SPRING 2002 ABSTRACTS

Allen*, A., and J. Fegley. Corning School of Ocean Studies, Maine Maritime Academy, Castine, ME 04420

MORPHOLOGICAL CHARACTERISTICS AND BIOMASS DISTRIBUTION OF *ASCOPHYLLUM NODOSUM* AT DIFFERENT WAVE EXPOSURES.

Morphological characteristics and biomass distributions of Ascophyllum nodosum, a commercially harvested intertidal brown alga, were studied at a sheltered and exposed site in mid-coast Maine. Information from this study will be used to develop additional management strategies to promote the sustainable use of the resource. Plants were collected from Schoodic Point (exposed), ME and Wadsworth Cove (sheltered), Castine, ME during the winter of 2002. Plants were randomly chosen from the mid-intertidal zone approx. 10m to 18m from MLW. All plants with holdfasts within a 25cm x 25cm quadrat were removed (n=8 for Schoodic and n=7 for Wadsworth Cove). In the laboratory, plants were measured for maximum length, age, number and size of shoots, annual growth, and biomass distribution. Biomass distribution along the thallus was determined by cutting the plants into 10cm segments beginning at the holdfast and weighing each group. Preliminary examination of the data indicates there are significant differences in the morphological characteristics and the distribution of biomass along the thallus depending upon wave exposure. A. nodosum plants that grow in sheltered areas tend to be older, longer, and have more biomass distributed in the middle of the plant than A. nodosum that grows in exposed areas.

Altieri*, A.H., and J.D. Witman. Department of Ecology and Evolutionary Biology, Brown University, Providence, RI 02912.

DE-COUPLING OF TOP-DOWN AND BOTTOM-UP CONTROL DUE TO HYPOXIC DISTURBANCE IN NARRAGANSETT BAY, RHODE ISLAND

Predation pressure (i.e. top-down control) has been shown to control the lower depth distribution of the blue mussel (*Mytilus edulis*) in many areas of the world. Moreover, in many of these systems the distribution and abundance of many predator species are trophically dependent on availability of the highly productive mussels (i.e. bottom-up control). The opportunity to test the generality of these interactions arose in the winter of 2000, when a pulse of blue mussel recruitment covered large areas (over 7,200 m^2) of the benthos in Narragansett Bay to depths exceeding 10 m. The following spring we initiated a series of surveys and experiments at 3-16 subtidal sites on a scale of tens of kilometers designed to elucidate the relative importance of top-down and bottom-up interactions between blue mussels and their predators. Here we present several lines of evidence that suggest blue mussels did exert strong bottom-up control of predator distribution and abundance as predicted by previous studies.

However, during the period of our study we observed a massive die-off in the blue mussel population of Narragansett Bay that appeared to be of a strong and pervasive abiotic origin. Our results suggest that an intense period of oxygen depletion (hypoxia) in Narragansett Bay waters was responsible for this control of the blue mussel populations. In sum, it appears that while blue mussels can play an important role in the bottom-up structuring of the benthic community in Narragansett Bay, environmental stress in the form of hypoxic disturbance, rather than predation, drives the dynamics of the blue mussel population.

Bell, R.[1], R. Buchsbaum[2]*, C. Roman[3], and M. Chandler1. [1]New England Aquarium, Central Wharf, Boston, MA 02110; [2]Massachusetts Audubon Society, 346 Grapevine Rd. Wenham, MA 01984; [3]National Park Service, University of Rhode Island Narragansett, RI 02882.

INVENTORY OF INTERTIDAL RESOURCES OF THE BOSTON HARBOR ISLANDS, A NATIONAL PARK AREA

The Boston Harbor Islands, a new addition to the National Park System, encompass about 60 km of shoreline on over 30 islands. In 2001, we carried out an intertidal natural resources inventory designed to develop an intertidal zone classification scheme for the Islands, provide detailed intertidal habitat maps and summary statistics for 15 islands, compile species lists, and develop a list of potential management issues. The habitat maps were derived from field-based delineations using a Global Positioning System. Classifications were based on substrata and biotic communities. Mixed coarse sediment was the most common intertidal substratum in the islands. Mussel reefs were another frequently encountered substrate type, and Mytilus edulis was the most common biotic assemblage. Detrended Correspondence Analysis (DCA) showed a gradient in both substrata and biotic assemblages from the inner to outer islands with the outer islands more dominated by rocky intertidal assemblages. Ninety five species of animals, 70 marine algae, 15 vascular plants and three fungi were identified to the species level in the Boston Harbor Islands intertidal zone. Of the animals, 85 are native species, eight non-native, and two of unknown (cryptogenic) origin. Of the seaweeds, 66 are considered native and four non-native. The invasive species included the recent invasive crab, *Hemigrapsus sanguineus* but did not include *Codium fragile*. By comparing the lists from our survey to those of nearby locations, it is clear that more intertidal species will be found in the Boston Harbor Islands with continued observations.

Blasi*, J.C. and N.J. O'Connor. Department of Biology, University of Massachusetts-Dartmouth, North Dartmouth, MA, 02747

MARINE AMPHIPODS AS PREY FOR THE NON-INDIGENOUS CRAB, *HEMIGRAPSUS SANGUINEUS*

Ecological impacts of the non-indigenous Asian shore crab, *Hemigrapsus sanguineus*, are not yet known. Amphipods, numerous in the intertidal zone, are possible prey for this invasive

crab. This study is designed to determine whether amphipods are consumed by *H. sanguineus*, negatively affecting amphipod densities. Two methods, field manipulation and laboratory feeding trials, were used. A preliminary field experiment was performed by creating different densities of *H. sanguineus* in treatment plots with amphipods at ambient densities. After four weeks, the number of amphipods remaining in each plot was determined. Due to a loss of equipment in a storm during the pilot trial, the results of the fieldwork are not conclusive. Feeding trials showed that male H. sanguineus consumed amphipods under laboratory conditions. However, when substrate is present, the number of amphipods eaten decreased significantly. Future experiments, including additional field and laboratory work, are planned to determine the full impact of this invading crab upon marine amphipods, possibly altering food web dynamics and community structure.

Boucher*, J., K. Krecek, and S. Stoltz. Corning School of Ocean Studies, Maine Maritime Academy, Castine, ME 04420

INTERPRETATION OF OPAL IN SEDIMENT CORES: ESTUARINE CONSIDERATIONS

Opal accumulation is one of several proxies used to infer the history of primary production and eutrophication in marine environments. In this study opal and other biogenic sediments are examined in cores from three sites in Penobscot Bay, ME. Sedimentation rates of ~0.3 cm a-1 at all three sites are estimated from models of organic carbon decomposition. Additional similarities between sites include the total and organic phosphorus content of the sediments. In contrast, opal content varies up to threefold between sites. Bathymetry may account for some of the spatial variation; the shallowest site is colonized by benthic diatoms and is most enriched in opal. Trends in opal accumulation through time, if present, are not as apparent. Indeed, greatly different patterns of opal accumulation are seen in cores collected just 0.5 m apart. These data suggest that an opal-based sediment chronology may be difficult to establish for this estuary.

Boudreau, P. Dept. of Fisheries and Oceans, Bedford Institute of Oceanography, P.O. Box 1006,
Dartmouth, Nova Scotia B2Y 4A2, Canada

CONSIDERATION OF MARINE INVERTEBRATES IN HABITAT CLASSIFICATION AND ASSESSMENT

There is a need to develop a workable classification for marine benthic habitats to allow for collection, compilation and mapping for habitat. To do this successfully requires an understanding and agreement on the appropriate level of information for different biological and physical parameters. This presentation will provide a brief introduction to the results of the extensive work on marine habitat classification that has been carried out for European coastal and marine waters. The European system directly attempts to classify habitats from the high water mark down to the abyssal plain. Their use of some high level information on depth,

exposure, sediment type, etc., can be used to develop a hierarchical classification that can build on available information and direct future sampling. The talk will provide some comments on how such work facilitates the development of a useful habitat classification model for the Northwest Atlantic.

Bowen, M.1, K. Payne[1], C. Heinig[2], and K. Groves[3]. [1]Normandeau Associates, 253 Main St., Yarmouth, ME, 04096; [2]MER Assessment Corp., 14 Industrial Dr., Brunswick, ME 04011; [3]Casco Bay National Estuary Project, Univ. of S. Maine Law Institute, Box 9300, Portland, ME. 04103.

RESTORING AND SUSTAINING CLAM RESOURCES IN CASCO BAY, MAINE

One of the missions of the Casco Bay Estuary Project is to ensure communities around Casco Bay in Maine have a healthful shellfish harvest that sustains commercial and recreational shellfishing for generations to come. A "clam team' of stakeholders including the US Environmental Protection Agency, the Friends of Casco Bay, Maine Department of Marine Resources, individual cities and towns, and the Maine Department of Environmental Protection was formed to find the most productive shellfish areas currently closed to harvest, determine sources of contamination, and find ways to remediate. A field review of the 57 clam flats -800 acres- of soft-shell clam habitat that are currently closed to harvest targeted 22 of these, totaling 370 acres of highly productive clam flats. Review of water quality data pinpointed sources of contamination. Many of the flats are closed simply due to the presence of an overboard discharge (OBD) system that treats household waste. The project is currently supporting an intensive effort to design and construct replacement systems, a collaborative effort between the towns, state, and individual homeowners. Additional water sampling efforts are in progress to determine other nonpoint sources of contamination, including farm runoff, leaking septic systems, and wildlife. A third element of the project is investigating the sustainability aspect, investigating the effectiveness of regulatory options including licensing, harvest limits and techniques, and conservation closures. As part of this effort, we are conducting a clam seeding experiment, evaluating the effects of seed size, seeding season, sediment treatment, and netting effectiveness on the survival of clam seed.

Bozek*, C.M., and D.M. Burdick. Department of Natural Resources, Jackson Estuarine Laboratory, University of New Hampshire, 85 Adams Point Rd, Durham, NH 03824.

THE EFFECTS OF SEAWALLS AND BERMS ON SALT MARSHES: IMPLICATIONS FOR MARSH PERSISTENCE

The effects of man-made barriers, such as seawalls and berms, on salt marshes in the Great Bay Estuary of New Hampshire will be examined. Increasing human development near the coast, along with rising sea level, has resulted in the construction of seawalls and berms along much of the coastline. These barriers may have detrimental effects on adjacent salt marshes:

enhancing erosion and changing grain size distribution by reflecting wave energy; raising the fresh groundwater table; trapping wrack; and contributing to long term salt marsh loss through ?coastal squeeze.? The impacts of wave reflection, wrack burial, and altered groundwater flows on salt marsh communities will be assessed by studying sediment dynamics and plant populations along transects in areas with and without man-made structures. It is expected that changes to the plant community near seawalls and berms will be determined by the specific processes that may dominate a particular site. The process level results examined at specific sites will be interpreted in the larger context of the distribution of barriers in the Great Bay Estuary, and implications for the persistence of salt marshes adjacent to these structures will be assessed. Understanding the effects of seawalls and berms on salt marshes will help managers guide regulation of these structures in the future.

Burdick*, C.L., and F.T.Short. Dept. of Natural Resources, Univ. of New Hampshire, Durham, NH, 03824

AN EELGRASS MESOCOSM EXPERIMENT: EFFECTS OF WATER DEPTH ON INTERTIDAL AND SUBTIDAL EELGRASS SHOOT DENSITY, SHEATH LENGTH AND CANOPY HEIGHT

To answer the question of whether intertidal and subtidal eelgrass shoots should be transplanted at water depths similar to the donor site, a mesocosm experiment was conducted during summer 2001. Eelgrass collected from intertidal and subtidal sites was planted at equal densities into twelve flow-through seawater mesocosm tanks at three different water depths. Over the course of the experiment, the density of plants from both intertidal and subtidal sources increased, with no significant differences in density between plant source or water depth at the end of the experiment. At the start of the experiment, there was no difference between sheath length and canopy height in shoots from the same donor site, but a significant difference in these parameters between intertidal and subtidal plants. After 9-10 weeks, there was no longer a significant difference between the intertidal and subtidal plants' sheath length or canopy height. After 16 weeks, the intertidal and subtidal shoots at the same water depth continued to have similar sheath length and canopy height. There was, however, a significant difference in sheath length and canopy height between plants growing in the deepest and shallowest water. The sheath length and canopy height of plants collected from both intertidal and subtidal areas adjusted to the new water depths, indicating the phenotypic plasticity of eelgrass and suggesting that water depth is not critical in selected eelgrass donor sites for transplanting.

Businski, T.N., E. Renkene*, and C. Urban*. Department of Biology, Bates College, Lewiston, ME 04240

EFFECTS OF BAITWORM DIGGING ON INTERTIDAL BENTHIC CARBON REMINERALIZATION

We examined the effects of bait-worm harvesting, a major sediment disturbance on mudflats in

Maine, on benthic remineralization and community structure. Aerobic respiration rates were determined by tracking oxygen depletion over 12-24 hours from sealed sediment cores collected from dug and undug plots. We also determined macrofaunal biomass and abundance in order to estimate the contribution of macrofauna to respiration and to quantify community response to digging. Plots were dug in December and April. For plots dug in December, digging had no immediate effect on aerobic mineralization, but after one month remineralization rate was 90% higher in dug than undug plots (mean ± SE, undug: 78.4 ± 6.5 mgC m-2 d-1; dug: 148.5 ± 23.5 mg C m-2 d-1). Two months after digging, the remineralization rate for dug plots had recovered to the undug rate. The polychaete Heteromastus filiformis was the only macrofauna effected by digging; one month after digging it was twice as dense in the dug compared to the undug plots. We predict that the sediment community will respond to digging faster in April when water temperatures are warmer than in December. The response in mineralization rate to digging could be caused by a change in macrobenthic and microbenthic community structure in response to digging and/or by increased organic matter deposition caused by the more pronounced topography of dug areas. Our results indicate that digging has a significant effect on the fate of carbon in intertidal sediments.

Carmichael*, R. H., A. C. Shriver, and I. Valiela. Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543

USING N STABLE ISOTOPES TO LINK GROWTH RESPONSES OF COMMERCIALLY IMPORTANT BIVALVES TO LAND-DERIVED N LOADS

Quahogs and softshell clams live in shallow water coastal habitats that are susceptible to anthropogenic nutrient enrichment. We have found that as N load increases, phytoplankton concentration increases in the water column and at the sediment surface, providing more food for quahogs and softshell clams and increasing their growth. We linked this response of bivalves to anthropogenic N loads by using the N isotopic signatures in food, gut contents, tissue, and shells of transplanted and native quahogs and softshell clams. Through this analysis, we 1) defined the N source primarily mediating isotopic signatures of food supply for these bivalves, 2) identified the primary food source for quahogs and softshell clams, 3) quantified species- and tissue-specific incorporation of N isotopic signatures, and 4) determined a rate of signature acquisition for each species. These results allow development of a mass-balance approach to assess how N in food is assimilated by each species and how the assimilated N is processed into tissue, shell, feces and pseudofeces under different N loading conditions.

Cieri,* M.[1], B. Fry[2], L. Deegan[2], B. Peterson[2], J. Hughes[2], and C. Tobias[2]. [1]Maine Department of Marine Resources, McKown Point Rd. West Boothbay Harbor, ME 04575; [2]The Ecosystem Center, Marine Biological Laboratory Woods Hole, MA 02543

WHAT A DIFFERENCE A YEAR MAKES: USING STABLE ISOTOPES TO TRACK CHANGES IN AN ESTUARINE FOOD WEB

Estuaries are highly variable ecosystems on both temporal and spatial scales. On yearly scales, changes in precipitation can dramatically affect an estuary's hydrology, productivity, and the distribution of resident organisms. Results of these changes may be apparent in the food web and in how the system processes nutrients. Stable isotopes allow for the examination of nutrient and energy flows among trophic levels, and make possible the investigation of changes in the primary productivity of a system. We used stable isotopes (C13 & N15) to investigate the Rowley River Estuary, Massachusetts, under two different precipitation extremes: a dry (1999) and a wet (2000) summer. Salinity and an added conservative tracer (Rhodamine) were used to investigate residence time. Samples of primary producers (phytoplankton, benthic algae) and consumers (zooplankton, benthic invertebrates, and fish) were collected at different times and locations, analyzed for background C13 & N15, and compared. Lower than average rainfall resulted in low river discharges, high water residence times, and high phytoplankton productivity. Higher than average rainfall resulted in high discharge, low residence times, and low phytoplankton productivity. While the distributions of organisms were different between years, these fundamental changes in hydrology and primary productivity were not reflected in the background C13 & N15 for most organisms. This lack of change suggests that much of the pelagic productivity of the estuary was either exported or utilized by transient consumers.

Costa*, C. S. B., and J. C. Marangoni. Departamento de Oceanografia, Universidade de Rio Grande (FURG), C.P. 474, 96201-900 Rio Grande, RS. Brazil. docosta@furg.br

COMPETITION, PHYSICAL STRESS TOLERANCE AND HERBIVORY ROLES IN THE PLANT COMMUNITY OF AN IRREGULARLY FLOOED SALT MARSH

Dominant salt marsh plants of the microtidal and meso-oligohaline estuary of the Patos Lagoon (southern Brazil) show distribution over a wide vertical range with a high degree of overlap. The local occurrence of monospecific patches of the rhizomatous dominant *Spartina alterniflora*, *Scirpus maritimus* and *Spartina densiflora* along the lower/medium marsh border suggests interspecific competition as a determinant of plant distribution, but physiological tolerance may not be critical. Using reciprocal transplants, this study aimed to determine the relative importance of interspecific competition and physiological tolerance in shaping the marsh plant communities at the low/medium marsh border. Despite better vegetative growth on the medium marsh, the two *Spartina* species and *Scirpus maritimus* grew vigorously on the low marsh in the absence of neighbors. Intra- and interspecific competitions had a strong and symmetric effect on *Spartina* species throughout the low marsh/upper marsh border. Herbivory by the Grapsidae crab *Chasmagnathus granulata* had a significant effect on the growth of both Spartina species, and selectively excluded *Spartina alterniflora*, areas of *Scirpus maritimus* dominance.

Costa*, C. S. B., Copertino, M., Cunha, S. R., Knak, R. and Mazzo, A. M. M. Departamento de Oceanografia, Universidade de Rio Grande (FURG), C.P. 474, 96201-900 Rio Grande, RS. Brazil. docosta@furg.br

SALT MARSH PLANT ASSEMBLIES OF THE BRAZILIAN ESTUARINE NATIONAL PARK OF LAGOA DO PEIXE (RS, BRAZIL)

Salt marsh plants cover the extensive intertidal areas of 34000 ha large estuarine National Park of Lagoa do Peixe (southern Brazil). Salt marshes provide vital habitat and an important food source for Lagoon invertebrates and resident and migratory birds. Cluster Analysis using the visual cover of dominant plants as attributes classified 38 vegetational zones from 11 different sites of the lagoon into 6 plant assemblies; *Paspalum vaginatum*/*Cotula coronopifolia*, *Paspalum vaginatum*/*Spartina densiflora*, *Spartina densiflora*, *Paspalum distichum* and *Juncus acutus*/*Paspalum vaginatum*. The low species number (17) of marsh plants was related to the wide seasonal variation of water salinity and/or the low availability of nutrients in the sandy sediments. Tropical and warm-temperate elements of the flora characterize Lagoa do Peixe marshes as part of a biogeographical transition zone. Three biophysiographic groups of margins were distinguished between the more saline region (mean +/- standard-error = 29,7 +/- 4,7 g NaCl L-1), next to the single inlet in the central part of the lagoon, and the extremities, but particularly the northern one (16,8 +/- 1,7 g NaCl L-1). The three biophysiographic, dominated by medium (*Spartina densiflora*) and small size (*Cotula coronopifolia*) decumbent and small reptant plants (*Paspalum vaginatum* and *Paspalum distichum*), can be explained by different tolerance of their dominant species to salt water flooding stress and disturbance by extensive cattle and horse grazing.

Davis*, D.S. MIDI Society, c/o Collections Management Section, Nova Scotia Museum of Natural History, 1747 Summer St., Halifax, NS B3A 2M3 Canada

THE DEVELOPMENT OF THE MARINE INVERTEBRATE DIVERSITY INITIATIVE (MIDI) WEB-SITE AS A TOOL FOR MARINE EDUCATION AND CONSERVATION

For some years we have recognized the need for a comprehensive catalogue of marine invertebrates of the Northwest Atlantic coast. Our main references are a catalogue published by J.R. Whiteaves in 1901 and a new catalogue for the Gulf and Estuary of the St. Lawrence by Brunel et al, 1998. The current project focuses on the Gulf of Maine, Bay of Fundy, Scotian Shelf and the small, almost land-locked Bras d'Or Lakes. It includes all habitats from the high tide mark to the deep water of the continental slope and rise. The MIDI project is based upon an interactive website which includes the species list (currently about 800 species) and species profiles (currently 80 species completed). We have estimated that there could be 3500 species including meiofauna and pelagics and perhaps more with parasites. Also, references, localities, photographs and other illustrations are provided. Users can register with MIDI to contribute to or review the contents and there is also a place to post questions that others may respond to. We

know that addressing a wide audience while trying to maintain scientific integrity is a difficult task, for example in writing technical material in a way that it can be understood by non-technical people. We see many applications in various levels of formal education and in assisting people help monitor environmental change, (eg the occurrence of invasive species) and in the preparation of environmental assessments, but in particular to help people understand, enjoy and help conserve life in the sea.

Dennison*, T.H., L.E. Sahl, K. Krecek, and J. Boucher. Corning School of Ocean Studies, Maine Maritime Academy, Castine, ME 04420

PARTICLE COMPOSITION, DISTRIBUTION AND VERTICAL FLUX IN THE PENOBSCOT RIVER AND BAY

This study of particles in a river and a large estuary examines the effects of the river plume, storm winds, and waves on particle distributions and vertical flux. In the winter and spring of 2001 sediment traps were deployed at three locations; in the river, in the bay and in the transition zone between river and bay. At each location there were two moorings, and on each mooring one trap was positioned below the river plume and one immediately above the sea bed. CTD/transmissometer casts were done to determine water column structure and particle distribution. As determined by transmissometer data, particle concentrations were usually highest in the river plume and sometimes relatively high near the sea bed too. The suspended particles were mostly lithogenic with minor amounts of combustible organics, calcium carbonate and biogenic silica. This suggests that the sediment traps placed below the river plume measure mostly lithogenic particles that are the erosion products of the continent. The traps at the sea bed measure the flux of particles from the river plume, and the settling of particles due to in situ production and resuspension by currents and waves. Since the particles in the bottom traps are also mostly lithogenic, comparison of the flux from the plume to that at the sea bed shows considerable reworking of sediment in the river and bay. A comparison of sediment trap data show that flux in the river and bay was markedly increased during weeks when storms occurred. Higher fluxes were measured in the traps beneath the plume and those at the sea bed, indicating that both increased river flow and sediment resuspension played a part in the higher fluxes.

Dionne, M. Wells National Estuarine Research Reserve, Wells, Maine, 04090

INTEGRATED BIOLOGICAL MONITORING OF COASTAL HABITATS IN THE GULF OF MAINE: POTENTIAL APPROACHES AND FIRST STEPS

The environmental influence of human activity is increasingly apparent along the coast and within the estuaries and open waters of the Gulf of Maine. There is now a pressing need on the part of scientists and managers to track and assess the response of coastal habitats to human-mediated alteration. These alterations may be local, as in the case of coastal development and resource harvesting, or they may be driven by processes working at regional or global scales, as

in the case of invasive species and climate change. A number of groups currently monitoring various species and taxa throughout the Gulf, and others interested in monitoring, participated in a November 2001 workshop to discuss the value of an organized Gulf-wide biological monitoring network. A steering committee is now working to further develop ideas discussed at the workshop as a preliminary monitoring plan. This preliminary plan will further define the scope, goals, habitats, variables, methods and implementation of the monitoring program. The plan will hybridize existing Gulf of Maine monitoring efforts with a West Coast regional monitoring program known as PISCO. Similar to PISCO, a major feature of the plan will be the use of "larval collectors" to measure recruitment patterns of marine invertebrates, and the use of hydrographic parameters now being measured continuously by the Gulf of Maine Ocean Observing System (GOMOOS), and habitat parameters, to interpret these patterns. The MIDI database will be of great value in the development of the monitoring protocols, the identification of species observed once monitoring is underway, and the dissemination of invertebrate monitoring data and data products to a broad audience.

Duff*[1], E.B, R. Buchsbaum[1], A. Ridlon[1], and D.M. Burdick[2]. [1]Mass Audubon, Wenham, MA 01984; [2]University of New Hampshire, Jackson Estuarine Lab, Durham, NH 03824.

SALINITY AND *PHRAGMITES*: WHAT'S THE RELATIONSHIP? A PRELIMINARY ASSESSMENT FROM THE MASS AUDUBON SALT MARSH SCIENCE PROJECT

The MAS Salt Marsh Science Project is a unique collaboration among MAS staff, scientists, middle & high school students & teachers. Since 1996, students have helped collect data to examine salt marsh health in MA. Currently, 13 schools are monitoring 15 sites. Two major impacts to salt marshes are tidal restrictions and invasion by *Phragmites australis*. Since lower soil salinity due to restricted tidal exchange is thought to encourage its expansion, the program links sites with classes to monitor soil salinity and annual growth and spread of *Phragmites* at restricted and restored sites. Vegetation is monitored yearly for spread (point-line intercept method along permanent transects) and annual growth (heights of 2 tallest stems every 5 m) for year to year comparisons. Pore water salinity from wells is examined relative to 3 vegetation zones of transects: *Phragmites* dominated, transition and native plants. With tidal restoration, we expected salinity to increase and *Phragmites* to drop back on transects and decrease in height, as found at the restored Argilla Marsh. However, the student data do not show such a clear relationship. Salinity levels rose from 20 to 27 ppt at a tidally-restored marsh, but *Phragmites* maintained its position and grew robustly (264 cm height). A restricted marsh with hypersaline conditions (35 ppt) and a marsh with low salinity (7 ppt) show stunted, sparse *Phragmites* (128 and 111 cm in height, respectively). Results indicate the relationship between salinity and *Phragmites* vigor needs critical examination. Hydrologic & soil factors should be considered in restorations where increasing tidal flow and salinity is assumed to stop the spread of *Phragmites*.

Eberhardt*, A.L., and D.M. Burdick. Dept. of Natural Resources, Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH 03824

EVALUATION OF CULVERT IMPACTS AND TIDAL RESTORATION BENEFITS ON FISH COMMUNITIES IN NEW ENGLAND SALT MARSHES

Much of the salt marsh habitat that lined the New England coastline has been altered or destroyed, and many of the remaining systems are tidally restricted. Efforts have begun to restore the tidal regime based on flooding requirements of salt marsh plants. Many of the benefits of tidal restoration projects are fairly well known (e.g., changes to hydrology and vegetation structure), but higher order functions such as use and productivity by secondary consumers are not yet understood. It is well documented that salt marshes serve as important habitats for feeding, spawning, and refuge for many species of fish. However, the effects of tidal restrictions on fish use of New England salt marshes are poorly known. Furthermore, many marshes, restricted and restored, may have barriers significant for fish. Fish populations and movements will be examined in tidally restricted, tidally restored, and reference salt marsh habitats to evaluate and separate the effects of hydrologic barriers from fish barriers. Fish will be captured via minnow traps placed along the creek edges of restricted, restored and reference salt marsh areas. Minnow traps have been proven to be a successful method for mark recapture studies (rapid, simple, and high recapture rates). Captured fish will be identified, measured for length and biomass, marked via injection of acrylic paint, and returned to the marsh. Sampling will also be conducted in these areas with seines and lift nets to estimate fish populations. Results will help us understand how culverts affect the movements of fish, and provide quantitative information on fish populations and energy flow up the trophic structure of coastal systems when hydrology is restored to salt marshes.

Evans*, N.T., and F.T. Short. Dept. of Natural Resources, University of New Hampshire, Jackson Estuarine Laboratory Durham, NH

USING FUNCTIONAL TRAJECTORIES TO ASSESS THE SUCCESS OF TRANSPLANTED EELGRASS BEDS IN THE GREAT BAY ESTUARY, NH

Trajectory models were constructed to chart the functional development and evaluate the success of eelgrass (Zostera marina L.) beds transplanted for the New Hampshire Port Authority Mitigation project, Great Bay Estuary, NH. We examined two sites transplanted in 1993-94 and compared them to three nearby reference sites of naturally occurring eelgrass. Post-transplant monitoring has been conducted at the sites from 1993 through the present, representing the longest monitoring of an eelgrass transplant project in New England. To assess development trends, trajectory models of key functions were constructed for transplant sites vs. the mean and standard deviation of all reference sites, including primary production (biomass = g m-2), three dimensional habitat structure (leaf area and shoot density), and habitat use (density and diversity of fish and infauna). Biomass and shoot density values for transplanted beds were within 1SD of the mean of reference site values (defined here as functional equivalency) after 1-

4 years. After reaching functional equivalency, most parameters fluctuated above reference levels until 1999 when both transplanted and reference sites experienced an overall decline due to wasting disease. In 2001 both the transplanted and reference beds began to recover. Further monitoring at these sites may indicate if eelgrass beds recovering from a disease impact will follow the trajectory-predicted time course of development.

Fulweiler*, R.W., S.W. Nixon, B. Buckley, and S.L. Granger. University of Rhode Island, Graduate School of Oceanography, South Ferry Road, Narragansett, RI 02882

QUANTIFYING NUTRIENT LOADING FROM THE PAWCATUCK WATERSHED TO LITTLE NARRAGANSETT BAY

In order to quantify nutrient loading from the Pawcatuck Watershed, nitrogen, phosphorous and organic carbon fluxes have been determined using weekly, or more frequent sampling of the Pawcatuck River since December of 2001. The Pawcatuck Watershed (797 km^2, located in southern Rhode Island (80%) and Connecticut, is unusual for a southern New England coastal area because sixty-five percent of it remains undeveloped land, including over thirty-one percent classified as protected natural habitat. The Pawcatuck River (47 km long) drains this watershed until it meets tidal waters at the Pawcatuck River estuary and Little Narragansett Bay. Little Narragansett Bay is a shallow marine ecosystem that supports a wide variety of finfish, shellfish, and other invertebrates and is valued for recreation. However, a population increase in the river watershed of over twenty-percent in the last decade, combined with increasing demands on freshwater resources, is potentially degrading water quality. In Little Narragansett Bay recent ecosystem changes include increased macroalgae and a loss of submerged aquatic vegetation (SAV). Our sampling site was chosen to correspond with United States Geological Survey (USGS) which has been recording continuous flow data since 1940. The USGS also obtained water quality data, at varying intervals (monthly, bimonthly and quarterly), at this station from 1976 to the present. We will be able to compare the long-term USGS nutrient flux data with our more recent samples to document changes in the nutrient and carbon flux from the watershed to the estuary.

Gaeckle*, J.L.[1], B.S. Kopp[2], and F.T. Short[1]. [1]Department of Natural Resources, Jackson Estuarine Laboratory, University of New Hampshire, 85 Adams Point Road, Durham, NH 03824; [2]U.S. Geological Survey, Patuxent Wildlife Research Center, 26 Ganneston Drive, Augusta, ME

THE EFFECT OF INITIAL PATCH SIZE ON THE VEGETATIVE REPRODUCTION AND AREAL EXPANSION OF TRANSPLANTED EELGRASS (*ZOSTERA MARINA* L.)

Transplanting Eelgrass Remotely with Frame Systems (TERFSTM) is a habitat restoration method that involves securing eelgrass shoots to ballasted wire frames with biodegradable ties.

TERFS frames are deployed from a boat and hold shoots in place as they take root. Afterwards, frames are removed and reused. In the summer of 1999, as part of a large-scale eelgrass restoration effort, two sites in Outer New Bedford Harbor were transplanted with different size patches using TERFS frames. Preliminary results showed that patch size influenced patch survival, but its effect on areal expansion was inconclusive. In 2000, we investigated the effect of patch size on eelgrass areal expansion and shoot density by deploying TERFS singly and in clusters of four and nine. Patch size and shoot density were measured once a month for three months following transplantation, and seasonally thereafter. Fifteen months after transplanting, there were no significant differences in shoot density between the three initial cluster sizes. Single TERFS, however, showed significantly greater areal expansion compared to clustered TERFS. Rates of expansion for the groups of four and nine TERFS did not differ significantly. Our results demonstrate that transplanting eelgrass using single TERFS in an evenly distributed pattern will cover a restoration site through vegetative expansion in nearly half the time of clustered TERFS.

Gazda*, S.K., R.C. Connor, Department of Biology, University of Massachusetts Dartmouth, Dartmouth, MA 02747

EVIDENCE OF ROLE SPECIALIZATION AMONG FORAGING BOTTLENOSE DOLPHINS (TURSIOPS TRUNCATUS) OFF CEDAR KEY, FLORIDA

Observations of bottlenose dolphin (Tursiops truncatus) populations in different geographical locations have indicated highly diverse foraging strategies. One strategy off Cedar Key, Florida shows evidence of role specialization within two groups of dolphins. This is only the second well-documented case in mammals. In both groups, a particular dolphin takes the role of the driver, indicating a possible division of labor. The driver herds fish into circles, while nondriving dolphins wait for the fish to jump out of the water. Both nondrivers and driver capture fish in midair. In the TLFN group, the driver captures significantly more fish than the nondrivers. There was no significant difference in captures between the driver and nondrivers of the PNT group. The TLFN nondrivers captured significantly more fish than the PNT nondrivers, and the same result was seen between the two drivers. Group stability may be a reason why the TLFN group is more successful than the PNT group.

Geoghegan*, P.[1], and R.A. Sher[2]. [1]Normandeau Associates, Bedford, NH, 03110-5500; [2]North Atlantic Energy Service Corporation, Seabrook, NH, 03874

LONG-TERM TRENDS IN THE ICHTHYOPLANKTON COMMUNITY OF COASTAL NEW HAMPSHIRE

Ichthyoplankton collections have been made monthly since 1983 at two stations located about 2 km off the New Hampshire coast as part of the Seabrook Station Environmental Monitoring Program. Temporal trends in the ichthyoplankton community structure were evaluated by

cluster analysis (numerical classification) and non-metric multi-dimensional scaling (MDS) of the annual log(x+1) density of each taxon. Two major groups were found in the fish egg community. The first group contained the years 1982 through 1987 and the second group contained the years 1988 through 2001. Group 1 was characterized by relatively high densities of cod/haddock and hake eggs compared to Group 2. Densities of Atlantic mackerel, cunner/yellowtail flounder, hake/fourbeard rockling, and silver hake eggs were higher in Group 2. The fish larvae community was also divided into two major groups. Group 1 consisted of the years 1983 through 1988 and Group 2 consisted of the years 1989 through 2001. Group 1 in the fish larvae community was by relatively high densities of American sand lance, fourbeard rockling, Atlantic herring, and winter flounder. Densities of cunner were much higher in the Group 2 of the fish larvae community. Cluster analysis and MDS identified a major change in the ichthyoplankton in the late 1980s. Densities of eggs and larvae of some commercially important species such as Atlantic cod, haddock, and hakes, and winter flounder were reduced in recent years while egg and larval densities of other fishes such as Atlantic mackerel and cunner increased. The dynamic nature of the ichthyoplankton community is indicated through these analyses.

Giblin, A.E. The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA, 02543.

PRELIMINARY RESULTS OF THE ESTUARINE RESEARCH FEDERATION WORKSHOP: FACILITATION OF RESEARCH ON ESTUARINE RESPONSES TO CLIMATE CHANGE AND VARIABILITY

Coastal environments continually change because of the natural variability of climate and runoff and because of their sensitivity to small changes in sea level, and to variations in the intensity and frequency and storms. The rate of these changes may now be accelerating due to human induced climate change. In the 21st century, coastal ecosystems will face changes in nutrient loading, species composition and abundance, and sea level and temperatures that are greater than those measured over the last century. How will estuaries respond to these changes? A first step to helping answer this question is to identify critical gaps in our knowledge. In April a group of estuarine scientists met with climate scientists and social scientists to identify areas where we are lacking critical information that would help us better understand and predict estuarine responses to climate change and variability. In this talk, I will give the preliminary results of the workshop. I will present some of the highlights of current research findings from scientists examining this question and discuss the recommendations for priority research areas. Audience feedback is strongly encouraged.

Green*, M.A., P. Chapman, N. Charette, N. Dowse, A. Waleik, M. Jones, and C. Renaud. Department of Marine and Environmental Science, Saint Joseph's College of Maine, 278 Whites Bridge Road, Standish, Maine 04084

SPATIO-TEMPORAL PATTERNS OF CARBON REMINERALIZATION IN CASCO BAY ESTUARY, GULF OF MAINE.

Benthic remineralization rates and associated infaunal community activities were examined in Casco Bay Estuary from October 2000 to December 2001. Sediment cores were collected at monthly intervals at 5 subtidal stations throughout the estuary using a GOMEX Box-Corer. Incubation of sediments at in situ temperature show average TCO2 production rates from all stations that range from 1.75, 1.06, and 0.88 umol TCO2 cc sed-1 d-1 during summer in the 0-1, 1-2, and 2-3 cm surface sediments to 0.55, 0.29, and 0.11 umol TCO2 cc sed-1 d-1 during winter. These production rates correspond to depth-integrated production fluxes (0-10 cm) of 53.5 + 9.3 and 11.5 + 4.3 mmol TCO2 m-2 d-1 during summer and winter, respectively. The slopes of the natural logarithm of TCO2 production rates vs. absolute temperature yield average activation energies in the surface 0-1, 1-2, and 2-3 cm of 56.1, 58.8, and 80.8 kJ mol-1. Oxygen penetration depth (L-O2) in sediments yield average penetration depths of 1.86 + 0.38 mm during summer and 4.71 + 0.43 mm during winter, corresponding to O2 fluxes of ~40 and 14 mmol O2 m-2 d-1, respectively. Annual C/N ratios in sediment pore water range from 6-12, providing evidence for remineralization of labile carbon. Higher C/N ratios during winter correspond to periods of carbonate undersaturation and are in part due to dissolution of biogenic CaCO3. Estimates of Db made using Chl-a distributions range from ~0.05 to 0.1 cm2 d-1. Modelling of added Br- tracer in incubated sediment cores yield transport rates 1.5 - 10X that of molecular diffusion. Taken together, these data demonstrate high reactive-particle flux, intense bioturbation and rapid remineralization rates in sediments of Casco Bay Estuary.

Gullo,A.M.* and J.R. Moring. Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME 04469-5751.

THE VALUE OF ROCKWEED (*ASCOPHYLLUM NODOSOM*) AS HABITAT FOR TIDEPOOL FISHES

The guild of tidepool fishes includes both unique species and juveniles of commercially important fishes. Understanding the ecology of the intertidal zone is important due to the potential for negative human effects on the ecosystem. One such effect is the removal of algal species such as rockweed, Ascophyllum nodosom, for commercial use. Rockweed has been studied as habitat at high tide, but no research has been done to describe rockweed's role at low tide, in tidepool habitats. The questions addressed in this study are which species use rockweed as habitat, and what is the short-term effect of experimental rockweed removals? Nine tidepools were sampled at three sites in Maine: Quoddy Head, Great Wass Island, and Schoodic Point. Fishes were collected from the rockweed fringe and from open water habitat for comparison. Physical characteristics, along with algal and invertebrate composition, were recorded. Three samples were taken from each pool before assignment of treatments, which included a control with no removal, an intermediate removal, and a full rockweed fringe removal. Four samples were then collected. Preliminary results show 11 species and 422 individual fishes captured, with approximately 10% found in the rockweed fringe. Analysis of habitat use and its relation to other factors such as physical characteristics or invertebrate concentrations are discussed. The results not only provide information on unique and commercially important fishes, but also have

implications towards management of the rockweed harvest, now taking place on the Maine Coast.

Haas*, H.L.[1], L.A. Deegan1, and K.A. Rose[2]. [1]Marine Biological Laboratory, Woods Hole, Massachusetts, 02543; [2]Coastal Fisheries Institute, Louisiana State University, Baton Rouge, LA 70803

BUILDING A SIMULATION MODEL TO EVALUATE THE EFFECT OF FLOODING FREQUENCY AND DURATION ON MUMMICHOG PRODUCTION IN A NEW ENGLAND SALT MARSH

With continued advances in the computational power of personal computers and in the extent and resolution of spatial information, fine-scale and spatially-explicit simulation models are becoming more prevalent. Individual-based models use these technologies to examine ecological issues such as animal movement patterns, patchy distributions, and fine-scale changes in landscapes and climates. In this presentation, we provide an example of a simulation model which examines the effect of landscape patterns on shrimp survival, and we introduce an in-progress model which examines the effect of marsh flooding patterns on fish production. The shrimp model simulated the movement, mortality, and growth of individuals while in estuarine marshes. Relationships between shrimp survival and marshscape patterns were examined by overlaying the simulation on four habitat maps created from aerial photographs. Surviving shrimp grew faster, moved less, spent more time in vegetation, and experienced slightly higher local densities than shrimp that died during the simulation. Maps with more edge habitat supported higher simulated survival. The characteristics of surviving shrimp suggested that high-edge habitats increase survival by providing shrimp direct access to the benefits of vegetated marsh without the high-density cost that may be encountered in low-edge habitats. These results highlight the important role of marsh habitat in determining the recruitment of an estuarine-dependent species. A similar model is being developed to explore the effect of various marsh flooding regimes on the production of mummichogs in a New England saltmarsh. The authors are hoping to receive feedback on the preliminary design of the mummichog model.

Holton*, K.L.1, R.B. Jonas2, K. Marano Briggs2, J.E. Darga1 and D.J. Ellis1, 1Biology Department, University of Massachusetts, N. Dartmouth, MA 02747; 2Biology Department, George Mason University, Fairfax, VA 22033

NOVEL SULFIDOGENIC THERMOTOLERANT BACTERIA OBTAINED FROM SUBTROPICAL ESTUARINE BLUE HOLE

Bahamian blue holes, karst features similar to sink holes, have formed in the carbonate islands of the Bahamas. Tarpon Blue Hole, located in Stafford Creek Estuary on Andros Island, is a salinity- and sulfide-stratified estuarine blue hole. It has a surface salinity that ranges from near zero to 16 parts per thousand and a bottom salinity that reaches concentrations of over 23 parts

per thousand. The salinity stratification creates an isolated subpycnocline layer that is anoxic and sulfidic. Directly beneath the pycnocline, a dense red layer exists. Microscopic examination of this layer demonstrated the presence of a microbial community. Previous nvestigations revealed the presence of Desulfovibrionaceae and Dethiosulfovibrio species, suggesting that the microbial community may be actively involved in the biogeochemical cycling of sulfur. The elevated temperatures, high levels of sulfide and presence of sulfidogenic bacteria suggested that this system might be home to additional thermotolerant sulfide producers. A strictly anaerobic, thiosulfate-reducing bacterium, strain T3B, was isolated from the sediment-water interface of Tarpon. Strain T3B is a non-motile, non-spore forming, sheathed Gram-negative rod. Preliminary morphological and phylogenetic characterization indicated that strain T3B may represent a new species of Geotoga in the order Thermotogales, within the genus Geotoga. The isolation of two novel sulfidogenic bacteria from Tarpon blue hole suggests that estuarine sink holes may represent a source of undiscovered microbial diversity .

James-Pirri*, M.J.[1], and C.T. Roman[2]. [1]Graduate School of Oceanography University of Rhode Island, Narragansett, RI 02882; [2]National Park Service, University of Rhode Island, Narragansett, RI 02882.

A NEW NEKTON SAMPLER FOR SALT MARSH DITCHES

Excellent quantitative enclosure trap methods are available and widely used for sampling nekton in shallow subtidal marsh creeks, salt marsh pools, and intertidal marsh surface habitats. These methods provide repeatable estimates of nekton density and species composition. Ditches, created for mosquito control or to facilitate salt hay farming, are common features on salt marshes of the northeastern U.S., but currently available methods are not appropriate to quantitatively sample these habitats. To sample nekton in these narrow tidal channels we designed an enclosing ditch net. The ditch nets are adjustable to fit any size ditch up to 1 m wide, are portable, and relatively inexpensive to manufacture. The net encloses a known area of water so that quantitative estimates of nekton density can be determined. Additionally, several replicate samples can be taken at simultaneously. Fish densities in ditches ranged from 0 to 322 fish per m^2 and other nekton (shrimp, crabs) ranged from 0 to 960 individuals per m^2 indicating that ditches support high nekton densities and should not be overlooked during salt marsh monitoring programs. Comparison of composition and abundance between pool and ditch habitats will be discussed.

Keats*, R.A.[1], L.J. Osher[2], H.A. Neckles[3], B. Kopp[3]. [1]Ecology and Environmental Sciences Program, University of Maine, Orono, ME 04469; [2]Dept. of Plant, Soil and Environmental Sciences, University of Maine, Orono, ME 04469; [3]USGS Patuxent Wildlife Research Center, Augusta, ME 04330; USGS Patuxent Wildlife Research Center, Augusta, ME 04330

THE EFFECT OF NUTRIENT LOADING ON AN ESTUARINE FOOD WEB: A

STABLE ISOTOPE APPROACH

Coastal ecosystems worldwide face increased nutrient enrichment from shoreline and watershed development and atmospheric pollution. Our research formed part of a larger study by the US Geological Survey of the relationship between watershed development and ecosystem integrity within a small estuary dominated by the submerged macrophyte *Ruppia maritima* (widgeon grass) in Acadia National Park, Maine. We used a stable isotope approach to characterize the natural faunal community of the estuary and to determine the response of dominant estuarine consumers to nutrient enrichment using existing in situ experimental mesocosms. The estuarine faunal community is dominated by brackish water invertebrates including midge larvae (Chironomidae), oligochaetes, damselfly larvae (*Enallagma* sp.), amphipods (*Gammarus* sp.), ostracods, and water boatmen (*Trichocorixa* sp.), and fish (*Fundulus* sp.). Experimental nutrient additions changed the community of primary producers, with losses of *R. maritima* and increases in epiphytic and planktonic algae. Although increased nutrients did not significantly alter total invertebrate abundance and diversity, higher nutrient mesocosms had reduced densities of chironomids and greater densities of oligochaetes. Assessment of food web structure using stable isotopes showed a dependence of consumers on epiphytic algae and terrestrial detrital pools under both natural and enriched conditions. *R. maritima* and epiphytic algae became more enriched in ¹⁵N and *R. maritima* became more depleted in 13C in the enriched mesocosms. Experimental nutrient loading altered the composition and structure of the natural community in this estuary.

Kidder*, G. W. III[1], R. L. Preston[2], and C. W. Petersen[3]. [1]Mt Desert Is. Biol. Lab., Salisbury Cove, ME; [2]Dept. of Biol. Sci., Illinois State Univ., Normal, IL; [3]Coll. of the Atlantic, Bar Harbor.

BEHAVIORAL OSMOREGULATION IN KILLIFISH - PROSPECTUS FOR AN ECOLOGICAL, PHYSIOLOGICAL AND MOLECULAR STUDY OF FUNDULUS FROM NORTHEAST CREEK, BAR HARBOR

The killifish, Fundulus heteroclitus, is capable of surviving indefinitely in either sea water or fresh water. The reversed osmotic gradients between these conditions requires active salt transport in different directions and by different organs, which requires synthesis of transport proteins, consuming energy in addition to that required for active transport itself. We suggested that killifish could minimize their energy expenditure and maximize their fitness by choosing to inhabit water roughly isotonic to their blood. Some laboratory experiments show behavior consistent with this prediction, as do preliminary field data. We have also measured water movements with the energy supply restricted, and note that the apparent permeability is variable and seemingly controllable by the organism. Respirometry is being used to determine whether oxygen consumption is minimal in isotonic conditions, which one might predict. Finally, molecular studies have shown that at least one transport protein (CFTR) is up-regulated in the gill when fresh water fish are transferred to salt water. Other proteins and changes in other transport tissues (kidney, gut) remain to be elucidated. We can also determine the adaptive state

of wild fish by molecular examination. The investigators are from three institutions, and bring different expertise to the project. We will be working in association with 8 undergraduate students, who will live and work at MDIBL for two months during the summer, and continue their investigations at their home institutions (COA and ISU) during the rest of the year.

Kim*, A.K., and N.J. O'Connor. Department of Biology, University of Massachusetts Dartmouth, Dartmouth, MA 02747

THE ASIAN SHORE CRAB, HEMIGRAPSUS SANGUINEUS, AS A NOVEL FOOD SOURCE FOR THE STRIPED KILLIFISH, *FUNDULUS MAJALIS*

Hemigrapsus sanguineus is a recent invader of the U.S. Atlantic coast rocky intertidal shores, whose ecological impacts are little known. For example, predators of *H. sanguineus* have not been well identified. One potential predator of *H. sanguineus* is the striped killifish, *Fundulus majalis*, an opportunistic bottom feeder of sandy and pebbly substrates, whose diet includes crustaceans. Laboratory experiments were performed with and without a substrate (sand and rocks) to determine the ability of *F. majalis* to consume megalopae (postlarvae) and juvenile *H. sanguineus*. Results show that *F. majalis* can consume *H. sanguineus* megalopae and 1st stage crabs, but crabs greater than or equal to 3 mm in carapace width were rarely consumed. Although fewer 1st stage crabs were consumed when substrate was present, megalopae were eaten in large numbers regardless of substrate. Gut content analysis of field caught *F. majalis* had no evidence of *H. sanguineus* consumption; however, megalopae and 1st stage crabs may have been absent from the collection site. *F. majalis* may prey on megalopae and small juvenile *H. sanguineus* in the field, but crabs likely escape predation at relatively small sizes.

*Konisky, R.A., and D.M. Burdick, University of New Hampshire, Jackson Estuarine Laboratory, 85 Adams Point Road, Durham, NH 03824

TIDAL RESTRICTION AND RESTORATION: A SPATIAL SIMULATION MODEL OF DRAKES ISLAND MARSH (WELLS, MAINE)

Drakes Island is a 31 ha salt marsh within the Wells National Estuarine Research Reserve (Maine) with a long history of hydrologic manipulation. An undersized 0.9 m diameter culvert (with a flap gate pre-1988) controls tidal flow of the system, restricting tides and impounding freshwater. We have developed a spatial simulation model that integrates hydrologic, geologic and biologic processes in order to assess impacts of tidal hydrology on wetlands, and to predict changes associated with potential restoration. To configure the model for Drakes Island, data was collected according to the Global Programme of Action Coalition for the Gulf of Maine (GPAC) protocol, and stored in a spatial database of elevation, plant cover, salinity, sediments, and flood levels. Plant response to changing hydrology was based on a transplant experiment with six plant community types (salt marsh species Spartina alterniflora, Spartina patens, and Juncus gerardii, and the brackish invasive species Phragmites australis, Typha angustifolia, and Lythrum salicaria). A 20-year simulation of existing conditions predicted that Typha and Phragmites would dominate the marsh and exclude salt marsh plant species. Hydrologic

restoration scenarios were considered to a) add a second same-sized culvert 0.5 m lower in elevation and b) add the second culvert with a flap gate. Scenario modeling showed that the gateless culvert best improved tidal exchange, leading to increased Spartina alterniflora and Spartina patens. These results indicate that simulation models based on the GPAC protocol can be useful management tools for assessing tidal wetland restoration in the Gulf of Maine.

Logan*, J.M., L.A. Deegan, R.H. Garritt, and H.L. Haas. The Ecosystems Centers, Marine Biological Laboratory, Woods Hole, Massachusetts 02543

EVALUATING THE ACCURACY OF FORAGE FISH ABUNDANCE ESTIMATES IN A NEW ENGLAND SALT MARSH BASED UPON SEINE SAMPLING DATA.

Measurements of estuarine fish diversity and abundance have traditionally been based upon routine sampling of fractions of the population using capture gear such as beach seines. In the Plum Island estuary, we have conducted monthly seine surveys of forage fish diversity and abundance for selected years during the 1990's for comparison with a survey conducted by the Massachusetts Division of Marine Fisheries in 1965. Seine survey results demonstrate a trend of increasing forage fish abundance between 1965 and 1990's sampling dates. However, studies assessing seine sampling technique have demonstrated low and often variable catch efficiencies. These results suggest that trends observed in forage fish abundance based upon seine sampling data may be partially due to sampling error rather than actual abundance patterns. To determine the extent of sampling error in our current seine sampling protocol, we have designed an experiment to measure catch efficiency for the upcoming field season. We plan to enclose multiple sample sites with block nets and to conduct depletion and mark-recapture experiments using standard seine sampling technique within these enclosed regions. The enclosure sampling will be repeated several times during the field season. Seine catch efficiency experiments may also be coupled with experimental usage of alternative gear types such as throw traps and lift nets which may ultimately complement or replace seines in future surveys. We are seeking input on alternative sampling gear and our catch efficiency design.

MacKenzie, R.A. Wells National Estuarine Research Reserve, Wells, ME, 04090.

EMERGING INSECTS FROM A SALT MARSH SYSTEM IN SOUTHERN MAINE

Insects emerging from salt marsh habitat were quantitatively sampled during the summer of 2001 to document: 1) community structure, 2) the spatial and temporal distribution of these insects, and 3) how various human activities might influence these patterns (i.e., development, marsh management techniques). Samples were collected from the vegetated marsh surface and from standing pools of salt and brackish water on the marsh surface known as marsh pannes. Preliminary results revealed that more insects emerged from the vegetated surface 868 ± 148 no m^2 than from brackish water pannes (635 ± 42 no m^2) or salt marsh pannes (57 ± 23 no m^2) during the sampling period (end of May through end of August). Chironomids were the most

abundant insects emerging from the vegetated marsh and brackish marsh pannes and were largely represented by Chironomus sp., Tanytarsus mendax group, and T. recurvatus group. The tipulid, Liogma nodicornis , was the most abundant emerging insect from the salt marsh pannes. The vegetated marsh appeared to support the highest number of insect species compared to the brackish and salt water pannes, including the seaside dragonlet, Erythodiplax berenice, the salt marsh caddisfly, Limnephilus ademus, and an unidentified coenagrionid damselfly.

Manski, D. Division of Resource Management, Acadia National Park, P.O. Box 177, Bar Harbor, ME 04609

PROTECTING SHORELINE LANDSCAPES THROUGH CONSERVATION EASEMENTS; EXAMPLES FROM ACADIA NATIONAL PARK

Acadia National Park consists of widely dispersed parcels in and adjacent to the Gulf of Maine, including lands on Mount Desert Island, the Schoodic Peninsula, and offshore islands. Because of the close proximity and interspersion of private landholdings with Park property, the Park faces major challenges in the preservation and protection of its coastal resources. The National Park Service and it's land trust partners are using conservation easements to protect private lands surrounding the park in the Acadian Archipelago that have significant scenic, ecological, and cultural resource values. Acadia National Park holds conservation easements on 170 parcels totaling over 11,000 acres. This presentation will provide an overview of the park's land conservation program, give examples of private property that are now being protected through conservation easements, and discuss some of the future challenges to protecting shoreline and island landscapes that remain in private ownership.

Meltzer, K.R. Department of Biology Bates College, Lewiston, ME 04240

INTERANNUAL GROWTH RATE VARIATION IN THE SOFT-SHELLED CLAM, MYA ARENARIA, AND ITS RELATIONSHIP TO INTERANNUAL TEMPERATURE DIFFERENCES AND HABITAT AT MAQUOIT BAY, MAINE

Internal annual growth bands in the soft-shelled clam, Mya arenaria, were used to determine age and growth rates of individuals collected in different areas of Maquoit Bay, Maine. An annual standard index of growth (SGI) was developed for the years 1991 to 2001, using both the ontogenetic von Bertalanffy growth model with the (omega)parameter, and a linear regression model using slope. Interannual variations in growth were then related to interannual differences in air temperature and habitat (seagrass vs. mudflat). Mean summer air temperature was the best predictor of Mya growth rates, responsible for 67% of the clams' variation in growth. No spatial differences in growth were found in the bay. Mudflat clams, however, were found to grow 34% faster than seagrass clams. Seagrass in Maquoit Bay decreases water flow by 50% which may reduce food delivery to the seagrass clams, thus inhibiting their growth. Surprisingly, average lengths of clams from Maquoit Bay were 42%-60% greater than clams

from six sites in a 1980 Maine study. The large size of young clams at Maquoit Bay may be the result of unusually high abundances of food. Quantifing other variables, such as food abundance and annual ice cover, may give more insight into the environmental factors responsible for these increases in growth.

Mullan, C.P.*, Bertness, M.D., and Silliman, B.R. Brown University Department of Ecology and Evolutionary Biology, Box G-W, Providence, RI 02912

SHIFTS IN WETLAND COMMUNITY COMPOSITION ACROSS ESTUARINE SALINITY GRADIENTS: PHYSICAL AND BIOLOGICAL DETERMINANTS

Elucidating the mechanisms that generate species distribution patterns is critical to preserving landscape community structure and to predicting the effects of anthropogenic change to the environment. In estuaries, plant community composition changes dramatically from salt marshes near the coast to tidal freshwater marshes upriver. Current models of coastal marshes assume that salinity stress alone dictates the zonation of species along this environmental stress gradient, but this hypothesis has never been tested. We conducted reciprocal transplant experiments between salt and fresh-tidal marsh dominant plants with and without neighboring native vegetation to investigate the roles of physical stress and biotic interactions in controlling species distribution in a Rhode Island estuary. After one growing season, the salt marsh grasses Spartina patens and Spartina alterniflora transplanted into a fresh-tidal marsh with neighboring vegetation removed were performing as well as, or better than, in their native habitat, but were etiolated and dying when neighbors were included. Fresh-tidal marsh dominants, Typha angustifolia and Scirpus americanus, died within weeks of transplanting into a salt marsh regardless of neighbor treatment. These results indicate that competition for resources, in addition to physical factors, regulates the distribution of wetland plants across salinity gradients. In addition, results from this study suggest that the theory developed along vertical gradients in the intertidal, that superior competitors dominate physically benign habitats and displace weaker competitors to physically harsh habitats, may be generalizable to horizontal environmental gradients.

Mullaney, J.R.*[1], G.E. Schwarz[2], E.C.T. Trench[1], [1]U.S. Geological Survey, East Hartford, CT, 06108; [2]U.S. Geological Survey, Reston, VA, 20192

ESTIMATION OF NONPOINT NITROGEN LOADS FROM BASINS DRAINING TO LONG ISLAND SOUND USING MULTIPLE-LINEAR REGRESSION MODELING

A log-linear regression model (ESTIMATOR) was used to estimate annual nitrogen loads from 1988-98 for 28 monitoring stations in the Long Island Sound watershed. Nitrogen yield data from these estimates along with basin characteristics and ancillary data were used to develop a new generalized-least squares regression equation to estimate nonpoint nitrogen yields from

monitored and unmonitored basins. Statistically significant regression variables include time, population density, annual mean runoff (minus wastewater return flow), point-source nitrogen yields, percentage of basin area classified as recreational turf, agricultural land, and the ratio of deciduous to total forest area. Nonpoint nitrogen loads from monitored and unmonitored basins were computed using the regression equation by setting the point-source nitrogen yields and wastewater-return variables to zero, and incorporating streamflow information from index stations in or near unmonitored basins. Average nonpoint nitrogen yields from monitored and unmonitored basins ranged from 1,100 – 15,000 pounds per square mile per year. Annual estimated nonpoint nitrogen load from the study area ranged from 21 million pounds during 1995 to 50 million pounds in 1990. Nonpoint nitrogen load estimates can be improved with additional data collection, measurements of instream transformation or losses of nitrogen, improved reporting of total nitrogen concentrations from municipal wastewater-treatment facilities, and tracking of intrabasin and (or) interbasin diversion of water.

Murawski*, S.A. National Marine Fisheries Service, Woods Hole, MA 02543

USE OF LARGE-SCALE FISHERY CLOSURES IN FISHERIES MANAGEMENT AND BIODIVERSITY PROTECTION - A NEW ENGLAND CASE HISTORY

This paper describes the historical development, use, and consequences of large-scale fishery closures as a management tool for New England fisheries. Offshore closure areas were first initiated in 1970 as seasonal spawning closures for haddock on Georges Bank. Beginning in 1994, four large year-round closures totaling 30,000 km2 have been closed to fishing gears capable of catching groundfish stocks. The importance of this management tool in relation to progress in groundfish stock rebuilding is evaluated. Additionally, impacts of closures on other biota is assessed. Development of fishery closures as permanent measures for simultaneous management of resource species and as measures to enhance non-resource species protection can be viewed as a quantitative optimization problem - a framework for such considerations is presented.

Nutting, G.E. Maine Department of Marine Resources, West Boothbay Harbor, ME, 04575

THE GREEN CRAB - EMERGING SUSTAINABLE FISHERY OR TOTAL ERADICATION

The European green shore crab Carcinus maenas is an invasive species that severely impacts Maine's soft-shell clam (*Mya arenaria*) population. In the spring of 2001 the Maine Soft-Shell Clam Advisory Council initiated legislative action to create a "green crab only" fishing license. In order to develop an authorized trap, 13 experimental wire traps of various shapes, entrance designs, and mesh sizes were fished off the Department of Marine Resources (DMR) laboratory dock in West Boothbay Harbor; in the Scarborough, Kennebec, and Machias Rivers; and in Cobscook's East Bay. DMR dock (nine different trap designs) catch (numbers) per trap-haul trends indicated the cylindrical "eel" trap with a side entrance captured more crabs (28.0) when

compared to traps of other designs (2.0 to 8.5). The DMR dock traps CPUE of lobster by-catch, an important law enforcement issue, ranged from 0 to 2.3, with top entrance box traps competing successfully with a side entrance box trap. In the Kennebec River the CPUE of green crabs caught in box "eel" traps with a side entrance ranged from 39.7 to 289.7, mesh size 1.5 in. and 1.0 in., respectively. Box traps fished in the Scarborough River and Cobscook Bay had similar catch rates. These traps differed in volume and entrance designs. There was higher green crab CPUE at the Machias town landing (38.5) than at Machiasport (2.5) for the same trap design. The final approved trap design was limited only to 1) an entrance opening of 1.5 in. wide based on the height of the largest crab caught (Machias River) and 2) having an escape panel a minimum of 3.75 in. square.

O'Donnell, K. Brown University, Box 5374, Providence, RI 02912, Kerrie_O'Donnell@brown.edu

WHAT IS THE STATE OF NARRAGANSETT BAY? HOW WOULD YOU KNOW?

There is currently no agreement on whom or how monitoring data should be synthesized to evaluate the state of Narragansett Bay and the Bay watershed. Without a framework in place to translate monitoring data into ecosystem wide trends, scientists cannot know how effective conservation and management efforts have been, nor can they successfully inform policy makers and the public of changes in the ecosystem. After conducting a historical review of monitoring and indicator development in Rhode Island, I have found that a standardized and repeatable process to select indicators is lacking. Other organizations have developed indicator selection processes, yet often they are prohibitively complex. Therefore, in order to aide the Narragansett Bay Estuary Program, the Partnership for Narragansett Bay, and the University of Rhode Island's Coastal Institute in their efforts to develop a suite of indicators to evaluate the state of the Bay, I present and evaluate an indicator selection process that can serve as a preliminary screening process for available monitoring data. The goals of this evaluation are to suggest an appropriate indicator selection process, to highlight the most promising indicators, and to demonstrate different ways to present these indicators in order to communicate a comprehensive evaluation of the condition of Narragansett Bay.

Pakenham, A.*, and Paul E. Fell. Department of Zoology Connecticut College, KECK Research Grant, CT 06320

EXAMINATION OF MACROINVERTEBRATE POPULATIONS IN A RESTORING AND REFERENCE TIDAL MARSH USING SEVERAL SAMPLING METHODS

During the past 20 years the state of Connecticut has been restoring tidal flow to many formally impounded salt marshes, which has resulted in varying degrees of restoration. In August of 2000, tidal flow was reestablished to Mill Meadows, a 17-acre tidal wetland in Old Saybrook Connecticut on the upper reaches of the Oyster River, by the addition of a larger culvert and floodgate. During the summer of 2001, macroinvertebrate populations above and below the former impoundment were examined along 9 transects using quadrat, litter-bag, and pitfall trap sampling. Along the river, a salinity gradient, vegetation differences, and elevation differences

appeared to influence the invertebrate populations. However, there were few clear differences in animal populations that could be attributed to impoundment. Of the sampling techniques used, quadrats better-sampled gastropod mollusks, which comprised 93% of the total number of animals collected. On the other hand, litter-bags more effectively sampled arthropods, which comprised over 94% of the total animals sampled, and active fiddler crabs were captured using pit-fall traps. To adequately sample macroinvertebrate populations on marshes, it was found that multiple sampling techniques are needed.

Paul, A. and J. Fegley. Corning School of Ocean Studies, Maine Maritime Academy, Castine, ME 04420

COMPARISON OF COMMUNITIES OF PHYTAL ORGANISMS THAT LIVE AMONG ASCOPHYLLUM NODOSUM AND FUCUS VESICULOSUS

Coastal macroalgae provide habitat to a wide range of phytal organisms. *Ascophyllum nodosum* and *Fucus vesiculosus* are dominate brown algal species located in the intertidal zone on rocky coasts in the North Atlantic. Three plants of each, from three different locations, were collected and the phytal organisms housed in each of these seaweeds were identified and enumerated. Differences between the two types of seaweeds could be enough to cause differences in the communities of organisms. Thus, the surface area of each plant and the mass were quantified in order to standardize the numerical abundance of the phytal organisms based on the measures of habitat architecture. An Analysis of similarities was used to test for differences between phytal communities. Significant differences between the two types of seaweeds were found. There was also a significant difference in species richness. These results suggest that both dominate brown algal species have different communities of phytal organisms due to phytal preferences of habitat architecture and other components of the seaweed environment.

Pederson*, J., MIT Sea Grant college Program, 292 Main Street, E38-300, Cambridge, MA 02139

HITCHHIKE, SWIM, OR WALK: DISPERSAL OF NONINDIGENOUS SPECIES

Species may be introduced into new areas by shipping (ballast and fouling), aquaculture, fishing, recreational activities, research, aquarium shops, and other unique ways. Once in the marine environment, they may disperse by swimming, floating, walking, or hitchhiking (on boats, floating objects or other species). Some, but not all species, become invasive and may impact ecosystems and human health and wealth. The spread of species is best documented with macro-organisms, e.g., the green fleece alga, Codium fragile ssp. tomentosoides and the Asian shore crab, Hemigrapsus sanguineus, that are large and readily seen, but smaller species may be overlooked for years (e.g., the Asian skeleton shrimp, Caprella mutica and small phytoplankton). Managing introductions depends on identifying new intruders and responding appropriately. The challenge of properly identifying species, even macro-organisms is discussed in the context of ongoing monitoring activities in the northwest Atlantic along with their

strengths and weaknesses. NOAA is developing a pilot project that involves building a database for rapid identification of introduced species that, in turn, would lead to a rapid response and possibly eradication or containment of the unwanted non-native species. Other databases (e.g., MIDI, SERC, USGS) also identify nonindigenous species and are readily accessible to the general public to assist with early identification. How viable is this concept?

Roman*, C.T.[1], J.F. Heltshe[2], M.J. James-Pirri[3]. [1]National Park Service, University of Rhode Island, Narragansett, RI 02882; [2]Dept. of Computer Science and Statistics, University of Rhode Island, Kingston, RI 02881; [3]Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882

MONITORING SALT MARSH VEGETATION CHANGE: SOME THOUGHTS ON SAMPLE SIZE

Numerous initiatives are underway throughout New England to quantify salt marsh vegetation change, mostly in response to habitat restoration, sea level rise, nutrient enrichment, and other factors. Habitat mapping through aerial photograph interpretation provides information on broad vegetation changes, but if investigators require more detailed information then field-based plot sampling techniques are often used. To detect temporal changes in vegetation at a marsh or to compare vegetation among different sites with a degree of statistical certainty an adequate sample size is required. Based on 1 m2 vegetation plots from eleven New England salt marshes we conducted a power analysis to determine the minimum number of samples that are necessary to detect changes. If interested in detecting subtle changes between vegetation data sets (e.g., comparing vegetation in a marsh over two consecutive years), a sample size of 20 would provide a 90% probability (power, 1 - Beta = 0.9) of detecting a difference. With a lower sample size, and thus low power, there is an increased probability of not detecting a difference (e.g., Type II error). However, if investigators expect to detect major changes in vegetation then a sample size 5, 10 or 15 may be appropriate while still maintaining adequate power. There are other techniques to determine minimum sample size, but this power analysis will prove to be a useful guide for New England salt marsh investigators in determining sample size for research and monitoring on vegetation change.

Rozsa*, R.[1], and R.S. Warren[2]. [1]CT Department of Environmental Protection, Office of Long Island sound Programs, Hartford, CT 06106; [2]Connecticut College, Department of Botany New London, CT 06320

TIDAL WETLAND LOSS IN WESTERN LONG ISLAND SOUND: A REFLECTION OF RECENT SEA LEVEL RISE?

In the late 1980's the CT DEP received reports of a "dying" salt marsh in western Long Island Sound (LIS) along the Five-mile River, Darien, Connecticut. The wetland was polyhaline low

marsh wherein the normally tall (i.e., 1.8 m) and dense *Spartina alterniflora* was stunted, less than 0.3 m tall, sparse, and with praemose leaf tips. Today mud flat has replaced more than half the vegetated area of ca. 1970. Similar patterns of low marsh loss have since been documented in other western LIS, high tidal range (ca.2 m) systems. The largest single area of documented LIS tideland loss is in the mid-estuary position of the Quinnipiac River where over 80 ha of mesohaline marsh, dominated by *Typha angustifolia* and *Phragmites australis* (haplotype M), are converting to peat flat. Various causal factors that could drive such changes, ranging from chemical spills to goose eat-out, have been eliminated. Here we propose that a key factor contributing to these losses is an imbalance between marsh accretion and recent sea-level rise, which has increased hydroperiods beyond the limits tolerated by *S. alterniflora*, *T. angustifolia*, and *P. australis*. Loss rates were assessed using the image analysis extension to ArcView to perform on-the-fly wetland boundary delineation for a time series of false color infrared photography from 1974 to the present. Characteristics of submerging LIS marshes, rates of marsh loss, and sea level trends over the past quarter century are also presented.

Rutecki*, D., R.H. Carmicheal, and I. Valiela. Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543.

THE MAGNITUDE AND EFFECT OF COMMERCIAL HARVEST ON HORSESHOE CRABS, LIMULUS POLYPHEMUS, IN PLEASANT BAY, MA.

Atlantic horseshoe crabs, Limulus polyphemus, are currently harvested for the biomedical purposes, scientific research, and for use as bait in the conch and eel fisheries. In recent years, changes in population abundance and magnitude of commercial harvesting have raised concerns among coastal managers, researchers, and the public about the status of this resource and the economic and ecological effects of the harvest. We determined the number, size, and sex of horseshoe crabs collected by each of the three harvests from Pleasant Bay, MA, the largest estuary on Cape Cod in which horseshoe crabs spawn. We estimated the magnitude of mortality for each harvest relative to a census of the total population of horseshoe crabs in Pleasant Bay. The total 2001 harvest for all industries accounts for approximately 1-2% of the annual adult horseshoe crab mortality in Pleasant Bay. The size distribution of crabs harvested for the different purposes differed in the possible different effects on reproduction in the population.

Saltonstall, K. Dept. of Evology and Evolutionary Biology, Yale University, New Haven, CT.

NATIVE OR INTRODUCED? GENETIC VARIATION IN NORTH AMERICAN POPULATIONS OF *PHRAGMITES AUSTRALIS*

Over the past century, the distribution and abundance of *Phragmites australis* (common reed) has dramatically increased in both freshwater and brackish wetlands throughout North America. It has been hypothesized that the increased competitive ability of *Phragmites* could be the result of an introduction of a more aggressive genotype. This study compares historical and modern

Phragmites populations to determine if such an introduction has occurred. Sequence data from two non-coding regions of the chloroplast genome show that native haplotypes can be found throughout North America and population structuring by geographic region is evident. Today, one haplotype dominates the Atlantic coast and is found across the continent in lower frequencies; this type is also common throughout Europe and Asia. Comparisons of modern populations with historic samples show that in New England this cosmopolitan type has replaced native haplotypes and it is invading new sites throughout the rest of the country. These data suggest that a new strain of *Phragmites* has been introduced to North America and may be responsible for the rapid spread of the species over the past century.

Saarman, E., W. Prell, D. Murray, C. Deacutis, D. Kester, and C. Oviatt. Department of Geological Sciences, Brown University, Providence RI 02912

HYPOXIC CONDITIONS IN NARRAGANSETT BAY DURING THE SUMMER OF 2001

How hypoxic is Narragansett Bay? To address this question, we examined data from multi-institutional water quality monitoring surveys conducted in mid July, August, and September, 2001. Each survey is a snapshot (sampled in less than 7 hours) with the water column at over 70 locations throughout Narragansett Bay. Data collected continuously throughout the summer from the surface and bottom at 3 locations provided temporal context for the snapshot surveys. Narragansett Bay is a partially to well-mixed estuary and thus hypoxia is expected to be minimal. However, we found that hypoxic conditions were extensive and persistent in Upper Narragansett Bay during the summer of 2001. The hypoxic waters formed in shallow water near the head of the estuary and subsequently were advected into adjacent regions of the bay along surfaces of constant density. The isopycnal distribution of dissolved oxygen implies that the dominant source of hypoxic water was bottom decomposition and respiration due to high levels of organic matter and nutrient loading on the shallow flats near the head of the estuary. We observed that a high bottom oxygen demand and stratification of the upper 3 meters of the water column were both crucial for the development of hypoxia.

Shelley, P. Conservation Law Foundation, Rockland, ME 04841

INTRODUCTION TO MARINE PROTECTED AREAS: A LEGAL, POLITICAL AND HISTORICAL CONTEXT FOR CONSIDERING THIS FORM OF STEWARDSHIP

Unlike land, where the conservation vocabulary is rich with designations such as park, refuge, sanctuary, preserve, wilderness area, conservation land, and national or state forest, the marine vocabulary for habitat protection is poor. Marine Protected Areas (MPAs) serve many purposes, depending on their design, intent, and management, and can mean dramatically different things to different people. Worldwide, they have primarily been employed to conserve marine biodiversity. A second and perhaps more traditional purpose has been to manage the

exploitation of specific marine resources, often finfish. Finally, they serve as laboratories for improving resource management, providing benchmarks against which more disturbed areas can be evaluated. If desirable, all these objectives can be pursued simultaneously depending upon the design and management of a particular area. Currently, less than 1% of US ocean waters are fully and permanently protected from human activities, although sizable areas have been temporarily protected from specific activities. Given the ecological and economic importance of the Gulf of Maine marine system and the nature of its oceanographic, chemical, and biological interactions and interrelationships, a scientifically designed and functionally interactive system of fully protected MPAs merits serious scrutiny and analysis. While such a program, if implemented, would be a dramatic step relative to the status quo, expanding scientific evidence indicates that it would be a step in the right direction for the future. MPAs are the missing piece to a coherent and integrated approach to marine ecosystem management.

Short*, F.T.[1], R.G. Coles[2], M.D. Fortes[3], and E.W. Koch[4]. [1]Dept. of Natural Resources, Jackson Estuarine Lab., Univ. of New Hampshire, Durham, NH [2]Dept. of Primary Industries Queensland, Northern Fisheries Centre, Cairns, Qld 4870 Australia; [3]Marine Sci. Institute CS, Univ. of the Philippines, Diliman Quezon City 1101 Philippines; [4]Horn Point Lab., Univ. of Maryland Center for Environmental Science, Cambridge, MD

SEAGRASSNET: ASSESSING A CRITICAL COASTAL RESOURCE WORLD WIDE

SeagrassNet is a global monitoring program to investigate and document both the status of seagrass resources world wide and the threats to this important and imperiled marine ecosystem. The program started with an ongoing pilot study in seven countries of the Western Pacific and is now expanding to other countries; a globally applicable monitoring protocol and web-based data reporting (SeagrassNet.org) have been established. The goal is continued expansion of SeagrassNet to other areas of the globe and establishment of a network of monitoring sites linked via the World Wide Web by an interactive database. SeagrassNet's efforts to monitor known seagrass areas and to reconnoitre uncharted seagrasses are important first steps in understanding and sustaining the seagrass resource. Synchronous and repeated global sampling of selected plant and environmental parameters will reveal both human impacts and natural fluctuations in coastal environments throughout the world. The monitoring protocol includes assessment of basic plant parameters, including species identification, percent cover, biomass, density, canopy height along with photographic records, sediment samples, and long-term temperature and light data. At each site, a permanent transect is established and monitored quarterly so that changes in depth distribution of seagrass, the extent of the meadow, and species composition can be assessed over time. Scientists and managers at locations across the Western Pacific have now been trained in the protocol and are now actively sampling and submitting data electronically; other countries are starting to participate and further training workshops are scheduled.

Shriver*, A.C., R.H. Carmichael, and I. Valiela. Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA, 02543

GROWTH, CONDITION, REPRODUCTIVE POTENTIAL, AND MORTALITY OF BAY SCALLOPS, ARGOPECTEN IRRADIANS, IN RESPONSE TO EUTROPHIC-DRIVEN CHANGES IN FOOD RESOURCES

Anthropogenic nutrient enrichment of coastal waters is changing habitat and food resources of bay scallops, Argopecten irradians. As land-derived nitrogen enters estuaries, phytoplankton abundance, particulate organic matter, and the nitrogen content of seston could increase, providing a higher quantity and quality of food. Understanding these changes is important for monitoring declining populations or developing field aquaculture systems. To examine if changes in food resources due to nutrient enrichment will affect shell growth, condition, reproductive potential, and mortality, we conducted a field experiment in seven estuaries each having a different land-derived N load. We placed juvenile bay scallops within these estuaries for 12 weeks while monitoring food quantity and quality. Stable isotopic signatures suggest that scallops assimilated food from specific estuaries. Growth rates were relatively high and did not increase with higher phytoplankton concentration, suggesting that ambient phytoplankton concentrations were in excess of the assimilation ability of scallops. Growth rates decreased with low salinities, and where high densities of competitors (barnacles and slipper shells) had fortuitously settled on the scallops. Condition index significantly increased with higher growth rates. Gonad index and mortality did not relate to food resources, but mortality increased with lower salinity levels. Land-derived N load seems unlikely to directly alter condition, reproductive potential or mortality. These results suggest that estuaries undergoing anthropogenic nutrient additions may provide food concentrations above the maximum ration assimilable resulting in high bay scallop growth rates.

Spencer, L.T. Natural Science Department, Plymouth State College, Plymouth, NH 03264

A SEAGULL'S EYE VIEW OF THE MARINE ENVIRONMENT

Seagulls have a unique view of the marine environment. Unlike us Earth bound humans (unless one is Icarus or his son--and look at the problems they had), segulls view the shore's edge from high in the sky and determine appropriate dropping ground for urchins, snails and poop. This talk will demonstrate using satellite and other imagery the nature of the Mt. Desert marine environment.

Stefany, E. A.*, Department of Environmental Studies, Bates College, Lewiston, ME, 04240

COMPARISON OF MACROBENTHIC COMMUNITY STRUCTURE INSIDE AND OUTSIDE OF A ZOSTERA MARINA BED IN MAQUIOT BAY, MAINE

My study examines the effects of a large intertidal Zostera marina bed in Maquiot Bay, Brunswick, Maine, on infaunal community structure. Five stations were spaced evenly along a transect into the Zostera marina bed, with stations 1 and 2 in unvegetated sediment, station 3 on the edge of the bed, and stations 4 and 5 in dense grass. Shoot density increased with distance into the bed. Total infaunal density (individuals m-2) decreased as distance into the bed and shoot density increased. Density ranged from 30,000-70,000 individuals m-2 in unvegetated sediment and to as low as 800 individuals m-2 in dense grass. These differences are largely due to bivalve and polychaete density, as densities of other infauna and crustaceans were not significantly affected by station position. Percent Loss On Ignition (%LOI) increased as distance into the bed increased. The infaunal density pattern is, therefore, not likely a result of amount of food in the sediment. The infaunal pattern may be a result of differences in larval settlement as distance into the bed increases. These results differ from the findings from studies done on grassbeds elsewhere.

Taylor*, D. L., University of Rhode Island, Graduate School of Oceanography, Narragansett, RI 02882.

DETECTING JUVENILE WINTER FLOUNDER IN THE STOMACHS OF INVERTEBRATE PREDATORS WITH THE …UCHTERLONY IMMUNOASSAY

Year-class strength of the winter flounder, *Pseudopleuronectes americanus*, is believed to be determined at the post-settlement, juvenile stage, controlled primarily by invertebrate predation. From laboratory experiments, the sand shrimp *Crangon septemspinosa*, and the green crab *Carcinus maenas*, have been implicated as potential predators of recently settled winter flounder, but these predator-prey relationships have not been documented in the field. Visual estimates of a predator's stomach content have traditionally been used to verify trophic linkages under field conditions. Unfortunately, visual identification of invertebrate predator diets is hampered due to the mastication of food items by mandible and gastric mill grinding. As an alternative approach, biochemical techniques provide a reliable means of positively identifying prey proteins in a predator's stomach. The following investigation examines the effectiveness of the ?uchterlony double-diffusion immunoassay in detecting the presence of juvenile winter flounder in the guts of sand shrimp and green crabs. This procedure uses the highly specific binding and recognition capabilities of antibodies to identify immunogenic moieties present in the stomach contents of predators. Results indicate that certain antisera are effective in identifying flounder in invertebrate guts for up to 6 hours post-feeding without appreciably cross-reacting with predator tissue and other non-fish prey. The double-diffusion immunoassay is limited, however, in that it provides strictly qualitative results (i.e. presence/absence of prey) and the potential for false-positive and negative outcomes.

Watling, L. Darling Marine Center, Univ. of Maine, 193 Clark's Cove Rd., Walpole, ME 04573

MPAS AREN'T JUST FOR DEEP WATER: THE SCIENTIFIC VALUE OF ESTUARINE MPAS.

MPAs are becoming widely recognized as management tools in marine waters. Benefits include preservation of habitat, development of natural communities in the absence of human disturbance, and enhanced production of fish with spillover into adjacent areas. Within the United States estuaries are under increasing pressure from human activities and many are showing severe signs of stress. Protected Areas can be used to address some of the stressors, such as fisheries resource extraction, marina and other shoreline development issues, and aquaculture activities. However, most estuaries are enclosed to semi-enclosed so water borne stressors will have to be managed at a region-wide level. Recommendations for the establishment of Estuarine Protected Areas should follow those given by the World Wildlife Fund for MPAs.