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ABSTRACTS

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NITROGEN-REMOVAL SERVICES OF RESTORED SALT MARSHES IN JAMAICA BAY (NEW YORK, NY)
Coastal wetlands are important sites of nitrogen removal, a critical ecosystem service in highly eutrophic environments. In Jamaica Bay, over 92% of historic wetland area has been lost over the past century. Despite considerable efforts to restore wetland ecosystems in Jamaica Bay and throughout New York City, few studies have examined the value of ecosystem services used to justify their cost, and little is known about the ecological mechanisms contributing to the success or failure of reconstruction. Past and ongoing restoration efforts in Jamaica Bay provide a unique opportunity to study nitrogen-removal ecosystem services in natural and restored wetlands in an urban, eutrophic environment. In collaboration with researchers from several institutions, we are using a chronosequence of marsh restorations to assess how marsh vegetation, sediment characteristics, and key processes of the nitrogen cycle develop over time following restoration. The goal of our project is to determine the restoration age and environmental conditions under which salt-marsh restoration will effectively provide ecosystem services such as nitrogen removal. We employ a combination of flow-through incubation, field survey, and experimental methods to identify the key biological and abiotic factors limiting nitrogen-removal services in natural and restored marshes. Preliminary results indicate that restored marshes remove a significant amount of nitrogen via microbial denitrification and accumulation of organic material and that marsh plants have a strong, positive influence on nitrogen-removal rates. Across the restoration chronosequence, we detected increases in plant root mass, indicating that restored marshes also become more stable over time.

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EPA'S MANAGEMENT STRATEGIES FOR NITROGEN REDUCTION IN LONG ISLAND SOUND
The Long Island Sound (LIS) Total Maximum Daily Load (TMDL) agreement to reduce nitrogen (N) loading from waste water treatment plants by 60% was agreed to in 2000 and will be achieved latter this year. Despite this progress, there are still many impacts of eutrophication found in LIS, including bottom water hypoxia in the Western Sound, harmful algal and macro-algal blooms, limited seagrass acreage, and others. Therefore, additional N removal measures are needed. EPA has proposed a 3-pronged strategy to address these issues, 1. Additional N removal from wastewater treatment plants, 2. N removal from major tributaries such as the Connecticut River, 3. N removal from many of the numerous embayments around LIS. Since many of these are non-point sources, further N reduction will be a challenge. Such efforts are also being closely coordinated with active state N reduction efforts in both New York and Connecticut.

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NITROUS OXIDE FLUXES AND NITRIFIER AND DENITRIFIER GENE ABUNDANCE FROM NITROGEN REMOVAL TANKS AT CENTRALIZED AND ADVANCED ONSITE WASTEWATER TREATMENT SYSTEMS
Biological nitrogen removal (BNR) systems are being implemented throughout the U.S. within both centralized wastewater treatment plants (WWTP) and residential onsite wastewater treatment systems (OWTS) in order to reduce human-derived nitrogen loads to the environment. These systems all include naturally occurring nitrifying and denitrifying bacteria to convert ammonium and nitrate to nitrogen gas. However, nitrous oxide, a potent greenhouse gas with multiple microbial sources, can also be emitted. The objectives of this study were to (a) quantify and compare nitrous oxide fluxes from BNR systems at a WWTP and three types of commonly-used advanced OWTS (Orenco Advantex AX-20, SeptiTech D Series, and BioMicrobics MicroFAST) in the Narragansett Bay, RI watershed and (b) determine the abundance of nitrifying and denitrifying microorganisms that may be producing nitrous oxide, via quantitative PCR analysis of the monooxygenase gene (*amoA*) and nitrous oxide reductase (*nosZ*) genes, respectively. A Picarro G2508 was used to measure nitrous oxide fluxes from the Field's Point WWTP and nine residential OWTS (n=3 per technology) in June and October 2016. Nitrous oxide fluxes were highly variable within and among all systems, WWTP and OWTS, ranging from -4×10^{-3} to 10×10^{-2} µmol N_2O m^{-2} s^{-1}. Nitrous oxide fluxes represented a small proportion (<1%) of nitrogen removed from the WWTP and all OWTS, except Advantex AX-20 (up to 24%). There was not a relationship between *nosZ* nor *amoA* and nitrous oxide fluxes. Future studies must combine biogeochemistry and molecular ecology to further constrain the drivers of large variability observed in fluxes.

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FACTORS AFFECTING CARBON ACCUMULATION IN NEW ENGLAND EELGRASS MEADOWS

As atmospheric and oceanic concentrations of carbon dioxide continue to increase, quantifying the carbon storage potential of seagrass meadows and improving the understanding of the factors controlling carbon sequestration in seagrass meadows is essential information for decision-makers. In 8 seagrass meadows from New Hampshire to Rhode Island, we deployed sediment traps, collected sediment cores, measured various eelgrass and water quality parameters. The sites were chosen to represent a range of exposure to nitrogen and water movement. Sediment traps and sediment cores were also deployed in nearby unvegetated areas for use as a reference. Carbon and nitrogen content and stable isotopes were measured in the plant tissue, sections of the sediment cores and from the material collected in the sediment traps. Lead-210 concentrations were measured to establish sediment chronologies and estimate sediment and carbon accumulation rates. We analyzed the relative importance of various plant parameters and site exposure to deposition rates in the sediment traps and carbon accumulation rates in the meadows. Based on preliminary results, carbon content of sediment cores from within the eelgrass meadows exceeded carbon content of reference areas in 7 out of 8 locations. Stable isotopes, indicated that a large percentage of the carbon in seagrass meadows originated from sources outside of the meadow. In 7 out of 8 locations, the quantity of material collected in the sediment traps was greater in the reference area than in the meadows, likely due to sediment resuspension. The implications of the results of this study will be discussed.

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DENSITY DISTRIBUTION AND MOVEMENT OF THE COMMON PERIWINKLE (*LITTORINA LITTOREA*) IN THE PRESENCE OF THE PREDATORY SNAIL *NUCELLA LAPILLUS*

Abiotic (temperature and tidal variations) and biotic (effects of predation) factors can influence the distribution of intertidal organisms along the rocky shore, producing specific patterns of zonation. The ecology of periwinkle snails (*Littorina littorea*) has been studied extensively as a primary resident of the rocky shore community. These snails are able to tolerate varying environmental conditions, however local distribution patterns are often influenced by biotic interactions involving competition, disturbance, and predation. On the North Shore of Massachusetts, the predatory snail (*Nucella lapillus*) may be a major factor in the distribution of periwinkle snails. A 490 foot transect line was set-up on Long Beach in Nahant Bay, Massachusetts, running from high to low tide marks. The transect line was divided into 15 equal intervals of which seven 0.25 square meter quadrats were sampled, recording the species and number of snails present. Preliminary results show that *Littorina littorea* is the primary snail in the intertidal area and the population density remains constant over time; whereas the predatory snail, *Nucella lapillus*, was less common and usually found in the lower part of the intertidal. In areas with the predatory snail, the periwinkle often exhibited a clumped

distribution. Therefore, the presence of the predatory snail may influence the distribution of the periwinkles within the rocky intertidal.

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NEW YORK SEAGRASS CONSERVATION AND MANAGEMENT CHALLENGES.
Concern for declining eelgrass, *Zostera marina*, habitat in New York waters led to the creation of a Seagrass Task Force in 2006 and their Final Report in 2009 prompted the state law known as the 'Seagrass Protection Act' signed in 2012. An initial directive is to establish Management Areas and subsequent Plans in consultation with local governments and stakeholders. Even with local officials and civic organizations receptive to this unique collaborative effort, there are deficiencies in institutional capacity that hinder progress. A NY Seagrass Symposium was convened in 2016 to update to the science and management topics addressed by the Task Force. Water quality is still identified as the leading threat to eelgrass and there appears to be potential for incorporating seagrass habitat concerns into nitrogen pollution management planning that is happening on Long Island. Temperature stress is another principal threat for *Z. ma*rina, especially regarding restoration efforts. Additional environmental concerns include sediment sulfide toxicity and less understood impacts from herbicides and pesticides. Seagrass mapping frequency is still a problem for some NY estuaries that have gaps up to 14 years or more. The preceding topics and other challenges will be presented for deliberation of strategy and actions.

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INVESTIGATION OF QPX HARD CLAM DISEASE WITH ENVIRONMENTAL FACTORS.
QPX, Quahog Parasite Unknown, is considered an opportunistic pathogen as it is attributed with severe mortalities of hard clams, *Mercenaria mercenaria*, but has also been found in apparently healthy clam populations. Lab experiments confirmed differences in clam stock susceptibility along with an ability of clams to undergo healing. Subsequent trials observed a significant influence of temperature and salinity conditions on disease response. The general trend was of higher temperatures promoting clam resistance and low salinity restricting QPX impact. Temporal and spatial analysis of QPX disease monitoring in Raritan Bay, NY, revealed similar environmental relationships. An applied field study confirmed the potential to reduce infection progress utilizing spatial gradients in estuarine temperature and salinity. Climate change is typically viewed as a source of stress for estuarine organisms, but the projected warming and intensified precipitation events for the Northeast may actually help deter future development of QPX epizootics in the region.

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INTERACTION OF EUTROPHICATION AND CLIMATE CHANGE ON THE ZOOPLANKTON OF LONG ISLAND SOUND
A monitoring program for zooplankton is useful for several reasons. First, because zooplankton are short-lived and grow rapidly, they are good indicators of environmental perturbations such as eutrophication, point-source pollution, and climate change. Changes in zooplankton also affect phytoplankton, the base of the food-web. In turn, because zooplankton are prey for fish and shellfish, some of which are of commercial importance, changes in zooplankton communities can provide early indications of imminent changes in the food conditions for fish, birds and mammals. A zooplankton monitoring program has been in effect in Long Island Sound since 2002, with monthly sample frequency at six stations that span the entire main axis of the sound. There is a gradient of zooplankton abundance (Factor of 2-3) from west to east, with consistently lowest abundance on the eastern end. This gradient is consistent in pattern with that of nitrogen concentration (factor of ~ 10) and primary productivity (factor of ~2), which suggests that zooplankton abundance is constrained by bottom up factors. Comparisons of zooplankton abundance in the central sound during the monitoring period relative to the early 1950 also shows decadal variability, but the causes are not clear yet. There has also been a noticeable change in the phenology of the warm-water copepod Acartia tonsa in the last ten years, and a reduction in copepod body length since the 1950s. Both of these changes are better explained by increasing temperatures in the Sound. There appears to be an interaction of temperature and resources in effecting changes of zooplankton in the Sound.

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THE URBANIZED NARAGANSETT BAY: THE PROVIDENCE AND SEEKONK ESTUARINE TIDAL RIVERS POST CLEAN WATER ACT REGULATION: A SIGN OF HOPE?
Most urban estuaries have been exposed to significant levels of anthropogenic stressors (including toxic metals and excess nutrients) for decades if not centuries. Yet many of these estuaries began a path to improvement after passage of the Clean Water Act in 1972. The Providence-Seekonk tidal river at the head of Narragansett Bay experienced a significant decrease of toxic heavy metals in the 1980s, and more recently, a significant (>50%) decrease in total annual TN loadings from 11 major WWTFs. Much of this area had previously been written off for ecological restoration due to poor habitat conditions from these anthropogenic insults. We re-examine this assumption, and discuss preliminary results of the 1st study in over 10 years to assess benthic habitat condition in relation to fish usage of this estuarine headwater.

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COASTAL ISLAND INFLUENCES ON NEAR-SHORE TEMPERATURE FLUXES IN WESTERN LONG ISLAND SOUND.
The Norwalk Islands are a chain of islands in western Long Island Sound that were formed during the last ice age as a terminal moraine. These islands are oriented parallel to the southwestern Connecticut shoreline and adjacent to three small coastal rivers. The influence of these islands on freshwater pathways and water temperature has become of particular concern in recent years. The reason for this is that despite temperature traditionally being used as a proxy for concentrations of pathogenic bacteria (like *Vibrio parahaemolyticus*), little is known about how the Norwalk Islands influence water temperatures. With this in mind, the Regional Ocean Modeling System is used to identify how the Norwalk Islands and their surrounding shoals ultimately affect water temperatures behind the islands. This is done using a nested 100-meter grid with 30 sigma levels, forced with weather and water temperature data collected during the summer of 2015. The spatial distribution and volume-average of water temperature behind the islands is first assessed, followed by a quantifying of surface and advective temperature fluxes into the area. Finally, flushing time and dispersion rates for water in the Norwalk River and Harbor, and immediately behind (north) of the islands is determined. A temperature gradient is observed with warmer water temperature towards shore and in the river channels. Islands act to cool water immediately behind them, reduce flushing time, and increase along-shore dispersion. The shoals that surround the islands, meanwhile, were found to increase water temperature, advective and surface temperature fluxes, and flushing time, while decreasing dispersion.

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HURRICANE SANDY RESILIENCY EFFORTS AT SEATUCK NWR: SEDIMENT ENRICHMENT USING OLD AND NEW DREDGED MATERIAL
Seatuck National Wildlife Refuge (NWR) is located in the Town of Islip, NY on the south shore of Long Island. It is 84.5 ha in size and is bordered on the east by Champlin Creek and to the south by Great South Bay. The Refuge habitats are composed of approximately 50% ditched tidal marsh and 50% upland. Seatuck NWR was established in 1968 under the Migratory Bird Conservation Act and hosts over 200 species of birds. The tidal marsh at Seatuck NWR has been severely degraded over time through ditching, tidal flow restrictions, and most recently through extensive ditch plugging. Ditch plugging has resulted in the impoundment of surface and subsurface water. This, in turn, has resulted in the loss of marsh vegetation and elevation subsidence of the marsh platform. Department of Interior funding for Hurricane Sandy resiliency projects has allowed for extensive work at Seatuck NWR. Dredged sediments, from an unrelated maintenance project in an adjacent navigation channel, provided suitable material for filling salt marsh areas that had subsided during the last several decades. Additional "legacy" dredge sediments, which had been stored in mounds on the refuge, were mobilized to provide further sediment to the salt marsh. Salt marsh target elevations were 0.9 ft NAVD 88 – sufficient to provide suitable hydrology for high marsh vegetation. Other project actions

included planting salt marsh vegetation plugs in the area that received dredged sediments. The site's tidal channels (ditches) were altered to restore appropriate inundation and drainage. These activities included ditch plug removal, ditch elimination through fill with dredged sediments, and ditch widening/extension.

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ASSESSING THE ROLE OF OYSTER AQUACULTURE TO IMPROVE WATER QUALITY AND THE IMPACTS OF OYSTER BIODEPOSITION ON THE UNDERLYING SOILS
An oyster can filter between 15 and 55 liters of seawater per day, consuming phytoplankton and nutrients in the process, and helping to control phytoplankton growth. Through this action both phytoplankton and suspended sediment, that would otherwise reduce water clarity, are drawn from the water column to the benthos via oyster biodeposits (feces and pseudofeces). Though some studies claim oyster aquaculture may be a way to restore or improve water quality in coastal systems, few studies have examined the effects of oyster biodeposition to the soil environment. In this study, we examined the environmental impacts of oyster aquaculture by measuring water quality, rates of biodeposition, and soil sulfide levels. Water quality parameters such as chlorophyll a (chl a), dissolved oxygen (DO), total suspended solids (TSS) were measured at aquaculture and control sites within three coastal lagoons in southern Rhode Island, from May to October. Biodeposition rates were also measured for different sized oysters (6-13 cm). To assess the impacts of biodeposition to the soil environment we also measured soil sulfide levels. Results showed that chl a levels were lower at aquaculture sites, compared to control sites, but no significant differences were identified for DO or TSS. We also found that biodeposition rates were directly correlated to oyster size, whereby larger oysters had higher rates of biodeposition. Additionally, aquaculture sites had higher levels of soil sulfides compared to control sites. Overall, our results suggest that although oysters may improve water quality by controlling chl a levels, the biodeposits may cause negative effects to the soil environment.

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DIURNAL, TIDAL, AND SEASONAL VARIATIONS IN CARBON DIOXIDE AND HEAT FLUXES OVER A SUBTROPICAL SALT MARSH: DEPENDENCE OF THE TIMING OF LOW TIDE RELATIVE TO LOCAL NOON
Salt marshes may play an important role in the sequestration of atmospheric carbon dioxide. The magnitude of carbon storage in marshes depends ultimately on net CO_2 exchanges between the marsh and atmosphere. These exchanges depend on seasonal changes in photosynthesis and respiration as well as direct and indirect effects of tidal inundation. This net ecosystem exchange (NEE) is often derived from discrete flux chamber measurements collected periodically, usually at low tide, and extrapolated to annual estimates. In this study, we use high-resolution, temporally continuous direct covariance measurements to generate time series estimates of NEE in a salt marsh located at Freeman Creek in Jacksonville, North Carolina. We hypothesize that the direction and magnitude of the CO_2 flux will be affected by the timing of

tides in relation to local solar noon. This direct covariance method measured temporal variation of vertical CO_2 and heat exchange between the marsh and atmosphere as functions of radiation; air, water, and sediment temperatures; and inundation, on time scales of hours to months from October 2015 to January 2017. The data reveal diurnal, semidiurnal, and seasonal variations, indicating the CO_2 exchange and heat balance of the 3-layer sediment-water-air marsh system depend not only on irradiance and temperature, but also on the relative timing of the tides and diurnal cycle. Data sets like ours will help build carbon budgets and quantify the importance of, and mechanisms behind, salt marsh carbon sequestration.

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PATTERNS OF NITROGEN-CYCLING MICROBIAL ABUNDANCE AND DIVERSITY ACROSS A SALT MARSH LANDSCAPE
We investigated patterns of nitrogen-cycling microbes across a salt marsh landscape in SE Connecticut by characterizing patterns of nitrogen-fixing and ammonia-oxidizing bacteria, and presence of anammox genes from sites in the Barn Island salt marsh, representing areas dominated by three marsh grasses and unvegetated microbial mats. We also characterized diversity of nitrogen-fixing bacteria in these four habitats plus upland soils and water from Long Island Sound. Abundance patterns of nitrogen-fixers and betaproteobacterial ammonia-oxidizers suggest that nitrogen-fixers are more salinity-tolerant than betaproteobacterial ammonia oxidizers. Diversity of nifH genes was high within the marsh compared to upland or baywater samples, and most sequences were affiliated with Proteobacteria. Sites dominated by tall and short *Spartina alterniflora* shared the most OTUs, suggesting the possibility of specifc plant-microbe interactions. Only one OTU was recovered from all 6 sites. Comparison of nifH sequences recovered from DNA and RNA extracted from microbial mat samples suggest that not all microbes with nifH genes were active at the time of sampling. We also detected anammox functional genes for hydrazine oxidoreductase (hzo) in sites dominated by tall *S. alterniflora*. Diversity of hzo genes was low, with most sequences belonging to the same OTU. Distribution of hzo sequences does not appear to vary significantly with sediment depth. Future work will include quantification of anammox, archaeal amoA, and nirS (denitrification) genes to identify potential correlations or potential couplings of nitrogen-cycling processes in the marsh. Sequence analysis and mRNA work will also help to elucidate important patterns in the marsh.

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ENHANCEMENT OF BLUE MUSSEL (MYTILUS EDULIS) POPULATIONS IN MASSACHUSETTS TIDAL RIVERS
Blue mussels were abundant in the North and South Rivers during the 1980s but have declined in the past 30+ years. To understand the feasibility of re-establishing a benthic community of blue mussels in these rivers, multiple experiments and restoration efforts were conducted between 2012 and 2016, including growth of mussels in culture socks, transplantation of mussels, and efforts to determine size-related impacts of green crabs. Through these iterative (trial and error) studies, mussels were able to establish in isolated areas of the rivers.

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UNDERSTANDING THE RESPONSE OF EELGRASS TO EUTROPHICATION IN WEST FALMOUTH HARBOR, CAPE COD, MA
Eelgrass beds provide key ecosystem services in coastal marine environments, but are vulnerable to degradation as a result of increased anthropogenic activity in the coastal zone. There have been substantial worldwide declines in both seagrass areal extent and habitat quality in recent years, and much of the decline has been attributed to multiple interactive stressors associated with eutrophication. For the past decade we have been monitoring nitrogen loading, water quality, and eelgrass (*Zostera marina*) bed health and extent in West Falmouth Harbor, Cape Cod, MA (an estuary significantly influenced by eutrophication associated with a high point source nitrogen load). Our data show large diel variation in water column dissolved oxygen and pH, with low DO values at dawn in the inland portions of the estuary, which is likely a significant stressor. Grazer populations were lower and epiphytic colonization higher in the N-impacted area, contributing to light limitation of the eelgrass shoots and increased nitrogen fixation, which further increased the N load. High resolution sonar and drone surveys show shifting of the eelgrass bed boundaries over this time, including the complete loss of the inland bed in 2010. Seagrass net primary production decreased in the more impacted part of the harbor in the years leading up to the die-off, which coincided with a shift in whole system NEP. We expect the N load to the system to decline markedly in the near future, which will hopefully prevent further loss of eelgrass extent and allow us to study recovery as the remaining habitat to returns to a more healthy condition.

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EXAMINING *CRASSOSTREA VIRGINICA* DENITRIFICATION RATES: HOW DOES PROLONGED EXPOSURE TO CONTRASTING ENVIRONMENTAL FACTORS INFLUENCE THE EFFICIENCY OF NITROGEN REMOVAL?
As anthropogenic activities continue to input nitrogen into the marine environment at excessive levels, understanding how marine organisms will be impacted is vital. The eastern oyster, *Crassostrea virginica* offers the ecosystem service of nitrogen removal through the process of denitrification. The rates associated with this process are not well appreciated at this time, but are likely influenced by dynamic environmental conditions. The goal of this study was therefore to examine how denitrification efficiency of *C. virginica* is influenced by location and/or nutrient enrichment, by maintaining organisms at contrasting ends of the estuarine gradient of Point Judith Pond in Narragansett Rhode Island; as well as under enriched or ambient conditions at each location. Results from this four-month field manipulation indicate that proximity to tidal influence is of significant importance in regards to rates of denitrification of oysters; that is, closer to tidal mixing results in more efficient nitrogen removal. Treatment

had no significant effect on denitrification rates. Results from this study can aid in decision making regarding aquaculture and restored oyster reef restoration, as well as offer insight on how to maximize water quality benefits from *C. virginica*.

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SALT MARSH LOSS IN A NUTRIENT-IMPAIRED RIVER IN SOUTHEASTERN MASSACHUSETTS
Recent studies have suggested that nutrient enrichment can be a driver of salt marsh loss. High nutrient levels commonly associated with coastal eutrophication can increase the above-ground leaf biomass of *Spartina alterniflora*, decrease the dense, below-ground biomass of bank-stabilizing roots, and increase microbial decomposition of organic matter. These habitat alterations reduce geomorphic stability and result in creek-bank collapse. Salt marsh islands are a predominant feature of the Westport River, an estuary in Southeastern Massachusetts. Local reports suggested that in recent years there has been significant and rapid loss of salt marshes. Additionally, the water quality of the Westport River is impaired by nitrogen over-enrichment and a draft watershed Total Maximum Daily Load has been developed. At six salt marsh islands, we quantified salt marsh loss over the last 80 years using aerial imagery, and field work was performed to characterize biomass and general conditions to assess potential causes of loss, including nutrient pollution. Since 1938 the six marshes studied have decreased in area by between 26 and 66% with the rate of marsh loss accelerating in the past 15 years. Our observations suggest that there are multiple causes for marsh loss in the Westport River, including evidence that sea level rise and nitrogen pollution both contribute.

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INTO THE WEST OR ONTO THE SHELF? PATHWAYS OF THE CONNECTICUT RIVER WATER
Using the Regional Ocean Modeling System (ROMS), with passive dyes, the main routes of the Connecticut River (CR) water, are determined. The results suggest an annual cycle of CR water pathways. During summer, CR water enters central Long Island Sound (LIS) by flowing underneath the previous spring water, and half of these waters stay until next spring flood. Most winter CR water stays in eastern LIS because of influence by the westerly winds. Spring floods run into central LIS along the coast, and freshen the sound again.

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A UNIQUE APPROACH TO RESTORING COASTAL HABITATS, CAP HEAVY METALS, ABATE WAVE ENERGY AND ALLOW SUCCESSFUL HORSESHOE CRAB SPAWNING.
The American horseshoe crab obtains food resources, spawns and has nursery habitats in our urban coastal seas. The east coast of the US and particularly Long Island Sound (LIS) is dominated by human activity and characterized by armored shorelines, high nutrient loads, large fluctuations in algal and bacteria populations, increased levels of pollutants (e.g. heavy metals and pesticides), hypoxia and relatively low pH. The LIS watershed harbors more than 9

million people and this urban sea has been significantly modified by human use. We have found that the horseshoe crab population in LIS is reproducing well below its maximum rate with the recruitment of newly molted adults ranging from 5.6 to 12% of the spawning population on sampled beaches. One- to three- year-old juvenile horseshoe crabs have low population densities, with a patchy distribution and are absent from more than half of estuarine habitats surveyed (n = 10). The probable causes are due to legal and illegal overharvest of adults and poor quality nursery habitat (polluted and hypoxic estuaries). Possible solutions include multi-habitat restoration using the living shoreline concept (e.g. beach stabilization, marsh grass planting, and artificial reef installation) for wave abatement, sediment deposition, capping of heavy metals and increased biodiversity. Also, establishing marine protected areas in LIS is imperative to increase recruitment of juvenile horseshoe crabs as well as other ecologically and economically important marine species.

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TEMPERATURE SHIFTS AND WINTER FLOUNDER PHENOLOGY: CLIMATE CHANGE ADAPTATIONS
Phenotypic traits such as peak spawning time may vary within and differ 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 and post construction sampling was conducted for winter flounder (*Pseudopleuronectes americanus*) eggs within New Bedford Harbor as part of a mitigation program for the construction of the New Bedford Marine Commerce Terminal. Historically, winter flounder peak spawning has been reported between February to March. Our analyses of two years 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 and 90% in 2016) were identified from samples in May. Investigation of seawater temperature over 50 years from Woods Hole, MA showed a +0.02 (ºC/year) increase in the average yearly temperature. 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
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 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. Oyster growth, water quality and nitrogen dynamics were monitored relative to the oyster culture area from June to December as Phase I of a continuing Shellfish Demonstration Project 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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IMPLICATIONS OF ALKYLPHENOLIC POLLUTION OF MACROALGAE IN LONG ISLAND SOUND
Macroalgae are broadly distributed in Long Island Sound (LIS), and may be exposed to alkylphenols, including bisphenol A (BPA), due to human pollution and septic discharges. Alkylphenols are endocrine disrupting pollutants to both vertebrates and invertebrates. Millions of tons of alkylphenols, including BPA, and alkylphenol ethoxylates are produced annually. They are used in plastics, detergents, antioxidants and can liners. Marine environments, including LIS, receive up to 60% of the alkylphenols which are long-lasting. They have estrogenic activities in vertebrates and molting hormone and juvenile hormone effects on invertebrates. We have found earlier that alkylphenols at low levels affect lobster survival, growth and development. Macroalgae are food for many species including humans, which also use algae as sources of hydrocolloids, bioreactive compounds and fertilizers. We tested 10 macroalgal samples by ultra-high performance liquid chromatography – tandem mass spectrometry (UPLC-MS/MS) from 3 locations in LIS (near Norwalk, Bridgeport/New Haven, and Greenwich). All samples had detectable levels of BPA (*Saccharina*, *Gracilaria*, *Fucus*, and *Ulva*). Cumylphenol, nonylphenol, and octylphenol were absent. Samples 1, 2, 3, 4, &7 had low amounts of 2, 4-bis-dimethylbenzyl phenol, in the range of 0.87 – 93.49 ng/g of tissue. However, we found huge amounts of BPA in 2 samples of *Fucus vesiculosus*, 78,907 ng/g and 14,439 ng/g, and one *Ulva compressa* had 26,943 ng/g from Norwalk, CT. To avoid negative pollution effects from alkylphenols in the marine environment, we need reduced pollution emissions and large masses of contaminated macroalgae should be identified and removed to bioremediate these coastal waters.

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TOUGHIES AND FLUFFIES: SEASONAL PATTERNS OF COHESIVE PARTICLE CHARACTERISTICS IN THE CONNECTICUT RIVER ESTUARY

The fate of fine-grained, cohesive sediments in estuaries is largely determined by the particle settling velocity. Flocculation of fine sediments, or formation of aggregates composed of silts and clays through inter-particle collision and adhesion, is a major control on the effective settling velocity of these muddy sediments which are of interest in estuaries due to their impact on the fate of contaminants. In dynamic environments like estuaries, flocculation may vary widely in time and space. This study quantifies cohesive suspended-particle dynamics in the Connecticut River estuary and assesses the impact on fine-sediment transport and trapping in a highly stratified, seasonally-varying system. Spatial and seasonal measurements of floc size, density, salinity, suspended-sediment concentration (SSC) and bed stress have been collected over three sampling periods with varying discharge regimes representative of seasonal variability. Three particle populations are apparent in the estuary each season, with major changes in floc density and size. In Nov. 2013, a moderate-discharge event with high sediment supply resulted in the largest observed flocs (median size 302 μm). High SSC supports the building of fresh, large, loosely-bound flocs (median excess density 17.6 kg/m^3). A spring freshet was captured in May 2014, where the highest SSC and lowest-density flocs were observed throughout the estuary (13.9 kg/m^3). Flocs form and grow (180 to 400 μm) with increasing bottom stresses to 0.6 Pa, above which high stress causes floc breakup. This trend disappeared in Sept. 2015, a period of low discharge and sediment supply when the smallest, most compact flocs (244 μm; 60.1 kg/m^3) were observed.

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COMPARISON OF NUTRIENT CONDITIONS IN GULF OF MAINE BAYS

Nutrients exported to the coastal ocean result in the potential for expression of eutrophic symptoms. Can we detect these changes over time and space and establish coastal numeric criteria that protect against adverse effects of nutrient enrichment? We hypothesized that a stressor-response relationship of nutrient impacts could be established among coastal bays of similar typology but differing nutrient loading from riverine and wastewater sources. For three summers from 2009 to 2011, EPA sampled coastal waters in six bays of similar typology from north of Boston to Casco Bay in Maine. We conducted water column profiles for oceanographic variables and measured total nitrogen, total phosphorus and chlorophyll at surface, mid-depth (sub-pycnocline) and bottom depths. In 2011, most stations exhibited coastal characteristics; surface salinities were typically 30 to 32 psu and usually, but not always, a clear pycnocline was evident. Median levels of total nitrogen in nearshore surface samples were about 0.21 mg/l, with little differences among bottom and surface waters. Mid-depth stations, however, exhibited slightly higher chlorophyll levels. Although there were no strong differences in nutrient levels among the six bays, Broad Sound and Salem Sound in Massachusetts exhibited higher levels of chlorophyll than the other four bays. Differences in biological response to

nutrient enrichment in these bays can be partially explained by differences in nutrient loading, temperature regime or residence time of the water in the bay. This spatial stressor-response approach can be useful in developing nutrient criteria.

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DOCK AND PIER IMPACTS ON SALT MARSH VEGETATION IN MASSACHUSETTS ESTUARIES
Private docks and piers are commonly constructed over salt marsh vegetation in estuaries along the U.S. East Coast. Regulatory agencies have developed guidelines and regulations to minimize structural impacts to salt marsh vegetation, but little field data exist to support the efficacy of these management strategies. To address these data gaps, we performed a three-year field study using an experimental array of docks set at three different heights in an estuary in southern Massachusetts. We also collected clip plot samples under and adjacent to existing private docks along the Massachusetts coastline (n=212) and assessed relative stem density and biomass in relation to a suite of dock design characteristics. We collected light data for the experimental dock array and a subset of private docks with different designs (n=31). Total light increased as a function of dock height, height:width (HW), and orientation, but not decking type. Aboveground production followed observed relative light availability; stem density and biomass increased with dock height and HW, and biomass increased with orientations approaching north-south. Community composition under docks in the high marsh zone shifted towards a higher proportion of *Spartina alterniflora*. Docks with grated decking supported greater aboveground *Spartina* biomass than docks with traditional plank decking, but also contained a higher proportion of *S. alterniflora*. Docks in Massachusetts currently overlie approximately 6 hectares of salt marsh habitat, and cumulative shading impacts on aboveground production can affect salt marsh ecosystem services. Height-based design conditions can help reduce but not avoid such impacts.

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WATER QUALITY ON LONG ISLAND - FROM SCIENCE TO ADVOCACY
Long Island water quality, in decline for decades, has become a visible centerpiece for effective political action. Working from best available natural science, local advocates, led by The Nature Conservancy, used social science tools to explore public perceptions and values related to Long Island's water quality challenges. Social science research results contributed to powerful and compelling communications architecture and messages that advocates directed at key audiences to get funding allocations and regulatory changes that will protect and restore surface and ground water quality on Long Island.

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AN UP ESCALATOR: THE GULF STREAM AS PREDICTOR OF ESTUARY CHANGE?
The story of one adventurous woman’s quest to row across the Atlantic in the spring of 2015 brings climate change in New England waters into focus. Normal complexity in understanding

the environmental uncertainty we face as we try to make sense of what we observe is compounded by large systems like the Atlantic Meridional Overturning Current, of which the Gulf Stream is a potent ingredient. This complexity is exacerbated by the warming trends we have seen thus far and which are projected to continue and intensify. The NEERS region is in the bulls eye of rising sea temperatures; the U.S. Northeast Shelf is projected to warm twice as fast as previously thought and almost three times faster than the global average (NOAA, 2017) and the Gulf of Maine is a big part of that area. Connecting dots of individual pieces of information is most likely premature from a climatological standpoint but the exercise may serve a useful purpose as a reminder that estuaries are part of much larger systems.

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NONQUITT SALT MARSH: THREE YEARS OF RESTORATION
As of 2013, the Nonquitt salt marsh in Dartmouth, MA had been tidally restricted for over a century, leading to a loss of healthy salt marsh habitat. *Phragmites australis* (invasive) and *Typha latifolia* (freshwater species) had become prevalent. In 1989 the culvert connecting the marsh to Buzzards Bay became occluded. The impounded freshwater drowned approximately 60% of the vegetated area converting it to a mudflat. In November of 2013 tidal exchange was restored in order to improve the ecological health of the marsh. Data on flooding regimes, sediment pore water salinity, vegetation, and fauna were collected along four transects from 2013-2016. Full vegetation maps were created annually as well. The restored tidal flow has facilitated an annual increase in *Spartina* species, a steady decrease in *P. australis*, and a total decline of living *T. latifolia*. *Spartina* is slowly revegetating the mudflat through rhizome growth. The improved conditions have led to an increased utilization of the marsh by birds, fish, and invertebrates. Understanding the subsequent processes and changes following tidal restoration is important to ongoing and future salt marsh restoration projects.

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PLANT GROWTH AND SEASONAL DENITRIFICATION IN WETLANDS
Nitrogen pollution in coastal ecosystems can cause eutrophication and pose a threat to human health and local fishing industries. Microbial denitrification in wetlands can be an important way to remove nitrogen from coastal ecosystems. Plants can compete with microbes for nitrogen, alter the nitrogen demand of microbes by changing the C:N ratio of soil organic matter and promote cyclic oxygenation of sediments. In this study, we analyzed patterns in denitrification during the growing season to determine which of these mechanisms are most important. Based on previous work, we chose three wetland sites on Long Island that differ in aboveground and belowground biomass. Throughout the growing season we measured stem height and percent cover to approximate above ground biomass and extracted soil cores to determine root biomass, nutrient levels and microbial nitrogen-cycling rates. We found that denitrification potential (DEA) peaked for all three sites within a three week period in late spring - early summer. DEA was highest when plant nitrogen demand was highest, suggesting that plants were not suppressing denitrification through competition. Mineralization did not

vary among sites suggesting that differences in root biomass did not affect DEA by increasing microbial demand for inorganic nitrogen. Ammonium decreased during early summer and nitrate increased, suggesting that nitrification increased with plant biomass, providing more nitrate for denitrification. In line with this idea, nitrate predicted DEA well across vegetated sites, but not in unvegetated sites. In vegetated sites, specific leaf area and stem height also predicted DEA, suggesting that plant traits influence DEA by affecting nitrification.

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QUANTIFYING SEDIMENT DEPOSITION SINCE THE CONSTRUCTION OF THE POINT JUDITH, RHODE ISLAND HARBOR OF REFUGE BREAKWATER USING SEISMIC REFLECTION PROFILES AND HISTORIC HYDROGRAPHIC DATA
The Point Judith Harbor of Refuge (HOR), a breakwater harbor completed in 1914 at the eastern end of the Rhode Island south shore (RISS) was surveyed as part of a larger seismic reflection survey in 2016. A distinct, acoustically transparent reflector in the center of the HOR is distinctly different from the adjacent shoreface. The interpretation is that this reflector represents sediment deposited post-1914, and the HOR is a sediment sink at the end of the (net) longshore sediment transport direction for the RISS. An additional significant sink is the ebb-tidal delta at the Point Judith inlet. The volume of sediment deposited post-construction is estimated at 2,800,000 m^3. A qualitative estimate based on the changes in water depth between a 1913 lead line survey (depth was adjusted for sea level rise) and a 2009 hydrographic survey reports a slightly lower volume (2,200,000 m^3). The hydrographic data suggests sediment eroded (340,000 m^3) from the upper shoreface could not account for much of this sediment, making longshore transport from adjacent shoreline the likely source. While the interpretation is that much of sediment deposited is likely sand, there also anomalous reflectors within this unit (possibly gas). Verification would require sediment coring. Previous work calculated a sedimentation rate of ~10,000 $m^3 yr^{-1}$ (or ~ 1,000,000 m^3 in 100 years) on the flood tidal delta within Point Judith Pond. The sediment volume deposited in the HOR was at least double that estimate (22-29,000 $m^3 yr^{-1}$). Taken together this suggests the HOR is an important component of the RISS sediment budget.

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THE BLOCK ISLAND BEACH PROFILE PROJECT: USING (SUPER) CITIZEN SCIENTISTS TO MONITOR BEACHES AT HARD TO ACCESS FIELD SITES: REDUX
Beginning in 2013, eight beach profiles on Block Island, Rhode Island have been measured monthly by local residents using the modified Emery Method. Profile BI-MB (Mansion Beach), initiated by Dave Vanko, and was measured biannually (May and August) between 2007 and 2013. BI-MB represents the only profile that captures recent significant storm events, including Tropical Storm Irene (2011) and Superstorm Sandy (2012). Profiles are measured by trained volunteers and the data are sent to the author for plotting and interpretation. The accessibility of the Emery method makes this an ideal technique for non-geologists to learn, however, this project has benefitted immensely from the scientific training and background of the (super)

citizen scientists involved. These profiles are conducted in conjunction with other on-going projects examining bluff erosion and historic shoreline change mapping. Note this talk was originally schedule for the fall 2016 meeting and was canceled due to weather! While too early to draw significant conclusions, several key inferences can be reached. 1. Profiles on the eastern shoreline are the most dynamic, although erosion and deposition has largely been limited to the berm; 2. BI-MB showed little erosion during TS Irene but showed significant (25 m3/m) erosion of the foredune during Sandy; and 3.The western profiles north of the inlet to New Harbor (BI-WB and BI-WP) have showed a slight loss in volume over the last three years with no significant storms. This area is highly sediment starved due to the lack of bypassing at the inlet.

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RAPID REPEATED EVOLUTION TO TOXIC POLLUTION IN *FUNDULUS HETEROCLITUS*.
In the face of environmental change, species may acclimate, evolve, or become extirpated. Here we investigate the genetics of adaptation to severe environmental pollution by the fish, *Fundulus heteroclitus*. We find that this species has rapidly and repeatedly evolved alterations to the signal transduction pathway that underlies toxicity, and that these alterations differ among populations. We also find extraordinary genetic diversity in *F. heteroclitus*, which may be a crucial factor enabling the adaptation we observe.

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LONG-TERM SALT MARSH CHANGE RESULTING FROM GRID DITCHING AT BARN ISLAND, STONINGTON, CT
The natural salt marsh is a simple landscape with levee and basin topography. Continuous levees supporting nearly pure stands of *Spartina patens* form along the tidal creeks. Between the levees or between the levees and upland are the basins which are dominated by *Spartina alterniflora* stunted (SAS). Post grid ditching (1932), ditch spacing 30m, the over-drained basins are colonized by *S. paten*s stunted (SAS). Post grid ditching (1932), ditch spacing 30m, the over-drained basins are and *Juncus gerardii* colonizes the levees in response to the depression of high tide. This is the ditched marsh described by Egler in 1947. As early as 1964, the basins at Brucker Marsh are reverting to SAS and this change is completed by 1974. These same changes are occurring elsewhere but at different rates. The levees shrink overtime, retreating in a waterward direction. Niering and Warren established four transects on Palmer Neck marsh in 1987 locating the boundaries between major vegetation types. These data are converted to a GIS shapefile and in 2016 the transects are resurveyed with a hand held GPS unit. Coleman's vegetation map (1976) reveals former levee switches from *Juncus* to *Distichlis spicata* a colonizer of disturbed salt marsh. By 1987 *Distichlis* changes to the forb panne. The landward limit of this community corresponds to the location of former levee. In 2016 nearly all of the forb panne is replaced by SAS and the central region of SAS is becoming salt panne. At Sassafras Marsh, where the ditches are aggraded, levees growth has resumed and the marsh has reverted to the levee and basin topography.

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ASSESSING THE IMPACTS OF OYSTER AQAUCULTURE ON BENTHIC INFAUNA OF COASTAL LAGOON SOILS IN SOUTHERN RHODE ISLAND

Over the past twenty years, oyster (*Crassostrea virginica*) aquaculture has become increasingly popular in the coastal ponds of southern New England. Though it is understood that oysters help to provide beneficial ecosystem services (e.g. nutrient cycling, improved water quality), little research has been conducted on the impacts of oyster biodeposits (feces and pseudofeces) and soil disturbances (e.g. movement of gear, foot traffic from farmers) on the benthic environment. We assessed the impacts of oyster aquaculture on the trophic structure and diversity of benthic infauna. Core samples were collected from the upper 20 cm of the soil profile of aquaculture and control sites in Potter, Ninigret, and Winnapuag Ponds in southern Rhode Island. Benthic infauna were removed from the soil by sieving (0.05-mm-mesh), preserved in 70% ethanol, and dyed with rose Bengal to aid identification. Organisms were identified to species level, and subsequently sorted by functional feeding group. Our results show 68 species and seven functional feeding groups were present across all sites. Aquaculture sites had a higher total abundance, and higher numbers of deposit feeders and interface feeders, than control sites. These results suggest a potential shift in the trophic quality of aquaculture sites, favoring more opportunistic species indicative of disturbance (i.e. *Capitella capitata*). Further statistical analysis is necessary to identify relationships between functional feeding groups, the role of predator-prey relationships, and changes in species diversity over time. Results from our study will provide baseline data useful to benthic ecologists, land-use managers, and aquaculture farmers in southern New England.

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ASSESSMENT OF SHELLFISH COMMUNITIES IN THE COASTAL PONDS OF SOUTHERN RHODE ISLAND

The coastal ponds along the south coast of Rhode Island are tidally-influenced shallow lagoons that provide suitable habitat for marine fish, shellfish, and wildlife. The ponds' resident shellfish populations provide several ecosystem services and have historically supported significant commercial and recreational fisheries. While the significance of shellfish resources for these areas are well known, little information is available describing their stock structure. To better understand the current status of shellfish resources in the coastal ponds, the State of Rhode Island's Marine Fisheries Section initiated shellfish surveys in two prominent coastal ponds (Pt. Judith and Quonochontaug Ponds) in the summer of 2016. Shellfish and benthic infauna were surveyed using two methods at each site: a 1-m^2 x 0.5-m excavation using suction sampling, and a short-stick bullrake. Abundances and size distributions of major recreational shellfish species, including the Northern quahog (*Mercenaria mercenaria*), soft shell clam (*Mya arenaria*), and razor clams (*Ensis* spp.) are presented by pond and collection strategy. Shellfish presence and abundance are also compared to environmental conditions measured during sampling to understand the habitat requirements for these species in relation to current

management schemes. This survey will expand in 2017 in both space (additional ponds) and temporal coverage (spring and fall) to obtain further information on these resources.

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GROUND MOVEMENT OF A SALT MARSH IN RESPONSE TO TIDAL FLOODING AND DRAINING
With the sea level rising 3 mm/year in New England the question is whether the marsh accretion is rapid enough or not for the marsh to keep up. The accretion rate of 1 mm/year is considered typical. Several Surface Elevation Tables (SET) were established at the Waquoit Bay Reserve to monitor the long term evolution. With the SET method the marsh surface elevation is estimated during annual surveys by means of 36 mechanical rods, which are lowered to the ground, giving a standard error of about 1 mm. Recently, we realized that ground movement caused by tide flooding the marsh needs to be taken into the account. We monitored the ground movement using different methods including manual checks with a precision caliper. We developed an inexpensive device consisting of a 10 ft fiberglass rod and a bigger diameter 2 ft long PVC pipe. The relative motion of the pipe and rod are mechanically converted into a spinning motion of a thin reel which is recorded by a logger. The device has 50 micrometer resolution. We found that the shorter pipe moves as much as 10 mm up and down during each tidal cycle relative to the longer rod. The longer rod reaches and grabs a harder layer deeper down, while the shorter pipe moves with the top layer which gets water saturated during high tide and gets drained during low tide. The range diminishes with the distance of the site from the open water. The largest range (10 mm) is observed next to the mosquito channels. At one of our SET sites (in Sage Lot Marsh) the range was observed to be about 2 mm which is significant compared to the expected annual accretion. These results also have implications for studies of water and nutrient percolation through soil.

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VELOCITY STRUCTURE AND SUSPENDED-SEDIMENT FLUX IN A HIGHLY-STRATIFIED ESTUARY
The transport and fate of fine sediments in estuaries have important implications for many natural and anthropogenic factors, including ecological habitats, response to sea level rise, navigation and pollutant transport. In the upper Connecticut River estuary, strong density gradients exist in both the horizontal and vertical dimensions. The along-channel position of the head of the salt wedge and the degree of stratification are modulated by tidal currents and river discharge, and are thought to have a strong effect on suspended-sediment concentration (SSC) and transport. Prior observations of seasonal changes in bed sediment grain size and infilling of adjacent bays suggest that landward fine-sediment flux occurs near the bed during low-discharge conditions when the salt wedge is present and the water column is stratified. Recent observations of currents, salinity and SSC over a range of conditions in the upper estuary have been obtained using optical and acoustic sensors mounted on moorings and bottom frames. Preliminary data from ~10 km up-estuary reveal that near-bed velocities regularly exceed 0.5 m/s landward at low discharge, and landward flow continues throughout the ebb tidal phase. At high discharge, the salt wedge is expelled and the entire water column

flows seaward with maximum velocities exceeding 1.5 m/s, except for brief periods around maximum flood current. The salt wedge and near-bed landward flow are reestablished quickly after a high-discharge event. Future analyses will calculate suspended-sediment fluxes at multiple locations and conditions. This work will expand our understanding of the driving processes of flux, and shed light on long-term patterns of transport and deposition in the estuary.

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RECENT ATMOSPHERICALLY-DRIVEN CHANGES IN PH AND THERMAL PROPERTIES OF FRESHWATER LAKES IN CAPE COD NATIONAL SEASHORE (MASSACHUSETTS, USA).Freshwater lakes are important natural and cultural resources in National Parks across the United States. At Cape Cod National Seashore, the water quality of "kettle" lakes and precipitation chemistry has been measured since the 1980s. These datasets, along with air temperatures obtained from a local weather station, were analyzed to assess temporal trends in recent decades. During the months of July-August, maximum/minimum daily air temperatures, precipitation pH, surface water temperature, and surface water pH have all increased significantly. In addition, thermocline depths have decreased in some lakes, and temperature differentials at the thermocline and between surface-bottom waters have increased. These patterns indicate recovery from acid rain and seasonal strengthening of thermal stability. Such changes, which appear to be driven by regional climate warming and air quality improvements, have the potential to influence myriad physical, chemical, and ecological processes within these systems.

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IMPACT OF CHRONIC NITROGEN LOADING ON GREENHOUSE GAS FLUXES IN COASTAL WETLANDS
Excess nitrogen inputs into coastal wetlands can alter their structure and function, limiting their ability to sequester carbon. These inputs can stimulate emissions of potent greenhouse gases (GHG), nitrous oxide (N_2O), carbon dioxide (CO_2), and methane (CH_4). Short-term nitrogen additions have shown to increase N_2O emissions, possibly offsetting carbon sequestration rates. The impact of chronic nitrogen inputs on GHG emissions is less known. Understanding the dynamics between nitrogen inputs and N_2O emissions is needed to guide coastal management and "Blue Carbon" policies. We measured GHG fluxes, plant biomass, and soil and porewater properties in three salt marshes along a nitrogen gradient in Narragansett Bay, RI which historically has received more than 100-fold differences in levels of anthropogenic nitrogen inputs. Measurements were taken bi-weekly from May-November within the low marsh zone (*Spartina alterniflora*-dominated). Results show average CO_2 uptake at the sites ranged from -0.34 to -6.72 µmol m^{-2} s^{-1}. Average N_2O and CH_4 fluxes were more variable, ranging from -0.08 to 0.61 µmol m^{-2} h^{-1} and 0.65 to 39.2 µmol m^{-2} h^{-1}, respectively. Data on plant biomass and soil

and climate parameters provide context for the role of chronic nitrogen inputs on the size and range of greenhouse gas emissions from coastal marshes. Given that these GHG emissions observed thus far in coastal wetlands are relatively low, our results suggest a high capacity for nitrogen retention, highlighting this important beneficial function within these valuable ecosystems.

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NITROGEN LOADING TO LONG ISLAND SOUND'S 110 EMBAYMENTS
The estuarine watersheds of the northeast region are some of the most densely populated coastal areas in the USA. These dense populations result in high loadings of nutrients to waters with high value for recreational and commercial use. Controlling nitrogen input to coastal waters has been a priority since the establishment of the Clean Water Act in 1972. In urbanized areas, the main source of nitrogen continues to be from sewer and septic, unlike the highly agricultural Mississippi basin where fertilizer and animal waste dominate, or the Northeast where atmospheric deposition dominates. The sources of nitrogen within a watershed determine the approaches used to reduce nitrogen loads. Northeast estuaries have focused on sewer inputs and substantial reductions have been achieved throughout the region. The timescale of recovery from eutrophic conditions can be long and many of these systems have only achieved reduced nitrogen inputs from point sources within the last ten years or less. As reductions of nitrogen input from point sources are reduced to target goals, assessment of ways to reduce nitrogen from non-point sources have become the focus for many communities. At a local level, modeling of nitrogen sources on a subwatershed level allows for targeting of sources specifically relevant to the watershed. Increasing efforts to address eutrophication in coastal waters is critical to maintaining the ecosystem services provided by these environments in a changing world.

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FUNCTION AND PERFORMANCE OF NITROGEN REMOVING BIOFILTERS (NRBS) & PERMEABLE REACTIVE BARRIERS (PRBS) FOR TREATMENT OF WASTEWATER & GROUNDWATER
Nitrogen Removing Biofilters (NRBs) are potentially a cost-effective replacement for the antiquated individual onsite wastewater treatment systems that are a leading cause of water quality degradation throughout the region, resulting in contamination of drinking water supplies, harmful algal blooms, loss of protective wetlands, and the devastation of shell and finfish populations. Comprised of sand and lignocellulose, NRBs are a form of non-proprietary innovative alternative onsite treatment that has demonstrated in the pilot phase an ability to consistently achieve high percentages of total nitrogen removal, as well as highly efficient attenuation of pathogens, pharmaceuticals and other personal care products. As a form of passive treatment, the systems are simply designed and operated largely by gravity, making them low energy, low-maintenance, and thus, low-cost. Further, the shallow profile of these systems (less than four feet) makes them a suitable option in regions impacted by sea level rise. Permeable reactive barriers (PRBs) harness similar lignocellulose technology to achieve nitrogen removal from areas of high groundwater flow. This presentation will provide an overview of the form and function of NRBs & PRBs emphasizing recent efforts by the Center for

Clean Water Technology to further develop these technologies. The presentation will focus on new results elucidating the microbial ecology of NRBs and the diversity of microbial function. The presentation will also discuss the performance of these systems in terms of both traditional water quality parameters and contaminants of emerging concern.