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ABSTRACTS

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SYMPOSIUM: THE USE OF BIOINDICATORS TO ASSESS THE HEALTH OF NEW ENGLAND COASTAL HABITATS
(in order of presentation)

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BIOLOGICAL INDICATORS OF COASTAL WETLAND HEALTH and USEPA's *DRAFT* NATIONAL WETLAND MONITORING and ASSESSMENT STRATEGY

In 1998, EPA New England convened the New England Biological Assessment of Wetlands Work Group (NEBAWWG). Modeled after its national counterpart, the NEBAWWG is comprised of representatives from several federal and state agencies, academic institutions, and non-governmental organizations. The NEBAWWG's chief goals are to:
1. develop and institutionalize a region-wide biomonitoring network for wetlands;
2. oversee state pilot projects and deal with logistical and technical issues; and,
3. coordinate with and complement the efforts of other biomonitoring groups and interested parties.
Pilot wetland biological monitoring projects are ongoing in Maine, Massachusetts, and Vermont. From the national and regional biological monitoring efforts directed towards wetlands grew a realization of the need for a comprehensive national wetland monitoring and assessment program. Consequently, in November, 1999, the U.S. EPA National Wetlands Program identified the establishment of comprehensive state and tribal wetland monitoring and assessment programs as one of two national priorities. A workgroup with representatives from the Wetlands Division in the Office of Wetlands, Oceans and Watersheds and from all ten EPA Regions was convened in Spring, 2000 to develop a national wetland monitoring and assessment strategy. Implementing this strategy will depend in large part on developing and refining appropriate biological indicators to assess the health of wetland systems

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DEVELOPMENT OF NUTRIENT POLLUTION INDICATOR USING EELGRASS *ZOSTERA MARINA* ALONG NUTRIENT GRADIENTS IN NEW ENGLAND ESTUARIES

Eelgrass plant morphology and tissue nutrient constituents reflect environmental nutrient availability. Estuarine and coastal ecosystems receive enormous amount of anthropogenic wastewater release, which causes nutrient over-enrichment. Eelgrass responds to the increased

nutrient loading, and the plant responses can be used as an indicator for nutrient over-enrichment. In the present study, eelgrass leaf tissue nutrient constituents and plant morphology were measured along nutrient gradients in three New England estuaries: Great Bay Estuary (NH), Narragansett Bay (RI) and Waquoit Bay (MA) during June 1998 and September 1999 to identify which eelgrass plant characteristics best reflect environmental nutrient conditions. Eelgrass leaf nitrogen (N) content was significantly higher in up-estuary sampling stations than stations down-estuary. While plant morphological characteristics such as number of leaves per shoot, blade width, leaf and sheath length weakly correlated with leaf tissue N content, a plant measurement we term "leaf mass" (mg dry wt cm^{-2} leaf area) exhibited a strong and consistent negative relationship with tissue N content in all three estuarine systems. This relationship suggests that both eelgrass leaf tissue N content and leaf mass reflect changes in environmental nitrogen conditions. We found that the ratio of eelgrass leaf N content to leaf mass is a more sensitive indicator of early changes in environmental nitrogen conditions than either characteristic alone, and suggest this ratio as a nutrient pollution indicator (NPI), a robust early indicator of nitrogen over-enrichment in estuarine ecosystems.

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APPLICATION AND ADAPTATION OF AN INDEX OF BIOTIC INTEGRITY BASED ON ESTUARINE FISH COMMUNITIES

We have applied an index of estuarine biotic integrity (EBI), based on fish communities of Cape Cod, to estuaries in Buzzards Bay, Rhode Island, Connecticut, and along the southwestern shore of Chesapeake Bay. The original index is comprised of 8 metrics that measure numerical abundance, biomass, total species, species dominance, and species composition by life history and activity zone. Two forms of the index are calculated, based either on numerical abundance metrics (EBI-Number) or biomass metrics (EBI-Biomass). Areas sampled within each estuary were selected from historical distributions of SRV and covered a broad range of anthropogenic stressors. The EBI was highly correlated with submerged rooted vegetation (SRV; eelgrass, *Zostera marina*) in southern New England estuaries, and was sensitive to eelgrass habitat decline. The relationship of SRV and the EBI to an independently-derived index of eutrophication demonstrated inherent time lags between the degradation and improvement of water quality, fish habitat, and response of the fish community. Chi-square analysis showed that the EBI and its metrics as originally formulated were less successful in classifying sites by habitat quality in Chesapeake Bay than in the Cape Cod. Box plots illustrated that adjustment of the critical or threshold values for metrics was required in the Chesapeake to accommodate differences between the eco-regions in fish community structure and use of habitat. Recalibration of the EBI by adjusting metric thresholds resulted in a large improvement in site classification success of the EBI in Chesapeake Bay. After recalibration, the EBI achieved values in Chesapeake Bay that were similar to corresponding values by habitat quality in Cape Cod. The coherency and repeatability of the EBI as developed in Cape Cod and as adapted for the Chesapeake sites suggest that the fish

community's response to the same SRV habitat criteria is proportionally similar in both eco-regions.

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EELGRASS, IT'S NOT JUST FOR NEERS ANYMORE

NEERS meetings have historically been a popular venue to report on the scientific study of eelgrass. The only problem with NEERS meetings for diehard eelgrass enthusiasts, has been enduring the litany of talks on topics other than eelgrass. In addition, public policy types and non-technical government decision makers tend to be intimidated by scientific meetings. In an attempt to bridge the gap between good science and informed public policy decisions, EPA has been organizing an annual one day workshop devoted to the science, regulation and management of eelgrass. For 6 of the last 7 years, academics, government regulators, non-profit advocates and professional consultants, have gathered in Boston to discuss appropriate mapping techniques, measuring functions and values, restoration and various other topics. This past year's meeting attracted 67 participants from 6 states and 21 different organizations, including a wide range of fisheries biologists, restoration ecologists, aquatic botanists, engineers and others. The theme of this year's meeting was "Towards a Seagrass Health Index". The morning sessions consisted of several different approaches to developing a health index for eelgrass, several of which will be discussed by their authors in this session. The afternoon sessions were open group discussions identifying scientific, policy and regulatory concerns with the use of seagrass health indexes. Scientific concerns expressed included the large amount of natural variability in the marine enviroment and the question of on what is the appropriate scale to use. Regulatory and policy concerns included, the health indexes are not predictive in nature. In addition, the question arose, do we need more health assessment tools or more protective legislation and regulation to protect seagrass? A spirited discussion ensued, where the group recommended that more could be done with State's water quality standards to further protect seagrass and more could be done to raise the general awareness
of the importance of seagrass.

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INDICATORS OF NITROGEN LOADING USED TO DEFINE MANAGEMENT ACTION IN BUZZARDS BAY, MA

A significant threat to Buzzards Bay, and a major focus of the Buzzards Bay Project National Estuary Program, is the addition of excess nitrogen from human activities. These nitrogen inputs are causing significant changes in ecosystem health, particularly in the many shallow, poorly flushed bays and estuaries found along the shores of Buzzards Bay. To document impacts from excess nitrogen inputs, and to evaluate recommended nitrogen loading limits, the Buzzards Bay Project, in collaboration with the citizen’s group the Coalition for Buzzards Bay,

established a water quality monitoring program for coastal embayments in 1992. Data from this program, including average summertime total nitrogen concentrations and a Eutrophication Index developed by the Buzzards Bay Project based on chlorophyll a, dissolved oxygen, water transparency, and various nitrogen species, show a good correlation with estimates of nitrogen loading derived from land use data. These data, together with hydraulic turnover of coastal waters and an eelgrass abundance index has led the Buzzards Bay Project to revise its nitrogen loading methodology and recommended Total Maximum Annual Loads of nitrogen. Despite these successes, disagreement on assumed loading from land use and the highly embayment-specific response to nitrogen loading has demonstrated the need for a wider range of ecological indicators and ecosystem response to defend management action, particularly where the costs of management action are high, or where predictions of future ecosystem conditions are uncertain.

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PERSPECTIVES ON THE USE OF INFAUNAL BENTHIC COMMUNITY DATA AS BIOINDICATORS.

The development of metrics to allow the identification of pollution on natural communities has been a goal in ecology for decades. In the study of subtidal infaunal communities, many such efforts have been hampered by a number of factors. These include an incomplete understanding of the communities to be managed, lack of theoretical underpinnings, blindness of many biodiversity indicators to changes in species composition, and, frequently, the adoption of metrics derived from and adapted to other habitats, sampling methods, or environments. In quantifying infaunal diversity thresholds included in its Contingency Plan, MWRA attempted to avoid these pitfalls to develop a set of area-specific indicators of change using results from our 9-year baseline monitoring. The identified threshold levels are sufficiently different from baseline to warrant increased evaluation and the early notification of regulators and a technical oversight committee. However, implicit in basing thresholds tests on difference from a baseline is the possibility that thresholds may be triggered by natural variability outside what was observed.

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A RAPID ASSESSMENT OF THE PRESENCE OF MARINE INVASIVE SPECIES ALONG THE COAST OF MASSACHUSETTS

Marine species are introduced through a variety of vectors - ballast, hull fouling, aquarium trades, aquaculture, seafood industry and research - that transport organisms from one location to areas not in their native range. Invasive species may become established, increase in population size, and disperse to new regions from the site of introduction. Over the last few decades, there is an apparent increase in marine invasive species with implications for human

health, economic and ecosystem effects. In Massachusetts marine invasive species of concern are the European green crab, *Carcinus maenas*, the European oyster, *Ostrea edulis*, the Japanese green alga, *Codium fragile* ssp. *tomentosoides*, however, their impacts are not well-documented. This past summer the MIT Sea Grant College Program coordinated a collaborative effort with MA Coastal Zone Management, the Massachusetts Bays Program, and the Massachusetts Port Authority to conduct a Rapid Assessment Survey of marine invasive species from northern Massachusetts to the Rhode Island border. The RI Coastal Resource Management Council also collaborated and continued the survey from the Massachusetts to Connecticut border. Twelve scientists with taxonomic expertise in macroinvertebrates and macroalgae sampled species growing on floating docks and pilings during August 6-11, 2000. Survey sites were selected based on criteria that reflect human activities such as, shipping, aquaculture, freshwater inputs and seafood industry. To date 24 introduced and 25 cryptogenic species were identified in the total of 262 species. There were two species that had not been previously identified; a purple tentacled anemone (tentatively identified as *Sagartia elegans*) and an isopod (*Ianiropsis* sp.). This information will be used by the state to document introductions and develop approaches for managing, controlling and preventing invasions. Other uses of the data may include detecting warming trends, identifying major transport vectors, and estimating risk to humans, aquaculture plants and animals, ecosystems and socio-economic change.

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SALT MARSHES: GENERAL PERSPECTIVES ON THE NOTION OF "MARSH HEALTH" RELATED TO PLANTS, FISH, AND MACROINVERTEBRATES

The indexing of coastal wetland "health" by a few easily determined metrics requires that human society attach relative values to the various ecological functions and attributes of these communities. Coastal wetlands have multiple functions and attributes but their relative importance or magnitude may vary considerably among and between marsh-estuarine systems. Clear causal, quantifiable links exist between and among some functions and attributes. A case in point: the structure of high salt marsh vegetation, presence of shallow open water, and use of high marsh habitat by selected bird species. Other commonly assumed relationships such as angiosperm primary production and support of estuarine secondary production are more difficult to quantitate for individual systems except in generalized terms. Also, although most tidal salt marsh ecological functions and attributes are organized in whole or part by tidal action, many appear to be quite independent of each other. For example, invasion of brackish tidal wetlands by *Phragmites* significantly decreases or eliminates a number of angiosperm and bird species, but increases system primary production; in addition the vegetation and bird changes may have little impact on support of macroinvertebrate and fish populations. Also, in tidally restored marshes, macroinvertebrate species return independently and may be well established on systems that remain *Phragmites* dominated. Conversely, restored marshes rapidly recolonized by *Spartina* spp. may be a less effective resource to some estuarine fish than undisturbed marshes with very similar vegetation. Developing broadly and easily applicable

standards for marsh health bioindicators may be a difficult challenge.

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THE DEVELOPMENT OF A MULTIMETRIC APPROACH FOR MEASURING ECOLOGICAL HEALTH OF SALT MARSH SYSTEMS, WITH A FOCUS ON AVIFAUNA AND VEGETATION

The Massachusetts Bays Program and Massachusetts Coastal Zone Management have applied recently developed wetland biological assessment protocols for avifauna, vegetation, aquatic macroinvertebrates, and nekton, in connection with chemical, hydrological, and land-use disturbance indicators, to selected salt marsh study sites along Cape Cod Bay. The goals of the project were to develop techniques for assessing the ecological integrity of coastal wetlands and to assist with management actions for identifying degraded wetlands and monitoring restoration efforts. Data generated from this study were analyzed by screening the species and abundance information through a set of metrics to produce a quantitative Index of Biological Integreity (IBI). Investigations have examined the effects of different types and intensities of land use on the ecology of salt marsh study sites and the impacts of tidal restrictions on selected salt marsh sites. Comparisons were made to reference, or control, sites with little or no human influences. For the studies on tidal restrictions, reference sites were located downstream of the restriction. Differences in the biological index scores were detected between reference sites and study sites, and similar patterns were found in the chemical, hydrological, and land-use disturbance indicators. Efforts continue to evaluate the use of multimetrics for measuring ecological integrity.

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COASTAL HABITAT FUNCTION FROM A FISHEYE PERSPECTIVE

Individual, population and community attributes of fish have the potential to integrate the ecological status of coastal habitats, and their societal attributes enhance their utility as indicators of intertidal habitat health. From a practical standpoint, fish are relatively large organisms that are easily identified and measured. They occur in densities amenable to appropriate spatial and temporal sampling, using relatively simple habitat-appropriate sampling gear. They can be used to track immediate and long-term response of coastal habitats to human-mediated habitat change (whether negative or positive). The Wells NERR has employed a number of fish monitoring techniques to gather baseline information regarding fish utilization of Gulf of Maine estuarine habitats, especially those characterized by tidal marsh. Other habitats of particular interest from a fisheye perspective are those structured by eelgrass, macroalgae,

cobble and gravel. A coordinated and integrated fish monitoring effort to assess Gulf of Maine intertidal and subtidal habitats would substantially augment scientific, management and community understanding of the processes that degrade and restore the ecology of these coastal habitats.

CONTRIBUTED PAPERS AND POSTERS

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POST-CONSTRUCTION BENTHIC ANALYSES OF CAD CELLS IN INNER BOSTON HARBOR. IS THIS A SUCCESSFUL SUCCESSIONAL PROJECT?

Disposal of maintenance-dredged sediments poses a challenge for most ports, as these sediments are often unsuitable for unconfined, open-water disposal. In 1997, the US Army Corps of Engineers, New England District, and the Massachusetts Port Authority began using the relatively new technique of disposing dredged Boston Harbor sediments into confined aquatic disposal (CAD) cells. Nine CAD cells were excavated beneath the navigational channels of Boston Harbor and filled with approximately 1 million cubic yards of maintenance sediments. Once filled and allowed to consolidate, these cells were capped with sand. Because of the limited previous use of this disposal technique, the re-colonization of benthic infauna and biodiversity of filled CAD cells is unknown. In June 2000, we completed a survey designed to determine whether benthic infauna re-colonized four of the nine CAD cells in Boston Harbor constructed and filled between 1997 and 2000. Sediment profile image photographs were taken to determine sediment characteristics and infaunal successional status. Benthic grabs were collected from which abundance, density, diversity, and evenness statistics were calculated. Our results suggest that the establishment of these CAD cells had minimal impact to the benthic community and they are actively undergoing benthic re-colonization.

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DEVELOPMENT OF AN AUTOMATED MONITORING SYSTEM FOR A CREATED POND AT GREAT KILLS PARK, STATEN ISLAND, NEW YORK

An automated monitoring system has been developed for a newly created pond. The system is designed to operate continuously, providing baseline data on various aspects of the pond water quality, including temperature, pH and dissolved oxygen. These parameters will be tracked throughout the self-organization of the pond. The data will allow us to correlate changes in water quality with processes at work during the early development of the pond ecosystem. The data will also serve as an "early warning system" for management of the pond. Managers will be aware of any significant deterioration of water quality and will be able to make informed decisions as to the proper course of action. The system is controlled by a computer running a program written in Labview 6i, which gathers the data, processes it and transmits it to a geospatial database on a remote webserver. The data can be visualized and analyzed through an ArcIMS application running on the web server.

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EFFECT OF HABITAT FRAGMENTATION ON TIDAL MARSH BIRDS

Tidal marsh birds have been negatively affected by habitat loss and degradation, but the role of habitat fragmentation in these declines is an open question. We surveyed birds and vegetation on survey plots in 40 tidal marshes along the coast of Connecticut to determine whether some species tend to be less common in small patches of apparently suitable habitat. We found that the number of individuals per survey plot increased with marsh area for Willet (*Catoptrophorus semipalmatus*), Saltmarsh Sharp-tailed Sparrow (*Ammodramus caudacutus*), and Seaside Sparrow (A. maritimus), all of which are largely restricted to salt meadows. In contrast, Swamp Sparrow (*Melospiza georgiana*) and Marsh Wren (*Cistothorus palustris*), which are found primarily in brackish marshes dominated by cattail (*Typha*) or reedgrass (*Phragmites*), were equally frequent in plots in large and small marshes. Only plots with appropriate habitat for a particular species were included in these analyses. Thus, salt meadow specialists may be especially vulnerable to habitat change because they tend to be less common in small patches of apparently suitable habitat.

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THE IMPACTS OF SALT MARSH HAYING ON THE VEGETATION COMMUNITY AND BIRD USE OF SALT MARSHES: A PRELIMINARY ASSESSMENT FROM PLUM ISLAND SOUND

Haying was one of the most common activities carried out by humans on salt marshes of the east coast of the United States until about the end of the 19th Century. Today, very few marshes are subjected to haying. The one exception is the Plum Island Sound region in northeastern Massachusetts, where over 400 hectares are hayed approximately once every two

years. Because it mimics large scale herbivory or detritus removal, haying raises interesting ecological and management questions. We initiated studies this past summer related to salt marsh haying as part of the Plum Island Sound Long Term Ecological Research project and in cooperation with a local hayer. Vegetation analysis indicated that hayed marshes had higher percent cover, biomass, and shoot densities of Spartina patens compared to reference marshes. This could be related to a greater tolerance of mowing by this species or to water level manipulations carried out by hayers that favor this plant. There were no obvious differences in overall plant productivity, diversity, and standing dead biomass. The rapidly changing microtopography of marshes is likely a stronger factor in determining changes in the plant community than any impact of haying. Shorebird use of one area increased immediately after haying, then declined over the next several weeks. The birds likely responded immediately to the easy access to invertebrates provided by a recently mowed marsh and then quickly used up this food source. Our preliminary assessment was that haying was neither ?good? nor ?bad? from an ecological perspective. Hayed and reference marshes did differ in terms of their vegetation and bird use, however there was no indication that hayed areas were degraded in terms of the ecological functions we measured.

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A PROPOSAL TO DEVELOP A DONOR BED SELECTION MODEL FOR EELGRASS TRANSPLANTING

Eelgrass transplanting technologies including plugs, cores, peat pots, seeds, stapled bundles, bare roots, and new methods, such as TERFSTM, have made transplanting more cost effective and less labor intensive. Use of a site selection model to pick eelgrass transplant sites eliminates from consideration potential sites where low shoot survival is probable and increases transplant success. Despite such improvements, it is evident that eelgrass shoots from particular donor sites have higher survival and growth rates than eelgrass from other donor sites. The objective of this proposed research is to investigate possible genetic differences and plant morphological characteristics, as well as physical site characteristics, to identify the features of a donor site selection model. Three donor bed sites will be tested, Fishing Island in Maine, West Island in Massachusetts, and Great Bay in New Hampshire. Additionally, the shoot densities, shoot growth, and bed expansion in two different transplant sites with plants from the three above donor sites will be measured. The anticipated results include no detectable genetic differences but significant differences in physical sites and plant characteristics. It is expected that these differences will be reflected in the experimental transplant success. The development of this model will help to lower costs and reduce efforts of future eelgrass transplanting projects by providing a scientifically proven method to choose donor sites.

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THE PLANTS OF NELSON ISLAND AND OTHER WASTE PLACES (AND A MODEST PROPOSAL)

Nelson Island is a half mile long island, surrounded by salt marsh, which lies on the landward side of Plum Island Sound in Rowley, MA. We have conducted a year long survey of the plants of Nelson Island and its surrounding salt marsh, during which the site was visited at least once per month, and the most common species observed and photographed. These photographs were digitized, organized by species and season, and stored on disc. The island and its major topographic and floral features were mapped using a GPS data logger, and organized in a GIS. The plants of the salt marsh proper were the usual suspects, changing in occurrence and appearance over the seasons. An outstanding characteristic of the upland community is the common occurrence of non native and/or invasive species such as bush honeysuckles, purple loosestrife, leafy spurge, and sulfur cinquefoil. It is currently possible to organize digitized data into field guides or field trips available on the WWW. Software is being developed in order to empower Web users to participate in identifying and mapping invasive plant and other species.

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CAT COVE AQUACULTURE LABORATORY, A NORTH SHORE RESOURCE AND CATALYST OF CHANGE

Since its official opening by Massachusetts Governor Paul Celluci on 26 April 1999, the Cat Cove Aquaculture Laboratory has become an increasingly important aquaculture resource. An Aquaculture Concentration has been established within the Department of Biology, realizing modest but growing enrollment. Training programs have been implemented on and off campus, attracting a spectrum of participants from teachers to commercial fishers. The 5,500 ft2 Wet Laboratory serves as a hatchery, library and meeting site for shellfish harvesters on the North Shore; in 2000 over 30,000 clams were released and over a half million will be released this summer as part of regional enhancement and restoration efforts. The on-site 8-acre tidal pond, Smith Pool, is used to rear increasing numbers of juvenile clams in upwellers and will be used to investigate cage/net pen culture opportunities appropriate for southern New England. Research projects funded by the College, State and competitive grants are on-going, nurturing aquaculture opportunities and removing impediments to aquaculture. Links have been forged with primary, secondary and post secondary schools both locally and throughout New England, introducing young people to aquatic ecology through interactive experiences that teach with and about aquaculture. In slightly more than two years, the Cat Cove Aquaculture Laboratory has moved from a setup and debugging mode to being an increasingly important and acknowledged regional resource facilitating the acceptance and implementation of sustainable aquaculture in a manner consistent with the social, economic, and historic environment of New

England.

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THE USEPA'S APPROACH FOR ESTABLISHING NATIONAL NUTRIENT CRITERIA FOR ESTUARIES AND COASTAL WATERS

The USEPA is developing procedures for establishing nutrient criteria to aid states and tribes in setting nutrient standards for the nation's water bodies and coastal waters. Criteria are being developed separately by water body type (e.g. lakes and reservoirs, rivers and streams, wetlands, estuaries and coastal marine waters). To account for regional differences caused by local environmental conditions, criteria for freshwater systems are being developed separately for each distinct ecoregion. Technical guidance manuals have been published for lakes and reservoirs and for rivers and streams, and associated criteria documents are being developed for aquatic systems in each ecoregion. For lakes and streams, nutrient criteria are largely based upon reference conditions determined from comparative analysis of similar water bodies in the same ecoregion. This presentation focuses on the process for developing nutrient criteria for estuaries and coastal marine waters, systems that are highly individual in their susceptibility to nutrient enrichment. The technical guidance manual for estuaries and coastal marine waters is currently in peer review. Approaches for developing nutrient criteria in estuaries include analysis of past loading rates and concentrations, identification of reference-quality estuaries that can be used as the reference condition for other similar estuaries, and use of data for minimally impacted freshwater tributaries to estimate reference nutrient loading rates from the entire watershed. Because of the more variable and complex hydrodynamics of estuaries, the proposed procedures for these systems focus more strongly on estuary-by-estuary analyses, rather than on comparative analyses of reference conditions as do those for freshwater systems. Modeling is also an important component of the process being developed for estuaries. The USEPA anticipates that nutrient criteria for estuaries and coastal waters will evolve with time, and the Office of Research and Development is undertaking a long-term research program to further develop loading-response relationships. The USEPA's Office of Science and Technology anticipates completing nutrient criteria on an estuarine/coastal province basis within the next 3–5 years.

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NARROW RIVER BIBLIOGRAPHY PROJECT

Southern Rhode Island’s Pettaquamscutt River Estuary, commonly known as Narrow River,

encompasses deep anoxic basins, shallow coves, estuarine waters, and salt marshes. It provides a living laboratory for the University of Rhode Island (URI) and other scientific and historical agencies. Thus the goal of Narrow River Bibliography Project was to produce an up-to-date, comprehensive, computerized bibliographic database of the scientific, historic, cultural, and general interest works conducted in and about the Narrow River watershed while providing the graduate student Coastal Fellow with an opportunity to learn about the Narrow River, its watershed, and its advocacy organization, the Narrow River Preservation Association (NRPA), and to undertake a document search and learn about computerized bibliographic databases. The search for relevant works involved visiting libraries, scientific institutions, scientific consulting agencies, town, state and federal agencies, historical sites, and private collections. Various internet search engines, and on-line databases were also used. The database uses the software ProCite(R) for Windows 95/NT, Version 4. Each entry was reviewed and has an abstract or summary. The entries are searchable by workform, author, title, date, and keywords. Journal articles, dissertations, maps, newspaper articles, and web pages are among the 161 entries in the database. Funding for this project started as a partnership by the URI Coastal Fellows Program and NRPA, and has been continued by NRPA.

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ASSESSMENT OF COASTAL TRANSPORT IN CAPE COD BAY

Previous studies have indicated that there is a general counterclockwise circulation in the Massachusetts/Cape Cod Bay system, with net transport to the south along the Massachusetts shoreline from Newburyport into Cape Cod Bay. This net transport has a significant potential effect on the transport of icthyoplankton, and associated effects on the life cycle of fish in the coastal ecosystem. The present study was performed to quantify the net circulatory and winter flounder (*Pseudopleuronectes americanus*) larval transport in Cape Cod Bay near Plymouth, MA. The study consisted of a field program and data analysis. The field program, conducted during May 2000 consisted of water velocity and tidal height measurements, and sampling of winter flounder larvae along a transect oriented perpendicular to the shoreline at Plymouth, MA. Acoustic Doppler Current Profilers and tidal gages were deployed for the entire May 2000 study period at three locations along the designated transect. Larval flounder were collected and classified according to larval stage at five locations along the transect during four field sampling efforts during the study period. The current and tidal measurement data were analyzed to determine the ebb, flood, and net volumetric transport rate. Larvae data were combined with the current measurements to determine the larval transport along the coast, for each of the four sampling efforts. The results, in accordance with the expected counterclockwise circulation, indicate that there is a consistent net flow of water and net larval transport along coastal Cape Cod Bay towards the south and the east.

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A PROPOSAL TO DEVELOP FUNCTIONAL TRAJECTORY MODELS FOR TRANSPLANTED EELGRASS (*ZOSTERA MARINA* L.) BEDS IN THE GREAT BAY ESTUARY, NEW HAMPSHIRE

Although trajectory models have been used in salt marsh restoration projects, relatively little is known about long-term trajectory models for indicators of function in transplanted eelgrass (*Zostera marina* L.) beds. A functional trajectory is the hypothetical path that indicators within a transplanted bed follow as the bed develops and reaches the level of control beds. The primary objective of this proposed research is to produce functional trajectories for six indicators of eelgrass function (1) biomass , (2) canopy height, (3) shoot density, (4) infaunal density, (5) sediment grain size, and (6) sediment organic content in two transplanted eelgrass beds compared to two control beds within the Great Bay Estuary , New Hampshire. These indicators will be used as proxies for eelgrass functions of primary production, habitat structure, habitat use, sediment filtering, and organic matter accumulation, respectively. A second objective is to quantify the response of these six indicators to a natural disturbance (wasting disease). Trajectory models will be constructed and analyzed using non-linear regression of data for each indicator collected during field sampling between 1993 and 2001. These trajectory models will aid in the management of restored beds by predicting the time course of restoration, and recovery from disturbance, of different eelgrass bed functions. They may also reveal which indicators are best to use in sampling programs and how to most successfully construct sampling regimes.

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EFFECTS OF MACROALGAE BLOOMS ON INTERTIDAL COPEPODS IN JAMAICA BAY, NY

Ulva lactuca was removed from quadrats on a vegetated sand flat. Density and Species Richness of copepods were estimated from cores over 7 periods at paired vegetated, *Ulva*-removal, and unvegetated reference sites. Compared with the non-vegetated sites, copepod density was 80% lower in the *Ulva*-Present treatment; and increased by a factor of 2X after removal of *Ulva*. Anoxia within the *Ulva* mat is a probable explanation for copepod losses. In a second experiment, *Ulva* biomass was added to quadrats at three levels: No Addition, 100 g per M-2 (DW), 200 g per M-2. Densities of copepods were estimated from cores over 8 biweekly periods. Meiobenthic copepods declined to 7% of control levels in the 200 g treatment. Predominantly epiphytal species increased from < 2 to 8 individuals per 10 cm-2 in the 200 g treatment. Hyperbenthic taxa dropped by 75% in the 100 g treatment but persisted in both *Ulva* treatments at about 25% of control densities. At sea lettuce biomass of 200 g DW, the remaining copepods in cores are primarily epiphytal species.

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A PLASTOCHRONE METHOD FOR MEASURING LEAF GROWTH IN EELGRASS, ZOSTERA MARINA L.

Eelgrass, *Zostera marina* L., leaf growth measurement methods were investigated and compared in the low intertidal zone at the Fishing Island eelgrass meadow in Kittery, Maine. The commonly used leaf marking method, developed by Zieman (1974), measures only the weight of the new leaf material produced in the time interval between marking and collecting plants. We demonstrate, from data collected in 1988, that Zieman's method underestimates growth when the sampling period is less than the time between the initiation of two successive leaves on a shoot, the plastochrone interval. Subsequently, leaf growth was measured monthly between October 1999 and October 2000, using two different methods: Short (1987), and plastochrone method (Short and Duarte 2001). The Short (1987) method calculates growth from blade elongation in relation to a leaf weight-to-length ratio based on mature leaf material. In the plastochrone method, eelgrass leaf growth is calculated as the weight of a mature leaf divided by the plastochrone interval. Our results show that both the Short (1987) and the plastochrone methods provide statistically equal measures of eelgrass leaf growth and assess plant growth more accurately than earlier methods. Our investigations demonstrate that the leaf plastochrone interval in eelgrass varies seasonally; to use the plastochrone method, the plastochrone interval must be measured for each growth determination. Based on our comparisons, we recommend the plastochrone method as a more efficient and accurate way to measure eelgrass leaf growth.

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LONG-TERM TRENDS IN DEMERSAL FISH ABUNDANCE OFF COASTAL NEW HAMPSHIRE.

The demersal fish community of coastal New Hampshire has been sampled monthly with otter trawls at three stations since 1976 as part of the Seabrook Station Environmental Monitoring Program. For all species combined, geometric mean CPUE (catch per ten minute tow) peaked in 1980 through 1981, and 1989 through 1990. Total CPUE declined after 1990, but is presently increasing. There have been major changes in the demersal fish community since 1976. In the late 1970s and early 1980s, yellowtail flounder was a dominant commercial fish and was primarily responsible for the increase in total CPUE in 1980 through 1981. CPUE of yellowtail flounder has decreased significantly over the time series although in recent years there has been a slight increase. Similar to yellowtail flounder, CPUE of winter flounder was highest in 1980 through 1981, however, there has been no significant trend in CPUE since

1976. Atlantic cod CPUE was highest from 1978 through 1983 with additional peaks in 1988 and 1993. Atlantic cod CPUE has declined significantly and is presently at historic low levels. CPUE of hake spp. has been variable, but has declined significantly since sampling began. CPUE of skates and windowpane have increased since the study began while CPUE of longhorn sculpin has remained relatively constant. Trends observed in our monitoring program were generally consistent with those present in NMFS resource assessment data in the Gulf of Maine and Georges Bank. The decrease in the CPUE of commercially important fish is probably due to overfishing, even though no commercial trawling takes place in our sampling area. The agreement in CPUE trends between coastal New Hampshire and Georges Bank and the Gulf of Maine is an indication of close coupling of the demersal fish community among these three areas.

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DISTRIBUTION AND MIGRATING BEHAVIOR OF *MELAMPUS BIDENTATUS* ON A MASSACHUSETTS SALT MARSH

This study investigated the natural distribution and migrating behavior of *Melampus bidentatus*. Marsh elevation or distance from the creek edge does not solely determine the spatial distribution of *Melampus bidentatus*. A slight correlation is found between both juvenile and adult snails. The possibility exists that elevation and distance have some impact on distribution. However, a bend in the creek supplied more water to the upland area on our study site than expected which made this relationship difficult to analyze. When relative time of inundation is tested against snail density a positive correlation is found. Plants, pH, and salinity did not correlate with the distribution of *Melampus bidentatus*. Some evidence of a migrating snail population was found. This migrating population included both juvenile (<5mm) and adult snails (35mm). More migration occurred during the spring high tide sequence than during the neap high tides. Distance traveled ranged from 10.4% to 31.1% of the marsh transect (11.4 meters), providing some evidence of migratory behavior late in the field season. When comparing natural with restored/created marshes, only marshes of similar hydrology, or flow patterns, should be used. *Melampus bidentatus* density should be sampled at the same distance from the creek and on the same day of the tidal sequence.

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GEOLOGICAL EVOLUTION AND HYDROLOGY OF GREAT LAKES ESTUARIES

Like the oceans, many large lakes can possess estuarine-like environments in the lower reaches of their tributary streams. These geomorphic features are particularly prevalent in the North American Great Lakes region where crustal rebound, following deglaciation, has caused the northern part of the region to rise over 100m. As a result, the lower courses of the southern tributaries have been flooded, creating the drowned river mouths typical of estuarine systems.

This paper focuses on the geologic setting of the Great Lakes with particular attention to Lake Erie, the most southerly and thus the one exhibiting the best developed estuaries. Virtually all of the tributaries entering Lake Erie along the Ohio shore have estuarine-type lower reaches and attendant wetland marshes and swamps, where lake-water masses affect water levels and quality for several kilometers upstream from traditional mouths. This paper also explores hydrologic analogues for Lake Erie and marine estuaries, particularly encroachment of lake water into the tributary mouths and the subsequent mixing of lake and river water within the estuaries. Measurements of water quality parameters, currents, and water mass movements demonstrate not only the encroachment of Great Lake water into the estuaries, but also the discharge and flow patterns of estuarine water in the lakes.

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STORMS AND GREAT LAKES ESTUARIES

Great lakes estuaries are storm driven systems. Storms in the watershed as well as storms on the Great Lakes affect and largely regulate the chemistry and plankton populations within the estuaries. In Old Woman Creek Estuary on Lake Erie, storm runoff from the watershed is the major source of nutrients and other pollutants. This estuary, while being affected by the runoff, is quite efficient at mitigating nutrient and pollutant loads that pass through it. About one-half of the soluble reactive phosphorus and one-third of the nitrate are transformed or otherwise removed from the water during passage of storm runoff through the estuary. Storm runoff has a dichotomous effect on the planktonic communities: on one hand the passage of the storm water flushes much of the existing phytoplankton and zooplankton populations out into Lake Erie, but at the same time this runoff brings in nutrients necessary for the rapid regrowth of the phytoplankton. Through much of the year small diatoms and flagellates, which could be considered pioneer species, dominate the estuarine phytoplankton. Only during base-flow periods, when a barrier beach closes the mouth, do blue-green and green phytoplankton species become important components in the estuary.

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A SIMULATION MODEL TO PREDICT PLANT COMMUNITY RESPONSE TO HYDROLOGIC RESTORATION OF TIDAL-RESTRICTED SALT MARSHES

Degradation and loss of salt marsh habitat due to tidal restrictions is a significant issue in New England. Restoration efforts often produce unintended and less than optimal results due to a lack of information concerning ecological interactions between biologic, hydrologic, and geologic processes. A generalized simulation model is being developed that combines these processes to assess the impacts of hydrologic restoration scenarios on salt marsh community

structure. A field experiment is underway to quantify plant growth and competitive profiles for six common plant species across a salinity and elevation gradient at nine locations. The species include three dominant New England salt marsh plants, *Spartina alterniflora*, *Spartina patens*, and *Juncus gerardii*, and three brackish invasive species *Phragmites australis*, *Typha angustifolia*, and *Lythrum salicaria*. Growth and competition results from the field experiment are presented for three study locations, completed in summer 2000. Preliminary results from the field experiment are integrated into the model to simulate twenty years of plant community changes upstream of a tidal restriction at Oak Knoll Marsh in Rowley, Massachusetts. Modeled impacts of a potential culvert expansion at the site are also presented.

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WETLAND HEALTH ASSESSMENT TOOLBOX (W.H.A.T.) CITIZEN MONITORING PROGRAM

The Wetland Health Assessment Toolbox (W.H.A.T.) is a multi-metric technique used by scientists from Massachusetts Coastal Zone Management, the Massachusetts Bays Program and UMass Extension in their ongoing research on Cape Cod and the North Shore. For each wetland study site, seven parameters are investigated: birds, plants, water chemistry, land use, tidal influence, benthic macroinvertebrates and fish. These data are combined to arrive at an overall picture of health for a wetland. Since the job of wetland health assessment is such an enormous, time-consuming one, the researchers have also launched a parallel program to train volunteers in these field techniques. For the third year, trained volunteers will be collecting data on North Shore salt marshes this summer. Project sites include the Forest River, Salem; Long Wharf, Gloucester; Conomo Point, Essex; and Great Neck, Ipswich and consist of both study and reference wetlands. Study sites are assessed in comparison to their corresponding reference site, considered a background condition. Study sites have all been affected by tidal restrictions or stormwater runoff with restoration projects either completed or in the works. Volunteers have collected baseline data at some of these sites and, beginning this summer, will collect post-remediation data to try and determine the success of those efforts.

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INCLUDING EXTREME PATCHINESS IN A MODEL OF MACROALGAE PRODUCTION

The distribution of macroalgae biomass in shallow systems is highly patchy. Much of the biomass is concentrated in large, unattached mats (or clumps) that tend to form and break apart in a seemingly random manner. Further, light is attenuated rapidly within the mat canopy (~0.4 per cm). Macroalgal production across total biomass is therefore non-linear because only a

shallow layer of the mat is photosynthetically active (approximately 5 cm on average). An ecological model of production depends upon specifying the spatial distribution of the biomass, yet this is a feature not usually included. I propose a predictive empirical relationship that defines the spatial distribution of algal biomass as a function of cumulative basin area and a single estimate of maximum biomass. In Waquoit Bay and other sites a pattern of biomass distribution emerges where B=Bm*A^6 where B is biomass (g dw/m2), Bm is the maximum biomass observed (g dw/m2), and A is the fraction of total area or cumulative area (0 to 1.0) where B is to be determined. The biomass distribution is dictated by the maximum mat thickness (g dw/m2) and the cumulative area to the power of 6 (A^6). Using this description of spatial patchiness, and a photosynthesis vs. irradiance function, the model integrates over varying mat thickness throughout the day to compute a basin-wide average specific growth rate for the macroalgae.

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THE HISTORICAL EFFECTS AND FUTURE IMPLICATIONS OF NITROGEN INPUTS ON THE EELGRASS COMMUNITIES OF WEST FALMOUTH HARBOR, MA.

Seagrass communities historically dominated West Falmouth Harbor of Cape Cod, Massachusetts. Nutrient inputs threaten specialized fish and invertebrate habitats of eelgrass (*Zostera marina*) in the shallow water embayment. We analyzed housing density, road, marshland, eelgrass and sand bars cover in the harbor from 1835 to the present. Today, eelgrass communities still flourish in the well-flushed outer harbor. The more developed inner harbor has seen an obvious reduction in eelgrass area. We sampled for invertebrate and fish biomass, abundance and diversity in both inner and outer harbors. Correlations were observed between eelgrass biomass and invertebrate species richness, biomass, and abundance. The outer harbor supports approximately four times the fish biomass of inner harbor and ten-fold the biomass of eelgrass. The inner harbor supports a slightly higher fish diversity including sandy bottom and open water species probably reflecting the heterogeneity of the habitat. Historical analysis showed a link between housing density and eelgrass disappearance, even though natural disasters have contributed to die-off in the past. We hoped to directly link the loss of eelgrass from the inner harbor to the anthropogenic nutrient inputs by comparing eelgrass stable isotopes and water column nutrient analysis along a transect from the inner to outer harbor. Eelgrass $d^{15}N$ did not significantly vary along this transect, however, there was a significant gradient in dissolved inorganic nitrogen.

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A FISHERIES HABITAT SURVEY METHOD FOR NEAR SHORE ENVIRONMENTS UTILIZING SCUBA

Near shore coastal environments are important fishery habitats, which are hard to survey by traditional methods. Water depth is shallow and variable due to numerous objects and tides, making it impossible for access by large research vessels. Using scuba, these areas can be surveyed from shore or by small boat. More research is required to identify and describe near shore coastal Essential Fish Habitats (EFH). Additionally, more information is required for all life history stages complete with identification of habitat requirements and species interactions within these environments. For most commercially managed species, only presence/absence data and habitat-related densities are known. Very little information exists for growth, reproduction, or survival, as well as production rates. We have developed a protocol utilizing the Linear Point Intercept (LPI) Method (Aronson & Precht, 1995, Ohlhorst et al., 1988), to accurately survey near shore habitats for substrate and organisms. The recreational diving community can utilize this relatively inexpensive and easy to use method. Hundreds of divers visit these areas every week. With proper training, these groups can conduct surveys of near shore coastal environments. This utilization of recreational divers to conduct these surveys would significantly increase the areas surveyed. Large amounts of fishery habitats could be surveyed, something, which could not be done within the scientific or fisheries management community due to, limited labor force. We conducted a pilot study with recreational divers to determine the feasibility of utilizing recreational divers to conduct these surveys. We present the protocol and compare results obtained using recreational divers versus scientific divers.

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THE SYMBIOTIC RELATIONSHIP OF THE RED HAKE AND SEA SCALLOP AS A POSSIBLE MANAGEMENT TOOL

The symbiotic relationship of the sea scallop (*Placopecten magellanicus*) and red hake (*Urophycis chuss*) in near coastal waters of New England was monitored by researchers using scuba gear. Scallop beds off the coast of Salem, MA were sampled on a monthly basis as conditions permitted between February and December 1999. After being brought to the surface, scallops were measured and opened to extract hake. Collected hake were counted, measured, and transported to the Cat Cove Marine Laboratory, Salem State College. Water depth ranged from 18 to 21m, and bottom temperature varied from 2 to 15 Á C. All dives were conducted adjacent to the mouth of Salem Sound along a line running roughly north and south from 42^{o} 32.857'N, 70^{o}, 48.757' W to 42^{o} 30.502' N, 70^{o}, 42.032'W. A total of 2,978 scallops and 1,421 hake were collected or 0.48 hake per scallop. Percent of scallops with hake varied seasonally, declining sharply to 0% in July and increasing to 96% in mid-September as large

numbers of young-of-the-year appeared. Scallop size remained fairly constant (avg.=119.4mm, SD=14.3mm). Fish length ranged from 44 to 122mm, reflecting recruitment and growth. Individual scallops frequently contained two to four fish; the greatest incidence occurred in October, when multiples represented 29% of fish collected. Fish frequently exited the scallops post collection, and 22% of all hake were collected as free fish. Hake were transported alive to the laboratory and transferred to 1900L recirculating systems readily ingesting commercial feed within 24h. Fish fed, survived, and grew despite problems associated with the newly set up facility. On occasion, water temperature rose above 25 deg. C, and total ammonia nitrogen exceeded 15 ppm. Average weight of fish increased from 3.4g on 12 April to 320g on 2 December, 1999. Collected data indicate that significant numbers of red hake are lost when scallops are harvested, a potential bycatch of one fish for every two scallops. Our data suggest that scallop harvest conducted between June and August would minimize the coincidental catch of hake. Alternatively, if hake were collected and retained during the colder part of the year (Oct-Mar.) when post-capture mortality was minimal (<30%) and fish were most abundant, the potential exists for commercial culture or stock enhancement.

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MACROPHAGE AGGREGATES IN MUMMICHOGS AS BIOINDICATORS OF POLLUTION IN BUZZARDS BAY AND NEW BEDFORD HARBOR

Hepatic macrophage aggregates increase slowly in size and number in fish with age but at increased rates when toxic substances are present in their environment. Macrophage aggregates (MA's) in fresh and salt water fish have been used as bioindicators of harbor health. In summer 1999 and 2000 we collected mummichogs (*Fundulus heteroclitus*) from sites along the edge of Buzzards Bay including Marion Harbor (Marion); the lower Weweantic River (Wareham); Bourne's Cove (Wareham); West Falmouth Harbor (Falmouth); and four sites in New Bedford Harbor inside the hurricane barrier. Mummichog livers were frozen-sectioned and sections were examined via fluorescence microscopy for MA's, which contain the autofluorescent pigment lipofuscin. An image analysis system was used to measure and record MA area per field. Average MA area for these fields was calculated and plotted against length, the latter presumed to correlate roughly with age. Although only one site was included in New Bedford Harbor in summer 1999, it was the worst of all sites in that year. For the rest of Buzzards Bay, Marion Harbor fish had the highest MA index and Bourne's Cove fish had the lowest in 1999. In summer 2000 Weweantic fish had the highest MA index and Marion Harbor fish had the lowest; for New Bedford Harbor, small (young) fish from sites closer to contaminant sources had higher MA's compared with those from sites further from contaminant sources

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IS FISH USE OF BRACKISH TIDAL MARSHES ALTERED BY THE INVASION OF PHRAGMITES?

Several fish and crustacean species use the flooded surface of tidal marshes for foraging, nursery habitat, and refuge. Since the mid 1960s *Phragmites australis* has expanded rapidly within many brackish tidal marsh systems, forming dense nearly monotypic stands, and raising concern that invaded marshes may be altered in ways that reduce their capacity to serve as fish and crustacean habitat. Significant areas of tidal wetland bordering the Lieutenant River, a lower Connecticut River tributary, are now *Phragmites* dominated; in 1995-96 lower reaches of the Lieutenant were treated (herbicide and mowing) to control *Phragmites*. During spring tides from early June through early September 2000, fishes and crustaceans were captured in Breder traps as they left the flooded marsh at 90 sites, equally distributed among *Phragmites*, *Typha angustifolia*, and treated *Phragmites* areas, along a 4 km stretch of Lieutenant River. There were no clear differences in species compositions or abundances in the different vegetation types. Size distributions, size specific biomasses, and diets of *Fundulus heteroclitus* (1.0 - 10.0 TL) the numerically dominant fish species, were also similar. The mean number of *Fundulus* caught per trapping event was negatively correlated with site elevation. Larval and juvenile *Fundulus* (0.4 - 2.5 cm) were caught in pit traps (18 per vegetation type) on the marsh surface. Only small numbers of young fish were caught, but more were captured in *Typha* than in *Phragmites* dominated sites, suggesting that the former may provide better nursery habitat.

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EFFECTS OF VECTOLEXÂ ON POPULATION DENSITIES AND BIOMASS PRODUCTION OF LARVAL SALT MARSH AEDES SOLLICITANS.

Vectolex (*Bacillus sphaericus*) on corn cob granules at 10 to 40 lbs./acre, was applied to 3 plots for each treatment. Mosquito larvae were regularly sampled for 17 days after application. Numbers, instars and mean individual weights of larvae were recorded. Standing biomasses of larvae in control and treated plots were compared. Reductions of larval biomass production in treated plots were approximately 0.25 gm dry weight/m^2 for one brood or perhaps 1gm for the summer. Implications of these losses to the ecosystem are briefly discussed.

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CONSERVATION OF *ERIOCAULON PARKERI* (PARKER'S PIPEWORT) IN HAMBURG COVE, LYME, CT

Hamburg Cove contains the largest Connecticut population of *Eriocaulon parkeri* , which is listed as a State-Threatened species in Connecticut and as a G3 species by The Nature Conservancy. Development, including dock construction, proceeds rapidly in parts of Hamburg Cove
that contain *Eriocaulon parkeri*. We are currently assessing the impacts of dock construction on this species.

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GREAT LAKES ESTUARIES: MICROCOSMS FOR THE STUDY OF THE EFFECTS OF WATER LEVEL CHANGE

Great Lakes estuaries share with coastal salt water estuaries many of the characteristics that define all estuaries: free openings to and free exchange of water with larger bodies of water, and mixing of those waters. They also share geologic history and tidal influence. More interesting than the shared characteristics are the differences between Great Lakes and coastal salt water estuaries, the most interesting of which is the natural and relatively rapid change in water level in the Great Lakes. Seasonal fluctuations of the water level in the Great Lakes can range from 30cm to 60cm and are imposed on longer term changes. From a high in the mid 1980s, the water levels of the Great Lakes are now at a 35 year low. In the light of the interest on sea level change in response to global warming, the relatively small Great Lakes estuaries, subject to rapid and dramatic short term changes as well as long term changes in water level, can and do provide an ideal site for the study of the effect of those changes.

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A VIRTUAL TRIP TO THE SEASHORE

This presentation will describe a web site entitled "A virtual trip to the seashore". I put this site together to be used in association with the teaching of a majors marine biology course at Plymouth State College. Since Plymouth State College is somewhat distant from the real sea shore, we only make a limited number of field trips to the ocean. I designed this website to augment those trips.

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THE EFFECTS OF DOCKS AND MECHANICAL DISTURBANCE ON SUBMERGED AQUATIC VEGETATION IN TIDAL-FRESH HAMBURG COVE (LYME, CONNECTICUT)

Little is known about the effects of docks on submerged aquatic vegetation (SAV) in tidal fresh estuaries. The purpose of this study was to evaluate the effects dock and mechanical disturbance, such as those associated with boating activities, on SAV in Hamburg Cove (Lyme, Connecticut). This study investigated light attenuation and SAV quantities at five docks. Light was measured at three locations in relation to each dock (beneath, adjacent and away) and SAV were sampled by count and biomass in several plots extending distally from beneath each dock. Three shade classes defined light attenuation data and the SAV plots: shaded, semi-shaded, and unshaded. Biomass was measured under experimental conditions; stems were clipped at the peak of the growing season (mid-season), and again at the end of the growing season. Stem count and biomass measurements showed that four out of eleven species observed (*Ceratophyllum demersum*, *Elodea canadensis*, *Myriophyllum spicatum*, and *Vallisnaria americana*) made up 97.8% of stems counted, and 99.8% of first and second clipping biomass. Shaded plots had significantly lower stem counts and biomass than semi-shaded and unshaded plots. Diversity indices increased form shaded to semi-shaded to unshaded plots. Clipping of the SAV at mid-season resulted in an increase in biomass but a decrease in diversity (compared to the end-of-season clippings) indicating that SAV can recover relatively rapidly form mechanical disturbance, though with discernible changes in community structure. This study tenatively suggests that the effects of docks on SAV are apparent and significant on both quality (diversity) and quantity (count and biomass).