NEERS 2016 Spring Meeting
April 14 -16, 2016
York Harbor, Maine

Organized and Hosted By:

US Fish and Wildlife Service & Wells National Estuarine Research Reserve

Susan C. Adamowicz, USFWS; Chris Feurt, Wells NEER;
Pam Morgan, University of New England; Bev Johnson, Bates College

ABSTRACTS

Alldred, M.; Department of Natural Sciences, City University of New York Baruch College, New York, NY. malldred1@gmail.com

USING PLANT TRAITS TO PREDICT MARSH STABILITY AND DENITRIFICATION IN WETLAND ECOSYSTEMS

Understanding how changes in ecological communities affect ecosystem function, including the provisioning of ecosystem services, is a critical challenge in the field of ecology. I apply a trait-based approach to link wetland plant communities to their effects on marsh stability and nitrogen-removal services. In a meta-analysis of 419 published measurements of denitrification, I estimated that plants increase the ability of marshes to remove nitrogen by 55%. My study was the first to quantify the effect of wetland plants on this globally important term of the nitrogen cycle. In freshwater tidal marshes of the Hudson River, I determined that removing an invasive grass increased sediment nitrogen and decreased denitrification relative to marshes containing invasive or native plants. These results suggest a trade-off between removing invasives to conserve biodiversity and managing wetlands to promote nitrogen removal. My second field project addressed interactions between dominant salt marsh grass *Spartina alterniflora* and ecosystem processes on Long Island, NY. I found that root growth responded positively to salinity and negatively to nitrogen, suggesting that eutrophication and sea-level rise may have opposing effects on marsh stability. Results from greenhouse experiments suggest that roots influence nitrification and denitrification rates by introducing oxygen to sediments. Field measurements confirmed that plant traits predicted denitrification potential among wetland sites as well as abiotic predictors. My results support the utility of trait-based approaches in understanding the role of plants in promoting stability and nitrogen-removal services in wetlands.

Batchelder*, D. B.[1], Burdick, D. M.[1], Moore, G. E.[1], Dijkstra, J. A.[1], and M. C. Tyrrell [2].; [1] University of New Hampshire, Durham, NH; [2] U.S. Fish and Wildlife Service, Hadley, MA. dkb2001@wildcats.unh.edu

A HOSTILE TAKEOVER IN THE SALT MARSH: INVASIVE SNAIL THREATENS ESSENTIAL PLANT SPECIES

Surveys and experiments improved our understanding of the interactions occurring between two ecosystem engineers, *Littorina littorea* and *Spartina alterniflora*, in a fringing salt marsh along an eroding shoreline (York ME). The common periwinkle (*L. littorea*) is an invasive snail that destabilizes surface sediments and will often climb *Spartina alterniflora*, creating radulations as it grazes, which can weaken and kill the plant. Due to its ability to withstand regular inundation, *S. alterniflora* is the cornerstone species responsible for sediment trapping and marsh establishment, making it critical for coastal zone protection from erosion and sea level rise. As a result, the outcome of *L. littorea* and *S. alterniflora* interactions could have consequences for intertidal shorelines across New England. Snail densities reached 616 snails*m^{-2} at our research site and tended to be greater in vegetated areas. Research questions for this study include: What is the maximum number of snails the average stand of *S. alterniflora* can sustain before experiencing significant biomass loss? Can N enrichment stimulate plant growth to overcome the snail driven biomass loss? What are the best plant protection strategies? Initial results show that the presence of snails reduced new shoot growth by 54%, while N enrichment increased new shoot growth by 48%. Since sea level rise and human encroachment both impact coastal marshes, preservation and restoration of remaining marshes is a priority and better understanding of community dynamics could improve restoration methods and management strategies to support healthy salt marsh ecosystems where *L. littorea* is present.

Benvenuti*,B. [1], Surrell, D. [1], O'Brien, K. [2], Walsh, J. [1], Burdick, D. [1], and A. Kovach [1]; [1]Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH; [2] U.S. Fish and Wildlife Service, Rachel Carson National Wildlife Refuge, Wells, ME. bar1@wildcats.unh.edu

NESTING BEHAVIOR AND MANAGEMENT OF SALTMARSH SPARROWS

Habitat is crucial to the continued persistence of tidal marsh-dependent wildlife, but habitat alone does not ensure long-term population viability. Tidal marsh birds that nest on the surface of salt marshes have developed an array of adaptive responses in nest timing and placement to minimize the impacts of tidal inundation on nesting success. We investigated adaptations in nesting behavior of the Saltmarsh Sparrow, an obligate tidal marsh breeding bird that exhibits breeding behavior highly synchronized with the tidal cycle. We evaluated the relationship of nest success, nest structure, placement, elevation, and vegetation community from 370 nests, including multiple nests from the same individuals between 2011-2015 on four marshes in New Hampshire, Massachusetts, and Maine. We also conducted a short-term management experiment for maintaining flood-free high marsh nesting habitat through the use of artificial habitat islands. We installed four artificial habitat islands with *Spartina patens* and *Spartina alterniflora* in a marsh pool, and we monitored them through the breeding season and winter. The islands remained free of tidal inundation and supported vegetation growth and expansion, suggesting that floating habitat islands hold promise as a method for mitigating nest flooding of tidal-marsh-nesting birds.

Brittis-Tannenbaum*, A. [1]Johnson, B.[2]Dostie, P. [3]; [1] Department of Geology, Bates College, Lewiston, ME[2] Department of Geology, Bates College, Lewiston, ME
[3] Department of Geology, Bates College, Lewiston, ME. abrittis@bates.edu

MONITORING THE EFFECTS OF MARINE DERIVED NITROGEN DUE TO AN ALEWIFE MIGRATION AT NEQUASSET LAKE, WOOLWICH, ME.

Nequasset Lake, in Woolwich Maine, is a coastal lake that serves as spawning habitat for the anadromous fish Alosa Pseudoharengus, commonly known as alewives. Annually, during the migration period, the Kennebec Estuary Land Trust has performed fish counts using local volunteers, extrapolating fish populations using techniques set out by Gary Nelson (2006). In 2013, approximately 41,000 alewives were

estimated to have migrated into Nequasset Lake. In 2015, approximately 126,395 alewives migrated into the lake. Increases in fish populations are predicted to bring larger inputs of nitrogen into the lake during fish migration due to fish excretion, mortality and gamete release. To assess the impact of the fish migration on the nitrogen budget of Nequasset Lake, nitrate concentrations and nitrogen isotope composition were measured at the fish ladder (the sole outlet of the lake) 2 weeks prior to, and throughout, the 2015 alewife run. The δ^{15}Nnitrate decreased significantly prior to the start of the alewife run, likely in response to an increase in primary productivity brought on by the spring bloom. The δ^{15}Nnitrate became isotopically enriched 2 weeks into the alewife run, reflecting the increased importance of marine derived nitrogen in the nutrient cycling of Nequasset Lake. Concentrations of chlorophyll, as well as the δ^{15}N of particulate organic matter, were also assessed at the top of the dam as supplementary information for changes in δ^{15}Nnitrate.

Burdick, D.M.*[1] C. Peter [1], G. E. Moore [1], S. Adamowicz [2], N. Pau [3]; [1] Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH; [2] Rachel Carson National Wildlife Refuge, Wells, ME; [3] Parker River National Wildlife Refuge, Newburyport, MA. david.burdick@unh.edu

CAN ADDING SUGAR TO SOIL REDUCE GROWTH AND SUCCESS OF *PHRAGMITES AUSTRALIS* IN SALT MARSHES?

A non-native form of *Phragmites australis* has been invading tidal marshes in New England. Recent evidence suggests it is most successful in mesohaline marshes, but can also survive and expand in salt marshes. *Phragmites* has been successfully controlled using chemical herbicides, followed by rapid colonization by a diverse plant community, (at Parker River National Wildlife Refuge). At the Rachel Carson NWR, herbicide is not an option and we are exploring alternatives to stress or eliminate this invader. We studied the effects of sugar on *Phragmites* in greenhouse and field experiments. For the greenhouse experiment, soil cores from *Phragmites* stands were exhumed and re-grown to 30 cm in height before treating with sugar (to produce 0.4% sugar solution in soils) and salt (+15 ppt) every two weeks for two months. Between treatments, plants cores were watered as needed with ambient seawater (about 20 ppt). The survival of *Phragmites* treated with sugar in the greenhouse was less than 50% by 4 weeks and 5% by 8 weeks. Rapid plant death followed leaf curling, indicating severe osmotic stress to the plants. In 2015, in-situ treatment units were countersunk into four stands of *Phragmites* at Parker River NWR and watered with sugar and/or salt every two weeks for six weeks (four treatments in a factorial design). In the soil porewater, redox potential and pH became lower in sugar than only salt or water (control) treatments, whereas sulfide concentrations increased to 1.7 mM, high enough to stress *Phragmites australis*. Although differences were not as dramatic as found for the greenhouse experiment, sugar treatments led to decreased survival in the field, suggesting promise for control using non synthetic chemicals.

Colarusso*, P.[1], J. Simpson [2], A. Novak [3], K. Ford [4], P. Vella [5], R. Lyons [1], P. DiBona [5], J. Deane [6]; [1]US EPA, Boston, MA [2]MIT Seagrant, Cambridge, MA [3]Boston University, Boston, MA [4]Mass Division of Marine Fisheries, New Bedford, MA [5]Massachusetts Bays National Estuary Program, Boston, MA [6]McGill University, Montreal, Canada. colarusso.phil@epa.gov

ASSESSING CARBON STORAGE CAPACITY IN EELGRASS (*ZOSTERA MARINA*)MEADOWS IN MASSACHUSETTS

Coastal wetland habitats (salt marsh, mangrove and seagrass) have been identified as significant areas of carbon storage. Data on carbon storage in seagrasses have been geographically skewed in the United States, studies being conducted predominantly in Chesapeake Bay and Florida. We sampled 5 eelgrass meadows in Massachusetts from Martha's Vineyard to Gloucester over a range of wave exposure. Meadows were sampled for eelgrass shoot density and canopy height. Eelgrass tissue and sediment cores from within the meadows and from unvegetated reference areas were analyzed for carbon content and carbon stable isotope concentration. Meadow area was delineated using acoustic methods, groundtruthed with divers or drop cameras. Concentrations of sediment carbon were greater within eelgrass meadows

than from the unvegetated reference areas and were comparable or exceeded other values reported from the North Atlantic. Stable isotope data from within the meadows revealed that sediment carbon originated from both the plants themselves and from phytoplankton and particulate organic matter. Higher wave exposure correlated with higher amounts of above-ground organic carbon and lighter 13C values in plant tissues, but showed no correlation in sediment organic carbon. These data suggest that eelgrass meadows in Massachusetts sequester large quantities of carbon, yet another rationale for their conservation.

Coupland*, C. [1] and D. Brady [1]; [1] Darling Marine Center, 193 Clarks Cove Rd, Walpole, ME 04539. ccoupland4@gmail.com

UNDERSTANDING OYSTER GROWTH IN THE DAMARISCOTTA RIVER THROUGH MODELING AND THE SUSTAINABLE ECOLOGICAL AQUACULTURE NETWORK (SEANET)

This presentation will introduce one of many interdisciplinary research projects being sponsored by the University of Maine's "Sustainable Ecological Aquaculture Network (SEANET)" project, and will include a general summary of the SEANET project and its goals. As climate change continues to alter marine ecosystems through fluctuations in ocean temperature, salinity, pH, and sea level, understanding how estuaries will respond to these stressors is critical to sustainable management of human activities such as aquaculture. Approximately 70% of all oysters produced in Maine are grown in the Damariscotta River Estuary. Studying this system will help us to evaluate the interactions between shellfish aquaculture and this estuary in the context of these environmental stressors. Specifically, increased understanding of this system will allow us to define the limitations and opportunities for aquaculture expansion throughout the state. We are developing a coupled hydrodynamic-biogeochemical model (FVCOM-RCA) of the Damariscotta River that will focus on understanding aquaculture productivity. The model will incorporate parameters such as temperature, salinity, nutrient concentrations, fresh water flow, primary production rates, chlorophyll a standing stock, uptake rates by oysters, proportion of food coming from detritus vs phytoplankton, benthic pelagic coupling and remineralization rates, bottom type, and bathymetry. Several questions of interest to explore with the model include: What is the carrying capacity of the Damariscotta River for oysters? Where are the best places in the river for future lease sites? Will decreased pH due to increased freshwater runoff or low pH shelf water intrusion have an impact on growth rates?

Duball, C.E. [1], Stolt, M.H. [1], and J.A. Amador [1]; [1] Department of Natural Resources Science, University of Rhode Island, Kingston, RI. chelsea_duball@my.uri.edu

EFFECTS OF OYSTER AQUACULTURE ON RESIDENT BENTHIC INFAUNA AND THE SOILS THEY INHABIT IN RHODE ISLAND COASTAL LAGOONS

Coastal lagoons are unique estuarine systems functioning at the interface between marine and terrestrial ecosystems. These areas are a focus for the expansion of shellfish aquaculture and many have water quality issues because of anthropogenic inputs. Although it is well established that native shellfish provide water quality ecosystem services, few studies have examined the ecological impacts of continuous shellfish aquaculture on the benthic environment. In this study, we assess the effects of oyster aquaculture on the estuarine environment by using benthic infauna and subaqueous soils as indicators of environmental impact. We selected three coastal lagoons in southern New England to study, all with active oyster aquaculture. Sampling locations were stratified based on the number of years the location was utilized for aquaculture (4-20 years). Samples were collected from the upper 20 cm of the soil surface of the three lagoons; in aquaculture areas and from adjacent non-aquaculture locations, as a control. Core samples were taken for soil analysis (e.g.: pH, particle size, bulk density), and others were sieved for benthic infauna, individually sorted, and identified to each respective functional feeding group. Benthic results revealed yearly variations in functional feeding group populations, with populations peaking primarily around 7-11 years of aquaculture use, followed by a dramatic decline in the following years, returning to

pre-aquaculture levels. Preliminary soil analysis revealed no specific trend in soil pH between aquaculture and control sites, and particle size analysis showed little variation across all sites. Data suggests continuous aquaculture use may have no negative impact to these coastal systems.

Eckert, R.L.; University of New Hampshire, Biology Department, Durham, NH 03824.
robert.eckert@wildlife.nh.gov
SPATIAL PATTERNS OF SPAT DENSITY IN RELATION TO DISTANCE FROM NATIVE OYSTER REEFS IN GREAT BAY ESTUARY, NEW HAMPSHIRE
Oyster restoration aims to restore the ecological functions of native oyster reefs. Understanding how proximity to a native oyster reef affects recruitment patterns will assist in restoration site selection. In this study, spatial patterns of oyster recruitment were studied at three native oyster reefs in Great Bay Estuary. Mesh cages used for sampling oyster spat were placed on native reefs and at 200, 400, 600, 800 and 1000 meters upstream and downstream of native reefs. There was a significant decrease in spat densities as proximity from a native reef increased, while recruitment was not significantly different upstream or downstream from a native oyster reef. Results suggest that restoration efforts should consider extending the natural boundary of native oyster reefs to provide the greatest potential for natural recruitment and thus long-term reef development.

Edquist*, S. and Harris, L.; University of New Hampshire, Durham, NH. skn269@wildcats.unh.edu
IMPACTS OF THE TREMATODE PARASITE, *ZOOGONUS RUBELLUS* ON ITS PREDATORY HOST *HEDISTE DIVERSICOLOR* IN THE GREAT BAY ESTUARY SYSTEM, NH
Parasites have the potential to mediate interactions predator prey interactions through their impacts on host biology. Nereid worms are among the most common predators in the infaunal communities and have been demonstrated in to play important roles in structuring these communities. The trematode *Zoogonus rubellus* infects predatory Nereid worms *Alitta virens* and *Hediste diversicolor*. Infection of Nereid worms by *Z. rubellus* is common within the Great Bay Estuary system in New Hampshire; field surveys have shown that nearly all Nereid worms are infected by up to fifty Z*. rubellus* metacercariae. However, very little is known about the effects of parasitism by *Z. rubellus* on its Nereid worm hosts. To determine the effects of *Z. rubellus* on Nereid worm biology, a series of laboratory studies were conducted to measure growth and predation activity of *H. diversicolor* post exposure to *Z. rubellus*. The results indicate that infection at a single time point does not affect growth of the host worm over a four week period, regardless of exposure intensity. Immediately following parasite exposure, the prey consumption of *H. diversicolor* is reduced. However, this effect is short lasting and no longer detectable one week post exposure. These results suggest that during periods of high exposure, predation activity of *H. diversicolor* may be temporarily reduced, but that this is a short term effect.

Elliott*, J.A. [1] S. Lopez [1] and L. Atkinson [1]; [1] Department of Biology, Salem State University, 352 Lafayette Street, Salem, MA 01970. j_elliott4@salemstate.edu
PHYLOGENETIC RELATIONSHIPS AMONG SUBSPECIES OF THE COMMON WOOD NYMPH BUTTERFLY *CERCYONIS PEGALA* (NYMPHALIDAE: SATYRINAE)
The common wood nymph, *Cercyonis pegala*, is a North American butterfly that is found along the northeastern coastline of the United States. *C. pegala agawamensis* is a recently described subspecies that is differentiated from *C. pegala* based on habitat, behavior, and phenotype. A major defining characteristic of the three subspecies is habitat, with *C. pegala maritima* found in upland coastal habitat, *C. pegala nephele* in northeastern upland habitat, and the recently described *C. pegala agawamensis* found in salt marsh habitat. This study examines the level of genetic differentiation and phylogenetic relationships among the three subspecies of *C. pegala*. The cytochrome c oxidase I (CO1) gene, a 648 base pair region found in the mitochondrial DNA, is commonly used as a barcoding standard to help identify the

relationships between species and subspecies. In this study, DNA was extracted using a QIAamp DNA Minikit from Qiagen and amplified using COI primers. The PCR products were cleaned using the QIAquick PCR Purification kit from Qiagen and sent to New England BioLabs, Inc., Ipswich, MA to obtain DNA sequence data. Thus far, two mtDNA haplotypes have been identified in all three subspecies and there is no evidence that the subspecies are genetically differentiated. More sequencing data will be obtained to further elucidate the phylogenetic relationships and genetic differentiation between the subspecies.

Fahey, C. T.; Department of Biology, Salem State University, Salem MA. c_fahey1@salemstate.edu
POPULATION MONITORING STUDY OF THE INVASIVE GREEN CRAB *Carcinus maenas* IN A SEMI-CLOSED ECOSYSTEM.

The ecological and economic impact of the Green Crab *Carcinus maenas* on the bivalve aquaculture industry is not yet fully understood. A population monitoring study was conducted in Smith Pool at Cat Cove Marine Lab, Salem State University. This location allows for the study of adult and larval forms of *C.maenas* and their population dynamics within a semi-closed ecosystem. This population monitoring study is examining the growth of the individuals over time and whether the water temperature effects the population's density at Smith Pool. The data collected is providing insight into how the water temperature and substrate may impact the crabs' population densities and structure. Samples were collected using commercial crab traps wrapped with 7mm mesh. The trapping data suggest that the catch per unit effort (CPUE) of the crab trap is effective in trapping crabs with a carapace width greater than 30mm. A secondary part of the study is exploring different techniques in capturing crabs with a carapace width less than 30mm. A tertiary part of this study is a mark and recapture of individuals and the distances traveled between sampling. All of the captured crabs are marked and released at a centralized location, then traps are placed at predetermined locations.

Feldsine*, N.A. [1], G.E. Moore [2], D.M. Burdick [3], and S.C. Adamowicz [4]; [1] Department of Biological Sciences, University of New Hampshire, Durham, NH; [2] Department of Biological Sciences, Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH; [3] Department of Natural Resources & the Environment, Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH; [4] Rachel Carson National Wildlife Refuge, U.S. Fish and Wildlife Service, Wells, ME. nay53@wildcats.unh.edu
EFFECTS OF BIODIVERSITY ON SAND DUNE SYSTEMS OF PLUM ISLAND, NEWBURY, MASSACHUSETTS

The impacts of Superstorm Sandy on eastern U.S. coasts have emphasized the importance of resilient sand dune systems. While dunes are primarily dominated by American beachgrass (*Ammophila breviligulata*), a host of other native species commonly occur in these systems, providing diversity and habitat complexity that is often not recognized or incorporated into dune restoration initiatives, and could benefit sites where dune die-off is a concern . We sought to explore the importance of biodiversity on dune resiliency by using a variety of native species (in addition to *A. breviligulata*) to stabilize and revegetate dunes impacted by coastal storms and human activity. Field experiments were used to determine which species may be well suited for restoration by recording plant survivorship. We also compared differences in sand accretion capability of a single species (*A. breviligulata* only) versus low diversity (*A. breviligulata* with *Solidago sempervirens*) and high diversity (*A. breviligulata* with *S. sempervirens*, *Lathyrus japonicus*, and *Cakile edentula*). Finally, diversity and percent cover were compared between healthy dunes, restoration areas and dunes exhibiting signs of dune "die-off." Based upon preliminary results, *S. sempervirens* and *L. japonicus* appear to be best-suited for restoration plantings. Diversity level did not impact relative sand accretion. As expected, diversity and percent cover were greatest in the control sites, compared with the other areas of interest. While it is clear that biodiversity is essential to maintaining functional coastal ecosystems, the quantitative effects of diversity on dune resiliency will require further study.

Gunn*, C.M. [1] Johnson, B.J. [1] Dostie, P. [1] Bohlen, C. [2]; [1] Department of Geology, Bates College, Lewiston, ME; [2] Casco Bay Estuary Partnership, Portland, ME. cgunn@bates.edu

METHANE FLUXES ALONG A SALINITY GRADIENT ON A RESTORED SALT MARSH, HARPSWELL, ME

This study functions to understand the relationship between salinity and methane emissions on a recently restored salt marsh in Casco Bay, Maine. Salt marshes are highly dynamic and susceptible ecosystems that provide a multitude of ecosystem services. The emplacement of causeways and narrow culverts restricts tidal flow leading to the loss of healthy salinity gradients, resulting in freshwater vegetation growth. Recent restoration efforts on Long Marsh, Harpswell, ME replaced a severely undersized culvert in February, 2014. The salinity gradient has since been restored along the marsh, resulting in dieback of freshwater vegetation. Using static gas chambers, we quantified CH_4 fluxes along two transects at five diverse sites during the months of July, August and October. Sites ranged from healthy, saline marsh with *Spartina* vegetation, to regions invaded by *Typha* and other freshwater vegetation. CH_4 concentrations were determined using a gas chromatograph with a flame-ionization detector. Preliminary findings suggest reintroduction of healthy tidal flows into the marsh inhibits CH_4 production, where the lowest fluxes were observed from the most saline sites (average 4.3 µmol $CH_4/m^2/hr$), and highest CH_4 fluxes from the freshest sites (average 62.3 µmol $CH_4/m^2/hr$) for months of July and August. Transitional sites exhibited ranges from 1.2 µmol $CH_4/m^2/hr$ to 16.8 µmol $CH_4/m^2/hr$. For all sites, lowest fluxes were observed during the month of October, suggesting seasonal influence on CH_4 emissions. These data are complimented by sediment analyses of $\delta^{13}C$, % organic carbon and bulk density using isotope-ratio mass spectrometry, and decomposition rates using a tea bag index.

Hill*, T.D. (1, 2), S. Anisfeld [1], and G. Benoit [1]; [1] Yale School of Forestry and Environmental Studies, New Haven, CT; [2] US EPA Atlantic Ecology Division, Narragansett, RI. hill.troy@gmail.com

MERCURY POLLUTION IN SALT MARSHES OF LONG ISLAND SOUND AND THE HUDSON-RARITAN ESTUARY

We report mercury depth profiles and accumulation histories for 13 salt marshes in Long Island Sound and the Hudson-Raritan Estuary. We found substantial variation in the timing and magnitude of peak Hg accumulation, which occurred as late as the 1980s, though composite data showed a broad regional peak between 1930 and 1950. Surface Hg levels in sediment cores also varied dramatically between marshes, but 48 surface samples from within a single marsh suggested that surface levels were more uniform at the scale of individual marshes. Aquatic sources of Hg overshadowed the regional atmospheric signal throughout the twentieth century. We document hot-spots of pollution in coastal wetlands along the coastline that further indicate the importance of local, non-atmospheric contributions. Although all sediment cores showed declining Hg levels and accumulation in recent decades, surface levels in eight of the 13 marshes exceeded the National Oceanic and Atmospheric Administration's Effects Range-Low (0.15 ppm) threshold, indicating potential for biological impacts.

J. S. Latimer [1]*, K. Parlee [2], A. Elskus [3], M. Liebman [4], and C. M. Tilburg [5]; [1] U.S. Environmental Protection Agency, Office of Research and Development, Narragansett, RI [2] Environment and Climate Change Canada, Dartmouth, Nova Scotia, CA [3] U.S. Geological Survey, Turner's Falls, MA [4] U.S. Environmental Protection Agency, Region 1, Boston, MA [5] Gulf of Maine Council, Buxton, MA. latimer.jim@epa.gov

ESIP: BOLDLY GOING TOWARDS ESIP 2.0 AND YOUR PHONE

The Gulf of Maine Council's EcoSystem Indicator Partnership (ESIP) was formed in 2006 to evaluate changes in the health of the Gulf of Maine ecosystems through the use of indicators. ESIP's initial approach to indicator development focused on seven ecosystem themes, which were based on priority issues identified by scientists, decision-makers and other stakeholders. To date, ESIP has made indicator data available online through its Indicator Reporting Tool and published fact sheets on six of its indicator themes: aquaculture, aquatic habitats, climate change, coastal development, contaminants, and eutrophication. As part of a bold and innovative new approach, ESIP 2.0 will focus on indicators to track

ecosystem services; the benefits that people and coastal communities obtain from the ecosystem. ESIP is participating in conversations with other organizations and agencies to determine the best approach to incorporate indicators of ecosystem goods and services along with traditional, environmental indicators. Together with ongoing work that relates watershed drivers and environmental impacts, the Gulf of Maine community will help lead the effort towards better incorporation of ecosystem services into discussions about the health of the Gulf of Maine. Alongside this scientific effort ESIP is growing a community of citizen scientists in the region through its new smartphone app: ICUC ("I See You See"). This app allows users to find information on local monitoring activities in the Gulf of Maine. In addition, users can participate in data collection by uploading smartphone photos at specific locations to an on-line photo library which will allow users to evaluate change over time via an associated ESIP web page.

LaBonte*, G. [1] and K. Wilson [2]; [1]University of Southern Maine, Biology Department, Portland, ME; [2]University of Southern Maine, Department of Environmental Science, Aquatic Systems Research, Portland, ME. gregory.labonte@maine.edu

USE OF NATURAL MARKERS TO INVESTIGATE HABITAT USE AND GROWTH OF JUVENILE ALEWIFE

Change in growth corresponding to a change in habitat of Penobscot estuary and bay juvenile alewife were investigated using otolith microchemistry and otolith growth increments. Alewives were collected via pelagic trawl in the Penobscot estuary and bay during May and October of '13, and '14. Alewife otoliths were brought to SUNY college of Environmental Science and Forestry, Syracuse, New York to quantify otolith elemental ratios of Ca, Ba (indicative of freshwater) and Sr (indicative of saltwater) using laser ablation techniques (Limburg 1998). Using water chemistry from the Penobscot watershed, criterion were established to determine habitat changes using Ba and Sr. Not all groups statistically averaged the same amount of time in freshwater or bay habitats (ANOVAFW: $F_{5,128} = 4.902$, $p < 0.001$, ANOVAbay: $F_{5,128}=3.209$, $p<0.05$), but all groups statistically averaged the same amount of time in estuarine habitat. A linear regression using all fish showed a strong negative correlation between age and mean growth increment width ($R^2=0.66$). Differences in time spent in a habitat had no effect on growth, as mean growth did not statistically differ between groups during freshwater, estuary, or bay phases. However, mean growth regardless of group was found to be highest in freshwater and lowest in estuarine habitat. Mean bay growth was higher than estuarine growth, but did not differ statistically. Although growth between bay and estuary are considered equal, it contradicts our regression findings, as juveniles on average entered the bay in the last 35% of their life. This suggests that juvenile alewife may utilize the bay to at least maintain growth as they age, something that may not be possible in the estuary.

Labrie*, M.S.; Schlezinger, D.R.; Sundermeyer, M.A.; Howes, B.L.; School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, MA. mlabrie@umassd.edu

QUANTIFYING IMPACTS OF SUSPENDED OYSTER AQUACULTURE ON NITROGEN CYCLING IN SOUTHEASTERN MASSACHUSETTS COASTAL EMBAYMENTS

Estuaries worldwide are being degraded by anthropogenic inputs of nitrogen (N), primarily from their watersheds. On Cape Cod Massachusetts, N loading is attributable primarily to on site wastewater disposal and fertilizer run off. The addition of this bio-available N stimulates phytoplankton blooms, which can result in declines in oxygen levels and increases in turbidity in the estuaries. Several municipalities in southeastern MA are implementing suspended oyster aquaculture (SOA) in their estuaries as a bio-remediation method to increase N removal. Suspended oyster aquaculture is thought to remove N through the processes of assimilation and more significantly enhanced denitrification (microbial conversion of nitrate to N_2). Municipalities require quantitative data to determine the effectiveness of SOA before it can be incorporated into a regulatory framework. To quantify N removal, we must first determine the flux of biodeposits from SOA, the biodeposit settling rate through the water column, and the lateral dispersal of biodeposit loading to the sediment. In this study, we deployed biodeposit traps to determine individual

oyster and whole oyster bag biodeposition rates over a range of food concentrations; a particle image velocimetry system to quantify settling rates of oyster biodeposits falling from SOA; and two Nortek ADCPs beneath SOA, a Signature1000 to determine the lateral distribution of biodeposits in a shallow water estuary with minimal horizontal flow and an Aquadopp Current Profiler to verify biodeposit settling rates. This study highlights the initial steps in developing a research based quantitative N removal term for SOA within eutrophic Cape Cod coastal embayments.

Legault*, R [1], G Zogg [2], and S Travis [2].; [1] M.S. in Biological Sciences candidate, Department of Biology, University of New England, Biddeford, ME ; [2] Department of Biology, University of New England, Biddeford, ME. rlegault@une.edu

EFFECTS OF NUTRIENT LOADING, COMPETITION, AND TEMPERATURE IN *PHRAGMITES AUSTRALIS* AND *SPARTINA ALTERNIFLORA* MESOCOSMS

New England salt marshes are characterized by distinct species compositions based on an elevational gradient – classically designated as low marsh and high marsh zones. These native species compositions are currently threatened by invasion of a non-native haplotype of common reed, *Phragmites australis*, spreading through high marsh zones at alarming rates. The dominant low marsh plant, *Spartina alterniflora*, or smooth cordgrass, is similarly threatened by sea-level rise and other effects of climate change, pushing these two species into inevitable competition. In this study, *Spartina alterniflora* and *Phragmites australis* competition mesocosms were built and subjected to varying levels of nutrient loading and temperature warming to assess effects on growth and survival. Nutrient inputs reflect anthropogenic effects, while greenhouses were built to simulate increasing temperatures due to climate change. Initial stem height results show a potential negative effect of competition on *Phragmites australis* at all nutrient levels, while *Spartina alterniflora* showed little change in stem height with varying nutrient levels. Aboveground biomass data will be analyzed to elucidate these effects further, including belowground biomass data from an additional growing season.

Lessard, J. GP Zogg and SE Travis; Department of Biology, University of New England, ME. jlessard2@une.edu

ANALYIZING THE EFFECTS OF INVASIVE *PHRAGMITES AUSTRALIS* ON GENETICALLY DIVERSE *SPARTINA ALTERNIFLO*RA ECOSYSTEMS

New England's Salt marshes have faced 350 years of destruction and pollution, which has had a lasting effect on them. In addition, invasion by *Phragmites australis*, which is known to alter the structure and function of marsh ecosystems by changing species composition, nutrient cycling, and the availability of other resources like water, has the potential to leave lasting and irreparable effects on these delicate ecosystems. In order to test the stability and the resistance of salt marshes to an invasive species, I conducted a project designed to test the effects of genotypic diversity of a common marsh plant, *Spartina alterniflora* on competitive interactions when grown alongside an invasive plant, *P. australis*. I hypothesized that increasing the genotypic diversity of *S. alterniflora* would serve as a biological defense mechanism against invasion of *P. australis*. To test my hypothesis, I grew the two species of plants together. 60 mesocosms were equally divided between two *S. alterniflora* diversity levels, a diversity of 1 genotype and a diversity of 4 genotypes. In addition, equal numbers of mesocosms received *P. australis* from one of three locations. Above ground biomass measurements were taken every 2 weeks. Above ground biomass data showed there was a significant difference in growth levels of *S. alterniflora* between genotypic levels when grown in competition with *P. australis*, with higher genotypic diversity leading to greater productivity. Data also showed a significant difference in growth rates of *P. australis* depending on collection site.

Macfarlane, S.; Coastal Resource Specialists, 290 Kingstown Way #379, Duxbury, MA 02332. sandymac@capecod.net

SHELLFISH TO THE RESCUE? EFFORTS TO USE SHELLFISH TO RESOLVE WASTEWATER ISSUES

Nutrient enrichment, plaguing our estuaries, is where the ramifications of too much of a good thing is most acutely observed: phytoplankton blooms, sometimes of toxic mono-specific species or ones disruptive to normal balanced functions, or seaweed mats lining and then decaying along the shores, or habitat changes that impact certain species, or oxygen depletion that may start a cascade of issues. Much of the excess nitrogen originates with on-site septic systems where nitrogen leaches to the groundwater. A major goal of the Massachusetts Estuaries Project that has analyzed 89 estuaries in the Southeast region is to reduce the amount of human-induced nitrogen entering into the estuaries from both ground and surface water, degrading water quality and shellfish habitat. Reducing the amount of nitrogen necessary to meet Total Maximum Daily Loads (TMDLS) of nitrogen established by the state will, in some cases, mean reductions greater than 75%. Correcting the problem brought on through decades of land-based development will be mind-bogglingly expensive. With moving targets such as migrating barrier beaches, sea level rise, and planning horizons of twenty to fifty years or more adding to the complexity, action has stalled again and again. Some have wondered if the filtering capacity of shellfish can save the day as a cheaper alternative than traditional sewage treatment plants. While shellfish provide an attractive possibility, many issues remain to be resolved as the debate continues. Each suggestion means taking a long view toward the future.

Mancuso, P. J.; Department of Estuarine and Ocean Sciences, University of Massachusetts Dartmouth, School for Marine Science and Technology, MA. pmancuso@umassd.edu

TIDAL RESTORATION OF THE NONQUITT SALT MARSH AND ACCELERATED RECOVERY

Restoring tidally restricted salt marshes has become common practice due to the importance of salt marshes and the large number of restricted, and degraded systems. Proper tidal restoration will restore normal ecological function to restricted marshes, although it may take decades for the process to complete naturally. The Nonquitt salt marsh in Dartmouth, MA was tidally restricted for over four decades and had tidal exchange restored in November 2013. Data on marsh elevation, flooding regimes, sediment pore water salinity, vegetation, and fauna were gathered pre and post restoration to track changes through time. In the summer of 2015, three field experiments were implemented to accelerate recovery of the marsh due to slow shifts in the vegetation community and the absence of keystone invertebrate species. Experimental plots (1m^2) were established in unvegetated mudflat areas to test if periodic additions of fertilizer would increase Spartina alterniflora recolonization rates. A second experiment was aimed at reducing coverage of the invasive reed, Phragmites australis. Root connections between high and low marsh stands of Phragmites were broken to stop transport of fresh water to the low marsh Phragmites. To restore invertebrate populations, fiddler crabs (Uca pugnax) and ribbed mussels (Geukensia demissa) were transplanted into the marsh at the beginning of their reproductive season to establish populations. Future salt marsh tidal restorations could build upon these techniques to enhance restoration trajectories.

Mogensen*, H.M. [1], A.B. Novak [1], P.D. Phippen [2]; [1] Department of Earth & Environment, Boston University, Boston, MA; [2] Merrimack Valley Planning Commission, Haverhill, MA. hannammogensen@gmail.com

MARSH INVADERS: ABUNDANCE AND POPULATION CHARACTERISTICS OF THE EUROPEAN GREEN CRAB (*CARCINUS MAENAS*) IN GREAT MARSH, MA

A recent population explosion of the invasive crab, *Carcinus maenas* (European green crab) has been implicated in the decline of soft-shell clams and other benthic organisms in Great Marsh, Massachusetts. To support the development of effective management strategies for green crabs in this system, abundance and population characteristics were assessed through seasonal trapping surveys conducted between April 2014 and December 2015. Results show average catch per unit effort (CPUE) was highest in the summer of

2014 (178), and significantly decreased in the fall (97) and spring [5] following intensive trapping and a cold winter. However, by the following winter of 2015, despite moderate trapping efforts, average CPUEs (78) had returned to levels seen in the previous year. Abundance of male and female green crabs also varied seasonally, with females found in significantly higher numbers during the summer, and males during the fall and winter. The largest green crab carapace sizes were observed in the winter of 2015 (54.4 mm) and coincided with the increase of male green crabs and native rock crabs during this season. Findings from our study provide baseline information on the green crab populations in Great Marsh and confirm reports that abundances are comparable to other regions in New England experiencing shellfish declines and habitat destruction. We recommend continuing management efforts to reduce green crab abundance in the system and focusing such efforts during key times of the year, such as summer months when reproductive females are abundant.

Moore*, G.E.; University of New Hampshire Jackson Estuarine Laboratory 85 Adams Point Road Durham, NH 03824. Gregg.Moore@unh.edu

COULD CLIMATE CHANGE BE INFLUENCING THE RANGE EXPANSION OF THE BLACK MANGROVE (MANGLE NEGRO), *AVICENNIA SCHAUERIANA* STAPF & LEECHMAN EX MOLDENKE, IN TROIS BAIES NATIONAL PARK, HAITI?

Increasing evidence suggests that climate change is influencing recent shifts in plant species distribution patterns worldwide. While unlikely a new arrival in Haiti, the threatened mangrove species *Avicennia schaueriana* Stapf & Leechman ex Moldenke was observed during a comprehensive ecological assessment of the Trois Baies National Park located in the north coast of Haiti on the island of Hispaniola. Voucher specimen collected at several sites in-country confirm the identification of this globally rare species. The population center of *A. schaueriana* is in Brazil where 90% of its documented occurrence resides. According to published literature, the northern range *A. schaueriana's* is thought to be limited to Anguilla, approximately 950 km south east of the present account. Well-established stands were observed in discontinuous patches within the National Park, in the embayments of Forte Liberte Bay, Caracol Bay and Borde de la Mer in Limonade. Observations of *A. schaueriana* often co-occurred with the similar taxon, *A. germinans* (L.), as well as *Laguncularia racemosa* (L.) C.F.Gaertn and *Rhizophora mangle* (L.). Confirmation of the presence of *A. schaueriana* in Trois Baies represents its first documented observation in Haiti and a northern range expansion for the species. Since population trends for this species are reportedly in decline within the Caribbean, the discovery of *A. schaueriana* in a previously undocumented geography is encouraging. However, given the extensive, unmanaged resource extraction common in Haiti (*i.e.* cutting for charcoal and fuel wood), documenting the presence and extent of the population is critical to its protection.

Mora, J.W.; Waquoit Bay National Estuarine Research Reserve, Falmouth, MA. jordan.mora@state.ma.us

THE HIGH VALUE OF VOLUNTEER-BASED WATER QUALITY MONITORING: LONG-TERM TRENDS IN THE WAQUOIT BAY ESTUARY SYSTEM

The high rate of residential development on Cape Cod over the last fifty years has led to significant water quality degradation caused by excess nutrient loads, or eutrophication. The effects of eutrophication on the Waquoit Bay Estuary have been well-studied over the last three decades especially as it relates to the loss of eelgrass beds and bay scallops in the area. More recently, there has been a shift in local water quality research to climate change impacts as long-term monitoring efforts have accumulated enough data to examine ten- or twenty-year trends. The Waquoit BayWatchers, a citizen science program coordinated by the Waquoit Bay National Estuarine Research Reserve, is one example with over twenty years of temperature, salinity, depth, dissolved oxygen, and chlorophyll data for five sites in the Waquoit Bay Estuary. The increasing trends in temperature and chlorophyll as well as the decreasing trends in dissolved oxygen provide compelling evidence that the estuarine system is experiencing negative impacts from

climate change in addition to eutrophication. Seasonal variation in these trends shows the greatest temperature change in the spring and fall, which may reflect an expanding growing season in New England. The warmer temperatures earlier and later in the year are likely to increase annual algal production and accelerate microbial activity, further reducing dissolved oxygen levels critical to the success of local commercial aquaculture and recreational fishing.

Pelletier, M.C.; US EPA Office of Research and Development, NHEERL-Atlantic Ecology Division, Narragansett, RI. pelletier.peg@epa.gov

TRENDS IN THE BENTHIC COMMUNITIES OF SUB-EMBAYMENTS OF NARRAGANSETT BAY, RI

Narragansett Bay has been a valued ecological resource from pre-colonial periods, and humans have historically altered the landscape around the Bay. This alteration was accelerated after European colonization. Land was clear-cut. Wetlands and tidal flats dredged and filled. With industrialization, chemicals were discharged into the bay. Currently, eutrophication is one of the more prominent environmental threats to the bay. Nitrogen loads in the bay have risen as human development has increased. There is a distinct eutrophication gradient from the head of the bay to the mouth, which is also seen for organic and metal contaminants. This gradient is also reflected in the benthic invertebrate community. In this study benthic invertebrate data from the 1950s to mid-2000s were assembled to look for environmental patterns over time and then related to environmental stressors and changes for those time periods. In Greenwich Bay, pressures and stressors have decreased over time but the benthic community overall still shows signs of stress. In this case, physical forcing factors and environmental shifts may prevent significant improvement in the benthos over time. In the Providence River, pressures and stressors have decreased over time, and the corresponding benthic communities have become more diverse. With continuing environmental upgrades, further improvement in benthic health in Providence River would be expected.

Peterson*, E. J.[1], Schmidt, C.[1], Berounsky, V. M.(1,2) and DeSilva, A.(1,2); [1] Narrow River Preservation Association, Narragansett, RI; [2] Graduate School of Oceanography, University of Rhode Island, Narragansett, RI. eric_peterson@my.uri.edu

WATER QUALITY AT SOUTHERN PETTAQUAMSCUTT ESTUARY (NARROW RIVER) IN RHODE ISLAND

Water quality was studied in the southern portion of Pettaquamscutt Estuary (also known as Narrow River) and brooks that flow into that area. Pettaquamscutt Estuary is an estuary in southern Rhode Island. The whole estuary has been monitored since 1992 by a volunteer program called the University of Rhode Island Watershed Watch. Because of high fecal coliform values, the whole estuary has been closed to shell fishing since 1994 .This study was undertaken to attempt to identify the source of the high bacteria levels and any contributing factors. Water samples were taken for fecal coliform, enterococci, total nitrogen, nitrate+nitrite, ammonia, total phosphorus, and dissolved phosphorus. Temperature, salinity, and dissolved oxygen were measured using electronic sensors. Samples and measurements were taken at 13 different sites approximately every two weeks from May to October in 2014 and 2015. Discharge was measured at the brooks about every two weeks starting in late July 2015. The data was entered into Microsoft Excel and graphed. For both years, the minimum dissolved oxygen concentration was always above 2 mg O2/L at all the sites. The bacteria concentration was multiplied by the discharge to calculate how much bacteria was flowing into Pettaquanscutt Estuary. Of the three brooks studied, Mumford Brook is by far the largest source of bacteria. For 2014, total nitrogen and also nitrate plus nitrite values in Mettatuxet Brook and Mumford Brook were usually 2 to 10 times higher than for sites in the estuary itself, suggesting those brooks are a source of nitrogen. Nutrient loading will be calculated when the 2015 nutrient data is available.

Preziosi* B. M. and Bowden T. J. School of Food and Agriculture, Aquaculture Research Institute, University of Maine; Hitchner Hall, University of Maine, Orono, ME 04469, USA. brian.preziosi@maine.edu

MORPHOLOGICAL CHARACTERIZATION VIA LIGHT AND ELECTRON MICROSCOPY OF ATLANTIC JACKKNIFE CLAM (*ENSIS DIRECTUS*) HEMOCYTES

The Atlantic jackknife clam, *Ensis directus*, is currently being researched as a potential species for aquaculture operations in Maine. The goals of this study were to describe the hemocytes of this species for the first time, provide a morphological classification scheme, and acquire hemocyte counts for healthy *E. directus* in the winter. We viewed hemocytes under light microscopy (using Hemacolor, neutral red, and Pappenheim's panoptical stains) as well as transmission electron microscopy (TEM). The 2 main types of hemocytes found were granulocytes and hyalinocytes (agranular cells). The granulocytes were subdivided into large and small granulocytes while the hyalinocytes were subdivided into large and small hyalinocytes. The large hemocytes had both a larger diameter and smaller nucleus to cell diameter ratio than their smaller counterparts. Using TEM, granulocytes were found to contain many electron-lucent and electron-dense granules of various sizes. The granules took up the neutral red stain, which indicated they had low-pH contents. Hyalinocytes had few of these granules relative to granulocytes. Large hyalinocytes had both various organelles and large vesicles in their abundant cytoplasm while small hyalinocytes had little room for organelles in their scant cytoplasm. Total hemocyte counts averaged 1.96 x 106 cells mL-1 while differential hemocyte counts revealed that granulocytes dominate the hemocyte population (over 75%). The results of this study provide a starting point for future studies on *E. directus* immune function.

Rasmussen*, S. A. [1], Neil, A. J. [1], Cressman, J. A. [1], Bradley, M. J. [1], LaBash, C. [1], August, P. V. [1], Lynch, J. C. [2], Stevens, S. [2].; [1] Environmental Data Center, Department of Natural Resources Science, University of Rhode Island, Kingston, RI; [2] Department of the Interior, National Park Service, Northeast Coastal and Barrier Network, Kingston, RI. scottrasmussen@edc.uri.edu

HIGH RESOLUTION MAPPING OF SALT MARSH VEGETATION ELEVATION RANGES USING A ROBOTIC TOTAL STATION

High resolution elevation mapping is essential to understanding and predicting the response of salt marshes to sea-level rise. These elevation data are required to support accurate and precise marsh response and migration models with the output informing future management strategies. Light Detection and Ranging (LiDAR) provides a reasonable elevation data set for many coastal features (e.g., beaches, dunes, tidal flats), with an elevation accuracy varying from 5-30cm. However, with the dense vegetation cover of salt marshes LiDAR is a less preferred method for acquiring high resolution elevation. Moreover, marsh vegetation zones can typically vary by only a few centimeters in elevation (or duration of tidal inundation). To better measure the elevation of the salt marsh surface and relate its position to local tidal datums, we used a Robotic Total Station. This method of elevation collection provides sub-centimeter accurate measurements and also the ability to consistently measure the marsh platform. These field-based elevation data, with accompanying water level elevation, were collected at Fire Island National Seashore (NY), with findings for a marsh site provided here. We collected comprehensive elevation data from the bay side edge to the upland using 20m grid spacing. A water level logger was deployed to understand tidal dynamics in the immediate vicinity of the marsh. Vegetation species composition and abundance were collected at each grid point. These intensive on-the-ground elevation and water level data are used to quantify the elevation range and duration of tidal flooding for each marsh plant species.

Santos*, E.A. [1] Oczkowski, A. [1] Wigand, C. [1] Hanson, A. [1] Mckinney, R. [1] and Sczura, K. [1]; [1] United States Environmental Protection Agency, Atlantic Ecology Division, Habitat Effects Branch, Narragansett, RI. easantos@my.uri.edu

UNDERSTANDING THE CHARACTERIZATION OF NUTRIENTS AS THEY ARE DISTRIBUTED SPATIALLY THROUGHOUT THE SAN JUAN ESTUARY

In cooperation with the U.S. Environmental Protection Agency this ongoing research and data to understand how nutrients are distributed temporally and spatially through the San Juan Bay Estuary was complied. This effort is a part of larger research project that is also looking at nitrogen and carbon stable isotopes in over 200 samples from locations along the San Juan Estuary. This presentation focuses on the characterization of those sediment samples. Stable isotope analysis was performed to quantify the amount of nitrogen present, and the sediment samples were further analyzed and characterized with a grain size analysis, phosphorus analysis using spectrophotometry, and determination of percent carbonate and percent organics with the loss of ignition method. Our data showed elevated levels of nitrogen in the Caño Martín Peña and the Laguna San José, based on our knowledge of this estuary we believe that these levels will remain elevated. These findings have serious implications for environmental and health risks along the San Juan Estuary.

Schmidt*, S.R., M.M. Whitney, and Jia Y.; Department of Marine Sciences, University of Connecticut, Groton, CT. steven.r.schmidt@uconn.edu

INVESTIGATING THE INFLUENCE OF COASTAL ISLANDS ON RIVER WATER DISTRIBUTION AND MIXING IN WESTERN LONG ISLAND SOUND

The Saugatuck, Norwalk, and Five Mile Rivers enter western Long Island Sound (LIS) adjacent to a chain of islands. These islands can influence the exchange of river water with the broader estuary. An observational and modeling approach is taken to determine the influence of these islands on the flow pathways and mixing of these coastal river waters. Prior research used a LIS- wide application of the Regional Ocean Modeling System (ROMS) and passive tracers to track the distribution of waters from individual major rivers (e.g. Connecticut and Housatonic) and groups of smaller coastal rivers. The western group of small coastal rivers (including the Saugatuck, Norwalk and Five Mile Rivers) contributes less than 10% of the freshwater in western LIS. The farther removed but larger Connecticut and Housatonic collectively account for more than 75% of the freshwater. These small coastal rivers, however, were found to enhance coastal stratification in early summer more so than the larger rivers. The LIS-wide model, however, lacked adequate resolution to include the island chain and its effects on circulation and freshwater distribution. Recent observations have suggested that these islands can enhance mixing in specific areas around the islands. Observed surface salinities tend to be fresher inshore of the island chain and show a clear freshening after major rain events. A new high resolution nested grid is applied to this area in ROMS to resolve the islands and to isolate their effects. Model output and data collected during the summer of 2015 low discharge season are used for comparative purposes and to determine the overall influence of these islands on the flow pathways and mixing of coastal river waters.

Scouten, E. SE Travis and GP Zogg; Department of Biology, University of New England, ME. escouten@une.edu

THE ROLE OF GENETIC DIVERSITY IN THE RESPONSE OF *SPARTINA ALTERNIFLORA* TO NUTRIENT LOADING AND INVASIVE SNAILS

Salt marshes provide essential ecosystem services to humans, such as acting as a buffer between the mainland and the ocean, and as a nursery for estuarine fishes. In New England, salt marshes and the important ecosystems services they provide are at risk from herbivory by an invasive snail species (*Littorina littorea*) and nutrient loading from humans sources. Species diversity has been shown to promote ecosystem stability in the face of environmental stressors, but in systems dominated by a single species –

Spartina alterniflora in these marshes – genotypic diversity may substitute for species diversity. To test this idea, *S. alterniflora* was taken from a marsh in New Hampshire and grown in flow-through seawater tanks at varying levels of diversity. *S. alterniflora* was exposed to varying levels of nutrients and two different levels of snail herbivory. The plants were measured periodically throughout the study for their productivity. Increased genotypic diversity had a positive effect on stem height. Nutrient loading had no effect on plant production and snail herbivory had a negative effect on plant production. Although plant production in response to nutrient loading and herbivory by snails appeared to be greater in the high diversity treatment, the difference was not statistically significant.

Semrod*, K. and Benoit, G.; [1] School of Forestry & Environmental Studies, Yale University, New Haven, CT. kelsey.semrod@yale.edu

QUANTIFYING STORMWATER MANAGEMENT BENEFITS OF BIORETENTION IN NEW HAVEN, CT: FROM GREY TO GREEN INFRASTRUCTURE

Stormwater runoff due to urbanization is a major cause of impairment to US waterways, and growth in urban development augments stormwater volumes, associated peak flows, and pollutant loads. There is growing interest in using green infrastructure (GI), which harnesses nature in the treatment of runoff, to combat pollution and flooding in cities. Eight bioretention swales (bioswales) and three in-ground infiltration cisterns were installed in a neighborhood in New Haven, CT in a combined sewer system within the urban West River watershed. The goal of this research was to quantify how effective GI is at decreasing stormwater runoff and reducing its contaminant loads. A Before-After-Control-Impact (BACI) study was conducted to compare two sewersheds: one with GI implementation and one without. Flow was monitored using weirs and level loggers installed within sewer pipes and cistern inlets, and with tipping buckets in three of the bioswales. Up to 24 water samples were collected per storm. Samples were tested for total suspended solids, nitrate, total nitrogen, orthophosphate, cadmium, copper, conductivity, and temperature. Results indicate that bioswales and cisterns provide a very significant reduction in the volume of water that travels to the combined sewer system, thereby reducing combined sewer overflows and improving water quality in the West River. The favorable water quality effect of GI is difficult to quantify, because of the substantial contribution by sanitary sewage, but our results suggest that even here there is a benefit. This research is one of the first to quantify the time course of the effectiveness of bioretention, building a case for investments in green infrastructure in cities around the country.

Sewall*, L.; The Harward Center for Community Partnerships, Bates College, Lewiston, ME.; The Harward Center for Community Partnerships, Bates College, ME. lsewall@bates.edu

WHY COLLABORATE?: THE NEW STORY OF NECSA

Climate related changes to the Gulf of Maine system are accumulating without coordinated monitoring of near shore conditions. The Northeastern Coastal Station Alliance is a new network of field stations and marine labs (FSMLs) working to integrate place-based data across the Gulf of Maine, across disciplines, and in the interest of tracking climate impacts. Our mission emphasizes integrative approaches that span geographic and historic scales; that leverage field-based observations; and that facilitate outreach for the public good. But our work together is time intensive, so why do it? Because: 1) FSMLs accumulate site specific knowledge; 2) linking data across sites achieves specific description at the regional scale; 3) immersive experience, or contextual observation, facilitates interdisciplinary inquiry and analysis, and innovative research; 4) because FSMLs are embedded within communities, affording easy access for outreach purposes; and 5) because integrative approaches are our best bet for tackling “wicked problems.” Last, but not inconsequential, working together is worth the effort because climate impacts are psychological and social as well as environmental. These are uncertain times and we need one other to make common sense of the unleashed, unprecedented, and large-scale deviations before us.

Sharif, R; P.O. Box 32 Peacedale, RI 02883. rahatsharif@gmail.com
PERFORMANCE OF SELECTED RAIN GARDENS IN RHODE ISLAND
Rain gardens are constructed with the goal of mitigating the detrimental effects of storm water runoff, including eutrophication, sedimentation, and flood damage. Rain gardens have been advertised as supporting other ecosystem services, such as biodiversity through the use of native plants, as well as being aesthetically pleasing. They are versatile, and can be used in environments such as sidewalks, a single residential lot, and large parking lots. In Rhode Island six rain gardens were investigated to look at effectiveness in retaining storm water runoff. This project sought to investigate existing rain gardens to see if they function appropriately to handle the runoff generated in their drainage area. The amount of runoff was calculated by measuring the amount of impervious surface contributing runoff into the garden then multiplied by 1", 2" of rain, and 24 - hour storm scenarios. Four out of the six rain gardens studied were found to be oversized for 1-2 inches of runoff, while the one was undersized and other was failing due to vegetation die off. Rain gardens are part of a larger category of infrastructure, called green infrastructure. Green infrastructure has been made highly relevant after the detrimental impact of flooding from Hurricanes Irene and Sandy. The effects of urbanization can compound flooding situations. As structures such as rain gardens are built, they should be monitored over time to confirm they work as intended. Studies such as this one hope to illuminate possible methodologies for monitoring efforts.

Smith, S.M.; National Park Service, Cape Cod National Seashore, 99 Marconi Site Road, Wellfleet, MA. stephen_m_smith@nps.gov
MULTIDECADAL TRENDS IN ATMOSPHERIC AND OCEAN CLIMATE VARIABLES IN OFFSHORE WATERS NEAR CAPE COD (MASSACHUSETTS, USA)
Global climate change is influencing the ocean environment in myriad ways and many of these effects may directly or indirectly impact coastal ecosystems. In this study, a number of atmospheric and ocean climate variables were analyzed from a National Oceanographic and Atmospheric Administration (NOAA) weather station located near the Cape Cod (Massachusetts, USA) peninsula between 1983 and 2011. The data suggest that a number of significant trends have occurred during this time. These include a significant warming of air and water temperatures in summer, increased wind speeds in the winter and fall coupled with reductions in spring and summer, decreased wave periods, reduced barometric pressure, changes in wave direction, and increased wave heights. All variables exhibited considerable seasonal variability as well, which is important given that they are likely to have more or less influence at certain times of the year. The results are discussed within the context of climate change and potential alterations to coastal ecosystems of the Cape Cod region.

Unruh, A., University of Massachusetts-Dartmouth School for Marine Science and Technology, New Bedford, Massachusetts, USA, aunruh@umassd.edu ; Howes, B. L., University of Massachusetts-Dartmouth School for Marine Science and Technology, New Bedford, Massachusetts, USA, bhowes@umassd.edu; 706 South Rodney French Blvd. aunruh@umassd.edu
QUANTIFYING NITROGEN ATTENUATION IN CAPE COD, MA FRESHWATER PONDS
As coastal areas develop, nitrogen (N) pollution to coastal embayments has become a major ecological issue. Massachusetts has been working to restore nitrogen impaired estuaries under the Massachusetts Estuary Project (MEP) by quantifying the level of N enrichment supportive of unimpaired resources and to set Total Maximum Daily Load for each of the 89 southeastern. MA estuaries. The MEP determined most estuaries are currently impaired due to N enrichment and developed plans to restore each system to a healthy state. It has been suggested that watershed N loading can be reduced by increasing natural N attenuation in freshwater ponds within the watershed transport path. One example of this is Flax Pond, which is being evaluated for restoration of down gradient Rands Harbor. Initial analysis indicates that Flax Pond currently attenuates 10% of the N passing through it and 13% of the total N load to the Harbor passes

through it. The goal is to improve Pond's natural N removal to reduce N loading to the estuary. As part of this effort a N mass balance for the pond including all inputs and outputs is being developed, which includes denitrification rate, burial rate, and groundwater and stream input and output. Watershed N loading will be calculated for the sub-watershed. Measurements include denitrification by N2 production in intact sediment cores, burial rate based on CHN sediment analysis and 210Pb based accretion rate, and stream loading by continues stream flow and N concentration measures. These data will provide an understanding of the nitrogen attenuation in small ponds and give guidance to approaches to increase N retention.

Vaudrey, J.M.P.; Department of Marine Sciences, University of Connecticut, Groton, CT 06340. jamie.vaudrey@uconn.edu

EUTROPHICATION IN LONG ISLAND SOUND EMBAYMENTS: LINKING SOURCES TO CONSEQUENCES

Long Island Sound, sometimes called the "Urban Sea," is a body of water heavily impacted by the dense populations along it's coastline. The water quality in the main stem reflects the gradient in population, with symptoms of eutrophication present in the Western Sound, near New York City, and better water quality in the relatively non-urbanized Eastern Sound. Long Island Sound has ~115 embayments, defined as a recess in a coastline or an indentation off a shoreline which forms a bay. While the embayment contribution to Long Island Sound's coastal nitrogen load is relatively small (~20% of coastal contribution), people are interested in the local effects of nitrogen on "their" embayment; and these effects can have a substantial impact on local embayment water quality. A rapid assessment approach conducted in late summer of 2011 and 2012 was used to determine the extent and degree of eutrophication in eight embayments. Habitat characteristics were assessed and compared to the nitrogen load and trophic status of these embayments. Work continued in 2013 and 2014, conducting rapid assessments of an additional seven embayments and revisiting two from the 2011-2012 cycle. Results indicate embayments exhibit hypoxia in the innermost portions of the embayment, even in eastern areas where Long Island Sound does not exhibit hypoxia. Nitrogen loads to all 115 embayments were estimated using a land use-based model resulting in a list of embayments most likely to be experiencing the impacts of eutrophication. Results provide guidance on targeting locally specific efforts at non-point source nitrogen reductions likely to have the greatest impact on embayment water quality.

Webb*, A. [1], Wilson, K. [2], Lasley-Rasher, R. [3], and LaBonte, G. [1]; [1] Department of Biological Science, University of Southern Maine, Portland, ME; [2] Department of Environmental Science, University of Southern Maine, Gorham, ME; [3] Department of Marine Science, University of Maine, Darling Marine Center, Walpole, ME. amy.webb@maine.edu

FEEDING HABITS AND MOVEMENT OF JUVENILE ALEWIFE (*ALOSA PSEUDOHARENGUS*) IN THE PENOBSCOT ESTUARY

This study examines the feeding habits and movement of juvenile alewife in the Penobscot Estuary using stomach content and carbon isotope analysis. Fish were collected by NOAA Fisheries Maine Field Station's on-going otter trawl survey. During this time plankton samples were collected and analyzed by Dr. Rachel Lasley-Rasher from the Darling Marine Center. This data was used to calculate electivity indices for each prey item. 132 alewife collected from May to September, 2013 ranging in size from 47 mm to 208 mm fork length, were used in the diet analysis. 128 alewife (97%) had identifiable prey in their stomachs. Diet composition was relatively homogenous among both small (47-90 mm fork length) and large (91-208 mm fork length) size groups throughout the estuary. Diet was dominated by *Eurytemora affinis* (estuarine copepods) which were positively selected for along with two other organisms, *Balanus sp.* (barnacle larvae) and *Neomysis americana* (mysid shrimp) across all months. ^{13}C values of juvenile alewife were used to infer recent movement between the Penobscot lakes (freshwater), bay (marine) and river (estuarine) habitat. ^{13}C values of young of year alewife from freshwater were consistently depleted, while juveniles collected

from the bay were enriched. The results of ^{13}C from juvenile alewife collected in the estuary showed recent movement from both marine and more freshwater habitat across all months sampled. These results suggest frequent movement between estuarine and marine habitat and that the estuary is a significant feeding habitat for these fish.

Whitney*, M. M. [1], K. DeRosia-Banick [2], and E. Ward [1]; [1]Department of Marine Sciences, University of Connecticut [2]Connecticut Department of Agriculture, Bureau of Aquaculture. michael.whitney@uconn.edu
FORECASTING *VIBRIO PARAHAEMOLYTICUS* IN LONG ISLAND SOUND OYSTERS TO PROMOTE SAFE SEAFOOD
Vibrio parahaemolyticus (Vp) is a marine bacterium that occurs naturally in brackish and saltwater environments and may be found in higher concentrations in the warmest months. Vp is a growing threat to producing safe seafood. Consumption of shellfish with high Vp levels can result in gastrointestinal human illnesses. Management response to Vp-related illness outbreaks includes closure of shellfish growing areas. Water quality observations, Vp measurements, and model forecasts are key components to effective management of shellfish growing areas. There is a clear need for observations within the growing area themselves. These areas are offshore of coastal stations and typically inshore of the observing system moorings. New field observations in Long Island Sound (LIS) shellfish growing areas are described and their agreement with high-resolution satellite sea surface temperature data is discussed. A new dataset of Vp concentrations in shellfish tissue is used to determine the LIS-specific Vp vs. temperature relationship following methods in the FDA pre-harvest Vp risk model. This information is combined with output from a high-resolution hydrodynamic model of LIS to make daily forecasts of Vp levels. The influence of river inflows, the role of heat waves, and predictions for future warmer climates are discussed. The key elements of this observational-modeling approach to pathogen forecasting are extendable to other coastal systems.

Wilson*, K.A.[1], Pearson, A.O.[2], and M. Thurrell [3]; [1] Department of Environmental Science and Policy, University of Southern Maine, Portland, ME [2] Environmental Studies, Colby College, Waterville, ME [3] Department of Biology, University of Southern Maine, Portland, ME. karen.wilson@maine.edu
RESTORATION OF A SALT MARSH: 10 YEARS OF VEGETATION CHANGE
Sherman Marsh is a 200 acre salt marsh located along the southern branch of the Marsh River in Newcastle, Maine. The marsh was dammed in 1934 during improvements to U.S. Route 1, which created a shallow freshwater lake. A dam breach during a heavy rain event in October 2005 drained the impoundment, exposing well-preserved salt marsh peats, and reintroducing limited salt water tidal flushing. In the fall 2008 the Maine DOT completed the reconstruction of the marsh inlet under Route 1, allowing tidal flow to approximate that of the downstream Marsh River. We monitored plant species percent cover and soil porewater salinities at permanent plots in Sherman Marsh and an adjacent reference marsh from 2006 to 2010, and returned in 2015 to assess change over ten years of regrowth. Three brackish and salt marsh plant species dominated in 2006: *Typha* sp. (cattail), *Schoenoplectus maritimus* (alkali rush), and *Juncus gerardii* (black rush). Freshwater legacy plant species were found throughout the marsh in 2006 but largely disappeared by 2007. As expected, recolonization of the marsh by salt marsh plants first occurred near the inlet, and over time spread to the far reaches of the marsh. Despite recolonization by a diversity of salt marsh species by 2015, *Juncus gerardii* and *Typha* continue to be found at higher percent cover in Sherman Marsh than the reference marsh. After 10 years, the distribution of these plant species continue to reflect early patterns of plant regeneration.

Zarnoch, C.* [1], Alldred, M. [1], Hoellein, T. [2], and Bruesewitz, D. [3]; [1] Department of Natural Science, Baruch College, City University of New York, New York, NY; [2] Department of Biology, Loyola University Chicago, Chicago, IL; [3] Environmental Studies Program, Colby College, Waterville, ME.
chester.zarnoch@baruch.cuny.edu

WILL RESTORED SALT MARSHES IN URBAN EUTROPHIC ESTUARIES PROVIDE ECOSYSTEM SERVICES?

Salt marshes are important areas of nutrient cycling, flood mitigation, and biodiversity on coastal landscapes but have experienced considerable degradation worldwide. Salt marsh restoration efforts are now common and are often motivated towards regaining lost ecosystem services including nitrogen (N) removal and carbon (C) sequestration. There have been multiple large-scale restoration projects in New York City, however, it is not clear if restored marshes have the capacity for N removal and C retention in urban eutrophic environments. In summer 2015 we began a 2-year study examining the interactions among plant growth, sediment conditions, and C and N dynamics across a chronosequence of restored marshes in Jamaica Bay. We measured N fluxes seasonally at 2 restored marshes using continuous-flow sediment core incubations. The older marsh site (restored 9 years ago) had higher rates of denitrification (i.e. N removal) than the younger marsh (restored 3 years ago). Denitrification rates were lower in summer than in fall likely due to nitrate limitation in summer. We measured above and belowground plant biomass at each site and found that biomass increased with marsh age. Our preliminary results suggest that coevolution between restored marshes and biological communities may be an important driver of ecosystem services in urban eutrophic estuaries.