

NEERS Spring 2000 - Abstracts

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GIS MODELING OF WAVE EXPOSURE AND HABITAT SUITABILITY FOR EELGRASS RESTORATION IN NEW BEDFORD HARBOR, MASSACHUSETTS.

Exposure to wave energy has a dramatic effect on bottom sediments and organisms that reside there. In an area such as New Bedford Harbor, MA, the impact of wave energy on the nearshore habitat is very difficult to measure due to the irregular shoreline shape. The U.S. Army Corps of Engineers developed a method to rate wave exposure based on fetch measurements from any given point. Using a variation of that method developed by Murphey and Fonseca (1995) as input to a Geographic Information System (GIS), exposure was calculated for the entire New Bedford Harbor area. Local wind data was collected and summarized to determine average velocity and percent occurrence for the eight major compass headings. Effective fetch, the average of nine cosine weighted fetch measurements, was then calculated for each of these compass headings. The wind data was used to weight the effective fetch measurements and determine exposure, providing a rating of wind stress on eelgrass beds. The exposure information was then combined with existing eelgrass distribution data to identify the optimal habitat conditions where eelgrass currently grows. This information was then used to rate potential sites for transplant suitability.

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IMPACTS OF *PHRAGMITES AUSTRALIS* INVASION AND CONTROL IN BRACKISH TIDAL WETLANDS: PATTERNS AND COMPOSITION OF SEDIMENT DEPOSITION

This study addresses the impact of *Phragmites australis* expansion within brackish tidal marshes on sediment trapping and deposition from flooding tidal water. Sediments were collected on ashless filter paper during the summer of 1999. Sampling was at nine sites along a ca. 1 km reach of the Lieutenant River, a sub-estuary of the Connecticut River, three each in areas dominated by *Phragmites*, un-invaded *Typha* and *Spartina patens* meadow, and in experimental *Phragmites* control sites now restored to brackish meadow vegetation. At each location sediment traps were deployed six times from June to September at creekside (0 m), on the levee (10m) and central high marsh (30, 35 or 60m); sampling periods varied from 4 to 6 days and 8 to 12 flooding events. Elevation, flooding frequency and flooding duration were determined for each trap site. Collected and calculated data included total deposition, % organic matter, and sedimentation rates expressed as mg hr flooded⁻¹ and flooding event⁻¹. For all sites and for low and high marsh locations considered separately, flooding duration was a better predictor of total sedimentation than flooding frequency. Sedimentation rates were significantly greater in low marsh (0 m) than high marsh sites; there were no rate differences between low marsh *Phragmites* and *Spartina alterniflora*; deposition in *Phragmites* was similar to other vegetation types, while in areas of *Typha*, deposition was greater than in *S. patens*. Organic content was less in low marsh than high and within the low marsh, greater in *Phragmites* than *S. alterniflora*; organic content of high marsh *Phragmites* and *Typha* sediments were similar and less than from *S. patens* and restored meadow sites.

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EFFECTS OF URBAN RUNOFF ON THE INVERTEBRATE COMMUNITIES OF NATURAL AND CREATED SALT MARSHES IN PORTSMOUTH, NEW HAMPSHIRE

Salt marshes created as mitigation are often adjacent to impacts from development, in urban areas subject to freshwater inputs carrying pollutants from streets, combined sewer overflows, and industry. Faunal use of created salt marshes is not well documented, and little has been published about the effects of urban runoff on the fauna of created marshes. To compare the effects of runoff on invertebrate communities, epibenthic macroinvertebrates were sampled in 10 marshes in Portsmouth, New Hampshire. Four created and 6 natural marshes were studied. Half of the marshes of each origin (2 created, 3 natural) are subject to runoff from storm drains, and half are distant from outfalls. Litterbags composed of 5-mm mesh were filled with 50 g each of *Spartina alterniflora*, *Zostera marina*, and macroalgae, and placed in the marshes for two one-month periods in summer 1998. A total of 200 litterbags trapped 11,829 individuals of 24 highly stressed urban setting were found to be similar. More invertebrates were trapped in both natural and created marshes influenced by stormwater runoff, with the greatest abundance closest to outfalls. Near outfalls deposit feeders dominated assemblages, while samples distant from sources of runoff were dominated by shredders and grazers. Changes in the pathways available for energy flow in the community appear to influence faunal assemblages in marshes near outfalls. Such changes may influence trophic transfer of energy from salt marshes to coastal ecosystems. These findings indicate that proximity to outfalls should be considered when selecting mitigation sites and assessing their fauna.

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SALT MARSH VEGETATION RESPONSE TO INCREASED TIDAL FLUSHING IN IPSWICH, MA: ONE YEAR POST RESTORATION

Argilla Road Salt Marsh in Ipswich, MA has been degraded by a culvert sized too small to allow adequate seawater to flood the marsh at high tide. As a result of lowered salinities and less extensive flooding, the invasive grass, *Phragmites australis*, replaced natural salt and brackish marshes in many sections of this marsh. In late fall 1998, we replaced the old 36 inch diameter culvert with an eight x five foot box culvert, thus increasing the amount of water flushing the marsh by about six fold. After one year, average *Phragmites* heights were reduced, groundwater salinities were higher, and the spatial cover of *Phragmites* has been reduced. At this point, however, we cannot attribute these changes solely to the increased tidal flushing resulting from our restoration, since *Phragmites* growing nearby at a marsh where no changes in tidal regime occurred, were also shorter on average in 1999. We attribute the general decline in *Phragmites* heights in 1999 compared to 1998 to the extremely dry spring and summer, which led to higher salinities and poorer growing conditions for *Phragmites* regardless of any alterations. Similarity indices were used to compare differences over time between the altered and control marshes. Despite the striking visual appearance of decline, it will likely take several years before we can detect a difference statistically in *Phragmites* as a result of our restoration.

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CHEMICAL ANALYSIS OF ANTHROPOGENIC HEAVY METAL CONTAMINATION AND ITS RELATION TO LAND USE IN TWO MAINE SALT MARSHES

Vibracores 2m in length were taken from two salt marshes in Wells and Phippsburg, ME, in order to examine the differences in modern anthropogenic pollution trends between a developed site and a relatively pristine one, and to relate such trends to the land use histories of each area. Sediments were dried to a constant weight, ashed, and digested in aqua regia, and concentrations of Cu, Fe, Mn, Pb, and Zn were determined using Inductively Coupled Plasma Emission Spectroscopy (ICP). ^{210}Pb dating was used to examine the recent temporal patterns in the metal concentrations. A second preparation technique was also used for 6 samples selected from throughout the Wells core to compare the results between the methods. Samples prepared by drying to a constant weight, passing through a 250 μm sieve, and digesting with a solution of aqua regia and H₂O₂ had metal concentrations 55 % lower on average than the first preparation technique. In the Wells core, concentrations of all metals more than doubled in the top 20cm of sediment. When standardized against Fe as a proxy indicator of sedimentation rate and sediment composition, however, Pb was the only metal that exhibited enrichment in the top 20cm of the sediment column. Results suggest that wastewater and industrial effluents have not had a major impact on the marsh. The Pb concentration profile, however, exhibits a pattern of surficial enrichment that closely correlates with modern anthropogenic inputs to the marsh, including runoff from major roads in the watershed and automobile emissions.

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HYDROLOGIC AND CHEMICAL CONTROL OF PHRAGMITES GROWTH IN TIDAL MARSHES

The roles of hydrology and sediment chemistry on relative positions of *Phragmites* and *Spartina alterniflora* stands were investigated in three marshes along the estuarine salinity gradient of the lower Housatonic River in western CT. Continuous water table measurements and monthly analyses of porewater ammonium, phosphate, sulfide and salinity were completed along triplicate transects grading from pure *Phragmites* stands, through *Phragmites/Spartina* mixed stands, and into pure *Spartina* stands. Although slack low tide water table depth was not different between the *Phragmites* and *Spartina* stands, the total water table change and flooding duration were higher at the *Spartina* and mixed stands relative to the *Phragmites* stands. Flooding depth in *Phragmites* stands at the lowest salinity site was greater than flooding in other *Phragmites* stands down the salinity gradient, suggesting that *Phragmites* is more tolerant of flooding at low salinity. Porewater hydrogen sulfide and ammonium were consistently highest in the mixed vegetation stands which coincided with the shallowest water table depth. Although *Phragmites* shoots were shorter in the mixed stands, no other measures of plant vigor (stem density, leaf carbon and nitrogen content) were different from pure *Phragmites* stands. Because of its extended tolerance to flooding in less saline water, opportunities for controlling *Phragmites* growth via manipulation of wetland hydrology decrease with distance up the estuarine salinity gradient.

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DEVELOPMENT AND USE OF A PASSIVE COLLECTOR TO SAMPLE MOBILE INVERTEBRATES IN RHODE ISLAND SALT MARSHES

Understanding how invertebrate communities respond to habitat changes requires background data. As part of a larger study of six Rhode Island salt marshes, I designed and tested a passive sampler, a pit trap, to collect mobile benthic invertebrates. Pit traps were 7.5 cm diameter by 60 cm long, constructed of rigid PVC pipe, contained approx. 10% formaldehyde and were allowed to sample for one week. I placed pit traps in subtidal soft sediment habitats and sampled each salt marsh with equal effort (8 traps per marsh). Samples were collected during late spring and late summer. A diverse fauna was present in the traps with seven phyla collected in spring and six collected in summer. Crustaceans, especially decapods, were found in all marshes and were abundant during both periods. Mean size of the green crab, *Carcinus maenus*, decreased during sampling which may suggest movement to, or from, the marshes. Invertebrate community diversity (Shannon-Weaver) differed significantly during each period with one marsh, Coggeshall marsh, having consistently high diversity. Bray—Curtis similarities were used to determine the organisms which contribute most to within marsh similarity. In many of the marshes the presence of crustaceans, especially shrimps, crabs and harpacticoid copepods, were determined to enhance within marsh similarity. Although pit traps are effective invertebrate samplers, they should be used with caution because they failed to collect at least one prominent member of the invertebrate marsh community: fiddler crabs from the genus *Uca*.

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THE SETTLEMENT AND POPULATION MAINTENANCE OF *CYANEA* SP. SCYPHISTOMA IN RELATION TO THE DISTRIBUTION OF MEDUSAE IN THE NANTIC RIVER, CT, USA

Scyphozoan jellyfish are seasonally conspicuous in coastal waters, but relatively little is known about the factors that control their distribution and population dynamics. *Cyanea* sp. is a cosmopolitan species that is seasonally present in great abundance in the Niantic River, CT, USA. In order to get a better understanding of the factors controlling medusan abundance and distribution we examined the temporal and spatial distribution of settled scyphistoma in relation to that of the medusae. Both temporally and spatially scyphistoma settlement patterns were closely related to the presence of mature female medusae. In addition, the scyphistoma exhibited a strong vertical distribution pattern, primarily settling near the bottom. After settlement, planula cysts or polyps were out competed by large barnacle and ascidian sets resulting in a sharp decline in polyp population abundance. These findings should give insight into likely locations of medusan seed populations.

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DO ANEMONES MOVE? A STUDY OF THE MOVEMENT PATTERNS OF *BUNODACTIS STELLA* AND *TEALIA FELINA* IN ANEMONE CAVE, MT. DESERT ISLAND MAINE.

To what degree, if at all, are Actinaria (Cnidaria: Anthozoa) mobile? Anemones are typically seen as sessile organisms. Solitary attached anemones are columnar with an adherent pedal disk at the base and an oral disk with rings of tentacles circling the mouth. Scattered information in the literature shows that anemones are not always sedentary but instead may temporarily or permanently live loosely attached, detached, or even move pelagically. Efforts have been made in the past to study the degree to which anemones move, but these have been in a laboratory setting or in a contrived manner. In this study, research was conducted in Anemone Cave in their natural habitat without molestation and found that they move over long periods of time. However the anemones primarily remain stationary or move in conjunction with asexual reproduction. A statistical analysis of the results will be presented.

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A COMPARATIVE STUDY OF TWO TIDALLY RESTRICTED MARSHES TO A NATURAL UNDISTURBED SALT MARSH IN OLD ORCHARD BEACH, ME.

Following a 1996 flood, two flapper gates were installed at the request of Ocean Park, ME residents. Citizens concerned with the health of the impacted salt marshes asked us to monitor the effect of the tide gates on the marshes. Our objective was to compare certain structural and functional attributes of marsh ecology at two restricted marshes and one natural site found outside the tide gate. We compared marsh characteristics such as soil salinity, above ground biomass, percent soil organic matter, and elevation using eight random quadrats in each site. We also compared creek salinity and plant diversity between the three sites. From our study we found that there was a significant difference in mean soil and creek salinity between the restricted site furthest from the tide gate and the natural site. Above ground dead biomass was significantly greater in the two disturbed marshes than in the natural site, however, no we found no significant difference in the live above ground biomass in the three sites. We found no significant difference in the average percent soil organic matter at each site. The elevation on the furthest restricted site was notably higher than the other two sites. The two disturbed sites had greater species richness as well as a greater percentage of upland species while the natural site had fewer total species but a greater percentage of obligate wetland species. From our results and study we have found that the tide gates have had a significant impact on the restricted Ocean Park marshes. These results support what has been observed in other tidally restricted marshes throughout New England.

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EFFECT OF CLAY SUSPENSIONS ON CLEARANCE RATE IN THREE SPECIES OF BENTHIC INVERTEBRATES.

Recent attempts are being made, especially in Asia, to displace harmful algal blooms by spraying fine particulate mineral suspensions (e.g. "china clay") over the surface of affected coastal waters. In practice, the particles adsorb onto the surface of the algal cells, promoting coagulation and displacement to the bottom. Very little is known, however, about the impact of this technique on benthic communities and processes. To examine the effects of differing concentrations of china clay on clearance rate, short-term laboratory experiments were performed on three benthic species: the bay scallop (*Argopecten irradians*), the eastern oyster (*Crassostrea virginica*), and a hydroid (*Obelia* sp). Colleagues in Korea furnished us with the china clay used in their field trials. Depletion rate assays were performed using solutions of 10, 100, 1000, or 10,000 mg/l of china clay suspended with *Rhodomonas lens* (2.5 x 10⁴ cells/ml) in 0.4 Fm filtered seawater. Particle concentrations and size distributions were determined using a Coulter Multisizer. Results showed a decrease in weight specific clearance rates with increasing concentrations of clay. Both the oyster and the scallop showed a slight increase in particle clearance at 100 mg/l. These results strongly suggest that further studies are required to determine the full effects of this clay-coagulation practice on the benthos.

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EFFECTS OF SEA LETTUCE ON INTERTIDAL SAND FLAT COPEPODS IN JAMAICA BAY

The effects of *Ulva* biomass on interstitial copepods in a Jamaica Bay sand flat adjacent to a fringing salt marsh were studied from midjuly through October, 1999: Three treatments were established: *Ulva* present (UP), *Ulva* removed (UR), and Unvegetated (UV.) 18 species were identified from core samples. Mean sample species richness (SR) increased from 1.6 spp at the UP site to 3.29 spp at the UV site. Copepod densities increased from 9.7 (UP) to 28 per 20 cm⁻² at the UV site. The overall effects of *Ulva* accumulation were a 52% and 65% reduction respectively in SR and abundance. SR and density were lowest in late summer, especially at the UP and UR sites. This is correlated with diurnal patterns in DO; periods of anoxia lasting up to 16 hrs per night and morning were recorded within the *Ulva* mat. Traps were deployed to sample the emergence of copepods on flood tides. Lowest rates occurred at the UV site. This study suggests that sea lettuce-related degradation of the shore environment could affect resident fish species (e.g. *Fundulus majaii* which, as post-larvae (<20 mm,) are obligate consumers of copepods.

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THE EFFECTS OF MICROTOPOGRAPHY ON EELGRASS (*ZOSTERA MARINA* L.) PRODUCTION AND MORPHOLOGICAL CHARACTERISTICS

We monitored plant characteristics and production of eelgrass, *Zostera marina* L., at the intertidal Fishing Island eelgrass meadow in Kittery, Maine, between March 1999 and April 2000. Groups of eelgrass shoots were pinned within the leaf sheath every month at two sites 50 m apart: Fishing Island East (HE) and Fishing Island West (FIW). Sites were similar except for small differences in water depth (< 0.25 m), which resulted in greater intertidal exposure at FIW during extreme low tide periods. As a result of this microtopography, there were important differences in several eelgrass morphological characteristics, including average leaf length and width, sheath length, shoot production, and plastochron between the two sites. Eelgrass leaf and sheath length at HE, the less exposed site, were larger throughout the study and reached their maximum dimension two months earlier than FIW. In addition, maximum shoot growth at HE occurred in June, two months earlier than the more exposed FIW. Larger shoots at FIE allowed greater daily growth per shoot through the spring and summer, but growth at both sites was similar throughout the fall and winter. The leaf plastochron followed a similar pattern between sites throughout the year, but during the spring and summer new leaves were produced faster at

FIW. Surprisingly, this small difference in intertidal microtopography affected plant morphology and overall site production between HE and FIW and elucidate an important factor controlling eelgrass production throughout the intertidal Fishing Island eelgrass meadow.

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AN IDENTIFICATION MANUAL TO THE COASTAL AND ESTUARINE ZOOPLANKTON OF THE GULF OF MAINE REGION

This new manual uses tabular style keys, large illustrations and text descriptions, to identify adult holoplanktonic zooplankton to species. All copepoda (calanoids, cyclopoids and harpacticoids), cladocera, ostracoda, chaetognatha and larvacea found in the region can be identified. Identifications are made without the removal of appendages. Instead, identifications are based on external features observed with compound and stereo-dissecting microscopes. Also, the common types of meroplanktonic organisms (e.g., larval stages of invertebrates and fish) are identified using illustrations and text descriptions. The manual consists of two separate parts. Part I contains the text that includes the instructions, identification keys, species descriptions, distributions, methods, glossary and references. Part II contains over 200 large illustrations that show dorsal and/or lateral views of the entire specimen as well as details of various body parts. Both male and female are shown for each species. The intended useful range of the manual is from Passamaquoddy Bay to Long Island Sound, though the maximum useful range encompasses the entire coastal Canadian Maritimes southward to about Delaware Bay.

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SEASONAL PATTERNS OF CARBONATE DIAGENESIS IN NEARSHORE
TERRIGENOUS MUDS: RELATION TO SPRING PHYTOPLANKTON BLOOM AND
TEMPERATURE.

Pore water saturation states with respect to calcite and aragonite minerals in Long Island Sound sediments fluctuate from saturated and near-saturated conditions in late fall, to undersaturated during winter, before slowly changing to supersaturated conditions during late spring and summer. Undersaturation occurs during cold, winter periods when lower rates of ECO_2 production (low rates of heterotrophic metabolism) and oxidation of reduced minerals such as FeS lower calcium carbonate saturation states. Higher ECO_2 production rates during warmer periods cause the CO_2 - concentration to become supersaturated for both calcite and aragonite. Direct evidence that dissolution is occurring during periods of undersaturation comes from increases in pore water Ca^{2+} , Sr^{2+} , and F-in excess of overlying water concentrations. In addition, pore water undersaturation coincides with periods of rapid foraminifera disappearance and suggests that benthic forams are a component in the yearly cycling of CaCO_3 in estuarine sediments. Other organisms with carbonate tests, particularly juvenile bivalves, may also be affected by periods of undersaturated pore waters.

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INTERTIDAL INVERTEBRATES IN CASCO BAY: BEFORE AND AFTER THE JULIE N
OIL SPILL

In late September, 1996, the Julie N oil tanker struck the Million Dollar Bridge between Portland and South Portland, Maine and spilled oil into the Fore River region of Casco Bay. A fortnight before the spill occurred, biological and sediment samples were collected from the intertidal mudflats of the Fore River for master's thesis work. Armed with limited pre-spill data, samples were collected one year after the spill and compared with previous data. The results revealed a community that responded in various ways, depending upon the biological level considered. Each species and feeding guild responded in varying ways, not revealing any definitive short-term effects. At the community level though, the results exhibited a potential shift in community structure from a more evenly distributed population to one in which two taxa accounted for over sixty percent of the total population.

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GUT CONTENTS OF MUMMICHOGS, *FUNDULUS HETEROCLITUS* (L.) FROM RESTORING AND UNRESTRICTED REGIONS OF SACHUEST POINT SALT MARSH, MIDDLETOWN, RI

Gut contents of mummichogs, *Fundulus heteroclitus* (L.), from three habitats (creeks, pools, and marsh surface) within restoring and unrestricted regions of Sachuest Point salt marsh were examined. Major diet components were detritus, copepods, diatoms, insects (larvae and adults), ostracods, and chironomids. The percentage of fish that had items in their guts and the percent gut fullness were similar between restoring and unrestricted regions of the marsh. Diet composition and percent abundance of diet items were also similar between the unrestricted and restoring marshes. However, differences in foraging patterns were observed among marsh habitats (creeks, pools, and marsh surface). Samples collected from creeks had the highest percentage of fish with items in their guts (96%), followed by fish sampled from pools (78%) and the marsh surface (69%). Fish from creeks also had the fullest guts, followed by fish from pools and marsh surface. Diet composition also differed among marsh habitats. Fish sampled from the creeks foraged primarily on detritus, diatoms and copepods, whereas fish from the pools foraged on mainly detritus, copepods and chironomids. Detritus, insects and diatoms were most a that restoring New England salt marshes can quickly reach functional equivalency with natural salt marshes in terms of feeding patterns of dominant marsh consumers.

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GROWTH STRATEGY AND DISTRIBUTION OF *PHRAGMITES AUSTRALIS* ALONG ESTUARINE GRADIENT

Recent expansion of common reed (*Phragmites australis*) into tidal marshes of the Northeast U.S. has resulted in significant changes to the plant community and possibly wetland function. Above- and below-ground growth and plant nutrient status of *P. australis* were measured to predict the potential for spread in three marshes along the estuarine gradient of the Housatonic River, CT. Differences in allocation of growth and plant nutrients were also related to environmental variables (salinity, flooding duration, and sulfide). In contrast to higher average flooding depth between *P. australis* stands at the lowest salinity and high salinity sites (24.6 cm; 8.7 cm, respectively), average flooding duration was not significantly different between *P. australis* stands at the lowest salinity site and *P. australis* stands in the high salinity site (21.9%; 17.6%, respectively). Sulfide concentrations were higher in high salinity marsh, where *P. australis* is limited to small, isolated stands, relative to low salinity marsh, where *P. australis* is a near monoculture. The allocation of below-ground resources was lower in expanding *P. australis* stands in the lower salinity marshes. Rhizome characteristics (node length, diameter, number of root and rhizome buds) however, increased as we moved in the direction of decreasing salinity, along the estuarine gradient, suggesting that *P. australis* is allocating energy and resources towards vegetative propagation and expansion. Because of higher porewater sulfide and perhaps higher salinity, we suggest that *P. australis* is merely maintaining existing stands in higher salinity marshes and expanding in lower salinity marshes.

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PHENOTYPIC VARIATIONS IN THE DOG-WHELK, *NUCELLA LAPILLUS*, ACROSS A GRADIENT OF WAVE EXPOSURE IN MAINE, USA

Different phenotypes of *Nucella lapillus*, an intertidal gastropod that exhibits non-pelagic, direct development, were measured across a gradient of wave exposure, ranging from environments with high wave energy (exposed) to environments with low wave energy (protected). Whelks were collected from six sites: three exposed to wave action sites (Pemaquid Point, Long Cove Point, and Giant Stairs) and three protected from wave action sites (Simpson Point, Cobworks Bridge, and Pemaquid Beach). The morphologies of shell shape and banding patterns were measured for all individuals. A dynamometer was used to measure exposure and group sites into exposed shores and protected shores. Whelks from protected shores were significantly larger in overall length than whelks from exposed shores (51.96%). After controlling for the variations in overall shell lengths, aperture lengths and widths were found to vary significantly as a function of exposure. Whelks from exposed shores showed a 11.22% increase in aperture length and a 23.07% increase in aperture width. There was a significant increase in the number of banding patterns that occurred at the exposed shores over the protected shores. Twelve different banding patterns were observed on the whelks from exposed shores and six different banding patterns were observed on the whelks from protected shores. Additionally, banding patterns were found to vary among locations. The variations in shell shape morphologies are largely adaptive: larger apertures offer more resistance to dislodgment at the wave exposed sites; smaller apertures offer greater resistance to increased predation intensities at the protected sites. The mechanism for the variations in banding pattern is still unknown.

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SPECIES RICHNESS INCREASES IN MASSACHUSETTS COASTAL SEDIMENTS.

Soft-bottom benthic monitoring in coastal waters of the Massachusetts Bays system has been carried out annually by MWRA since August 1992. Sampling has been carried out at from 9-20 "nearfield" stations within 5 km of the future offshore outfall in western Massachusetts Bay and at an additional 11 "farfield" reference stations in the remainder of the system. Species richness at relatively shallow nearfield and farfield stations in western Mass. Bay decreased approximately 20% between 1992 and 1993, from an average log-series alpha of 12.7 (1992) to 10.4 (1993). A similar decrease is apparent in average species per grab, which declined from 63.3 to 47.6. Species richness at these sites increased monotonically from 1994-1997, stabilizing in 1997 & 1998 at levels approximately 15% higher than observed in 1992. Species richness at deeper farfield stations remained essentially unchanged between 1992 and 1995, with mean log-series alpha ranging from 11.4 to 12.1. The 92-93 decrease observed in shallow waters can be confidently attributed to widespread sediment disturbance resulting from severe winter storms in December 1992. Causes for the system-wide increases observed between 1995 and 1997- are still under investigation, but do not appear to be related to methodological improvements within the monitoring team, nor from changes in the productivity of the overlying waters or the delivery of organic matter to the sediments.

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TEN YEARS OF GREAT BAY COAST WATCH VOLUNTEER DATA: ANALYSIS OBJECTIVES, PRELIMINARY RESULTS, AND CHALLENGES

Volunteer water quality data has been collected by the Great Bay Coast Watch in New Hampshire since 1990. With ten years of data collection complete, we have now begun a detailed statistical analysis of the database to characterize the Great Bay Estuarine System, and to determine trends in key water quality measures. We will share the preliminary results of this analysis, and discuss the multiple goals, objectives, and challenges of working with volunteer water quality data.

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A SPATIAL STUDY OF SEDIMENT PHOSPHORUS IN PENOBSCOT BAY, MAINE

Grab samples were collected in 1997 from surface sediments throughout Penobscot Bay, Maine. Each of the 71 samples was analyzed for total, inorganic and organic Phosphorus. Phosphorus concentrations were higher near the head of the estuary and decreased towards the mouth. concentrations were also generally higher on the eastern side of the bay. These spatial variations are compared to variations seen in the concentrations of iron analyzed in the same samples by researchers at UNH.

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EFFECTS OF NITROGEN ENRICHMENT ON BIOMASS ALLOCATION, GROWTH, AND LEAF MORPHOLOGY OF THE SEAGRASS *THALASSIA TESTUDINUM*

The effects of sediment ammonium (NH_4^+) enrichment on biomass allocation, growth, and leaf morphology of the seagrass *Thalassia testudinum* in Corpus Christi Bay (CCB) and lower Laguna Madre (LLM), Texas were examined from May to October 1997. Prior studies had shown that shoot height and leaf biomass at CCB were significantly higher than those at LLM and ambient sediment NH_4^+ concentrations in CCB (ca. 100 μM) were significantly higher than those in LLM (ca. 30 μM). It was hypothesized that the differences in plant morphology and biomass between the two areas could be related to differences in sediment nitrogen levels between the two sites. To test this hypothesis, we conducted an *in situ* fertilization experiment at both sites over a six-month period. Results of this experiment revealed that seagrass growth, biomass and leaf size significantly increased as a result of sediment NH_4^+ enrichment at LLM, but had little NH_4^+ enrichment effect at CCB. In unfertilized plots, the average leaf production rate (7.4 g dry wt $\text{m}^{-2} \text{d}^{-1}$) and shoot height (43.3 cm) at CCB were significantly higher than those at LLM (2.5 g dry wt $\text{m}^{-2} \text{d}^{-1}$ and 18.8 cm, respectively). After fertilization, leaf production rates and leaf size at LLM increased to reach equivalent levels to CCB. Leaf biomass at LLM increased significantly as a result of sediment NH_4^+ enrichment, but there was little change in below-ground biomass. The below- to above-ground biomass ratio at LLM (4.7) was about 3-fold higher than that at CCB (1.6) in unfertilized plots, but decreased significantly with sediment NH_4^+ enrichment, while the ratio at CCB remained unchanged. We conclude, based on seagrass growth responses to increases in sediment NH_4^+ , that sediment nitrogen availability at LLM limits seagrass productivity. *T. testudinum* responded to limited nitrogen conditions by increasing below- to above-ground biomass ratios.

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COMPARING THREE METHODS FOR ASSESSING FAUNAL ABUNDANCE AND SPECIES DIVERSITY IN EELGRASS BEDS: SEINE, SCUBA, AND REMOTE VIDEO

Three methods were used to estimate species richness and relative abundance of mobile macrofauna in eel grass (*Zostera marina*) beds of the Great Bay Estuary, Maine/New Hampshire. The methods compared were beach seine, visual fast count (VFC) and remote video. The three sampling methods were also compared with regard to precision. The beach seine was 15 x 2 m with 1 cm mesh on the diagonal. VFC is a SCUBA-based census technique used to assess coral reef fish assemblages. The remote video system consisted of a high-resolution, analog camera mounted on a sled, which was pulled along an underwater transect. The camera was connected to a digital video recording system, and the footage was analyzed for fauna in the laboratory. Results indicated that VFC detected significantly more species overall than the beach seine or video ($P = 0.0002$). Due to the high degree of variability of all three sampling methods, no significant differences were found in relative abundance estimates. In considering precision, VFC was significantly better than video ($P = 0.0001$). However, no other differences in sampling precision were significant. Results suggest that to obtain satisfactory precision levels, a larger sampler size (at least 10 repetitions) is needed for all three methods. For two reasons, it is recommended that VFC be used instead of the seine. Because VFC is non-destructive, the high number of repetitions needed for a satisfactory level of precision will not result in damage to the habitat and organisms therein. Secondly, VFC sampled species richness more accurately than the other two methods. Video detected less species than VFC and sampled most organisms with low precision. However, video sampling provides a permanent visual record of the sampled habitat, can allow validation of the species within the habitat, and can be used in habitat mapping as well as public outreach projects. In locations with greater species richness and abundance, video may be a viable option.

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THE CONTRIBUTIONS OF SELECT SUSPENSION FEEDERS TO PRODUCTION OF TRANSPARENT EXOPOLYMER PARTICLES (TEP) IN NEAR SHORE WATERS

In the marine environment, the presence of large, discrete, transparent exopolymer particles (TEP) has been directly correlated with the flocculation of phytoplankton, detritus, and bacteria have both been shown to contribute to the production of TEP, via the exudation of precursor sticky mucopolysaccharides. Little is known, however, about other potential sources of mucins that could lead to TEP formation. The purpose of this research is to identify other potential sources of TEP. Many benthic suspension feeders utilize mucus-coated structures to capture and transport food particles. The working hypothesis of our research is that bivalves and other suspension feeders release significant amounts of mucins into the surrounding water, and that this material enhances TEP production through physico-chemical processes, resulting in increased flocculation of particles. Concentrations of TEP in both the laboratory and field setting are determined using an Alcian Blue staining technique and quantified using a spectrophotometer. Preliminary field data from the Long Island Sound and Bermuda suggest that the presence of TEP, above background levels, is correlated with proximity to blue mussel (*Mytilus edulis*) beds and other suspension feeders, respectively. Additional laboratory experiments are being conducted in order to quantify the production of TEP by bivalves under controlled conditions.

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USING FUNCTIONAL TRAJECTORIES TO MODEL CONSTRUCTED SALT MARSH DEVELOPMENT IN THE GREAT BAY ESTUARY, ME/NH.

A growing number of studies have assessed the functional equivalency of constructed (i.e., created and restored) salt marshes and natural salt marshes. Several of these have explored the use of functional trajectories to model the increase in constructed marsh function over time, however these studies have disagreed as to the usefulness of these models in long-term predictions of constructed marsh development. We compared indicators of four marsh functions (primary production, soil organic matter accumulation, sediment trapping and maintenance of plant communities) in six constructed and eleven reference salt marshes in the Great Bay Estuary (GBE). Because the constructed sites ranged in age from 1- 12 years, we were also able to explore the use of trajectories in modeling functional development. A high degree of variability was observed among natural salt marsh pointing to the importance of including many reference sites in the study. As expected, mean values for constructed site (n=6) and reference site (n=11) functions were significantly different. Using constructed marsh age as the independent variable and functional indicator values as dependent variables, non-linear regression analyses produced several ecologically meaningful trajectories ($r^2 > 0.9$). These models illustrate that although indicators of some functions (primary production, sediment deposition, plant species richness) should reach natural site values relatively quickly (<10 years), soil organic matter content will take 15 years or longer to develop in constructed marshes in the GBE.

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DEVELOPING TOOLS TO PREDICT AND MONITOR EFFECTS OF NUTRIENT ENRICHMENT ON SMALL NORTHEASTERN ESTUARIES: A PROPOSAL

Many estuaries in the northeast are threatened by nutrient over-enrichment and consequent eutrophication, with concomitant losses of biological diversity and habitat value. This spring we are initiating a 3-year project within a small, *Ruppia*-dominated estuary at Acadia National Park to develop tools managers can use to predict responses to nutrient enrichment and detect early changes in ecosystem integrity. We will identify sources and quantify inputs of nutrients to the estuary, measure landscape characteristics within the watershed and relate them to nutrient flux, and use in situ experiments to determine critical thresholds of enrichment resulting in changes in ecosystem structure and function. We will also test the sensitivity and define the variability of various indicators of eutrophication. Expected results include a GIS-based decision support system linking estuarine responses to changing land use patterns, and recommendations for incorporating indicators of ecosystem status into an estuarine monitoring program.

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HAS *PHRAGMITES* EXPANSION IMPACTED NEKTON HABITAT ALONG THE HUDSON RIVER?

Phragmites australis invasion into tidal marshes could influence wetland function. We quantified nekton habitat utilization and associated hydrogeomorphic attributes in *P. australis* and *Typha angustifolia* stands in two tidal marshes along the Hudson River, NY. Lift nets and seines were used bi-weekly to measure nekton density (# m⁻²) on marsh surfaces and abundance in tidal creeks. Surface hydrology was measured using wells instrumented with pressure transducers. Benthic invertebrate prey availability and vegetation density were also measured. A total of 4,143 individuals representing 16 species were caught in the tidal creeks and 422 individuals representing 6 species were caught on the marsh surface. At Piermont Marsh, total nekton density was higher within high elevation relative to low elevation *P. australis* stands despite significantly shallower flooding depth at the high elevation stands. Biomass and density of nekton using the marsh surface at Iona Island were not significantly different across vegetation or elevation treatments. Significant differences between elevations were found in flooding depth and frequency, but not duration, implying that flooding duration regulates habitat use at Iona Island Marsh. First year results suggest that *P. australis* and *T. angustifolia* habitats are equally capable of supporting nekton.

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PATTERNS OF ONTOGENETIC SHIFTS IN NEKTON HABITAT USE ALONG A MARSH COENOCLINE: ATLANTIC SILVERSIDECASE STUDY

A growing body of evidence suggest that communities of marsh nekton are stratified along a depth gradient partly in response to the influence of tidal and diel changes in physical conditions. In addition, ontogenetic shifts in habitat use along this gradient are key to our understanding of marsh function and the process of trophic relay, yet have rarely been specifically addressed. The goal of this study was to develop sampling methodologies and collect preliminary data to test the hypothesis that nekton faunal assemblages, species densities, and ontogenetic stages of Atlantic silversides and other species, are stratified along a marsh creek-to-bay coenocline (i.e., the marsh gradient). Preliminary results include: 1) successful development and use of a new seine sampling technique that provides density estimates of nekton in marsh creek and shallow bay environments, 2) we obtained sufficient preliminary data (69 seine samples) to compare the effectiveness of this new technique against a more conventional standardized seining method, 3) we obtained preliminary data on the diel and tidal changes in temperature along the marsh gradient, 4) we obtained preliminary data illustrating strong diel changes in nekton density distributions and faunal assemblages along the marsh gradient, and 5) we obtained preliminary data suggesting strong ontogenetic shifts in density distributions along the marsh gradient, and of strong interactions with diel period suggesting ontogenetic diel migration patterns. Amazingly, low tide fish densities reached values well over 500 fish sq. m.

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TRANSPLANTING EELGRASS (*ZOSTERA MARINA* L.) REMOTELY WITH FRAME HABITAT RESTORATION METHOD

The high cost of restoring eelgrass beds in subtidal environments, and the difficulty in protecting transplants from various bioturbating organisms, led us to develop a new method not requiring SCUBA. Transplanting Eelgrass Remotely with Frame Systems (TERFS™) is a modification of bare-root transplanting methods. Eelgrass shoots are attached with biodegradable ties to ballasted wire frames that provide mechanical protection

from uprooting and bioturbation. Deployed from any small boat, TERFS™ create 0.25 m² patches at a relatively high shoot density of 200 m⁻². After three to five weeks, the frames are retrieved for reuse, leaving behind dense patches of eelgrass. Preliminary tests in the Great Bay Estuary, NH, showed this method to be highly effective in creating eelgrass patches, even at sites where conventional transplanting had previously failed. Initial success (one month survival) of transplant stock ranged from 50 to 95%. In a side-by-side comparison in New Bedford Harbor, MA, the TERFS™ method outperformed the horizontal rhizome method at nine of ten sites. The ease and success of this technique provides an approach to restoration that can involve citizen volunteers. More importantly, it significantly reduces the cost of eelgrass restoration.

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EFFECTS OF SEAGRASS BEDS ON THE GROWTH OF THE SOFT-SHELLED CLAM, *MYA ARENARIA*

The growth rate of the soft-shelled clam *Mya arenaria* was examined to determine if growth rates differ depending on whether clams live inside or outside of sea-grass (*Zostera marina*) beds and whether seasonal (winter/summer) temperature differences have an effect on yearly growth rates. Grass beds are important habitats for many marine invertebrates and have also been shown to enhance the growth of hard clams (*Mercenaria mercenaria*) in more southern areas. Winter 1999/2000 was the coldest Maine winter of the last four years. Maquoit Bay, our study site, was covered by as much as 18 inches of ice since early January. The harsh weather conditions caused us to examine the effects of temperature on clam growth. Preliminary data suggests that low winter temperatures and high summer temperatures have a negative effect on clam growth.

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DISTRIBUTION AND ABUNDANCE OF MACROINVERTEBRATES AND FISH ON A RESTORING TIDAL MARSH SYSTEM AFTER 21 YEARS.

Although the restoration of vegetation on formerly impounded tidal marshes has been extensively studied, few data exist on fish and invertebrate communities of these marsh systems, and in fewer cases has their recovery been studied at regular intervals following the initiation of restoration. We studied macroinvertebrate and fish populations in a restoring tidal marsh system on Barn Island in Stonington, Connecticut. This marsh has converted from a *Typha*-dominated system to one with typical tidal marsh vegetation during the 21 years following reintroduction of tidal flushing. Invertebrates were sampled during a 10-week period in the summer of 1999 at the same marsh locations and using the same methods as an earlier study in 1990. Fish were sampled once a week during 33 weeks in 1999 using unbaited minnow traps; Breder traps were used on the marsh surface during one perigee spring tide in the fall. The mean densities of *Melampus bidentatus* and *Geukensia demissa* above and below the impoundment dike were not significantly different (>60 quadrats were sampled in each region). However, the mean densities of 3 species of marsh amphipods and 1 species of isopod were significantly different in the restored marsh. Ten species of fish were caught above the impoundment compared to 15 species below. While no significant difference exists between mean numbers of *Fundulus heteroclitus* caught in creek habitats above and below the impoundment, its numbers in man-made mosquito ditches are significantly higher on the restoring marsh above the impoundment than in the reference marsh below. This pattern did not show significant seasonal variation. Overall, the number of *F. heteroclitus* caught during winter was significantly lower than during other seasons. The results indicate that twenty-one years after the re-introduction of tidal flushing, the marsh has reached an advanced stage of restoration and possesses a characteristic assemblage of marsh invertebrates and fish species. However, the restored marsh is not yet equivalent to the reference marsh.

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POPULATION ECOLOGY OF DIAMONDBACK TERRAPINS OF THE LOWER HOUSATONIC RIVER, CT

The nesting habitats and adult population structure of diamondback terrapins (*Malaclemys terrapin*) on Milford Point and in Nell's Island marsh on the lower Housatonic River were examined, to expand baseline information on this important estuarine species. Measurement and mark and recapture techniques were used in tidal creeks of the 800-acre wetland to determine the spatial distribution and assess the potential for maintenance and/or growth of the terrapin population that now has been studied for two consecutive field seasons. To summarize these data, 252 terrapins have been trapped over the past two field seasons, including 182 original captures and 70 recaptures. Of the 252 total, 162 were males and 90 were females (with 28 of these gravid). The range in "ages" (loosely based on number of rings on scutes) was from 3 to 14 years. Terrapins were captured in three separate creeks and there was no overlap in recapture locations, i.e., terrapins caught in one creek were always recaptured in that same creek. Roughly one-fourth of all terrapins captured exhibited shell anomalies (extra laminae, divided scutes, etc.), suggestive of developmental alterations prior to hatching. A smaller number of terrapins were scarred or were missing limbs owing to predation and/or accidents as juveniles or adults. Attempts to track the success/failure of specific nests on Milford Point using GPS were thwarted by high rates of initial predation on terrapin eggs immediately after laying. The population monitoring program for terrapins at Milford Point and in the adjacent wetlands of the lower Housatonic River has provided a clearer picture of the current status and management potential of diamondback terrapins in urbanized estuaries where restoration of coastal habitat is proposed.

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EFFECTS OF HYPDIXIA ON AN ESTUARINE PREDATORY-PREY INTERACTION

Predator-prey dynamics between the blue crab *Callinectes sapidus* and an infaunal clam, *Mya arenaria*, were examined to assess the impact of hypoxia upon predator foraging rates and prey mortality. Laboratory experiments quantified the behavioral response of *Mya* to varying dissolved oxygen levels through the analyses of 1) sediment burial depth, and 2) siphon extension above the sediment surface. Moreover, functional response of adult blue crabs to two densities of *Mya* (6 and 24 clams tank⁻¹) was examined across three dissolved oxygen treatments: (1) normoxia (> 6.0 mg O₂ l⁻¹), (2) moderate hypoxia (3.0-4.0 mg O₂ l⁻¹), subsequent to clam acclimation to normoxia, and (3) moderate hypoxia (3.0-4.0 mg O₂ l⁻¹), subsequent to clam acclimation at severe hypoxia (< 1.5 mg O₂ l⁻¹). *Mya* sediment burial depth

decreased and siphon extension increased during exposure to severe hypoxia. Initiation of moderate hypoxia following normoxia altered blue crab foraging behavior from a destabilizing, type II functional response, to a partially stabilizing, type I functional response. Conversely, blue crabs exhibited a type II functional response under moderate hypoxia subsequent to clam exposure to severe hypoxia. Therefore, low dissolved oxygen concentrations appear to affect the predator-prey interaction between *Callinectes* and *Mya* by either hindering blue crab foraging, or alternatively, increasing clam vulnerability by altering their siphon extension and depth distribution within the sediment column. The collective results indicate that fluctuations in dissolved oxygen concentrations (i.e. initiation or dissipation of hypoxia) must be considered to understand its impact upon predator-prey dynamics in marine systems. Research identifying the influence of hypoxia on predator-prey relationships is critical to predicting the effects of changes in water quality on trophic interactions and food web dynamics in marine and estuarine systems.

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THE IMPACT OF TIDAL RESTRICTION ON THE SULFUR DYNAMICS OF A MAINE SALT MARSH

Over the past several decades there has been rising concern for the health of our nations wetlands, including that of salt marshes. The number of salt marshes in Connecticut alone is estimated to have dropped by 50% from pre-industrial numbers; other New England states have suffered similar losses. These losses are the result of diking, ditching, and drainage to allow farming, mosquito control, and development (Portnoy, 1999). The alteration of the salt marsh hydrology leads to dramatic changes in the way the salt marsh functions; it is no longer able to effectively cleanse water before it reaches the ocean. This study was performed at the Morse Mountain Conservation Area in Phippsburg, Maine. Water samples were collected from above and below a tidal restriction at six different sites. At each site porewater samples were taken as well as water from drainage ditches, pans, and the main channel. Alkalinity, pH, salinity, and temperature measurements were taken on each sample. In addition the sulfate of each sample was measured using an ion chromatograph and sulfide was measured using a colorimetric blue method. It is postulated that there will be a greater concentration of sulfide below the restriction than above it since there is less oxygen moving through the system due to the presence of constant standing water at the site. There is also expected to be significant differences between the abundance of sulfate and sulfide at the mouth of the marsh and at sites a greater distance from the mouth as differences in the hydrology of those areas has already been observed.

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A COMPARATIVE STUDY OF MICROALGAL DIVERSITY AND CHLOROPHYLL A CONCENTRATION IN A TIDALLY RESTRICTED AND UNRESTRICTED AREA OF SYBIL CREEK MARSH, BRANFORD, CT.

Benthic microalgae are important primary producers in tidal salt marshes, which contribute to the salt marsh food web and stabilize marsh sediments. Tidal restriction may greatly impact microalgal diversity and production within a salt marsh by influencing water and nutrient availability and changing macrophyte community structure (change in light levels). Sybil Creek Marsh in Branford, Cr. has been restricted from tidal exchange by the presence of a tide gate since the early 1900's. The marsh supports primarily *Phragmites australis* in the tidally-restricted area and *Spartina alterniflora* and *Spartina patens* in the tidally-unrestricted area. Microalgal community structure and chlorophyll a concentrations were quantified among different subhabitats (*S. alterniflora*, *S. patens*, *P. australis*, and pannes) within tidally-unrestricted and restricted areas of the marsh. Environmental variables (vegetation density, salinity, and sediment ammonium and phosphorus) were measured to determine their influence on the microalgal community. The microalgal community was described through identification of the dominant microalgal groups and colorimetric determination of chlorophyll a. In contrast to phosphorus, ammonium concentrations were consistently higher in the restricted area (0.35 and 0.83 mm cc⁻¹) relative to the unrestricted area (0.28 and 0.25 mm cc⁻¹) in the *S. patens* and panne subhabitats, respectively. Regardless of subhabitat, chlorophyll a concentrations were higher in the restricted area (3.8 mg m⁻²) relative to the unrestricted area (1.58 mg m⁻²). Ammonium concentrations were weakly correlated with chlorophyll a concentrations in both the unrestricted ($r^2 = 0.22$) and restricted areas ($r^2 = 0.0098$) of the marsh indicating that others factors (e.g. flooding or stem density) may have a greater influence on microalgal biomass.

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RESTORATION OF DEGRADED TIDAL MARSHES IN CONNECTICUT - THE FIRST 20 YEARS

Hydromodifications that led to the draining or impoundment of tidal wetlands (i.e., mesohaline brackish and polyhaline salt marshes) along Connecticut's coast have resulted in loss of significant functions and values. The Connecticut Department of Environmental Protection has been systematically reconnecting degraded marshes to Long Island Sound for over 20 years with the expectation that tidal flow restoration will reset the marshes on a trajectory to become self-maintaining tidal marsh communities. Responses of angiosperm, macroinvertebrate, fish, and bird populations to the return of tides have been followed at several sites with a restoration history of five to 20 years; these provide insights into restoration processes and timeframes. Plant communities, habitat features such as pannes, invertebrate populations, tidal creek fish, and salt marsh dependent birds become re-established, but these ecological functions may return at very different rates. Restoration rates for various ecologic functions is highly variable both within and between sites, from very rapid, within several years, to two decades. Factors affecting restoration rates include species autecology and especially hydroperiod. Avian use rates are dependent, in part, upon rates of plant community recovery. In the oldest restoration site, once extensive stands of *Phragmites* persist only along upland borders, but even after 20 years, this grass is being replaced by typical salt marsh species. It is expected that the next 20 years of research will more completely identify key forcing factors, allowing more definitive estimates of restoration time frames.

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TIDEMINER A UTILITY FOR HYDROPERIOD CALCULATIONS FROM TIDAL PREDICTIONS AND HISTORIC TIDAL DATA.

The TideMiner program calculates flooding frequency and duration using tidal prediction files generated by Tidel (Micronautics, Inc., Rockport, ME) and other commercial tidal prediction software. The program also works directly with html page files from NOAA's historic tidal record website (http://www.opsd.nos.noaa.gov/data_res.html). Hydroperiod calculations can be made for an unlimited number of elevations; elevation values may be entered directly, from existing files, or copied from spreadsheets. Results are generated in delimited (*.csv, *.tab, or other custom delimiter) files that may be opened directly by Excel, Lotus, and other spreadsheet programs. TideMiner also has a companion program, TideTrimmer, that removes selected fields from Tidel and NOAA generated files for easy graphing or statistical manipulations. Both these programs will be demonstrated during the poster session. Both TideMiner and TideTrimmer are compiled C++ programs running on Microsoft Windows(tm) operating systems (95 and later). By mid-June there will be versions available in Java (which will run on other operating systems). Both may be downloaded free from the internet (<http://www.NumbersToKnowledge.com>) and source code is available as well (on request).

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NURSERY HABITAT IN AN URBAN ESTUARY: INTEGRATING JUVENILE FISH DISTRIBUTION AND ABUNDANCE WITH BENTHIC HABITAT CHARACTERISTICS

This study investigates temporal and spatial features of juvenile fish distribution and abundance in New Bedford Harbor during 1998 - 1999. Furthermore, the study attempts to associate settlement and migration strategies with benthic habitat characteristics. New Bedford Harbor (NBH) is an excellent example of an urban port impacted by centuries of anthropogenic perturbations, extending from colonial settlement to its current role as a major fishing port. Despite the extent of changes to the environment, suitable nursery habitat for several fish species exist in the harbor, as evidenced by the substantial numbers of juvenile fishes collected during this study. A total of 10,844 fish, comprising thirty-six species, was collected from the inner and outer harbor by otter trawl. Four species, scup (*Stenotomus chrysops*), cunner (*Tautoglabrus adspersus*), winter flounder (*Pseudopleuronectes americanus*), and black sea bass (*Centropristis striata*) comprised 66% of the total catch, although species composition and relative abundance differed between stations and months. Discernible differences were evident between the inner and outer harbor benthos as illustrated by the in situ seafloor photographs (sediment profile and planview images) and examination of macroalgae collected by the otter trawls. Outer harbor benthic conditions were generally characterized by harder substrate (e.g., pebbles, coarse sand, and shell debris), diverse biogenic structures (e.g., worm tubes) and the presence of *Codium fragile* as the dominant vegetation. Inner harbor stations were predominantly soft sediments (e.g., silt and mud) with few demersal structures, and colonized by *Agardeilla* spp. and *Ulva* spp. Integration of the fish survey and seafloor characterization suggest apparent habitat associations of early life history fishes in this urban estuary. For example, newly settled scup (~15 - 30 mm total length [TL]) inhabited outer and inner harbor habitats, with substantially larger numbers collected in the outer harbor, and remained in NBH until fall migration to deeper water. Black sea bass, ranging from 20 - 49 mm TL, initially appeared to prefer the outer harbor; although individuals >49 mm TL were collected in the inner harbor. The occurrence of newly settled and early juvenile fishes and apparent seafloor heterogeneity elucidate the variability of fish habitat within NBH.

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ALLOZYME COMPARISONS OF ATLANTIC AND GULF COAST POPULATIONS OF THE HERMIT CRAB, *PAGURUS LONGICARPUS*.

Using cellulose acetate gel electrophoresis, allozymes from two Atlantic coast populations and one Gulf of Mexico population of the hermit crab, *Pagurus longicarpus*, were compared. Of the five loci studied two were monomorphic (LDH and MDH) and three were polymorphic (GPI, PGM, and MDHP). Allele frequencies were used to calculate Nei's genetic distances which were in turn used to create a phylogenetic dendrogram. Of the three populations examined, the two Atlantic populations appear to be more closely related to each other than to the Gulf of Mexico population. Additional data involving comparisons of external morphology and DNA support this conclusion.