strategy could or should be used today to address the challenges raised by new scientific information.

Haviland*, Katherine (1,2), Hayn, Melanie (1,2,3), Howarth, Robert (1,2,3), Marino, Roxanne (1,3)
A COST-EFFECTIVE METHOD FOR ANALYZING NET SEDIMENT ACCUMULATION IN LOW-ENERGY ESTUARIES OVER VERY SHORT TIME SCALES
(1) Cornell University Department of Ecology and Evolutionary Biology, Ithaca NY;
(2) Cornell University Field of Natural Resources, Ithaca NY;
(3) Marine Biological Lab Ecosystems Center, Woods Hole MA
Increased sediment organic matter in seagrass meadows can lead to toxic levels of sulfide in the rhizosphere. Reduced wave action within beds leads to settling of organic matter, which may exacerbate prevalence of sulfide. We developed a low-cost method to measure net sediment accumulation and organic matter within subtidal seagrass meadows for use over 2- to 7-day deployments. We tested our method in eelgrass meadows in West Falmouth Harbor (WFH), where we deployed more than 130 sediment traps over the course of 3 months. We found spatially heterogenous sediment accumulation levels, spanning 6 to nearly 3000 g dry weight (DW) sediment m^{-2} per day depending on site and distance from seagrass bed edge. Our average values (142 g DW sediment m^{-2} day^{-1} and 10 % organic matter by weight) aligned with measurements of sediment trapping from the literature derived from other methods, both in New England and around the world. Our findings indicate decreased net sediment accumulation during tropical storm and high-wind events in WFH, perhaps due to scouring. Through the creation of 7-m long transects traversing the edge of a seagrass bed, we found high levels of sediment accumulation 1-m outside seagrass beds, decreased accumulation just inside a bed, and then a potential increase in sediment accumulation 4-5 m inside a bed. Organic matter followed the opposite pattern. Our method may be applicable to other sheltered estuaries but needs modification prior to use in high-energy environments. Because of the low-cost requirement, deployment of multiple traps both within sites and across adjacent sites allows us to better understand small-scale changes in seagrass meadow sediment dynamics.

Heyer,*M.E(1), M, Alldred

USING LIDAR DATA TO DOCUMENT ELEVATIONAL CHANGES IN RESTORED URBAN COASTAL WETLANDS

Department of Earth and Environmental Science, State University of Plattsburgh, NY

Jamaica Bay (New York, NY) is a hypereutrophic, urban estuary that has lost over 92% of its historic wetland area over the past century. As a consequence, it has been the site of a series of large-scale (40 acre) marsh restorations over the past two decades. Whether these restored marshes will remain stable long-term and provide the same ecosystem services as natural marshes remains an open question. The goal of this project is to document changes in elevation for the wetlands in Jamaica Bay to determine whether the marshes are keeping pace with sea-level rise or experiencing subsidence. Here we focus on two large-scale marsh restorations: Elders East, which was completed in 2006, and Yellow Bar, which was completed in 2012. Using publicly available LiDAR data collected between 2008 and 2020, we determine how elevations of the marsh platform and marsh edge, relative to mean sea level, have changed over time following initial restoration. We compare changes in elevation in these two restored marshes to Black Bank, an unrestored marsh that has declined rapidly in both stability and total extent. The period of available LiDAR data includes two major disturbance events, Hurricane Irene and Superstorm Sandy. Superstorm Sandy occurred 6 years after the completion of Elders East and directly following the completion of Yellow Bar, providing us with a rare opportunity to document the elevational responses of two young marshes to a major disturbance event. The results of this project will complement ongoing interdisciplinary efforts to document the efficacy of coastal marsh restoration efforts in New York and throughout the Northeastern United States.

Kahn, B.C.M.*(1,4), Drew, J.A. (2), Humphries, A. (3), Palmer, M.I. (1), Tufts, D.M. (1)

VARIATION IN METAL CONTENT, BODY CONDITION, AND A METALLOTHIONEIN GENE IN EASTERN OYSTERS (*CRASSOSTREA VIRGINICA*) TO INFORM MANAGEMENT AND PRACTICES FOR RESTORATION

(1) Columbia University;
(2) State University of New York College of Environmental Science and Forestry;
(3) University of Rhode Island;
(4) The Graduate Center, City University of New York

The Eastern oyster (*Crassostrea virginica*) is an ecologically and economically important species. The eastern U.S. coastline has a long industrial legacy of heavy metal contamination, the effects of which are poorly understood. We assessed the latitudinal impact and distribution of heavy metal contamination on C. virginica from Virginia to Maine, comparing spatial variability in heavy metal concentrations, condition index (CI), and a metallothionein-coding gene (CvMT-1). X-ray fluorescence on shells showed that copper and lead were significantly higher in oysters from contaminated sites in the Delaware Bay, Rhode Island, and Maryland compared to clean sites. Lead, copper, titanium, and zinc were linked to lower CI values. DNA sequences showed slight variation among sites, but no substitutions appeared to be adaptive to metal conditions in this particular gene. Deeper understanding of the ecotoxicological effects of heavy metals would be beneficial for oyster restoration and aquaculture, particularly in urban or formerly industrial coastlines.

Kennedy*, C, A., Pappal, M. Carullo, S. Duffey
TRANSITIONS OVER TIME: ESTABLISHMENT OF LONG-TERM SALT MARSH SENTINEL SITES IN MASSACHUSETTS
Massachusetts Office of Coastal Zone Management, Boston, MA
Climate change, in particular sea level rise, will have profound impacts on salt marshes. If marshes are unable to accumulate sediment or biomass to keep up with the rate of sea level rise, they will begin to drown – ultimately leading to the conversion of salt marsh into mudflat. The ability of salt marshes to migrate upland is impeded by both natural and anthropogenic barriers such as steep slopes, habitats resistant to conversion, and coastal development including roads, parking lots, homes, hardened shorelines, and legacy berms and ditches. Given the potential impacts from climate and other stressors on salt marsh habitat, it is critical that monitoring programs are established to track changes through time. In 2017, the Massachusetts Office of Coastal Zone Management (CZM) established three long-term sentinel sites in Massachusetts (Essex, Barnstable, and Westport). Permanent transects running from the marsh seaward edge into the surrounding upland were established at each site and baseline data were collected including elevation, hydrology and plant communities. CZM will return to the sites every 3-5 years to collect vegetation, elevation and hydrology data, and analyze trends over time. This on-the-ground information combined with modeling and remote sensing efforts will provide a better understanding of salt marshes in Massachusetts, and will inform state agencies, town managers and property owners about potential changes in habitat over the long-term.
LaBash*, B., A. Hoadley, L. Clay, B. Burke
ASSOCIATING UNDERWATER IMAGERY WITH GEOLOCATION FOR THE STUDY OF EELGRASS HEALTH
Cohasset Center for Student Coastal Research, Cohasset, MA
Within Cohasset's harbor exists extensive eelgrass beds that are valued for habitat, combatting ocean acidification, and their function as blue carbon sinks. Upon receiving a grant from the Marjot Foundation, high school researchers from the Cohasset Center for Student Coastal Research tasked themselves with determining if there was a correlation between the eelgrass health (measured by coverage density) and the sediment type in Cohasset's harbor. After beginning the research, an important question emerged: how can we collect a sufficient amount of data? In previous years, data was collected at anchored sites using Esri's Survey123, with each site taking approximately 15 minutes from down-anchor to up-anchor. This year, instead of collecting data at a stationary site, we drove a grid of transects over the harbor while capturing underwater video and geolocation. We engineered a GoPro-compatible underwater staff to record video of bottom type and its eelgrass as we traversed the tracks of the grid, and developed an application on top of Esri's QuickCapture to record geolocation every 6 seconds. Using Python, each GPS point was matched with the closest frame in the GoPro video, generating 600 geo-tagged pictures per hour of video footage. With this method, each recorded GPS point effectively becomes a study site as coverage density and apparent particle size are provided by the matched underwater imagery. The larger quantity of study sites provides a more accurate correlation coefficient while higher study site density yields a more comprehensive map of the subtidal area that hosts Cohasset Harbor's eelgrass meadows.

Loffredo*, J.A.(1,2), J. Bishop (1,2), D. Perry (3), C. Tremper (4), C. Chaffee (5), W. Ferguson (6), C. Wigand (7)

APPLYING DREDGED SEDIMENTS TO BUILD COASTAL RESILIENCE IN SALT MARSHES: SOIL BIOGEOCHEMICAL RESPONSES

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(2) Department of Natural Resources Science, University of Rhode Island, Kingston, RI; (3) Mass Audubon, Lincoln, MA;
(4) ORAU Student Services at USEPA-ORD-CEMM-ACESD, Narragansett, RI;
(5) Narragansett Bay National Estuarine Research Reserve, Prudence Island, RI;
(6) Save the Bay - Narragansett Bay, Providence, RI;
(7) US Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling, Atlantic Coastal Environmental Sciences Division, Narragansett, RI

Tidal marshes in the US are vulnerable to increased flooding due to sea level rise and an increase in the frequency and severity of storms. Some salt marshes are drowning in place, and observations of plant die-off and shoreline erosion have been reported. Increasing marsh surface elevation by applying dredged sediments over the tidal marsh peat is one approach to build coastal resilience. In this study we examined the effects of applying varying depths of clean dredge material (+5cm, +10cm) on soil biogeochemistry and vegetation recruitment in a greenhouse mesocosm experiment. The dredge materials for the mesocosms were obtained from Quonochontaug Marsh, RI–a restoration site where sediment placement occurred in 2019. Initially, buried marsh soils had lower redox potentials and higher porewater sulfide concentrations, indicating more reducing conditions. Over time, subsurface redox potential tended to increase, which could be attributed to vegetation recruitment and/or increasing biogeochemical complexity with time. Additionally, porewater salinity was generally lower in buried peat. We detected increased methane efflux with dredge treatment in the fall in the low marsh. Restoration managers should be aware of and potentially monitor these initial responses. Previous research found that labile ammonium can accumulate in buried marsh soils, which could facilitate vegetation recruitment. However, based on our findings, the simultaneous accumulation of phytotoxic sulfides may inhibit plant-mediated nutrient uptake. Future work aims to compare and validate the greenhouse findings with field measurements. We will also assess nitrogen attenuation capacity through denitrification assays and genomic analyses.

McGuire*, P.M.(1), J.W. Partan (2), M. Jakuba (3)
TIDERIDERS: PROTOTYPE LOW-COST PROFILERS FOR WATER QUALITY MONITORING
(1) Brookline High School;
(2) Woods Hole Oceanographic Institution
(3) Woods Hole Oceanographic Institution
The TideRider is an easy-to-build, $1200 profiling float designed to collect water quality data. The device uses a bi-stable buoyancy system to alternate between resting on the seafloor and drifting on the surface, timing its surfacings to leverage favorable tides and winds, either to move toward a waypoint or to hold position as a “virtual mooring.”. We presented the TideRider concept at the 2020 Spring NEERS Meeting along with preliminary results from an early prototype that demonstrated short-term waypoint navigation in a tidally-flushed estuary. In this lightning talk, we provide an update of development activities over this past summer. The current prototype proved significantly more reliable following integration of a custom electronics backplane, and it features improved control software, a novel and more effective buoyancy system, and mechanicals designed around configurability and ease of construction. A series of in-water tests culminated in a two-day deployment in a freshwater pond where it collected 30 profiles of temperature and ambient light to 8 m depth over the course of 50 hours returning mission status in near real-time via the cellular network. In the future, we will add additional scientific instruments, including those that measure salinity, dissolved oxygen, conductivity, and oxidation-reduction potential. We continue to work toward a multi-day deployment in Buzzards Bay to demonstrate waypoint control. We anticipate that TideRider’s realized low cost will allow deployment in large numbers, and, with further development, to augment monitoring efforts in Buzzards Bay and elsewhere.
Mittermayr*, A.(1), S.E. Fox (2), J.A. Nelson (3)
PROMINENCE OF OMNIVORY AND SEASONAL FOOD WEB NICHE EXPANSION AND CONTRACTION IN SEAGRASS FOOD WEBS IN PLEASANT BAY, MA
(1) Center for Coastal Studies, 5 Holway Ave., Provincetown, MA;
(2) Cape Cod National Seashore, 99 Marconi Site Rd., Wellfleet, MA;
(3) Department of Biology, University of Louisiana, 300 E. St. Mary Blvd., Lafayette, LA
Seagrass ecosystems perform important ecosystem services which are supported by their productivity and expansive food webs. Although food webs and ecosystem flow of energy are dynamic in both space and time, these trophic relationships are most often analyzed as static constructs. To understand the spatial and temporal dynamics of temperate seagrass food webs, we sampled producers and consumers in two seagrass beds in Pleasant Bay, MA from June till October. Samples were analyzed for C, N, and S stable isotopes. Using the literature, consumers were classified into feeding guilds. The triple stable isotope data was analyzed using isotope bi-plots and nMDS, which showed considerable similarity among season, sites, and feeding guild. Using stable isotope data, consumers were re-assigned to feeding guilds, and the dominance of omnivory was revealed, even for species well documented as grazers. Isotope data were then modeled using MixSIAR, and results revealed significant differences in consumer diet sources and trophic levels across seasons. Omnivores, in particular, displayed considerable flexibility and shifts in their diets from early summer till fall. Furthermore, for several omnivorous species, the size of their feeding niche within the food web contracted through the season with larger niches in early summer when food resources are scarce and the smallest niche in early fall when food resources are most abundant. This study tracks the pathway of seagrass ecosystem productivity across the growing season and highlights the value of triple isotope analysis and modeling to reveal the tremendous adaptability of omnivores in these critical ecosystems.

Moore, E.C., L.E. Cruz*
NBC'S CSO ABATEMENT PROJECT - A PROGRESS REPORT FOLLOWING PHASE II
Narragansett Bay Commission, Providence, Rhode Island
The Narragansett Bay Commission (NBC) owns the two largest wastewater treatment facilities (WWTFs) in Rhode Island and manages over 60 combined sewer overflow (CSO) outfalls within the service district. During heavy rain events, these outfalls may release combined sanitary and storm-water flows into Narragansett Bay and urban rivers. These discharges are violations of the Clean Water Act, negatively impacting water quality and public health. The NBC is implementing a three-phase CSO Abatement Project expected to eliminate 98% of CSO discharges. Phase I was completed in 2008, when a three-mile long, 65-million-gallon CSO storage tunnel was constructed in Providence, capturing approximately 50% of all CSO flows for treatment at the Field's Point WWTF. Phase II, completed in 2015, included separation of sanitary and storm sewers, diversion of additional CSO flows to the tunnel, and construction of a screening and storage system at an existing wetland CSO discharge point. Phase III, currently in design, will consist of green infrastructure projects and construction of a second storage tunnel along the Blackstone River, terminating at the Bucklin Point WWTF. Since the completion of Phases I and II, the NBC has measured substantial water quality improvements in the urban rivers and estuarine receiving waters in Narragansett Bay. These improvements have led to increased days open to shellfishing as well as potential licensing of public beaches in the Providence River. This talk will include preliminary analysis results and an overview of the report goals to inform the local audience and solicit feedback on our approach from the NEERS community.

Oviatt*, C.A.(1), H. Stoffel (1), K. Huizenga (1), L. Reed (1), D. Codiga (2), L. Fields (3)
A TALE OF TWO BLOOMS IN NARRAGANSETT BAY: HOW MANAGED NUTRIENT REDUCTION AND STORM NUTRIENT INPUTS IMPACT PRIMARY PRODUCTION, COMMERCIAL SPECIES AND SUMMER HYPOXIA
(1)Graduate School of Oceanography, University of Rhode Island, Narragansett, R.I.;
(2)15 Dresden St, Jamaica Plain, MA;
(3)Carter & Sloope, Athens, Georgia
We explore whether the managed nitrogen reduction that was implemented from 2005 to 2012 in Narragansett Bay needs modification using long term monitoring data sets. Regulations reduced nitrogen inputs by about 60% and decreased primary production by a third. Two storms, one during the period of nitrogen reduction and one after, caused large phytoplankton blooms. The two storms, occurring in colder months in March 2010 and Fall 2017 to winter 2018, increased annual nutrient inputs above the average annual values for the year. The impact of the nutrients was inverse to storm intensity; flooding in the storm of spring, 2010 caused a smaller increase in primary productivity than the lesser storms of fall 2017 to winter 2018 probably, due to increased flushing rates during the 2010 storm. The storms caused a large bloom in spring 2010 and a massive winter-spring bloom in 2018, followed by increased summer productivity, increased summer sediment oxygen demand and increased ammonia fluxes, at least for the 2017 event. Some commercial fishing species appeared to increase after the storm events. Neither storm enhanced summer hypoxia the following summer. During both summers hypoxia was typical of minimal years indicating that managed summer nitrogen reduction remained adequate even in the aftermath of organic inputs from large storms that occurred during the colder months. Storm nutrient impacts on commercial species suggest that increasing nitrogen inputs in colder months from WWTF might enhance Bay fisheries for squid and hard clam without diminishing summer water quality.

Perry*, D.C. (1,5), C. Chaffee (2), W. Ferguson (3), C. Wigand (4), C. Thornber (5) PROVIDING SALT MARSHES MORE TIME: IMPLEMENTING CLIMATE CHANGE ADAPTATION STRATEGIES FOR DROWNING NEW ENGLAND SALT MARSHES
(1) The Massachusetts Audubon Society, Lincoln, MA;
(2) Coastal Resources Management Council, Wakefield, RI;
(3) Save The Bay, Providence, RI;
(4) US EPA ORD CEMM Atlantic Coastal Environmental Sciences Division, Narragansett, RI;
(5) Department of Natural Resources Science, University of Rhode Island, Kingston, RI
Sea level rise within New England is accelerating at a rate faster than the global average, leaving salt marshes particularly susceptible to degradation. Due to low elevations and limited sediment supplies, New England salt marsh accretion rates often cannot keep up with sea level rise rates leading to drowning salt marshes. Rhode Island coastal managers have implemented the climate change adaptation strategies, sediment enhancement and hydrological restoration (e.g. runnel installations) to offset the effects of sea level rise within salt marshes and protect this important resource. Sediment enhancement is a technique that uses dredge material to increase salt marsh surface elevation. Runnels (shallow channels) are used to enhance drainage within salt marshes. This hydrological restoration technique, implemented along the Narrow River in Narragansett, RI, showed positive implications on the recolonization of the low marsh plant, *Spartina alterniflora*, and the persistence of the high marsh plant, *Spartina patens*, in areas of higher elevation. The

sediment enhancement project, implemented at Quonochontaug Pond in Charlestown, RI, incorporated adaptive management exemplifying interdisciplinary partner and stakeholder collaboration and iterative learning methods. The findings of these projects highlight the complex effects of climate change adaptation strategies, and provide insights into the beneficial uses of adaptive management to address uncertainties associated with climate change.

Peteet, D.(1), C. Meyer (1), A. McCarthy (1), C. Gorczicky (1), J. Nichols (2), J. Browne (3), S. Stern-Protz (1), C. Chang (2), S. Kovari (1), C. Kwong (2), M. Reza (1), T. Kenna (2)

COMPARING FOUR CENTURIES OF COASTAL MARSH HISTORY OF THE NORTH AND SOUTH SHORE, LONG ISLAND

(1) NASA/Goddard Institute for Space Studies, NY, NY;
(2) Div. of Paleoecology, Lamont Doherty Earth Observatory, Palisades, NY;
(3) Dept. of Conservation and Waterways, Town of Hempstead, Pt. Lookout, NY

Sediment marsh cores taken on Long Island's North Shore, Alley Creek and Udall's Cove provide a history of vegetation, heavy metal pollution, foraminifera, and carbon sequestration from the time of European settlement to present. The cores were first scanned using x-ray fluorescence spectroscopy (XRF), and then analyzed for loss-on-ignition (LOI), carbon and nitrogen isotopes, pollen and macrofossil analysis at 4-cm resolution. The urban impact on the northern shore of Long Island is similar to that of Jamaica Bay marshes, with a decline in inorganic matter and increases in nitrogen toward the present. Pollen and spores along with lithology indicate a shift from low marsh to high marsh peat in more recent years locally, and regionally a decline in *Carya* (hickory) with an increase in *Phragmites* (common reed). Heavy metals such as lead and copper in the marsh sediment indicate the vulnerability of the coastal waters to increased pollution with sea level rise.

Polanco, H.(1), S. Hayes (1), C. Roble (1), M. Krupitsky (1), B. Branco (2)(3)

THE PRESENCE AND SIGNIFICANCE OF MICROPLASTICS IN SURFACE WATER IN THE LOWER HUDSON RIVER ESTUARY 2016-2019: A RESEARCH NOTE

(1) Hudson River Park Trust;
(2) Brooklyn College;
(3) CUNY Graduate Center

Microplastics are a major environmental issue of concern. Since 2016, Hudson River Park has collaborated with Brooklyn College to survey microplastics within Park waters, between Chambers and 59th Streets in Manhattan. It was hypothesized that microplastic concentration is influenced by proximity to combined sewer overflow (CSO) points, precipitation, and tides. Samples were collected at channel and near-shore locations at downtown and midtown sites. Microplastics were analyzed following NOAA methods via stereo microscope. Concentrations in 2018 were higher than in 2016, 2017 and 2019 ((ANOVA $F(1,70) = 5.2$, $p<0.03$*; post hoc Tukey test $p<0.009$*)), and near-shore sites tended to exhibit higher concentrations than channel sites (ANOVA and post-hoc Tukey: $p<0.03$*). Microfibers were not fully accounted for and fragments were highly prevalent in all samples (~70%). Additional data will improve the understanding of the presence of microplastics in the Lower Hudson and elucidate the effects of wet weather on plastic concentrations.

Robinson*, A.R., C.E. Tilburg
DETERMINING SURFACE FLOW OF A SEMI-ENCLOSED HARBOR USING UAV IMAGERY
School of Marine and Environmental Programs, University of New England, Biddeford, ME
Photogrammetry and orthomapping using aerial imagery have been historically applied to studies of coastal morphology. Low cost and readily available unmanned aerial vehicles (UAVs) are increasing the feasibility of using aerial imagery to supplement traditional methods. We used advanced geographical information system (GIS) software to develop a methodology to capture and process imagery from a quadcopter drone to calculate the direction of surface flow across occupied mooring fields. Harbors hosting a high degree of human activity require careful study of potential impacts on the ecosystem by the flow field. Financial and logistical constraints in deploying moored current meters or Lagrangian drifters can be offset by the use of UAVs in targeted areas. UAV imagery of anchorage sites and mooring fields were processed in GIS software to estimate the trajectory of surface flow, based on the tendency of moored boats to orient into the current. Short and frequent flights to efficiently capture a few oblique images that are later projected onto a geographic coordinate system produced data of relatively high spatial and temporal resolution. This technique was applied in Wood Island Harbor and Biddeford Pool, Maine to assess surface flow direction across a variety of wind and tidal conditions. Preliminary results show competing influences of wind and tidally-driven surface flow across tidal cycles. Bathymetric influences are also revealed by eddy-type features and flow that is closely oriented with deep channels. Maximum utility is achieved by combining this method with techniques that measure absolute current velocity, but even alone, UAV imagery provides useful information about relative current direction over space and time.

Rock*, M.T., Zeeman, S.
A COMPARISON OF FLOOD STAGE VS. EBB STAGE PHYTOPLANKTON IN A TIDALLY DOMINATED ESTUARY
University of New England
New England estuarine systems are dependent on both rooted plants (*Spartina*) and phytoplankton as primary producers. Phytoplankton, including both diatoms and dinoflagellates, provide much of the energy for the primary consumers, which are mainly zooplankton and shellfish. The Biddeford Pool estuary, in Maine is a habitat for many organisms such as clams, mussels, Atlantic sturgeon, etc., yet has not been the subject of research on phytoplankton. By the use of Flow Cam technology, the phytoplankton species were analyzed for cell count and species identification to create a baseline database. Research was also conducted to determine whether or not the phytoplankton population would decrease due to infaunal grazing. It was hypothesized that grazing would cause a decline in total phytoplankton between the flood and ebb tidal stages. Phytoplankton were sampled at two locations in Biddeford Pool. The first location was at the mouth, the second was at a creek, where the estuary meets a Spartina marsh. The data shows that at the creek location there was a pattern of higher phytoplankton concentrations on the ebb tide. This could be due to the organisms being dislodged from the marsh grasses. However, at the mouth location, the data indicates that there were higher amounts of phytoplankton on the flood tides. This indicates that phytoplankton coming in on the flood tides are being grazed upon during the tidal cycle. This study is a baseline study that can be ongoing to create a larger database of phytoplankton species in Biddeford Pool, Maine.

Schoell*, M., S. Anisfeld, C. Brodersen
RECONSTRUCTING THE HISTORY OF COASTAL WETLAND MIGRATION AT HAMMONASSET MARSH, CONNECTICUT
Yale School of the Environment, Yale University, CT
Accelerated rates of sea-level rise (SLR) are a threat to the extent and function of coastal wetlands. One key mechanism for marshes to survive under these conditions is to retreat landward to adjacent, higher elevations. While we recognize a need to protect adjacent uplands to foster marsh migration, we need to better understand how upland land type, such as a coastal forest, influences the pace of marsh migration. We reconstructed the timeline of marsh migration into a marsh-bordering *Juniperus virginiana* forest in Madison, Connecticut, using a combination of ecological field methods and dendrochronology (tree-ring analysis) to understand how SLR interacts with storm events such as Superstorm Sandy to drive tree stress and forest dieback, and ultimately facilitate marsh migration. Overall, lower-elevation stands had trees with greater signs of stress and a greater presence of marsh vegetation in the understory. Additionally, both the frequency and magnitude of flooding that trees experienced over time were negatively correlated with tree growth rates. Flooding frequency and magnitude played similar roles in decreasing growth rates for trees at higher elevations. However, flooding frequency was a stronger driver of decreased growth rates for trees at a lower position in the tidal frame, and flooding magnitude played a role in tipping stressed trees past their point of recovery. Overall, coastal dieback required a combination of frequent flooding, supplemented by large magnitude storms that ultimately led to tree death. These results will not only improve model estimates of marsh migration rates into coastal forests, but can inform policy and management decisions around land use development and SLR.

Smith, T.P(1), Leduc, E.
UTILIZING A WEB-BASED EXPERT ELICITATION PROCESS TO COLLECT INPUT PREDICTIONS FOR TIDAL MARSH RESTORATION ADAPTIVE MANAGEMENT OBJECTIVES
(1) Cape Cod National Seashore, Wellfleet, MA;
(2) Woods Hole Group, Bourne, MA
The Herring River Restoration Project Adaptive Management Plan developed a hierarchy of objectives with corresponding performance measures and predictive methods. The range of objectives covers more than 40 ecological and socioeconomic factors that will guide decision analysis as the project is implemented. Predictions of expected conditions are necessary to distinguish advantages and disadvantages among the potential restoration scenarios. For a subset of the ecological objectives, robust predictions are available from outputs directly provided by, or derived from, a comprehensive two-dimensional hydrodynamic model. However, for other objectives numerical models either have not been developed or are not cost-effective. For these objectives a web-enabled survey designed for subject matter experts in coastal ecology and wetlands restoration is being used to collect predictive data. Topics covered by the survey include sediment dynamics, water quality changes, mosquito populations, carbon fluxes, and anadromous fish migration. Users are asked targeted questions to elicit their predictions about how the parameter of interest will change in response to project-driven changes to tidal dynamics, as predicted by the hydrodynamic model. Using a multi-point elicitation method, respondents provide low and high ranges for their predictions, the most likely value, and their degree of confidence that the true value will fall within their stated range. Data output from the elicitation web survey is formatted for use in an R-based decision analysis application that summarizes all predictions and

incorporates utility functions and objective weighing to provide a quantified evaluation of the restoration scenarios being considered.

Soukup, J.V.(1), Meyerson, L.A.(2), Cronin, J.T.(3)
EXAMINING THE COMBINED STRESS OF SALINITY AND HERBIVORY ON THE COMMON REED, PHRAGMITES AUSTRALIS, IN NEW ENGLAND SALTMARSHES. (1) University of New Hampshire;
(2) University of Rhode Island;
(3) Louisiana State University
The common reed, or *Phragmites australis*, is a cosmopolitan species of perennial grass that can be found on every continent with the exception of Antarctica. In some ecosystems, such as the Mississippi River Delta (MRD), this species acts as the dominate form of primary producers, providing essential ecosystem services such as sediment stabilization and storm buffering. However, a phenomenon of unknown cause known as reed dieback threatens these wetlands with the rapid decline of these reed stands, reducing habitat and sediment accumulation, as well as exposing previously protected shorelines to land and sediment erosion. To preserve these wetlands and the valuable resources they provide it is essential that we understand the possible factors and environmental stresses that could be contributing to reed dieback. In this study, we use a greenhouse experiment to examine how the combination of salinity and herbivory may contribute to carbon starvation and the subsequent decline of two lineages in New England: the North American native and the introduced European invasive. We measured the carbohydrate levels (i.e. glucose and sucrose) in aboveground tissues, starch content in belowground tissues, aboveground biomass, and leaf water content, toughness, and specific area across three salinity treatments with and without *S. frugiperda*, or the fall armyworm. We found that sucrose does not play a role in terms of mediating salinity stress and that the percentage of starch granules found in the rhizomes increases with salinity, for both lineages. Overall, we found that the native and introduced lineage of P. australis are similarly affected by herbivory from *S. frugiperda*, with and without the addition of salinity.

Towne*, S.K.(1), A. Mittermayr (2), M. Cahill (3), K.R. Brown (1), K.C. Medeiros (1), R.K. Thiet (3), S.E. Fox (1)
ASSESSING HABITAT RECOVERY THROUGH BENTHIC INVERTEBRATE ASSEMBLAGES WITHIN A PARTIALLY RESTORED ESTUARY
(1) Cape Cod National Seashore, Wellfleet, MA;
(2) Center for Coastal Studies, Provincetown, MA;
(3) Antioch University New England, Keene, NH
East Harbor is a back barrier salt marsh lagoon located in Truro, Massachusetts within Cape Cod National Seashore. The system was cut off from Cape Cod Bay tides for over a century until limited tidal flow was reintroduced in 2002. This partial tidal restoration has allowed for recolonization of many estuarine species, suggesting that water quality has greatly improved after decades of low salinity, invasive vegetation, low oxygen, and other stressors. Benthic invertebrates are good pollution indicators, as tolerance for poor habitat conditions is well documented for many species. To evaluate species composition and habitat quality, we sampled water quality and the benthos in East Harbor in 2017. Invertebrates were sampled, sorted and identified to species level. Organisms were then classified using the AZTI Marine Biotic Index

(AMBI) protocol, a method to categorize species based on their tolerance of degraded environmental conditions and to determine site quality based on the invertebrate assemblages present. Each station had class II (indifferent) and III (tolerant) species. In roughly half of stations, class I (sensitive) and V (pollution indicating) species were each present, and most sites had some class IV (opportunistic species) species. Percentage of class I or V species most influenced overall AMBI site classification. Based on invertebrate compositions, AMBI classified most East Harbor stations as slightly disturbed and the system overall as a slightly polluted ecosystem. Habitat features, such as water column turbidity, seemed to drive the habitat disturbance. This analysis suggests that most of the partially-restored habitat in East Harbor is now suitable for a breadth of species.

Tremper, C*.(1), Wigand, C. (2), Loffredo, J. (3), Bishop, J. (3)
USING A TEABAG INDEX TO INVESTIGATE DECOMPOSITION IN A SHORT-TERM SALT MARSH MESOCOSM EXPERIMENT
(1) Environmental Protection Agency Student Services Contractor, Narragansett, Rhode Island;
(2) Environmental Protection Agency, Narragansett, Atlantic Coastal Environmental Sciences Division, Rhode Island;
(3) University of Rhode Island, Kingston, Rhode Island;
A Teabag Index (TBI) was used to determine decomposition rates in dredge soils and marsh peat in a mesocosm salt marsh restoration experiment. Burying bags containing materials (green and rooibos tea) with differing decomposability in close proximity allows calculation of a decomposition rate. Sets of green and rooibos tea bags were placed in three treatments (control, +5 cm added dredge soils, +10 cm added dredge soils) in high and low marsh mesocosms (4 replicates for each treatment) for approximately 3 months. We found that the control mesocosms with natural salt marsh peat had significantly lower decomposition rates than those with added dredge material. There was a trend, albeit not significant, of greater decomposition rates in the high marsh than the low marsh treatments. We hypothesized that dredge material promoted greater decomposition rates because it was less compacted and more aerobic. Further experiments using the TBI in restored marshes that have been underway for a number of years in the field will be beneficial in determining the pattern of changing decomposition rates over time.

Whaley*, T., M. Alldred

A META-ANALYSIS REVEALS CONTEXT DEPENDENCE IN THE *SPARTINA- GEUKENSIA* MUTUALISM

Center for Earth and Environmental Science, SUNY Plattsburgh, NY

Smooth cordgrass (*Spartina alterniflora*) and Atlantic ribbed mussel (*Geukensia demissa*) play a foundational role in wetland biogeochemical processes and community structure in coastal marshes throughout the Eastern United States. The relationship between *Spartina* and *Geukensia* is widely considered to be a textbook example of a mutualistic species interaction. Previous research has revealed that *Spartina* provide structure that promotes *Geukensia* settlement and shading that protects *Geukensia* from overheating and desiccation. *Geukensia* promote the growth of *Spartina* by transferring nutrients from the water column to sediments. Both species have been shown to influence biogeochemical processes by altering oxygen and carbon availability in sediments. Mutualisms often differ in strength and direction of effect depending on environmental context. Context-dependence in the *Spartina-Geukensia* mutualism would have profound implications for salt marsh conservation and restoration. We performed a systematic review and meta-analysis to quantify the effects of this mutualism on biomass and growth, and the effects of the two species on nitrogen-cycling processes. We found that the *Spartina-Geukensia* mutualism remains understudied in urban and restored ecosystems. The data suggested significant differences in the mutualism's outcome between rural and urban wetlands, as well as between natural and constructed wetlands, that are worthy of further study. The variability in the outcomes of the *Spartina-Geukensia* mutualism suggests that care must be taken when incorporating the mutualism into habitat management programs.