FALL 2006
COAST GUARD ACADEMY, NEW LONDON
NEERS MEETING ABSTRACTS

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EFFECTS OF DITCH PLUGGING ON SALT MARSH PEAT

Most East Coast salt marshes have been ditched since Colonial times either for salt haying or mosquito control. These ditches drain both surface and subsurface water from the marsh in order to increase salt hay production or reduce mosquito-breeding areas. One consequence of ditching is the loss of surface water habitat suitable for waterfowl, wading birds and shore birds as well as fish and crustacean. Another consequence has been changes in vegetation community structure. Ditch plugging, has been employed widely in East Coast *Spartina* marshes as a means of increasing surface water habitat on previously ditched marshes. Ditch plugs are formed by excavating peat from the surface of a salt marsh and packing it in a narrow portion of a ditch. Water then is impounded in the ditch channel on the upstream side of the plug. We examined 2 physical soil parameters (bulk density, percent organic matter), interstitial hydrogen sulfide concentration, groundwater levels, vegetation community, and above-ground biomass at ditched and unditched marshes at 2 sites each in Maine, Massachusetts and Connecticut. Ditch plugs were installed from 1 to 10 years prior to the study except at 1 Connecticut site where ditches were not maintained and had filled in naturally over a period of decades. Results are given in light of long-term consequences for maintaining peat integrity and salt marsh accretion processes in the face of sea level rise.

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THE RE-DISCOVERY OF THE NATIVE COMMON REED, *PHRAGMITES AUSTRALIS* SUBSP. *AMERICANUS* SALTONSTALL, PETERSON, AND SORENG, IN CONNECTICUT.

A small population of the native subspecies of Common Reed, *Phragmites australis* subsp. *americanus* Saltonstall, Peterson, and Soreng, was recently re-discovered at Ragged Rock Creek, brackish tidal wetland of the lower Connecticut River estuary. Although *Phragmites* was historically reported on the lower Connecticut River, the native subspecies of *Phragmites* was presumed to be extinct due largely to the rapid expansion and monopolizing dominance of the non-native form of *Phragmites*. Currently, the distribution of the non-native *Phragmites* is quite extensive along the lower tidal Connecticut River estuary, leading to a widespread campaign to remove it. The rediscovery of native *Phragmites* mixed within extensive stands of non-native *Phragmites* poses a real challenge to managers engaged in restoration and *Phragmites* control efforts. To avoid accidentally eradicating the native subspecies of *Phragmites*, clearly, restoration projects would benefit from additional survey work and careful field observation.

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Aspects of population ecology in two populations of fiddler crabs, *Uca pugnax*.

Fiddler crabs, *Uca pugnax*, were collected from a highly contaminated site and a relatively clean site in New Jersey to determine if and how environments with varying levels of pollutants may impact aspects of population biology including individual size, morphology (major cheliped size), population density, fecundity, recruitment and survivorship of early benthic phases. Crabs from the highly contaminated site were significantly larger in size, but had lower population density, lower recruitment, reduced reproductive season and lower survivorship of early benthic phases. Our study suggests that contamination may play a role in population ecology of *Uca pugnax*. This study also determined that the reproductive season for *Uca pugnax* in New Jersey is much longer than reported in the literature and may be a reflection of climate change.

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PAST AND PRESENT ANTHROPOGENIC IMPACTS ON THE WATER QUALITY OF THE PETTAQUAMSCUTT RIVER ESTUARY (NARRAGANSETT, RI)

The Pettaquamscutt River Estuary, or Narrow River, extends approximately 9 km from the freshwater Gilbert Stuart Stream in the woods of North Kingstown, RI, crosses two deep ice-block basins with anoxic bottom waters, flows past numerous neighborhoods in Narragansett and South Kingstown, accepts the outfall of eleven storm drains, includes the flow from the 1.3 km^2 Chafee National Wildlife Refuge at Pettaquamscutt Cove, finally spilling out over a sand tidal delta into Narragansett Bay. As part of a larger study by the Army Corp of Engineers, historical and recent data on nitrogen, dissolved oxygen, and bacteria in the Narrow River are being examined for long term and seasonal trends. Monthly water samples were taken from 1992 to the present, from May through September by the University of Rhode Island's Watershed Watch program. Two years of this total nitrogen data stand out: 1993 for being approximately twice the value of other years at all stations (between 920 and 1320 ugN/L or 66 to 94 umolN/L); and 2001 for being generally the lowest value of the data set (200-300 ugN/L or 14-21 umolN/L). Other years are generally between 400 and 700 ugN/L or 30-50 umolN/L. Most neighborhoods were sewered in the 1990's, but the following build-out and increase in impervious surfaces may counter-act sewering benefits. Presently new stormwater facilities, utilizing innovative designs for nitrogen and bacteria management, are being constructed. Understanding these changes is crucial to determining how suitable the present habitat is for eelgrass and shellfish. Further investigations of historical data, such as Miller's 1970's nitrate values, are warranted to determine if previous conditions were more suitable.

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THE EFFECT OF WATERSHED LAND COVER ON ALLOCHTHONOUS INPUT OF COLORED DISSOLVED ORGANIC MATTER (CDOM) TO COASTAL RECEIVING WATERS

Eleven small estuaries along the northern coast of Long Island Sound were studied to examine factors affecting the input of colored dissolved organic matter (CDOM) to estuaries from their watersheds. The land use/ land cover characteristics of a watershed are strongly related to the CDOM concentration in incoming freshwater. An empirical regression equation, using the percent cover of four land use/land cover types (coniferous forest, turf, agricultural land and developed land) as the variables, predicts 45 percent of the observed variability in freshwater CDOM concentration in 11 southern New England estuaries. This is nearly the same fraction attributed to cross-site variability. CDOM concentrations were linearly correlated with salinity in the shallow estuaries studied here, but the slopes were not constant in any of the estuaries examined. This makes salinity a poor proxy for CDOM over time scales of days or longer. Freshwater CDOM concentrations entering estuaries were highly variable, both among sites and over time within one site, while the seaward end members in Long Island Sound and Block Island Sound had fairly uniform CDOM concentrations. Although incoming CDOM concentration is highly variable over time within a single estuary, the freshwater inflow is not a good predictor of the incoming CDOM concentration and no seasonal pattern is apparent in freshwater CDOM concentration.

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TRACKING COLONIES OF *SPARTINA CYNOSUROIDES* AND PHRAGMITES ALONG THE SEEKONK RIVER: DISASTER, OPPORTUNITIES, AND PERSPECTIVES

The Seekonk River, an upper arm of Narraganasett Bay, is recovering from the Industrial Revolution. Today, much of the shoreline is in a dynamic state of linear salt marsh development. *Spartina cynosuroides*, the tall cordgrass, is actively expanding and dominates both sides of the estuary's northern sector. On the west shore, once extensive Phragmites is now limited to the wider shore area from Goose Point south to the Grotto Brook salt marsh. This wider shoreline area contains various sizes of species-specific colonies of the two tall grass species. Phragmites colonies are dense, light-limiting monocultures; colonies of *S. cynosuroides* are less dense and have an understory flora including a tall sedge, and water hemp. The Grotto Brook salt marsh is the only embayed salt marsh along the Seekonk River estuary. From the edge of the salt marsh, the view is that of a continuous, impenetrable ~9 ft wall of tall grass. Recent emergency repairs to a municipal sewer line beneath the marsh left a firm swath across this long-term study area. The fortuitous transect enables us to report that within the embayed salt marsh, colonies of each of the two species may abut, but do not appear to intermix. Multiple abutted colonies form irregular series. Within the series, colonies maintain their own species-specific features; both small and large colonies, and abutted colonies, are distributed in a random fashion. These observations suggest that the embayed salt marsh is undergoing a dynamic transition similar to that of the linear salt marsh.

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A COMPARISON OF PLANT N DYNAMICS IN FERTILIZED AND NATURAL NEW ENGLAND SALT MARSHES; A PAIRED 15N TRACER STUDY

We examined the effects of increased nutrient availability on N dynamics in dominant New England salt marsh plants (tall and stunted *Spartina alterniflora*, and *S. patens*) using paired, large-scale 15NO3- tracer additions. We compared physiological variables of plants in fertilized (~17x ambient N and P in incoming tidal water) and reference marsh systems to quantify NO3- uptake and uptake efficiency, allocation of N to tissues, end-of-season N resorption, leaf litter quality, and other potential responses to increased nutrient availability. Reference system plants sequestered ~2.3 g NO3-N ha-1d-1 in aboveground pools during mid-summer, while fertilized plants sequestered ~26.9 g NO3-N ha-1d-1. But NO3- uptake efficiency (% of total incoming NO3-N sequestered aboveground) was higher in the reference system (7.1%) than fertilized the system (2.6%), suggesting that our fertilization rate (70 mM NO3- in incoming water) approaches or exceeds the uptake saturation point for this vegetation community. Leaf litter quality was clearly affected by N availability; both N resorption efficiency and proficiency were lower in all plants of the fertilized system. The result was that senesced leaves from the fertilized creek contained ~30% (tall *S. alterniflora*), 19% (stunted *S. alterniflora*), and 13% (*S. patens*) more N per unit biomass than reference creek leaves. This work is part of a larger synthetic study (TIDE) that provides unique mechanistic data quantifying ecosystem-scale responses to increases in nutrient pollution.

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POTENTIAL MICROBIAL BIOINVASIONS VIA SHIPS' BALLAST AND PROPOSED INTERNATIONAL LEGISLATION TO REDUCE INTRODUCTIONS

Aquatic invasive species are delivered to coastal regions through the discharge of water, sediments, and biofilm from ships' ballast-water tanks. During eight years of studying ships arriving to the lower Chesapeake Bay, we evaluated the mechanisms by which invasive microorganisms could arrive to the region. Within a given ship, habitats included ballast water, unpumpable water and sediment (collectively known as residuals), and biofilms formed on internal surfaces of ballast-water tanks. We sampled 69 vessels arriving largely from western Europe, the Mediterranean region, and the U.S. East and Gulf coasts. All habitats contained bacteria, viruses, and microalgae (inferred by the presence of chlorophyll *a*). By extrapolating microbial metrics to the estimated volume of ballast water, biofilm, or residuals within an average vessel, we calculated the potential total number of microorganisms contained by each habitat, thus creating a hierarchy of risk of delivery. The estimated concentration of microorganisms was greatest in ballast water >> sediment and water residuals >> biofilms. Thus, treatment options should first target the ballast-water fraction of ship-borne microorganisms. Extrapolated delivery and survival of microorganisms to the Port of Hampton Roads in lower Chesapeake Bay showed on the order of 10^{20} microorganisms (bacteria and viruses) were discharged annually to the region. The issue of ship-borne microorganisms is of concern to the international community: acceptable limits on the discharge of specific microorganisms have been proposed by the United Nations' International Maritime Organization. These regulations and the efforts to meet them will be briefly discussed.

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FUSARIUM SPECIES ASSOCIATED WITH DECLINING *SPARTINA* IN AREAS AFFECTED BY SUDDEN WETLAND DIEBACK

Sudden wetland dieback (*syn* Brown marsh) is a phenomenon of unknown etiology. Characteristics include a rapid death of brackish and salt water wetland grasses, primarily *Spartina alterniflora* and *S. patens*. Declining plants from affected areas along the coast of Louisiana, and in Madison, Connecticut, were sampled to determine if fungal pathogens could be found and associated with declining plants. Foliar and root tissue were sampled, washed in distilled water, surface disinfested in 10% household bleach, rinsed, and placed on an agar medium. Colonies of *Fusarium* spp. were recovered. Isolates were identified using spore and colony morphology and by amplifying partial sequences of the elongation factor alpha gene using PCR. An undescribed species was found among the Louisiana isolates and shown to belong to the African clade of the *Fusarium* sexual stage, *Gibberella fujikuroi*. These findings suggest that the Louisiana species were introduced to North America. The Connecticut isolates were distinctly different from the Louisiana isolates and represented new species that belong to the trichothecene clade of *Fusarium*, a group of *Fusarium* species that produces mycotoxins. Pathogenicity tests have shown that these Louisiana and Connecticut species are capable of inciting lesions on the plant; however, their role in sudden wetland dieback is unclear.

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RESPONSES OF BENTHIC-PELAGIC COUPLING TO CLIMATE CHANGE IN A TEMPERATE ESTUARY

We report the first demonstration of the impact of climate change on benthic-pelagic coupling and the biogeochemical cycles of a coastal marine system. Over the last thirty years Narragansett Bay, a 328 km ^{2}) temperate estuary on the east coast of the United States, has undergone a variety of ecological changes. Building on a robust data set that spans three decades, we present a link between warming (+1.7^{o}C in annual mean water temperature) in the bay and a marked decrease in sediment oxygen consumption, in the fluxes of ammonia and phosphate from sediments to the overlying water, and in sediment denitrification. We attribute this reduction in biogeochemical exchange to a dramatic drop in the standing crop of water column chlorophyll as the system has shifted from one characterized by a dominant winter-spring bloom to one supported by more ephemeral and less intense summer-fall blooms. The recent climate induced oligotrophication of the bay will be further exacerbated by forthcoming nitrogen reduction due to tertiary sewage treatment.

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PERSPECTIVES ON OXYGEN DEPLETION IN CONNECTICUT ESTUARINE WATERS

This paper presents a 2003 study of hypoxia and anoxia in 5 small Connecticut estuaries, strongly influenced by their geometry and watershed characteristics[3]. The results are presented in the broader perspective of a proposed construct for oxygen depletion in aquatic environments, worldwide. Frash Pond and Selby Pond, in Stratford, were the primary focus of this field program. Frash Pond, alone, contained permanently anoxic bottom water with high levels of hydrogen sulfide. Ventilation of bottom waters by cold, oxygenated tidal water during winter months oxidized 95% of the sulfide. Selby Pond has a high rate of ecosystem respiration, but is sufficiently shallow and unstratified that strong hypoxia was not observed. The upper Niantic and Thames Rivers are seasonally hypoxic but hydrogen sulfide was not observed in either case. Density stratification, rather than organic loading appears to be responsible in both instances. The overall impact of hypoxia on macrobenthic infauna is reduced diversity and abundance, although certain species, such as the polychaete worm *Streblospio benedicti*, were tolerant of depressed oxygen levels. Permanent anoxia eliminated the macrofauna. Anoxic waters have occurred naturally over geologic time. Oxygen depletion is usually assigned negative environmental effects; we discuss benefits of anoxic basins as well.

[3] Gaines, A.G., and S.D. Pratt, 2003. Oxygen Depletion in Connecticut Waters. Prepared for the Long Island Sound License Plate Program, Connecticut Department of Environmental Protection, Hartford, Connecticut, by The Coast & Harbor Institute, Woods Hole, MA. 87 pp.

+ 1 Appendix.

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DEVELOPMENT OF A RIPARIAN BUFFER "TOOLBOX" OF EXISTING RESOURCES FOR LONG ISLAND SOUND REGION

Riparian buffers are one of the effective methods to reduce non-point source pollution from upland areas to streams, lakes, estuaries and oceans. Elevated levels of non-point source pollution cause hypoxia (i.e. deficiency of the oxygen) in water bodies, and as a result, degradation of fish habitat. One of the seven management areas of the Long Island Sound Comprehensive Conservation and Management Plan (CCMP) is hypoxia. Therefore, riparian buffers can considerably contribute to hypoxia reduction and CCMP program. The implementation of riparian buffers by coastal managers requires specific knowledge on their implementation, funding, regulations and scientific background. It is also important to know case studies and contact people or agencies who already implemented riparian buffer projects. This and other information was assembled in developed web-based riparian buffer “toolbox” in coordination with the Long Island Sound Study and Non-Point Source Pollution Working Group in Connecticut. The “toolbox” is available on http://www.hydroqual.com/projects/riparian/. It allows users to view, read, copy, or download documents and data, including: glossary of terms, Geographic Information Systems data, references on scientific research, educational materials, regulations, restoration practices and funding sources. The structure of the web site provides links to various national sources of information and data. The site also has interactive GIS-based map that allows viewers to see current, completed and potential restoration projects in Long Island Sound.

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METAL IMPACTS ON BENTHIC MACROINVERTEBRATE COMMUNITY AND THEIR IMPLICATIONS FOR THE FEEDING HABIT OF MUMMICHOGS

Anthropogenic stressors such as metals can often alter the structures and functions of benthic food webs at tidal salt marshes. As benthic macroinvertebrates are in direct contact with metals in sediments, benthic community composition often indicates metal contamination levels in the environment. Benthic macroinvertebrates are also common prey items often found in the guts of many fish feeding at marshes. To test the hypothesis that metal impacts on benthic macroinvertebrate prey affect the feeding habit of mummichogs (*Fundulus heteroclitus*), one of the most abundant resident fish at tidal salt marshes near a highly industrialized area, the Arthur Kill (AK), NY/NJ, benthic macroinvertebrates and mummichogs were collected from AK as well as a local reference site near Raritan Bay in mid-summer of 2004. The benthic community composition at the polluted sites showed that there were significantly higher abundances of pollution-tolerant polychaetes and oligochaetes and fewer pollution-sensitive species including bivalves and gastropods than those at the reference site. The gut contents of mummichogs from the polluted salt marshes indicate that altered benthic prey community composition was reflected in the diet composition of mummichogs. A significantly larger number of gastropods were observed in fish from the reference site than the polluted sites, while a significantly larger number of polychaetes were observed in fish from the polluted sites than the reference site. These results show that metal accumulation in sediments at AK seems to have strong implications for altered species interactions in benthic food webs at AK.

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LATE HOLOCENE FLUCTUATIONS OF C3 AND C4 PLANT COMMUNITIES AND CARBON SEQUESTRATION IN A MAINE SALT MARSH

A transect of sediment cores were analyzed for stable carbon isotope composition of organic matter and higher plant leaf wax (HPLW) lipid biomarkers to determine Holocene shifts in C3 (higher high marsh) and C4 (low and/or high marsh) plant deposition and carbon sequestration at the Sprague River Salt Marsh, Phippsburg, Maine. Between 3700 and 2500 cal yr BP, organic deposition into tidal flat muds was dominated C3 terrestrial plant matter. At 2500 cal yr BP, the current salt marsh was established. Isotopic data indicate that the salt marsh plant communicates have responded to small changes in relative local sea level (i.e., two transgressional regressional sequences followed by a transgressional sequence) over the last 2500 years. These shifts represent changes in the balance between RSLR and sediment accumulation. The average annual carbon sequestration rate over the last 2500 years is approximately 40 g C yr-1m-2, and is in strong agreement with other values published for the Gulf of Maine. Given that Maine salt marshes cover an area of ~79 km2, their importance as a carbon sink should not be overlooked. It has been argued that a continued rise in sea level brought about by global warming would increase the terrestrial carbon sink by expanding salt marshes onto gently sloping upland terrain, thus modulating future global warming and sea level rise. However, Sprague Marsh, and many others in the south-central region of the Gulf of Maine, occupy glacially carved valleys and are surrounded by topographic highs. A rapid sea level rise in the Gulf of Maine might result in drowning of the salt marshes and loss of an effective carbon sink.

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PASS THE PICOPLANKTON PLEASE: AGGREGATES FACILITATE THE UPTAKE OF SMALL PARTICLES BY SUSPENSION-FEEDING BIVALVES

Suspension-feeding bivalves capture individual picoplankton cells (0.2 - 2.0 µm) with a retention efficiency of less than 50%, leading to the common assumption that picoplankton play a minor role in the nutrition of bivalves. Picoplankton, however, are often concentrated within marine aggregates (i.e., marine snow) which are abundant in coastal environments where large populations of bivalves thrive. If bivalves capture and process aggregates, which range in size from a few micrometers to more than a centimeter, they may be able to utilize embedded picoplankton as food. We fed four species of bivalves 1-µm and 0.5-µm fluorescent beads that were either evenly dispersed in seawater, or embedded within aggregates generated in the laboratory. Dispersed 10-?m beads were also delivered so that feeding activity could be determined. All feces were collected over a 48-hr period, digested in NaOH, and the fluorescent activity measured using spectrophotometric analysis. The number of beads ingested was then calculated using a previously established standard curve. Our results indicate that aggregates significantly enhance the uptake of 1-µm and 0.5-µm beads by clams (*Mercenaria mercenaria*), mussels(*Mytilus edulis*), bay scallops (*Argopecten irradians*), and eastern oysters (*Crassostrea virginica*). Interspecific differences in the quantity of aggregates ingested were apparent and may be a consequence of variations in gill structure and mechanisms of particle processing. Our data suggest that aggregates allow suspension feeders to utilize embedded particles as a food source.

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NITROGEN LOAD - EELGRASS EXTENT MODEL APPLICATION TO NITROGEN CRITERIA DEVELOPMENT FOR ONE CLASS OF US ESTUARIES – A PROOF-OF-CONCEPT

Empirical models of nitrogen load vs. biological response can provide managers the needed basis for deriving nitrogen limits for coastal systems. This talk details a process for calculating nitrogen input limits for protection of eelgrass habitats in shallow southern New England coastal embayments. The process is based on an empirical model of nitrogen load vs. biological response. The biological response is a biocriterion based on eelgrass extent. Eelgrass biocriteria are derived using three approaches; percentile, ecological/societal value, and threshold. After a criterion is determined then the nitrogen load-eelgrass response model is used to derive a generic nitrogen loading limit linked to the criterion. Once estimated, the generic nitrogen loading limit is applied to estuaries using the individual characteristics of each (e.g., volume, residence time). These effects-based criteria and associated generic nitrogen loading limits are suitable for estuaries in the estuarine class for which they were derived. Application of these approaches to other US estuaries will require a classification scheme and class-specific load-response models. The USEPA is in the process of developing such a classification scheme.

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USING NATURAL RADIONUCLIDES TO RECOGNIZE THE EXTENT OF HYPOXIA IN WESTERN LONG ISLAND SOUND

During the seventies, the natural radionuclides polonium-210 ($t_{1/2}$ =138 d) and lead-210 ($t_{1/2}$ =22 y) were used to trace water masses in Long Island Sound (Beninger, 1975). Since then, few studies have employed these isotopes in coastal estuarine systems despite their consistent application in the open ocean. This study attempts to apply these natural radionuclides with very different half-lives and unique behaviors in order to distinguish the spatial and temporal extent of seasonal hypoxia in Western Long Island Sound. Summer time hypoxia has worsened over the past five decades, but the exact cause of the intensity of these episodes remains unclear. There is evidence that both anthropogenic eutrophication as well as changes in seasonal hydrophysics may be responsible. While ^{210}Pb is an indiscriminant particle tracer, ^{210}Po has a high affinity for organic carbon. This inherent nature of the polonium and lead (^{210}Po/^{210}Pb) system may provide insight into the fate of particulate organic carbon (POC) as well as the nature of spring and summer stratification. Samples were collected during a one week cruise in June 2006 aboard the *R.V. Hugh Sharp*. Water and particulate samples were taken on an East-West transect from near the Throgs Neck Bridge to Oyster Bay, Nassau County. A CTD rosette with twelve 10L Niskin bottles was used to collect water and filterable (>1.2 μm) particles at three or more depths at fifteen stations. Besides natural radionuclides, supporting data include oxygen concentrations, nutrient levels, chlorophyll a, and standard physical parameters.

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FISH BIOMASS SIZE SPECTRA IN NARRAGANSETT BAY

Biomass size spectra can be sensitive to natural or anthropogenic disturbances that alter the energy balances and transfers within a system, and therefore could be potentially useful as ecosystem management tools. Empirical studies have indicated that size spectra are stable in shape and structure in a wide range of freshwater and marine ecosystems throughout the world. This stability is a result of the underlying ecological energetics, which have been hypothesized to result from the transfer of energy from one trophic level to another through predation. Narragansett Bay has a long history of anthropogenic impacts, including fisheries, nutrient and pollutant loads and invasive species, as well as natural climactic variability such as the North Atlantic Oscillation. The Rhode Island Department of Environmental Management's (RIDEM) has conducted a long-term trawl survey from 1979 to the present, where fish were collected monthly at 13 stations around Narragansett Bay. Using this data, biomass size spectra were constructed for different seasons, years and locations, and the slope and intercepts of these spectra were compared to investigate their usefulness as indicators of ecosystem status and function. Preliminary results show that the normalized slope of the fish spectrum was -2, which is steeper than the predicted slope of -1. This indicates that there are less large individuals in the community than would be expected in an unexploited system.

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NOSING AROUND FOR WASTEWATER MANAGEMENT SOLUTIONS

Removing excess nitrogen from Cape Cod estuaries has emerged as a pressing environmental need. While a distinct biogeographic region, the Cape's 15 municipalities almost always share estuaries that cross political borders but wastewater management planning, as part of the Massachusetts Estuaries Program, has been left to the individual municipalities, not a larger governmental entity. Volunteer water quality sampling programs in existence for a decade or more for some estuaries, including Pleasant Bay in Chatham, Orleans, Harwich and Brewster, gained priority on the state's list for determining total maximum daily loads (TMDLs) allowed for each estuary as part of the Estuaries Program. Once the numbers are known, towns will determine methods needed to achieve the goals. To get the public educated about potential solutions, the Friends of Arey's Pond and Orleans Pond Coalition, both non-profit citizen organizations, sponsored a bus tour of wastewater management options currently functioning on the Cape. A full busload of town officials, committee members, neighboring town officials, and community activists was invited to attend the six-hour tour. The group visited a range of solutions from a centralized tri-town municipal septage treatment plant to a single-business, relatively low flow treatment solution, to a residential complex system, to a high school facility. The tour's primary purpose was to introduce the concept of decentralized systems as available options demonstrating that sewering may not be the only solution to the town's wastewater problem.

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A MULTI-SCALE APPROACH TO SEAGRASS MONITORING: FEASIBILITY TEST IN PLEASANT BAY, MA

Seagrasses are threatened by diverse human activities, including direct alterations, indirect effects of land management practices, and long-term impacts of a changing global climate. The long-term and cumulative effects of multiple stresses on the structure, function, and sustainability of seagrass ecosystems are often unknown. Monitoring can improve the ability to detect threats, identify the sources of problems, and suggest management solutions. A multi-scale monitoring framework provides an efficient approach to document regional status and trends and diagnose causes of habitat change. As part of the NPS Vital Signs Monitoring Program, we tested the feasibility of conducting nested, multi-scale monitoring of eelgrass in Little Pleasant Bay, MA, within Cape Cod National Seashore. An existing state mapping program provides information on large-scale changes in plant distribution at five-year intervals. We supplemented this information with annual high-resolution measurements at specific sites and intermediate-resolution measurements on a bay-wide scale. Intermediate-resolution monitoring is based on rapid assessments of eelgrass cover, shoot length, and water depth at 70 locations selected by stratified-random sampling. High-resolution monitoring includes measurements of eelgrass condition (percent cover, density, biomass, shoot morphology, epiphyte cover, wasting disease) and environmental characteristics (water depth, light availability, sediment features) within permanent quadrats at different depths, using an adaptation of SeagrassNet sampling methods. Integration across scales permits estimation of eelgrass biomass throughout the bay from easily measured parameters and identification of potential causes of changes in distribution.

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FISH COMMUNITY STRUCTURE IN THE BRACKISH FRESHWATER MARSH OF THE QUINNIPIAC RIVER

At the southern end of the Quinnipiac River there is a marsh complex composed of over 1000 acres of salt and brackish waters. This system consists of a matrix of different marsh patch types and an extensive marsh creek corridor system. These are habitat for a number of fish species, and serves as an important nursery. Along with severe encroachment of the non-native invasive plant, Phragmites australis, this marsh is surrounded by extensive development (eg. landfills, shopping malls, train tracks, train yards, major roadways, industrial sites, and an asphalt processing plant). Sediment and water pollution have resulted from these prolonged impacts. However, there have not been extensive icthyofaunal studies performed here. By sampling fish populations in the northern, central and southern sections of this marsh, we hope to assess the current state of these communities and the marsh. Not only will fish populations be studied on a spatial level, but the conditions of each habitat will also be factored into the analysis. In this poster we present our preliminary findings on fish and benthos, and discuss potential applications of the data. The aim of this study is to 1. provide information regarding these fish populations to the public and scientific community, 2. develop an understanding of the fish community dynamics, 3. examine a possible link between the anthropogenic pressures that are applied to this marsh and a particular species of fish that may have developed an adaptation to such pressures, 4. conversely, identify a particularly vulnerable species, and 5. to evaluate the habitat characteristics that may or may not dictate community structure and distribution.

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USE OF LIDAR AND AIRBORNE AND SATELLITE MULTISPECTRAL IMAGERY TO CLASSIFY AND MAP *PHRAGMITES AUSTRALIS* IN TIDAL MARSHES OF THE LOWER CONNECTICUT RIVER.

The University of Connecticut's Center for Land Use Education and Research, in collaboration with the Connecticut Department of Environmental Protection, has acquired a high-resolution LiDAR dataset that covers the state's coast from New Haven Harbor to the mouth of the Connecticut River. These data were collected in October 2004 using an LH Systems ALS50

scanner. The LiDAR data points were collected at submeter horizontal resolution and include values for first return (i.e. top most reflective surface such as a rooftop or tree canopy) and last return (i.e. bare earth surface). Vertical accuracies are reported to have an RMSE of 0.057 meters. Data collection was funded through a NOAA Coastal Services Center cooperative project designed to provide remote sensing data to support coastal assessment and management activities in the state. The LiDAR data are being used in conjunction with high-resolution ADS40 airborne imagery to aid in the detection and mapping of *Phragmites australis*, a highly invasive plant that has invaded many of the state's tidal marshes. *P. australis* typically grows to a height of 3 to 5 meters in extremely dense stands that can be "seen" in the LiDAR dataset. The poster will provide an overview of the LiDAR data, its characteristics and how it is being used to help identify *P. australis*.

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NATURE VS. NURTURE: A BEHAVIORAL AND GENETIC STUDY OF TWO POPULATIONS OF BLUE CRAB (*CALLINECTES SAPIDUS*) IN NEW JERSEY

Blue crabs were collected from Hackensack Meadowlands (HM), a contaminated site in northern NJ and two sites within Tuckerton (TK), a relatively clean site in southern NJ. Behavioral differences were previously found in predator avoidance, prey-capture, and response (attack or flee) to a threatening stimulus in HM blue crabs. Specifically, HM adult blue crabs were less efficient at capturing prey compared to their TK conspecifics. However, HM juveniles were more efficient at predator avoidance than TK juveniles. When exposed to a threatening stimulus, HM juveniles were more likely to attack and TK juveniles either fled or gave a mixed response. Genetic analysis of six microsatellite loci has revealed that the three populations are genetically similar, suggesting that the behavioral differences between the populations are environmental (e.g., salinity, food, sediment/water quality). Further studies are being conducted to further explore behavioral differences between these populations, their causes and their ecological significance.

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EFFECTS OF HEAVY GILL PARASITE BURDENS ON *FUNDULUS HETEROCLITUS* ANATOMY AND PHYSIOLOGY

Parasites can affect many aspects of host functioning including behavior, morphology, growth, fecundity and survival. Little research has been done to examine potential behavioral or physiological effects of high endoparasite loads in the gills of fish. We have found that mummichogs (*Fundulus heteroclitus*) from several areas in the Hackensack Meadowlands

District, NJ have gills that are highly infected (1000's) with digenean trematode metacercariae compared to other sites (100's). We hypothesize that severe gill parasite infections can impair host respiration, and hosts may try to compensate for decreases in oxygen extraction by modifying their physiology (e.g., reduced respiration) and/or anatomy (e.g., increase gill surface area). Respiration rates and gill morphology were examined in fish from two highly infected populations and one less infected population. Highly significant differences (P=0.001) in both respiration rates and anatomical abnormalities were found between severely infected fish versus less parasitized conspecifics. A moderately positive correlation (R^2=0.4402) was found between parasite abundance and the number of additional gill branches. More parasitized individuals had lower respiration rates and more gill branching.

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DEVELOPMENT OF AN OFFSHORE FOOD WEB MODEL FOR LONG ISLAND SOUND

A large body of information exists on the ecology of Long Island Sound. However, this knowledge has yet to be distilled and integrated into food web based research. A preliminary food web model of the LIS offshore environment is currently being constructed using the Ecopath with Ecosim software. Principle species and associated trophic dynamic data have been collected from an extensive and continuous literature search, as well as contact from persons with LIS expertise from government and private agencies. It is the goal of this project to a) build a trophic dynamic food web model that includes the main trophic components in deep waters of the Sound and b) identify information gaps where research needs to be directed. The completed model will hopefully help answer questions concerning LIS trophic dynamics and be applied to various management issues. The model can be built upon and use for simulating responses to various human and natural disturbances.

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SUMMERTIME RATES OF PELAGIC RESPIRATION IN WESTERN LONG ISLAND SOUND

As part of the Long Island Sound Integrated Coastal Observation System (LISICOS) research project, pelagic respiration rates were determined at four western Long Island Sound sampling stations, between August 2nd 2006 and August 5th 2006. Rates were measured at 10 and 20 meter depths for each station. Dissolved Organic Carbon measurements were conducted in conjunction with respiration experiments. Rates of respiration for each depth were determined by performing dark incubations in 300mL BOD bottle with 4 replicates per treatment. Bottles were placed in black bags and incubated in seawater to ensure complete darkness and steady temperature throughout the incubation period. Sample replicates were fixed at the start of each experiment, and were incubated for 12 and 24 hours. Oxygen levels were analyzed using a spectrophotometric modification of the Winkler method. Dark respiration rates were in the range 0.002 - 0.01 mg O_2 1^{-1} hr^{-1} and generally decreased with depth. Preliminary experiments indicated most of the respiration was due to bacteria and that an important substrate was recent local photosynthetic carbon.

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STATE GROWTH MANAGEMENT AND THE EFFECTIVENESS OF COASTAL MANAGEMENT PROGRAMS: A COMPARISON OF CONNECTICUT AND WASHINGTON STATE EXPERIENCES

This research provides a comparative focus in evaluating the effectiveness of state coastal management programs in protecting estuaries and coastal wetlands in Connecticut and Washington State. The latter has become a national leader in implementing its Growth Management Act (GMA) since 1990. The GMA has played a role in strengthening Washington State's pre-existing Shoreline Management Act. Connecticut has proceeded in its state coastal management largely in the absence of state-wide growth management legislation. Connecticut has relied on its Coastal Management Program, led by the Office of Long Island Sound Programs within the Department of Environmental Protection, to manage its coasts. The Connecticut Coastal Management Act of 1980 provides the primary authority for the state's comprehensive Coastal Management Program. The author poses the question of the relative value of state-level growth management legislation as an essential and integral legislative instrument for effective coastal management based on the Connecticut and Washington State experiences. Applying the evaluative approach of Good, Weber, and Charland (1999), Connecticut and Washington State coastal management programs are assessed by means of an indicator based-process to estimate: (1) the relative importance of the issue in each state; (2) the potential effectiveness of the programs, based on analysis of the policies, processes, and tools used; (3) on-the-ground outcome effectiveness based on an analysis of outcome indicators; and (4) the overall context-based performance for coastal management in each state.

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A COMPARISON OF THE NITROGEN ASSIMILATED INTO BIOMASS ESTIMATED FROM THE OXYGEN RATE OF CHANGE FOR TWO ESTUARIES: MUMFORD COVE AND NIANTIC RIVER.

Total ecosystem metabolism (TEM) was estimated for two embayments of Long Island Sound: Mumford Cove and Niantic River. TEM refers to the sum of the metabolic processes carried out by all organisms within a defined system and can be used as an indicator to assess the affects of changes in the driving forces of primary productivity, both natural and human-induced. TEM was estimated from the oxygen rate of change via deployments of automated unattended sampling instruments from 2002-2004. The instruments sampled at 15 minute intervals for deployments of 12 days at multiple stations within the estuary. The calculated TEM metrics included deployment averaged daily rates of ecosystem -net primary production, -gross production, and -respiration. While TEM is a useful integrated indicator of estuarine status, we were also interested in the amount of nitrogen fixed into biomass by the primary producers. To convert the oxygen produced to nitrogen fixed into biomass, data on the primary producers specific to each estuary were collected. Both estuaries are dominated by seagrass and macroalgae with relatively low phytoplankton and benthic microalgae biomass. C:N ratios were determined from samples collected over the three years and were used to create an estuarine specific O_2:N conversion based on the relative abundance of each of 4 groups of primary producers in the estuaries. Estimates of nitrogen assimilated into biomass were compared with modeled predictions of nitrogen loads from the watershed based on land use. The modeled nitrogen load was lower than the estimated nitrogen assimilated into biomass, indicating that the modeled values underestimate the amount of nitrogen available to the primary producers.

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TRACKING THE INVASION OF *PHRAGMITES AUSTRALIS* INTO A GREAT LAKES FRESHWATER ESTUARY

The invasion of *Phragmites australis* into the Great Lakes and its associated coastal wetlands is a recent phenomemnon. Few studies have documented its presence and tracked the invasion process from its early stages to subsequent large-scale plant community changes. This is in contrast to the numerous studies in the eustaries and coastal wetlands along the east coast of the United States. Using low altitude aerial photography and ground surveys we tracked the spread of Phragmites in the Old Woman Creek National Estuarine Research Reserve, a 60 hectare Lake Erie coastal wetland. Aerial photographs for the period 2002-2005 show a shift in the established mixed-emergent community structure to large monotypic beds of *Phragmites*. *Phragmites* currently occupies 30% (11 hectares) of the lower wetland and is also a significant component of the emergent community which covers 45% of the lower wetland. Declining water levels provided a foothold for *Phragmites* (invasive European type) and the plant community underwent a major shift in species composition. The floating-leaved *Nelumbo lutea* (American water lotus), the major species in the wetland from the 1970's through 1999 was replaced by emergents. *Phragmites* first appeared in the wetland in the 1980s establishing small stands on and around the beach. By the late 1990's *Phragmites* had spread to all areas of the wetland yet remained a minor component of the vegetation. Since the late 1990's Old Woman Creek has shifted from a predominantly open water system to a shallow water emergent system. This shift has coincided with a decline in Lake Erie water levels, which are now closer to the long-term mean.

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INTEGRATED MARSH MANAGEMENT (IMM): A HOLISTIC APPROACH TO WETLAND RESTORATION AND ENHANCEMENT IN CONNECTICUT

Following a diverse history that ran the gamut of decades of operational mosquito control in Connecticut, to elimination of the state's Public Health Vector Control Program in 1992, to reinstatement in the Department of Environmental Protection's Wildlife Division in 1993, the Wetland Habitat and Mosquito Management (WHAMM) Program promotes the concept of Integrated Marsh Management (IMM) for restoring and managing Connecticut's degraded wetlands and minimizing public health risks caused by mosquito-borne diseases. IMM is a holistic approach to wetland restoration and enhancement utilizing a variety of techniques to achieve site-specific goals. IMM takes into consideration the many aspects of wetlands restoration and management including mosquito control, invasive vegetation management, wildlife habitat enhancement, hydrologic modification, and fill removal. IMM projects can be relatively simple, with goals being achieved through minimal effort and cost while others can be very complex requiring input from many disciplines. IMM projects depend on diligent education and the formation of partnerships to share expertise, equipment and funding. The term, Integrated Marsh Management, is also offered as a means to help alleviate a semantics issue that sometimes occurs among agencies caused by the use (or misuse) of certain terminology used in wetland management such as open marsh water management (OMWM).

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Application of marine protected area design models in large estuarine systems with a focus on Long Island Sound

Marine protected areas (MPAs) are being explored as conservation tools in marine systems using different approaches, including MPA design models. However, there have been few attempts to model and assess potential MPA sites in large estuarine systems which have unique sets of factors that need to be considered in reserve design (e.g. strong physical, chemical and biological gradients). We are investigating how an MPA design model (MARXAN) can be applied to estuarine systems by modeling and assessing various MPA conservation scenarios in Long Island Sound. We are using sedimentary variables as a proxy for habitats that might support different benthic communities, and have tested model solutions based on differences in species richness and community representation inside and out of the modeled MPA sites. These analyses indicate that the nature of differences in ecological variables change along the large-scale estuarine gradient and that development of MPA and / or zoning sites can be confounded by sudh gradients. Multi-site scenarios appear to be better options, capturing changes in biotic communities along these gradients than single site solutions. Application to managemnt is discussed.