NEERS MEETING ABSTRACTS - Spring 2010

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THE ALLENS POND SAGA: HOW SHIFTING SANDS ALTERED A SALT MARSH AND CHANGED THE TRAJECTORY OF A RESTORATION PROJECT

In the fall of 2004, Mass Audubon collaborated with the Buzzards Bay Project and NRCS to increase tidal flushing to a 4 ha section of salt marsh at Allens Pond Wildlife Sanctuary in South Dartmouth, MA. This sanctuary is one of New England’s premier location for marsh birds. Pre restoration monitoring indicated that much of this section of marsh had been invaded with *Phragmites australis*. Other sections were bare of any vegetation. The restoration involved replacing a small, collapsed culvert with four 0.6 m diameter polyethylene culverts. *Spartina alterniflora* expanded in the first few years post restoration while *Phragmites* remained stable. In the spring of 2008, the inlet that connects Allens Pond to Buzzards Bay was sealed by shifting sands, completely eliminating tidal flushing. This raised the water level of the pond to the point that its surrounding marshes were submerged for several months. Dredging eventually restored tidal exchange, but the marsh grasses in the restoration area and elsewhere had died back substantially. *Phragmites* was unaffected. Our one year post inundation monitoring indicated a decline in breeding saltmarsh sharp-tailed sparrows, a species of conservation concern. Seaside sparrows and willets showed no differences. We also found substantial differences in the marsh invertebrate community in areas where the marsh had died off compared to reference marshes. Our monitoring will continue to track the anticipated recovery of the marsh vegetation in the restored and reference areas as well as any long term effects on marsh fauna.

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A SIMPLE MODEL OF NITROGEN CONCENTRATION, THROUGHPUT, AND DENITRIFICATION IN ESTUARIES.

The Estuary Nitrogen Model (ENM) is a mass balance model that calculates nitrogen losses within bays and estuaries (e.g. denitrification and burial in sediments) as rates that are proportional to system nitrogen content. The model has been used to demonstrate the dependence of throughput and denitrification of nitrogen in bays and estuaries on flushing time. The model also has been successfully used to predict average concentrations of total nitrogen in bays and estuaries based on the rates of nitrogen input from the watershed and direct atmospheric deposition, and across the seaward boundary. The ENM can be used to compare the relative contributions to in-estuary nitrogen concentrations of loading from the watershed and atmosphere with those from loading

across the seaward boundary. The ENM can also provide estimates of the sensitivity of in-estuary nitrogen concentrations to changes in loading from the watershed and atmosphere. When riverine loading rates are based on output from USGS SPARROW models, one can estimate contributions of individual source classes, e.g. point, nonpoint and atmospheric inputs, to in-estuary nitrogen concentrations. This is useful in assessing likely consequences of different nitrogen control strategies, including relocation of outfalls, advanced treatment at sewage treatment plants, or changes in air emissions that result in reduced atmospheric deposition.

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DO SPARTINA ALTERNIFORA CLONES VARY IN THEIR TOLERANCE TO SEA LEVEL RISE?

Both the structure and function of New England salt marshes are at risk of being altered by rising sea levels accompanying global warming. Because marsh grasses contribute to the vertical accretion of salt marshes directly via organic matter inputs, and indirectly by trapping inorganic sediment, how marsh elevation responds to increased tidal inundation will largely be determined by plant responses. Although there is considerable evidence for intraspecific variation in morphology and stress tolerance among genetically cohesive clones of <u>Spartina altenriflora</u> (smooth cordgrass), it is unclear how plant productivity varies among genotypes in relation to tidal inundation - a potentially critical factor in determining community response to sea level rise. To examine clonal response to flooding, we transplanted seven <u>S. alterniflora</u> clones from the Wells National Estuarine Research Reserve in Wells, Maine, to an experimental array of flow-through seawater tanks to compare growth in a natural tidal regime versus a simulated rise in sea level of 50 cm. We harvested these clones after 16 weeks and determined clone-specific responses to variation in flooding based on four separate measures of productivity. In approximately half of our experimental genotypes, simulated sea level rise increased plant production (relative to the “natural” tidal regime), whereas the remaining genotypes showed the reverse trend; however, due to substantial (38%) mortality of our replicate transplants, the statistical power of our test was only adequate to show a significant difference in productivity between hydrological treatments for one of seven (14%) clones.

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ARE THERE ASSOCIATIONS BETWEEN *FUSARIUM* AND MARSH CRABS IN SALT MARSHES AFFECTED BY SUDDEN VEGETATION DIEBACK?

Sudden Vegetation Dieback (SVD) is the loss of smooth cordgrass (*Spartina alterniflora*)

(SA) along intertidal creeks in salt marshes of the Atlantic and Gulf states. The cause of SVD remains unclear. A three year survey of SVD sites show greater incidence of a newly described pathogenic fungus called *Fusarium palustrium* (*palus* = marsh) than in healthy marshes. Plant pathogens alone are not believed to cause SVD. SVD sites frequently have more herbivory from the blue marsh crab (*Sesarma reticulatum*) than in non SVD sites. When SA plants were grown for two in years in exclusion cages in a SVD site, plants were larger than uncaged plants even though all plants were heavily colonized by *F. palustrium*. Transplanting healthy plants into two SVD sites resulted in recovery in one site and no recovery in another. The incidence of *F. palustrium* on SA tended to be greater in the site that did not recover. Pitfall trapping of the blue marsh crab in 2009 did not statistically differ in both sites, but *Uca* spp. and *Carcinus* spp. were found in greater densities in SVD sites. Is herbivory by marsh crabs greater on SA plants that are colonized by *F. palustrium*? A series of studies were done with marsh crabs that were reared in captivity and provided healthy SA plants or plants inoculated with *F. palustrium*. Estimates of herbivory (% vegetation consumed) did not statistically differ among inoculated and healthy plants. These findings provide no evidence that (*S. reticulatum*) differentiates between plants stressed by *F. palustrium* and healthy plants. Furthermore, recovery from SVD may be unrelated to (*S. reticulatum*) densities.

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MASSACHUSETTS DIVISION OF MARINE FISHERIES EELGRASS RESTORATION PROJECTS IN BOSTON HARBOR AND SALEM SOUND

The Massachusetts Division of Marine Fisheries (DMF) plans to restore up to 4 acres of eelgrass to sites in Boston Harbor and Salem Sound, MA. The project will be funded as mitigation for the 2002 loss of eelgrass during construction of the Algonquin HubLine natural gas pipeline which cut through an eelgrass bed in Salem Sound. This mitigation is in addition to the DMF Boston Harbor eelgrass restoration project of 2004-2007. A transplant site suitability screening process conducted by Battelle and DMF identified 3 sites (out of 9 tested) with shoot survival greater than 30%: Deer Island Flats (36.5%), Governor Island Flats (34%), and Beverly (64%). DMF will target all three sites for restoration. The project will be designed to investigate research topics associated with eelgrass restoration such as the efficiency of various transplant methodologies, optimal time-of -year for transplanting, assessment of sediment parameters in relation to eelgrass restoration, and the regulatory feasibility and effectiveness of using alternative mitigation, such as conservation moorings and water-quality improvements, for direct eelgrass impacts.

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SEDIMENT ACCUMULATION AND EROSION IN EELGRASS BEDS MEASURED WITH SURFACE ELEVATION TABLES (SET)

The Great Bay Estuary (GBE) on the border of New Hampshire and Maine has experienced declines in eelgrass (*Zostera marina* L.) coverage and biomass over recent decades, including total loss in central GBE since 2006. Eelgrass beds enhance sediment accumulation by reducing current velocity within their canopies and binding sediments in their roots and rhizomes, thereby inhibiting sediment resuspension and erosion and reducing turbidity. The Surface Elevation Table (SET) has been commonly used to monitor change in sediment elevation in wetlands, but never before in seagrass habitat. To investigate the potential relationship between eelgrass cover and changes in sediment elevation, we analyzed the data from a study (1996-2008) that employed SETs. Permanent SET sites were established at eight locations in subtidal habitats throughout the GBE. The SET measures change in sediment elevation from a permanent base acting as a spatial datum, allowing the processes of accretion and erosion to be integrated into a single measurement. The upper GBE (3 sites) retained eelgrass and experienced net sediment gain of 11.0 ± 2.8 cm, while the central GBE (5 sites) lost all of its eelgrass by 2006 and experienced net sediment loss of 7.2 ± 1.6 cm by 2008. Greatest sediment accretion occurred in conjunction with dense eelgrass and periods of greatest sediment erosion followed declines in eelgrass. We conclude that eelgrass beds in the GBE influence sedimentary processes and that eelgrass declines result in sediment resuspension and loss. We also demonstrate SETs to be an effective tool to measure sediment dynamics in subtidal seagrass habitat.

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COLLABORATIVE LEARNING STRATEGIES TO OVERCOME BARRIERS TO ECOSYSTEM MANAGEMENT IN COASTAL WATERSHEDS OF THE GULF OF MAINE

Marine resource managers and environmental policy makers trained in disciplines grounded in the bio-physical sciences learn quickly that some of the biggest challenges to the practice of ecosystem management are social ones. While ecosystem theory provides a conceptual framework for integrating the ecological, socioeconomic, cultural and institutional elements of environmental problems, the practice of ecosystem management remains elusive. A United States “science to management” initiative implemented within the National Estuarine Research Reserve System (NERRS) provided the context for developing innovative interdisciplinary approaches supporting ecosystem management to mitigate land based pollution impacts in coastal watersheds in the Gulf of Maine. The Coastal Training Program of the NERRS represents a manifestation of what NOAA Director Dr. Jane Lubchenco calls The New Social Contract for Science. This action research case study of the development of the CTP at the Wells, Maine NERR evaluated the application of social science methodologies to community-based ecosystem management. Stakeholder and institutional analysis methodologies facilitated

understanding of the context of municipal decision-making about water and land use. Results of these methodologies, combined with instructional design and collaborative learning methodologies contributed to formation of partnerships and conservation planning in coastal watersheds in southern Maine. The conceptual framework for integrating social science into ecosystem management developed through this research is proposed as one model for a fundamental perspective shift in the meaning of interdisciplinary at the science-management-policy interface.

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MAPPING AND ANALYZING *PHRAGMITES AUSTRALIS* EXPANSION IN RESPONSE TO ANTHROPOGENIC FACTORS

The invasive spread of nonnative *Phragmites australis* into New England salt marsh habitats poses an increasing threat to these ecosystems. Once established, plants are capable of producing multiple new shoots, allowing for aggressive patch expansion and formation of dense, monocultural stands. Factors influencing *P. australis* invasion include anthropogenic disruptions such as nitrogen runoff from surrounding development and lowered salinity levels from tidal restrictions, although the extent to which each of these factors affects the rate of expansion has not been established. This study looks at 21 *P. australis* patches at Drakes Island marsh in Wells, Maine. The objectives of the study are to: (1) calculate the change in patch perimeter over the course of one growing season, (2) determine whether patch expansion varies with respect to environmental variables, and (3) determine whether patch expansion varies with respect to geographic variables. It is hypothesized that expansion will be greater in patches with higher nutrient levels, lower salinity and greater proximity to human development. In June 2009, perimeter data were gathered on all patches. Measurements were repeated in November 2009 and will be repeated again in June 2010. Data on nitrogen availability and salinity were gathered in summer 2009. Geographic information systems are being used to map individual patches, calculate expansion rates and analyze expansion relative to surrounding features, nutrient data and salinity. This work is aimed at providing local knowledge on *P. australis* invasion that will allow managers to better formulate control strategies and allocate resources to habitats most imminently threatened.

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SPARTINA ALTERNIFLORA'S (POACEAE) PECULIAR RELATIONSHIP WITH SULFIDE

Salt Marsh coord grass *Spartina alterniflora* lives in hypoxic/anoxic sediments with high pore water concentrations of bacterially produced sulfides. This highly reduced sulfur species causes problems for species trying to live in this environment through various mechanisms, including the inhibition of alcohol dehydrogenase resulting in the inability to control anaerobically produced alcohol. *Spartina alterniflora* has a remarkable tolerance to sulfides and ecologically this helps it dominant salt marshes in its native range and where it is invasive. Previous work has shown conflicting evidence for the influence of sulfides on the growth of *Spartina*. More oxidized forms of sulfur are important macronutrients for plants because of their importance in forming iron-sulfur clusters and two essential proteins. Sulfides are currently known as a phytotoxin, but some studies have shown that this plant preferentially uptakes sulfide (over sulfate) from its environment and that its root tips enzymatically oxidize sulfides. In the context of a sand culture experiment showing increased growth of this species with sulfide concentration, a hydroponic experiment was conducted here that precluded rhizosphere formation and had low dissolved oxygen levels. Preventing a stagnant rhizosphere disallowed bacterial colonization of the space and therefore eliminated the possibility that a rhizosphere community aids in sulfide tolerance. In contrast to the sand experiment, this study found toxicity of sulfide treatment at 1 and 3 mM levels and growth decreases at 3 mM sulfide suggesting the importance of the rhizosphere or a symbiotic association.

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FINE-SCALE CURRENT MAPPING AS A GUIDE TO EELGRASS RESTORATION

Eelgrass (*Zostera marina*) seeds are dispersed while attached to broken-off reproductive shoots. Since transport depends on surface currents, we measured currents as a guide to efficient restoration. PVC pipe buoys containing a GPS receiver, a radio transmitter and appropriate control circuits were recorded by multiple shore stations. Position data is ±1.33 meter (SE), and the velocity (speed & direction) is derived from pairs of observations 2 minutes apart. Buoys (1 or 2) were deployed on 37 days between 7/1/2009 and 10/9/2009, with variation in the time of high tide providing coverage of the tide cycle. After rejecting duplicate (multiply relayed) and spurious data (buoy on the dock, washed ashore or in transit) we retained 8522 records as the valid data set. Analysis shows an equal distribution of points across the tide cycle. The distribution of velocities shows an easterly (toward ocean) trend to the current during the ebb tide, and speed is also maximum at these times. During the flood tide there is no corresponding westerly current. Two factors could account for this observation. First, the prevailing winds are from the west, and tend to produce surface currents which add to the tidal currents, with water returning as a sub-surface current. Secondly, there is a considerable fresh water inflow from Northeast Creek, which varies in magnitude but is always present. This would establish a net outflow from Eastern Bay toward the east and would intensify the current at the surface. Note that Frenchman Bay is one of the few portions of the Maine coast which has never been closed due to red tide (*Alexandrium* sp.); this prevailing outflow might be preventing the organism from entering the bay.

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THE STATUS OF 5 NEW HAMPSHIRE STATE-LISTED TIDAL MARSH PLANTS

The tidal marsh habitats of New Hampshire are home to 27 rare, threatened, and endangered plant species. Rare plants are especially threatened by anthropogenic disturbances as they are physiologically unable to adapt to changing environments. The status of four threatened species (*Eleocharis parvula, Samolus valerandi, Lilaeopsis chinensis*, and *Agalinis maritima*) and one endangered species (*Salicornia bigelovii*,) was examined in order to determine the extent of the impact. Site-specific features of the species' habitats were documented in the summer of 2009, including pore water salinity, pH, proximity to development, and co-occurrence of invasive species; these habitat features had not been previously documented for these species. Such features are critical for understanding and predicting population trends, as well as for informing conservation and management efforts. We found that all of the species in the study occurred within narrow salinity ranges that were species specific. Additionally, new populations of *E. parvula, A. maritima, L. chinensis*, and *S. bigelovii*) were discovered during this study. These discoveries are most likely due to a lack of prior study on these species and not expansion within the state. Along with providing updated elemental occurrence data for the state's Natural Heritage database, our results will establish a baseline for long term monitoring of the effects of anthropogenic impacts on these populations. The results will also be used to model potential effects of climate change, such as sea level rise, altered hydrology, and habitat migration in tidal marshes of New Hampshire.

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TRENDS IN TOTAL DISSOLVED NITROGEN CONCENTRATIONS AND LAND USE IN THE IPSWICH AND PARKER RIVER WATERSHEDS

Nitrogen processes and abundance in watersheds are known to be affected by increasing urbanization and development. Correlations have been shown between increased nutrient export and impervious surface coverage. Ratios of dissolved organic nitrogen (DON) to total dissolved nitrogen (TDN) have been linked to percent cover of wetlands and developed land in watersheds in the northeastern region of the US. Ongoing measurements of nutrient concentrations have been recorded for three major watersheds draining into Plum Island Sound, northeastern Massachusetts as part of the Plum Island Ecosystems - Long Term Ecological Research project. Grab samples taken monthly at sites on the Parker, Ipswich, and Rowley rivers, have been analyzed for ammonium nitrogen, nitrate, and TDN. While ample focus has been attributed to watershed dynamics within the larger Ipswich river basin, less data has been published regarding the adjacent Parker watershed. Trends in data over the previous 15 water years will be presented for annual volume weighted means of TDN, ammonium nitrogen, nitrate, and calculated

dissolved organic nitrogen along side of changes in land use for both the Parker and Ipswich watersheds.

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VEGETATION RESPONSE TO PREDICTED INCREASED TIDAL MARSH INUNDATION IN NORTHERN NEW ENGLAND BRACKISH MARSHES: A PROPOSAL

Brackish marsh vegetation distribution is strongly controlled by its hydraulic regime, and is likely to be impacted by climate change and sea level rise due to changes in the periodicity and magnitude of freshwater and salt water inputs. With increases in sea level, shifts in dominant marsh species would be expected, altering typical brackish marsh plant diversity and moving these systems towards saltier marsh vegetation. Yet little is known about the effects of these hydraulic regimes on brackish marsh floral communities in northern New England. Quantifying vegetation response in these systems to hydraulic factors such as inundation and salinity will lead to stronger predictions of change when considering long-term protection and conservation of these fragile habitats. The goal of this study is to construct a model as a guide for predicting vegetation response to climate change along a brackish gradient using experimentally obtained information on plant responses to different inundation and salinity regimes.

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CURRENT RESEARCH IN THE MARSH RIVER SYSTEM

The Sherman Marsh Restoration Project is an on-going effort where University of Southern Maine is partnering with Maine Department of Transportation to restore the marsh habitat along Route 1 at the former Sherman Lake in Newcastle, ME. Since 2006, graduate students at the University of Southern Maine have helped to monitor vegetation and hydrologic change in Sherman Marsh and adjacent marshes in the Marsh River system. Currently, research is focusing on assessing ecosystem functionality using arthropod food webs. This involves describing arthropod distribution in the affected salt marsh in relation to associated common salt marsh plants. Arthropods were collected in the summer of 2009 and are being identified and processed for stable isotope analysis of ^{13}C and ^{15}N. These data will be used to describe food web structure (i.e., what arthropods are found where) and function (i.e., how primary production is passed through the food web). Starting in May 2010, we will begin quantifying brackish vegetation response to inundation in this system. This project will allow stronger predictions of vegetation

change in the face of climate change, and expand the current knowledge of salinity tolerance of plants growing in northern New England estuaries. These new projects will add critical information to on-going efforts for the Sherman Marsh restoration project.

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HUMAN MODIFICATION OF PHYSICAL GRADIENTS IN NEW ENGLAND TIDAL MARSHES

Natural gradients are important in governing the distribution of plants within salt marshes. The harsh physical conditions characteristic of the low marsh (i.e. high salinity and flooding frequency) gradually lessen to more benign conditions at the upland edge (i.e. low salinity and flood frequency), which leads to recognizable patterns in the plant community. We examined whether berms, defined as earthen barriers that obstruct high tides and impede drainage, interfere with the natural physical gradients in salt marshes. Humans have built berms in marshes for a variety of reasons. This study investigates the pore water and soil dynamics of four berms, which vary in origin but are all orientated parallel to the creek edge. We hypothesized that due to reduced saline flooding and trapped freshwater inputs, the area on the landward side of the berm would be fresher than the seaward side. Also, salinity in reference marshes (no berm) would be significantly higher than berm areas where flooding is restricted. Surprisingly, the seaward and landward areas of the berm do not vary greatly in terms of physical properties and salinity did not differ significantly. Furthermore, salinity was generally higher in the area landward of the berm than in the high marsh reference plots. Based on our findings, both hypotheses must be rejected. With increased understanding of the pore water and soil variables that influence marshes, the impact of berms on natural marsh gradients and plant communities can be assessed and used to plan for sea level rise.

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SUSTAINING QUALITY OF PLACE IN THE SACO RIVER ESTUARY THROUGH COMMUNITY BASED ECOSYSTEM MANAGEMENT

This project, part of the Maine Sustainability Solutions Initiative, brings together the social and natural sciences to tackle the long-term goal of sustaining the structure and function of the Saco River estuary. The Saco River watershed is the largest in southern Maine, encompassing more than 1,500 square miles. We use social science methods to understand management and policy challenges, and to examine the existing gaps in scientific knowledge required to address these challenges. Phase I of the project also focuses on developing ecological indicators that reflect impacts to the estuary from coastal development along the river’s shoreline and in the watershed, and on ways to mitigate these impacts. This project uses community based ecosystem management as an interdisciplinary approach to connect the values of communities with the health of the estuary. Research science collaborators, stakeholders and students engage in an on-going collaborative process to develop shared goals for sustaining quality of place and ecosystem health.

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LEAF REDDENING IS CAUSED BY ANTHOCYANINS, MODIFIES PLANT PHYSIOLOGY AND MORPHOLOGY, AND SERVES A PHOTO-PROTECTIVE ROLE IN *THALASSIA TESTUDINUM*

Leaf reddening occurs in at least fifteen seagrass species from the intertidal and shallow subtidal waters of the Tropical Atlantic, Tropical Indo-Pacific, and Temperate Southern Oceans bioregions, but the ecology and physiology of leaf reddening is poorly understood. To develop an understanding of the reddening process in seagrass leaves, we identified the molecules responsible for red coloration in *Thalassia testudinum* and compared physiological and morphological attributes of *T. testudinum* with red leaves to *T. testudinum* with green leaves. We determined four anthocyanin molecules are responsible for red coloration in *T. testudinum*. In addition, we documented physiological, morphological, and structural differences between green and red plants. Red *T. testudinum* plants had higher concentrations of photo-protective pigments (anthocyanins, UV-absorbing compounds, and carotenoids), higher values of $\Delta F/Fm'$ (photosynthetic efficiency) at high irradiances, and shorter, thinner, and lighter-weight leaves than green *T. testudinum* plants. Red patches of *T. testudinum* had shorter canopy height, smaller leaf area index, and lower percent cover compared to green patches. Our results demonstrate that leaf reddening in *Thalassia testudinum* is caused by high concentrations of anthocyanins, modifies plant physiology and morphology, and serves a photo-protective role in this species by preventing down-regulation of photosynthesis during periods of high light stress.

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EELGRASS IN TAUNTON BAY 1955-2009, FEATURING THE GREAT DIEBACK OF 2001: WHY DID IT HAPPEN?

Eelgrass (*Zostera marina*) in Taunton Bay, Maine, exhibits variability decade-to-decade. In a single year, 2001, it abruptly died back 90% in both spread and density for unknown reasons. Possible factors affecting the rapid decline were thought to include wasting disease (*Labyrinthula zosterae*), turbidity, wind speed and direction, cloud cover, air temperature, water temperature, herbicide pollution, ice scour, depleted subaqueous soil

nutrients, toxic runoff from blueberry barrens, and salinity. This presentation, based primarily on aerial photographs taken between 1955 and 2009, summarizes the author's eight-year effort to piece together the circumstances that led to this localized eelgrass dieback and, in addition, its uneven recovery in subsequent years. The methodology used in this study relies heavily on the author's personal field observations in what he calls "total immersion" in the problematic situation. This is not a scientific study in the traditional sense so much as an experiential exploration relying heavily on human consciousness to match its characterizations and understanding to patterns it perceives in sensory phenomena. When the balance in awareness is judged to be appropriate to the problematic situation, the resulting conclusion about the cause of the dieback is more a product of aesthetic approval of cohesiveness than rigorous statistical analysis. The two routes to discovery are presented as being alternative means for advancing human understanding of environmental events and anomalies. The author's conclusion is that extremely low rainfall in 2001 caused Taunton Bay to be unusually saline, allowing wasting disease to thrive, leading to the abrupt dieback in that year.

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ESTIMATING ELEVATION CHANGE AND ACCRETION RATES FROM SURFACE ELEVATION TABLES AND MARKER HORIZONS AT PLUM ISLAND ESTUARY

The elevation of salt marshes is maintained in equilibrium with sea level by organic matter and mineral sediment accumulation. Surface Elevation Tables (SETs) measure long-term elevation change that is affected by both surface and subsurface processes. Marker horizons (MHs) are used in combination with SETs to measure vertical accretion. At the Plum Island Long Term Ecological Research Project in Rowley, MA we have taken semi-annual measurements on 12 SETs and marker horizons for 7 years, and an additional 6 SETs and marker horizons for four years. There are three SETs and MHs at six locations along the Rowley River, where *Spartina alterniflora* and *Spartina patens* are the dominant vegetation. Our results show accretion rates to vary between 1-10 mm per year, with some sites showing shallow subsidence. These data on physical processes that affect coastal wetland elevation may be useful in predicting ecosystem response in salt marshes, particularly to the increasing rate of sea-level rise.

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MARSH LUNACY - THE ROLE OF THE METONIC CYCLE IN TIDAL WETLAND VEGETATION CHANGE.

Miller & Egler (1950) described the erosion of the upland edge at Barn Island in 1947 and suggested that mowing and grazing caused the loss of vegetation and peat erosion and the upland edge. This phenomenon was termed the "eroded edge" and but they went

on to describe a vegetation cycle. This cycle repeats every ~20 years and is likely due to the natural tidal cycle known as the metonic or lunar nodal cycle. The tidal range increases by 6 centimeters in the first half of the cycle and then decreases in the second half. It is hypothesized that as the tide range increases, the marsh is building peat at a faster rate and as the tide range decreases, the peat becomes aerobic and starts to decompose. However, only at the upland margin of the tidal wetland, does the peat 'erode'. At the Brucker marsh section of Barn Island, the peat has eroded exposing the original outwash sands. This peat is likely the new peat that formed since the 1983 erosional event and had thickness of approximately 8 centimeters. Is there a period of marine transgression followed my marine retrogression? The edge is widest where the substrate is outwash sands (narrow adjacent to till) suggesting that the groundwater and not surface water runoff is the source of peat erosion. While peat erosion is restricted to the upland margin, long-term vegetation data suggest cycles of vegetation change on the high marsh. The waxing and waning of *Salicornia bigelovii* may represent that alternating periods of wet versus 'dry' periods.

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CAN WE ASSUME A CONSTANT RELATIONSHIP BETWEEN MASS AND VOLUME OF ORGANIC MATTER IN TIDAL SALT MARSH SOIL?

The accumulation of organic matter is important to the vertical accretion rates of tidal salt marshes. When assessing the contribution of organic matter to vertical accretion, many researchers assume the relationship between organic matter mass and volume is constant, with a conversion of 1.14 g to 1 cm^3. In this study, we test the validity of this assumption, with respect to fresh roots and rhizomes. Roots and rhizomes were extracted from ingrowth cores deployed in the high marsh of three different sites. The marsh at Kouchibouguac National Park, on the New Brunswick coast of the Gulf of St. Lawrence is microtidal. Our second site at Isle Verte in the St. Lawrence River estuary (in Quebec) is mesotidal. Our third site is at Dipper Harbour, a macrotidal marsh on the New Brunswick coast of the Bay of Fundy. We measured root volume by displacement, and compared that to the mass of root organic matter. Our analyses show there is a significant linear relationship, but that the conventionally used conversion factor underestimates the contribution of belowground production to salt marsh vertical accretion. Additionally, the relationship varies with marsh and probably nutrient status, which challenges the use of a constant conversion factor for equating mass to volume.

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THE LOOMING EELGRASS CRISIS

Eelgrass on the east coast of the U.S. and Canada is experiencing a silent and increasing crisis. While we study it, measure it, and even restore it, eelgrass habitat is being degraded by the loss of water clarity from increasing human populations and watershed development. Nitrogen (N) enrichment and sediment loading are the two main factors causing eelgrass loss, with direct physical damage a lesser and localized impact. Using the Great Bay Estuary (GBE), NH-ME, as an example of eelgrass loss, we see disappearance of deeper beds, thinning of intertidal meadows, and increasing macroalgal invasion with overall eelgrass biomass in the GBE down 50% in the last decade. Nitrogen inputs are wastewater treatment plants (31%) and non-point sources including atmospheric deposition (65%). Sediment loading results from development and increased impervious surfaces. None of this is rocket science – or new. We know what happened in Chesapeake Bay in the 1970s and Waquoit Bay in the 1980s. As we track eelgrass loss northward, we are challenged to take action before further resource loss is unavoidable. The development of N criteria for the GBE (based on levels that support eelgrass survival) requires a 50% reduction in N inputs to the estuary, a huge environmental and political challenge. How to proceed?

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SEASONAL CHANGES IN ZOOPLANKTON DISTRIBUTION IN DORCHESTER BAY WITH REGARDS TO THE NEPONSET RIVER IN-FLOW

Within Massachusetts Bay, Boston Harbor is an embayment greatly infuenced by the adjacent urban environment and three major rivers. The harbor and the bay interact through frequent, high volume flushing as the harbor experiences and average tide of 2.7m. These factors have a heavy influence on the local zooplankton. The purpose of this study is to observe and quantify the seasonal changes in zooplankton biomass and distribution in Dorchester Bay as influenced by the Neponset River, and to relate these changes in abundance to observed temperature, salinity, and chlorophyll concentration. Our sampling for 60um-180um and 180um and larger zooplankton occurred bi-weekly at three locations of varying riverine and ocean infuence. This analysis is part of a larger study with the goal being to understanding the controls on plankton dynamics in Dorchester Bay and to model possible changes from climate change.

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FOLLOWING THROUGH: INDICATORS IN THE GULF OF MAINE

In 2009 the Gulf of Maine Council's Ecosystem Indicator Partnership (ESIP) concluded a thorough investigative and discussion process which resulted in the selection of twenty two priority indicators for the Gulf of Maine. The indicators were selected to assist in assessing the state of the Gulf of Maine with respect to aquaculture, aquatic habitats, coastal development, climate change, contaminants, eutrophication, and fisheries. A concentrated effort on the part of ESIP's volunteer members and data providing organizations has resulted in the completion of initial analysis for the following indicators: aquaculture economic value, production and area for aquaculture sites, distribution of eelgrass, employment density, population density, location of point sources, sea level change, precipitation trends, air temperature trends, nitrogen loading, and dissolved oxygen. Data for the indicators is available through ESIP's Indicator Reporting Tool (www.gulfofmaine.org/esip/reporting). This innovative tool allows users to easily locate and graph datasets from multiple organizations which in turns allows the user to compare indicators across the Gulf of Maine. In addition, fact sheets are due to be released this year for aquaculture, aquatic habitats, climate change, and eutrophication. By providing multiple avenues for obtaining status and trend information for the region, ESIP has gone a long way towards assisting individuals and organizations to evaluate the health of this large and productive watershed that stretches from Cape Cod, Massachusetts to Yarmouth, Nova Scotia.

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HOW DO WE ASSESS THE SUSCEPTIBILITY OF SALT MARSHES TO COASTAL SQUEEZE?

Increased rates of sea level rise that accompany global warming are likely to cause loss of seaward marsh edges. If salt marshes are to exist they must migrate inland. However, urban development and the slopes of adjacent land will prevent inland migration of some marshes, subjecting them to a coastal squeeze. If funds are limited, then investments in conservation and restoration of marshes should consider the threat of coastal squeeze, to maximize the potential for sustainability of the habitat. We evaluate the resources available to assess threats of coastal squeeze on the Gulf of Maine and present a scheme for ranking salt marshes based on their susceptibility to coastal squeeze. For demonstration we use marshes selected from the Gulf of Maine Council's Habitat Restoration Database.

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IN SITU DETECTION OF ZOOPLANKTON FLUORESCENCE IN DORCHESTER BAY, BOSTON HARBOR.

Zooplankton have been found to excrete fluorescent organic material (Peak Z) both in the laboratory and in the field. We modified a fluorometer to detect this material and began testing the fluorometer in the waters off the dock at the University of Massachusetts Boston. Vertical profiles were conducted throughout October during the end of the fall phytoplankton bloom and will be conducted in April during the spring bloom. Analysis of the autumn data, showed some initial small subsurface peaks while later casts had little detectable Peak Z fluorescence. This agrees with earlier work conducted using discrete water samples. An examination of the zooplankton community showed few mesozooplankton copepods but high concentrations of polycheate worms and microzooplankton. Previous work with discrete water samples has shown Peak Z in the water during the spring. This will be tested using the fluorometer. This is preliminary work on the testing of the fluorometer to detect zooplankton derived Peak Z.

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LONG-TERM PHYTOPLANKTON AND ZOOPLANKTON DISTRIBUTION IN DORCHESTER BAY WITH REGARDS TO THE NEPONSET RIVER IN-FLOW

Boston Harbor is an urban marine environment that has many direct relationships to terrestrial inputs. There are three major watersheds that flow into the harbor which includes: the Mystic, the Charles, and the Neponset Rivers all of which directly affects the characteristics of coastal ecosystems in the region. Our case study focused on the influence of the Neponset River on Dorchester Bay a small embayment located in the southwestern corner of Boston Harbor. We were examining the seasonal and inter-annual changes in chlorophyll, salinity, and temperature and mesozooplankton composition. As part of a long-term monitoring program at UMASS Boston, we were sampling bi-weekly for chlorophyll size fractions (>8.0 µm and total chlorophyll), temperature, salinity and mesozooplankton collected with vertical net tows. The main objective was to record observed surface chlorophyll, salinity, and temperature within the Dorchester region of the bay and compare those findings to historical observations obtained from the MWRA buoys 140,100, and 41. The objective is to learn about seasonal and inter-annual fluctuations in plankton concentrations and to begin to examine how freshwater inputs could influence bi-valve larvae distribution.

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DOES GROUNDWATER FLOW CONTROL SURFICIAL SALT MARSH POOL MORPHOLOGY? A CASE STUDY FROM GRAND MARSH, GOULDSBORO, ME

In form, salt pools (shallow, water-filled depressions common to north-temperate salt marshes) resemble open-water features from other landscapes, like flarks found in northern peatlands. Studies suggest that groundwater can play an important role in the maintenance of flarks, yet no previous work examines its role in the creation or maintenance of open-water features in salt marsh environments. In 2008, we installed shallow (about 1 m depth) and deep (about 2.5 m depth) groundwater wells in 14 locations in Grand Marsh, Gouldsboro, ME to investigate how groundwater flow paths relate to surficial pool morphology, specifically pool necks (distinct, elongate, open-water features that extend from the main pool body). Hydraulic potentials indicate that horizontal movements of shallow and deep groundwater generally align with measurements of neck orientation and that vertical flow paths reveal up-welling of shallow groundwater to open-water features, suggesting a connection between groundwater and the surficial expressions of pool and neck morphologies. While provocative, our study is data limited and only the first step toward understanding potential groundwater control of open-water features in northern salt marshes.