NEERS SPRING 2004 MEETING

Abbe,J.,Z.Adams,R.Boumans*,J.Cerretti,J.Clark,T.Coe,J.DAgostino,B.Davis, K.Davis,G.deGooyer,S.DeLano,J.Errecart,C.Friede,E.Geczi,M.Hey,B.Huggett,B.Kirk,M.Kreider, S. Lovitz,K.McCutcheon,W.Morgan,L.Noa,J.Roberts,and S.Wheeler, The Rubenstein School of Environment and Natural Resources.The University of Vermont. George D. Aiken Center, 81 Carrigan Drive, Burlington, VT 05405-0088

EXPLORING THE POTENTIAL FOR INTEGRATED WATERSHED PLANNING IN THE LEWIS CREEK BASIN, VERMONT.

In today?s world, human impacts on ecological life support systems are increasingly complex and far-reaching. As a response, academia is shifting from addressing problems in isolation to studying whole, complex, interconnected systems and the dynamic interactions between the parts. Incorporating both biophysical and social dynamics makes these problems complex, difficult, and impossible to address from within the confines of any single discipline or scientific framework. This report is the outcome of a class in integrated analyses designed to address these substantial challenges. The class framework followed a trans-disciplinary approach to science and management by means of a case study. The objective was not to master a single set of tools to apply to a problem, but to become intimately familiar with the problem so that appropriate analytical tools could be negotiated among the class participants. The focus of our study was the natural processes and human activities that affect the Lewis Creek Watershed. The Lewis Creek Watershed encompasses seven towns, each of which have developed a town plan. To explore the potential for Integrated Watershed Plan we analyze the relationship between town?s conservation practices, town regulations, and town goals. Our comparison involved an analysis of consistency within towns between stated goals and actual practices in the form of zoning bylaws and subdivision regulations. We also developed matrices to look at cross-town comparisons of goals. Components of the matrices spanned economic, social and ecological disciplines.

Abdelrhman, M. A. USEPA Office Research and Development, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, 27 Tarzwell Drive, Narragansett, RI 02882

MODELING OF FLUSHING AND LOCAL RESIDENCE TIMES IN 42 EMBAYMENTS IN NEW ENGLAND, USA

A simple protocol has been developed to model tidal flushing and local residence times in large numbers of embayments quickly and reliably. Results are presented for 42 embayments in southern New England, USA. The methodology uses simplifying assumptions: calm winds, two-dimensional flow, and tidal forcing to simulate circulation, flushing times, and local residence times. Flushing time results for a subset of the systems compare favorably with published values. Colored maps illustrate spatial distributions of the local residence time within each embayment.

Local residence times are short near the seaward boundary and increase many folds toward the interior of the embayments. A set of relationships to empirically estimate flushing and maximum local residence times from the length and surface area of embayments in southern New England is developed from the modeled 42 embayments.

Ajaj, J. E.*, J. Eyzaguirre*, A. Rossi*, and D. J. Brousseau. Biology Department, Fairfield University, Fairfield, CT 06824.

DIETS OF THREE SHALLOW-WATER FISH IN LONG ISLAND SOUND: A FOCUS ON ASIAN CRAB PREDATION

This study examined the diets of three species of nearshore fish (common mummichog, *Fundulus heteroclitus*), striped mummichog, *Fundulus majalis* and cunner, *Tautogolabrus adspersus*) from two sites in western Long Island Sound during the period September-December 2003. All three species are omnivorous, but the type and range of food items consumed differed among species. *Fundulus heteroclitus* (N=232) had the most varied diet, consuming mainly green and brown algae, arthropods (shrimp, amphipods, insect larvae, crabs), and polychaete worms, whereas *F. majalis* (N=22) fed primarily on molluscs (*Gemma gemma*) and green algae. The primary food items found in the stomachs of *T. adspersus* (N=55) were algae and small crustaceans, mostly amphipods, shrimp and crabs. Small Asian shore crabs (4-5mm CW) were found in 17% of the *F. heteroclitus* stomachs with food and 7% of the *T. adspersus* stomachs. No Asian crabs were found in any of the *F. majalis* stomachs analyzed. The only brachyurans found in the stomachs of fish from these sites were Asian crabs. This study represents the first documented account of predation by *Fundulus heteroclitus* and *Tautogolabrus adspersus* on the recently-introduced Asian shore crab, *Hemigrapsus sanguineus*. Juvenile Asian crabs may provide an important new food source for small nearshore fishes as well as larger ones which forage in intertidal areas during high tide. Further studies are needed to assess the importance of fish predation in the regulation of Asian crab populations.

Baker, J. Massachusetts Office of Coastal Zone Management, 251 Causeway St. suite 900, Boston, MA 02114

THE MARINE INVADER DATABASE: A STRATEGY FOR TRACKING THE DISTRIBUTION OF INVASIVE SPECIES IN THE WATERS OF THE NORTHWEST ATLANTIC

Increasing threats from marine biological invasions in the Northeastern US and Atlantic Canada have led scientists and natural resource managers to intensify marine invasive species (MIS) monitoring efforts. These short and long term biological monitoring programs provide information essential for the effective management of MIS in the region. However, these data sets currently reside in a variety of locations and formats, resulting in an incomplete understanding of regional MIS distributions. In response to the need for a collective approach to MIS data management, the Northeast Aquatic Nuisance Species Panel and the Massachusetts Office of Coastal Zone

Management (CZM) have developed a Marine Invasive Species Database for the Northeast Region (MarineID). MarineID will serve as a central repository and clearinghouse for MIS occurrence data, allowing scientists and managers to contribute data online, and download relevant information. CZM and the Panel have developed MarineID through a partnership with the Marine Invertebrate Diversity Initiative (MIDI). MarineID has capitalized on a proven web enabled data management foundation laid by MIDI while expanding its online mapping, capabilities. This partnership will provide access to an existing network of researchers collecting biological data in the Northwest Atlantic. Effective implementation of MarineID will require participation from a broad array of area researchers. Project proponents have identified a limited number of relevant data sets for incorporation, and are actively seeking participation from those involved in biological monitoring efforts. Long-term success of the project will require buy-in from biological monitors throughout the region.

Brawley*, J.W.[1], D.J. Yozzo[2], W. Pabich[3], M. Fobert[4], and T. Benjamin[4]. [1]Battelle Memorial Institute, Duxbury, MA 02332, [2]Barry A. Vittor & Associates, Inc., Lake Katrine, NY 12449; [3]Tetra Tech EM Inc., 125 Cambridgepark Drive Cambridge, MA 02140; [4]M. Forbert, T. Benjamin, Rizzo Associates, One Grant Street, Framingham, MA 01701.

THE DEVELOPMENT OF A RESTORATION PLAN FOR THE WINSEGANSETT EAST MARSH, FAIRHAVEN, MA

Winsegansett East Marsh is an 80 acre salt marsh located on Sconticut Neck, Fairhaven, MA. A large portion (ca. 32 acres) of the existing high marsh, now dominated by invasive *Phragmites australis*, was studied in order to assess potential restoration activities that would halt encroachment of *P. australis*, enhance the native salt marsh plant community (e.g. *Spartina spp.*), and provide an increase in habitat quality for natant macrofauna. Based on the results of hydrological and vegetative investigations, a series of restoration options were developed. The design goals were to (a) increase the area of low marsh habitat and (b) control and/or reverse the invasion of *P. australis* within high and low marsh zones by increasing the frequency and duration of tidal flooding. This would largely be accomplished by improvements to the existing tidal drainage network. A historical review of the study area revealed that much of the existing *Phragmites*-dominated high marsh was once hardwood forest and/or forested swamp. Time-series analyses suggest that the Great Hurricane of 1938 was probably responsible for significant destruction and subsequent dieback of this forested area, leaving much of it vulnerable to *P. australis* invasion. Therefore, it is possible that this perturbation shifted the former ecosystem to a new, alternative state. This suggests that an "ecosystem enhancement" approach may be more appropriate for Winsegansett East Marsh than "restoration to historic condition" as the former state is not likely to be easily attained.

Calabretta, C. J. * and Candace A. Oviatt. University of Rhode Island Graduate School of Oceanography Narragansett, Rhode Island 02882

BENTHIC MACROFAUNA IN NARRAGANSETT BAY, RHODE ISLAND: AN

EVALUATION OF DIFFERENT APPROCHES FOR DESCRIBING COMMUNITY ASSEMBLAGES

Growing concern about the overall "health" of coastal ecosystems in the presence of both natural and anthropogenic stressors has lead to increased efforts to monitor and assess status and trends in environmental condition. Benthic invertebrates have become well established as useful bio-indicators of ecological quality in coastal and estuarine environments. This study compared data collected using two different methodological approaches for sampling macrobenthic community assemblages. The sampling programs analyzed were those used during the Marine Ecosystem Research Laboratory's Upper Narragansett Bay Benthic Study and those used during the U.S. EPA?s National Coastal Assessment (NCA). Inconsistencies identified between the results of each survey suggested that, at least in some instances, the method by which sediment is obtained for community analysis will affect the story told by the resulting data as to the status of the benthos. Three main factors were identified which should be considered during the design of programs for sampling macrobenthic fauna: (1)the method used for sediment collection; (2)temporal variability in macrofaunal abundance; and (3)spatial variability in macrofaunal distribution. Among the likely causes for the discrepancies between these studies was an underestimate of opportunistic fauna during the NCA sampling caused by the use of a van Veen grab for sediment collection. Taking into consideration trends in benthic community structure, it is likely that the effects of surface sediment displacement inherent with van Veen grab sampling would become most evident during the interpretation of data for assemblages of opportunist taxa while having little effect on the assessment of climax communities.

Casper*, A.F. and L.E. Johnson. Qu?bec-Oc?an and Departement de Biologie, Pavillion Vachon, Universit? Laval, Qu?bec, Qu?bec J1K 7P4, Canada

LIFE ON THE EDGE: GROWTH AND ECOPHYSIOLOGY OF *DREISSENA* IN THE ESTUARINE TRANSITION ZONE OF THE ST. LAWRENCE RIVER

The St. Lawrence Estuary has been receiving large inputs of larval *Dreissena* for over a decade -is there a negative impact? When assessing the ecosystem impacts of *Dreissena*, accurate growth/production estimates are integral but the flexible energy allocation common to bivalves complicates this; a change in shell length (a common surrogate for total growth) does not honestly reflect all components of mussel growth. In addition, the physically-chemically heterogeneous estuarine transition zone presents a variety of bioenergetic challenges that could limit establishment of significant zebra and quagga mussel populations (*Dreissena polymorpha* and *D. bugensis*). We compare the effects of divergent environments on mussel condition, shell growth, and as an honest indicator of somatic growth, RNA/DNA ratio of both species using a combination of field and laboratory experiments. Reciprocal transplants of mussels between the estuary and riverine sectors show the estuary is the most productive for this freshwater mussel. This counter intuitive finding is independently confirmed through controlled laboratory experiments showing highest growth under fluctuating (0-4 PSU) versus constant 0 or 4. However the caveat is that results are affected by method; shell growth suggesting differences that RNA/DNA ratio did not. Based on the integration of both methods/experiments we conclude that despite the ecophysiological challenges the estuary

poses for *Dreissena*, it appears to be a more productive environment for the mussel. We also speculate that there may be evidence of differentiation between river and estuary sub-populations. Three untested mechanisms could explain this, counter gradient variation, a reduced the contribution of drifting larvae to downstream populations, or local adaptation. Each of these mechanisms could counteract the strong selection pressure associated with either the St. Lawrence transition zone?s unidirectional gene flow and physiologically challenging environment.

Dahlen*, D. T.[1], S. Emsbo-Mattingly[1], C. Hunt[1], and K. Keay[2].[1]Battelle Memorial Institute, Duxbury, MA 02332;[2]MWRA, Boston, MA 02129.

COMPOSITIONAL CHANGES IN MASSACHUSETTS COASTAL SEDIMENTS ATTRIBUTED TO THE MWRA WASTEWATER DISCHARGE: A COMPREHENSIVE COMPARISON OF PRE- AND POST-DIVERSION PERIODS.

The Massachusetts Water Resources Authority (MWRA) conducts monitoring to address concerns related to the 2001 diversion of effluent discharge into Massachusetts Bay. This presentation will discuss the compositional changes in sediment contaminants and sewerage tracers that occurred before and after the new outfall came on-line. Baseline data from 1992 to 2000 showed multiple regions defined by physical and chemical composition. Near the Massachusetts Bay outfall, there is a series of heterogeneous sediments in relatively close proximity to, and roughly equidistant from, the primary historic source of contaminants (Boston Harbor). Factors that influence contaminant variability in the nearfield include local (Boston) and distributed sources, primarily related to gradients in depositional environments. In contrast, regional stations are spatially distributed throughout Massachusetts and Cape Cod bays, with some stations close to, and others distant from Boston. Factors that influence contaminant concentrations at regional stations distant from the harbor include distributed sources (e.g., atmospheric input). While increases in some contaminants were observed at some individual stations, sediment data suggest that effluent discharge at the outfall has not increased concentrations of contaminants of concern to the bay system. However, abundance of the sewage tracer, *Clostridium perfringens*, did increase at nearly all nearfield stations following outfall startup, suggesting that *C. perfringens* are an excellent early indicator of the response in the sediments to diversion of the effluent discharge.

Dettmann*, E. H.[1], R. B. Moore[2], K. W. Robinson[2], H. A. Walker[1], and J. B. Palter[3]. [1]U.S. Environmental Protection Agency (USEPA), ORD, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, 27 Tarzwell Dr. Narragansett, Rhode Island 02882, [2]U.S. Geological Survey (USGS), New Hampshire/Vermont District, 361 Commerce Way, Pembroke, New Hampshire 03275, [3]Duke University, School of Environment and Earth Sciences, Division of Earth and Ocean Sciences Durham, North Carolina 27705.

USE OF OUTPUT FROM THE NEW ENGLAND SPARROW MODEL TO ESTIMATE CONCENTRATIONS OF TOTAL NITROGEN IN ESTUARIES

The USGS SPARROW Model is a statistical model with mechanistic features that has been used to calculate annual nutrient fluxes in nontidal streams nationally on the basis of nitrogen sources, landscape characteristics, and stream properties. This model has been useful for assessment of water quality in stream networks. In this study, we explore use of output from an application of this model to New England watersheds, with higher spatial resolution than in the national model, for assessment of concentrations of total nitrogen in estuaries receiving these stream fluxes. Output from the New England SPARROW Model, calibrated using estimates of nitrogen sources and measured river fluxes in the early 1990s, was used with supplemental data on discharges by wastewater treatment plants into tidal areas, estuary flushing times, and nitrogen concentrations at the seaward boundaries, as input to a USEPA model to calculate annual average concentrations of total nitrogen in three New England estuaries: Narragansett Bay, Boston Harbor, and the Piscataqua Estuary. This USEPA model calculates annual spatially-averaged concentrations of nitrogen in an estuary using the nitrogen loading rate from the watershed and atmosphere, estuary flushing time, and concentration of nitrogen at the seaward boundary. We describe previous tests of the EPA model, perform a limited validation of the results of this application with nitrogen fluxes calculated by the SPARROW model, and explore the utility of this methodology in wider assessment of estuarine water quality.

Duff*, E.B.[1], R. Buchsbaum[1], and D. M. Burdick[2]. [1]Mass Audubon; [2]Jackson Estuarine Laboratory

INTEGRATING SCIENCE AND EDUCATION AT THE PLUM ISLAND ECOSYSTEM LONG TERM ECOLOGICAL RESEARCH SITE

Since 1996, Mass Audubon has been carrying out a K-12 integrated science and education program with schools in the Plum Island Sound Ecosystem. Under guidance of Mass Audubon, schools have set up their own transects to analyze vegetation changes over the long term and are also making measurements of porewater salinities and the fish community. Students have been engaged in research on the spread and impacts of invasive species, particularly *Phragmites australis* , in the salt marsh. Their studies are in parallel with those LTER and collaborating scientists. The goals of the project are to spark the students? interest in field science and enhance their understanding of a local ecosystem, to develop and enhance a sense of stewardship in local citizens, to create a regional network of students, teachers and scientists, and to provide teachers with support in teaching and meeting the goals of education reform. Teachers appreciate that students collect real data that are of value to the scientists studying the Plum Island Sound Ecosystem. The they are encouraged to integrate the framework of the salt marsh and the research into a number of related areas, such as writing, mathematics, and technology. Essential elements of the project are teacher trainings which instruct the teachers in the methodologies, hands-on help in the field by Mass Audubon education staff, input by scientists particularly with data analysis, an annual conference where students share their results, a website, and program evaluation. A recent evaluation carried out by Lesley University reported that the program had positive impacts on the students, teachers, and the community. Contact: Liz Duff lduff@massaudubon.org

Foertch*, J.F., J.T. Swenarton, and M. Keser. Millstone Environmental Laboratory, Dominion Nuclear Connecticut, Inc., Rope Ferry Rd., Waterford, CT 06385.

ROCKY INTERTIDAL COMMUNITY CHANGES (1979-2003) NEAR MILLSTONE POWER STATION, CONNECTICUT, RELATED TO LOCALIZED THERMAL INPUT AND REGIONAL FACTORS

Rocky intertidal species abundance and distribution (percent cover) were monitored bimonthly in permanently marked strip transects since 1979 at four sites near Millstone Power Station (MPS), Waterford, Connecticut, to assess impacts from the cooling water thermal discharge. Several analytical methods were employed to characterize spatial and temporal community variability, including time-series of abundance for selected species and multivariate techniques (cluster analysis and multidimensional scaling (MDS)). Thermal impacts were most apparent in the low intertidal zone immediately east of the discharge. During three-reactor operation, an expansive population of the opportunistic green alga *Codium*, a perennial *Polysiphonia* population, and periodically heavy sets of blue mussels replaced the low intertidal *Chondrus* population and its associated seasonal epiphytes near the discharge. *Codium* steadily declined following extended shutdown (1996-98) and restart of MPS, and is no longer a low intertidal dominant along this shoreline. Seasonally high abundance of *Hypnea musciformis* and expanded populations of *Sargassum filipendula, Corallina officinalis*, and *Gelidium pusillum* now characterize the discharge area low intertidal zone. In addition to the localized changes associated with the MPS discharge, this monitoring program has documented regional patterns and modifications to shore communities unrelated to MPS operation. These include the introduction and spread of an exotic red alga, *Antithamnion pectinatum*, decreases in barnacle abundance in recent years, and a long-term increase in abundance of the brown rockweed, *Fucus*.

Fredericks*, V. L., Williams*, K. E., and P.A. Morgan, Department of Environmental Studies, University of New England, Biddeford, ME 04005.

MONITORING THE EFFECTS OF A NEW DOCK ON A FRINGING SALT MARSH AT THE UNIVERSTIY OF NEW ENGLAND

This study is being conducted to monitor the effects of the construction of a dock in 2001 over a fringing salt marsh at the University of New England's Biddeford, Maine campus. Light levels were recorded at points under, adjacent to and far from the dock. Plant height, canopy structure and species density were also measured. Light levels were significantly lower under the dock compared to light levels adjacent to and far from the dock. Plant heights of *Spartina alterniflora* under the dock decreased in year two by more than two-thirds. Stem density of both *Spartina alterniflora* and *Spartina patens* also decreased from years one to three. No trends in canopy structure were observed over the past three years. We also saw lasting effects from trampling during construction. Although the area of impact from this dock construction may be small, the cumulative effects of many similar docks may result in more significant destruction.

Freeman*, C.J.[1,2], Haas,H.[1], Warren, S.[2], Deegan, L.[1], and Logan, J.[1]. [1] The Ecosystems Center, Marine Biological Laboratory Woods Hole, MA 02543 [2]Connecticut College, New London, CT 06320

WHAT MAKES MUMMICHOGS GROW?- THE RELATIONSHIP BETWEEN GROWTH RATES AND GUT CONTENTS OF *FUNDULUS HETEROCLITUS* HELD IN ENCLOSURES ALONG A SALINITY GRADIENT IN A NEW ENGLAND SALT MARSH

The mummichog, *Fundulus heteroclitus* , is a key member of estuarine ecosystems in the transfer of energy from tidal creeks and marshes to higher trophic levels and beyond the estuary. Mummichogs utilize the marsh platform at high tides, foraging heavily on marsh amphipods, isopods, insects, detritus, and algae for a significant portion of energy needs. This study used four $10m^2$ marsh enclosures, each stocked with individually marked mummichogs, along the salt (Site 1) to fresh (Site 4) salinity gradient of the Rowley River. Growth rates, gut contents, and stable isotopes of individual fish were collected at intervals during the growing season. At the first harvest (ca. 40 days), we transferred fish among sites to assess the effect of habitat change on growth rates. At this time, fish at Site 4 had the highest growth rates and Gut Fullness Index closely followed the rates at all four sites. Mean abundance of insects in the gut showed the clearest relationship to growth. Amphipods and isopods were common in guts only at Site 1; detritus and algae were most frequent at Sites 2 and 3, and insects were most common at Site 4. Changes in growth after transfer varied, probably reflecting both food availability and salinity change. $d^{13}C$ and $d^{15}N$ values of the fish from Site 4 reflect freshwater and terrestrial systems; closer to the mouth the values indicate increasing dependence on C from C_4plants and N from marine sources. The relationships found between growth rates and gut contents support the argument that detritus and algae are inferior quality food relative to invertebrates.

Graf, M.-T.* and G. L. Chmura Department of Geography and Centre for Climate and Global Change Research, McGill University, Montreal, Canada

JOHN LUSBY MARSH: A DIKELAND'S RETURN TO SALT MARSH CONDITIONS

John Lusby Marsh is a 600-acre salt marsh at the head of the Bay of Fundy. Diked by the Acadians in the late 1600s, the marsh was farmed for about 250 years. With the economic downturn of the 1930s and the subsequent labour shortage of WWII, the dikes in the marsh became neglected and eventually failed in the late 1940s. They were never rebuilt. Today, John Lusby Marsh is the largest contiguous parcel of salt marsh that remains in the Bay of Fundy and has been named a RAMSAR wetland of international importance. Historical documents lend important insight into John Lusby Marsh. Records and maps dating back to the 17th century, and a series of air photos from the 1930s to the 1990s, illustrate the marsh?s changing land use and geomorphology. They provide an interesting look at the unplanned and unmanaged restoration from agricultural dikeland to coastal wetland. Since dike breach, tides have deposited

approximately 1 m of sediments over the agricultural soils. Despite this, the marsh surface still retains striking evidence of human activity. The imprints of old field configurations and drainage networks are clearly visible on modern air photos, as are remnants of dikes, roads and wharfs. We can see that most first order marsh creeks follow channels that existed prior to diking; however, many of the smaller higher order creeks follow the artificial drainage network constructed to drain the dikelands. This type of historical record gives a valuable background and context for future studies.

Hale, S. S., Atlantic Ecology Division, U.S. Environmental Protection Agency, 27 Tarzwell Drive, Narrgansett, RI 02882

DEVELOPMENT OF AN INDEX OF BENTHIC CONDITION FOR COASTAL AREAS OF THE GULF OF MAINE

The National Coastal Assessment has sampled benthic assemblages each summer since 2000 in coastal areas of the U.S. Gulf of Maine. We are developing a multimetric index to be used as an indicator of benthic condition for both spatial comparisons of condition along the coast and for year-to-year comparisons. During the first two years, states (ME, NH, MA) sampled benthic assemblages at 182 stations with a 0.01-m2 Young-modified Van Veen grab and sieved the samples through a 0.5-mm mesh. We used stepwise and canonical discriminant analysis with several candidate metrics of benthic condition to develop a discriminant score that could distinguish between sites with low benthic environmental quality (BEQ, based on levels of sediment chemical contaminants, sediment toxicity, and dissolved oxygen level of the bottom water) and sites with high BEQ. We developed a discriminant function, using measures of diversity and community structure, that successfully classified 85% of the stations. Our next step will be to validate the index with independent data sets. The benthic index will provide environmental managers with a simple tool for assessing the health of Gulf of Maine coastal benthic communities.

Halterman, S.[1] and B. Howes[2]. [1] MA Dept. of Environmental Protection Watershed Management and Permitting, [2] School of Marine Sciences and Technology UMASS/Dartmouth.

THE ROLE OF THE MASSACHUSETTS ESTUARIES PROJECT IN ESTABLISHING NUTRIENT RELATED WATER QUALITY AND ECOLOGICAL HEALTH INDICATORS

The Massachusetts Estuaries Project is a collaborative effort between the MA DEP, SMAST, EPA Region 1 and other environmental groups and municipalities. The MEP Linked Watershed-Embayment Model is being used to determine critical nitrogen loads and assimilative capacities of estuaries from Duxbury, MA south to the Rhode Island border inclusive of Cape Cod, Martha?s Vineyard and Nantucket. The 89 estuaries targeted in this geographic area will have site-specific nitrogen thresholds or limits established as TMDLs based on a variety of biological, water chemistry, ecological and hydrologic parameters related to watershed development and the hydrodynamics of each system. This Project is developing linkages between watershed land uses,

N concentrations and estuarine ecological health indicators that will be used by the State to evaluate the relative health of marine environments. The monitoring of indicators such as the diversity and number of benthic infaunal communities, the health and history of eelgrass beds, macroalgae, and N regeneration from estuarine sediments will provide the information necessary for observing ecological responses to water quality changes that historically would have been based on simply water quality criteria. This information will be used by the MA DEP to generate nitrogen TMDLs for each estuary based on their intended uses. Monitoring to evaluate progress toward achieving designated uses in estuaries and related water body segments will be based on the response of indicators and water quality improvements. The Linked Watershed-Embayment model is providing a much needed management tool that focuses on an estuary?s assimilative capacity for nitrogen and the resulting ecological and habitat changes.

Heffner*, L.R. and A.M. Pregnall, Biology Department, Vassar College, Poughkeepsie, NY, 12604

EFFECTS OF HYPOXIA ON ALGAL GLUTAMINE SYNTHETASE ACTIVITY IN COASTAL POND CORES

Eutrophication increases the likelihood of hypoxia/anoxia in coastal ponds by stimulating the growth of algae, which consume oxygen at night during summer months. We examined ammonium assimilation via the enzyme glutamine synthetase (GS) of the green alga *Ulva lactuca* in cylinders containing coastal pond mud cores, seawater, and various amounts of algae (mats 10-30 cm thick) before and after hypoxic conditions were created in the laboratory. GS analyses were performed on algal samples from the top and bottom of the mats, and at the beginning and end of a 48-hour light incubation followed by a 24-hour dark incubation. Nutrient concentrations, oxygen levels, and temperature were also measured from the top to the bottom of the water column at the beginning and end of the incubations. The severity of hypoxia increased with algal mat thickness during dark incubations. Ammonium, phosphate and nitrate concentrations increased during hypoxia, while nitrite remained low. Algal GS activity decreased for all mat thicknesses during hypoxic conditions except for algae at the top of the thinnest mats (10 cm), which experienced the least-severe hypoxia. We speculate that *Ulva lactuca* survives hypoxic/anoxic events by slowing down physiological processes, then increasing GS activity after oxygen levels return to normal, thereby utilizing the sudden abundance of ammonium to further proliferate.

Hung*, G.A. and G.L. Chmura. Dept. of Geography (and Centre for Climate and Global Change Research), McGill University, 805 Sherbrooke St. W., Montreal, QC H3A 2K6.

THE IMPORTANCE OF GEOCHEMICAL NORMALIZATION IN THE INTERPRETATION OF TRACE METAL SEDIMENT DATA: AN EXAMPLE FROM SALT MARSHES OF THE BAY OF FUNDY

Trace metal variability in salt marsh sediments is used to infer the source and extent of anthropogenic pollution in estuarine systems. However, metals from both natural and

anthropogenic sources accumulate in salt marsh sediments, complicating interpretations of observed variability. Geochemical normalization is a technique used to separate the natural variability of metals from variability due to differences in anthropogenic inputs. We studied the accumulation of metals in surface sediments of seven salt marshes on the New Brunswick coast of the Bay of Fundy. These study sites geographically span the whole estuary, and thus encompass a wide range in sediment deposition (0.5 to 1.7 cm yr^{-1}), bulk density (0.5 to 1.3 g cm^{-3} and clay content (12 to 38%). In this presentation we use our measurements of lead to demonstrate the importance of normalization. Without normalization lead fluxes (micrograms cm^{-2} yr^{-1}) decrease from the head to the mouth of the Bay, suggesting lead pollution inputs are greatest at the head and decrease towards the mouth of the Bay. When normalized to lithium, however, lead fluxes did not follow the head-to-mouth trend but instead showed an exponential decrease with increased distance from the city of Saint John. The difference is due to greater clay content in sediments at the head of the Bay, which creates a greater capacity for metal adsorption. Lithium is generally not a pollutant and its abundance parallels clay content, thereby accounting for differences in grain size. Without normalization pollutant sources may be missed or misinterpreted.

Hunt, C. D.[1]*, B. Burgan[2], D. Keeley[3], and L. McLeod[1]. [1]Battelle, Duxbury, MA, [2]US EPA Ocean Coastal Protection Division, Washington DC, [3]Maine State Planning Office, August, ME.

DEVELOPING REGIONAL INDICATORS FOR COASTAL REGIONS? THE ATLANTIC NORTHEAST COASTAL MONITORING SUMMIT

In 2002, a workshop was held to develop a framework for a coordinated regional ocean monitoring network for US states and Canadian provinces bordering the northwest Atlantic Ocean. The workshop brought together environmental managers, scientists, and NGO?s to develop a strategy for an ecologically driven regional monitoring program to support the region?s environmental management and reporting needs. The workshop addressed information on current monitoring, regional concerns, and questions that should be answered by a coordinated effort. Discussions were guided by focusing on nutrients, habitat, and contaminants to address how the monitoring network might be organized and challenges and benefits that could come from coordinated regional monitoring. The conveners developed a plan to further develop the program, obtain seed money, and establish critical involvement from key groups. One of these was to hold a second workshop to determine indicators for the region in support regional and national *State of the Environment Reports*. The indicators workshop, held in January 2004, reviewed previous indictor development efforts lessons learned, identified key issues (fisheries, eutrophication, contaminants, land use, aquatic habitat, and climate change) requiring indicators, and developed key questions and indicators necessary to convey the status of the environment in this region. The process followed for these workshops provides a model for developing regional information that supports environmental policy managers and the growing consensus on the need for integration of coastal information at regional and national scales. The key questions and indicators developed will be discussed in this presentation.

Kelly, S.J. Department of Biological Sciences, University of Rhode Island, Kingston, RI 02881

THE ESTIMATION OF AGE-SPECIFIC DEMOGRAPHIC PARAMETERS FOR SCUP, *STENOTOMUS CHRYSOPS*, IN LONG ISLAND SOUND

Identifying environmental and demographic processes that account for fluctuations in the abundance of organisms is a central goal of population ecology. In many cases, specific ages or stages have the largest influence on population growth rate and population size, but few estimates of age- or stage-specific demographic rates exist for many species. The goal of this study was to determine the demographic structure of the commercially important fish, *Stenotomus chrysops* (scup) in Long Island Sound by identifying the appropriate population age structure and estimating age-specific vital rates using the Long Island Sound Trawl Survey (LISTS) census data. I evaluated the strength of evidence in this data for alternative age-structured models of scup using maximum likelihood estimation and information theoretics. The best approximating model incorporated age-specific survival parameters and age-specific fecundity estimates. Environmental factors and density dependence were also analyzed separately, using a subset of the LISTS data. Significant density dependent effects on the population size were found. Temperature and salinity were found to have a weaker, negative effect. Results from a subsequent elasticity analysis indicate that the population is growing (lambda = 1.07) with the survival of age 1 and 2 individuals and the reproduction of age 3 individuals having the greatest influence on the population growth rate. This suggests that management should emphasize the protection of ages 1-3 in order to maximize survival and allow individuals the opportunity to reproduce once prior to becoming susceptible to the fishery.

Kremer, J.* and J. Vaudrey.

SYSTEM METABOLISM USING A(NOTHER) MOORED WATER QUALITY PROFILER IN SHALLOW EMBAYMENTS

Diel oscillations in oxygen can yield measurement of total system metabolism, which may be a useful indicator or eutrophication status. However, spatial structure including vertical patterns complicate the design of an appropriate sampling strategy. An automated profiler using the YSI 6600 water quality sonde has been developed that records profile of a suite of variables at closely spaced intervals in shallow coastal waterbodies. Even in quite shallow (1-2m), strongly tidal systems, pronounced vertical structure is often seen. Recent time series of profiles demonstrate large diel and tidal variations in the O2 profiles that have implications for calculations of total system metabolism. Differences in closely spaced profiles (~ 5 mins) suggest large, fast internal displacements perhaps associated with internal waves.

Liang, S.-Y., D. Hersh, and W. Leo*, Environmental Quality Department, Massachusetts Water Resources Authority, Charlestown, MA 02129.

MANAGEMENT AND USE OF A LONG-TERM WATER QUALITY MONITORING

DATABASE FOR BOSTON HARBOR AND MASSACHUSETTS BAY

The Massachusetts Water Resources Authority (MWRA) maintains an extensive environmental database, which consists of long-term monitoring data for Boston Harbor and Massachusetts Bay, and effluent testing data for MWRA treatment plants and combined sewer overflow treatment facilities. While most of the monitoring data have been collected by MWRA and its consultants during the past decade, other water quality data collected by state agencies and other organizations are included in the database. Seven major categories of monitoring data in the database are: water quality, benthic infauna, sediment contaminants, fish and shellfish chemistry and pathology, effluent chemistry, and plankton abundance. Ancillary information such as tidal data, weather data and GIS spatial data are also included. MWRA monitoring data were collected under stringent quality assurance and control following the Deming/Shewhart model for quality management. Data from other sources must be thoroughly documented. All data are stored in an Oracle relational database management system in which data integrity is maintained through automated database constraints. Additional checks are made upon data loading to identify possible study-specific errors. These checks are continually updated and corrections are made both to new data and retroactively. The database has been used intensively for management and decision making internally, for compliance with MWRA?s discharge permit and court orders, and also serves as a data warehouse for the academic community interested in the ecology and physical characteristics of Boston Harbor and Massachusetts Bay. Examples of the data use are given.

Mansfield*, A.M., C.D. Hunt, and C.S. Albro, Battelle, Duxbury, MA, 02332

PLUME TRACKING: LEADING TECHNOLOGIES FOR MONITORING OUTFALL DILUTIONS AND SEDIMENT RESUSPENSION

Today?s stringent NEPA and NPDES regulations require comprehensive, highly defensible evaluation of potential environmental impact. The foundation of these evaluations must be built on the highest quality data. It has also become increasingly evident that high resolution plume tracking and dilution studies can contribute significantly to defensible NPDES evaluations. Battelle has developed and applied technology that can provide fine scale measurements of both sediment and effluent discharges. This plume tracking system employs real-time *in situ* data on water quality characteristics, plume behavior, and the ability to simultaneously obtain water samples for other water quality measurements. Battelle?s towed system?s ability to integrate *in situ* measurements with continuous water collection in real-time provides unparalleled accuracy for mapping water quality characteristics in space and time. The *in situ* array typically includes measurements of depth, temperature, salinity, turbidity/transmissometry, chlorophyll a, dye, DO, pH, bathymetry, and DOM, but can easily be modified to suit specific project needs. The utility of this system will be demonstrated through the presentation of representative recent plume tracking efforts. Highlighted projects will include NPDES certification of Boston?s offshore outfall system, characterization of cruise ship discharge streams, and dredge resuspension in the Northwest and Northeast. These programs have highlighted Battelle?s ability to measure dilutions down to 1:3200 and track plume behavior on time scales from minutes to several days. These systems are redefining the way science and public agencies address compliance programs.

Neckles*, H. A., and B. S. Kopp. US Geological Survey, Patuxent Wildlife Research Center, 196 Whitten Rd., Augusta, ME 04330.

THE NATIONAL PARK SERVICE VITAL-SIGNS MONITORING PROGRAM: REGIONAL PROTOCOLS FOR TRACKING ESTUARINE NUTRIENT ENRICHMENT

The National Park Service (NPS) has initiated the Vital Signs Monitoring Program to track indicators of park ecosystem condition within 32 biogeographic networks of parks. Along the U.S. Atlantic coast from Maine to Virginia, the NPS Northeast Temperate Network and the Northeastern Coastal and Barrier Network contain nine parks with significant estuarine and coastal resources. An integrated monitoring program focused on important park ecosystems and stressors is currently under development in this region, and is scheduled for implementation in 2005. The program includes regional protocols for monitoring estuaries, salt marsh vegetation and nekton, shoreline change, visitor impacts, and land cover. The estuarine monitoring protocol is focused on detecting causes of and responses to nutrient inputs, which NPS resource managers cite as one of their highest priority issues. The protocol includes indicators of both nutrient load (e.g. land use, point-source discharges) and estuarine response (light attenuation, dissolved oxygen concentration, suspended chlorophyll concentration, sediment organic carbon, benthic invertebrates, seagrass distribution, and seagrass population parameters). The approach to monitoring water-quality response indicators combines use of spatially discrete and continuous sampling during a summer index period. A preliminary pilot test has shown the importance of continuous monitoring to supplement weekly spatial surveys. The indicator set and spatial sampling designs are compatible with those of EPA?s National Coastal Assessment, which will allow integration of long-term estuarine monitoring data between these two federal programs.

Neubert, M. G. Biology Department MS 34, Woods Hole Oceanographic Institution, Woods Hole, MA 02543-1049.

MARINE RESERVES AND OPTIMAL HARVESTING: CHARGOGGAGOGGMANCHAUGGAUGGAGOGGCHAUBUNAGUNGAMAUGG

It is widely agreed that marine reserves provide significant conservation benefits. Their use as a fisheries management tool is, however, more controversial. Analysis of a simple, spatially-explicit, generalization of the classic Schaefer harvesting model using methods from optimal control theory shows that no-take marine reserves are an integral component of a harvest designed to maximize yield. The nature of the optimal harvest is sensitive to the habitat size, the population growth rate, and the dispersal ability of the fish. In some cases, it is a ``chattering control' with infinite sequences of reserves alternating with areas of intense fishing. The optimal harvest generates a spatial source-sink structure, and source populations are always placed in reserves. When the optimal harvest is difficult to implement, an approximate yet practicable policy can be constructed.

Noel, P.E., G.A. Hung, E. L. Heller and G.L. Chmura Department of Geography (& Centre for Climate and Global Change Research), McGill University, 805 Sherbrooke St. W.; Montreal, QC H3A 2K6

SEARCH FOR THE RECLAMATION SURFACE OF A RECOVERING DYKELAND: SAINTS REST MARSH, SAINT JOHN, NEW BRUNSWICK

Saints Rest marsh has a complicated history. Dyked sometime between 1786 and 1864 the marsh was first managed mainly for pasture and hay production. Barns were constructed in the marsh, roads traversed it, and forestry and gravel extraction occurred in the adjacent upland and beach. Sometime prior to WWII the marsh was greatly modified as a military shooting range. Subsequent abandonment in the 1950?s resulted in the dyke falling into disrepair and eventually being breached. Currently a sewage treatment plant discharges at the head of the marsh creek. Now, the largest salt marsh in Saint John, Saints Rest is part of the Irving Nature Park. Saints Rest Marsh is a natural laboratory in which to study the process of recovery in salt marshes after tidal restriction (and other disturbances). To study recovery requires recognition of the buried reclamation surface in a recovering marsh. Here we report a pilot study that uses paleoecological techniques to identify the historical surface. Examination of fossil rhizomes and colour in sediments outside the dyke (our reference condition) reveals a simple progression from low marsh to high marsh. Detailed analyses were performed on sediments from two sites inside the dyke to interpret the more complex stratigraphy there. In one site we found a higher abundance of weed pollen and coprophilous fungi (as an indicator of pasturing) at a depth clearly recognized by its sediment colour. Reduction in organic matter content and appearance of *S. alterniflora* rhizomes above this layer indicate return of tidal flooding to the system. Our other site (across the main tidal creek) inside the dyke shows a stratigraphy complicated by continued disturbances over the history of the marsh.

Paul, J. F.[1],W. Galloway[2], G. Pesch[2], M. Charpentier[3], J. Heltshe[4],D. Cobb[2], C. Strobel[2], H. Walker[2]*. [1]National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711; [2] Atlantic Ecology Division, U.S. Environmental Protection Agency, Narragansett, Rhode Island 02882; [3]CSC Corporation, Narragansett, Rhode Island 02882; [4]Department of Statistics, University of Rhode Island,Kingston, Rhode Island 02882

THE USE OF EXISTING MONITORING PROGRAM SITES IN A PROBABILITY SURVEY DESIGN - EVALUATION CRITERIA AND APPLICATION FOR NORTHEASTERN U.S. ESTUARIES

U.S. EPA?s National Coastal Assessment is a five-year effort led by EPA?s Office of Research and Development to evaluate the assessment methods it has developed to advance the science of ecosystem condition monitoring. The program is being conducted through strategic partnerships with coastal states. These states are conducting surveys in their waters with a common set of indicators. The resources monitored in 2000-2002 were estuarine waters. A flexible probability

survey design was used to incorporate, to the extent possible, existing state monitoring program sites. Three criteria were developed to evaluate existing state program sites in the northeastern U.S. for possible incorporation into the national design. These criteria were (1) sites were selected to be representative, (2) distributions of variables were equivalent to those for probability samples, and (3) correlation structure of variables was equivalent to that for probability samples. The states of Massachusetts, Rhode Island, and Connecticut conduct fish trawl surveys with stratified random designs, which were directly incorporated into the overall design. Existing program sites for Maine, Long Island Sound, New York, New Jersey, and Delaware Estuary satisfied the criteria and were appropriately incorporated. A detailed example is presented for Long Island Sound water quality sites.

Rozsa, R. CT Department of Environmental Protection, Office of Long Island Sound Programs, Hartford, CT 06106

DECADAL CHANGES OF *ZOSTERA MARINA* IN LONG AND FISHERS ISLAND SOUNDS.

Zostera marina occurred throughout the shallow waters of Long (LIS) and Fishers (FIS) Island Sounds prior to the 1931 decline. By the 1950?s, full recovery occurred in eastern LIS and FIS but recovery was poor in central and western LIS. The first systematic mapping of *Zostera* occurred in 1993/94, the western limit of beds Clinton Harbor. With a grant from the EPA LISS, CT DEP contracted with the USFWS to map *Zostera* using aerial photography (acquired in June 2002) and the national CCAP protocols. *Zostera* beds in the open waters of FIS expanded significantly and beds in embayments declined especially where nitrogen enrichment from STP?s is present. Perplexing is the cause of declines in the Poquonnock River. Several of these sites had extensive beds in the 1980s. The relocation of the Mumford Cove STP to the Thames River in 1987 has resulted in the spontaneous restoration of 50 acres of *Zostera* over a 15 year period! Niantic River beds continue to be highly restricted in distribution perhaps dues to nonpoint source nitrogen enrichment. Thermal stresses in 1999 are noteworthy given the mesocosm studies of Dr. Nixon and his students at URI. Niantic River beds undergo a dramatic but short-term recovery following winters with high precipitation. In 1931, the refuge for *Zostera* was waterbodies with low salinity. In 1993, the health of the Clinton Harbor beds was poor and no plants were observed in 2002.

Sheldon*, S. P.[1] , S. Twichell[1], and L. A. Deegan[2]. [1]Department of Biology, Middlebury College, Middlebury VT 05753; [2.]Ecosystems Center, MBL, Woods Hole MA 02543.

THE EFFECTS OF LONG TERM NUTRIENT ADDITION ON A SALT MARSH COMMUNITY

Increasingly there is concern about the effects of increasing nitrogen on complex systems. The experiments can be hard to do, because they must take place over a long time scale. In the Plum Island Sound MA, a wastewater treatment facility has been releasing treated wastewater into the

top of a salt marsh for > 40 years. We studied the effects of N addition on the plant and animal communities of this creek, and compared them to a reference creek. Surprisingly, there were no significant impacts of long term N addition on benthic algae biomass or species composition, on benthic invertebrates, or on mummichog *Fundulus heteroclitus* and green crab size or growth rates. The only differences were in an increase of biomass of marsh plants and there were more oligochaetes next to the outfall pipe. These differences could no longer be detected 0.6 km down stream of the outfall. These results support the notion that wetlands perform important "ecosystem services". In this case, intact marsh plants are able to take up high N, turn it into plant biomass, and remove it from the creek.

Short, F. T. and D. M. Burdick*. Jackson Estuarine Laboratory, Department of Natural Resources, University of New Hampshire, 85 Adams Point Road, Durham, NH 03824

A NUTRIENT POLLUTION INDICATOR (NPI) FOR ESTUARINE ECOSYSTEMS USING EELGRASS

Nutrient over-enrichment of estuaries due to anthropogenic loading leads to nuisance algal blooms, hypoxia, loss of seagrasses, and fish kills. Such detrimental effects necessitate an indicator for early detection of eutrophication. Direct measurements of in situ nutrient concentrations to detect early eutrophication are largely ineffective because of dilution and rapid uptake by microbes and plants. We developed an early indicator based on eelgrass leaf tissue nutrient constituents and plant morphology that were measured along nutrient gradients in New England estuaries. Both eelgrass leaf nitrogen content and area specific leaf mass reflected the environmental nitrogen conditions which plants experienced. Since leaf N content and leaf mass showed strong and consistent negative correlation, the ratio of leaf N content to leaf mass provides a more robust indicator than either characteristic alone. Natural eelgrass populations and deployments of eelgrass where it does not grow can be used to predict early stages of eutrophication due to excess nitrogen in estuarine ecosystems. The method and the scientific basis for the NPI is presented along with a methods manual in a CD-ROM format.

Spencer, L. T. Department of Biological Sciences, Plymouth State University, Plymouth, NH 03264

NEW ZEALAND ESTUARIES, A VISITOR?S VIEW

New Zealand is often best known for its mountain scenery, but due to its relatively long coastline and the high level of geologic activity associated with the coastal areas, it also has a number of spectacular estuaries. McClay in 1975 classified 301 New Zealand estuaries using the following criteria: area, adjoining human population size, topography class, degree of stratification and pollution status. Although during a sabbatical stay in New Zealand, I was unable to visit all 301 estuaries, I was able to visit a nummber of them and record photographically many of their attributes. This talk will describe a select few and in the course of doing so, indicate the status of estuarine studies in New Zealand and the well-being of the estuaries I personally was able to visit.

Swenarton*, J.T., J.F. Foertch, J.M. Vozarik, D.F. Landers, and M. Keser. Millstone Environmental Laboratory, Dominion Nuclear Connecticut, Inc., Rope Ferry Rd., Waterford, CT 06385.

LONG-TERM (1985-2003) MONITORING STUDIES OF EELGRASS (*ZOSTERA MARINA* L.) POPULATION DYNAMICS IN EASTERN LONG ISLAND SOUND

Eelgrass (*Zostera marina* L.) shoot density, proportion of seed-bearing shoots, shoot length, and standing stock biomass were monitored during summer months from 1985 to 2003 at three locations in eastern Long Island Sound (LIS) near Millstone Power Station (MPS), Waterford, Connecticut, USA. Some degree of long-term decline was detected at all three areas monitored. Two populations near the fringes of the thermal plume (oC above ambient conditions). By comparison, heavy eelgrass losses were documented in the Niantic River, located >2 km from the MPS thermal plume. While the causes were not determined, anthropogenic influences such as nutrient loading from surface run-off and groundwater sources may have contributed to observed declines, and are currently being investigated. Short-term declines in eelgrass abundance were directly associated with fouling and overgrowth of eelgrass on two occasions: once by blue mussels and once by a bloom of green algae (*Cladophora*). Another abrupt decline was concurrent with a sharp increase in sediment silt/clay content and presence of thick mats of the red macroalga *Agardhiella*. To supplement our studies of population characteristics, we have also conducted 11 diver surveys of eelgrass distribution in the Niantic River since 1987, with results corroborating high temporal and spatial patchiness. Methodology developed over the series of surveys, particularly in recent years using GPS and GIS overlays, allows comparisons and complements to other studies.

Switzer, D. I.,Ecosystems Assessment Unit, USEPA New England, 11 Technology Drive, North Chelmsford, MA 01863-2431

EPA?S GOALS AND EXPECTATIONS FOR STATE COMPREHENSIVE MONITORING AND ASSESSMENT STRATEGIES

In 2003, EPA produced a guidance document, Elements of a State Water Monitoring and Assessment Program (March 2003) as a tool for the states to use to define their water monitoring programs and develop their monitoring and assessment strategies for meeting both Clean Water Act and their own state environmental goals. Development of the strategies will meet a requirement of CWA 106(e)(1) and Section 106 grants, and will present monitoring designs and core indicators for more comprehensive reporting under 305(b) and 303(d) requirement. It is critical that state monitoring programs define their goals and objectives in relation to desired outcomes, have the infrastructure to attain the goals, measure progress toward specific goals, and clearly identify their resource needs. Each of the ten elements of state monitoring programs should work toward attaining comprehensive coverage, good science, and a balanced program that addresses multiple management objectives.

Trowbridge*, P. R.[1], Jones, S.H.[2], Siegel, L.S.[1], Neils, D.[1], and W.G. Comstock[1]. [1]New Hampshire Department of Environmental Services, Watershed Management Bureau, Concord, NH, 03302-0095;[2]Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH 03824.

COMPARING PROBABILISTIC AND DETERMINISTIC METHODS FOR ASSESSING AQUATIC LIFE USE SUPPORT IN NEW HAMPSHIRE'S ESTUARIES

New Hampshire's estuaries are monitored using both deterministic and probabilistic methods. For the 2004 Section 305(b) Water Quality Report, the N.H. Department of Environmental Services (NHDES) used both the traditional deterministic methods and the newer probabilistic methods to assess the estuarine waters for aquatic life use support. The results of the deterministic and probabilistic assessments were different in a variety of ways, primarily with regards to the area of estuarine waters assessed and the specific impairments that were found. This experience highlights some of the benefits and difficulties involved with integrating probabilistic methods with mandated Clean Water Act reporting requirements such as the Section 305(b) Water Quality Reports.

Turek, J.G. NOAA Restoration Center, Narragansett, RI 02882

DIADROMOUS FISH RESTORATION IN THE CONNECTICUT RIVER WATERSHED: PROGRESS THROUGH NOAA'S COMMUNITY-BASED RESTORATION PROGRAM PARTNERSHIPS

Diadromous fish including Atlantic salmon (*Salmo salar*), American shad (*Alosa sapidissima*), alewife (*A. pseudoharengus*), blueback herring (*A. aestivalis*), and American eel (*Anguilla rostrata*)are well recognized as important fishery resources of the Connecticut River watershed. Restoring passage of these species to and from their spawning and nursery habitats as well as restoring and enhancing riverine habitat are primary objectives of NOAA's Restoration Center (RC). Since 1996, the RC has administered its Community-Based Restoration Program to restore diadromous fish and other living marine resources and their habitats by providing technical and funding assistance through local, state, regional and national partnerships. To date, the RC has been involved in at least 18 projects throughout the Connecticut River Watershed (CT, MA, NH, VT) benefiting diadromous fishery resources. Project types include structural fishway construction, channel restoration, natural-like by-pass channel installation, bank stabilization and riparian plantings, invasive plant control, and increasingly, dam removals. While dam removals are generally the most costly and lengthy of these restoration activities, they represent the most significant ecological benefits for river and diadromous fish restoration. Examples of these restoration projects will be presented, discussing the ecological benefits and economic, regulatory, and social constraints. Several of these projects are targeted for benefiting not only diadromous fish, but also the dwarf wedge mussel (*Alasmidonta heterodon*), a federally endangered species. Discussion will also be provided on the relative costs of restoring these fishery resources, and

suggestions will be provided on prioritizing sub-watersheds and projects within the Connecticut River watershed.

Vaudrey, J.M.P., Department of Marine Sciences, University of Connecticut, 1080 Shennecossett Road, Groton, CT 06340.

ECOSYSTEM METABOLISM IN SMALL COASTAL EMBAYMENTS ? AN ANALYSIS OF FIELD METHODS.

Automated meters were deployed in small (3 km^2) shallow (avg. depth less than 2m) coastal embayments for 5 to 25 days from May 2002 to the present time. These meters continuously record dissolved oxygen, temperature, conductivity, chlorophyll, and turbidity. Ecosystem production and respiration were calculated from hourly averages of the oxygen rate of change. Depth integrated metabolic rates (g O_2 m^{-2} hr^{-1}) were corrected for atmospheric exchange based on local wind data and estuarine-specific gas transfer coefficients. One station per estuary is not adequate for determining ecosystem metabolism. The number of required stations is a function of the bathymetry and the abundance and diversity of benthic primary producers. While calculated rates of production and respiration at stations within an estuary are not quantitatively similar, they do follow the same trends. During periods of low productivity, the signal to noise ratio is so small that measurements of ecosystem metabolism are unreliable. Metabolism measurements are most reliable during times of peak primary production. Estuarine ecosystem production and respiration can be calculated from diel changes in dissolved oxygen measured via automated meters, but the temporal and spatial variability must be considered if these measurements of ecosystem metabolism are to be accurate.

Watson, O.J.*, L. D. Sanderson, & G. L. Chmura. Department of Geography, McGill University, 805 Sherbrooke St. West, Montreal, Quebec. H3A 2K6

VEGETATION PATTERNS IN THE SALT MARSH AT LA POCATIERE, QUEBEC.

There has been little information published on vegetation of Qu?bec salt marshes. The salt marsh at La Pocati?re (located at 47° 21$^'$ 02$^"$ W), Qu?bec has been studied by McGill Geography students since 1998, as part of their course, Ecological Biogeography. La Pocati?re is located on the south shore of the St. Lawrence River estuary. Average temperatures range seasonally between -11°C and +19°C. The record low for this location was -36.7^o C and the record high was 35°C. The average salinity of the St. Lawrence at La Pocati?re is 15$^o/_{oo}$. Vegetation was sampled in plots spaced along transects perpendicular to the shore. Data, such as, cover, end-of-season standing crop, stem density and species richness was used to characterize the marsh plant community. Species distribution throughout the marsh was examined with respect to elevation and site characteristics. In Qu?bec, seasonal disturbance caused by ice, such as, scouring and sediment deposition may affect distribution patterns of some marsh forbs. We believe this is the most comprehensive, quantitative study of a Spartina - dominated marsh at this latitude, thus contributes

to our knowledge of the ecological biogeography of North American salt marshes.

Watzin, M.C.*, R. L. Smyth, E. A. Cassell, W. C. Hession, R. E. Manning, and D. Wang. University of Vermont, School of Natural Resources, Burlington, VT, 05405

DEVELOPING ECOSYSTEM INDICATORS AND AN ENVIRONMENTAL SCORE CARD FOR LAKE CHAMPLAIN

We have developed an approach for monitoring ecosystem health that explicitly links management goals and objectives to the condition of the Lake Champlain ecosystem. In our framework, ecological indicators are used as performance measures for the Lake Champlain Basin Program?s comprehensive management plan *Opportunities for Action*. The indicators will be applied within the context of Adaptive Management to both track the ecological condition of the lake and to fine-tune the management strategies outlined in *Opportunities for Action*. Each indicator relates to our overall Pressure-State-Response (PSR) framework and our conceptual model of the Lake Champlain ecosystem. Indicators are clustered in PSR chains that relate to key management issues and challenges. To make our indicators interpretable, we have used both ecological modeling and analysis, to define a healthy condition from an ecological perspective, and social choice and norm curve analysis, to characterize public preferences about the condition of the lake, to define an acceptable level of each indicator. These acceptable levels provide a reference point for judging management success. Example indicator chains that relate to water quality and human health issues will be presented. An environmental scorecard developed from the indicators is meant to become a key part of the public education efforts associated with the program.

Zogg, G.P. Department of Biological Sciences, University of New England, Biddeford, ME 04005

EFFECTS OF NUTRIENT LOADING AND FLOODING ON NITROGEN MINERALIZATION IN A HIGH MARSH ECOSYSTEM

Several recent studies indicate that sea level rise and cultural eutrophication could have a dramatic effect on plant community composition within New England high marshes. However, our ability to predict the effects of such perturbations on marsh ecosystems also requires an understanding of their impacts on microorganisms, particularly given the importance of microbially-derived nitrogen (i.e., remineralized organic matter) to plant competitive interactions and primary productivity. I examined the effects of phosphorous additions and increased tidal inundation on soil inorganic nitrogen pools, net nitrogen mineralization rates, and microbial biomass and respiration, within a high marsh ecosystem in southern Maine. Using a combination of field and laboratory experiments, I found that phosphorous amendments promoted microbial immobilization of nitrogen, and that flooding further enhanced the phosphorous effect. Interestingly, the increased nitrogen uptake appears to be due to a stimulation of the metabolic activity of select microbes, rather than an increase in total microbial community biomass or metabolism. Based upon these results, I suggest that further research on soil microbial responses to hydrological alterations and nutrient loading is warranted, including an investigation of their potential, indirect effects on plant dynamics.