ABSTRACT BOOKLET

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Meeting Hosts

Sara Grady –NSRWA MassBays Program

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FARMERS IN THE MARSH: AN OVERVIEW OF HISTORIC FARMING PRACTICES, PERSISTENT FEATURES, AND LASTING IMPACTS
We identify large-scale geomorphic features used by salt marsh farmers based on historic documents, literature, and aerial imagery. While use of salt marshes for grass cultivation dates to early European settlement, the features still recognizable today are consistent with techniques used in the mid- to late-1800s – namely dikes, trunk ditches and water control structures. Such alterations and remnant features are not limited to northern New England but can be found along much of the East Coast. The use of Spartina patens, "salt hay", for livestock fodder is just one of several examples of agricultural use. Farmers were able to extend production to increasingly freshwater species by terracing alterations from seaward edge up along the elevation gradient into fresh/upland meadows. We provide 3 case studies to review in detail. Most importantly, we posit that these prior alterations still have significant effects on marsh hydrology as well as and responses to current stressors such as increased sea levels and climate change. Ignoring the continuing influence of these alterations will stymie restoration/resiliency efforts. Site managers are placed in a better position if they are able to identify these features, understand their current effects on marsh processes and account for them in any future management efforts.

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MAINE: STATE OF THE STATE'S SALT MARSHES
While known for its rocky shoreline, Maine also hosts thousands of acres of tidal marsh. Much of that acreage is held in Scarborough Marsh itself, though a slightly larger number of acres is held by the Rachel Carson National Wildlife Refuge in its 11 divisions across 50 miles of coastline. With tides ranging from 9 to over 20 feet in height, the state's salt marshes experience a meso- to macro-tide range. Salinities range from euryhaline to oligohaline. Though there are a few large salt marsh systems (Scarborough, Webhannet, Brave Boat Harbor), many of the sites are relatively small fringing marshes. Maine's salt marshes are definitely experience change/stress on multiple fronts. Fiddler crabs (*Uca* spp) were first documented southern Maine in 2016. Though there have not been documented cases of *Sesarma*, *Carcinus maenas* may be having a significant effect on marsh edge stability. Certainly we have lost the sloping zone of Spartina alterniflora along many channels and now have unstable straight-sided banks, or collapsing banks with crevasses on the marsh platform. Large sediment deposits noted in New Hampshire in 2018 also occurred in southern Maine. We also await assessment of sediment deposition from Winter Storm Reily and the Nor'easter that followed a week later. With contributions from many state colleagues, we hope to present a brief synopsis of our marshes "by the numbers."

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NITROGEN LOADING FROM ONSITE WASTEWATER TREATMENT SYSTEMS IN THE GREATER NARRAGANSETT BAY WATERSHED: MAGNITUDE AND REDUCTION STRATEGIES
Onsite wastewater treatment systems (OWTS) are an important part of the water infrastructure in the U.S. Advanced OWTS are used instead of conventional OWTS to lower nitrogen (N) inputs to coastal ecosystems and groundwater sources used for drinking. Knowledge of the N load from OWTS can help identify drivers of excess N and develop strategies to lower N inputs. We used flow and effluent total N (TN) concentration to determine the mass N load from 42 advanced N-removal OWTS technologies (Orenco Advantex AX-20®, BioMicrobics MicroFAST®, SeptiTech D® series) and 5 conventional OWTS

within the Rhode Island side of the Greater Narragansett Bay watershed. The median N load (g N/syst/d) followed the order: conventional systems (31.1) > AX-20 (10.8) > FAST (10.1) > SeptiTech (9.6), and was positively correlated with flow. Results of a Monte Carlo simulation estimated the N load from the current distribution of septic systems (105,833 systems total; Current scenario) to the watershed at 1,217,539 kg N/yr. Compared to the Worse Case scenario (100% conventional OWTS), advanced OWTS currently prevent 53,898 kg N/yr from entering the watershed. The per capita N load (kg N/person/yr) from OWTS under the Current scenario is 4.68, and 1.47 for a local wastewater treatment plant (WTP) with biological N removal (BNR). Replacing 5,150 conventional OWTS yearly with the most effective OWTS technology would result in a per capita N load from OWTS equivalent to that for a WTP with BNR after ~15 years. Increasing the proportion of advanced OWTS that achieve the final effluent standard of 19 mg TN/L – through monitoring and recursive adjustment – would reduce the time and cost necessary to achieve parity with the WTP.

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THE EFFECT OF SIMULATED CDOM ON *ZOSTERA MARINA* GROWTH
Colored dissolved organic matter (CDOM) reduces light penetration in water and can alter water's natural color spectrum, potentially affecting marine plants such as eelgrass, *Zostera marina* L. For a study on declining eelgrass in Hudson Bay, we tested the effects of CDOM and light levels on the growth of *Zostera marina* in mesocosm tanks at the University of New Hampshire. Twelve tanks were planted with eelgrass from Great Bay, NH and randomly assigned one of four treatments simulating conditions observed in Hudson Bay: 34% light and amber tint, 50% light and yellow tint, 50% light with no tinting, and 100% light at ambient conditions. Tinted light was achieved using acrylic panels; the 50% light no tint, with neutral density screening. Each treatment tank had three replicates. The experiment ran from June to November 2017. Eelgrass shoot density, leaf height, leaf width, rhizome length, and plant weight were measured twice. Overall, eelgrass growth increased the most under ambient conditions and was reduced with both light reduction and light tinting.

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THE PLANKTONIC PIECE OF THE PIE: RESOLVING NITROGEN USE BY PHYTOPLANKTON IN A MESOTIDAL SALT MARSH OF PLUM ISLAND ESTUARY
In tidally influenced estuaries, phytoplankton community composition can change rapidly, potentially affecting nutrient cycling and food quality for consumers over short time scales. This study uses a whole system ^{15}N enrichment experiment to determine the interaction between phytoplankton community composition and nitrogen use throughout the tidal cycle in a salt marsh ecosystem. Over the 11-day experiment, we measured chlorophyll (as a proxy for biomass) and uptake of $^{15}NO_3$ at varying tidal stages for three phytoplankton size classes corresponding to pico-, nano-, and microplankton (>3, 3-20, and 20-200&mum). Throughout the experiment, biomass was dominated by nano- and microphytoplankton. Within these size classes, microscope counts showed that from the spring to neap tide, the average percent of diatoms decreased from 34.5 to 10.8%, while that of dinoflagellates increased from 53.2 to 85.4%. Despite their relatively low biomass, picoplankton generally had the highest &delta^{15}N values, which increased during semidiurnal ebb tide. Both spring/neap and flood/ebb cycles were correlated with differences in size- and taxa-specific biomass and N use. While water-column &delta$^{15}NO_3$ reached peak values >2000, phytoplankton &delta^{15}N reached a peak value of 28, indicating dominant use of recycled N forms. Each size class showed a distinct relationship between &delta^{15}N and biomass, suggesting possible partitioning of different N forms among phytoplankton groups. Continuing analyses are investigating size-specific N use in relation to tidal dynamics and the availability of ^{15}N-labeled and total NO_3/NH_4.

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IMPROVING JUVENILE FISH POPULATIONS BY ENHANCING FISH HABITAT – EVALUATING THE USE OF OYSTER REEFS AS A TOOL TO INCREASE FISH PRODUCTIVITY

The life of a juvenile fish is challenging. They often rely on complex structured habitats such as oyster reefs, salt marshes, and seagrass for forage and refugia. In fact, more than 70% of RI's recreationally and commercially important fish spend part of their juvenile lives in shallow-water coastal habitats containing complex structured habitats. Unfortunately, in Rhode Island many of these habitats have experienced losses over recent decades. Oyster reefs have been hit particularly hard, experiencing a 90 percent decline since the mid-1900's, reducing the overall amount and quality of this habit for juvenile fish. The goal of this project is to determine if oyster reef construction can be used to improve productivity of recreationally important juvenile fish, including black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), tautog (*Tautoga onitis*), and winter flounder (*Pseudopleuronectes americanus*). The monitoring of fish on reefs, compared to unenhanced control sites, is conducted using a Before-After-Control-Impact design that utilizes an array of fish survey techniques to categorize fish assemblages and abundance. Oyster monitoring events occur in the spring and fall of each year and focus on measuring the growth, health, and survival of the oysters on the reefs created by this work. Reefs have been seeded with different oyster linages to inform future restoration efforts, as well as to evaluate how reef metrics influence fish productivity. This presentation will provide an overview of the results from the baseline and post-reef construction monitoring conducted in Ninigret and Quonochontaug Pond in southern Rhode Island.

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SALT MARSH VEGETATION INFLUENCE ON CARBON-BASED SERVICES

Coastal marshes are important "blue carbon" reservoirs that are increasingly threatened by sea-level rise and invasive species. Restoration efforts often aim to restore salt marsh vegetation composition, but it is unclear how vegetation shifts associated with restoration and sea level rise alter microbial respiration rates. In 2017, we surveyed 20 Connecticut salt marshes (10 tidally restored, 10 unrestored) and sampled plants and soils from three vegetation zones (*Spartina alterniflora*, *S. patens*, *Phragmites australis*). We quantified above- and below-ground biomass, a suite of sediment characteristics (pH, conductivity, soil moisture, % carbon, and several ion concentrations), soil respiration rates (SIR: substrate induced respiration; Cmin: carbon mineralization), and are in the process of sequencing sediment bacterial 16S rRNA genes. While none of our response variables differed between tidally restored and unrestored sites, we observed strong differences among vegetation zones. *P. australis* had greater aboveground biomass and lower root to shoot ratios than both *Spartina* zones. We observed higher rates of microbial respiration (SIR, Cmin) in the sediments of both *Spartina* zones than *P. australis*. Our data suggest that *P. australis* sediments have higher carbon storage capacity than native *Spartina* sediments, and should be considered when preserving ecosystem function in coastal marshes.

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CONSERVATION AND MANAGEMENT OF MAINE'S TIDAL MARSH BIRDS

Maine's coastal marshes are home to a community of birds that are uniquely adapted to living in this dynamic environment. Many of these species build nests on the marsh surface, making them highly susceptible to tidal flooding. Rising sea levels and climate change add an additional threat to the persistence

of tidal marsh birds throughout the Northeast as storm frequency and flooding duration increases. One species most vulnerable to these changes is the Saltmarsh Sparrow, a specialist species that is currently experiencing dramatic population declines. Join us as we discuss the conservation of tidal marsh birds in Maine, and how we can protect these unique species and their habitat.

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MONITORING WATER QUALITY AND MANAGING ANTHROPOGENIC INPUTS FOR A QUARTER CENTURY (1992-2017) IN THE PETTAQUAMSCUTT ESTUARY (RI) WITH COMPARISONS TO 1970'S DATA AND LOWER NARRAGANSETT BAY DATA.

The Pettaquamscutt Estuary (Narrow River), typical of many east coast US estuaries, has seen a dramatic increase in watershed residential development since the 1960's. Nitrate plus nitrite and fecal coliform bacteria measurements were taken in the 1970's. Since 1992, water quality data has been collected monthly from May through September from 10 stations in the estuary and four stations (two streams, an outfall, and an estuary site) were added later. The nitrogen and bacteria concentrations in the 25 year study are high in the first half of that study but then decrease to near 1970's levels. Concentrations of ammonia and nitrate plus nitrite have been measured separately since 2007 and are lower in recent years. Stations near the mouth have lower nitrogen levels due to less nitrogen entering with offshore water. Several Best Management Practices for stormwater have been built and appear to be reducing levels in the estuary itself. Highest bacteria and nitrate plus nitrite levels were at the stream flowing through the adjacent Chafee National Wildlife Refuge. Lowest bacteria levels are found in the forested, less developed northern reaches of the estuary. Nitrogen levels affect the productivity of the ecosystem, while bacteria levels are of concern for human health.

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NEERS: NATURALLY, EFFECTIVE EDUCATION REQUIRES SILLINESS

We have all been there: the presenter is droning on, putting up facts and figures and equations, and speaking in an almost inhuman monotone. To survive, you read your email under your desk and send "sleepy" emojis to the person next to you. We have all also been to talks where the speaker is presenting similar material but where you have been engaged, attentive, and aching to hear more. In science communication, style matters. Without a clear message made relevant to the audience, with readable slides, and an engaging speaking voice, even the most compelling scientific findings may be boring and poorly received. But what to do if you are not Neil DeGrasse Tyson, with the Cosmos behind you? Include a little humor and novelty. For example, engage your audience through something unexpected like the "History of Sediment Toxicity Assessment as told Through Bumper Stickers". Also, a few light jokes or self-deprecating cracks help to lighten the mood and engage the audience. If you really need to get the audience into it, games work great for connecting people and science. Games can be used as teaching tools for everyone from third graders to partner organizations to fellow scientists. They can be as simple as a cooler of animals and a score sheet, or as complex as a computer simulator with a fancy model behind it. At the Atlantic Ecology Division, we have piloted a number of different games to engage the local community in our science. These include watershed models, sustainability challenges, the "Compost Challenge", and the "Sediment Game". We will share some of the most successful games and their communication success stories that can be adapted for use in your own communities or work.

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A NEW METHOD FOR CALCULATING RATES OF SHORELINE CHANGE IN A COASTAL EMBAYMENT WITH FRINGING SALT MARSH

Many studies use the basinward edge of marsh vegetation as a proxy-based shoreline indicator to quantify

shoreline change, but no peer-reviewed publications have given a detailed account of the methods used and associated uncertainties. The basinward edge of marsh vegetation or 'marshline' is presented here as a proxy-based shoreline indicator to calculate rates of shoreline change in a low energy coastal embayment with fringing salt marsh. The visual cues used to delineate the marshline on aerial photographs are objective, repeatable and reliable. In addition, several sources of uncertainty in calculating rates of shoreline change are reduced when using the marshline relative to more common shoreline indicators. These include the timing of aerial photographs regarding: tidal stage; seasonality; post-storm temporal proximity; and the misinterpretation of the shoreline indicator. The High Water Line (HWL), the most prevalent proxy-based shoreline indicator, captures a different coastal feature than the marshline. Some studies have used both indicators in the same embayments and complications may arise. A 40 km stretch of shoreline with fringing marsh was examined using the HWL and marshline. Less than 9.8 km of coast exhibited statistically significant shoreline change using the HWL as compared to 22.5 km using the marshline for the same segments of shoreline for the same temporal period. Thus, using both indicators may not provide investigators or managers with the best representation of shoreline change. Additionally, the marshline allows investigators to quantitatively assess changes in salt marsh habitat with regards to surface area, fringing marsh width, and marsh appearance and disappearance.

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INVESTIGATING THE EFFECT OF MICROBIAL COMMUNITIES ON THE PERFORMANCE OF ADVANCED ONSITE WASTEWATER TREATMENT SYSTEMS
Nitrogen (N) loading into the environment can pose a threat to human life and marine ecosystems. Advanced nitrogen removal onsite wastewater treatment systems (OWTS) can help to reduce the amount of N entering the groundwater from domestic wastewater sources. Microbially-mediated N removal in advanced OWTS relies on two N-cycling genes, nosZ (nitrous oxide reductase) and amoA (ammonia monooxygenase). To investigate the performance in terms of total N removal in these systems with respect to the number of microbial communities present, we obtained wastewater samples from 50 advanced OWTS in Charlestown, RI in September 2017. We quantified the number of amoA and nosZ genes present in each sample using qPCR (quantitative polymerase chain reaction) and compared this to the amount of total nitrogen (TN) in each sample. Here we present our findings on the relationship between N-cycling microbial population size and TN in advanced treated wastewater samples and compare them to previously reported values for similar systems in Rhode Island. The results of this study will help elucidate the effect microbial communities have on the N-removal performance of advanced OWTS. Reducing the amount of N-loading into the environment is necessary for the health and sustainability of aquifer and marine ecosystems. Reduction of N-loading can be achieved with the use of advanced OWTS whose performance may be based on the number of amoA and nosZ genes present in the samples.

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HISTORICAL CONTEXT OF THE TIER 1 SUBMERGED AQUATIC VEGETATION MAPPING EFFORTS IN NARRAGANSETT BAY
Rooted submerged aquatic vegetation (SAV) is an ecologically important habitat, and SAV loss is considered an indicator of nutrient pollution in estuaries. Therefore, the Narragansett Bay Estuary Program (responsible for producing technical reports on the state of the Narragansett Bay watershed) uses the extent of SAV as a critical status and trends indicator. In order to help quantify and discern trends (if any) of SAV, the R.I. Eelgrass Mapping Taskforce has led a series of aerial photographic surveys of SAV since 2006. These surveys have utilized orthophotography, GPS, and underwater video cameras to quantify the presence or absence of SAV (Tier 1). In order to place these Tier 1 surveys in a historical context, we reviewed and created GIS layers of historical (1900 – 1995) SAV maps and data. These maps were geo-referenced, and SAV beds were digitized to derive historical acreages of SAV. From this analysis, we estimated that about 2700 acres of SAV were present in the Bay during the 1900s. Later, the wasting

disease event of the 1930s and the hurricane of 1938 decimated SAV. After the 1930s, we believe SAV increased steadily as SAV recovered to about 1100 acres during 1970s, until a precipitous drop to around 100 acres during the mid-1990s. The more recent aerial surveys of SAV beginning in 2006 point to an increase of SAV until 2016 when an 8% decrease in was observed from the previous years' survey (2012). We note that SAV trends correlated broadly to nutrient input over the span of data, with the significant interruption in the 1930s due to wasting disease and the hurricane. Our analyses give us a baseline of SAV coverage for management decisions and will further our understanding of SAV dynamics.

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PROSPECTS AND UNCERTAINTIES FOR TIDAL MARSHES IN NEW HAMPSHIRE

In New Hampshire as the rest of New England, tidal marshes are responding to climate change. Warmer climate allows northern limits of plants like *Iva frutescens* and *Hibiscus moscheutos*, to extend northward. The rate of marsh building is chasing increased sea levels, but some marshes cannot keep up, leading to dramatic changes. Some of these high marshes are transitioning gradually to low marsh, but others exhibit hummock formation and dieback before cordgrass can return. Low marsh can drown as well, with significant and rapid loss of elevation (marsh collapse) seen in particularly vulnerable marshes. Although NH has been a leader in restoring tidal flow, a recent examination of culverts installed to restore tidal hydrology shows partial restrictions often remain and these may put upstream marshes in jeopardy. Loss of historic drainage paths combined with rising sea levels may lead to vegetation loss following tidal restoration. Since marshes require regular tidal flooding and ample sediment supply to build in elevation, the longer we wait to restore the tides to restricted marshes, the less likely marshes will be able to recover. Replacement of drowned marsh via migration onto uplands is a great concept, but marshes have built into large flat meadows over millennia, shores are generally much steeper, especially in NH and many shorelines have been (or will be) walled off with barriers. To hedge against widespread marsh loss in the region, it would be prudent to consider new and combined approaches, including artificial sediment nourishment and re-engineering new and existing shoreline barriers into living shorelines with new marshes that grade gently into uplands.

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THE CHANGING ECOLOGY OF NARRAGANSETT BAY AS TOLD BY HABITAT

Narragansett Bay has changed in many ways over millennia due to natural and human forces, and the rate of this change increased greatly after European colonization. We evaluated distributions of three stressors and four habitats in eight subdivisions of the Bay for aspects of ecology that have changed since 1700, as data allowed. Specific areas within the Bay have responded differently to human impacts, and we explored ecological change from north to south and east to west. We compared stressor and habitat changes in the Providence River system to those in the Barrington-Palmer-Warren River system, about 6 miles away. We examined distributions of seagrass, benthos, salt marsh, and shellfish in different Bay regions over time to compare historic changes to recent conditions. While higher levels of nutrients and other stressors in the northern Bay moved distributions of valued benthic and seagrass habitats southward for 200 years, we suggest that the last 20 years of data may show these distributions now moving northward. Bay-wide, salt marshes experienced high historic losses and a few recent decades of moderate loss, but are now in steep decline due to the combined effects of several new stressors. Monitoring habitats in the next five to ten years will be vital for understanding and managing these most recent changes in Bay ecology over time and in different regions of the Bay.

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LONG TERM MONITORING OF TWO WATER QUALITY SITES IN THE UPPER NARRAGANSETT BAY: A TREND ANALYSIS

Since 2003, the Narragansett Bay Commission (NBC) has operated two fixed site YSI monitoring stations as part of the larger bay-wide Narragansett Bay Fixed Site Monitoring Network (NBFSMN). In general, these stations are active from May – October and take temperature, salinity, dissolved oxygen, pH, and chlorophyll data at 15 minute intervals. Phillipsdale Landing and Bullock Reach fixed site stations are both located in the estuarine upper reaches of Narragansett Bay and have been established in proximity to the Field's Point and Bucklin Point wastewater treatment plant outfalls. These sites are impacted by very different water quality conditions. Phillipsdale Landing is located in the shallow Seekonk River, and is highly affected by tidal fluctuations and river flow from the Blackstone River; Bullock Reach is located in a deeper, more saline area of the Providence River. The substantial reductions in nutrient inputs that have occurred in the upper Narragansett Bay were done with the ultimate goal of reducing hypoxia. Over this long-term time series, have we seen any changes in dissolved oxygen at these long term stations? In addition, this analysis will examine if there have been any observable changes in temperature, pH and chlorophyll at these two locations.

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HISTORIC CHANGES IN GROUNDWATER TABLE HEIGHTS ALONG THE SOUTHERN RHODE ISLAND COAST

The southern Rhode Island coast has been a popular tourist destination for decades, thanks to its picturesque barrier beach complex morphology and ecosystems. As a result, construction and enlargement of seasonal and year-round homes near the coast has accelerated since the 1960s. Historically, many of these communities have relied on individual onsite wastewater treatment systems (OWTS; also called septic systems) to treat and disperse household wastewater. OWTS design is predicated upon a certain separation distance between the drainfield's infiltrative surface and the seasonal high water table, so that there is an adequate volume of unsaturated soil below the drainfield to attenuate both nutrients and pathogens, before wastewater percolates into the groundwater. However, a survey of historical depth-to-groundwater table data, submitted to the Rhode Island Dept. of Management with OWTS permit applications, indicates that groundwater tables along the southern RI coast are rising at a rate of around 2 cm per year since 1960. These rates are greater in some regions of the coast than in others. Our preliminary estimates of human and climate derived changes in inputs to groundwater can account for roughly half the rate of change in coastal groundwater table heights. Communities where potable water is imported seem to be facing greater rates of rising groundwater tables. As water inputs change in the coming decades, changes in water tables may result in reduced OWTS functionality, threatening coastal drinking water aquifers and ecosystems with nutrient and pathogen pollution from failing OWTS.

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TROPHIC RELATIONSHIPS BETWEEN WALLEYE POLLOCK AND THEIR SURROUNDING MARINE FOOD WEB NEAR KODIAK ISLAND, ALASKA

Despite Walleye Pollock's status as one of the United States' largest fisheries, relatively little is known about how they fit into the surrounding marine food web. Previous studies have focused on the diet of adult Pollock. The present study explores the Pollock's trophic position at various stages of their life from larvae to adult. This research includes estimating the Pollock's trophic level, as well as where they feed in the environment. The samples were obtained onboard the NOAA vessel, OSCAR DYSON, in the waters surrounding Kodiak Island, Alaska. They were collected using an Aleutian wing trawl during the summer of 2013, and were frozen for later stable isotope analysis (&delta^{13}C and &delta^{15}N). A small piece of muscle tissue was dissected from each sample, and processed using a stable isotope mass spectrometer. Other members of the food web (fishes and invertebrates) were also analyzed, and the results were assembled into

a food web model. Figures will be presented to portray the relationship between Pollock and the other species within its food web. Length vs. isotope ratio plots will be presented to indicate when during the Walleye Pollock's life history ontogenetic diet shifts occur.

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GREEN CRAB ABUNDANCE AND IMPACT ON THE FRINGING SALTMARSH OF THE NAPATREE LAGOON: WESTERLY, RI
Salt marsh loss is linked to many factors including; sea level rise, wave erosion and biological processes. Observations made at the coastal lagoon at the Napatree Point Conservation Area (NPCA) in Watch Hill, Rhode Island suggest that the fringing saltmarsh adjacent to the Lagoon has been narrowing as the marsh erodes, potentially jeopardizing an important component of the overall lagoon ecosystem. NPCA is a barrier spit extending 2.5 km across Little Narragansett Bay. The lagoon is located on the western end of the barrier. Past studies conducted in New England salt marshes have found that invasive crab species' burrowing into the marsh can be responsible for marsh erosion. As part of an overall evaluation of the Napatree marsh, the impact of crab burrowing is being assessed. Monthly trapping surveys (April-December 2017) provide estimates of the total crab abundance within the lagoon. The crabs are captured in baited Ketcham crab traps (n=4) distributed throughout the lagoon and fish for 24 hours. Crabs are counted, measured (carapace width) and sexed. Time-lapse cameras captured images throughout one tidal cycle and observed crab activity on the marsh platform and edge. Initial results indicate there is a large presence of green crabs (*Carcinus maenas*) within the lagoon and burrowing into the marsh. Green crabs are the only species present in the traps, but the cameras recorded both green and fiddler crabs (Uca) burrowing into the marsh. Further research in 2018 will include continued crab trapping, as well as additional work on the marsh, including mapping vegetation distribution, extent of burrows along the marsh edge sediment density and marsh platform thickness using an RTK GPS.

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RESTORATION OF SALT MARSHES ON LONG ISLAND FOLLOWING HURRICANE SANDY: INTERN'S PERSPECTIVE
Salt marshes play an important ecological role as the interface between the marine and the terrestrial environment. Salt marshes also affect public health by providing larval habitat for mosquitoes that are vectors for disease. Previously, ditching and pesticides have been used as a control mechanism. But ditching requires maintenance and mosquitoes can develop resistance to pesticides in the long term. An alternative approach improving access to larvae by predatory fish was proposed following Hurricane Sandy, which radically altered the geography of salt marshes on the South Shore of Long Island. This method improves flow access from Great South Bay and increases water quality enhancing survivability of insectivorous fish. Beginning in the summer of 2017, select marshes on the south shore of Long Island were sampled weekly, for mosquito larvae, nekton, vegetation, and biomass were collected and water quality parameters (dissolved oxygen, temperature, and salinity) were measured by undergraduate interns through a partnership with Suffolk County Community College. Hot spots of mosquito larvae were frequently found near locations of the invasive Common Reed, *Phragmites australis*, where reduced water flow and low salinities were also identified. Based on the data obtained by the interns, restoration of these marshes is scheduled for 2018 with an emphasis on the improvement of water quality and removal of *P. australis*.

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FACTORS INFLUENCING THE GROWTH OF *SPARTINA PATENS* IN UPLAND SOIL
High elevation salt marsh plants, such as *Spartina patens* (salt hay) can cope with accelerated sea level rise by migrating inland. It is not fully understood whether environmental factors will inhibit *S. patens* inland migration and its ability to colonize upland forest soil. For one growing season, we tested how *S. patens* above and belowground biomass was influenced by upland or marsh soil, high or low salinity levels, and

the presence or absence of ground litter. Eighty *S. patens* plugs were collected from each of 3 Maine salt marshes. Plugs were divided into specific site-soil-salinity-litter treatments so that there were ten replicates for each treatment combination, giving a total of 240 plugs (3 sites x 2 soil x 2 salinity x 2 litter x 10 replicates). Aboveground biomass significantly responded to salinity, soil treatment, and site-soil interactions. Aboveground biomass weight from plugs grown in upland soil ranged from -1.5 to 39.2% less than aboveground biomass weight in marsh soil depending on the three sites. Belowground biomass significantly responded to soil treatment and site-soil interactions. Belowground biomass in upland soil weighed from 29.8 to 57.2% less than belowground biomass in marsh soil. The results suggest that soil type will have a larger effect on *S. patens* overall growth in upland forest soil than salinity or ground litter, and the success of growth will be site specific.

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CARBON STORAGE IN EELGRASS BEDS OF CASCO BAY, GULF OF MAINE
Zostera marina, commonly referred to as eelgrass, is a tidal angiosperm found throughout the Gulf of Maine. Eelgrass beds provide a number of ecosystem services such as buffering against coastal erosion, filtering out heavy metals and other pollutants, and sequestering and storing carbon. However, they are vulnerable to disease, climate change, human activities and invasive species. This project seeks to estimate the amount of carbon stored in eelgrass beds in Casco Bay. Three approximately one-meter long cores were collected from eelgrass beds at three sites in Casco Bay using a percussion hammer to penetrate the silty sands. Additionally, cores were collected from Larrabee cove near Machias. Cores were subsampled every 10cm and analyzed for bulk density, total organic carbon, and grain size. The average carbon density from all three sites in Casco Bay is in agreement with values found globally (Fourqurean at al., 2012) and indicates that eelgrass beds are an effective carbon sink for the region. Estimating carbon storage is limited partially by the accuracy of the eelgrass area maps. Eelgrass beds are difficult to image because they are underwater and ephemeral in nature which makes determining area a challenge in calculating carbon stocks for a region. Spatial differences in carbon density and grain size are currently under investigation.

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FACTORS INFLUENCING HABITAT SUITABILITY AND HIGH PRIORITY TRAPPING SITES FOR THE EUROPEAN GREEN CRAB (*CARCINUS MAENAS*) IN THE NORTH SHORE OF MASSACHUSETTS
Since the arrival of the invasive European green crab (*Carcinus maenas*) in Massachusetts waters in the late 1800's the species has had a significant impact on New England shellfish economy. Various locations in New England have noted a recent increase in the numbers of green crabs with a concurrent decline in soft-shell clams. From the results of recent long-term trapping study, many attributes of the green crab are well understood in in Salem sound, Massachusetts. With caution, what green crabs consider to be favorable habitat is assumed to be conserved across the coast of northeastern Massachusetts. To reinforce the results from Young et al. (2017) on factors influencing habitat suitability, passive surveillance data are used from the Massachusetts Office of Coastal Zone Management (MORIS). Combined green crab occurrences are overlaid with layers modeling distance to anthropogenic change (measured via spectral signatures), sediment type, bathymetry and suitable soft-shell clam habitats. Knowing which of these variables are most influential in habitat suitability can better inform recreational and commercial shell fishermen to which sites are best for trapping green crabs. In addition to a thorough analysis of the study area, this study aims to find out which of these factors are most influential in the likelihood of a green crab occurrence. To do this, the listed factors are ranked based on correlation and significance with green crab abundance. Preliminary results demonstrate that sediment type is the most influential factor for green crab abundance.

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A GEOSPATIAL HABITAT SUITABILITY MODEL TO DETERMINE THE SPATIAL AND TEMPORAL VARIATION OF ULVA BLOOMS IN A EUTROPHIC ESTUARY- JAMAICA BAY, NEW YORK.
A geospatial habitat suitability model is being developed to predict the spatial and temporal variability of Ulva blooms in Jamaica Bay, New York. Water quality data collected by the National Park Service and the Department of Environmental Protection are used to create the model, and include Photosynthetically Active Radiation (PAR), temperature, depth, dissolved oxygen, salinity, pH, nitrates and ammonia. These parameters are ranked based on importance in Ulva growth; temperature, PAR, nitrates and ammonia are weighted heavier than the other parameters. The locations of several islands within Jamaica Bay present a modeling challenge since interpolation from surface points cannot extend into the islands. Inverse Path Distance Weighted interpolation is used to create surfaces from the water quality data; these surfaces are combined in ArcGIS to produce an output surface that will predict where the blooms are most likely to occur. In ArcGIS with the use of map algebra, the weighted parameters will be combined using specific formulas to predict the distribution and intensity of Ulva blooms in the Bay. The model output generated from ArcGIS will be compared to biomass data and high resolution satellite imagery and aerial photographs. During the growing season from June to October 2017, Ulva biomass data was collected at five sites, namely Marine Park, Plumb Beach, Crossbay Bridge- West, Norton Basin and Big Egg around the bay. The comparison of actual field data with the predicted output for the Ulva blooms will facilitate Model Tuning. Biomass along with imagery collected during

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PROVIDENCE RIVER AND NARRAGANSETT BAY PHYTOPLANKTON POST-WASTEWATER TREATMENT FACILITY NITROGEN LOAD REDUCTIONS
Between 2003 and 2014, Narragansett Bay Commission (NBC) wastewater treatment facility (WWTF) nitrogen loadings to the urbanized Providence River (PR), at the head of Narragansett Bay (NB), were reduced over 65% through WWTF upgrades. These reductions were mandated by the Rhode Island Department of Environmental Management in an attempt to reduce hypoxic events. However, it is unknown how the nitrogen reductions impact phytoplankton community diversity and ecology. Here, microscopy is used to reveal abundance and diversity within the PR phytoplankton community during and after WWTF upgrades in comparison to the phytoplankton community at an un-impacted site near the mouth of NB maintained by the University of Rhode Island Graduate School of Oceanography. The NBC began monitoring the PR phytoplankton community in the fall of 2012 at one site on a semimonthly to monthly basis along with simultaneous semimonthly nitrogen species analyses, weekly CTD casts, and a seasonal (April-October) buoy array that collects physical data (CTD, dissolved oxygen, chlorophyll *a*) at 15 minute intervals. Within this short time-series, phytoplankton abundance and community composition are remarkably similar between the impacted PR site and the un-impacted NB site. Both sites are dominated by diatoms and the five dominant taxa at both sites are identical, although more dinoflagellates and flagellates are observed at the impacted site. Environmental factors explain only 11% of overall community composition, perhaps due to the brevity of the dataset. Continuing such long-term monitoring datasets provides insights into phenological responses and assists in making informed management decisions.

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CONSTRAINING MARSH CARBON BUDGETS USING LONG-TERM C BURIAL AND CONTEMPORARY ATMOSPHERIC CO_2 FLUXES
Salt marshes are sinks for atmospheric carbon dioxide that respond to environmental changes related to sea level rise and climate. Here, we assess how climatic variations affect marsh-atmosphere exchange of carbon dioxide in the short-term (2013-2017) and compare it to long-term burial rates based on radiometric dating. The five years of atmospheric measurements show a strong interannual variation in atmospheric carbon

exchange, varying from -104 to -233gCm^{-2} a^{-1} with a mean of -179±32gCm^{-2} a^{-1}. Variation in these annual sums was best explained by differences in rainfall early in the growing season. In the two years with below average rainfall in June, both net uptake and Normalized Difference Vegetation Index (NDVI) were less than in the other three years. Measurements in 2016 and 2017 suggest that the mechanism behind this variability may be rainfall decreasing soil salinity which has been shown to strongly control productivity. This seems to control carbon fluxes in both high and low marsh. The net ecosystem carbon balance was determined as burial rate from four sediment cores using radiometric dating and was lower than the net uptake measured by eddy covariance (mean: 110±13gCm^{-2} a^{-1}). The difference between these estimates was significant, and may be because the atmospheric measurements do not capture lateral carbon fluxes due to tidal exchange.

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TIDAL MARSH RECOVERY AFTER NATURAL STORM-SURGE DEPOSITION AND INTENTIONAL DEPOSITION IN THIN-LAYER PLACEMENT MANAGEMENT

Accelerated sea level rise threatens valuable tidal marshes in the northeastern United States. In general, marsh accretion no longer keeps up with the rate of sea level rise, resulting in flooding and marsh degradation. This study examined marshes affected by storm deposition events and marshes managed by spreading of mineral materials on top of the marsh surface to raise the elevation (thin-layer placement, TLP). Vegetation distributions were recorded and soil samples collected in 2016 at three Hurricane Sandy (2012) deposition sites and three thin-layer placement sites in southern in New England. Our objectives were to assess vegetative recovery from deposition events and track the changes in soil properties such as bulk density, soil organic matter content, and sulfides (dynamic soil properties). We expected the thickness of the deposits and surface elevation to influence vegetation recovery. Four years after the Sandy overwash events, these marshes showed strong vegetation recovery (average vegetative cover was about 66%). Much of the recovery appeared to be the result of vegetative regrowth encroaching onto the deposition material. A cumulative distribution of vegetation cover vs. sand thickness in the overwash sites showed diminishing vegetative recovery in areas with more than 15 cm of overwash sand. Changes in dynamic soil properties were site-specific. Soil bulk density and below-ground biomass both differed significantly between storm deposition sites and thin-layer placement sites, but soil organic matter content did not. Data from the storm deposition sites provided a context for the thin-layer placement management projects and helped with formulation of expectations and goals.

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ESTABLISHING THE RELATIONSHIP BETWEEN COLIFORM AND *VIBRIO* BACTERIA SPECIES ON THE SURFACE OF FARMED SUGAR KELP *SACCHARINA LATISSIMA* AND IN SURROUNDING SEAWATER

Aquacultured kelp is an emerging market in the USA. As with any new industry, regulations and guidelines for best practices are being developed as the industry develops. Water quality can be an indicator for some ocean food product safety. However, the connection between water quality and farmed kelp is not clear. During the Summer of 2017, 6 sample sites with mature *Saccharina latissima* (sugar kelp) were established in Saco Bay, Maine. Kelp tissue and water were collected weekly for 8 weeks. Total Coliforms (TC) and other enteric pathogens; *Vibrio parahaemolyticus, V. algynolyticus*, and *V. cholera* were cultured using selective agar, incubated for 24 hours. The mean number of colony forming units (CFU) of TC and *Vibrio* were calculated for each site for water and kelp. Results showed that FIB and *Vibrio* are present on both the kelp tissue and in the surrounding waters in varying amounts. The kelp had significantly fewer CFUs when compared with water samples across all sites. There was no significant spatial variation in the number of CFUs between sites for kelp or water. It is important to identify the relationship between water quality and

the kelp harvested from nearshore waters from a perspective of public health and best practices for farming and harvesting. It should be stressed that this research was conducted in a manner to maximize the probability of bacterial detection by taking place in the summer in a populated region, whereas *S. latissima* is typically grown in winter and harvested in early spring when bacterial communities are typically lower. Further study is needed to establish kelp-water-bacterial relationships both during the growing season and during post-harvest handling and processing.

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AN INVESTIGATION INTO THE PRESENCE AND PREVALENCE OF WASTING DISEASE IN GULF OF MAINE SEA STARS, ASTERIAS FORBESI AND ASTERIAS RUBENS, THROUGH HISTOLOGY AND DNA ANALYSIS

Sea star wasting disease (SSWD) is a well-documented infection that has recently decimated sea star populations on the United States' west coast. Although anecdotal reports suggest that SSWD may be present in the Northeast, the prevalence of this disease has been significantly understudied in this region. In October of 2016, captive *Asterias forbesi* and *Asterias rubens* held at the University of New England's Marine Science Center died unexpectedly, mirroring symptoms of SSWD. For this study we used morphology, histology, and molecular techniques to confirm the presence of SSWD and to gain a baseline estimate of the prevalence of SSWD in southern Maine. Local sea star populations were opportunistically and directly monitored in the summer months of June-August 2017 at four sites within Saco and Casco Bay, resulting in the collection of a total 53 sea stars (40 *A. rubens*;13 *A. forbesi*), with an overall density of 0.14/m2. We continued monitoring at intertidal locations into the winter 2017. Only one *A. forbesi* collected from western Casco Bay and one *A. rubens* collected from the Saco River Estuary, displayed potential symptoms of SSWD. Histological analysis revealed cuticle loss, edema, and ulceration of outer epithelium tissue, consistent with west coast cases of SSWD. Ongoing efforts using PCR techniques are aiming to characterize the viral infection with a sea star-associated densovirus (SSaDV) that reportedly affects sea stars at the west coast. Overall, histological and visual examination strongly suggest that SSWD is present in Southern Maine, but at a low prevalence.

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TEMPERATURE SHIFTS AND WINTER FLOUNDER PHENOLOGY: CLIMATE CHANGE ADAPTATIONS

Peak spawning time may vary within and between populations in relation to environmental factors such as temperature. As our climate changes, monitoring the potential temporal shifts in life cycles is important. For marine fishes, increases in temperature can act as an important cue in the timing of migration and reproduction synchronized with seasonal increases in food abundance. Baseline sampling was conducted for winter flounder (*Pseudopleuronectes americanus*) eggs within New Bedford Harbor as part of a mitigation program for the New Bedford South Terminal Extension Project. Historically, winter flounder peak spawning has been reported between February and March. Our analyses of three years (2011, 2016, and 2017) of winter flounder egg sampling showed that there may be a seasonal shift in peak spawning for this species to a later time of year. We found that the majority of eggs (80% in 2011,90% in 2016, 2017 TBD) were identified from samples in May. Investigation of seawater temperature over 50 years from Woods Hole, MA showed a +0.036(ºF/year) change. While additional studies are needed to confirm these results, our study parallels other work that has shown statistically significant correlation between increasing average water temperature and shifts of other marine benthic flatfish spawning, suggesting that climate change can have a significant impact to fish phenology.

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EVALUATION OF THE POTENTIAL FOR OYSTER MEDIATED NITROGEN REDUCTION IN A COASTAL SALT POND: YEAR TWO FINDINGS
The Town of Orleans, MA is developing nitrogen management plans to restore nitrogen impaired habitats within its estuaries. As part of this process the use of oyster aquaculture is being investigated as a cost-effective option for nitrogen mediation. To this end, a three-year field experiment was established in 2016 with 200,000 small and medium size oysters being deployed in floating aquaculture bags in a eutrophic salt pond, Lonnies Pond, a sub-embayment of Pleasant Bay. In 2017, the oyster deployment expanded to 600,000 small and medium size oysters. Oyster growth, water quality and nitrogen dynamics were monitored relative to the oyster culture area from April to December to determine the number and size of oysters needed to lower nitrogen to acceptable levels in Lonnies Pond. In this study, water quality and sediment-nutrient regeneration and denitrification rates were measured over the course of the oyster field season to determine and quantify any water quality benefits of the suspended oyster aquaculture system. Results suggest that the oysters had a large and significant positive effect on water clarity and lowering phytoplankton levels, with associated enhanced nitrogen removal. Also, it appears that characteristics of the embayment, such as, its geometry, current velocity, and sediment type contribute to the observed effect of oysters on water quality and nitrogen removal. Therefore, site selection and oyster placement within an embayment must be considered when implementing suspended oyster aquaculture as a nitrogen management method.

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IDENTIFICATION OF THE BLOOM FORMING *ULVA* IN JAMAICA BAY, NEW YORK
Eutrophication is prevalent in shallow water ecosystems world-wide. *Ulva* is a genus of bloom forming macroalgae that occur in shallow estuaries. *Ulva* have ecosystem consequences such as *Zostera* spp. degradation, fish, and shellfish declines. The presented study describes a comprehensive survey of *Ulva* sp. distributed in Jamaica Bay, NY, USA. Using ITS and tufA DNA Barcoding and cytological techniques, we identified the dominant species of *Ulva* at 8 sites in Jamaica Bay and 1 site in Long Island Sound, CT to match *Ulva compressa*, *Ulva* cf. *clathratioides*, *Ulva prolifera*, *Ulva stipitata*, *Ulva laetevirens*, and *Ulva* lactuca with other sequences world-wide. All samples collected had <1% divergence between species. Ulva *stipitata*, a compressed tubular species, was found in Jamaica Bay and is the first known occurrence of the species in the Northwest Atlantic. Historical Jamaica Bay specimens were also obtained and classified based on morphology and original name given. The presented study has management implications because we know the nitrogen storage potential of *Ulva* spp. from this major bay in metropolitan New York City coastal waters. Modelling the storage of nitrogen in *Ulva* spp. could be useful for optimal harvesting purposes to manage *Ulva* blooms.

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COASTAL CHANGE ALONG THE OUTER CAPE: APPLICATION OF THE DIGITAL SHORELINE ANALYSIS SYSTEM (DSAS) TO MAP THE DYNAMIC SHORELINE OF CAPE COD NATIONAL SEASHORE
Understanding the magnitude and direction of coastal change is important for the management of coastal resources and development. The unconsolidated, glacially-deposited bluffs of outer Cape Cod,

Massachusetts are dynamic features which have been studied by scientists at Cape Cod National Seashore (CCNS) for decades. To better describe the short-term patterns of shoreline change and assess the effectiveness of current shoreline mapping protocols, analysis was conducted using the Digital Shoreline Analysis System (DSAS), a freely-available statistical program developed for ArcMap. DSAS computes a suite of statistics of shoreline rate-of-change using a time series shoreline dataset. This study focused on a 45 km-long subset of wave-dominated, eastern-facing coastline from Herring Cove Beach in Provincetown to Nauset Beach in Eastham. Shoreline measurements were collected through continuous runs along the coastline of CCNS with an RTK GPS to measure the location of the mean high water level. Spring and fall shorelines have been collected twice annually since 1994. The shorelines are imported into ArcMap as vector files and analyzed using DSAS. Annual shoreline rates of change ranged from -5.0 to 4.8 meters/year (where negative values are shoreward or erosional), with the fastest rates occurring in the spring. The majority of the coastline was net erosional during the 13-year time frame, though some stretches of net accretion suggest variation in driving sediment transport processes. These results could provide insight for monitoring and management of coastlines in CCNS.

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CITIZEN SCIENCE TO ACHIEVE BOTH RESEARCH AND ENGAGEMENT OBJECTIVES: EXAMPLES FROM THE COASTAL RESEARCH VOLUNTEER PROGRAM
Given limited resources available to support research and monitoring, NH Sea Grant and University of New Hampshire Cooperative Extension's Coastal Research Volunteer (CRV) program is a citizen science program created to increase research capacity as well as to provide community members with authentic research and stewardship experiences along the coast. The CRV program is a novel model of citizen science that engages both adult and student volunteers to work with university researchers and state and local partners on a variety of projects related to the coastal watershed. CRV assists in projects such as horseshoe crab surveys, monitoring blue mussels for toxic contaminants, eel monitoring, sand dune restoration and research, ascophyllum phenology monitoring, and beach profiling, among others. This presentation will highlight citizen science as a method for achieving both community engagement and research objectives. We will detail CRV program impacts in terms of research outcomes, on the ground accomplishments and our efforts toward creating a network of citizens engaged in the stewardship of coastal resources.

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AUTONOMOUS BROAD AREA SEAFLOOR MAPPING
C-2i Inc tested an alternate means of site characterization using an autonomous bottom crawler called the Sea Otter. Deployed at Pilgrim lake MA, ad hoc instrumentation was mounted on the crawler including Onset light transmission and dissolved Oxygen data loggers, a AML multi-parameter data-logger measuring CTD, a Go-Pro video and internal 3-axis gradient and pressure. The crawler permits broad area close-to-the seafloor observation, sampling and mapping. The data from the disparate instrumentation was time and position synched and integrated into a recently developed Survae program that displays thumbnail data and imagery as a function of position; greatly easing data reduction, simplifying cross correlation and making it understandable to lay-persons.

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NESTING ADAPTATIONS AND FITNESS IN A HYBRIDIZING POPULATION OF SALTMARSH AND NELSON'S SPARROWS
Salt marshes provide breeding habitat for a community of uniquely adapted birds that are threatened by ongoing changes in vegetation, loss of habitat, and increased tidal flooding regimes due to rising sea levels.

Two species that breed in tidal marshes - Saltmarsh and Nelson's sparrows - also interbreed where they co-occur in a 200 km hybrid zone along the northeast Atlantic coast (southern ME to northern MA). Understanding their interspecific interactions aids in predicting population viability and responses to climate change, providing insight for conservation management. Previous work has shown that first generation hybrids are uncommon across the hybrid zone, and pure individuals of the two species rarely interbreed in the southern range. However, it is unclear how often inter-specific mating occurs in populations of similar abundance and if hybrids have reduced fitness. We examined these questions using demographic and genetic data from a population (adult: n=203, offspring: n= 281) in the center of the hybrid zone. To determine female fitness, we modeled nesting success in relation to genotypic (via a panel of SNP genetic markers), environmental (tidal water level), and nest structure characteristics. All sparrows experienced high nest failure due to tidal flooding; however, Saltmarsh sparrows had the highest reproductive success, followed by hybrids and Nelson's sparrows, respectively. Differences in fitness were attributed to nest structure/timing adaptations in relation to tidal flooding, suggesting that hybridization may provide adaptive benefits for Nelson's but not Saltmarsh Sparrows. Further, interspecific matings were rare. Assortative mating may help maintain each species without genetic swamping.

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CREPIDULA FORNICATA AS POTENTIAL LIVING FILTERS FOR MICROPLASTICS
Microplastics ranging from 10 - 200µm have been found in concentrations up to ~500 items m-3 in the Atlantic Ocean, with highest measured concentrations along the European coast. Between 93-236 thousand metric tons of small plastics (<5mm) are currently projected to be in the world's oceans. This amount of small plastics will increase as macroplastics are chemically and physically degraded. Slipper snails, *Crepidula fornicata* are known to retain 10µm particles at ~100% efficiency rate. This experiment examines the fate of 10µm polystyrene microspheres removed by *C. fornicata* from the water. Initial particle concentrations of 104 mL-1 using ratios of 1:0, 3:1, 1:1, 1:3, 0:1 of plastic microspheres to PhytoFeast Live (blend of *Pavlova, Isochrysis, Thalassiosira weissflogii, Tetraselmis, Nannochloropsis,* and *Synechococcus*) were set in 700mL jars of ultrapure seawater. Five replicates of hour long feeding periods provided measures of beads in water, feces, and pseudofeces, counted using a flow cytometer. Results of ANOVA analysis showed no relationship between initial treatment and end concentrations in water samples, feces, or pseudofeces ($p>0.05$), likely because experimental setup hindered even mixing. An average of 471 and maximum of 2080 microbeads were counted in pseudofeces, suggesting removal of beads from water. No beads were found in feces, but a longer sampling time could better show if any were digested. With removal shown, and selectivity displayed by presence in pseudofeces, further studies can determine if microplastics are resuspended, removed more permanently through burial, or if *C. fornicate* act as an entry for microplastics into the food web.

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A GUIDE TO BETTER PRACTICES FOR TIDAL SALT MARSH CONSERVATION: CLIMATE CHANGE CONSIDERATIONS FOR RESILIENT INVESTMENTS
This study explores the full toolbox of options available to public and private landowners to aid in tidal salt marsh conservation. Considerations for climate change impacts - specifically, migrating marshes - are discussed in the review of these tools. The use of GIS and modeling for the identification and prioritization of conservation parcels with the goal of maximizing conserved marshland is also discussed. The MA Conservation Land Tax Credit program is used as a case study to examine how climate change considerations may impact where investments in land are made.

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DOCUMENTING THE EFFECTS OF A LARGE-SCALE NATURALLY-OCCURRING SEDIMENT DEPOSITION EVENT ON PLANT COMMUNITY STRUCTURE AND PRODUCTIVITY IN SALT MARSHES IN MASSACHUSETTS

In mid-winter 2018, a combination of extreme cold followed by storm surge resulted in a series of unprecedented, natural sediment deposition events on the surface of salt marshes noted in MA, NH and ME. These large-scale events were presumably caused by freezing seawater on exposed flats and rafting of sediment-laden ice over marsh areas during a period of astronomical tides coinciding with a significant storm. In MA, reports of these events were noted in Manchester (Wolf Trap), Essex (Lowes Is.), Ipswich (Jeffrey's Neck) and Newbury (Plum Island). Aerial drone and field surveys estimate their cumulative footprint at approximately 50 acres. Sediment thickness, while variable, was 17.33 0.84mm with a max of 92mm. Roughly, this represents ~4,500c.y. of sediment addition. Given the average accretion rate in New England marshes is ~2 mm per year, this single event could represent over 8 years-worth of deposition. The natural, incremental process of sediment addition is critical to building and maintaining the marsh platform. Yet the magnitude of this event is extremely uncommon, providing opportunity to study effects of large-scale sediment additions over marsh areas on a scale that is ecologically significant and difficult, if not impossible, to recreate given environmental regulations. Marsh surface elevation, added sediment thickness, and vegetation response (abundance by species and biomass) will be examined for thickness ranges and control plots at each site, while repeated drone surveys will track sediment redistribution patterns. Results will be used to characterize marsh plant and soil responses to sediment nourishment and determine whether this natural event increases or decreases marsh resilience to sea level rise.

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BENTHIC VIDEO MONITORING IN THE PROVIDENCE RIVER ESTUARY - WHAT DO WE SEE?

The Narragansett Bay Commission (NBC) has been conducting benthic video surveys in the Providence River since 2014. The objective of these surveys is to build understanding of the local benthic ecosystem and observe changes over time as they relate to infrastructure improvements and wastewater treatment upgrades. Surveys focus on three transects of varying water depth: Edgewood Shoal (1 - 3 m), Sabin Point (2 - 4 m), and Bullock Reach (3 - 5 m). Transects are approximately 1 km in length and have been filmed 3 - 6 times per year. Since the project inception, the methods of surveying and analysis have been continually refined based on collaborative discussions among researchers studying the Narragansett Bay benthos, ensuring each individual project is complementary and supportive of others. To this end, NBC’s video analysis includes classification of the benthic substrate and dominant biotic community using the Coastal and Marine Ecological Classification Standard (CMECS) language, a tool enabling data comparison across studies of varying scales, methods, and locales. Using the CMECS substrate and biotic component classification schemes, preliminary biotopes are being described for surveyed areas. In addition to CMECS classification, the videos are analyzed for abundance of common organisms, locations of substantial debris or structure (e.g., boulders, tires), and reviewed for other noteworthy observations. The videos are also a powerful public outreach tool, helping our ratepayers and other stakeholders better understand the biology of these waters and building interest in benthic research. Recent observations and data maps will be shared.

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BUT WHY THE DECLINE? SHIFTS IN MACROALGAL BIOMASS IN A SHALLOW, MICROTIDAL ESTUARY

Previous research has established that increased nitrogen loads from residential septic systems have contributed to a rise in macroalgal species and a decline in eelgrass in the Waquoit Bay Estuary (WBE). In

an effort to track the long-term effects, the Waquoit Bay National Estuarine Research Reserve has been monitoring eelgrass and macroalgal biomass every 3-5 years since 2004. As of today, four surveys have been conducted: 2004, 2007, 2011, and 2016. Based on the data collected, macroalgal production seems to be increasing in areas with historically low nitrogen loads and decreasing in some areas with very high and increasing nitrogen loads. While an increasing trend in nitrogen levels explains the growing macroalgal productivity in the oligotrophic areas, the areas with high nitrogen and decreasing productivity are much more curious. A review of the relevant scientific literature and further analyses of local climate variables indicate that the WBE is experiencing rising water temperatures, decreasing summer wind speeds, and increasing precipitation. The frequent and prolonged hypoxia resulting from the combination of these climate factors and high nitrogen concentrations is likely shifting the benthic microbial community to primarily anaerobic respiration. Anaerobic respiration would cause sulfides to buildup in the sediments and may create a toxic environment for macroalgae. In order to reverse this trend and prevent other parts of the WBE from experiencing the same fate, town officials must act quickly and take climate impacts into account while considering mitigation plans to meet total maximum daily loads for nitrogen.

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POST-1900 SEDIMENT ACCUMULATION IN THE POINT JUDITH HARBOR OF REFUGE, POINT JUDITH, RHODE ISLAND

The Pt. Judith Harbor of Refuge (HOR), a breakwater harbor constructed between 1900 and 1914, located at the east end of the Rhode Island south shore (RISS) was surveyed in 2016 and 2017 using seismic reflection profilers. A distinct, acoustically transparent facies, overlying a prominent seismic reflector was mapped under much of the HOR. The current interpretation is that this reflector represents the shoreface prior to construction of the jetties. The sediment above this reflector is interpreted to be sediment deposited following construction. The current estimate is that this represents 3,100,000 m^3. A semi-quantitative estimate based on changes between a 1913 lead line survey and a 2009 hydrographic survey reports a slightly lower volume of 2,200,000 m^3 (depth was adjusted for sea level rise) (22,000 m^3 y^{-1}). The hydrographic data also suggests the upper shoreface of the HOR lost sediment over that time (340,000 m^3). This volume is significantly less than the total depositional volume, indicating much of the deposited sediment delivered by longshore sediment transport into the HOR. Our current interpretation is that this sediment is largely sand, however there are anomalous reflectors within this unit (gas). Verification ultimately requires sediment coring. Previous work indicates sedimentation rate of ~10,000 m^3 yr^{-1} (~ 1,000,000 m^3 in 100 years) on the flood tidal delta within Point Judith Pond. This study determined sedimentation in the HOR is at least double that estimate (22,000 - 26,000 m^3 yr^{-1}). Taken together this shows that the HOR is an important sink within the overall RISS sediment budget.

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MULTIMETRIC INDICES FOR INTEGRATED ASSESSMENTS OF SALT MARSH INTEGRITY

Tools for assessing and communicating salt marsh condition are essential to guide decisions aimed at maintaining, enhancing, or restoring ecosystem integrity and services. Ecosystem monitoring is recognized as a critical component of environmental decision making, and integration of monitoring data into a multimetric index (MMI) offers a way to detect changes in ecosystem condition and report on overall system health. Ultimately, the usefulness of the index depends both on how well it reflects conservation goals and its sensitivity to change. The U.S. Department of the Interior protects extensive salt marsh acreage within northeastern National Wildlife Refuges and National Parks, and MMIs have been developed for salt marsh assessments to meet specific conservation mandates. The National Wildlife Refuge MMI is based on a structured decision making framework to optimize management decisions. Monitoring variables were selected to target management objectives, and linear value modeling was used to aggregate multiple attributes into a single performance score representing total management benefit. The National Park MMI was generated using an algorithmic approach for selecting the combination of metrics most strongly correlated with human disturbance. In each case, the MMI provides an efficient, transparent approach to incorporate monitoring data into conservation practice.

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BENTHIC VIDEO MONITORING IN THE PROVIDENCE RIVER ESTUARY: APPLYING CMECS TERMINOLOGY TO EVALUATE SITE SUITABILITY FOR HABITAT RESTORATION

Historically, the urban Providence River Estuary (PRE) at the head of Narragansett Bay has been considered degraded due to centuries of pollution discharging into the waters. Recently, concerted efforts to reduce nutrient inputs have led to water quality improvements in the estuary. In order to monitor the effects of these changes, a multi-method and collaborative effort to evaluate the PRE's current condition is underway. This work is part of a larger goal to collect baseline data on the estuary, fill data gaps, and identify areas of highly degraded fish habitat. More specifically, data gathered from this benthic video survey will be used in conjunction with other PRE monitoring methods to help determine the most appropriate locations for habitat restoration and enhancement work, and to outline basic information about the current state of these areas and the fauna that reside there. By utilizing standardized CMECS terminology to analyze the results, comparisons to other estuary systems and concurrent research may be possible, allowing for a more complete picture of the area to be developed. This effort utilized an underwater video camera and sled apparatus to collect transect data at 12 sites along the PRE from the head of the Seekonk River to Conimicut Point. In addition to CMECS, the analysis consisted of a qualitative whole video review (QWVR) to identify rare occurrences along each transect. Our results provide an overview of preliminary results from transects collected in 2017, and how they may be incorporated into the larger goals of this work.

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POTENTIAL DENITRIFICATION RATES VARY WITH SALT MARSH VEGETATION ZONES

Denitrification is an important ecosystem function that reduces reactive nitrogen in coastal marshes and may vary with dominant vegetation. Vegetation zones of salt marshes are shifting with sea-level rise and tidal restoration. The goal of our study was to determine how potential denitrification rates vary among dominant vegetation zones in restored and unrestored coastal salt marshes in Connecticut. At 10 tidally restored and 10 unrestored sites, we quantified potential denitrification rates using denitrification enzyme activity assays (DEA) on sediment collected from vegetation zones dominated by *Spartina alterniflora*, *Spartina patens*, and *Phragmites australis*. We also quantified a suite of plant biomass and soil chemistry parameters. The average potential denitrification rate in the *S. alterniflora* zone was significantly lower than both the S. patens and *P. australis* zones. These results suggest that as tidal restoration and sea-level rise facilitate the expansion of S. alterniflora zones, the capacity of coastal salt marshes to remove nitrogen via denitrification may decrease. Although tidal restoration is known to shift patterns of vegetation dominance, our preliminary results show potential denitrification rates are not significantly different between restored and unrestored sites. Further analyses will examine the mechanisms driving potential denitrification by exploring the influence of plant biomass and soil chemistry parameters. Because our results suggest denitrification rates vary with vegetation zones, incorporating shifting vegetation under sea-level rise and tidal restoration scenarios is critical for predicting the future of nitrogen cycling in coastal wetlands.

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HISTOPATHOLOGICAL ANALYSIS OF PARASITES AND ENVIRONMENTAL STRESS RESPONSES OF FARMED BLUE MUSSELS (*MYTILUS EDULIS*) IN CASCO BAY, MAINE

Blue mussels (*Mytilus edulis*) farmed in Casco Bay, Maine are a profitable product in high demand on the East Coast. However, due to increased water temperature and ocean acidification as a result of climate change, threats to mussels are increasing. In order to mitigate or potentially predict adverse mussel health events, it is important to understand the health of this blue mussel population through tissue analysis by the

means of histopathology. This project focuses on identifying parasites and pathogens as well as physiological responses to environmental stress in contribution to a preliminary health assessment of farmed blue mussels in the Gulf of Maine. Data from the summer of 2017 identified low levels of common parasites including gill ciliates and trematode infections present in the mussel populations. Highly prevalent oocyte atresia (degeneration of female gametes) was found in 95.83% of female mussels sampled. Oocyte atresia has been documented to be associated with unfavorable spawning conditions, nutrient deficiencies, or exposure to contaminants such as crude oil. Other environmental stress responses such as digestive gland atrophy and hemocyte filled mantle follicles were also documented. Mussel health compared between inshore and offshore farm sites based on biophysical parameters (salinity, dissolved oxygen, temperature) will provide further insight to potential causes of oocyte atresia and establish a correlation between environmental conditions and blue mussel health.

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EFFECTS OF SEA-LEVEL RISE ON SALT MARSH ELEVATION DYNAMICS IN NEW HAMPSHIRE
Salt marshes, valued for their ecosystem services such as flood control, carbon capture, and nutrient cycling are currently threatened with increased submergence and collapse due to sea level rise. Marshes can build in elevation through growth of roots and rhizomes and deposition of sediments on the marsh surface, but elevation growth is unable to keep pace with sea level rise in 58% of the marshes in the United States. Researchers have shown that plant production is impaired by higher flooding rates, but no one has shown how biomass reductions relate to elevation change. Using a mesocosm experiment, I found that belowground production decreased linearly as flooding duration increased for both the high marsh species, *Spartina patens*, and the low marsh species, *Spartina alterniflora*. However, average belowground volume was much higher for *S. alterniflora*, indicating that the low marsh may be more resilient to sea level rise than the high marsh. Higher belowground production did not result in increases in elevation gain. The effect of increased plant production may have been negated by other soil processes such as decomposition and compaction that reduce marsh elevation.

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COMPARING HISTORIC OYSTER POPULATIONS TO PRESENT DAY AQUACULTURE ACTIVITIES IN EAST COAST ESTUARIES
From the 17th to the 19th centuries the large oyster populations that had grown in areas all along the East Coast of the United States were overharvested and subject to other threats. These include habitat loss mostly due to pollution, channel dredging and disease such as dermo and MSX. As the human population and demand for shellfish increased, the number of oysters decreased. By the end of the 20th century this combined with diseases caused almost all the region's oyster populations to disappear. Recently, the importance of oysters as a commercially harvested food source and its importance to the marine ecosystems are being recognized by many towns along the East Coast. As a result, oyster aquaculture has become a growing practice in the Northeast and Mid-Atlantic region. In this study we will explore how oyster populations have changed from pre-colonial times to the present day. Data from these studies may be used to inform locations of future larger oyster farms or reefs as well as possible re-establishment of natural oyster populations.

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MONITORING WATER QUALITY IN NORTHWEST ATLANTIC COASTAL WATERS USING DINOFLAGELLATE CYSTS

Nutrient pollution is a major environmental problem in many coastal waters around the US. Determining the total input of nutrients to estuaries is a challenge. One method to evaluate nutrient input is through nutrient loading models. Another method relies upon using indicators as early warning signs of water quality degradation. Dinoflagellate cysts (the fossilizable life stage of planktonic dinoflagellates) are an advantageous indicator of water quality since they are well preserved in the sedimentary record and can be used to track changes in nutrient pollution both spatially and temporally. We analyzed surface sediments from >30 estuaries spanning from Prince Edward Island (Canada) to Delaware Bay, and in short sediment cores collected from the northern Gulf of Mexico "dead zone." By covering an extensive geographic area, we encompassed four estuary types and incorporated estuaries ranging from low to highly impacted. In the spatial study we show that heterotrophic dinocysts correlate to nutrient loading, and that the relationship improves when the type of estuary is taken into account. In the Gulf of Mexico sediment cores, dinocysts reveal changes in eutrophication since the 1930s. We demonstrate that four species in particular can be used as indicators of nutrient pollution in the Gulf of Mexico "dead zone."

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USING A SOILS APPROACH TO IDENTIFY SHALLOW GROUNDWATER DISCHARGE LOCATIONS IN SOUTHERN NEW ENGLAND COASTAL PONDS

Groundwater discharge into estuarine environments is a significant source of excess nutrients in estuarine environments. As much as 99% of the phosphorus and 93% of dissolved inorganic nitrogen inputs into Rhode Island coastal lagoons each year comes from groundwater discharge. These nutrients are non-point pollution sources that can lead to detrimental environmental conditions such as algal blooms, eutrophication, and hypoxia. Rhode Island groundwater typically has a low pH. providing another avenue for coastal acidification in the ponds—a growing concern in estuarine environments. The objective of this study was to test a soils approach to identify locations of groundwater inputs into estuaries. We sampled 100 near-shore shallow water locations in three estuaries in Rhode Island and Connecticut. Almost half (49) of these soils had soil colors indicative of inputs of Fe (referred to here as aeric colors). Soils with aeric colors had a significantly lower soil pH (M=6.36; $p < 0.001$) and salinity (M=641µS; $p < 0.001$) than non-aeric soils (pH M=6.87, salinity M=2890µS), indicating that these colors are indicative of groundwater inputs. There were no significant differences in overlying water column pH ($p=0.385$) or salinity ($p=0.103$) between sites with aeric (pH M=7.76, salinity M= 48350µS) and non-aeric (pH M=7.64, salinity M=49250µS) soils. Our studies suggest that using aeric soil colors is an effective approach to identifying locations of groundwater input. Being able to predict and map areas of estuaries where groundwater discharge is occurring will assist coastal managers in planning ways to minimize the impacts of the excess nutrients and acidity in the groundwater.

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ASSESSING NITROGEN INPUTS TO THE CHARLESTOWN COASTAL WATERSHED FROM ADVANCED ONSITE WASTEWATER TREATMENT SYSTEMS

Wastewater from onsite wastewater treatment systems (OWTS) can serve as a source of nitrogen (N) to coastal watersheds. Because excessive N loads can cause eutrophication in coastal ecosystems, advanced OWTS technologies have been used to mitigate their impact on these ecosystems by reducing N inputs. Advanced N-removal OWTS can facilitate the processes of nitrification and denitrification before the effluent is applied to the soil treatment area and percolates to the groundwater. In this study, we selected 50 advanced N-removal OWTS in Charlestown, Rhode Island to determine the capacity of six different N-removal OWTS technologies (Orenco Advantex AX20, Orenco Advantex RX30, BioMicrobics MicroFAST, and Norweco Singulair Models TNT, 960, and DN) to meet the Rhode Island Dept. of Environmental Management's standard for final effluent total N concentration of 19 mg/L or less. Twenty-four of the systems are for houses occupied year-round, while 26 are for seasonally-occupied houses. The year-round systems are sampled quarterly and the seasonal systems are sampled four times over the summer

occupancy period. For all systems, field measurements are made of effluent pH, temperature, and concentration of dissolved oxygen (DO), ammonium (NH_4^+), and nitrate (NO_3^-) in the final effluent. Final effluent is also analyzed in the laboratory for pH, alkalinity, biochemical oxygen demand, NH_4^+, NO_3^-, and total N. These data will allow us to quantify rate of compliance with state effluent standard as a function of technology, seasonality/temperature, and home occupancy pattern, and help identify conditions that may be adjusted within each technology to optimize N-removal treatment performance.

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LONG-TERM TIDAL WETLAND CHANGES AT BARN ISLAND, STONINGTON, CT
Many wetland scientists point to sea level rise as a primary driver of biophysical changes in tidal wetlands. A careful examination of changes over eight decades reveal that the Barn Island wetlands are responding to the drastic alteration of tidal hydrology by the construction of mosquito ditches. Ditching depresses the height of high water to the extent that the once wide and continuous levees shrink over eight decades. This causes a shift of the dominant levee grass from *Spartina patens* to *Juncus gerardii*. In 1947 Dr. Frank Egler describes a dieback of the *Juncus* belt along the upland border and this dieback returns in 1963, 1983 and 2008. In 1976 and 2017, the *Juncus* belt has been replaced by forbs everywhere except for the one small natural marsh with levee and basin topography. Here the *Juncus* belt remains intact and therefore the dieback is the result of the altered hydrology from ditching and the tidal range fluctuations of the lunar nodal cycle. In 1976, the plant communities at several locations are mapped. Discovered in 2016 are Dr. Niering's field notes describing four new transects on the Palmer Neck section. These transects were resurveyed in 2017 and 1976-2017 data set allow for a detailed description of vegetation change in the last 40 years. Not all changes are slow as evident at and adjacent to the 2008 dieback at Brucker Marsh. In several locations, the marsh is reverting to the equilibrium levee and basin topography.

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STANDING ON THE SHOULDERS OF GIANTS (AND PICKING THE LOW-HANGING FRUIT) – UPDATING THE NARRAGANSETT BAY WATERSHED NUTRIENT BUDGET
Population growth and development intensified nutrient loading to the Narragansett Bay Watershed since the Industrial Revolution. Over the last 15 years, management policies and significant investments in wastewater treatment facilities reduced the nitrogen and phosphorus loadings to the Watershed. As part of the 2017 *State of Narragansett Bay and Its Watershed* report, the Narragansett Bay Estuary Program updated nitrogen and phosphorus loadings from 37 wastewater treatment facilities and 6 major rivers (the low-hanging fruit) in Massachusetts and Rhode Island, continuing work started by Nixon and colleagues (1995, 2008) and Krumholz (2012). Between 2000 and 2015, wastewater treatment facility nitrogen and phosphorus loadings declined 55% and 42%, respectively. River loadings decreased 62% and 78% in nitrogen and phosphorus. Since the 1980s, total nitrogen and phosphorus loadings throughout the Watershed declined by over 50%. Overall, the management policies and significant investments at wastewater treatment facilities have reduced nutrient loading to the watershed, improving water quality. Furthermore, these results highlight the pieces of the budget that were not updated (the higher-hanging fruit) – atmospheric deposition, urban runoff, and groundwater.

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DECADAL SCALE RESEARCH IN ROCKY SUBTIDAL HABITATS, MASSACHUSETTS BAY
Our ongoing studies in the rocky subtidal zone of Massachusetts Bay comprise the most comprehensive and consistently sampled data set for any such community, anywhere in the world (5 sites,1978-present). We quantified sessile species percent cover from over 150 permanent quadrat photographs per season, and abundance of all mobile consumers in photographs and field transects. This study was designed to answer several questions concerning community structure: Stability of these biotic assemblages over decades? Predation effects on community structure? Factors most likely to have caused observed major changes (e.g.

physical stress, increased predation, recruitment limitation, competition, food delivery)? Factors limiting population density, individual growth rates, and recruitment rates of the most common species? How often do new species enter these communities and are their effects substantially different from those of native species? This long-term study was conducted concurrently with several experimental studies of component species and their interactions. During the four decades of this study, large scale changes occurred at all sites including; the arrival and disappearance of nonindigenous species, major changes in sea urchin population densities, disease-related population reduction of major predators and sessile benthos, and alterations of species composition that correlate with decadal scale temperature change. This database is a unique resource that can be used now and in the future for many types of analysis not envisioned when the study began. The data collected provides individual growth rates, mortality rates, and organism size-frequency distributions for incorporation into our community analysis and models.

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CORE POROSITY AND CONE PENETRATION TESTING IN WAQUOIT BAY SAGE LOT MARSH

With the sea level rising 3mm/year in New England the open question is whether the marsh accretion is rapid enough or not for the marsh to keep up. The marsh top layer can be considered as a self loaded spring or sponge (representing the intertwined plant remnants mixed with sediment) partially submerged in water. We found that with rising and falling tides this layer is swelling and subsiding as much as 10mm in places close to the drainage creek. To investigate the mechanical properties of the soil in the marsh we conducted water percolation tests in the lab with a 4inch diameter 1m long extracted core and performed manual cone penetration tests (mCPT) in the field. During the core porosity/water percolation tests we drained water from the core in 100ml amounts and observed the subsequent water level equilibration over the following days. The level drops exponentially during the first 2 hours and then asymptotes to a linear behavior with time scale of days. During the mCPT using a slide hammer we rammed down into the marsh soil a dummy stainless steel cylinder with 60 degree cone with the standard frontal area of 10cm^2. Unlike the standard CPT tests we could not measure the lateral friction, but were able to measure only the frontal resistance. The frontal resistance q_c was found to be about 0.1MPa in the top part of the marsh soil and about 2MPa when we encountered the sandy layers. It took about 100-200 slide hammer blows to make a test at one spot to a depth about 1.5m. This method proved to be efficient for quantitatively sounding the marsh soil structure along a transect, revealing the depth of the base sandy layer varying from 1.6m in low marsh to 10cm in high marsh zone as well as various smaller scale laminas.

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OVERVIEW OF SALT MARSH LOSSES ON CAPE COD, WITH SPECIAL EMPHASIS ON CRAB-DRIVEN VEGETATION LOSSES AND CONSEQUENCES

Research over the last 10+ years has revealed that salt marsh plants on Cape Cod are being consumed and eventually killed from intense, continuous grazing by a species of native, herbivorous crab—*Sesarma reticulatum* (Purple Marsh Crab). Losses within the low-marsh zone, dominated by smooth cordgrass (*Spartina alterniflora*), have been particularly severe. However, vegetation losses have also occurred in the high marsh, which is comprised of mainly saltmeadow cordgrass (*Spartina patens*). In contrast to the low marsh, high-marsh losses consistently occur along the seaward-most edge of this zone, suggesting a link with flooding frequency and, therefore, sea level rise. Plants growing there also seem to have a much-reduced capacity to recover from *Sesarma* grazing. Throughout marshes, the creation of non-vegetated areas seems to have facilitated invasions of mud fiddler crabs (*Uca pugnax*). Manipulative field experiments indicate that these crabs may be attracted to open, unvegetated habitats with softer substrates. This is important since these crabs contribute to elevated suspended sediment loads in the water column through bioturbation (burrowing and feeding) and this leads to erosion and elevation lowering. The loss of vegetation through *S. reticulatum* herbivory has resulted in a cascading series of events, with substantial consequences for vegetation recovery and overall marsh resiliency.

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A LOOK BACK IN HISTORY: THE INTRODUCTION TO THE MARINE SCIENCES COURSE AND ITS RAMIFICATIONS ON MARINE SCIENCE EDUCATION IN NH.
The New Hampshire College and University Council was established in 1966 with the idea of fostering cooperation among the private and public institutions of higher education in NH. One of the early groups associated with the Council was the Marine Science Consortium, a group of self selected faculty interested in the marine sciences. This group organized and ran a semester long course called "Introduction to the Marine Sciences" that was taught on Saturdays, with each Saturday at a different institution. The consortium also organized a summer program at the Cobscook Bay Laboratory. This presentation will describe the rise and fall of this effort in marine science education.

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MAKING NATURE GREAT AGAIN: EPISODE II - THE PHANTOM MENACE
The Anthropocene continues on its path of ecosystem overexploitation by the Human Nation. Many ecosystems are in decline due to extinction, alien invasions, and indiscriminate economic forces that annex Nature's land and foster unsustainable trade practices that have intractably altered Nature's prime infrastructure. Half-hearted and superficial attempts by the Human Nation at adaptation have proven to be scientifically uncertain and ineffective if not counter-productive. Though the Human Nation footprint seems to have suppressed Nature's ability to become great again, there are signs of transformative resilience in Connecticut coastal watershed ecosystems where Nature's resistant forces persist. Fragmented forests increasingly encroach on Human habitats and residual core forest show signs of transformation that hold promise for Nature's recovery to former greatness. Nature's capital may not have been intractably drained, and its structure may be adapting into sustainable functionality. This natural recovery is a paradoxical divergence from desired outcomes from restoring or repurposing ecosystems to meet the demands of the Phantom Menace that caused the problem. The state of 160 Connecticut coastal watersheds will be reviewed and watershed – buffer health indices paired to identify prospects and direction for resilient and healthy coastal stream and estuarine ecosystems under a new regime of Making Nature Great Again.

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CARBON ACCOUNTING IN ESTUARIES (BLUE CARBON)
Blue carbon is the carbon stored in the plants and soils of shallow subtidal and intertidal components of an estuary. In this study, we examined the soils component of the blue carbon in salt marshes and subaqueous soils of shallow subtidal wetlands in southern New England. Our subaqueous soils work focused the spatial relationships between SOC pool size and subaqueous soil landscape units in three coastal lagoons in Rhode Island and estimated SOC sequestration rates for these soils. Fifty two pedons were sampled to a meter and analyzed for SOC content and bulk density to calculate SOC pools. Pools varied significantly among soil landscape units and subaqueous soil great groups. Average SOC pools for the upper meter ranged from 170 Mg C ha^{-1} to 40 Mg C ha^{-1}. Average sequestration rates ranged from 0.18 to 1.45 Mg C ha^{-1} yr^{-1} and were significantly different among soil landscape units. In comparison, SOC pools in adjacent tidal marshes ranged from 120 to 240 Mg C ha^{-1} for the upper 50 cm of the soil. These carbon stocks varied significantly among marsh types with back barrier marshes having the lowest carbon stocks and tidal river marshes having the highest carbon stocks. Our studies add to the debates regarding carbon density in these systems. We reviewed the various errors associated with carbon accounting and will discuss those in this paper.

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DETERMINING THE FATE OF LAND-DERIVED NITROGEN IN SALT MARSHES USING A ^{15}N ISOTOPE TRACER EXPERIMENT
Salt marshes are an important nutrient sink, intercepting and utilizing land-derived nitrogen through numerous biological and physical processes. However, salt marshes are under unprecedented stress,

receiving high land-derived nutrient loading from agriculture and wastewater runoff. Their ability to retain and process N will affect the structure and function of the marsh ecosystem. We used a 15N isotope tracer experiment to determine the fate of incoming nitrogen, and the role of the high marsh platform in sequestering N. The tracer was added as $K^{15}NO_3^-$ over 10 days (19 tides) to a primary creek marsh system in Plum Island, Massachusetts. Tides ranged from neap tides (mean water exchange of 3,300 m^3) that did not flood the marsh, to tides that flooded the marsh platform (mean water exchanged m^3). We used this tracer to assess the N cycle, to estimate net-nutrient budgets over four tidal cycles, to assess plant nitrogen uptake, and to study food web interactions. We achieved a peak $\delta^{15}NO_3^-$ enrichment level of 3100 ‰. The average $\delta^{15}NH_4^+$ value was low, initially 19‰ in days 1-4 of enrichment, but increased to 29‰ after 6 days of enrichment. This is likely the result of remineralization of fast turnover algal compartments, such as benthic macroalgae, which reached a $\delta^{15}NO_3^-$ value of 215‰. The marsh platform could play an important role in nitrogen uptake and processing, and we expect to see differences in overall nutrient retention and denitrification during larger tides that flood the marsh platform.

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GULF OF MAINE INSTITUTE: LEARNING TO STEWARD THE GULF
The mission of the Gulf of Maine Institute (GOMI) is to promote stewardship of the Gulf of Maine watershed and the Gulf of Maine, a bioregion stretching from Massachusetts to Nova Scotia that provides ecological, economic, and social services critical to the region. GOMI embraces the philosophy of community-based stewardship (CBS) in its approach to educate the larger community and coming generations in "Learning to Steward the Gulf". CBS emphasizes 1.) immersion in experiences that emphasize unique biota, history, culture, economy, literature, and art of a specific place, 2.) civic engagement that results in concrete, beneficial actions to understand, protect and promote a healthy ecosystem, and 3.) connection of local community efforts to the larger bioregion. GOMI's initiatives employ three overlapping strategies: teacher professional development, civic engagement, and amplifying voices. GOMI believes the most effective way to reach coming generations is by educating and training teachers. It fosters partnerships between teachers and regional research scientists, managers, and naturalists to create projects for students at all levels. GOMI also engages the larger community through public forums such as Climate Cafés and by supporting citizen scientist projects. Through its on-line Journal, GOMI strives to amplify the voices of all its participants by publishing – in each issue - articles from students, teachers, naturalists, managers, and scientists. The Journal offers an opportunity for students to present their work in a public forum, and provides a platform for the exchange of ideas among stakeholders. GOMI seeks to expand its network throughout the region and offers many ways to participate.

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ENVIRONMENTAL DNA – AN EMERGING TOOL IN WATER RESOURCES MANAGEMENT
Environmental DNA (eDNA), or DNA present in an environmental sample, includes whole microorganisms (microalgae, bacteria etc.) and fragments of tissue, reproductive and waste products, and other cellular material from plant or animal species. eDNA methods allow resource managers to identify species in an estuarine ecosystem without having to actually capture and identify individual organisms. The method is particularly useful for identification and management of invasive or rare species, but is currently limited to determining presence/absence, not abundance. We will briefly introduce eDNA methods, discuss advantages and potential disadvantages, and give examples from pilot studies in estuarine environments. For instance, the eDNA identification of fish and crab species present in water and sediment samples in several estuaries, and initial data related to American Eels in estuaries and rivers. We will also discuss the unique challenges encountered when sampling and analyzing eDNA in estuaries.

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A DEMONSTRATION IN POLYCULTURE ON CAPE COD, MASSACHUSETTS
The eastern oyster, *Crassostrea virginica*, is a valued shellfish. On Cape Cod, many estuarine waterways are currently experiencing eutrophication and periodic hypoxia due to excessive nutrient inputs stimulating macroalgal blooms that die and decompose. An alternative is to harvest excess algae that has value as fertilizer for local agriculture or as a source of agar. Oyster aquaculture has also been proposed as one strategy for remediating eutrophic conditions in ponds resulting from excess nutrients. I investigated whether growing oysters together with the common green algae, *Ulva lactuca*, could enhance the productivity of oysters, improve removal of nitrogen, and produce a second useful algal crop valued for agar. I measured the growth and survival of both *Ulva* and oysters grown separately and together in four replicate one m2 by 0.2 m high cages in Bournes Pond, Falmouth, on Cape Cod. During the 3 month period July 4-Sept 28 2017, *C. virginica* grew about 50% larger in cages without *U. lactuca* compared with oysters grown in cages containing algae. Both length ($P=0.0147$) and harvest weight ($P < .001$) were significantly different between treatments. On the other hand, oysters grown alone showed nearly double the mortality (21.2% mortality compared to 13.8% in cages with algae). Negative effects of macroalgae on growth rate may have been caused by interference with filtration and feeding. Algae may improve survival by reducing predation. I also present data on nutrient levels and suspended chlorophyll in cages with oysters alone, oysters plus algae and algae alone.

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QUANTIFYING DENITRIFICATION IN FRESHWATER POND SEDIMENTS AS A SIGNIFICANT COMPONENT OF NITROGEN ATTENUATION IN CAPE COD, MA
According to the Massachusetts Estuaries Project (MEP), most of the 89 estuaries in Massachusetts are impaired by nitrogen loading. Many towns around Cape Cod and south coast MA, are working to reduce the nitrogen load to the estuaries by developing nitrogen remediation scenarios that use a combination of wastewater treatment and soft infrastructure solutions, such as freshwater ponds, aquaculture, wetland restoration, etc. It has been suggested that watershed nitrogen loading can be reduced by increasing natural nitrogen attenuation in freshwater ponds within the watershed transport path. Nutrient and flow data collected during the MEP indicated that a freshwater pond could attenuate as much as 50% of the nitrogen load passing through it. The nitrogen can be attenuated through denitrification, sedimentation, and plant uptake. In order to quantify the amount of nitrogen attenuated by denitrification a nitrogen mass balance is constructed. A nitrogen mass balance for the pond includes all inputs and outputs, i.e. denitrification rate, burial rate, and groundwater and stream input and output. From 2016 through 2017, at three small ponds, measurements were made biweekly for water quality and flow of the stream input and output(s). In addition, sediment cores were collected on at least three occasions in each pond to quantify the annual nutrient regeneration and denitrification rates from the sediments. Together, these data will provide an understanding of the nitrogen attenuation by denitrification in small ponds and give guidance to approaches to increase nitrogen attenuation in these systems, as a way to reduce nitrogen loading to down gradient estuaries.

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EVALUATION OF SHORELINE CHANGE AND SPIT NAPATREE LAGOON, WATCH HILL, RHODE ISLAND USING HISTORICAL AERIAL PHOTOGRAPHS, DIGITAL ORTHOPHOTOGRAPHS AND DIFFERENTIAL GPS
The lagoon at the west end of the Napatree Point Conservation Area (NPCA) is a 2km long barrier spit connected to Watch Hill Point and Napatree Point. The Hurricane of 1938 breached the barrier in several places, including disconnecting the Sandy Point barrier from Napatree Point. This marked the onset of spit formation and the current lagoon, which began in earnest following a hurricane in 1944. The last high tide

swash (LHTS) shoreline along the spit was mapped using georeferenced historic aerial photographs and digital orthophotographs (1939 and 2017). The position of LHTS has been mapped quarterly using handheld DGPS. The annualized rate of change as well as width and length of the spit have been measured using ESRI ArcMap software. Mapping results show the spit extended east from 1945-2010 approximately 440 m via longshore transport, while migrating south ~100 m through overwash and washover fan deposition during storms over the same period. Storms induce drastic changes of the spit; the inlet position switched from the eastern end to a more western position in 2010/2011. The spit eroded significantly during Sandy, the spit has reformed over the last six years and continues to grow to the east, with the inlet in a more eastern position. Ongoing work using RTK-GPS measured cross-shore profiles will examine changes in onshore/offshore sediment transport. The lagoon spit and the processes that shape it serve as a model of natural shoreline change and spit migration on other larger barriers.

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EVIDENCE FOR NITROGEN REMOVAL VIA PHYTOREMEDIATION WITH *PHRAGMITES*

Nitrogen eutrophication is one of the biggest challenges faced by shellfish restoration biologists in Martha's Vineyard, MA, similar to the situation found in many coastal areas. Locally, most of the controllable nitrogen inputs originate in residential wastewater. The high costs of sewer systems make them currently impractical for most rural watersheds. Even if installed, legacy N-rich groundwater will continue to enter the estuary for decades, making on-site mitigation a necessity. *Phragmites australis*, a cosmopolitan species that is highly invasive in North America, also provides ecological services, especially sequestration of nutrients. This strong affinity has been exploited for nutrient management in eutrophied estuaries and lakes worldwide, as well as in wastewater treatment applications. This project focused on the potential to harvest existing *Phragmites* to intercept nitrogen. We collected bimonthly data on reed height, biomass, and %N in 8 stands on Martha's Vineyard during 2016 and 2017. We conducted a stalk density survey and estimated area each year at 3 estuaries. Using these data coupled with an aerial survey, we calculated kg N m^{-2} in *Phragmites* biomass on Martha's Vineyard. Groundwater wells were used to measure nitrogen uptake from groundwater by a stand of *Phragmites*. Inspection of native species, permitting regulations, and the use of cut *Phragmites* for marketable products were included to support the vision of widespread, annual harvest of the invasive reeds for bioextraction. Although the study sites were focused on Martha's Vineyard, the results of this study may be applied to *Phragmites* across the region.

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LONG ISLAND SOUND TIDAL MARSHES IN THE ANTHROPOCENE

For the last *ca.* 350 years Long Island Sound tidal marshes have been on the receiving end of multiple human activities that have affected both community structure and a range of ecological functions. There were direct losses from fill and dredge and a range of impacts from tidal restrictions due to transportation corridors and tidal gates. Extensive ditching for mosquito control in the 1930s continues to alter vegetation patterns and ecological functions. Nutrient loading may be accelerating low marsh loss and is unquestionably estuarine degrading water quality. Accelerating relative sea level rise (RSLR) is the latest and potentially the most problematic anthropogenic factor affecting tidal marsh systems throughout the Sound. The *Spartina patens/Distichlis spicata/Juncus gerardii* high marsh community is the most threatened by RSLR. High marsh accretion rates along the Sound are typically 2 – 3 mm yr^{-1} while RSLR has averaged over 4 mm yr^{-1} for the past two to three decades, leading to an elevation deficit and increased hydroperiods. *S. patens* dominated vegetation sitting higher in the tide range has thus far remained relatively stable; systems with less elevation capital, however, show a decline in high marsh graminoids and an increase in forbs, stunted *Spartina alterniflora*, bare peat, and open water, all reflecting increasing hydroperiods. Loss of high marsh habitat both through erosion and conversion to a more low marsh like environment will lead to the loss of a range of ecological functions and presents a significant management challenge for individuals and institutions with stewardship responsibilities for the Sound's tidal wetlands.

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SALT MARSH SUSTAINABILITY IN NEW ENGLAND: PROGRESS AND REMAINING CHALLENGES

Natural resource managers, conservationists, and scientists described marsh loss and degradation in many New England coastal systems at the 2014 “Effects of Sea Level Rise on Rhode Island’s Salt Marshes” workshop, organized by the Narragansett Bay NERR, Save The Bay, RI CRMC, and US EPA. Workshop participants described how marsh loss and changes in vegetation and accretion patterns correlated with sea level rise and anthropogenic stressors. They agreed that partnerships throughout the New England region were needed to facilitate a better understanding of coastal marsh vulnerability, resiliency, and sustainability. Development of climate adaptation and restoration methods to build coastal resiliency were discussed, and an adaptive management framework incorporating reference systems was identified for implementation. I discuss the progress made in assessing, monitoring, and restoring coastal marshes in New England. I highlight the direction of the science including research addressing the underlying processes and dynamic feedbacks to sustain coastal marshes and communities. This progress has influenced the evolution of the adaptive management framework, with new emphasis on incorporating a social-ecological systems approach when defining restoration goals and selecting adaptation methods. Remaining challenges for social and ecosystem scientists are development of predictive, dynamic models to forecast coastal marsh resiliency to sea level rise, storm surges, and multiple stressors, and the incorporation of socio-economic parameters into models and indicators of coastal resilience. Using ongoing restoration efforts, I describe the process for successfully building partnerships and selecting climate adaptation actions.

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BIG PIPE VS. SMALL PIPE: A COMPARISON OF NITROGEN CYCLING MICROBIAL COMMUNITIES IN A NITROGEN REMOVING WASTEWATER TREATMENT PLANT AND IN NITROGEN REMOVING SEPTIC SYSTEMS

Wastewater is treated in two major ways: at large, municipal wastewater treatment plants (WWTP) and in onsite wastewater treatment systems (OWTS, i.e. septic systems). Advancing biological nitrogen removal has become a goal for both types of treatment. Nitrogen removal relies on two sequential microbial processes: nitrification and denitrification. The organisms performing these nitrogen transformations in both WWTP and OWTS, are vital to successful water treatment. To determine differences and similarities between the microbial community of WWTP and OWTS, we collected water samples from a WWTP (Field’s Point, Providence, RI) and nine advanced OWTS in Jamestown, RI. Using Miseq sequencing technologies, we analyzed DNA extracted from water samples for the diversity of organisms containing ammonia monooxygenase (amoA), a gene important for nitrification, and nitrous oxide reductase (nosZ), a gene important for denitrification. To calculate diversity indices and community similarity, we analyzed DNA sequences using QIIME 1.9.1. Understanding the structure of wastewater microbial communities is important to optimizing the conditions for nitrogen removal. The similarities and differences between WWTP and OWTS has not been well studied, though understanding the community structures in both may help us to overcome pitfalls in nitrogen removal. Additionally, information about the patterns in the microbial communities of these two types of wastewater may inform design decisions of both.